RESEARCH
Channel Change, Sediment Transport, and Fish Habitat in a Coastal Stream: Effects of an Extreme Event

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ABSTRACT / A study on sediment transport and channel change was conducted on Zayante Creek and the lower San Lorenzo River in Santa Cruz County, California. A rainstorm with a recurrence interval locally in excess of 150 years occurred during the study year, 1982 WY. Stream surveys indicated that significant aggradation occurred during and after the peak flood. Upper study reaches were substantially recovered after high flows of early April, but the lower study reaches still had significant filling of pools and burial of riffles by sand. Increases in width-depth ratio were minor and localized in upper reaches, but were significant in lower reaches. Large inputs of sand, primarily from landsliding, altered the sediment transport regime. A higher proportion of the bedload is now transported by lower flows than before the January event. Roads and sand quarries contributed significantly to sediment input to the stream. A proposed dam may alter the sediment transport regime of Zayante Creek. Mitigating the effects of this dam on downstream fish habitat may require occasional bankfull discharges.

Coastal streams in California have historically supported large runs of salmon and steelhead. Over the last several decades these runs have declined precipitously. The decline is largely a result of the interaction of land-use activities on erodible terrain and large infrequent storm events. Early land-use impacts included the effects of logging activities and overgrazing; more recently, impacts have included residential development, dam construction, and water diversion.

Some of the changes in sediment transport and channel morphology that affect fish habitat are not continuous, but occur during and after large storms. Historically important storms and floods in northern and central California occurred in 1940, 1955, 1964, and 1982, the year of this study. The relative geomorphic effectiveness of large storms on hillslopes and stream channels is highly variable, however, depending on factors such as antecedent precipitation, intensity, duration and aerial extent of rainfall, recent history of landsliding and in-channel sediment storage, and land-use history (Newson 1980).

Prompted by concern over effects of a proposed dam on downstream fish habitat, the California State Water Resources Control Board undertook a study on channel morphology and sediment transport in Zayante Creek and the lower San Lorenzo River, Santa Cruz County, California. The study period in the 1982 water year included a rainstorm during 3-5 January that had a recurrence interval for some parts of the basin in excess of 150 years. The storm had major effects on sediment supply and sediment transport in the basin, and provided a unique opportunity to document the effects of a rare event.

Study Area

The San Lorenzo River occupies a basin of 355 km² in Santa Cruz County, California (Figure 1), and is underlain by three main rock types. The upper basin area is dominated by older sedimentary rocks, while the southern portion is dominated by younger sedimentary rocks on the east side of the Ben Lomond Fault and granitic rocks on the west (Clark 1981). The vegetation is a mosaic of conifers (second-growth redwood and Douglas fir), oak-madrone woodland, chaparral, and grassland.

Zayante Creek drains a 69.2-km² basin in the Santa Cruz mountains and enters the San Lorenzo River at Felton, about 10 km north of Santa Cruz (Figure 2). Elevation ranges from 92 to 700 m a.s.l. Mean annual precipitation ranges from about 97 cm near Felton to about 127 cm in the upper watershed. The basin is comprised primarily of sedimentary rocks that are divided into two major groups by the Zayante Fault: the

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northern uppermost part of Zayante Creek is cut into steeply dipping sandstone, and the lower southern portion is cut into more recent sandstone, mudstone, shale, and conglomerate. The climate is Mediterranean, with virtually all of the precipitation falling between October and April. Most of the precipitation is rain, although upper portions of the basin experience occasional snowfall. Daily fog is common during summer months, but upper portions of the basin are frequently above the marine inversion. Vegetation of the watershed is similar to that of the San Lorenzo River basin, and most of the redwoods are second growth.

Concern for water quality, stream flow, and sediment transport in the San Lorenzo River and its tributaries stems largely from the dramatic decline in recent years of the salmon and steelhead fishery within the basin. In 1964, the estimated annual run was 20,000 steelhead and 2500–10,000 silver salmon. By 1977–78, the numbers had dropped to an estimated 3000 steelhead and 182 salmon. The following year, the steelhead run was down to fewer than 600 individuals. The precipitous decline is primarily a result of habitat damage, including increased sedimentation of spawning gravels, filling of pools, degradation of water quality, diversion of stream flow, and barriers to migration (Santa Cruz County 1979).

Sediment yield in Zayante Creek and the San Lorenzo River basin has been significantly increased by land-use activities, including road and homesite construction, timber harvest, quarrying, and grazing. Accelerated erosion and in-channel sedimentation often result from undercutting of steep and unstable slopes, removal of root support from forested slopes, exposure of the soil surface through removal of vegetation, alteration of local drainage patterns, and increased storm-flow peaks associated with urbanization. Brown (1973) suggested that perhaps 80% of the man-induced erosion in upper Zayante basin is associated with road construction. In the past, logging and quarrying activities caused the greatest impacts; these have probably been replaced in importance by suburban development. In the San Lorenzo River basin, much of the sediment delivery to stream channels is associated with landslides rather than surface and gully erosion.

Zayante Creek is a sandbed stream incised into consolidated sedimentary rock over much of its length. Significant alluvial deposits occur within the channel, and in many places the bedrock walls are mantled with soil. Prior to the January storm, reaches with significant stored sediment contained well-developed pool-riffle sequences with varying degrees of bedrock control.

A study by Hecht and Enkeboll (1981) provides a good description of the 1979–80 condition of the channel as it related to fish habitat. Most pools were partly or completely filled with sand and finer sediment, so that in some cases, pools and riffles were obliterated. Cobbles within riffles were highly embedded in finer material. Hecht and Enkeboll noted some improvement in sub-