STREAM INVENTORY REPORT

Soldier Creek

WATERSHED OVERVIEW

Soldier Creek is a tributary to North Fork Usal Creek (Figure 1). Elevations range from 180 feet at the mouth of the creek to 800 feet in the headwater areas. Soldier Creek's legal description at the confluence with North Fork Usal is T23N R18W Sec 48. Its location is 39°50'54"N. latitude and 123°49'48"W. longitude according to the USGS Hale's Grove 7.5 minute quadrangle.

HABITAT INVENTORY RESULTS

The habitat inventory of October 10, 1997, was conducted by Dave Wright. The total length of surveyed stream in Soldier Creek was 5854 feet (1.1 miles, 1.8 km) (Table 1). There were no side channels in this creek.

Flow measurements were not taken on Soldier Creek but are available through the 1997 GP electro-fishing survey.

Soldier Creek consists of one reach: An F-4 for the entire length of surveyed stream.

Table 1 summarizes the Level II riffle, flatwater and pool habitat types. By percent occurrence riffles comprised 73%, flatwater 5% and pools 22% of the habitat types (Graph 1). By percent total length, riffles comprised 97%, flatwater 1% and pools 2% (Graph 2).

Eleven Level IV habitat types were identified and are summarized in Table 2. The most frequently occurring habitat types were low gradient riffles, 37%, high gradient riffles, 32%, and plunge pools, 10% (Graph 3). The most prevalent habitat types by percent total length were low gradient riffles at 78%, high gradient riffles at 17% and plunge pools at 1% (Table 2).

Table 3 summarizes main, scour and backwater pools which are Level III pool habitat types. Scour pools were most often encountered at 93% occurrence and comprised 90% 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, such as Soldier Creek, pools with depths of (0.61 m) or greater are considered optimal for fish habitat. In Soldier Creek, only one of the 14 pools (7%) 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, 0% had a value of 3 and 100% had a value of 4 (Graph 5).

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Of the Level II habitat types, pools had the highest mean shelter rating at 15 (Table 1). Of the Level III pool habitat types, scour pools had the highest mean shelter rating at 17 (Table 3).

Of the 14 pools, 42% were formed by large woody debris (LWD): 29% by logs and 14% by root wads (calculated from Table 4).

Table 6 summarizes dominant substrate by Level IV habitat types. Of the low gradient riffles fully measured, 67% had gravel and 0 % small cobble as the dominant substrate (Graph 6).

Mean percent closed canopy was 84%: 26% coniferous trees and 58% deciduous trees. Mean percent open canopy was 16% (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 81% while mean percent left bank vegetated was 74%. Grass was the dominant bank vegetation type in 29% of the units fully measured. The dominant substrate composing the structure of the stream banks was cobble and gravel, found in 53% of the units fully measured.

DISCUSSION

During January of 1997, a major landslide occurred along a 400 foot section of the WRP road in the headwaters of Soldier Creek which caused a large debris torrent to enter the upstream reaches of the creek. Robert Ballard, a forester for Georgia Pacific, reported that the landslide had occurred to both the California Department of Forestry and Fire Protection (CDF) and the Division of Mines and Geology (DMG). DMG engineering geologist Julie Bawcom conducted a field reconnaissance of the landslide on January 21, 1997 and reported the following:

> The landslide is estimated to be about 400 feet wide at the road, where it failed to a depth of 40 feet on the measured 70 percent slopes The source area for the debris flow extends about 2000 feet below the road, beyond which the slide debris flowed rapidly down Soldier Creek.
>
> Vegetation that had been growing along the lower portion of the debris flow chute was sheared to the ground, leaving a bare swath.
>
> As viewed from the air, it appears that the debris transport zone is higher along the outside of bends. This would indicate that the slide debris moved rapidly down the canyon as a torrent "toboboganing" in response to the local topography.

The effects of the occurrence, sedimentation and aggradation, were observed by Georgia Pacific foresters and biologists to encompass the entire creek length. Soldier Creek had previously been surveyed by a CDF&G crew in 1995, but because of the magnitude of the slope failure, GP biologists determined that the drainage should be re-surveyed. The data gathered will be used both for comparison (against the 1995 survey) and as baseline data to be used in future efforts monitoring the effects of this landslide on Soldier Creek.

Level II habitat types by percent occurrence and length

Flatwater habitat types comprised a small percentage of the units by both percent occurrence and length at 5% and 1% respectively (Table 1 and Graph 1). These unit types usually do not provide optimal spawning or rearing habitat for salmonids. Riffle habitat units comprised an unusually high percentage of the stream by both percent occurrence and length at 73% and 97% respectively. Pools comprised a small percentage by percent occurrence and a very low percentage by length at 22% and 2% respectively. 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. 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. Soldier Creek, a second order stream, is comprised of a small quantity of shallow pools with only 7% of these pools having a maximum depth of two feet or greater.

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 had the highest shelter rating at 15. Of the Level III habitat types, scour pools had the highest shelter rating at 17. These values are extremely 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 Soldier Creek was 43%. 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 Soldier 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 the Soldier Creek was 84%. This is an adequate canopy cover as 80% or higher is considered optimum, Flosi and Reynolds (1994).

Deciduous trees occupied a larger portion of the canopy than did coniferous trees. Coniferous trees comprised only 26% of the canopy. The significance of this is that wood from alder and most other deciduous species deteriorates more rapidly than wood from coniferous species (Sedell, *et al*. 1988). Therefore, less 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 Soldier 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.

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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 Soldier 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.

Substrate

In Soldier Creek, 67% of the low gradient riffles had gravel and 0% had small cobble as the dominant substrate. The relatively high concentration of gravel and cobble in riffles indicates that there is a sufficient amount of substrate available as potential spawning habitat in this creek. But, while this creek had sufficient substrate for spawning in the riffles surveyed, all of these areas were observed to be highly embedded. This is an important point because regardless of the amount of substrate or spawning habitat available, this habitat may not be suitable for salmonids if it is highly embedded.(Table 1). Subsequently, there may be a lack of sufficient spawning habitat.

Overall, Soldier Creek appears to have been inundated by excessive volumes of sediment. Most of the available habitat structure has been buried resulting in a greatly simplified structural diversity. The degree of this simplification is exemplified by the habitat unit flagging that was still hanging from the 1995 survey: Where the 1995 crew found 86 units, we found 30; where they found 105, we found 44. By the end of the both surveys (which ended at the same location), the 1995 crew had found 276 units to our 63.

This sedimentation results in the extremely low shelter values and high embeddedness values found in Soldier Creek. In addition, while there might be sufficient substrate for spawning, habitat for rearing and winter flow shelter appeared to be almost nonexistent.

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Georgia-Pacific recognizes that there are areas of Soldier 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) Due to the enormity of the sedimentation problem on this creek, the net results of any expense or effort directed towards creek restoration, other than maintaining good canopy cover, would not be cost effective. The creek will flush out these sediments over a period of time, uncovering the buried structural elements. The most expedient response for GP to aid in the natural recovery process would be to 1) take steps to stabilize the landslide by whatever actions are economically feasible, and 2) restrict further input of sediment from other sources, i.e. roads and harvest plans.

2) Soldier Creek should be managed as an anadromous, natural production watershed.

3) Where feasible, design and engineer pool enhancement structures to increase the number/depth (or both) of pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.

4) Shelter values throughout Soldier 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.

5) 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.

Position (ft):	Comments:
115’	Begin survey. Soldier Creek is highly turbid while North Fork Usal Creek appears to have low turbidity. A bridge spans the channel.

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1625’	CCC hab #57.
1998	CCC habitat unit #76—950717.
2182’	CCC habitat unit #86 - 950717.
2905’	CCC habitat unit #105.
3435’	New clear cut unit on right bank.
6289’	Tributary enters on right bank. CCC unit #198. Restoration work done on corner pool; does not seem to be effective; water is traveling under the structure. Unit #59 shows much evidence of upstream slide: a featureless aggraded alluvial plain, alders appear to be buried under approx. 1 - 2 ft of sediment, which extends to the bankfull width on either side. Sediment height at 3-4 ft on tree trunks and banks.
5763’	Confluence with South Fork Soldier Creek. South Fork Soldier Creek has no observable turbidity while the mainstem appears completely turbid, although flow does not appear to be high. Flow appears low,water level not nearly to bankfull, although there has been one inch of rain in the last 48 hours.
5854’	End of Survey; series of high gradient waterfalls and bedrock sheets – barrier to anadromy. This is also where CCC ended their survey (950718).

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