Erosion and Fine Sediment

Stream bank erosion contribute cobble and gravel to the channels which are important components in spawning substrate. Accumulation of instream fine sediment indicates a decrease of available spawning substrate. Roads, other land use activities, and naturally occurring background geologic disturbances contribute fine sediment

The Outlet Creek Basin is on a list of water bodies for impairment or threat of impairment by sediments as required by section 303 (d) of the Clean Water Act. The 303(d) list describes water bodies that do not fully support all beneficial uses or are not meeting water quality objectives, and pollutants for each water body that impairs water quality. Because of the listing of the Outlet Creek Basin, the US EPA has developed numeric targets for sediment and established sediment allocations expressed as a total maximum daily load (TDML) in tons of sediment per square mile per year. At the time of the listing, sediment was judged to be affecting cold water fishery and associated beneficial uses as described in the US EPA (2004). Nearly all aspects of the cold water fishery are affected by sediment pollution, including migration, reproduction and spawning, and early development of cold water fish such as coho and Chinook salmon, and steelhead trout.

Stream banks

The stream banks in most of the streams surveyed are composed of sand/silt/clay and contribute fine sediment into the channel. (Figure X Average composition of stream banks of the streams surveyed in the Southern Subbasin). Fine sediment sources from this Subbasin are contributing large amounts of fine sediment which are pulsing through into Middle and Northern Subbasin, and the Eel river system.

The stream bank composition of Baechtel Broaddus, Haehl, and Willits are dominated by silt/sand/clay. The stream bank composition of the Southern Subbasin may supply fine sediment from eroding stream banks, which maybe increasing the embeddedness levels on these streams

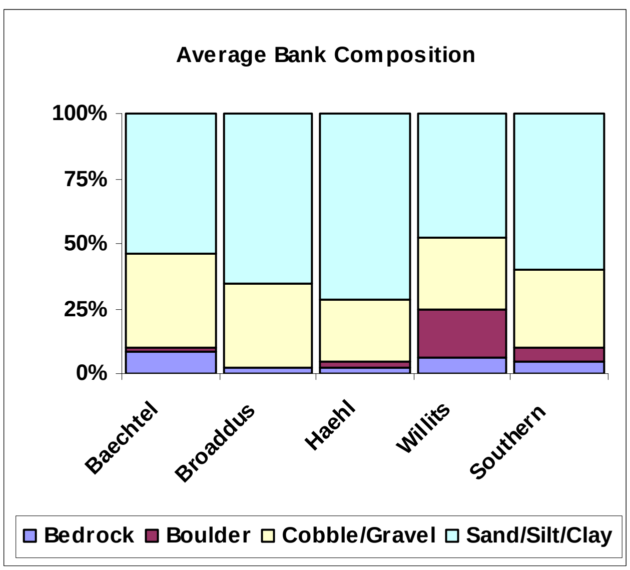

Figure X. Average composition of stream banks in the Southern Subbasin.

Embeddedness

The target values for embeddedness are to have 50% or more of the surveyed pool tail outs to be 50% or less embedded in fine sediment (sand, silt or clay) (Flosi et al 1998).

Fine sediment load is another important aspect of water quality. Salmonids cannot successfully reproduce when forced to spawn in cobble-gravel substrate embedded by excessive fine sediment. Eggs and embryos suffocate under excessive fine sediment conditions because oxygenated water is prevented from passing through the egg nest, or redd. Additionally, high fine sediment loads can cap the redd and prevent emergent fry from escaping the gravel into the stream at the end of incubation. High fine sediment loads can also cause abrasions on fish gills, which may increase susceptibility to infection. At extreme levels, fine sediment can clog the gills causing death. Additionally, materials toxic to salmonids can cling to sediment and be transported through downstream areas.

High embeddedness values indicate high fine sediment accumulation in the pool tail area where salmonids spawn, eggs mature, and fry emerge. High embeddedness values and fine sediment accumulation indicates a lack of suitable spawning areas and low rates of egg survival to fry emergence. Cobble embeddedness is the percentage of an average sized cobble at a pool tail out embedded in fine sediment. Category 1 is 0-25% embedded, category 2 is 26-50% embedded, category 3 is 51-75% embedded, and category 4 76-100% embedded. Category 1 is best, category 2 is supportive and categories 3 and 4 are unsuitable for successful spawning or incubation of salmonids.

In 1995 and 2004, the Southern Subbasin did not meet embeddedness target values. In 1995 and 2004, 65% and 75% of the pool tail outs in the Southern Subbasin were 51% or more embedded, respectively. The amount of quality spawning substrate available appears to have decreased between 1995 and 2004. However, in 1995, the embeddedness values were averaged for all of the streams surveyed in the subbasin, whereas in 2004, 24 random sites were surveyed throughout the Subbasin.

In 1995 and 2004, Baechtel Creek had 80% and 72% of the pool tail outs with an embeddedness of 51% or more, respectively. In 1995, Baechtel had 4% in category 1 and 8% recorded in 2004. Suitable substrate appears to have increased in Baechtel Creek indicating that spawning conditions have increased between 1995 and 2004.

In 1995 and 2004, Broaddus Creek had 49 % and 87 % of the pool tail outs 51% or more embedded, respectively. In 1995, Broaddus creek had 33 % in category 1 where none was recorded in 2004. Suitable substrate appears to have decreased in Broaddus Creek indicating that spawning conditions have decreased between 1995 and 2004.

In 1995 and 2004, Willits Creek had 70% and 76% of the pool tail outs 51% or more embedded, respectively. In 1995 Willits creek had 8% in category 1 and 3 % recorded in 2004. Suitable substrate appears to have decreased in Willits Creek indicating that spawning conditions have decreased between 1995 and 2004.

Davis, Mill and Berry creeks were not surveyed in 1995 and Haehl Creek was not surveyed in 2004. Data show that some quality spawning substrate is available on Haehl and Mill creeks. Berry Creek appears to provide unsuitable spawning substrate on the site surveyed in 2004. Davis Creek appears to provide unsuitable spawning substrate on the sites surveyed in 2004 (Figure X and Y. Embeddedness in Pool Tails of Southern Subbasin 1995 and 2004).

Overall, embeddedness values have increased and available spawning substrate has decreased between 1995 and 2004 in the Subbasin and in streams surveyed except Baechtel Creek. High embeddedness values are likely limiting the health and production of salmonids in the Southern Subbasin.

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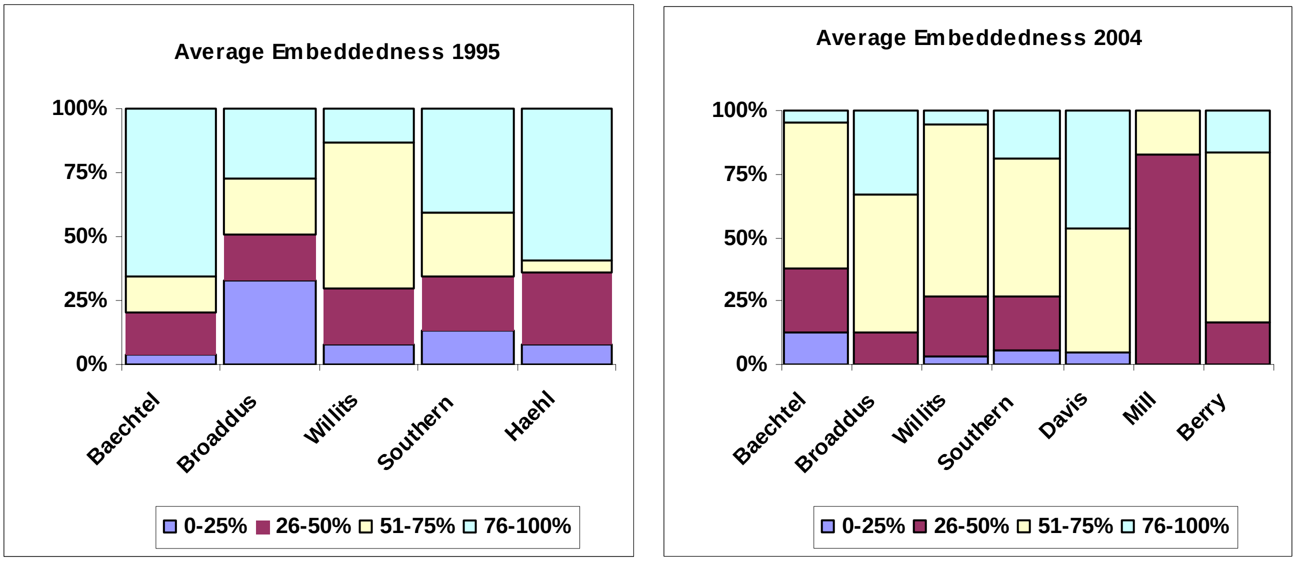


Figure X and Y. Embeddedness in Pool Tails of Southern Subbasin in 1995 and 2004.

Riparian

The target value for canopy density is to have 80% or more of the stream channel covered by coniferous or deciduous canopy (Flosi et al 1998)

A functional riparian zone helps to control the amount of sunlight reaching the stream, provides vegetative litter, and contributes invertebrates to the local salmonid diet. 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).

Riparian zone functions are important to anadromous salmonids for numerous reasons. Riparian vegetation helps keep stream temperatures in the range that is suitable for salmonids by maintaining cool stream temperatures in the summer and insulating streams from heat loss in the winter. Larval and adult macro-invertebrates are important to the salmonid diet and are dependent upon nutrient contributions from the riparian zone. Additionally, stream bank cohesion and maintenance of undercut banks provided by riparian zones in good condition maintain diverse salmonid habitat, and help reduce bank failure and fine sediment yield to the stream. Lastly, the large woody debris provided by riparian zones shapes channel morphology, helps retain organic matter and provides essential cover for salmonids (Murphy and Meehan 1991).

In 1995, the Southern Subbasin had an overall canopy density of 84%, which did meet canopy density values of 80%. In 2004, the Southern Subbasin had an overall canopy density of 60%, which does not meet target values. The canopy density appears to have decreased, with both the deciduous and coniferous components decreasing, between 1995 and 2004. However in 1995, the canopy density measurements were averaged for all of the streams surveyed in the Subbasin whereas in 2004, 24 random sites were surveyed throughout the Subbasin.

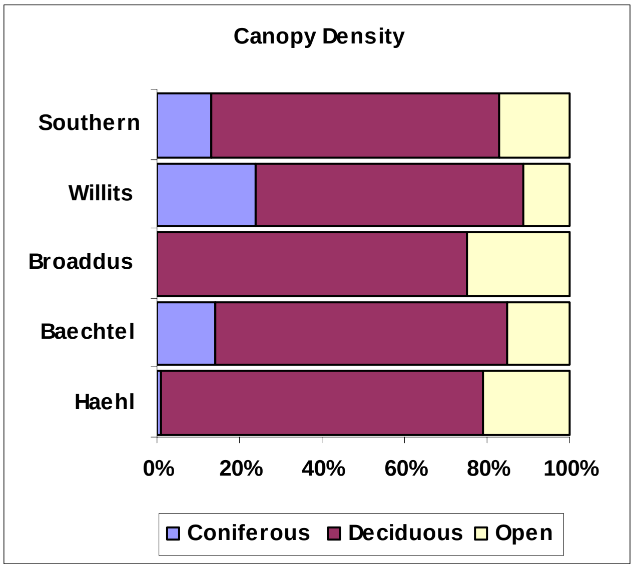
In 1995, Baechtel Creek did meet canopy density target values. In 2004, Baechtel Creek did not meet density target values. Between 1995 and 2004, the percentage of coniferous canopy did not change, while the percentage of deciduous canopy decreased. It appears that the riparian habitat of Baechtel Creek has significantly declined since 1995.

In 1995 and 2004, Broaddus Creek did not meet canopy density target values. Between 1995 and 2004, the percentage of deciduous canopy significantly decreased, while percentage of coniferous canopy increased slightly. It appears that the riparian habitat of Broaddus Creek has declined since 1995.

In 1995, Willits Creek did meet canopy density target values. In 2004, Willits Creek almost met the canopy density target values. Between 1995 and 2004, the percentage of coniferous canopy increased. It appears that the riparian habitat of Willits Creek has declined since 1995.

Davis, Mill and Berry creeks not surveyed in 1995 and Haehl Creek was not surveyed in 2004. Data show that canopy density target values were met on Mill and Berry creeks. Davis and Haehl creeks did not meet the density target values (Figure X and Y. Canopy Density and Vegetation Type of the Southern Subbasin in 1995 and 2004).

Overall, canopy densities values have decreased and open areas have increased between 1995 and 2004 in the Subbasin and all of the streams surveyed except Baechtel Creek. Low canopy density values are likely contributing to high water temperatures which are limiting the health and population of salmonids in the Southern Subbasin.



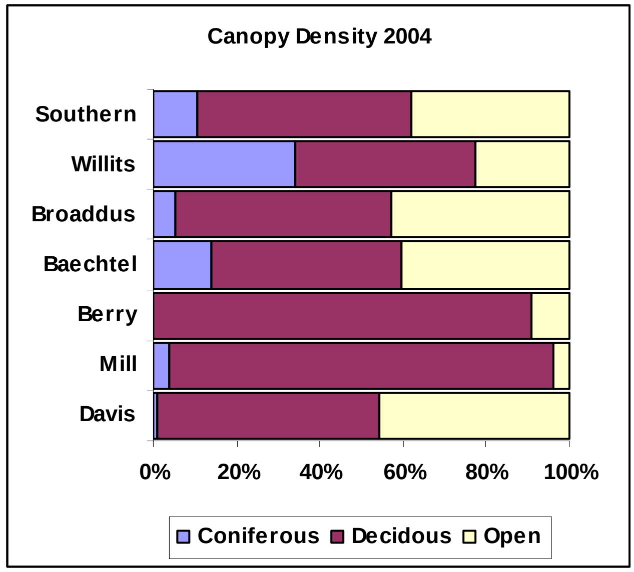


Figure X and Y. Canopy Density and Vegetation Type of the Southern Subbasin in 1995 and 2004.

Ecological Management Decision Support (EMDS) Canopy Density Conditions

The anadromous Subbasin EMDS evaluates the condition of the canopy density. EMDS calculations and conclusions are pertinent only to surveyed streams in 1995 and GRTS sites in 2004 and are based on conditions present at the time surveyed. EMDS scores were weighted by survey length to obtain overall scores for the streams and survey sites.

In 1995 and 2004, the overall canopy density condition in the Southern Subbasin was moderately and somewhat suitable, respectively. In 1995, lower Davis Creek was fully suitable; however it had one area that was moderately suitable. In 1995, Baechtel and Broaddus creeks showed moderate to somewhat suitable canopy density. In 2004, 24 sites were surveyed, which included 7 sites in Davis, 6 sites in Willits, 5 sites in Broaddus, 3 sites in Baechtel, 2 sites in Berry, and 1 site in Mill creeks. 2004, out of six sites in Willits Creek, one site each was moderately suitable and unsuitable, and four sites surveyed were fully suitable. Overall, the canopy density was moderately suitable in Willits Creek. In 2004, one of five sites in Broaddus was somewhat unsuitable, and four sites surveyed were fully suitable. Overall, the canopy density was suitable in Broaddus Creek. In 2004, one of three sites in Baechtel was fully unsuitable and one site each was fully and somewhat suitable. Overall, the canopy density was somewhat suitable in Baechtel Creek. In 2004, two of the two sites in Berry creek were fully suitable. Overall, the canopy density was suitable in Berry Creek. In 2004, the site surveyed in Mill creek was fully suitable. Overall, the canopy density was suitable in Mill creek. In 2004, two out of seven sites in Davis Creek were fully unsuitable, one site was somewhat unsuitable, one site was moderately unsuitable, two sites were moderately suitable, and one site was fully suitable. Overall, the canopy density was somewhat suitable in

Davis creek. In Davis, Mill and Berry creeks were not surveyed in 1995 and Haehl Creek was not surveyed in 2004. (Figure X and Y. EMDS Canopy Density Suitability in the Southern Subbasin in 1995 and 2004).

The EMDS results show that canopy density in some areas in the subbasin have improved and recovered between 1995 and 2004. Restoration efforts focused on improving canopy should be located in areas with unsuitable EMDS ratings.

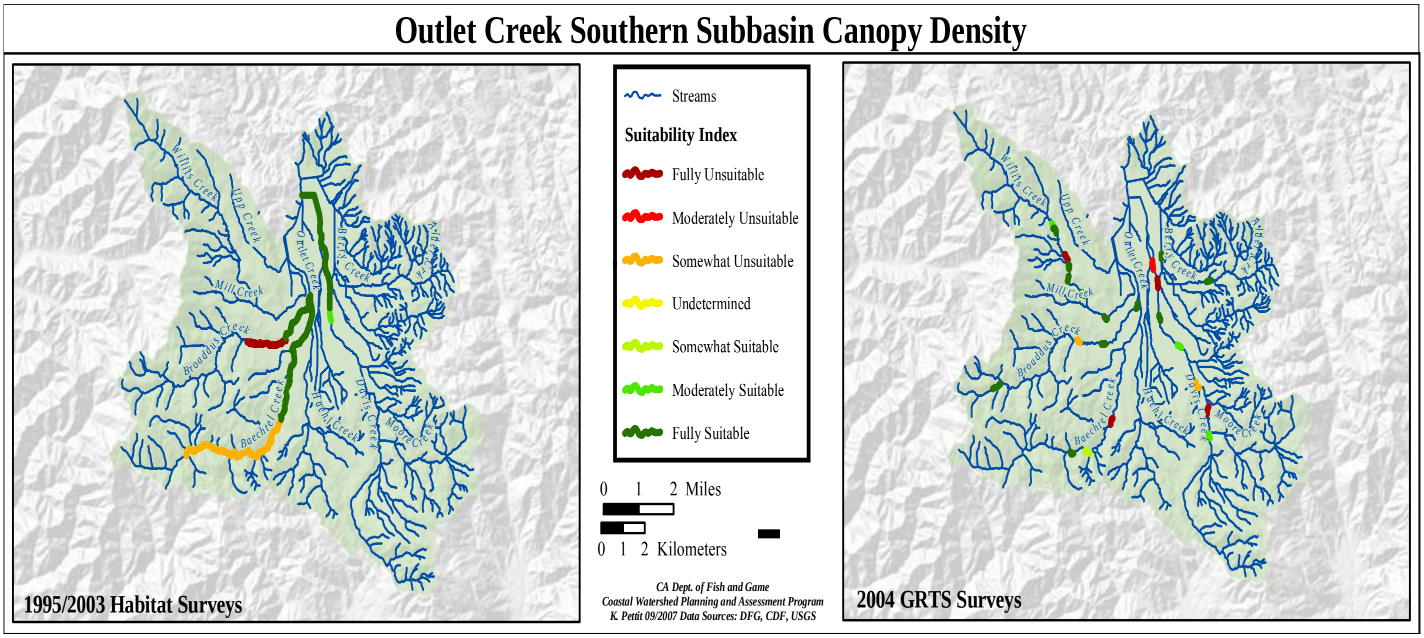


Figure X and Y. EMDS Canopy Density Suitability in the Southern Subbasin in 1995 and 2004.

Habitat Categories

Streams with adequate amounts of flatwater, pools and riffles contribute to the health and productivity of juvenile salmonids (Flosi et al 1998).

Habitat diversity for salmonids is created by a combination of deep pools, riffles, and flatwater habitat types. Pools, and to some degree flatwater habitats, provide escape cover from high velocity flows, hiding areas from predators, and ambush sites for taking prey. Pools are also important juvenile rearing areas, particularly for young coho salmon. They are also necessary for adult resting areas. A high level of fine sediment fills pools and flatwater habitats. This reduces depths and can bury complex niches created by large substrate and woody debris. Riffles provide clean spawning gravels and oxygenate water as it tumbles across them. Steelhead fry use riffles during rearing. Flatwater areas often provide spatially divided pocket water units (Flosi et al. 1998) that separate individual juveniles, which helps promote reduced competition and successful foraging.

Between 1995 and 2004, the habitat ratio changed slightly. In 2004, the Southern Subbasin had significantly less flatwater and riffle habitat, with occurrence of dry units. However, in 1995, the habitat category measurements were averaged for the entire stream surveyed in the Subbasin whereas in 2004, 24 random sites were surveyed throughout the Subbasin. In 2004, the dry habitat units were underestimated.

Between 1995 and 2004, the pool habitat increased, while flatwater decreased and riffle habitats remained unchanged in Baechtel creek. Between 1995 and 2004 dry habitat has increased. Increased pool habitat may be indicative of sediment moving downstream, reduced legal and illegal dewatering, and or positive impacts from restoration projects. However legal and illegal dewatering was actively occurring during the 2004 data collection period. It appears that the juvenile salmonid summer rearing habitat has increased since 1995.

Between 1995 and 2004, the pool habitat increased, and flatwater and riffle habitat remained unchanged in Broaddus creek. Between 1995 and 2004 dry habitat has increased. Increased pool habitat may be indicative of sediment moving downstream, reduced legal and illegal dewatering, and or positive impacts from restoration projects. It appears that the juvenile salmonid summer rearing habitat has increased since 1995.

Between 1995 and 2004, pool habitat increased, and flatwater and riffle habitat slightly decreased in Willits Creek. Increased pool habitat may be indicative of sediment moving downstream, reduced legal and illegal dewatering, and or positive impacts from restoration projects. It appears that the juvenile salmonid summer rearing habitat has increased since 1995.

Davis, Mill and Berry creeks were not surveyed in 1995 and Haehl Creek was not surveyed in 2004. Legal and illegal dewatering was actively occurring during the 2004 data collection period. The data shows the target ratio of riffle, flatwater and pool habitat were within suitable ranges on Davis, Haehl, Mill and Berry creeks (Figure X and Y. Habitat Categories in the Southern Subbasin and its streams surveyed in 1995 and 2004).

Overall, since 1995 the habitat categories ratios have become more adequate in the Southern Subbasin of Outlet Creek. The pool habitat on Baechtel, Broaddus and Willits creeks have increased indicating that over summer conditions for juvenile salmonids may have improved. Habitat category ratios appear suitable and are not likely limiting the health and production of salmonids in the Southern Subbasin.

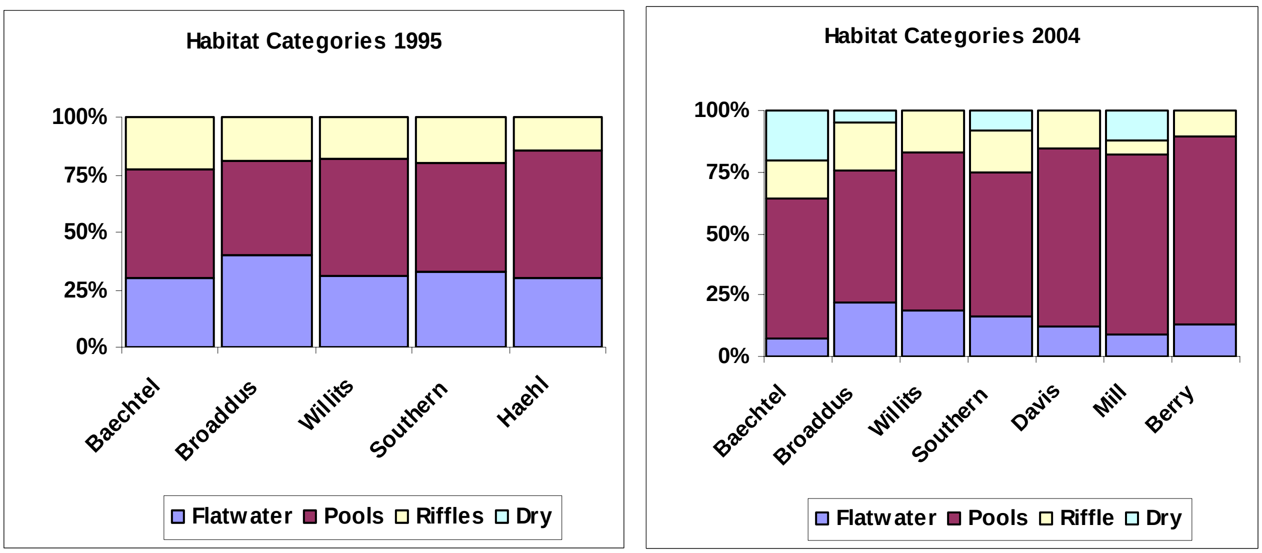


***Figure X and Y. Habitat Categories in the Southern Subbasin and its streams surveyed in 1995 and 2004*.**

Pool Habitat and Shelter

More frequent and deeper pools are associated with higher stream order. Target values are related to stream order and pool depth in that 1st and 2nd order streams require 40% of the pools to be 2 feet deep and deeper and 3rd order streams require 40% of the pools to be 3 feet deep and deeper. Pool shelter values of 80 are desirable. Large Woody Debris provides escape cover from predators (Flosi et al 1998).

In 1995 and 2004, most of the pools surveyed in the Southern Subbasin were 1-2 feet deep. Between 1995 and 2004, the frequency of pools 2 feet and deeper decreased and pools 4 feet and deeper became uncommon. However, in 1995, the pool habitat measurements were averaged for all of the streams surveyed in the subbasin, whereas in 2004, 24 random sites were surveyed throughout the subbasin.

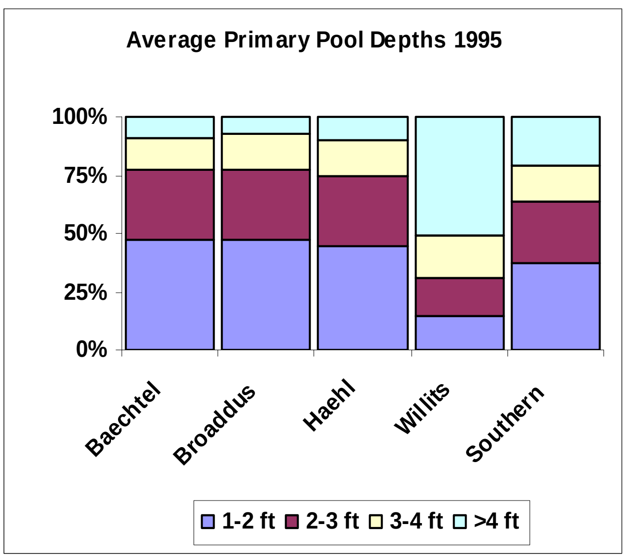
In 1995, most of the pools surveyed in Baechtel Creek were over 2 feet in depth, a second order stream. In 2004, pools 1-2 feet in depth were dominant. The pool frequency and pool depths in Baechtel Creek met target values in 1995, but not in 2004. The frequency of pools 2 feet or greater appear to have decreased significantly. The pool habitat was unsuitable to juvenile salmonids due to poor water quality and high temperature in the lower reaches and there were several illegal dewatering sites in the upper reach accessed by Muir Mill Road, which created subsurface conditions.

In 1995, half of the pools surveyed in Broaddus Creek were 1-2 feet in depth, a first order stream. In 2004, most of the pools were 2-3 feet in depth. Pool depths appear to have increased since 1995. The pool frequencies and pool depth in Broaddus creek met target values in 1995 and 2004. .

In 1995, most of the pools surveyed in Willits Creek were 4 feet and over in depth, a first order stream. In 2004, pools 1-2 feet in depth were dominant. Pool depths appear to have decreased significantly since 1995. The pool frequencies and pool depth in Willits creek did not meet target values in 2004.

Davis, Mill and Berry creeks were not surveyed in 1995 and Haehl Creek was not surveyed in 2004. Legal and illegal dewatering was actively occurring on all four creeks during the 2004 data collection period. In 1995, pool frequency and pool depth target values were met for Haehl creek, an intermittent stream. In 2004, pool frequency and pool depth target values were met for Mill, a 1st order stream, and Berry creeks while Davis Creek, a 2nd order stream, did not meet target values. Haehl and Berry creeks dry up while sections of Davis and Mill creeks dry up in the late summer and early fall, thus providing little additional juvenile summer habitat (Figure X and Y. Primary pool depths of stream surveyed in the Southern Subbasin in 1995 and 2004).

Overall, since 1995 the pool frequency and depth has decreased significantly in the Southern Subbasin. In addition, the pool suitability does not incorporate water quality data. Pool conditions declined on Willits and Baechtel while small improvement may have occurred on Broaddus Creek between 1995 and 2004. Davis and Mill creeks provide some suitable habitat while Haehl and Berry likely do not. Pool frequency and depth are somewhat unsuitable and limiting the production and health of salmonids in the Southern Subbasin.



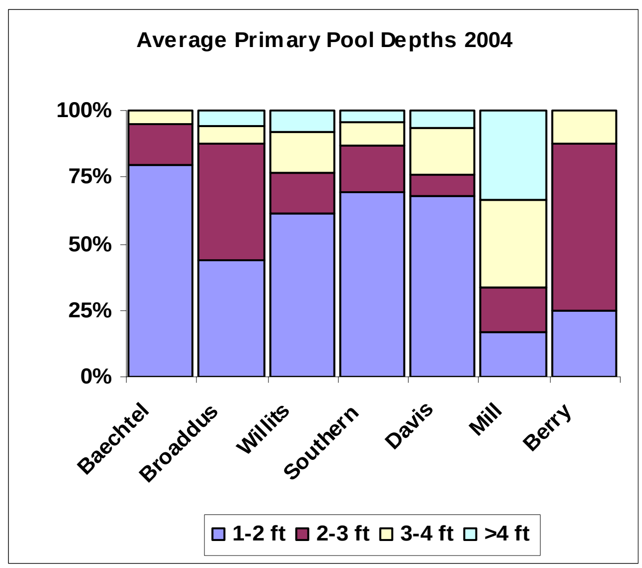


Figure X and Y. Primary pool depths of stream surveyed in the Southern Subbasin in 1995 and 2004.

Ecological Management Decision Support (EMDS) Pool Depth Conditions.

The anadromous Subbasin EMDS evaluates the condition of the pool depth. EMDS calculations and conclusions are pertinent only to surveyed streams in 1995 and GRTS sites in 2004 and are based on conditions present at the time surveyed. EMDS scores were weighted by survey length to obtain overall scores for the streams and survey sites.

In 1995 and 2004, the overall conditions of pool depths in the Southern Subbasin were somewhat unsuitable. In 1995, Baechtel and Broaddus were fully unsuitable. In 2004, 24 sites were surveyed in this subbasin which included 7 sites in Davis creek, 6 sites in Willits creek, 5 sites in Broaddus creek, 3 sites in Baechtel creek, 2 sites in Berry creek and 1 site in Mill creek. Out of seven sites in Davis Creek, two were fully unsuitable, one of the sites was moderately unsuitable, and four sites were fully suitable. Out of six sites in Willits Creek one site each was fully and moderately unsuitable, and three sites were fully suitable with one undetermined. Out of the five sites in Broaddus Creek, two of the sites were fully unsuitable, one was somewhat unsuitable and two were fully unsuitable. All three sites surveyed in Baechtel creek were fully unsuitable. Out of two sites in Berry Creek, one was moderately suitable and the other was fully unsuitable. Mill Creek was fully unsuitable. Davis, Mill and Berry creeks not surveyed in 1995 and Haehl Creek was not surveyed in 2004 (Figure X and Y. EMDS Pool Depth Suitability in the Southern Subbasin in 1995 and 2004).

The EMDS results show that pool depths in the subbasin have not improved or recovered between 1995 and 2004. Major restoration efforts focused on improving pool depth and be located in areas with unsuitable EMDS ratings.

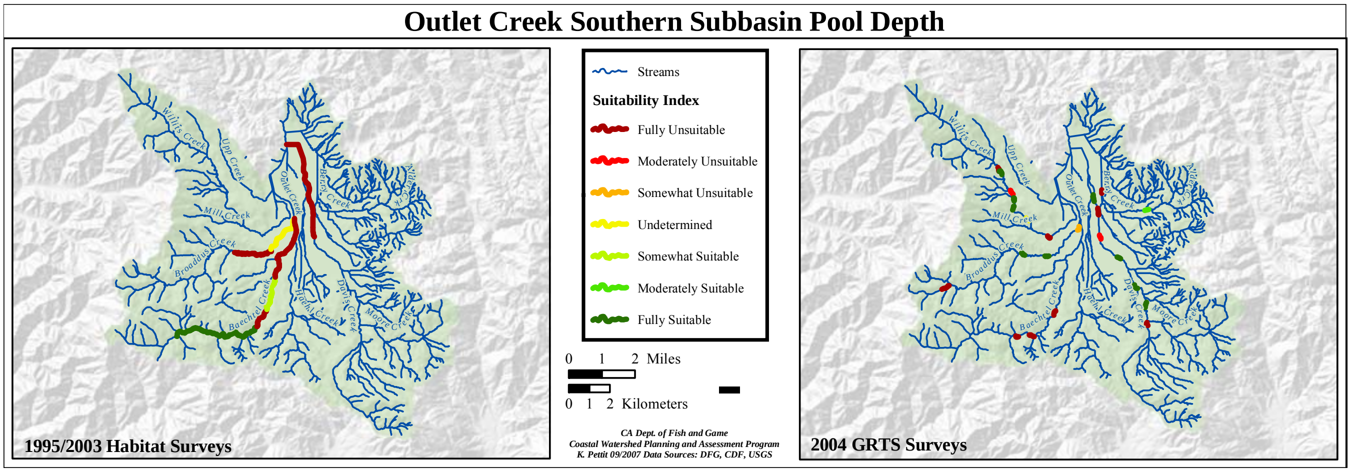
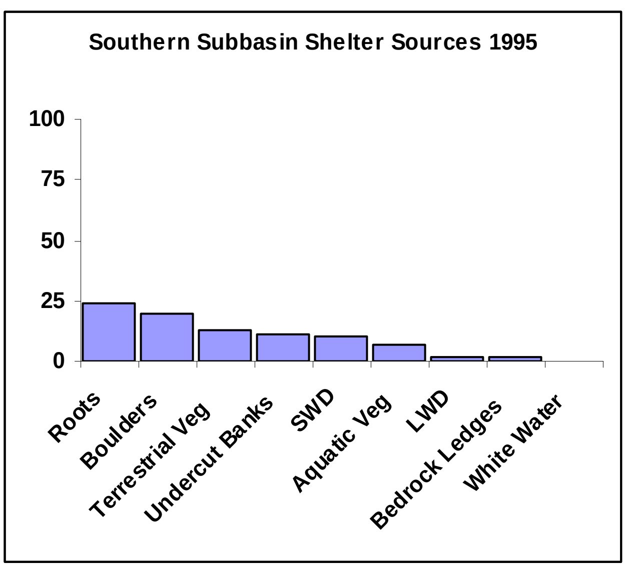


Figure X and Y. EMDS Pool Depth Suitability in the Southern Subbasin in 1995 and 2004.

In 1995, the dominant sources of pool shelter were provided by boulders and roots in the Southern Subbasin. In 2004, the dominant sources of pool shelter were provided by terrestrial vegetation and boulders. Undercut banks, small woody debris, aquatic vegetation and large woody debris were present during both surveys. An increase in undercut banks was observed from 1995 to 2004. However, in 1995, the pool shelter measurements were averaged for all of the streams surveyed in the Subbasin, whereas in 2004, 24 random sites were surveyed throughout the subbasin**.** The lack of instream Large Woody Debris (LWD) is likely caused by the legacy effect of timber harvest of conifers in the riparian zone and later construction of levees (Figure X and Y. Average frequency and source of pool shelter in the Southern Subbasin in 1995 and 2004).



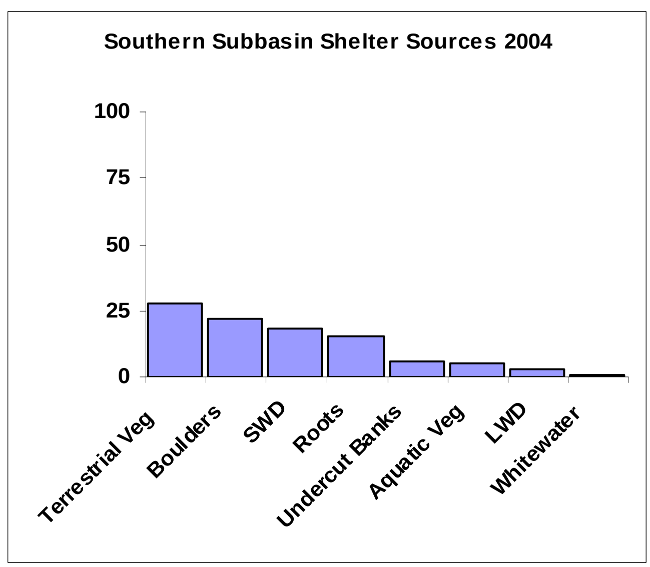


Figure X and Y. Average frequency and source of pool shelter in the Southern Subbasin 1995 and 2004.

In both 1995 and 2004, the measured sources of pool shelter included boulders, terrestrial and aquatic vegetation, bedrock ledges, small and large woody debris, roots, undercut banks and whitewater. Due to the restoration planning focus of this assessment, only restorable types such as roots, boulders, terrestrial vegetation, and small and large woody debris were included in the below figures so that we could identify both the composition and dominate sources.

In both 1995 and 2004, roots, boulders, and terrestrial vegetation were the dominant pool shelter in the Southern Subbasin. The shelter values for the streams surveyed in both 1995 and 2004 were 24 and 35, respectively. The target values were not met in this subbasin during either of the years surveyed. This subbasin is lacking LWD and root wads, thus pool shelter composition could be greatly enhanced by adding these two types rather than boulders.

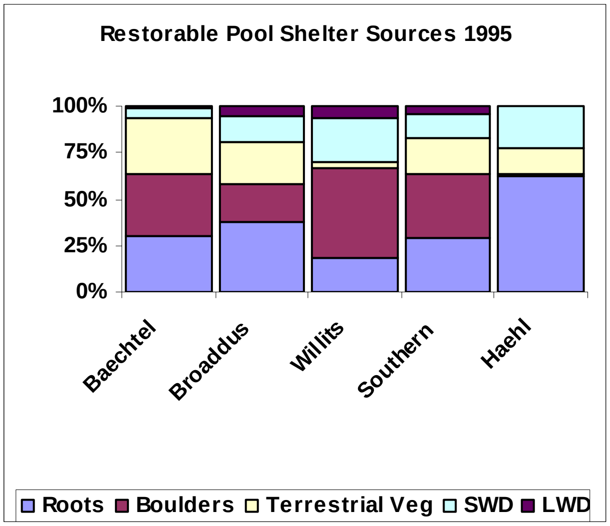
In 1995 and 2004, boulders dominated the pool shelter of Baechtel creek. Additional shelter was composed of SWD, terrestrial vegetation, and roots. The shelter values in 1995 and 2004 were 6 and 28, respectively. The target values were not met during any of the years surveyed. Baechtel creek is lacking root wads and LWD, thus pool shelter composition could be greatly enhanced by adding these shelter types.

In 1995, roots dominated the pool shelter of Broaddus creek. In 2004, small woody debris dominated the pool shelter of Broaddus creek. The shelter values in 1995 and 2004 were 15 and 35, respectively. The target values were not met during any of the years surveyed. Broaddus creek is lacking boulders and LWD, thus pool shelter composition could be greatly enhanced by adding these shelter types.

In 1995 and 2004, boulders dominated the pool shelter of Willits creek. In 2004, terrestrial vegetation values increased. The shelter values in 1995 and 2004 were 42 and 30, respectively. The target values were not met during any of the years surveyed. Willits creek is lacking boulders and LWD, thus pool shelter composition could be greatly enhanced by adding these shelter types.

Davis, Mill and Berry creeks were not surveyed in 1995 and Haehl Creek was not surveyed in 2004. In 1995, the shelter value for Haehl creek was 16 and the dominant shelter type was roots. In 2004, Mill and Berry creeks had target values of 32 and 35, with dominant shelter types of roots and terrestrial vegetation, respectively. Davis had a shelter value of 40. Mill, Berry, Davis and Haehl creeks are lacking boulders and LWD, and therefore could greatly be enhanced by adding these shelter types (Figure X and Y. Restorable pools shelter sources in the Southern Subbasin in 1995 and 2004).

Overall, since 1995, although the target values were not met, the pool shelter has slightly improved in the Southern Subbasin. Overall the amount of LWD has been low in the Southern Subbasin in 1995 and 2004. This may be indicative of recovery of the riparian from legacy timber removal prior to the adoption of the Forest Practice Rules. However, pool shelter is still unsuitable and limiting the health and production of salmonids in the Southern Subbasin



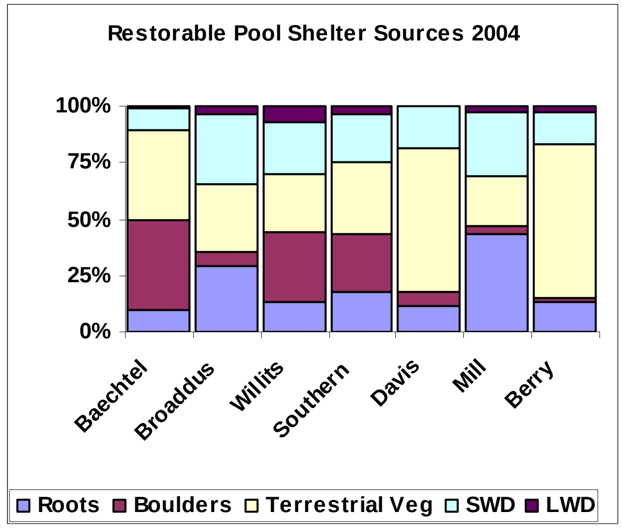


Figure X and Y. Restorable pools shelter sources in the Southern Subbasin in 1995 and 2004.

Ecological Management Decision Support (EMDS) Pool Shelter Conditions.

The anadromous subbasin EMDS evaluates the condition of the pool shelter. EMDS calculations and conclusions are pertinent only to surveyed streams in 1995 and GRTS sites in 2004 and are based on conditions present at the time surveyed. EMDS scores were weighted by survey length to obtain overall scores for the streams and survey sites.

In 1995 and 2004, the overall pool shelter conditions in the Southern Subbasin were moderately unsuitable. In 1995, Davis Creek was moderately unsuitable. In 1995 Baechtel and Broaddus creeks showed moderately unsuitable pool shelter conditions in the majority of the stream surveyed. In 2004, 24 sites were surveyed in this subbasin which included 7 sites in Davis Creek, 6 sites in Willits Creek, 5 sites in Broaddus Creek, 3 sites in Baechtel Creek, 2 sites in Berry Creek and 1 site in Mill Creek. 21 of the 24 sites were moderately unsuitable to fully unsuitable, while the remaining three sites were somewhat unsuitable. Davis, Mill and Berry creeks not surveyed in 1995 and Haehl Creek was not surveyed in 2004. (Figure X and Y. EMDS for Pool Shelter Suitability in the Southern Suitability in 1995 and 2004.)

The EMDS results show that the pool shelter conditions in the Southern Subbasin have remained unchanged between 1995 and 2004. Most restoration efforts should be focused on improving pool shelter on the Southern Subbasin.

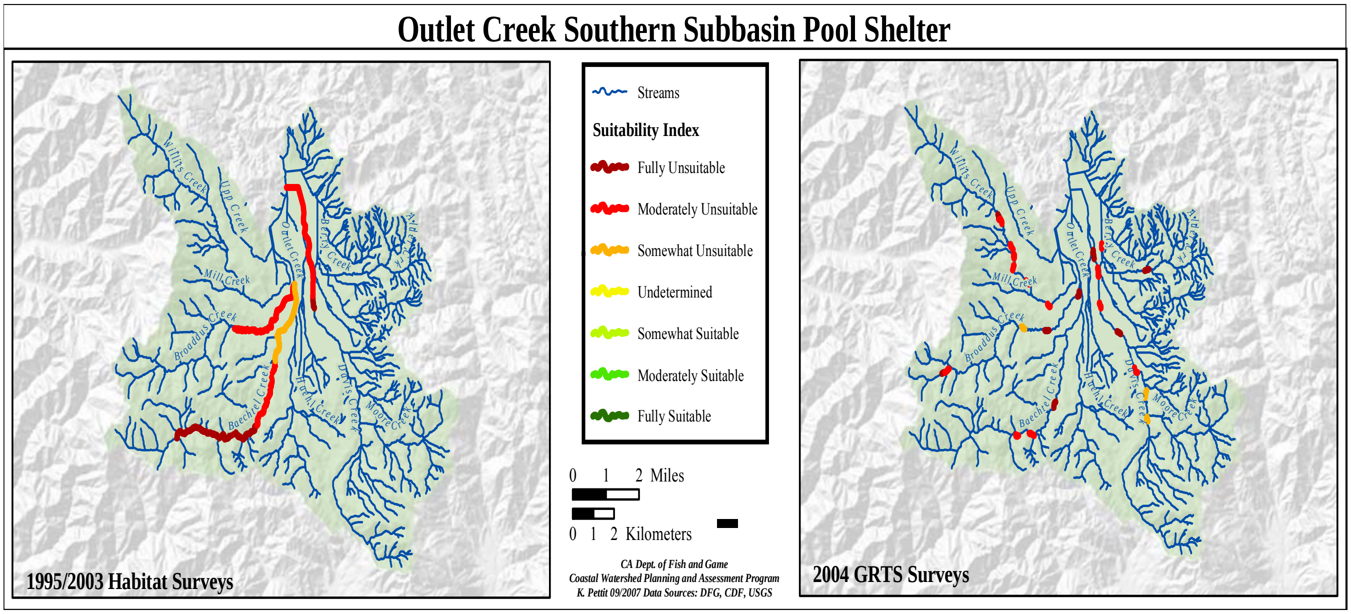


Figure X and Y. EMDS Pool Shelter Suitability in the Southern Suitability in 1995 and 2004.

Ecological Management Decision Support (EMDS) Reach Conditions

The anadromous Subbasin EMDS evaluates the condition of the reach conditions. EMDS calculations and conclusions are pertinent only to surveyed streams in 1995 and GRTS sites in 2004 and are based on conditions present at the time surveyed. EMDS scores were weighted by survey length to obtain overall scores for the streams and survey sites.

In 1995 and 2004, the overall reach conditions in the Southern Subbasin were somewhat unsuitable, while in 1995, a small section of Baechtel Creek was undetermined. In 1995, Davis Creek was moderately unsuitable. In 1995 Baechtel and Broaddus creeks showed somewhat unsuitable reach conditions in the majority of the stream surveyed. In 2004, 24 sites were surveyed in this subbasin which included 7 sites in Davis Creek, 6 sites in Willits Creek, 5 sites in Broaddus Creek, 3 sites in Baechtel Creek, 2 sites in Berry Creek and 1 site in Mill Creek. Twenty one out of the 24 sites were somewhat unsuitable, while the remaining three were somewhat suitable. Davis, Mill and Berry creeks not surveyed in 1995 and Haehl Creek was not surveyed in 2004. (Figure X and Y. EMDS Reach Condition Suitability in the Southern Subbasin in 1995 and 2004)

The EMDS results show that the reach conditions in the subbasin are unchanged between 1995 and 2004. Restoration efforts should be a high priority to improve conditions for juvenile salmonids, especially in Baechtel Creek due to the coho in the Southern Subbasin. Projects which focus on increasing pool depth while increasing pool shelter should be highest priority. The introduction of LWD, anchored or not, would scour substrate thus deepening pools while simultaneously increasing shelter cover. These sorts of projects are the highest priority in the Southern Subbasin.

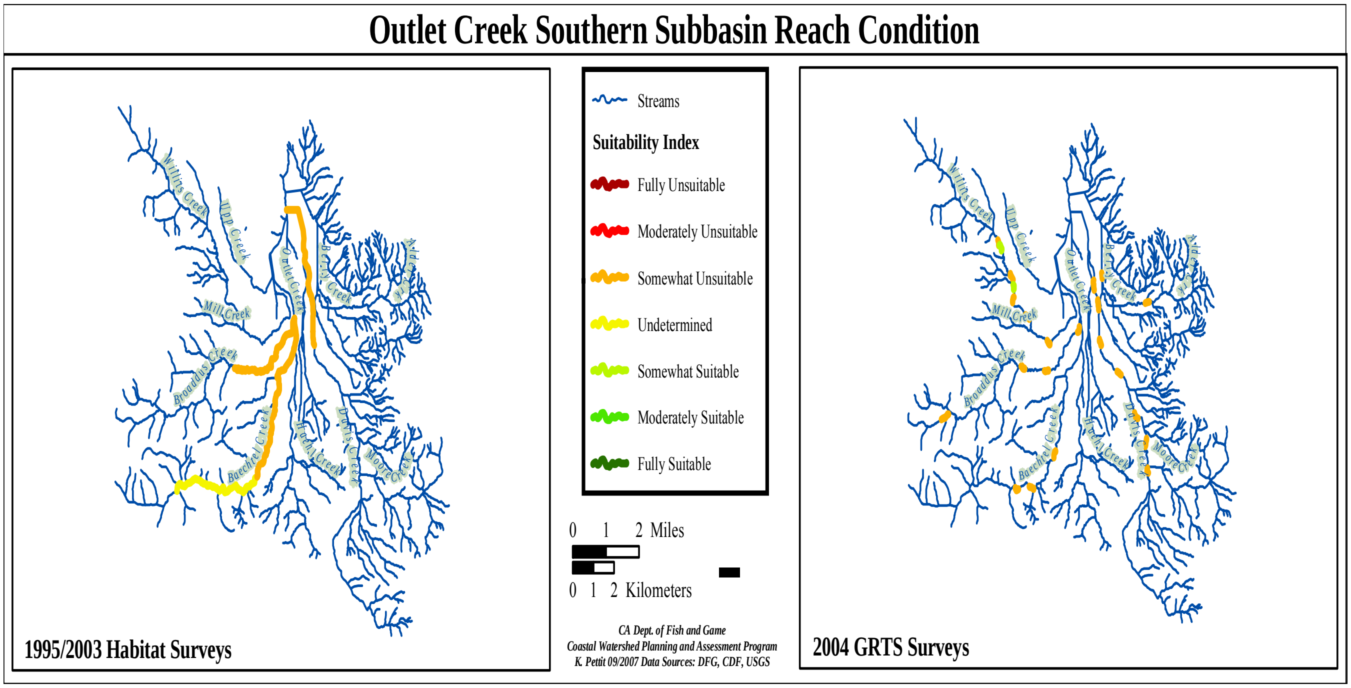


Figure X and Y. EMDS Reach Condition Suitability in the Southern Subbasin in 1995 and 2004.

Fish Passage Barriers

Free passage describes the absence of barriers to the free instream movement of adult and juvenile salmonids. Free movement in 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 adults. Temporary or permanent dams, poorly constructed road crossings, landslides, debris jams, or other natural and/or man-caused channel disturbances can disrupt.

There are a total of 14 barriers blocking 16 miles of stream, 5 complete and 9 partial barriers, plus 2 of unknown status in the Southern Subbasin. Dams are not included in this section. One partial and 1 unknown barriers on Baechtel Creek. One complete and five partial barriers on Broaddus Creek. One partial barrier and one unknown on Willits Creek. One each complete, partial and unknown barriers on Haehl Creeks One partial on Conklin Creek. One complete on Upp Creek (Table X. Fish Passage Barriers in the Southern Subbasin.)

Table X. Fish Passage Barriers in the Southern Subbasin

Stream	Complete	Partial	Unknown	Estimated Miles of Blocked
Baechtel	0	1	1	4.3
Broaddus	1	5	0	ND
Willits	2	1	0	5.4
Haehl	1	1	1	1.7
Davis	0	0	0	4.8
Conklin	0	1	0	ND
Upp	1	0	0	ND
Southern	5	9	2	16.2

Analysis of Tributary Recommendations

In order to compare the frequency with which recommendations were made within the Southern Subbasin, the top ranking recommendations for each tributary were compiled. Each tributary was originally assigned anywhere from zero to ten recommendations, which were ranked in order of importance.

The top improvement recommendations in each tributary were summed for each subbasin (Occurrence of improvement Recommendations Summary of the Southern Subbasin). In terms of the most frequently given recommendations in each subbasin, all of the streams had pool and shelter recommendations. All of the streams except Willits creek had Bank recommendations. All streams except Baechtel, Broaddus and Berry creeks had fish passage recommendations

Table X. Occurrence of improvement Recommendations Summary of the Northern Subbasin.

Stream	Number of Sites	Survey Length (ft.)	Bank	Roads	Canopy	Temp	Pool	Shelter	Spawning Gravel	LDA Wild/Livestock	Fish Passage
Baechtel	3	2378	3				1	2			
Davis	7	6205	2		3	1	5	4	6	8	7
Broaddus	5	3743	1	2	3	4	5	6			
Berry	2	1363	1	2			3	4			
Mill	1	1376	1				3	2			4
Willits	6	4455			4	1	2	3			5
Southern	24	19520	8	4	10	6	19	21	6	8	13

In order to further examine subbasin issues through the tributary recommendations, the top three ranking recommendations for each tributary were collapsed into five different recommendation categories: Erosion/Sediment, Riparian/Water Temp, Instream Habitat, Gravel/Substrate, and Other (Table X. How improvement recommendations were collapsed into recommendation categories for the Southern Subbasin). When examining recommendation categories by number of tributaries, the most important recommendation category in the Southern Subbasin was Instream Habitat and Riparian/Temperature. Table X. Distribution of recommendation categories in the Southern Subbasin).

Table X. How improvement recommendations were collapsed into recommendation categories for the Southern Subbasin.

Stream Recommendation Category	Subbasin Recommendation Category
Bank/Roads	Erosion/Sediment
Canopy/Temp	Riparian/Water Temp
Pool/Shelter	Instream Habitat
Spawning Gravel/LDA	Gravel/Substrate
Livestock/Barrier	Other

Table X. Distribution of recommendation categories in the Southern Subbasin

Stream	Erosion/Sediment	Riparian/Temperature	Instream Habitat	Gravel/Substrate	Other
Baechtel	3	0	3	0	0
Davis	2	4	9	6	15
Broaddus	3	7	11	0	0
Berry	3	0	7	0	0
Mill	1	0	5	0	4
Willits	0	5	5	0	5
Southern	11	16	40	6	24

However, comparing recommendation categories between streams could be confounded by the difference in the survey distance measured. Of the six streams evaluated, 19,520 feet were surveyed in the Southern Subbasin. Therefore, the percentage of stream feet assigned to the various recommendation categories was calculated for each stream. The percentage of the total stream length assigned to each subbasin recommendation category was then calculated for each stream.

Instream Habitat is the most important recommendation category in the Southern Subbasin followed by Riparian/Water Temperature, Erosion/Sediment, Gravel/Substrate and other (Figure X. Frequency of recommendation categories in the streams surveyed in the Southern Subbasin). Therefore, the number one priority rankings remained the same for the Southern Subbasin and its streams, whether assessed by the number of tributaries or the percentage of stream feet.

The high number of Instream Habitat recommendations across the Southern Subbasin, indicates that high priority should be given to restoration projects emphasizing pools, cover, and sediment reduction. The Other limiting factors recommendation reflects the presence of six dams and livestock.

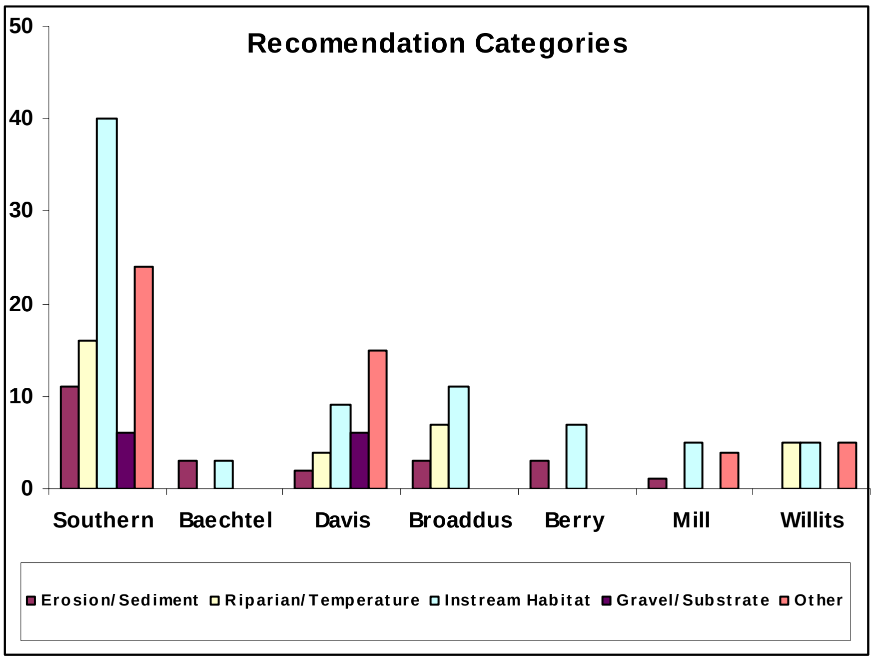


Figure X. Frequency of recommendation categories in the streams surveyed in the Southern Subbasin.

Limiting Factors

A main objective of this assessment was to identify factors that limit production of anadromous salmonid populations in the Southern Subbasins and its streams. This process is known as a limiting factors analysis (LFA). One component is the analyses of the freshwater habitat in order to identify whether any factors are at a level that limits production of juvenile anadromous salmonids in the Southern Subbasin. This limiting factors analysis (LFA) provides a means to evaluate the status of key environmental parameters that affect anadromous salmonid life history. These analyses are based on comparing measures of habitat data such as water temperature and pool complexity to a range of reference conditions determined from empirical studies and/or peer reviewed literature. If a component's condition does not fit within the range of reference values, it may be viewed as a limiting factor. This information will be useful to identify underlying causes of stream habitat deficiencies and help reveal if there is a linkage to watershed processes and land use activities.

Salmonids are limited by flow and water quality, erosion and fine sediment, riparian and instream habitat deficiencies. The Southern Subbasins appear to have more limiting factors center around flow and water quality and erosion and fine sediment. Table X. and Figure X. detail the subbasin's limiting factors and their associated locations.

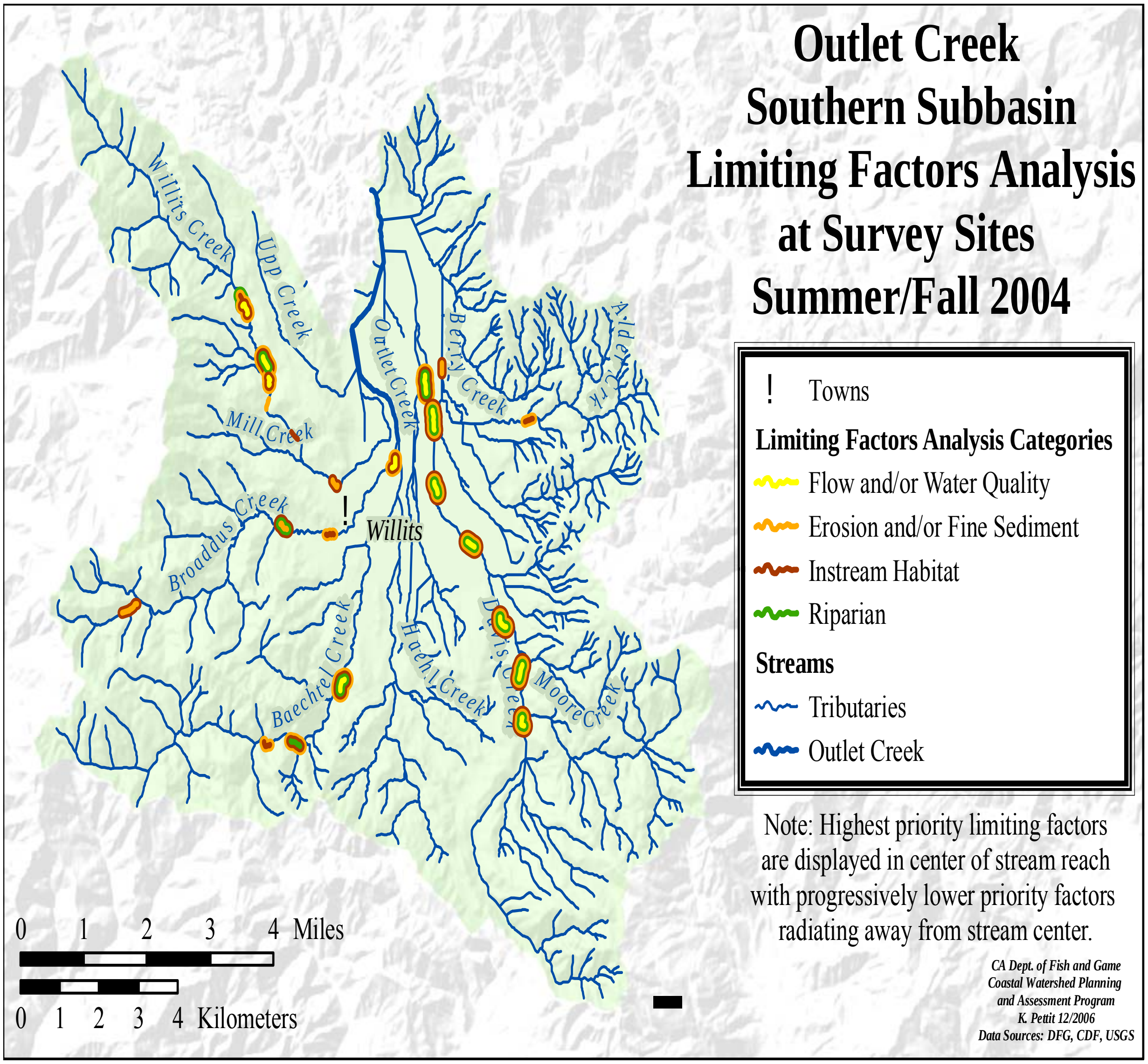


Figure X. Outlet Creek Southern Subbasin Limiting Factors Analysis- 2004.

Table X: Limiting Factors Analysis of the Southern Subbasins.

Limiting Factor		***Baechtel***	***Berry***	***Broaddus***	***Davis***	***Haehl***	***Mill***	***Willits***
Flow and Water Quality	Low and/or absent flow in August and September	X	X	X	**X**	**X**		
	Low and/or absent flow during November	X	X	X	**X**	**X**	X	X
	High summer water temperatures	X	X	X	**X**			
	Subsurface flows obstructing fish migration	X	X		**X**	**X**		
Erosion and Fine Sediment	Bank and debris slide erosion	X	X		**X**			**X**
	Fine sediment from roads, culverts, and land use activities.	X	X	X	**X**	**X**	X	X
	Bank erosion from livestock		X	X	**X**			
	Dam-related down cutting				**X**	**X**		
Riparian and Instream Habitat	Low canopy density	X			**X**	**X**		
	Remove non-native species on stream banks and replace with native species.				**X**			**X**
	Inadequate instream shelter and structure, like large woody debris.	X	X	X	**X**	**X**	**X**	**X**
	Inadequate pool depth and frequency					**X**		
	Barriers to migration		X		**X**			**X**
	Channelized and leveed stream banks	X	X	X	**X**	**X**	**X**	

Refugia Areas

Refugia habitat was identified and characterized in the Southern Subbasin by current data from both 1995 and 2004, EMDS expert professional judgment and criteria developed by the NCWAP and CWPAP (Figure X Outlet Creek Southern Subbasin Overall Refugia). The criteria included measures of basin and stream ecosystem processes, the presence and status of fishery resources, water quality, and other factors that may affect refugia productivity. Results were from information processed by EMDS at the stream reach and planning watershed and subbasin scales. The most complete data available were for tributaries surveyed by CDFG. However, many of these areas were still lacking data for some parameters. Salmonid habitat conditions are somewhat better in the Southern Subbasin than in the Northern Subbasin, but not as suitable as in the Middle Subbasin. The following refugia are rating map summarizes subbasin salmonid refugia conditions:

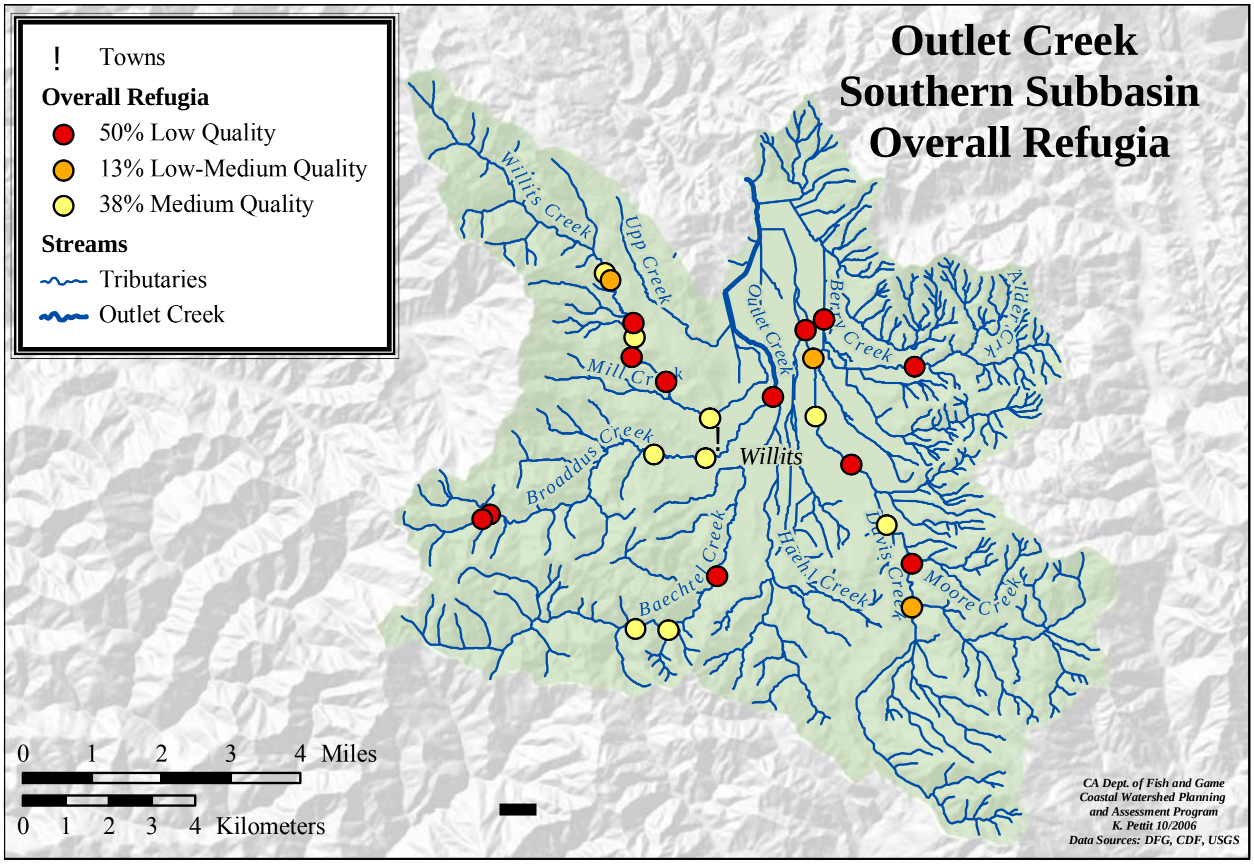


Figure X. Outlet Creek Southern Subbasin Overall Refugia.

Responses to Assessment Questions

What are the history of the populations, distribution, and relative health of salmonids in the Southern Subbasin?

Findings and Conclusions:

- The subbasin is inhabited by Chinook and coho salmon, steelhead, and rainbow trout. Coho salmon have been frequently observed on Baechtel creek in the recent past;
- Adult salmonids migrate from the Pacific Ocean into the Eel River System and move up into Outlet Creek on this way to spawn in this subbasin;
- Juveniles move down in this Subbasin into the Middle and Northern Subbasins on their way to the mainstem Eel and Pacific Ocean;
- No population data has been collected nor have estimates been made for salmonids in the subbasin;
- In 2004, snorkel surveys were conducted according to the 10 Pool protocol at GRTS survey sites which had some flow. Juvenile salmonids were observed at the sites surveyed;
- Several species have been introduced such as big and small mouth Bass and bull frogs which predate on and out-compete juvenile salmonids.

What are the current salmonid habitat conditions in the Southern Subbasin? How do these conditions compare to desired conditions?

Findings and Conclusions:

Flow/Water Quality

- Summer water temperatures may be limiting factor in the Southern Subbasin on the lower Baechtel and lower Broaddus creeks sites from 2000-2004. Baechtel creek, Broaddus, and Willits provide thermal refugia to juvenile coho and steelhead trout;
- The five year average summer water temperature for the sites sampled was 65.9F (18.8C) and ranged from 62.5-74.4 (F) which is considered somewhat suitable for salmonids;
- In 2004, six out of seven MWAT sites became unsuitable or lethal between July 3^{rd} and September 4^{th}. Willits Creek above Lake Emily had somewhat suitable summer water temperatures;
- The turbidity and conductivity ranges were 1.1-80 NTU and 285-1110 Ω.

Fish Passage

- The six dams located in this subbasin restrict flow and slow and/or retard the adult spawning migration into Outlet Creek from the main stem Eel;
- The impounds have decreased available juvenile rearing habitat in some areas;
- In both 1995 and 2004, DFG survey crews encountered many legal and illegal sites where water extraction operations were draining pools and creating areas of dry channel (barriers) resulting in juvenile salmonid mortality;
- Lack of flow through Little Lake Valley disconnects Baechtel, Broaddus, Berry and Davis Creeks to the mainstem of Outlet Creek;
- There are a total of 14 barriers blocking 16 miles of stream, 5 complete and 9 partial barriers, plus 2 of unknown status in the Southern Subbasin.

Erosion/Sediment

- Bank erosion, unimproved and unpaved roads, and road-related gullies are the most common fine sediment sources;
- The stream bank composition of Baechtel Broaddus, Haehl, and Willits show that fine sediment may be supplied by eroding stream banks, which maybe increasing the embeddedness levels on these streams.
- Overall, embeddedness values have increased and available spawning substrate has decreased between 1995 and 2004 in the Subbasin and in streams surveyed except Baechtel Creek.
- High embeddedness values are likely limiting the health and production of salmonids in the Southern Subbasin.

Riparian Condition

- Overall, canopy densities values have decreased and open areas have increased between 1995 and 2004 in the Southern Subbasin and all of the streams surveyed except Baechtel Creek indicating that riparian area has declined;
- Low canopy density values are likely contributing to high water temperatures which are limiting the health and population of salmonids;
- The EMDS results show that the canopy density in some areas in the subbasin have decreased between 1995 and 2004.

Instream Habitat

- Overall, since 1995 the habitat categories ratios have become more adequate in all of the Southern Subbasin indicating that conditions have juvenile salmonids have improved;
- The pool habitat on Baechtel, Broaddus and Willits creeks have increased indicating that over summer conditions for juvenile salmonids may have improved;

- Habitat category ratios appear suitable and are not likely limiting the health and production of salmonids in the Southern Subbasin;
- The EMDS results show that pool depths in some areas in the subbasin have improved and recovered between 1995 and 2004;
- The EMDS results show that the pool shelter conditions in the Southern Subbasin have remained unchanged between 1995 and 2004;
- Major restoration efforts focused on improving pool depth, shelters and canopy and be located in areas with unsuitable EMDS ratings.

Gravel/Substrate

- The lower reaches of the streams are characterized by low gradient, low sinuosity and depositional with sand, gravel, and cobble dominated substrates.
- Overall, embeddedness values have increased and available spawning substrate has decreased between 1995 and 2004 in the Subbasin and in streams surveyed except Baechtel Creek.
- High embeddedness values are likely limiting the health and production of salmonids in the Southern Subbasin;

Refugia Areas

- Most juvenile salmonid habitat conditions (63%) are of low or low-medium quality. Only 37% was medium high quality and was located on Broaddus, Baechtel, Willits and Davis.

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

<u>Findings and Conclusions:</u>

Hydrology

- There are approximately 27 miles of blueline streams which range in elevation between 1,310 to 2,400 feet;
- Baechtel, Broaddus, Davis, Haehl, Mill and Willits creeks are the largest perennial streams that drain into Little Lake. This subbasin is characterized by high gradient headwater streams draining into a seasonal lake which was channelized to facilitate draining;
- The overflow of Outlet Creek was the dredged thalweg of Little Lake;
- The stream network flows primarily in a northern direction. Six streams flow into Little Lake Valley which from Outlet Creek. Seven additional streams flow into Outlet Creek before reaching the confluence with the main stem Eel River;
- Artificial channels were created and natural channels straightened to facilitate the draining of Little Lake into Outlet Creek. This practice widened the channels, increased water transport rates, decreased pool depth, and increased runoff related stream bank erosion;
- Average rainfall is 56 inches per year with a range from 35-90 inches.

Geology

- The dominant geology is Coastal Belt. The geology, topography and climate combine to cause high erosion and fine sediment contribution into Outlet Creek, from this subbasin which moves downstream through the Middle and Northern Subbasin and into the Eel river system.

Vegetation:

- Open grasslands, oak woodlands, and mixed coniferous forest cover the north facing slopes and hills. Young ponderosa pines and large, old stumps are still found on some upper slopes.
- Invasive plant species included periwinkle, pampas grass, start thistle, Himalayan blackberry and Arundo.

How has land use affected these natural processes?

- The land uses include grazing, ranching, timber production, and small and large rural residential and commercial properties;
- Natural low flow conditions are severely reduced by legal and illegal dewatering;
- Roads and railroad lines have disconnected the stream bank and flood plains from the instream habitat.

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 on the information available for this assessment, it appears that salmonid populations are currently being limited by:

- Low and or absent flow in August and September;
- Low and or absent flow during November;
- High Summer water temperatures;
- Subsurface flows obstructing fish migration;
- Fine sediment from bank and debris slide erosion roads, livestock culverts and land use;
- Dam related down cutting;
- Low canopy density increasing water temperatures;
- Inadequate instream shelter pool depth and frequency;
- Natural and man-made barriers;
- Channelized and leveed stream banks.

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

<u>Findings and Conclusions:</u>

Flow and Water Quality Improvement Activities

- Enforce regulations to eliminate water extraction in July, August and September, especially in Baechtel, Broaddus, Mill and Davis;
- Start a neighborhood watchdog group to report water extraction through the subbasin during the late summer and early fall months.

Fish Passage

- Enforce and continue to enforce bypass flows on morris dam;
- Replace and /or eliminate culverts which inhibit migration;
- Restore conductivity to stream channel and levees in.

Erosion and Sediment Delivery Reduction Activities

- Paved, unimproved rural roads should be upgraded to reduce erosion which contributes fine sediment to the streams.

Riparian and Instream Habitat Improvement Activities

- Restoration efforts focused on improving canopy should be located in stream with unsuitable EMDS ratings such as Willits and Davis creeks;
- Major restoration efforts focused on improving pool depths and shelter, and be located in areas with unsuitable EMDS ratings;
- Implementation of restoration projects focused on increasing canopy, and pool depth and shelter, will improve the overall reach conditions.

Education, Research, and Monitoring Activities

- Continue to support efforts to establish and maintain an active watershed group focused on the outlet Creek Basin;
- CDFG should continue and expand existing monitoring of anadromous salmonid populations to include some winter spawning and reddd and spring/summer juvenile surveys;
- Support stream gage installations and maintenance to establish long term records;
- Start new and continue current water temperature and quality monitoring at current locations and expand these efforts where appropriate.

Restoration Grant Proposals that addresses high priority recommendations from the Coastal Watershed Planning and Assessment Program, Steel Restoration and Management Plan and/or Recovery Strategy for California Coho Salmon may receive up to one additional point added to the final technical score for the project proposal (Table X.)

Table X. Prioritized Improvement Activities in the Southern Subbasin

Location	Improvement Activities	DFG FRGP	Coho Recovery Plan Task Numbers	Steelhead Recovery Plan Task Numbers	CWPAP Priority
Davis; Willits	Enforce bypass flows during the summer and early fall to support juvenile salmonid survival.	HR	RW-II-A-02		1
Baechtel; Berry; Broaddus; Mill	Identify, dismantle and cite illegal water extraction.	HR	RW-II-A-02		1
Willits	Continue stream flow gage monitoring.	MD	RW-II-A-02		1
Baechtel; Berry; Broaddus; Davis; Mill; Willits	Continue and expand water quality (temperature, dissolved oxygen, and fine sediment) monitoring.	MD	RW-II-A-02		1
Baechtel; Berry; Broaddus; Davis; Mill; Willits	Conserve water during the summer and fall months.	WC	RW-XXXIII-A-01 ER-OC-02b-d		1
Baechtel; Berry; Broaddus; Davis; Mill; Willits	Identify sediment sources.	HU	RW-VI-D-01		2
Baechtel; Berry; Broaddus; Davis; Mill; Willits	Reduce bank erosion.. Reduce fine sediment input from roads, culverts, and other land use activities.	HS	RW-VI-a-02 RW-VI-D-01C		2
Berry; Broaddus	Reduce sediment input from debris slides where possible.	HS	RW-VI-a-02 RW-VI-D-01C		2
Baechtel; Berry; Broaddus; Davis;	Use exclusion fencing where erosion caused by grazing livestock.	HI	RW-XXII-A-02		2
Baechtel; Broaddus; Davis; Willits	Re-vegetate stream banks to develop and expand canopy.	HI	RW-XXII-A-04		2
Baechtel; Berry; Broaddus; Davis; Mill; Willits	Add large woody debris and other structure to increase cover and pool depth and frequency.	HI	RW-XXII-A-04	NC-08	2
Davis; Willits	Replenish or continue efforts toward replenishing spawning gravels	HI	RW-XXIX-F-01	NC-08	1

Baechtel; Berry; Broaddus; Davis;	Removal barriers to migration.	FP	RW-XXII-A-04	NC-02 and 03; NC-24	1
Davis	Develop and support water conservation education within the City of Willits	WC	RW-XXXIII-A-01 ER-OC-02bd		1

Southern Subbasin Conclusions

The Southern Subbasin is the largest within the Outlet Basin. Much of this subbasin is privately owned. Salmon and steelhead habitat conditions in the Southern Subbasin are generally degraded, but support some salmonid production. Salmonid populations are currently being limited by reduced habitat complexity, high water temperatures, low summer stream flows, embedded spawning gravels, and artificial passage barriers. However, historical accounts indicate that stream conditions were favorable for salmonid populations in the past. There are many opportunities for improvements in stream conditions in this subbasin as well as a great need to restore areas of stream refugia. Surveys by landowner, water temperature monitoring, riparian canopy restoration, and improvements to channel complexity such as additional LWD are examples of such opportunities. The stability and erosiveness of terrain should be considered before project implementation and appropriate BMPs should be followed to minimize erosion and sediment delivery to streams. Conditions beneficial to salmonids may be further enhances in this subbasin through encouraging all motivated subbasin landowners to us good land stewardship.