STREAM INVENTORY REPORT

Mill Creek (Lake Cleone)

WATERSHED OVERVIEW

Mill Creek is a tributary to Lake Cleone (Figure 1). Elevations range from 0 feet at the mouth of the creek to 600 feet in the headwater areas. Mill Creek's legal description at the confluence with Lake Cleone is T19N R17W S30. Its location is 39°29'15"N. latitude and 123°47'24"W. longitude according to the USGS Fort Bragg 7.5 minute quadrangle.

HABITAT INVENTORY RESULTS

The habitat inventory of November 15, 1996, was conducted by Dave Wright. The total length of surveyed stream in Mill Creek was 3,506 feet (0.66 miles, 1.1 km) (Table 1). There were no side channels in this creek.

Mill Creek consists of one reach: an F3 for the entire length of surveyed stream.

Table 1 summarizes the Level II riffle, flatwater and pool habitat types. By percent occurrence riffles comprised 14%, flatwater 31% and pools 51% of the habitat types (Graph 1). By percent total length, riffles comprised 12%, flatwater 46% and pools 38% (Graph 2).

Fourteen Level IV habitat types were identified and are summarized in Table 2. The most frequently occurring habitat types were mid-channel pools, 24%, step runs, 16%, and low gradient riffles, 14% (Graph 3). The most prevalent habitat types by percent total length were step runs at 30%, mid-channel pools at 19%, and low gradient riffles at 12% (Table 2).

Table 3 summarizes main channel, scour and backwater pools, which are Level III pool habitat Types. Main channel pools were most often encountered at 53% occurrence and comprised 58% of the total length of pools.

Table 4 is a summary of maximum pool depths by Level IV pool habitat types. In third order streams, pools with depths of three feet (0.91 m) or greater are considered optimal for fish habitat. In Mill Creek, one of the 49 pools (2%) had a depth of three 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).

Of the Level II habitat types, pools had the highest mean shelter rating at 39 (Table 1). Of the Level III pool habitat types, scour pools had the highest mean shelter rating at 42 (Table 3).

Of the 49 pools, 33% were formed by large woody debris (LWD): 20% by logs and 12% by root wads (calculated from Table 4).

Table 6 summarizes dominant substrate by Level IV habitat types. Of the low gradient riffles fully measured, none had gravel or small cobble as the dominant substrate (Graph 6).

Mean percent closed canopy was 89%: 55% coniferous trees and 34% deciduous trees. Mean percent open canopy was 11% (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 also 81%. Grass was the dominant bank vegetation type in 45% of the units fully measured. The dominant substrate composing the structure of the stream banks was sand/silt/clay, found in 53% 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 Mill Creek can be obtained over time.

Level II habitat types by percent occurrence and length

Flatwater habitat types comprised a moderate percentage of the units by percent occurrence and a high percentage by length at 31% and 46% 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 14% and 12% respectively. Pools comprised a high percentage by percent occurrence and a moderate percentage by length at 51% and 38% 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 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. Mill Creek, a third order stream, is comprised mainly of shallow pools with only 2% of the pools having a maximum depth of three 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 had the highest shelter rating at 39. Of the Level III habitat types, scour pools had the highest shelter rating at 42. 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 Mill Creek was 33%. 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 Mill 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 Mill Creek was 89%. This is relatively high since a canopy cover of 80% or higher is considered optimum (Flosi and Reynolds, 1994).

Coniferous trees occupied a larger portion of the canopy than did deciduous trees. Coniferous trees comprised 55% and deciduous trees 34% of the canopy. The significance of this is that wood from coniferous trees does not deteriorate as rapidly as wood from alders and most other deciduous 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 Mill 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 Mill 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 Mill Creek, none of the low gradient riffles fully measured had gravel or small cobble as the dominant substrate. The absence of gravel and small cobble in these riffles indicates that there is an insufficient amount of substrate available as potential spawning habitat in this creek. In addition to having insufficient substrate for spawning in the riffles surveyed, the overall percentage of riffles in the surveyed portions of the creek was low at only 14% (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, Mill Creek appears to have a low percentage of primary pools, low shelter values, high embeddedness values, insufficient substrate for spawning and insufficient habitat for spawning. This creek does appear to have sufficient canopy and LWD formed pools.

Georgia-Pacific recognizes that there are areas of Mill 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.

<u>RECOMMENDATIONS</u>

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

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

3) Shelter values throughout Mill 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.

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

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.

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6) Spawning gravel in this creek was limited. Projects should be designed at suitable sites to trap spawning gravel in order to increase spawning habitat throughout the stream.

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:
24	Five young-of-the-year (YOY) observed.
98	Five YOY observed.
235	Six YOY observed, substrate choked with tremendous silt load, silt depth approximately one foot.
283	Right bank gulch at end of unit.
364	Five YOY observed.
666	Ten YOY observed.
759	Twelve YOY. Bottom completely choked with sand and silt. Pool shows signs of having filled in.
972	Road crossing at 52'. Ten YOY observed.
1658	Five YOY observed.
1749	Pool filled in with silt. Silt depth > 1'.
1933	Six YOY observed.
2226	Six YOY observed.
2677	Unit ends at 6' log formed waterfall, possible barrier.
2775	No fish observed (NFO).
2805	NFO.
2862	NFO.

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2889	NFO.
2911	NFO.
3073	NFO.
3141	NFO.
3278	One 14 inch resident trout observed.
3330	NFO.
3368	NFO.
3423	One 10 inch resident trout, no YOY observed.
3506	End of survey at confluence with North and South Fork Mille Creek. Neither branch appears to be class one.

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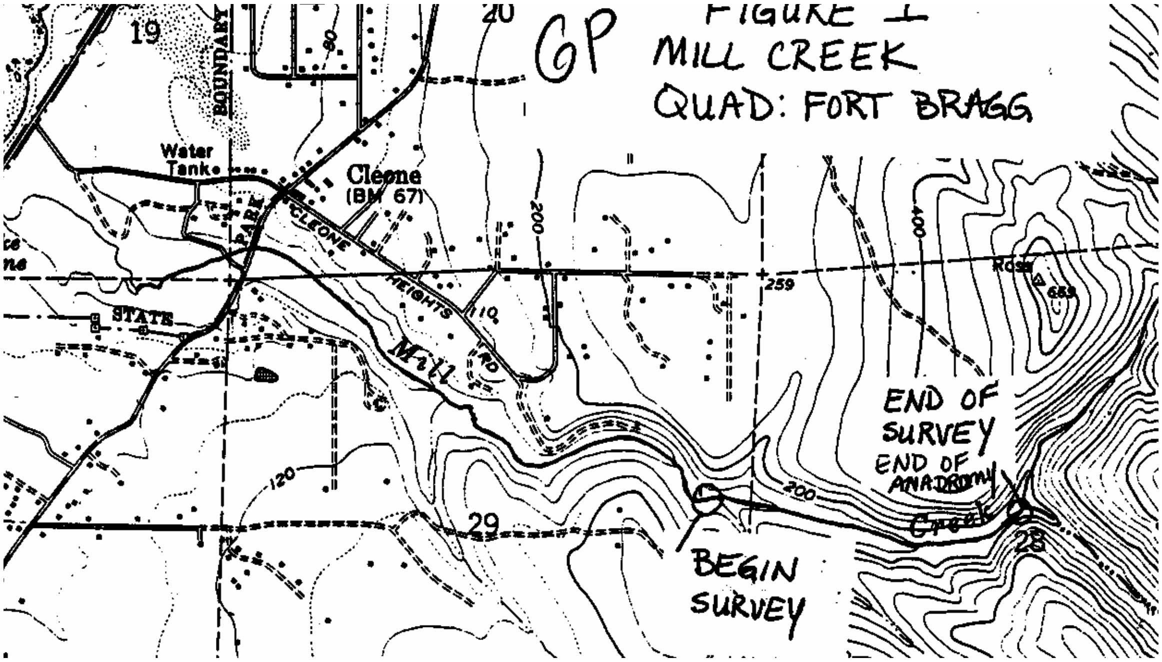
FIGURE 1
MILL CREEK
QUAD: FORT BRAGG
GP
19
20
29
28
Water Tank
Cleone
(BM 67)
BOUNDARY
PARK
CLEONE HEIGHTS RD
STATE
Mill
Creek
259
200
400
120
ROSS
END OF SURVEY
END OF ANADROMY
BEGIN SURVEY