Fish Habitat Relationship

Fishery 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 its tributaries by salmonids are not well documented. Francis and Russ creeks are the only tributaries with current salmonid observations (Table 10). Thirteen species of fish, including Chinook and steelhead were observed in the estuarine portion of the Salt River in 1995 (Table 11). Chinook presence indicates seasonal utilization of Salt River estuarine channels by salmonids.

Table 10. 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 11. 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 (*Oncorhynchus 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 (*Oncorhynchus kisutch*)

Until the summer of 2005, there had not been any recorded observations of coho salmon in the Salt River system channels 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 1930s and the 1980s (CDFG). In 1930 to 1934, 115,000 steelhead were planted in Russ Creek.

Coastal Cutthroat Trout (*Oncorhynchus 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- 203 mm) 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).

Habitat Overview

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 12).

Table 12. 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 ammocetes 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 yards 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.
	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			

Tributary	Date Surveyed	Source	Fish Comments	Habitat Comments	Barrier Comments	Management Recommendations
	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 Avenue Two adult coastal 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 Street to Arlington Avenue). 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.			
	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 RM 3.			
	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
	8/10/2005	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 (yoy) 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 Road	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		
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.	

Tributary	Date Surveyed	Source	Fish Comments	Habitat Comments	Barrier Comments	Management Recommendations
	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 Road. Pike minnow and stickleback were numerous; 1 ammocoete.	Water temp= 54°F Air temp= 56°F Water clarity was poor. Conductivity= 730 µS/cm		
	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.			

Current Conditions

The Salt River Basin was assessed as a separate watershed by Downie and Lucey (2005). The habitat data that were reviewed in that watershed assessment report were analyzed using EMDS in this assessment. Habitat inventories were conducted by CDFG on four tributaries in the Salt River Subbasin (Table 13, Figure 22). Francis Creek and one of its unnamed tributaries, as well as Williams Creek, were surveyed in 2003. Russ Creek was surveyed in 2004.

Table 13. Salt River Subbasin streams inventoried by CDFG.

Stream	Year of Survey	Survey length (miles)	Percent of stream surveyed	Number of Reaches
Unnamed tributary to Francis Creek	2003	0.2	36	1
Russ Creek	2004	2.2	42	2
Francis Creek	2003	2.7	62	2
Williams Creek	2003	4.1	58	3

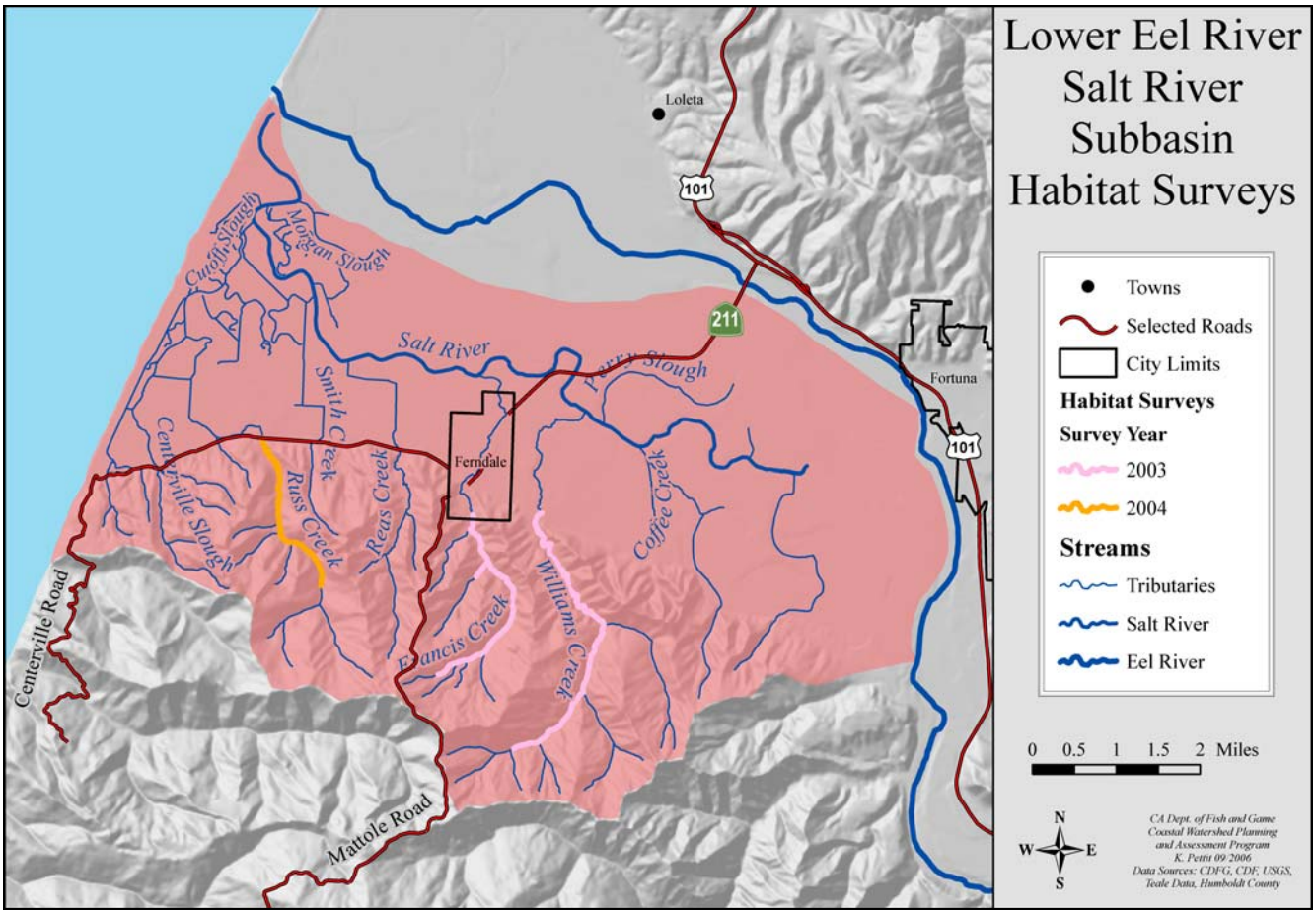

Figure 22. Habitat surveys conducted by CDFG in the Salt River Subbasin.

Canopy Density

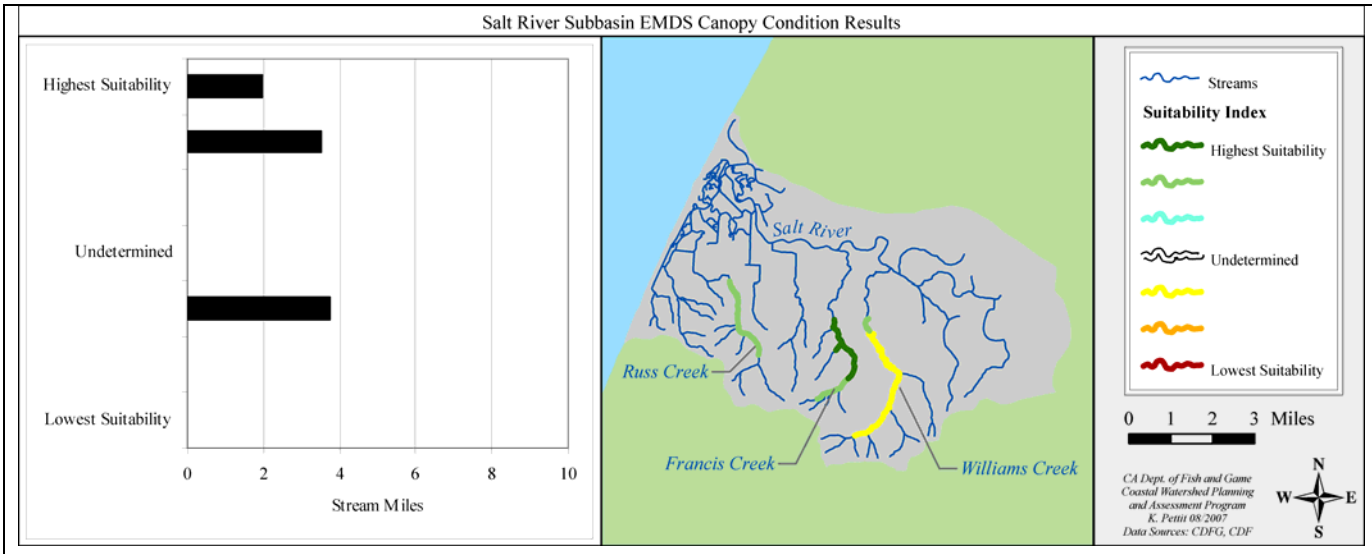

Figure 23. EMDS canopy results for the Salt River Subbasin by surveyed stream miles.

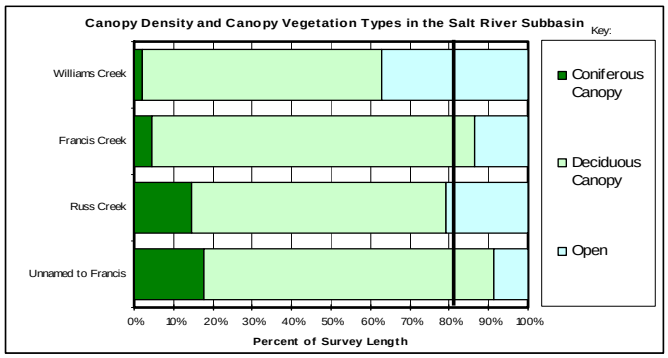

Figure 24. The relative percentage of coniferous, deciduous, and open canopy covering surveyed streams in the Salt River Subbasin.

Averages are weighted by unit length to give the most accurate representation of the percent of a stream under each type of canopy. Streams are listed in descending order by drainage area (largest at the top).

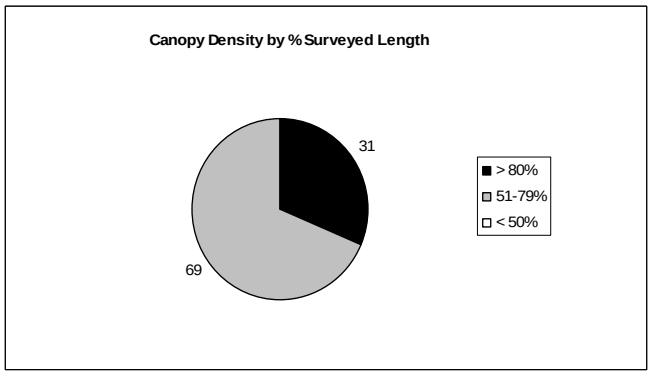

Figure 25. Canopy Density in the Salt River Subbasin.

Significance: Near-stream forest density and composition contribute 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 50% by survey length is below target values and greater than 80% fully meets target values.

Findings: Neither Williams Creek, nor Russ Creek met canopy density target value of 80%, though Russ Creek did obtain a measurement of 79%. While Francis and its unnamed tributary both reached suitable levels of canopy density, the majority of coverage was provided by predominantly deciduous trees. EMDS suitability ratings for canopy condition show that approximately five miles of all Salt River surveys ranked in the suitable range.

Habitat Categories

Table 14. Salt River Subbasin percent occurrence and percent by length of pool, run, and riffle habitats.

Stream	Stream Order	Survey Length (miles)	Pool, Riffle, Run% Occurrence	Pool: Riffle: Run% total length
Unnamed tributary to Francis Creek	1	0.2	38:21:42	25:10:65
Russ Creek	2	2.2	41:23:37	27:13:60
Francis Creek	2	2.7	41:39:20	34:24:43
Williams Creek	2	4.1	30:34:36	33:24:43

Significance: Productive anadromous streams are composed of a balance of pool, riffle and run habitat and each plays an important role as salmonid habitat. Looking cumulatively at pool, riffle, and run relationships helps characterize the status of these habitat types and also provides a measure of stream habitat diversity and suitability for fish. A pool: riffle ratio of approximately 1:1 is suggested as a desirable condition for most wadable, anadromous, fish bearing streams, but it is not applicable for evaluating salmonid suitability of all stream reaches and channel types (Rosgen 1996). However, pool: riffle relationships showing an over abundance of riffles or runs that may indicate aggraded channel conditions or lack of scour objects needed for pool formation.

Findings: Three of the surveyed tributaries had a greater number of pools by occurrence than riffles. Additionally, all four tributaries had a greater length in pools than in riffles - Williams Creek, Francis Creek, and unnamed tributary to Francis Creek all had over 30% of their stream length in pools. None of the tributaries had dry habitat units.

Pool Depth

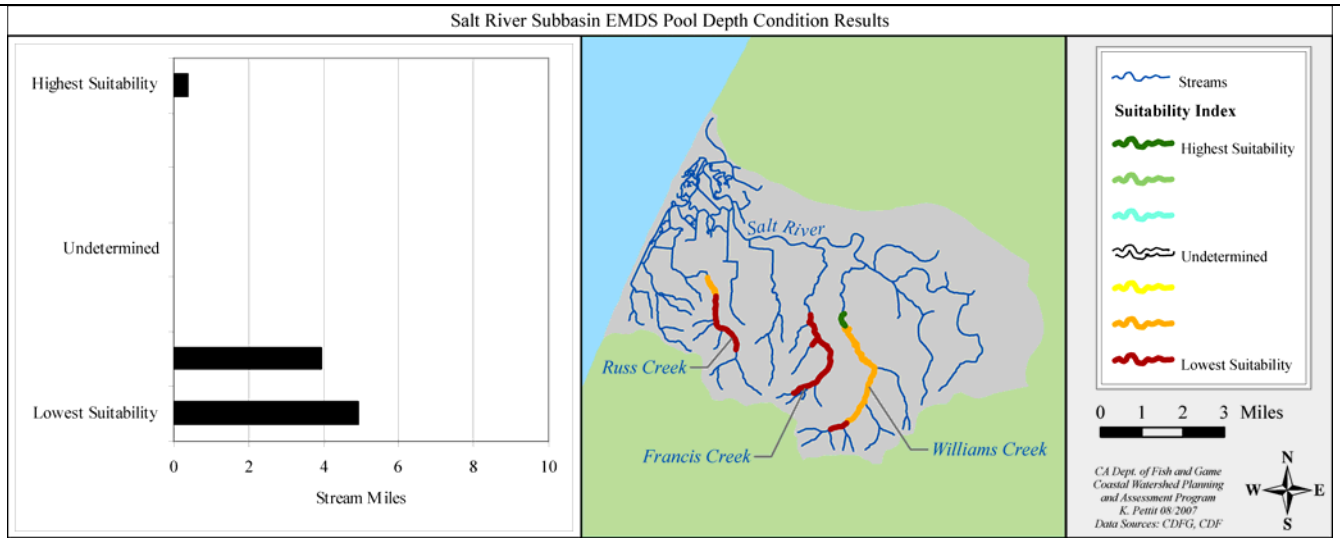

Figure 26. EMDS pool depth results for the Salt River Subbasin by surveyed stream miles.

Table 15. Percent length of a survey composed of pools in the Salt River Subbasin.

Stream	Stream Order	Percent all measured pools by survey length	Percent pools of depth <2 feet, by survey length	Percent pools of depth 2 - 2.9 feet, by survey length	Percent pools of depth 3 - 4 feet, by survey length	Percent pools of depth >4 feet, by survey length	Percent pools within target range (>2 feet) by survey length
Unnamed trib to Francis Creek	1	24.8	22.7	0	2.1	0	2.1
Russ Creek	2	27	11.5	8.4	6	1.1	15.5
Francis Creek	2	34.3	20.4	12.6	1	0.3	13.9
Williams Creek	2	32.9	7.4	14.4	8.3	2.8	25.5

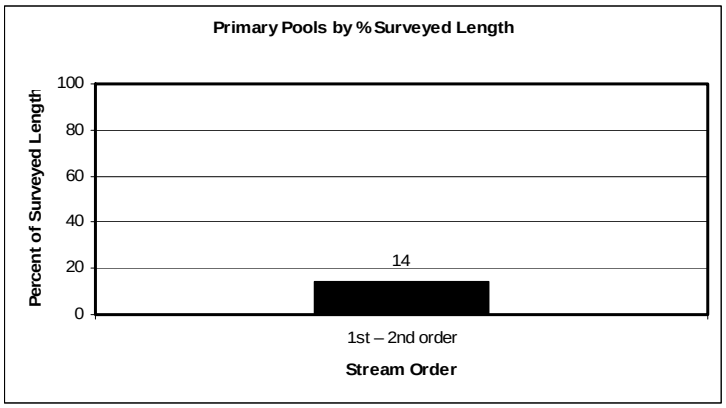

Figure 27. Primary Pools in the Salt River Subbasin.

Significance: 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. In first and second order streams, primary pools are those of greater than 2 feet deep.

Findings: None of the Salt River Subbasin streams met the target value of 40% length in primary pools. Francis Creek has the greatest amount of pools by survey length at approximately 34%, though pools were primarily composed of those <3feet in depth. The Salt River Subbasin survey results describe EMDS pool depth condition as moderately to fully unsuitable for the entire length of surveyed stream.

Pool Shelter

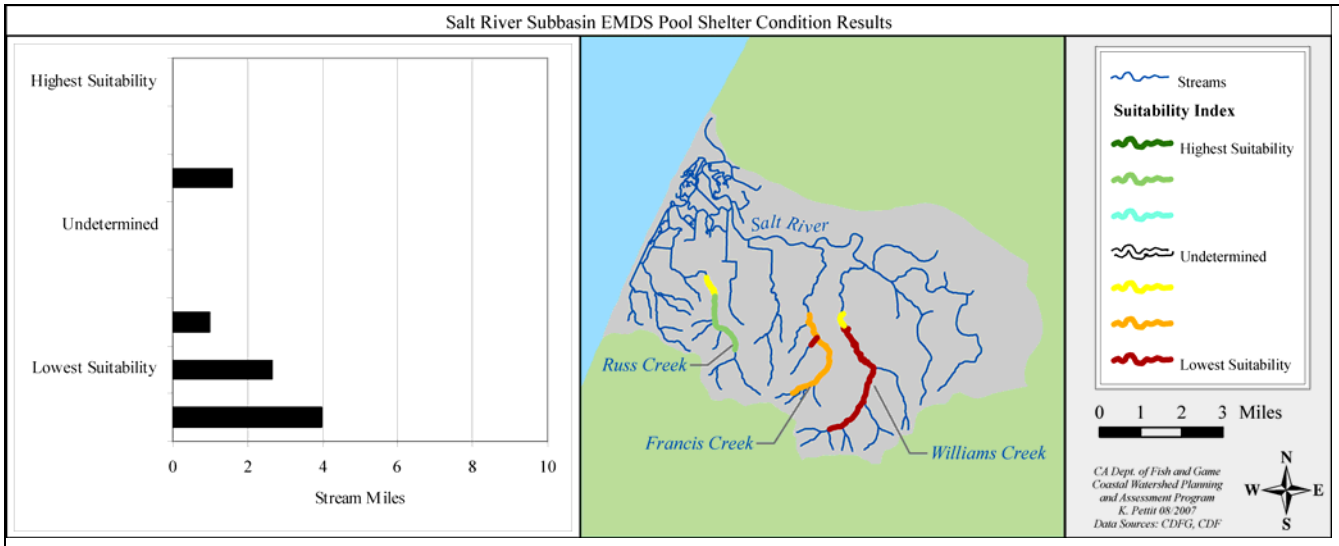

Figure 28. EMDS pool shelter results for the Salt River Subbasin by surveyed stream miles.

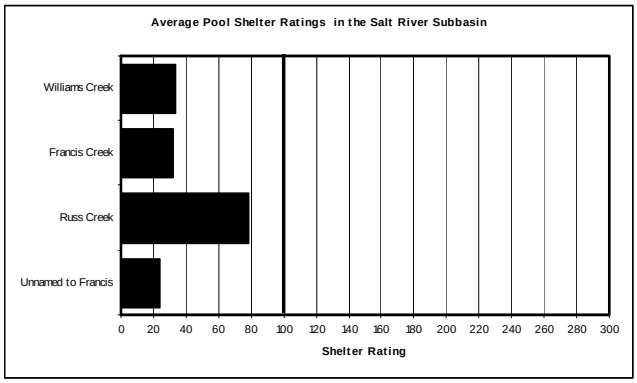

Figure 29. Average pool shelter ratings from CDFG stream surveys in the Salt River Subbasin.

Streams are listed in descending order by drainage area (largest at the top).

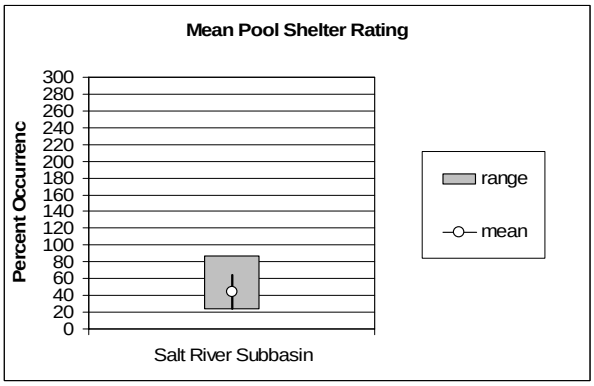

Figure 30. Pool shelter in the Salt River Subbasin.

Error bars represent the standard deviation. The percentage of shelter provided by various structures (i.e. undercut banks, woody debris, etc.) is described and rated in CDFG surveys.

Table 16. Mean percent of shelter cover types in pools for surveyed tributaries in the Salt River Subbasin.

Stream	Undercut Banks	Small Woody Debris	Large Woody Debris	Root Mass	Terrestrial Vegetation	Aquatic Vegetation	White Water	Boulders	Bedrock Ledge
Unnamed trib to Francis Creek	21.7	25	17.2	33.3	0	0	2.8	0	0
Russ Creek	9.5	35.3	28	2.5	18.5	0.3	1	1.3	2.2
Francis Creek	21	32.8	16.8	16.8	1	0.6	4.8	6	0.2
Williams Creek	25.5	27.5	18.7	9.6	11.5	1.3	0	3.2	2.6

Significance: Pool shelter provides protection from predation and rest areas from high velocity flows for salmonids. Shelter ratings of 100 or less indicate that shelter/cover enhancement should be considered. Shelter values ≤30 are considered fully unsuitable.

Findings: Pools shelter ratings for all surveyed streams in this subbasin were below the target value of 100%. EMDS pool shelter rated all surveyed streams as lowest suitability. Russ Creek did obtain one of the highest shelter ratings of the entire basin at 79%. The rating in the Francis Creek tributary was only 24%.

In addition to complexity rating, instream shelter composition is also collected during habitat inventories. There are a total of nine cover types that are identified during habitat inventories. Small woody debris was present in large quantities in all surveyed tributaries, and was the dominant shelter in Russ, Francis and Williams creeks. The most abundant cover type in the unnamed tributary to Francis Creek was root mass at approximately 33%.

LWD

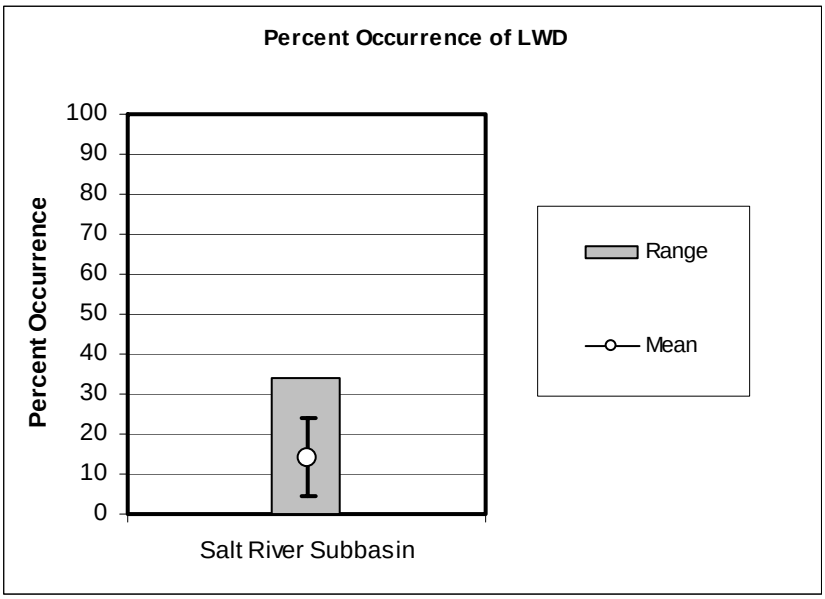

Figure 31. Large Woody Debris (LWD) in the Salt River Subbasin.

Error bars represent the standard deviation. The percentage of shelter provided by various structures (i.e. undercut banks, woody debris, root masses, etc.) is described in CDFG surveys. The dominant shelter type is determined and then the percentage of a stream reach in which the dominant shelter type is provided by organic debris is calculated.

Significance: Large woody debris shapes channel morphology, maintains organic matter, and provides essential cover for salmonids. There are currently no target values established for the % occurrence of LWD.

Findings: The average percent occurrence of LWD for the Salt River Subbasin was 14.2. Large woody debris readings ranged from 0 to 24 over the four streams. The dominant shelter type recorded in most stream reaches was small woody debris.

Cobble Embeddedness

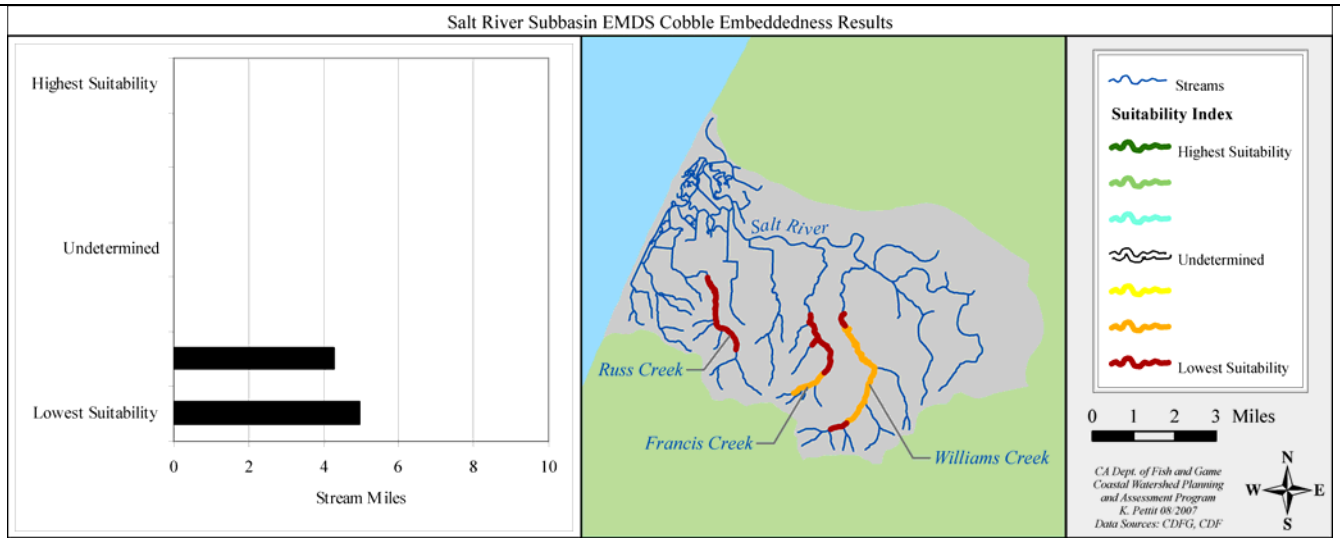

Figure 32. EMDS cobble embeddedness results for the Salt River Subbasin by surveyed stream miles.

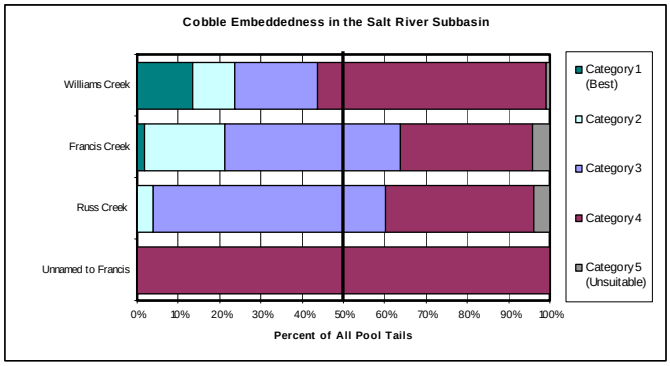

Figure 33. Cobble embeddedness categories as measured at every pool tail crest in surveyed streams in the Salt River Subbasin.

Streams are listed in descending order by drainage area (largest at the top).

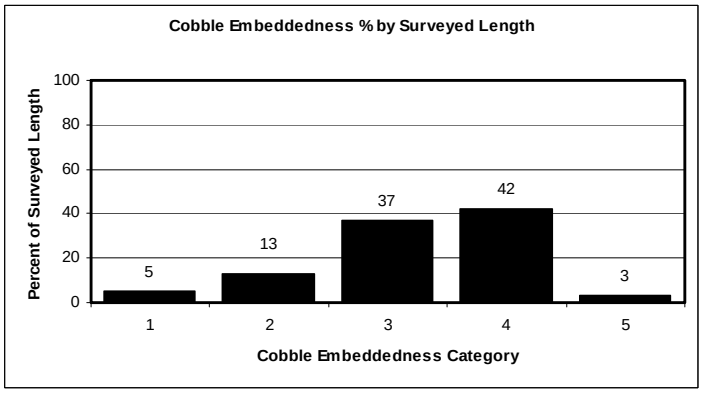

Figure 34. Cobble Embeddedness in the Salt River Subbasin.

Cobble Embeddedness will not always sum to 100% because Category 5 (not suitable for spawning) is not included.

Significance: Salmonid spawning depends heavily on the suitability of spawning gravel; fine sediments decrease successful spawning and incubation. 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 the fully supported range for successful use by salmonids.

Findings: As is reflected in all other surveyed streams in the Lower Eel Basin, none of the Salt River Subbasin streams met target values for cobble embeddedness. On all four surveyed tributaries, less than 25% of cobble embeddedness measurements fell within values considered suitable for salmonids (categories 1 and 2, combined). Additionally, 100% of all measured pool tailouts in the unnamed tributary to Francis Creek had cobble embeddedness values considered unsuitable. Similarly, Russ Creek (at 92%), and Williams and Francis creek (at 75% each), obtained unsuitable cobble embeddedness measurements (categories 3 and 4, combined). By surveyed length, embeddedness conditions of the Salt River Subbasin were all of low suitability using EMDS truth values.

Water Quality

Water Temperature

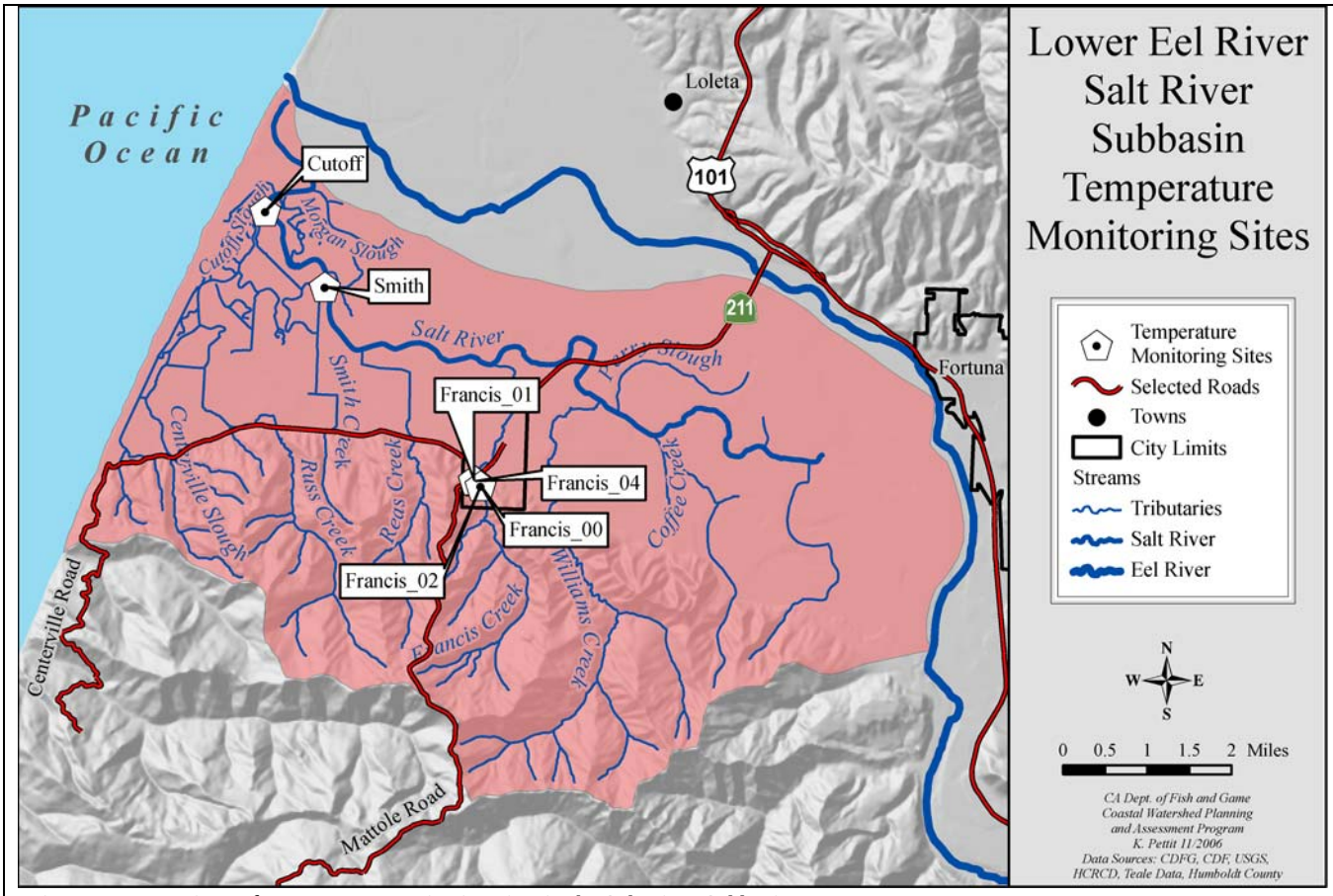

Figure 35. Locations of temperature monitoring sites in the Salt River Subbasin.

Table 17. MWATs 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

Figure 36. Maximum weekly average temperatures recorded at sites in the Salt River Subbasin.

Significance: The CWPAP has defined suitability ratings for MWATs as: fully suitable at 50-60°, moderately suitable at 61-62°, somewhat suitable at 63°, undetermined at 64°, somewhat unsuitable at 65°, moderately unsuitable at 66-67°, and fully unsuitable at ≥68°.

Findings: MWATs 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 MWATs 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.

Water Chemistry

Water chemistry interacts with basic trophic levels affecting the production and availability of food for aquatic organisms. Nutrients are often limiting factors in the biological capacity of a stream yet a proper balance is needed to prevent eutrophication. Pollutants are a concern where they interfere with the biological function of aquatic organisms, or can be a threat to those that consume them. Large sources of nutrients and pollutants are commonly municipal and industrial wastewater facilities, storm runoff, and agricultural operations. Naturally occurring nutrients and heavy metals are often found in much smaller concentrations.

The Water Board has set water quality objectives for the following parameters on the Eel and Van Duzen rivers:

- Conductivity [below 375 micromhos 90% of the time and below 225 (ER) and 175 micromhos (VDR) 50% of the time];
- Total Dissolved Solids [below 275 (ER) and 200 mg/L (VDR) 90% of the time and 140 (ER) and 100 mg/L (VDR) 50% of the time];
- Dissolved Oxygen (above 7.0 mg/L 100% of the time, above 7.5 mg/L 90% of the time, above 10.0 mg/L 50 % of the time);
- pH (between 6.5 and 8.5) (NCRWQCB 2006d).

In the Van Duzen River TMDL, turbidity levels are recommended at no greater than 20% above background levels.

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:

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

Turbidity and Rapid Bioassessment

The HCRCD studied water quality conditions in the Eel River in 1996 and 1997, including temperature and macro-invertebrate surveys. Macro-invertebrate communities are closely linked to water quality and are used to determine if a water body has been impacted and to what degree. Williams and Francis creeks were surveyed in the spring and fall of 1996 for species richness and diversity. Both creeks fell into the "highly impacted" category.

Farm Wastes

In the Salt River Delta, numerous factors related to farm wastes 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 NRCS, 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.

Wastewater Treatment

Figure 37. 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.

The City of Ferndale operates a wastewater treatment facility on the banks of Francis Creek and the Salt River (Figure 37). 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.

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 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.

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.

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.

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.

Table 18. Likely locations for nutrient contamination.

Phosphorous contamination is likely to occur where (MacGibbon 2001):	**Nitrogen 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.	• 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.

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 1990 and 1996.

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 indices designed to use stream macroinvertebrates as indicators of stream health.

Table 19. 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 indices may misrepresent the natural assemblages of macroinvertebrates expected in the Salt River.

The macroinvertebrate samples collected in 1990 (Table 20) 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).*

Table 20. Macroinvertebrate sampling conducted in 1990 by the USDA Soil Conservation Service.

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

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.

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

Figure 38. 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
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

Figure 39. 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.

Significance: 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).

Findings: Port Kenyon Road, Centerville Road, and Oeschger Road all have culverts on Reas Creek. Centerville Road also has a culvert on Russ Creek. Additionally, there are 10 culverts on Francis 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. 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. The culvert on Russ Creek at Centerville Road was passable for adult salmonids but was considered a temporary barrier for juvenile salmonids. 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.

All five surveyed culverts received low priority rankings due to the poor quality of habitat available upstream.

In addition to these culverts, there is a considerable barrier to salmonids 500 feet upstream of Centerville Road on Russ Creek (Figure 38). 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.

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 (RM 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.

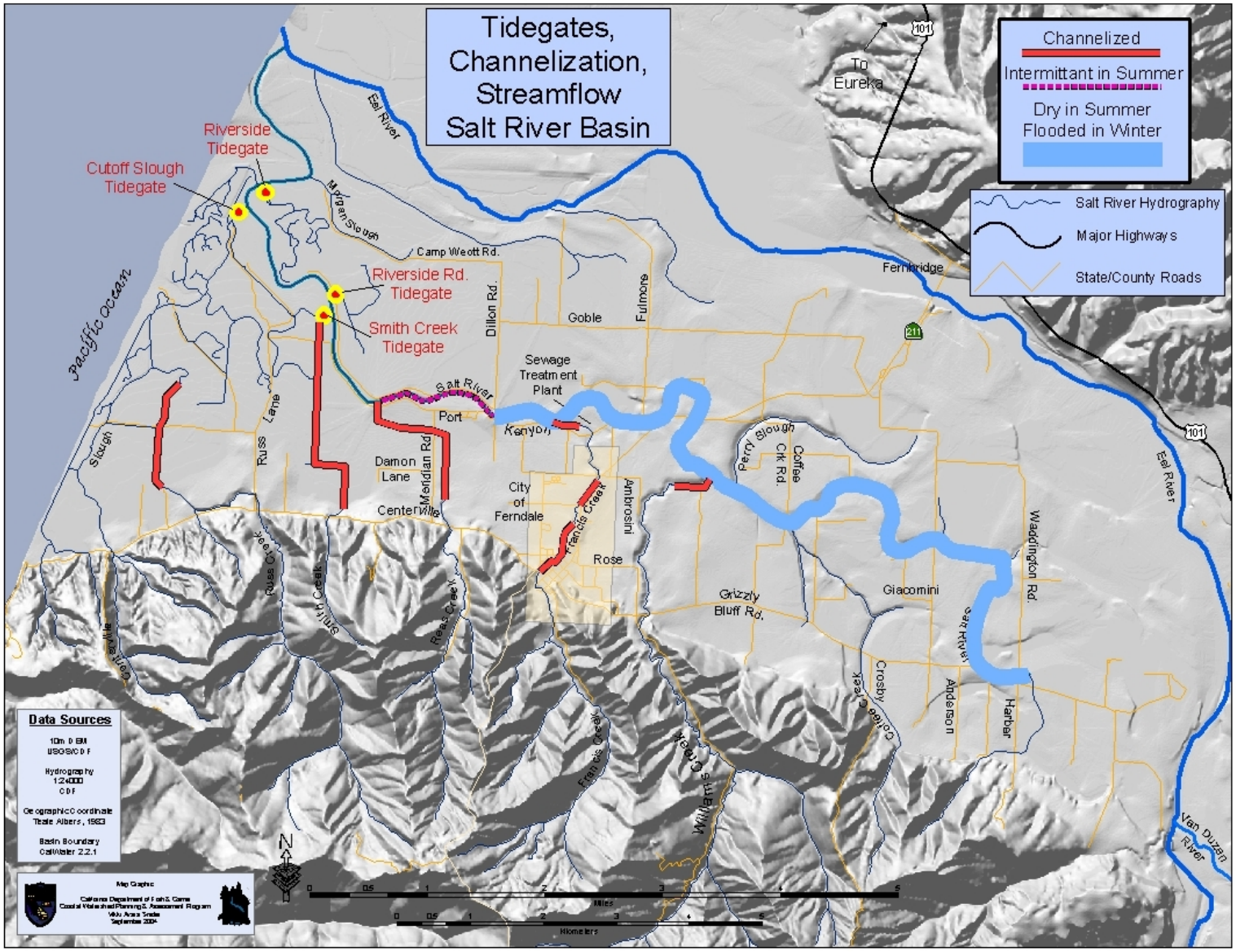

Figure 40. Possible barriers to fish movement in the Salt River Subbasin.

Habitat Conclusions

Streams surveyed before 1990 and habitat inventories from 2003 and 2004 were compared to indicate changes between historic and current conditions. Data from older stream surveys provide a snapshot of the conditions at the time of the survey. Terms such as excellent, good, fair, and poor are based on the judgment of the biologist or scientific aid who conducted the survey. The results of historic stream surveys are qualitative and cannot be used in comparative analyses with quantitative data provided by habitat inventory surveys with any degree of accuracy. However, the two data sets can be compared to show general trends.

Habitat data from both older stream surveys and recent stream inventories were only available on Russ Creek (Table 22). Spawning habitat decreased on Russ Creek.

Instream habitat conditions were generally poor in this subbasin at the time of recent CDFG surveys. Surveyed reaches fell below target values and were evaluated as unsuitable for salmonids by EMDS for pool quality, pool depth, and cobble embeddedness (Table 23) - thus these habitat factors are likely limiting to salmonid populations. Pool shelter was only evaluated as suitable for salmonids on Russ Creek.

Canopy density was suitable on Russ and Francis creeks and an unnamed tributary to Francis Creek, but unsuitable on Williams Creek. However, current canopy density measurements do not take into account differences between smaller, younger riparian vegetation versus the larger microclimate controls that are provided by old growth forest canopy conditions. Water temperature measurements did show that water temperatures were suitable in Francis Creek but unsuitable in Smith Creek. Water temperatures were not monitored at enough locations to determine whether they are limiting salmonid production across the subbasin, though they are likely doing so in Smith Creek.

Macroinvertebrate data indicate that Williams and Francis creeks are highly impacted systems. Additionally, several general locations were identified as having farm waste water quality problems including: Reas Creek, Williams Creek, Perry Slough, and Coffee Creek. It appears that water quality in the Salt River Subbasin is heavily impacted by nutrient enrichment is likely a limiting factor for salmonids.

Table 22. Comparison between historic habitat conditions with current habitat inventory surveys in the Salt River Subbasin.

Stream	Canopy Cover		Spawning Conditions		Pool Depth/Frequency		Shelter/Cover		Summary of Changes from Historic to Current
	Historic	Current	Historic	Current	Historic	Current	Historic	Current	
Russ Creek	ND	Suitable	Good	Fully unsuitable	ND	Unsuitable	ND	Fully unsuitable	Spawning habitat decreased

*ND is no data available

Table 23. EMDS Anadromous Reach Condition Model results for the Salt River Subbasin.

Stream	Year	Canopy	Pool Quality	Pool Depth	Pool Shelter	Embeddedness
Unnamed Tributary to Francis Creek	2003	+++	---	---	---	---
Russ Creek	2004	++	--	--	+	---
Francis Creek	2003	++	---	---	--	--
Williams Creek	2003	-	--	--	--	--
Salt River Subbasin		+	--	--	--	--

Key: +++ = Highest Suitability U= Insufficient Data or Undetermined - - - = Lowest Suitability

Restoration Projects

To date, twenty-eight restoration projects have been completed in the Salt River Subbasin. Twenty of these projects included aspects of assessments or studies, the majority of which are individual culvert/fish passage assessments. Besides bank stabilization, re-vegetation, and animal waste exclusion projects, some important restoration efforts have been directed at restoring the biological and hydraulic function of the Salt River. Specific

restoration projects in the Salt River Subbasin are listed below.

Salt River projects include:

- Feasibility study on Centerville beach to preserve coastal agricultural land and other coastal resources;
- Culvert inventory for fish passage improvement priorities on Reas and Francis creeks;
- Temperature and macro-invertebrate monitoring by HCRCD;
- Interest and cooperation solicitation of upslope landowners to facilitate future stream restoration;
- Planning of Salt River restoration project by U.S. Army Corps of Engineers ;
- Creation of the Salt River Advisory Group through the HCRCD in 2004;
- CDFG's "Steelhead and Salmon Go To School" curriculum;
- Williams Creek boulder wing deflectors and willow mattresses to stabilize banks;
- Remove sediment risk by laying back banks and removing a box culvert on Francis Creek;
- Water quality control via dairy waste storage improvement projects;
- Half mile of riparian fencing and re-vegetation on Williams Creek;
- Bank stabilization and re-vegetation on Francis Creek.

More detail, such as time and location, is available for most of these projects on the CalFish website (www.calfish.org). Projects not found there can be found on the Natural Resources Project Inventory Database (www.ice.ucdavis.edu/nrpi/).

Salt River has been severely impaired by sediment, has limited remaining aquatic habitat, and floods during even mild storms. The U.S. Army Corps of Engineers conducted a study of possibilities for restoring the Salt River between 2004 and 2007. Between 2001 and 2004, two outreach projects occurred that sought to unite affected and interested landowners in this subbasin. Northwest Resource compiled a mailing list and sent out newsletters informing residents of the issues in the subbasin and possibilities for solutions. The Salt River Advisory Group of the HCRCD was also funded to conducted field tours for landowners to recruit assistance and cooperation for restoration.

Currently, the HCRCD is taking the lead on the Salt River Ecosystem Restoration Project. With the help of the CDFG, U.S. Army Corps of Engineers, NMFS, California Coastal Commission, U.S. Fish and Wildlife Service, Natural Resource Conservation Service, representatives from Humboldt County and the City of Ferndale, and numerous private consultants, this project has become one of the most important restoration projects in California. Funding has been received from the State of California and from U.S. Fish and Wildlife to achieve three primary goals:

1) Dredge sediment from the mainstem Salt River from the mouth to at least Francis Creek,
2) Restore tidal flushing action to roughly 400 acres at the mouth of the Salt River, and
3) Identify and contain upslope sediment sources that contribute to sedimentation problems.

The County Planning Division is beginning the Environmental Impact Reports for this project that will most likely include, but will not be limited to:

- Riverside Ranch public land acquisition (north bank of lower Salt River);
    - tidegate removal or modification along one mile of Salt River;
    - estuarine wetland restoration;
    - set-back levees to protect adjacent agricultural lands.
- Salt River channel dredging and realignment;
    - create higher flow velocity and channel capacity;
    - improve hydraulic connectivity.
- Upslope sediment source assessment;
- Construction of sediment detention basins;
- Storm-proofing of roads and stream crossings;
- Riparian fencing;
- Riparian re-vegetation with native species.

Planning is ongoing, and ground-breaking will most likely start in the summer of 2008 (Humboldt County 2007).

Integrated Analysis

Analysis of Tributary Recommendations

In addition to presenting habitat condition data, all CDFG stream inventories provide a list of recommendations that address those conditions that did not reach target values (see the Fish Habitat section of this subbasin). In the Salt River Subbasin, four streams were inventoried, and recommendations for each were selected ranked by a CDFG biologist (Table 24). The tributary

recommendation process is described in more detail in the Synthesis section of the Basin Profile.

Table 24. Occurrence of stream habitat inventory recommendations for streams of the Salt River Subbasin.

Stream	Survey Length (mile)	Bank	Roads	Canopy	Temp	Pool	Cover	Spawning Gravel	LDA	Livestock	Fish Passage
Unnamed tributary to Francis Creek	0.2					1	2				
Russ Creek	2.2						2				1
Francis Creek	2.7	3	4			1	2			5	
Williams Creek	4.1	1	2	3		5	4				

In order to compare tributary recommendations within the subbasin, the recommendations of each stream were collapsed into five target issue categories (Table 25). The top three recommendations of each stream are considered to be the most important, and are useful as a standard example of the stream. When examining recommendation categories by number of tributaries, the most important target issue in the Salt River Subbasin is Instream Habitat.

However, comparing recommendation categories in the subbasin by number of tributaries can be confounded by the differences in the length of survey for each tributary. Therefore, the number of stream miles within the subbasin assigned to various recommendation categories was calculated (Figure 41). By examining recommendation categories by number of stream miles, the most important target issue was Erosion/Sediment, though Instream Habitat also remained an important target issue. Because of the high number of recommendations dealing with these target issues, high priority should be given to restoration projects that emphasize sediment reduction as well as increasing pools, and cover.

Table 25. Top three ranking recommendation categories by number of tributaries in the Salt River Subbasin.

Target Issue	Related Table Categories	Count
Erosion / Sediment	Bank / Roads	3
Riparian / Water Temp	Canopy / Temp	1
Instream Habitat	Pool / Cover	5
Gravel / Substrate	Spawning Gravel / LDA	0
Other	Livestock / Barrier	1

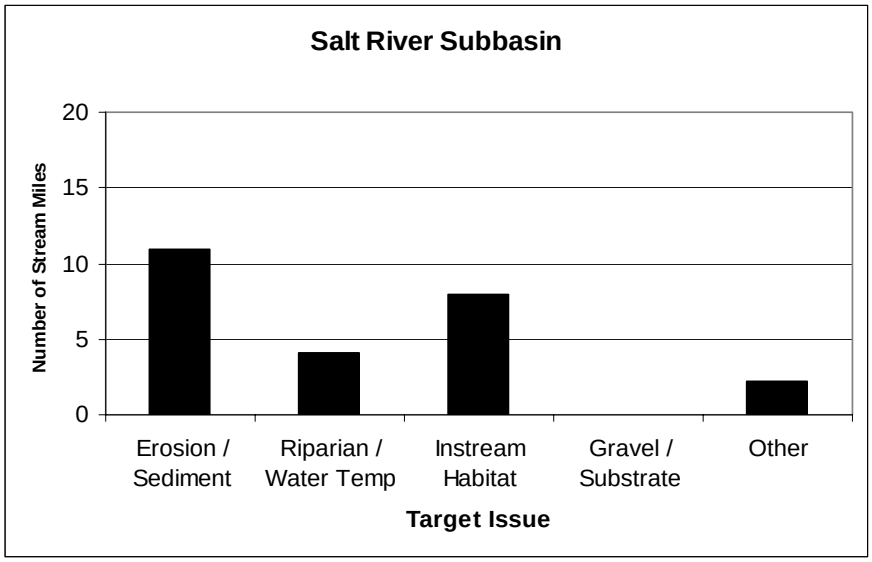

Figure 41. Recommendation target issues by stream miles for the Salt River Subbasin.

Refugia Areas

The interdisciplinary team identified and characterized refugia habitat in the Salt River Subbasin by using professional judgment and criteria developed for north coast watersheds. The criteria included measures of watershed and stream ecosystem processes, the presence and status of fishery resources, forestry and other land uses, land ownership, potential risk from sediment delivery, water quality, and other factors that may affect refugia productivity. The team also used results from information processed by the EMDS at the stream reach scale.

The most complete data available in the Salt River Subbasin were for tributaries surveyed by CDFG. However, many of these tributaries were still lacking data for some factors considered. Salmonid habitat conditions in the Salt River Subbasin on surveyed streams are generally rated as low quality. Francis Creek provides the best salmonid habitat in this subbasin, while the other surveyed tributaries provide low quality refugia. The following refugia area rating table summarizes subbasin salmonid refugia conditions.

Table 26. Tributary salmonid refugia area ratings in the Salt River Subbasin

Stream	Refugia Categories				Other Categories		
	High Quality	High Potential	Medium Potential	Low Quality	Non-Anadromous	Critical Contributing Area	Data Limited
Russ Creek				X			X
Reas Creek				X			X
Francis Creek			X				X
Williams Creek				X			X

Issues and Responses to Assessment Questions

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).

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 (together with the Middle Subbasin 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?

Findings and Conclusions:

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?

Finding and conclusions?

- 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?

Findings and conclusions?

- 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?

Findings and conclusions?

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?

Recommendation

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.