The River Benthos Record for Smurfit-Stone's Missoula Mill;Nearly a Half-Century of Clark Fork River Compliance Monitoring

David Rades
Integrated Paper Services, Inc.
Appleton, Wisconsin

The Missoula Mill of Smurfit-Stone Container discharges treated process water to the Clark Fork River near Frenchtown, Montana. Annual monitoring (1956 - present) of macroinvertebrate indicated river quality, is an integral part of the Missoula Mill's environmental protection effort. Quantitative riffle benthos samples from ten sites (study reach = 22 miles) are taken during August. Impact is determined using control vs experimental comparisons of community descriptors including the biometrics subsets used in the calculation of the Montana Biological Integrity Index. Study results show significant background (upstream mill) enrichment in incremental amounts over the period 1960 through the late 1980's, presumably a product of growth in the Clark Fork, Blackfoot and Bitterroot drainages. Mill related impact throughout this same period, also expressed as enrichment, was limited and localized to the zone of initial dilution. Recent study results (1995-1999) generally show either continuation, or a slight decline, in overall enrichment of the system relative to the Missoula Mill's treated effluent.

Introduction

Benthos studies of the Clark Fork River in the vicinity of Frenchtown, Montana, offer nearly a half-century record of impact assessment for the integrated pulp and linerboard mill located near this community. The "Missoula Mill", presently a facility of Smurfit-Stone Corporation, was under construction at the time of the first study (1956) in this series and annual monitoring has occurred since that initial work. Study objectives have been to characterize the riffle macroinvertebrate communities upstream and downstream of the mill and determine treated effluent related impact as an integral part of the Missoula Mill's environmental monitoring program.

Study Methods

A combination of quantitative and qualitative sampling methods have been used throughout these studies. The quantitative record is based on Surber samples (usually, 4 replicates per site) taken from riffle habitats. Time-limited hand collections at the same locations form the basis for the qualitative information. All samples are field processed (screened using a US # 30 sieve to reduce volume), preserved, and returned to the laboratory for sorting, identification, and enumeration of specimens.

A core of 10 sites encompassing about 20 river miles has been used to measure the Missoula Mill related environmental response. Minor movement of sampling locations has occurred, as needed, to accommodate stream channel changes. Three sites located upstream from the mill have been designated controls; 7 sites downstream from the mill constitute the experimental zone (Fig. 1). Field sampling has taken place in mid/late-summer, when low river flow and relatively high water temperature combined to maximize stress to the Clark Fork River fauna.

The benthic invertebrates are identified to the lowest taxonomic units feasible (usually genus/species). Data analysis utilizes control vs experimental comparisons, nearest neighbor comparisons, and Montana Department of Environmental Quality (MDEQ) biometrics to establish trends and assess impact based on the Missoula Mill effluent.

Discussion

Taxa Richness

A rather universally used measure of aquatic habitat quality is taxa richness (high diversity = best quality). Clark Fork River "total" and "Ephemeroptera, Plecoptera, and Trichoptera" taxa richness have documented relatively stable and reasonably diverse communities with little or no indication of adverse mill effluent impact (Figs. 2 & 3). Community diversity in the control area from 1995-1998 shows incremental taxa richness improvement with increased distance downstream from Milltown Reservoir/City of Missoula and indicates a system in transition at the Missoula Mill discharge point. The rather consistent diversity decline evident at the MDEQ Huson Trestle site (data point HT on Figs. 2 & 3) compared to other neighboring stations was believed to have resulted from "small" cobble size and riffle instability, not a marked decline in river quality associated with mill effluent.

The most diversified groups of benthic invertebrates taken in the study reach were the chironomids (Order Diptera), mayflies (Order Ephemeroptera), and caddisflies (Order Trichoptera). Stoneflies (Order Plecoptera), beetles (Order Coleoptera), and aquatic worms (Class Oligochaeta) were also found at most of the sampling sites. Most Clark Fork River study area organisms have a preference for erosional environments and relatively wide North American or Pacific Northwest United States distributions.

The Macroinvertebrate Standing Crop

The Clark Fork River, riffle habitat, macroinvertebrate standing crop (exclusive of black-fly larvae) over the past 40+ years has shown a significant rise, peaking in the late 1970s to mid 1980s, (Fig. 4). This abundance increase and subsequent incremental decline (recent years) was coincident to the cessation in headwaters mining/processing activity (reduced metals + other hazardous materials loading), intensified agribusiness and urbanization within the "five great valleys" (higher nutrient loading), and current efforts to minimize both point and non-point loadings.

The Missoula Mill impact response over this same period was, consistently, a localized and limited organic enrichment usually expressed as higher macroinvertebrate standing crop compared to controls. The filter-feeding organisms, particularly hydropsychid caddisflies, were the principle forms enhanced by the treated mill effluent (Fig. 4). Recent past data (Table 1) show a continuation of this trend with caddisfly abundance peaking immediately downstream from the mill (samples taken in an effluent rich, "biased", location) in 3 of 5 years. Incremental instream plant production (higher algal biomass) supported by nutrients contained in the effluent and/or treatment facility generated particulates (microorganism remains), functioning as food materials fostered these higher macroinvertebrate numbers. A massive green alga (Cladophora) bloom in 1998, affecting the entire study reach and an unusually severe scour in 1997 either mask or displaced the enrichment response in those years. Recovery to population levels more typical of the controls, usually occurred in the vicinity of Huson (downstream limit of the zone of initial mill effluent dilution).

Data analysis employing the MDEQ's "Clark Fork River benthos biointegrity" approach [Fig. 5 ("TOTAL") & Fig. 6 (ORGANICS SUBSET)] generally showed slightly impaired to moderately impaired conditions for most study area sites for the overall status and severely impaired to moderately impaired conditions for the organics pollution indication. No pattern of environmental quality degradation related to the Missoula Mill was indicated by these biointegrity indicators.

Study Conclusions and Missoula Mill Operatives

1). Invertebrate diversity, total and EPT (sensitive), was not adversely impacted by treated mill effluent -- continue and enhance mill "toxics controls" (biomonitor effluent quality through WET testing, employ process additive substitutions to lessen toxicity potentials, cross-check laboratory based testing results with real world monitoring)

2). Invertebrate density (abundance) showed incremental increases in the zone of initial effluent dilution -- maximize WWTP performance (incorporate applicable technology advances, minimize nitrogen and phosphorus additions to WWTP) and enhance process water conservation measures to reduce effluent volume (recycle/reuse and pretreat side streams)

3). Overall river quality was maintained in the mill reach -- strive to enhance Clark Fork River quality through total management of the Missoula Mill site as a watershed unit (promote biodiversity and control erosion through best land management practices)

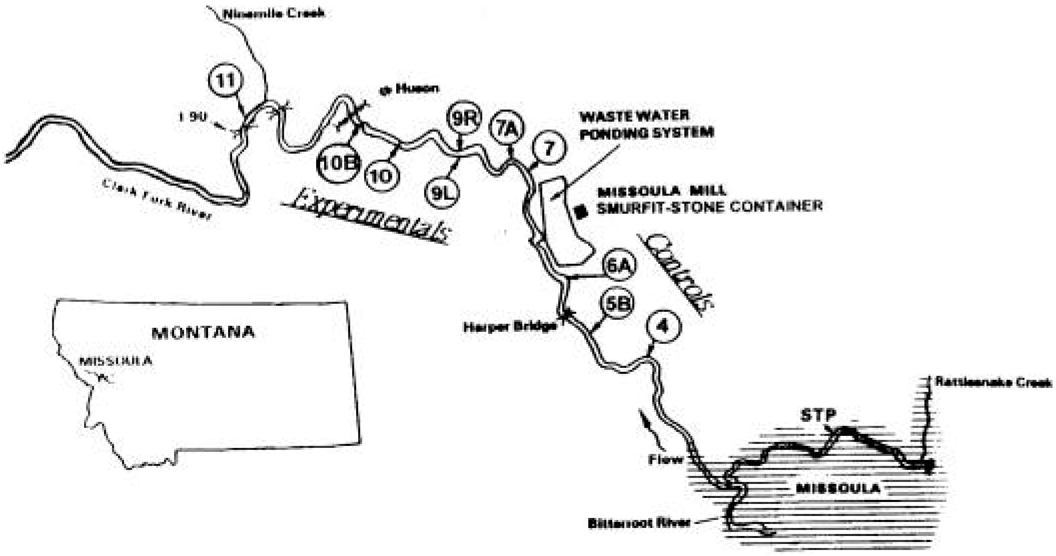

Figure 1. A Map of the Clark Fork River Showing Sampling Stations for the "Missoula Mill" Benthos Studv.

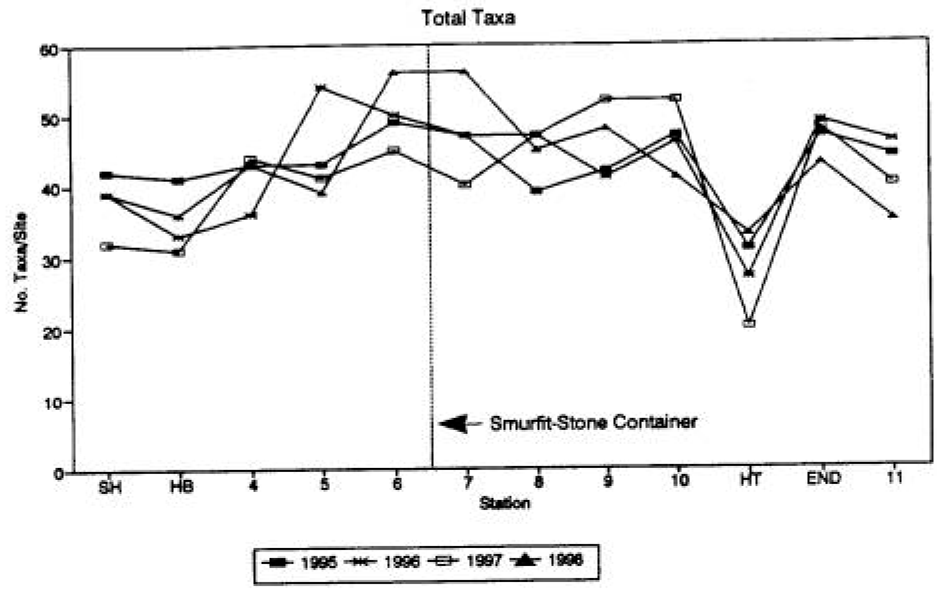

Figure 2. Clark Fork River Benthos Diversity (TOTAL TAXA) at MDEQ & Missoula Mill Sampling Sites, 1995 - 1998.

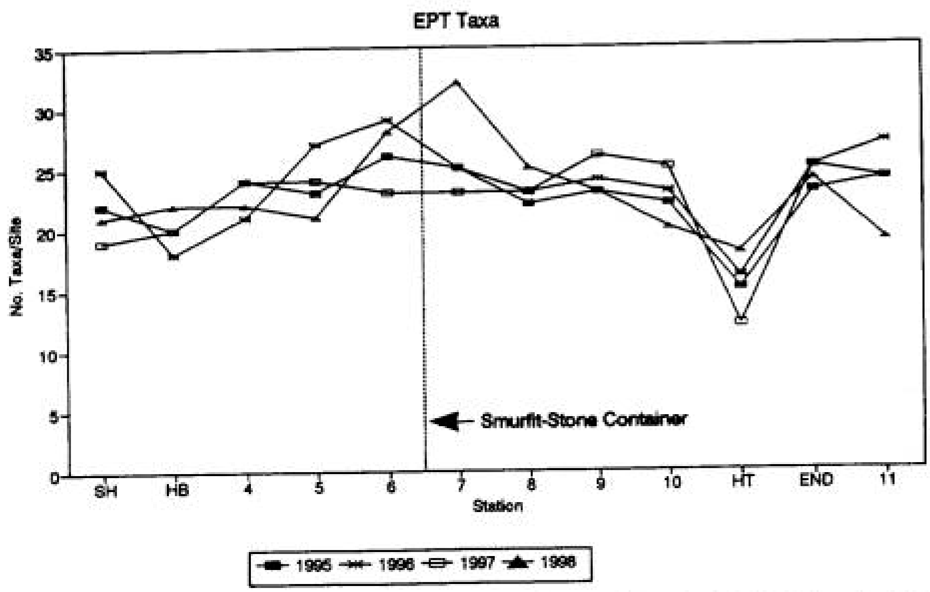

Figure 3. Clark Fork River Benthos Diversity (EPT TAXA) at MDEQ & Missoula Mill Sampling Sites, 1995 - 1998.

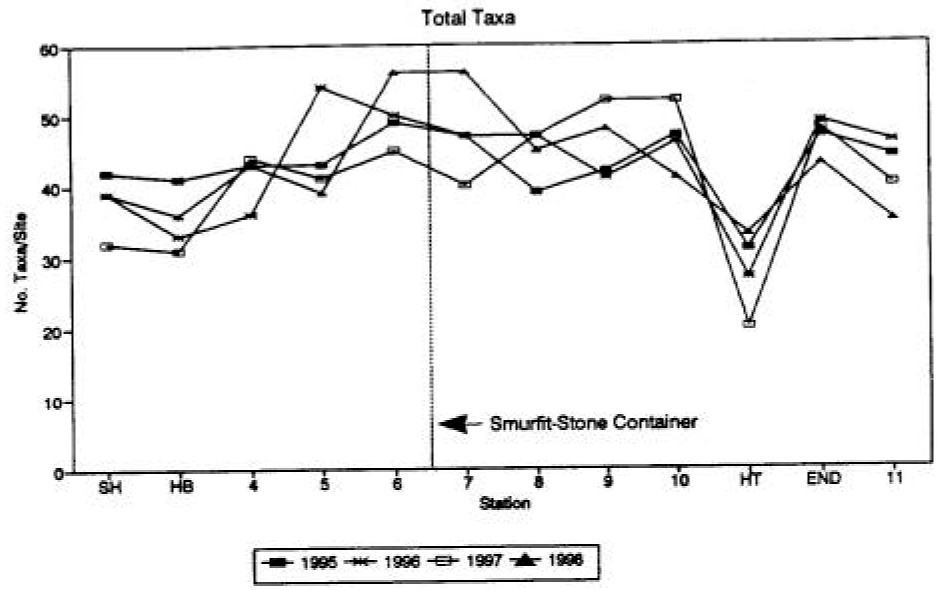

Figure 2. Clark Fork River Benthos Diversity (TOTAL TAXA) at MDEQ & Missoula Mill Sampling Sites, 1995 - 1998.

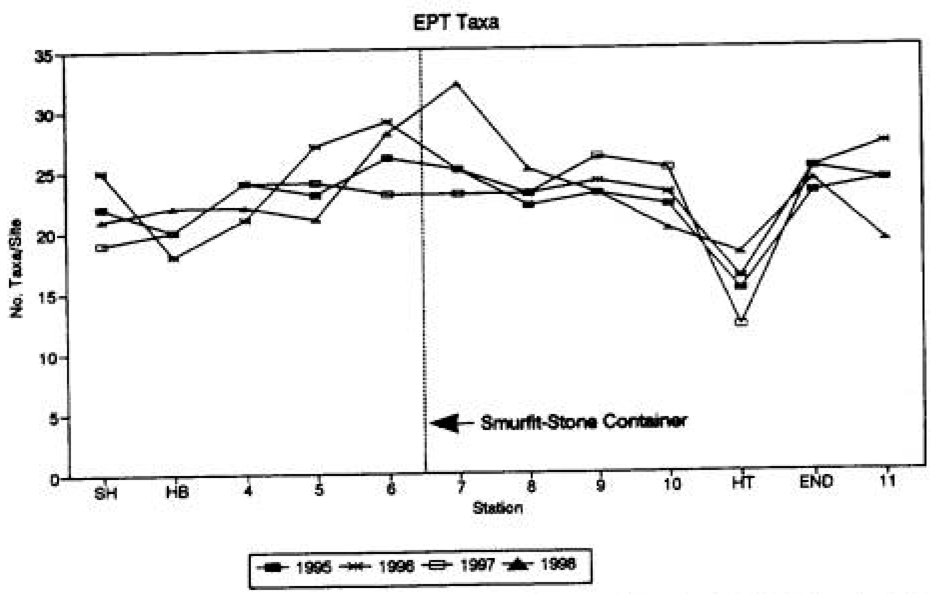

Figure 3. Clark Fork River Benthos Diversity (EPT TAXA) at MDEQ & Missoula Mill Sampling Sites, 1995 - 1998.

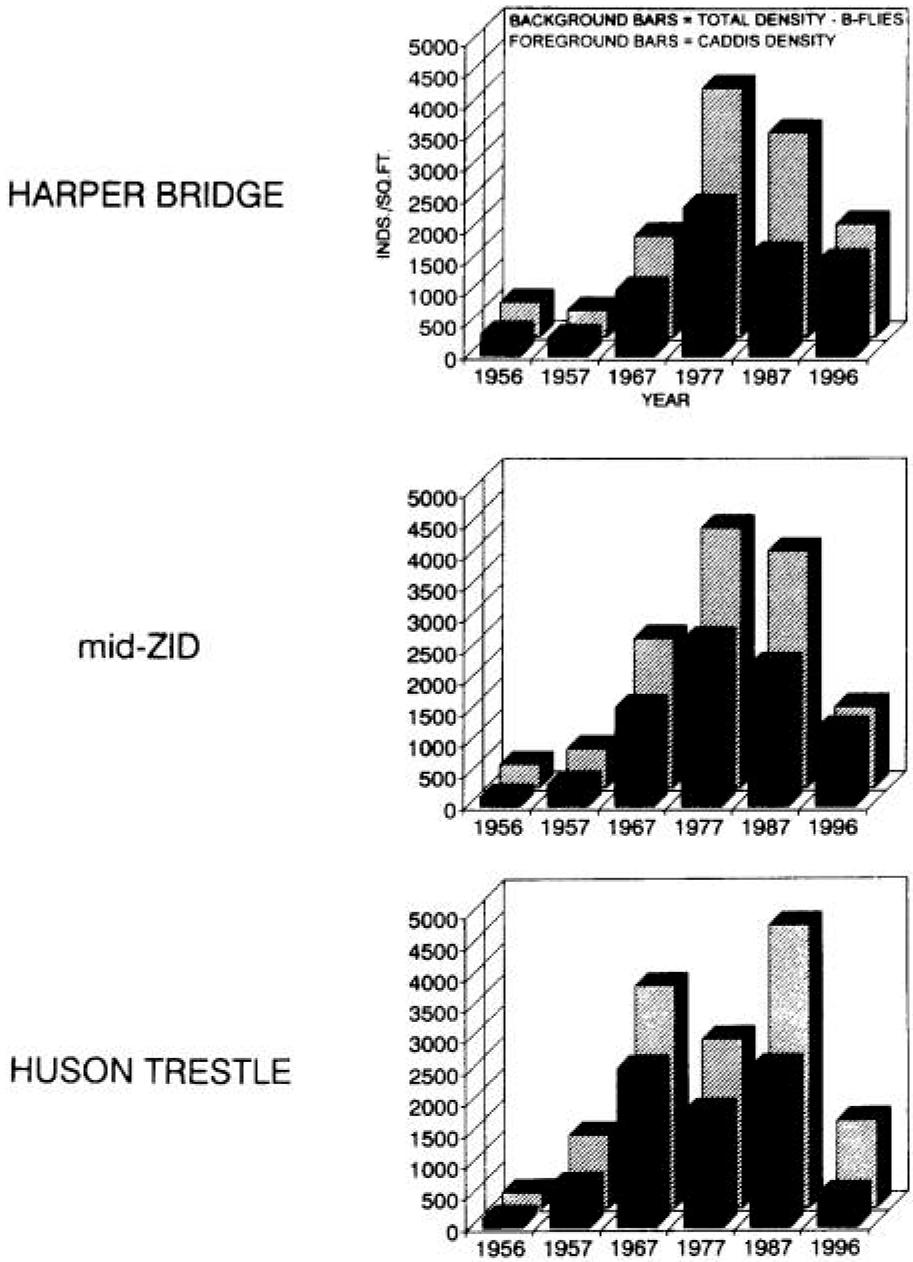

Figure 4. Total and Caddisfly Only Abundance at Selected Clark Fork River Monitoring Sites Over 4 Decades.

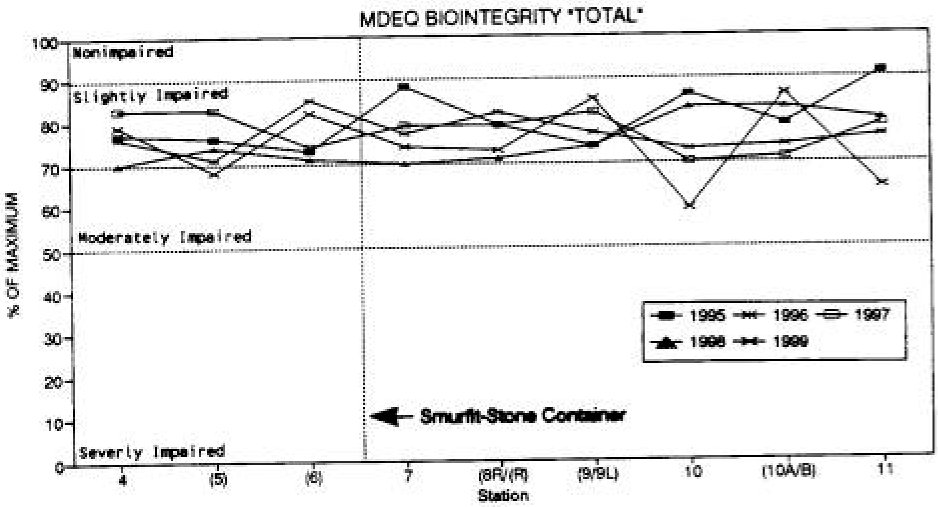

Figure 5. Missoula Mill Monitoring Data (1995-1999) Scored by MDEQ Biointegrity Analysis - TOTAL BIOINTEGRITY

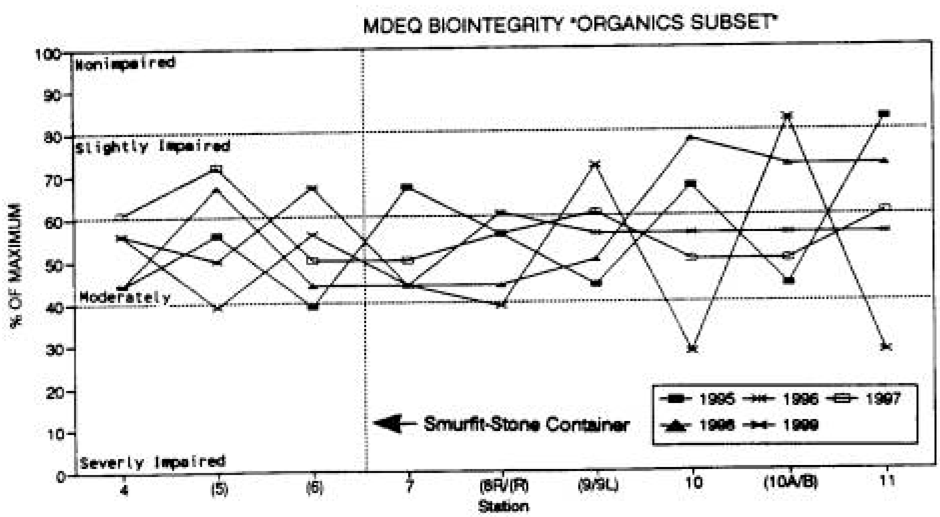

Figure 6. Missoula Mill Monitoring Data (1995-1999) Scored by MDEQ Biointegrity Analysis - ORGANICS SUBSET

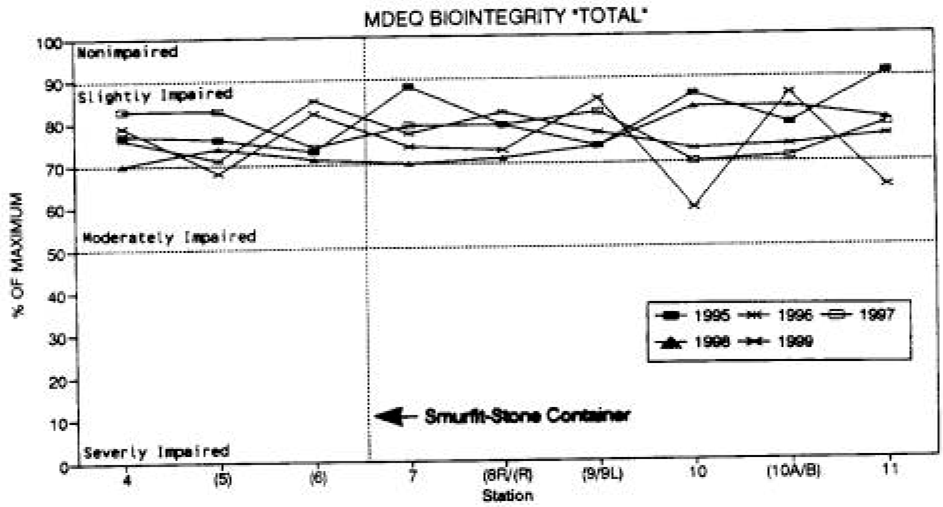

Figure 5. Missoula Mill Monitoring Data (1995-1999) Scored by MDEQ Biointegrity Analysis - TOTAL BIOINTEGRITY

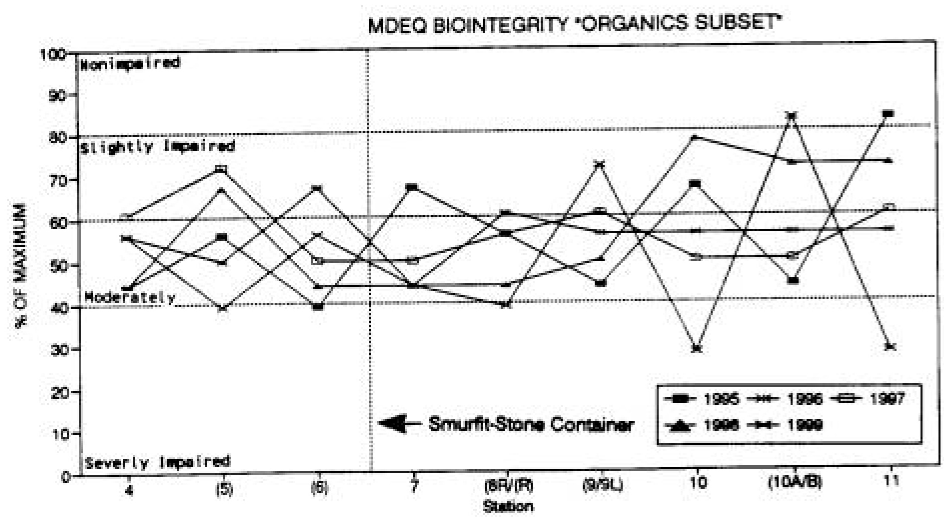

Figure 6. Missoula Mill Monitoring Data (1995-1999) Scored by MDEQ Biointegrity Analysis - ORGANICS SUBSET