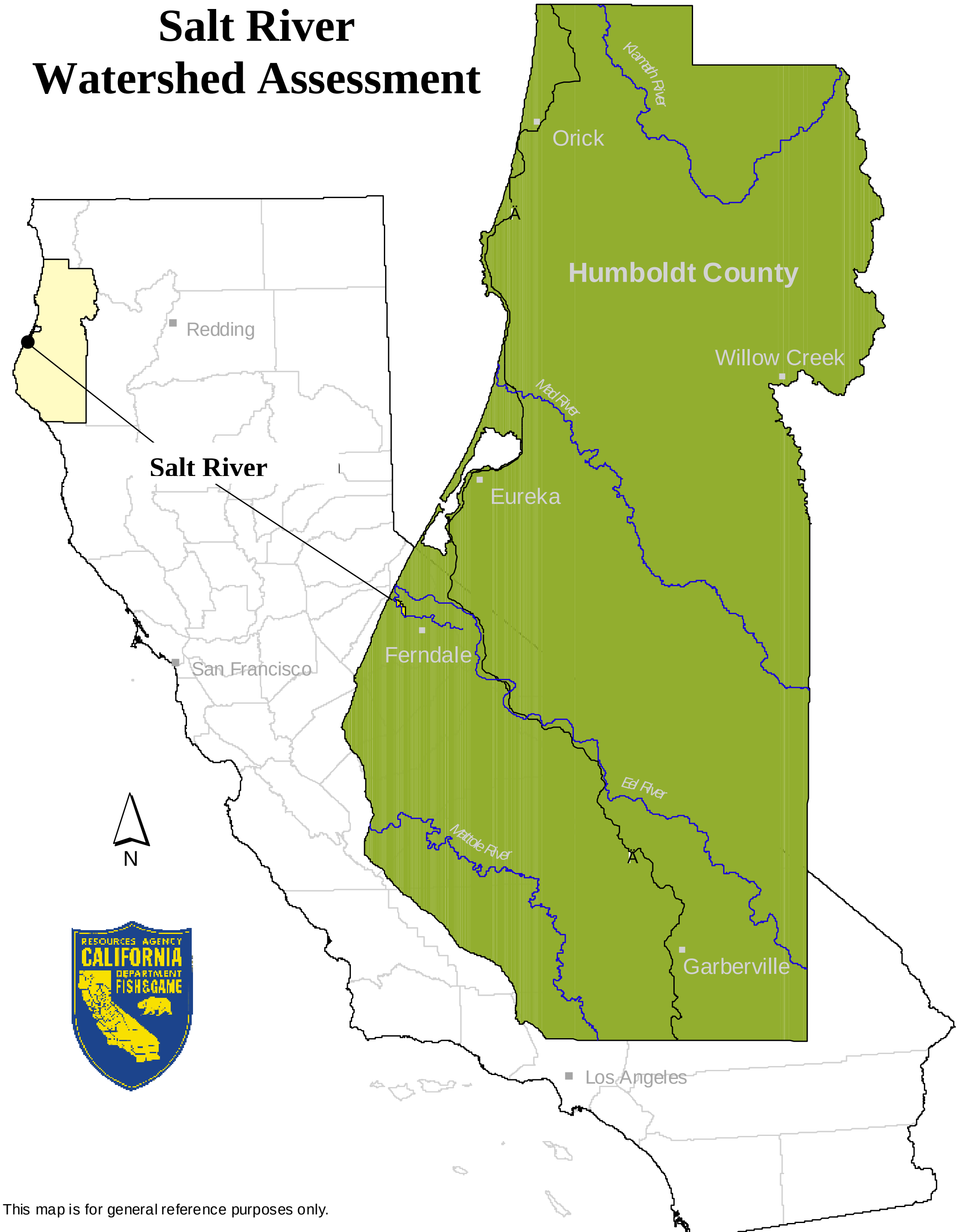
Salt River
Watershed Assessment



This map is for general reference purposes only.

Map: California Department of Fish and Game, June 2004.

Salt River
Watershed Assessment

Prepared through
a cooperative effort by

California Department of Fish and Game
Coastal Watershed Planning and Assessment Program

California Coastal Conservancy

Pacific States
Marine Fisheries Commission

Humboldt County
Resource Conservation District

May
2005

Coastal Watershed Planning and Assessment Program

Contributors

Department of Fish and Game
Director, Loris "Ryan" Broddrick

Salt River Watershed Assessment Contributors

Team Leader: Scott Downie
Primary Author: Kevin Lucey
Senior Biologist Specialist: Mark Wheetley
Associate Fishery Biologist: Steve Cannata
Fisheries Biologist: Beatrijs deWaard
GIS Specialist: Vikki Snider
Programmer: Karen Wilson

Acknowledgements: Natural Resource Conservation Service, UC Cooperative Extension, City of Ferndale, Humboldt County Planning Department, Ferndale Museum, Bruce Slocum, Bryan Furman, Marnie Atkins of the Wiyot Tribe.

Suggested Citation:

Downie, Scott T., Lucey, Kevin. P. 2005. Salt River Watershed Assessment. Coastal Watershed Planning and Assessment Program. Department of Fish and Game.

Table of Contents

List of Figures

List of Tables

Executive Summary

California Coastal Watershed Planning and Assessment Program

The Salt River Basin Assessment Report is a special project of the Coastal Watershed Planning and Assessment Program (CWPAP). CWPAP is a CDFG program conducting fishery based watershed assessments along the length of the California coast. The Salt River Basin was chosen as an assessment area due to the pressing nature of the socio-economic and natural resource problems caused by the river's dysfunction. The production of the Salt River Assessment Report adhered to the CWPAP methods manual and protocols; where applicable. The program's work is intended to provide answers to the following assessment questions at the basin and tributary scales in California's coastal watersheds:

- What are the history and trends of the size, distribution, and relative health and diversity of salmonid populations?
- What are the current salmonid habitat conditions; how do these conditions compare to desired conditions?
- What are the impacts of geologic, vegetative, fluvial, and other natural processes on watershed and stream conditions?
- How has land use affected these natural processes and conditions?
- Based upon these conditions, trends, and relationships, are there elements that could be considered to be limiting factors for salmon and steelhead production?
- What watershed management and habitat improvement activities would most likely lead toward more desirable conditions in a timely, cost effective manner?

The assessment program's products are designed to meet these strategic goals:

- Organize and provide existing information and develop limited baseline data to help evaluate the effectiveness of various resource protection programs over time;
- Provide assessment information to help focus watershed improvement programs, and to assist landowners, local watershed groups, and individuals in developing successful projects. This will help guide support programs, such as the CDFG Fishery Restoration Grants Program, toward those watersheds and project types that can efficiently and effectively improve freshwater habitat and lead to improved salmonid populations;
- Provide assessment information to help focus cooperative interagency, nonprofit, and private sector approaches to protect watersheds and streams through watershed stewardship, conservation easements, and other incentive programs;
- Provide assessment information to help landowners and agencies better implement laws that require specific assessments such as the State Forest Practice Act, Clean Water Act, and State Lake and Streambed Alteration Agreements.

General Assessment Approach

The general steps in our large-scale assessments include:

- Determine logical assessment scales;
- Discover and organize existing data and information according to discipline;
- Identify data gaps needed to develop the assessment;
- Collect needed field data;
- Amass and analyze information;

- Develop conclusions and recommendations;
- Facilitate implementation of improvements and monitoring of conditions.

Scale of Assessment and Results

The assessment team used the California Watershed Map (CalWater version 2.2.1) to delineate the Salt River Assessment Basin for assessment and analyses purposes. The study area was further delineated into ecological units: Wildcat Tributaries and the Salt River Delta. Demarcation in this logical manner provides a common scale for conducting assessments. It also allows for reporting of findings and making recommendations for watershed improvement activities that are generally applicable across relatively homogeneous areas.

Assessment Products

This report and its appendices are intended to be useful to landowners, watershed groups, agencies, and individuals to help guide restoration, land use, and management decisions.

Assessment products include:

- A basin level Synthesis Report that includes:
  - Collection of Salt River assessment basin historical and sociological information;
  - Description of historic and current vegetation cover and change, land use, geology and fluvial geomorphology, water quality, and instream habitat conditions;
  - Evaluation of watershed conditions affecting salmonids;
  - An analysis of the suitability of stream reaches and the watershed for salmonid production and refugia areas;
  - Tributary and watershed recommendations for management, refugia protection, and restoration activities to address limiting factors and improve conditions for salmonid productivity;
  - Monitoring recommendations to improve adaptive management efforts.
- Databases of information used and collected;
- A data catalogue and bibliography;
- Web based access to the Program's products: http://ncwatershed.ca.gov/, and http://imaps.dfg.ca.gov/, and ArcIMS site.

Salmonids, Habitat, & Land Use Relationships

There are several factors necessary for the successful completion of an anadromous salmonid's life history. In their freshwater phases, adequate flow, good water quality, free passage, good stream habitat conditions, and proper riparian function are essential for survival. Stream condition includes several factors: adequate stream flow, suitable water quality, appropriate stream temperature, and complex, diverse habitat. Adequate instream flow during low flow periods is essential to provide juvenile salmonids free forage range, cover from predation, and utilization of localized temperature refugia from seeps, springs, and cool tributaries. Important aspects of water quality for anadromous salmonids include water temperature, water chemistry, turbidity, and sediment load. Habitat diversity for salmonids is provided by a combination of deep pools, riffles, and flatwater habitat types.

A functional riparian zone helps to control the amount of sunlight reaching the stream, and provides vegetative litter and invertebrate fall. These contribute to the production of food for the aquatic community, including salmonids. Tree roots and other vegetative cover provide stream bank cohesion and buffer impacts from adjacent uplands. Near stream vegetation eventually provides large woody debris and complexity to the stream (Flosi et al. 1998).

Geology, climate, watershed hydrologic responses, and erosion events interact to shape freshwater salmonid habitats. "In the absence of major disturbance, these processes produce small but virtually continuous changes in variability and diversity against which the manager must judge the modifications produced by nature and human activity. Major disruption of these interactions can drastically alter habitat conditions" (Swanston 1991). Major watershed disruptions can be caused by catastrophic events, such as the 1955 and 1964 floods or major earthquakes. They can also be created over time by multiple small natural and/or human disturbances.

Natural disturbance and recovery processes, at scales from small to very large, have been at work on North Coast watersheds since their formation millions of years ago. Recent major natural disturbance events include large flood events such as occurred in 1955 and 1964 (Lisle 1981a). Major human disturbances associated with post-European expansion like dam construction, agricultural and residential land development, and timber harvesting practices used particularly before the implementation of the 1973 Z'Berg-Nejedly Forest Practice Act have occurred over the past 150 years (Ice 2000).

Salmonid habitat was also degraded during parts of the last century by well-intentioned but misguided restoration actions such as the removal of large woody debris from streams (Ice 1990). More recently, efforts at watershed restoration have been initiated at the local and state levels by such major programs as CDFGs Fishery Restoration Grants Program (FGRP). For example, several California counties, with FGRP funding, have addressed fish passage problems associated with their roads' stream crossings, opening many miles of historic habitat to salmonids. For additional information on stream and watershed recovery opportunities and project types, see the publication by the Federal Interagency Stream Restoration Working Group (FISRWG 1998).

Salt River Basin

The Salt River Basin is located in Humboldt County, 15 miles south of Eureka, CA and encompasses approximately 47 square miles (30,425 acres). The Salt River Basin is comprised of the Wildcat tributaries (12,775 acres) and the alluvial delta (17,650 acres). The headwaters of the Salt River Basin reach an average elevation of 800 feet with maximum elevations of 1,750 feet. The Salt River Basin has a moderate climate with an average annual temperature of 52°F. Average annual precipitation in the region is 44 inches, 90% of which falls during the winter season.

The Salt River Basin is part of the Eel River Delta and Estuary, although its role as an estuarine slough has lessened over the years. At one time the Salt River was a significant part of the Eel River Estuary and was a tidal stream at all times. It is thought that the Salt River occupies a former channel of the Eel River that was left behind as the dominant channel of the Eel River migrated north across the delta over centuries of change. The Salt River, under 1850 conditions, had four anadromous freshwater tributaries, seven smaller drainages and several significant estuarine tributaries.

The Salt River is located in an area where natural processes create a dynamic and ever-changing aquatic system. These natural processes include: loosely consolidated sedimentary rock formation in the Wildcat Hills that are susceptible to large scale landslides; steep slopes, and a high occurrence of earthquakes. The project area is also influenced by tectonic subsidence and uplift and by changes in sea level. Other natural processes that influence the Salt River include intense winter rainfall. A complex interaction of a century and a half of land use actions combined with natural conditions and events have destroyed the Salt River. The Salt River has currently reached a point where it is hydrologically incompetent and serves very few ecosystem benefits and has created numerous socio-economic problems.

Prior to Euro-American exploration and settlement, the Wiyot people inhabited the area. The Wiyot dwelling place, Wotwetwok, was located along the Salt River (Oka't). The Wiyot used the Salt River and its surroundings for fishing and transport.

In 1852, the Ferndale area was settled by the Seth Louis Shaw. The character of the Salt River Delta in the 1850's was much different than it is today. Where it was not a watercourse or a freshwater wetland the Salt

River Delta was densely vegetated with riparian thickets and spruce forests. A large portion of the western Salt River Delta was comprised of tidal lands.

A shipping industry was established along the banks of the Salt River in the town of Port Kenyon in the 1870's, which facilitated the growth of agriculture in the Ferndale area and supported several sawmills and canneries. At that time near Port Kenyon, the Salt River was 200 feet wide and 15 feet deep.

In the 1880's there was a substantial effort to reclaim tidelands in the western delta. A reclamation district was formed and an estimated 2,900 acres of tideland were targeted for reclamation. Levees and tidegates were installed along and across waterways in order to convert tidelands into agricultural land. The actions of widespread tideland reclamation across the Eel River Delta reduced the tidal prism of the Eel River Estuary, which contributed to the reduced the size of the Salt River. Also, several of the creeks tributary to the Salt River were channelized in attempt to reduce the risks of flooding and to accommodate property boundaries.

The vast majority of the Salt River Delta is now in agricultural production. The Wildcat Hills are managed for pastoral land use and small scale timber production by many landowners. Residential development upon the Salt River Delta and the Wildcat Hills will likely increase which is a problem due to an associated increase in road construction and a change in drainage patterns.

Documented fishery resources of the Salt River are at a historic low; however young of the year coho salmon were documented for the first time in Francis Creek in October 2005. Current coastal cutthroat trout observations in the Salt River tributaries are limited to Francis and Russ creeks. Sacramento pikeminnow have been observed in the upper and lower mainstem Salt River and in Francis, Williams and Reas creeks.

Residents that live and work along the banks of the Salt River are plagued by annual flooding and ponding, which has significant economic impact for those directly affected. Also, the Ferndale wastewater treatment plant, located at the confluence of Francis Creek and the Salt River, is currently operating under a Cease and Desist order issued by the North Coast Water Quality Control Board. The Water Quality Control Board has also imposed a moratorium of new sewer hookups for the City of Ferndale. The failure of the City to comply with water quality regulations is directly related to the ever-worsening channel conditions in the Salt River.

Sedimentation in the mainstem Salt River (river mile 7.5) has become so bad that the channel has completely filled with sediment and has caused a diversion of water. The eastern portion of the Salt River Basin has now been diverted to flow into the Old River which represents a 42% reduction in Salt River Basin size. At this time, Williams Creek no longer flows into the Salt River and is no longer accessible to salmonids.

Restoration of the Salt River is led by the Humboldt County Resource Conservation District and supported by the Salt River Advisory Group which is comprised of landowners, the California Department of Fish & Game, Natural Resource Conservation District, Coastal Conservancy, United States Army Corps of Engineers, Humboldt County and the City of Ferndale. Efforts to restore the Salt River aim to solve the cause of ecosystem problems rather than focusing on alleviating current conditions.

Salt River Management Issues

General Management Issues:

- Hydrologic energy in the Salt River has been reduced through the:
  - Loss of tidal prism through historic agricultural conversion of wetlands, sloughs and salt marshes;
  - Exclusion of periodic Eel River flood waters by the Leonardo Levee;
  - Diversion of the eastern 42% of the watershed into Perry Slough and Old River,

  - Prolific growth of nuisance instream vegetation, lessening water velocity and resulting in further sediment deposition;
- Highly erodible soils dominate the upper watershed;
- Seismically very active area and close proximity to the Mendocino Triple Junction;
- Potential of subsidence and uplift within in the Eel River Delta;

Socio-economic

- The Salt River is no longer a navigable waterway;
- Flooding has increased because a reduction of channel capacity of all watercourses in the Salt River Basin due to sediment deposition;
- Degradation of Francis Creek and the Salt River channel has resulted in the Ferndale Wastewater Treatment Plant to be in violation of water quality regulations leading to a cease and desist order issued by the North Coast Water Quality Control Board;
- Health hazards are posed through water quality degradation;
- Agricultural production and land values are decreased by flooding;
- Most domestic and irrigation wells are less than 30 feet deep. Nitrates, fecal contaminants could easily contaminate the shallow ground water;

Land use

- Majority of Salt River Delta is in agricultural production;
- Livestock has access to streams in many locations within the Basin resulting in: stream bank erosion, no recruitment of riparian plant growth, direct input of fecal and urine contaminants, and trampling of stream banks;
- There have been negative impacts to streams and fish habitat from historic timber harvest practices;
- Channel realignment in the trans-delta reaches of some of the Wildcat tributaries from a distributory flow regime to a channelized flow regime has resulted in greater input of sediment in the mainstem Salt River;
- Urbanization and channelization has altered discharge and sediment deposition patterns of Francis Creek;
- Dairy farm waste management infrastructure is, in places, inadequate;
- Unknown, but suspected high quantities of nutrients from agricultural land may present water quality problems in the mainstem of the river as well as in the estuary;
- Erosion from roads and stream banks in the Salt River tributaries is a significant by indeterminate source of suspended sediment;
- Extensive system of levees and berms throughout the basin disrupt channel connectivity with adjacent floodplain;
- Sand quarries may have had a negative impact on the amount of sediment in the Salt River.

Fish and Wildlife

- Canopy cover and riparian vegetation is lacking in some portions of the Wildcat tributaries;
- 2,900 acres of tide land in the Salt River Basin were reclaimed in the late 1800's;
- Salmonid access into the Salt River system is severely impaired, and access to Williams Creek and Coffee Creek has been eliminated;
- Salmonid habitat throughout the entire basin is poor;

- Aquatic macroinvertebrate populations in basin indicate instream sediment impairments;
- Potential large woody debris (LWD) recruitment is generally poor;
- Spawning habitat is inadequate due to excess fine sediments;
- Mercury contamination has been found in the flesh of fish in the Eel River system (Stokes, 1981).

Assessment Sample Base

This assessment was based on the following information:

- CDFG included over 30 field assessments of the Salt River and its tributaries: Williams, Francis, Reas, Coffee and Russ.
- CDFG and Humboldt State University have conducted three fishery surveys on the Eel River Estuary in 1951, 1977, and 1995.
- Natural Resource Conservation Service (formerly known as the Soil Conservation Service) has published five documents focused on Salt River issues as well as numerous memorandums and draft documents concerning: landslides, earthquake assistance, sediment deposition information, macroinvertebrates and soil information.
- Humboldt County Resource Conservation District has contracted numerous studies on the Eel River Delta including: Biological Conditions of the Eel River Delta, Vegetation Survey of the Eel River Delta; Habitat Types of the Eel River Estuary and their Associated Fishes and Invertebrates; Animal Waste Assessment Project, Eel River Delta Animal Waste Demonstration Project, and channel elevation surveys.
- HSU has contributed several papers on the geologic history and current geologic events in the Eel River Delta.
- Technical review and initial project design of the Salt River Restoration process is derived from work compiled by the Salt River Advisory Group which is comprised of the NRCS PL566 Small Watershed Planning Program, Humboldt County Resource Conservation District, County of Humboldt, City of Ferndale, Coastal Conservancy, and Department of Fish and Game, as well as numerous land owners in the Salt River Basin.

Response to Assessment Questions

This assessment uses six guiding assessment questions to organize its issues, findings, conclusions and recommendations.

What are the history and trends of the sizes, distribution, and relative health and diversity of salmonid populations in the Salt River Basin?

Findings and Conclusions:

- Limited fish surveys combined with anecdotal evidence suggests that coastal cutthroat trout populations within the Wildcat tributaries were abundant and have recently reached a historic low;
- Electrofishing in July and October 2005 revealed multiple young of the year coho salmon in Francis Creek through the City of Ferndale;
- Fish surveys of the mainstem Salt River in 1977 indicate the presence of coho, Chinook, and steelhead; however, their numbers were few compared with other sites in the Eel River Estuary at that time;
- Fish surveys of the mainstem Salt River in 1995 indicate the presence of Chinook and steelhead; however, their numbers were very few compared with other sites in the Eel River Estuary at that time;

- Fish surveys of the Wildcat Tributaries in 2003 and 2004 indicate that Francis Creek supports cutthroat and steelhead trout and Russ Creek supports cutthroat trout. There have been no salmonid observations in Williams Creek despite extensive sampling. No salmonids have been detected on Reas Creek although sampling efforts have been limited by access to private land;
- The Salt River cutthroat population represents the southern extent of the range of the coastal cutthroat trout species;
- It is unknown whether the cutthroat trout in the Salt River Basin are anadromous;
- Most recently, pikeminnow have been observed in all portions within the Salt River Basin with the exception of Russ Creek.

What are the current salmonid habitat conditions in the Salt River Basin? How do these compare to desired conditions?

<u>Findings and Conclusions:</u>

(Instream Habitat)

The Wildcat tributaries that historically supported salmonids (Williams, Francis, Reas, and Russ creeks) have been assessed for the quality of salmon habitat with the exception of Reas Creek:

- Based on CDFG target values, the amount of pool habitat, the average depths of pools, and the amount of pool shelter elements are unsuitable in Williams, Francis and Russ Creeks;
- The dominant pool cover type in Williams, Francis and Russ creeks is provided by small woody debris followed by undercut banks in Williams and Francis creeks and large woody debris in Russ Creek;
- There is a complete barrier to salmonids on Russ Creek, 500 ft upstream of Centerville Road, but there are resident cutthroat trout upstream of the barrier;
- There is a partial barrier to juvenile salmonids on Russ Creek at the Centerville Road culvert;
- Two culverts on Reas Creek present temporary or partial barriers for juvenile salmonids, and one culvert on Reas Creek presents a nearly complete barrier to juvenile salmonids and adult cutthroat trout;
- There are six tide gates in the Salt River Basin;

(Riparian Condition / Water Temperature)

- Water temperatures throughout the Salt River Basin are generally suitable for salmonids.
- Canopy density measurements from the Salt River Basin tributaries are generally suitable; however, the upper reaches of Williams Creek have less than suitable mean canopy density measurements and the conifer component of the shade canopy is low along all steams;

(Erosion / Sediment)

- Sediment deposition in the mainstem Salt River and its tributaries has reduced the availability and value of estuarine and freshwater habitats by the infilling of the channel and spawning gravels with sediment;

(Gravel / Substrate)

- Available data from the sampled Salt River tributaries indicate that Williams, Francis and Russ creeks do not have suitable spawning gravel;
- The potential of recruiting and retaining appropriately sized gravel from natural processes appears to be poor;

(Other)

- Farm wastes and effluent from the Ferndale waste water treatment facility present water quality problems related to nutrient enrichment;
- The Ferndale wastewater treatment facility has accumulated 241 known water quality violations since 1996.

What are the impacts of geologic, vegetative, fluvial, and other natural processes on watershed and stream conditions?

<u>Finding and conclusions?</u>

- Originally, the majority of the Salt River channel was maintained by tidal action;
- The Salt River Basin is located in a complex tectonic setting near the Mendocino Triple Junction, which has a high occurrence of earthquakes;
- The Wildcat tributaries are particularly prone to landslides due to the loosely consolidated nature of the Wildcat Sedimentary Rock Formation, steep slopes, close proximity to the Mendocino Triple Junction, and heavy winter rainfall;
- There is indication that the Eel River Delta is experiencing non-uniform subsidence; the average net subsidence rate was calculated to be 1 mm/ year in the north and 3.6 mm/ year in the south area;
- Rise in sea level in this region is assumed to be on the order of 1-2 mm/ year;
- The Salt River Delta is a depositional area and is affected not only by those forces within the Salt River Basin but also by the greater Eel River;
- The Salt River was adversely affected by the 1955 and 1964 floods. Much sediment was deposited upon the Salt River Delta and in the Salt River channel.

How has land use affected these natural processes?

<u>Findings and conclusions?</u>

- One of the first land use changes to occur on the Salt River Delta was agricultural conversion. In conjunction with reclamation activities, several dams were built across major sloughs. It is estimated that 2,900 acres of tidelands were converted into farmland by the end of the 19th century, and as a result of the levees and tide gates major slough channels have silted-in completely;
- Basin wide clearance of vegetation (timber harvest, agricultural conversion) from the Wildcat Hills and from the delta has changed the ecological character of the delta and destabilized hillsides in the Wildcat Hills;
- Human activities have interacted with natural geological instability to increase sediment production above natural background levels, although background levels remain indeterminate.
- Many of the impacts on instream habitat conditions are spatially and temporally separated from their upland disturbance sources, which makes the determination of cause and effect indeterminate;
- Eel River has the highest recorded average annual suspended sediment yield per square mile of any river of its size in the U.S;
- Great volumes of sediment, originating from the Wildcat tributaries, deposit in the depositional reaches of the tributaries and in the mainstem Salt River;
- Reas Creek channel has been modified and contained in levees from Centerville Road to its confluence with the Salt River. Additionally, the path of Reas Creek across the delta has been redirected and increased in length by 30%. These changes to Reas Creek affect the flow regime and sediment deposition patterns.
- The modified reach of Reas Creek transports flows that are laden with sediment, which have deposited in lower Reas Creek in the mainstem channel creating a sill, or a high point in the channel elevation;
- Sediment sills in the mainstem Salt River occur downstream of all the Salt River tributaries creating a channel that does not always slope downstream because of sediment accumulations. This process closed the river channel with sediment and redirected the flow of Coffee Creek in 1978 and then again at Williams Creek in 1998; which has essentially split the Salt River Basin into two separate watersheds due to the infilling of the mainstem channel;

- An earthen levee, built in the Grizzly Bluff region of the Salt River Delta in 1967 has eliminated the Eel River floodwaters up to the 10 year flood event. This action has likely contributed to a loss in periodic channel flushing in the eastern most reaches of the mainstem Salt River;
- There are at least six operational tidegates in the Salt River Basin. The specific effects of tide gates on fish passage, water quality, sediment deposition, and instream vegetation growth in the Salt River Basin are have not been quantified;
- The 1964 flood in the Eel River occurred following a post war logging boom in which timber harvests were conducted without regulation;
- The small diameter of near-stream trees limits the recruitment potential of large woody debris to most areas within the Wildcat tributaries and contributes to the lack of instream habitat complexity.

Based upon these conditions, trends, and relationships, are there elements that could be considered to be limiting factors for salmon and steelhead production?

<u>Findings and conclusions?</u>

Based off available information for the Salt River Basin, salmonid populations are being limited by:

- Instream sediment conditions in all portions of the Basin;
- Lack of available, appropriately-sized spawning gravel;
- Lack of habitat complexity throughout the basin;
- Lack of instream large woody debris in the Wildcat tributaries;
- Nuisance instream vegetation conditions in the mainstem Salt River;
- Decreased channel capacity in estuarine and freshwater channels;
- Competition with and predation by exotic pikeminnow;
- Current sediment conditions prevent fish passage to Williams Creek;
- Complete fish passage barriers in Russ Creek and Reas Creek;
- Several partial fish passage barriers in Reas Creek;
- Lack of estuarine channel complexity.

What watershed and habitat improvement activities would most likely lead toward more desirable conditions in a timely, cost effective manner?

<u>Recommendation</u>

Flow, Drainage and Water Quality Improvement Activities

- Re-establish mainstem Salt River from river mile 5.1 to 8.3 (Francis Creek to Coffee Creek), and improve channel conditions from river mile 3.4 to 5.1 (Reas Creek to Francis Creek) to improve drainage and allow access for salmonids;
- Restore estuarine habitat and estuarine wetlands from river mile 0 to 3.4 (confluence of the Salt River with the Eel River to Reas Creek).
- Removal or modification of tide gates and levees in the Salt River Basin for the purpose of improving fish passage, water quality, habitat diversity and channel flushing;
- Assess whether the re-introduction of the Eel River through the Leonardo levee is feasible;
- Improve coordinated planning efforts concerning drainage, wastewater treatment and development with the City of Ferndale;
- Re-introduce east side drainage into Francis Creek downstream of Port Kenyon Road;

- Implement Ferndale Drainage Master Plan;
- Establish a Market Street Drainage Plan;
- Obtain compliance at the Ferndale Wastewater Treatment Facility;
- Continue to implement dairy waste reduction plans and encourage the use of Best Management Practices for dairy waste management;
- Enhance and protect wetland areas and floodplain forests for the purpose of nutrient assimilation, flood storage capacity, sediment deposition and fish and wildlife enhancement;

Erosion and Sediment Delivery Reduction Activities

- Conduct an upslope erosion inventory in the Wildcat tributaries. Potential stream bank and road related sediment sources should be mapped and prioritized. Identified sites should then be treated to reduce the amount of fine sediments entering the stream;
- Design, install and maintain sediment basins on tributaries where sediment loads, stream alterations and infrastructure limit opportunities for restoring natural processes, such as lower Francis Creek;
- Encourage the use of Best Management Practices for all land use development activities to minimize erosion and fine sediment delivery to streams;
- Provide technical assistance and incentives to landowners/ managers in developing and implementing fine sediment reduction plans;
- Limit additional road building in the Wildcat Range.

Riparian and Habitat Improvement Activities

- Increase tidal influence (tidal prism) for the improvement of salmonid rearing habitat and for developing and maintaining channel structure;
- Replace or modify culverts or barriers that create fish passage problems;
- Where necessary, increase the canopy in the Wildcat tributaries by planting appropriate native vegetation like willow, alder, Sitka spruce and Douglas fir along the stream where shade canopy is not at acceptable levels. In many cases, planting will need to be coordinated to follow bank stabilization or upslope erosion control projects;
- Encourage the use of temporary riparian exclusion fencing where there is evidence of stream bank erosion caused by grazing of livestock;
- Where feasible, design and engineer pool enhancement structures to increase the number and quality of pools. This must be done where the banks are stable or in conjunction with streambank armor to prevent erosion;
- Suitable size spawning substrate in the Wildcat Tributaries is limited to a few limited areas. Projects should be designed at suitable sites to trap and sort spawning gravel;
- Improve fish habitat conditions in the trans-delta reaches of Reas Creek and Williams Creek.
    - Utilize set back levees for the improvement of flood control, riparian function and to establish channel meander and habitat diversity in the trans delta reach of Reas Creek;
- Enhance riparian protections for the improvement of ecosystem benefits;
    - Utilize USDA/ NRCS Wetland Reserve Program or Farm and Ranch Land Protection Program;

Education, Research, and Monitoring Activities

- Encourage and promote Salt River Advisory Group as the lead entity to help facilitate restoration funding efforts and monitoring activities;
- Improve educational and community outreach;
- Continue and expand water quality monitoring efforts of surface waters in the Salt River Basin to include a robust assemblage of water quality parameters;
- Conduct systematic assessment of biological resources in the Salt River Basin;
- Continue to monitor fish populations in the Eel River Delta and the Salt River system;
- Continue to monitor Salt River Basin salmonid habitat;
- Determine ownership boundaries along the Salt River within areas identified in alternative development;
- Analyze Salt River hydrology and hydrodynamics to include the estuary portion and portions of the Wildcat tributaries;
- Analyze Salt River geomorphology in the Salt River Basin;
- Conduct topographic mapping of the Salt River Delta;
- Analyze geomorphic change in the Salt River Basin to include analysis of changes in channel dimensions, sedimentation, channel location and shore lines over the past 130 years;

General

- Acquire conservation easements as an incentive for landowners to conserve and enhance habitat.

The Salt River Advisory Group (SRAG) has approved a framework approach for dealing with the multitude of problems in the Salt River Basin (**SEE APPENDIX A)**. The SRAG restoration framework has organized issues into six major goals which include:

- Improve watershed education, outreach and monitoring;
- Improve water quality conditions;
- Restore channel function and condition;
- Improve drainage and flood control functions;
- Improve and prevent point and non-point source water pollution;
- Enhance and protect fishery and wetland habitats.

Salt River Basin Profile

Introduction

The story of the Salt River Basin is one of hydrologic manipulation, human disturbance, and resultant dysfunction. The Salt River was the main vector of trade and transportation in the days of early settlement on the Eel River, and supported a shipping industry from 1860's until the early part of the 20th century. What was once a tidally influenced slough that measured 200 feet across and 15 feet deep at Port Kenyon (River Mile 4.1), is now a marsh without a defined channel. The channel of the Salt River is clogged with sediment eroded from its tributaries and as a result, adjacent roads, houses, and pastures on the delta are flooded annually causing damage to both private and public infrastructure. There are several issues that prohibit the Salt River from functioning in a natural manner:

- Sediment, from upslope and stream bank erosion, enters the mainstem from the tributaries in large volumes and deposits in the Salt River channel; reducing the channel capacity;
- The reduction of tidal influence caused by the construction of levees and tide gates in the western delta, has lessened the systems ability to clear sediment deposits from the channel;
- Extensive channelization and realignment of the Salt River tributaries have dramatically changed the discharge and sediment equation as well as the drainage network;
- The problems of flooding and sediment deposition have been made worse by the prolific growth of instream vegetation;
- In channel bedload transport from periodic Eel River floodwaters has practically been eliminated by levee construction in the eastern delta.

The fundamental problem with the Salt River is that it has filled with sediment faster than it could be removed naturally because channel cleansing forces have been practically eliminated. Since settlement, Salt River Delta residents have been faced with repeated high water events that have resulted in the loss of property and capital. There have been numerous attempts to control flood events on the delta that have indirectly perpetuated annual flooding. The residents in the Salt River Basin are seeking a solution on how best to restore the Salt River into a hydrologically and ecologically functional river while maintaining socio-economic needs. This restoration effort is supported by a myriad of public entities.

Location and Area

The floodplain of the Eel River from the mouth to its confluence with the Van Duzen River is called the Eel River Delta. The Eel River Delta is approximately 50 miles^2 (Figure 1).

For this assessment, the Salt River Basin consists of the southern tier of the Eel River Delta and its associated tributaries in the Wildcat Hills. The Salt River Basin will be assessed as an independent watershed due to its unique status, conditions and problems; although the Salt River Basin is part of the larger Eel River Delta and Estuary.

Inclusive of the Wildcat tributaries the Salt River Basin is 31,260 acres and is located in Humboldt County, California approximately 15 miles south of Eureka. The city of Ferndale is the major population center within the Salt River Basin. Access to Ferndale is from Highway 101 and across the Eel River at Fernbridge on Highway 211.

Climate

The Eel River Delta or 'foggy bottoms' is influenced by coastal fog throughout the year and is one of the cloudiest areas in the country (Stokes 1981). The dry season is marked by considerable fog or low

Figure 1. Eel River Delta

cloudiness that clears by late morning or early afternoon. The amount of sunshine increases greatly with distance inland from the coast. The weather of the coastal Salt River Basin can be characterized by a definitive rainy season with mild fluctuations in daily and annual temperature. The rainy season lasts from October through April, accounting for about 90 percent of the annual precipitation (USDA 1993). Average annual precipitation in Ferndale is 44.2 inches per year (USDA 1993). The dry season lasts from May through September. Temperatures on the delta are moderate and the annual temperature range is one of the smallest in the lower 48 states (Stokes 1981). Average annual temperature is 52°F. The Eureka weather station reports a mean low temperature of 41.2°F. September is the warmest month on the Eel River Delta with an average daily high of 67.5°F.

Hydrology

The Salt River Basin is comprised of two significant ecological units; the Salt River Delta, and the tributaries that drain the Wildcat Range (Figure 2).

- The **Salt River Delta**, as defined by this report, refers to the gently sloping alluvial floodplain that comprises the southern tier of the larger Eel River Delta.
- The **Wildcat tributaries**, as defined in this report, refer to those tributaries that flow from the Wildcat Hills across the Salt River Delta including: Coffee, Williams, Francis, Reas, Smith, and Russ creeks. Centerville Slough also originates in the Wildcat Range and is a tributary to the Salt River via Cuttoff Slough.

Salt River Delta

The Salt River flows across the Salt River Delta in a 'westerly direction and runs south of and almost parallel' to the Eel River before entering the Eel River Estuary 0.8 miles from the mouth of the Eel River (USDA 1993). Although the Salt River is a distinct ecological unit, it is intricately linked to the Eel River Estuary. The Salt River is not a river in and of itself, but rather a remnant channel of the Eel River (Slocum 2001). Historically, the Salt River was largely influenced by tidal ebb and flow and was referred to as the 'principal slough' tributary to the Eel River Estuary (Westdahl 1888; in Roberts 1992). With a significantly reduced tidal prism, which is the volume of water exchanged during a daily tide cycle, the Salt River's function as a slough has been marginalized.

In the mainstem Salt River there has been a drastic decrease in permanent length due to channel aggradation from excessive upslope erosion. The permanent channel of the Salt River has become much smaller from a historic 13.4 miles of permanent channel to 4.8 miles currently.

The Salt River Delta is characterized by its relatively flat topography; delta elevations range from sea level to about 80 feet above sea level. In 2004, the Salt River Delta drainage area was measured to be 10,100 acres, which is a reduction from 17,650 acres before 1975.

One of the earliest insights of the conditions of the Salt River comes from Ferdinand Westdahl during a reconnaissance mission for the U.S. Coast and Geodetic Survey in 1888.

> *"The principal slough to the southward of the (Eel) river is called the Salt River. It is connected with the Eel River in periods of freshets, when the waters of the latter river run into it by several small channels too shallow to admit immense drift-logs and snags which abound in Eel River. The Salt River is therefore comparatively deep and free from snags and offers better facilities for shipping than the main river. Salt River is at all times a tidal stream, almost equally active throughout the year"(Westdahl 1888; in Roberts 1992).*

Wildcat Tributaries

The southern boundary of the Salt River Delta is marked by the toe of the Wildcat Hills (Figure 2). The average elevation of the Wildcat Hills is about 800 feet; the highest point is 1,750 feet. The Wildcat Hills can be characterized by their steep topography with slopes that often exceed 100%. Average hill slope in the area is 42% (USDA 1992). The steep hillsides of the upper Wildcat tributaries are sharply contrasted with their flat alluvial canyon floors. The valley floors of the Wildcat tributaries have in places been converted to pasture. The **trans-delta** reaches of the Salt River tributaries flow across the Salt River Delta before they coalesce with the Salt River. Urban development and agricultural modifications have severely impacted the trans-delta reaches of the Wildcat tributaries.

Before 1975, the upper Salt River Basin consisted of four anadromous streams and seven smaller drainages with a total land area of 12,775 acres (Table 1). Currently, the Salt River has three potentially anadromous streams and four smaller drainages with a total land area of 7,440 acres. This dramatic change in watershed size is due to a complicated series of natural and human-induced events which are explained below.

Table 1. Salt River tributary information

Subwatersheds	Watershed Area[1]	Elevation Range	Salt River Mile	Permanent Stream Length[3]	Intermittent Stream Length[3]
	(Acres)	(Feet)	(Miles)	(Miles)	(Miles)
Morgan Slough	-	-	0.3	1.3	-
Cuttoff Slough	-	-	1.1	2.2	-
Unnamed Slough[2]	350	9 to 500	-	1.3	-
Centerville Slough[2]	830	30 to 1000	-	2.6	1.8
Russ Creek[2]	2,335	20 to 1550	-	5.2	1
Smith Creek	190	35 to 950	2.4	2.6	1.9
Unnamed Tributary	400	30 to 900	2.8	-	0.2
Reas Creek	1,300	40 to 1500	3.4	3.5	0.7
Francis Creek	2,035	60 to 1500	5.1	4.3	0.6
Williams Creek*	3,770	50 to 1750	7.5	7.2	0.6
Perry Slough*	-	-	7.7	-	2.2
Unnamed Tributary*	495	40 to 950	7.9	-	-
Coffee Creek*	505	40 to 925	8.3		2.5
Unnamed Tributary*	565	50 to 925	10		0.2
TOTAL AREA	**12,775**				

1 Watershed areas include only the upland wildcat drainage and not any portion of the delta.
2 Tributaries to Cuttoff Slough.
3 Tributary lengths provided by CDFG river mile and stream length estimates for the Eel River Basin based upon 2004 field observation and mapping.
* Williams Creek, Coffee Creek and two unnamed tributaries are now tributary to the Old River.

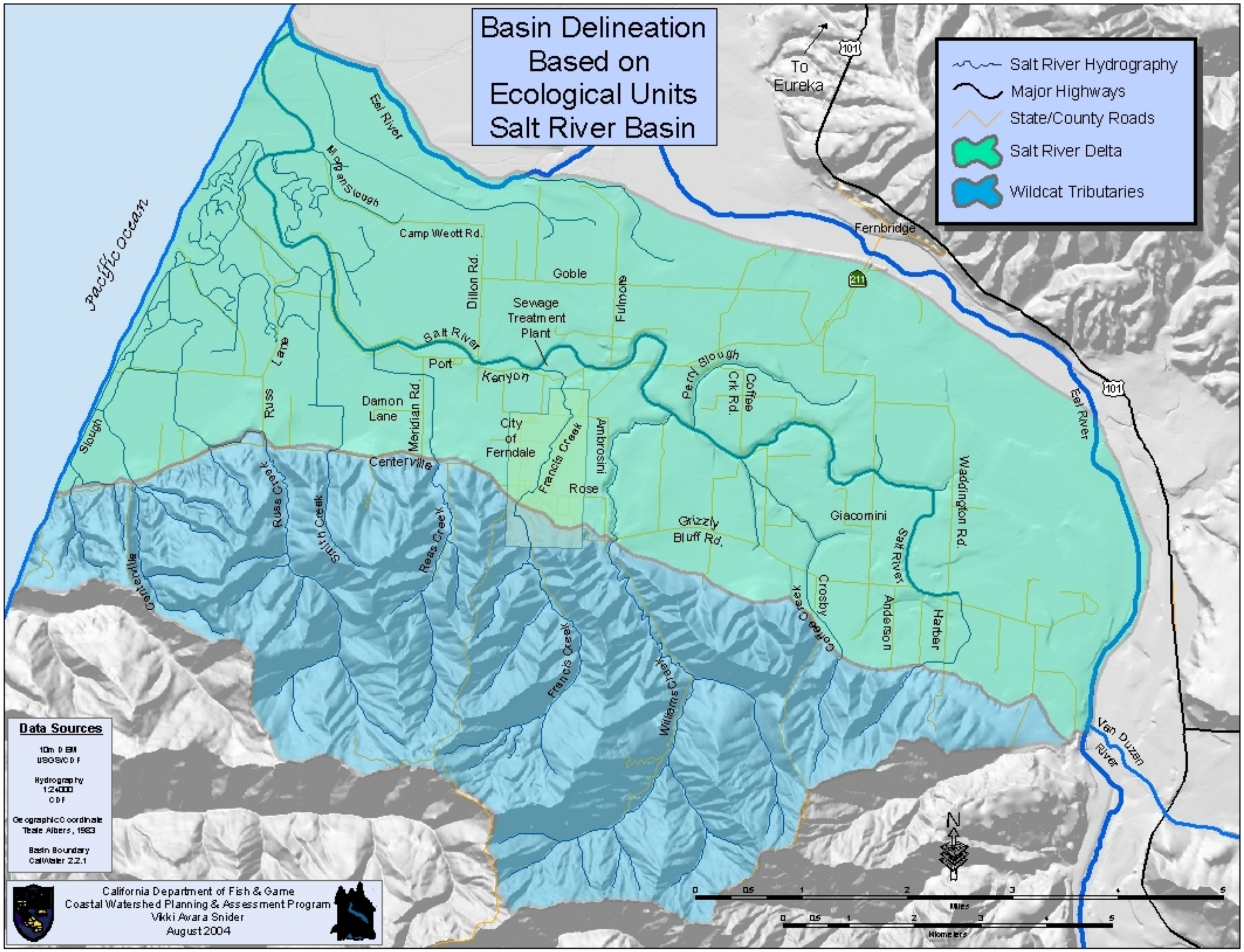


Figure 2. Assessment Area: Salt River Delta and Wildcat Tributaries

Fluvial Geomorphology

There has been significant change in the hydrology of the Salt River Basin since 1850. The naturally functioning systems that fashioned the Salt River into a navigable stream no longer exist. Changes in the Salt River were the result of:

- Land reclamation;
- Construction of levees and the installation of tide gates;
- Channelization of the Salt River tributaries;
- Rampant growth of instream vegetation (see pg 40).

Land Reclamation

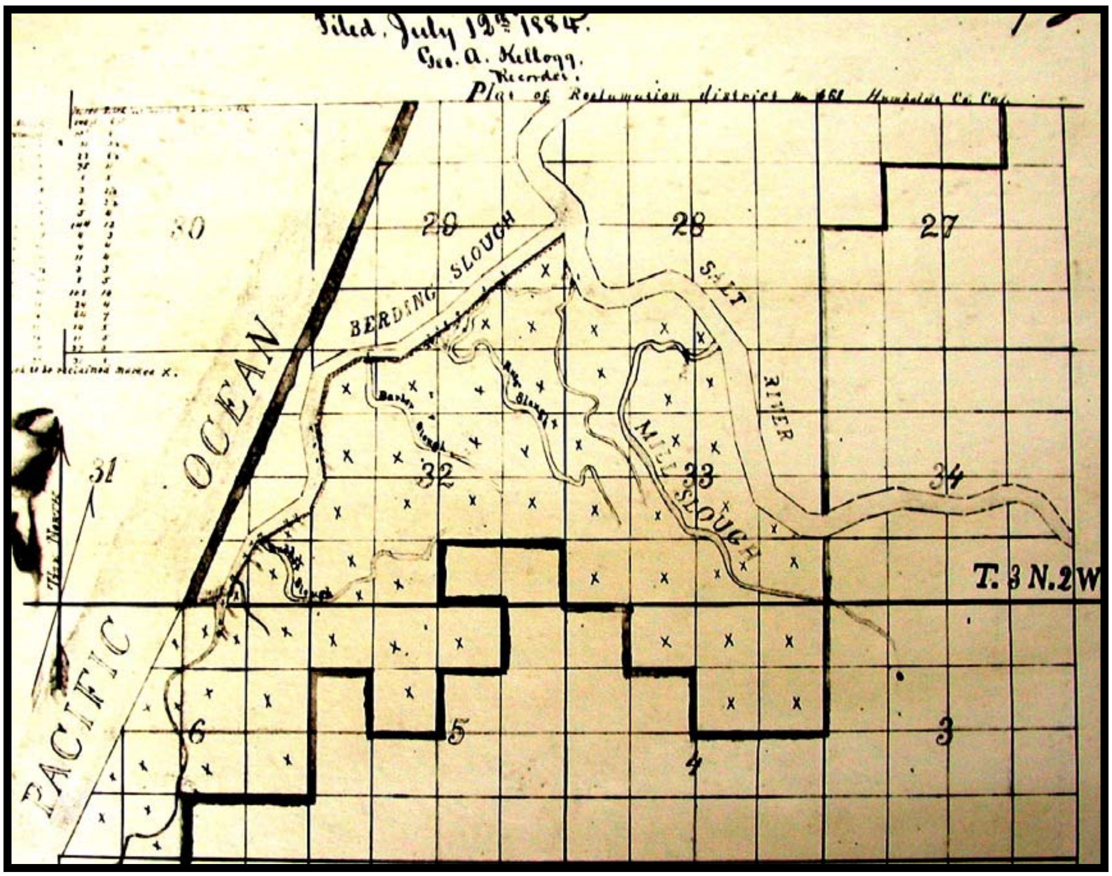


Figure 3. Plan of reclamation of the Salt River tidelands in 1884. The caption reads: "Land to be reclaimed marked X". The reclaimed area in this map adds up to 2,025 acres.

Tidelands

When the Salt River Delta was first settled by Seth Louis Shaw in 1852, much of the land was considered worthless as it consisted of wetlands and salt marsh. Large scale reclamation activities began in western Salt River Delta in 1884 when the Reclamation District was formed (Eidness, Van Kirk 1988).

> *"This enterprise is to add to our resources about 2,000 acres of valuable farming and grazing land, which heretofore has been entirely valueless… In order to make the land of any value whatever it is necessary that all salt water should be kept off it, and it is to this end the work is being done. The land is intersected by many small sloughs, and through the western end of the district runs quite a body of water known as the Centerville*

Slough. It is the intention to dam all these small sloughs near the point where they branch from the main body of water, putting floodgates in the dams, thus forming a complete system of drainage which will leave the large body of marsh land as dry as the land on the adjoining hills" (Ferndale Enterprise, 1884 in Eidness, Van Kirk, 1988).

Only four years after the Reclamation District was formed, Ferdinand Westdahl, a US Coast and Geodetic surveyor, wrote of the changes that occurred on the Salt River Delta

Nearly all the small sloughs have been injudiciously dyked across their mouths, and even some of the large sloughs have been stopped up, as for instance the Centerville Slough, which has a dam across it. The dyked sloughs rapidly fill up and thus the tidal area is being decreased and the volume of water flowing in and out through the entrance lessened" (Westdahl 1888; in Roberts 1992).

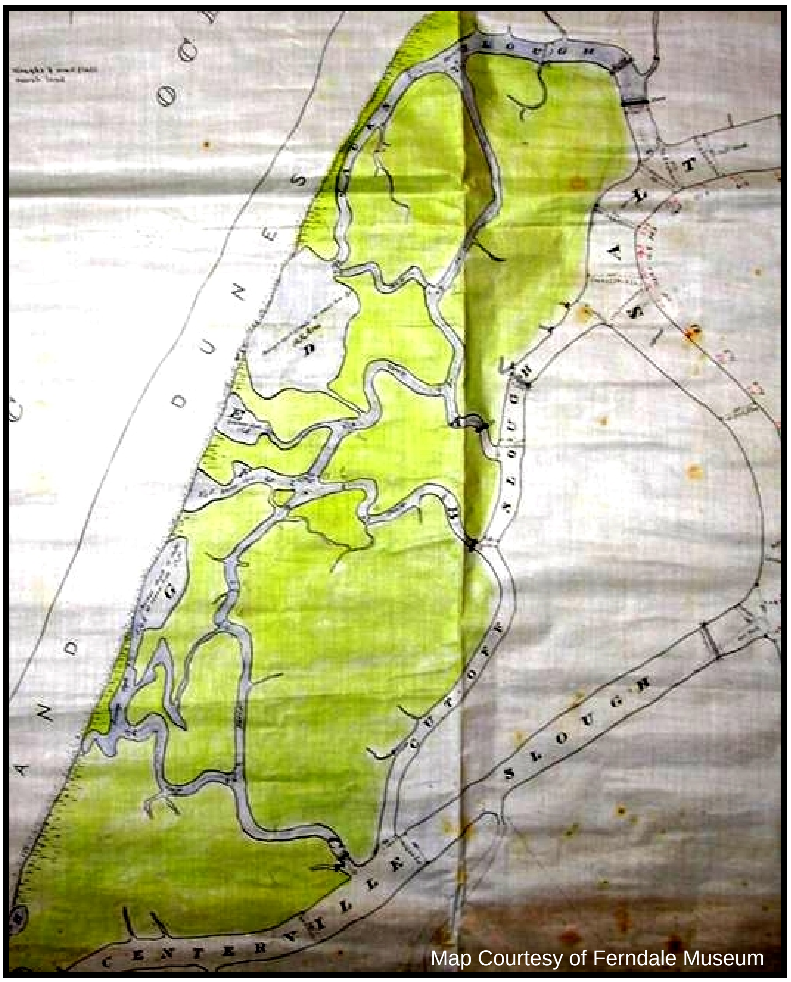


Figure 4. Map of the Centerville Slough area concerning the Supreme Court Trial in 1901. The highlighted area is that which had been cut off to tidal influence by 1898.

Table 2. Tidal area of Salt River measured in 1901 in reference to figure 4.

Tidal area cutoff to tidal influence	332 acres
Area included in sloughs and mudflats	48 acres
Tidal capacity in sloughs	437,000 yd^3
Tidal capacity of adjacent marsh which is flooded at high tide	458,000 yd^3
Tidal capacity of area	895,000 yd^3
Tidal prism of Salt River	2,700,000 yd^3
Tidal prism of area cut off	877,000 yd^3

The ecological benefits and channel maintenance features of wetlands and tidelands were not fully understood or appreciated in the 19th century. Reclamation activities were likely seen as a positive step toward harnessing the agricultural potential of the fertile soils of the Eel River Delta. However, the negative effects of the reclamation efforts of the Centerville area became appar ent when navigation on the Salt River was impeded by the sediment that was quickly filling the Salt River channel and its tributaries.

In 1898, R.W. Robarts, proprietor of the Port Kenyon shipping industry, filed a lawsuit against Z. Russ and Sons Co. over the legality of the dams and tide gates installed in the Centerville Slough region (Figure 4). In 1898, the court ruled in favor of Russ and Sons; however, the decision was later overturned by the Supreme Court in 1901 (Ferndale Enterprise 3/5/1901 in Eidness, Van Kirk 1988). The 1901 decision was based on the fact that “no owner of the tide lands of any harbor, bay, inlet, estuary, or other navigable water in this state, shall be permitted to destroy or obstruct the free navigation of such water” (CA Supreme Court 1901). It was found that reclamation activities in Centerville Slough reduced the size of the tidal prism in the Salt River and was deemed to be an obstruction of the free navigation of the Salt River. Regardless, the Salt River shipping industry ended soon thereafter largely due to a dramatic increase in sediment deposition.

In 1901, the tidal prism of the Salt River was estimated to be 2,700,000 yd^3 (Table 2). Evidence from the 1901 Supreme Court trial indicates that efforts to reclaim 332 acres of tideland west of Cutoff Slough reduced the Salt River tidal prism by 33%. Historic maps have confirmed that 2,360 acres of tidal lands adjacent to the Salt River were reclaimed by 1900 (Kellogg 1884; CA Supreme Court 1901). It is estimated that that an additional 560 acres of tide lands were likely reclaimed in what is now the Riverside Ranch property. In total, an estimated 2,900 acres of former tidelands in the Salt River Basin were reclaimed prior to 1900.

Figure 5. Map of Coffee Creek wetland that was drained in the late 1800’s (left). Aerial photograph of the same location in 1965 (right).

Freshwater Wetlands

Prior to Euro-American modification, a large freshwater wetland occupied the land between Williams Creek and Coffee Creek south of the Salt River (Figure 5). R.F. Herrick, a county surveyor in the late 1800’s, designed a drainage system to drain the Coffee Creek wetland. The drainage system involved 1.3 miles of main drainage channel and 2.4 miles of side ditches. The map indicates that the southern bank of the Salt River was 9 feet above the bottom of the channel. The swamp land at its lowest point was five feet below the bank of the Salt River at a distance of 1¼ miles from the south bank of the Salt River. Based off the historic drainage map the wetland was measured to be approximately 700 acres. The presence of other freshwater wetlands upon the Salt River Delta is unknown, but it is likely that other freshwater wetlands existed on the Salt River Delta at the toe of the Wildcat Range.

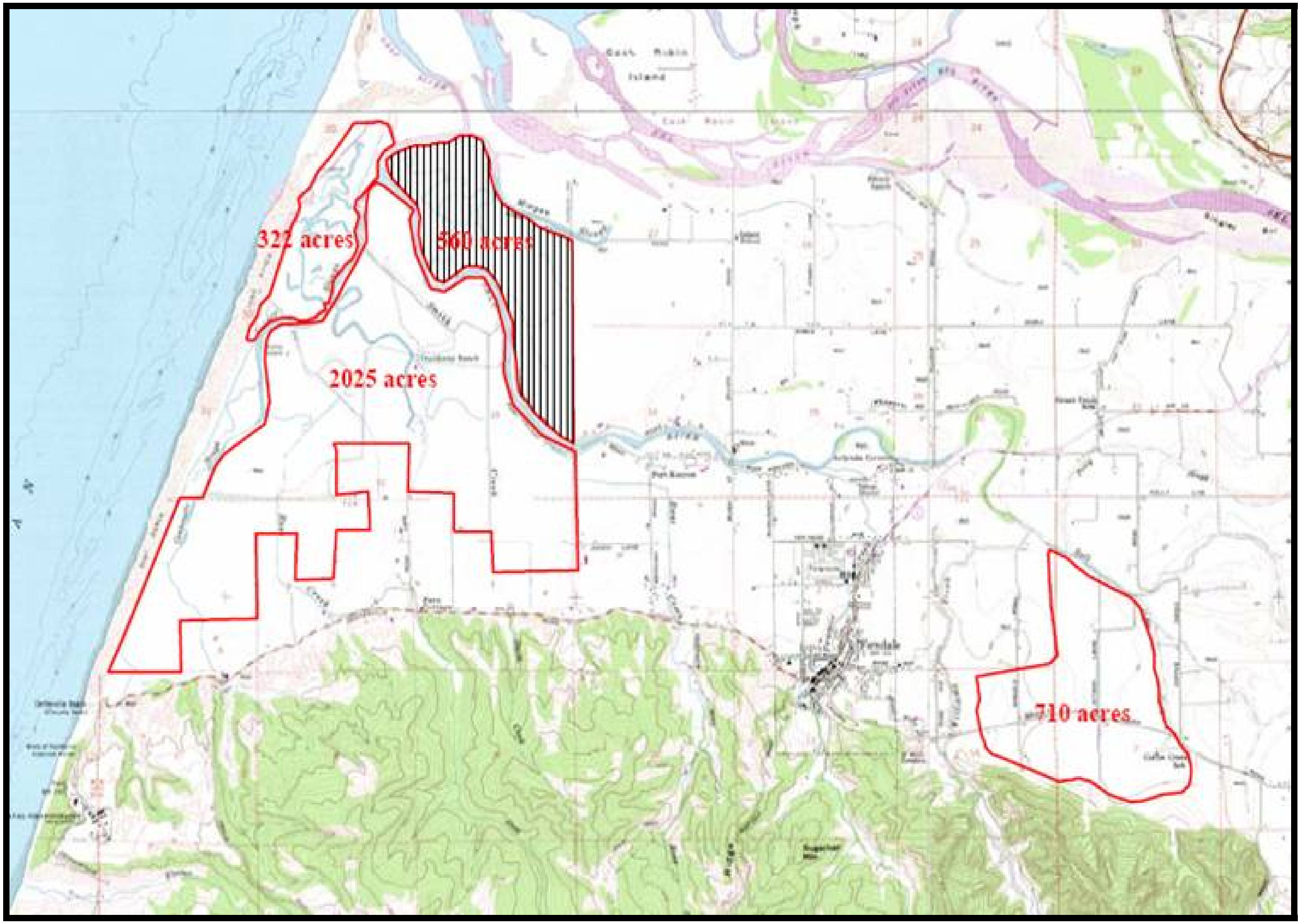


Figure 6. Wetlands and tidelands that are known to have been reclaimed. The area in black is estimated; the remaining areas have been confirmed with historic documentation.

Tide Gates and Levees

The interface between land and water throughout the Salt River Delta is, in general, controlled by an extensive network of levees. The intention of the levees was to control flood waters and to convert tidelands into productive agricultural land.

Leonardo Levee

The Salt River is often referred to as a hanging channel of the Eel River indicating that the Salt River channel was the former path of the Eel River. Floodwater from the Eel River jumped its banks and entered the floodplain from the eastern side of the delta and flowed through abandoned meander channels and coalesced with the Salt River. Landowners on the eastern side of the delta received the brunt force of the flood waters and finally built an earthen levee in 1967 in an effort to quell the force of floodwaters from the Eel River (Questa 1991).

The Leonardo Levee, as it is known locally, is located near the south eastern boundary of the Salt River Delta. It is estimated that the Leonardo Levee could provide protection up to the ten year frequency flood event and has been successful at keeping flood waters from inundating the southern side of the Eel River Delta. Since its construction, the levee has been breeched twice and repairs have been made by the Army Corps of Engineers under the disaster assistance program (Questa 1991).

The floodwaters from the Eel River were partly responsible for keeping the Salt River channel free of sediment and debris. The Leonardo Levee represents one of the causes of the sediment constriction that has diverted the eastern basin from the mainstem Salt River. An option outlined in the USDA Local Implementation Plan was to modify the Leonardo Levee 'to allow the flushing flows from the Eel River through the Salt River' (USDA 1993). This option would require extensive dredging, maintenance and infrastructure changes and therefore was not considered a viable option at that time.

Tide Gates

The impact of tide gates is a general problem that has recently generated interest among the natural resource conservation community in the Pacific Northwest, particularly considering the recent interest in the importance of estuaries in the life cycle of salmonids. The effects of tide gates on estuarine function include the elimination of upland tidal flooding and they change the velocity, turbulence and pattern of freshwater discharge that fluctuates between water stagnation and flushing flows (Giannico, Souder 2004). There are six operational tide gates in Salt River that are used in conjunction with dams and levees to keep the tide from inundating low lying areas.

Tide gates create new physical, chemical and biological environments on both sides of a levee that may not be conducive to the native biota. Physical changes that commonly take place as a result of tide gates are an increase in water temperatures and a change in channel morphology. Chemical changes that commonly take place behind tide gates include an increase in nutrient concentration, an increase in turbidity, and reductions in dissolved oxygen and pH. (Giannico, Souder 2004).

The biological impact of tide gates that is relevant to the Salt River is the obstruction of fish migration. In the case of anadromous salmonids, tide gates prevent migration and impact the quality of their habitats (Giannico, Souder 2004). The duration that a tide gate is closed, the size of the opening and the velocity of water moving back and forth through the tide gate are all factors that influence the daily and annual migration of salmonids. Another biological impact of tide gates is change in the composition and abundance of aquatic plants. The slough channels become choked with submergent and emergent aquatic vegetation. On a site reconnaissance in July, 2004 Cuttoff Slough was filled with the submergent plant, eel grass, on the upstream and downstream sides of the tide gate.

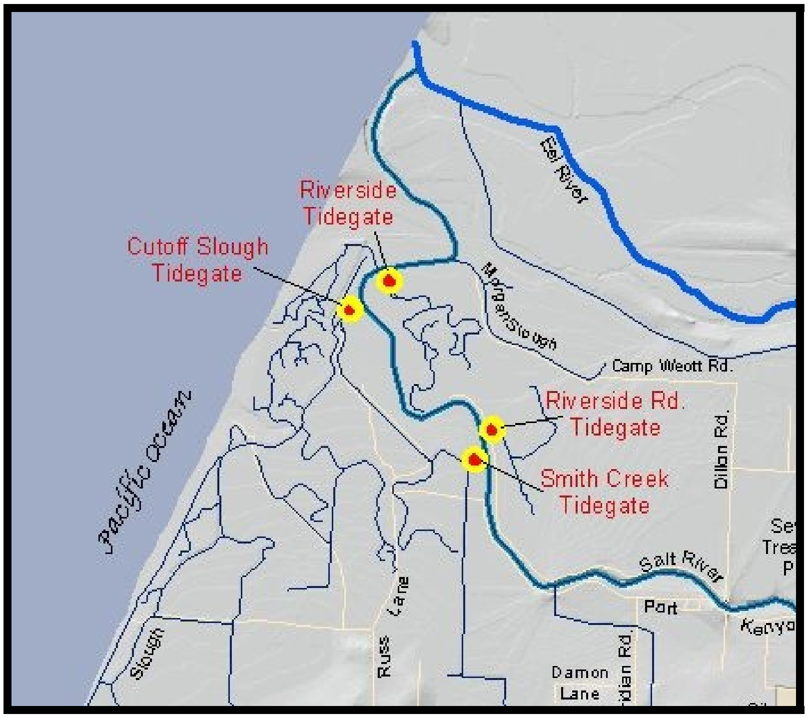
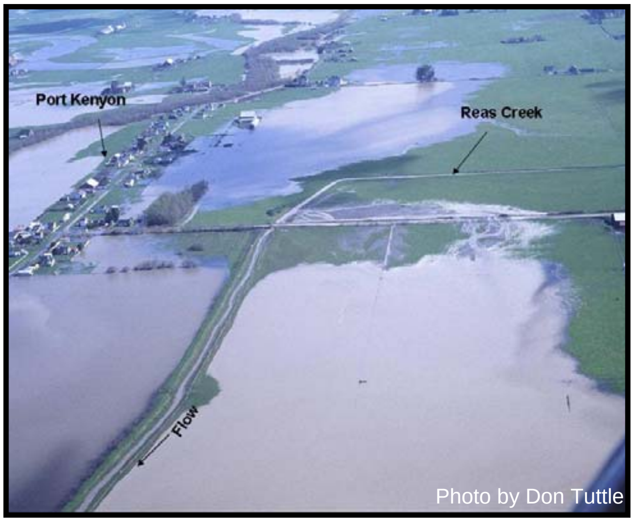


Figure 7. Tidegates in the Salt River system

An option outlined in the Salt River Local Implementation Plan was to remove the tide gates in the Salt River. Tide gate removal would restore tidal action to the marsh areas behind the tide gates and would increase channel scour downstream of the existing tidegates; however, it was determined that tide gate removal would result in slightly less channel scour in reaches upstream of existing tide gates. The 1993 plan determined that tide gate removal would not result in decreased sedimentation upstream of Smith Creek and therefore was not considered a viable option. Tide gate modification for the purpose of salmonid habitat improvement and for the improvement of salmonid access was not considered in the 1993 plan. Fish-friendly modifications can be made to existing tide gates to allow for the passage of salmonids, such as, installing small fish doors attached to buoys within the large floodgates. Fish passage through tide gates should be considered in final restoration initiatives.

Figure 8. Cutoff Slough tide gate



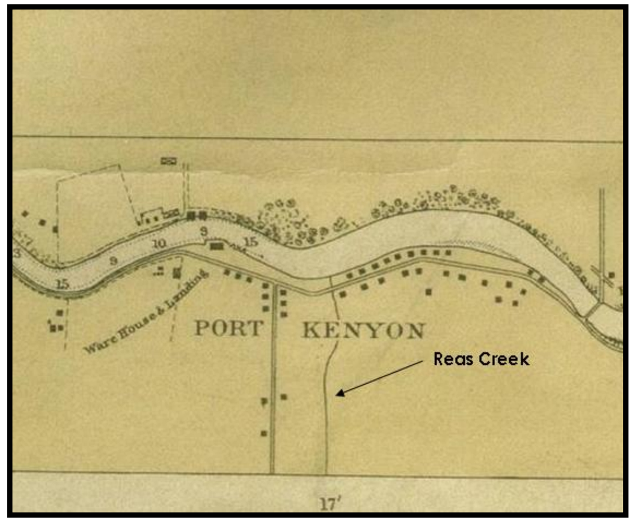


Figure 9. Reas Creek in its lower reaches has been realigned and channelized as it runs 8,200 feet across the Salt River Delta (Left), One of the historic paths of Reas Creek in 1921 flowed straight through Port Kenyon (Right). The channel alteration increased the length of Reas Creek across the delta by 30%.

Channelization

Portions of the Wildcat tributaries, as they flow across the floodplain, have been channelized and converted from a distributory, meandering flow regime into a swift channelized flow regime to accommodate for agriculture and residential growth. Many times realignment and channelization took place to correspond with property boundaries, to raise the elevation of pastures, and for irrigation purposes. Often this channelization has reduced the local stream gradient, which has caused the realigned reaches to fill with sediment (USDA 1993). There have been unanticipated consequences from the modification of the Wildcat tributaries in the trans-delta reaches that have resulted in a change in both the sediment budget and hydrologic flow regime in the Salt River.

In order to control the flow of the tributaries, levees have been built to contain creeks in a predictable and controlled path. Reas Creek is contained in levees the entire length across the delta (Figure 9) Several historic maps have shown that the path of Reas Creek has been in three distinct configurations since Euro-American settlement. The trans-delta reach of Reas Creek from Centerville Road to the Salt River confluence is now 2,360 feet longer than it was in 1921 (Figure 9). Currently, Reas Creek also has two 90 degree angles, which are not part of the natural channel configuration. The channelization and lengthening of the trans-delta reach of Reas Creek is suspected of causing problems related to sediment deposition and discharge within Reas Creek as well as in the Salt River.

In 1999, a levee was constructed without appropriate permitting on Williams Creek from the mouth extending upstream 2,500 feet to Ambrosini Lane. The Williams Creek levee constitutes development under the Coastal Act and should have required a coastal development permit. The construction of the levee may have affected the flow of peak high water events. Enforcement action is currently pending concerning the Williams Creek levee construction, and should be resolved soon.

Channelization creates a homogenous stream reach. Typically, rivers are described by their diversity of meanders, pools, riffles and runs; but when a river or stream is channelized the diversity of habitats and channel roughness is reduced. Roughness can be described as channel features that slow water velocity, create a diversity of habitat types, and form and maintain a channel that is appropriate for the amount of discharge, suspended sediment, and bedload.

A problem arises when the flow regimes of the tributaries do not match that of its receiving waters. Most tributary streams in the North Coast enter a larger, more robust stream with sufficient hydrological energy to manage sediment deposition in the receiving waters. This is not the case in the Salt River Basin. Because of the difference in flow regimes between the mainstem and its tributaries, the Salt River becomes inundated with great volumes of water that have high concentrations of suspended sediment, which then deposit in the Salt River channel.

The Old River and Perry Slough

Figure 10. Aerial Photographs of the confluence of Williams Creek and the Salt River 1996 (left), 2000 (right). Note the change in the Williams Creek drainage in the center of the photos from a westward course in the Salt River (left) to an eastward course into the Old River (right). This action has caused a 42% reduction in Salt River Watershed size.

In the past 25 years, the four eastern-most drainages to the Salt River have been diverted from the mainstem Salt River into the Old River via Perry Slough creating a new watershed. In 1978, a sediment plug completely blocked the Salt River channel (R.M 7.7); diverting the flow of Coffee Creek into the Old River channel. In 1998 Williams Creek (R.M. 7.5) was also diverted into the Old River. The Old River/ Perry Slough system is an ephemeral watercourse, meaning that is dry in the summer. Old River flows north under the Old River bridge that crosses Highway 211 and meets the Eel River 0.7 miles downstream of Fernbridge (Eel River Mile 5.8).

The diversion of Williams Creek was attributed to a tree that fell across the channel and was deemed to be a natural event; however, due to excessive aggradation, channel capacity in the upper reaches of the Salt River has been decreasing annually for the past century and the obstruction in the channel can be considered as the straw that broke the camels back. Enforcement action concerning the Salt River diversion near Williams Creek is currently pending. Williams Creek was the largest sub-watershed in the Salt River and as such was the largest source of flow and the largest contributor of sediment to the mainstem. Because of the diversion, sediment delivery to the Salt River was reduced by 33%; however, the sediment problem with Williams Creek has simply been transferred to Old River/ Perry Slough.

The diversion of Williams Creek is a point of contention within the basin because the change in channel course has benefited some while burdening others (Ferndale Enterprise Jan. 28, 1999). The Old River / Perry Slough is not a perennial watercourse and as such has no value for anadromous salmonids. The diversion has eliminated fish passage to a once anadromous stream and reduced the drainage area of the Salt River Basin by 42%. Francis Creek now functions as the eastern extent of the headwaters of the Salt River.

Table 3. Hydrological changes have reduced the size of the Salt River Basin and have created the Old River/ Perry Slough Basin.	
Estimated Wildcat tributary land area (1850)	**12,775 acres**
Estimated Salt River Delta land area (1850)	**17,650 acres**
Estimated total Salt River Basin (1850)	**30,425 acres**
Wildcat tributary land area draining to the Salt River (2004)	**7,440 acres**
Salt River Delta land area (2004)	**10,100 acres**
Total Salt River Basin (2004)	**17,540 acres**
Old River / Perry Slough watershed (2004)	**12,885 acres**

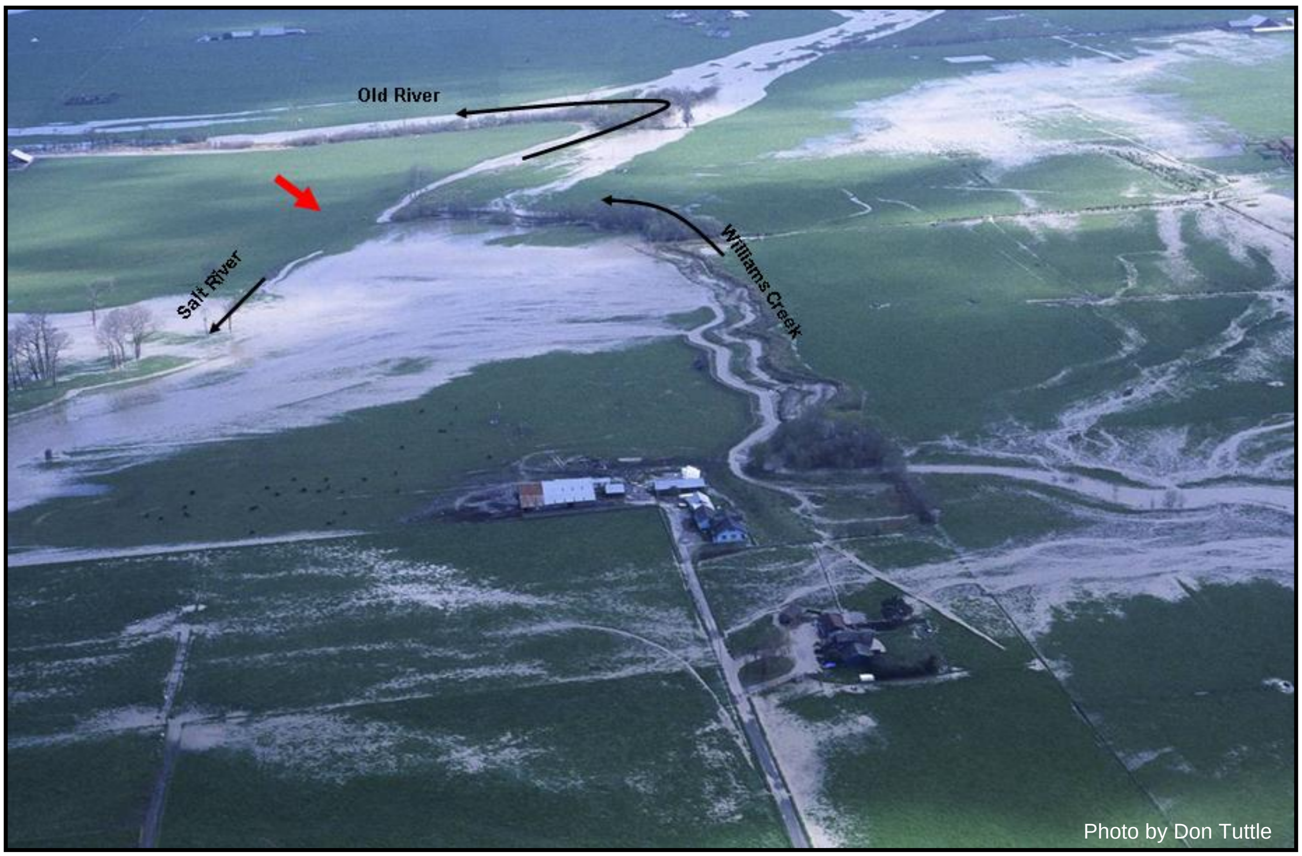


Figure 11. Williams Creek, Salt River and the Old River in February 2004. Red arrow indicates the sediment plug in the Salt River at river mile 7.5.

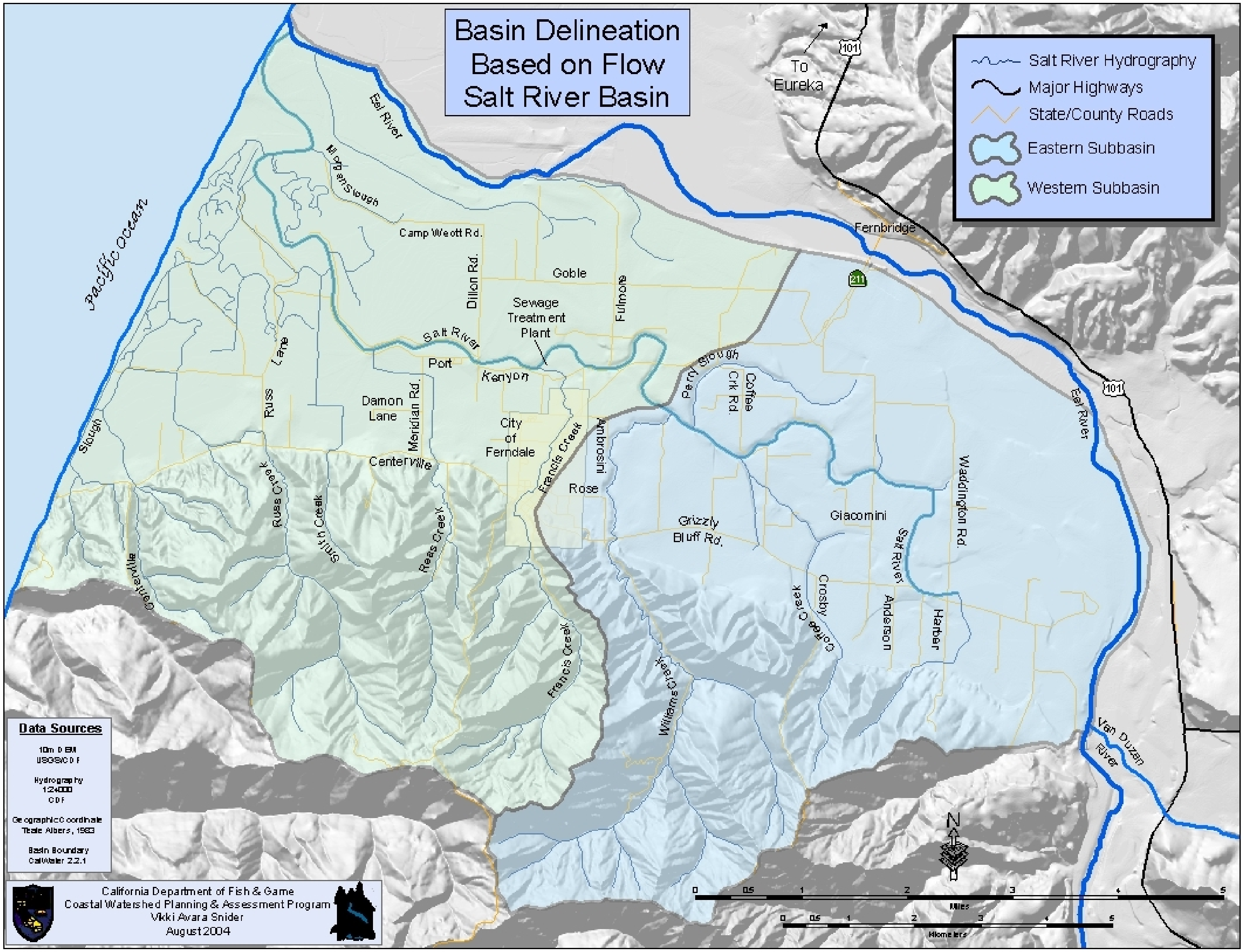


Figure 12. Salt River and Old River Watersheds, 2004

Salt River Timeline

The Salt River Basin has undergone significant changes and modification since Euro-American settlement of the Eel River Delta 150 years ago. Many of the modifications have had unforeseen cumulative ecological and hydrological impacts. The rate of change in the system over the last 150 years has been slight; however, the Salt River has now reached a point where the change has rendered the system hydrologically incompetent.

Pre-1850 The Eel River Delta is home to the Wiyot people, the Wildcat Range representing the southern extent of the Wiyot territory;

1852 The Shaw brothers settle the land near the current site of Ferndale;

≈1884 An extensive system of levees is constructed in the estuary adjacent to the Salt River. An estimated 2,900 acres of tideland are reclaimed for agriculture and at least 700 acres of freshwater wetland are reclaimed near Williams Creek;

≈1890 Four dams with tide control devices are constructed in sloughs tributary to the Salt River. These dams contribute to the reduction of the Eel River Estuary tidal prism;

1901 U.S Court of Appeals recognizes that the tide control structures on Centerville Slough have negative effects on the navigability of the Salt River;

1911 Fernbridge is completed connecting Eel River Delta, Bear River, and Mattole Valley residents to the Humboldt Bay region;

1955 Second largest flood recorded on the Eel River: discharge peaks at 27.7 feet at Fernbridge;

1964 Largest recorded flood in the Eel River: discharge peaks at 29.5 feet at Fernbridge;

1967 The Leonardo Levee is constructed in the southeastern delta to reduce Eel River flooding;

≈1970 Department of Fish and Game curtails the unregulated cutting of riparian vegetation in the Salt River Basin;

1975 Ferndale wastewater treatment plant is built at the confluence of Francis Creek and Salt River;

1978 Sediment plug forms in the Salt River channel upstream of Williams Creek (R.M 7.7) diverting Coffee Creek flow from the Salt River Basin into the Old River/ Perry Slough;

1987 The Eel River Conservation District (RCD) is formed by popular vote in March, with the primary purpose of addressing resource problems associated with sedimentation and flooding along the Salt River;

1988 The Eel River RCD requests assistance from the USDA Soil Conservation Service to investigate problems associated with accelerated sedimentation in the Eel River Estuary and Salt River channel;

1989 Army Corps of Engineers (USACE) funding that had been approved in 1986-1987 to address flooding in the Salt River is denied. USACE determined that the Salt River problems were associated with drainage and not flooding and therefore did not qualify as a Corps project;

1990 Ferndale publishes their Master Drainage Plan that identifies drainage problems in the Francis Creek watershed;

1992 Ferndale Earthquake (M 7.1) triggers landslides in Francis Creek and elsewhere in the watershed and causes coastal uplifting near Petrolia;

1993 The Salt River Basin- Local Implementation Plan is published by the USDA- Soil Conservation Service;

1996 **Riparian vegetation hanging in the Salt River channel is removed from Riverside Ranch to Francis Creek by the California Conservation Corps;**

1997 **Federal listing of coho salmon as "threatened" under the Endangered Species Act;**

1998 **Sediment plug forms downstream of Williams Creek (RM. 7.5) diverting the flow into the Old River/ Perry Slough making Francis Creek the headwaters of the Salt River. A total of 42% of the Salt River Basin is diverted into the Old River/ Perry Slough;**

2000 **City of Ferndale, begins work on the Francis Creek flood mitigation project funded through the Department of Water Resources -Prop. 13 and Caltrans;**

2002 **Francis Creek flood mitigation project reaches completion with funding from Department of Water Resources Urban Streams Project;**

2003 **Army Corps of Engineers begins to draft the Salt River Project Management Plan under the aquatic ecosystem restoration program;**

2004 **Salt River Advisory Group (SRAG) is established to build a partnership between private landowners living adjacent to the Salt River and public groups including:**

- **California Department of Fish and Game;**
- **Humboldt County Resource Conservation District;**
- **Natural Resource Conservation Service;**
- **City of Ferndale;**
- **California Coastal Conservancy;**
- **Humboldt County;**

2004 **Funding for the Army Corps of Engineers aquatic ecosystem restoration program on the Salt River restoration is eliminated;**

2004 **Four hundred thousand dollars of funding for the Salt River project is secured through extensive contractual agreements with two state agencies; CA Department of Fish and Game (CDFG) and CA Coastal Conservancy (CC);**

2004 **An extensive amount of work has been completed on the Salt River Project to date:**

- **Salt River aerial photo composite maps provided by Humboldt County;**
- **Salt River Bibliography and Literature Search Report;**
- **Congressman Thompson requests appropriations for the Salt River;**
- **NRCS-Watershed Planning Services unit pledges assistance;**
- **Salt River and Francis Creek Thalweg and Channel Survey conducted by Spencer Engineering;**
- **Aerial reconnaissance Salt River flood conditions on 2/18/04 conducted by Humboldt County;**
- **NRCS releases draft report of the Salt River rare plant survey by NRCS landscape ecologist;**
- **CDFG publishes draft stream / fishery survey reports on Francis, Williams, Russ and Reas creeks;**
- **CDFG establishes contract with Northwest Resources to conduct upslope erosion assessment;**
- **CDFG releases draft Salt River Watershed Assessment with recommendations;**
- **Estuarine hydrological analysis is initiated in May 2005**

1963

1965

2000

2004

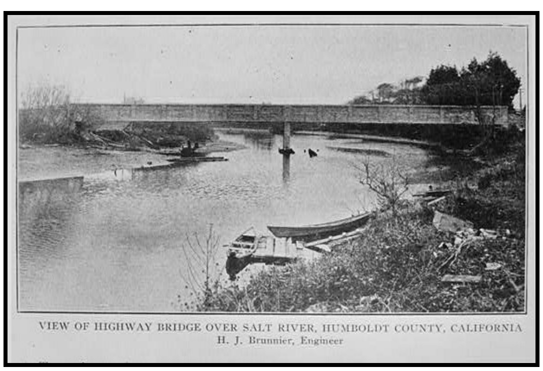


Figure 13. Aerial view of Salt River at Dillon Road Bridge in 1963, 1965, 2000, 2004. Cross-section view of Valley Flower Bridge (Dillon Road Bridge) from 1920 (left) and early 1990's (right)

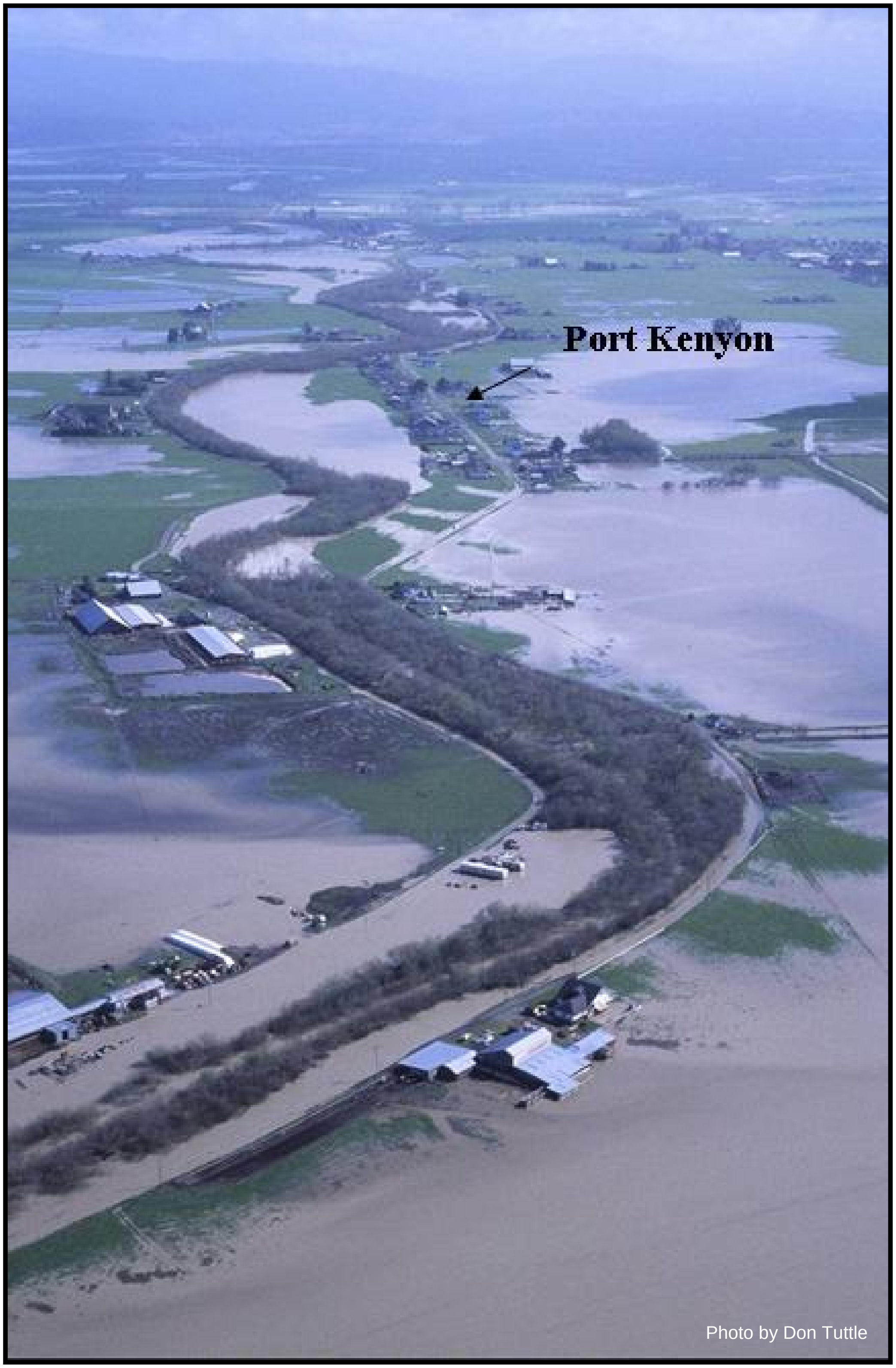


Figure 14. The Salt River during February 2004.

Floods

The north coast of California is dominated by intense, short duration rainstorms in the winter, with peak flows that are among the highest on record for the western United States (Sommerfield 2002). The winter peak flows often cause severe flooding on the Eel River Delta; in fact, the Federal Emergency Management Agency (FEMA) has designated practically the entire delta as a floodway. Flooding has always been a part of life on the Delta; however, the effects of floods have become more severe as the flood capacity of the Salt River and the greater Eel River Estuary have been significantly reduced.

There have been numerous large floods on the Delta; the most notable and destructive include 1955 and 1964. The flood of 1964 was the largest recorded flood to occur in the Eel River Watershed and has been referred to as a system reset event for the Salt River. It is the 1964 flood that has been identified as the beginning of the end of the Salt River channel. The 1964 flood occurred following a post-war logging boom that was associated with an extensive increase in road building and watershed disturbance which caused excessive erosion and runoff from the hillsides that were carried into the river. Forty years later, the effects of the 1964 flood continue to present resource management dilemmas in the Eel River Watershed.

Table 4. Historic floods of the Eel River. Flood stage for Fernbridge is 20 feet.

Date	Flood Level at Fernbridge
12/23/1964	29.5
12/22/1955	27.7
1/16/1974	26.33
2/18/1986	26
12/11/1937	25.4
1/9/1995	25.31
1/1/1997	25.22
2/8/1960	24.85
3/30/1974	24.81
1/24/1970	24.8
2/28/1940	24.43
1/5/1966	24.2
12/19/1981	23.7
1/27/1983	23.6
1/21/1993	23.46

The 1964 flood had significant environmental and economic ramifications on the Salt/ Eel River Delta. The U.S Army Corps of Engineers indicated that the Salt River agricultural land was devastated with up to four feet of silt and sands being deposited in the Eel River Valley (McLaughlin and Harradine in USDA 1993). According to the analysis completed by the Soil Conservation Service of data published in 1965, roughly 5,100 acre feet of sand and 6,300 acre-feet of silt were deposited over 13,000 acres in the Salt /Eel River flood plain as an immediate consequence of the 1964 event (USDA 1993). In addition many homes were lost and approximately 2,000 cows perished in the storm. The flood of 1964 caused significant environmental damage in the Eel River Delta that continues to have lasting effects that are mostly related to increase in sediment deposition and a decrease in channel capacity.

Flood control in the Eel River Delta has been the topic of much debate over the years. It was proposed in 1937 that the Eel River, from Fernbridge downstream, be dredged in a straight line and reinforced with levees. The intention of the proposal was to simulate the state of the Eel River during settlement and to lessen the losses accrued during flood periods. At that time in 1937, 100 acres of land was being eroded annually (Anonymous 1937). Ultimately, the project was not acted upon; however, flood control and bank protection remains a major concern on the banks of the Eel River. The idea of bank protection and flood control resurfaced after the 1964 flood. The Army Corps of Engineers proposed building 30 miles of levees on the lower Eel River, beginning at the Van Duzen River. The plan of improvement also included construction of levees on the Salt River extending upstream to Port Kenyon. Due to legislation in the early 1970's, a 12 year moratorium was placed on levee construction on the Eel River and the improvement plans were tabled (Monroe 1974).

Geology

The impaired condition of the Salt River and its aquatic resources are partly due to the unstable nature of the geology of the Wildcat tributaries including: loosely consolidated sedimentary rock formations, high frequency of earthquakes, and the potential of tectonic subsidence and uplift. These features create a consistent background of sediment contribution to the Salt River and Eel River Estuary.

Geology of the Eel River Delta

The Eel River Delta lies in the Coast Range Province in Northern California. The valley is formed by the Eel River Syncline (Li 1992). The Eel River Delta is a depositional land formation that was created as alluvial materials were delivered from upslope sources to the ocean. The Eel River Delta is underlain to great depths by unconsolidated alluvial sediments originating from a complex system of Franciscan type rocks including mudstone, siltstone, claystone, and sandstone (McLaughlin, et al 2000).

The Wildcat Range is formed of a group of sedimentary rock called the Wildcat Formation Group. Wildcat Formation pertains directly to those sediments in the mountains south of Ferndale, but has since become established in literature as a loose term for Tertiary sediments of Humboldt County of suspected Pliocene age (Ogle 1953). The Wildcat Formation Group is subdivided into five categories: Pullen, Eel River, Rio Dell, Scotia Bluffs Sandstone, and Carlotta Formations (Ogle 1953). The Wildcat Formation Group is susceptible to erosion and large scale land slides particularly the Rio Dell Formation (Table 5).

Table 5. Wildcat geologic formation group. (USGS Fortuna Quad, OFR 85-1SF).

Wildcat Formation Name	Description of Formation
Pullen	Mudstone, diatomaceous mudstone, and local sandstone; highly sheared.
Eel River	Mudstone, siltstone, and sandstone; unit is sheared in places
Rio Dell	Interbedded mudstone, semiconsolidated sandstone, and siltstone; landslide failures along the interface between sandstone and mudstone beds are common, particularly along the coast.
Scotia Bluffs	Fine-grained, massive semiconsolidated sandstone with minor amounts of siltstone, mudstone, and pebbly conglomerate
Carlotta	Non-marine sandstone, conglomerate, and claystone gradationally overlying Scotia Bluffs Formation; deposits are poorly consolidated.

Earthquakes

The Eel River Delta is located upon a complex tectonic setting near the junction of three crustal plates known as the Mendocino Triple Junction (MTJ). The MTJ is where the Pacific and the Gorda Oceanic plates meet the North American plate. The cascadia subduction zone (Csz) is an area just offshore where the Juan de Fuca and the Gorda plates are under thrusting beneath the North American Plate. The Csz originates at the Mendocino Triple Junction and extends north through Oregon and Washington running parallel to the Pacific Northwest coast line. The complex tectonic structure contributes to a high concentration of earthquakes in the north coast region. The Salt River area has experienced hundreds of earthquakes of significance ($M \geq 4$ on Richter scale) in the past 120 years (USDA 1993).

On April 25, 1992 a large earthquake, the Cape Mendocino earthquake, occurred near Petrolia, (USGS 2004). The quake measured 7.1 on the Richter scale. The earthquake had a very energetic aftershock sequence, including two large strike-slip earthquakes (both magnitude 6.5). The Cape Mendocino earthquake caused significant ground shaking, landslides, coastal uplift, and liquefaction. The onshore earthquake caused measurable coastal uplift of 4 to 5 feet on Cape Mendocino and a two foot tsunami was measured in Crescent City as a result of the earthquake (Carver, et al. 1994).

As a result of the earthquake, Humboldt County was declared a Federal Disaster area. The center of Ferndale was severely impacted with significant damage to buildings, but Ferndale citizens were fortunate as there were no major injuries reported. There were 356 reported injuries throughout Humboldt County and only 5 people were admitted to the hospital. All told the April 25th, 1992 earthquake resulted in $61 million dollars in losses in Humboldt County and destroyed 159 homes and caused major damage to 150 businesses and public offices (Cox 1992).

Landslides

The potential for landslides in the Wildcat tributaries is high due to a number of factors including unstable geological structure, high rates of tectonic activity, climatic interactions, and current and historic landuse practices. The dominant factor that contributes to the high potential of landslides in the Wildcat tributaries can be attributed to the unstable nature of the Wildcat Formation Group, particularly the Rio Dell formation. Much of the Wildcat Range is naturally prone to landslides for the following reasons (USDA 1992):

- Rio Dell Formation is relatively soft and erodible. Landslides along the interface between mudstones and sandstones are common;
- The region receives a significant winter rainfall with an average annual rainfall of 44.2 inches;
- Hills in the Wildcat Range are steep with slopes often greater than 100%;
- Located 13 miles from the Mendocino Triple Junction, the Wildcat tributaries of the Salt River area are in a very seismically active zone;

The 1992 Cape Mendocino earthquake triggered “localized slope failures and fissures along roads and steep hillsides in the Wildcat Hills” (USDA 1992). In the headwaters of Francis Creek a 15-20 acre earthslump was reactivated. The landslide was actually part of a larger slide that extends across the entire headwaters of Francis Creek. The earthquake trigged slope failures were the primary contributors to increased instream turbidity that was observed after the quake. It is likely that the landslides in the headwaters of Francis Creek were a large contributor to the further silting-in of the confluence of the Salt River and Francis Creek in the past thirteen years. It was recommended by the Soil Conservation Service that a sediment basin at the mouth of Francis Creek be considered to limit the sediment contributions into the Salt River. Stabilization of the large slide was ‘neither technically nor economically feasible’ (USDA 1992).

Subsidence

The Eel River Delta is affected by both tectonic uplift and subsidence, which has resulted in slight changes in elevation. Subsidence is the process where land sinks and results in a change in elevation of the landscape and in the Eel River Delta is typically triggered by tectonic activity. Subsidence is distinguishable in estuarine soil profiles because a sudden submergence in the land forms an abrupt and sharp contact between overlying intertidal mud or sand and buried rich organic matter creating an obvious stratification (Li 1992). According to Li, sudden subsidence has occurred in the Eel River Delta 300, 800, 1200, 1500 and 2000 years before present. “Submergence strata of the buried vegetation layer in the Eel River Delta seems too wide spread, too large, and too sudden to be attributed to anything other than coseismic subsidence” (Li 1992).

Essentially, the mouth of the Eel River suddenly dropped in elevation five times in the past 2000 years; however, the change in elevation is not occurring equally across the mouth of the Eel. An average subsidence rate has been calculated, 1mm/ year in the northern area, and 3.6 mm/year in the southern area (Li 1992). The unequal subsidence in the Eel River Delta will dictate where the river runs its course as it finds the areas with the lowest elevation.

Sediment and Erosion

Eel River

Regional uplifting and faulting of the Franciscan geology in the Eel River Watershed have produced physical characteristics such as steep slopes and exposed sedimentary cliffs that make the entire basin especially prone to erosion (Stokes 1981). The combination of steep topography and unstable geology in the Eel River Basin combined with high precipitation and high peak flows have contributed to naturally high levels of suspended sediment in the river. Historic landuse practices in the greater Eel River Watershed such as timber harvest, agricultural conversion, road building and the construction of the Northwestern Pacific Railroad intensified erosion and affected Eel River depositional areas like the Salt River. "The Eel River has the highest recorded average annual suspended sediment yield per square mile of drainage area of any river of its size or larger in the USA (31 million tons per year). The Eel River carries fifteen times as much sediment as the Mississippi River and more than four times as the Colorado River (Brown, Ritter 1971). The suspended sediment load recorded at Scotia during the 1964 flood was 160 million tons, representing 51% of the entire Eel River suspended load computed for the 10 year study at the Scotia Station (Brown, Ritter 1971).

Erosion and landslides are the means by which the Eel River Delta was formed through deposition of alluvial material, which is the principle reason the delta is such fertile agricultural property. Although high levels of suspended sediment are the norm in the Eel River, the rate of watershed disturbances is of particular concern to resource managers. A study of the continental shelf deposits offshore from the mouth of the Eel River indicates that there has been a sudden, three-fold increase in the rate of sedimentation since 1954. The study also indicates that major floods after 1950 have had a "more pronounced effect on coastal sediment delivery and accumulation than previous recorded events of similar magnitude"(Sommerfield 2002). This increase in sediment delivery and accumulation in the Eel River depositional areas such as the delta has had dramatic effects on the productivity of the Eel River fishery and has increased sediment deposition in the Eel River Estuary.

Salt River

The largest source of suspended sediment within the Salt River Basin is derived from the Wildcat tributaries. Although erosion rates in the Salt River are largely un-quantified there are two main types of erosion occurring in the Wildcat tributaries; preventable erosion and non-preventable erosion. Preventable erosion sites include stream bank erosion, and runoff from roads. Erosion sites in the Wildcat range that are difficult to prevent include the large scale landslides.

Figure 15. Preventable (left) and non-preventable erosion (right).

A study conducted during 1994 estimated that 11,400 tons of sediment flow into the Salt River each year. Since that time one of the Salt Rivers largest contributors of suspended sediment, Williams Creek, no longer flows or contributes sediment into the Salt River, reducing the annual sediment yield to the Salt River to 6,140 tons/ year. The diversion of the Williams Creek was largely due to its high rate of sediment contribution to the Salt River (5,240 tons/ year), which over the years reduced the channel capacity.

The high rate of sediment coming from the Wildcat tributaries has been utilized locally to raise the elevation of adjacent pastures. This practice has caused flood waters to inundate public roads now that the elevation of pastures is sometimes higher than the roads. Deposition, although locally problematic, reduces the amount of suspended sediment that reaches the Salt River; however, it is often costly for both private parties and public entities:

- Salt River channel has aggraded 20 feet near Riverside Ranch (Section 28, T3N, R2W); and 10 feet in area between Dillon Road and the Salt River and Francis Creek confluence (Section 35, T3N, R2W) by 1987 (USDA 1987);
- Williams Creek deposited 5 to 6 feet of sediment on the Salt River floodplain near its confluence with the Salt River (Section 1, T2N, R2W) (USDA 1987);
- A fence installed along Reas Creek in 1984 was completely buried three years later (USDA 1987);
- In 1989, 4,038 tons of sediment were deposited on 4.6 acres at the outlet of Russ Creek, a volume of sediment that would cover a football field two feet high (USDA 1989);
- In 1999- 2001, the City of Ferndale paid $80,000 in order to clean up the silt that had deposited within their jurisdiction (Taubitz, 2001);
- In 2000-2001, from October to February, an estimated three feet of silt had deposited in lower Francis Creek (Taubitz 2001);

Table 6. Salt River has two major problems concerning sediment: factors that increase sediment deposition and factors that reduce the Salt Rivers capacity to flush the sediment to the ocean (USDA 1993).

Factors that increase the volume of sediment entering the mainstem of the Salt River	Factors that decrease the channel cleansing capacity
Naturally high levels of erosion in the Wildcat tributaries.	Low gradient of the Salt River Delta.
Natural erosion rates have increased due to past and present land use activities such as timber harvest, pasture conversion, road construction, sand quarries and riparian deforestation.	Potential for uplift and subsidence occurring unequally throughout the Eel River Delta, creating changes of landscape.
Channelization and realignment of the Wildcat tributaries in their lower reaches results in greater suspended sediment reaching the Salt River.	Willow growth in the Salt River channel is prolific, which slows water velocity.
Earthquakes in the basin are common and of a large magnitude.	Loss of cross-sectional area of all portions of the Eel River Estuary and its tributaries.
	Reduction of tidal prism, caused by construction of levees and the installation of tide control structures.
	Leonardo levee has almost eliminated Eel River flood waters from entering the eastern portion of the Salt River.

Table 7. Sediment yield to the Salt River channel from upland subwatersheds- average annual estimates for watershed conditions originally published in 1993. Adapted to reflect changes in watershed conditions since 1993.

Sub-Watershed Number	Upland Tributary Name	Watershed Area	Sediment Yield to base of Wildcats from All Sources		Sediment at the Base of Wildcats (%)		the Salt River Channel (%)			Avg. Annual Sediment yield to Salt River Channel (tons / year)		
		acres	(tons/year)	(tons/acre-year)	Bed	Wash	Bed	Wash	Total Load	Bed	Wash	Total
1	Cuttoff Slough	360	870	2.4					50			440
2	Centerville Slough	1020	2700	2.6					50			1350
3	Russ Creek	2080	3790	1.8					10**			380
4	Smith Creek	160	700	4.3					35			250
5	Unnamed #5	420	520	1.2					35			180
6	Reas Creek	1210	2690	2.2	60	40	40	98	63	650	1050	1540
7	Francis Creek	1990	5480	2.8	55	45	5	75	34	150	1850	2000
8	Williams Creek	3660	9960	2.7	47	53	10	90	52	470	4750	5,240
9	Unnamed #9	590	580	1					0			0*
10	Coffee Creek	350	1050	3					0			0*
11	Unnamed #11	470	930	2					0			0*
Total Average		12300 (rounded)	29300 (rounded)	2.4					39			11,400 (rounded)
Adapted Total Average									27*			6140*

* The Salt River is completely blocked by sediment just downstream of the Williams Creek confluence; recalculated to reflect change

** Russ Creek flow is being diverted during the wet season and spread onto pasture to raise the level of the ground

Bed = Bed Material Load
Wash= Wash Load

Figure 16. Reas Creek upstream of Meridian Road on October 20th, 2004

Figure 17. Reas Creek upstream of Meridian Road on December 3rd, 2004.

Soil Types on the Salt River Delta

There are 15 major soil types on the Salt River Delta. The soils on the Salt River Delta can be characterized as very deep soils with small changes in slope located at low elevations and formed on mixed alluvium. The defining features among the soils in the Salt River Delta are their location upon the delta and their subsequent interaction with water.

The USDA Natural Resource Conservation Service has classified almost the entire Salt River Delta as prime farmland (if irrigated) with the exception of the Wigi and Occidental Soil Series. The Wigi and Occidental soil types are located at the western edge of the delta in poorly drained areas and they are both influenced by the tide and have high salinity contents. The Wigi and Occidental soil series are described as being "neither wooded nor farmable under natural conditions" (NRCS Draft Soil Series 2004). Due to reclamation activities, the hydrology of the Occidental soil series has been altered in "some or all areas of the map unit… and the soil characteristics indicate that hydric soil conditions existed prior to alteration of drainage" (NRCS Draft Soil Series 2004). Many of the dominant soils in the delta region are classified as hydric soils including: Worsick, Weott, Swainslough, Arlynda, Loleta, Jollygiant, Occidental, and Wigi.

A comprehensive view of the soil composition and distribution in the Salt River Delta may provide a valuable resource management tool. Soil maps help in wetland identification. With comprehensive soils information, restoration designs can aim to recreate tidal and or freshwater wetlands in appropriate locations. Soil information also indicates areas that are environmentally sensitive or areas that could be managed differently than adjacent soil types.

Vegetation

Historic Vegetation Composition

In its pristine state, the Salt River Delta would have likely been dominated by a flood plain forest and water related features such as sloughs, freshwater wetlands, tributaries, tidelands, and mudflats. The floodplain forest would have been comprised of a mix of spruce forest and willow/ alder riparian forest with occasional presence of Redwood. In the vicinity of tributaries and other drainage features, the floodplain forest would have been bordered by wetlands and meadows/ fern prairies. The floodplain forest would have gradually transitioned into an estuarine wetland in the vicinity of Smith Creek. Historical reports, maps and photographs have shown that the Salt River Delta was once densely vegetated with a diversity of vegetation types:

- **Fern prairies in the Ferndale area and Waddington area (Genzoli, 1972);**
- **Freshwater wetlands near the confluence of Williams Creek and Salt River (Herrick, 1880);**
- **A mix of pine and Sitka spruce forests (Westdahl, 1888);**
- **Riparian forests of alder, willow near watercourses (Schoolcraft 1853 in Eidness and VanKirk, 1988);**
- **An estimated 3,000 acres salt marsh and mudflats in the southwestern delta sections (Kellogg, 1884);**

Early descriptions of the conditions of the Salt River Delta include field notes from George Gibbs in 1851.

> *"Much of this is, however, covered in thickets of willows. etc., and is subject to floods in the rainy season. Those tracts above the reach of the freshets are generally of fern prairies, rich, but not easily subdued. In approaching the coast, the country is much cut up with sloughs, communicating with the river, and near the mouth consists of salt marsh and tide-land…Game is excessively abundant, including deer, elk, bear, and all the fall and wintering ducks, geese, brandt, cranes, and other water fowl" (Schoolcraft 1853 in Eideness and Van Kirk 1988).*

Ferdinand Westdahl, an employee of the U.S. Coast and Geodetic Survey described the changes in vegetation in the Eel River Delta region from the period between 1872 and 1888.

> *"The entire delta of the river has been covered with forests of pine, spruce, and here and there redwood, with alder growing near the water courses. The town of Ferndale consisted then of but a small number of houses and Port Kenyon was an unbroken forest. Now the two places almost merge into one another." Looking east from the ocean, "the forest formed an almost unbroken line across the low land. A great many houses are seen on the hills to the southward of the valley and the timber on these hills is greatly thinned out…these forests have nearly all cleared away, the timber remaining only in bunches" (Westdahl 1888 in Roberts 1992).*

Current Vegetation Composition

Currently, 86% of the Salt River Delta is in agricultural production leaving 14% of the remaining land area for urban/ suburban development, roads, shrub land and riparian forests. To obtain this level of agricultural production dramatic changes to the character of the delta have been made. As indicated above by historical reports, there were once many water related features on the Salt River Delta including: freshwater wetlands, tidelands, sloughs, and meandering tributaries. After 150 years, the wetlands have been drained, the tidelands cutoff, the sloughs marginalized and the tributaries channelized.

Based on GIS analysis, the subwatersheds of the Salt River Basin are dominated by hardwood forests and areas of mixed conifer forests. Typical forest composition in the Wildcat tributaries consists of Sitka spruce, Douglas fir, grand fir, alder, and big leaf maple. Hardwood forests compose 91% of the stream canopy cover in the Wildcat tributaries assessed by CDFG in 2003 and 2004.

Instream Vegetation

Prior to human settlement, instream vegetation growth in the Salt River was controlled by salt water intrusion and scouring river flow that maintained channel morphology. Halophytes, saltwater tolerant plants, were the only plants able to grow in or near the lower reaches of the Salt River.

By 1900, many changes had occurred in the Salt River Basin that drastically changed the hydrology of the system for the worse. In response to the degrading channel conditions in the mainstem Salt River, landowners cut the instream and riparian willows to keep the Salt River free of debris and sediment. Landowners were able to keep the entire river clear of vegetation by individually managing the willow growth adjacent to their property. The 1941 aerial photograph of the Salt River shows a river system that has no canopy cover from Arlynda Corners to the ocean. The manual removal of willows in the mainstem Salt River was curtailed by CDFG in the late 1970's. Now the growth of willows and other freshwater vegetation in the Salt River channel between Francis Creek and Reas Creek is prolific and represents one of the causes for the Salt Rivers dysfunction.

Instream vegetation slows water velocity causing suspended sediment to fall out of suspension and deposit on the channel bottom. The cycle of instream vegetative growth and sediment deposition is self perpetuating. The Salt River channel in some areas has completely filled with sediment and instream vegetation; functioning now more as a wetland than a river. The encroachment of freshwater vegetation in the Salt River channel can be attributed to a number of factors including a loss of tidal prism, excessive sediment deposition in the mainstem Salt River, a reduction in hydrologic energy caused by the construction of the Leonardo levee, and a mandate that stopped the unregulated removal of trees from the riparian corridor of the Salt River.

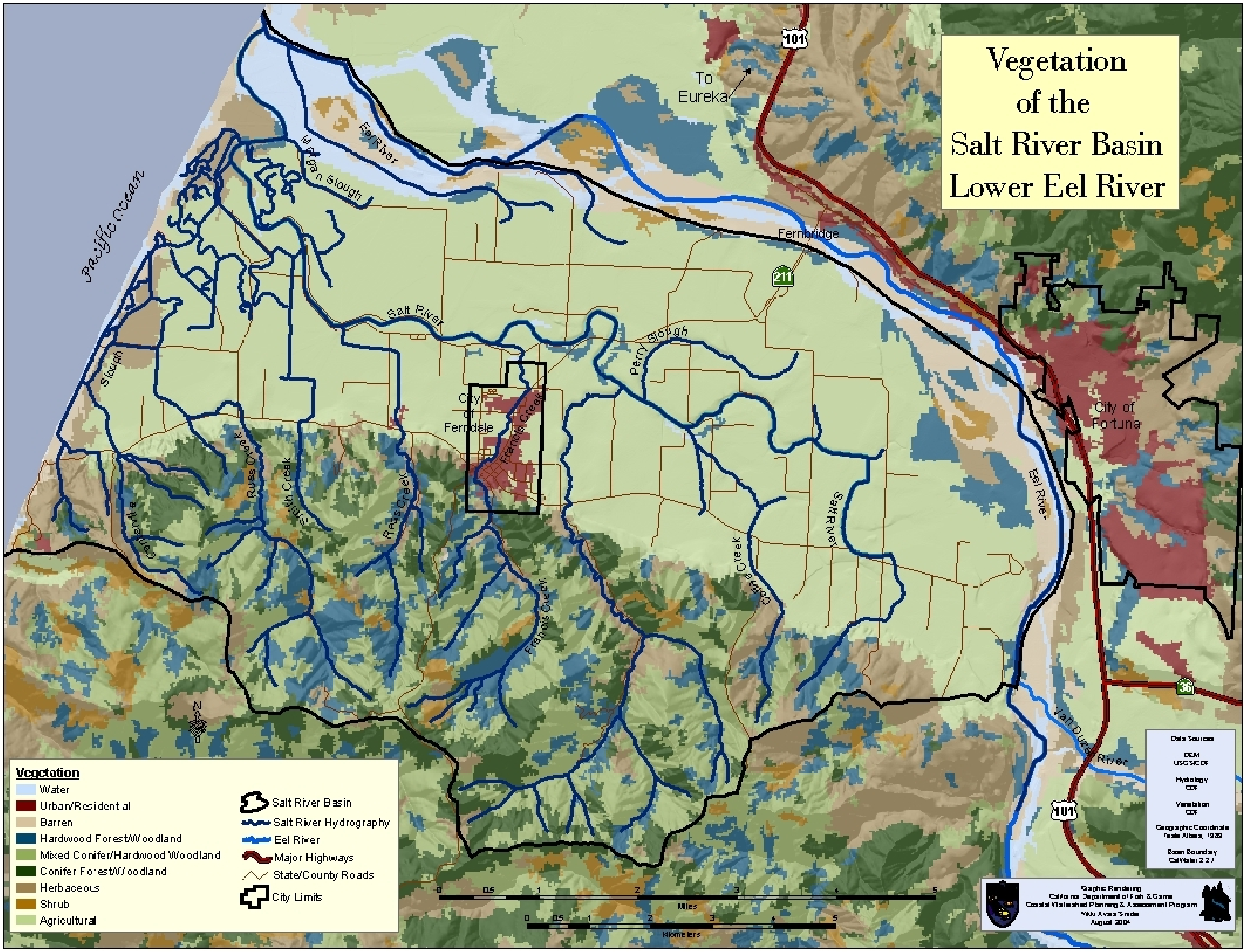


Figure 18. Vegetation types on the Salt River Delta and Wildcat tributaries.

Managing Riparian Areas

Riparian areas are identified by soil characteristics and distinctive vegetation. Vegetation in a riparian area grows on or near the bank of a stream on soils that exhibit some wetness characteristics during some portion of the growing season. Riparian areas are often thought of as the terrestrial extension of an aquatic habitat.

Riparian corridors are the critical link between terrestrial and aquatic systems which allow for a rich diversity of terrestrial and aquatic plants and animals. According to the California Department of Fish and Game *Salmonid Stream Habitat Restoration Manual*, approximately 95% of the historic riparian habitat has been lost in California. California residents, landowners, and agencies are becoming increasingly interested in promoting and enhancing watershed processes; particularly riparian corridor management. Often riparian corridors are enhanced to provide shade canopy to decrease and maintain water temperature. A fully functioning riparian corridor can help maintain channel integrity, reduce erosion damage to adjacent lands, as well as filter sediment and pollutants.

Riparian Deforestation

Riparian corridors in the Salt River Basin are, in places, lacking riparian vegetation; particularly, the Wildcat tributaries. The trans-delta reaches of the Salt River tributaries, such as in Reas Creek tend to have little to no riparian vegetation. Riparian deforestation typically results in a decline ecological integrity (MacGibbon 2001) including**:**

- Increased instream nuisance vegetation and periphyton;
- More rapid and extensive changes in bed morphology;
- Increased magnitude and intensity of floods;
- Changes in seasonal flow patterns, especially in summer low flows;
- Loss of native fisheries habitat due to increased summer maximum temperature;
- Decreased water quality including reductions in dissolved oxygen;

Although it is not indicated on Figure 18, cattle grazing occurs in Williams, Francis, Reas and Russ creeks. These valleys provide valuable grazing land; however, the impacts of cattle on stream quality are apparent. It should be noted that there are only a few areas in the Salt River Basin with riparian exclusion fencing. In stream reaches that are heavily impacted by livestock, exclusionary fencing can give the stream bank enough protection to recreate healthy stands of native vegetation. By fencing riparian areas, stream health will be promoted by limiting the direct input of nutrients and bank trampling until riparian vegetation reaches mature development and can withstand stock impacts. Free access of livestock to streams greatly accelerates stream bank erosion (MacGibbon, 2001):

- Intensive grazing of stream banks reduces the ability of the bank to resist the erosive forces of flooded streams;
- Treading and trampling of banks exposes soil to erosion;
- Livestock accessing the stream for water tend to cut their own paths which can become drainage points for runoff and sources of sediment and nutrient to the stream;
- The sheer weight of cattle can accelerate stream bank slumping.

Table 8. Vegetation habitat types in the Eel River Estuary. The following information is a summary of the vegetation survey of the Eel River Delta that was written by Annie Eicher and Mignonne Bivin as part of the larger Biological Conditions of the Eel River Delta that was prepared for the Eel River Conservation District in 1991

Riparian Forest: Near-stream fringe of vegetation bordering the Eel and Salt Rivers	• Habitat type with the highest species diversity; • Most common species includes: arroyo willow (*Salix lasilepis*) 70% occurrence, 30% cover. Other willow species includes Pacific willow (*S. lasiandra*), Sitka willow (*S sitchensis*); • Red alder (*alnus rubra*) – Common component of riparian forest canopy- 50% occurrence and 17% cover; • Black cottonwood (*Populus trichocarpa*) occurred occasionally, tended to be the dominant species where it was found, and reached 60 feet tall; making it the tallest tree in riparian; • Dominant shrub: California blackberry (*Rubus vitifolius*) 87% frequency, 22% cover. Thimbleberry (*R. parviflora*) was common, salmonberry (*R spectabilis*) was occasional; • Herb Stratum includes: stinging nettle (*urtica dioica*), poison hemlock (*conium maculatum*), cow parsnip (*hercleum lanatum*), sword fern (*polystichum munitum*), and horsetail (*Equisetum*);
Riparian Scrub Shrub: Riparian areas lacking woody vegetation and poorly developed herb stratum.	• Occurs in places on the Eel that typically receive high water, occurring on rocky alluvium; • Sitka spruce , black cottonwood were co-dominant; • Arroyo willow, sandbar willow and pacific willow were common members of the scrub- shrub.
Levees*:* Human-made barrier between surface water and adjacent land and often separates streams from its floodplain.	• Vegetation varied based on adjacent vegetation type; • Mostly coyote brush (Baccharis pilularis var consanguinea).
Sand Dunes: Coastal strip north and south of the mouth of the Eel River.	• Dominated by European beach grass (*Ammophila arenaria*) (80% occurrence, 48% cover), an introduced non-native invasive weed; • **Beach layia** (*layia carnosa*), an endangered dune species. Estimated cover of beach layia is 1-5 %.
Pasture: Majority of the delta is low-lying lands that are in agricultural production.	**Upland:** Species composition depends upon what is planted in adjacent lands. • Kentucky bluegrass (Poa pratensis), perennial ryegrass (Lolium perenne), clover (Trifolium spp.), field mustard (Brassica campestris), creeping buttercup (Ranunculus repens)
	Wet Fresh: Includes areas that are typically ponded or temporarily flooded by freshwater runoff. • Creeping spikerush (Eleocharis palustris), spreading bentgrass (Agrostis stolonifera), silverweed (*Potentilla anserine)*, creeping buttercup, soft rush, manna grass (Glyceria occidentalis), dock (Rumex spp.*)*, canary grass *(Phalaris arundinacea)*
	Wet Brackish: Includes areas that receive tidal seepage from adjacent or nearby tidal sloughs. • Spreading bentgrass, creeping spikerush, silverweed, dock,

Salt Marsh: Occurs near the mouth of the Eel and Salt River and on islands, bordering a network of tidal sloughs	• Historic range greatly reduced;
	• Lowest species diversity of delta habitat types, which is characteristic of salt marshes;
	• Dominant plant species was Chilean cordgrass (*Spartina densiflora*) introduced from Chile in 1860 (80% occurrence, 37% cover);
	• Common salt marsh plants include natives:
	  ◦ perennial pickleweed *(Salicornia virginica)*;
	  ◦ salt grass (*Distichlis spicata*);
	• Areas characterized as a less saline environment supported:
	  ◦ tufted harigrass (*Deshampsia caespitosa*);
	  ◦ alkali bulrush (*Scirpus robustus*);
	  ◦ lyngbye'e sedge (*Carex Lygbyeii*);
	• Rare endemic**, Humboldt Bay gumplant** (*Grindelia stricta spp. Blakei*). Endemic to Humboldt Bay and the Eel River delta- mean cover 3%;

Land Use

Native Inhabitants

Wiyot people have inhabited California's north coast since time immemorial. The ancestral lands of the Wiyot people start at Little River and continue down the coast to Bear River Ridge, then inland to the first set of mountains. Modern towns that are within traditional Wiyot territory include McKinleyville, Blue Lake, Arcata, Eureka, Kneeland, Loleta, Fortuna, Ferndale, and Rohnerville.

This area has long been renowned for its majestic redwood forests and abundant salmon runs. Before the coming of European settlers, Wiyot people were centered on Wigi (Humboldt Bay) and inland to the first set of mountains. Wiyot people would hunt the area's wildlife, fish for salmon, and gather roots for medicine, food and basketry. Major village sites were located along the rich waterways such as the Wiyot (Eel River), from which the Wiyot people derived their name; Potowat (Mad River), Iksori (Elk River); and today's Van Duzen River.

There were smaller villages located inland and along sloughs and smaller waterways that led to Wigi. The village of Wotwetwok was located along Oka't (Salt River) and had numerous families living in it. The families would fish, hunt, and gather along Oka't and use it to navigate to Wiyot and then out to the Pacific Ocean. With the European development of Ferndale and the Eel River delta, these families were displaced from Wotwetwok and the Oka't area to make way for cattle that the settlers brought to the area.

Before 1850, Wiyot people were numbered in the several thousands. By 1860, there was an estimated population of only 200 people left. By 1910, there were less than 100 Wiyot people estimated to live within ancestral Wiyot territory. This rapid decline in population was due to disease, slavery, family displacement, murder, and massacres.

Currently, there are approximately 150 residents that reside on the 88 acres that make up the Table Bluff Reservation. The reservation is located 16 miles south of Eureka near Loleta. Additionally, there are 300+ enrolled tribal members that are living off the reservation in the surrounding cities and towns, or elsewhere within the United States.

Submitted by Marnie Atkins, Cultural Director

Table Bluff Reservation- Wiyot Tribe

Historic Land Use

Shipping

Port Kenyon was established on the banks of the Salt River around 1876, with the intention of establishing a trade route from the Eel River to San Francisco. At that time, the Salt River was large enough to accommodate relatively large boats, the steamer Thomas A. Whitelaw was 136 feet long and had a depth of 13'3 feet (Edeline 1983). The Thomas A. Whitelaw was the first ship commissioned to make regular runs between Ferndale and San Francisco (*Where the Ferns Grew Tall* 1977). According to testimony given by Andrew Swickard in 1899, the width of the Salt River at the confluence with the Eel River was 380 feet. At that location Mr. Swickard also stated that the maximum depth was 18 feet at mean high tide. The width of the Salt River near Port Kenyon was approximately 200 feet wide and was 15 feet deep (USDA 1993). The Eel River shipping industry began in earnest in 1870 and came to an end in 1909 after the steamer *Argo* was beached on the Eel River spit.

Figure 19. Steamer Argo docked at Port Kenyon

The transportation of goods from the fertile soil of the Eel River Delta to San Francisco was a constant dilemma. The residents of the Salt River Delta lived in relative isolation as they were separated from Humboldt Bay by Table Bluff, and the Eel and Salt rivers. Ferries were one of the only means by which they could cross the Eel River. There were four ferries that operated on the Eel River from 1861 to around 1916 (*Where the Ferns Grew Tall* 1977). The ferries stopped operating shortly after the completion of Fernbridge.

Several bridges were built across the Salt River and its various sloughs; however, few structures remained permanent on the delta after the torrents of the Eel River. A shipping industry was the only means by which the residents could efficiently export their goods, but even the shipping was unreliable. The passage into the Eel River presented many ships with troubles, which worsened as the channel filled with sediment. At the request of local residents, government surveyors assessed the possibilities of establishing a permanent shipping industry out of the Eel River. A canal through Table Bluff was suggested to transport goods from the Eel directly to Humboldt Bay (Rees 1917). Other infrastructural improvements were suggested including jetties off the mouth of the Eel River. It was noted by the chief engineer that navigational improvements on the Eel River could also serve as efforts to control the river during flood periods. Government investment and interest was denied on the account of the Eel Rivers close proximity to Humboldt Bay and the unpredictable nature of the Eel River.

Transportation on the north coast changed quickly with the shipping success of Humboldt Bay, the advent of the Northwestern Pacific Railroad, and the later proliferation of the automobile and subsequent highway construction. The shipping industry out of Port Kenyon existed for almost 40 years; however, access through the Eel River spit worsened annually and was particularly dangerous during the late summer. Regardless, the forty years of shipping out of Port Kenyon helped to establish Ferndale as the agricultural center of Humboldt County.

Navigation of the Eel River was limited by several factors:

- Ecological changes induced by dramatic land use changes made shipping impossible as the river became too shallow;
- There were not enough exports to facilitate an Eel River shipping industry;
- Technological advances in transportation made the development of the Eel River shipping industry unnecessary.

Timber Harvest

The Enterprise Lumber Mill opened in 1878 operating on the west bank of the Salt River, at the mouth of Soulay Slough, 4 miles from the confluence with the Salt and Eel River and 1 mile from Port Kenyon (Edeline 1983). The mill was able to cut 20 thousand feet of redwood and 15 thousand feet of spruce and pine per day, which were abundant on the Salt River delta. "Timber supply for the mill was inexhaustible, as there were millions of spruce and pine trees within a five mile radius from the mill, and on the Eel River countless millions of redwoods" (Edeline 1983). A new mill was built in 1887 that cut on average 28 thousand feet per day. Timber products were exported from Port Kenyon to San Francisco. When the ships stopped coming to Port Kenyon, the mill was primarily reliant on local demand because Humboldt Bay had become the primary port for trade on the North Coast.

Eel River Fishery

The first cannery in the Eel River Delta opened in 1877 at the mouth of the Eel River (Edeline 1983). The Cutting and Packing Company in its ten year operation produced 4,123,200 pounds of processed salmon (Table 9). In addition, many barrels of salted salmon were shipped from the Eel River. Much of the work force in the cannery was provided by Chinese laborers. The cannery industry was adversely affected when the Chinese community was 'evacuated' in 1885/ 1886 from Humboldt and Del Norte counties on the account of a Eureka City Council member being struck by a stray bullet in a predominantly Chinese neighborhood (Edeline 1983). The Cutting and Packing Company argued against the anti-Chinese rule of the county, citing that Chinese labor was integral to their business. "It is manifestly unreasonable and unjust that the residents of Humboldt County should single out the Pacific Coast Packing Company, and attempt to force them to employ exclusively white men, thus putting them in a hopeless competition with every other salmon cannery on the coast" (Edeline 1983). The Tallant Cannery opened in 1905 at Port Kenyon but by that time the Eel River fishery as it was known for the 30 years previous, was gone. In 1893, the editor of the *Ferndale Enterprise* wrote,

> *"The gradual disappearance of the salmon is something that should cause concern on this coast. The catch in the last year is only a fraction of that of years gone by...and the salmon will soon be extinct in California waters unless some adequate measures are taken.... There is no mystery in the cause of the decline of the salmon. The fish have been mercilessly hunted...there is no stream on the Pacific Coast that is fished as closely as Eel River…Whether anything can be done for California streams or not is doubtful" (Ferndale Enterprise, January 17, 1893).*

Table 9. Records of canned salmon from the Cutting and Packing Company (Edeline, 1983)

Year	Cases (48, 1lb cans)	Estimated Processed Salmon (lbs)
1877	3,500	16,8000
1878	11,900	571,200
1880	8,400	403,200
1881	6,300	302,400
1882	8,700	417,600
1883	9,000	432,000
1884	8,000	384,000
1885	5,600	268,800
1886	12,500	600,000
1889	12,000	576,000
	Total	4,123,200

Current Land Use

Agricultural Land Use

The Salt River Delta is approximately 17,695 acres, of which approximately 15,243 acres are in agricultural production (LaVen 1994). Dairy farming is the dominant type of agriculture on Salt River Delta. Other agricultural activities include the production of beef cattle, hay, silage and corn. As of 1994, the average dairy farm size was 162 acres. The peak population of dairy cows on the Salt River delta occurred in 1965 with over 18,500 cows being milked; in 1994, there were approximately 14,500 cows (LaVen 1994).

Specific land practices in the delta region are dependent upon proximity to the Salt River and Pacific Ocean. In general, land management becomes more difficult and more complex as one approaches the tidal zone and less complex in the Grizzly Bluff area (LaVen 1994). Some pastures in the Salt River region are grazed year-round; however, most cows are generally pastured from late April through October or November. During the rainy season, cows are often confined either using free stalls, unpaved lots with limited housing or open corrals lined with three to four feet deep wood chips (USDA 1993).

Much of the Salt River Delta is classified as prime farm land by the United States Department of Agriculture. Prime farm land is classified based on: soil quality, growing season and available water capacity to produce high yields economically. There is a sizeable portion, mostly in the western delta that is too wet and too saline to be considered prime farmland.

There are 13 organic dairies in Humboldt County, 11 of which are located on the Eel River Delta and 8 are located within the project area. Organic dairy farms in the Salt River Delta comprise approximately 3,500 acres, which is roughly 23% of the land in agricultural production in the Salt River Delta (Eicher 2004). The USDA has defined organic foods as “a production system that is managed to respond to site specific conditions by integrating cultural, biological and mechanical practices that foster cycling of resources, promote ecological balance and conserve biodiversity” (Greene 2001). The conversion of conventional farms to organic farms on the Salt River Delta was precipitated by the higher prices paid for organic dairy products. Existing pasture-based dairy farming on the Salt River Delta lends itself to a relatively easy conversion to qualify to the USDA organic standards.

Urbanization

The urban area of Ferndale is 540 acres or 0.85 mi^2. The population of the City of Ferndale is 1,382 as of 2000 (US Census 2000). Urbanization in the Ferndale area is an important management concern in the Salt River Basin. The City of Ferndale is straddled upon Francis Creek and also encompasses two significant drainages known as East side and West side drainages.

The upper portion of Francis Creek flows through steep forested hills where livestock grazing and timber harvest are the major land use. Two miles of lower Francis Creek have been channelized and straightened through downtown Ferndale. Additionally, the Ferndale wastewater treatment facility is located at the confluence of Francis Creek and the Salt River.

The 1854 and 1894 maps of Francis Creek clearly show the confluence of a tributary in the vicinity of Port Kenyon Road, which is now known as East side drainage (Figure 20). In addition to draining the eastern part of Ferndale, East side drainage receives overflow from both Francis and Williams Creek (Spencer Engineering 2004b). Due to a century's worth of modifications, East side drainage no longer has a confluence with Francis Creek. During the rainy season East side drainage now flows down Market Street ditch across Port Kenyon Road and into 'Lake Vevoda.' This configuration of East side drainage causes several private landowners significant risk of flooding and loss of agricultural production and is a concern of the City of Ferndale.

The Westside drainage consists of a network of street gutters, drainage channels and culverts (Spencer Engineering 2004b). According to Spencer Engineering Inc. the drainage channels are densely vegetated and draining at full capacity. Westside drainage runs north toward Port Kenyon Road where "runoff ponds, percolates, or drains west in a small agricultural ditch (Spencer Engineering 2004b).

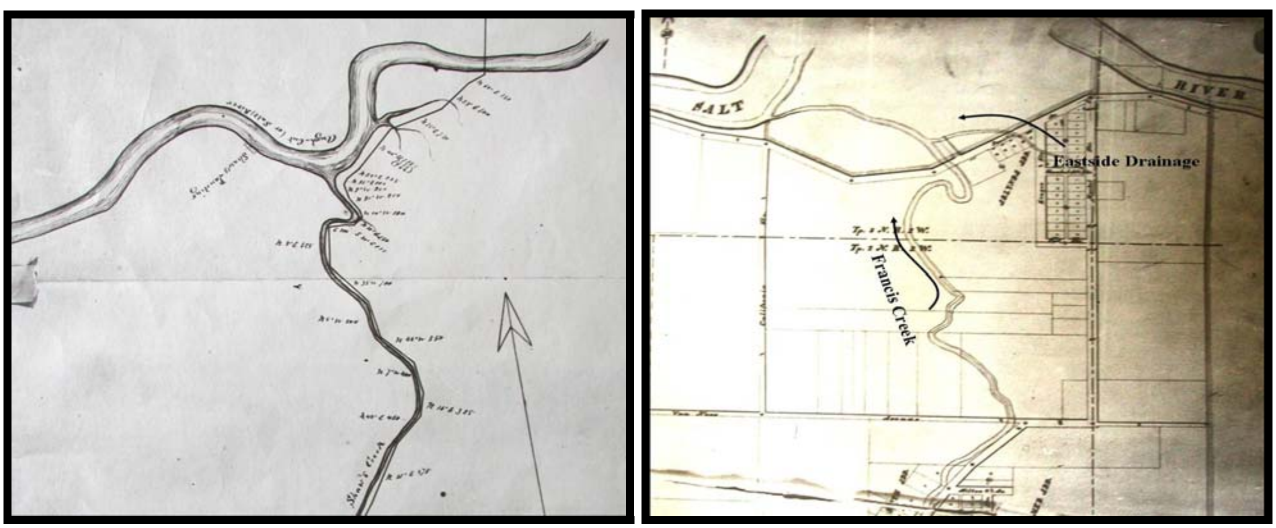


Figure 20. The confluence of Francis Creek and the Salt River and Eastside Drainage in 1854 (left) and in 1894 (right).

In 1986, the Ferndale City Council recognized flooding and erosion hazards into its general plan. Flooding of Francis Creek had caused business and property losses and required expenditures for stream bank repair and city cleanup. In 1990, the Drainage Master Plan was adopted by the City of Ferndale, which has since been updated in April, 2004. The Drainage Master Plan sought to identify drainage problems, establish prioritized drainage projects and to improve the flood capacity of Francis Creek.

In the past, the flood capacity of Francis Creek had been restricted by culverts, bridges, sediment build-up instable banks and debris. A series of flood mitigation projects on Francis Creek have improved Francis Creek flood capacity from 250 cfs to 750 cfs. Flood mitigation funding for Francis Creek was provided through various sources including: Federal Emergency Management Agency (FEMA), Caltrans, and

California Department of Water Resources Urban Streams Project. At least $1,034,000 of monies were spent on Francis Creek improvements from 2000 to 2002 (Spencer Engineering, 2004b). The first of three flood mitigation phases began in 2000 and phase 2 and 3 were completed by 2002. Various methods were used to widen and improve the Francis Creek channel including: large rock slope protection, re-vegetation with native plant species to enhance stream bank functions and provide canopy cover, and instream habitat enhancement structures.

The City of Ferndale has identified eight major drainage problem areas in its 2004 Drainage Master Plan. To address the identified drainage problems the city expects that $1,028,000 is necessary to complete the various projects. The city has also identified the need to develop a Market Street Drainage Plan which would identify drainage problems and solutions in the Eastside drainage. Ultimately, the Eastside drainage needs to be reintroduced into Francis Creek near its historic confluence.

Non-urban development in the Salt River Basin is another concern that is a risk to the existing quality of life, available farmlands, and water quality caused by new erosion sources.

Recreation and Public Lands

Russ Park, a 105 acre tract, was donated to the City of Ferndale by Mrs. Zipporah Patrick Russ in 1920. The land was given to the city under the conditions 'that the property be used forever as a park and recreation grounds…as a refuge and breeding place for birds.' Russ Park is dominated by second growth Sitka spruce and grand fir and interspersed with western red cedar, and Douglas fir. Estimates place the oldest tree in Russ Park as 130 years old.

Water Quality

Water quality within the Salt River Basin is particularly important because of its direct effect on the Salt River ecosystem and the Eel River Estuary. The Salt River Delta is among the most intensively managed working lands in Humboldt County for agriculture and therefore should require a robust water quality monitoring regiment to ensure high quality surface water. Water quality monitoring efforts in the Eel River Delta have been scattered and incomplete and likely do not adequately portray water quality conditions. There are three major sources of pollutants that contribute to potential water quality problems in the Salt River:

- Ferndale wastewater treatment plant;
- Farm and dairy wastes;
- Erosion.

Wastewater Treatment

The City of Ferndale operates a wastewater treatment facility on the banks of Francis Creek and the Salt River (Figure 21). The wastewater treatment plant provides secondary treatment and consists of a gravity collection system, a seven-acre aerated oxygen pond, settling basin, chlorine contact basin, and a dechlorination system (NCRWQCB 2003). The Ferndale wastewater treatment facility is designed to process one million gallons of effluent per day (mgd). In the winter months, the effluent from the Ferndale wastewater treatment plant is directed into Francis Creek, which historically had sufficient flow to meet dilution requirements year round. Sediment deposition has reduced the cross sectional area of the creek and now the wastewater treatment plant effluent exceeds 1% of receiving flows during winter months, which is a violation of Waste Discharge Requirements. During the summer, wastewater effluent is applied to nearby pastures because the summer flows of Francis Creek and Salt River are inadequate to meet dilution requirements.

The City of Ferndale is currently operating its wastewater treatment facility under a Cease and Desist Order issued by the California Regional Water Quality Control Board - North Coast Region and is required to achieve compliance by February 1, 2005. The Ferndale wastewater treatment facility has accumulated 241 water quality violations since 1996 (Spencer Engineering 2004a). Improvements to the existing facility have been made in recent years and the number of water quality violations has been on the decline. The City of Ferndale is currently in the process of designing a wastewater treatment facility that is in compliance with water quality regulations. A number of alternatives have been discussed including:

- Pumping effluent to outfall on the Eel River to obtain dilution;
- Improving wastewater effluent by adding a constructed wetland (3.3 acres) to existing system;
- Adding a storage pond (40 acres) to existing system to comply with dilution requirements;
- Adding tertiary treatment of lagoon effluent;
- Designing a new system, Sequencing Batch Reactors, on the footprint of existing facility;
- No action;

Figure 21. Westward aerial view of the Ferndale waste water treatment plant during February 2004. The ponded area on the right is known as Lake Vevoda. Francis Creek flows around the settling pond, Arlynda Corners is in the foreground.

Farm Wastes

In the Salt River Delta there are numerous factors related to farm wastes that contribute to surface and ground water pollution; "There is a high density of dairies in the Salt River area with limited acreage available for disposal, high water table and close proximity to surface water bodies. There is a need for intensive waste management under these conditions to reduce and further prevent surface and groundwater contamination" (USDA, Appendix A 1993).

According to the Natural Resource Conservation Service, in one year 100 dairy cows will produce 58,000 ft^3 of contaminated liquid (wash water, urine, and intercepted rainfall) and 14,600 ft^3 of solid waste (manure, sands, silt and feed) (USDA, Appendix A 1993). Given these figures, an estimate can be made for dairy waste production in Salt River Delta. As of 1994, there were 14,500 cows on the Salt River Delta therefore, 8,410,000 ft^3 of contaminated liquid and 2,117,000 ft^3 of solid waste are produced annually by cows in the Salt River Delta. Proper and careful management of nutrients is necessary to avoid excess nutrients leaching into surface water which may change the biological, chemical and physical interactions within the system.

Two water quality monitoring studies have taken place in the Eel River Delta to assess the impacts of farm wastes on surface waters: Animal Waste Assessment Project in the Eel River Delta (1997) and Eel River Delta Agriculture Management and Enhancement Plan (1994). The Eel River Delta Agriculture Management and Enhancement Plan indicated that there were water quality problems associated with dairy waste in the streams in the Ferndale area. Sixteen locations were sampled for water temperature, dissolved oxygen, pH, electrical conductivity and ammonia. In 1994, Ammonia concentrations were at their highest downstream of the wastewater treatment facility (LaVen 1994).

The Animal Waste Assessment Project in the Eel River Delta took water samples throughout the Salt River area beginning in early 1996 and ending in April 1997. A total of 21 sites were sampled throughout the Salt River Basin. Water quality parameters included pH, salinity, electric conductivity, dissolved oxygen, unionized ammonia, and total ammonia. Several general locations were identified as having farm waste water quality problems including: Reas Creek, Williams Creek, Perry Slough, and Coffee Creek (Anderson, 1997).

Both reports indicate that farm waste related water quality problems exist in the Salt River; however, watershed-wide conclusions on the state of water quality in the Salt River from existing reports are difficult to make due to: 1) limited number of samples; 2) limited range of water quality parameters being assessed; 3) limited time period of sampling; and 4) locations of the monitoring sites was left to the discretion of the technical advisory committee to avoid identification of individual operations that may be sources of pollution.

The Eel River Delta Agriculture Management and Enhancement Plan *(1994)* gathered farm waste management information through a questionnaire and a soils mapping project. Analysis was conducted based on USGS quadrangles. The final conclusions of the report indicated (LaVen 1994):

- About half of the dairy operations on the Eel River Delta have animal waste handling and disposal problems;
- 65% of Salt River Delta soils have severe limitations if used for the handling of and disposal of animal wastes during increased precipitation;
- Salt River Delta soil limitations are so severe that individual customized waste management plans may be necessary for sustainable operations;
- Operations that do not separate their solids and liquid wastes are more likely to have animal waste handling or disposal problems than operations that separate their wastes;
- Solid waste management takes a relatively large portion of the dairy operators time and energy and resources but represents a relatively small part of the waste pollution problem;
- Uncontrolled runoff is another major source of animal waste production;
- Problems with waste management become more complex toward the tidal zone and less complex in the Grizzly Bluff area;
- Some of the more complex problems are not confined to single ownerships. There are cases where landowners are being impacted by the waste of adjacent property owners;
- Channel conditions in the Salt River and its tributaries exert an influence on the ability of much of the agricultural land in the Ferndale bottoms to drain properly.

Cultural Eutrophication

Eutrophication is a slow and natural process in the geologic history of a water body where sediment reduces the volume of water resulting in a change in biological and ecological communities (Lampert 1997). Cultural eutrophication differs from natural eutrophication in that the rate is greatly accelerated (Goldman 1983). The Salt River is a prime example of cultural eutrophication. The past 150 years in the Salt River Basin has seen a dramatic increase in watershed disturbance including: wetland conversion, land clearance, nutrient enrichment, increased erosion and other modifications that have all contributed to the impaired state of the Salt River. The Salt River has experienced a change in biological and ecological communities over 150 year, where it functions more as a marsh than a river.

There are two nutrients that are of particular concern when considering nutrient contamination of water bodies; nitrogen and phosphorus. In 1977, the California Department of Water Resources conducted a physical, chemical and biological survey of the Eel River Estuary. Phosphorus, in its various forms was sampled throughout the estuary. The report concluded that "substantially higher phosphate concentrations found in the sloughs" (DWR, 1977). The study indicated that neither the Eel River, at least during low flow periods, nor the ocean were responsible for contributing the main stores of phosphate for primary production (DWR, 1977). Sources of phosphorus in the sloughs include: sediment deposits, irrigation waters, dairy or agriculture processing waste water and runoff from feedlots. Sources of nitrogen in estuary sloughs are similar to phosphorus sources.

Phosphorous contamination is likely to occur where (MacGibbon 2001):

- Stream receives discharge from oxidation ponds;
- Soil erosion is a problem;
- Low soil permeability encourages increased surface runoff;
- Stream bank erosion is occurring;
- Dung is deposited by livestock directly in surface water;
- Phosphatic fertilizer is applied to saturated soils.

Nitrogen contamination is likely to occur where (MacGibbon 2001):

- Soils are very porous;
- Irrigation water is applied excessively;
- Wetlands have been drained- losing the denitrification process;
- Excessive fertilizer application;
- Livestock have access to the creek.

Algae blooms occur annually in the Salt River as well as in portions of the Eel River Estuary. Algae blooms are the result of excess nutrient loading. Algae blooms are able to cause health and aesthetic problems and some varieties contain neurotoxins which have been known to result in death in humans as well as pets that may ingest contaminated waters. Additionally, the decay of algae and aquatic vegetation often results in less oxygen available to sensitive species, such as salmonids.

Water Temperature

The maximum weekly average temperature (MWAT) is the maximum value of the seven day moving average temperatures. The MWAT range for "fully suitable conditions" of 50-60°F was developed as an average of the needs of several cold water fish species, including coho salmon and steelhead trout. As such, it may not represent fully suitable conditions for the most sensitive cold water species (usually considered to be coho). Temperatures between 61-62°F are considered "moderately suitable," while a temperature of 63°F is considered "somewhat suitable." The suitability of a 64°F temperature is considered "undetermined." Temperatures of 65°F and above are within the ranges considered "unsuitable" for salmonids.

Table 10. Water temperature criteria

MWAT[2] Range	Description
50-60°F	Fully Suitable
61-62°F	Moderately Suitable
63°F	Somewhat Suitable
64°F	Undetermined
65°F	Somewhat Unsuitable
66-67°F	Moderately Unsuitable
≥ 68°F	Fully Unsuitable

Table 11. MWAT's for the locations in the Salt River Basin.

Name	MWAT (°F)	Location
Francis Creek 2004	61.6	Francis Creek near Scout Hall, under rock pile in riffle mid-channel.
Francis Creek 2002	57.9	150 feet downstream of Main Street bridge
Francis Creek 2001	58.7	100 feet upstream of Main Street bridge
Francis Creek 2000	59.2	150 feet downstream of Main Street bridge
Smith Creek 2004	74.4	Located at Zane's Sheep Farm- tied to middle post of Smith Creek bridge.
Cuttoff Slough 2004	64.4	Located just upstream of the Cuttoff Slough/ Salt River confluence in mid channel

MWAT's were calculated at 5 sites within the assessment area. Francis Creek was sampled at three separate locations during in 2000, 2001, 2002 and 2004. Three of the four MWAT's on Francis Creek were considered to be with the fully suitable range. Smith Creek proved to have water temperatures that were fully unsuitable for salmonids with a MWAT of 74.4 °F. The MWAT on Cuttoff Slough was within suitable temperature range for salmonids

Other water quality issues

- Mercury contamination of fish in the Eel River system (Stokes 1981);
- Fecal contamination from farm wastes and from the Ferndale waste water treatment plant may cause human health problems;
- Farm runoff, such as fertilizers, pesticides, herbicides;
- Pharmaceuticals such as hormones, antibiotics, prescription and non-prescription drugs have been found in 80% of the nations waterways, which are typically sourced from human wastewater treatment facilities and from farm wastes (Koplin 2001) ;
- There is a lack of standardized water quality monitoring throughout the basin.

Wildlife Habitat Relationships

Eel River Delta

The value of the Eel River Delta for fish and wildlife is high because of the diversity of habitat types such as: shallow water bays, deep water sloughs, freshwater marshes, salt marshes, tidal mudflats, riparian woodland, sand dunes, gravel bars, well drained pasture, poorly drained pasture (Monroe 1974). Within the Salt River Basin many of these natural habitat types have been significantly reduced in size and function. The Eel River Delta is home to 200 bird species (resident and migrant), 61 species of mammals, 15 species of crustacean, 40 species of fish, and 170 plant species (Gilroy 2002; Bivin, Eicher 1991). The Eel River Delta also serves as a stop over on the coastal fly-way for migratory waterfowl, shorebirds, wading birds and other water-associated birds (Monroe 1974).

The Eel River Delta has a growing residential population which is concentrated to the communities of Fortuna, Ferndale, Loleta, and Fernbridge. Land area in the Eel River Delta is largely privately owned and predominantly dedicated for agricultural purposes.

Eel River Estuary

> *"The Estuarine portion of the Eel River Delta has been severely altered by many influences of both man and nature in recent times. However, increased sediment yield from land-use abuses in the five upstream subbasins, and the greatly reduce tidal prism from marsh lands reclamation in the delta itself are primary reasons the Eel River Estuary and the Salt River are but a fraction of their former size and volume. Accelerated erosion of the Eel River Watershed and aggradation of the river and estuary have reduced the capacity of the river to support salmon and steelhead. Sedimentation adversely affects anadromous fish by filling pools, raising temperature, lowering dissolved oxygen and smothering food organisms. Estuarine habitat is further degraded by excessive animal wastes from nearby delta farming area. Nutrients from decomposition of these wastes stimulate the growth of algae and reduce dissolved oxygen in streams", (CDFG 1997).*

The Eel River is the fourth largest estuary in California (USDA 1993). In 1870, the Eel River tidal area was estimated to be 6,525 acres (USDA 1989). The estuary, inclusive of sloughs and side channels, was estimated to be about 2,200 acres, or 3.4 square miles in the mid 1970's (CDFG 1997). In 1989, the Soil Conservation Service estimated that the Eel River estuary is only 40% of its original size. The upstream Eel River estuarine boundary is generally delineated to about river mile seven near Fernbridge, but extreme high tides can extend the estuarine influence to river mile 8.6, near 12th Street in Fortuna (CDFG 1997). The reduction in estuarine size corresponds with the increase of agricultural land within the delta region. There was a 7 % increase in total land in agricultural production between 1964 and 1974, "this is believed to have been reclamation of marshlands near the coast" (Stokes 1981). Over the past 150 years, levees, tide gates, and berms have been installed to reduce tide water volume, to reclaim wetlands for agricultural conversion, and to better control high water events. The network of levees and tide gates in the Eel River estuary has reduced channel connectivity and blocked the ebb and flow of the ocean tides and has reduced what is known as the tidal prism, which is the volume of water that is exchanged between tides.

Aquatic Macroinvertebrates

Macroinvertebrate assemblages in a stream can serve as an indicator of biological integrity and the ability of a stream to support designated uses such as strong fish populations. Macroinvertebrates are sensitive to streambed sediment alterations, can integrate the effects of changes over time and tends to characterize local conditions. In the Salt River Basin, macroinvertebrate studies were conducted in 1996 and 1990.

In 1996, Francis and Williams creeks were sampled for macroinvertebrates as part of a larger Eel River Water Quality Monitoring Report that was prepared for the Humboldt County Resource Conservation District. Francis and Williams creeks were among twenty-two Eel River tributaries sampled (Freidrichson 1998). The data were analyzed using several ecological indicies designed to use stream macroinvertebrates as indicators of stream health.

Table 12. Macroinvertebrate sampling conducted in 1996.

	1996	Francis Creek	Williams Creek	Highly Impacted	Target Values
Modified Hilsenhoff Index	Fall	2.2	2.57	>2.5	<2
	Spring	2.86	2.56		
Simpson Index	Fall	0.75	0.82	<0.08	>0.9
	Spring	0.31	0.6		
Percent Dominant Taxa	Fall	411	37.2	>40%	<20%
	Spring	82.6	53.7		
EPT Index	Fall	10	13	<15	>25
	Spring	9	9		
Richness Index	Fall	21	26	<25	>40
	Spring	16	17		

The macroinvertebrate assemblages in the Francis and Williams creek during 1996 do not satisfy any of the accepted target values and often exceed the accepted levels for highly impacted streams. Francis and Williams creeks are not typical North Coast streams in that they are part of a very highly erosive watershed that has naturally high levels of sediment. Macroinvertebrates are particularly sensitive to instream sediment deposition. In the case of the Salt River tributaries, application of standardized macroinvertebrates stream health indicies may misrepresent the natural assemblages of macroinvertebrates expected in the Salt River.

Table 13. Macroinvertebrate sampling conducted in 1990 by the USDA Soil Conservation Service.

	Williams Creek	Francis Creek	Russ Creek
Shannon Weaver Diversity Index	1.18	2.02	1.85
Beck's Biotic Index	10	9	5

The macroinvertebrate samples collected in 1990, from Williams, Francis and Russ creeks were gathered in locations where the streams emerged from the Wildcat Hills onto the Salt River plain. "In general the samples indicated the aquatic community had been moderately disturbed, but still fell in the 'good' water quality category. The most commonly found insect was a predatory stonefly (Plecoptera, Perlodidae, Isoperla sp.) associated with erosional / and depositional stream habitats. The only mayfly present (Emphemeroptera, Baetidae, Baetis sp.) is also associated with erosional / depositional habitats, as was the only caddisfly (Trichoptera, Yphriinae sp.) Beck's Biotic Index ranged from 5 to 10. This indicates a quality range from slightly polluted to clean with occasional perturbations. The Shannon Weaver Diversity Index similarly ranged from 1.18 to 2.02 or, again somewhere in the good to slightly polluted condition range. Most streams from healthy forested landscapes would range between 2.0 and 3.0 using this index, and a diversity index less than 1 would be considered polluted" (USDA, 1990 b).

Salmonid Fisheries Resources

Fishes of the Salt River

Assessment of the Salt River fisheries can be broken down into two components: 1) fish composition in the upland tributary riverine habitat, and 2) fish composition in the downstream trans-delta/ estuarine habitat. Documented and anecdotal evidence indicate that salmonid populations in the Salt River have reached a historic low; however, the historic distribution, abundance and utilization of the Salt River and it's tributaries by salmonids are not well documented. Currently, anadromous salmonids are thought to be absent from the Salt River and its tributaries. Francis and Russ creeks are the only tributaries with current salmonid observations (Table 14). Thirteen species of fish, including Chinook and steelhead were observed in the estuarine portion of the Salt River in 1995 (Table 15). Chinook presence indicates seasonal utilization of Salt River estuarine channels by salmonids.

Table 14. Presence of fish species observed in Salt River tributaries upstream of Centerville/ Grizzly Bluff Road in 2003, 2004, 2005 (DFG 2003; DFG 2004, DFG 2005).

	Coho	**Steelhead**	**Cutthroat**	**Pikeminnow**	**Stickleback**
Williams Creek				X	X
Francis Creek	X	X	X	X	X
Reas Creek				X	X
Russ Creek			X		X

Table 15. Presence of fish species observed in the estuarine portions of the Salt River in 1977 and 1995 (DFG, 1977 and Cannata 1995).

Anadromous		**1977**	**1995**
Coho	*Oncorhynchus kisutch*	X	X
Chinook	*Oncorhynchus tshawytscha*	X	X
Steelhead trout	*Oncorhynchus mykiss*	X	X
Cutthroat trout	*Oncorhynchus clarki*		X
Estuarine			
Pacific herring	*Clupea harengus*	X	X
Pacific sardine	*Sardinops sagax caerulens*		X
Surf smelt	*Hypomesus pretiosus*	X	X
Top smelt	*Atherinops affinis*	X	X
Longfin smelt	*Spirinchus thaleichthys*	X	
Threespine stickleback	*Gasterosteus aculeatus*	X	X
Bay Pipefish	*Sygnathus griseolinealus*	X	
Redtail surf perch	*Amphistichus rhodoterus*	X	X
Shiner surf perch	*Cymatogaster aggrenteum*	X	X
Prickly sculpin	*Cottus asper*		X
Coastrange sculpin	*Cottus aleuticus*	X	
Pacific staghorn sculpin	*Leptocottus armatus*	X	X
English sole	*Parophrys vetulis*		X
Starry flounder	*Platichthys stellatus*	X	X
Freshwater			
Sacramento pikeminnow	*Ptychocheilus grandis*		X

Chinook Salmon (Onchorhynchus tshawytscha)

Chinook salmon have been observed in the slough portion of the mainstem Salt River in 1973, 1977, 1984 and in 1995 (CDFG 1973; CDFG 1977; CDFG 1984; Cannata 1995). Chinook have not been recorded in any of the upper reaches of the Salt River tributaries.

Coho Salmon (Onchorhynchus kisutch)

Until the summer of 2005, there have not been any recorded observations of coho salmon in the Salt River system for 20 years. During a stream bank stabilization project conducted within Fireman's Park in Ferndale, several coho salmon were identified. Later in the summer of 2005, additional coho were observed within the Ferndale City limits. One of three recorded observations of coho salmon in the Salt River drainage occurred in 1972 in the only accessible portion of Reas Creek below an eight foot tall concrete barrier that was attached to the Port Kenyon Road crossing, 100 yards from the confluence with the Salt River (CDFG 1972). In 1984, CDFG captured a coho salmon in Centerville Slough near the Centerville Road crossing. (CDFG 1984). The other reported observation of coho occurred in 1977 in the slough portion of the Salt River (CDFG 1977).

Steelhead Trout (Oncorhynchus mykiss)

Steelhead young of the year were captured and relocated in Francis Creek in 2003 by CDFG during a flood control project on Francis Creek in Ferndale. Steelhead have been observed in the slough portion of the Salt River in 1973 and 1995 (Puckett 1973, Cannata 1995). Steelhead trout were stocked annually in Francis Creek during the 1930's and the 1980's (CDFG). In 1930 to 1934, 115,000 steelhead were planted in Russ Creek.

Coastal Cutthroat Trout (Onchorhynchus clarki)

Prior to 1951, the presence of cutthroat trout had not been documented in the Eel River or its tributaries by DFG officials despite anecdotal evidence of their presence provided by sport fisherman. On January 30, 1951, cutthroat trout were found to be abundant in streams tributary to the Salt River; specimens (76-203mm) were collected from: Russ, Reas, Francis and Williams creeks (Dewitt 1951). These cutthroat specimens were deposited in collections of the California Academy of Sciences as the definitive record of cutthroat in the Eel River system (Dewitt 1951). Since that time cutthroat trout have been observed in Centerville Slough in 1968 and 1984; in the lower Salt River Estuary in 1995, in Francis Creek in 2000, 2001 and 2003 and in Russ Creek in 2004. The Eel River Delta coastal cutthroat trout population represents the southern extent of the range of the species.

Interestingly, both the 1951 and the 1984 electrofishing surveys noted that the proportions, coloration and spotting of the cutthroat was not typical. "The tidewater specimens of trout were quite silvery and had only faint evidence of the cutthroat mark" (Dewitt 1951). During the CDFG Coastal Cutthroat Inventory in 1984, biologists noted that the cutthroat at Centerville Slough showed unusual characteristics including: variable number of spots; variable spotting pattern (generally restricted to area above the lateral line); variable jaw to head ratio; and large girth (CDFG 1984).

Electrofishing of Russ Creek in 2004 revealed relatively abundant cutthroat trout (71- 188 mm) compared to other Salt River tributaries, and a wide variety of spotting and coloration among those cutthroat observed and measured. Twenty-two cutthroat trout were captured from 8 of 10 sample sites over a 4,000 foot section of Russ Creek, and were evenly distributed throughout the surveyed reach. In Francis Creek, twenty-one cutthroat trout were captured from 13 of 21 sites sampled over a distance of 14,000 feet.

Personal accounts indicate that cutthroat trout, as large as 18 inches, were caught in the Salt River upstream of Fulmor Road bridge in the late 1950's (Slocum pers. com. 2004). Cutthroat trout were stocked in Francis Creek from 1962 to 1966.

Sacramento Pikeminnow (Ptychocheilus grandis)

A troubling aspect about the current Salt River fishery is the recent observations of Sacramento pikeminnow in the Wildcat tributaries and the Salt River Estuary. The Sacramento pikeminnow is an exotic invasive species to the Eel River that were illegally introduced into Pillsbury Lake in 1979. Within ten years, pikeminnow expanded their distribution throughout the mainstem Eel River and most of its tributaries (Brown and Moyle 1997 in Nakamoto, R.J, Harvey, B.C. 2003). The pikeminnow is known for its predatory feeding habits and there is concern that salmonid populations are negatively affected by pikeminnow predation in the Eel River system. In general, predation of salmonids by pikeminnow is dependent upon pikeminnow body size (Brown, 1990 and Brown and Moyle 1997 in Nakamoto, R.J Harvey, B.C 2003). Pikeminnow become piscivorous at about 10 inches (254 mm).

Pikeminnow have been observed throughout the Salt River system with the exception of Russ Creek. Sacramento pikeminnow were abundant in Williams Creek and Francis Creek in several surveys conducted since 1999. Pikeminnow were observed in Reas Creek in 2001, and 2004 (CDFG 2004). Pikeminnow fork lengths from Francis Creek ranged from 70 to 180 mm which is a size range typical in Reas and Williams Creek. Additionally, pikeminnow were seined in the estuary portion of the Salt River in 1995 (Cannata, 1995).

Fish Habitat Relationships

Historic Conditions

Stream surveys were conducted by CDFG on tributaries to the Salt River as early 1938; however, stream survey efforts were neither specific nor standardized until 1990 when the *California Salmonid Stream Habitat Restoration Manual* was published. Most observations in the historic stream surveys are not quantitative and have limited use in comparative analysis with current habitat inventories. However, data from these stream surveys provide a snapshot of conditions at the time of survey and at the very least provide documentation of the presence of fish species in the Salt River system (Table 16).

Table 16. Summary of stream surveys conducted in the Salt River by the California Department of Fish and Game and private consultants. All comments are taken from survey sheets.

Tributary	Date Surveyed	Source	Fish Comments	Habitat Comments	Barrier Comments	Management Recommendations
Reas Creek	4/4/1972	DFG observations From the mouth to 3 miles upstream (Rogers, D., Rudder, L.L, 1972)	One 6.9 inch coho was captured in the pool below Port Kenyon Road. Cutthroat trout (pure and hybridized) were captured from Port Kenyon Road upstream to the limits of access; average length of nine trout sampled was 117 mm. Port Kenyon Road to Centerville Road trout population is estimated to be 5 fish/ 100 ft. Centerville Rd. upstream trout population is estimated at 25 fish/ 100ft. Three spine sticklebacks present and lamprey ammoceates are present throughout. Cutthroat trout of 20 inches (508mm) have been reported. "It is probably the best trout stream in the Eel Delta below the Van Duzen River"	Below Centerville Road: Nearly all the riparian vegetation has been removed. Cattle have free access to almost its entire length. Barn and feedlot wastes enter the creek Above Centerville Road there is adequate shelter, provided by overhanging vegetation, pools, undercut banks, and debris.	"Immediately below and attached to Port Kenyon Road is a 8 ft concrete falls. This is a complete block to anadromous fish allowing only 100 yds of stream for their use. The culvert under Centerville Road may be a barrier at low flow."	Stream provides a decent trout fishery as is. It could be improved by limiting access of cattle to the stream. If the barrier near the mouth were removed anadromous runs would become established, probably to the detriment of the resident farms.

Tributary	Date Surveyed	Source	Fish Comments	Habitat Comments	Barrier Comments	Management Recommendations
	7/9/1984 (b)	DFG- coastal cutthroat trout inventory	Electrofishing was conducted in a 250 ft stream section below Centerville Road culvert. Coastal cutthroat trout were not observed.	The stream channel is highly aggraded and the stream bottom is composed of fine sediments and muck. Banks are broken down and there is little in-stream cover.		
	08/28/2001 09/18/2002 07/02/2003(a)	North Coast California Coho Salmon Investigation	Electrofishing of the middle reach over a three year period yielded: stickleback, Sacramento pikeminnow, cyprinidae			
	9/28/04 (b)	DFG-biological observations	Electrofishing was conducted on two properties upstream of Centerville Road 31 Pikeminnow were captured, no salmonids were observed.	Cattle have access to the creek in most locations above Centerville Road.	Private road culvert could present passage problems approximately 4,000 feet upstream of Centerville Road.	
Francis Creek	July 2000	Douglas Parkinsons and Associates Flood Mitigation Phase 1.	Electrofishing was conducted 1,087 ft upstream from Arlington Avenue. 37 pikeminnow (89-165 mm), 15 threespine stickleback, 1 sculpin.	Francis creek is channelized with concrete sides or broken concrete rubble stacked along the banks as slope protection. Chunks of concrete serve as surrogate cobble and boulder cover.		
	7/3/01	Fish rescue for Francis Creek flood mitigation project	Electrofishing was conducted on 800 ft upstream of Arlington ave. Two adult costal cutthroat were captured (170 & 180 mm)			
	7/30/01	Fish rescue for Francis Creek flood mitigation Project	Electrofishing was conducted on 1,100ft of channel (Fern St. to Arlington Ave). Captured fish were relocated downstream including: 47 pikeminnow (70-150mm), 3 sculpin, and several sticklebacks.			
	8/8/2001	Fish rescue for Francis Creek flood mitigation project	Electrofishing was conducted from Fern Street Bridge upstream 800 ft. 17 pike minnow (120-180mm), 3 cutthroat (150- 180 mm), 2 sculpin (95-105mm). Cutthroat were relocated upstream.			
	10/2/2003	DFG fish relocation for Francis Creek flood mitigation project	Electrofishing yielded: 2 cutthroat, 3 steelhead/ rainbow trout, 8 sculpin, 5 stickleback.			

Tributary	Date Surveyed	Source	Fish Comments	Habitat Comments	Barrier Comments	Management Recommendations
	8/18/2003(a)	DFG habitat assessment and biological sampling	Electrofishing was conducted upstream of Eugene Street. Twenty one sites were sampled over a distance of 14,000 feet yielding: 21 cutthroat trout, 7 unknown trout. Pikeminnow were observed within the first 350 feet of sampling; however, pikeminnow were not observed above R.M. 3.			
	8/10/2005	DFG Field Note	A coffer dam was placed upstream of a bank stabilization work site in Francis Creek at Fireman's Park. In total 5 cutthroat (2+), 2 cutthroat (1+), 4 coho (1+), 18 Sacramento pikeminnow, 3 stickleback and 9 sculpin were documented. The total length of stream sampled was 150 feet.			
	10/15/2005	DFG Field Note	Fish relocation: two passes conducted in 150 foot reach. 5 coho (1+) and 5 Sacramento pikeminnow were captured. Fork length of the coho (mm): 95, 98, 92, 90, 85			
Coffee Creek	2/21/1973	DFG Observations	Electrofishing was conducted 200 yards upstream from Grizzly Bluff Road. One adult rainbow trout captured. Lamprey larvae, sticklebacks and roach were captured to about 1/4 mile above Grizzly Bluff Rd.	The bottom is composed of silt and mud; Pools are few in number; 10 culverts; Cattle have access to the stream and have broken down the banks along the entire length. Due to the ditching of the stream, lack of habitat, and pollution present there is little chance that this creek can provide a fishery.		There is no history of stocking and stocking is not recommended. It should be observed periodically and in the unlikely event of land use changes, measures can be taken to re-establish a fishery.
Centerville Slough	6/28/1984(a)	DFG coastal cutthroat trout inventory	All of the 21 cutthroat captured (149-258mm) were caught in the only sizable pool, which was located immediately below the Centerville Road culvert. Cutthroat showed unusual characteristics: variable number and pattern of spots, variable head to jaw ratio and large girth. 13 salmonid fry (40-50 mm) & 1 coho were also observed	Surveyed above and below Centerville Road which separates steeper gradient reaches and low gradient reaches Pool surveyed measured 30 x 20 with a maximum depth of 3 to 4 feet. Grazing impacts throughout; silting evident		

Tributary	Date Surveyed	Source	Fish Comments	Habitat Comments	Barrier Comments	Management Recommendations
Unnamed Tributary to Centerville Slough	10/10/1968	DFG field notes	Electrofishing was conducted on both forks for 50 yards above Centerville Road. 25 to 30 coastal cutthroat trout (76-203 mm) captured at outlet of Centerville culvert. Three spine sticklebacks were common.			
Russ Creek	8/14/1938	DFG stream survey	Stickleback were abundant, and no trout were seen. Natural propagation should be considerable.	Water temp= 62 °F Air temp= 66 °F 5'wide x 3" deep Gravel bottom, food abundant, spawning area was good.	Small dam 4'5" high x 20' wide at 3 1/3 miles above mouth.	
	10/10/1968	DFG Field Note	Electrofishing was conducted for 100 yards downstream of Centerville Road Crossing. One cutthroat trout. Sticklebacks were common Location: NW ¼ of SE ¼, Sec. 5, T2N, R2W.		A small dam could be blocking access to cutthroat spawning areas. This dam has been estimated to be 3,000 feet downstream of Centerville Road.	
	08/28/2001, 09/16/2002, 09/17/2002, 08/13/2003	North Coast California Coho Salmon Investigation	Electrofishing upstream of Centerville Road over a 5 year period yielded: stickleback, lamprey.			
	10/22/2004(a)	DFG habitat assessment and biological sampling	Electrofishing was conducted from Centerville Road upstream for 4,400 feet. Ten sites were sampled yielding: 22 cutthroat trout (71-188mm), and numerous stickleback.		Five hundred feet upstream of Centerville Road is a small dam (8 feet high, 20 feet wide, 15 feet deep). There is a thin apron of water flowing over a concrete sheet on a 55° angle. The jump pool is 1 foot deep. Water is impounded upstream of dam.	
Williams Creek	9/27/1999	DFG electrofish log field form	Electrofishing was conducted at two sites with an effort of 428 seconds upstream of Centerville Rd. Pike minnow and stickleback were numerous; 1 ammocoete.	Water temp= 54°F Air temp= 56°F Water clarity was poor. Conductivity= 730 µS/cm		

Tributary	Date Surveyed	Source	Fish Comments	Habitat Comments	Barrier Comments	Management Recommendations
	8/20/2003 (b)	DFG habitat assessment and biological sampling	Electrofishing was conducted upstream of Grizzly Bluff Road. Nine sites were sampled in 3,400 feet section upstream of Grizzly Bluff Road. Additional sites were sampled that were 12,700 to 16,000 feet upstream of Centerville Road. 1,300 feet of Little Creek (Williams Creek Tributary) was sampled as well. Pikeminnow were captured in all locations that were sampled during 2003. No salmonids were observed.			

Salt River Tributary Analysis

Habitat inventory surveys were conducted by CDFG in 2003 and 2004 on three of the four salmonid bearing Salt River tributaries: Williams, Francis, and Russ creeks. The habitat inventories on the Salt River tributaries were conducted on the upstream side of Centerville and Grizzly Bluff Road and extended upstream as far as access to private property would permit. Reas Creek was not included in the habitat inventories because access onto key parcels was denied. Stream habitat inventory methods were conducted according to methods determined in the *California Salmonid Stream Habitat Restoration Manual* (Flosi, et al. 1998). Salt River tributary habitat inventory data have been compiled and analyzed to determine stream conditions that are relative to salmonids. Analysis of the Salt River tributaries includes the following:

- Canopy Density;
- Habitat Type Categories;
- Cobble Embeddedness;
- Pool Characteristics;
  - Pools by maximum depth;
  - Pool shelter;
- Target Values and Basin Characteristics;

CANOPY DENSITY

Canopy density, as estimated during CDFG surveys, is a measure of the percentage of shade canopy over a stream. Canopy density measurements provide an indication of stream health and riparian conditions. The CDFG *Salmonid Stream Habitat Restoration Manual* recommends that areas with less than 80% average shade canopy density be considered as candidates for riparian improvement efforts (Flosi et al., 1998).

When analyzed by total stream length, average canopy density was 87% in Francis Creek, 79% in Russ Creek and 63% in Williams Creek. Only Francis Creek fell within the target value range for canopy density; however, Russ Creek is relatively close to target value range. Williams Creek has a mean canopy density that is well below target values.

When analyzed by individual reaches it was determined that reach one of Francis Creek was the only reach that exceeded target values (Figure 22). Reach two and three of Williams Creek had low canopy density measurements and are candidates for riparian improvement. The remaining reaches scored close to or slightly below the target value of 80% canopy density.

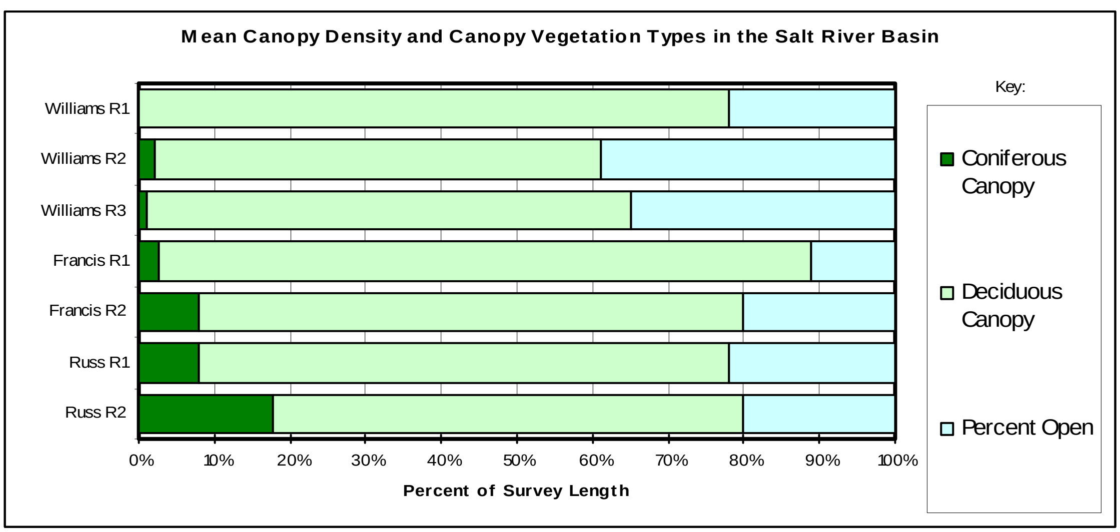


Figure 22. Canopy density and the relative percentage of coniferous, deciduous and open canopy above surveyed streams in the Salt River Basin analyzed by reach. Target value is greater than 80%.

Deciduous trees comprise the majority of the riparian canopy cover in Russ, Francis and Williams creeks (Figure 22). In Williams and Francis creeks, particularly in the lower reaches, the deciduous riparian vegetation is comprised of a relatively young willow and alder forest. Coniferous canopy cover represents a larger component of canopy density in Russ Creek where there are numerous mature coniferous trees (Grand Fir, Douglas Fir and Sitka Spruce) along the riparian corridor.

Upon further analysis, it was determined that 32% of the length of total canopy measurements in Williams Creek had a canopy density of less than 50% (Table 17). Canopy densities of less than 50% indicate areas that do not provide suitable shade and therefore, are considered to be unsuitable for contributing and maintaining cool water temperatures that support salmonids. Canopy density was less than fifty percent in 12% of the length of total canopy measurements in Russ Creek, and 5% of the length of total canopy measurements Francis Creek (Table 17).

Table 17. Average canopy density groupings by percent length of habitat units sampled for canopy density.

	0-25%	26-50%	51-75%	76-100%
Williams Creek	14%	18%	20%	48%
Francis Creek	1%	4%	10%	85%
Russ Creek	5%	7%	18%	70%

HABITAT TYPE CATEGORIES

Pool, flatwater, and riffle habitat units were measured, described, and recorded during CDFG stream surveys. During their life history, salmonids require access to all of these types of aquatic habitat. It is recommended that a stream be comprised of 40% primary pools by length (>2 feet). The Salt River tributaries on average have 31% pools by length (Figure 23).

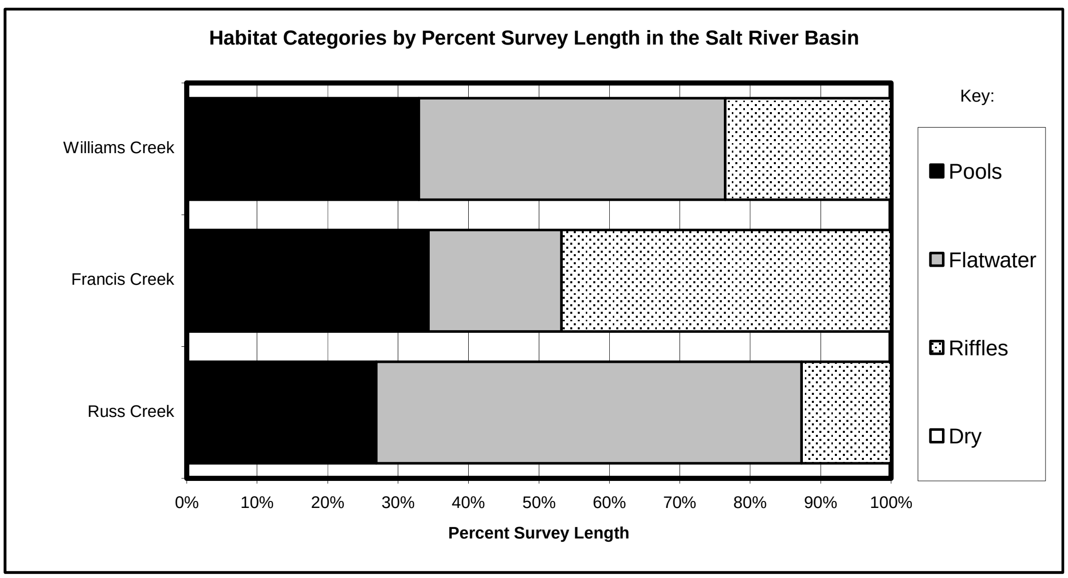


Figure 23. Percent of pool habitat, flatwater habitat, riffle habitat by survey length in the Salt River Basin

COBBLE EMBEDDEDNESS

The depth of embeddedness of cobbles in pool tail-outs is measured by the percent of the cobble that is surrounded or buried by fine sediment. The cobble embeddedness measure is broken into five categories: Category 1 is 0-25% embedded; Category 2 is 26-50%; Category 3 is 51-75% embedded; Category 4 is 76 to 100% embedded; Category 5 is unsuitable for spawning such as log sill, bedrock, and boulders.

Category 1 offers the best spawning potential, category 2 is supportive of salmonids, and categories 3 and 4 are not within the suitable range for successful spawning. CDFG recommends that greater than 50% of those pool tail-outs measured be in category 1.

The Wildcat tributaries do not meet the optimal target value for cobble embeddedness. Based on CDFG cobble embeddedness target values only 23.8% of Williams Creek; 21.3% of Francis Creek; and 3.8% Russ Creek are supportive of salmonids (Category 1 and 2) (Figure 24).

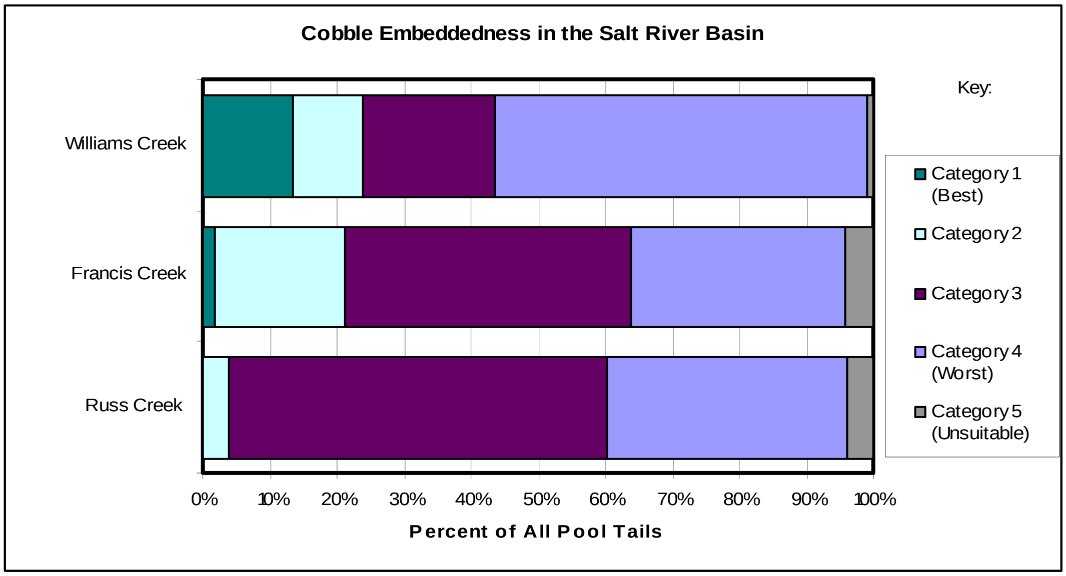


Figure 24. Cobble embeddedness categories as measured at pool tailouts in surveyed streams in the Salt River Basin.

POOL CHARACTERISTICS: Pools by maximum depth

Pool depth is an important habitat component for salmonids. The CDFG Restoration Manual describes ‘primary’ pools as those with a maximum residual depth greater than 2 foot in the first and second order stream. The CDFG target for primary pools is 40% of reach length to be in primary pools. Analysis of pool depths will indicate reach and stream conditions relative to other streams in the basin, and focus habitat improvement efforts.

Table 18. Percent length of a survey composed of pools in the Salt River tributaries based on maximum residual depths.

Stream	Stream Order	Percent pools by survey length	Percent pools >1.5 by survey length	Percent pools >2.0 by survey length	Percent pools >2.5 by survey length	Percent pools >3.0 by survey length	Percent pools >4.0 by survey length
Williams Creek	2	32.9	30.9	25.5	17.1	11.1	2.8
Francis Creek	2	34.3	19.4	8.9	3.7	1.2	0.28
Russ Creek	2	26.9	25	15.5	11.2	7.1	1.1

All survey reaches were below the CDFG target values for primary pool depths. Williams Creek ranked the best with 26% of stream length comprised of primary pools (> 2 feet) while Francis Creek had 9% and Russ Creek had 16%. Mean maximum residual depth was highest in Williams Creek and lowest in Francis Creek, meaning that Williams Creek has the deepest pools throughout followed by Russ and Francis creeks.

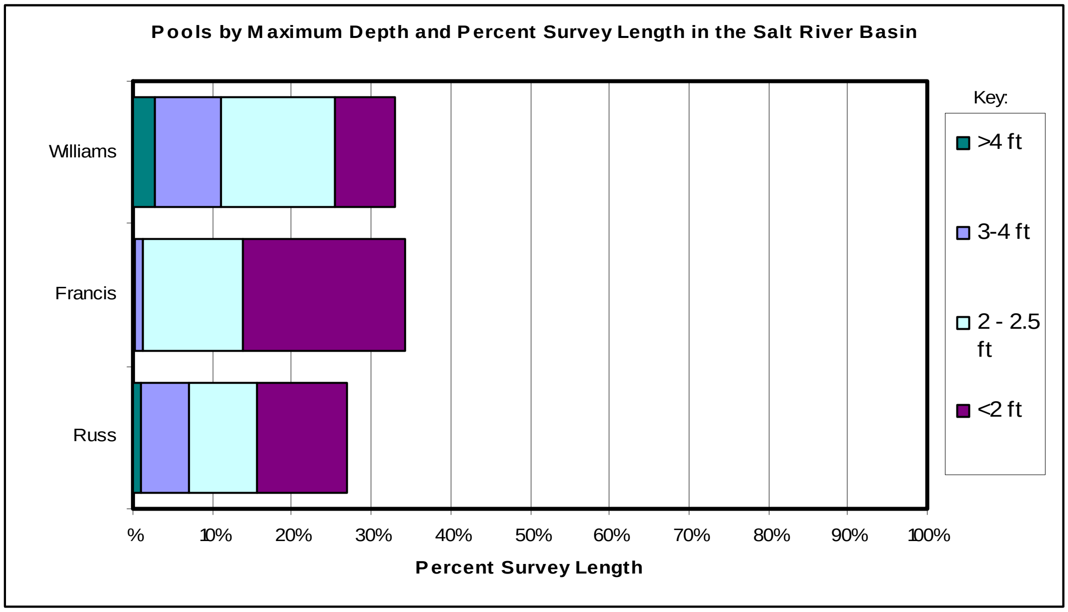


Figure 25. Percent length of survey composed of pools in the Salt River Basin

POOL CHARACTERISTICS: Pool shelter

Pool shelter rating illustrates pool complexity, another component of pool quality. Ratings of pool shelter range from 0 -300. The CDFG Restoration Manual considers pool shelter to be fully unsuitable when shelter ratings are less than 30. Shelter ratings above 100 are considered to be fully suitable.

Both reaches within Russ Creek were considered suitable for salmonids and provided the best shelter of all surveyed reaches within the Salt River Basin with an average shelter value of 79. Both Francis and Williams creeks were considered barely suitable for salmonids with shelter values of 32 and 34, respectively (Figure 26). It should be noted that the reach 2 of Williams Creek was considered fully unsuitable with a shelter value of 28. Reach 3 of Williams Creek was 30, which is on the border of unsuitable habitat.

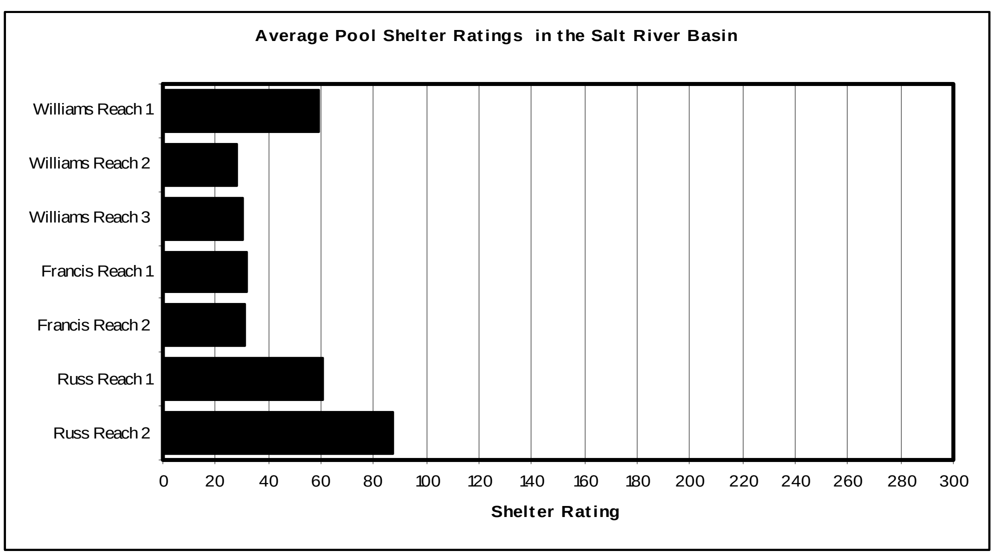


Figure 26. Average pool shelter ratings from stream surveys in the Salt River Basin

Pool cover types in the all the surveyed reaches of the Salt River tributaries are dominated by small woody debris (Table 19). The subdominant cover types are undercut banks in Williams and Francis Creek and large woody debris in Russ Creek. It is expected that woody debris provide a significant component of pool cover in forested streams such as the Wildcat tributaries.

Table 19. Dominant and subdominant pool cover types; 1 indicating most dominant.

Stream	Undercut Banks	Small Woody Debris	Large Woody Debris	Root Mass	Terrestrial Vegetation	Aquatic Vegetation	Whitewater	Boulders	Bedrock Ledges
Williams Creek	2	1	3						
Francis Creek	2	1	3	3					
Russ Creek	3	1	2						

TARGET VALUES AND BASIN CHARACTERISTICS

Part of the stream inventory analysis involves comparing individual stream habitat characteristics to north coast standards, or target values. The intention of target values is to compare stream characteristics to what has been determined to be an optimal assemblage of habitat components. Variations between habitat conditions of creeks are expected and it should be recognized that target values represent ideal standards for salmon habitat. There is, for instance, no indication that the Salt River tributaries ever provided optimum salmonid habitat conditions. However, there is little doubt that the ecosystem benefits generated by the functioning state of the Salt River systems circa 1850 was substantially better than current conditions. The target values serve to direct efforts to improve habitat conditions within the Salt River Basin.

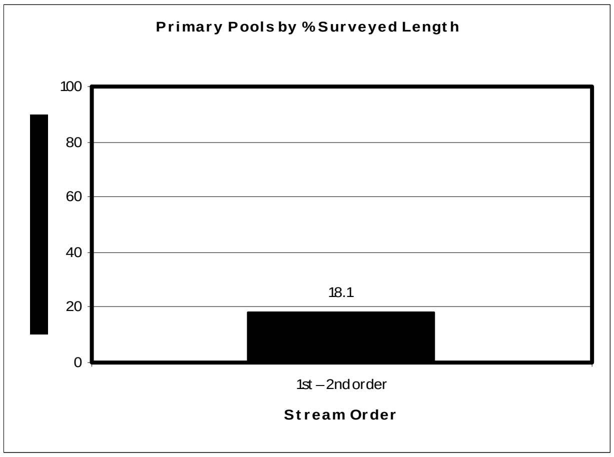
The surveyed reaches of Francis Creek met the target values for canopy density; however, Williams Creek did not and Russ Creek fell just below the target value of 80% canopy density. The target value for pool depth/frequency was not met for any of the other streams surveyed although; Williams Creek was the closest to the target values with 26% of its length in primary pools. Pool shelter cover was highest in Russ Creek and was barely suitable on Williams and Francis creeks. Embeddedness values of pool-tail outs of the Salt River tributaries fell well below the optimal target values for all tributaries surveyed.

Table 20. Summary of fish habitat assessment results in the Salt River Basin and habitat target values defined by Flosi et al. 1998.

Habitat Element Stream Name	Year Surveyed	Surveyed Length (feet).	Mean Canopy Density Cover	% Embeddedness	% Length of surveyed stream in primary pools	Shelter Cover Ratings
Target Values (Flosi et al 1998)			Greater than 80% canopy density	Greater than 50% of embeddedness measurements in category 1*	Greater than 40% of stream length of pools deeper than 2 feet	Optimal= 100 shelter values below thirty are fully unsuitable for salmonids
Williams Creek	2003	21,881	63%	14% in category 1	26%	34
Francis Creek	2003	14,165	87%	2% in category 1	9%	32
Russ Creek	2004	11,665	79%	0% in category 1	16%	79

** Category 1 is a pool tail out embeddedness range of 0-25% of substrate embedded by fine sediment.*

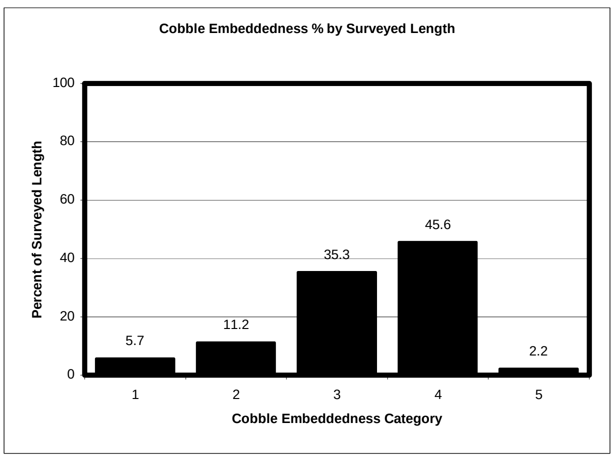
Basin Characteristics



Significance: Primary pools are those with depths greater than two feet. Primary pools provide escape cover from high velocity flows, hiding areas from predators, and ambush sites for taking prey. Pools are also important juvenile rearing areas. Generally, a stream reach should have 30-55% of its length in primary pools to be suitable for salmonids.

Comments: The percent of primary pools by length in the Wildcat Tributaries is below target values for salmonids

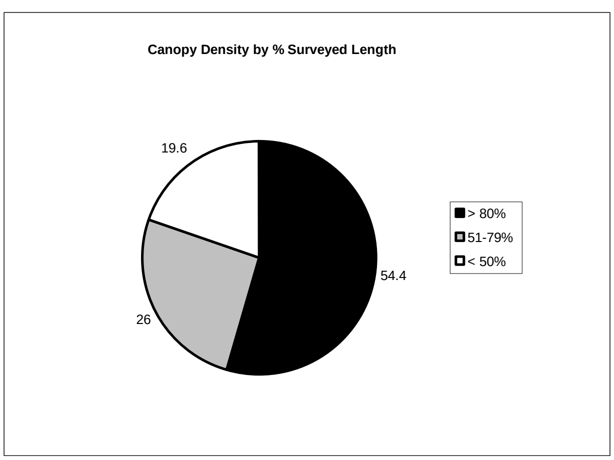
Figure 27. Primary pools in the Salt River Basin



Significance: Salmonids cannot successfully reproduce when forced to spawn in streambeds with excessive silt, clays, and other fine sediment. Cobble embeddedness is the percentage of an average sized cobble piece at a pool tail out that is embedded in fine substrate. Category 1 is 0-25% embedded, category 2 is 26-50% embedded, category 3 is 51-75% embedded, and category 4 is 76-100% embedded. Cobble embeddedness categories 3 and 4 are not within a supportive range for successful use by salmonids.

Comments: 83% of pool tail outs measured fall into categories 3 and 4, which does not meet spawning gravel target values for salmonids.

Figure 28. Cobble embeddedness in the Salt River Basin.



Significance: Riparian canopy cover density contributes to microclimate conditions that help regulate air temperature, which is an important factor in determining stream water temperature. Stream water temperature can be an important limiting factor of salmonids. Generally, canopy density less than 80% by survey length is below target values.

Comments: Canopy densities analyzed on a basin scale indicate that 45% of the length of surveyed streams have canopy densities less than 80%, which is below target values. When analyzed on a reach by reach basis it is apparent that canopy density impairment is limited to several sections within the Wildcat tributaries.

Figure 29. Canopy density in the Salt River Basin.

Fish Passage Barriers

Free movement in well-connected streams allows salmonids to find food, escape from high water temperatures, escape from predation, and migrate to and from their stream of origin as juveniles and as adults. There are several issues in the Salt River Basin that create fish passage problems including:

- Stream crossings;
- Dry channel;
- Tide gates;
- Channelization.

Stream Crossings

Culverts on county roads were surveyed as part of the Humboldt County Culvert Inventory and Fish Passage Evaluation conducted by Ross Taylor and Associates (2000). Five culverts occurring on county roads were evaluated for fish passage. Another nine culverts are located within the Ferndale city limits and have not been evaluated for fish passage.

Criteria for priority ranking of the culverts included salmonid species diversity, extent of barrier present, culvert risk of failure, current culvert condition, salmonid habitat quantity, salmonid habitat quality, and a total salmonid habitat score. The five culverts that were assessed in the Salt River received low priority ranking. The relatively low priority ranks of the crossings in the Salt River Basin can be attributed to the poor habitat quality available upstream of the culvert. The report refers to Reas Creek as a 'trainwreck' and to Francis Creek as the "poorest habitat encountered during the inventory" (Taylor 2000).

Figure 30. Definitions of barrier types and their potential impacts to salmonids (from Taylor 2001)

Barrier Category	Definition	Potential Impact
Temporary	Impassable to all fish some of the time.	Delay in movement beyond the barrier for some period of time.
Partial	Impassable to some fish at all times.	Exclusion of certain species and life stages from portions of a watershed.
Total	Impassable to all fish at all times.	Exclusion of all species from portions of a watershed.

Reas Creek

Port Kenyon Road, Centerville Road, and Oeschger Road all have culverts on Reas Creek. The Reas Creek culverts on Port Kenyon Road and Centerville Road were both deemed passable for adult salmonids but were determined to be partial barriers for all juveniles (Table 21). The Oescheger Road culvert on Reas Creek was considered passable for most adults but is nearly a complete barrier for coastal cutthroat trout and all juvenile salmonids. Priority ranking of 67 culverts in Humboldt County for treatment to provide unimpeded salmonid passage to spawning and rearing habitat placed the culvert on Port Kenyon Road at rank 63 and the culvert on Centerville Road at rank 64 and the culvert on Oescheger Road culvert at rank 51. The low priority ranking of culverts on Reas Creek was due to the poor habitat quality available upstream.

Russ Creek

The culvert on Russ Creek at Centerville Road was passable for adult salmonids but was considered a temporary barrier for juvenile salmonids (Table 21). The Centerville Road culvert on Russ Creek was assigned a priority ranking of 62 out of 67.

There is a considerable barrier to salmonids 500 feet upstream of Centerville Road on Russ Creek (Figure 31). This concrete structure has an 8 feet vertical height and is 20 feet wide. There is a concrete apron that is on a 55° angle and is 10 feet long. The pool at the base of the structure is made of concrete and is about 1 foot deep, in which a cutthroat trout was captured during biological sampling.

Francis Creek

A total of 10 culverts were identified on Francis Creek. The Port Kenyon Road culvert on Francis Creek was the only culvert surveyed but was not evaluated by Fish Xing software for fish passage due to the extreme amount of sediment in the culvert. The Port Kenyon Road culvert on Francis Creek may present a velocity barrier at higher flows and was assigned a priority ranking of 65 out of 67.

Figure 31. Centerville Road culvert on Russ Creek (left) and fish barrier on Russ Creek 500 ft. above Centerville Road (right).

Table 21. Culverts surveyed for barrier status in the Salt River Basin (Taylor, 2000)

Stream Name	Road Name	Priority Rank	Barrier Status	Upstream Habitat	Treatment
Russ Creek	Centerville Road	62	Passable for most adults, and a temporary barrier for all juveniles. There is a lack of depth for adults at lower migration flows and a potential velocity barrier at higher migration flows for juveniles. The slightly perched outlet may be a problem for juveniles. COMMENTS: Properly-sized box culvert would require baffles and outlet beam to improve fish passage, but habitat is very poor due to unfenced grazing, timber harvest, and channelization	18,000 feet of 'poor quality' habitat	None proposed at this time
Reas Creek	Port Kenyon Road	63	Passable for most adults and a partial barrier for all juveniles. Determined that the inadequate sizing created a velocity barrier at a wide range of migration flows. COMMENTS: Undersized, but at grade so not a barrier during most migration flows. Road shows sign of flooding. Creek is channelized and even dammed in summer for stock watering.	20,300 feet of 'poor quality' habitat.	None proposed at this time
Reas Creek	Centerville Road	64	Passable for most adults and partial barrier for all juveniles. Perched concrete floor created a lack of depth at low flows and velocity barrier at a range of migration flows. COMMENTS: Large concrete box culvert would require baffles to improve low-flow passage, but habitat is very poor from unfenced grazing and timber harvest. Creek is channelized and dammed in summer for stock watering.	17,900 feet of 'poor quality' anadromous channel	None proposed at this time

Stream Name	Road Name	Priority Rank	Barrier Status	Upstream Habitat	Treatment
Reas Creek	Oescheger Road	51	Passable for most adults and nearly a complete barrier for coastal cutthroat trout and all juveniles. 3% slope of culvert created a velocity barrier at a wide range of migration flows. COMMENTS: Extremely undersized culvert. Habitat is extremely poor from unfenced grazing and timber harvest.	12,300 feet of 'poor quality' potentially anadromous channel	None proposed at this time
Francis Creek	Port Kenyon Road	65	Not evaluated because of sediment in the culvert. Probably a velocity barrier at higher flows COMMENTS: Is an adequately-sized box culvert that is nearly full of fine sediment. Extremely poor habitat upstream, plus flows through numerous culverts and concrete ditches in downtown Ferndale.	22,000 feet of 'extremely poor' potentially anadromous channel	None proposed at this time

Dry Channel

Sedimentation has blocked the Salt River downstream of Williams Creek and has eliminated fish passage to Coffee Creek and Williams Creek. In terms of salmonid passage the Salt River currently begins at the confluence with Francis Creek (R.M 5.1). However, the Salt River becomes intermittent slightly upstream of Reas Creek (R.M 3.4), which eliminates low flow passage to Francis Creek. The permanence of the Salt River channel has been reduced over the years as it fills with sediment and instream vegetation.

Tide Gates

Currently, there are six tide gates located in the Salt River Basin .

- Centerville Slough, approximately 900 feet upstream of its confluence with the Salt River;
- Salt River near Riverside Ranch, approximately 300 feet downstream of Smith Creek confluence;
- Salt River on the north side of Riverside Ranch opposite Morgan Slough;
- Smith Creek, approximately 200 feet upstream of its confluence with the Salt River.
- Two small tide gates on drainage canal near Smith Creek

Channelization

All of the Salt River tributaries have been channelized in some parts of their lower reaches. Besides having an enormous effect on the hydrologic and sediment budgets; channelization has direct effects on salmonids that are related to their safe passage upstream and their habitat needs. Channelized reaches create homogenous stream reaches, which provide very little escape and ambush refugia for young salmonids. The channelized reaches are not necessarily barriers to salmonid anadromy, but they are factors that limit the success of salmonid survival in the Salt River Basin.

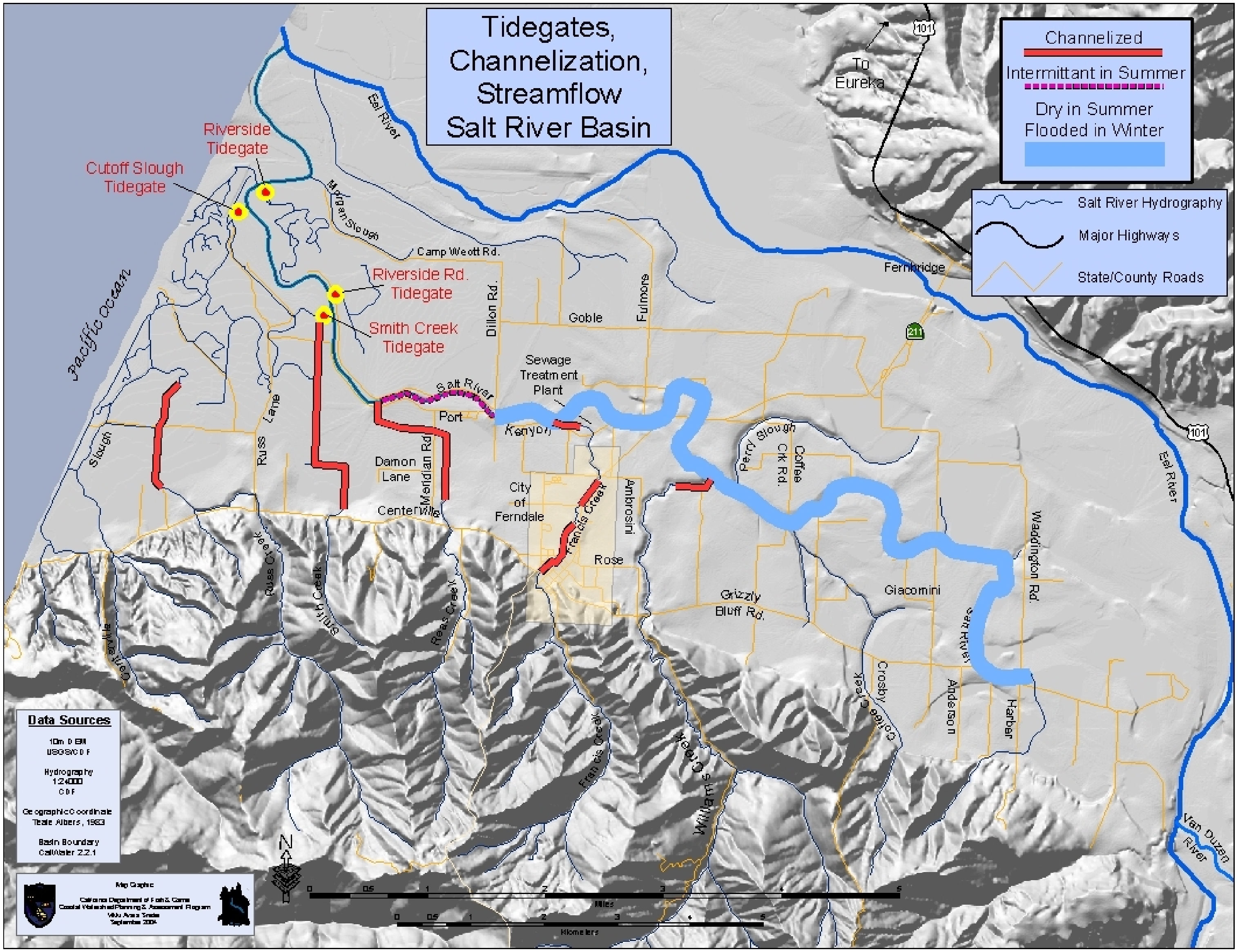


Figure 32. Possible barriers to fish movement

Bibliography

Anderson, K. (1997). Animal Waste Assessment Project in the Salt River Delta, Prepared for the Humboldt County Resource Conservation District by Q & A Ag. Services.

Anonymous (1937). Excerpts from Transcripts of Public Hearing Held in Ferndale, December 16, 1937 for the Preliminary Examination for Flood Control. Ferndale: 55.

Anonymous (1894). Map of the City of Ferndale, CA. Humboldt County.

Brown, W. M., J. Ritter, (1971). Sediment Transport and Turbidity in the Eel River Basin, California, US Geological Survey Water Supply Paper: 67.

Canatta, S., T. Hassler, (1995). Spatial and Temporal Distribution and Utilization Patterns of Juvenile Anadromous Salmonids of the Eel River Estuary June 1994 - September 1995. Salmon Restoration Conference, Santa Rosa.

Carver, G. A., A.S. Jayco, D.W. Valentine, W.H. Li. (1994). "Coastal Uplift Associated with1992 Cape Mendocino earthquakes, Northern California." Geology(22): 4.

CDFG (1938). Russ Creek Stream Survey.

CDFG (1968). Russ Creek, Fish Sampling, CA Department of Fish and Game: 1.

CDFG (1968). Centerville Slough, Fish Sampling, CA Department of Fish and Game: 1.

CDFG (1972). Reas Creek, Stream Survey, CA Department of Fish and Game: 2.

CDFG (1973). Coffee Creek- Stream Survey, CA Department of Fish and Game: 2.

CDFG (1977). The Eel River Estuary-Observations on Morphometry, Fishes, Water Quality and Invertebrates: Memorandum Report., Department of Fish and Game: 26.

CDFG (1984)a. Coastal Cutthroat Trout Survey, Centerville Slough, CA Department of Fish and Game: 1.

CDFG (1984)b. Coastal Cutthroat Trout Survey, Reas Creek, CA Department of Fish and Game: 2.

CDFG (1997). Eel River- Salmon and Steelhead Restoration Action Plan, CDFG- Inland Fisheries Division: 100.

CDFG (1999). Williams Creek Electrofish Log, CA Department of Fish and Game.

CDFG (2003)a. Stream survey report, Francis Creek, CA Department of Fish and Game.

CDFG (2003)b. Stream survey report, Williams Creek, CA Department of Fish and Game.

CDFG (2004)a. Stream survey report, Russ Creek, CA Department of Fish and Game.

CDFG (2004)b. Biological Inventory, Reas Creek, CA Department of Fish and Game

Cox (1992). Earthquake of 1992, Small Town- Big Event, Cox Cable Network.

California Supreme Court. (1899). Robert W. Robarts, Plantiff. vs. W.N. Russ and Z. Russ & Sons Company, Defendants, California Supreme Court. Including map of location

Department of Health, (1951). A Pollution Study of the Lower Eel River Near Loleta, State of California, Department of Public Health, Bureau of Sanitary Engineering: 17.

Department of Water Resources (1977). Some Physical, Chemical, and Biological Characteristics of the Eel River Estuary., State of California, The Resources Agency: DWR, Northern District: 106.

Douglas Parkinsons and Associates (2001). Francis Creek Flood Mitigation Phase 1, Fish Removal Results, July 2000 and 2001.

Edeline, D.P. (1983). Along the Banks of the Salt River.

Eicher, A. (2004). Organic Dairies on the Eel River Delta. C. CDFG. Fortuna, UC Cooperative Extension.

Eicher, A., M.M. Bivin. (1991). Vegetation Survey of the Eel River Delta, Prepared for Eel River Resource Conservation District by Oscar Larson and Associates: 35.

Eidsness, J.P., S. Van Kirk (1988). Initial Cultural Resources Study for the Ferndale Wastewater Rehabilitation Project City of Ferndale, Humboldt County, CA. Eureka, CA, City of Ferndale: 38.

Ferndale Enterprise (1999). Dixon leads candid discussion on Williams Creek, Direction change good for some, hindrance to others. Ferndale Enterprise. Ferndale, CA: 2.

Ferndale Enterprise (1893). January 17.

Ferndale Union High School. (1976). Where the Ferns Grew Tall, an early history of Ferndale. Ferndale, CA.

Friedrichsen, L.G. (1998). Eel River Water Quality Monitoring Project, Prepared for the Humboldt County Resource Conservation District: 78.

Flosi, G., S.Downie, J. Hopelain, M. Bird, R. Coey, B. Collins (1998). California Salmonid Stream Habitat Restoration Manual. Sacramento, CA, California Department of Fish and Game.

Genzoli, A. (1972). Eel River Country...Pioneer Days, Adventure; Finding a Way of Life in the Great Redwoods! Fresno, CA, Mid-Cal Publishers

Giannico, R.G., J.A Souder (2004). The Effects of Tide Gates on Estuarine Habitats and Migratory Fish, Oregon State University: 9.

Gilroy, M. (2002). The Essential Eel River Estuary- Unpublished. Salt River Journal. 2: 6.

Greene, C.R. (2001). US Organic Farming Emerges in the 1990's: Adoption of Certified Systems. Agriculture Information Bulletin, United States Department of Agriculture, Economic Research Service, Resource Economics Division: 28.

Goldman, C.R., A.J. Horne. (1983). Limnology. New York, McGraw-Hill Inc.

Herrick, R.F. (1880's). Williams and Coffee Creek Swampland reclamation. Ferndale.

Higgins, P. (1992). Habitat Types of the Eel River Estuary and Their Associated Fishes and Invertebrates (Including Notes on Research Needs), Prepared for the Redwood Community Action Agency: 20.

Jong, B. (2004). Personal communication concerning North Coast California Coho Salmon Investigation in the Salt River Basin.

Kellogg, G.A. (1884). Plan of Reclamation District, Humboldt County.

Koplin, D.K., et al (2002). "Pharmaceuticals, Hormones and other Wastewater Contaminants in U.S Stream 1999-2000: A National Reconnaissance." Environmental Science and Technology 36(6): 1202-1211.

Lampert, W., U. Sommer (1997). Limnoecology- The Ecology of Lakes and Streams. New York, Oxford University Press.

LaVen, R.D. (1994). Eel River Delta Agricultural Management and Enhancement Plant. Fortuna, Humboldt County Resource Conservation District: 100 and 42 pages of appendix.

Li, W.H., G.A. Carver (1992). The Last Halocene Stratigraphy of the Eel River Delta. Department of Geology. Arcata, Humboldt State University: 12.

MacGibbon, R. (2001). Managing Waterways on Farms, a guide to the sustainable water and riparian management in rural New Zealand. Wellington, NZ, New Zealand Ministry for the Environment: 212.

McLaughlin, R.J., et al. (2000). Geology of the Cape Mendocino, Eureka, Garberville and Southwestern part of the Hayfork 30 x 60 Minute Quadrangle and Adjacent Offshore Area, Northern California., United States Department of Interior, U.S Geological Survey.: 26.

Monroe, G., F. Reynolds, B.M Browning, W.S. John (1974). Natural Resources of the Eel River Delta, California Department of Fish and Game, Coastal Wetlands Series No 9: 108.

Murphy, G.I., J.W. DeWitt (1951). Notes on the Fishes and Fishery of the Lower Eel River, Humboldt County, California., California Department of Fish and Game: 30.

Murray (1854). Plat for a Road, Shaw Creek (map). Humboldt County

Nakamoto, R.J., B.C. Harvey. (2003). Spatial, Seasonal and Size-Dependent Variation in the Diet of the Sacramento Pikeminnow in the Eel River, Northwestern California. California Fish and Game 89 (1). Pg 30-45.

NCRWQCB (2003). Cease and Desist Order R1 2003- 0049. Requiring the City of Ferndale to Cease and Desist From Discharging and Threatening to Discharge Waste in Violation of Waste Discharge Requirements, North Coast Regional Water Quality Control Board: 3.

Ogle, B.A. (1953). Geology of Eel River Valley Area, Humboldt County, California, State of California Department of Natural Resources, Division of Mines: 128.

Questa Engineering Corporation. (1991). Hydrologic / Sedimentation Study for Salt River, California, Prepared for Eel River Resource Conservation District by Questa Engineering Company: 8 chapters plus appendices.

Rees, T.H (1917). Preliminary Examination of the Eel River. U. S. A. Chief of Engineers. San Francisco, War Department.

Roberts, R.C. (1992). Preliminary Environmental Evaluation, Salt River Improvements., Prepared for the Humboldt County Resource Conservation District by Oscar Larson and Associates: 22.

Roberts, R.C. (1992). Biological Conditions in the Eel River Delta: A Status Report of Conditions in the Early 1990s, Prepared for Eel River Resource Conservation District and the California State Coastal Conservancy by Oscar Larson and Associates .

Slocum, B. (2001). Request for Funding. Unpublished. S. W. Chesbro.

Sommerfield, K.C., D.E Drake, R.A. Wheatcroft (2002). "Shelf Record of Climatic Changes in Flood Magnitude and Frequency, North Coastal California." Geological Society of America 30(5): 4.

Spencer Engineering and Construction Management, Inc. (2004)a. Application for Wastewater Discharge Dilution Reduction City of Ferndale (Revision 1). McKinleyville, CA, California Regional Water Quality Control Board: 46 & Appendix A-F.

Spencer Engineering and Construction Management, Inc. (2004)b. Drainage Master Plan. McKinleyville, CA, City of Ferndale: 40.

Spencer Engineering and Construction Management, Inc (2004)c. Salt River Channel Elevation survey.

Stokes, J. (1981). Ecological Characterizations of Central and Northern California Coastal Region, Eel River Watershed Unit, Bureau of Land Management and United States Fish and Wildlife Service prepared by Jones and Stokes Associates, INC.: Chapter 6 (163-196).

Taubitz, F. (2001). City of Ferndale communicationto Bruce Slocum concerning Siltation and the Sewage Treatment Plant.

Taylor, R. (2000). Final Report: Humboldt County Culvert Inventory and Fish Passage Evaluation: 36 and 95 pages of Appendix.

USACE (2004). DRAFT Salt River Restoration Project, Humboldt County, CA. DPR Phase. Project Management Plan.

USCGS (1921). Entrance to the Eel River (map). United States Coast and Geodetic Survey.

USDA, NRCS. (1995). Eel River Delta Resurvey, Humboldt County, California. Eureka, CA, USDA Natural Resource Conservation Service: 26 plus appendix.

USDA, NRCS. (2004). DRAFT Soil Series for the Eel River Delta. Eureka, CA, USDA- Natural Resource Conservation Service.

USDA, SCS. (1987). Salt River Watershed Review Report., USDA Soil Conservation Service in cooperation with the Eel River Resource Conservation District.: 10.

USDA, SCS. (1989). Preliminary Results of the Transect Survey of Russ Creek Deposition Area, USDA, Soil Conservation Service: 2.

USDA, SCS. (1990)A. Salt River Watershed, Humboldt County, California: Study Guide, USDA Water Resources Planning Staff, Soil Conservation Service, in cooperation with the Eel River Resource Conservation District.: 37.

USDA, SCS (1990)B. Macroinvetebrate Sampling in Wildcat Tributaries

USDA, SCS. (1992). Earthquake Assistance- Petrolia, Humboldt County. Red Bluff, USDA, Soil Conservation Service: 10.

USDA, SCS. (1993). Salt River Watershed, Local Implementation Plan, USDA Soil Conservation Service, Water Resources Planning.: 82.

USDA, SCS. (1993). Salt River Watershed, Local Implementation Plan, Appendix A: Water Quality Report., USDA Soil Conservation Service, Water Resources Planning.: 26.

US EPA, (1993). Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. http://www.epa.gov/owow/nps/MMGI/index.html 2004

United States Census (2000). Ferndale, CA. 2004.

USGS (2002). The Cape Mendocino Earthquakes, USGS- Earthquakes Hazards Program- Northern California. 2004.

Williams, P.B. (1988). An Overview of an Enhancement Program for the Eel River Estuary, California Coastal Conservancy: 14 & Appendix.

Ziemer, K., W. Anderson, (2000). Eel River Delta Animal Waste Demonstration Project. Eureka, Ca, Humboldt County Resource Conservation District: 28.

Glossary

ACCRETION—The addition to land by deposition of water-borne sediment. An increase in land along the shores of a body of water, as by Alluvial deposit.

AGGRADATION: The geologic process in which streambeds, floodplains, and the bottoms of other water bodies are raised in elevation by the deposition of material eroded and transported from other areas. It is the opposite of degradation.

ALLUVIUM: A general term for all deposits resulting directly or indirectly from the sediment transport of streams, thus including the sediments lay down in riverbeds, floodplains, lakes, fans, and estuaries. ALLUVIAL *adj.*

ANADROMOUS: Fish that leave freshwater and migrate to the ocean to mature then return to freshwater to spawn. Salmon, steelhead, and shad are examples.

AERIAL: Having to do with or done by aircraft. For example, aircraft equipped with cameras capture images of the earth in air photos.

BANKFULL DISCHARGE: The discharge corresponding to the stage at which the floodplain of a particular stream reach begins to be flooded; the point at which bank overflow begins.

BANKFULL WIDTH: The width of the channel at the point at which overbank flooding begins.

BASIN: see watershed.

BOULDER: Stream substrate particle larger than 10 inches (256 millimeters) in diameter.

CALWATER: A set of standardized watershed boundaries for California nested into larger previously standardized watersheds and meeting standardized delineation criteria.

CANOPY: The overhead branches and leaves of streamside vegetation.

CANOPY COVER: The vegetation that projects over the stream.

CANOPY DENSITY: The percentage of the sky above the stream screened by the canopy of plants, sometimes expressed by species.

CHANNEL: A natural or artificial waterway of perceptible extent that periodically or continuously contains moving water. It has a definite bed and banks, which serve to confine the water.

COAST RANGE: A string of mountain ranges along the Pacific Coast of North America from Southeastern Alaska to lower California.

COBBLE: Stream substrate particles between 2.5 and 10 inches (64 and 256 millimeters) in diameter.

CONIFEROUS: Any of various mostly needle-leaved or scale-leaved, chiefly evergreen, cone-bearing gymnospermous trees, or shrubs such as pines, spruces, and firs.

COVER: Anything that provides protection from predators or ameliorates adverse conditions of streamflow and/or seasonal changes in metabolic costs. May be instream cover, turbulence, and/or overhead cover, and may be for the purpose of escape, feeding, hiding, or resting.

CULTURAL EUTROPHICATION: Accelerated eutrophication (generally enrichment by nutrients) that occurs as a result of human activities in the watershed that increase nutrient loads in runoff water that drains into surface water

DEBRIS: Material scattered about or accumulated by either natural processes or human influences.

DEBRIS JAM: Logjam. Accumulation of logs and other organic debris.

DECIDUOUS: A plant (usually a tree or shrub) that sheds its leaves at the end of the growing season.

DELTA: A fan-shaped alluvial deposit at the mouth of a river.

DEPOSITION: The settlement or accumulation of material out of the water column and onto the streambed. Occurs when the energy of flowing water is unable to support the load of suspended sediment.

DEPTH: The vertical distance from the water surface to the streambed.

DISCHARGE: Volume of water flowing in a given stream at a given place and within a given period of time, usually expressed as cubic meters per second (m^3/sec), or cubic feet per second (cfs).

DISSOLVED OXYGEN (DO): The concentration of oxygen dissolved in water, expressed in mg/l or as percent saturation, where saturation is the maximum amount of oxygen that can theoretically be dissolved in water at a given altitude and temperature.

DIVERSION: A temporal removal of surface flow from the channel.
EMBEDDEDNESS: The degree that larger particles (boulders, rubble, or gravel) are surrounded or covered by fine sediment. Usually measured in classes according to percentage of coverage of larger particles by fine sediments.
ENDANGERED SPECIES: Any species which is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of this Act would present an overwhelming and overriding risk to man.
EROSION: The group of natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the earth's surface. EROSIONAL *adj.*
ESTUARY: A water passage where the tide meets a river current.
EUTROPHIC: Pertaining to a lake or other body of water characterized by large nutrient concentrations such as nitrogen and phosphorous and resulting high productivity. Such waters are often shallow, with algal blooms and periods of oxygen deficiency.
EXTINCTION: The death of an entire species.
FINE SEDIMENT: The fine-grained particles in stream banks and substrate. Those are defined by diameter, varying downward from 0.24 inch (6 millimeters).
FISH HABITAT: The aquatic environment and the immediately surrounding terrestrial environment that, combined, afford the necessary biological and physical support systems required by fish species during various life history stages.
FLATWATERS: In relation to a stream, low velocity pool or run habitat.
FLOOD: Any flow that exceeds the bankfull capacity of a stream or channel and flows out of the floodplain; greater than bankfull discharge.
FLOODPLAIN: The area bordering a stream over which water spreads when the stream overflows its banks at flood stages.
FLOW: a) the movement of a stream of water and/or other mobile substances from place to place; b) the movement of water, and the moving water itself; c) the volume of water passing a given point per unit of time. Discharge.
FLUVIAL: Relating to or produced by a river or the action of a river. Situated in or near a river or stream.
FRESHETS: A sudden rise or overflowing of a small stream as a result of heavy rains or rapidly melting snow.
GEOGRAPHIC INFORMATION SYSTEM (GIS): A computer system for capturing, storing, checking, integrating, manipulating, analyzing, and displaying data related to positions on the Earth's surface. Typically, a GIS is used for handling maps of one kind or another. These might be represented as several different layers where each layer holds data about a particular kind of feature (e.g. roads). Each feature is linked to a position on the graphical image of a map.
GEOMORPHOLOGY: The study of surface forms on the earth and the processes by which these develop.
GRADIENT: The slope of a streambed or hillside. For streams, gradient is quantified as the vertical distance of descent over the horizontal distance the stream travels.
GRAVEL: Substrate particle size between 0.08 and 2.5 inches (2 and 64 millimeters) in diameter.
HABITAT: The place where a population lives and its surroundings, both living and nonliving; includes the provision of life requirements such as food and shelter.
HABITAT TYPE: A land or aquatic unit, consisting of an aggregation of habitats having equivalent structure, function, and responses to disturbance.
HYDROLOGY: The science of water, its properties, phenomena, and distribution over the earth's surface.
INSTREAM COVER: Areas of shelter in a stream channel that provide aquatic organisms protection from predators or competitors and/or a place in which to rest and conserve energy due to a reduction in the force of the current.
INTERMITTENT STREAM: A stream in contact with the ground water table that flows only at certain times of the year when the ground water table is high and/or when it receives water from springs or from

some surface source such as melting snow in mountainous areas. It ceases to flow above the streambed when losses from evaporation or seepage exceed the available stream flow. Seasonal.

LARGE WOODY DEBRIS (LWD): A large piece of relatively stable woody material having a diameter greater than 12 inches (30 centimeters) and a length greater than 6 feet (2 meters) that intrudes into the stream channel. Large organic debris.

LEVEE (MANMADE)—An embankment, generally constructed on or parallel to the banks of a stream, lake or other body of water, for the purpose of protecting the land side from inundation by flood water or to confine the stream flow to its regular channel.

LEVEE (NATURAL)—Bank of sand and silt built by a river during floods, where the Suspended Load is deposited in greatest quantity close to the river. The process of developing natural levees tends to raise river banks above the level of the surrounding flood plains.

LEVEE SYSTEM—A flood protection system which consists of a levee, or levees, and associated structures, such as closure and drainage devices.

MACROINVERTEBRATE: An invertebrate animal (animal without a backbone) large enough to be seen without magnification.

MAINSTEM: The principal, largest, or dominating stream or channel of any given area or drainage system.

NUTRIENT: A nourishing substance; food. The term *nutrient* is loosely used to describe a compound that is necessary for metabolism.

ONCORHYNCHUS: A genus of the family salmonidae (salmons and trouts). They are named for their hooked (onco) nose (rhynchus).

ORGANIC DEBRIS: Debris consisting of plant or animal material.

PERMANENT STREAM: A stream that flows continuously throughout the year. Perennial.

pH: A measure of the hydrogen ion activity in a solution, expressed as the negative $\log_{10}$ of hydrogen ion concentration on a scale of 0 (highly acidic) to 14 (highly basic) with a pH of 7 being neutral.

PRODUCTIVITY: a) Rate of new tissue formation or energy utilization by one or more organisms; b) Capacity or ability of an environmental unit to produce organic material; c) The ability of a population to recruit new members by reproduction.

REDD: A spawning nest made by a fish, especially a salmon or trout.

RIFFLE: A shallow area extending across a streambed, over which water rushes quickly and is broken into waves by obstructions under the water.

RIPARIAN: Pertaining to anything connected with or immediately adjacent to the banks of a stream or other body of water.

RIPARIAN AREA: The area between a stream or other body of water and the adjacent upland identified by soil characteristics and distinctive vegetation. It includes wetlands and those portions of floodplains and valley bottoms that support riparian vegetation.

RIPARIAN VEGETATION: Vegetation growing on or near the banks of a stream or other body of water on soils that exhibit some wetness characteristics during some portion of the growing season.

SALMONID: Fish of the family *Salmonidae*, including salmon, trout, chars, whitefish, ciscoes, and graylings.

SCOUR: The localized removal of material from the stream bed by flowing water. This is the opposite of fill.

SEDIMENT: Fragmented material that originates from weathering of rocks and decomposition of organic material that is transported by, suspended in, and eventually deposited by water or air, or is accumulated in beds by other natural phenomena.

SLOUGH: A tidally influence side channel or bottom-land creek.

SMOLT: Juvenile salmonid one or more years old that has undergone physiological changes to cope with a marine environment, the seaward migration stage of an anadromous salmonid.

SMOLTIFICATION: The physiological change adapting young anadromous salmonids for survival in saltwater.

SPAWNING: To produce or deposit eggs.

STREAM: (includes creeks and rivers): A body of water that flows at least periodically or intermittently through a bed or channel having banks and supports fish or other aquatic life. This includes watercourses having a surface or subsurface flow that supports or has supported riparian vegetation.

STREAM BANK: The portion of the channel cross section that restricts lateral movement of water at normal water levels. The bank often has a gradient steeper than 45 degrees and exhibits a distinct break in slope from the stream bottom. An obvious change in substrate may be a reliable delineation of the bank.

STREAM CORRIDOR: A stream corridor is usually defined by geomorphic formation, with the corridor occupying the continuous low profile of the valley. The corridor contains a perennial, intermittent, or ephemeral stream and adjacent vegetative fringe.

STREAM REACH: A section of a stream between two points.

SUBSTRATE: The material (silt, sand, gravel, cobble, etc.) that forms a stream or lakebed.

SUBWATERSHED: One of the smaller watersheds that combine to form a larger watershed.

THALWEG: The line connecting the lowest or deepest points along a streambed.

THREATENED SPECIES: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

TIDAL FLAT: An extensive flat tract of land alternatively covered and uncovered by the tide, and comprising mostly unconsolidated mud and sand. Also referred to as Tide Flat.

TIDAL MARSH: Low, flat marshlands traversed by interlaced channels and tidal sloughs and subject to tidal inundation. Typically, the only vegetation present is salt-tolerant bushes and grasses (Halophytes).

TIDAL PRISM: The volume of water exchanged in an estuary between high and low tide

TIDE GATE: A swinging gate on the outside of a drainage conduit from a diked field that excludes water at high tide and permits drainage at low tide.

TOPOGRAPHY: The general configuration of a land surface, including its relief and the position of its natural and man-made features.

TRIBUTARY: A stream feeding, joining, or flowing into a larger stream. Feeder stream, side stream.

UNDERCUT BANK: A bank that has had its base cut away by the water action along man-made and natural overhangs in the stream.

VELOCITY: The time rate of motion; the distance traveled divided by the time required to travel that distance.

WATERSHED ASSESSMENT: An interdisciplinary process of information collection and analysis that characterizes current watershed conditions at a course scale.

WATERSHED: Total land area draining to any point in a stream, as measured on a map, aerial photograph or other horizontal plane. Also called catchment area, watershed, and basin.

WETLAND: An area subjected to periodic inundation, usually with soil and vegetative characteristics that separate it from adjoining non-inundated areas.

Salt River Restoration Appendix

When envisioning the future of the Salt River it is imperative that we look to the past in order to determine the ecological conditions of the delta prior to Euro-American settlement. Of course, we will never fully understand the conditions that fashioned the Salt River; however, through the researching of historical maps and documents particular problems have been identified as issues that inhibit the Salt River from functioning properly.

By looking to the past to infer restoration directives for the future we inherently arrive at the questions of 'what is natural' and 'are natural conditions a desired goal'? It should be understood that the Salt River was likely an abandoned channel of the Eel River. There are in fact many abandoned channels upon the delta. In alluvial systems, such as the Eel River Delta, the natural course of succession of abandoned channels is to fill with sediment and vegetation; eventually becoming land once again. Therefore, the Salt River has followed a somewhat natural path of aquatic ecosystem succession, but at an accelerated rate.

The rapid pace of eutrophication of the Salt River can be largely attributed to the unregulated land use decisions of humans over the past 150 years. Some might say that to restore the Salt River is to fight against natural processes. Most will agree however, that the proper hydraulic function of the Salt River is necessary to meet the community's socio-economic needs and also in the interest of restoring habitat for several listed species. The Salt River will likely never return to its 1850 size or function, nor is it necessary for that to happen. It is only necessary to make channel and watershed conditions such that the Salt River can become hydrologically functional again and provide ecological and economic benefits.

Current Restoration Alternatives

The Salt River Advisory Group (SRAG), a sub-committee of the Humboldt County Resource Conservation District, is comprised of many land owners and representatives from the California Department of Fish and Game, Natural Resource Conservation Service, Humboldt County Resource Conservation Service, the City of Ferndale, Humboldt County and the Coastal Conservancy. The NRCS Small Watershed Planning program and SRAG have discussed preliminary Salt River restoration concepts; however, current restoration alternatives are still being evaluated and necessary hydrological analysis has yet to be conducted.

The Salt River Watershed is almost entirely privately owned and therefore the restoration of the Salt River is dependent upon the involvement of many private landowners. A viable restoration strategy of the Salt River cannot go forth without involvement and input from all land owners within the Basin. The landowner community is ultimately responsible for the success of restoration efforts in the Salt River Basin. A lack of community interest and ownership of the problems in the Salt River Basin may have been one of the reasons why past improvement efforts have not succeeded.

The following section details various treatment options that can be implemented to fix problems in the Salt River. These treatment options differ from those proposed in 1993 in that they focus on complementing and accommodating watershed processes rather than focusing on treating conditions. These options are organized by landscape areas of the Basin from the headwaters to the confluence with the Eel River. This order follows hydrologic transport processes based on source, transport and depositional reaches for watershed products.

Figure 33. Examples of erosion in the upland Salt River Tributaries.

Upland reaches of the Wildcat Tributaries

(Centerville Road and Grizzly Bluff Road South):

PROBLEM: The Wildcat Hills are naturally prone to erosion which has been made worse by historic and current land use decisions. The major management concerns in the upland reaches of the Salt River tributaries are stream bank/road related erosion, and aquatic/riparian habitat enhancement.

POTENTIAL SOLUTIONS: There are a variety of treatment options that can be employed in the upland reaches of Williams, Francis, Reas, and Russ creeks:

- Erosion hazard assessment and planning;
- Erosion proofing and upgrades of road systems;
- Decommission abandoned or unnecessary roads;
- Near-stream and riparian tree planting;
- Temporary riparian cattle exclusion fencing, where appropriate;
- Removal or modification of fish barriers;
- Installation of stream enhancement structures, where appropriate.

A road and streambank erosion hazard inventory is currently being conducted in the uplands of the Salt River tributaries and a list of priority treatment options will be generated. Watershed groups, like the Salt River Advisory Group, can seek funding for watershed restoration from grant sources such as the CDFG Fisheries Restoration Grant Program or other watershed improvement programs.

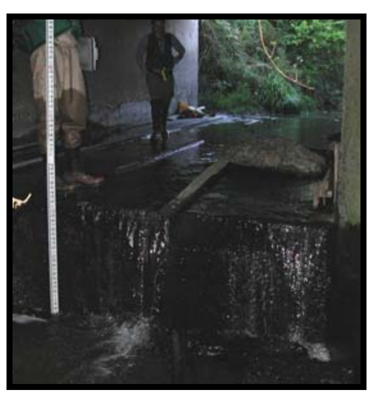


Figure 34. Examples of fish passage barriers in the upland Salt River tributaries.

Figure 35. Trans-delta reach of Williams Creek.

Figure 36. Trans-delta reach of Francis Creek.

Figure 37. Trans-delta reach of Reas Creek.

Trans-Delta Reaches of the Wildcat Tributaries
(Centerville Road and Grizzly Bluff Road to Salt River)

PROBLEM: The principal concern in managing the trans-delta reaches of the Wildcat tributaries is to decrease sediment contributions to the mainstem Salt River and to promote riparian and aquatic habitat integrity. The four main tributaries to the Salt River (Williams, Francis Reas and Russ creeks) have been modified to the extent that sediment processes and hydrologic function have been compromised. The modifications (riparian deforestation, urban development, and channelization) have resulted in the following problems:

- Increased occurrence of long-term flooding;
- Significant cost to individual landowners for loss of agricultural production;
- Significant cost to Ferndale for sediment removal;
- Channel widening in Williams Creek;
- Loss of ecologic integrity, specifically in regards to riparian and salmonid habitat.

POTENTIAL SOLUTIONS: One way to promote natural sediment processes in the trans-delta reaches is to utilize set-back levees. Appropriately sized setback levees:

- Allow controlled sediment deposition within a levee system which will decrease sediment contributions to the mainstem Salt River;
- Help protect flood prone properties;
- Facilitate the establishment of a riparian zone;
- Allow the stream to meander and support numerous riparian and aquatic habitat types;
- Allow the stream to connect with its floodplain.

The major disadvantage of setback levees is that land contained within the levees will have reduced agricultural production. Also, wider levee systems cannot be applied in all instances. For example, Francis Creek does not allow an adequate length to utilize the full potential of levee setbacks. Although setback levees can still be installed along lower Francis Creek, the maintenance time would be shortened due to smaller sediment storage capacity within the levee system. Other potential solutions include:

- **Sediment basins:** can capture sediment on the trans-delta reaches for manual removal as a maintenance program.
- **Promotion of riparian areas or flood-plain forests:** would curtail channel widening and promote channel integrity and offer other ecosystem benefits; however, overbank deposition would not be alleviated.

Mainstem Salt River- Reas Creek to Williams Creek

River mile: 3.4 to 7.5

PROBLEM: The mainstem Salt River from Reas Creek to Williams Creek has experienced severe aggradation since Euro-American settlement; the results of which have become most severe in the past 10 years.

- The river corridor from Reas to Francis Creek (R.M 3.4 to 5.1) has prolific nuisance instream vegetation growth that has clogged the channel. The channel is a braided configuration within this corridor and there are portions where a defined channel is difficult to distinguish. Subsurface flow during the dry summer months was apparent at River Mile 3.9 in 2004.
- The river corridor from Francis Creek to Williams Creek (R.M 5.1 to 7.5) is dry in the summer and is flooded during the winter. Due to a large sediment plug that formed in the mainstem Salt River in 1998, Williams Creek found a new path to the Eel River via Old River and Perry Slough. This dramatic change in watershed condition has reduced the Salt River Watershed size by 42% and eliminated fish passage to a once anadromous stream.

POTENTIAL SOLUTIONS: Treatment options within this project reach are focused on the manual reconfiguration of a proper channel. Preliminary concepts of the Salt River configuration indicate a relatively small low-flow channel with a wide terraced flood plain area. The vegetation composition would likely be managed to maintain an herbaceous plant community on the floodplain with coniferous trees on the higher terraces.

This massive dredging project will likely entail the removal of up to 250,000 yd^3 of material. Dredging within this project area will require clearing a maximum of 29.5 acres of riparian vegetation. It is a possibility that the path of the Salt River could be changed from its historic route to better conform to current land elevations. One possible reconfiguration of the Salt River is through the Williams Creek Overflow which is a swale that runs beneath highway 211 near the junction of Port Kenyon Road. Final restoration directives and the exact configuration of the Salt River in this project area are dependent upon land owner input and the results of further hydrological analysis, especially within the tidal estuarine zone, that will be conducted in 2005.

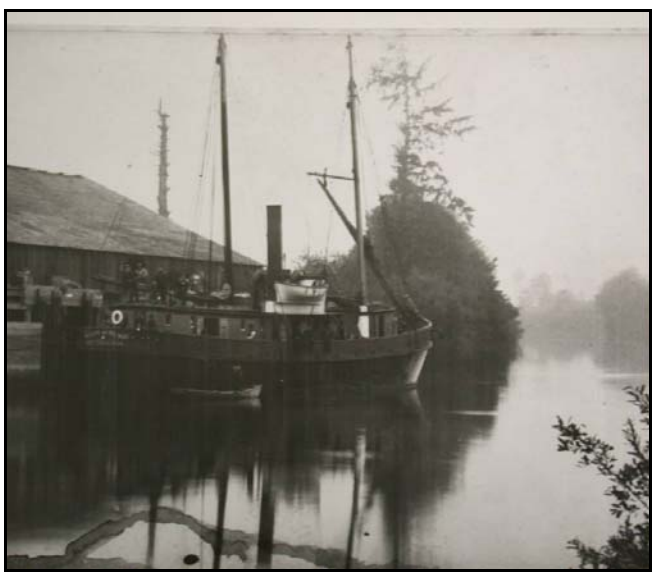


Figure 38. The Salt River- then and now; steamer Mary Hume 1885 at Port Kenyon (left) and mainstem channel at nearby Dillon Road Bridge 2004 (right).

Figure 39. Salt River Estuary upstream of Smith Creek, note the wide floodplain and vegetation composition.

Figure 40. Tide gate on Cuttoff Slough.

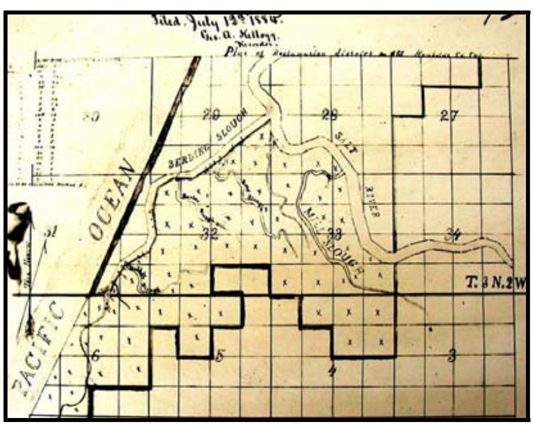


Figure 41. 2,900 acres of Salt River tideland were reclaimed prior to 1900.

Salt River Estuary – Reas Creek to Eel River

Length: Mouth to river mile 3.4

PROBLEM: A fundamental problem with the Salt River Estuary is that its tidal area and tidal prism are too small to adequately exhaust sediment from the system. Historically, the ebb and flow of the tide flushed sediment, eroded from the Wildcat Hills, from the Salt River channel. Slowly over the years tidal flushing has decreased and sediment has deposited permanently upon the bottom of the Salt River channel. Modifications in this region have created a simplified estuarine aquatic habitat.

POTENTIAL SOLUTIONS: In order to increase the tidal prism and to improve habitat complexity of the Salt River dramatic solutions must be implemented. Among the most dramatic includes the conversion of agricultural land back into tide land. This solution may entail consideration of:

- removal or modification of tidegates;
- dredging of accreted floodplain;
- dredging of channel bottom;
- levee removal;
- breeching of levees.

The specifics of potential restoration treatment options are dependant upon the results of a hydrological analysis, especially within the tidal estuarine zone, that will be conducted in 2005.

Summary of Recommendations

The dysfunction of the Salt River has been the topic of numerous reports and studies over the past few years. The following recommended restoration activities have been compiled from the following documents:

- *Salt River Local Implementation Plan.* USDA Soil Conservation Service, 1993;
- *Draft Preliminary Management Plan.* United States Army Corps of Engineers, 2004;
- *An Overview of an Enhancement Program for the Eel River Estuary.* Phillip Williams and Associates, 1988;
- *Biological Conditions of the Eel River Delta.* Chad Roberts, Ph.D. Oscar Larson and Associates, 1992;
- *Hydraulic/ Sedimentation Study for the Salt River, CA.* Questa Engineering Corporation.

Table 22. Proposed Salt River restoration activities.	
Tidal Basin: a body of water that is subject to tides whose water level is maintained at a desired level by artificial means.	
Purpose	To increase tidal prism and to increase channel scouring velocities. Estimated to be 90 acre feet capacity.
Location	Two tidal basin sites were evaluated: The first tidal basin was proposed along the banks of the Salt River, near the confluence of Reas Creek; however, this site location was ruled out because the site proved to be ineffective in enhancing the scour in the river upstream of Reas Creek. The preferred alternative that was proposed was located between Port Kenyon Road and the Salt River upstream of Dillon Road. It is estimated that 90,000 yds^3 of spoils would need to excavated and relocated to disposal sites. This option would require that the Salt River channel downstream of the basin be 20 feet wide with side slopes of two horizontal to one vertical (2:1).
Benefits	This option was deemed by Questa Engineering to be "the most effective alternative… and stable with respect to the scour and deposition of sediment, without the need for maintenance dredging of the channel"; Would increase tidal prism; Increase downstream channel scouring capacity; Partially self-cleansing; Increase estuarine habitat.
Disadvantages	Would only increase scour below the tidal basins; therefore, those areas upstream of the basin would not receive significant benefits from this alternative; Tidal basins would be a depositional area and would be subject to regular maintenance and cleaning; Large flood events in the Eel River would deliver significant quantities of sediment to the basin; Land acquisition would be necessary.
Sediment Basins on Tributaries: Sediment basins are structures designed to detain the flow of a watercourse. The slowed water velocities allow sediments to drop out of the water column, which can then be removed manually.	
Purpose	To control sediment deposition at a certain location where it can be managed easily in order to reduce the quantity of sediment depositing in the mainstem Salt River
Location	Three basins were proposed in the Local Implementation Plan: Reas Creek; approximately 100 feet upstream from Meridian Road; Francis Creek, approximately 100 feet upstream from the Port Kenyon Road culvert; Williams Creek, approximately 100 feet upstream from the confluence with the Salt River.
Benefits	Sediment contribution to the mainstem Salt River will be significantly reduced; Fish passage accommodations can be made to sediment basins;

	Will better ensure successful restoration of any dredging activities;
Disadvantages	Regular manual removal of sediment basins would be required;
Dredging: It is inevitable that the restoration of the Salt River will include dredging/ excavation to some degree. Two dredging alternatives have been proposed; from the outlet to Williams Creek (A) and from Reas Creek to Francis Creek (B)	
Purpose	Enlarge Salt River channel and increase channel capacity
Location	(A) From the Outlet to Williams Creek=170,000 yds^3 of spoils Would require clearing 29.5 acres of riparian vegetation Instream structures would need to be installed at the confluence of all Salt River tributaries to avoid down cutting.
	(B) From Reas Creek to Francis Creek = 50,000 yds^3 of spoils Would require clearing 16.4 acres of riparian vegetation Instream structures would need to be installed at the confluence of all Salt River tributaries to avoid downcutting.
Benefits	Could be preformed in combination with other alternatives or alone; Would improve flood capacity and alleviate winter flooding; Would increase tidal influence, could help control instream plant growth; Would open passage to salmonids.
Disadvantages	Wider channel or cross-sectional area may decrease scour due to reduced velocities; May not be self maintaining and could require regular dredging depending on watershed conditions; Dredging is an alternative that alleviates conditions but does not guarantee long term success; Large quantities of spoils to be disposed of; Environmental review process for a dredging project would be highly contentious and would result in a longer and more expensive review process; The effects of dredging cannot be mitigated.
Tide Gate Removal: Tide gate removal was not considered a viable alternative by the Local Implementation Plan because the removal would not result in a net increase in sediment removal. Tide gate modification should be considered for the purpose of salmonid passage.	
Purpose	Removal of one or more of the tide gates tributary to the Salt River to restore tidal action to those areas upstream of existing tide gates; Modification of tide gates to allow for salmonid passage.
Location	Centerville Slough, approximately 900 feet upstream of its confluence with the Salt River; Salt River near Riverside Ranch, approximately 300 feet downstream of Smith Creek confluence; Salt River on north side of Riverside Ranch opposite Morgan Slough; Smith Creek, approximately 200 feet upstream of its confluence with the Salt River.
Benefits	Increase tidal influence above tide gate; Increase in channel scour in reaches downstream of the tide gate; Would allow for the passage of anadromous fishes.
Disadvantages	Potential loss of agricultural land to salt water intrusion; Decrease in scour in reaches upstream of tide gates.
Levee Removal: Removal or breaching of levees in the western delta is another means to increase the estuary's tidal prism.	
Purpose	Breaching levees would allow land to be returned to its natural estuarine conditions.
Location	Unknown
Advantages	This alternative would avoid the significant adverse effects associated with dredging; Would increase tidal area while preserving existing substrate;

<table>
<tr><td></td><td>The levee breaching alternative would be “much more likely than the dredging alternative to gain ultimate acceptance and regulatory approval” (Roberts, 1992);</td></tr>
<tr><td>Disadvantages</td><td>Net decrease in agricultural land in the Salt River Delta.
Existing functional values of habitats in the western delta (ie. Seasonal wetlands) could be compromised by the conversion of habitats into estuarine conditions, which could result in regulatory approvals being withheld.</td></tr>
<tr><td colspan="2">Re-introduction of Eel River Flow: The Eel River once flowed across the southern portion of the Eel River Delta; this function was curtailed by construction of the Leonardo levee, and sedimentation.</td></tr>
<tr><td>Purpose</td><td>Provide for the introduction of Eel River discharge into the upper reaches of the Salt River to create flushing flow and increased scour in order to improve channel capacity.</td></tr>
<tr><td>Location</td><td>Would likely occur near the Leonardo levee.</td></tr>
<tr><td>Benefits</td><td>May increase the scouring potential of the Salt River in its upper reaches.</td></tr>
<tr><td>Disadvantages</td><td>A canal and gates would be necessary to connect the Salt River and Eel River; these structures would need maintenance;
Major infrastructural changes would be necessary (bridges) and risks to public and private property exist The unpredictable nature of Eel River discharge;
Salt River channels and swales no longer exist as they did before the construction of the Leonardo levee.</td></tr>
<tr><td colspan="2">Upland Erosion Control Measures: Local sponsors would provide services and funding to alter land-use activities in the Wildcat Tributaries to promote riparian areas and reduce erosion (ie. riparian exclusion fencing, streambank stabilization, riparian re-vegetation, road upgrading, road decommissioning).</td></tr>
<tr><td>Purpose</td><td>To promote riparian corridors in the upland Wildcat Tributaries to decrease preventable erosion.</td></tr>
<tr><td>Location</td><td>Priority tributaries include Williams, Francis and Reas creeks.</td></tr>
<tr><td>Benefits</td><td>Ecosystem benefits for fish and wildlife;
Decrease in road and stream bank erosion.</td></tr>
<tr><td>Disadvantages</td><td>Would require years of advanced planning;
Would require cooperation from a majority of landowners.</td></tr>
<tr><td colspan="2">Resource Enhancement: Sustainable watershed management</td></tr>
<tr><td>Purpose</td><td>Proposes actions to protect, restore, and enhance natural resources in the Eel River Delta (Roberts 1992).</td></tr>
<tr><td>Actions</td><td>Resource Enhancement:
Resist further urbanization;
Limit water quality degradation;
Increase riverine pool volume;
Curtail excessive erosion;
Increase estuarine tidal prism;
Prohibit riparian destruction;
Limit access to sensitive areas;
Allow or increase localized flooding;
Manage livestock to benefit wetland values;
Stabilize eroding uplands and stream banks;
Enhance native plant species and their habitats.</td></tr>
<tr><td colspan="2">Setback Levees Levees can be set back away from the stream to allow for bankfull discharge and provides connectivity between the stream and the floodplain, while continuing to protect flood prone properties.</td></tr>
<tr><td>Purpose</td><td>The purpose of setback levees is to control flood waters and to allow for a functional riparian corridor, channel meanders, and habitat diversity.</td></tr>
</table>

Location	The proposed site currently is the trans-delta reach of Reas Creek, however, this technique can be utilized on Francis and Williams Creek as well. "Proper siting and alignment of proposed structures can be established based on hydraulic calculations, historical flood data, and geotechnical analysis of riverbank stability" (EPA, 1993).
Benefits	Setback levees are an effective method of protecting flood prone properties; Setback levees are less prone to erosion and other damage during flood events; Setback levees facilitate the establishment of a riparian zone along the trans-delta reach; Setback levees allow the stream channel to meander and support numerous aquatic habitat types; Setback levees enhance sediment processes and allow deposition on the alluvial fan;
Disadvantages	Setback levees would require the retirement of agricultural land to accommodate for a wider levee configuration;

Salt River Advisory Group (SRAG) Goals and Objectives

The following list of preliminary goals and objectives were a collaborative effort between landowners and public agencies in the Salt River Advisory Group (SRAG).

Re-establish and maintain the functionality of the Salt River watershed by:

- Establish effective drainage patterns and meander zones in the lower reaches of the system to reduce flooding;
- Establish effective and acceptable riparian vegetation species and distribution;
- Establish channel management corridors;
- Identify and treat upslope sediment sources and reduce sedimentation;
- Conduct demonstration and interim projects;
- Secure regulatory support for channel project permits;
- Support efforts to improve conditions for the Ferndale sewage treatment plant;
- Promote improvement of dairy waste management practices;
- Improve fish and wildlife habitat;
- Promote public education and community support;
- Identify landowner incentives for landowner participation.

Salt River Improvement Program Mission Statement

The Salt River Improvement Program will provide local effort and guidance to restore natural hydrologic function and beneficial conditions to the Salt River watershed for the improvement of adequate drainage, water quality, wastewater treatment, flood control, anadromous fisheries and other benefits to local economic and environmental resources.

Salt River Advisory Group Opportunity

There is an opportunity to improve aquatic/riparian function and conditions in several miles of the Salt River drainage system as well as many acres of tidal lands. According to the 2004 Army Corps of Engineers Salt River Project Management Plan Draft, "restoring the natural function of the corridor would provide access to rearing, resident and migratory habitats for anadromous fish species, and have positive impacts on upper reaches of the Salt River as well as the Eel River Estuary in general. Without the project, water quality and habitat quality will continue to degrade in this system." By aiming to improve ecosystem conditions within the Salt River Basin, pressing socio-economic issues such as wastewater treatment, dairy waste management, flood control and fishery health will be addressed and improved.

Goal One: Improve watershed education outreach and monitoring

Objective 1: Build upon the effective partnership that has initially organized background information and human resources to address the need for action. Promote Salt River Advisory Group as a lead entity to facilitate local coordination with agencies and to promote funding activities as well as to act as a clearing house to disseminate information to appropriate parties.

Objective 2: Improve educational and community outreach.

Task 1: Engage local school group participation with watershed education groups such as:

- AmeriCorps Watershed Stewards Project;
- Salmon in the Classroom.

Task 2: Employ various forms of media and community activities to improve landowner participation and understanding of the Salt River watershed situation and improvement alternatives to include:

- An informational Salt River community workshop scheduled for March 12, 2005, 0900 – 1500;
- Salt River Journal;

- Salt River website;
- Radio public service announcements;
- Newspapers;
- Information / status reports for elected officials.

Objective 3: Establish sampling frameworks and protocols for monitoring water quality, fishery status, and instream habitat conditions.

Task 1: Continue and expand water quality monitoring efforts to include a robust assemblage of water quality parameters.

Task 2: Conduct systematic assessment of biological resources in the Salt River Basin.

Task 3: Establish systematic monitoring of fish populations in the Eel River Delta and Salt River system.

Task 4: Establish systematic monitoring of Salt River Basin salmonid habitat.

Goal Two: Improve water quality conditions in the Salt River Basin

Objective 1: Decrease sediment contributions to the mainstem Salt River by conducting the following activities in the Wildcat tributaries:

Activity 1: Conduct upslope erosion inventory, prioritize treatable stream bank and road erosion sites, and organize and implement projects (in progress).

Task 1: Consultants will conduct an initial upslope erosion inventory and identify priority treatable erosion sites by March 2005 (in progress).

Task 2: The Salt River Advisory Group will develop grant proposals and cost estimates by May 2005 to treat priority stream bank and road related erosion sources in the Salt River for implementation in 2006. Erosion reduction projects may include but are not limited to the following:

- Control stream bank erosion sites;
- Conduct road erosion proofing upgrades and decommissions where necessary and beneficial;
- Plant native riparian plants in areas where canopy density is lacking;
- Install temporary riparian exclusion fencing where necessary and beneficial to aquatic/riparian conditions.

Task 3: Consultants will prepare a comprehensive survey of treatable erosion sites by December 2005 identifying priority erosion reduction projects and cost estimates (in progress).

Task 4: Salt River Advisory Group will identify funding sources and prepare proposals by May 2006 for a second phase of work to treat the remainder of identified priority stream bank and road related erosion sources in the Salt River system for implementation in 2007.

Task 5: Implement erosion reduction projects in the summer of 2006, if 2005 grant monies are awarded.

Task 6: Implement additional, identified erosion reduction projects in the summer of 2007, if 2006 grant monies are awarded.

Activity 2: Design, install and maintain sediment basins on tributaries where sediment loads, stream alterations and infrastructure limit opportunities for restoring natural processes, such as lower Francis Creek.

Task 1: Perform preliminary site analyses, prepare conceptual plans and outline roles and responsibilities for construction and maintenance.

Option 1: Include the construction of a sediment basin on Francis Creek into future Ferndale sewer treatment alternatives.

Option 2: Design and build sediment basins where necessary and beneficial using the USDA PL-83-566 Program.

Option 3: Emphasize sediment basin construction as a feature of the USACE/Coastal Conservancy Section 206 Aquatic Ecosystem Restoration Feasibility Study.

Objective 2: Improve Ferndale wastewater treatment facility (See Goals 4 and 5).

Objective 3: Decrease non-point source pollution by improving dairy waste management (See Goal 5).

Goal Three: Restore Salt River channel function and condition.

Objective 1: Determine property boundaries for parcels adjacent to the Salt River corridor (in progress).

Activity 1: Develop real estate scope of work for delineating ownership boundaries within the areas identified in alternatives development.

Task 1: Establish land ownership for the purpose of evaluating restoration alternatives including at least:

- Preliminary parcel mapping within the project area derived from Humboldt County Assessors Office maps, property owner interaction and, where necessary, property surveys;
- Map feasible private property access routes in the Wildcat Range and Salt River Delta to facilitate project implementation;
- Prepare comparative report on private property access requirements for each alternative;
- Develop land cost estimates for alternatives.

Objective 2: Conduct necessary activities and analyses for channel restoration project design, and to understand the physical and economic affects of the re-establishment of the Salt River channel from Coffee Creek to the confluence with the Eel River.

Activity 1: Conduct topographic mapping of the Eel River Delta (in progress).

Task 1: Consultants will conduct an elevation survey of the Salt River corridor from the Old River (river mile 7.7) downstream to the mouth of the Salt River. The elevation survey will include portions of Williams Creek, Francis Creek and Reas Creek as they flow across the delta as well as numerous swales and other drainage features (in progress).

Task 2: Conduct necessary mapping and elevations on tide gates, levees, channel dimensions, mudflats, and salt marshes (in progress).

Task 3: Analyze topographic elevations to:

- Determine the location and relative size of sediment accumulations in the mainstem Salt River;
- Determine potential interim projects to alleviate current conditions (in progress).

Task 4: Conduct land surveys outlined under the Army Corps of Engineers Section 206 Aquatic Ecosystem Restoration Program Project Management Plan (PMP): "Obtain sufficient data to generate 1-foot contours at plus or minus 0.1-foot accuracy between Fulmor Bridge and the Salt River Beach, the vicinity of swales upstream between the Eel River and Fulmor Bridge, and between the Leonardo Levee and the Eel/Van Duzen River confluence, approximately 1000 feet upstream along the Van Duzen River and 5000 feet upstream along the Eel River. Completion of basin hydraulics tasks is dependent on this task. Schedule to be determined based upon USCOE funding availability.

Activity 2: Analyze Salt River hydrology and hydrodynamics to include the estuary portion and the Salt River tributaries.

Task 1: Conduct basin hydrological analysis as outlined under the Army Corps of Engineers (PMP): "Obtain sufficient data on pertinent basin hydrology to develop and/or update flow-frequency, flow-duration and stage-discharge relationships. Determine upstream boundary conditions at the Eel River and the Salt River tributaries for a range of flows covering flood frequencies of 50, 25, 10, 4, 2 and 1% recurrence intervals. Completion of basin hydraulics task is dependent on this subtask. May be concurrent with hydrology work." Scope and schedule to be determined based on available funds.

Task 2: Develop a basin hydraulics model as outlined under the Army Corps of Engineers PMP: "Assemble and test a numerical model to demonstrate that it will duplicate measured or observed conditions within the project area over a range of flood frequencies, as mentioned above, with various probable bed-form and hydraulic upstream and downstream boundary conditions, including all of the above Salt River tributaries, swales upstream from the project area, and Eel River upstream conditions, with and without the Leonardo Levee (upstream). Completion of project sediment task is dependent on this subtask. Scope and schedule based on available funds.

Activity 3: Analyze fluvial geomorphology in the Salt River Basin as outlined under the Army Corps of Engineers PMP.

Task 1: Conduct sediment analysis as outlined in Army Corps of Engineers PMP: "Determine tidal and fluvial sources of sediment and the existing status (stable, accumulating or degrading). Obtain characteristics of samples that have been taken from suitable project locations. Estimate sediment transport quantities and character of suspended and bed loads. Estimate tidal volume in the existing project and in comparable project locations in previous times. Estimate previous sediment conditions. Completion of project geomorphology task is dependent on this subtask. Scope and schedule dependent on available funds.

Activity 4: Analyze geomorphic changes in the Eel River Delta to include changes in channel dimensions, sedimentation, channel location and shore lines over the past 130 years.

Task 1: Conduct geomorphology assessment as outlined in the Army Corps of Engineers PMP: "Compare Salt River channel conditions with a similar existing slough or sloughs in the Eel River delta. Estimate probable outcome for project geomorphology based on the comparison(s). Completion of project baseline task is dependent on this subtask. Scope and schedule dependent on available funds.

Task 2: Compile an historical atlas of the Salt River using legacy maps to "rubber-sheet and geo-correct various maps into a mosaic of the study area" 1 to determine relative changes in channel dimensions and locations over the past 150 years. This process will standardize various maps of different sizes to a common dimension. Scope and schedule are dependent on available funds.

Activity 5: Compile information from Activities 1-4, and perform an assessment of opportunities and constraints and develop alternatives.

Activity 6: Determine locations for the disposal of dredging spoils.

Goal Four: Improve drainage and flood control functions

Objective 1: Reduce the potential for flooding of community infrastructure, particularly the Ferndale Wastewater Treatment Plant and key transportation routes.

Activity 1: Organize coordinated planning with City of Ferndale focusing on:

- Development of integrated goals and objectives;
- Sharing data;
- Development of a project to meet community goals for wastewater treatment that minimizes risk for stream discharge in floods;
- Flood damage reduction generally, including reduction in chronic flooding to transportation routes and agricultural lands;
- Fisheries and habitat enhancement.

Activity 2: Implement Ferndale Drainage Master Plan.

1. **Rose Avenue Culvert** - Replace existing Rose Avenue 12-inch storm drain with 470 feet of new 24-inch to 30-inch pipe. Will require obtaining easements, and working in narrow areas. Estimated cost does not include the cost to acquire easements.

2. **Fifth Street Storm Drain** - Regrade and widen the channel west of 5th Street to improve flow conditions and replace the existing 6-inch by 24-inch storm drain crossing 5th Street with a new 2-foot by 4-foot storm drain.

[1] Scope of Work. Aldaron Laird, Environmental Planner, May, 2004.

3. **Herbert Street Storm Drain System and Dewey Avenue** - Install a drop inlet and 510 feet of 48-inch pipe from Herbert Street down Dewey Avenue to the East Side Drainage Channel.

4. **Intersection of Shaw Avenue and Berding Street** - Overlay 100 feet of roadway on Shaw Avenue west of the intersection and repair 200 feet of roadway on Berding Street south of the intersection to improve cross slopes.

5. **Washington Street Culvert** - Replace existing 24-inch Washington Street culvert with a 4-foot wide by 2-foot high concrete box culvert or equivalent.

6. **Market Street Culvert** - Abandon the culvert crossing Market Street just north of Highway 255 and redirect the flow to keep the water on the west side of Market Street. Will require upsizing several driveway culverts and increasing the capacity of the existing ditch.

7. **Ambrosini Lane Culvert** - Replace the existing 36-inch section of the Ambrosini Lane culvert with a new 48-inch section.

8. **Fairgrounds Storm Sewer Pipe** - Install a new storm sewer line through the Fairgrounds between Arlington Avenue and Van Ness Avenue.

Activity 3: Establish a Market Street Drainage Plan and reintroduce East Side drainage into Francis Creek downstream of Port Kenyon Road.

- Identify sources of drainage and quantify.
- Determine possible routes to convey drainage and lessen flooding.
- Work with affected property owners.
- Establish a scope of work.
- Complete the environmental review process.
- Identify sources of funding for construction.

Activity 4: Map permanent drainage ditches in the Salt River Basin.

Goal Five: Improve and prevent point and non-point source water pollution

Objective 1: Continue implementation of dairy waste production program (in progress)

Objective 2: Obtain compliance at Ferndale Waste Water Treatment Plant.

- Adopt increased sewer rates to provide construction and financing funds.
- Receive Funding Notices from Agencies
- Complete Permit and Environmental Processes

Objective 3: Investigate the coordination of an anaerobic digestion system between the City of Ferndale wastewater treatment plant and the Dairy Waste Production Program to facilitate both programs' operations, provide regional energy generation, and improve water quality.

Goal Six: Enhance and protect fishery and wetland habitats

Objective 1: Increase tidal influence to enhance discharge of sediment as well as for the improvement of estuarine rearing habitat (contingent upon estuarine analysis and topographic analysis). Possible actions to achieve the objective likely would include a combination of the following:

- Acquire identified parcels for tideland and channel restoration;
- Increase tidal prism by the breaching or removal of levees in the western delta;
- Increase tidal prism by dredging lower Salt River;
- Increase tidal prism by constructing a tidal basin upstream of Dillon Road Bridge;
- Increase tidal prism by removing or modifying identified tide gates.

Objective 2: In order to improve fish passage and instream habitat condition in the Salt River system, the following activities must be addressed.

Activity 1: Re-establish mainstem Salt River at river mile 5.1 to 8.3 (Francis Creek to Coffee Creek), and improve channel conditions from river mile 3.4 to 5.1 (Reas Creek to Francis Creek) to allow access for salmonids and to alleviate flooding. Options to achieve this activity include but are not limited to the following (contingent upon the findings of the channel corridor elevation survey as well as the basin hydrological survey):

- Dredge mainstem Salt River;
- Increase tidal influence of the Salt River to improve channel cleansing;
- Analyze the practicality of allowing the Eel River to flow across the Salt River Delta during high water events.

Activity 2: Replace or modify culverts or barriers that create fish passage problems:

- Francis Creek- Port Kenyon Road culvert;

- Reas Creek- Port Kenyon Road culvert, Meridian Road culvert, Centerville Road culvert and Oeschger Road culvert;
- Russ Creek- Centerville Road culvert;
- Russ Creek- Modify barrier 500 feet upstream of Centerville Road.

Objective 2: Increase pool quantity and quality in the Wildcat tributary reaches.

Activity 1: Where feasible, design and engineer pool enhancement structures to increase the number of pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.

Objective 3: Increase canopy cover in specific reaches in the Wildcat tributary reaches.

Activity 1: Increase the canopy on Salt River tributaries by planting appropriate native species such as willow, alder, spruce, and Douglas fir along the stream where shade canopy is not at functional levels. In many cases, planting will need to be coordinated to follow bank stabilization or upslope erosion control projects.

Objective 4: Improve fish habitat conditions in the trans-delta reach of Reas Creek and Williams Creek.

Activity 1: Widen and re-align Reas Creek trans-delta levee system for flood control, channel meander, and riparian function within levees.

Activity 2: Utilize increased channel gradient and stream energy in trans-delta reach to establish habitat diversity.

Objective 5: Enhance wetland protections for the purpose of flood storage capacity improvements, nutrient assimilation, and wildlife benefits.

Option 1: Utilize USDA/NRCS Wetland Reserve Program or Farm and Ranch Land Protection Program.

Option 2: Utilize California Department of Conservation or Coastal Conservancy conservation easement programs.

Salt River Tributary Appendix

Williams Creek

Williams Creek is historically a tributary to the Salt River, a tributary to the Eel River, a tributary to the Pacific Ocean, located in Humboldt County, California (Map 1). Williams Creek's legal description at the confluence with Salt River is T02N R02W S01. Its location is 40°35'21.0" north latitude and 124°14'16.0" west longitude. Williams Creek is a second order stream and has approximately 8.3 miles of blue line stream according to the USGS Ferndale 7.5 minute quadrangle. Williams Creek drains a watershed of approximately 6.8 square miles. Elevations range from about 30 feet at the mouth of the creek to 750 feet in the headwater areas. Grass, mixed hardwood and Redwood/Douglas Fir forest dominate the watershed. The watershed is entirely privately owned and is managed for rangeland and timber production. Vehicle access exists via Grizzly Bluff Road.

The habitat inventory of 6/2/2003 to 6/16/2003, was conducted by Elizabeth Pope and Kevin Lucey (WSP). The total length of the stream surveyed was 21,881 feet.

Williams Creek is a G4 channel type for the first 2,011 feet of the stream surveyed, an F4 channel type for the next 17,607 feet of the stream surveyed and an A1 channel type for the remaining 2,263 feet of the stream surveyed. G4 channels are entrenched "gully" step-pool channels on moderate gradients with low width /depth ratios and gravel dominant substrates. F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates. A1 channels are steep, narrow, cascading, step-pool, high energy debris transporting channels associated with depositional soils, and a very stable bedrock channel.

Table 8 - Fish Habitat Inventory Data Summary

Stream Name: Williams Creek		LLID: 1242377405892	Drainage: Eel River - Lower
Survey Dates: 6/3/2002 to 6/16/2003	Survey Length (ft.): 21881	Main Channel (ft.): 21881	Side Channel (ft.): 0
Confluence Location: Quad: FERNDALE	Legal Description: T02NR02WS01	Latitude: 40:35:21.0N	Longitude: 124:14:16.0W

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 1

Channel Type: G4	Canopy Density (%): 78	Pools by Stream Length (%): 56
Reach Length (ft.): 2011	Coniferous Component (%): 0	Pool Frequency (%): 52
Riffle/Flatwater Mean Width (ft.): 8.3	Deciduous Component (%): 100	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Deciduous Trees	< 2 Feet Deep: 6
Range (ft.): 17 to 22	Vegetative Cover (%): 79	2 to 2.9 Feet Deep: 29
Mean (ft.): 17	Dominant Shelter: Small Woody Debris	3 to 3.9 Feet Deep: 29
Std. Dev.: 2	Dominant Bank Substrate Type: Sand/Silt/Clay	>= 4 Feet Deep: 35
Base Flow (cfs.): 2.5	Occurrence of LWD (%): 8	Mean Max Residual Pool Depth (ft.): 3.3
Water (F): 57 - 61 Air (F): 58 - 66	LWD per 100 ft.:	Mean Pool Shelter Rating: 59
Dry Channel (ft): 0	Riffles: 0	
	Pools: 0	
	Flat: 1	

Pool Tail Substrate (%): Silt/Clay: 18 Sand: 0 Gravel: 76 Sm Cobble: 6 Lg Cobble: 0 Boulder: 0 Bedrock: 0

Embeddedness Values (%): 1. 0 2. 0 3. 6 4. 94 5. 0

STREAM REACH: 2

Channel Type: F4
Reach Length (ft.): 17607
Riffle/Flatwater Mean Width (ft.): 12.8
BFW:
Range (ft.): 15 to 35
Mean (ft.): 23
Std. Dev.: 4
Base Flow (cfs.): 2.5
Water (F): 55 - 66 Air (F): 54 - 70
Dry Channel (ft): 0

Canopy Density (%): 61
Coniferous Component (%): 4
Deciduous Component (%): 96
Dominant Bank Vegetation: Deciduous Trees
Vegetative Cover (%): 85
Dominant Shelter: Small Woody Debris
Dominant Bank Substrate Type: Sand/Silt/Clay
Occurrence of LWD (%): 17
LWD per 100 ft.:
Riffles: 0
Pools: 2
Flat: 0

Pools by Stream Length (%): 34
Pool Frequency (%): 31
Residual Pool Depth (%):
< 2 Feet Deep: 33
2 to 2.9 Feet Deep: 41
3 to 3.9 Feet Deep: 21
>= 4 Feet Deep: 5
Mean Max Residual Pool Depth (ft.): 2.5
Mean Pool Shelter Rating: 28

Pool Tail Substrate (%): Silt/Clay: 3 Sand: 6 Gravel: 66 Sm Cobble: 13 Lg Cobble: 9 Boulder: 2 Bedrock: 1
Embeddedness Values (%): 1. 16 2. 12 3. 21 4. 50 5. 1

STREAM REACH: 3

Channel Type: A1
Reach Length (ft.): 2263
Riffle/Flatwater Mean Width (ft.): 6.4
BFW:
Range (ft.): 15 to 35
Mean (ft.): 19
Std. Dev.: 2
Base Flow (cfs.): 2.5
Water (F): 54 - 62 Air (F): 57 - 71
Dry Channel (ft): 0

Canopy Density (%): 65
Coniferous Component (%): 2
Deciduous Component (%): 98
Dominant Bank Vegetation: Brush
Vegetative Cover (%): 85
Dominant Shelter: Boulders
Dominant Bank Substrate Type: Bedrock
Occurrence of LWD (%): 0
LWD per 100 ft.:
Riffles: 2
Pools: 1
Flat: 1

Pools by Stream Length (%): 7
Pool Frequency (%): 10
Residual Pool Depth (%):
< 2 Feet Deep: 60
2 to 2.9 Feet Deep: 20
3 to 3.9 Feet Deep: 20
>= 4 Feet Deep: 0
Mean Max Residual Pool Depth (ft.): 1.9
Mean Pool Shelter Rating: 8

Pool Tail Substrate (%): Silt/Clay: 0 Sand: 0 Gravel: 40 Sm Cobble: 20 Lg Cobble: 0 Boulder: 0 Bedrock: 40
Embeddedness Values (%): 1. 0 2. 20 3. 40 4. 40 5. 0

Francis Creek

Francis Creek is tributary to the Salt River, which is tributary to the Eel River Estuary. Francis Creek is a second order stream and has approximately 5.2 miles of blue line stream according to the USGS Ferndale 7.5 minute quadrangle. Francis Creek's legal description at the confluence with Salt River is T03N R02W S35. Its location is 40° 35' 40.0" north latitude and 124° 15' 46.0" west longitude. Francis Creek drains a watershed of approximately 4.6 square miles. Elevations range from about 25 feet at the mouth of the creek to 1000 feet in the headwater areas. Grass and mixed hardwood and conifer forests dominate the watershed. The watershed is primarily privately owned and is managed for timber production and rangeland. The watershed is also influenced by urban and suburban development. The habitat assessment survey began just off Eugene Street in Ferndale and extended upstream 2.7 miles.

The habitat inventory of June 2nd to June 20th, 2003, was conducted by Sarah Ganas, Lesley Merrick , Dian Bacigalupi (AmeriCorps WSP). The total length of the stream surveyed was 14,062 feet with an additional 103 feet of side channel.

This section of Francis Creek has two channel types: an F4 channel type for the first 9,114 feet of the stream surveyed (Reach 1) and an A4 channel type for the next 4,948 feet of the stream surveyed (Reach 2). F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates. The suitability of F4 channels for fish habitat improvement structures are good for bank place boulders, fair for plunge weirs, single and opposing wing deflectors, channel constrictors, and log cover; and are poor for boulder clusters. A4 channels are steep, narrow, cascading, step-pool, high energy debris transporting channels associated with depositional soils, and gravel channels. A4 channels are generally not suitable for fish habitat improvement structures.

Table 8 - Fish Habitat Inventory Data Summary

Stream Name: Francis Creek | LLID: 1242628405945 | Drainage: Eel River - Lower

Survey Dates: 6/2/2003 to 6/20/2003 | Survey Length (ft.): 14165 | Main Channel (ft.): 14062 | Side Channel (ft.): 103

Confluence Location: Quad: FERNDALE | Legal Description: T03NR02WS35 | Latitude: 40:35:40.0N | Longitude: 124:15:46.0W

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 1

Channel Type: F4	Canopy Density (%): 89	Pools by Stream Length (%): 46
Reach Length (ft.): 9114	Coniferous Component (%): 3	Pool Frequency (%): 45
Riffle/Flatwater Mean Width (ft.): 8.6	Deciduous Component (%): 97	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Deciduous Trees	< 2 Feet Deep: 71
Range (ft.): 13 to 21	Vegetative Cover (%): 80	2 to 2.9 Feet Deep: 26
Mean (ft.): 17	Dominant Shelter: Small Woody Debris	3 to 3.9 Feet Deep: 2
Std. Dev.: 2	Dominant Bank Substrate Type: Sand/Silt/Clay	>= 4 Feet Deep: 1
Base Flow (cfs.): 1.1	Occurrence of LWD (%): 16	Mean Max Residual Pool Depth (ft.): 1.7
Water (F): 53 - 60 Air (F): 54 - 70	LWD per 100 ft.:	Mean Pool Shelter Rating: 32
Dry Channel (ft): 0	Riffles: 1	
	Pools: 3	
	Flat: 1	

Pool Tail Substrate (%): Silt/Clay: 13 Sand: 0 Gravel: 86 Sm Cobble: 0 Lg Cobble: 0 Boulder: 0 Bedrock: 1

Embeddedness Values (%): 1. 2 2. 19 3. 43 4. 35 5. 1

STREAM REACH: 2

Channel Type: A4	Canopy Density (%): 80	Pools by Stream Length (%): 12
Reach Length (ft.): 4948	Coniferous Component (%): 10	Pool Frequency (%): 29
Riffle/Flatwater Mean Width (ft.): 4.3	Deciduous Component (%): 90	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Deciduous Trees	< 2 Feet Deep: 94
Range (ft.): 13 to 22	Vegetative Cover (%): 84	2 to 2.9 Feet Deep: 6
Mean (ft.): 17	Dominant Shelter: Boulders	3 to 3.9 Feet Deep: 0
Std. Dev.: 3	Dominant Bank Substrate Type: Cobble/Gravel	>= 4 Feet Deep: 0
Base Flow (cfs.): 1.1	Occurrence of LWD (%): 18	Mean Max Residual Pool Depth (ft.): 1.3
Water (F): 54 - 58 Air (F): 55 - 63	LWD per 100 ft.:	Mean Pool Shelter Rating: 31
Dry Channel (ft): 0	Riffles: 3	
	Pools: 10	
	Flat: 3	

Pool Tail Substrate (%): Silt/Clay: 12 Sand: 0 Gravel: 73 Sm Cobble: 0 Lg Cobble: 0 Boulder: 12 Bedrock: 3

Embeddedness Values (%): 1. 0 2. 21 3. 42 4. 18 5. 18

Russ Creek

Russ Creek is a tributary to Centerville Slough, which is a tributary to Cutoff Slough, which is a tributary to Salt River, which is a tributary to Eel River, which is a tributary to the Pacific Ocean, located in Humboldt County, California. Russ Creek's legal description at the confluence with Centerville Slough is T02N R02W S06. Its location is 40°35'31" north latitude and 124°20'10" west longitude, LLID number 1243360405919. Russ Creek is a second order stream and has approximately 5.2 miles of blue line stream according CDFG river mile and stream length index for the Eel River Basin. The Russ Creek watershed is located within the USGS Ferndale 7.5 minute quadrangle. Russ Creek drains a watershed of approximately 2335 acres (3.65 mi2). Elevations range from about 5 feet at the mouth of the creek to 1515 feet in the headwater areas. Douglas fir, Sitka spruce and mixed hardwood forests dominate the watershed. The watershed is entirely privately owned and is managed for timber production and rangeland. Vehicle access exists via-Centerville Road to Fern Cottage.

The habitat inventory of 10/13/2004 to 10/18/2004, was conducted by Corby Hines (CCC), Kevin Lucey (PSMFC). The total length of the stream surveyed was 11,609 feet with an additional 56 feet of side channel.

Russ Creek is a F6 channel type for 3196 feet of the stream surveyed (Reach 1), a B6 channel type for 8413 feet of the stream surveyed (Reach 2). F6 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and silt-dominant substrates. B6 channels are moderately entrenched, moderate gradient, riffle dominated channels with infrequently spaced pools, very stable plan and profile, stable banks on moderate gradients with low width /depth ratios and silt dominant substrates.

Table 8 - Fish Habitat Inventory Data Summary

Stream Name: Russ Creek		LLID: 1243360405919	Drainage: Eel River - Lower
Survey Dates: 10/13/2004 to 10/18/2004	Survey Length (ft.): 11665	Main Channel (ft.): 11609	Side Channel (ft.): 56
Confluence Location: Quad: FERNDALE	Legal Description: T02NR02WS06	Latitude: 40:35:31.0N	Longitude: 124:20:10.0W

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 1

Channel Type: F6	Canopy Density (%): 78	Pools by Stream Length (%): 33
Reach Length (ft.): 3196	Coniferous Component (%): 10	Pool Frequency (%): 40
Riffle/Flatwater Mean Width (ft.): 6.8	Deciduous Component (%): 90	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Deciduous Trees	< 2 Feet Deep: 46
Range (ft.): 8 to 18	Vegetative Cover (%): 85	2 to 2.9 Feet Deep: 29
Mean (ft.): 13	Dominant Shelter: Small Woody Debris	3 to 3.9 Feet Deep: 21
Std. Dev.: 4	Dominant Bank Substrate Type: Sand/Silt/Clay	>= 4 Feet Deep: 4
Base Flow (cfs.): 0.0	Occurrence of LWD (%): 10	Mean Max Residual Pool Depth (ft.): 2.4
Water (F): 55 - 58 Air (F): 55 - 74	LWD per 100 ft.:	Mean Pool Shelter Rating: 61
Dry Channel (ft): 0	Riffles: 0	
	Pools: 2	
	Flat: 0	

Pool Tail Substrate (%): Silt/Clay: 22 Sand: 0 Gravel: 70 Sm Cobble: 0 Lg Cobble: 0 Boulder: 0 Bedrock: 9

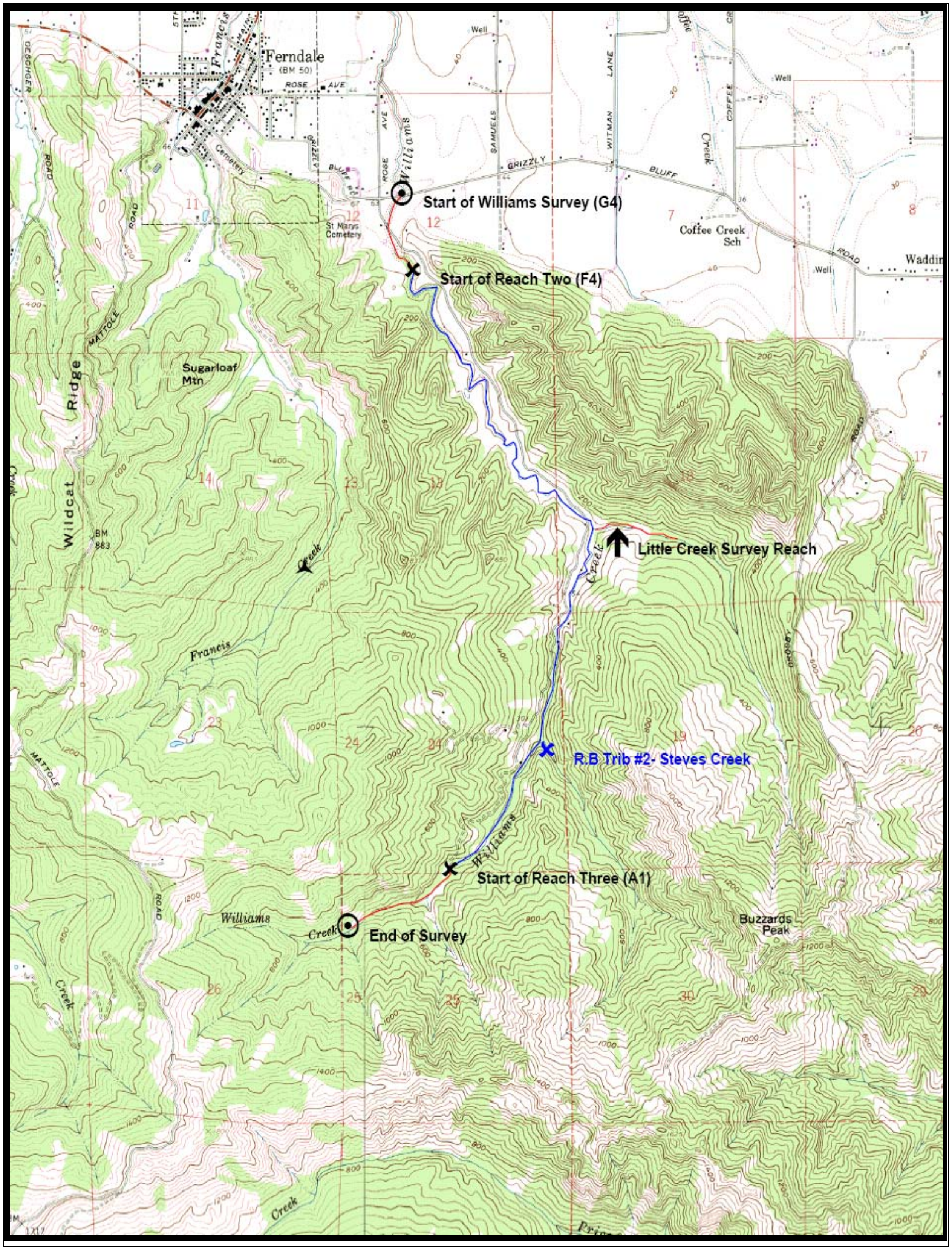
Embeddedness Values (%): 1. 0 2. 0 3. 46 4. 25 5. 29

STREAM REACH: 2

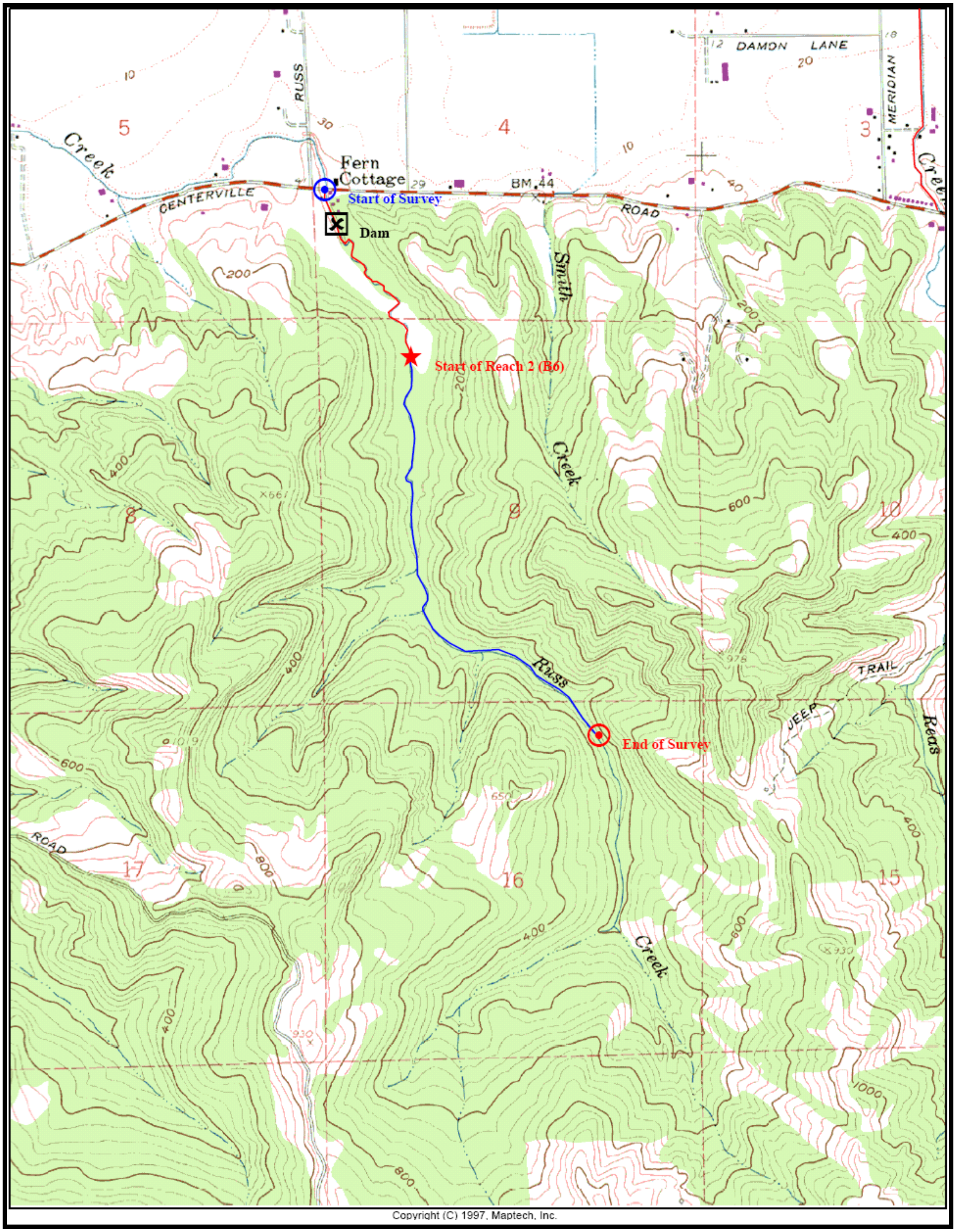
Channel Type: B6	Canopy Density (%): 80	Pools by Stream Length (%): 25
Reach Length (ft.): 8413	Coniferous Component (%): 22	Pool Frequency (%): 41
Riffle/Flatwater Mean Width (ft.): 6.7	Deciduous Component (%): 78	Residual Pool Depth (%):
BFW:	Dominant Bank Vegetation: Deciduous Trees	< 2 Feet Deep: 47
Range (ft.): 11 to 22	Vegetative Cover (%): 90	2 to 2.9 Feet Deep: 36
Mean (ft.): 17	Dominant Shelter: Small Woody Debris	3 to 3.9 Feet Deep: 11
Std. Dev.: 4	Dominant Bank Substrate Type: Sand/Silt/Clay	>= 4 Feet Deep: 6
Base Flow (cfs.):	Occurrence of LWD (%): 34	Mean Max Residual Pool Depth (ft.): 2.3
Water (F): 0 - 62 Air (F): 0 - 74	LWD per 100 ft.:	Mean Pool Shelter Rating: 87
Dry Channel (ft): 0	Riffles: 0	
	Pools: 4	
	Flat: 0	

Pool Tail Substrate (%): Silt/Clay: 25 Sand: 0 Gravel: 71 Sm Cobble: 2 Lg Cobble: 0 Boulder: 0 Bedrock: 2

Embeddedness Values (%): 1. 0 2. 6 3. 61 4. 7 5. 26


Ferndale
Start of Williams Survey (G4)
Start of Reach Two (F4)
Little Creek Survey Reach
R.B Trib #2- Steves Creek
Start of Reach Three (A1)
End of Survey
Sugarloaf Mtn
Wildcat Ridge
Coffee Creek Sch
Buzzards Peak
Williams Creek
Francis Creek

Ferndale
(BM 50)
Start of Survey (F4)
St Marys
Cemetery
Sugarloaf
Mtn
Wildcat
Ridge
Channel Type Change (A4)
Francis
Creek
End of Survey


Fern Cottage
Start of Survey
Dam
Start of Reach 2 (B6)
End of Survey
Smith Creek
Russ Creek
CENTERVILLE ROAD
DAMON LANE
MERIDIAN
RUSS
JEEP TRAIL
ROAD
BM 44