Scott River Riparian Restoration Analysis

Prepared by the Siskiyou RCD

For the United States Fish and Wildlife Service

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Special Thanks to:

Scott Valley Landowners

Preston Harris- Siskiyou RCD

Introduction

Landowners and land managers in the Scott River Watershed have been proactively working to protect, restore and enhance the aquatic and riparian ecosystems for the past several decades. Concerns over the status of the Klamath River's anadromous fisheries have been a major impetus to restoration efforts instream and in the riparian corridor. The Scott River provides spawning and rearing habitat for a significant population of coho salmon (*Oncorhynchus kisutch*), Chinook salmon (*O. tshawytscha*), and steelhead trout (*O. mykiss*). The majority of anadromous habitat in the Scott River is within privately owned lands in the Scott Valley. The entire mainstem of the Scott River is privately owned for 38 miles (RM 57.1 to RM 19.1), as well as most of the lower reaches of the tributaries used by anadromous salmonids. Many of the landholders are small parcels which lack the financial resources to implement large scale restoration projects. This ownership pattern makes coordination and planning of effective restoration efforts complex and time consuming.

It is the goal of this analysis to evaluate the effectiveness of existing riparian protection and enhancement projects throughout the Scott Valley. This evaluation of previous effort is used to generate a series of recommended restoration and protection techniques that have worked in different areas of the watershed. Additionally, an evaluation of data pertaining to the current riparian condition, the distribution of target species and the potential for successful riparian recruitment has been performed to help prioritize future riparian restoration efforts.

The riparian ecosystem is a unique and complex assemblage of flora and fauna that is dependent on water. The riparian zone is the interface between the lotic ecosystem of the stream and the adjacent lands. The riparian zone has multiple functions that generate aquatic health and complexity while buffering potential pollution from adjacent lands. Roles of the riparian zone include: stabilize stream banks and adjacent soils with root structure, slow flood waters and filter sediment with the vegetation's "roughness", capture and filter polluted surface runoff, provide shade and reduce thermal inputs to the stream's surface water, provide nutrients (feed) to aquatic organisms, serve as a source of fish cover and future instream woody debris in the stream, and provide essential wildlife habitat. A properly functioning riparian zone provides many benefits that are essential to a healthy productive aquatic ecosystem. Additionally, an established and protected riparian zone can maintain itself and downstream reaches through natural recruitment through the dispersal of seed and other methods of propagation.

The development of the Scott River Watershed through a historic progression of resource utilization is characteristic of most watersheds in the Western United States. The itinerant fur trappers of the Hudson Bay Company were the first non indigenous people to discover the Scott Valley in the 1830's. These mountain men named the area "Beaver Valley" due to the extremely rich population of the desirable fur bearing mammal. Subsequent discovery of gold in the watershed by John W. Scott at Scott's Bar in 1850 triggered the renaming of the river and valley and heralded a century long period in which the methods of gold extraction significantly altered the stream's channel, floodplain and adjacent lands. Agricultural operations quickly followed the significant population of miners that were driven to the gold fields and the 20th century saw the Scott Valley largely populated by small family farms producing live stock, wheat and hay. The 20th century was additionally characterized by road building and timber harvest in the upslope areas of the Scott River Watershed and efforts to clear and straighten parts of the Scott River's channel in the Valley to reduce the regular occurrence of winter flooding. Severe bank erosion and channel alteration occurred in the Scott River during a series of floods and high flows in the late 1950's that triggered a campaign to stabilize banks and the river's course through bank stabilization utilizing large rock (rip-rap) armoring. This progression of development throughout the watershed has created a stream channel, riparian corridor and aquifer that are hypothesized to be significantly altered from the historic "natural" condition. Development of a restoration plan that identifies and works with current watershed conditions to improve overall stream and riparian function is essential to any chance for success in the developed streams of the American West.

Protection of the riparian corridor through cattle exclusion fencing followed by riparian planting efforts are believed to be two of the most important steps in restoring the quality of the adjacent stream. These activities were identified in the Scott River in the late 20th century as necessary to reduce sediment and thermal inputs to the stream channel while allowing for survival and natural recruitment of the riparian corridor. In order to address these needs, fencing and riparian planting have been a focus of the local landowners, Siskiyou RCD (RCD), Scott River Watershed Council (SRWC), Natural Resource Conservation Service (NRCS) and various funding sources.

Since the mid 1990's, approximately 275 acres of Scott River main stem and tributary have been planted. In addition, an estimated 90-100 miles of river and tributary have been fenced for livestock exclusion. Many of the stream reaches with documented coho salmon presence are currently protected with livestock exclusion fencing. Several significant reaches with no known riparian fencing have been identified outside of the areas with documented coho salmon. Protection of these areas for the improvement of ecosystem health and water quality is important. It is estimated that there is currently approximately 50 miles of stream in the Scott River that potentially needs livestock exclusion fence to protect the riparian corridor and stream banks.

Despite the time and energy that has been put into riparian restoration efforts in the Scott River, much of the Scott River corridor still has little to no shade providing vegetation (*i.e.*, mature trees). The planting efforts completed to date have had mixed success, from complete failure to sites with moderately good survival and growth.

The Scott River is listed under the California 303d list as impaired for temperature and sediment. The health of the riparian corridor plays a key role in water temperature, and impacts instream sediment levels. The Scott River Temperature and Sediment Total Maximum Daily Load (TMDL) Action Plan was adopted by the North Coast Regional Water Quality Control Board in 2006. The TMDL identifies specific shade requirements for the main stem Scott River and major tributaries.

Purpose

In order to better plan future riparian planting projects, develop the most cost effective riparian restoration projects and address TMDL requirements, the RCD has attempted to analyze all previous riparian planting efforts. This analysis includes an inventory of past projects to determine survival and current condition, an analysis of previous planting techniques, an analysis of the geomorphology of reaches of the Scott River and determination of locations most likely to respond to future planting efforts.

This project attempts to address the following specific tasks:

- Task 1 - Compile the documentation on past riparian projects.
- Task 2 - Map existing riparian protection and restoration projects.
- Task 3 - Complete inventories of the current condition of past restoration projects.
- Task 4 - Identify locations with intact riparian vegetation for use as planting stock.
- Task 5 - Identify and prioritize areas most likely to respond to restoration and protection efforts.
- Task 6 - Verify prioritization with the North Coast Regional Water Quality Control Board's riparian shade model, available fish spawning and rearing distributions and other applicable data sets.
- Task 7. Use expert judgment to develop effective restoration and protection prescriptions (techniques) for various landscapes of the Scott Valley.

Chapter 1 - Historical Impacts on the Riparian Corridor of the Scott River

Since fur trappers discovered the Scott Valley in the 1830's, a combination of human activities and acts of nature have altered the riparian corridor and surrounding landscape. When the earliest settlers arrived in the 1850's following the discovery of gold, the Scott River Valley was formerly referred to as Beaver Valley due to the large population of beaver in the valley floor. Beaver trapping was likely the earliest human activity to begin to significantly alter the "natural" conditions of the river.

Direct human impacts to the stream's channel and riparian corridor include extensive gold placer mining, channel clearing, straightening and leveeing, expansion of agricultural efforts, removal of large woody debris from riparian corridors and river channels and the beginning stages of riparian restoration efforts. The cumulative effect of human impacts interacting with natural events has played a large role in shaping the current stream and riparian condition. Natural processes that have altered the riparian and stream condition include disease and flood. Restoration effort success was limited by plant mortality due to the droughts of 1987-1992 and again 2001-2002. The accumulation of environmental and anthropogenic factors that have affected the current condition of the Scott River and its riparian corridor is well summarized in Kennedy, et al., 2005.

Gold mining was one of the earliest human activities to severely impact the Scott River and tributaries. Hydraulic mining was conducted in many tributaries to the Scott River for several decades. Hydraulic mining uses water under high pressure to mine alluvial deposits causing large amounts of sediment to be delivered into the river channel, changing the channel elevation and altering flood regimes. A group of farmers in the Sacramento Valley filed suit against the hydraulic miners in 1884 (Edwards Woodruff v. North Bloomfield Mining and Gravel Company). A federal judge ruled against the miners, however, in 1893 the United States Congress passed the Camminetti Act, which allowed hydraulic mining to continue if proper sediment control measures were in place. Hydraulic mining continued in California in various forms until the late 1960's. Abandoned hydraulic ditches still remain in many tributaries to the Scott River.

Several large tributaries of the Scott River (including McAdams Creek and the South Fork of the Scott River) have significant amounts of tailings along the stream's banks and floodplain. Large scale dredger mining of the Scott River's main stem (RM 52.3 – 56.4) from 1936 – 1951 by the Yuba Consolidated Gold Fields Company heavily impacted the channel and riparian corridor. Dredger mining essentially turns the river bed's substrate "upside down" compared to natural conditions. This leaves the surface substrate as primarily large cobble with little fines to provide nutrients and store water. Generally, the tailing piles are several feet in elevation above the water's surface limiting access to the floodplain and the dissipation of energies during high water events. Frank J. Jackson - a former Conservationist of the Siskiyou Soil Conservation District - stated in an undated document: "The handling of these dredger tailings and the damage they are causing to the best lands in Scott Valley was one of the most important reasons or motivations for the formation of the Siskiyou Soil Conservation District in 1949." (F.J. Jackson, Undated).

Figure 1. Aerial view of Scott River Tailing reach – confluence of Scott River Forks in extreme foreground

In the late 1930's, the Army Corp of Engineers cleared, straightened and leveed several miles of the main stem Scott River from approximately RM 33 to RM 43 in response to concern over flooding. The history of stream alterations to the Scott River Watershed is well summarized in Kennedy et al., 2005.

In addition to stream channel alteration, the riparian corridor of the Scott River was negatively impacted in multiple ways throughout the 1950's. In the early 1950's, infestations of the oystershell scale (*Lepidosaphes ulmi*) insect severely impacted willow growth and survival (Lewis 1992). The December 1955 flood caused significant bank erosion on the main stem Scott River. This was then followed by two drought years, (1959-1961) and then the 1964 flood which removed much of the existing riparian corridor along the main stem Scott River and tributaries. The historic photo below shows representative riparian and stream channel condition directly following the 1964 flood.

Figure 2. Scott River at Youngs Point (upper right) after the 1964 flood. (photo by F.J. Jackson)

Chapter 2 - Regulatory setting

Scott River TMDL and Scott River Watershed Wide Permitting Program (ITP)

Scott River TMDL Requirements

The Scott River watershed was listed as impaired for temperature and sediment in 2003 under the Clean Water Act 303(d) listing. The Scott River TMDL Action Plan was developed by the North Coast Regional Water Quality Control Board and adopted in September 2006. The Scott River TMDL calls for the Scott River to achieve a minimum amount of "effective shade" for stream temperature regulation. The potential effective shade was calculated by a model - Heatsource v.7 – for the main stem Scott River. The potential effective shade requirement varies throughout the watershed, dependent primarily upon elevation, aspect and bankfull channel width. The outputs of the model are summarized in **Appendix A**.

Scott River Watershed Wide Permitting Program (Incidental Take Permit)

In February 2004, the California Fish and Game Commission adopted the Coho Recovery Strategy. The Recovery Strategy emphasizes cooperation and collaboration, and recognizes the need for funding, public and private support for restoration actions, and maintaining a balance between regulatory and voluntary efforts to meet the goals of the Recovery Strategy. The Shasta and Scott River watersheds were identified for a pilot program to address coho salmon recovery issues and solutions related to agriculture and agricultural water use in Siskiyou County. The Recovery Strategy for California Coho Salmon (Feb 2004) identifies specific recommendations for the Scott and Shasta Rivers in the Shasta-Scott Pilot Program (Pilot Program). In addition to identifying recommendations for the Pilot Program, the Shasta-Scott Recovery Team identified the need to develop a programmatic implementation framework (i.e., an incidental take permit program "ITP") that works toward the recovery of coho salmon, while affording take authorization to agricultural operators. The avoidance, minimization, and mitigation actions required by this Permit are consistent with the recovery tasks identified in the Shasta-Scott Pilot Program of the Recovery Strategy.

Scott River Watershed Wide Permit Program Requirements

The Scott River Watershed-wide Permit Program identifies specific mitigation obligations of the Siskiyou Resource Conservation District (SQRCD).

Under the terms of the Permit "the SQRCD shall prepare a plan that identifies in order of priority riparian locations in the Program Area that if fenced to exclude livestock would benefit coho salmon. The SQRCD shall submit this Priority Plan within one year of the effective date of the Permit. This Priority Plan will identify locations, and list those locations in order of priority. "

During the terms of the ITP the SQRCD is obligated to protect an average of two miles of additional stream every year with riparian exclusion fencing.

According to the terms of the Permit, sub-permitees may not graze livestock within a fenced riparian area unless the grazing is done in accordance with a grazing management plan prepared by the sub-permitee and approved by the Department. The grazing management plan shall address the timing, duration, and intensity of livestock grazing within the riparian zone and shall explain how the proposed management plan will result in improved riparian function and enhanced aquatic habitat.

Chapter 3 - Previous riparian analysis

An inventory of the riparian condition along both banks of twenty nine miles of the main stem Scott River (RM 52.0 to RM 22.2) was completed in 1991 (Lewis, 1992) The riparian survey identified stream banks with existing rip rap stabilization, stream banks with proposed rip rap stabilization, vegetation types in the riparian corridor and existing cattle exclusion fences. The survey, additionally, classified stream banks and riparian corridor condition along the river as being pristine, good, degrading or recovering. The inventory data is summarized in a series of maps and tables in the Lewis report.

At the time of this inventory, a questionnaire survey was completed by the landowners indicating their level of willingness to participate in future restoration efforts. The results of the survey indicated a high degree of willingness to address riparian condition through restoration. The riparian inventory completed by Alvin Lewis in 1991 determined that 55% of the sites inventoried were in good condition, and 45% were disturbed or degrading. In 1991, 64% of the sites that were determined to be in good condition had livestock exclusion fencing. Disturbed and degrading sites had livestock exclusion on less than 25% of the sites.

Lewis estimated that the average age of the riparian trees on the main stem Scott River was 19-20 years. This indicates that a large amount of the existing riparian vegetation was recruited after the 1964 flood, which removed a significant amount of vegetation on the main stem and tributaries.

Previous riparian restoration efforts:

A series of small and large riparian planting efforts have been performed in the tributaries and the main stem of the Scott River over the past two decades.

A small scale demonstration effort was completed by A. Lewis in conjunction with the riparian analysis to plant the riparian corridor in a section of the main stem Scott River above the Serpa Lane Bridge (RM 35-35.2). The plantings were subsequently irrigated by the landowner and Alvin Lewis for several years to insure initial survival and establishment. The cottonwood and golden willows (*Salix alba "Vitellina"*) planted and irrigated at this location are some of the largest and most successful products of riparian restoration in the main stem Scott River.

The Siskiyou RCD and CalForest Nursery performed extensive riparian restoration efforts in the Scott River from the end of the tailing pile to the mouth of French Creek (RM 48.1 to RM 51.0) in 1998 – 1999 using funds from the Cantara Trustees. Multiple plots of land were planted with a variety of tree species (*e.g.*, cottonwood, willow, pines) and planting techniques. A large amount of rooted stock was planted in rows and irrigated using drip line. A smaller amount of live cuttings were planted in holes excavated to the low flow water table. The plantings and irrigation were maintained and assessed for several years subsequent to planting. The Siskiyou RCD revisited the planting in 2008 and assessed the condition and density of riparian vegetation in the sites planted a decade earlier. Various levels of success of the Cantara plantings were documented in 2008.

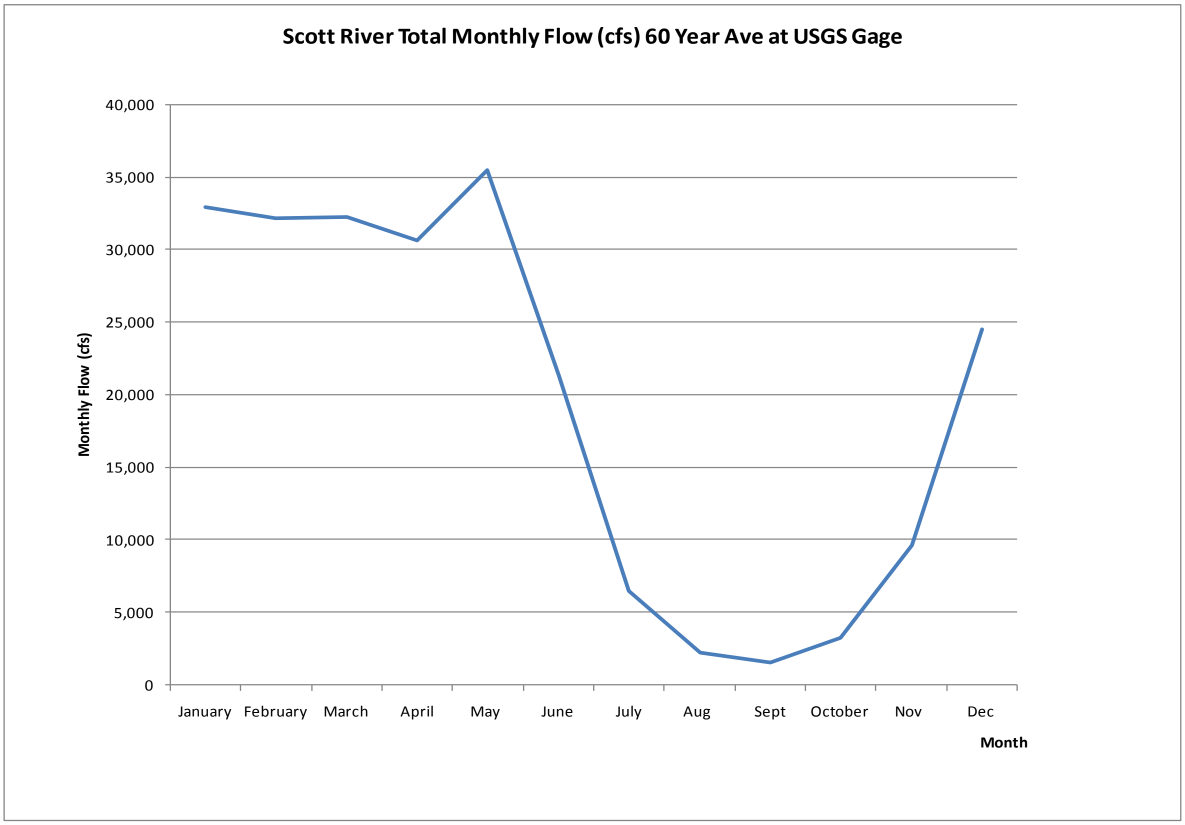
The Siskiyou RCD has performed multiple small scale riparian restoration projects throughout the Scott River and most major tributaries. Projects have been performed on the East Fork Scott River, French Creek, Kidder Creek, Moffettt Creek and Mill Creek in Quartz Valley. A variety of planting techniques were used on the different sites. The Siskiyou RCD revisited a majority of the planting sites in 2008 and inventoried the current condition.

Challenges to Riparian Restoration

The following are some of the most significant challenges that have limited the success of past riparian restoration efforts along the Scott River main stem.

Conditions on gravel bars: Many of the potential planting sites in the existing riparian corridor are predominantly composed of large cobbles which do not hold water well as the water table recedes in the spring. This condition makes it especially difficult for natural recruitment of cottonwood, which has a significant moisture requirement to establish new seedlings. In addition, the exposed cobble reflects significant amounts of heat (solar radiation) onto young seedlings causing potential cambium burn and death. It is estimated that temperatures on the gravel bars can exceed 110° F in the hottest part of summer. Attempts in the past to reduce the amount of solar reflection at some restoration sites included mulching of the soil adjacent to introduced plantings. The mulch was found to attract rodents which fed on and killed the seedlings (see below). The use of "shade cards" to shade new seedlings instead of mulching is a potential solution to preventing excessive solar radiation without increasing the amount of rodent browse.

Altered hydrologic regime and access to the flood plain: The Scott River typically has relatively high flows during the period of snow melt runoff which lasts from spring until early July. After this point instream flows, and potentially the water table, drop relatively rapidly (Figure 3). The rapidly dropping water table can cause the root structure of newly established plantings to become dry and die during the months of summer and early fall. The soil moisture in the soil profile above the water table (vadose zone) becomes extremely low to non-existent in areas that are not irrigated during the dry months of summer and fall. It is hypothesized that access to the aquifer's water table or irrigation is essential for the survival and establishment of riparian plantings.



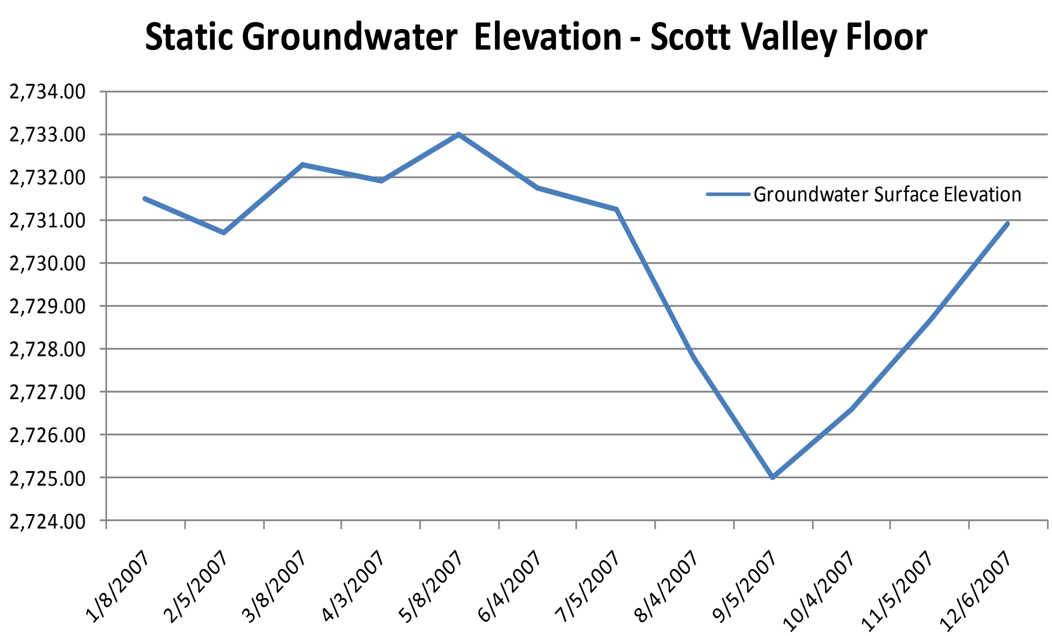


Figure 3 – The top graph depicts accumulated monthly flow (60 year average) at USGS gage Scott River below Ft. Jones and the bottom graph depicts the static groundwater elevation in a randomly selected well on the Scott Valley Floor

Altered stream channel and bank profile: Depth to low flow water table in regions of the main stem Scott River can be greater than ten feet, prohibiting the establishment of natural riparian recruitment and the success of non irrigated riparian plantings. Areas with levees along the stream banks can have land with elevations significantly higher than the water surface elevation of the adjacent river and underlying water table. Attempting to establish riparian vegetation in these lands that are adjacent to the stream but lack the essential year round water supply for hydrophilic plants could be an exercise in introducing plants into the incorrect ecosystem.

Browse by wildlife: Multiple species of wildlife (deer, elk, beaver, rodents, etc.) have browsed on the newly established riparian plantings. Use of fence cages has limited the amount of browsing by larger wildlife. Experience has shown that fence cages need to be established at the same time as the planting.

Competition with other vegetation: Some locations in which planting occurred were previously occupied by rhizomatous grasses (e.g., reed canary grass - *Phalaris arundinacea*) before execution of the restoration project. Some of these grasses were removed in the preparation of the site but quickly reemerged from the disturbed rhizomes. It is hypothesized that the grasses can quickly utilize the limited surface water supply and out compete the introduced plantings. An effective treatment to remove the grass previous to introduction of plantings is desired.

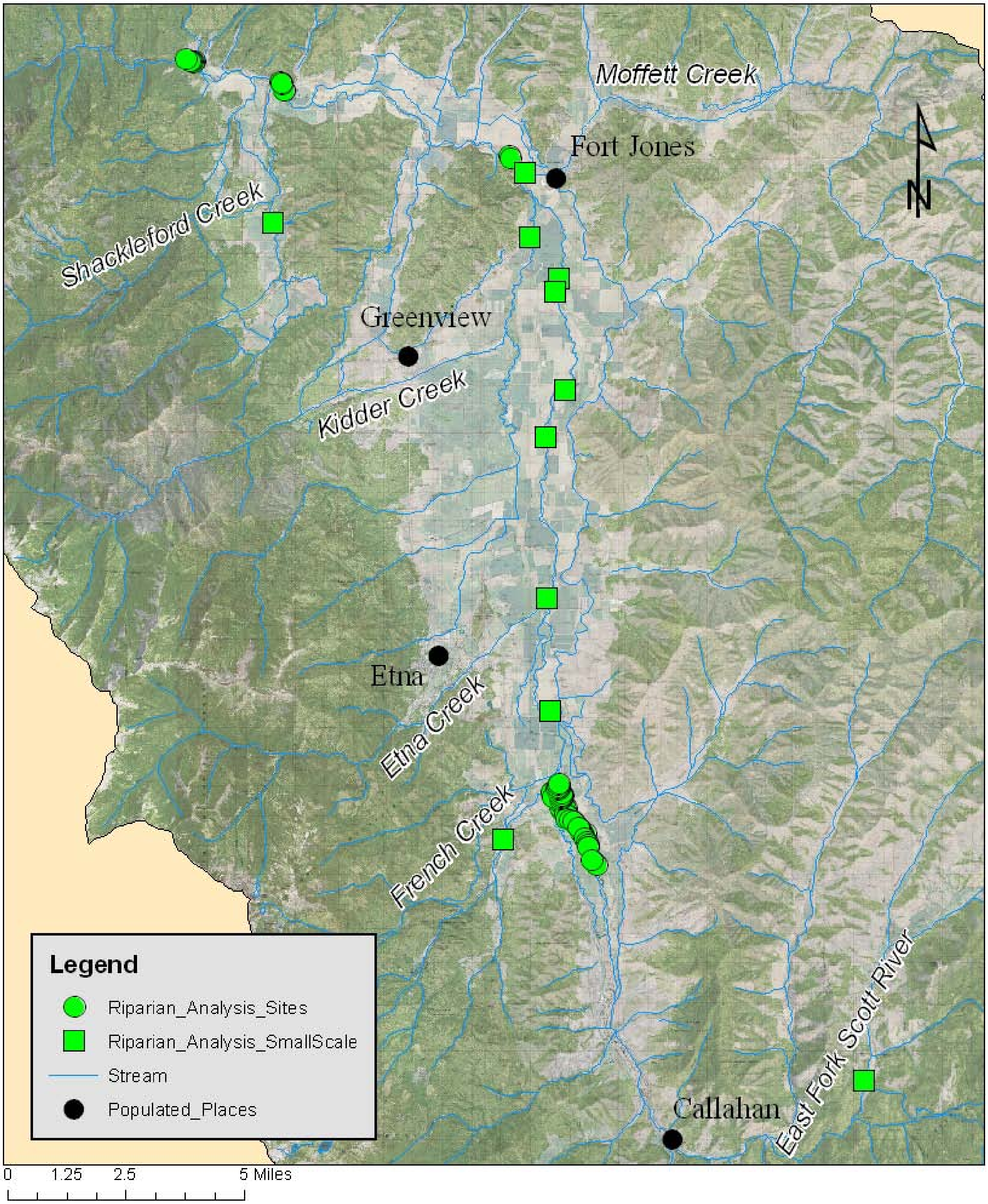
Chapter 4 – Inventory and assessment of past riparian projects
Methods

Compilation of supporting documentation on past riparian projects:

The first step in this Scott River Riparian Restoration Analysis was to compile specific information on all past riparian replanting efforts in the Scott River Watershed. Information gathered for each planting effort performed by the Siskiyou RCD includes: planting location, approximate acreage planted, year of planting, planting technique and species, and any maintenance method(s). This information for projects performed in a single location is summarized in **Table I Summary of Past RCD Riparian Restoration Projects** and projects with multiple spatially separate planting locations are further detailed in **Table II. Detailed summary of select projects.** See Map #1- Scott River Riparian Analysis Sites – 2007 - 2009 for locations inventoried.

Riparian replanting efforts analyzed for this project were established from 1992 to 2008. A variety of planting techniques were utilized and site conditions varied throughout the watershed. See **Appendix B** for results of site inventories completed in 2007-2009.

Scott River Riparian Analysis Sites - 2007-2009



Map 1 – Riparian restoration project sites that were assessed from 2007 - 2009

Before identifying locations to be inventoried, the main stem Scott River was evaluated for general differences in site conditions. Based on differences in soil condition (type), channel condition and the elevation difference between riparian landforms and the low flow water table, three broad main stem reaches have been identified (See Map #2 – Scott River riparian analysis – Main stem reaches). A table of river miles (RM) and river kilometers (RKM) for key features in the Scott River is available in Appendix D. Tributaries were group as a separate category in addition to the three main stem reaches. A subset of past projects in each reach was inventoried.

1.) Tributary locations -

Soil types in tributaries are varied. However, many of the planting locations are in alluvial sections that have higher quality soils. Due to the riparian corridors closer proximity to the active channel, the elevation of the water table at planting locations was more consistent throughout the dry season than some main stem sites. Tributary locations with year round flows (e.g., French Creek below Miners Creek and above the Highway 3 Bridge) currently have areas with mature riparian forests in good condition. The potential for natural recruitment in these tributaries is high in areas protected by riparian exclusion fencing. Reaches of the tributaries that do not have year round flow (e.g. Kidder Creek above and below the Highway 3 Bridge) are currently limited in the density and distribution of riparian plantings.

2.) Scott River - Callahan to the end of tailing piles - RM 57.1 – 52.1

This is a reach predominated by areas with tailing piles on both banks of the river with limited occurrence of riparian vegetation along much of the bank. Some areas have near vertical banks of tailing piles directly adjacent to the river's active channel with no potential for riparian recruitment or introduction without extensive landform alteration. Due to the limited potential for riparian planting success this reach has not been treated in any of the past projects and was not included in the prior riparian analysis.

3.) Scott River– end of tailing piles to Youngs Dam - RM 52.1 – 46.7

The Scott River from the end of the tailing piles to Youngs Dam (the SVID diversion structure) is a reach defined by a wide floodplain and riparian zone and a relatively shallow water table. All locations in this reach with livestock pasture adjacent to the stream have had exclusion fencing in place for over a decade.

The west side of this reach has considerable influence from west side perennial streams (*e.g.*, Sugar Creek, French Creek and Wolford Slough). Surface and subsurface flows from these streams likely contribute to a relatively high water table in summer. Stream channel cross-sections taken on the Scott River at Wolford Slough (June 2009) indicate that ground surface elevation on the adjacent terraces is 4-7 feet above the thalweg of the Scott River, which should roughly correlate with the base flow water table. This corroborates observations during previous planting efforts that indicated the water table was 4-7 feet below the ground surface elevation (Gary Black 1998). See detailed write up of cross section elevations at end of chapter**.**

The combined width of the available riparian zone on both sides of the stream in this reach varies from approximately 200 to 1,000 ft with an average of 600 ft. The available riparian zone is identified as the area between riparian exclusion fencing and the stream bank. The smallest width of available riparian habitat is in the last downstream mile of this reach. Many of the locations analyzed have in excess of 300 feet of fenced riparian or floodplain on one side of the river with several locations having 500 – 700 ft available. This reach has the widest fenced riparian and floodplain land in the main stem Scott River.

3.) Scott River - Below Youngs Dam (SVID) to Moffettt Creek - RM 46.7 – 31.8

A large portion of this reach of the Scott River was "straightened, cleared and leveed" by the Army Corp of Engineers in the late 1930's. Many areas of stream bank that were actively eroding following the 1955 flood event have been stabilized with large rock rip rap. Several areas of successful riparian and non-riparian plantings were introduced by the Soil Conservation Service through this reach.

This reach is characterized by limited flood plain connectivity with the majority of the land adjacent to the active channel comprised of leveed stream banks. Riparian planting sites were mostly at or above the elevation of the adjacent field (e.g. top of levee), soil characteristics vary but soils are mostly comprised of gravel and cobble substrate which does not hold moisture in the dry summer months. Based on observations recorded in contract final reports and observations in the field it is estimated that ground surface elevations on the adjacent terraces is between 8-11 feet above the low flow surface and groundwater elevations.

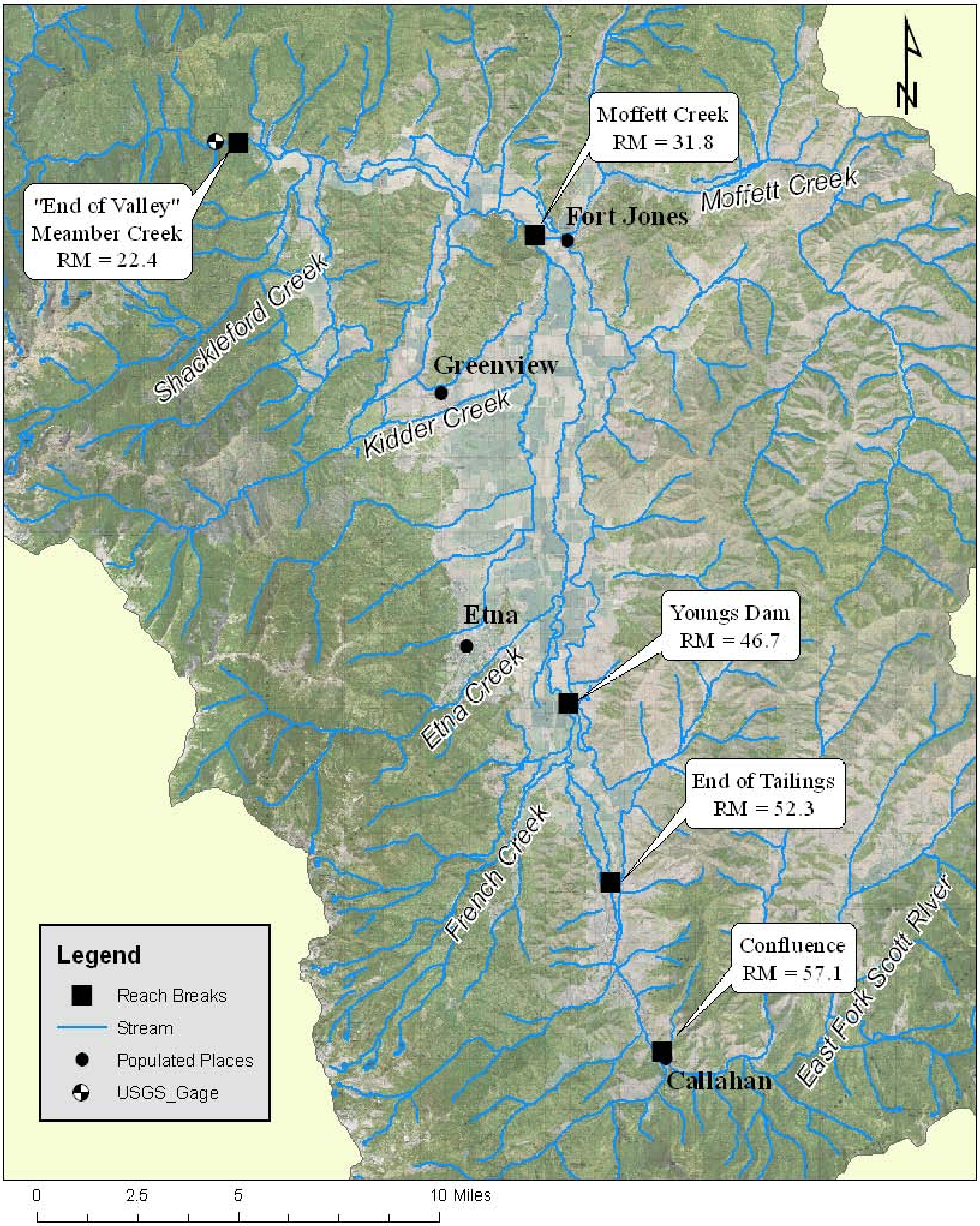
Cross section data collected at Etna Creek shows that the depth to water may be 5-7 feet in a normal year, but in a year such as 2001, greater than 10 feet.

Most historic planting sites are currently barren of introduced trees with only perennial grasses and weeds present. It is hypothesized that the invasive rhizomatous perennial grasses observed in many locations throughout this reach were a significant competition to past riparian planting efforts. Determination of viable eradication and/or control methods to remove these grasses at sites of future riparian planting is desired.

Etna Creek provides only subsurface flows in the summer months, Patterson, Johnson, and Crystal Creek combine to form the Big Slough. Big Slough joins Kidder Creek to the east of Greenview and Kidder Creek joins the Scott River upstream of the confluence with Moffettt Creek. The affects on the groundwater elevation from the major tributaries to the west of the Scott River in this reach is largely unknown.

The combined width of the available riparian zone on both sides of the stream in this reach varies from approximately 70 to 1,000 ft with an average of 350 ft. The upstream end of this reach has a greater width of riparian and floodplain land on average compared to the downstream end. A stretch of the Scott River approximately 3 miles long (centered on RM – 34.4) has an average of less than 110 ft of combined available land on both sides of the river. This reach has the smallest average width of available land adjacent to the stream for riparian planting and potentially has the greatest distance from "riparian" landforms to the low flow surface and groundwater elevations.

Scott River riparian analysis - Main stem reaches



Map - #2 – Main stem Scott River reach breaks and select major tributaries

4.) Scott River from Moffett Creek to below Meamber Creek (RM 31.8 – 22.1)
This reach has some similar characteristics to the reach from below Youngs Dam to Moffett Creek but does not have an area of restricted riparian availability and high elevation levees. This reach of the Scott River is dominated by gravel and cobble throughout the stream banks and adjacent flood plains. Historic planting sites varied from sandy loam to high gravel bars. The distance to groundwater at the planting sites is estimated to be greater than 10ft in many locations. Levees are not as prevalent in this reach as upstream and it is hypothesized that the difference between landform and low flow surface and groundwater elevations is not as severe as observed in some locations upstream. Analysis of historic plantings demonstrates mixed results with some locations showing moderate to good success and other locations with limited success.

Shackleford and Oro Fino Creeks enter this reach of the Scott River from the south and Indian, and Rattlesnake Creeks enter from the north. All of these tributaries are dry during the summer months at and above the confluence with the Scott River. There is very little to no riparian vegetation along these dry reaches of the tributaries.

The combined width of the available riparian zone on both sides of the stream in this reach varies from approximately 125 to 1,000 ft with an average of 550 ft. The available width for riparian planting is uniform throughout the majority of the reach with only a few locations in which the combined available width is less than 300 feet.

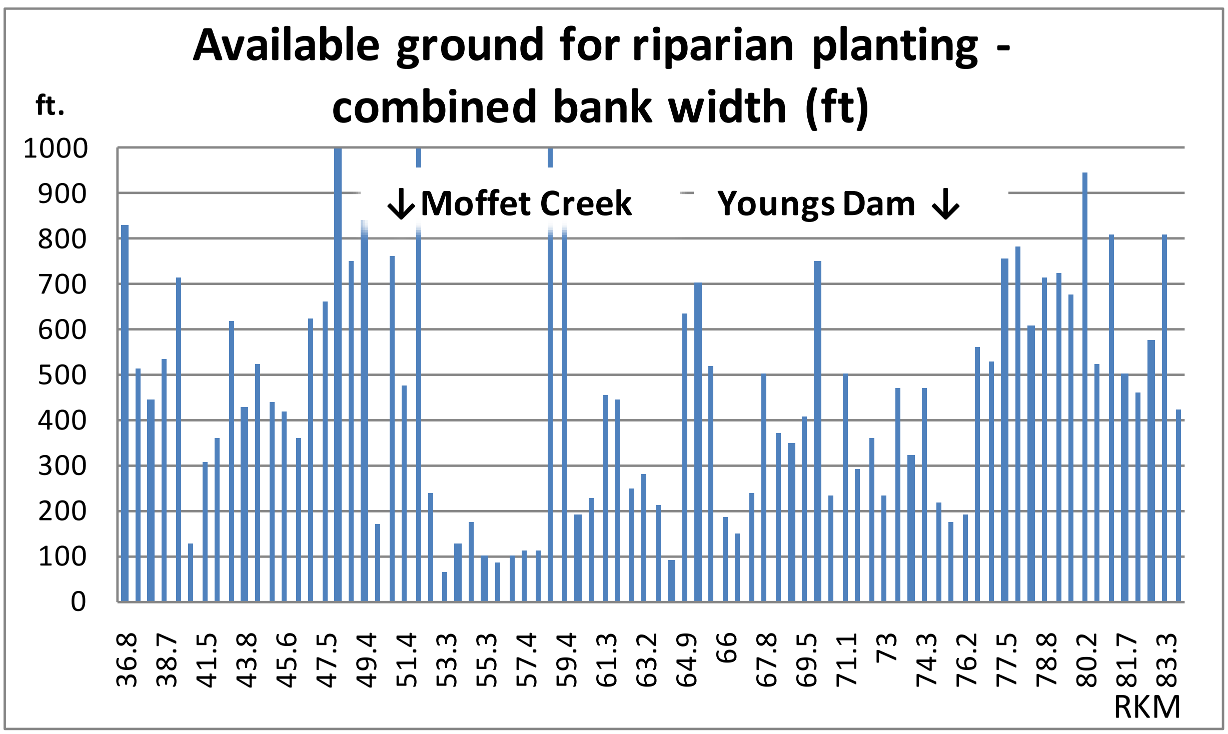


Figure 4 – Available combined width for riparian planting – both banks combined

Table I-Summary of Past RCD Restoration Projects

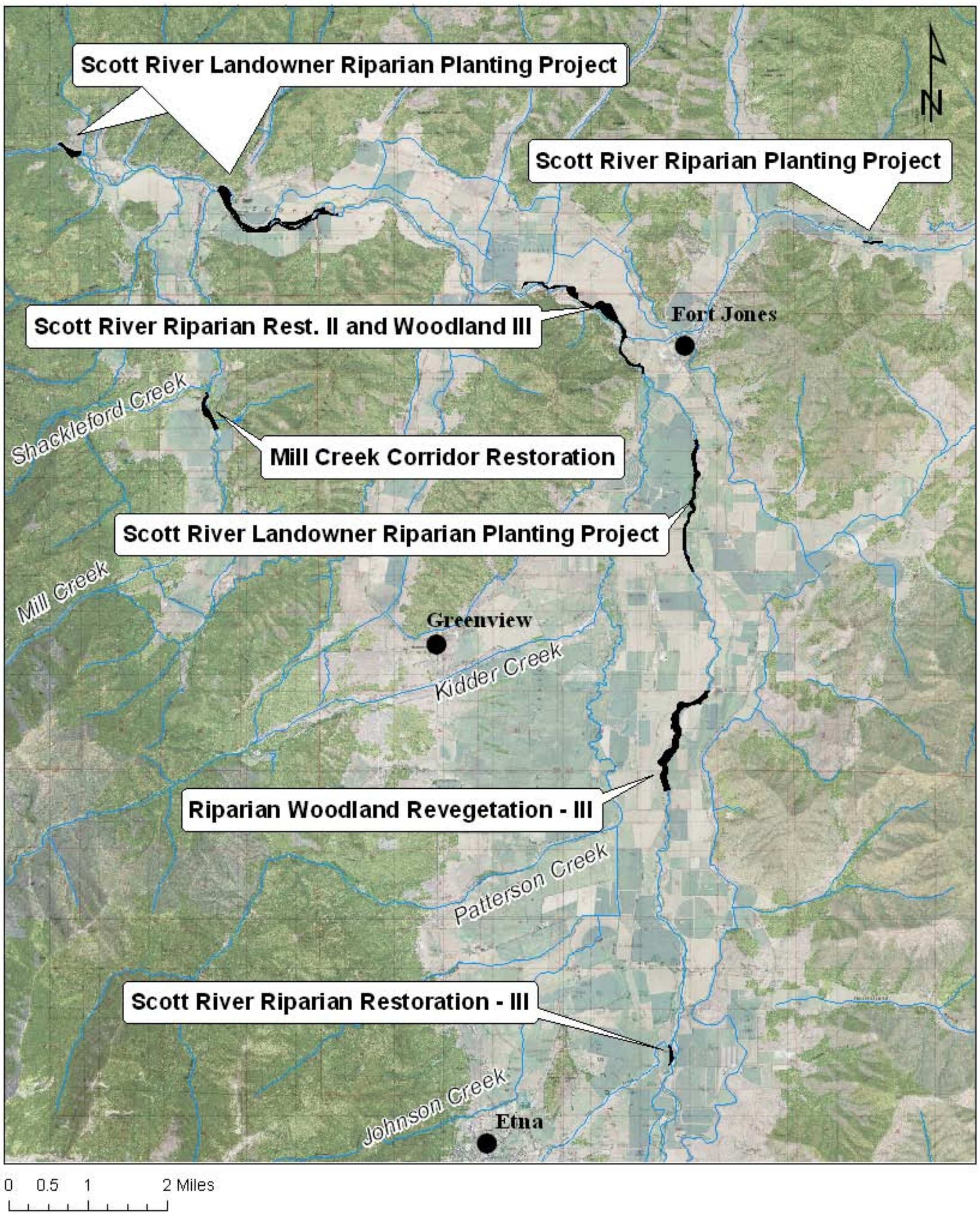
Project	RCD #	Year of Planting	Location	Site Description	Species	Acres	density	intent	planting technque	Maintainence	Conclusions from contract final report
Scott River Riparian Fencing Planting II	61	1995	Pastures of Heaven								
Riparian Woodland Revegetation II	See Sheet 3	1995	Scott	See Table II	Pacific or yellow tree willow (Salix lucida ssp lasiandra) Arroyo willow (S. lutea) Black Cottonwood (Populus trichocarpa) Ponderosa Pine (Pinus Ponderosa)	27.5					
Cal-forest	63	1997	Scott	See Table II	willow, alder, cottonwood, pine	58			rooted stock on drip line, dormant stock w/out fully	mulch and cardboard shade boards	
RCD	63	1997	Scott	See Table II	Pacific willow, Arroyo willow, Cottonwood	14	150-210		Pole stock planted 4-6'deep		
French Creek Riparian Woodland Revegetation	67	1997	Opposite Confluence of French Cr. And Scott River		Pacific or yellow tree willow (Salix lucida ssp lasiandra) Arroyo willow (S. lutea) Narrow leaf willow-Sand Bar (S. exigua) Black Cottonwood (Populus trichocarpa) White Alder (Alnus rhombifolia) Ponderosa Pine (Pinus Ponderosa)		473	restore riparian condition following flood of 1997	plug stock of all, and willow whips	Drip irrigation of non-dormant stock through summer and fall. Soil sites watered once a week. Sand and gravel sies watered 2-3 times, or continuously.	1.) Planting timing should be mid March - mid april for dormant stock, late-april to mid- may for non-dormant 2.) Mulching is essential in areas of heat stress 3.) allow plants to dry between watering to promote vertical root growth
Center Bar	67	1997		unconsolidated cobble, gravel, sand		11		restore riparian condition following flood of 1997	plug stock of all, and willow whips	Drip irrigation of non-dormant stock through summer and fall. Soil sites watered once a week. Sand and gravel sies watered 2-3 times, or continuously.	1.) Planting timing should be mid March - mid april for dormant stock, late-april to mid- may for non-dormant 2.) Mulching is essential in areas of heat stress 3.) allow plants to dry between watering to promote vertical root growth
French Cr. Bar	67	1997		entirely DG		4		restore riparian condition following flood of 1997	plug stock of all, and willow whips	Drip irrigation of non-dormant stock through summer and fall. Soil sites watered once a week. Sand and gravel sies watered 2-3 times, or continuously.	1.) Planting timing should be mid March - mid april for dormant stock, late-april to mid- may for non-dormant 2.) Mulching is essential in areas of heat stress 3.) allow plants to dry between watering to promote vertical root growth
Mill creek Corridor Restoration	58	1998	Mill Creek	higher eleveation w/poor soil condition	Pacific willow, Arroyo willow, Black Cottonwood						
Scott River Riparian Restoration I	63	1998						Establish a riparian area			
Scott River Corridor Habitat Improvement	64	1998			Golden willow, Arroyo willow, Red willow, Black cottonwood, Pondersa Pine, alder.			Use of riparian planting to stabilize stream banks.	willow baffle and debris jams Willow and cottonwood Baffle: rooted stock and pole cuttings(at least 4	yes	Success with pole plantings,68% on rooted stock after two seasons.
Riparian Woodland Revegetation I	81	1998									
Scott River Restoration II	81	1998	5.0 miles of stream south of the mouth of Etna Cr.		Pacific willow, arroyo willow, red willow, black cottonwood	36		Improve and estend riparian and cold water habitat throughout a 5 mile section of Scott River.	Pole cuttings 3' in diameter and 12-14' long, back-hoe planting to reach estimated summer water table. Tips cut down to only 1 foot.	Mulch, shade cards, and browse cages where necessary	See Sheet # 3
Scott River Corridor Enhancement Project	87	1998	Eller Lane	Eller Lane downsteam to Hansen Property	cottonwood, willow, pondersa pine	10	Unkown	increase channel diversity and devleop riparian zone	irrigated stock	irrigation	
Scott River Landowner Riparian Planting Project	80-1	1998	Various - Sheet 3	See Table II	Pacific willow, Arroyo willow, Black Cottonwood	11.5	150-210	Establish a riparian area.	Back-hoe digging to estimated water table. Ple cuttings ~2.5" in diameter uo to 12' long.	None	
Shackleford-Mill Corridor Improvement Project	56	1999	Mill Creek			0.75					Natural reveg of alder, red willow, pacific willow, black cottonwood and pine, sedges and annual grasses, after 10 mo of exclusion fencing.
Scott River Riparian Restoration III	60	1999/2000	Scott R. near Etna Cr.	upstream from the mouth of Etna Creek	willow	14	200 total	establish a riparian to stabilize eroding bank		deer browse cages	excessive deer browse, 80% survival
Riparian Revegetation III	95-III			See Table II	Alder, cottonwood, Maple, Pine , Willow	32.8					
Scott River Enhancement Project	77	2000	Scott River downstream from SVID			11		re-establish a functioning riparian zone and reduce channel width.	pole cuttings	some caging and watering, but pump was out of order for over a month.	drought and deer browse affected the plantings.

Table I (cont.) -Summary of Past RCD Restoration Projects

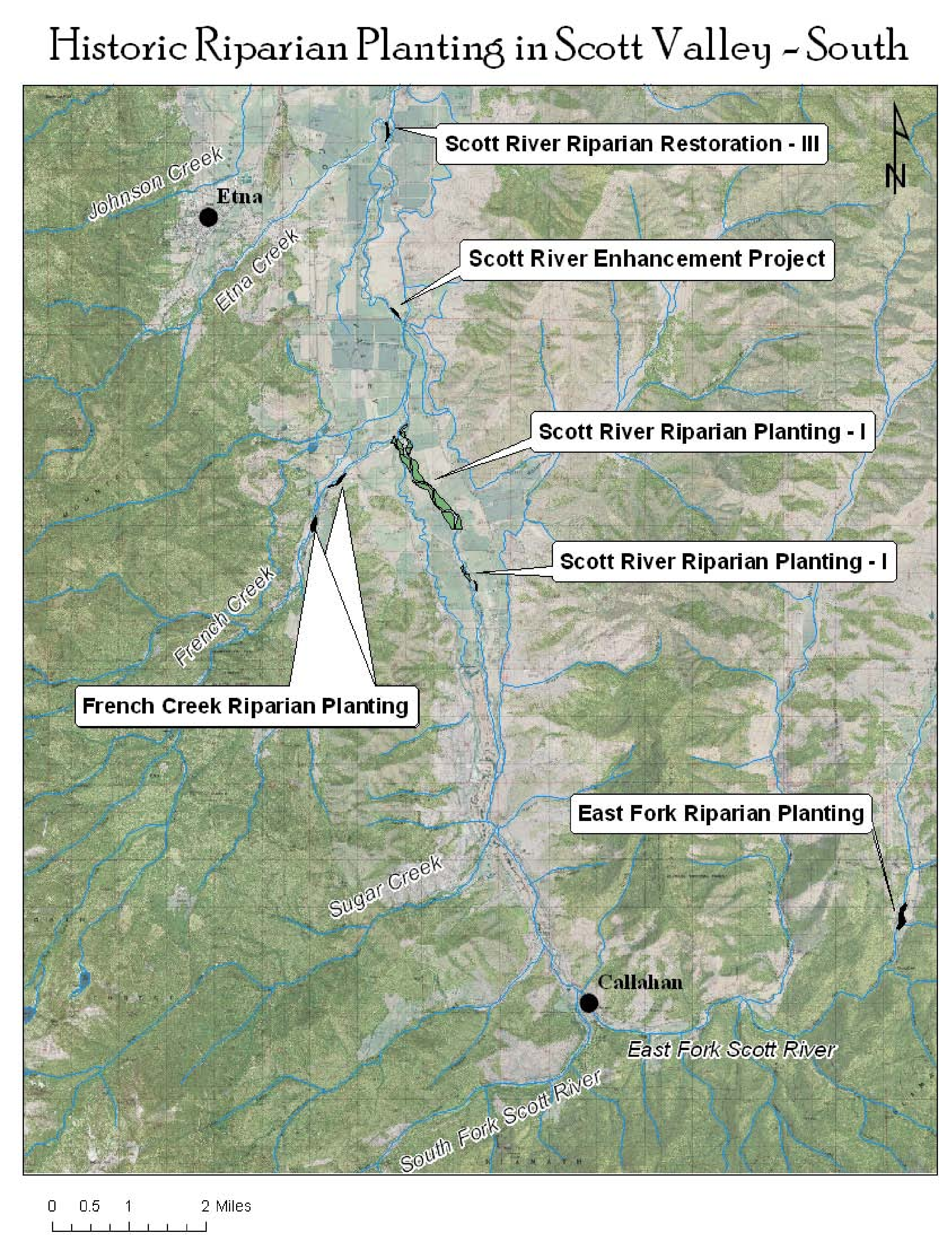
Project	RCD #	Year of Planting	Location	Site Description	Species	Acres	density	intent	planting technque	Maintainence	Conclusions from contract final report
Scott River Landowner Riparian Planting Project	80-2	2000	Various - Sheet 3	See Table II	Pacific willow, Arroyo willow, Black Cottonwood	10.5	150-210	Establish a riparian area.	Back-hoe digging to estimated water table. Ple cuttings ~2.5" in diameter uo to 12' long.		
East Fork of the Scott River	83	2001	Lower Masterson Rd	East Fork Scott River near Grouse Creek. Site has been used for mining and agriculture for over a century. Banks were eroded prior to stabilization.	Willow and black cottonwood	8			Pole cuttings . 3-8 feet to water table.	All plantings mulched, some covered for shade.	drought year heavily impacted plantings
Finley Ranch Enhancement	75	2002	Kidder Cr. Slough(.4 miles below Serpa Lane Bridge		Ponderosa Pine and Willow?			Establish a riparian zone by providing an overstory riparian community along a reach of the Scott R. and Kidder Creek.	Large stock planted to approximate estimated summer water table depth. Wheel-line irrigation	deer browse protection & wheel line irrigation	91% after one season
Scott River	75	2002				2.5	160-220				
Kidder Slough	75	2002				5	160-220				
Kidder Creek Enhancement Project	37	2003	Lower Kidder Slough	1.1 miles of stream, plantings on both sides	Pacific willow, red willow, black cottonwood, ponderosa pine	5	160-210		4-10 foot deep trenches with 4-5 feet of plant above surface	wire cages (60%)	beaver activity impacted 30% of the uncaged trees. Replanted the west side in 2004, caged all plantings. All livestock removed permanently prior to plantings. Deer browse did not impact plantings.
French Creek Riparian Restoration Project	46	2003	French Creek	Abv Hwy 3 to Miners Creek	Pacific, Arroyo willow, black cottonwood, Ponderosa Pine	5.5	260-500	Expand existing riparian width, develop contiguous riparian vegetation	Large cuttings trenched to low flow water table.	Winter wheat planted for shade, mulch, browse cages	
Scott River Enhancement Project	77	2003		planting at instream area	Arroyo and golden willow, Black Cottonwood and Ponderosa Pine	1.5	350 total	re-establish a functioning riparian zone and reduce channel width.	pole cuttings	cage and irrigation with water truck	none
Scott River Landowner Riparian Planting Project	80-III	2003	See Table II	See Table II	Various - Sheet 3	6		establish riparian in selected areas	Back-hoe digging to estimated water table. Ple cuttings ~2.5" in diameter uo to 12' long.	2,300 feet of fencing	Good growth, deer browse continues to be a problem, 50% 2005
Kraus Bank Stabilization	92	2006	Moffet Creek		willow and cottonwood	N.A		Planting streambank stabilization structures			
Owens East Fortk Stabilization	97	2006	East Fork		willow and cottonwood	N/a		Planting streambank stabilization structures			
French Creek Drainage Protection & Enhancement Project	46-2	2006	French Creek	Stapleton/Tobia		2	Tobias 150-220				
French Creek Drainage Protection & Enhancement Project	46-3	2008									

Map Existing Riparian protection and restoration projects

Historic Riparian Planting in Scott Valley - North



Map #3 – Historic planting locations in North Scott Valley



Map #4 – Historic planting locations in South Scott Valley

Inventories of current riparian condition

During the summers of 2007 and 2008 RCD staff visited a subset of all previously completed riparian restoration projects to assess the survival of plantings and evaluate which planting techniques were most successful. See **Appendix B- Riparian Planting Inventory Results** for detailed site specific information.

Methods

Sub inventory Technique

For smaller scale planting sites, the site was assessed for survival and relative health of plantings. Small scale sites are defined as those which were less than an acre, or which were narrow strips of planting following the river bank. Photographs were obtained at each site to document the current state of the riparian plantings and any potential naturally recruited vegetation.

For larger planting sites, such as the Cantara riparian planting, a series of representative 0.1 acre plots were surveyed using the following protocol. Each planting block was sampled at three to five representative 0.1 acre circles. A circle with a radius of 37.5 ft was delineated in the selected locations of each planting block. The location of each sampled location was captured with hand held GPS. The trees within the circle were counted and classified by height and recorded on a datasheet. Photographs of each sub-sampled location were obtained.

Selection of sites for Sub inventory

Based on the categories identified in Task 1, and site conditions (soils, water table, competing vegetation, etc) locations were selected for one time inventory during the summers of 2007 and 2008. The results of the inventory for each site are presented in **Appendix B.** The original intent was to inventory a sub-set of all projects in each reach. However, planting efforts in the Scott represent different approaches and methodologies in planting techniques. In this inventory, effort was made to inventory sites in each reach that represent all the planting methods utilized in that reach. The following summarizes the inventory results:

Tributary Locations: All planting locations on tributaries were inventoried with the exception of a site on Kidder Creek that completely washed out in 1997 and a site on McAdams Creek.

Main stem locations: Multiple project sites in each of the three main stem reaches were inventoried. The intent was to inventory sites representing different planting techniques and different landscape and channel conditions.

Tables III-a – III-d summarize the results of the site inventories. The following definitions are used in the evaluation of past planting projects:

Failure- no planted vegetation remains

Success- some amount of planting stock remains with good growth (*e.g.*, tree heights greater than 10 ft) observed.

Natural Recruitment- Site has had natural recruitment of vegetation since original planting effort.

Partial success-some planted stock remains but growth is poor.

Table III-a - Tributary Locations

Stream	Site Description	Inventory Result	Conclusion
Kidder Creek	Kidder Creek between Serpa Lane and Hwy 3	Successful - Cattle Exclusion in place	
Kidder Creek	Scott River Riparian Woodland Revegetation II.	Site not inventoried	Washed out in 1997 flood
Mill (Shackleford)	Mill Creek above the confluence with Shackleford. Current presence of beaver dam.	Successful with significant natural recruitment - cattle exclusion in place	This site appears to experience a very stable water table and natural recruitment was more successful than the plantings following cattle exclusion.
French Cr.	Below the Miners Rd bridge to the Hwy 3 Bridge	Partial success	Subject to deer browse
French Cr	Above the Miners Rd Bridge (north side)	Success after one year of growth	Utilized browse cages
Etna Creek	South side of Etna Creek at the confluence with the Scott.	Failure Poor soil and groundwater conditions.	Aggressive maintenance with browse protection and irrigation.
East Fork Scott	Upstream from Grouse Creek to above Masterson Road Bridge	Partial Success with natural recruitment. Livestock damage and 2001 drought stress.	Natural recruitment with more success likely if livestock excluded. This reach experiences accretion flows.

Table III-b Scott River mainstem above Youngs Dam (SVID).

Stream	**Project**		Notes
Above Fay Lane-Barnes	Scott River Riparian Restoration I (Cantara)	Success with natural recruitment	Replant to expand/enhance existing riparian vegetation
Tobias	Scott River Riparian Restoration I (Cantara)	Success with natural recruitment	Replant to expand/enhance existing riparian vegetation
Spencer	Scott River Riparian Restoration I (Cantara)	West-side success, East side failure	Replant west side to expand/enhance existing riparian vegetation

Table III-c Scott River Between SVID and Moffett Creek

Stream	**Project**	**Inventory Results**	**Conclusion**
Scott River below Black Bridge – Sharps Gulch	Scott River Riparian Woodland Revegetation III. (#95)	Failure	Failure potentially due to unintended cattle grazing, discontinuation of irrigation and competition with grasses.
Scott River below Black Bridge	Scott River Riparian Woodland Revegetation III (#95)	Partial success	Suitable for planting pine or cottonwood. Used irrigation and deer browse protection.
Scott River around Etna Creek	Scott River Riparian Restoration II (60)	Failure	Potential reasons for failure include: deer browse, drought and depth to water table.
Scott River directly below Youngs Dam	Scott River Enhancement Project (#77)	Partial success	Irrigation system failure and period of drought
Scott River upstream of Serpa Lane	Planted by Alvin Lewis – Soil Conservation Service	Success	Intensive irrigation of golden willow and cottonwood – one of the most successful plantings
Scott River below Moffettt Creek	Landowner Enhancement Project (#75)	Partial success	Need to evaluate depth to water table – deer browse and drought potentially limited initial success.

Table III-d Scott River from Moffett Creek downstream.

Stream	Project	Inventory Results	Conclusion
Scott River below Moffettt Creek	Just downstream from Moffettt Creek (Eiler)	No survival, drought and flood	
Scott River below Moffettt Creek	Eiler Ranch	Failure	Planting on gravel bars failed due to "high and dry" condition of bars
Scott River below Moffettt Creek	Main stem Scott one mile below Moffett Cr.	Failure	
Scott River above Meamber Bridge	Scott River Landowner Riparian Planting Project (80-II)	Not inventoried due to lack of access	
Scott River above Shackleford Creek	Below Meamber Bridge above Shackleford Creek	Success with natural recruitment	Willows/cottonwoods, good condition
Scott River below Shackleford Creek	Below Meamber Cr. Above USGS	Success - willows and cottonwoods in good condition	Landowner performed irrigation and maintenance are keys to success

Riparian site inventory Discussion

Tributary Locations

Planting efforts in tributary locations have been both successes and failures. One of the most successful sites surveyed was in Mill Creek (Quartz Valley) in which cattle exclusion fencing was combined with riparian plantings and natural recruitment to create an area with a robust riparian forest and significant beaver dam and impoundment. This area and other tributary locations above the alluvial fan appear to maintain a relatively stable water table. Tributary areas outside of the aggraded alluvial fans typically have some existing vegetation that helps to create a micro-climate that shelters the plantings during establishment and are an essential source for natural recruitment. Locations with stable channels and water tables that will potentially support introduced plantings include: French and Miners Creek, Mill Creek (Shackleford) and the lower reaches of the South Fork Scott River. Some of these locations have current riparian areas that do not require restoration and serve as potential sources for natural recruitment and stock for future riparian planting efforts. Locations in the alluvial fans (Kidder Creek, Lower Etna Creek, Patterson Creek and the mouth of Shackleford Creek) are subject to the same challenges that main stem sites have, including: significant fluctuations in depth of water table, lack of flood plain connectivity, potential lack of natural recruitment and higher potential for significant stream channel erosion. The introduction of cattle exclusion fencing in areas with grazing adjacent to the stream is an essential first step in any attempt to protect and/or enhance the riparian corridor.

Successful riparian plantings –

Mill Creek and French Creek have had some of the most robustly successful riparian planting efforts. In these locations, the naturally stable water table and existing riparian vegetation have aided in the establishment of a healthy riparian corridor. A project to that introduce fencing and plantings in Mill Creek after the 1997 flood serves as an example of the most successful effort to date.

Mill (Shackleford) Creek: This was the site of streambank stabilization, cattle exclusion fencing, and riparian replanting completed in 1998 and 1999. Analysis of aerial photographs of the planting location in 1993 and 2005 demonstrate a significant increase in riparian vegetation within the fenced area (Figure 5). A large beaver dam and associated impoundment has been observed in this area of Mill Creek since 2005.

This 15.3 acres site on Mill Creek was a major riparian restoration project started in 1998 and completed in 1999. The stream channel was re-profiled and stream banks were protected and stabilized with large rock armor. Cattle exclusion fencing was installed on the .7 mile reach with an average of 450 feet between fence lines. A small amount (.75 acres) of riparian replanting was completed within the fenced area adjacent to the active channel. In addition to the planted vegetation, after just 10 months of cattle exclusion fencing significant natural recruitment was observed in this reach. Naturally recruited vegetation include: alder, red willow, pacific willow, black cottonwood, ponderosa pine, sedges and annual grasses.

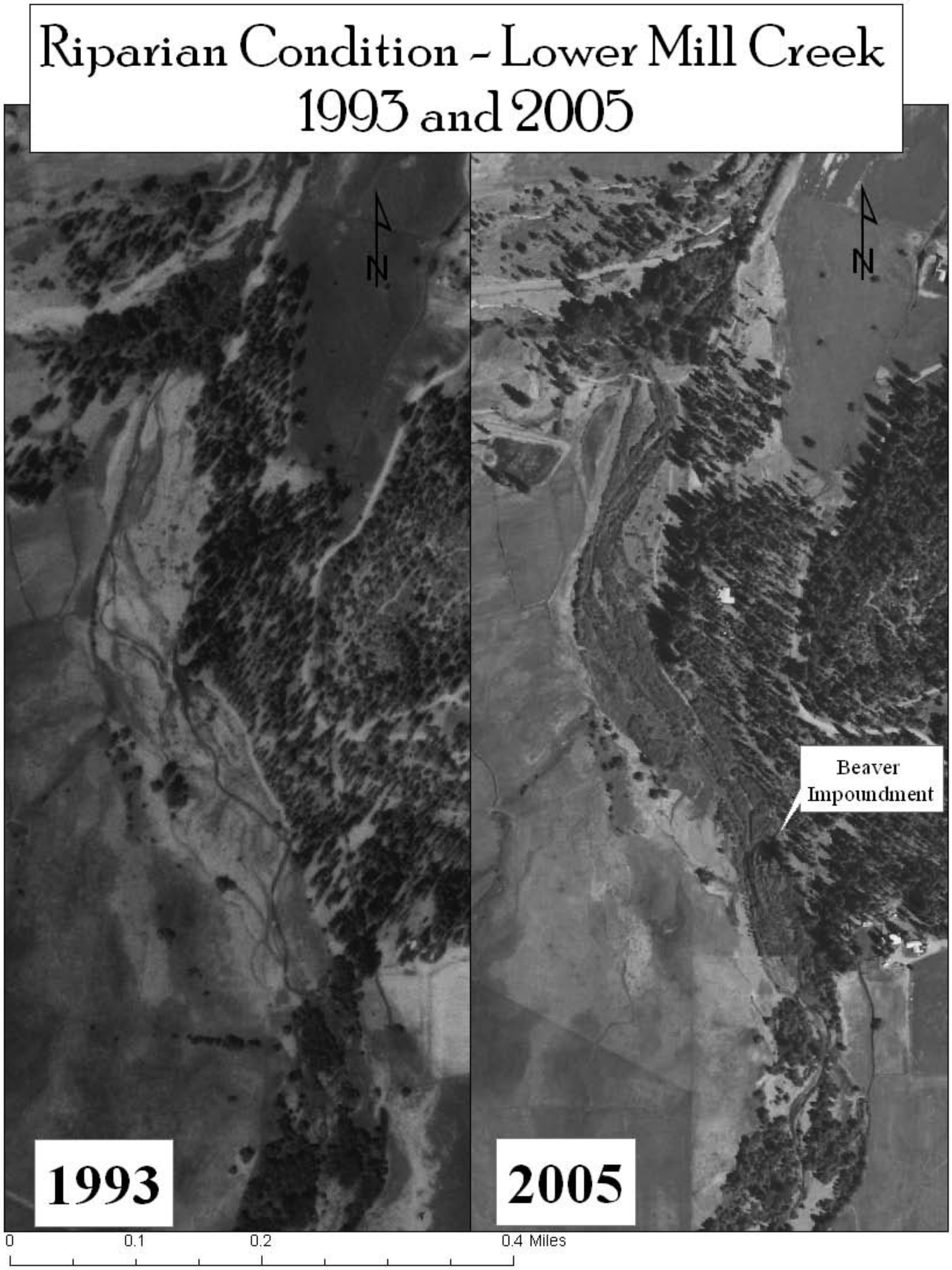


Figure 5 – Aerial images of the same reach of Mill Creek in 1993 (left) and 2005 (right).

The image above clearly illustrates the current (2005) extent of riparian vegetation in the project reach in contrast to the almost denuded state of the channel's banks and floodplain in 1993. A beaver dam and significant impoundment currently exists in the upstream portion of this reach.

No indication of beaver presence is observable from the 1993 aerial photograph. It is hypothesized that the increased riparian vegetation allowed the beaver to create a dam that impounds the creek effectively increasing the water table in the area and supporting further riparian growth. Besides the positive effect on riparian vegetation the beaver dam's impoundment has been documented to provide habitat for rearing juvenile coho salmon and rainbow trout.

Figure 6 This picture shows the completed fencing and riparian planting in 1999 - Mill Creek on left

Figure 7 This picture shows the same exclusion fence on Mill Creek, December 2008 **-** Mill Creek on left – overflow from beaver impoundment in foreground

Figure 8 This picture shows natural vegetation within the fenced riparian area after 10 months **-** 1999

The success of this site is attributed to combination of the cattle exclusion fencing in a reach with a stable year-round water table and the existence of a source riparian seeds above and within the reach.

Figure 9 Impoundment behind beaver dam in Mill Creek, December 2008.

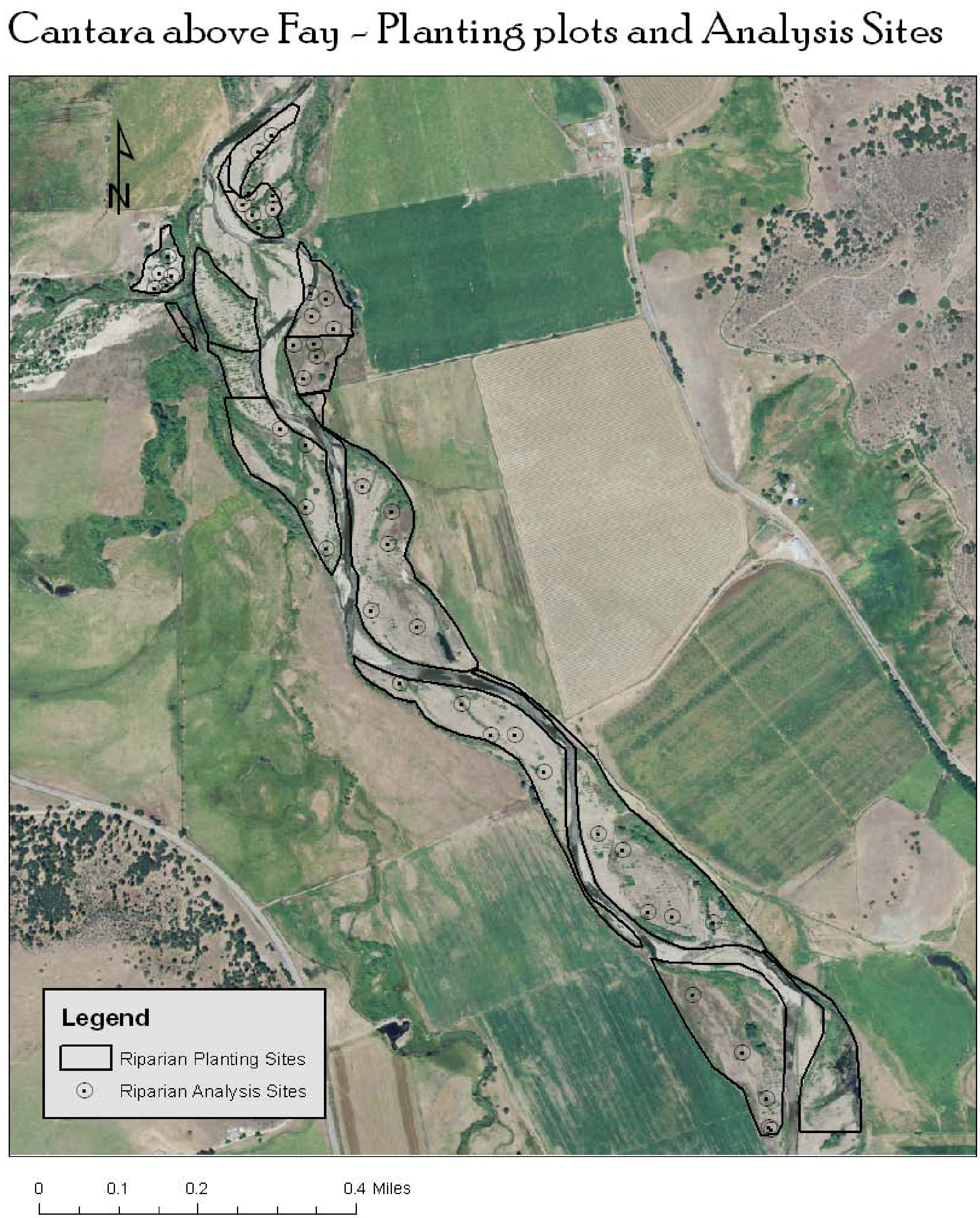
Figure 9 shows a view of the beaver dam from the west bank. The dam provides a stable water table year round that is ideal for riparian plants and rearing anadromous salmonids.

Additional examples of tributary plantings can be found in **Appendix B- Riparian Restoration Site Inventory.**

Scott River Mainstem

Scott River mainstem above Youngs Dam (SVID).

The first large scale effort to implement riparian planting efforts in the Scott River was in this reach. A total of 100 acres adjacent to the Scott River from French Creek to above Hwy 3 were planted in 1997 and 1998.This area had significant channel alignment alteration during the flood of 1997 and was dominated by barren gravel bars before restoration efforts. This project is generally referred to as the Fay Lane project or the Cantara site. The full extent of the planting effort was from below the confluence of French Creek upstream to above Fay Lane Bridge -See Map 5 Cantara Planting and Analysis Sites. At these sites the planting technique was primarily rooted stock with irrigation for up to three years with some live cuttings placed into excavated trenches. Plantings done in 1997 were partially wiped out by the 1997 flood. Some sites were replanted in 1998. Plantings on gravel bars were subject to cambium burn from heat reflected from the exposed substrate. There are plantings surviving at nearly all of the planting sites with the exception of a couple plots on the east side of the river that are currently barren.



Map #5 – Cantara plantings and analysis sites

Successful sites: Plantings at the mouth of French Creek between French and Wolford Slough were the most successful (Figure 10). This is potentially attributable to a higher water table with less annual fluctuation due to the subsurface water contributions from the two streams.

Failed sites: Plantings directly across the Scott River from Wolford Slough (e.g., Osprey Site) were a complete failure (Figure 11). This location's soil is primarily composed of gravel and cobble, with poor water retention and no protection from solar radiation. This site was planted with rooted stock and irrigated with drip line for a period subsequent to planting. The site is currently vegetated with sparse willows and severely stunted pine trees with grasses covering a portion of the ground. The exact reasons this site failed are unknown but it is hypothesized that a combination of extreme local heat on the barren bar, limited availability of water during the low flow period and poor soil conditions limited the success of the plantings. It is unknown if extensive irrigation and protection maintenance would generate success in this location. There is currently no riparian vegetation to create a shaded and cooler micro-climate during the summer months to aid the success and survival of introduced plantings. Protection measures (e.g., cages with shade cards and mulch) might create the desired micro-climate around each plant.

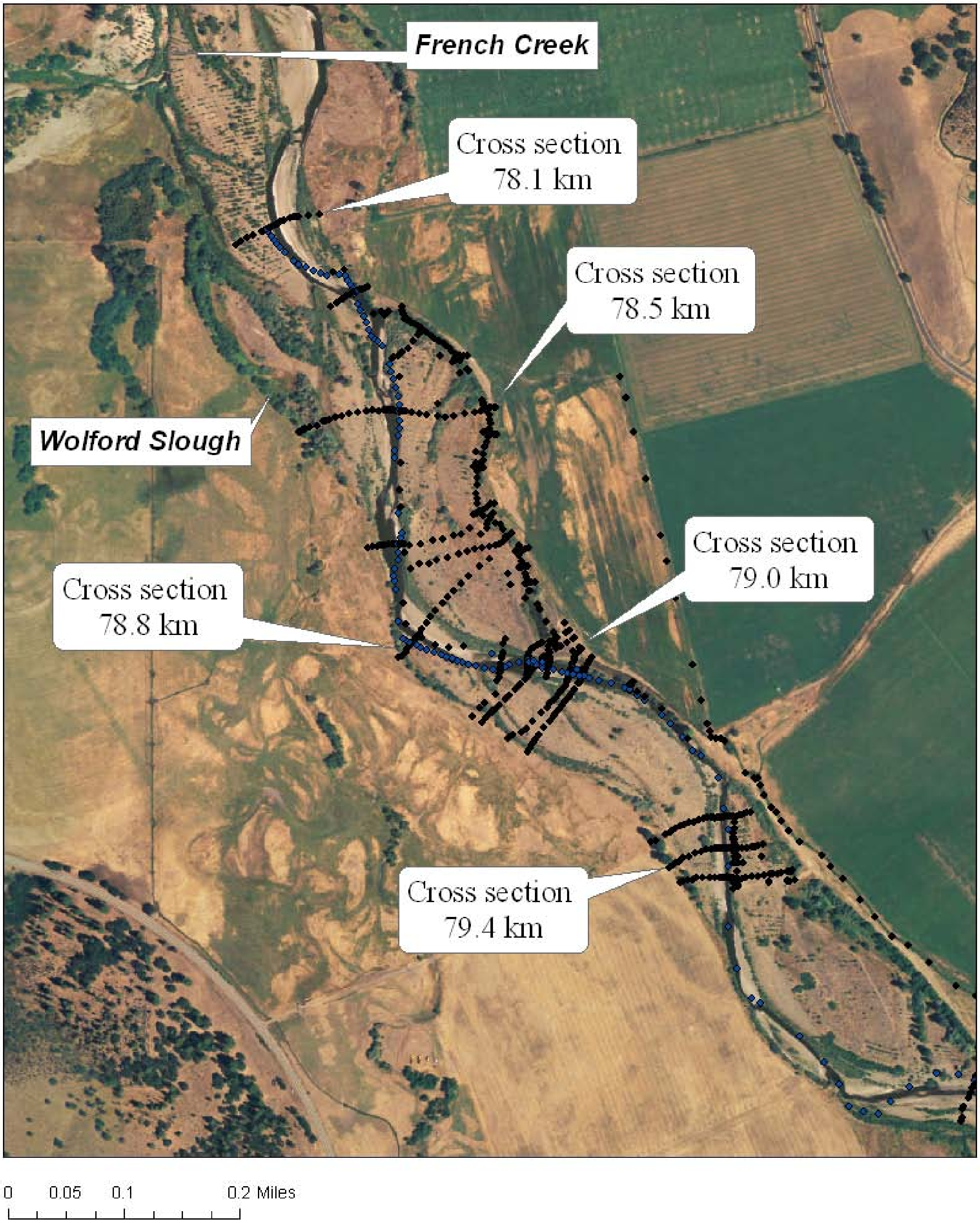
Figure 10 – Successful cottonwood planting north of the confluence of French Creek

Figure 11 – Failed riparian planting on east side of Scott River above French Cr. Confluence

Analysis of stream, bank and floodplain morphology that promotes riparian survival

A reach of the Scott River upstream of the confluence of French Creek was analyzed using multiple techniques, in order to determine what factors promote riparian vegetation recruitment. A longitudinal profile and cross section survey was performed through a reach of the Scott River (Map #6) that was planted as part of the Cantara Project. Analysis of the cross section elevations and presence or absence of riparian vegetation could demonstrate the relation between access to low flow water tables and riparian success.

Scott River above French Creek



Map #6 - Longitudinal profile and cross section survey of Scott River above French Creek

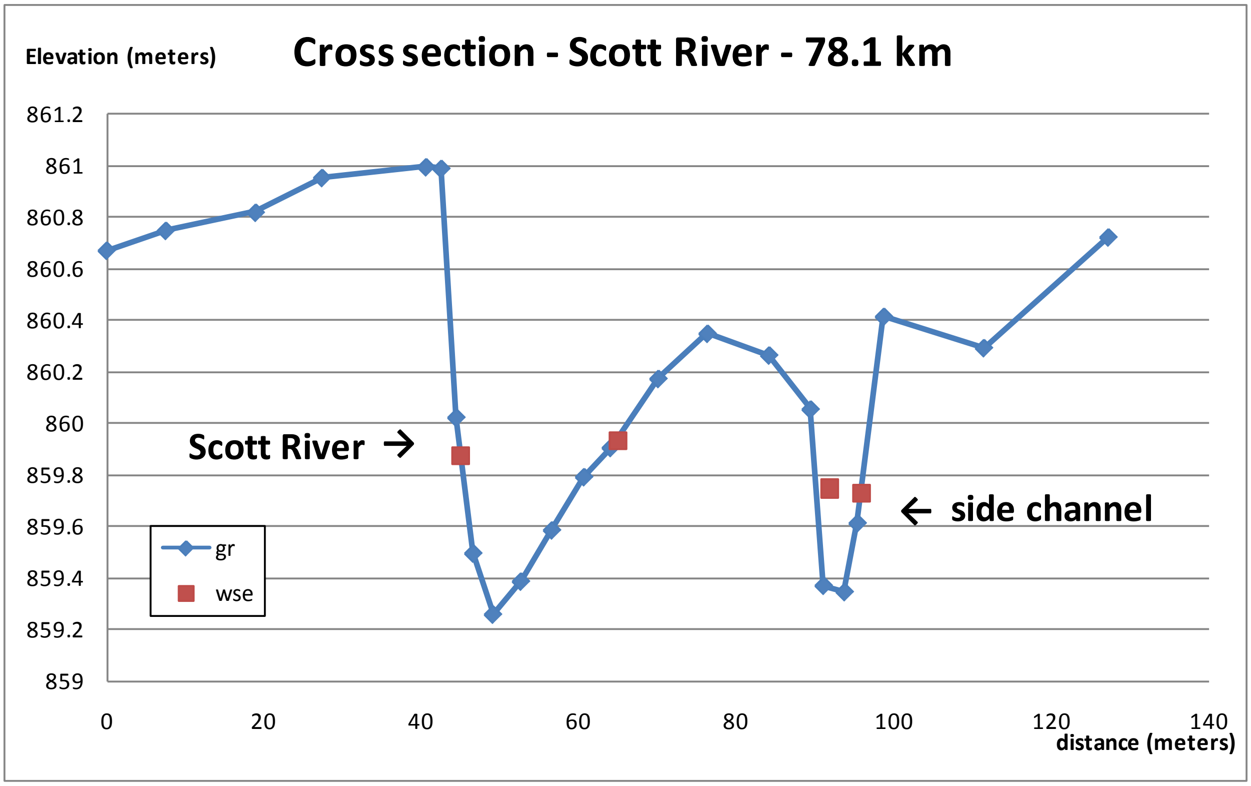


Figure 12 – Cross section of Scott River at RKM – 78.1 with water surface elevation (wse)

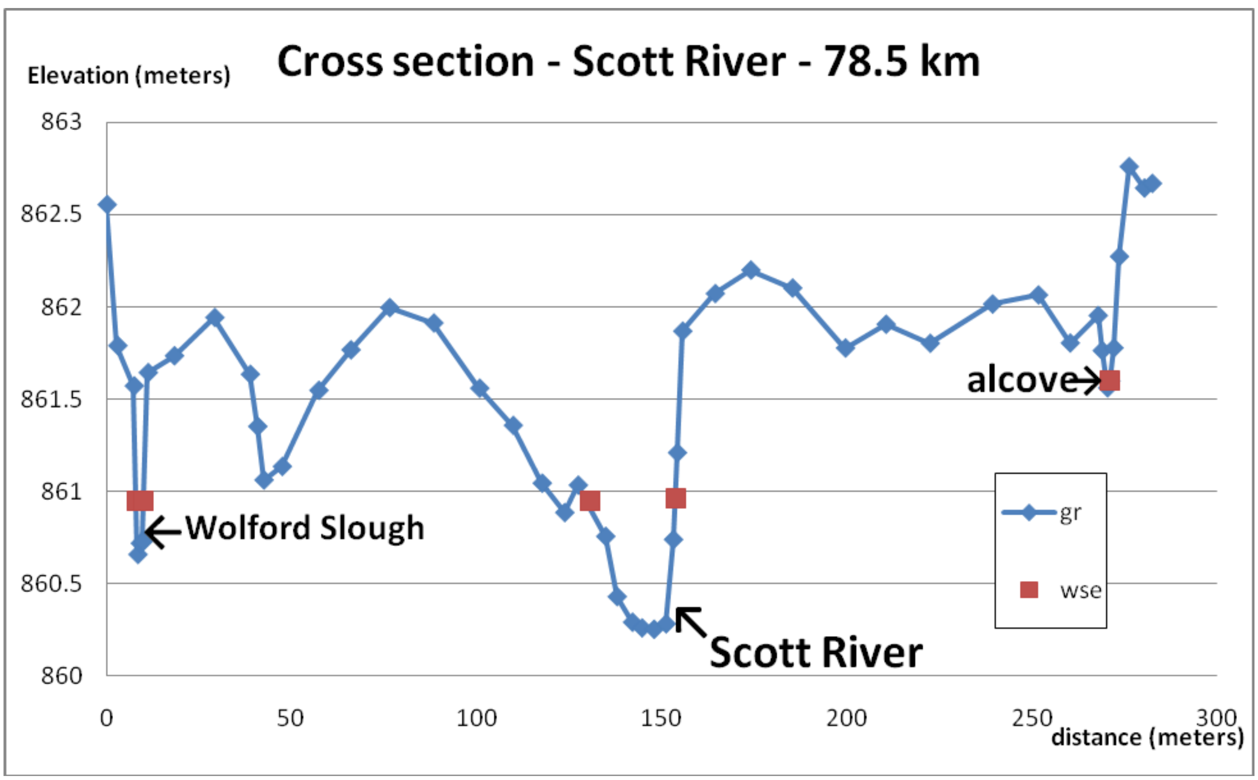


Figure 13 - Cross section of Scott River at RKM – 78.5 with water surface elevation (wse)

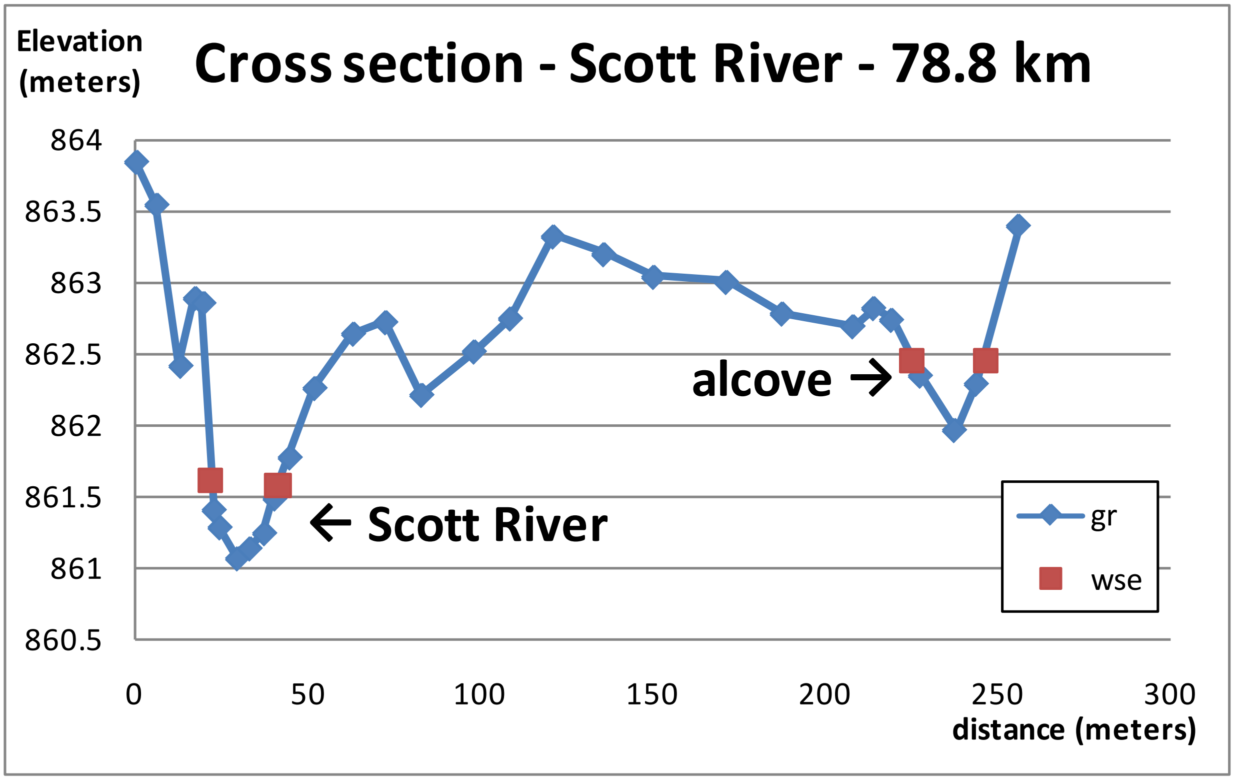


Figure 14 - Cross section of Scott River at RKM – 78.8 with water surface elevation (wse)

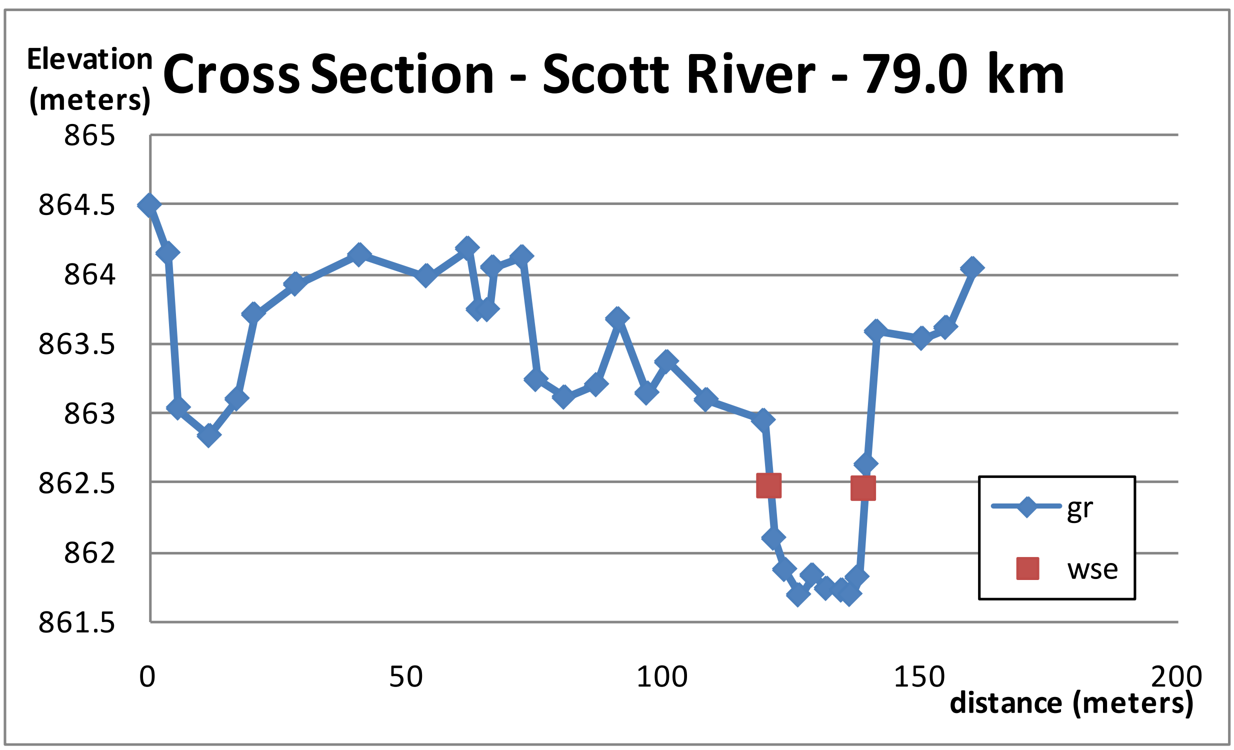


Figure 15 - Cross section of Scott River at RKM – 79.0 with water surface elevation (wse)

The downstream portion of the study reach is characterized by cross sections performed at RKM 78.1, 78.5 and 78.8 - Figures 12, 13 & 14, respectively. Wolford Slough is on the west side and a side channel (historic channel) is on the east side of the Scott River. Significant bars with maximum widths of approximately 100 meters (300 ft.) on which plantings were performed in the late 1990's separate these water features. Riparian vegetation is relatively dense along both Wolford Slough and the side channel with more limited vegetation across the bars (Figure 16). Analysis of the cross sections and water surface demonstrates that the elevations of the land adjacent to the water courses are less than those on the gravel bar. These water courses offer both surface water and land that is closer to the water table potentially increasing the survival and natural recruitment of riparian plants.

Figure 16 – Denser riparian vegetation in the background is associated with Wolford Slough

The cross section performed at RKM – 79.0 (Figure 15) shows a low elevation "trough" at the western edge (Left Bank). Analysis of the 2005 aerial photograph shows this trough is occupied by a strip of riparian vegetation in an area otherwise sparsely vegetated. Analysis of the aerial photograph captured in 1993 shows this area with lower elevation was occupied by the Scott River's channel previous to the 1997 flood (Figure 17). Though the channel has migrated, the former location has significantly lower elevation than the surrounding gravel bar creating an area with a depth to water table that is less than the depths on the adjacent gravel bar. The occurrence of riparian vegetation in this corridor with access to a "higher" water table indicates the importance of the water table's elevation in respect to the land in the success of riparian vegetation establishment.

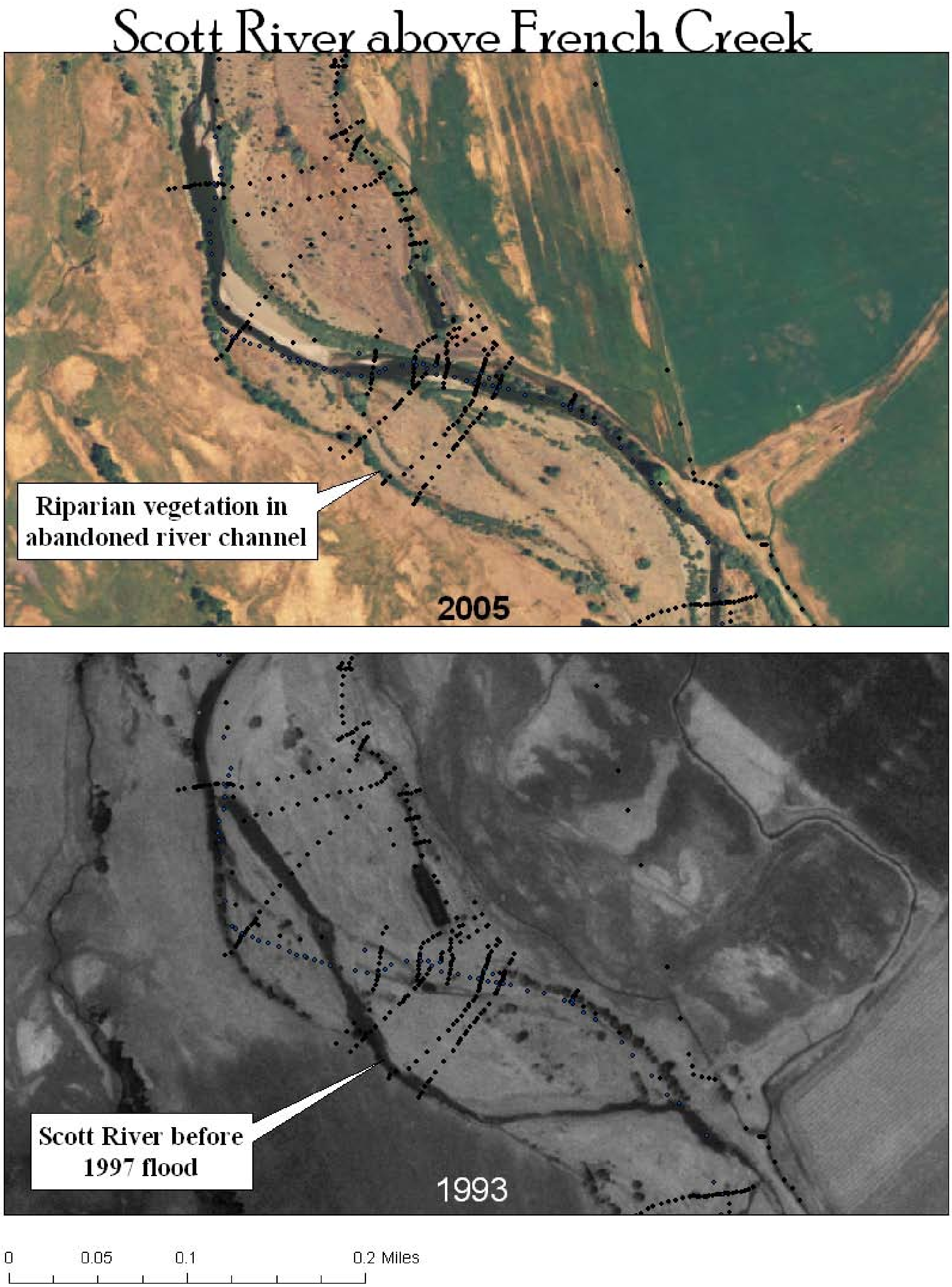


Figure 17 – Aerial images of study reach in 2005 (above) and 1993 (below)

Further analysis of the aerial images from 1993 and 2005 demonstrates multiple locations of channel alteration attributable to the 1997 flood in this reach (Figures 18a and 18b). Many of these abandoned channels are characterized by strips of riparian vegetation in the 2005 image. The reach from the bottom of the tailing pile to Youngs Dam does not have the significant elevation difference between the stream bed and adjacent lands that is observed in the leveed areas of the Scott River below Youngs Dam.

Figure 18a - Aerial image of study reach 1993

The access to the floodplain and more dynamic channel alignment in this reach has created a channel with wide gravel bars and areas of both robust and limited riparian vegetation. The elevation of these gravel bars is approximately 3 – 6 feet higher than the stream's thalweg. A potential riparian planting technique for this reach is live cuttings placed in holes and trenches excavated to the low water table elevation. Historic and natural plantings have shown that greater success occurs in areas with a shallower more stable water table and total failure can occur in areas with deeper water tables even though irrigation was installed. Placing cuttings into the water table precludes the need for the installation and maintenance of irrigation in areas with a high water table.

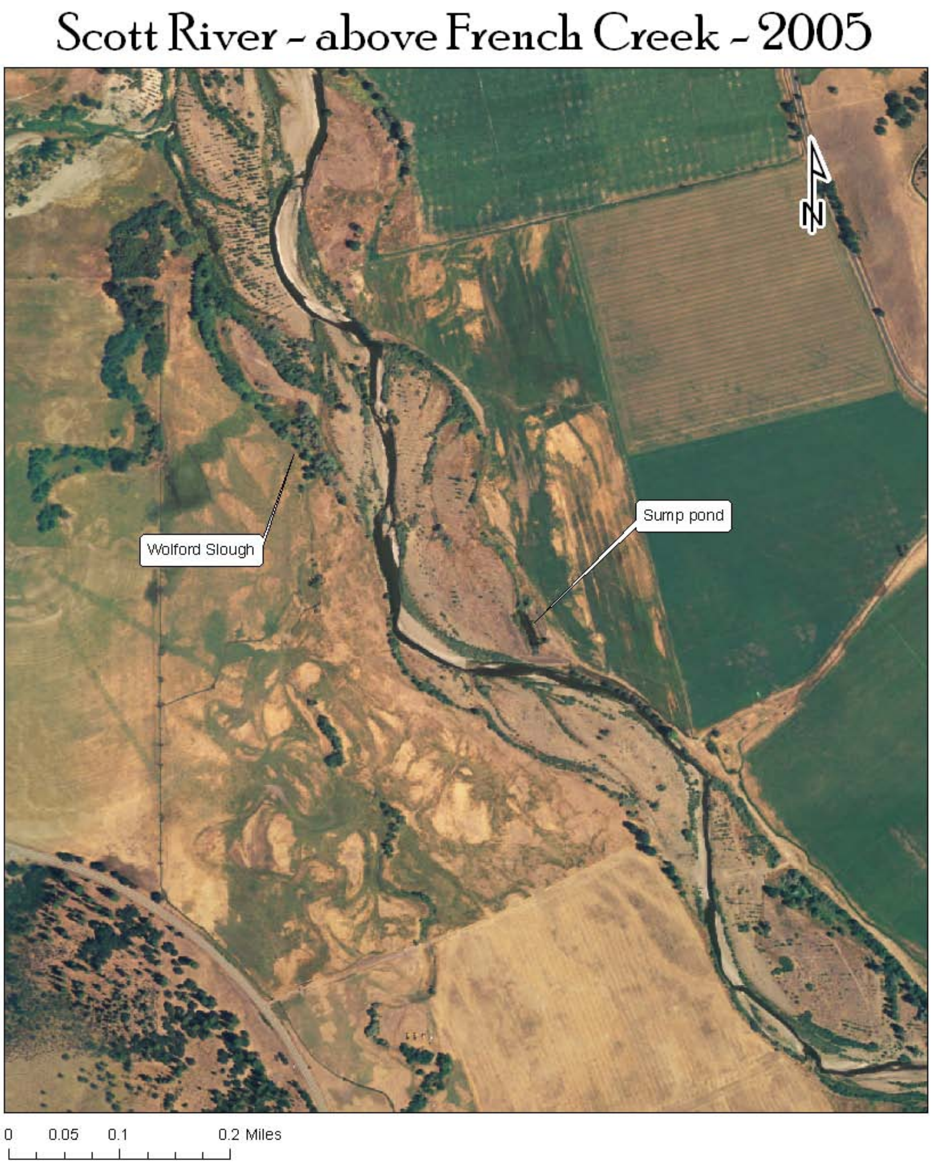


Figure 18b – aerial image of study reach 2005

<u>Scott River below Youngs Dam to Moffettt Creek</u>

Riparian plantings in this reach have not been very successful. It is hypothesized that this is partially attributable to the levees and constrained channel conditions and deeper water table. It is hypothesized that the leveed nature of the banks of this reach (downstream from Etna Creek especially) makes it not truly "riparian" This area lacks the bank structure to fully support a riparian corridor. The elevations and soil moisture of the leveed banks are characteristics more representative of the "upland zone" (Figure 19). It is expected that cottonwoods and pine trees might flourish in this but willows might have a more difficult time becoming established. The development of effective planting techniques for areas adjacent to the stream with high land elevations relative to surface and groundwater and low soil moisture is an essential prerequisite to direct future planting efforts in this reach with limited historic planting success.

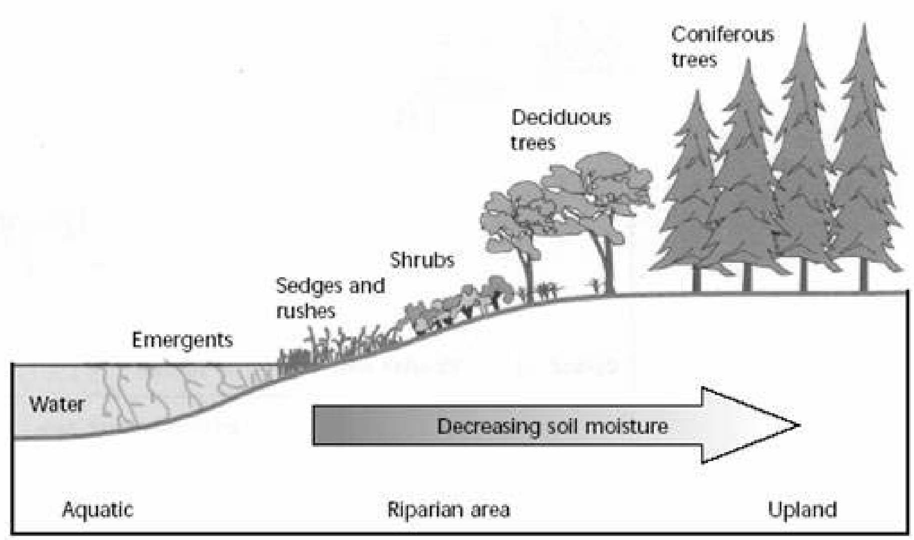


FIGURE 1 *Illustration of the moisture gradient in a typical riparian ecosystem (from Stevens et al. 1995:2).*

Figure 19 – Schematic illustration of "typical" riparian ecosystem

Figures 20 and 21 depict representative cross sections for the reach below Youngs Dam. Both of these cross sections have one bank that is very steep with the bank's top 12 to 15 ft higher than the stream's thalweg. The width of the available riparian land between fences is significantly less than the cross sections discussed for the reach upstream. Each cross section has an area of gravel bar with moderate slope on the bank opposite the steep bank. The current riparian density and distribution at RKM – 66 is mixed with areas of dense mature vegetation and areas vegetated with only grass and weeds (Figure 22). Some of the successful "riparian" plants are non-native species of trees introduced by the Soil Conservation Service – the trees on the right of this photograph are examples of these introduced trees. These trees are a mix of conifers, deciduous trees and willows. This example of successful plantings with trees that are not exclusively riparian is a potential model for future planting efforts.

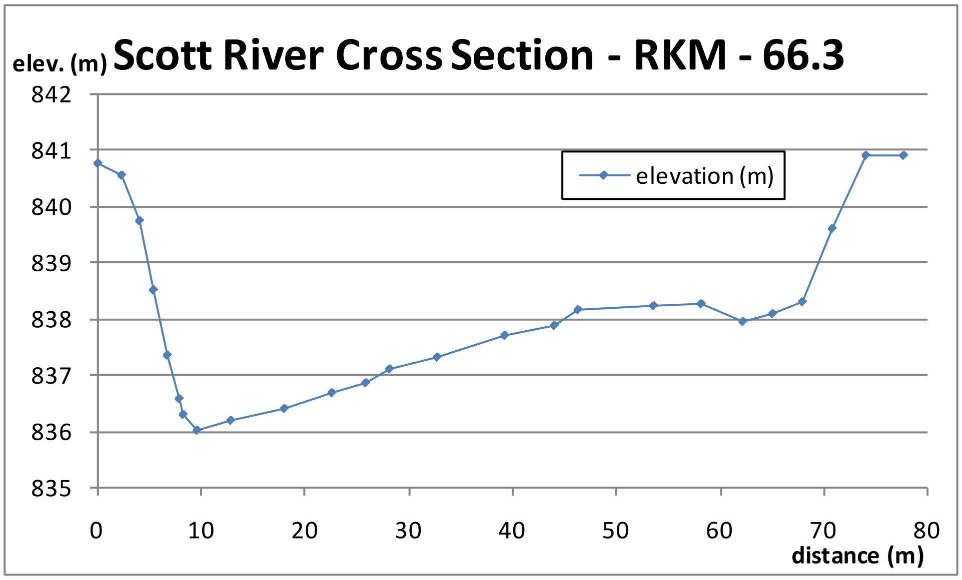


Figure 20 – Cross section at RKM – 66.3

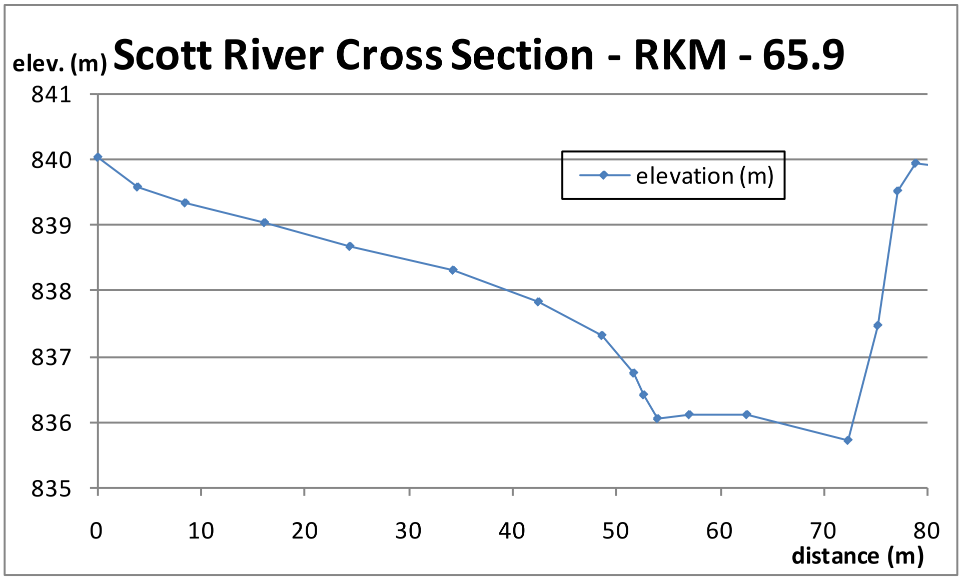


Figure 21 - Cross section at RKM – 65.9

The landowner of the surveyed reach has noted that a large number of the mature cottonwoods that were present through this reach have died in the near past. It is hypothesized that stream down cutting through this reach has lowered the water table effectively leaving the mature trees root structure above the base flow water table resulting in death. This example demonstrates the importance of insuring the survival of existing riparian vegetation while trying to introduce new riparian growth.

Figure 22 – Riparian canopy in area of RKM - 66

According to Wayne Elmore of the NRCS Riparian Service Team (Elmore 2004) "Portions of this reach of the river were channelized or leveed by the U.S. Army Corps of Engineers starting in 1938. The channelization straightened and thus shortened the length of Scott River. The shorter length causes an increase in velocity and subsequently leads to channel bed down-cutting. The down-cutting causes an overall lowering of Scott River bed elevation. The river can no longer access its historic frequent floodplain, which prevents it from dissipating energies during frequent events like 2- and 5- year events. The increased river energy has resulted in the need to rip-rap many sections of the river to prevent loss of adjacent agricultural areas. The vegetation along the channel is relatively sparse for the size of the Scott River. Agricultural areas have encroached on the banks of the river and leave little space for riparian vegetation. The root masses of existing riparian plants are insufficient to withstand the erosive forces of peak flow events. It is probable that cottonwood and willow composed a substantial portion of a much wider historic riparian zone. Few of these stabilizing trees and shrubs are present. Historically, a wide area of live trees and roots were intertwined with down, buried and partially buried LWM that combined to dissipate stream energy."

Elmore further states that "*A consequence of the channelization and levees is that the broad and relatively level floodplain no longer stores water for late-season release. As soon as the spring flow drops, the deeply incised channel cutting through the valley floor allows the accumulated groundwater to run into the relatively empty Scott River. The channel now acts as a drainage ditch similar to those used to drain wet areas. Historically, when the river bed was higher, the hydrostatic pressure of the river and its saturated bed held back the groundwater in the valley until late in the summer and early fall. Additionally, portions of the Scott Valley were historically* *home to large beaver colonies that created a maze of small dam complexes that stored large quantities of water. This water was gradually released during the late summer as adjacent river flows decreased. A greater amount of water was in the river longer when all the tributaries were at full potential for water storage. The fact that more water was infiltrated throughout the landscape, tributary floodplains, and valley floodplain, created a regime within which a longer period of time was required for groundwater molecules to wait their turn to exit the Scott River watershed*." This contributes to the observed lower groundwater table in this reach of the river.

However, some level of stream shading can be supplied in this reach. Lewis (1992) indicated that mature cottonwood could provide an almost closed canopy over this narrow stretch of the river. Plantings completed at Serpa Lane in 1992 demonstrate excellent success of riparian planting when proper irrigation is maintained. These planting are beginning to provide significant afternoon shading of the Scott River.

Many of the surveyed riparian planting sites that had few to no remaining plants were occupied with grasses. Many of these sites had rhizomatous grasses (e.g. canary reed grass) before the introduction of plants. Efforts were made to remove the grass when the sites were prepared for planting including using an excavator to dig up the sites soil and grass. It is believed that these eradication efforts were not successful and the grasses out competed the introduced plantings for the limited water supply. Development of techniques to effectively remove invasive grasses from planting sites previous to the placement of plants is an essential step to insure future planting efforts have the highest probability of success.

Scott River from Moffettt Creek downstream

The reach of the Scott River just above the canyon is not entrenched, and can access the floodplain during typical high flow events. Plantings within this reach have been fairly successful. This is likely due to a more accessible water table. There are currently no cross section surveys for this reach for comparison to the upstream reaches. Photographic evidence (Figures 23 and 24) demonstrate the gradual grade of the stream banks, an accessible flood plain and areas of good riparian density and growth. Figure 24 illustrates the presence of vegetation types that are representative of the types in the schematic diagram of typical riparian types. There is emergent vegetation (grasses) along the bank that is directly adjacent to the stream's active channel with willow shrubs in the area of slightly higher elevation. No mature deciduous is observed in the elevations above the willow shrubs in Figure 24, but mature deciduous vegetation can be seen on both sides of the Scott River above Meamber Bridge. The lack of levees in most areas of this reach allows for a wider more dynamic river with areas dominated by large mostly barren gravel bars. The downstream portion of this reach is characterized by significant amounts of accretion to surface water flows. Insuring that the cold water from the accretion flows is not instantly warmed by solar radiation is an objective of future riparian planting efforts. The downstream portion of this reach has some of the highest density of adult Chinook salmon spawning observed in the Scott River. Protecting this key spawning habitat from fine sediment pollution from stream bank failure and adjacent land use is another objective of riparian planting and protection efforts.

Figure 23- Scott River at Meamber Bridge looking upstream

Figure 24 – representative stream bank above Shackleford Creek

Successful sites: Riparian planting efforts in the Scott River below Meamber Bridge were successful when the plantings survived the initial period of establishment. Existing growth in the surveyed areas have reached heights greater than 20 ft at 8 years of age. Some locations within the planting sites show no survival but this may be due to high waters from the 2005 flood. This site has also experienced some natural recruitment. Overall survival is estimated at less than 20%. This site would likely have benefited from irrigation.

The site directly downstream from the confluence of Meamber Creek was also considered a success. The surviving trees have large amounts of growth and 85% of them are greater than 10 feet tall. This site benefited from adequate irrigation and maintenance. However, natural recruitment appears to be largely absent in the areas currently dominated by grasses.

Failed sites: The riparian planting along the Scott River directly below Moffettt Creek have mostly failed. The soil in this area is primarily composed of gravel and cobble with little fines. Currently, the site is completely barren offering no protection for plantings when summer temperatures at the site soar above 100 degrees. The drought of 2001 and 2002 stressed the newly planted trees and the high waters of 2005 deposited sand and gravel on the remaining plantings. Field observations noted that the terraces are of higher elevation than those found in the downstream portion of this reach. The elevation of the terraces is not as far above the stream elevation as the leveed area of the Scott River but it is hypothesized that this area still has some landforms adjacent to the river with low soil moisture and a significant distance to the base flow water table. This area that is downstream of the constrained and leveed portions of the Scott River could also experience greater amounts of stream channel alteration and stream bank erosion that reduces the survival of natural and introduced riparian plantings.

Chapter 5 - Priority Locations for Riparian Vegetation

Main stem Scott River

The following factors have been identified in the prioritization of planting locations for the main stem Scott River. They are listed in order of importance.

1.) Success or failure of past riparian planting efforts.

  a. Planting should be prioritized in past locations identified as successful (if needed) to expand and enhance the existing riparian corridor.

  b. The reach from Fay Lane to Etna Creek has shown moderate to good success in past planting efforts. Planting some of the areas currently lacking riparian vegetation would increase the density and distribution of riparian shade in this reach with documented accretion flows.

2.) Depth to base flow (low) water table.

  a. The morphology of the main stem Scott River and adjacent banks and floodplain should be surveyed (*e.g.*, longitudinal profiles and cross-sections) to determine the depth to water in representative locations. Plantings should focus on locations with a relatively stable and shallow water table when possible.

  b. Planting techniques for areas with a deep water table need to be developed to insure success.

3.) Start planting efforts in the upstream portion of the stream to prevent cool surface water from heating by solar radiation.

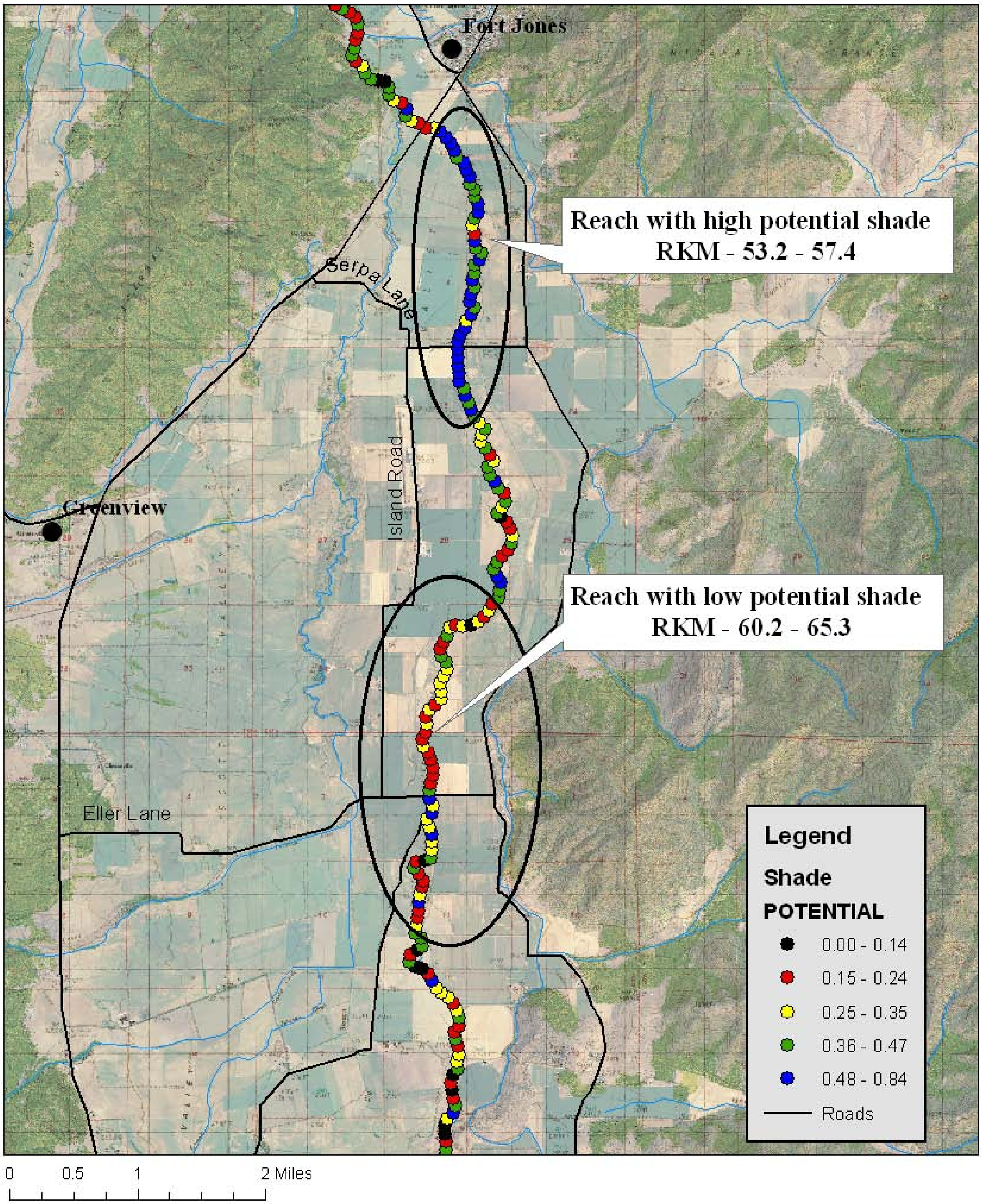
  a. Planting efforts should initially focus on the downstream end of the tailings reach to protect the cool water exiting the tailings.

  b. Planting efforts should be focused in areas of documented surface water accretion to protect the resulting cooler water and potential thermal refugia for rearing cold water fish.

4.) Areas with the highest potential shade per HeatSource Model

  a. Plantings in areas with higher potential shade values will generate the greatest reduction of stream heating from solar loading.

Potential Shade - HeatSource 7.0 from NCRWQCB for Scott TMDL



Map #7 – Potential shade values calculated for 0.1 km nodes of the Scott River – data developed in HeatSource 7.0 by the NCRWQCB for the Scott River TMDL.

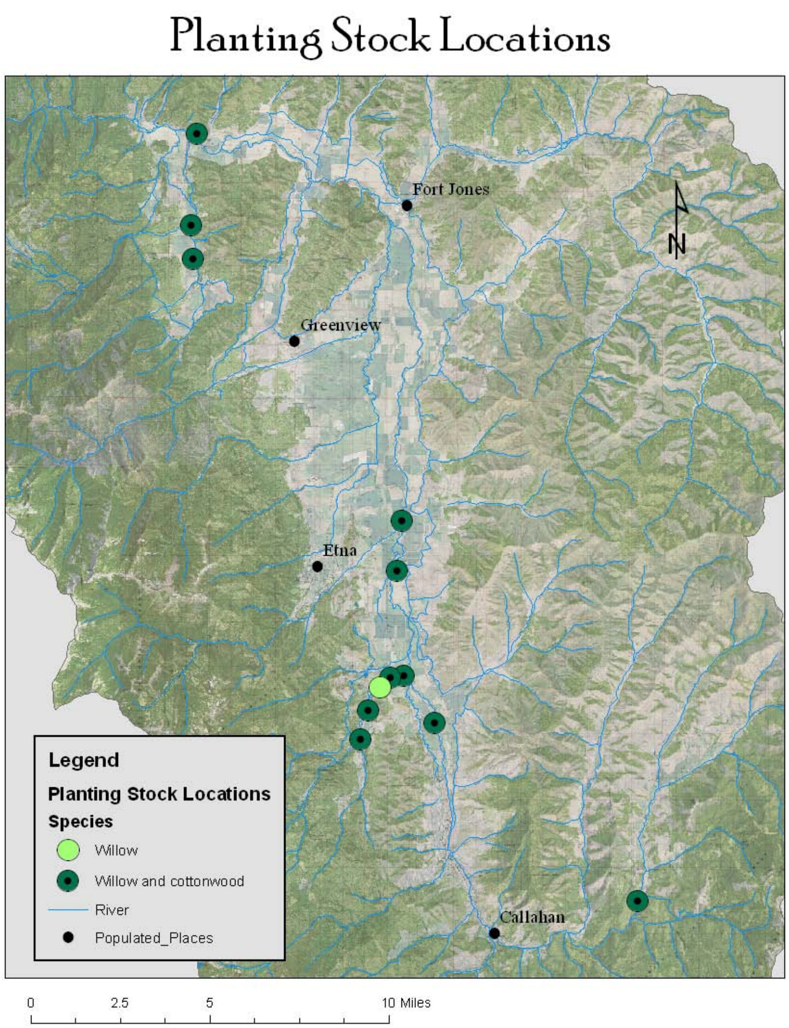
Tributary locations

The first priority for planting sites in the tributaries should focus on locations with a stable channel above the alluvial reaches.

- French Creek from Miners Creek to Hwy 3.
- Mill Creek from disconnected reach to confluence with Shackleford
- Shackleford Creek from confluence with Mill to disconnected Reach

Identified Locations with Native vegetation

Based upon observations during the inventory of previous riparian restoration projects, as well as observations from planting projects, the following locations have been identified as having sufficient existing native vegetation to serve as a source for live planting stock. See Map # 8 Native Vegetation Locations.



Map #8 – Locations with currently available planting stock

Main stem Scott River:

Location	Location	Species
Confluence of Etna Creek	T42N R9W Sec 23	willow, cottonwood
Above Horn Lane	T42N R9W Sec 26/35	willow, cottonwood
Confluence of French Creek	T41N R9W Sec11	willow, cottonwood
Above Fay Lane	T41N R9W Sec24	willow, cottonwood
Downstream from Meamber Bridge	T44N R10W Sec 26/27	Willow
Below Highway 3	T43N R09W Sec 3	Willow, cottonwood

Tributaries

Location	Coordinates	Species
Mouth of French Creek	T41N R9W Sec11	Willow/cottonwood
French Cr. Above Miners Rd Crossing	T41N R9W Sec15	Willow/cottonwood
French Creek above Hwy3	T41N R9W Sec10/15	Willows
East Fork - Lower Masterson Rd to Grouse Creek	T40N R8W Sec18	willow, cottonwood
Confluence of Miners and French Creek	T41N R9W Sec 22	Willow/cottonwood
Shackleford/Mill Confluence	T43N R10W Sec11	willow, cottonwood
Mill Creek below Quartz Valley Rd Crossing	T43N R10W Sec 14	willow, cottonwood

Chapter 6 - Recommended techniques and planting methods

Based on the analysis of previous riparian planting projects and review of professional literature, the following recommendations are made for enhancing the success of future riparian restoration efforts in the Scott Valley.

1.) Planting sites should be selected based on the prioritizations identified in Chapter Five.

2.) Perform channel cross-section surveys to identify relative depth to water table and natural swales (depressions) prior to the implementation of planting at any location.

3.) Utilize live cuttings (pole and brush) buried in holes and trenches excavated to the low flow water table in appropriate locations.

4.) All plantings on the main stem Scott River should be maintained for a minimum of three years. Maintenance of rooted stock should include: irrigation, browse and weed protection and shade cards to prevent cambium burn. Live cuttings could include (depending on site characteristics): irrigation in critical dry periods, browse and weed protection and shade cards. All planting sites should be surveyed in spring to assess any maintenance requirements (e.g., replacement of cages). At the end of the three year period each planting site should be evaluated to assess the need for future maintenance.

5.) Plantings in stable tributary locations should be protected from browse and with shade cards in barren landscapes. The need for irrigation in tributary locations should be determined on a per site basis.

6.) At sites with high potential for future bank erosion, bioengineered bank stabilization techniques should be used to prevent further bank erosion and promote riparian establishment.

7.) Local organizations (*e.g.*, Siskiyou RCD and Scott River Watershed Council) should investigate the possibility of establishing “nurseries” of native cottonwood and pine to serve as sources for future planting efforts.

Chapter 7 - Summary and Recommendation

The Scott River riparian analysis attempted to visit and assess as many sites of historic riparian planting efforts as possible. A series of recommendations for future planting efforts have been generated through the review of the methods used to plant and maintain the various sites and the success or lack thereof of the different techniques and locations. The analysis attempted to delineate areas in the Scott River watershed that had similar characteristics so that recommendations could be tailored for the different environments. The characteristics used to delineate the different riparian areas include: historic channel and floodplain alteration, depth to water table, stability of water table, stream morphology, current riparian condition and the level of success of historic planting efforts. The riparian areas of the Scott River were broken into three main stem reaches and tributary reaches. Areas with relatively high stable water tables (*e.g.*, tributaries) and access to the floodplain (*e.g.*, above Youngs Dam) have some of the best current riparian condition and highest level of riparian planting success in the watershed. Areas with a relatively low and/or unstable water table and significant channel and floodplain alteration currently have limited riparian corridors and success of historic plantings. The development of effective planting and maintenance techniques for the reaches with limited riparian corridors and historic restoration success is an essential next step in the development of a successful riparian restoration program for the Scott River Watershed.

Several observations and recommendations were made through the performance of this analysis. The most important recommendation is that proper protection and maintenance techniques are imperative for the short and long term success of riparian planting projects. The protection and maintenance measures include removal of invasive grasses, browse protection, protection from extreme heat and irrigation in areas with a low water table. The analysis observed higher rates of planting success in areas with a relatively high water table versus areas with a relatively low water table. The pursuit of further plantings in areas with a relatively high water table is recommended. Planting sites that were planted a decade ago and currently have some success with areas of barren landscape is recommended.

The next step in the development of an effective riparian restoration program for the Scott River watershed is the development of a Schedule and Strategy for Riparian Planting as recommended in the Scott River TMDL. The Schedule and Strategy will develop techniques for planting in areas with a high and low water table. The development of effective riparian restoration techniques for areas with a low water table in relation to the land elevation is a critical step in the pursuit of a riparian restoration program for the watershed.

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