

**PHYSIOLOGICAL AND WEIGHT CHANGES OF WILD BROWN TROUT
INHABITING WATERS WITH ACUTELY TOXIC CADMIUM AND ZINC
CONCENTRATIONS: AN IN SITU STUDY**

John D. Woodling
Colorado Division of Wildlife
6060 Broadway
Denver, Colorado 80216
Phone: 303-291-7224
Fax: 303-291-7456
e-mail: john.woodling@state.co.us

ABSTRACT

During determination of background conditions, significantly increased hematocrit and condition factors were determined in wild brown trout inhabiting an Arkansas River stream reach in Colorado, USA, where cadmium and zinc exceeded acutely lethal concentrations compared to trout from an upstream, relatively unimpacted, reach (Figures 1 & 2). Brown trout collected from both sites were subsequently used as test organisms in a 96-h in situ bioassay. Trout from both groups were exposed to higher cadmium and zinc concentrations at a site on the Arkansas River nearer the contaminant source of California Gulch near Leadville, Colorado, where metal concentrations exceeded those of the initial two collection sites. The object of this study was to compare hematocrit, condition factor and plasma ions following an assumed lethal response to the additional metal concentrations. The upstream, relatively uncontaminated site was termed the clean water site. The site with the highest metal concentrations just downstream of California Gulch was termed the lethal site. A mixing zone site was located in the stream where metal concentrations were intermediate between the clean water and lethal site. The downstream location was termed the polluted water site.

Dissolved cadmium and zinc averaged 0.4 ug/l (95% C.I. 0.3 ug/l - 1.0 ug/l) and 126 ug/l (89 ug/l - 197 ug/l), respectively, at the clean water site. At the lethal site, cadmium and zinc averaged 10.2 ug/l (5.9 ug/l - 16.6 ug/l) and 3,041 ug/l (1,365 ug/l - 6,479 ug/l), respectively. At the mixing zone site, cadmium and zinc averaged 5.7 ug/l - 4,323 ug/l), respectively. At the polluted water site, cadmium and zinc averaged 6.1 ug/l (3.4 ug/l - 10.4 ug/l) and 1,786 ug/l (761 ug/l - 3,245 ug/l), respectively.

All brown trout exposed to the higher cadmium and zinc levels at the lethal site became moribund within 60-h. The average condition factor of in situ clean water fish at the lethal site was significantly higher than clean water in situ control fish. The average hematocrit of moribund, clean water fish at the lethal site was significantly higher than clean water site controls or clean water site fish exposed at the mixing zone and polluted water sites (Figure 3). Average plasma sodium clean water site fish was significantly less at the lethal and polluted water sites than at the control and mixing zones sites.

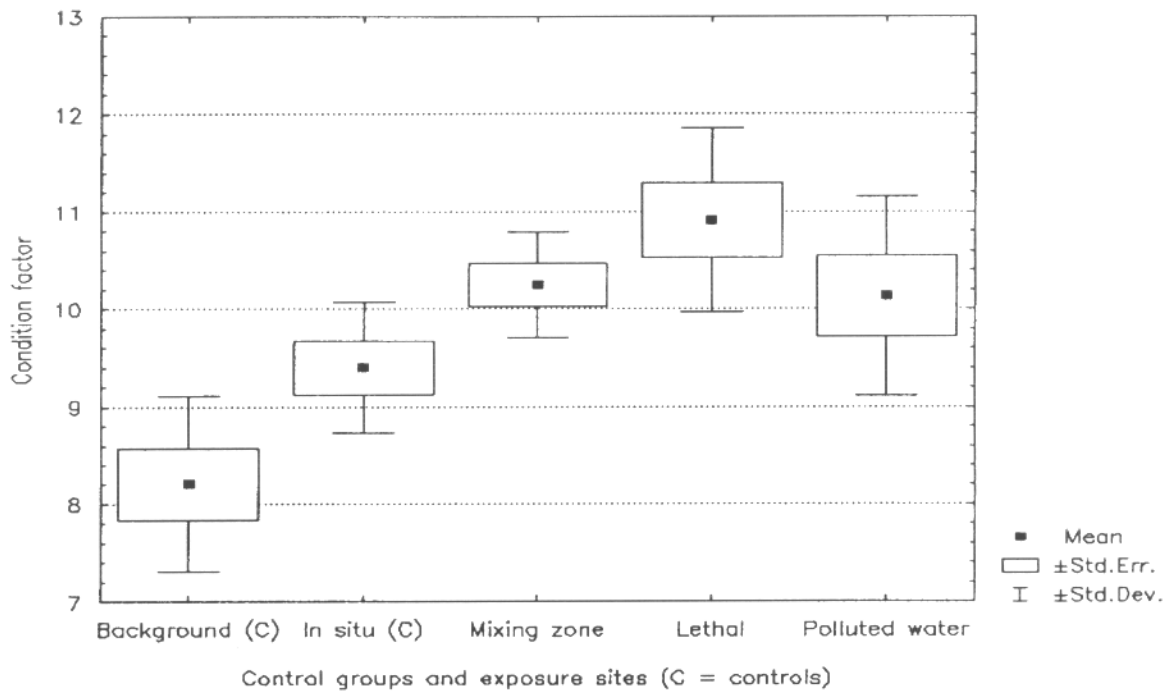


Figure 1. Average condition factor of clean water site brown trout, Arkansas River, August 6-10, 1990.

There were no significant differences in condition factor among lethal site fish among either in situ control fish or exposure groups (Figure 2). The average hematocrit of polluted water site fish was significantly higher at the lethal site compared to polluted water site controls or polluted water site fish exposed at the other two sites (Figure 3).

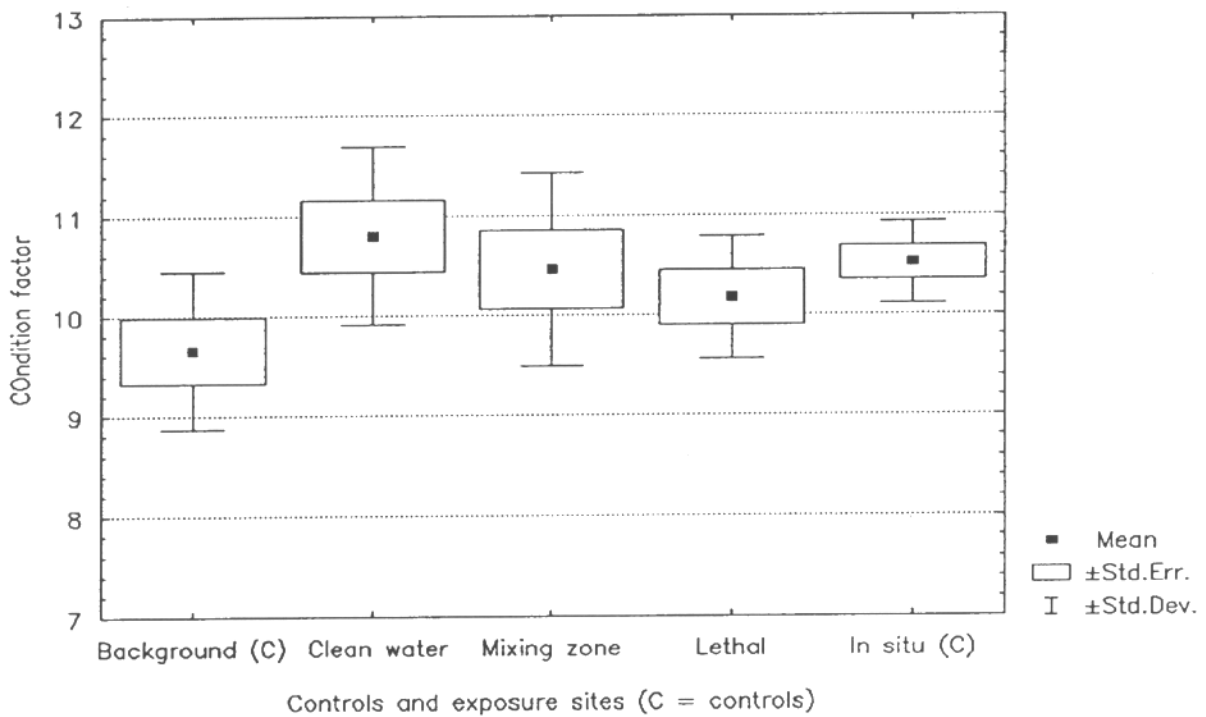


Figure 2. Average condition factor of polluted water site brown trout, Arkansas River, August 6-10, 1990.

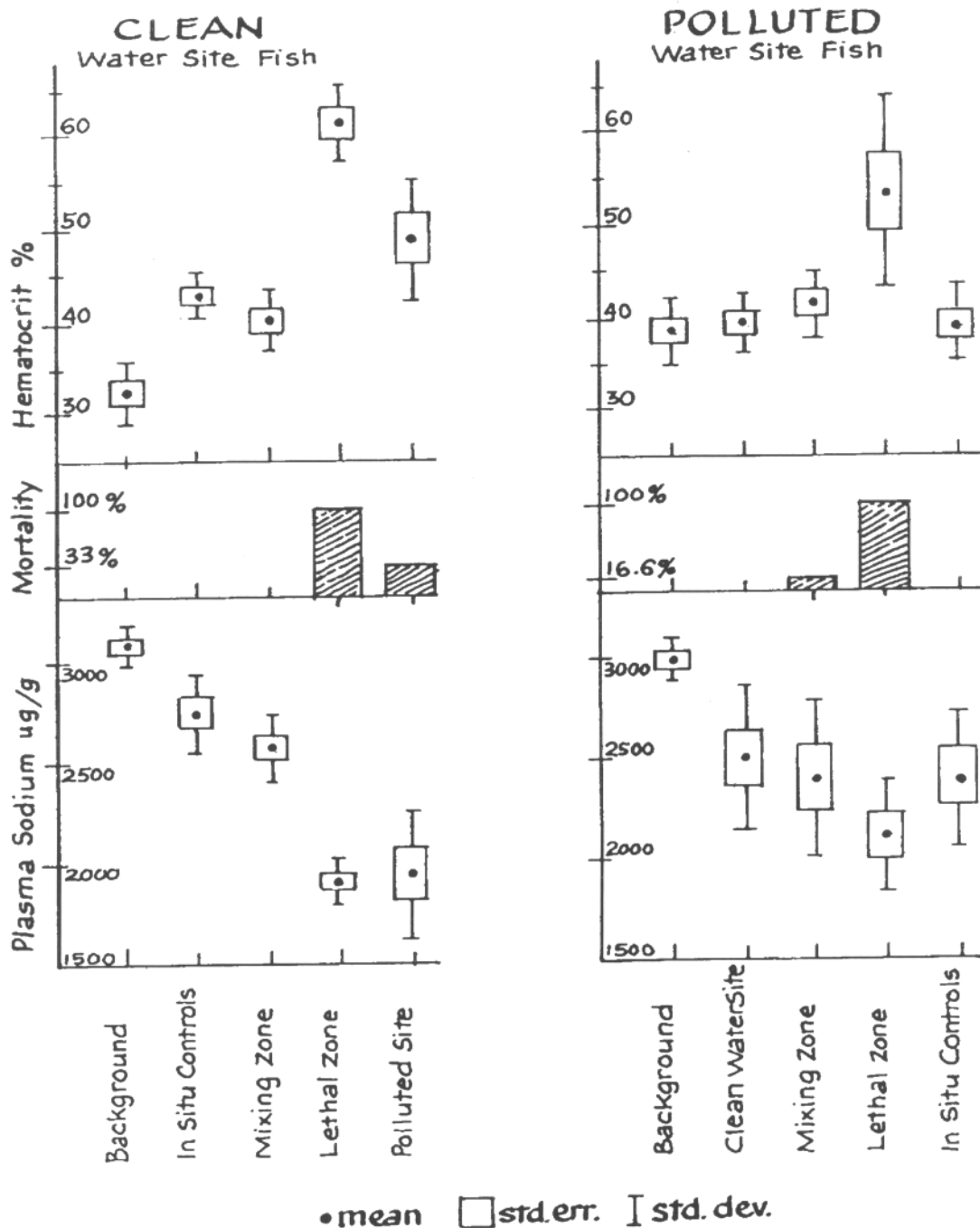


Figure 3. Average plasma sodium, mortality and hematocrit, Arkansas River, August 6-10, 1990. Clean water site fish on left and polluted water site fish on right.

The hematocrit of individual moribund trout at the lethal site increased in a log linear fashion compared to length of survival, not site of origin. A log linear increase in hematocrit was not observed in clean water site fish at the polluted water site where a 33% mortality was observed. Two different patterns of hematocrit change were observed at sites where brown trout became moribund. Where all fish became moribund (lethal site) hematocrit increased relative to length of survival. Where only a percentage of fish became moribund (clean water fish at the polluted water site) hematocrit was higher in moribund fish compared to survivors. The same patterns were observed for plasma sodium.

A significant positive linear relationship was found for clean water site fish at all exposure sites for average condition factor compared to dissolved cadmium and zinc. Clean water site fish gained weight linearly in relation to dissolved cadmium and zinc at the exposure sites. There were no linear relationships of average condition factor for polluted water site trout to cadmium and zinc.

Increased hematocrit and decreased plasma sodium were not the cause of fish becoming moribund at the lethal site since there were no threshold levels that resulted in fish becoming moribund. The first fish to become moribund did not exhibit increased hematocrit or decreased plasma sodium and magnesium levels. The longer fish survived, the greater the change in hematocrit and plasma ions. Plasma ion decrease may have been an indicator of impending death, while increased hematocrit may have indicated impaired osmoregulation.

Increased condition factors may have resulted from increased body water and osmoregulatory failure. Stress results in increased weight in freshwater fish attributable to water uptake (Mazeaud et al., 1977). Increased percentage of body water may be permanent response in brown trout that inhabit river reaches where cadmium and zinc exceed acutely toxic concentrations. Measurements of percent body water may serve as a technique to differentiate between brown trout inhabiting stream reaches where cadmium and zinc exceed acutely toxic levels and sites where these metals are not acutely toxic. The increased condition factors may indicate that brown trout surviving at the polluted water site were not acclimated to the metals. The fish may have been stressed, an indication of possible decreased resistance to cadmium and zinc exposure compared to the clean water site fish.

Reference Cited

Mazeaud, M, Mazeaud, F and Donaldson e 1977 Primary and secondary effects of stress in fish: some new data with a general review. *Trans. Amer. Fish. Sec.* 106:201-212