

The Significance of Suspended Organic Sediments to Turbidity, Sediment Flux, and Fish-Feeding Behavior¹

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For over three decades, geologists, hydrologists and stream ecologists have shown significant interest in suspended load in running waters. Physical scientists have focused on turbidity, the development of sediment-rating curves and estimation of sediment yields, often as an indicator of changing land uses (Beschta 1981). Stream ecologists, on the other hand, have focused on 1) the role of suspended sediments in water quality degradation and its deleterious impacts on biological communities (for example, Waters 1995); or 2) its beneficial roles in providing food resources for filter-feeding invertebrates and as the major pathway of organic matter transport and export, linking upstream and downstream reaches and affecting such ecosystem processes as nutrient spiraling (Minshall and others 1983, 1985; Wallace and Grubaugh 1996). The focus of these interests has dictated the way in which sediment samples are examined. In many cases, the organics in suspended load samples are removed by ashing or chemical digestion. But physical scientists and stream ecologists concerned with the deleterious role of suspended sediments tend to discard data on the organic fraction (ash-free or carbon digested), while ecologists interested in its beneficial role discard information on the mineral fraction (ash or digestion residue).

Failure to distinguish between organic and inorganic components of the suspended load or to consider the full suite of information present in suspended sediment samples has hindered full understanding of sediment dynamics as it affects stream health and reflects watershed condition. The present study establishes the contribution of size-specific, inorganic and organic components to turbidity and sediment flux in streams in the redwood region (in Redwood National and State Parks and Jackson State Forest). We investigated the influence of organic suspended load on the feeding efficiency and condition of juvenile salmonids and their invertebrate food base through field observations and flume experiments (*fig. 1*).

¹ This paper was presented at the Redwood Science Symposium: What does the future hold? March 15-17, 2004, Rohnert Park, California.

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Figure 1—A biologist makes underwater observations of fish feeding behavior during low-turbidity conditions in northern coastal California. Photograph by Samantha Hadden.

Suspended sediment was sampled in several watersheds for two years. Watershed characteristics are listed in *table 1*. Samples were analyzed for particle sizes and organic content. Organic particles were abundant in samples with turbidity readings of up to about 60 NTU (nephelometric turbidity units), typically occurring during times of rising and falling streamflows. At higher turbidity levels and peak flows, the sediment samples had a higher proportion of inorganic materials. Organic materials tended to be more abundant in samples collected during early-season storms. Particulate organic matter constituted 10 to 65 percent of the total annual suspended sediment load for in Water Years 2002 and 2003 (Madej 2005). The influence of organics on specific streams depended on floodplain conditions and underlying geology. The percentage of organics in the suspended load varied with riparian condition, which also affects benthic macroinvertebrate communities. In previous studies of suspended sediment, researchers have tended to assume that the remaining material is all inorganic. Our results show that in four streams, the organic fraction of the sediment load is high at low-to-moderate turbidity levels and should be included in analyses of suspended-sediment concentrations.

Results of the biological phase of the study showed that the biomass of invertebrate prey sampled from the foreguts of juvenile coho salmon and steelhead trout declined with increasing turbidity. Our field observations also revealed a decline in the rate of prey capture by juvenile salmonids with increasing turbidity. These data are unique in that other studies of salmon feeding efficiency in response to turbidity or suspended-sediment concentrations have all been flume- rather than field-based. Although the efficiency of prey capture decreased at higher turbidity levels, limited fish feeding activity was still observed at the highest turbidity levels (45 NTU) in which underwater observations were made. These observations are important because many previous studies have assumed that 30 NTU is a turbidity threshold above which fish cannot feed.

Table 1—Drainage area, gradient, riparian composition, and dominant substrate characterizing the study sites.

Site	North Fork Caspar Creek	South Fork Caspar Creek	Upper Prairie Creek	Little Lost Man Creek
Area (km ²)	3.8	4.2	10.5	9.9
Stream gradient (percent)	1.5	0.8	1.0	2.6
Dominant overstory riparian composition	Second-growth redwood (<i>Sequoia sempervirens</i>)	Red alder (<i>Alnus rubra</i>)	Old growth redwood (<i>Sequoia sempervirens</i>)	Old growth redwood (<i>Sequoia sempervirens</i>)
Dominant substrate	Pebble, cobble	Pebble	Pebble, sand	Cobble, pebble

Reference

- Madej, Mary Ann. 2005. **The role of organic matter in sediment budgets in forested terrain.** In: Proceedings of the international symposium on sediment budgets; 2005 April 3-9; Foz do Iguaco, Brazil. IAHS Public. 292 Sediment Budgets 2. Wallingford, UK: International Association of Hydrological Sciences; 9–15.