

THE CONTRIBUTION OF SUSPENDED ORGANIC SEDIMENTS TO TURBIDITY AND SEDIMENT FLUX

**Mary Ann Madej¹, Research Geologist, USGS Western Ecological Research Center, Arcata
CA ; Margaret Wilzbach, Research Fishery Biologist and Assistant Leader, USGS
California Cooperative Fishery Research Unit, , Arcata CA; Kenneth Cummins, Adjunct
Professor of Fisheries Biology, Humboldt State University, Arcata, CA; Colleen Ellis,
Graduate Student, Humboldt State University, Arcata, CA; Samantha Hadden, Graduate
Student, Humboldt State University, Arcata, CA**

¹USGS-WERC, 1655 Heindon Road, Arcata, CA 95521, Phone:707-825-5148,
Fax: 707-822-8411; mary_ann_madej@usgs.gov

ABSTRACT

Background

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 (e.g. 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 et al., 1983; Minshall et al., 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). When data are reported on suspended load as derived from turbidity readings, it is seldom made clear whether reported values have been “corrected” for the organic fraction or whether, as is the usual case, both inorganic and organic components are combined. Nevertheless, a few studies have demonstrated the importance of suspended organic matter in sediment transport regimes. LaHusen (1994) reported the mean percentage of organic material causing stream turbidity was 64 percent of the total dry weight of suspended sediment. In coastal Oregon, coarse particulate organic matter (>0.2 mm) comprised 10 to 50 percent of the material transport along the stream bottom (Beschta, 1981). These studies suggest a closer look at the role of suspended organic sediment is warranted.

Problem: 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. For example, because organic sediments remain in suspension longer than do similarly-sized inorganic components, and therefore contribute more to turbidity, they may have a greater effect on light reduction. An increased proportion of suspended organic sediments would thus be expected to decrease primary production and lead to a loss of invertebrate scrapers

that feed on periphyton. At the same time, an increased proportion of organic suspended sediments in the appropriate size range would benefit filter-feeding invertebrates (filtering collectors). Both scrapers and filtering collectors are important components in the diets of salmonids and other drift-feeding fishes, and the net effect of organic:inorganic ratios on prey availability for fish is not known. Apart from indirect effects on fish through their food base, the effect of relative percentages of organic and inorganic components on light attenuation would also directly impact fish through loss of visual capability, leading to reduced feeding efficiency, feeding rate, and depressed growth (e.g. Berg, 1982; Wilzbach et al., 1986).

The particle size distribution of the organic suspended load is another important attribute that has not often been considered in previous studies. The particle size distribution and qualitative nature (e.g. microbial activity, relative amounts of plant, animal, and detrital material) of the constituents of the organic fraction of the suspended load predict the response of invertebrate filtering collectors.

Thus, the separation of suspended load material into inorganic and organic fractions, and particle size distribution of both fractions together with qualitative aspects of the organic fraction will provide far greater resolution of physical and biological conditions of watersheds than is currently being provided.

Objectives and Methods

One objective of this research is to establish the contribution of size-specific, inorganic and organic components to turbidity and sediment flux. The role of these components in influencing stream health, as reflected in the efficiency of growth of juvenile salmonids and their invertebrate food base, will also be assessed. The study involves sampling on both within-storm and seasonal time scales at a range of stream sites in northern California which differ in land use, watershed area, riparian cover, and salmonid use, and for which records of continuous turbidity values and suspended load are available. Suspended sediment, turbidity, and water discharge are sampled on rising and falling limbs of flood hydrographs throughout the year, and sediment concentration, particle size and organic content are analyzed by standard laboratory techniques (Guy, 1969). In addition, sediment and biological sampling at each site are made at each site throughout the year so as to capture a full range of discharge and turbidity conditions. Parameters that are assessed include the following:

Field:

- 1) physical parameters: turbidity, fluorescence (as an index of chlorophyll-a)
- 2) microbial respiration, indexed by measurement of dissolved oxygen in the field
- 3) abundance of macroinvertebrate functional groups: collected with D-frame net samples of cobble and large wood
- 4) foraging efficiency and condition of juvenile salmonids: foraging efficiency is estimated in field feeding trials, using the experimental feeding apparatus and procedures described in Wilzbach et al (1986). Effects of suspended sediments on fish foraging has previously been evaluated only in laboratory experiments (Waters, 1995). Condition is estimated from length, mass, and age determinations of individuals collected from minnow traps.

Lab:

- 5) total particulate (suspended load) mass

- 6) total inorganic fraction
- 7) total organic fraction
- 8) inorganic particle size fractions
- 9) organic particle size fractions

Preliminary Results

Although this project is still in its initial phase, preliminary results suggest that the role of organic sediment will be important. For example, in an early season flood, the fraction of suspended load composed of organics ranged from only 3% at the peak to 60 to 80% on the rising and falling limbs of the hydrograph. Although the total mass of suspended organic transport was greater on the rising limb, the contribution of organics, as a percentage of the total suspended sediment, was greater on the falling limb. These results imply that the turbid 'tail' of the hydrograph, important biologically, is greatly influenced by the suspended organic sediment (which constitute 20 to 60% of the sediment load on the falling limb.)

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