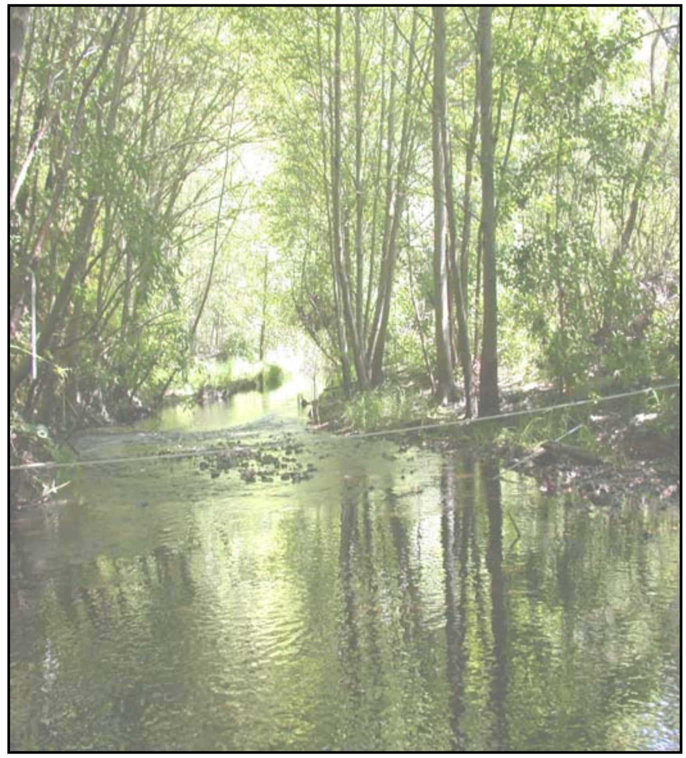
Middle Subbasin
Findings and Recommendation

Overview



The Middle Subbasin begins at the confluence with Long Valley Creek and extends upstream to the northern end of Little Lake Valley, just north of Willits. The Middle Subbasin has an area of 34 square miles (9,958 acres) and represents approximately 11% of the Outlet Creek Basin.

There is no principle community. Ninety-nine percent of the Subbasin is privately owned. The population is estimated at 1,065 residents.

The dominant geology is Coastal Belt. The geology, topography and climate combine to cause high erosion and fine sediment contribution to Outlet Creek, from both this subbasin and the Southern Subbasin, which moves downstream into the Eel River and its estuary. Open grasslands, oak woodlands, and mixed coniferous forest cover the both the east and west side hills. The land uses include agriculture, grazing, ranching, timber production, and large rural residential properties.

The average precipitation is approximately 45 inches per year which mainly falls as rain. There are approximately 12 miles of blueline streams which range in elevation between 1,150 to 2,400 feet.

Chinook and coho salmon and steelhead spawn, rear, and migrate through this subbasin on their way to and from the Pacific Ocean some 140 RM away. Chinook salmon juveniles move downstream from the Southern Subbasin into the Middle and Southern 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.

Otter are commonly observed while beaver have only recently been observed in the subbasin. Several species have been introduced such big and small mouth bass, sunfish, and bull frogs. The later species heavily predates on juvenile salmonids. Invasive plant species included periwinkle, pampas grass, star thistle, Himalayan blackberry, and *Arundo.* Sacramento pike minnow were not observed in this subbasin during this study.

Outlet Creek, a 3rd order stream, and Reeves Canyon, Sherwood, Rowes, Curly Cow and Ryan creeks, which are intermittent, are the largest perennial streams (Table X. Attributes of the main tributaries in the Middle Subbasin and Figure X. Middle Subbasin showing large streams and stream order). Outlet Creek is a 3rd order stream between Little Lake and Long Valley Creek. The channel characteristics range from moderately entrenched and riffle dominated to well entrenched and riffle/pool dominated. The substrate in these reaches is comprised of cobble, gravel, and fine sediment. Outlet Creek is characterized by low gradient, low sinuosity, and depositional conditions.

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

Stream	Length (Mi)	Stream Order	Channel Type	Characteristics
Outlet	7.1	3rd	F3	The channel is entrenched, meandering, and dominated by low gradient riffles composed of cobble substrate with mixed gravel and fine sediment. Boulders are a result of bank stabilization. Flows become intermittent during the summer and fall.
Ryan	1.2	Intermittent	B2, F4	The lower reach is moderately entrenched, riffle dominated with a moderate gradient and boulder dominated substrate. The middle reach is low gradient, low sinuosity, dominated by runs composed of gravel. The upper reach is higher gradient, dominated by riffles composed of cobble.
Reeves Canyon	1.9	Intermittent	B2, F4	The gradient is less than 2% and is well confined, slightly entrenched, with the lower reach having leveed stream banks.

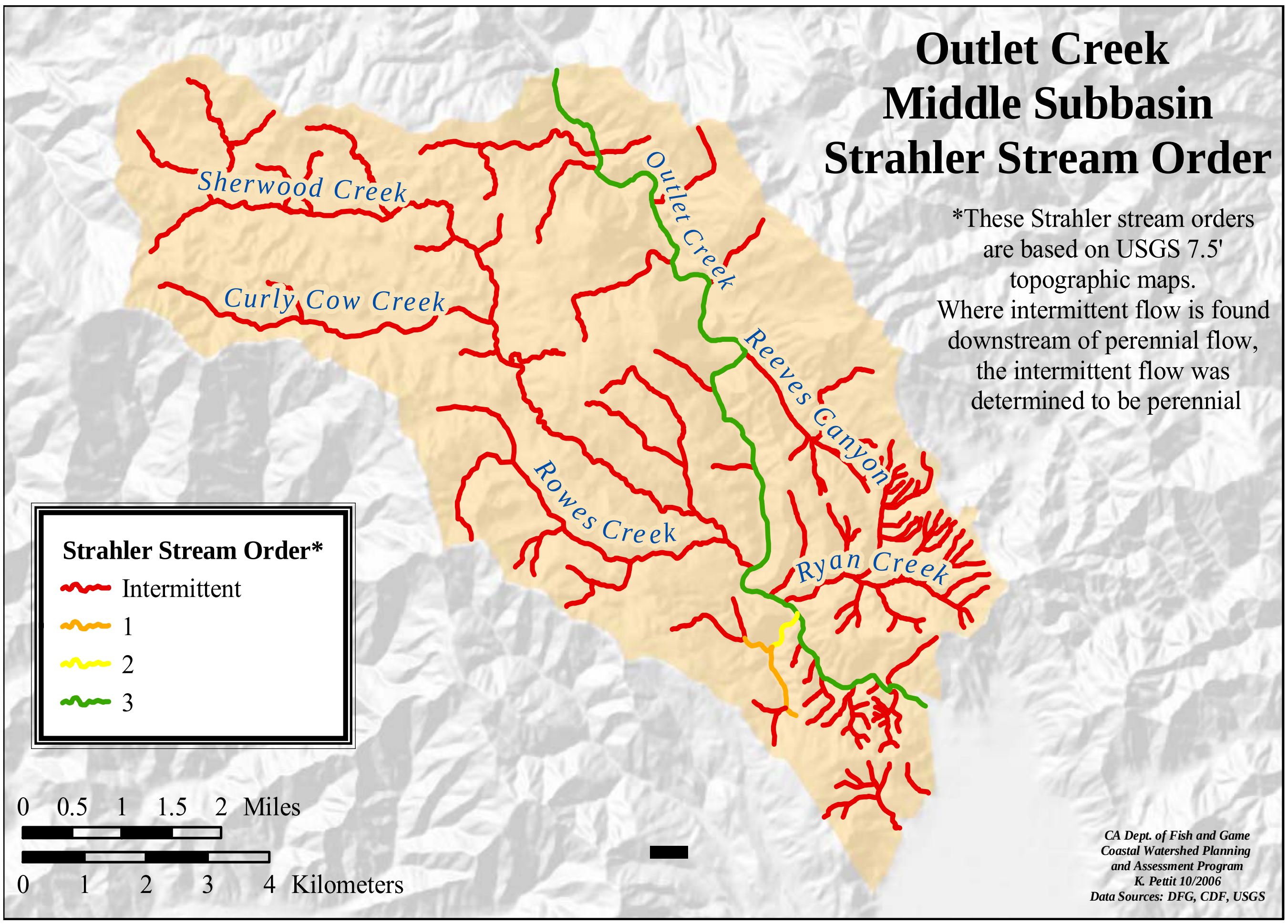


Figure X. Middle Subbasin showing large streams and stream order.

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;
- Significnt legal and illegal dewatering occurs throughout this subbasin;
- Summer and fall temperatures appear to be unsuitable for salmonids in this section of Outlet Creek and suitable in the tributaries sampled;
- During low flow periods, this section of Outlet Creek may be polluted by nutrients, bacteria, and sewage from upstream conditions;
- Fine sediment contribution from poorly maintained roads and stream crossings in this subbasin and the Southern Subbasin affect instream habitat in this subbasin;
- Fine sediment from alluvium geology in the Southern Subbasin is transported through and also deposited in this subbasin;
- 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;
- Low canopy density over Outlet Creek is contributing to water evaporation and elevated summer water temperatures in this subbasin and the Northern Subbasin;
- Timber harvests in the riparian zone prior to the Forest Practice Rules has reduced the instream large woody debris recruitment potential;
- Non-native introduced species, such as 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;
- The low gradient in this section of Outlet Creek provides continuous runs or pools and canopy which may provide summer rearing habitat;
- Bull, Ryan, and Reeves Canyon creeks may provide spawning and rearing refugia for salmonids;
- Natural and man-made barriers on Ryan Creek decrease available spawning habitat in the tributaries of this subbasin;
- Legacy effects are still being transported downstream from the 1955 and 1964 floods and are continue to impact this section of Outlet Creek. These effects can be observed by widened floodplains, absent riparian vegetation, and elongated sediment bars.

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 located upstream in the Southern Subbasin;
- 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 bank;
- 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, and ash, and included more coniferous species;
- The Pomo Native Americans used fire as a common management tool to clear brush to improve grasses, flower and bulb production;
- Old growth redwood and Douglas Fir species were also part of the riparian and dominated upslope vegetation;
- The riparian area helps insolate streams from solar radiation reducing stream water temperatures;
- Large woody debris was recruited from the well developed, old growth riparian area;
- Stream banks shifted course and naturally meandered.

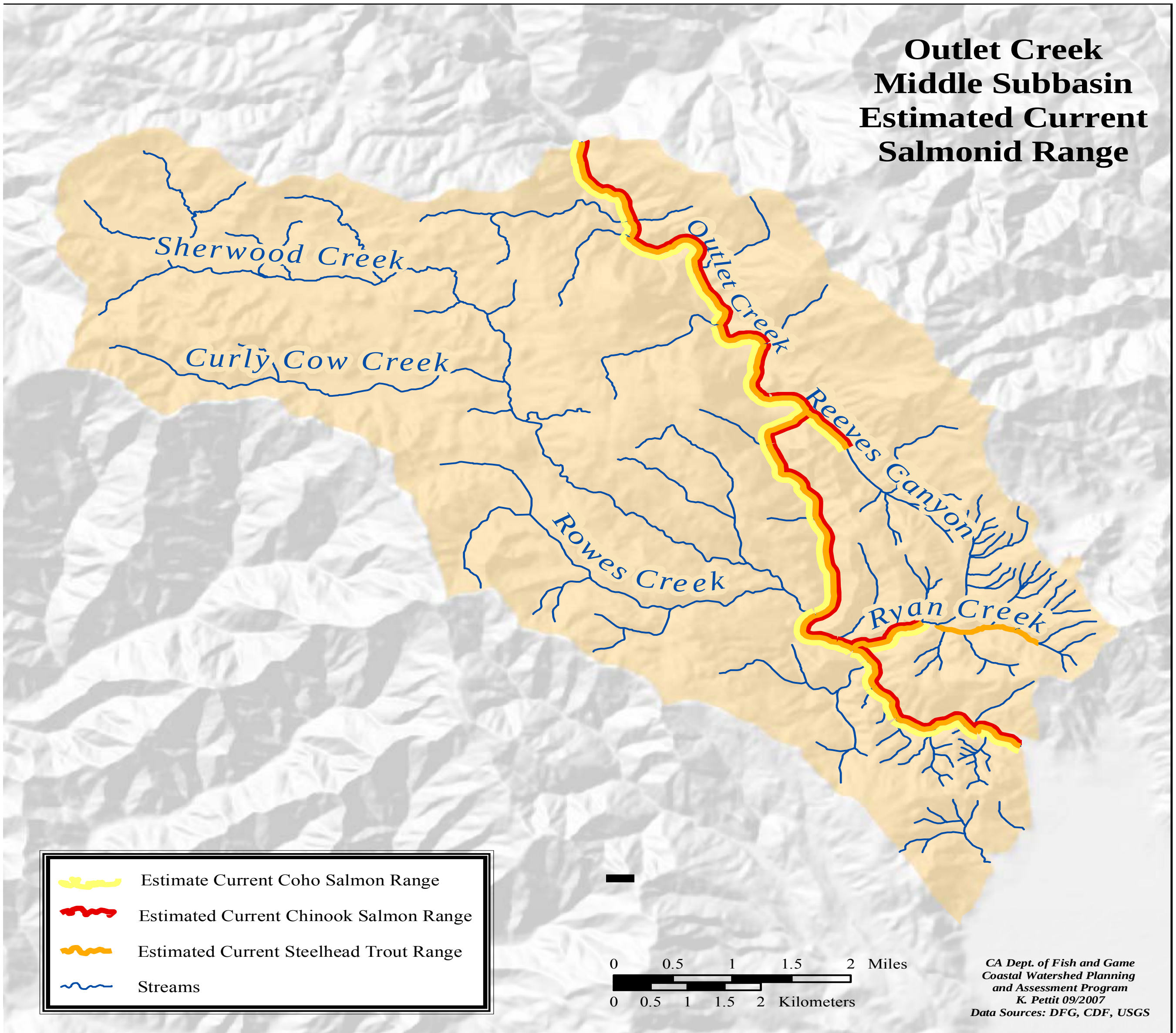


Figure X. Outlet Middle Subbasin Estimated Current Salmonid Range.

Current Habitat Conditions

Chinook salmon, coho salmon, and steelhead trout utilize headwater streams such as Reeves Canyon and Ryan Creeks, 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 frequently observed in the recent past. 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. Juvenile salmonids were observed at the sites surveyed. The summer and fall water temperatures and low flow conditions in this subbasin are supportive to all three salmonid species' life history.

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 Middle 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 form 0.30-8ft/s while temperature 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 2004, flows were taken as part of the habitat inventory and GRTS surveys on Outlet, Ryan and Reeves Canyon creeks. The flow was taken on Outlet Creek in 1995, an estimated flow of 1.0 cfs. In 2004, the flows ranged from 0.0-3.01 cfs. There were some subsurface flows in Outlet and Ryan Creek in 1995. In 2004, there was some subsurface flow in Reeves Canyon. 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.

Thermographs were deployed in 2004 at several sites in the Middle Subbasin. The summer water temperatures taken in 2004 had a range of 56.7-75.1 F (13.7-23.9 C). The average temperature for the subbasin was 66.3, which is considered somewhat suitable (Table X. MWATs from monitoring sites in the Middle Subbasin in 2004 and Figure X. MWAT survey sites in 2004 in the Middle Subbasin).

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Summer water temperatures may be a limiting factor in the Middle Subbasin on Outlet Creek sites in 2004. Ryan, Reeves Canyon, and Bull creeks provide thermal refugia to coho salmon and steelhead trout.

Table X. MWATs from monitoring sites in the Middle Subbasin in 2004.

Stream and Location	***MWAT (°F)***	***MWAT (°C)***	***Suitability***	***Week Starting***
Outlet above Long Valley Creek	73.1	22.8	Unsuitable	July 22
Outlet below Little Lake	69.1	20.6	Unsuitable	July 3
Reeves Canyon	56.7	13.7	Suitable	August 18
Ryan	62.8	17.1	Suitable	July 22
Sherwood-Rowes	75.1	23.9	Unsuitable	July 22
Bull Creek	61	16.1	Suitable	July 21
Average temp. for Middle Subbasin	66.3	19.0	Suitable	July 3-August 18

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.

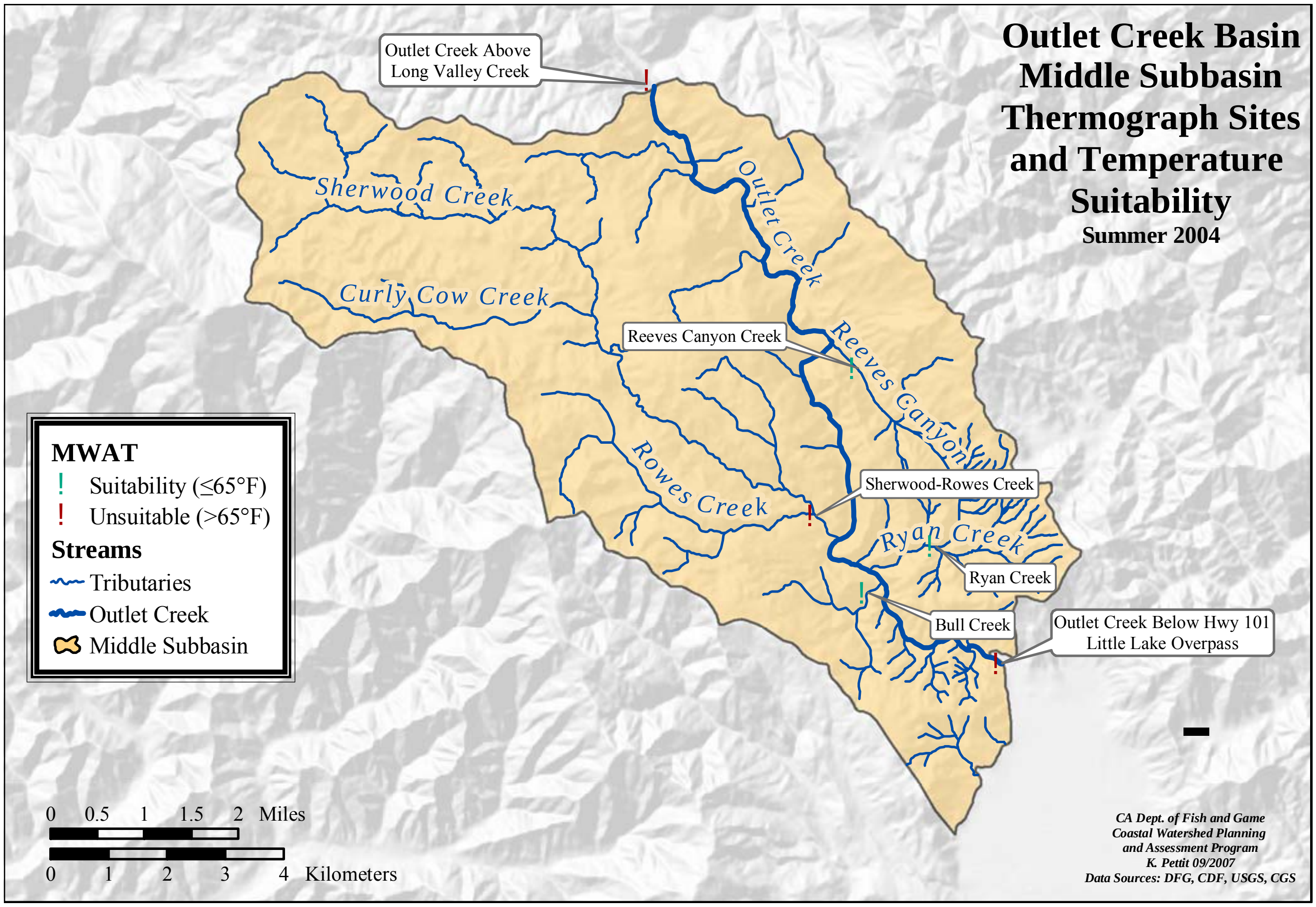


Figure X. MWAT survey sites in 2004 in the Middle Subbasin.

Turbidity and conductivity samples were taken at each of the 7 GRTS site in 2004. In the Middle Subbasin overall, turbidity and conductivity ranged from 0.85-80.0 and 330-642, respectively. Outlet Creek's turbidity and conductivity ranged from 0.85-80.0 and 249-2,080, respectively. Ryan Creek's turbidity and conductivity ranged from 1.1-2.0 and 249-2,080, respectively. Reeves Canyon Creek's turbidity and conductivity was 1.8 and 362 respectively.

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

Stream	Number of Sites	Range of Turbidity	Range of Conductivity (NTU)
Outlet	3	0.85-80.00	520-642
Ryan	3	1.1-2.00	330-417
Reeves Canyon	1	1.8	362
Middle Subbasin	7	0.85-80.00	330-642

Instream Habitat (1995 and 2004)

There are 12 perennial stream miles on 3 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 amphibian species observed, conducted pebble counts, and LWD surveys.

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

In 1995, 43,824 feet of stream were surveyed while in 2004, 7,770 feet were surveyed.

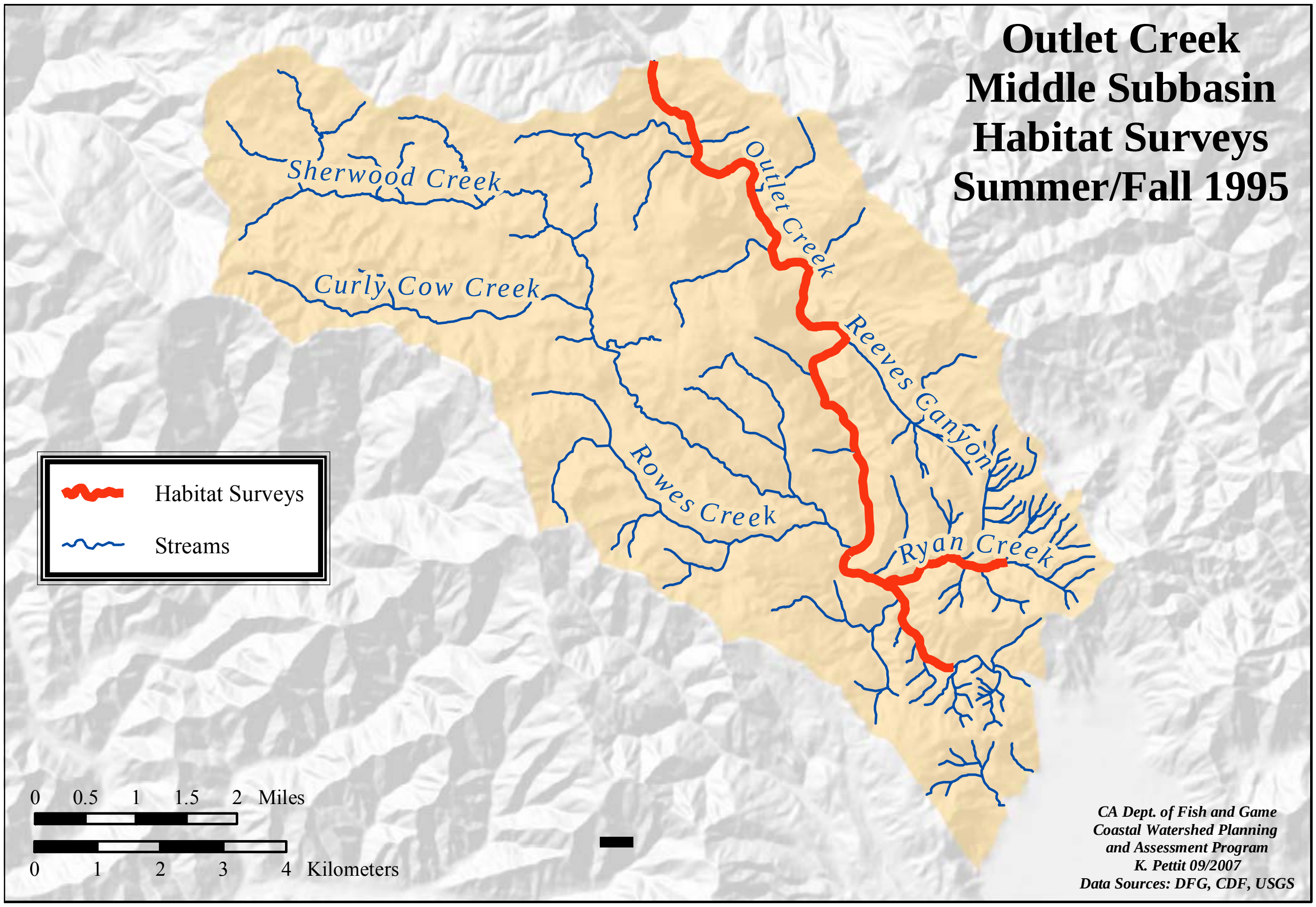


Figure X. Middle Subbasin Habitat Surveys 1995.

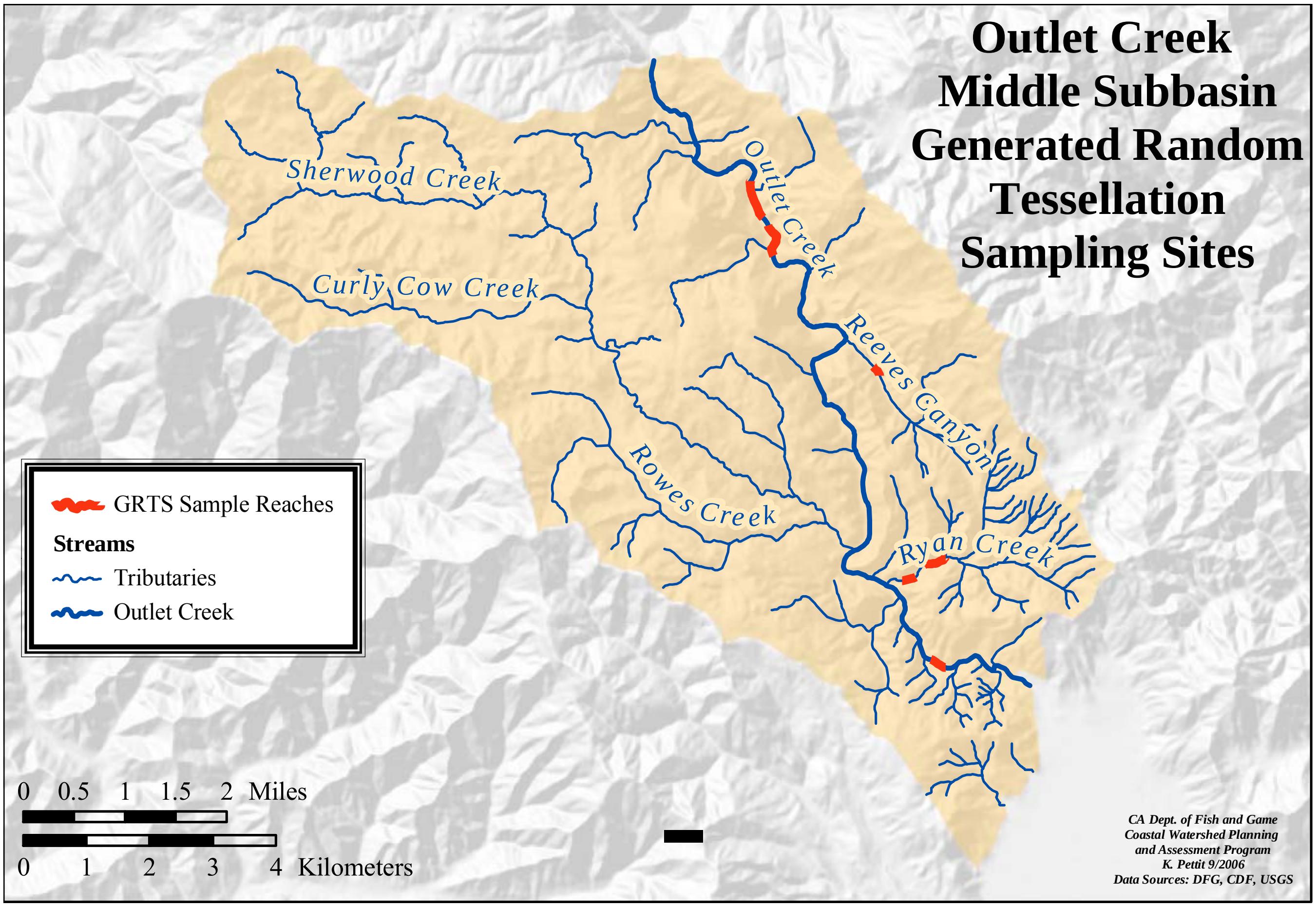


Figure X. GRTS Sampling in the Middle Subbasin in 2004.

Erosion and Fine Sediment

Stream bank erosion contributes cobble and gravel to the channel, which are both important components of the 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 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 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 as coho and Chinook salmon, and steelhead trout.

Stream banks

The stream banks in the Middle Subbasin in most of the streams surveyed are composed of cobble/gravel and sand/silt/clay with the later contributing fine sediment into the channel (Figure X. Average composition of the stream banks in the Middle Subbasin). Fine sediment sources from the Middle Subbasin are contributing large amounts of fine sediment, which are accumulating in and pulsing through this subbasin.

Ryan Creek is dominated by sand/silt/clay, while Outlet Creek is co-dominated by cobble/gravel and sand/silt/clay. Embeddedness values were high in both the subbasin and in the streams. Ryan and Outlet creeks may supply fine sediment from eroding stream banks, which maybe increasing the embeddedness levels in these streams.

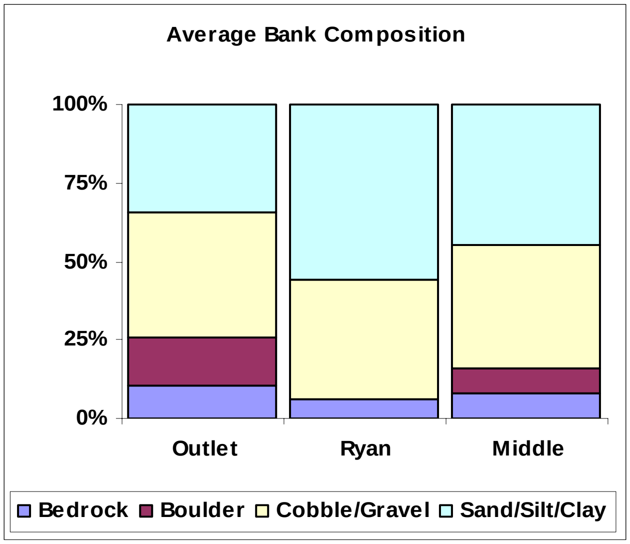


Figure X. Average composition of the stream banks in the Middle Subbasin.

Embeddeness

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 el 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 redds and prevents 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 indicate 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.

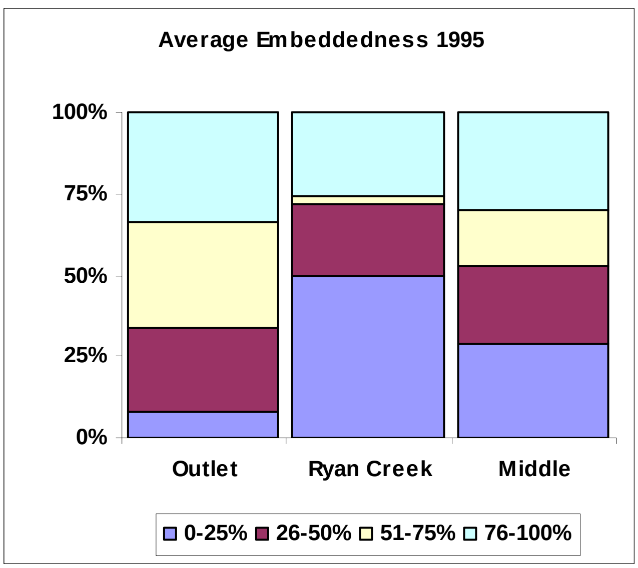
In 1995 and 2004, the Middle Subbasin did not meet embeddedness target values. In 1995 and 2004, 50% and 80% of the pool tail outs were 51% or more embedded, respectively. The amount of quality spawning substrate available appears to have decreased significantly between 1995 and 2004. However, in 1995, the embeddedness values were averaged for all of the streams surveyed in the subbasin, whereas in 2004, seven random sites were surveyed throughout the subbasin.

In 1995 and 2004, Outlet Creek had 66% and 58% of the pool tail outs with an embeddedness of 51% or more, respectively. Suitable substrate appears to have decreased in the middle reach of Outlet Creek, indicating that spawning conditions have decreased between 1995 and 2004.

In 1995 and 2004, Ryan Creek had 28% and 92% of the pool tail outs with an embeddedness of 51% or more, respectively. Suitable substrate appears to have decreased on Ryan Creek indicating that spawning conditions have decreased significantly between 1995 and 2004.

In 1995, Reeves Canyon Creek was not surveyed. In 2004, all of the pool tail outs in Reeves Canyon Creek were embedded 51% or more, which is unsuitable spawning substrate (Figures X and Y. Embeddedness in Pool Tails of Middle Subbasin and its streams surveyed 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. High embeddedness values are likely limiting the health and production of salmonids in the Middle Subbasin.



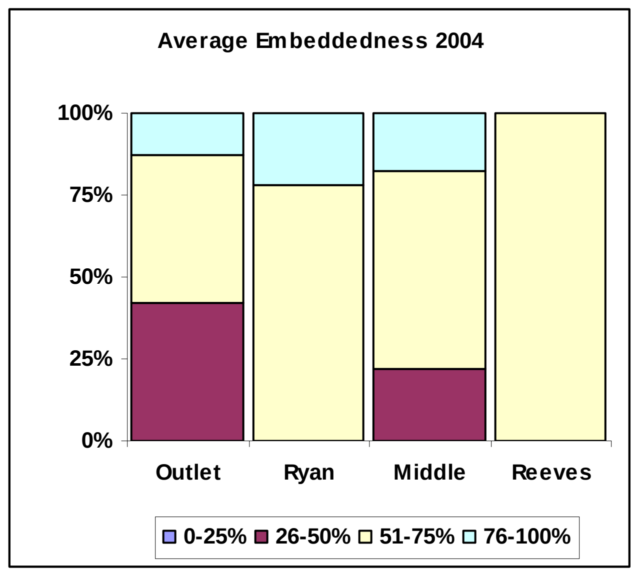


Figure X and Y. Embeddedness in Pool Tails of Middle Subbasin and its streams surveyed in 1995 and 2004.

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 Middle Subbasin had an overall canopy density of 71%, which did not meet the canopy density target value of 80%. In 2004, the subbasin had an overall canopy of 88%, which does meet the target value. The canopy density appears to have increased, with both the deciduous and coniferous components increasing, between 1995 and 2004. However, in 1995, the canopy values were averaged for all of the streams surveyed in the subbasin, whereas in 2004, seven random sites were surveyed throughout the subbasin.

In 1995 and 2004, Outlet Creek had a canopy density of 47% and 78%, respectively, which did not meet canopy density target values. The percentage of deciduous canopy increased, while the coniferous canopy decreased. The riparian habitat in Outlet Creek appears to have increased significantly in the middle reach of Outlet creeks between 1995 and 2004.

In 1995 and 2004, Ryan Creek had a canopy density of 94% and 98%, respectively, which meets the canopy density target value. The average canopy in Ryan Creek appears to have remained similar between 1995 and 2004.

In 1995, Reeves Canyon Creek was not surveyed. In 2004, the canopy density of Reeves Canyon was 89%, which meets the canopy density target value (Figure X and Y. Canopy Density and Vegetation Type of the Middle Subbasin in 1995 and 2004).

Overall, the canopy density values have increased in the subbasin between 1995 and 2004, indicating that the riparian area has improved. Since 1995, current canopy is unlikely limiting the health and production of salmonids in the Middle Subbasin.

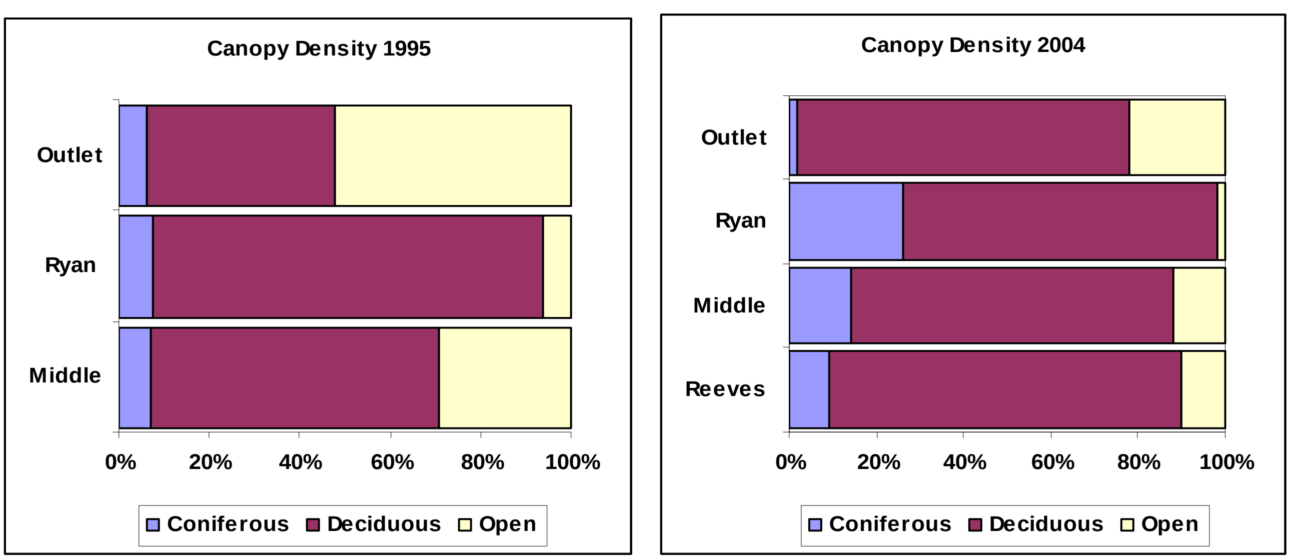


Figure X and Y. Canopy Density and Vegetation Type of the Middle Subbasin in 1995 and 2004.

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 Middle Subbasin was fully and moderately suitable, respectively. In 1995, Outlet and Ryan creeks were fully suitable, while one section in Outlet Creek, between the confluences of Reeves Canyon and Ryan creeks was somewhat unsuitable. Reeves Canyon Creek was not surveyed in 1995. In 2004, 7 sites were surveyed which included 3 sites in Outlet, 3 in Ryan, and one in Reeves Canyon creeks. One of the three sites in Outlet Creek was somewhat unsuitable, while one was fully, and the other was somewhat suitable. Overall, the canopy density was somewhat suitable in Outlet Creek. Two of the three sites in Ryan Creek were fully suitable, and one was fully unsuitable. Overall, the canopy density was moderately suitable in Ryan Creek. Reeves Canyon Creek was fully suitable (Figure X and Y. EMDS Canopy Density Suitability in the Middle Subbasin in 1995 and 2004).

The EMDS results show that the subbasin has remained unchanged between 1995 and 2004.
Restoration efforts focused on improving canopy should be located in areas with unsuitable EMDS ratings.

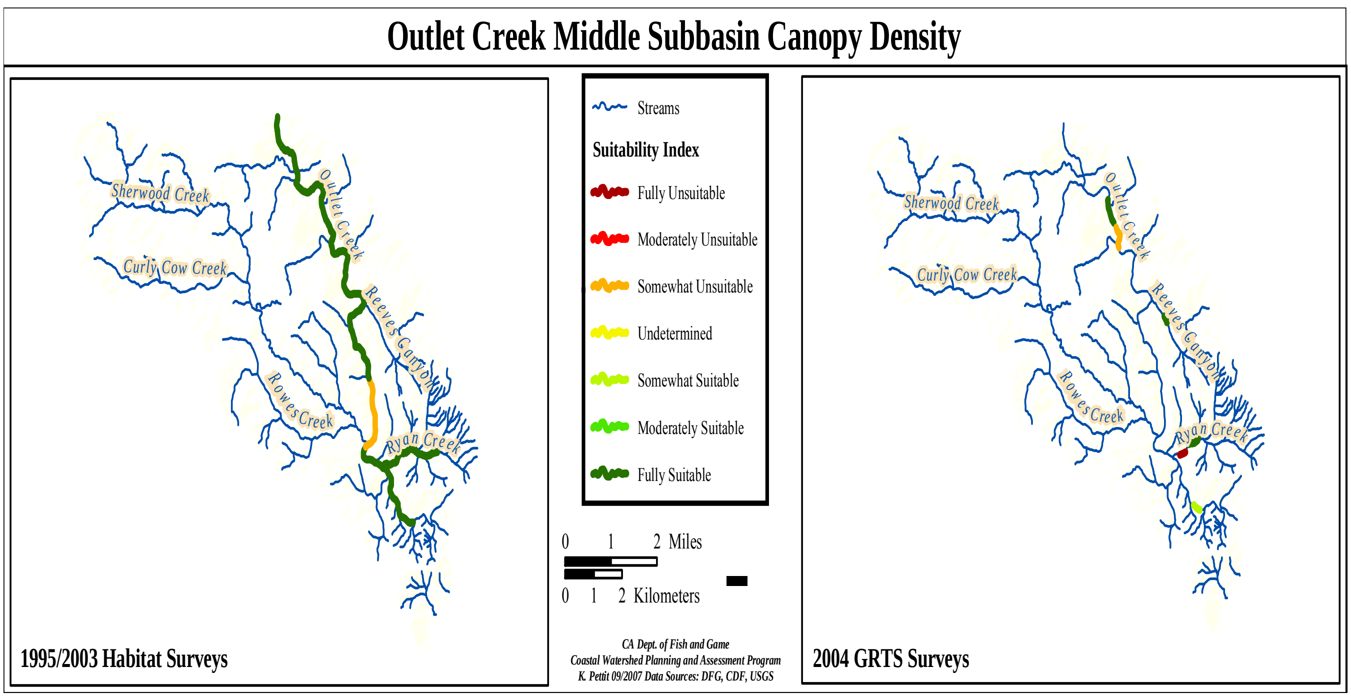


Figure X and Y. EMDS Canopy Density Suitability in the Middle Subbasin in 1995 and 2004.

Habitat Categories

Streams with adequate amounts of flatwater, pool, 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 has changed slightly. The pool habitat increased, and the flatwater and riffle habitat decreased in the Middle Subbasin. The dry units also decreased. However, in 1995 the habitat category measurements were averaged for all of the streams surveyed in the subbasin, whereas in 2004, seven random sites were surveyed throughout the subbasin. In 2004, the dry habitat units were underestimated.

Between 1995 and 2004, the pool habitat increased significantly and flatwater habitat decreased significantly, in the middle reach of Outlet 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 summer rearing habitat has increased since 1995.

Between 1995 and 2004, the pool habitat increased, and flatwater and riffle habitat decreased slightly in Ryan Creek. Between 1995 and 2004, dry habitat also decreased. 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 summer rearing habitat has increased since 1995.

In 1995, Reeves Canyon was not surveyed. Data from 2004 indicate that the habitat category ratio was in adequate due to a low pool ratio.

Overall, since 1995, the habitat categories ratios have become more adequate in the middle reaches of Outlet Creek. Pool Habitat has increased indicating that over summer conditions for juvenile salmonids may have improved. Habitat category ratios are not limiting the health and production of salmonids in the Middle Subbasin streams, except for Reeves Canyon Creek .(Figure X and Y. Habitat Categories in the Middle Subbasin and its streams surveyed in 1995 and 2004).

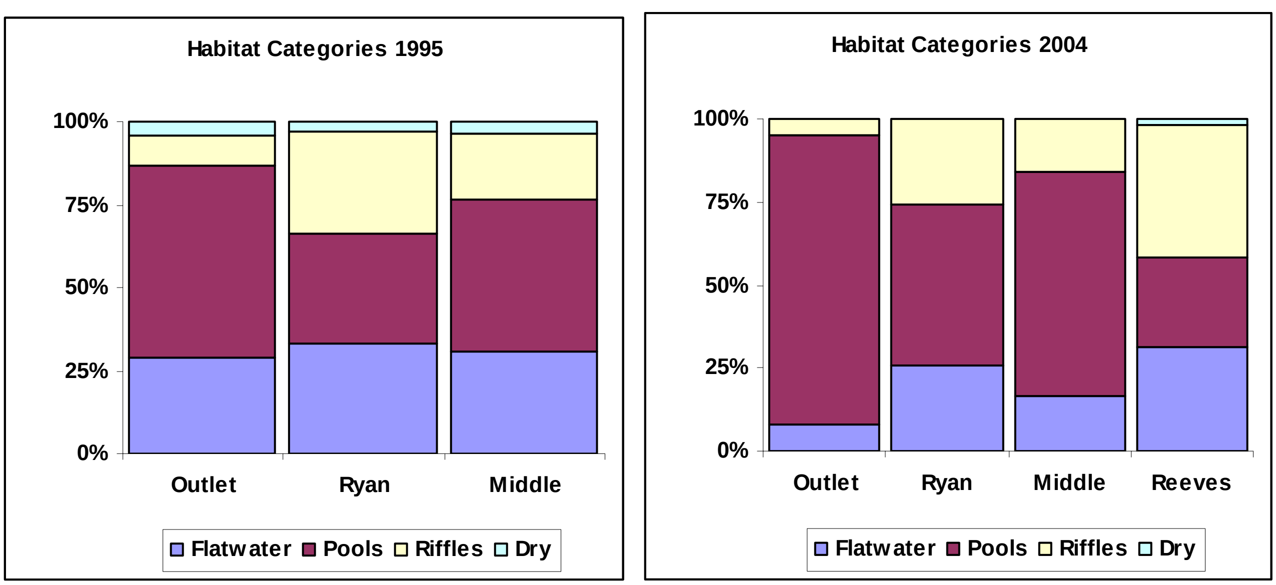


Figure X and Y. Habitat Categories in the Middle Subbasin and its streams surveyed in 1995 and 2004.

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, pools over 4 feet in depth dominated the Middle Subbasin. In 2004, pools 1-2 feet in depth were prevalent while pools 2 feet and over were dominant. The overall depth of pools appears to have decreased between 1995 and 2004. However, in 1995, the pool habitat measurements were averaged for all of the streams surveyed in the subbasin, whereas in 2004, seven random sites were surveyed throughout the subbasin.

In 1995 and 2004, pools over 4 feet in depth dominated the middle reaches of Outlet Creek, a third order stream. The pool frequencies and pool depths in Outlet Creek met target values in 1995 and 2004. The available pool habitat appears to be suitable for juvenile salmonids, however, poor water quality and high temperatures, as well as several legal and illegal sites where dewatering frequently occurred reduced overall pool quality in 2004.

In 1995, approximately 80% of the pools surveyed in Ryan Creek were 3-4 feet or deeper, an intermittent stream. In 2004, most of the pools were 1-2 feet in depth, and less than 25% were 3 feet or deeper. Even though target values have been met, the pool depth has decreased significantly between 1995 and 2004. The reduction in pool depth in Ryan Creek has likely been affected by rural residential development, unpaved road construction, and water extraction in the upper reach. .

In 1995, Reeves Canyon Creek, an intermittent stream, was not surveyed. In 2004, most of the pools had a depth of 2-3 feet, which met target values (Figure X and Y. Primary pool depths of streams surveyed in the Middle Subbasin in 1995 and 2004).

Overall, since 1995, the pool frequency and depth has decreased significantly on Ryan Creek. The pool frequency and depth is unchanged in the middle reach of Outlet Creek. Even though the target values for pool frequency and depth have been met, conditions are and limiting the health and production of salmonids in the Middle Subbasin.

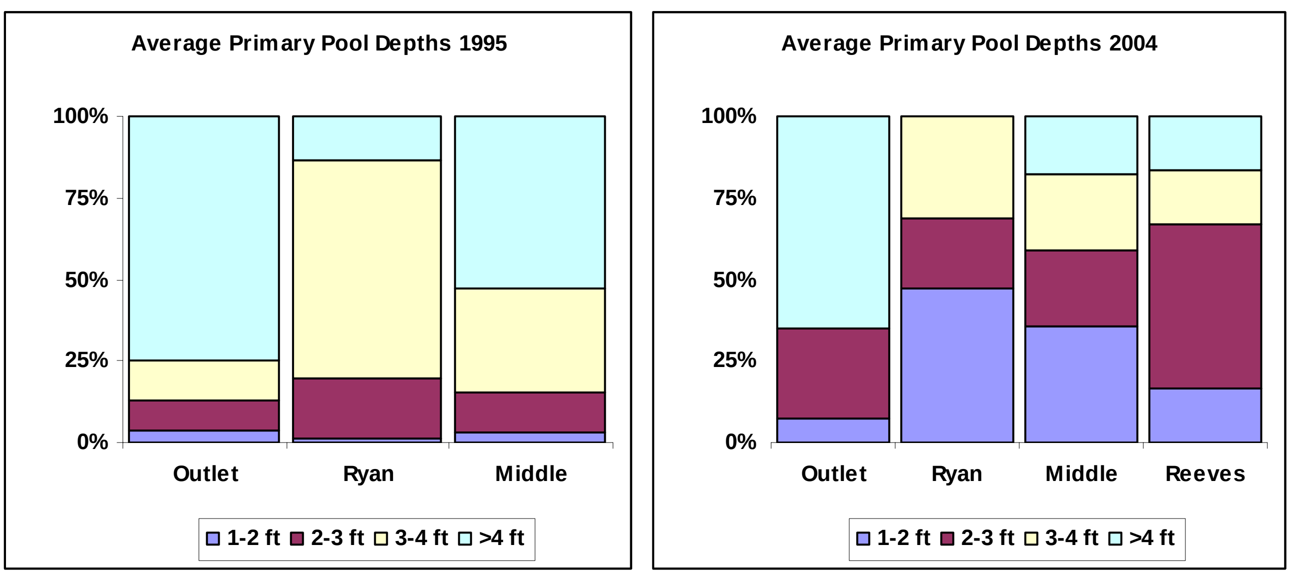


Figure X and Y. Primary pool depths of streams surveyed in the Middles Subbasin in 1995 and 2004.

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 condition of the pool depth in the Middle Subbasin was fully and somewhat unsuitable, respectively. In 1995, Outlet and Ryan creeks were fully unsuitable, while one section in Outlet Creek, between the confluences of Reeves Canyon and Ryan creeks was fully suitable. Reeves Canyon Creek was not surveyed in 1995. In 2004, 7 sites were surveyed which included 3 sites in Outlet, 3 sites in Ryan, and 1 in Reeves Canyon creeks. Two of the three sites in Outlet Creek were fully, and one was moderately unsuitable. Overall, the pool depth condition was moderately unsuitable in Outlet Creek. Two of the three sites in Ryan Creek were fully suitable, and one was fully unsuitable. Overall, the pool depth condition was moderately suitable in Ryan Creek. Reeves Canyon Creek was somewhat suitable (Figure X and Y. EMDS Pool Depth Suitability in the Middle Subbasin in 1995 and 2004).

The EMDS results show that pool depths in the subbasin and Ryan Creek have improved slightly, between 1995 and 2004, but are still unsuitable. Major restoration efforts should be focused on improving pool depths and located in areas with unsuitable EMDS ratings.

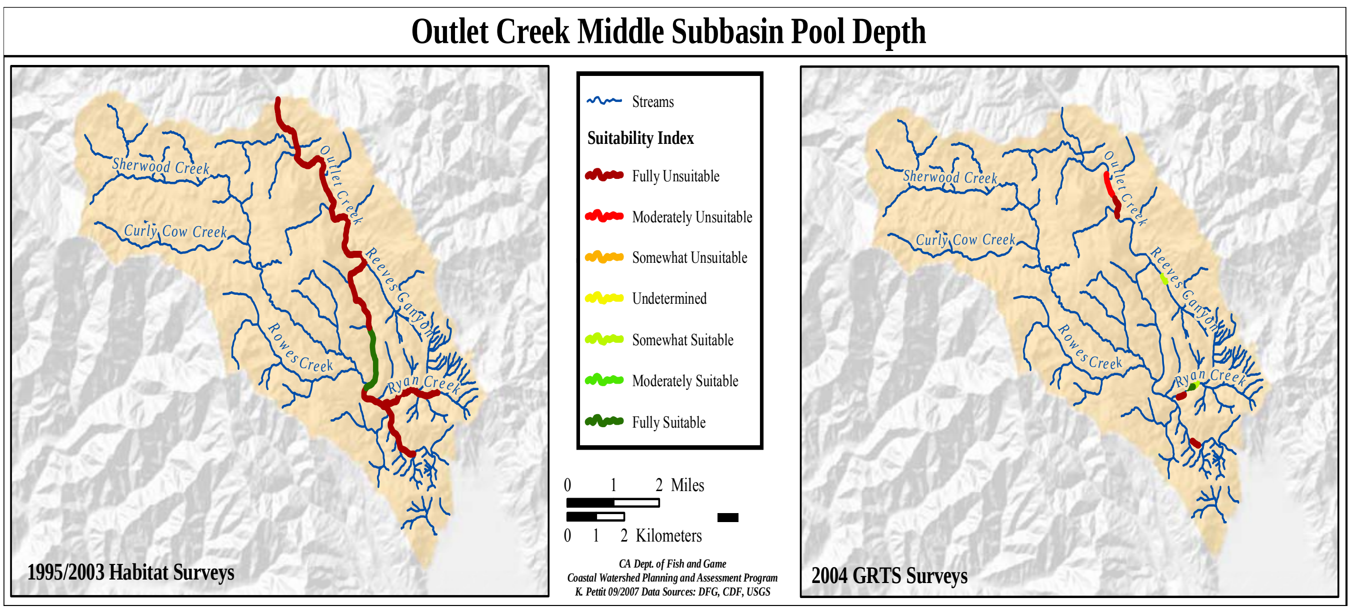
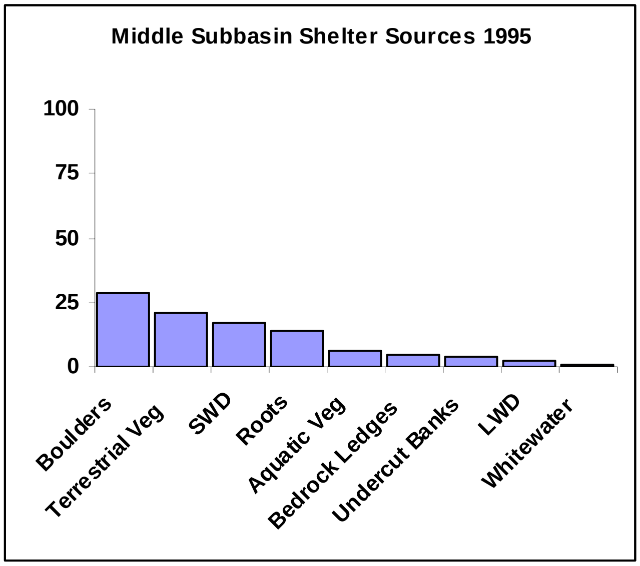


Figure X and Y. EMDS Pool Depth Suitability in the Middle Subbasin in 1995 and 2004.

In 1995, boulders and terrestrial vegetation dominated the pool shelter. In 2004, terrestrial vegetation and small woody debris (SWD) dominated the pool shelter. The shelter types which were least abundant were aquatic vegetation, bedrock ledges, undercut banks, whitewater and large woody debris (LWD). Pool shelter composition could be greatly enhanced by the addition of LWD in the subbasin. The overall pool shelter values and types in the subbasin appear to have remained similar between 1995 and 2004. However, in 1995, the pool shelter values were averaged for all of the streams surveyed in the subbasin, whereas in 2004, seven random sites were surveyed throughout the subbasin (Figure X and Y. Average Frequency and Source of Pool Shelter in the Middle Subbasin in 1995 and 2004).



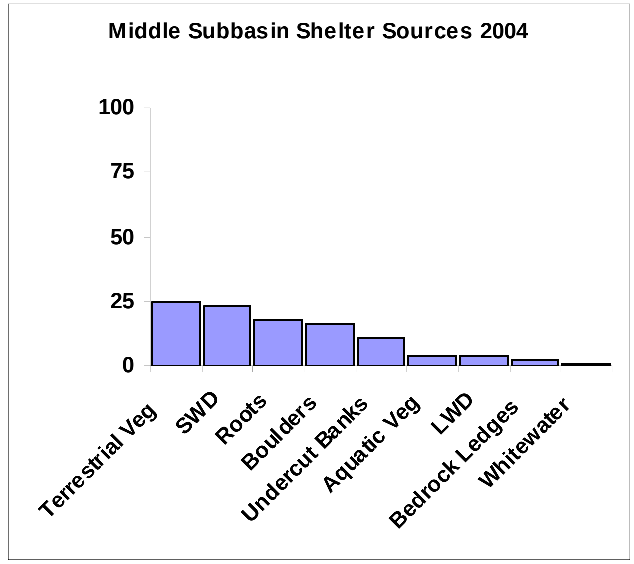


Figure X and Y. Average frequency and source of pool shelter in the Middle Subbasin in 1995 and 2004.

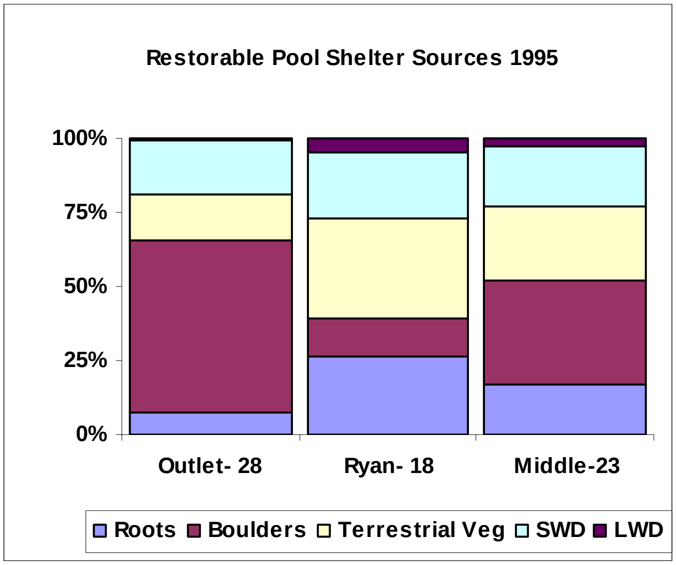
In both 1995 and 2004, the measured sources of pool shelter in the Middle Subbasin included boulders, terrestrial and aquatic vegetation, bedrock ledges, small and large woody debris, roots, undercut banks, and whitewater. In 1995 and 2004, the Middle Subbasin did not meet pool shelter cover target values, with shelter values of 23 and 40, respectively. This range does not include Reeves Canyon Creek, which was not surveyed in 1995. 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 dominant sources.

In 1995, boulders dominated the pool shelter in the middle reach of Outlet Creek. In 2004, terrestrial vegetation dominated the pool shelter. In 1995 and 2004, the target values were not met for Outlet Creek, with shelter values of 28 and 38, respectively. LWD was the most lacking source of pool shelter in both 1995 and 2004. The amount of boulders has decreased significantly between 1995 and 2004 while the amount of terrestrial vegetation has increased. Pool shelter composition could be greatly enhanced by the addition of root wads, boulders and LWD.

In 1995 and 2004, the dominant shelter types in Ryan Creek remained similar, with the exceptions of boulders and terrestrial vegetation. In 1995, terrestrial vegetation, roots, and SWD dominated the pool shelter. In 2004, boulders, roots, and SWD dominated the pool shelter. In 1995 and 2004, the target values were not met for Ryan Creek, with shelter values of 18 and 41, respectively. In 1995 and 2004, the shelter source that was the least available was LWD. Pool shelter composition could be greatly enhanced by the addition of LWD and terrestrial vegetation.

In 1995, Reeves Canyon Creek was not surveyed. Small woody debris (SWD) and roots dominated the pool shelter. Pool shelter composition could be greatly enhanced by the addition of LWD and terrestrial vegetation (Figure X and Y. Restorable pool shelter sources in the Middle Subbasin in 1995 and 2004).

Overall, the amount of LWD has been very low in the subbasin. The addition of this pool shelter type could greatly enhance the composition, as well as root wads, boulders, and terrestrial vegetation in areas where it is suitable. Although the target values were not met, the pool shelter has slightly improved in the Middle Subbasin. 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 Middle Subbasin.



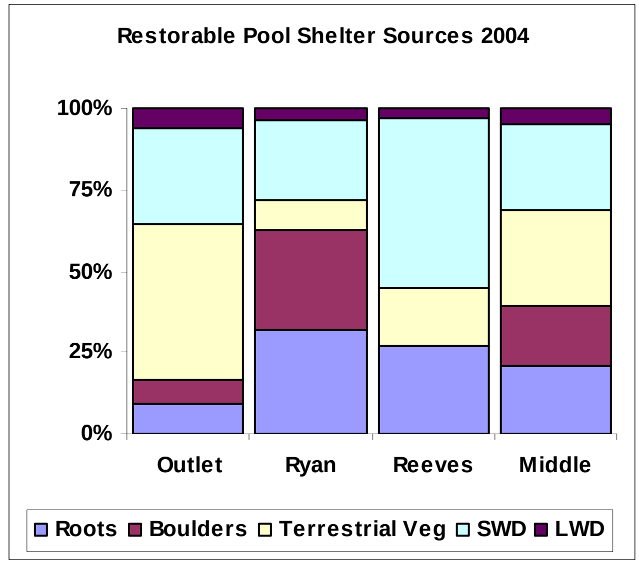


Figure X and Y. Restorable pool shelter sources in the Middle Subbasin in 1995 and 2004.

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 Middle Subbasin was moderately unsuitable. In 1995, Outlet Creek was moderately unsuitable, while one section in Outlet Creek, between the confluences of Reeves Canyon and Ryan creeks, as well as Ryan Creek, were fully unsuitable. Reeves Canyon Creek was not surveyed in 1995. In 2004, 7 sites were surveyed, which included 3 sites in Outlet, 3 sites in Ryan, and one site in Reeves Canyon creeks. Two of the three sites in Outlet Creek were moderately, and one was fully unsuitable. Overall, the pool shelter condition was moderately unsuitable in Outlet Creek. Two of the 3 sites in Ryan Creek were moderately and one was fully unsuitable. Overall, the pool shelter condition was moderately unsuitable in Ryan Creek. Reeves Canyon Creek was moderately unsuitable (Figure X and Y. Pool Shelter Condition Suitability in the Middle Subbasin in 1995 and 2004).

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

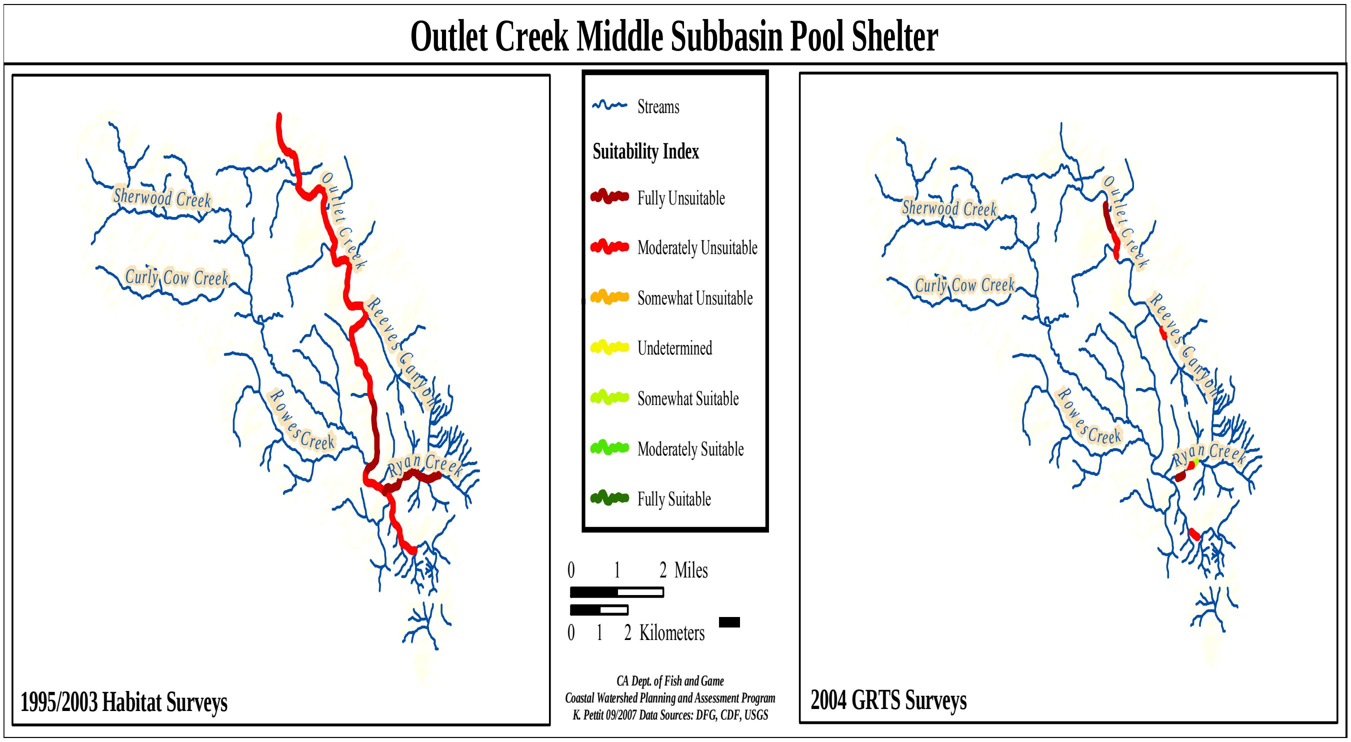


Figure X and Y. EMDS Pool Shelter Condition Suitability in the Middle Subbasin in 1995 and 2004.

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 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 reach condition in the Middle Subbasin was somewhat unsuitable. In 1995, Outlet Creek was somewhat unsuitable, while the reach condition of Ryan Creek was undetermined. Reeves Canyon Creek was not surveyed in 1995. In 2004, 7 sites were surveyed which included 3 sites in Outlet, 3 sites in Ryan, and one in Reeves Canyon creeks. All of the sites were somewhat unsuitable, and thus, the overall reach conditions were somewhat unsuitable (Figure X and Y. EMDS Reach Condition Suitability in the Middle 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 priority to improve conditions for juvenile salmonids, especially in Ryan Creek due to the coho population in the Middle subbasin. Projects which focus on increasing pool depth while increasing pool shelter should be the 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 Middle Subbasin.

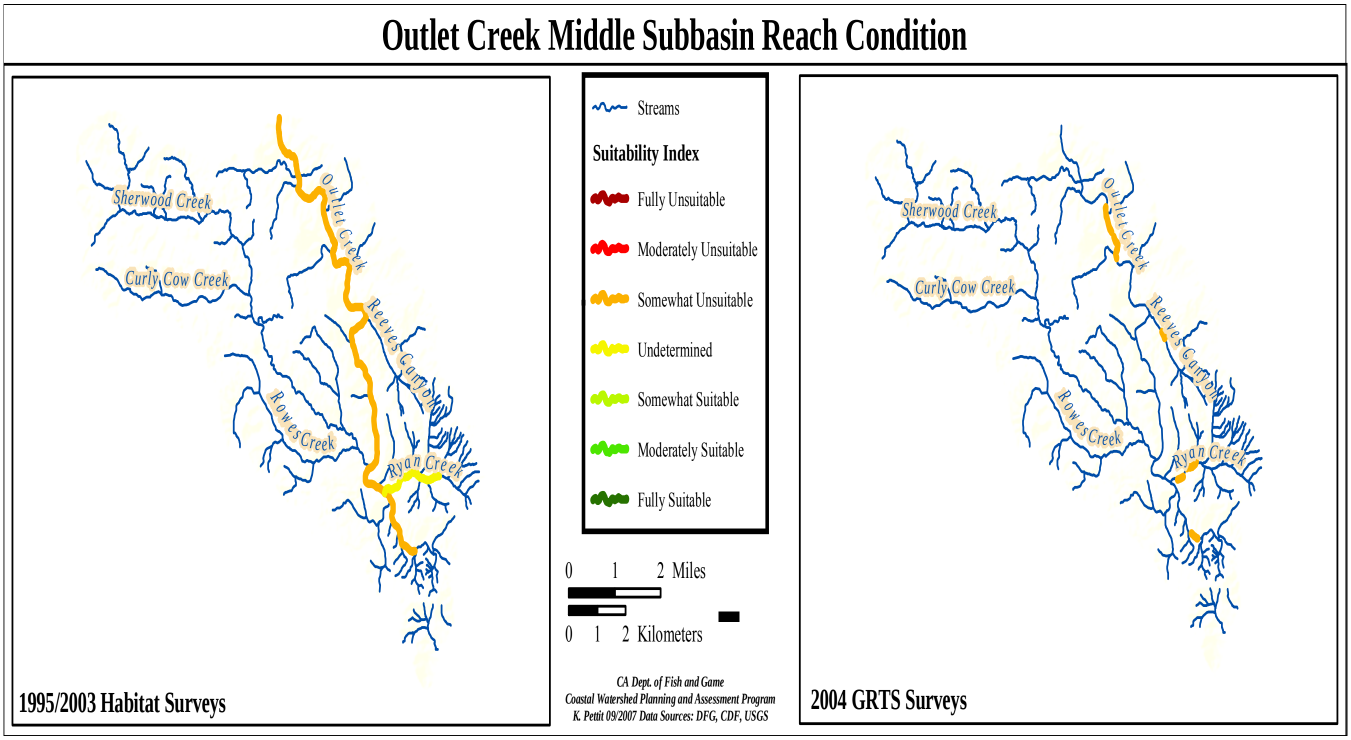


Figure X and Y. EMDS Reach Condition Suitability in the Middle Subbasin in 1995 and 2004.

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 5 barriers blocking 3 miles of stream, 2 are complete, 3 are partial, plus 5 of unknown status in the Middle subbasin. Five unknown status barriers on Outlet Creek. Two complete and two partial barriers on Ryan Creek. One partial barrier on Reeves Canyon Creek (Table X. Fish Passage Barriers in the Middle Subbasin.)

Table X. Fish Passage Barriers in the Northern Subbasin

Stream	Complete	Partial	Unknown	Estimated Miles of Blocked
Outlet	0	0	5	ND
Ryan	2	2	0	1.2
Reeves Canyon	0	1	0	1.7
Middle	2	3	5	~2.9

.

Analysis of Tributary Recommendations

In order to compare the frequency with which recommendations were made within the Middle 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 Middle Subbasin). All three tributaries had Shelter and Bank recommendations. Roads recommendations were made for 2 out of 3 tributaries surveyed.

Table X. Occurrence of Improvement Recommendations Summary of the Middle Subbasin.

Stream	Number of Sites	Survey Length (ft.)	Bank	Roads	Canopy	Temp	Pool	Shelter	Spawning Gravel	LDA	Wild/Livestock	Fish Passage
Outlet	3	4818	1	2				3	4			
Ryan	3	2095	2	1				3				4
Reeves	1	585	4				3	2				1
Northern	7	7498	7	3			3	8	4			5

In order to further examine subbasin 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 Middle Subbasin). When examining recommendation categories by number of tributaries, the most important Recommendation Category in the subbasin were Erosion/Sediment and Instream Habitat (Table X. Distribution of recommendation categories in the Middle Subbasin).

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

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

Table X. Distribution of recommendation categories in the Middle Subbasin

Stream	Erosion/Sediment	Riparian/Temperature	Instream Habitat	Gravel/Substrate	Other
Outlet	3	0	3	4	0
Ryan	3	0	3	4	4
Reeves	4	0	5	0	1
Middle	10	0	11	4	5

However, comparing recommendation categories between streams could be confounded by the difference in stream feet surveyed. Of the three streams evaluated, 7,048 stream feet were surveyed in the Middle Subbasin. Therefore, the percentage of stream feet assigned to the various recommendation categories was calculated for each stream.

Instream Habitat was the most important recommendation category followed by Erosion/Sediment, Gravel/Substrate and Other in the Middle Subbasin. Therefore, the number one priority rankings remained the same for the Middle Subbasin and its streams, whether assessed by the number of tributaries or the percentage of stream feet.

The high number of Instream Habitat and Erosion/Sediment Recommendations across the Middle Subbasin indicates that across the Middle Subbasin indicates that high priority should be given to restoration projects emphasizing pools and shelter, and reflects the negative effects of bank instability and roads. Gravel/Substrate Recommendations reflects the lack of suitable spawning substrate and the opportunity to implement both retention and addition of gravel where appropriate. The Other Recommendation indicates that a culvert on Reeves Canyon Creek, which is a barrier to upstream adult migration and downstream juvenile migration, should be removed.

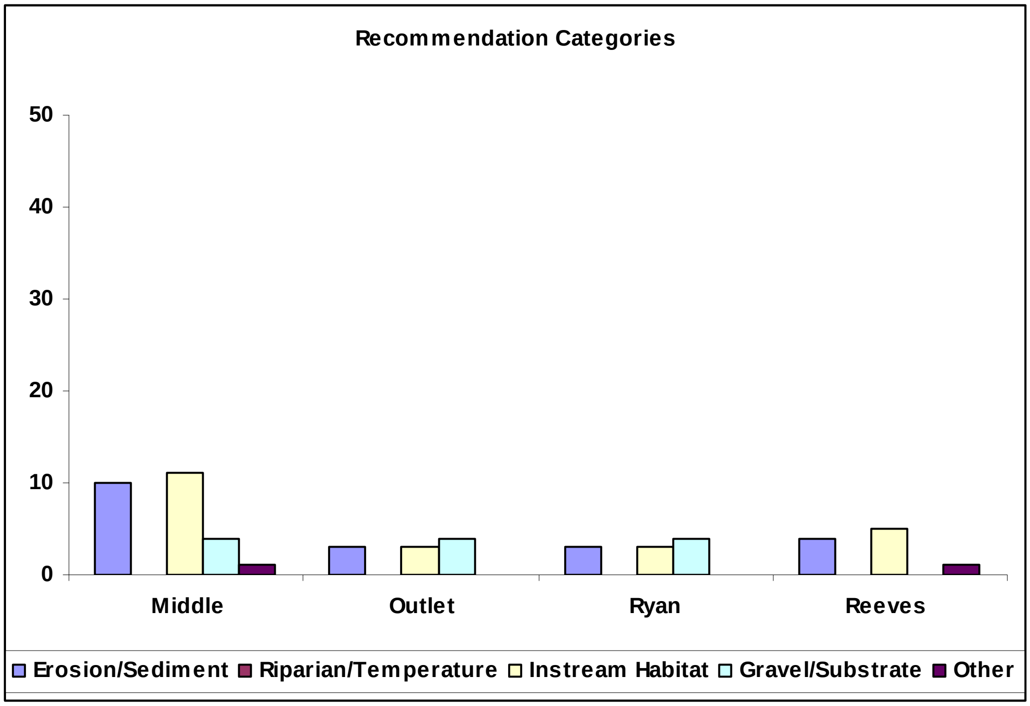


Figure X. Frequency of Recommendation Categories in the streams surveyed in the Middle Subbasin.

Limiting Factors

A main objective of this assessment was to identify factors that limit production of anadromous salmonid populations in the Middle 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 Middle 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 Middle Subbasin in most limiting factors center around erosion and fine sediment and flow and water quality. Table X. and Figure X. detail the basin's limiting factors and their associated locations.

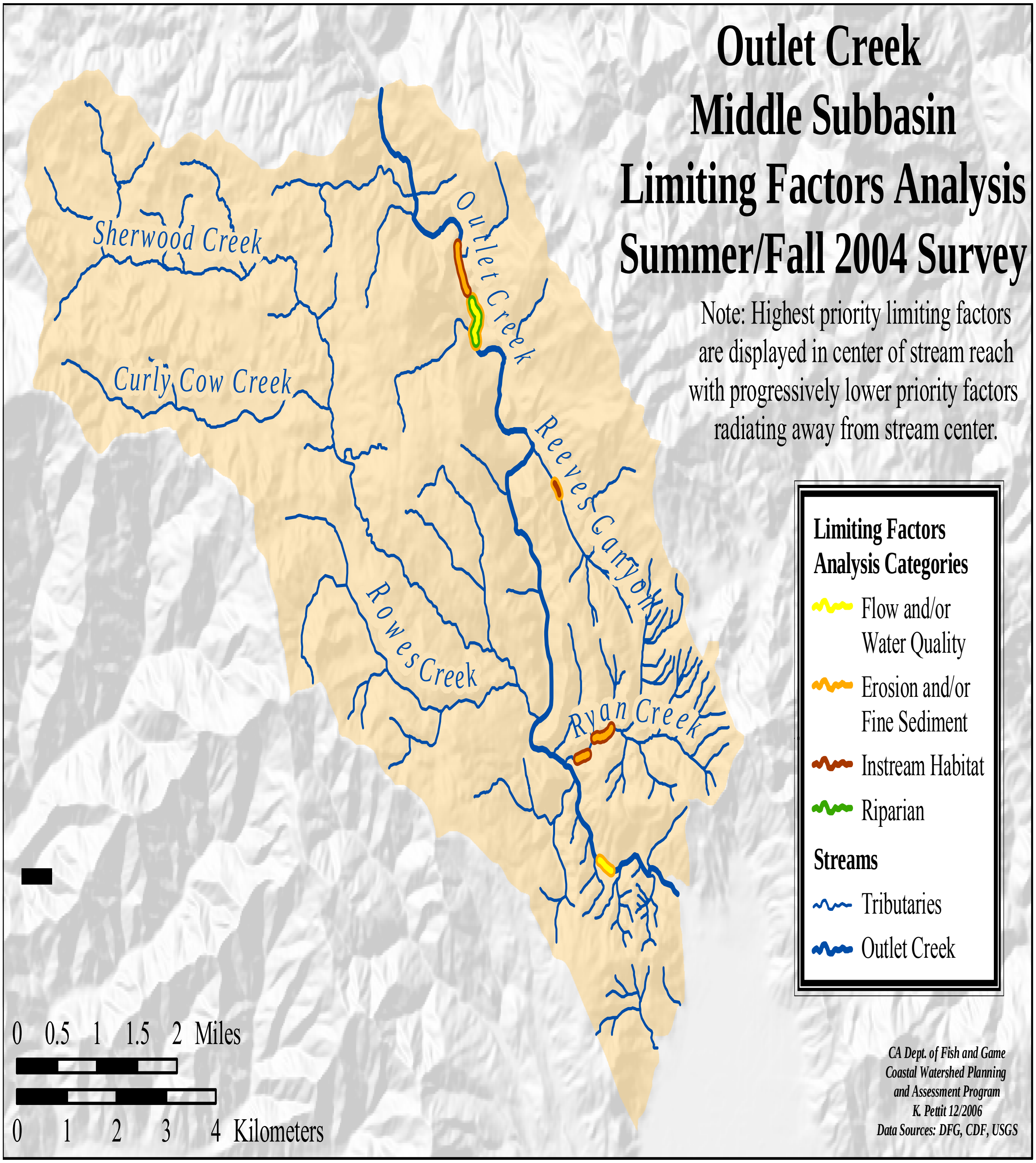


Figure X. Outlet Creek Middle Subbasin Limiting Factors Analysis- 2004

Table X: Limiting Factors Analysis of the Middle Subbasin.

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

Refugia Areas

Refugia Habitat was identified and characterize in the Middle 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 Middle Subbasin Overall Refugia). The criteria include 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 for some parameters. Salmonid habitat conditions are somewhat suitable in the Middle Subbasin. The following refugia area rating map summarizes subbasin salmonid refugia conditions:

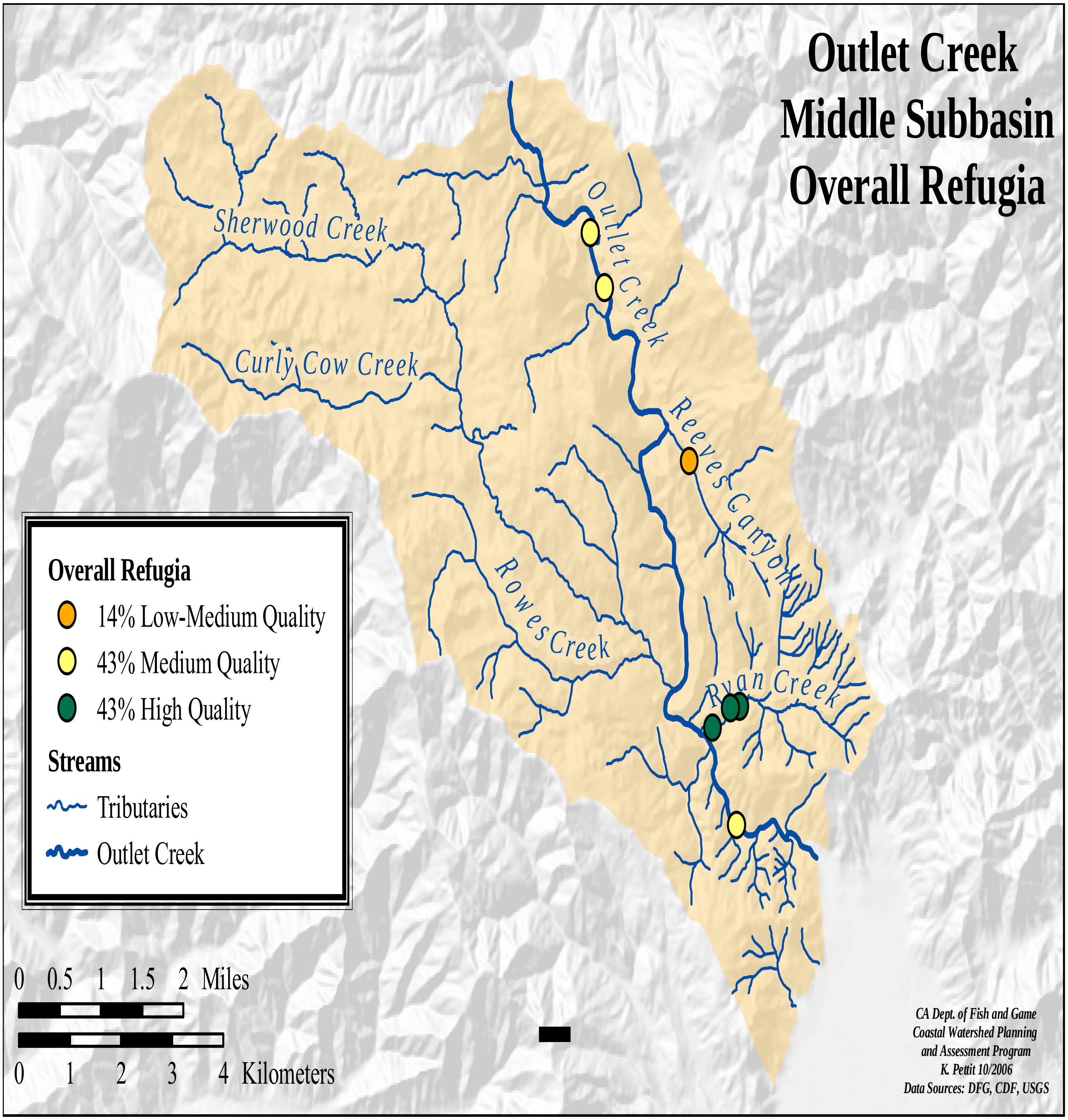


Figure X. Outlet Creek Middle Subbasin Overall Refugia.

Responses to Assessment Questions

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

Findings and Conclusions:

- The subbasin is inhabited by Chinook and coho salmon, steelhead, and rainbow trout. Coho salmon have been frequently observed in Ryan Creek in the recent past, and adults migrate through on their way to spawn in the Southern Subbasin and juveniles pass through on their way to the Northern Subbasin and the Eel River;
- 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. Juvenile salmonids were observed at any of the sites surveyed;
- Big and small mouth bass and bull frogs have been introduced.

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

Findings and Conclusions:

Flow/Water Quality

- Summer water temperatures may be a limiting factor on Outlet Creek sites in 2004. Ryan Creek, Reeves Canyon and Bull Creek Pinson provide thermal refugia to coho salmon and steelhead trout;
- The MWATS show that Outlet Creek was unsuitable between July 3 and July 22. Sherwood and Rowes were unsuitable or lethal on July 22. Ryan and Bull creeks were somewhat suitable between July 21 and July 22. Reeves Canyon Creek was fully suitable on August 18. Overall, the subbasin was somewhat unsuitable;
- The turbidity and conductivity ranges were >1.00-80.00 NTU and 330-642 Ω, respectively.

Fish Passage

- The six dams located upstream in the Southern Subbasin restrict flow and slow and/or retard the adult spawning migration both 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;
- Culverts on both Reeves Canyon and Ryan creeks are barriers to juvenile out-migration.

Erosion/Sediment

- Ryan and Outlet creeks may supply fine sediment form eroding stream banks, which maybe increasing the embeddedness levels in these streams;
- Overall, embeddedness values have increased and available spawning substrate has decreased between 1995 and 2004 in the subbasin and in the streams surveyed;
- High embeddedness values are likely limiting the health and production of salmonids in the subbasin;
- Erosion on unpaved roads in and around Ryan, Bull, and the main stem of Outlet creeks contribute fine sediment to the Outlet Creek stream channel.

Riparian Condition

- Overall, the canopy density values have increased in the subbasin between 1995 and 2004, indicating that the riparian area has improved;
- Current canopy is unlikely limiting the health and production of salmonids in the Middle Subbasin;
- The EMDS results show that the subbasin has remained unchanged between 1995 and 2004.

Instream Habitat

- Overall, since 1995, the habitat categories ratios have become more adequate in the middle reaches of Outlet Creek;
- Pool Habitat has increased indicating that over summer conditions for juvenile salmonids may have improved;
- Habitat category ratios are not limiting the health and production of salmonids in the subbasin streams, except for Reeves Canyon Creek;
- The EMDS results show that pool depths in the subbasin and Ryan Creek have improved slightly, between 1995 and 2004, but are still unsuitable;
- The EMDS results show that pool shelter conditions in the subbasin have remained unchanged between 1995 and 2004.

Gravel/Substrate

- The substrate in these reaches is comprised of cobble, gravel, and fine sediment;
- Overall, the embeddedness values have increased and available spawning substrate has decreased between 1995 and 2004 in the subbasin and in the streams surveyed. High embeddedness values are likely limiting the health and production of salmonids in the Middle Subbasin.

Refugia Areas

- Most juvenile salmonid habitat conditions in the subbasin are of medium to high quality.

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

<u>Findings and Conclusions:</u>

Hydrology

- The stream network flows primarily in a northern direction. Most of the streams in the Middle Subbasin are intermittent and include: Reeves Canyon, Ryan, Rowes, Curly Cow, and Sherwood creeks;
- Outlet Creek, which is a 3^{rd} order stream, and Reeves Canyon, Sherwood, Rowes, Curly Cow and Ryan creeks, which are intermittent, are the largest perennial streams;
- 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 Outlet Creek and the Eel River System. During late summer and early fall, flows dry and become subsurface in some of the tributaries and Outlet Creek, stranding juvenile salmonids. Natural low flow conditions are severely reduced by legal and illegal dewatering;
- The channel characteristics range from moderately entrenched and riffle dominated to well entrenched and riffle/pool dominated;
- Outlet Creek is characterized by low gradient, low sinuosity, and depositional character;
- 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 and fine sediment contribution to Outlet Creek, from both this subbasin and the Southern Subbasin, which moves downtown into the Eel River and its estuary.

Vegetation

- Open grasslands, oak woodlands, and mixed coniferous forest cover both the east and west side hills;

- Invasive plant species included periwinkle, pampas grass, star thistle, Himalayan blackberry, and *Arundo*.

How has land use affected these natural processes?

- The land use includes agriculture, grazing, ranching, timber production, and large rural residential 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 form 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 flow in August and September;
- Low and/or absent flow during November;
- High summer water temperatures;
- Subsurface flows obstructing fish migration;
- Bank and debris slide erosion from livestock;
- Fine sediment from roads, culverts, and land use activities;
- Low canopy density;
- Inadequate structure, like large woody debris;
- Inadequate pool depth and frequency;
- Barriers to migration;
- 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 in the middle reach of Outlet Creek;
- 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;
- Replace and eliminate culverts which inhibit migration;
- There are a total of 5 barriers blocking 3 miles of stream, 2 are complete, 3 are partial, plus 5 of unknown status in the Middle subbasin.

Erosion and Sediment Delivery Reduction Activities

- Unpaved, 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 areas with unsuitable EMDS ratings, such as the middle section of Outlet Creek between the confluences of Reeves Canyon and Ryan creeks;
- Major restoration efforts should be focused on improving pool depths and located in areas with unsuitable EMDS ratings;
- Most restoration efforts should be focused on improving pool shelter in the subbasin in areas with unsuitable EMDS ratings;
- Implementation of restoration projects focused on increasing canopy, 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 redd and spring/summer juvenile surveys;
- Support stream gage installations and maintenance to establish a long term record of the Outlet Creek hydrologic conditions;
- Start and continue current water temperature monitoring at current locations and expand efforts where appropriate.

Table X. Prioritized Improvement Activities in the Middle Subbasin

Location	Improvement Activity	DFG FRGP	Coho Recovery Plan Task Numbers	Steelhead Recovery Plan Task Numbers	CWPAP Priority
Outlet; Reeves; Ryan	Continue and expand water quality (temperature, dissolved oxygen, and fine sediment) monitoring.	HR	RW-II-A-02		2
Outlet; Reeves; Ryan	Conserve water during the summer and fall months.	WC	RW-XXXIII-A-01		1
Outlet; Reeves; Ryan	Identify, dismantle and cite illegal water extraction.	HR	RW-II-A-02 ER-OC-02b-d		1
Outlet; Reeves; Ryan	Identify sediment sources.	HS	RW-VI-a-02 RW-VI-D-01C		1

Outlet; Reeves; Ryan	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
Reeves; Ryan	Reduce sediment input from debris slides where possible.	HS	RW-VI-a-02 RW-VI-D-01C		2
Outlet	Revegetate stream banks to develop and expand canopy.	HI	RW-XXII-A-04		2
Outlet; Reeves; Ryan	Add large woody debris and other structure to increase cover and pool depth and frequency.	HI	RW-XXII-A-04	NC-08	2
Reeves; Ryan	Removal barriers to migration.	FP	RW-XXII-A-04	NC-02 and 03; NC-24	1
Outlet; Reeves; Ryan	Develop and support water quality monitoring.	MD	RW-II-A-02		2

Middle Subbasin Conclusions

The Middle Subbasin is the smallest, and provides the most suitable salmonid habitat within the Outlet Basin. Much of this subbasin is privately owned. Salmon and steelhead habitat conditions in the Middle Subbasin are generally suitable for the support of salmonid production. However, salmonid populations are currently being limited by reduced habitat complexity, high water temperatures, low summer stream flows, embedded spawning gravels, and artificial passage barriers. 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 landowners, 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 enhanced 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.