STREAM INVENTORY REPORT

Redwood Creek

WATERSHED OVERVIEW

Redwood Creek is a tributary to South Fork Ten Mile River (Figure 1). Elevations range from 320 feet at the mouth of the creek to 2,800 feet in the headwater areas. Redwood Creek's legal description at the confluence with South Fork Ten Mile River is T19N R16W S23. Its location is 39°29'34"N. latitude and 123°36'24"W. longitude according to the USGS Northspur 7.5 minute quadrangle.

HABITAT INVENTORY RESULTS

The habitat inventory of July 15, 1994 through July 26, 1994 was conducted by Warren Mitchell and Dave Lundby. The total length of surveyed stream in Redwood Creek was 24,268 feet (4.6 miles, 7.4 km) (Table 1).

Table 1 summarizes the Level II riffle, flatwater and pool habitat types. By percent occurrence riffles comprised 21%, flatwater 35% and pools 41% of the habitat types (Graph 1). By percent total length, riffles comprised 13%, flatwater 67% and pools 18% (Graph 2).

Seventeen Level IV habitat types were identified and are summarized in Table 2. The most frequently occurring habitat types were step runs,27%, low gradient riffles, 19%, and mid-channel pools, 14% (Graph 3). The most prevalent habitat types by percent total length were step runs at 63%, low gradient riffles at 11% and mid-channel pools at 5% (Table 2).

Table 3 summarizes main channel, scour and backwater pools which are Level III pool habitat types. Scour pools were most often encountered at 61% occurrence and comprised 55% of the total length of pools.

Table 4 is a summary of maximum pool depths by Level IV pool habitat types. In second order streams, pools with depths of two feet (0.61m) or greater are considered optimal for fish habitat. In Redwood Creek, 65 of the 118 pools (55%) had a depth of two feet or greater (Graph 4).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the pool tail-outs measured, 0% had a value of 1, 0% had a value of 2, 14% had a value of 3 and 86% had a value of 4 (Graph 5).

Of the Level II habitat types, both pools and flatwater units had the highest mean shelter rating at 28 each (Table 1). Of the Level III pool habitat types, scour pools had the highest mean shelter rating at 32 (Table 3).

Of the 118 pools, 29% were formed by large woody debris (LWD): 23% by logs and 6% by root wads (calculated from Table 4).

Table 6 summarizes dominant substrate by Level IV habitat types. Of the low gradient riffles fully measured, 89% had gravel as the dominant substrate (Graph 6).

Mean percent closed canopy was 82%: 56% coniferous trees and 26% deciduous trees. Mean percent open canopy was 18% (Graph 7, calculated from Table 7).

Table 7 summarizes the mean percent substrate/vegetation types found along the banks of the stream. Mean percent right bank vegetated was 55% while mean percent left bank vegetated was 52%. Brush was the dominant bank vegetation type in 40% of the units fully measured. The dominant substrate composing the structure of the stream banks was silt and clay, found in 91% of the units fully measured.

DISCUSSION

The information gathered in the process of habitat typing will provide Georgia-Pacific with baseline data on the current condition of this creek and the available habitat for salmonids. These data can be used to identify components of the habitat in need of enhancement so appropriate conditions for Redwood Creek can be obtained over time.

Level II habitat types by percent occurrence and length

Flatwater habitat types comprised a high percentage of the units by both percent occurrence and length at 35% and 67% respectively (Table 1 and Graph 1). These unit types usually do not provide optimal spawning or rearing habitat for salmonids. Riffle habitat units comprised a low percentage of the stream by both percent occurrence and length at 21% and 13% respectively. Pools, however, comprised a higher percentage by percent occurrence at 41% and a low percentage by length at 18%. Riffles usually provide good spawning habitat while pools provide important rearing habitat. In addition, Mundie (1969) reported that invertebrate food production is maximized in riffles while pools provide an optimum feeding environment for coho salmon. In fact, the most productive streams are those consisting of a pool to riffle ratio of approximately one to one (Ruggles 1966).

Pool Depth

According to Flosi and Reynolds (1994), a stream with at least 50% of its total habitat comprised of primary pools is generally desirable. Primary pools are at least two feet deep in first and second order streams and at least three feet deep in third order streams. The information from Graph 4 on maximum depth in pools was used to determine percent of primary pools. Redwood Creek, a second order stream, is comprised mainly of deep pools with 55% of the pools having a maximum depth of two feet or greater.

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Instream Shelter

Instream shelter ratings are derived from two measurements: instream shelter complexity and instream shelter percent cover. The first is a value rating which provides a relative measure of the quality and composition of the shelter, and the second is a measure of the area of a habitat unit covered by shelter. The various types of instream shelter include LWD, small woody debris, boulders, root wads, terrestrial vegetation, aquatic vegetation, bedrock ledges and undercut banks. Of the Level II habitat types, pools and flatwater units had the highest shelter ratings each at 28. Of the Level III habitat types, scour pools had the highest shelter rating at 32. These values are low as shelter values of 80 or higher are considered optimal for good rearing habitat (Flosi and Reynolds 1994).

Large Woody Debris

The presence of large woody debris in streams is a significant component of fish habitat. Woody debris creates areas of low flow, providing a refuge for fish during periods of high flow (Robison and Beschta, 1990). Woody debris also provides cover for fish, lowering the risk of predation. The percent of pools formed by LWD in Redwood Creek was 29%. Whether these numbers are high or low, relative to the needs of salmonids is difficult to ascertain since the optimum amount of woody debris in streams has not been specified (Robison and Beschta 1990). However, based on data from Georgia-Pacific's 1995 Aquatic Vertebrate Study, the only coho found in the Ten Mile River Basin were in stream reaches where approximately 50% of pools were formed by large woody debris. Those reaches that did not support coho had a significantly lower percentage of pools formed by large woody debris (Ambrose et al, 1996). This suggests that a low percentage of LWD formed pools could adversely affect juvenile coho populations (C.S. Shirvel 1990).

The above LWD analysis pertains only to pools formed by logs or root wads as described in Flosi and Reynolds (1994)**:** lateral scour pool-log enhanced, lateral scour pool-rootwad enhanced, backwater pool-log formed, and backwater pool, rootwad formed. Other pools containing LWD as a component were not included in the calculation. For example, plunge pools may be formed by boulders, bedrock or LWD, but are not described as such by habitat unit types. Therefore, the LWD formed pool calculation is limited to four pool types and does not quantify the total amount of LWD in Redwood Creek.

Canopy

There are two important benefits of canopy cover in coastal streams. Canopy keeps stream temperatures cool as well as providing nutrients in the form of leaf litter and organic material (Bilby 1988). This leaf litter, organic material, and their associated nutrients are utilized as a food source by benthic macroinvertebrates (aquatic insects). The macroinvertebrates, in turn, are major food sources for most fish species in forested areas (Gregory et al., 1987). Mean percent canopy cover for Redwood Creek was 82%. This is relatively high since a canopy cover of 80% or higher is considered optimum (Flosi and Reynolds, 1994).

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Coniferous trees occupied a larger portion of the canopy than did deciduous trees. Coniferous trees comprised 56% of the canopy. The significance of this is that wood from alders and most other deciduous species deteriorates more rapidly than wood from coniferous species (Sedell, *et al*. 1988). Therefore, more LWD would be available in the future for fish cover and LWD formed pools in this creek and others dominated by coniferous species.

Embeddedness

High embeddedness values (silt levels), such as those found in Redwood Creek, have been associated with many negative impacts to salmonids. These negative impacts can be observed in important environmental components of salmonid habitat, such as pool habitats, dissolved oxygen levels and water temperatures.

The impact high silt levels have on pool habitat is that they fill in and eventually eliminate pools. As already mentioned, pools provide important habitat for rearing salmonids.

High silt levels also impact oxygen levels in the water. They do so by reducing water circulation within the substrate, thus lowering the oxygen levels needed by salmonid eggs (Sandercock, 1991). This can hinder the survival of the eggs deposited in redds, as well as the survival of juvenile salmonids.

Water temperature is impacted by high silt levels in several ways. Hagans et al (1986) reported the following impacts to water temperatures: 1) the loss of a reflective bottom; 2) darker sediment (as opposed to clean gravels) storing heat from direct solar radiation which is then transferred to the water column; and 3) a reduction in the flow of water through the substrate interstitial spaces thereby exposing more of the water column to direct solar radiation.

Another means by which water temperatures are increased is through the widening of stream channels: over time, high silt levels increase the substrate surface level of the creek, resulting in a wider, shallower stream channel (Flosi and Reynolds 1994). In shallow streams more surface area is exposed to the sun relative to the volume of water, leading to an increase in solar heating which in turn leads to higher water temperatures.

Substrates embedded with silt in varying degrees were given corresponding values as follows: 0-25%= value 1, 26 - 50% = value 2, 51 - 75% = value 3 and 76 - 100% = value 4. According to Flosi and Reynolds (1994), creeks with embeddedness values of two or higher are considered to have poor quality fish habitat. In Redwood Creek, 100% of the pool tail-outs measured had embeddedness values of two or more.

It is important to consider, however, that the above embeddedness values were obtained in the summer during low flow conditions. In winter and spring, flows are usually higher due to the rainy season and the lowered evapotranspiration of the trees. This higher flow can carry away some of the previously deposited silt to sites further downstream. Therefore, embeddedness values may fluctuate throughout the year along different sections of the stream.

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Substrate

In Redwood Creek, 89% of the low gradient riffles had gravel as the dominant substrate. The relatively high concentration of gravel in riffles indicates that there is a sufficient amount of substrate available as potential spawning habitat in this creek. While this creek had sufficient substrate for spawning in the riffles surveyed, the overall percentage of riffles in the surveyed portions of the creek was low at only 21% (Table 1). Subsequently, there may be a lack of sufficient spawning habitat. Another point to consider is that regardless of the amount of substrate or spawning habitat available, this habitat may not be suitable for salmonids if it is highly embedded.

Overall, Redwood Creek appears to have a relatively high percentage of primary and LWD formed pools. However, this stream also appears to have low shelter values and high embeddedness values. In addition, while there was sufficient substrate for spawning, habitat for spawning appeared to be limited.

Georgia-Pacific recognizes that there are areas of Redwood Creek in need of enhancement, and where feasible will attempt to restore those areas over time as part of its long term management plan. The company will also attempt to facilitate a healthy environment for salmonids in this creek through sound management practices.

RECOMMENDATIONS

1) Redwood Creek should be managed as an anadromous, natural production watershed.

2) Shelter values throughout Redwood Creek could be increased by addition of large logs and root wads, boulder clusters, log and boulder weirs and log and boulder deflectors. These need to be placed carefully to prevent washing out in high flows. The Stream Habitat Restoration Manual, by Flosi and Reynolds, 1994, provides detailed descriptions for restoration efforts.

3) Log debris accumulations retaining large quantities of fine sediment should be modified if necessary, over time, to avoid excessive sediment loading in downstream reaches.

4) Sources of stream bank erosion should be mapped and prioritized according to present and potential sediment yield. Identified sites should then be treated to reduce the amount of fine sediment entering the stream. In addition, sediment sources related to road systems need to be identified, mapped and treated according to their potential for sediment yield to the watershed.

COMMENTS AND LANDMARKS

The following landmarks and possible problem sites were noted. All distances are approximate and taken from the beginning of the survey reach.

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Position (ft):	Comments:
3007	Right bank failure measures 20' long x 20' high, contributing fine sediment to the channel.
3609	Large debris accumulation (LDA) measures 18' long x 27' wide x 8' high.
3718	LWD cover is old railroad trestle.
3754	RBA site. First bridge crossing.
4459	Hobo temperature monitor site.
5049	Dry tributary on left bank.
5256	Left bank failure measures 15' long x10' high, contributing fine sediment to the channel.
5555	LDA measures 25' wide x 11' ling x 9' high, forming pool and retaining gravel.
5872	Tributary enters on right bank. Fish observed in tributary.
6520	Right bank failure.
7605	LDA measures 37' wide x 16' lon x 10' high.
10977	Left bank failure measures 25' wide x 80' high.
11811	LDA measures 25' wide x 18' long x 6' high, retaining gravel.
12909	RBA site.
12925	Hobo temperature monitor site.
13514	LDA forming pool.
13886	LDA over parts of unit retaining small woody debris (SWD).
14454	LDA measures 15' long x20' wide, retaining SWD.
14797	SWD accumulation.
15770	Right bank failure measures 15' wide x 20' high. LDA retaining gravel.

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16429	SWD accumulation measures 10' long x10' wide x 4' high.
17566	LDA measures 23' long x15' wide x 4' high. Water is scouring left bank around LDA.
17849	SWD accumulation measures 10' long x 6' wide x 4' high.
18224	Left bank failure measures 60' long x 30' high, partially revegetated.
18827	SWD accumulation.
19097	SWD accumulation measures 14' wide x12' long x 5' high.
22140	LDA measures 17' long x 15' wide x 5' high, retaining gravel.
22243	LDA.
22258	LDA.
23139	LDA measures 11' long x30' wide x 6' high.
23992	End of anadromy. A1 channel type. Accumulation of boulders and LWD in a 36% gradient.

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