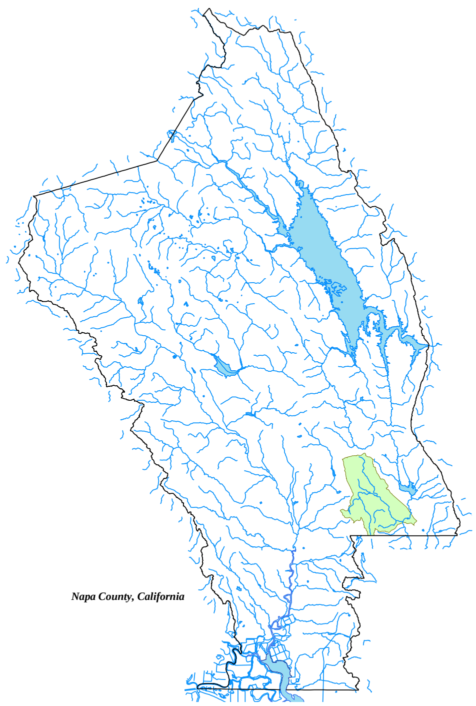
HABITAT INVENTORY REPORT
WOODEN VALLEY CREEK & WHITE CREEK



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INTRODUCTION

Stream inventories were conducted during June of 2002 on Wooden Valley Creek and its primary tributary, White Creek. The inventory was conducted in two parts; habitat typing and a visual biological inventory. The objective of the habitat inventory was to document the amount and condition of available habitat to fish, and other aquatic species with an emphasis on anadromous salmonids in the Wooden Valley watershed. The biological component documented fish species presence in addition to other pertinent observations on flora and fauna. The objective of this report is to document the current habitat conditions, and recommend options for the potential enhancement of habitat for steelhead trout, and possibly chinook salmon. Recommendations for habitat improvement activities are based upon target habitat values suitable for salmonids in California's north coast streams.

METHODS

The habitat inventory conducted in the Wooden Valley watershed follows the methodology presented in the California Salmonid Stream Habitat Restoration Manual (Flosi and Reynolds, 1994). The two-person field crew that conducted the inventory was trained in standardized habitat inventory methods by the California Department of Fish and Game (DFG).

SAMPLING STRATEGY

The inventory uses a method that samples approximately 10% of the habitat units within the survey reach (Hopelain, 1994). All habitat units included in the survey are classified according to habitat type and their lengths are measured. All pool units are measured for maximum depth. Habitat unit types encountered for the first time are further measured for all the parameters and characteristics on the field form. Additionally, from the ten habitat units on each field form page, one is randomly selected for complete measurement. Since pool habitat has been identified as a critical factor affecting salmonid populations in California streams, all pools encountered during this survey were fully measured.

HABITAT INVENTORY COMPONENTS

A standardized habitat inventory form has been developed for use in California stream surveys and can be found in the California Salmonid Stream Habitat Restoration Manual. This form was used in the Wooden Valley watershed to record measurements and observations. There are nine components to the inventory form: flow, channel type, temperatures, habitat type, embeddedness, shelter rating, substrate composition, canopy, and bank composition.

1. Flow:

Flow is measured in cubic feet per second (cfs) at the bottom of the stream survey reach using standard flow measuring equipment, if available. In some cases flows are estimated. Flows are also measured or estimated at major tributary confluences if possible. This survey did not include quantitative flow measurements due to the minimal surface flow observed during the survey period. Streamflow was estimated at the beginning of each day of the survey.

2. Channel Type:
Channel typing is conducted according to the classification system developed and revised by David Rosgen (1985 rev. 1994). This methodology is described in the California Salmonid Stream Habitat Restoration Manual. Channel typing is conducted simultaneously with habitat typing and follows a standard form to record measurements and observations. There are five measured parameters used to determine channel type: 1) water slope gradient, 2) entrenchment, 3) width/depth ratio, 4) substrate composition, and 5) sinuosity.

3. Temperatures:
Water and air temperatures, and time, are measured by crew members with hand held thermometers and recorded at each tenth unit typed. Temperatures are measured at the middle of the habitat unit and within one foot of the water surface.

4. Habitat Type:
Habitat typing uses the 24 habitat classification types defined by McCain and others (1988). Habitat units are numbered sequentially and assigned a type identification number selected from a standard list of 24 habitat types. Dewatered units are labeled "DRY". All habitat typing used standard basin level measurement criteria. These parameters require that the minimum length of a described habitat unit must be equal to or greater than the stream's mean wetted width. All unit lengths were measured, additionally, the first occurrence of each unit type and a randomly selected 10% subset of all units were completely sampled (length, mean width, mean depth, maximum depth and pool tail crest depth). As stated above, all pool habitat units were fully measured. All measurements were in feet to the nearest tenth.

5. Embeddedness:
The depth of embeddedness of the cobbles in pool tail-out reaches is measured by the percent of the cobble that is surrounded or buried by fine sediment. In all waterways, embeddedness was visually estimated. The values were recorded using the following ranges: 0 - 25% (value 1), 26 - 50% (value 2), 51 - 75% (value 3), 76 - 100% (value 4). Additionally, a rating of "not suitable" (NS) was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate particle size, having a bedrock tail-out, or other considerations.

6. Shelter Rating:
Instream shelter is composed of those elements within a stream channel that provide salmonids protection from predation, reduce water velocities so fish can rest and conserve energy, and allow separation of territorial units to reduce density related competition. Using an overhead view, a quantitative estimate of the percentage of the habitat unit covered is made. All shelter is then classified according to a list of nine shelter types. A standard qualitative shelter value of 0 (none), 1 (low), 2 (medium), or 3 (high) is assigned according to the complexity of the shelter. The shelter rating is calculated for each habitat unit by multiplying shelter value and percent covered. Thus, shelter ratings can range from 0-300, and are expressed as mean values by habitat

types within a stream.

7. Substrate Composition:
Substrate composition ranges from silt/clay sized particles to boulders and bedrock elements. In all fully measured habitat units, dominant and sub-dominant substrate elements were visually estimated using a list of seven size classes.

8. Canopy:
Stream canopy density was measured using modified handheld spherical densiometers as described in the California Salmonid Stream Habitat Restoration Manual, 1994. Canopy density relates to the amount of stream shaded from the sun. In all surveyed streams, an estimate of the percentage of the habitat unit covered by canopy was made from the center of approximately every third unit in addition to every fully-described unit, giving an approximate 30% sub-sample. In addition, the area of canopy was estimated visually into percentages of evergreen or deciduous trees.

9. Bank Composition:
Bank composition elements range from bedrock to bare soil. However, the stream banks are usually covered with grass, brush, or trees. These factors influence the ability of stream banks to withstand winter flows. In all surveyed streams, the dominant composition type and the dominant vegetation type of both the right and left banks for each fully measured unit were selected from the habitat inventory form. Additionally, the percent of each bank covered by vegetation was estimated and recorded.

BIOLOGICAL INVENTORY

Biological sampling during stream inventory is used to determine fish species and their general distribution in the stream. Biological inventory is conducted using one or more of three basic methods: 1) stream bank observation, 2) underwater observation, 3) electrofishing. These sampling techniques are discussed in the California Salmonid Stream Habitat Restoration Manual. In this study, all surveyed reaches included a visual biological inventory to document fish presence within the stream with emphasis on salmonids and key predatory, warm-water, and introduced species.

IMPACT INVENTORY & ANALYSIS

Problems such as migration barriers, streambed erosion, poor water quality or temperatures are noted and mapped. In some cases measurements are taken, an analysis of what caused the problem is made and restoration potential and alternatives are recommended.

DATA ANALYSIS

Data from the habitat inventory form are entered into *Habitat* for data storage and analysis. *Habitat* is a dBASE data entry program developed by the Inland Fisheries Division of the

California Department of Fish and Game. This program processes and summarizes the data, and produces the following tables and appendices:

- Riffle, flatwater, and pool habitat types
- Habitat types and measured parameters
- Pool types
- Maximum pool depths by habitat types
- Shelter by habitat types
- Dominant substrates by habitat types
- Vegetative cover and dominant bank composition
- Fish habitat elements by stream reach

Graphics are produced from the tables to include:

- Level II Habitat Types by % Occurrence and % Total Length
- Level IV Habitat Types by % Occurrence
- Pool Habitat Types by % Occurrence
- Maximum Depth in Pools
- Pool Shelter Types by % Area
- Substrate Composition in Low Gradient Riffles
- Percent Cobble Embeddedness by Reach
- Mean Percent Canopy
- Mean Percent Canopy by Reach
- Percent Bank Composition and Bank Vegetation

<u>LEVEL IV HABITAT TYPE KEY</u>:

The following table can be used to identify habitat types in stream report graphs.

HABITAT TYPE	LETTER	NUMBER
RIFFLE		
Low Gradient Riffle	[LGR]	1.1
High Gradient Riffle	[HGR]	1.2
CASCADE		
Cascade	[CAS]	2.1
Bedrock Sheet	[BRS]	2.2
FLATWATER		
Pocket Water	[POW]	3.1
Glide	[GLD]	3.2
Run	[RUN]	3.3
Step Run	[SRN]	3.4
Edgewater	[EDW]	3.5
MAIN CHANNEL POOLS		
Trench Pool	[TRP]	4.1
Mid-Channel Pool	[MCP]	4.2
Channel Confluence Pool	[CCP]	4.3
Step Pool	[STP]	4.4
SCOUR POOLS		
Corner Pool	[CRP]	5.1
Lateral Scour Pool - Log Enhanced	[LSL]	5.2
Lateral Scour Pool - Root Wad Enhanced	[LSR]	5.3
Lateral Scour Pool - Bedrock Formed	[LSBk]5.4	
Lateral Scour Pool - Boulder Formed	[LSBo]	5.5
Plunge Pool	[PLP]	5.6
BACKWATER POOLS		
Secondary Channel Pool	[SCP]	6.1
Backwater Pool - Boulder Formed	[BPB]	6.2
Backwater Pool - Root Wad Formed	[BPR]	6.3
Backwater Pool - Log Formed	[BPL]	6.4
Dammed Pool	[DPL]	6.5

Wooden Valley Creek
Habitat Inventory Results

The habitat inventory of Wooden Valley Creek, 6/14/2002 - 6/24/2002, was conducted by Jonathan Koehler and Alison Purcell. The survey began just above the confluence with Suisun Creek and extended up Wooden Valley Creek, dependant on landowner access permission, ending when surface flow was absent (see habitat map). The total length of stream surveyed was 16,677 feet, with an additional 267 feet of side channel.

Flows were not measured on Wooden Valley Creek, but visual estimates were made at the beginning of each survey day. Surface flows were minimal throughout the surveyed reaches and were categorized as low. Approximately one percent of the surveyed reaches of Wooden Valley Creek were completely dry **(Graph 1)**.

This section of Wooden Valley Creek has 6 reaches with 6 distinct channel types: from the confluence with Suisun Creek to 1625 feet it is a B1, followed by 2872 feet of C4, 2263 feet of F4, 2748 feet of F3, 2974 feet of F1 and 4195 feet of G6.

• B1 channel types are moderately entrenched, moderate gradient (2-4%), riffle dominated channels, with infrequently spaced pools, a very stable plan and profile, stable banks and have a predominantly bedrock substrate.

• C4 channel types are low gradient (<2%), meandering, point-bar, riffle/pool, alluvial channels with a broad, well defined floodplain and a predominantly gravel substrate.

• F1 channel types are entrenched meandering riffle/pool channels on low gradients (<2%) with a high width/depth ratio and a predominantly bedrock substrate.

• F3 channel types are entrenched meandering riffle/pool channels on low gradients (<2%) with a high width/depth ratio and a predominantly cobble substrate.

• F4 channel types are entrenched meandering riffle/pool channels on low gradients (<2%) with a high width/depth ratio and a predominantly gravel substrate.

• G6 channel types are characterized as well entrenched "gully" step-pool channels with a low width/depth ratio, a moderate gradient (2-4%) and a predominantly silt/clay substrate.

Water temperatures ranged from 15ºC to 23ºC. Air temperatures ranged from 17ºC to 32ºC.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of *occurrence* there were 36% Pool units, 34 % Flatwater units, 29% Riffle units and 1% Dry units **(Graph 1)**. Based on total *length* there were 45% Flatwater units, 27% Riffle units, 26% Pool units and 2% Dry units **(Graph 2)**.

A total of 230 habitat units were measured and 45% were completely sampled, and 23 Level IV habitat types were identified. These data are summarized in **Table 2**.

The most frequent habitat types by percent *occurrence* were Low Gradient Riffle at 27%, Glide at 24%, Mid-Channel Pool at 19%, Step Run at 9%, Lateral Scour Pool - Bedrock Formed at 3%, Lateral Scour Pool - Root Wad Enhanced at 3%, Corner Pool at 3%, Plunge Pool at 2%, Lateral Scour Pool - Boulder Formed at 2%, Bedrock Sheet at 1%, and all of the following at less than one percent: Dry, Backwater Pool - Log Formed, Backwater Pool - Root Wad Formed, Channel Confluence Pool, High Gradient Riffle, Dammed Pool, Not Surveyed, Backwater Pool - Boulder Formed, Step Pool, Run and Culvert **(Graph 3)**.

By percent total *length*, Glide at 30%, Low Gradient Riffle at 26%, Mid-Channel Pool at 15%, Step Run at 12%, Lateral Scour Pool - Bedrock Formed at 3%, Not Surveyed at 3%, Corner Pool at 2%, Dry at 2%, Lateral Scour Pool - Root Wad Enhanced at 1%, Lateral Scour Pool - Boulder Formed at 1%, Run at 1%, Plunge Pool at 1%, Channel Confluence Pool at 1%, and all of the following at less than on percent: Bedrock Sheet, Step Pool, Backwater Pool - Root Wad Formed, Dammed Pool, Backwater Pool - Log Formed, Backwater Pool - Boulder Formed, High Gradient Riffle and Culvert.

In the surveyed reaches of Wooden Valley creek, 80 pools were identified **(Table 3)**. Mid-Channel Pool pools were most often encountered at 19%, and comprised 60% of the total length of pools. Pool habitat types by percent occurrence are shown in **Graph 4**. In the surveyed reaches, 12 of the 80 pools (15%) had a depth of three feet or greater **(Graph 5)**. These deeper pools comprised 5% of the total length of stream habitat. **Table 4** is a summary of maximum pool depths by pool habitat types. Pool quality for salmonids increases with depth.

A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Pools rated 45, Riffles rated 19 and Flatwater units rated 19 **(Table 1)**. Of the pool types, Dammed Pool rated 180, Backwater Pool - Log Formed rated 140, Backwater Pool - Root Wad Formed rated 100, Lateral Scour Pool - Root Wad Enhanced rated 84, Step Pool rated 60, Plunge Pool rated 56, Lateral Scour Pool - Bedrock Formed rated 48, Mid-Channel Pool rated 41, Corner Pool rated 38, Lateral Scour Pool - Boulder Formed rated 25, Channel Confluence Pool rated 10 and Backwater Pool - Boulder Formed rated 10. Summarized mean shelter ratings are shown in **Table 3**.

Table 5 summarizes fish shelter by habitat type. By percent area, the dominant pool shelter types were Aquatic Vegetation at 35%, Boulders at 24%, Large Wood at 10%, Bedrock at 8%, Small Wood at 7%, Root Mass at 6%, Terrestrial Vegetation at 5%, Undercut Banks at 4% and White Water at 0%. **Graph 7** describes the pool shelter in Wooden Valley Creek.

Table 6 summarizes the dominant substrate by habitat type. In the 63 Low-Gradient Riffles surveyed, the dominant substrate was: Large Cobble in 4 riffles, Small Cobble in 2 riffles, Silt & Clay in 1 riffle and Gravel in 1 riffle.

The depth of cobble embeddedness was visually estimated at pool tail-outs and is summarized in **Graph 6**. Of the 79 pool tail-outs measured, 2 had a value of 1 (3%), 8 had a value of 2 (10%), 15 had a value of 3 (19%) and 30 had a value of 4 (38%). Additionally, 24 (30%) riffles rated a 5 (unsuitable substrate type for spawning). On this scale, a value of one is best for fisheries. **Table 8** describes percent embeddedness by reach. Gravel was the most common substrate in pool tail-outs **(Graph 8)**.

The mean percent canopy density for the stream reach surveyed was 64%. The mean percentages of deciduous and evergreen trees were 91% and 0%, respectively. **Graph 9** describes the canopy for the entire survey and **Table 8** describes the canopy by reach.

For the entire stream reach surveyed, the mean percent right bank vegetated was 42% and the mean percent left bank vegetated was 38%. For the habitat units measured, the dominant vegetation types for the stream banks were: 36% Grass, 34% Brush, 30% Deciduous Trees and 0.5% Bare Soil **(Graph 11)**. The dominant substrate for the stream banks were: 72% Silt, Clay & Sand, 14% Cobble & Gravel, 9% Boulder and 7% Bedrock **(Graph 10)**.

DISCUSSION

In this survey of Wooden Valley Creek 6 reaches were identified: 1625 feet of B1, 2872 feet of C4, 2263 feet of F4, 2748 feet of F3, 2974 feet of F1, and 4195 feet of G6.

According to the DFG Salmonid Stream Habitat Restoration Manual:

• B1 channel types are excellent for bank-placed boulders and bank cover and good for log cover.

• C4 channel types are good for bank-placed boulders and log cover. They are fair for low-stage weirs, single and opposing wing-deflectors, channel constrictors and log cover.

• F1 channel types are good for bank-placed boulders and fair for single wing-deflectors and log cover.

• F3 channel types are good for bank-placed boulders as well as single and opposing wing-deflectors. They are fair for low-stage weirs, boulder clusters, channel constrictors and log cover.

• F4 channel types are good for bank-placed boulders and fair for low-stage weirs, single and opposing wing-deflectors, channel constrictors and log cover.

• G6 channel types are good for bank-placed boulders and fair for low-stage weirs, opposing wing-deflectors and log cover.

Within these channel types, the following general guidelines and recommendations apply:

B and F types
Many site specific projects can be designed within this channel type, especially to increase pool frequency, volume and shelter.

B types
These channel types have suitable gradients and the stable stream banks that are necessary for the installation of instream structures designed to increase pool habitat, trap spawning gravels, and provide protective shelter for fish.

F types
Any work considered will require careful design, placement, and construction that must include protection for any unstable banks.

The water temperatures recorded on the survey days 6/14/2002 - 6/24/2002 ranged from 15ºC to 23ºC. Air temperatures ranged from 17ºC to 32ºC. The warmest water temperatures were recorded in Reach 5. These temperatures, if sustained, are above the threshold stress level of approximately 20° C (68°F) for salmonids.

Pools comprised 25% of the total length of this survey. In third and fourth order streams a primary pool is defined to have a maximum depth of at least three feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width. In Wooden Valley Creek, the pools are relatively shallow with only 15% having a maximum depth of at least three feet. These pools comprised 5% of the total length of stream habitat. However, in steelhead streams, it is generally desirable to have primary pools comprise approximately 30-50% of total habitat length.

The mean shelter rating for pools was 48. However, a pool shelter rating of approximately 80 is desirable. The moderate amount of pool shelter that now exists is being provided primarily by Aquatic Vegetation at 35%, Boulders at 24%, Large Wood at 10%, Bedrock at 8%, Small Wood at 7%, Root Mass at 6%, Terrestrial Vegetation at 5%, Undercut Banks at 4% and White Water at 0%. Log and root wad cover in the pool and flatwater habitats would improve both summer and winter salmonid habitat. Log cover provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

In the surveyed reaches, 3 of the 8 low gradient riffles measured (38%) had either gravel or small cobble as the dominant substrate. This is generally considered fair for spawning salmonids.

In Wooden Valley Creek, 57% of the pool tail-outs measured had embeddedness ratings of either 3 or 4. Only 3% had a rating of 1. Cobble embeddedness measured to be 25% or less (a rating of 1) is considered best for the needs of salmon and steelhead. The higher the percent of fine sediment, the lower the probability that eggs will survive to hatch. This is due to the reduced quantity of oxygenated water able to percolate through the gravel, or because of fine sediment capping the redd and preventing fry emergence. In Wooden Valley Creek/Reach 4/Reaches 5 and 6, sediment sources should be mapped and rated according to their potential sediment yields, and control measures taken.

The mean percent canopy for the survey was 64%. This is a relatively low percentage of canopy, since 80 percent is generally considered desirable. Cooler water temperatures are desirable in Wooden Valley Creek, and the currently elevated water temperatures could be reduced by increasing stream canopy. The large trees required for adequate stream canopy would also eventually provide a long term source of large woody debris needed for instream shelter and bank stability.

The vegetated riparian zone is thin or nearly absent in several areas with livestock and agriculture. Riparian removal, intensive grazing, and vineyard development within the riparian corridor could all lead to less stream canopy and channel incision causing bank erosion and higher water temperatures. Additionally, Reach 2, 3, and 4 had numerous bank erosion problems. This reach as well as other areas with bank erosion could benefit from re-vegetation techniques using native species.

During the survey of Wooden Valley Creek the following fish species were observed:

- Rainbow trout (*Oncorhynchus mykiss*)
- California roach (*Lavinia symmetricus*)
- Other Cyprinids (*unidentified spp.*)
- Sculpin (*Cottus sp*.)
- Bluegill (*Lepomis macrochirus*)
- Green Sunfish (*Lepomis cyanellus*)
- Threespine stickleback (*Gasterosteus aculeatus aculeatus*)
- Mosquitofish (*Gambusia affinis*)

Rainbow trout were observed in all surveyed reaches primarily in pool habitats. Multiple age classes, which were determined by size, were seen: young-of-year (1-3 inches), 1+ (3-6 inches), and 2+ (greater than 6 inches). The size of a given age class will vary by geographic region; however these size ranges are widely accepted for northern California streams. Several larger rainbow trout (~ 12 inches) were observed in deeper pools in reach 2 and 3. It is not known whether these were resident or anadromous fish. Past surveys of Suisun Creek have documented adult steelhead, and no apparent barriers exist between Suisun and Wooden Valley Creek. It is therefore likely that a number of the rainbow trout observed in Wooden Valley Creek were spawned from anadromous steelhead. However, this was not confirmed under the scope of this study. Several landowners confirmed the presence of migrating steelhead up Wooden Valley Creek during recent winter months. The younger age classes (yoy, and 1+) appeared to be most abundant in reaches 1, 2, and 3. Very few fish of any type were observed in Reaches 5 and 6.

Amphibians and reptiles observed in Wooden Valley Creek include, Western Pond Turtle (*Clemmys marmorata*), California Toad (*Bufo boreas halophilus*), Pacific Tree Frog (*Hyla regilla*), Rough-skinned Newt (*Taricha granulosa*), and American Bullfrog (*Rana* *catesbeiana*).

CONCLUSIONS AND RECOMMENDATIONS

1. Pool frequency and quality is greatly deficient throughout most of Wooden Valley Creek, especially in reaches 1, 2, 3, and 6. Where feasible, increase the number of pools and amount of pool shelter in these reaches. The suitability of each reach for these types of projects is discussed in the results section above.

2. Active and potential upslope and in-channel sediment sources need to be identified, mapped, and treated according to their potential for sediment yield to the stream and its tributaries. Wooden Valley Creek has a high level of embeddedness throughout the surveyed reaches, and treatments to reduce the delivery of fines into the stream should be considered. Sources of fine sediment include roads, culverts, agriculture, livestock, and landslides. Reaches 4-6 had the highest levels of embeddedness.

3. The existing cover is deficient throughout Wooden Valley Creek, and adding complexity with larger woody cover (LWD) or other shelter would greatly enhance habitat quality. Combination cover/scour structures constructed with boulders and woody debris would be effective in many pool and flatwater locations in reaches 2-5. This must be done where the banks are stable (Reach 2) or in conjunction with stream bank armor to prevent excessive erosion (Reaches 3-5).

4. Wooden Valley Creek provides habitat for several species of native and introduced fish including rainbow trout (presumably steelhead form). An assessment of the fish community within the stream and tributaries and the general distribution would be useful for evaluating future restoration and enhancement efforts, documenting the current species composition, and long term trend monitoring. The assessment may include visual snorkel surveys or limited sampling efforts; however a complete inventory would not be necessary due to the error associated with small population sizes within intermittent habitats such as Wooden Valley.

5. Much of Wooden Valley Creek is being impacted from livestock in the riparian zone in Reaches 2-5. Livestock in streams inhibit the growth of new trees, exacerbate erosion, and reduce the survival of fish through the combination of high temperatures and oxygen depletion. Alternatives to limit livestock access such as cattle fencing should be explored with landowners and developed wherever possible.

6. Stream bank erosion along Wooden Valley Creek is evident in Reaches 1-4, and general riparian degradation and removal is evident in much of Reaches 2-4. Site locations were noted during habitat surveys for future enhancement and restoration. These sites would benefit from native vegetation plantings and simple erosion prevention techniques. If planted in conjunction with trees, these sites would serve a dual purpose to reduce bank erosion and restore canopy function which in turn improves water temperatures and water quality.

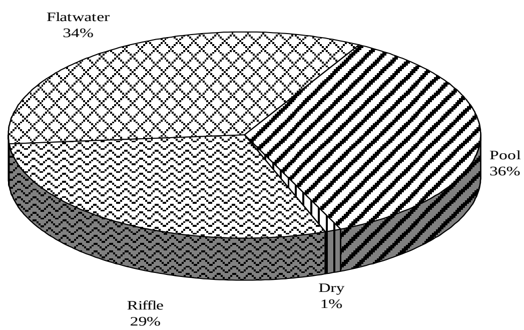
7. Migration barriers may limit the geographic range of steelhead populations within Wooden

Valley Creek. Several potential fish passage barriers were identified including, culverts, bridges, dams, and rock cascades. Further investigation is needed during periods of higher streamflow to determine the extent to which these various obstructions limit fish passage. No salmonids were observed in Wooden Valley Creek above a concrete dam in the middle of Reach 5. All potential barriers should be examined and removed or modified to allow for fish passage if possible. Generally, barrier modification or removal should be implemented if fish are unable to pass during at least 90 percent of anticipated flows, but each situation requires careful planning and consideration.

8. Surface flow is very limited in much of Wooden Valley Creek during summer months. These low flows severely limit the amount of habitat and food available to rearing salmonids. Additionally, low flows amplify the impacts of reduced riparian cover, which can lead to lethal temperatures and degraded water quality. Flows should be visually assessed regularly to determine what reaches are being affected the most in terms of cumulative impacts to juvenile fish.

Wooden Valley Creek

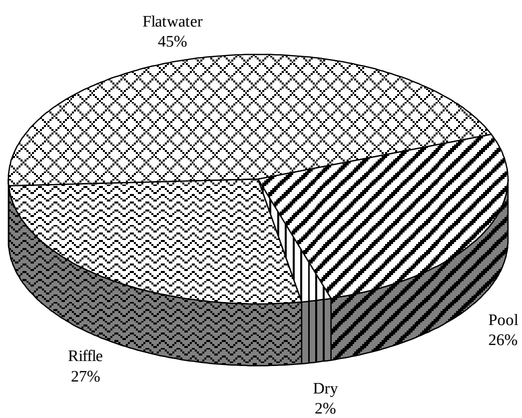
HABITAT TYPES BY PERCENT OCCURRENCE



GRAPH 1

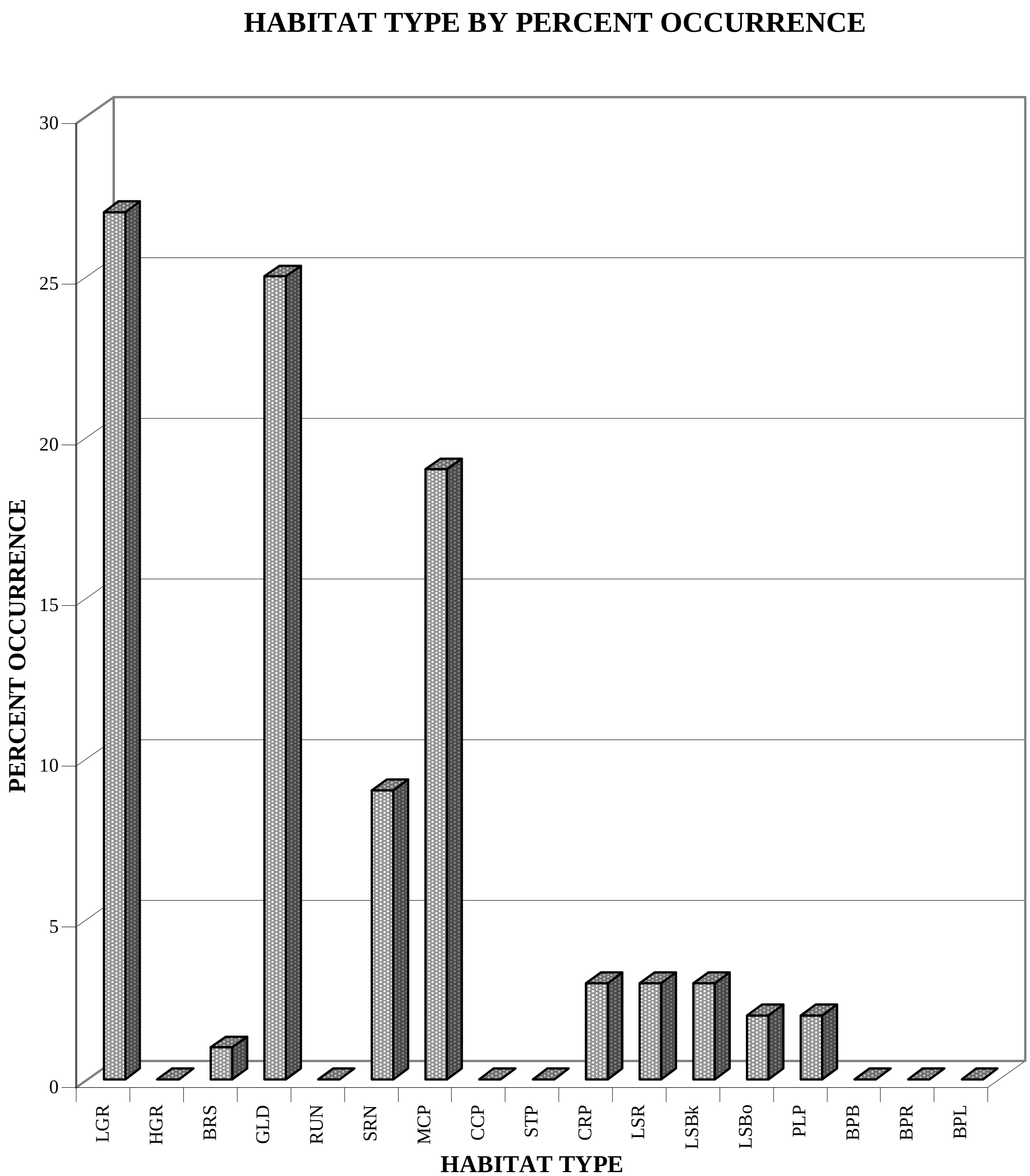
Wooden Valley Creek

HABITAT TYPES BY PERCENT TOTAL LENGTH



GRAPH 2

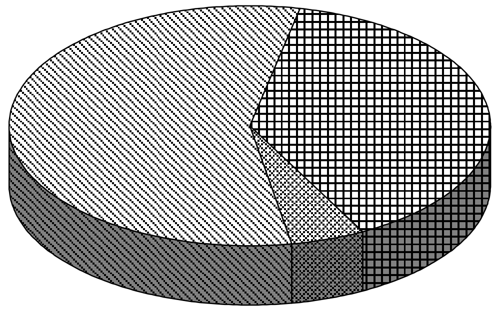
Wooden Valley Creek



GRAPH 3

Wooden Valley Creek

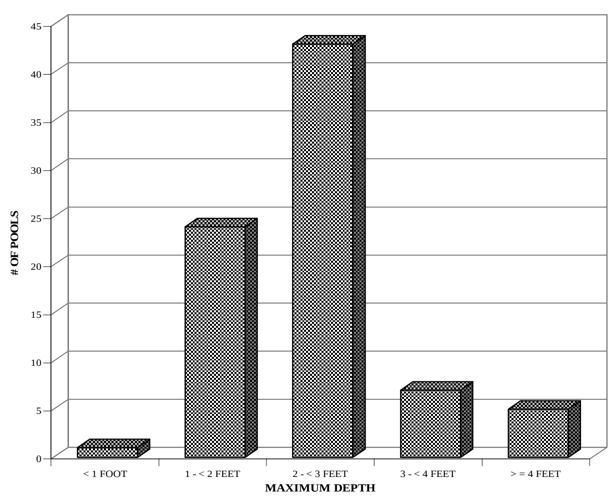
POOL HABITAT TYPES BY PERCENT OCCURRENCE



GRAPH 4

Wooden Valley Creek

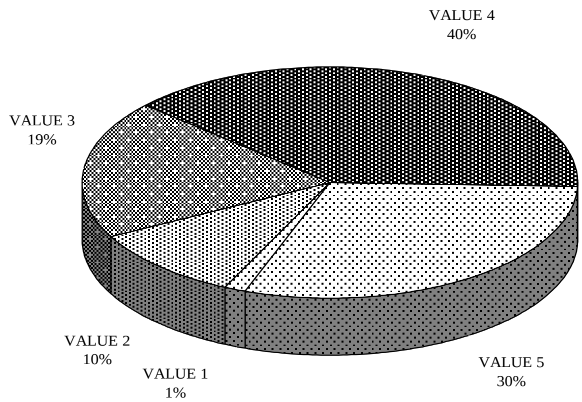
MAXIMUM POOL DEPTHS



GRAPH 5

Wooden Valley Creek

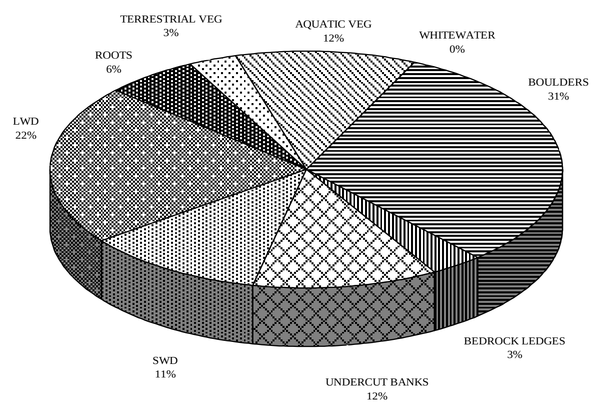
PERCENT EMBEDDEDNESS



GRAPH 6

Wooden Valley Creek

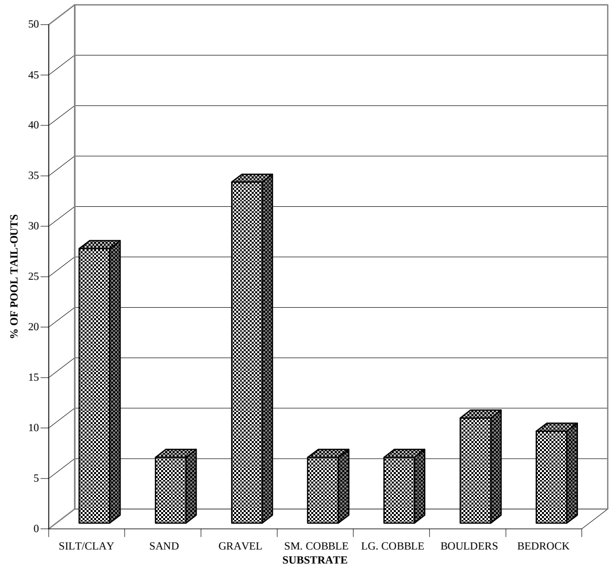
MEAN PERCENT COVER TYPES IN POOLS



GRAPH 7

Wooden Valley Creek

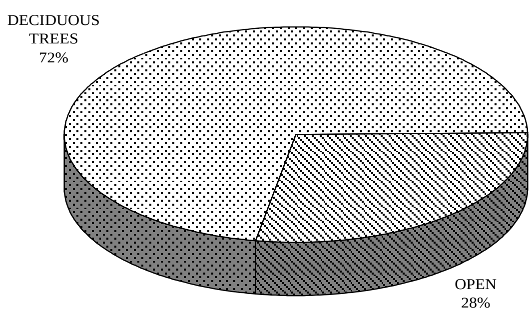
SUBSTRATE COMPOSITION IN POOL TAIL-OUTS



GRAPH 8

Wooden Valley Creek

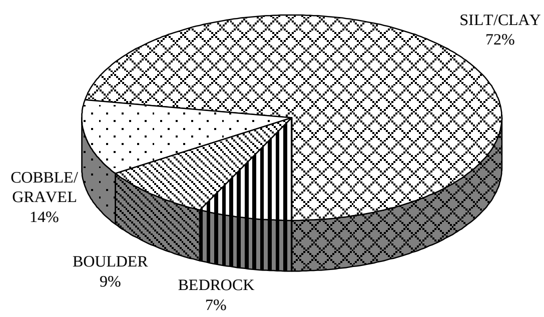
PERCENT CANOPY



GRAPH 9

Wooden Valley Creek

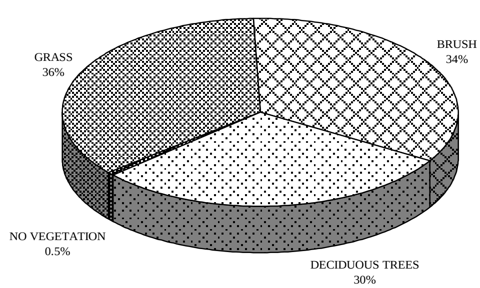
DOMINANT BANK COMPOSITION IN SURVEY REACH



GRAPH 10

Wooden Valley Creek

DOMINANT BANK VEGETATION IN SURVEY REACH



GRAPH 11

White Creek
Habitat Inventory Results

A very limited habitat inventory of White Creek on 6/25/2002 was conducted by Jonathan Koehler and Alison Purcell. The survey began at 38° 21.537' N latitude, 122° 11.044' W longitude just above the confluence of a tributary from the right. The survey began at this point due to restricted landowner access; however more extensive access permission is being actively pursued. The current survey extended up White Creek approximately ¼ mile until surface flow diminished and the channel was completely dry (see habitat map). The total length of stream surveyed was 1487 feet, with an additional 19 feet of side channel.

This reach of White Creek is an F3 channel type, which are entrenched meandering riffle/pool channels on low gradients (<2%) with a high width/depth ratio and a predominantly cobble substrate.

Water temperatures ranged from 17ºF to 18ºF. Air temperatures ranged from 21ºF to 27ºF.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of *occurrence* there were 43% Pool units, 22% Riffle units, 19% Dry units and 16% Flatwater units **(Graph 1)**. Based on total *length* there were 30% Pool units, 27% Riffle units, 24% Dry units and 19% Flatwater units **(Graph 2)**.

A total of 32 habitat units were measured and 50% were completely sampled. A total of 11 Level IV habitat types were identified. These data are summarized in **Table 2**.

The most frequent habitat types by percent *occurrence* were Mid-Channel Pool at 28%, Low Gradient Riffle at 22%, Glide at 13%, Dry at 9%, Step Run at 3%, Plunge Pool at 3%, Lateral Scour Pool - Root Wad Enhanced at 3%, Dammed Pool at 3% and Backwater Pool - Log Formed at 3% (Graph 2). By percent total *length*, Low Gradient Riffle at 27%, Mid-Channel Pool at 22%, Glide at 17%, Dry at 9%, Step Run at 2%, Lateral Scour Pool - Root Wad Enhanced at 1%, Dammed Pool at 1%, Plunge Pool at 1% and Backwater Pool - Log Formed at 1%.

In White Creek 14 pools were identified **(Table 3)**. Mid-Channel pools were most often encountered at 28%, and comprised 73% of the total length of pools. **Graph 4** shows pool habitat types by percent occurrence.

Table 4 is a summary of maximum pool depths by pool habitat types. Pool quality for salmonids increases with depth. In White Creek 6 of the 14 pools (43%) had a depth of two feet or greater **(Graph 5)**. These deeper pools comprised 16% of the total length of stream habitat.

A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Pools rated 71 and Flatwater units rated 5 **(Table 1)**. Of the pool types, Mid-Channel Pool rated 84, Backwater Pool - Log Formed rated 60, Dammed Pool rated 50, Plunge Pool rated 30 and Lateral Scour Pool - Root Wad Enhanced rated 30. Summarized mean shelter ratings are shown in **Table 3**.

Table 5 summarizes fish shelter by habitat type. By percent area, the dominant pool shelter types were Terrestrial Vegetation at 21%, Undercut Banks at 21%, Aquatic Vegetation at 20%, Root Mass at 16%, Small Wood at 13%, Large Wood at 6%, Boulders at 4%, White Water at 0% and Bedrock at 0%. **Graph 7** describes the pool shelter in White Creek.

Table 6 summarizes the dominant substrate by habitat type. In the 7 Low-Gradient Riffles surveyed, the dominant substrate was: Silt & Clay in 1 riffle.

The depth of cobble embeddedness was estimated at pool tail-outs and is summarized in **Graph 6**. Of the 14 pool tail-outs measured, 3 had a value of 2 (21%), 1 had a value of 3 (7%) and 5 had a value of 4 (36%). 5 (36%) riffles rated a 5 (unsuitable substrate type for spawning). **Table 8** describes percent embeddedness by reach. Small Cobble was the most common substrate in pool tail-outs **(Graph 8)**.

The mean percent canopy density for the stream reach surveyed was 72%. **Graph 9** describes the canopy for the entire survey and **Table 8** describes the canopy by reach.

For the entire stream reach surveyed, the mean percent right bank vegetated was 78% and the mean percent left bank vegetated was 76%. For the habitat units measured, the dominant vegetation types for the stream banks were: 62% Grass, 19% Deciduous Trees and 19% Brush **(Graph 11)**. The dominant substrate for the stream banks were: 66% Silt, Clay & Sand, 19% Cobble & Gravel and 16% Bedrock **(Graph 10)**.

DISCUSSION

This limited survey reach of White Creek has one channel type: 1487 feet of F3. These channel types are good for bank-placed boulders as well as single and opposing wing-deflectors. They are fair for low-stage weirs, boulder clusters, channel constrictors and log cover. Many site specific projects can be designed within this channel type, especially to increase pool frequency, volume and shelter. Any work considered will require careful design, placement, and construction that must include protection for any unstable banks.

The water temperatures recorded on the survey day (6/25/2002) ranged from 15ºC to 18ºC in pools, and up to 21° C in unshaded flatwater units. Air temperatures ranged from 21ºC to 27ºC. The water temperatures in pools are favorable to salmonids; however the exposed units have temperatures above the 20° C stress threshold for salmonids.

Pools comprised 30% of the total length of this survey. In first and second order streams a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width. In White Creek, the pools are moderately deep with 43% having a maximum depth of at least two feet. These pools comprised 16% of the total length of stream habitat.

The mean shelter rating for pools was 71. A pool shelter rating of approximately 80 is desirable. The relatively large amount of pool shelter that now exists is being provided primarily by Terrestrial Vegetation at 21%, Undercut Banks at 21%, Aquatic Vegetation at 20%, Root Mass at 16%, Small Wood at 13%, Large Wood at 6%, and Boulders at 4%.

In the surveyed reach of White Creek, 43% of the pool tail-outs measured had embeddedness ratings of either 3 or 4. None had a rating of 1. Cobble embeddedness measured to be 25% or less (a rating of 1) is considered best for the needs of salmonids.

The mean percent canopy for the survey was 72%. This is fairly good, since 80 percent is generally considered desirable.

The survey of White Creek was highly limited in scope due to a lack of landowner access and a lack of surface flow. It appears that White Creek goes completely dry above 38° 21.579’ N, 122° 11.280’ W. No surface water was seen above this end point. This point is marked by a transition from a series of narrow, deeply carved bedrock pools into a cobble dominated dry stretch, which extends for several miles upstream toward Leona Lakes.

Several young-of-year rainbow trout were observed in pools with adequate shading. No other fish were seen.

Local landowners described White Creek as a significant steelhead stream historically for angling, and suggest that it may have been more productive than Wooden Valley Creek. This survey did not include the reach of White Creek at the confluence with Wooden Valley Creek, which may provide good quality spawning and rearing habitat.

CONCLUSIONS AND RECOMMENDATIONS

1. Due to the constraints of limited landowner access, this survey does not cover the entire length of White Creek from the confluence of Wooden Valley Creek. This limited survey can be used as a preliminary assessment, documentation of surface flow limits, and fish presence. It represents a valid sub-sample of the habitat available in White Creek, and therefore summary tables and graphs have been produced. A complete habitat survey of White Creek is needed, however, to make sound conclusions on the stream’s ability to support steelhead populations.

2. Young of year rainbow trout were observed in pools along the survey reach. These fish appeared healthy and active. A fish survey, of White Creek would be instructive to determine the relative distribution of fish within the stream. A simple visual survey supplemented with snorkel observations would be adequate for a stream of this size.

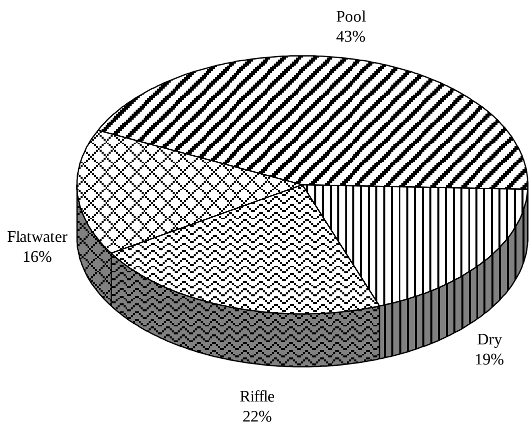
3. Much of the surveyed reach is lacking canopy and riparian vegetation on both banks, which is

likely contributing to elevated water temperatures in exposed areas. Additionally, the lack of bank vegetation and overhead trees is affecting bank stability, and several erosion sites were noted. This entire reach of White Creek would benefit from re-vegetation projects along the stream banks and riparian zone in addition to tree plantings to provide shade and long term sources of woody debris.

4. Flow observations in conjunction with water quality sampling should be conducted along this reach to determine the ongoing impacts to salmonids from critical low flows. Summer rearing months are most significant in terms of elevated temperatures, and reduced food availability from fast-water feeding lanes in riffles.

White Creek

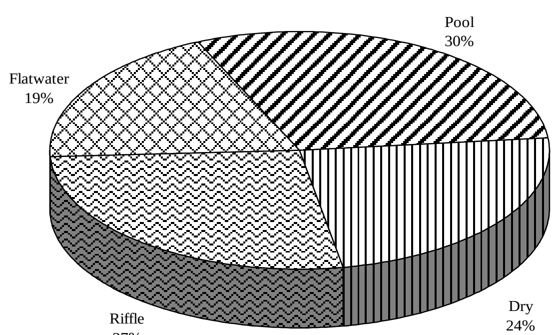
HABITAT TYPES BY PERCENT OCCURRENCE



GRAPH 1

White Creek

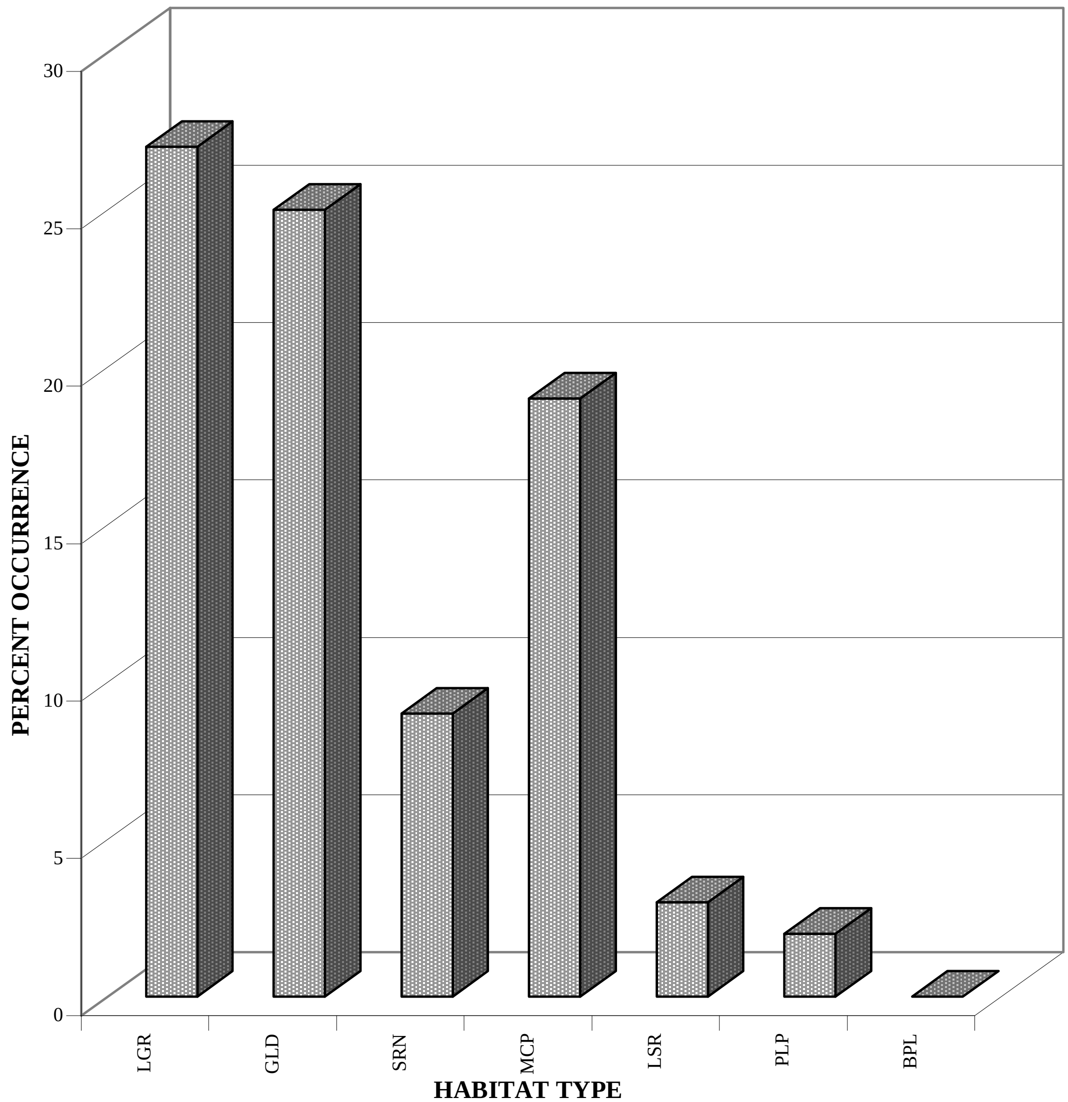
HABITAT TYPES BY PERCENT TOTAL LENGTH



GRAPH 2

White Creek

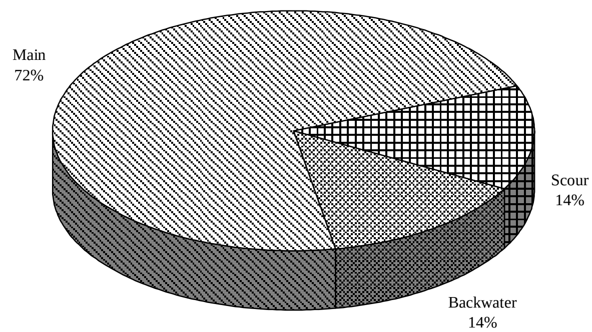
HABITAT TYPE BY PERCENT OCCURRENCE



GRAPH 3

White Creek

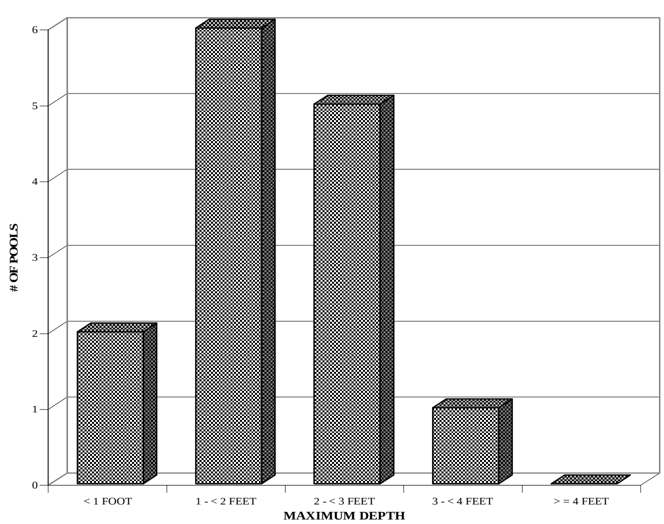
POOL HABITAT TYPES BY PERCENT OCCURRENCE



GRAPH 4

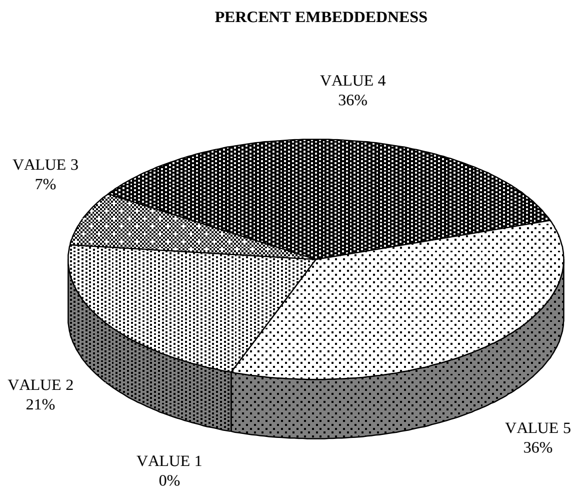
White Creek

MAXIMUM POOL DEPTHS



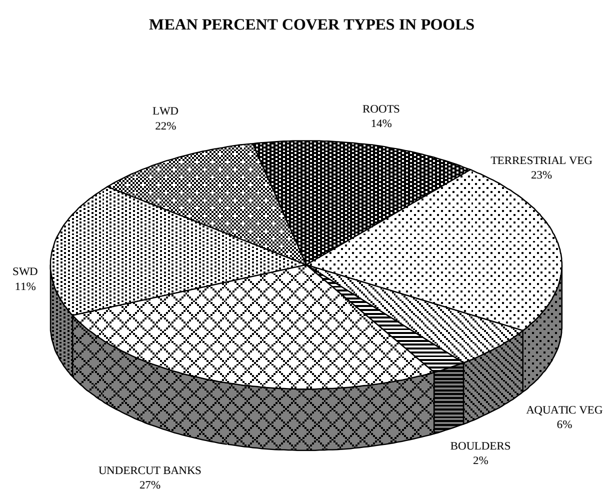
GRAPH 5

White Creek



GRAPH 6

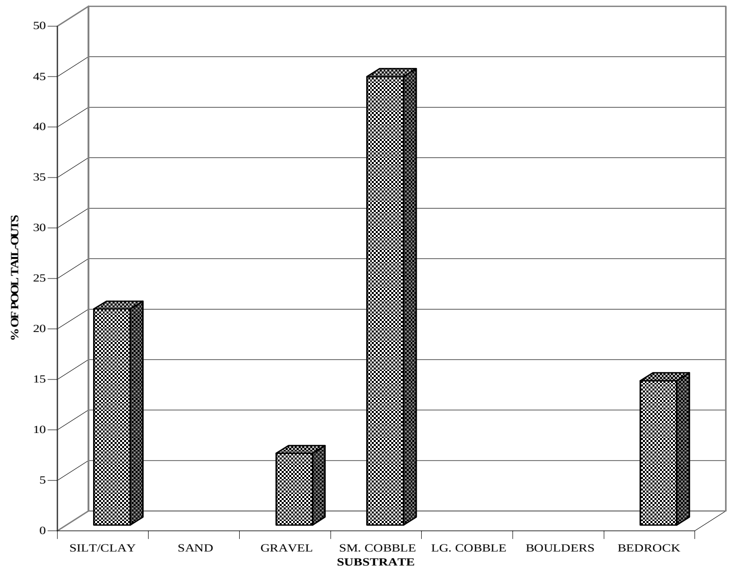
White Creek



GRAPH 7

White Creek

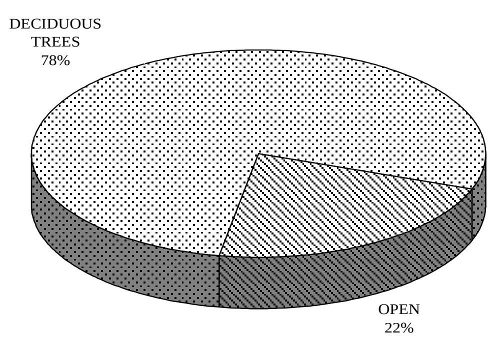
SUBSTRATE COMPOSITION IN POOL TAIL-OUTS



GRAPH 8

White Creek

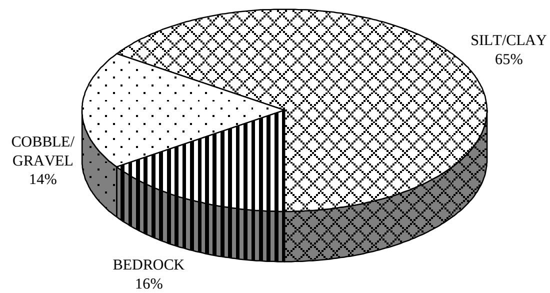
PERCENT CANOPY



GRAPH 9

White Creek

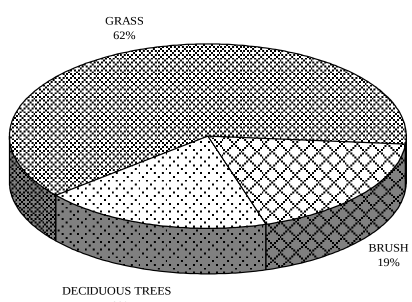
DOMINANT BANK COMPOSITION IN SURVEY REACH



GRAPH 10

White Creek

DOMINANT BANK VEGETATION IN SURVEY REACH



GRAPH 11

STEELHEAD ECOLOGY

Rainbow trout (*Onchorynchus mykiss*) occur both as resident fish and as anadromous steelhead, which migrate to and from the ocean. These two very different life histories often occur within the same populations in the same stream and are genetically indistinguishable. If access to the ocean is available, the steelhead form tends to dominate due to their larger size and increased egg production. However, if the stream contains barriers to upstream migration, steelhead will not return to reproduce, and the resident form will become dominant in the population.

Steelhead grow rapidly in the ocean and reach sizes much larger than resident rainbow trout. After spending one to three years in the ocean, adult fish between 15 to 30 inches in length return to their rearing streams to spawn. Unlike many other salmonids, a steelhead can make this spawning migration several times over its lifetime. However, in ephemeral streams, such as Wooden Valley Creek, low flows during the spawning months (January through April) may prevent anadromous fish from reproducing during a given season.

Natural and manmade barriers to upstream migration are important factors in steelhead distribution and abundance within a stream network. Typically in streams with short or easy migrations many adults return younger and smaller, but may return multiple times to reproduce. In streams with longer more difficult migrations, the larger, stronger adults tend to be most common. The “reproduce early and often” strategy has a distinct advantage in areas that experience severe seasonal variability with droughts, which cut off flow, or floods that destroy spawning nests (redds). A mixture of adult sizes provides the population with the greatest flexibility, and improves survivability over the long term.

Adult steelhead migration and spawning typically takes place from January through April, depending on late-season flows. Fish that make the upstream migration early have the advantage that their young emerge sooner and grow larger in the first year of life. However, they are more vulnerable to heavy winter storms, which can destroy redds and wash away young fish. Steelhead that migrate later in the season run the risk of being stranded by reduced flows to carry them back to the ocean. Most populations contain a mixture of early and late spawning fish, which improves the overall odds of success from year to year.

Steelhead spawn by constructing redds in the gravel substrate typically found in the tail of a pool. The female scoops out a shallow depression with powerful movements of the tail and lays eggs within the redd. Accompanying males then fertilize the eggs, and the female quickly buries the redd with gravel. The egg development rate is highly temperature dependent and takes between one to two months. Eggs hatch in about 31 days at 50˚ F (Flossi et. al., 1998). Like other salmonids, steelhead hatch as alevins with a large attached yolk sac and spend their first one to two weeks in the gravel before emerging into the stream.

Young steelhead spend between one to four years in freshwater; two years is most common in central California coast streams. They feed primarily on aquatic insects and other aquatic invertebrates in fast water feeding lanes (riffles) and grow rapidly if food is abundant. When stream flows are strong enough to support ample aquatic insect populations throughout the year, juvenile steelhead can reach lengths adequate to out-migrate (smolt) in one year. However, in streams with very low summer flows, steelhead grow very little during mid to late summer, and usually require two years or more to grow large enough to migrate to the ocean.

Since steelhead spend part of their life in freshwater and part in saltwater, they face a complex set of environmental and physiological challenges. Over thousands of generations, steelhead have adapted to cope with changes in the natural processes which have shaped their evolutionary path. However, since the introduction of European settlers in the early part of the 1800's steelhead populations have been subjected to a rapidly changing array of stresses. These factors combined present a significant risk to the long term survivability of steelhead within Northern California streams. It would be useful to identify these major limiting factors within the watershed and implement restoration and planning projects wherever feasible.

Migration Barriers

Barriers that prevent steelhead passage can be natural or manmade structures. They may prevent passage under any conditions or only during periods of low flow. Waterfalls, dry reaches, log jams, and other natural barriers exist to some degree in all streams. These represent naturally occurring stream features and are not generally considered for removal or improvement unless extensive. However, many structures that have been built by humans on or in streams have a severe impact on migration and reduce the number of steelhead able to reach habitat above them.

Steelhead, like all anadromous salmonids, migrate both downstream as juvenile smolts and upstream as spawning adults. Unlike other salmonids, however, steelhead are capable of making several spawning migrations throughout their lifetimes. During both migrations, steelhead must be able to remain in good condition if they are to survive to the following year. If adult fish must negotiate many difficult obstacles along the way to spawning habitat, they are less likely to survive the trip back to the ocean. Likewise, if out-migrating smolts are stressed heavily, they have far lower odds of surviving the rigors of saltwater life.

Dams built for water pumping and other uses can present a major barrier to fish migration, both upstream and downstream. For smaller dams steelhead passage is affected by the height of the dam and the size of the jump pool below. Large adult steelhead can usually handle a jump if the depth of the pool below is 1.25 times the height of the jump (Flossi et. al. 1998). If the dam is too large for adult steelhead to jump over, the genetic tendency for anadromous rainbow trout is reduced above the barrier.

Culverts often have a large drop from downcutting below the outlet side that prevents steelhead from passing upstream. If the culvert has riprap boulders or other material below it to prevent downcutting and erosion, the pool below the culvert is usually impacted and can interfere with jumping. Often within the culvert the stream flow is spread out into a shallow sheet of water that is difficult for adult steelhead to swim in. When culverts are steeply inclined, the combination of high flow velocity and shallow depth make them extremely difficult for all but the strongest adult steelhead to traverse.

Water Temperature and Quality

Water temperature, particularly during the spring, summer, and fall, is a significant factor that affects habitat quality and availability for steelhead. Water temperatures within a stream are influenced on a seasonal basis by a variety of factors, which include the release of water from upstream reservoirs, air temperature, instream flow, groundwater, shading from riparian vegetation, and other influences.

Steelhead trout are coldwater fish with a relatively narrow range of temperatures necessary for survival. The lower limits of temperature tolerance are probably very seldom present in the streams of Napa County . However, if water temperatures rise above 20˚ C (68˚ F), steelhead experience physiological stress and an increased metabolic demand. Juvenile steelhead are especially sensitive to these fluctuations due to their small size and rapid growth rate.

Exposure of various lifestages of steelhead to elevated water temperatures may result in chronic effects. These include reduced growth rates, reduced overall health, reduced survival rates, and depending on magnitude and duration of the exposure, direct mortality. The actual effects of elevated water temperature on steelhead vary substantially depending on a number of factors including lifestage of steelhead exposed, duration and magnitude of the exposure, food supply, and prevalence of diseases. General temperature guidelines for evaluating summer rearing habitat for juvenile steelhead include average daily temperatures of 20˚ C (68˚ F) or less, with maximum hourly temperatures of 23˚ C (73˚ F).

Temperature affects how much dissolved oxygen (DO) water can hold. As temperature rises, the amount of dissolved oxygen decreases and vice versa. When water holds all the dissolved oxygen it can hold at a given temperature, it is 100% saturated. Steelhead require high levels of DO saturation in order to thrive. Streams with DO levels in the 95% - 120% saturation range are considered best for maintaining healthy steelhead.

Spawning Habitat

The amount of suitable spawning habitat within a stream can directly determine the ability of that stream to support large populations of steelhead. Adult steelhead need access to spawning gravel in areas free of heavy sedimentation with adequate flow and cool, clear water. Steelhead utilize gravel that is between 0.5 to 6 inches in diameter, dominated by 2 to 3 inch gravel. Typically, steelhead use smaller pockets of spawning gravel than other salmonids, and a lack of available suitable spawning gravel is usually not a major limiting factor (Flossi et. al., 1998). Escape cover for spawning adults is also important, and is usually abundant during the high flow migration period.

Sediment deposition within pools has a deleterious impact on egg development and fry emergence from the spawning gravel. Fine sediment from roads, erosion, or some other upland source smothers eggs within the redd by blocking water and oxygen flow through the nest. Silt and sand in the streambed provide unstable habitats and fill crevices in the gravel and cobble, reducing both aquatic insect and steelhead abundance.

Rearing / Overwintering Habitat

Juvenile steelhead spend one to two years in freshwater, and must therefore have adequate year round habitat. Escape or hiding cover, provided by undercut banks, fallen trees, boulders and overhanging vegetation, is an important part of year round rearing habitat for juvenile steelhead, especially for larger yearling fish. Most artificial bank protection including concrete walls, sackrete (stacked bags of concrete), and gabions (wire baskets filled with rocks), provides no protective hiding places for fish. Large riprap boulders (2 foot + diameter) can provide a limited amount of cover when placed in the streambed. However, most smaller riprap, with small crevices between rocks, provides little hiding cover and often fills in with fine sediment and sand.

The amount of shade provided by trees and other vegetation along the stream affects rearing habitat in many ways. Shade from a dense riparian canopy benefits steelhead by blocking sunlight and keeping water temperatures cool during hot summer periods. However, too much shade prevents photosynthesis from occurring within the stream, thus reducing primary production at the base of the aquatic food web. Additionally, in streams with very dense canopies, the lack of sunlight may affect juvenile steelhead's ability to locate food. A balance of approximately 75% to 90% canopy cover is desirable in most streams of the central coast region.

Riparian trees provide a valuable source of complex habitat structure as large woody debris. When limbs are lost or whole trees fall into the stream, it creates cover for juvenile steelhead and can promote formation of large pools through scouring. The tree leaves that drop into the stream also provide a major source of nutrients for aquatic macroinvertebrates.

Fine inorganic sediment from erosion, roads, or other sources can have a significant impact on steelhead rearing habitat. The deposition of fine sediment onto the streambed reduces the amount of aquatic insect habitat, and it smothers algae and other plants which make up the base of the food web. As a consequence, the reductions in macroinvertebrate populations, especially aquatic insects, have direct effects on the availability of food to juvenile steelhead. This is especially critical in the seasonal streams of the central coast region. Since the period of maximum steelhead growth occurs for only a few months of the year, the reduction in food supply during this period has a major impact on smolt size.

Juvenile steelhead spend typically one or two winters in the stream, and therefore overwintering habitat that provides refuge from the winter storms is critical. This habitat is often in the form of deep pools with complexity from undercut banks, large woody debris, backwaters, calm eddies, and other refuges from high storm flows. If juvenile steelhead cannot overwinter safely they may never reach sizes sufficient for migration to the ocean or survive once they do reach the ocean. The abundance of larger, yearling steelhead is a good indicator of the year round habitat quality within a stream.

After spawning in winter most adult steelhead make the return migration to the ocean quickly. However, juvenile steelhead begin the physiological changes for smolting (migrating to the ocean) in late March through May. This late migration allows them to feed longer during the most productive time of the year, growing to sizes which increase the chances for survival. This is also a period of rapidly declining streamflows in California, making the downstream journey over barriers, shallow riffles, and drying stream reaches very risky. For many ephemeral or urbanized central coast streams the outmigration period is a primary limiting factor for steelhead populations. Adult access to good spawning and rearing habitat is unable to compensate for low smolt success during most years. If a stream's lower reaches are completely dry during the outmigration period, it will not support abundant and persistent steelhead populations.