Fish Habitat Relationships

Historic Habitat Conditions

The past conditions of the Outlet Creek Basin have been reconstructed from historic and aerial 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;
- The streams meandered through Little Lake Valley where a large seasonal lake formed. The lake provided water to Outlet Creek until early summer;
- It is likely that Outlet Creek and Willits, Baechtel, Broaddus, and Davis creeks remained connected through deep channel(s) within Little Lake.

Erosion and Fine Sediment

- High intensity rainfall coupled with high gradient on soft geology create high erosion potential;
- Naturally high levels of erosion which contribute fine sediment to the streams;
- Stream banks composed of highly erodible terrane were covered with native plant species;

Riparian and Instream Habitat

- Riparian areas along the stream banks were well developed and the vegetation consisted of willow, alder, and ash;
- Old growth redwood and Douglas Fir species were also part of the riparian and upslope vegetation;
- The healthy and functioning riparian help insolate streams for solar radiation reducing stream water temperatures;
- Large woody debris was recruited from the well developed, old growth riparian area;
- Stream banks shifted course and meandered;
- Stream banks and floodplains were not covered with railroad tracks and/or roads;
- Streams were not confined or relocated by Highway 101.

Current Habitat Conditions

The Basin Profile reports the findings and analyses of the current habitat conditions which are divided into three subsections: Flow and Water Quality, Erosion and Fine Sediment, and Riparian and Instream.

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 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.

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

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

The USGS collected water temperatures, flow, and limited water chemistry data at a stream gauge located on the lower mainstem of Outlet Creek near Longvale from May 1957–December 1988. The CDFG collected water temperature data with thermographs at different locations throughout the basin in 2000, 2001, and 2004. CDFG data from 2004 are included in this report.

The average daily summer temperature for the 30 year record was 70 F. The average daily summer temperature for June was 69 F, July was 74 F, August was 75F, and September was 68 F. The highest water temperatures were most commonly recorded in August and were over 75F in three out of the four decades. (Table X). The summer water temperatures were unsuitable over the past 30 years.

A linear regression of the data showed a slight cooling trend. Some possible causes of the decrease in water temperatures include an increase in canopy density over the stream and regulated water releases from dams and impounds. Summer water temperatures historically limited the health and production of juvenile salmonids in the Outlet Creek Basin

Table X. Average monthly summer water temperatures collected from 1958-1988

Decade	May	June	July	August	September	Decadal Range
1950s	70	70	79	77	68	68-79

1960s	63	68	76	77	71	63-77
1970s	60	69	70	70	64	60-70
1980s	63	68	72	77	67	63-77
30 yr avg	64	69	74	75	68	64-75
Avg	60-70	68-70	70-79	70-77	64-71	60-79

Twenty two thermographs were deployed throughout the basin to record summer water temperature in 2004 for this assessment (Figure X). Table X shows the temperature ranges recorded by the thermographs by subbasin. Maximum Weekly Average Temperatures (MWATs) were unsuitable on all Outlet Creek mainstem sites. Suitable temperatures were recorded in a few tributaries in all three subbasins. In general, west-east flowing tributaries were cooler and had greater canopy cover over the streams. Tributaries in the Middle Subbasin had the coolest temperatures. Further details of the water temperature data and MWATs are presented in the Subbasin Sections of this report.

Table 1. MWATs from 2004 in the Outlet Creek Basin.

Subbasin	Number of Sites	MWAT Range (°F)	MWAT Range (°C)	Month
Northern	7	63.8-78.1	17.7-25.6	July
Middle	6	56.7-75.1	13.7-23.9	July/August
Southern	9	62.5-74.4	16.9-23.6	July/September
Basin	22	56.7-78.1	13.7-25.6	July/September

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

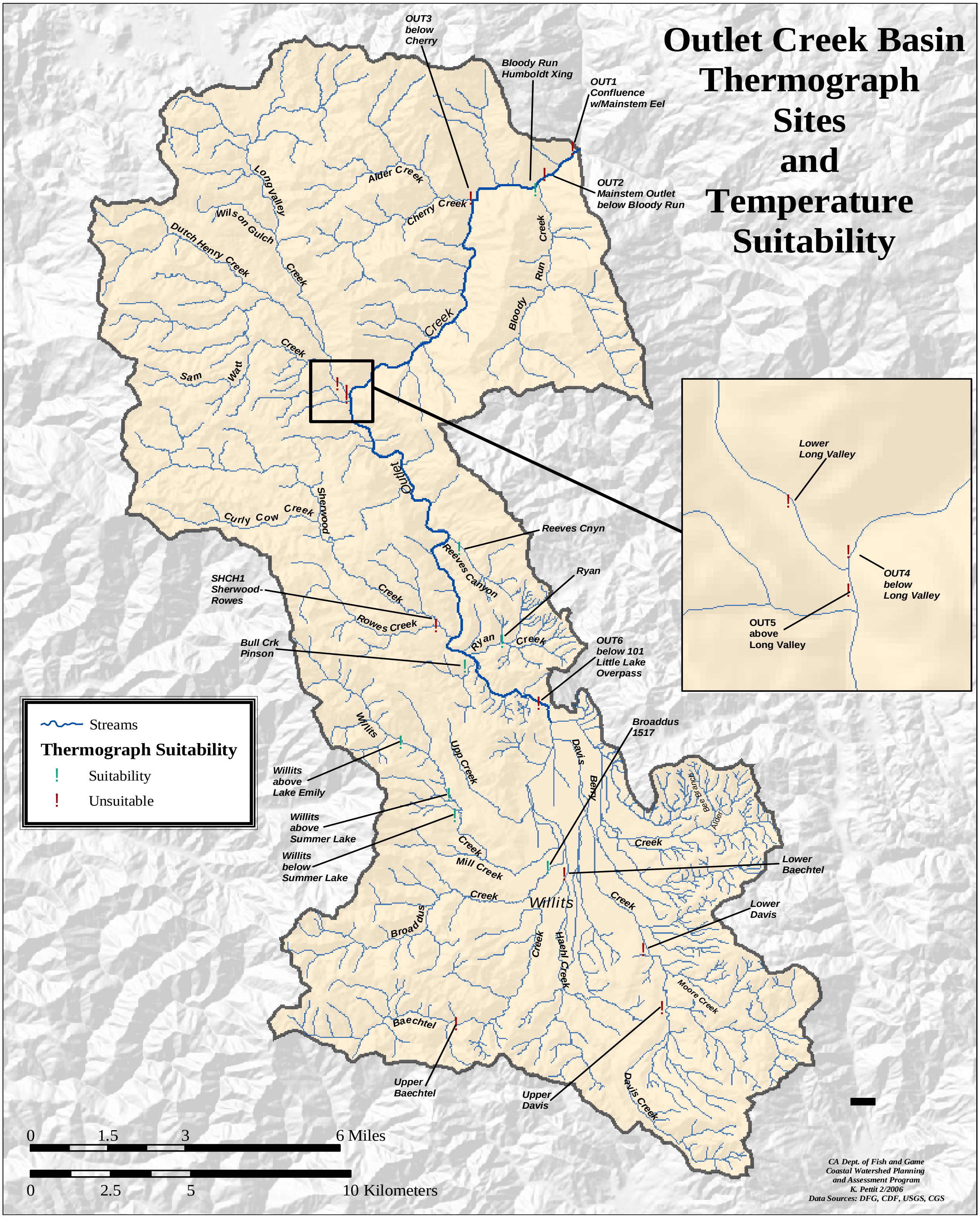

Figure X. MWATs and suitability from 2004.

Water Chemistry

From May 1958 – December 1988, the CWRCB and USGS collected some water chemistry data at the stream gauge located on Outlet Creek near Longvale. The percent of saturation of dissolved oxygen was measured at different times of the day usually before noon. The dissolved oxygen ranged from 82-147%. The suitable dissolved oxygen level for migrating adult salmonids is about 80% and 100% for rearing juveniles (CDFG 2004). It appears that the dissolved oxygen was not a limiting factor from 1958-1988. Current dissolved oxygen data does not exist for the Basin. It is recommended that dissolved oxygen data be collected as part of a Basin wide water quality monitoring program. This data could help determine if dissolved oxygen is currently limiting factor.

In September of 1960, a sampling reconnaissance was made of Outlet Creek and its tributaries in an attempt to locate the source of high boron concentrations. This survey found low total dissolved solids, concentrations of boron as high as 3.4 parts per million. Results indicate that most of the boron in Outlet Creek was coming from Long Valley Creek which carried 9.9 parts per million of boron just above its confluence with Outlet Creek. It is probable that it is supplied by volcanic or deep-seated waters from one or more springs similar to those that have been identified near Clear Lake, Lake County, California. High boron contents have often been associated with fracture zones and such a fault zone exists in the vicinity of Long Valley Creek. The boron concentrations were found to be diluted by the time they reach the Eel River.

Turbidity and conductivity samples were taken at each of the 50 GRTS site in 2004. In the basin overall, turbidity and conductivity ranged from 0.45-80.0 and 249-2,080, respectively. In the Northern Subbasin overall, turbidity and conductivity ranged from 0.45-23.0 and 249-2,080, respectively. In the Middle Subbasin overall, turbidity and conductivity ranged from 0.85-80.0 and 330-642, respectively. In the Southern Subbasin overall, turbidity and conductivity ranged from 1.1-80.0 and 346-1,110, respectively.

Table X. Turbidity and conductivity collected in 2004 in the Outlet Creek Basin.

Area	Number of Sites	Range of Turbidity (NTU)	Range of Conductivity
Northern	19	0.45-23.0	249-2,080
Middle	7	0.85-80.00	330-642
Southern	24	1.1-80.00	346-1,110
Basin	50	0.45-80.00	249-2,080

Instream Habitat (1995, 2003, and 2004)

There are 79.4 perennial stream miles on fourteen perennial tributaries in this basin. 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 Outlet Basin were based upon stream habitat inventories conducted in 1995 and 2003 by DFG which surveyed Outlet, Long Valley, Cherry, Bloody Run, Ryan, Broaddus, Baechtel, Willits and Haehl creeks (Figure X. Outlet Creek Basin Habitat Surveys 1995 and 2003). The General Random Tessellation Surveys (GRTS) conducted in 2004 by DFG and PSMFC crews surveyed random sections of the streams, with the addition of Alder and an unnamed tributary to Long Valley creeks in the Northern Subbasin, Reeves Canyon Creek in the Middle Subbasin, and Davis, Mill and Berry creeks in the Southern Subbasin, with the exclusion of Haehl Creek (Figure X. GRTS Sampling in the Outlet Creek Basin in 2004. Only streams where land owner access was granted were available to be surveyed in 1995, 2003 and 2004.

In 1995, the CDFG conducted habitat inventory surveys (Flosi et al. 1998) in all three of the subbasins. In the Northern Subbasin, lower Outlet, Bloody Run, Cherry, and Long Valley creeks were surveyed. In the Middle Subbasin, middle Outlet and Ryan creeks were surveyed. In the Southern Subbasin, Baechtel, Broaddus, Haehl, and Willits creeks were surveyed, as well as part of Davis Creek under a FRGP contract in 2003 (Figure X). Spot air and water temperatures, flows, salmonid presence, barriers, and recommendations were included in the Stream Inventory Reports. The locations and findings from these reports are detailed in the Subbasin Sections.

In 2004, CDFG conducted General Random Tessellation Sampling (GRTS) (Gallo et al. 2003, 2005) with some adapted methodologies which included habitat inventory surveys (Flosi et al 1998) and other components (Downie and LeDoux-Bloom 2004). See the methods section for further details. Fifty sites on fourteen streams were surveyed in the basin. Nineteen sites on five streams in the Northern Subbasin, seven sites on three streams in the Middle Subbasin, and twenty four sites on six streams in the Southern Subbasin were surveyed and sampled (Figure X).

The results and analyses and the comparisons between the two data sets are presented at the basin scale in this section and at the subbasin, tributary, and survey site level in the Subbasin Sections.

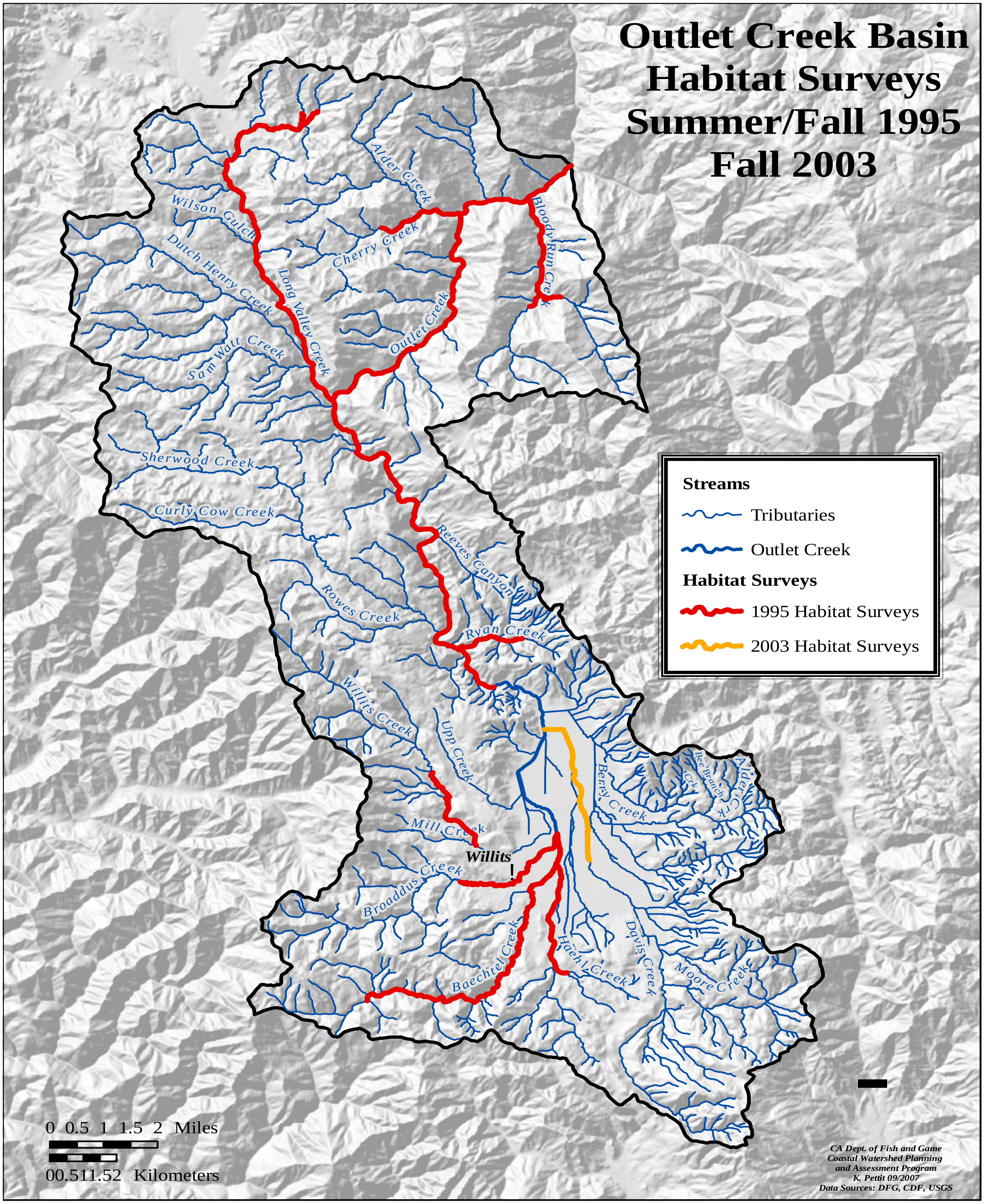

Figure X. Habitat Inventory Surveys completed in 1995 and 2003.

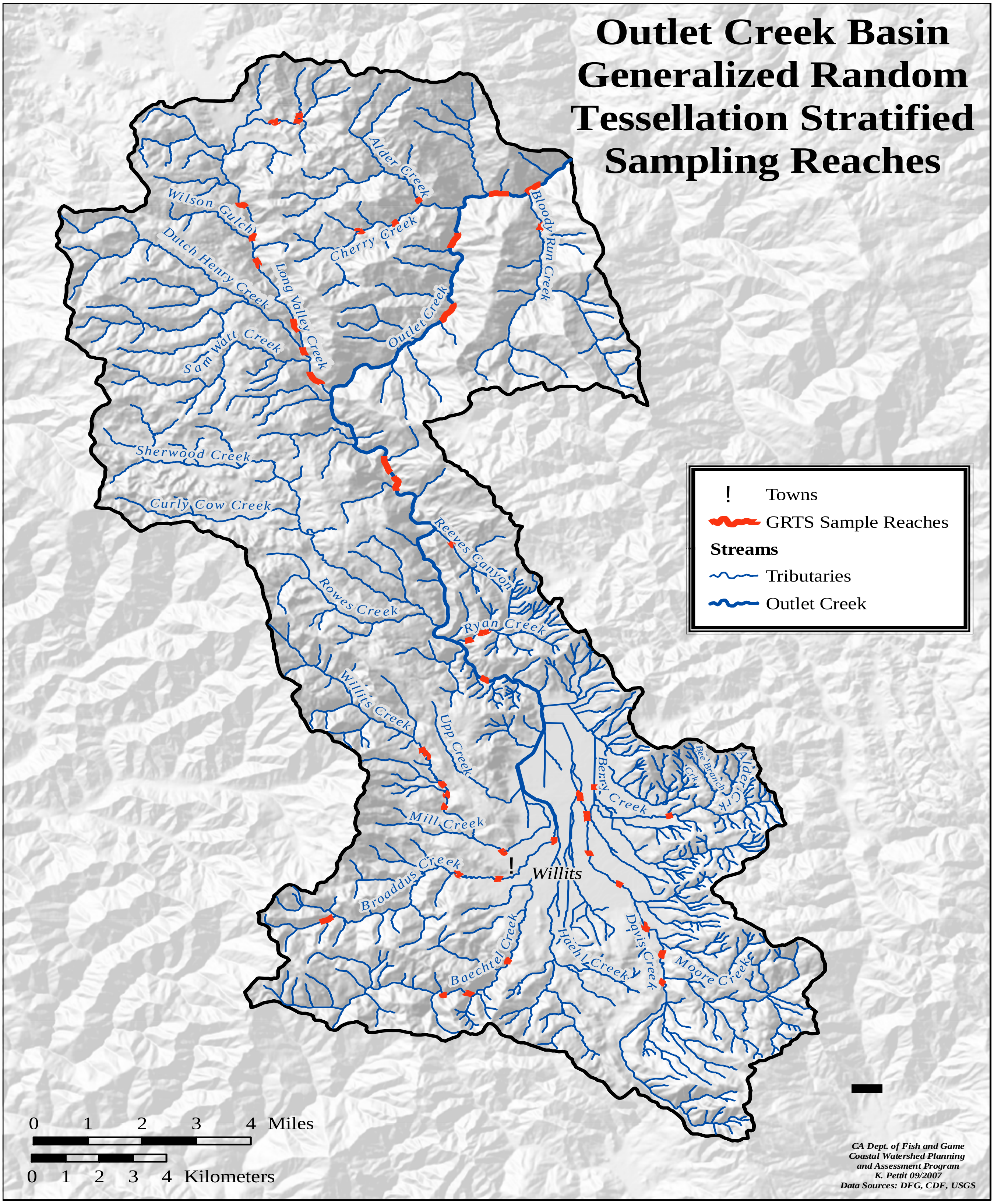

Figure X. General Random Tessellation Sampling in 2004.