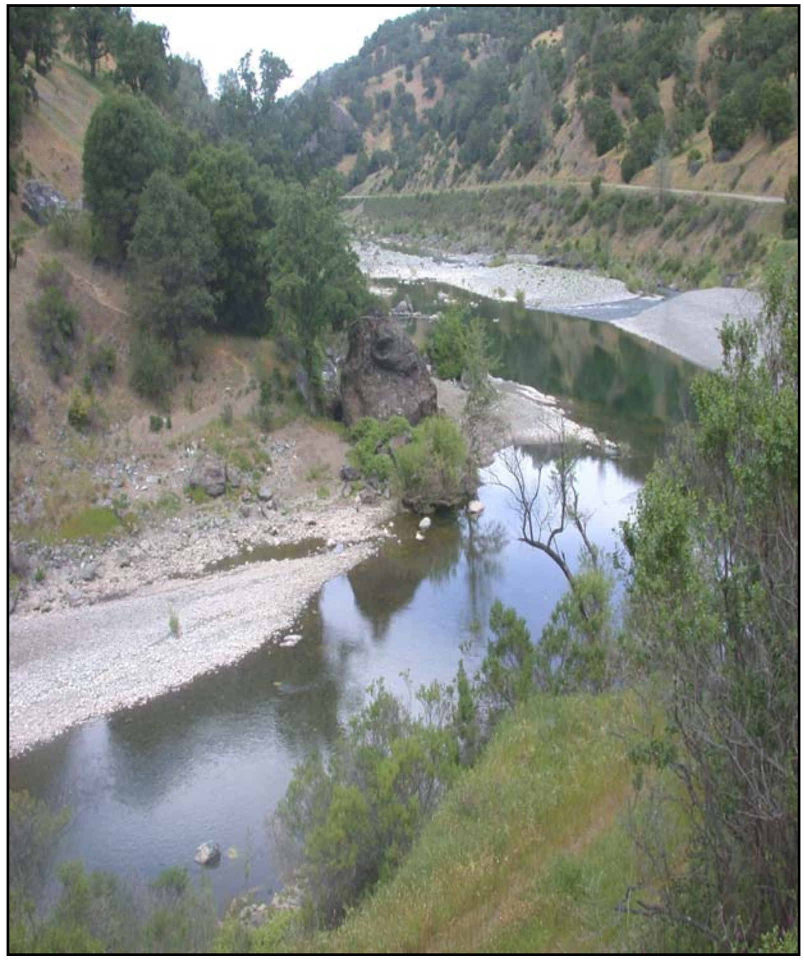
Northern Subbasin
Findings and Recommendations

Overview



The Northern Subbasin begins at the confluence with the mainstem Eel River and ends at the confluence with Long Valley Creek. This subbasin has an area of 62 square miles (39,832 acres), and represents approximately 44% of the Outlet Creek Basin.

Longvale was the principal community prior to the widening of highway 101. Ninety percent of the land is privately owned. The population is estimated at 282 residents.

The dominant geology is Coastal Belt. The geology, topography, and climate combine to cause high erosion which contributes fine sediment to Outlet Creek which moves downstream into the Eel River system. 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. The land uses include grazing, timber production, and large rural residential properties.

The average precipitation is approximately 45 inches per year which mainly falls as rain. There are approximately 28 miles of blueline streams which range in elevation between 1,000 and 3,000 feet.

Chinook and coho salmon and steelhead spawn, rear, and migrate through this subbasin on their way to and from the Pacific Ocean some 100 RM away. Chinook salmon juveniles move downstream from the Southern and Middle subbasins into the Eel River system and out into the Pacific Ocean shortly after emerging from their redds. Coho salmon juveniles also complete this migration usually as three years olds while steelhead trout juveniles out migrate between the ages of two and five years old.

Late fall and early winter rainfall is impounded by six dams located in the Southern Subbasin. Impounding this flow inhibits the upstream adult Chinook and coho salmon spawning migration to the Eel River System, and up into Outlet Creek and its tributaries. During late summer and early fall, flows become subsurface in some of the tributaries and Outlet Creek, stranding and causing mortality to juvenile salmonids. Natural low flow conditions are severely reduced by legal and illegal dewatering.

In this subbasin, several species have been introduced such as big and small mouth bass, sunfish, Sacramento pike minnow, and bull frogs. The latter two species heavily predate upon salmonid juveniles. Invasive plant species included periwinkle, pampas grass, star thistle, Himalayan blackberry, and *Arundo*.

Outlet, Bloody Run, Cherry, and Long Valley creeks are the largest perennial streams. Outlet Creek becomes a third order stream in the Middle Subbasin at the confluence with Little Lake Valley, while the remaining streams are first and second order or intermittent. The channels are moderately entrenched, braided and meandering. The most reaches are characterized by low gradient, low sinuosity and depositional with gravel, cobble, and bedrock dominated substrates. The upper reaches are higher gradient with boulder and bedrock substrates. (Table X. Attributes of the main tributaries in the Northern Subbasin and Figure X. Northern Subbasin showing large streams and stream order).

Table X. Attributes of the main tributaries in the Northern Subbasin.

Stream	Length (Mi)	Stream Order	Channel Type	Characteristics
Outlet	8.5	3rd	F3	The channel is wide and becomes braided in some areas. It is entrenched, meandering, and dominated by low gradient riffles with cobble substrate, intermixed with bedrock, gravel, and fine sediment. Most boulders are a result of bank stabilization projects. Flows become subsurface in the low gradient, depositional areas during the summer and fall.
Long Valley	8.7	2nd	F3, B2, F4	The lowest reach is entrenched, meandering, low gradient riffles dominated by cobble. The middle reach is moderately entrenched, more confined, and dominated by both natural occurring and bank stabilization projects. The upper reach is entrenched, meandering, low gradient riffles dominated by gravel.
Cherry	3.2	1st	A2, B1, B2, F3, F4	The lowest reach is a steep and high energy channel with a boulder and gravel dominated channel. The middle reaches are moderately entrenched with 2-4% gradient and dominated by a bedrock/boulder channel. The upper reaches are more confined with the substrate composed of gravel and cobble. Flows can become intermittent during the summer and fall.
Bloody Run	3.1	1st	B3, F4	The channel has moderate gradient, is moderately entrenched, and braided in some areas with a cobble dominant substrate. The upper channel is entrenched, meandering, and dominated by low gradient riffles and gravel substrate. Flows become intermittent during the summer and fall with the upper reach drying up.

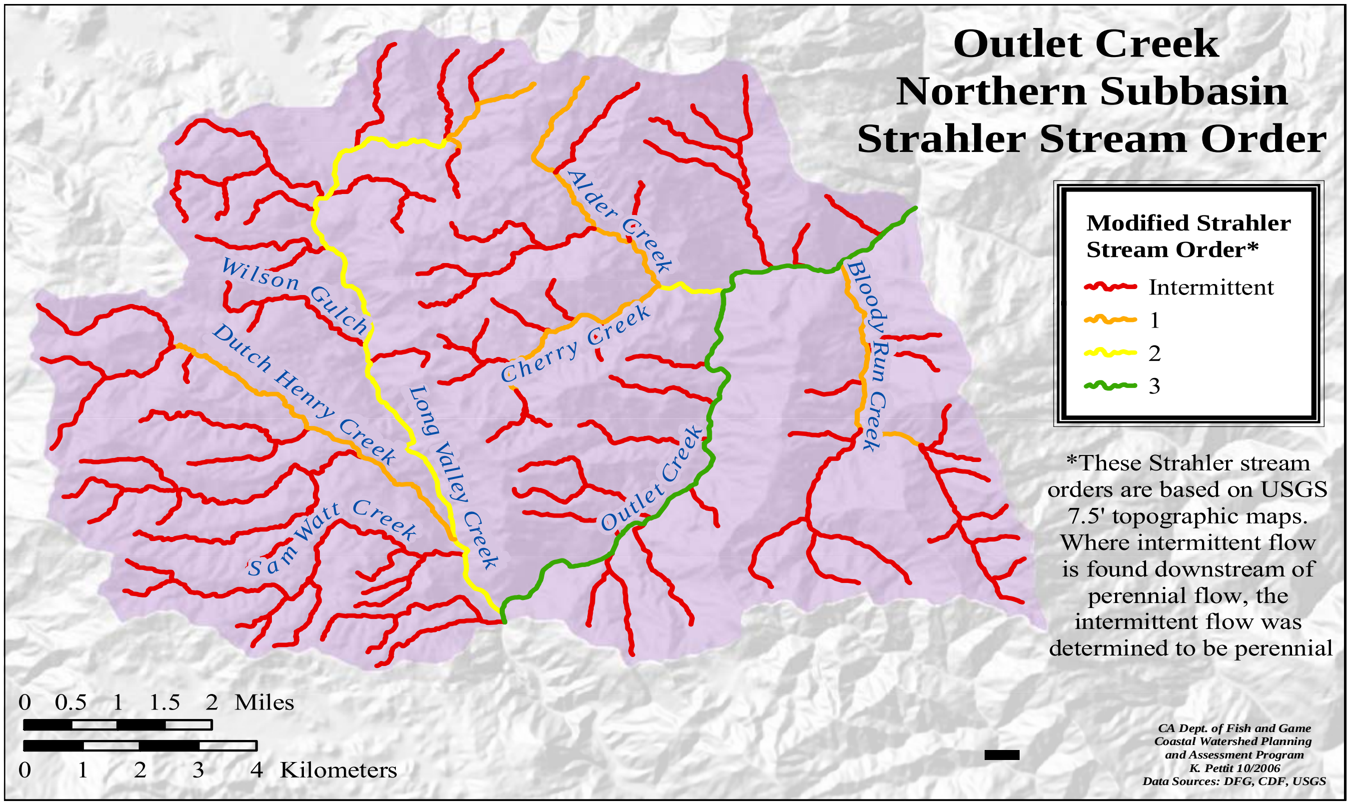


Figure X. Northern Subbasin showing large streams and stream order.

Issues

Public scoping meetings with residents and constituents, and initial analyses of available data by DFG fishery biologists developed this working list of general issues:

- Decreases in the salmonid populations have occurred and well as reduced habitat quantity and quality;
- Flows are impounded by six dams in the Southern Subbasin;
- Legal and illegal dewatering occurs throughout this subbasin;
- Low or no flow conditions are eliminating summer rearing habitats;
- Summer water temperatures are unsuitable in most locations on the mainstem of Outlet Creek and its tributaries;
- Stream banks erosion is common to Coastal Belt geology, but is significantly increased by the placement of roads and railroad lines in the floodplains, absent or sparse riparian cover, and grazing livestock;
- Fine sediment contribution from poorly maintained roads and stream crossings in the Southern and Middle subbasins affect instream habitat in this subbasin;
- Fine sediment from alluvium geology from the Southern Subbasin is transported through and also deposited in this subbasin;
- Legacy effects from the 1955 and 1964 floods are still being transported downstream to the lower reaches of Outlet Creek which are observed as widen floodplains, absent riparian zones, and elongated fine sediment bars.
- Low canopy density over the streams is contributing to water evaporation and elevated summer water temperatures in this subbasin and the Eel River system;
- Timber harvests in the riparian zone prior to the Forest Practice Rules has reduced the instream large woody debris recruitment potential;
- Natural and man-made barriers have decreased available spawning habitat in the tributaries in this subbasin;
- Non-native introduced species, such as Sacramento pike minnow and bullfrogs are preying upon young-of-the-year, and juvenile salmonids as they migrate down stream to the mainstem Eel River;
- Invasive plant species can be observed.

Fish Habitat Relationships

Historic Habitat Conditions

Analyses of the past conditions of the Northern Subbasin were reconstructed from the best available data, historic photographs, newspapers, diaries, and anecdotal information.

Flow and Water Quality

- Fall and winter rains provided flows which were unobstructed by dams and levees;
- Summer and fall flows were used by fish, wildlife, and a few hundred Pomo Indians.

Erosion and Fine Sediment

- Instream fine sediment was lower because the floodplains were connected to the stream banks;
- Stream banks were covered with native plant species;
- Spawning substrate was available and regularly recruited to the channel from stream banks and landslides.

Riparian and Instream Habitat

- Riparian areas were well developed and the vegetation consisted of willow, alder, ash and included more coniferous species;
- Douglas Fir species were also part of the riparian and dominated upslope vegetation;
- The riparian area helps insolate streams from solar radiation reducing water temperatures;
- Large woody debris was recruited from the well developed, old growth riparian area;
- Stream banks shifted course naturally and meandered.

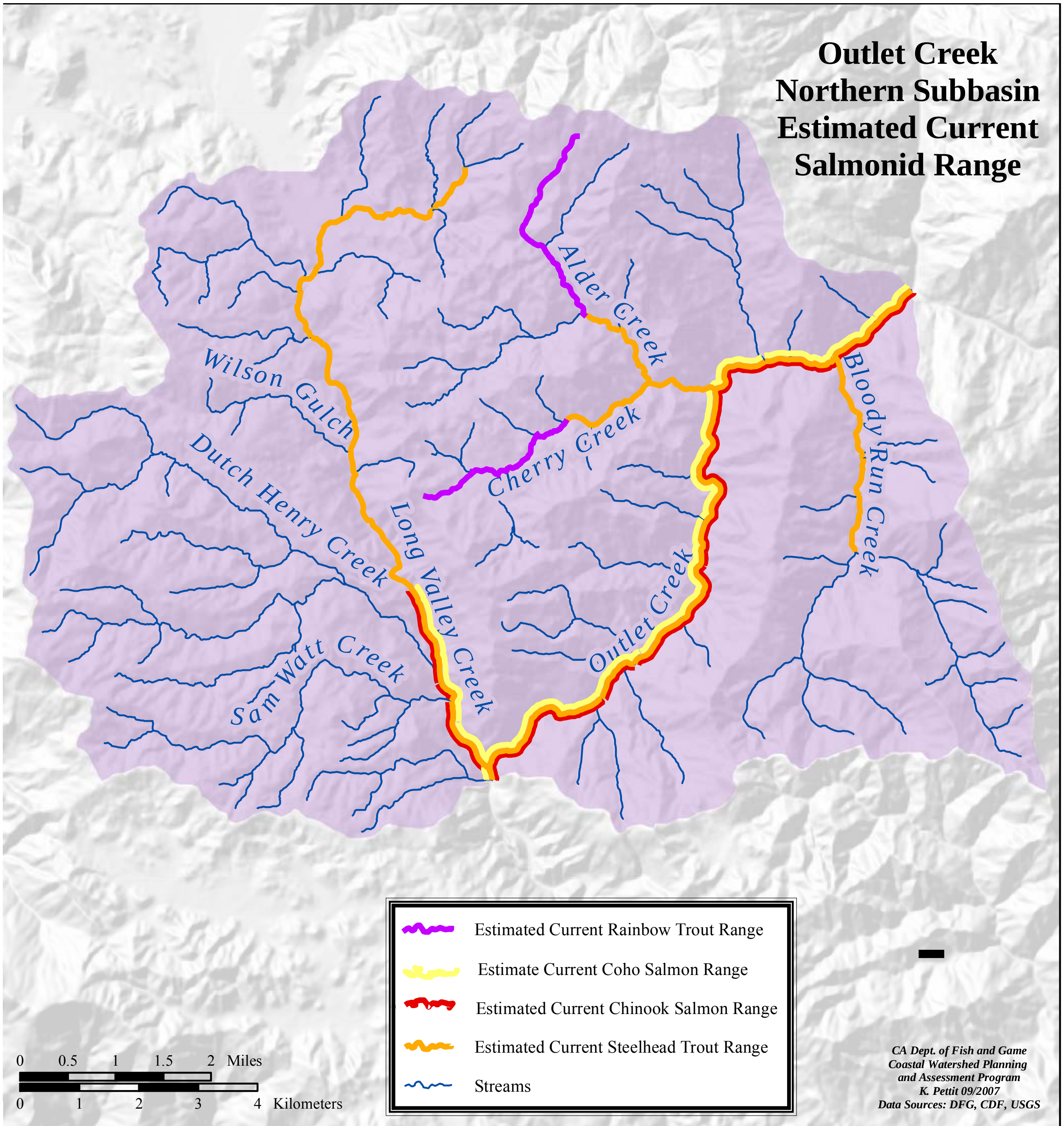


Figure X. Outlet Northern Subbasin Estimated Current Salmonid Range.

Current Habitat Conditions

Chinook salmon, coho salmon, and steelhead trout utilize headwater streams such as Bloody Run, Cherry, Alder, and Long Valley creeks, the larger Outlet Creek larger, the Eel River estuary, and the Pacific Ocean for parts of their life history cycles. There are several factors necessary for the successful completion of an anadromous salmonid life history.

The subbasin is inhabited by Chinook and coho salmon, steelhead, and rainbow trout. Coho salmon have been infrequently observed in the recent past, however adult coho migrate through on their way to spawn in the Middle and Southern subbasins and juveniles pass through this subbasin on their way to the main stem 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 Ten Pool protocol at the GRTS survey sites which had some flow. No juvenile salmonids were observed at any of the sites surveyed. The summer and fall water temperatures and low flow conditions in this subbasin are more supportive to the Chinook life history than other salmonid species.

Flow and Water Quality

Suitable flow and summer water temperatures are vital to maintaining healthy salmonid populations.

In the freshwater phase in salmonid life history, adequate flow, free passage, good stream conditions, and functioning riparian areas are essential for survival. Adequate instream flow during low flow periods is essential for fish passage in the summer time, and is necessary to provide juvenile salmonids free forage range, cover from predation, and utilization of localized temperature refugia from seeps, springs, and cool tributaries.

Stream condition includes several factors: adequate stream flow, suitable water quality, suitable stream temperature, and complex habitat. For successful salmonid production, stream flows should follow the natural hydrologic regime of the basin. A natural regime minimizes the frequency and magnitude of storm flows and promotes better flows during dry periods of the water year. Salmonids of the Outlet Creek Basin, such as those in the Northern Subbasin and its tributaries evolved with the natural hydrograph, and changes to the timing, magnitude, and duration of low flows and storm flows disrupt the ability of fish to follow their life history cues.

Important aspects of water quality for anadromous salmonids are temperature, turbidity, chemistry, and sediment load. In general, suitable temperatures for salmonids are between 48-56°F for successful spawning and incubation, and between 50-52°F and 60-64°F, depending on species, for growth and rearing. Additionally, cool water holds more oxygen, and salmonids require high levels of dissolved oxygen for all stages of their life cycle.

Another important aspect of water quality is turbidity. Fine suspended inorganic or organic materials (turbidity) affect nutrient levels in streams that in turn affect primary productivity of aquatic vegetation and insect life. This eventually reverberates through the food chain and affects salmonid food availability. Additionally, high levels of turbidity interfere with a juvenile salmonids' ability to feed and can lead to reduced growth rates and survival (Bill Trush, Trush & Associates; personal communication).

Water velocity and temperature requirements differ with the salmonid life cycle (Table X. Water velocity and temperature suitability ranges for coho salmon life stages). Water velocities requirements range from 0.30-8.0 ft/s while temperatures requirements range from 35-65 F.

Table X. Water velocity and temperature suitability ranges for coho salmon life stages.

Life Stage	Velocity (ft/s)	Reference	Water Temp (F)	Reference
Migrating Adult	<8.0	Reiser and Bjornn 1979	44.6-59.0	Reiser and Bjornn 1979
Spawning Adult	0.98-2.46; 1.2; 1.9 0.98-2.99	Briggs 1953 Reiser and Bjornn 1979 Reiser and Bjornn 1991	39.2-48.2	Reiser and Bjornn 1991
Rearing juvenile	0.30-0.98 (preferred age 0) 1.02-1.51 (riffle) 0.3-0.79 (pool)	Reiser and Bjornn 1979 PFMC 1999	35 lower lethal 78.8-83.8 upper lethal 48-59.9 optimum 63.7-64.9 MWAT 62.1 MWAT	Reiser and Bjornn 1991 Flosi et al. 1998 Ambrose and Hines 1997 Hines and Ambrose ND Welsh et al. 2001
Egg and Fry	0.82-2.95	PFMC 1999	39.2-51.8 39.2-55.4 32.-62.6	Davidson and Hutchinson 1938 Reiser and Bjornn 1991 PFMC 1999

During the summer and fall of 1995 and 2004, flow measurements were taken as part of the habitat inventory and GRTS surveys on Outlet, Bloody Run, Cherry, Alder, and Long Valley creeks. Flows ranged from 0.5-2.0 cfs. in 1995. During the summer and fall of 2004, flows ranged from 0-2.0 cfs. Flows were subsurface in Bloody Run and Outlet Creek in 1995. In 2004, flow data were not collected in Cherry Creek, however no flow conditions were observed at numerous locations throughout the subbasin which were not surveyed due to the random sampling protocols. 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.

Six sites had thermographs deployed in the Northern Subbasin between 2000 and 2004. Not all of the six sites were sampled every year except in 2004 for this watershed assessment. Two sites had multiple years of data. Figure X. (MWAT survey sites in 2004 in the Northern Subbasin) shows the thermograph locations. For the subbasin, the five year average summer water temperature for the six sites was 74.2F (23.5C) which is considered unsuitable, almost lethal (Table X. MWATs from the monitoring sites in the Northern Subbasin from 2000-2004).

Summer water temperatures were a limiting factor in the Northern Subbasin on all of the creeks sampled from 2000-04, except on Bloody Run Creek which had somewhat suitable water temperature. Bloody Run Creek may provide some thermal refugia to juvenile steelhead trout.

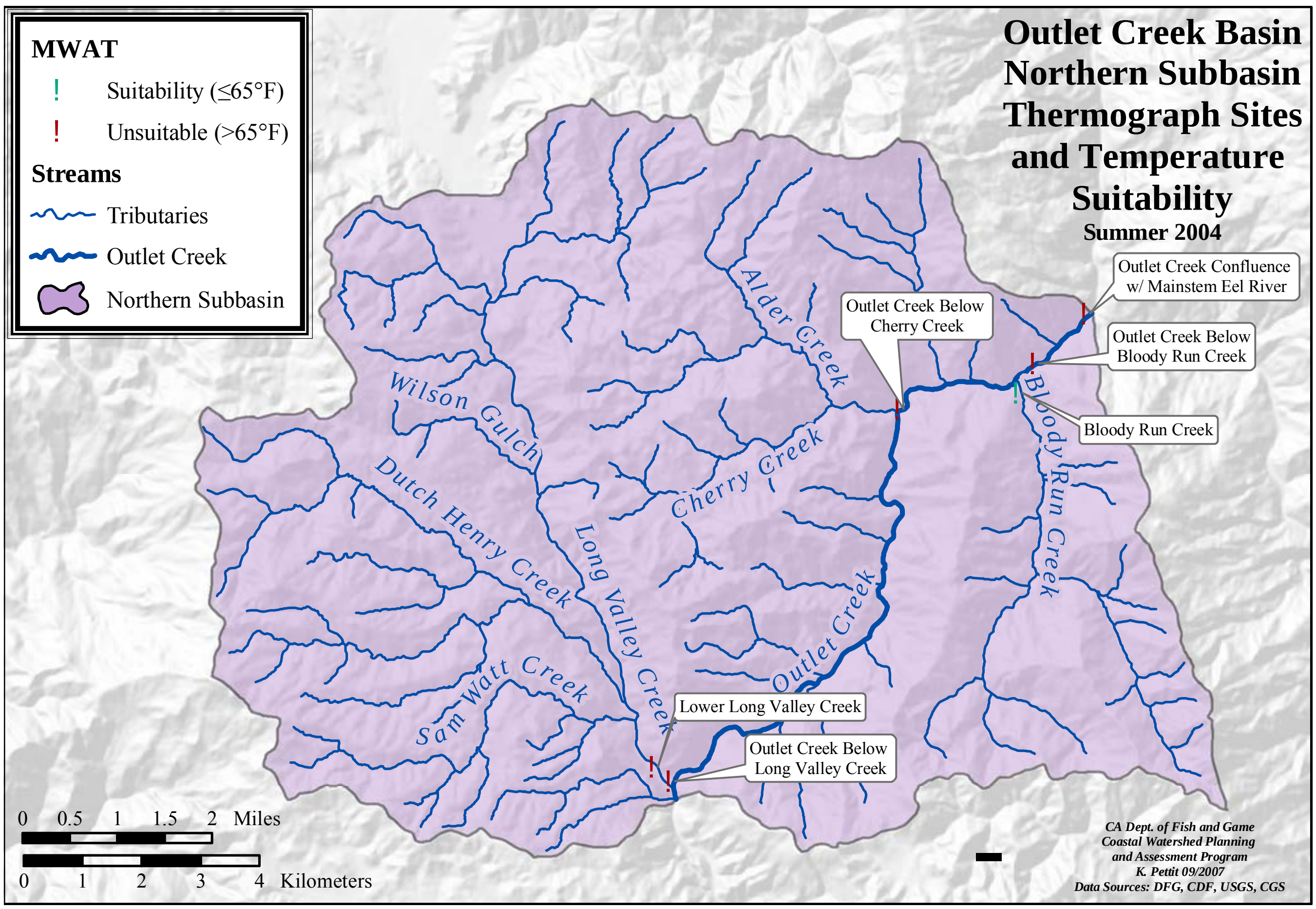


Figure X. MWAT survey sites in 2004 in the Northern Subbasin.

Table X. MWATs from the monitoring sites in the Northern Subbasin from 2000-2004.

Stream and Location	Year	MWAT (°F)	MWAT (°C)	Week Starting	EMDS Suitability Rating
Outlet with the Mainstem Eel	2004	78.1	25.6	July 3	Unsuitable
Outlet with the Mainstem Eel	2002	76.3	24.6	June 26	Unsuitable
Outlet with the Mainstem Eel	2001	78.5	25.9	July 2	Unsuitable
Outlet with the Mainstem Eel	2000	79.7	26.5	June 23	Unsuitable
Outlet below Bloody Run	2004	77.4	25.2	July 25	Unsuitable
Bloody Run	2004	63.8	17.7	July 3	Somewhat suitable
Outlet below Cherry	2004	76.8	24.9	July 25	Unsuitable
Outlet below Long Valley	2004	74.9	23.8	July 22	Unsuitable
Long Valley Lower Site	2004	69.3	20.7	July 23	Unsuitable
Long Valley Lower Site	2002	70.1	21.2	July 29	Unsuitable
Long Valley Lower Site	2000	71.7	22.1	July 27	Unsuitable
Average for Subbasin	5 years	74.2	23.5	June 26-July 29	Unsuitable

MWATs: fully suitable (50-60°F), moderately suitable (61-62°F), somewhat suitable (63°F), undetermined (64°F), somewhat unsuitable (65-66°F), moderately unsuitable (67°F), unsuitable (>68°F). Seasonal Maximum Temperature: >75°F lethal.

Turbidity and conductivity samples were taken at each of the 7 GRTS site in 2004. In the Northern Subbasin overall, turbidity and conductivity ranged from 0.45-9.4 and 249-1,001, respectively. Outlet Creek's turbidity and conductivity ranged from 0.45-9.4 and 249-2,080, respectively. Long Valley Creek's turbidity and conductivity ranged from 1.1-23.0 and 328-2,080, respectively. Bloody Run Creek's turbidity and conductivity was 11.0 and 251 respectively. Alder Creek's turbidity and conductivity was 1.8 and 649 respectively. Cherry Creek's turbidity and conductivity ranged from 1.6-1.7 and 362-365, respectively.

Table X. Turbidity and conductivity collected in 2004 in the Northern Subbasin.

Stream	Number of Sites	Range of Turbidity (NTU)	Range of Conductivity
Outlet	4	0.45-9.4	249-1001
Long Valley and tributary	11	1.1-23.0	328-2080
Bloody Run	1	11	251
Alder	1	1.8	649
Cherry	2	1.6-1.7	362-365
Northern	19	0.45-23.0	249-2080

Instream Habitat (1995 and 2004)

There are 28 perennial stream miles on five perennial tributaries in this subbasin. The surveys included channel typing using the classification system developed by Rosgen (1996), habitat typing, and biological sampling as described in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al. 1998). In addition to the above data, the 2004 survey sites also were documented with photos, recorded the amphibian species observed, conducted pebble counts, and LWD surveys.

Analyses of the current conditions in the Northern Subbasin were based upon stream habitat inventories conducted in 1995 by DFG which surveyed Outlet, Long Valley, Cherry and Bloody Run creeks (Figure X. Northern Subbasin Habitat Surveys 1995). The General Random Tessellation Surveys (GRTS) conducted in 2004 by DFG and PSMFC crews surveyed random sections of the streams (Figure X. GRTS Sampling in the Northern Subbasin in 2004). Only streams where land owner access was granted were available to be surveyed in both 1995 and 2004.

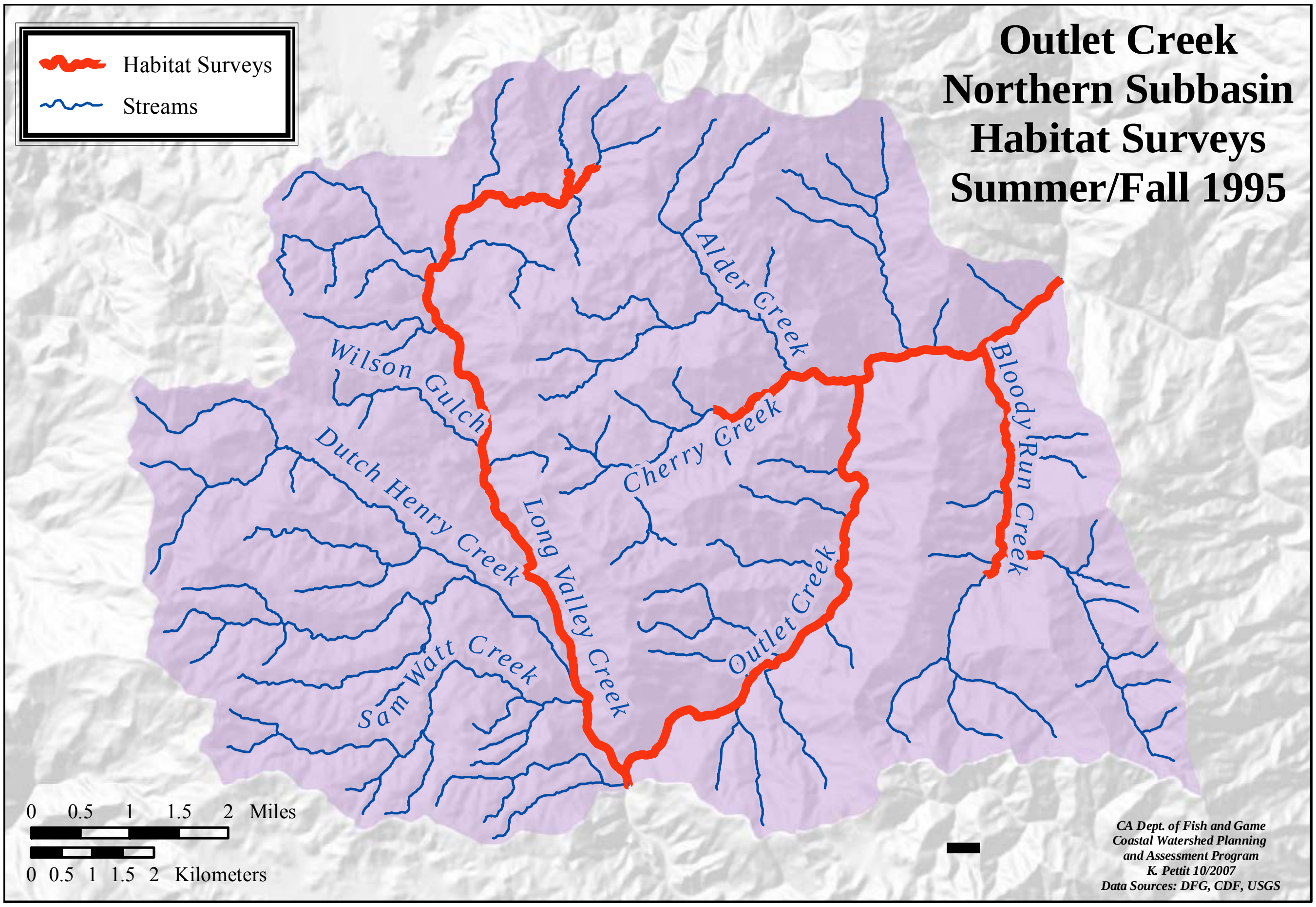


Figure X. Northern Subbasin Habitat Surveys 1995.

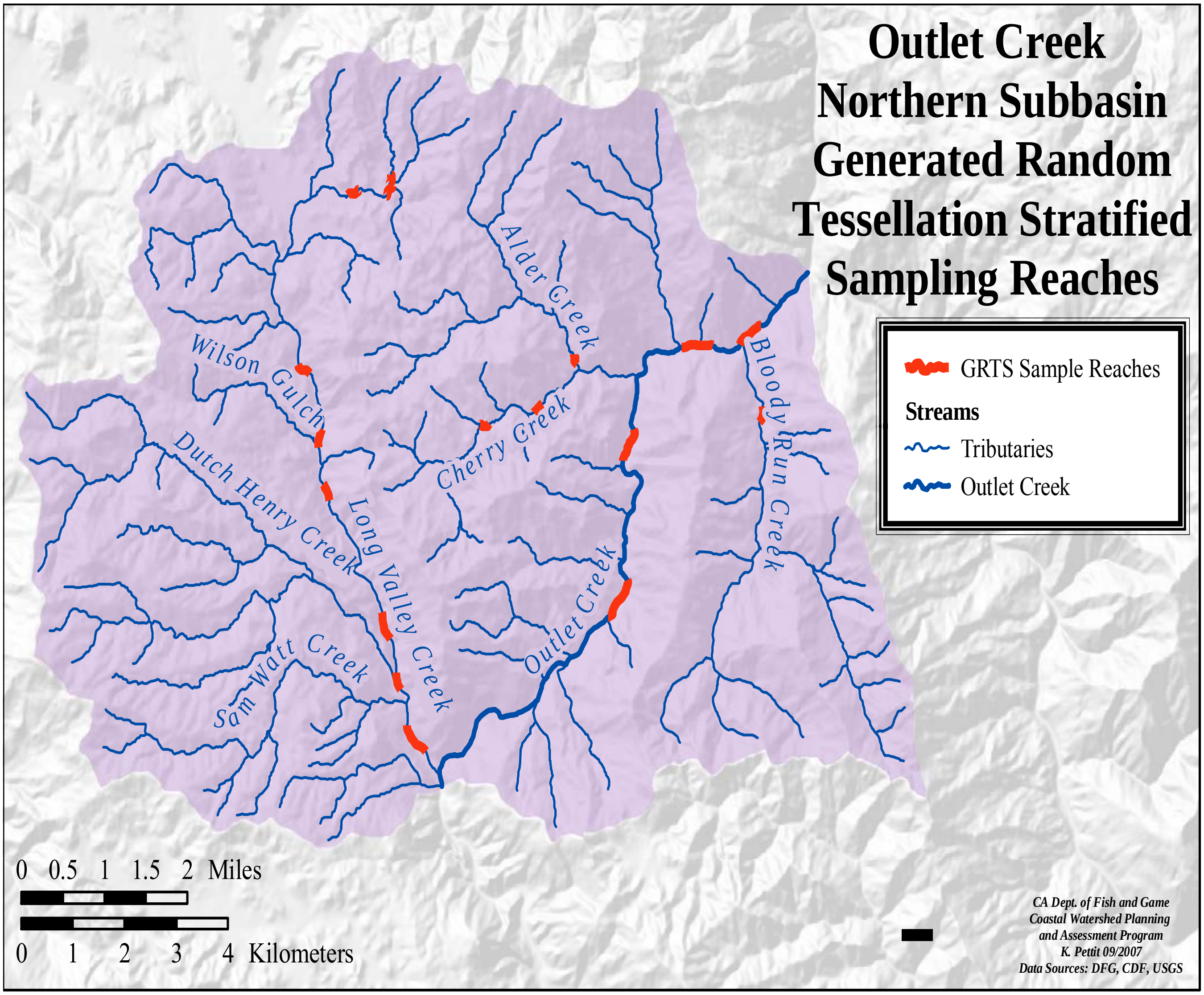


Figure X. GRTS Sampling in the Northern Subbasin in 20004.

Erosion and Fine Sediment

Stream bank erosion contribute cobble and gravel to the channel which are important components in spawning substrate. Accumulation of instream fine sediment indicates a decrease in 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 (TMDL) 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, spawning and reproduction, and early development of cold-water fish such coho and Chinook salmon, and steelhead trout.

Stream banks

The stream banks in the Northern Subbasin mainly contribute cobble and gravel to the stream channel. It appears that the stream banks contribute some fine sediment (silt/clay), but likely is not the major source. Fine sediment sources from the Middle and Southern subbasins are contributing large amounts of fine sediment which accumulating in and pulsing through this subbasin. The stream bank composition of Outlet, Cherry, and Bloody Run creeks are dominated by cobble/gravel. The stream bank composition of Long Valley Creek is dominated by silt/sand. Outlet, Long Valley, and Cherry creeks may supply fine sediment from eroding stream banks, which are maybe increasing the embeddedness levels on these streams. The stream banks on Bloody Run Creek are not likely contributing fine sediment into the channel. (Figure X. Average composition of stream banks in the Northern Subbasin).

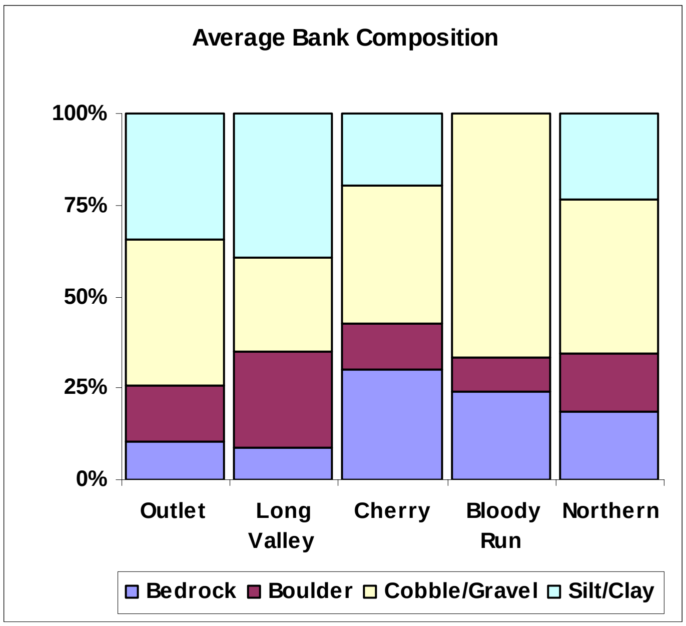


Figure X. Average composition of stream banks in the Northern Subbasin.

Embeddedness

The target value for embeddedness is 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, egg 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 is 76-100% embedded. Category 1 is best, category 2 is supportive, and categories 3 and 4 are unsuitable for successful spawning and incubation of salmonids.

In 1995 and 2004, the Northern Subbasin did not meet embeddedness target values. In 1995 and 2004, 55% and 75% of the pool tail outs were 51% or more embedded, respectively. The amount of quality spawning substrate available appears to have decreased significantly between 1995 and 2004. However, in 1995, the embeddedness values were averaged for the all of the streams surveyed in the subbasin whereas in 2004, 19 random sites were surveyed throughout the subbasin.

In 1995 and 2004, Outlet Creek had 70% and 80% of the pool tail outs were 51% or more embedded, respectively. In 1995, Outlet Creek had less than 10% in category 1, where none was recorded in 2004.

In 1995 and 2004, Long Valley Creek had 70% and 90% of the pool tail outs were 51% or more embedded, respectively. In 2004, a small amount of category 1 substrate was measured in Long Valley Creek where none was recorded in 1995, indicating that spawning conditions may have improved in some pool tail outs.

In 1995 and 2004, Cherry Creek had 60% and 10% of the pool tail outs were 51% or more embedded, respectively. In 2004, category 1 substrate was measured at 30% in Cherry Creek where 10% was recorded in 1995, indicating that spawning conditions may have improved in some pool tail outs.

In 1995 and 2004, Bloody Run had 40% and 100% of the pool tail outs were 51% or more embedded, respectively. The amount of quality spawning substrate available appears to have decreased significantly between 1995 and 2004 in Bloody Run Creek.

The unnamed tributary to Long Valley Creek (UNLV) and Alder Creek were not surveyed in 1995. Data from 2004 indicate that Alder Creek provides some suitable spawning substrate while the unnamed tributary is unsuitable (Figures X and Y. Embeddedness in Pool Tails of Northern Subbasin in 1995 and 2004).

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

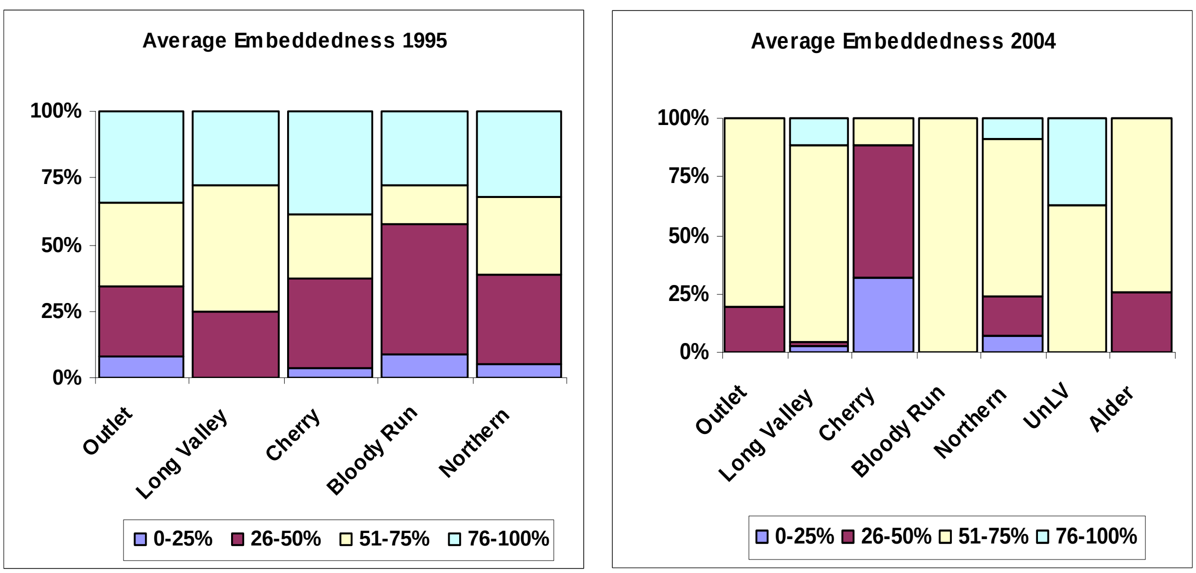


Figure X and Y. Embeddedness in Pool Tails of Northern Subbasin in 1995 and 2004.

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 and 2004, the Northern Subbasin did not meet canopy density target values. In both 1995 and 2004, deciduous canopy dominates and coniferous canopy increases in 2004. The canopy density has not significantly changed between 1995 and 2004. However, in 1995, the canopy density measurements were averaged for the all of the streams surveyed in the subbasin whereas in 2004, 19 random sites were surveyed throughout the subbasin.

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

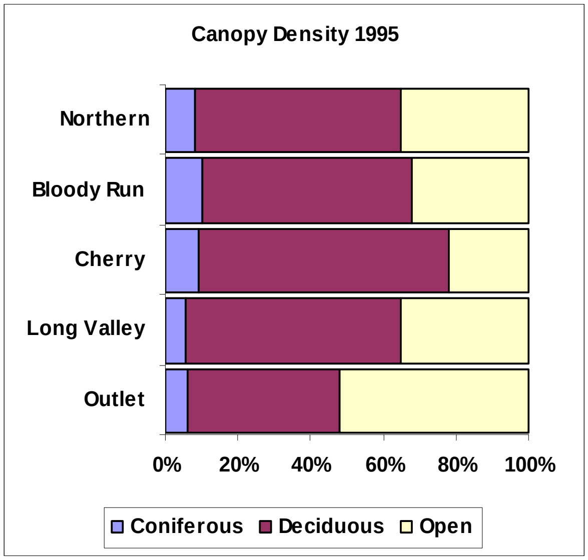
In 1995 and 2004, Long Valley Creek did not meet canopy density target values. Between 1995 and 2004, the percentage of coniferous and deciduous canopy increased slightly, thus the open area decreased. It appears that the riparian habitat has improved slightly since 1995.

In 1995, Cherry Creek did not meet canopy density target values. In 2004, Cherry Creek did meet canopy density target values. Between 1995 and 2004, the percentage of coniferous and deciduous canopy increased. It appears that the riparian habitat has improved since 1995.

In 1995 and 2004, Bloody Run Creek did not meet canopy density target values. Between 1995 and 2004, the percentage of coniferous and deciduous canopy remained relatively unchanged, however, the open area increased slightly. It appears that the riparian habitat has remained unchanged since 1995.

The unnamed tributary to Long Valley Creek (UNLV) and Alder Creek were not surveyed in 1995. Data from 2004 indicate that Alder Creek met canopy density target values while the unnamed tributary did not (Figures X and Y. Canopy Density and Vegetation Type of the Northern Subbasin in 1995 and 2004).

Overall, canopy density values are unchanged between 1995 and 2004 indicating that the riparian area remained the same. Low canopy density values are likely contributing to high water temperatures which are limiting the health and production of salmonids in the Northern Subbasin.



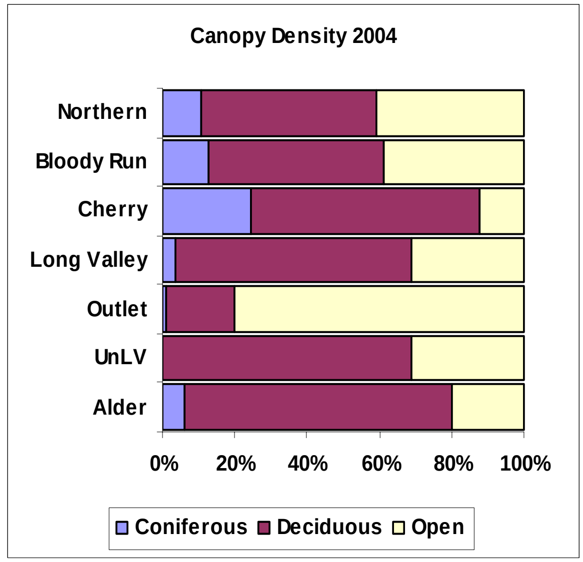


Figure X and Y. Canopy Density and Vegetation Type of the Northern Subbasin in 1995 and 2004.

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 the 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 Northern Subbasin was somewhat unsuitable and somewhat suitable, respectively. In 1995, Outlet Creek was mostly fully unsuitable and Long Valley was moderately unsuitable, while both had areas which were somewhat suitable. Both Cherry and Bloody Run creeks showed fully suitable canopy density condition. In 2004, 19 sites were surveyed which included 4 sites in Outlet, 10 sites in Long Valley, 2 in Cherry, and 1 each in Bloody Run, the unnamed tributary to Long Valley and Alder creeks. Three of the four sites in Outlet Creek were fully unsuitable, and one each was somewhat unsuitable. Overall, the canopy density was fully unsuitable in Outlet Creek. Two of the ten sites in Long Valley Creek were fully unsuitable, and one site each was somewhat and moderately unsuitable. Three sites were fully suitable, while two sites were moderately and one site was somewhat suitable. Overall, the canopy density was somewhat suitable in Long Valley Creek. The two sites in Cherry Creek were fully and moderately suitable. Bloody Run was somewhat suitable. Alder Creek was somewhat suitable while the unnamed tributary was somewhat unsuitable (Figure X and Y. EMDS Canopy Density Suitability in the Northern Subbasin in 1995 and 2004).

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

Outlet Creek Northern Subbasin Canopy Density

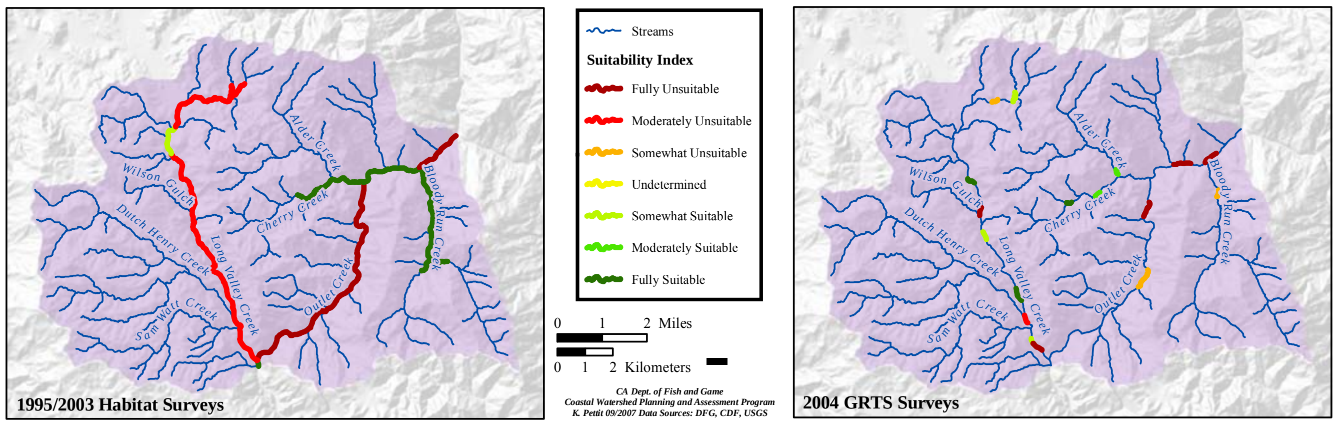


Figure X and Y. EMDS Canopy Density Suitability in the Northern Subbasin in 1995 and 2004.

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 remained relatively unchanged. However, in 1995, the habitat category measurements were averaged for all of the streams surveyed in the subbasin, whereas in 2004, 19 random sites were surveyed throughout the subbasin. In 2004, the dry habitat units were underestimated.

Between 1995 and 2004, pool habitat decreased, while riffle and flatwater habitats increased in the lower reach of Outlet Creek. Reduced pool habitat may indicate that sediment is aggrading and/or flows have been significantly reduced since 1995. Legal and illegal dewatering was actively occurring during the 2004 data collection period. It appears that the juvenile salmonid summer rearing habitat has decreased since 1995.

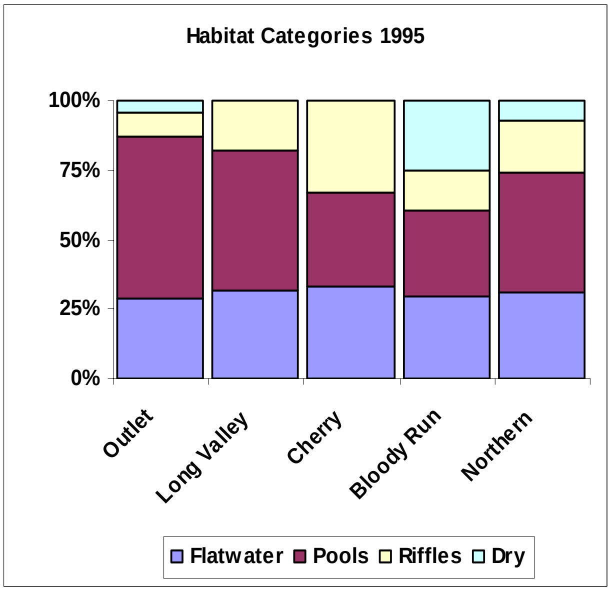
Between 1995 and 2004, pool habitat increased while flatwater decreased and riffle habitat remained unchanged in Long Valley Creek. Increased pool habitat may be indicative of sediment moving downstream, reduced legal and illegal dewatering, and/or positive impacts from restoration projects. However, 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, pool habitat increased while flatwater decreased and riffle habitat remained unchanged in Cherry 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.

Between 1995 and 2004, pool habitat increased while flatwater remained unchanged and riffle habitat increased in Bloody Run Creek. It appears that the juvenile salmonid summer rearing habitat has increased since 1995. In 2004, the dry habitat units were underestimated.

The unnamed tributary to Long Valley Creek (UNLV) and Alder Creek were not surveyed in 1995. Data from 2004 indicate that Alder Creek provides an adequate habitat category ratio. The unnamed tributary to Long Valley Creek was dominated by pools, but is an intermittent stream, thus provides no additional juvenile summer habitat and dry units were common on Alder Creek (Figures X and Y. Habitat Categories in the Northern Subbasin and its streams surveyed in 1995 and 2004).

Overall, since 1995 the habitat categories ratios have become more inadequate in the lower reach of Outlet Creek and Bloody Run Creek indicating that conditions have juvenile salmonids have declined. The pool habitat on Long Valley and Cherry creeks have increased indicating that over summer conditions for juvenile salmonids may have improved. Habitat category ratios are likely limiting the health and production of salmonids in the Northern Subbasin.



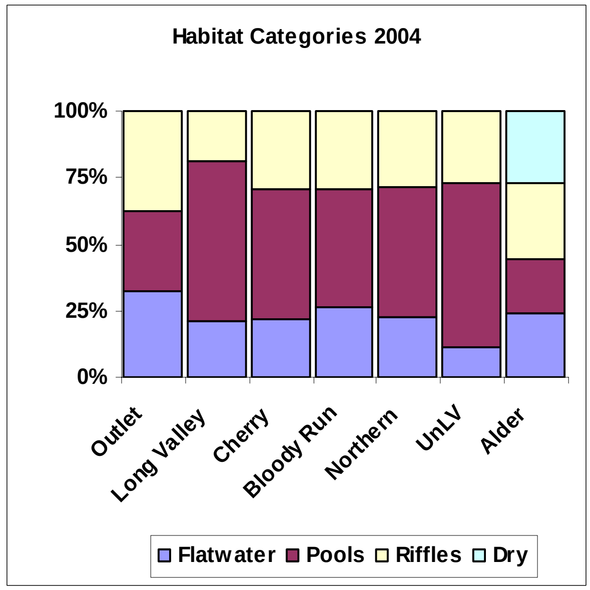


Fig X and Y. Habitat Categories in the Northern Subbasin and its streams surveyed in 1995 and 2004.

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 2ndt order streams require 40% of the pools to be 2 feet deep and deeper and 3rd order streams require to have 40% of the pools 3 feet deep and deeper. Pool shelter values of 100 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 Northern Subbasin surveyed were 1-2 feet. In 1995, pools over 4 feet and over were prevalent where in 2004, pools 2-3 were common. Between 1995 and 2004, pool habitat appears to have decreased in the Northern Subbasin. However, in 1995, the pool habitat measurements were averaged for all of the streams surveyed in the subbasin, whereas in 2004, 19 random sites were surveyed throughout the subbasin.

In 1995 and 2004, pools over 4 feet dominated Outlet Creek, a third order stream. In both 1995 and 2004, both pool frequency and pool depth target values were met in Outlet Creek. The pool habitat appears be unchanged between 1995 and 2004. However, the available pool habitat was unsuitable to juvenile salmonids due to poor water quality and high temperature, dominated by Sacramento pike minnow, and had several legal and illegal sites where dewatering had dried sections between the pools in 2004.

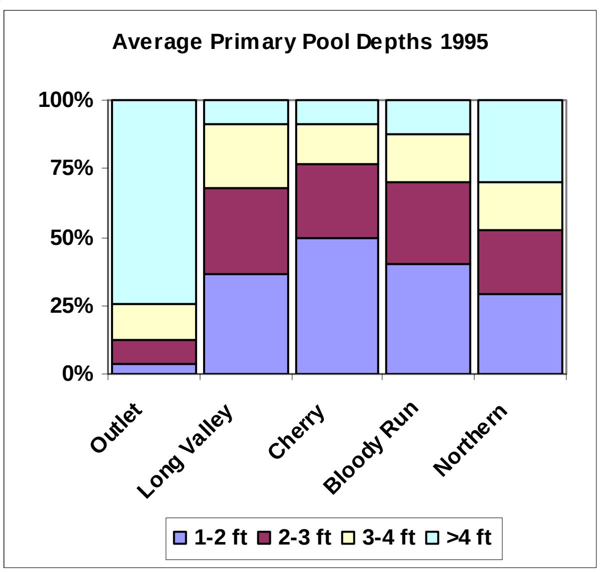
In 1995 and 2004, 1-2 foot pools dominated Long Valley Creek, a second order stream. In 1995 and 2004, pool frequency and pool depth target values were met. Although the pool target values were met, juvenile salmonids were affected by poor water quality, high temperature, and several dewatered sites below the Rest Area bridge.

In 1995 and 2004, 1-2 foot pools feet dominated Cherry Creek, a second order stream. In 1995 and 2004, pool frequency and pool depth target values were met. The available pool habitat in the upper reach provides suitable habitat to rainbow trout while the lower reaches were somewhat unsuitable to juvenile steelhead. The lower reach was disconnected from Outlet Creek due to subsurface flow in 2004.

In 1995, 1-2 foot deep pools dominated Bloody Run Creek, a first order stream. In 2004, Bloody Run Creek was dominated by 2-3 foot pools which are a reflection of the sites surveyed and not an actual increase in pool depth. In 1995 and 2004, pool frequency and pool depth target values were met. However, the upper reach was completely dry in September when we returned to conduct snorkel surveys and lower reach was disconnected from Outlet Creek due to subsurface flow in 2004. Bloody Run Creek provides small amounts of suitable pool habitat in the lower reach.

The unnamed tributary to Long Valley Creek (UNLV) and Alder Creek were not surveyed in 1995. Data from 2004 in Alder Creek indicate that the majority of the flow dries in the late summer and early summer. The unnamed tributary to Long Valley Creek dries up in the late summer and early fall, thus provides no additional juvenile summer habitat (Figure X. and Y. Primary pool depths of stream surveyed in the Northern Subbasin in 1995 and 2004).

Overall, since 1995 the pool frequency and depth is unchanged in the lower reach of Outlet Creek. However, the pool suitability does not incorporate water quality data. Cherry Creek appears to be unchanged. Private landowners in the Cherry Creek watershed have been active in restoration projects from 1995-2004. Alder and Bloody Run creeks provide some suitable pool habitat. Pool frequency and depth are limiting the health and production of salmonids in the Northern Subbasin.



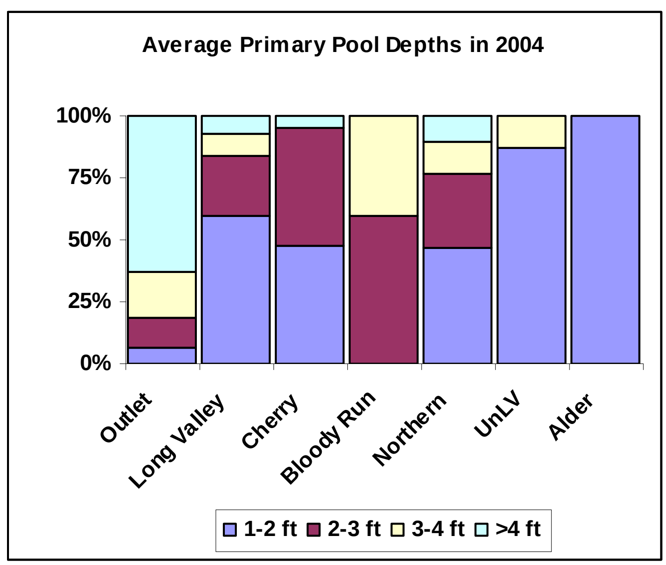


Figure X. and Y. Primary pool depths of stream surveyed in the Northern Subbasin in 1995 and 2004.

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 the 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 depth condition in the Northern Subbasin was moderately suitable and somewhat unsuitable, respectively. In 1995, most of Outlet and the lower reaches of Long Valley were fully suitable. Cherry Creek was somewhat unsuitable. Both Bloody Run and the upper reach of Long Valley creeks were fully unsuitable. Alder and the unnamed tributary to Long Valley were not surveyed in 1995.

In 2004, 19 sites were surveyed which included 4 sites in Outlet, 10 sites in Long Valley, 2 in Cherry, and 1 each in Bloody Run, the unnamed tributary to Long Valley, and Alder creeks. Two of the four sites in Outlet Creek were fully unsuitable, one each was moderately unsuitable and fully suitable. Overall, the pool shelter was somewhat unsuitable in Outlet Creek.

Seven of the ten sites in Long Valley Creek were fully unsuitable and three sites were fully suitable. Overall, the pool depth was somewhat suitable in Long Valley Creek. Both sites in Cherry Creek were fully unsuitable while Bloody Run was fully suitable. Alder Creek and the unnamed tributary were fully unsuitable (Figure X and Y. EMDS Pool Depth Suitability in the Northern Subbasin in 1995 and 2004).

The EMDS results show that the pool depth conditions in the subbasin have declined between 1995 and 2004. Major restoration efforts should be focused on improving pool depths and located in areas with unsuitable EMDS ratings.

Outlet Creek Northern Subbasin Pool Depth

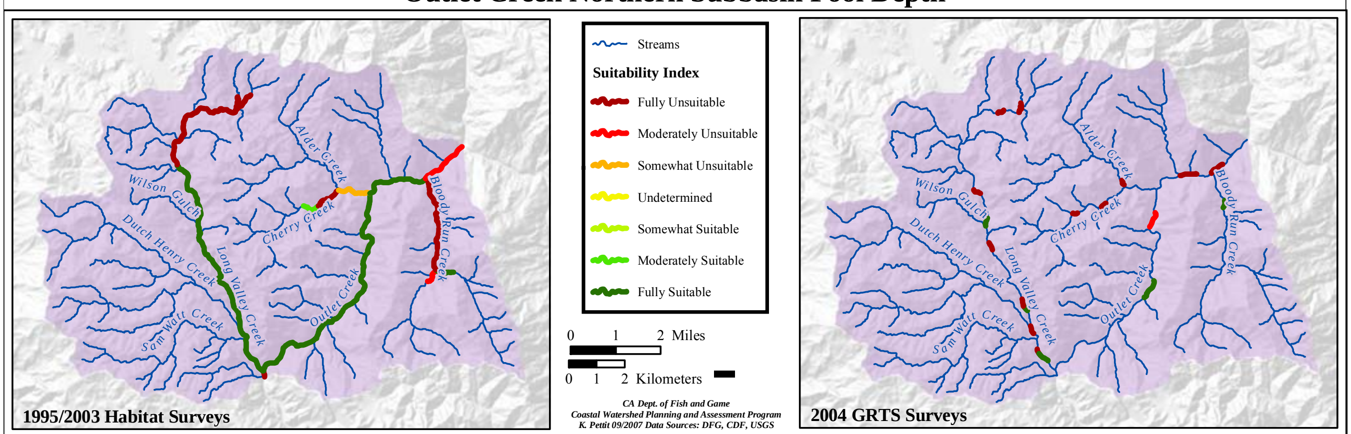


Figure X and Y. EMDS Pool Depth Suitability in the Northern Subbasin in 1995 and 2004.

In 1995 and 2004, the dominant source of shelter in pool was provided by boulders in the Northern Subbasin. In both 1995 and 2004, terrestrial vegetation was a secondary source. Bedrock ledges, aquatic vegetations, undercut banks, and small woody debris (SWD) were measured during both surveys. Both white water and large woody debris (LWD) provided the least shelter. The increase observed in LWD may be a reflection of recent restoration projects in the subbasin. However, in 1995, the pool shelter measurements were averaged for all of the streams surveyed in the subbasin, whereas in 2004, 19 random sites were surveyed throughout the subbasin (Figure X and Y. Average frequency and source of pool shelter in the Northern Subbasin in 1995 and 2004).

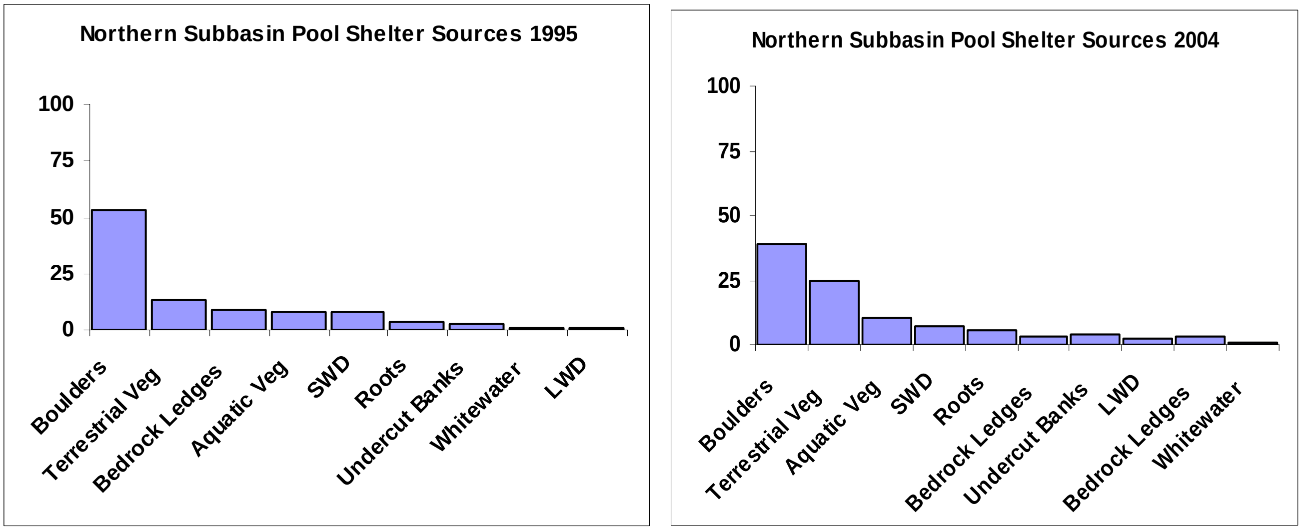


Figure X and Y. Average frequency and source of pool shelter in the Northern Subbasin in 1995 and 2004.

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, boulders, terrestrial vegetation and SWD were dominant in the Northern Subbasin. The shelter values for the streams surveyed in both 1995 and 2004 were 28 and 34, respectively. This range does not include the unnamed tributary to Long Valley nor Alder creeks. 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 Outlet Creek. Additional shelter was composed of SWD, terrestrial vegetation, and roots. The shelter values in 1995 and 2004 were 28 and 31, respectively. The target values were not met during either of the years surveyed. Outlet Creek is lacking LWD, root wads, and terrestrial vegetation, thus pool shelter composition could be greatly enhanced by adding these shelter types.

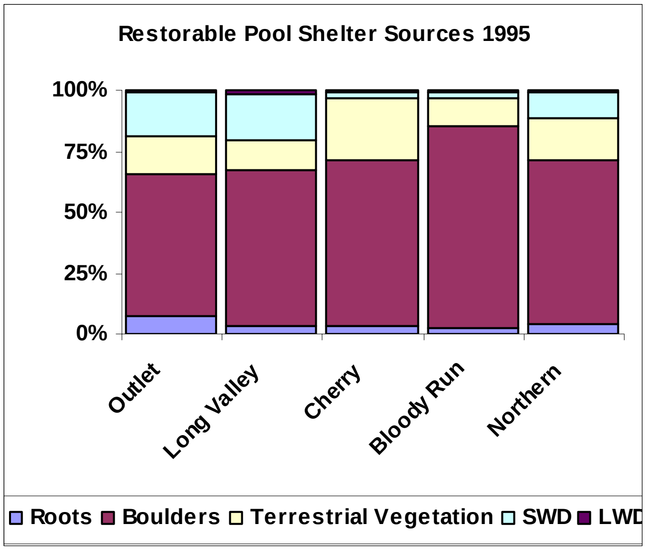
In 1995 and 2004, boulders dominated the pool shelter of Long Valley Creek. Additional shelter was composed of SWD, terrestrial vegetation, and roots. The shelter values in 1995 and 2004 were 56 and 39, respectively. The target values were not met during either of the years surveyed. Long Valley Creek is lacking LWD, root wads, SWD, and terrestrial vegetation, thus pool shelter composition could be greatly enhanced by adding these shelter types. The decrease in shelter values from 1995 and 2004 may correlate with the decrease in SWD which could have been transported downstream into Outlet Creek during high winter flow conditions.

In 1995 and 2004, boulders dominated the pool shelter of Cherry Creek. Additional shelter was composed of terrestrial vegetation. In 2004, root wads and SWD were likely present due to the restoration efforts by the landowners. The shelter values in 1995 and 2004 were 9 and 29, respectively. The target values were not met during either of the years surveyed, but increased significantly in 2004. Cherry Creek is lacking LWD and root wads, thus pool shelter composition could be greatly enhanced by adding these shelter types.

In 1995, boulders dominated the pool shelter of Bloody Run Creek. In 2004, terrestrial vegetation dominated. Additional shelter was root wads and SWD. The shelter values in 1995 and 2004 were 19 and 30, respectively. The target values were not met during either of the years surveyed. Bloody Run Creek is lacking LWD, thus pool shelter composition could be greatly enhanced by adding these shelter types.

The unnamed tributary to Long Valley Creek (UNLV) and Alder Creek were not surveyed in 1995. Data from 2004 indicate that Alder Creek and the unnamed tributary to Long Valley Creek were dominated by boulders and terrestrial vegetation. Both streams could be greatly enhanced by adding LWD and root wads (Figure X and Y. Restorable pools shelter sources in the Northern Subbasin in 1995 and 2004).

Overall, since 1995, although the target values were not met, the pool shelter has slightly improved in the Northern Subbasin and in 3 out of the 4 streams surveyed. This may be indicative of recovery of the riparian from legacy timber removal prior to the adoption of the Forest Practice Rules. Pool shelter is limiting the health and production of salmonids in the Northern Subbasin.



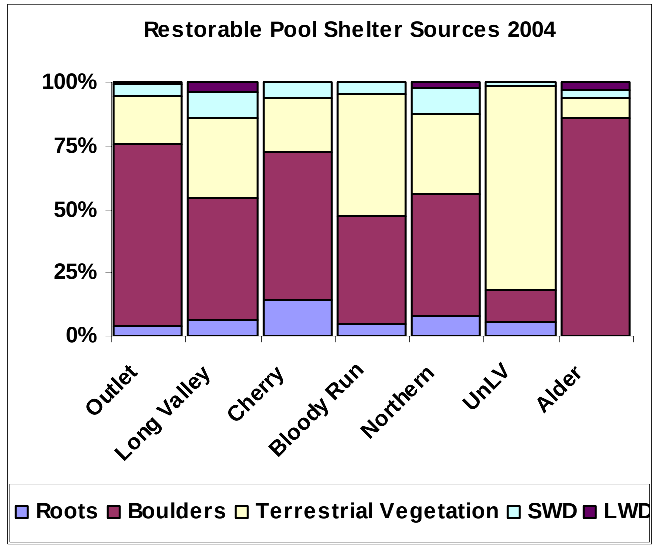


Figure X and Y. Restorable pools shelter sources in the Northern Subbasin in 1995 and 2004.

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 the 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 condition in the Northern Subbasin was moderately and somewhat unsuitable, respectively. In 1995, Outlet, Bloody Run, and a small section of the upper reach of Long Valley creeks were fully unsuitable. The upper reach of Long Valley Creek was somewhat unsuitable. In 2004, 19 sites were surveyed which included 4 sites in Outlet, 10 sites in Long Valley, 2 in Cherry, and 1 each in Bloody Run, the unnamed tributary to Long Valley, and Alder creeks. Sixteen out of 19 sites were either moderately or fully unsuitable while the remaining 3 sites were somewhat unsuitable (Figure X and Y. EMDS Pool Shelter Suitability in the Northern Subbasin in 1995 and 2004).

The EMDS results show that the pool shelter conditions in the subbasin have declined between 1995 and 2004. Most restoration efforts should be focused on improving pool shelter in the Northern Subbasin in areas with unsuitable EMDS ratings.

Outlet Creek Northern Subbasin Pool Shelter

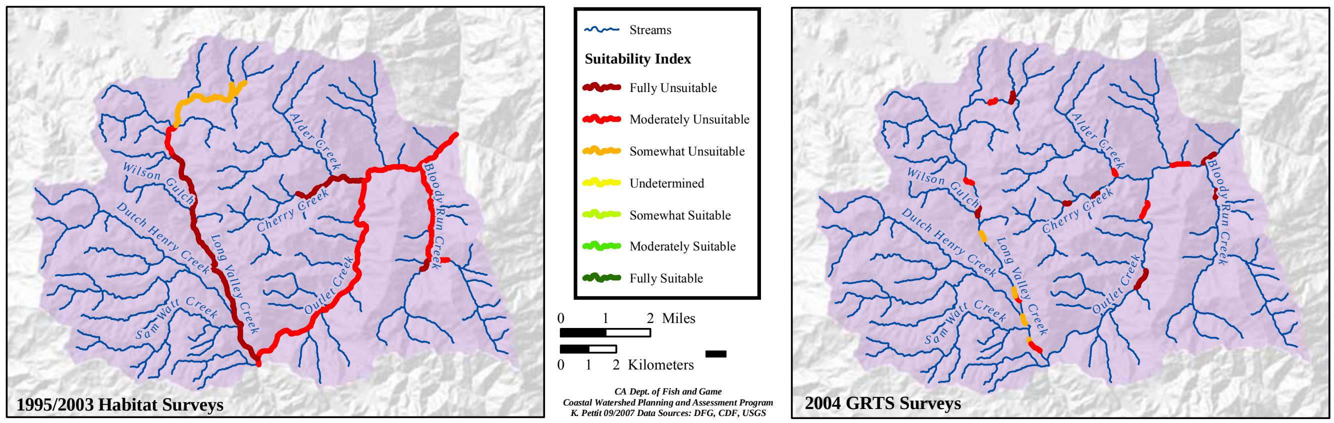


Figure X and Y. EMDS Pool Shelter Suitability in the Northern Subbasin in 1995 and 2004.

Ecological Management Decision Support (EMDS) Reach Conditions

The anadromous Subbasin EMDS evaluates the condition of stream reaches. EMDS calculations and conclusions are pertinent only to surveyed streams in 1995 and the 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 both 1995 and 2004, the overall reach conditions in the Northern Subbasin were somewhat unsuitable. In 1995, Outlet, Long Valley, Cherry and Bloody Run creeks were somewhat unsuitable, while a small section of lower Outlet Creek was somewhat suitable. In 2004, 19 sites were surveyed which included 4 sites in Outlet, 10 sites in Long Valley, 2 in Cherry, and 1 each in Bloody Run, the unnamed tributary to Long Valley, and Alder creeks. Eighteen out of 19 sites were somewhat unsuitable while one site was undetermined (Figure X and Y. EMDS Reach Condition Suitability in the Northern 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 in the Northern Subbasin. Projects which focus on increasing pool depth while increasing pool shelter should be the highest priority while increasing canopy cover to reduce water temperatures secondary. 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 Northern Subbasin.

Outlet Creek Northern Subbasin Reach Condition

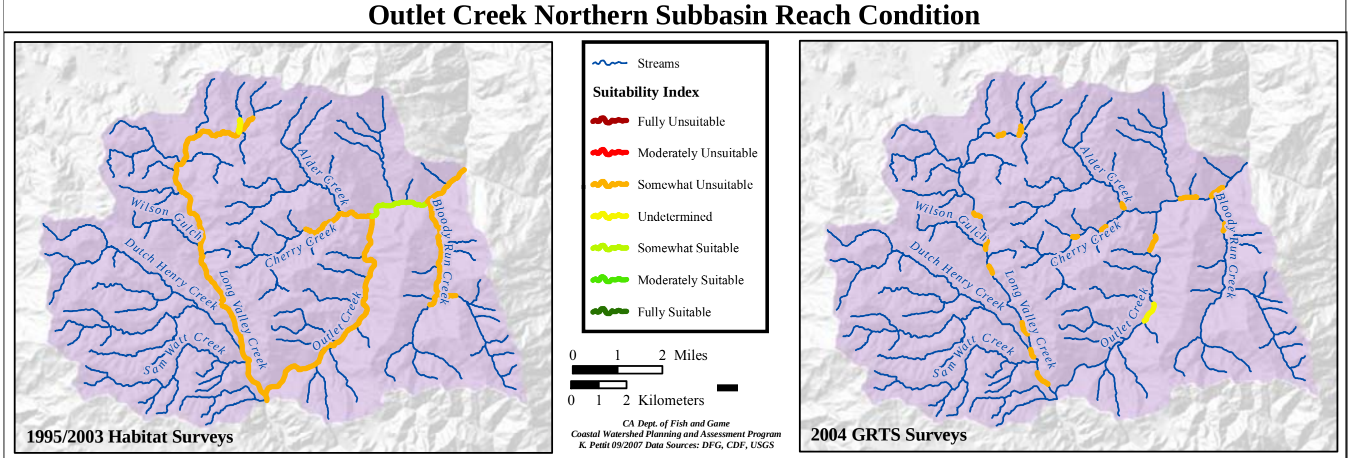


Figure X and Y. EMDS Reach Condition Suitability in the Northern Subbasin in 1995 and 2004.

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 11 partial barriers blocking about 9 miles of stream plus 5 of unknown status in the Northern subbasin. Two partial and 5 unknown barriers on Outlet Creek. Eight partial barriers on Long Valley Creek. One partial barrier on Bloody Run. No known barriers on Alder or Cherry creeks (Table X. Fish Passage Barriers in the Northern Subbasin.)

Table X. Fish Passage Barriers in the Northern Subbasin

Stream	Complete	Partial	Unknown	Estimated Miles of Blocked
Outlet	0	2	5	ND
Long Valley	0	8	0	8.5
Bloody Run	0	1	0	ND
Cherry	0	0	0	ND
Alder	0	0	0	ND
Northern	0	11	5	8.5

Analysis of Tributary Recommendations

In order to compare the frequency with which recommendations were made within the Northern 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 (Table X. Occurrence of improvement Recommendations Summary of the Northern Subbasin). All six tributaries had Pool and Shelter recommendations. Canopy and spawning gravel recommendations were made for 5 out of 6 tributaries surveyed. The top three recommendations for the entire basin in order of importance were Spawning Gravel, Shelter, and then Pool.

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	Wildlife Livestock	Fish Passage
Outlet	4	8,108	4		3	2	5	6	7			1
Long Valley	10	9,332		4	1		2	3	5			
Cherry	2	1,402	1	4			2	3				
Bloody Run	1	894			2	1	3	4	5			
Unnamed LV	1	577	2		3	4	5	6	8		1	1
Alder	1	673		2	3	1	5	4	6			
Northern	19	20,950	7	10	12	8	22	26	31	0	1	2

In order to further examine the issues, the 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 Northern Subbasin). When examining recommendation categories by number of tributaries, the most important Recommendation Category in Northern Subbasin was Instream Habitat and Gravel/Substrate (Table X. Distribution of recommendation categories in the Northern Subbasin).

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

Stream	Erosion/Sediment	Riparian/Temperature	Instream Habitat	Gravel/Substrate	Other
Outlet	4	5	11	7	1
Long Valley	4	1	5	5	0
Cherry	5	0	5	0	0
Bloody Run	0	3	7	5	0
Unnamed LV	2	7	11	8	2
Alder	2	4	9	6	0
Northern	17	20	48	31	3

However, comparing recommendation categories between streams could be confounded by the differences in the survey distance measured. Of the six streams evaluated, 20,095 stream feet were surveyed in the Northern 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 recommendation category was calculated for each stream.

Instream Habitat was the most important recommendation category followed Gravel/Substrate, Erosion/Sediment and Riparian/Water Temperature in the Northern Subbasin. Therefore, the number one priority rankings remained the same for the Northern Subbasin and streams whether assessed by the number of tributaries or the percentage of stream feet. Additionally, the overall rankings of Recommendation Categories in the Northern Subbasin as a whole remained the same in both analyses.

The high number of Instream Habitat and Gravel/Substrate Recommendations across the Northern Subbasin indicates that high priority should be given to restoration projects emphasizing pools, shelter, and reflects the lack of suitable spawning substrate and the opportunity to implement both retention and addition of gravel where appropriate. The Riparian/Temperature Recommendation indicate that summer and fall flows must be protected from legal and illegal water extraction, enforce bypass flows from the six dams in the Southern Subbasin and replanting and protecting the riparian habitat.

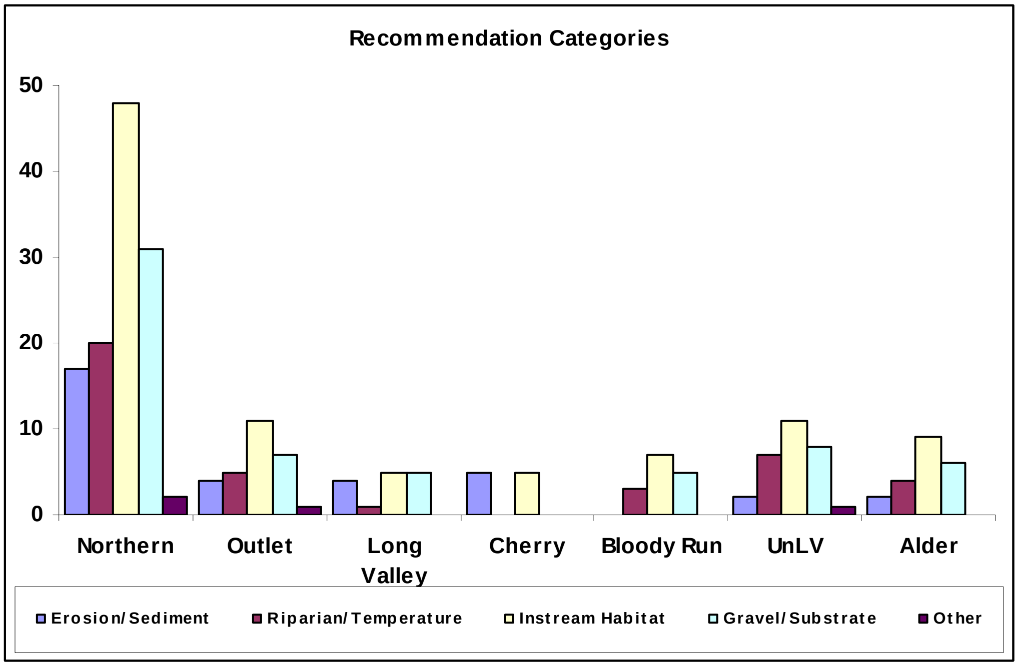


Figure X. Frequency of recommendation categories in the streams surveyed in the Northern Subbasin.

Limiting Factors

A main objective of this assessment was to identify factors that limit production of anadromous salmonid populations in the Southern Subbasin and its streams. This process is known as a limiting factors analysis (LFA). One component of the program 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 Northern 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 erosion and fine sediment. In the Northern Subbasin most limiting factors center around flow and water quality and fine sediment. Table X. and Figure X. detail the subbasin's limiting factors and their associated locations.

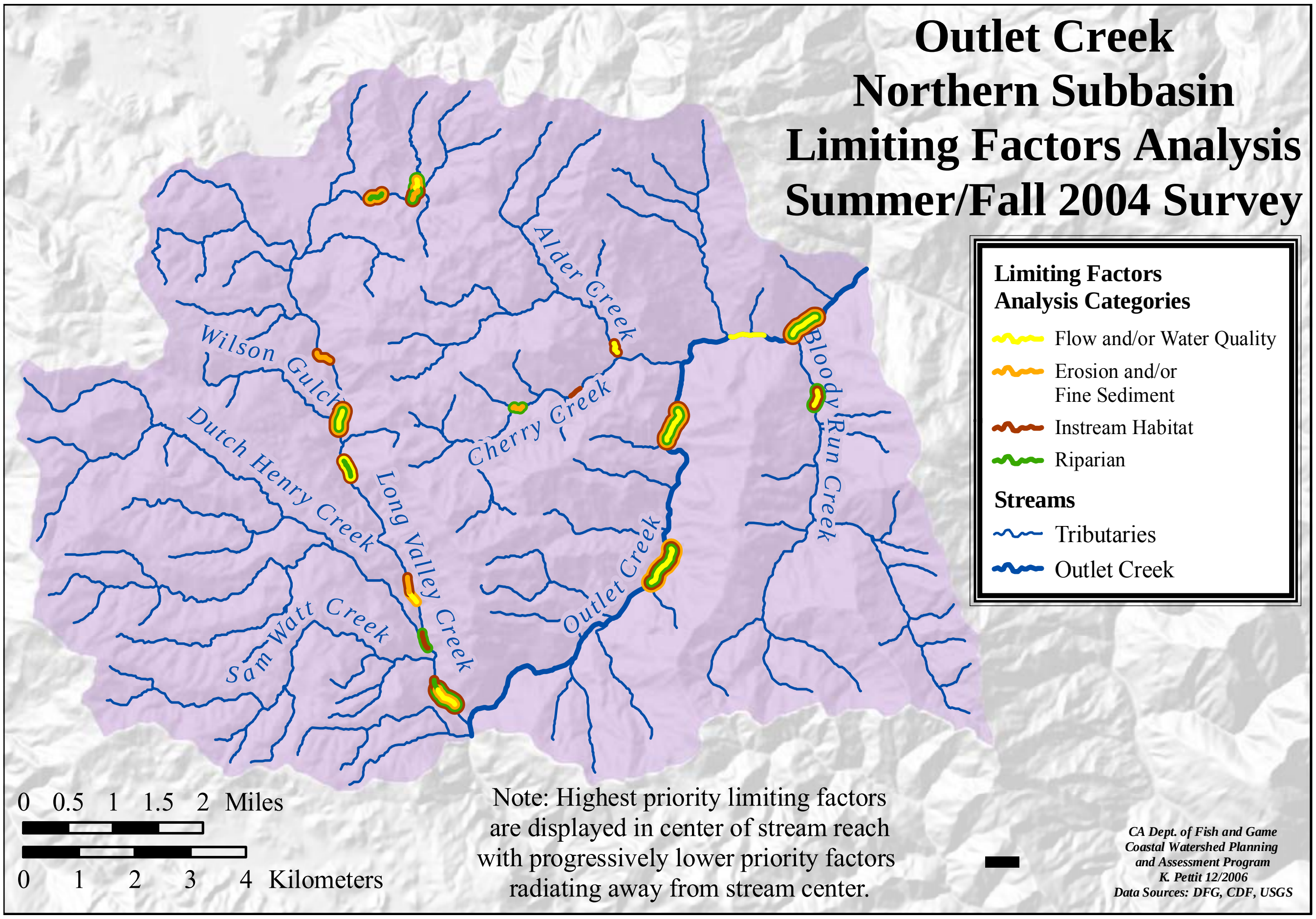


Figure X. Outlet Creek Northern Subbasin Limiting Factors Analysis- 2004.

Table X: Limiting Factors Analysis of the Northern Subbasin.

Limiting Factor		*Outlet*	*Alder*	*Bloody Run*	*Cherry*	*Long Valley*
Flow and Water Quality	Low and/or absent flow in August and September	X		X		
	Low and/or absent flow during November	X				
	High summer water temperatures	X				X
	Subsurface flows obstructing fish migration	X		X		
Erosion and Fine Sediment	Bank and debris slide erosion	X				X
	Fine sediment from roads, culverts, and land use activities.	X	X	X	X	
	Bank erosion from livestock, feral pigs, and/or other wildlife.		X			X
Riparian and Instream Habitat	Low canopy density	X		X		
	Inadequate structure, like large woody debris.	X	X	X	X	
	Inadequate pool depth and frequency	X		X		
	Barriers to migration	X				
	Channelized and leveed stream banks	X				

Refugia Areas

Refugia Habitat was identified and characterized in the Northern 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 Northern 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 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 generally somewhat worse in the Northern Subbasin than in the Middle or Southern subbasins. The following refugia area rating map summarizes subbasin salmonid refugia conditions:

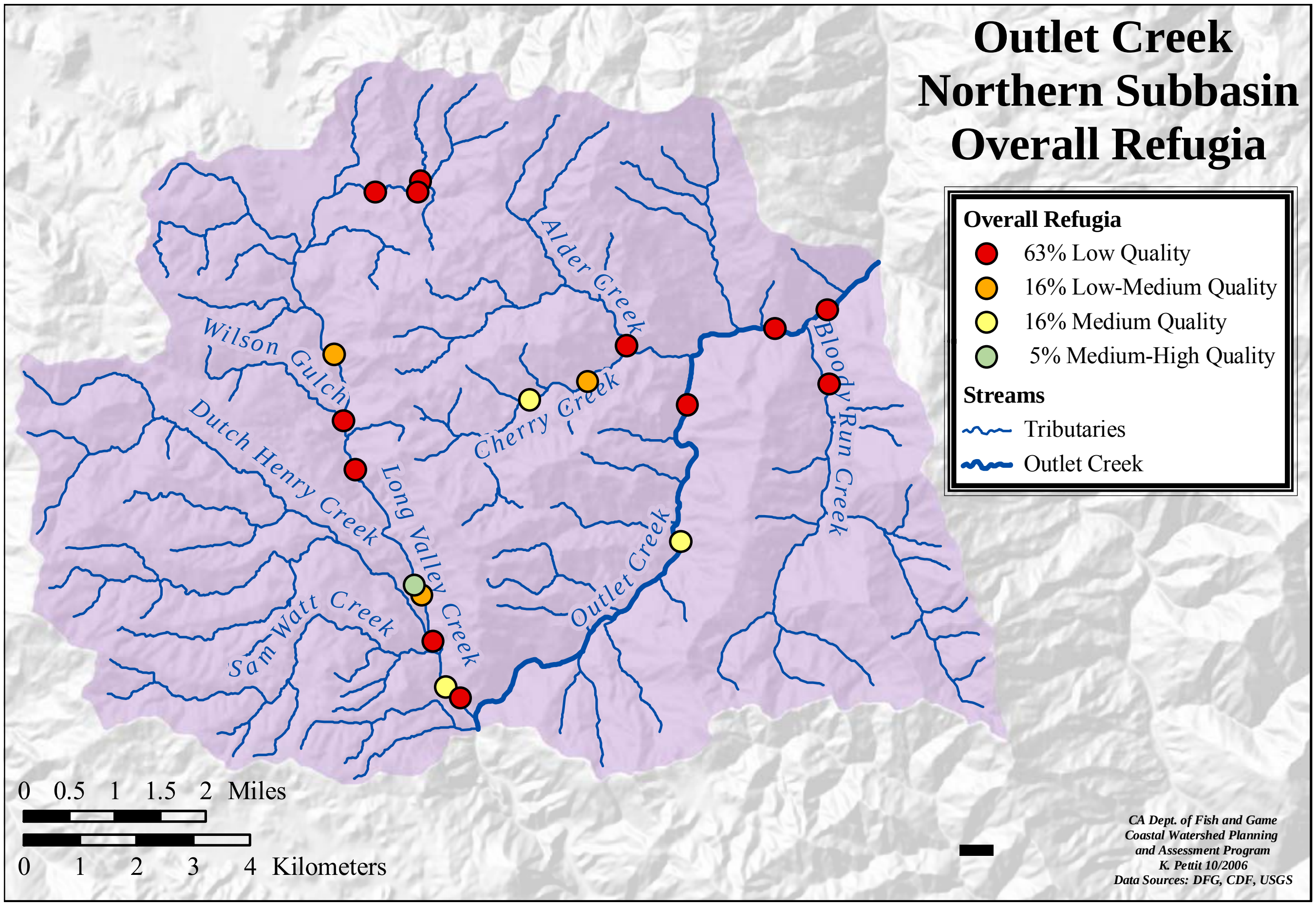


Figure ***X. Outlet Creek Northern Subbasin Overall Refugia***

Responses to Assessment Questions

What are the history and trends of the sizes, distribution, and relative health and diversity of salmonid populations in the Northern Subbasin?

__Findings and Conclusions:__

- Chinook and coho salmon, steelhead, and rainbow trout inhabit this subbasin, although coho salmon have been infrequently observed in the recent past;
- Adult salmonids migrate from the Pacific Ocean into the Eel River System and move up into Outlet Creek on their way to spawn in this subbasin, and the Middle and Southern subbasins;
- Juveniles salmonids move down into this subbasin from the Southern and Middle subbasins on their way to the main stem 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 Ten Pool protocol at the GRTS survey sites which had some flow. No juvenile salmonids were observed at any of the sites surveyed;
- The summer and fall water temperatures and low flow conditions in this subbasin are more supportive to the Chinook life history than other salmonid species;
- Several species have been introduced such as Sacramento pike minnow, big and small mouth bass, sunfish and bull frogs which predate on and out-compete juvenile salmonids.

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

Findings and Conclusions:

Flow/Water Quality

- Summer water temperatures were a limiting factor in all of the creeks sampled from 2000-04, except on Bloody Run Creek. Bloody Run Creek may provide some thermal refugia to juvenile steelhead trout;
- The five year average summer water temperature for the sites sampled was 74.2F (23.5C) which is considered unsuitable, almost lethal. The temperatures ranged from 63.8-79.7;
- In 2004, five out of six MWAT sites became unsuitable or lethal between July 3-29. Bloody Run Creek had somewhat suitable summer water temperatures;
- The turbidity and conductivity ranges were 0.45-23.0 NTU and 249-2080Ω.

Fish Passage

- The six dams located upstream in the Southern Subbasin which restrict flow and slow and/or retard the adult spawning migration into Outlet Creek from the main stem Eel;
- 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;
- There are a total of 11 partial barriers blocking about 9 miles of stream plus 5 of unknown status in the Northern Subbasin.

Erosion/Sediment

- Bank erosion, unimproved and unpaved roads, legacy railroad beds, and road-related gullies are the most common fine sediment sources;
- Outlet, Long Valley, and Cherry creeks may supply fine sediment from eroding stream banks, which maybe increasing the embeddedness levels on these streams. The stream banks on Bloody Run Creek are not likely contributing fine sediment into the channel;
- Overall, embeddedness values have increased and available spawning substrate has decreased between 1995 and 2004 and in the streams surveyed, except for Cherry Creek;
- High embeddedness values are likely limiting the health and production of salmonids.

Riparian Condition

- Overall, canopy density values are unchanged between 1995 and 2004 indicating that the riparian area remained the same;
- Low canopy density values are likely contributing to high water temperatures which are limiting the health and production of salmonids;
- The EMDS results show that the canopy density in some areas in the Shave improved between 1995 and 2004.

Instream Habitat

- Overall, since 1995 the habitat categories ratios have become more inadequate in the lower reach of Outlet Creek and Bloody Run Creek indicating that conditions have juvenile salmonids have declined;
- The pool habitat on Long Valley and Cherry creeks have increased indicating that over summer conditions for juvenile salmonids may have improved;
- Habitat category ratios are likely limiting the health and production of salmonids;
- The EMDS results show that the pool depth and pool shelter conditions in the subbasin have declined between 1995 and 2004;
- The EMDS results show that the reach conditions in the subbasin are unchanged between 1995 and 2004.

Gravel/Substrate

- The lower reaches of the streams are characterized by low gradient, low sinuosity and depositional with gravel, cobble, and bedrock dominated substrates. The upper reaches are higher gradient with boulder and bedrock substrates;

- Overall, embeddedness values have increased and available spawning substrate has decreased between 1995 and 2004 in the subbasin and in the streams surveyed except for Cherry Creek;
- High embeddedness values are likely limiting the health and production of salmonids in the Northern Subbasin.

Refugia Areas

- Most juvenile salmonid habitat conditions (79%) are of low or low-medium quality. Only 5% was medium high quality and was located on Long Valley Creek.

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

Findings and Conclusions:

Hydrology

- There are approximately 28 miles of blueline streams which range in elevation between 1,000 and 3,000 feet;
- Outlet, Bloody Run, Cherry, and Long Valley creeks are the largest perennial streams. Outlet Creek becomes a third order stream at the confluence with Little Lake Valley, while the remaining streams are first and second order, or intermittent;
- The channel characteristics range from moderately entrenched to braided and meandering;
- Late fall and early winter rainfall is impounded by six dams located in the Southern Subbasin. Impounding this flow inhibits the upstream adult Chinook and coho salmon spawning migration up the Eel River System into the Outlet Creek;
- During the late summer and early fall, flows become subsurface in some the tributaries and Outlet Creek, stranding juvenile salmonids;
- Natural low flow conditions are severely reduced by legal and illegal dewatering;
- The average precipitation is approximately 45 inches per year which mainly falls as rain.

Geology

- The dominant geology is Coastal Belt. The geology, topography, and climate combine to cause high erosion which contributes fine sediment to Outlet Creek from this, and which moves downstream 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, star thistle, Himalayan blackberry, and *Arundo*.

How has land use affected these natural processes?

- The land uses include grazing, timber production, and large rural residential properties which can change the composition of the vegetation and reduce surface water flow and aquifer dynamics;
- 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?

Findings and Conclusions:

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

- Low and/or absent flows in August and September;
- Low and/or absent flows in November;
- High summer water temperatures;
- Subsurface flows obstructing fish migration;
- Fine sediment from bank erosion, debris slide erosion, roads, culverts, livestock, feral pigs and other land use activities;
- Bank erosion for wildlife;
- 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?

Flow and Water Quality Improvement Activities

- Enforce regulations to eliminate water extraction in July, August, and September, especially in Outlet and Long Valley Creeks;
- 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 and out of Lake Emily;
- Replace and/or eliminate culverts which inhibit migration;

Erosion and Sediment Delivery Reduction Activities

- Pave and improved rural roads to reduce erosion which contributes fine sediment to the streams;

Riparian and Instream Habitat Improvement Activities

- Restoration efforts focused on improving canopy be located in streams with unsuitable EMDS ratings such as Outlet, Long Valley, and Bloody Run creeks;
- Major restoration efforts should be focused on improving pool depths and shelter, and located in steams with unsuitable EMDS ratings such as Outlet, Long Valley, and Cherry creeks;
- 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;
- CDFG should continue and expand existing monitoring of anadromous salmonid populations to include some winter spawning and redd and spring/summer juvenile surveys;

- Support new stream gage installation and maintenance to establish long term records;
- Start new and continue current water temperature and quality monitoring at current locations and expand 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 Northern Subbasin

Location	Improvement Activity	DFG FRGP	Coho Recovery Plan Task Numbers	Steelhead Recovery Plan Task Numbers	CWPAP Priority
Long Valley; Outlet	Identify, dismantle and cite illegal water extraction.	HR	RW-II-A-02		1
Outlet; Reeves; Ryan	Continue and expand water quality (temperature, dissolved oxygen, and fine sediment) monitoring.	HR	RW-II-A-02		2
Long Valley; Outlet	Conserve water during the summer and fall months.	WC	RW-XXXIII-A-01 ER-OC-02b-d		1
Alder; Bloody Run; Cherry; Long Valley; Outlet	Identify sediment sources.	HS	RW-VI-a-02 RW-VI-D-01C		1
Alder; Bloody Run; Cherry; Long Valley; Outlet	Reduce bank erosion. Reduce fine sediment input from roads, culverts, and other land use activities.	HS	RW-VI-a-02 RW-VI-D-01C		1
Outlet	Reduce sediment input from debris slides where possible.	HS	RW-VI-a-02 RW-VI-D-01C		2
Alder; Bloody Run; Cherry; Long Valley; Outlet	Revegetate stream banks to develop and expand canopy.	HI	RW-XXII-A-04		2
Alder; Bloody Run; Cherry; Long Valley; Outlet	Add large woody debris and other structure to increase cover and pool depth and frequency.	HI	RW-XXII-A-04	NC-08	2
Alder; Bloody Run; Cherry; Long Valley; Outlet	Use exclusion fencing where erosion caused by grazing livestock.	HI	RW-XXII-A-02		2
Long Valley	Removal barriers to migration.	FP	RW-XXII-A-04	NC-02 and 03; NC-24	1
Outlet	Reinstall USGS Stream gage at Long vale.	MD	RW-II-A-02		2

Northern Subbasin Conclusions

The Northern Subbasin is the most unsuitable, for salmonid habitat, within the Outlet Basin. Much of this subbasin is privately owned. Salmon and steelhead habitat conditions in the Northern 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 practices and enlisting the aid and support of agency funding opportunities.