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A Review of the Data from the Entiat River Basin Collected for the Ambient Monitoring Database

by
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March 1994

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Waterbody No. WA-46-1010

INTRODUCTION

Only one ambient monitoring sampling station is currently maintained in the Entiat River basin and it is located approximately 1.5 miles upstream from the mouth at a private bridge. Sampling was conducted during wateryears (WY) 1959-66, 1972, 1975-76, 1978-91, and is now included in the WY 1994 sampling schedule. This report is limited to the period WY 1978-91, because prior collections were more limited in the number of parameters recorded, and the detection limits of several chemical constituents have changed substantially making comparisons difficult. What follows is divided into two sections: 1) an analysis of trends (over time) of each parameter using a seasonal Kendall test for trends and a discussion of the results; and 2) a brief narrative description and graphical display of each parameter to illustrate the median and variability of the data by month.

Trend Analysis

The seasonal Kendall test for trend is a nonparametric test for detecting changes over time. Because it is a nonparametric test, it is not affected by non-normally distributed data, heteroscedasticity, or a moderate percentage of "below detection limit" data (unless the detection limit has changed). Initially, this analysis was done on all parameters (Table 1) using the original data. If a statistically significant trend was detected or a pattern was seen in the data which may have affected the result, then the data were flow-corrected or time-corrected and the trend analysis was repeated on the corrected data. Data correction is simply accounting for correlations between two variables (*i.e.*, suspended solids and flow, water temperature and the time of day when temperature was measured) using regression analysis. Effects were considered to be statistically significant if $P < 0.1$.

Table 1. Results of seasonal Kendall tests on Entiat River data, WY 1978-91. i = increasing trend = decreasing trend, n.s. = non significant result. $P<0.05$ was considered significant.

Parameter	Uncorrected	Flow-corrected	Time-corrected*
Temperature	i		n.s.
Dissolved Oxygen	d		
O_2 saturation	n.s.		
pH	**		
Specific conductivity	n.s.	d	
Total suspended solids	n.s.	d	
Turbidity	***		
Nitrate+nitrite-N	d	d	
Ammonia-N	***		
Total phosphorus	***		
Soluble reactive phosphorus	***		
Fecal coliform bacteria	d	****	

* corrected for correlation with the time of day when the sample was collected

** no analysis was done because of probable changes in measurement technique

*** no analysis was done because many values were at or below detection limits and the detection limits had decreased during the period of record

**** there was no significant correlation with flow

Results

A significant increasing trend in temperature was seen in the raw data, but this was apparently due to a change in the time of day when the data were collected. Prior to 1984, sampling usually occurred between 6:00 and 10:00 a.m., but beginning in 1984 sampling usually occurred between 12:00 and 4:00 p.m. This probably accounts for the apparent upward trend seen in the raw data because no trend was seen in the time of collection-corrected temperature data. Similarly, a decreasing trend in dissolved oxygen concentration (D.O.) was detected in the raw data. However, because D.O. is inversely related to water temperature and the fact that no trend was detected in percent oxygen saturation, the decreasing trend in the raw D.O. data should be considered to be an artifact of the change in the time of data collection. A marginally significant decreasing trend was seen in specific conductivity in the raw data, and a significant decreasing trend was detected in the flow transformed data. Total suspended solids showed a non-significant decreasing trend in the raw data but a significant decreasing trend in the flow-corrected data. A decreasing trend in nitrate+nitrite-N concentration was seen in both the raw data and the flow-corrected data. No significant trend was detected in flow. Fecal coliform bacteria showed a significant decreasing trend in the raw data. No flow-correction was applied to the data because the relationship was very poor ($r^2 < 0.1$). An obvious change in pH was seen after 1984, which was probably due to the measurement technique. No analysis was done on these data. Many of the values for turbidity, ammonia, total phosphorus and soluble reactive phosphorus were below the detection limit and the detection limit changed during the period of record. Because of this, no trend analysis was done.

Discussion

No significant trends were seen in flow, temperature, or dissolved oxygen concentration in this analysis. Apparent trends in temperature and dissolved oxygen concentration were artifacts of the change in the time of sampling from morning to the afternoon in WY 1984. Significant decreasing trends were detected in specific conductivity, total suspended solids and nitrate+nitrite-N concentration. These could all be related to a decrease in runoff related inputs to the stream. If we had information about the type and extent of forest management and agricultural activities in the basin, then we may be able to speculate as to the causes of these trends. A decreasing trend was also seen in fecal coliform data. Ammonia, total phosphorus, and soluble reactive phosphorus concentrations were usually quite low. Trend analysis was not recommended on the variables because of the large proportion of 'below detection limit' values and the changes (decreases) in detection limits during the period of study. The turbidity data exhibited the same problems and was also excluded from analysis.

Description

See Figures 1-11 for descriptive box plots of all variables. Flow usually peaked in June (Figure 1), as did suspended sediment concentration (Figure 2). Both specific conductivity (Figure 5) and nitrate/nitrite-N concentration (Figure 7) were negatively correlated with flow, probably due to dilution during snowmelt, with lowest median values occurring in June. Temperature regularly exceeded the Class A standard (18°C) in August and September (Figure 3). As mentioned above this was related to the time of day when the sample was collected and probably reflects a chronic condition in late afternoon. Dissolved oxygen did not fall below the 8 mg L-1 standard (Figure 4). pH was varied little seasonally but did occasionally exceed the 8.5 standard (Figure 6). Ammonia-N, total phosphorus, and soluble reactive phosphorus concentrations were usually near or below the analytical limits of detection (Figures 8-10). Fecal coliform counts displayed little seasonal variation or correlation with flow and were generally < 10 per 100 mL, although occasional high counts were recorded.

Conclusions

High temperatures in the afternoon during late-summer and fall is the major water quality standard violation seen in these data. Suspended solids concentrations were generally low, but this may be deceptive because large quantities of sediment may be transported during infrequent high flows and are often missed by monthly sampling. The pH excursions above 8.5 were relatively infrequent. In general, nutrient concentrations were low (ammonia-N, total phosphorus and soluble reactive phosphorus) while nitrate/nitrite-N concentration was well within the range expected of natural conditions and was decreasing. Fecal coliform counts were usually low.

FIGURES

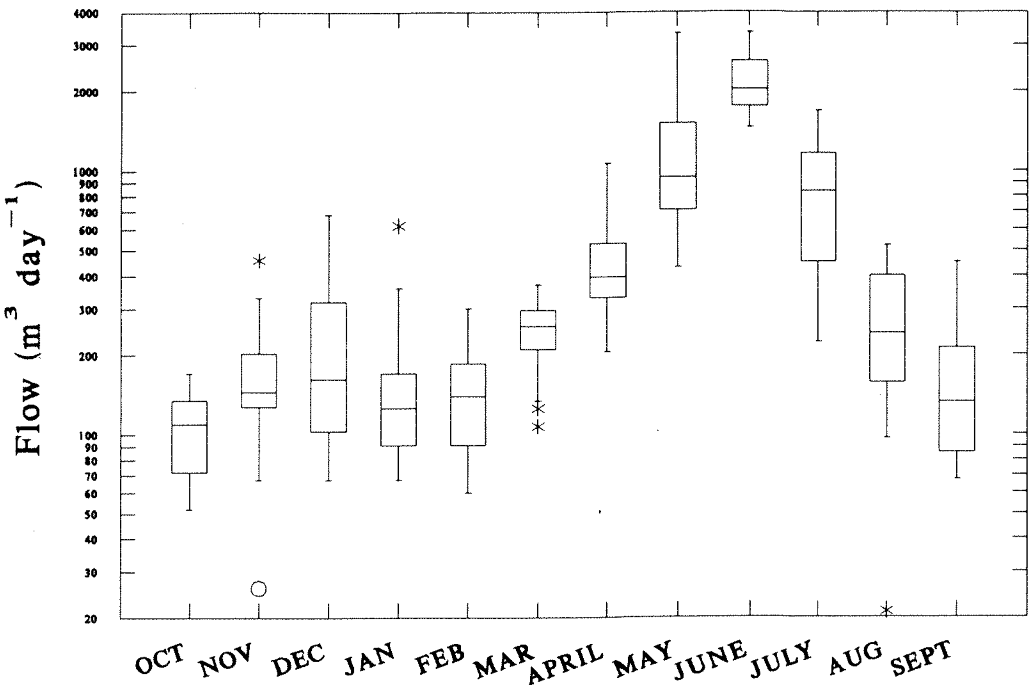

Figure 1. Flow distribution by month in the Entiat River. WY78–91.

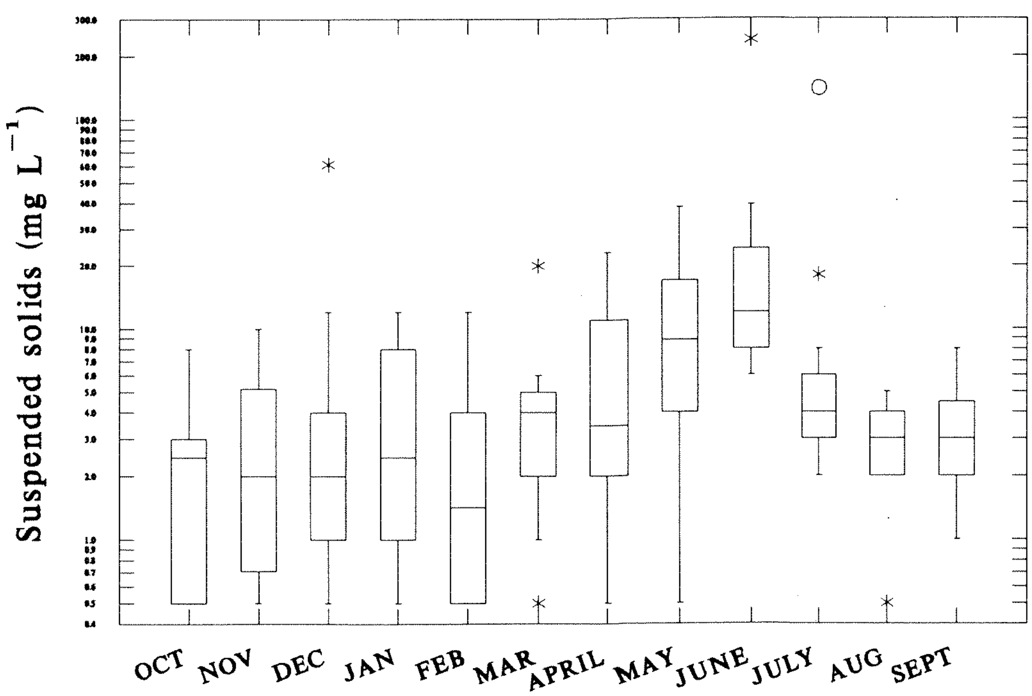

Figure 2. Suspended solids concentration distribution by month in the Entiat River. WY78–91.

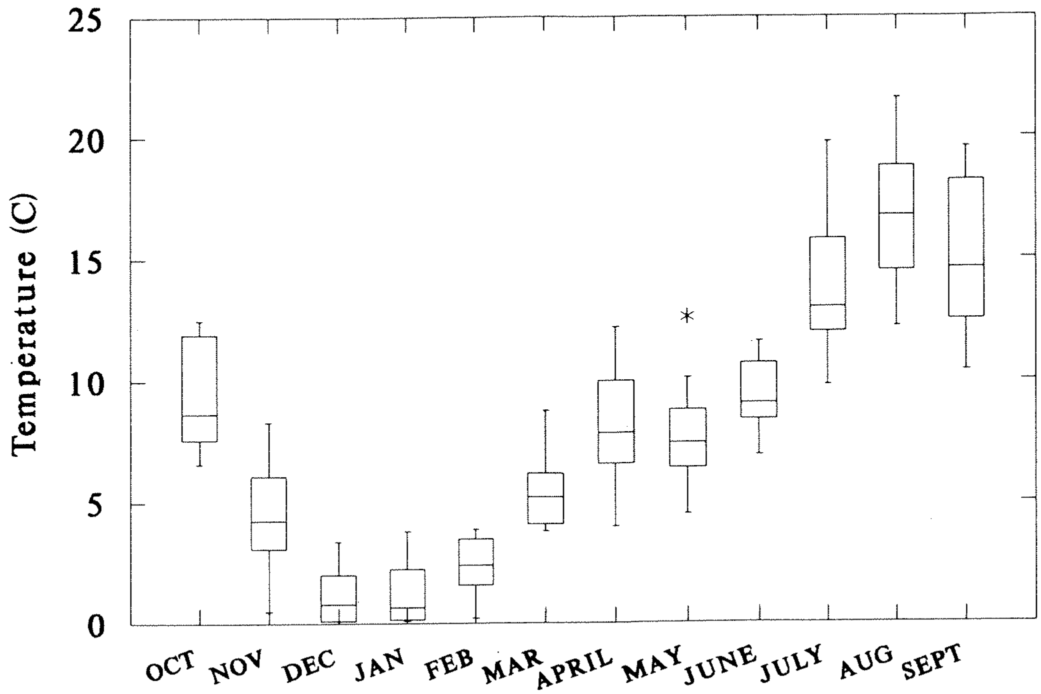

Figure 3. Temperature by month in the Entiat River, WY78–91.

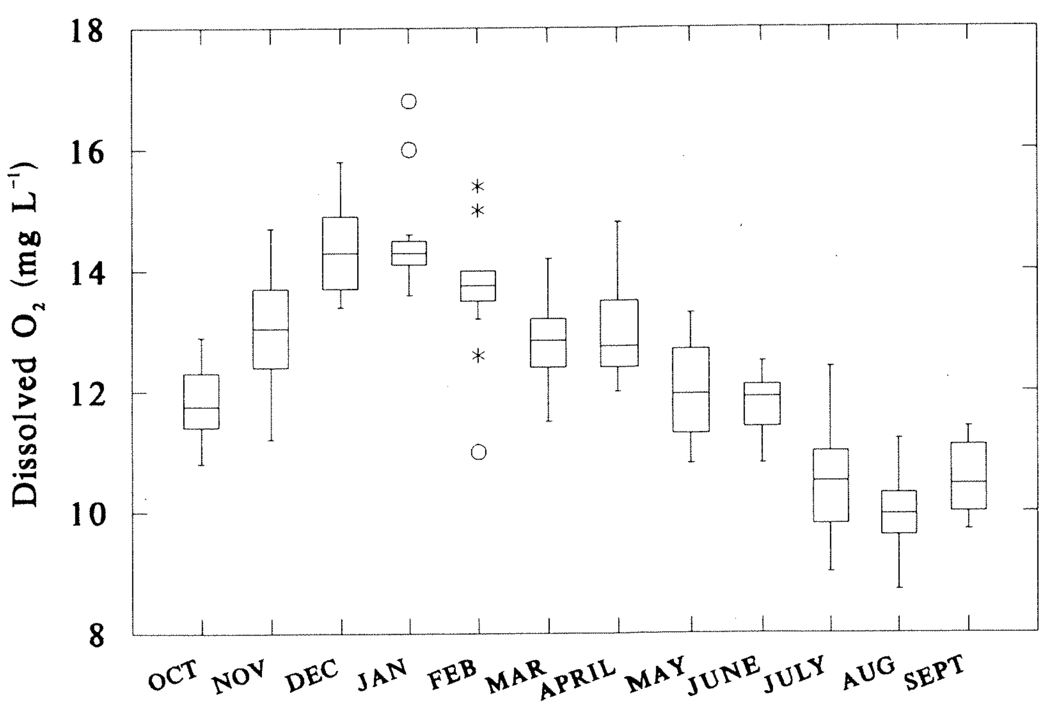

Figure 4. Dissolved oxygen concentration by month in the Entiat River, WY78–91.

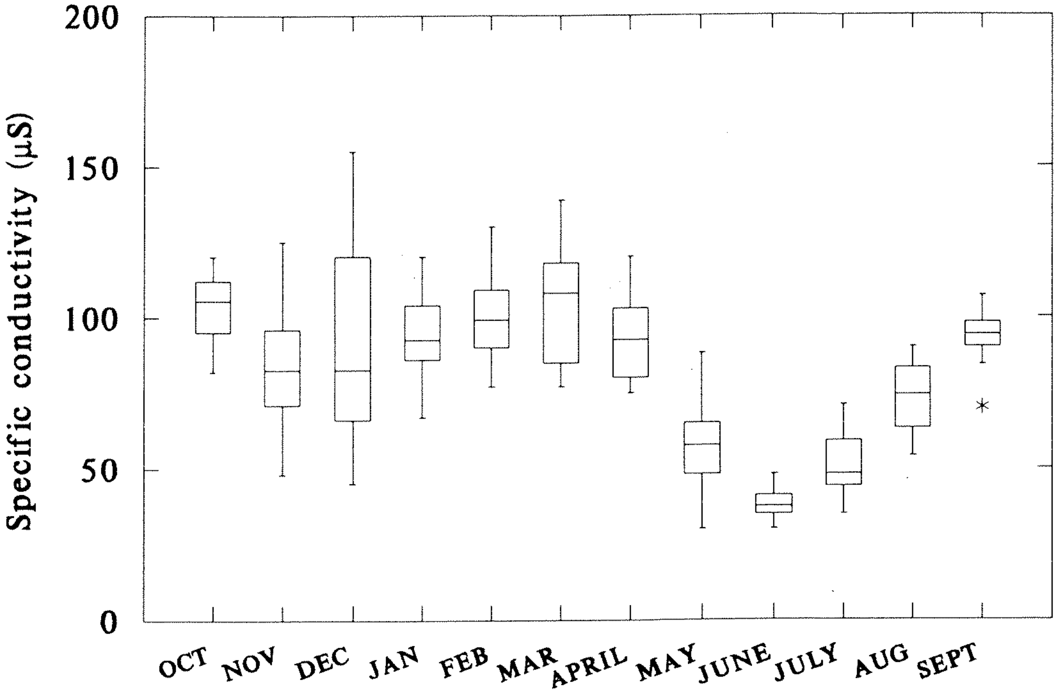

Figure 5. Distribution of specific conductivity values by month in the Entiat River, WY78-91.

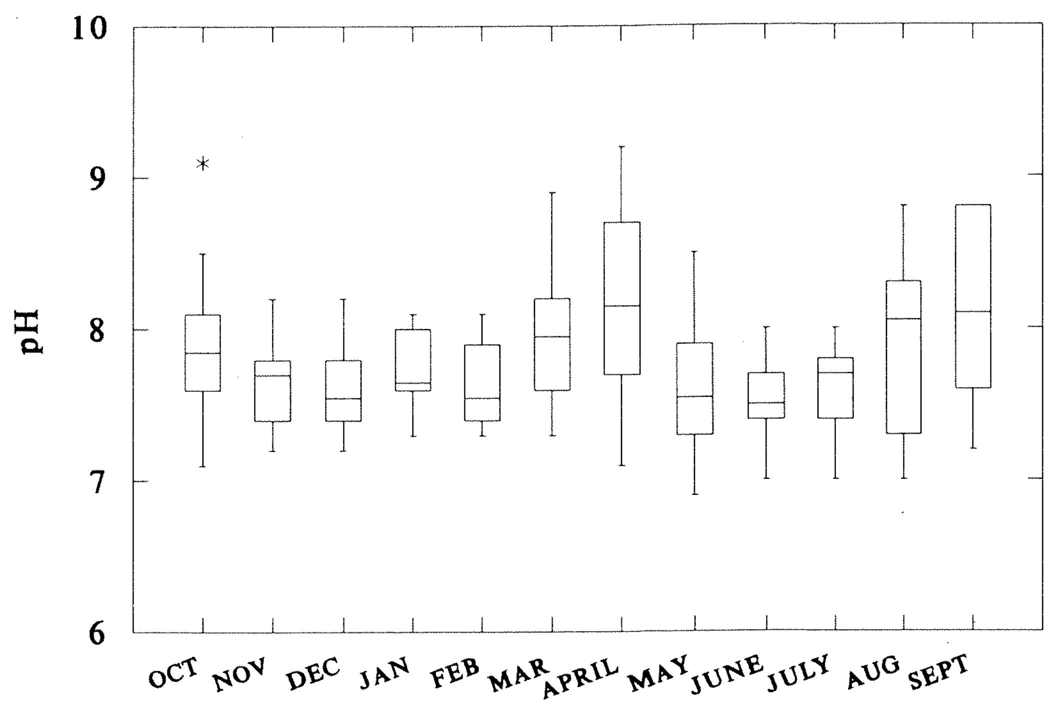

Figure 6. Distribution of pH values by month in the Entiat River, WY78-91.

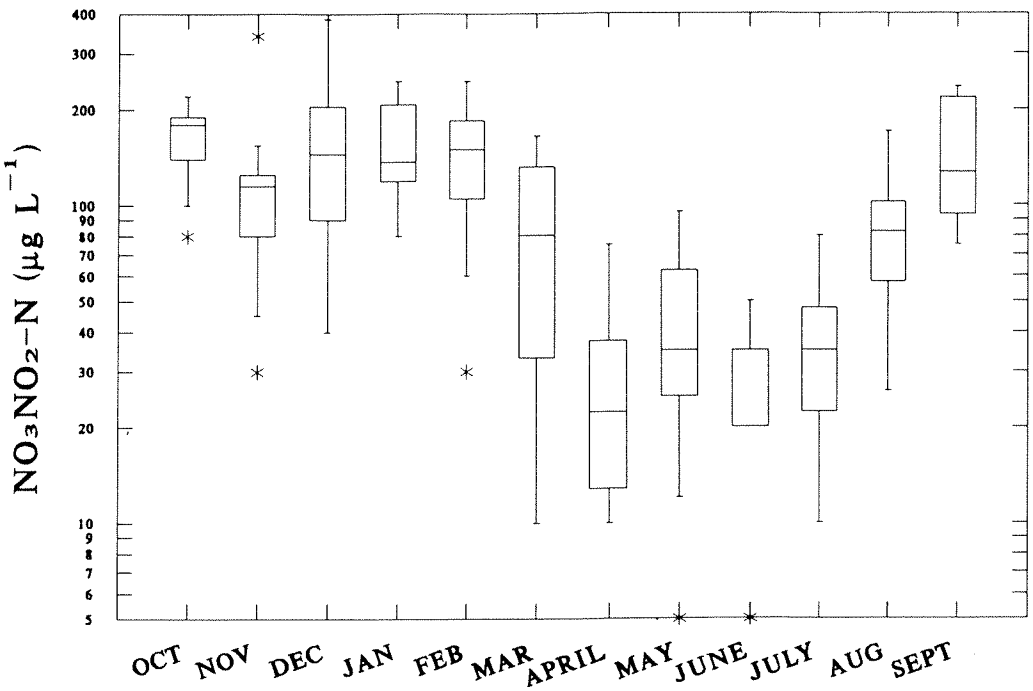

Figure 7. Nitrate+nitrite-N concentration distribution by month in the Entiat River. WY78-91.

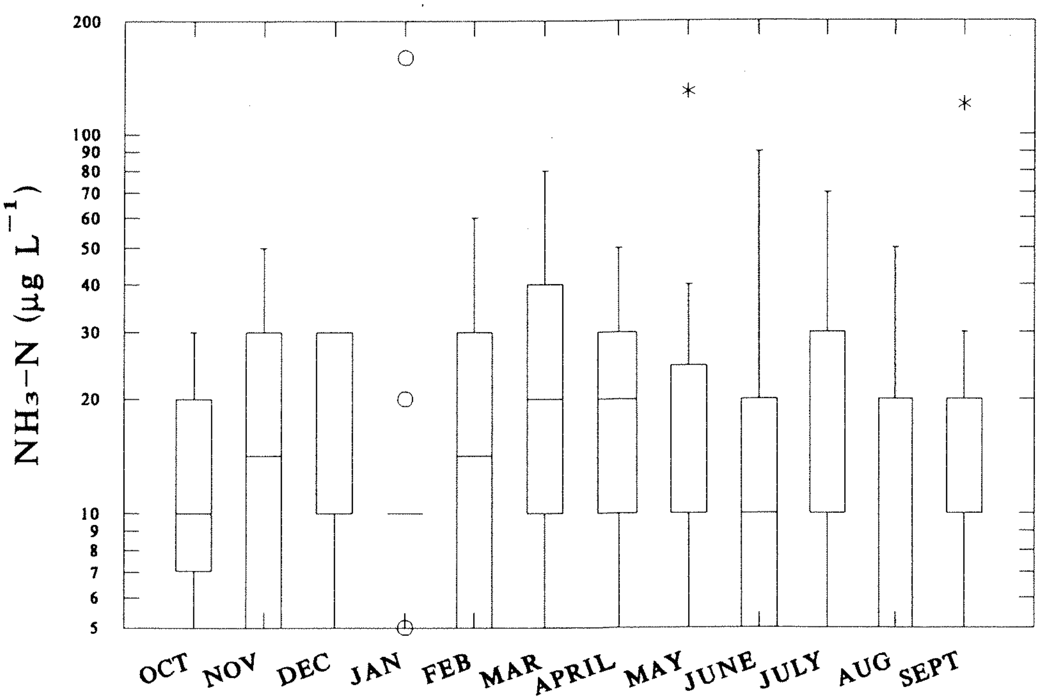

Figure 8. Ammonia-N concentration by month in the Entiat River. WY78-91.

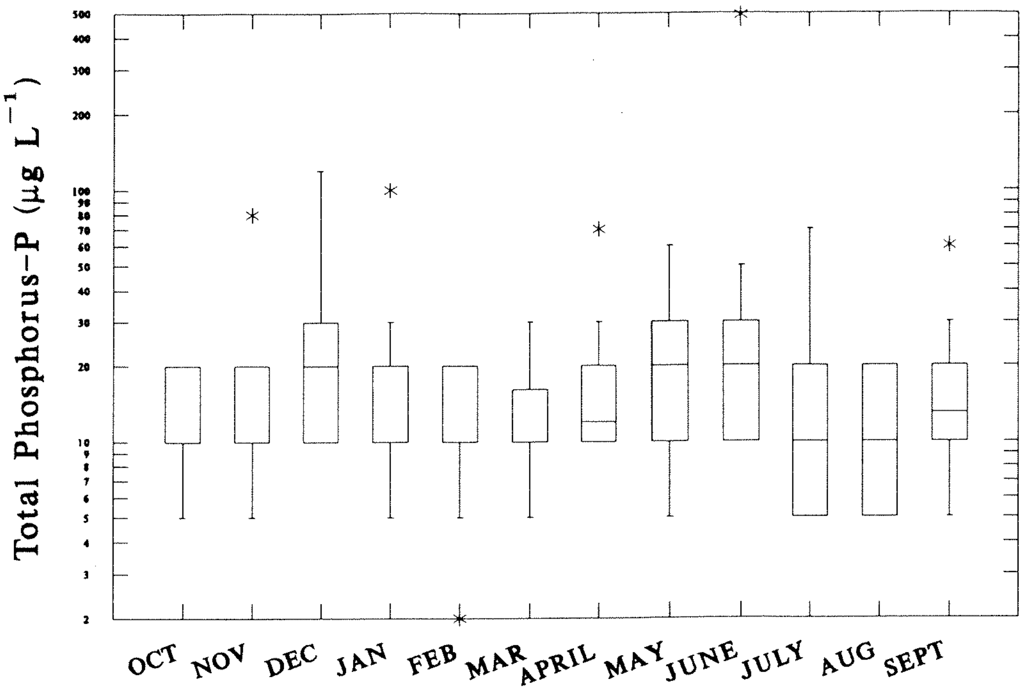

Figure 9. Total phosphorus concentration by month in the Entiat River, WY78-91.

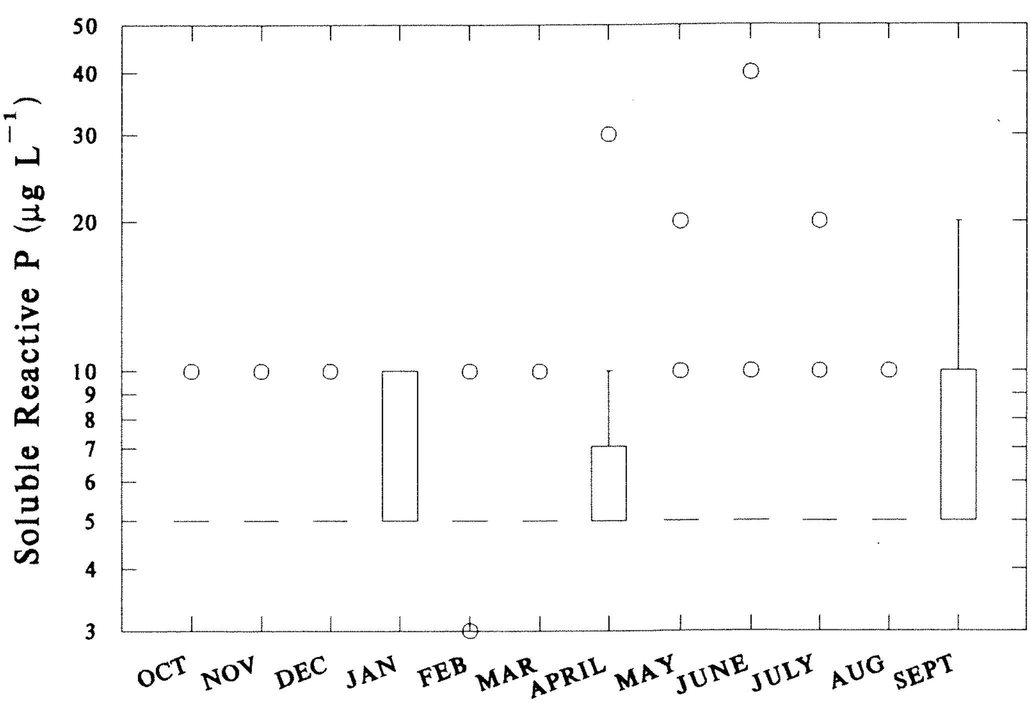

Figure 10. Soluble reactive phosphorus concentration distribution by month in the Entiat River, WY78-91.

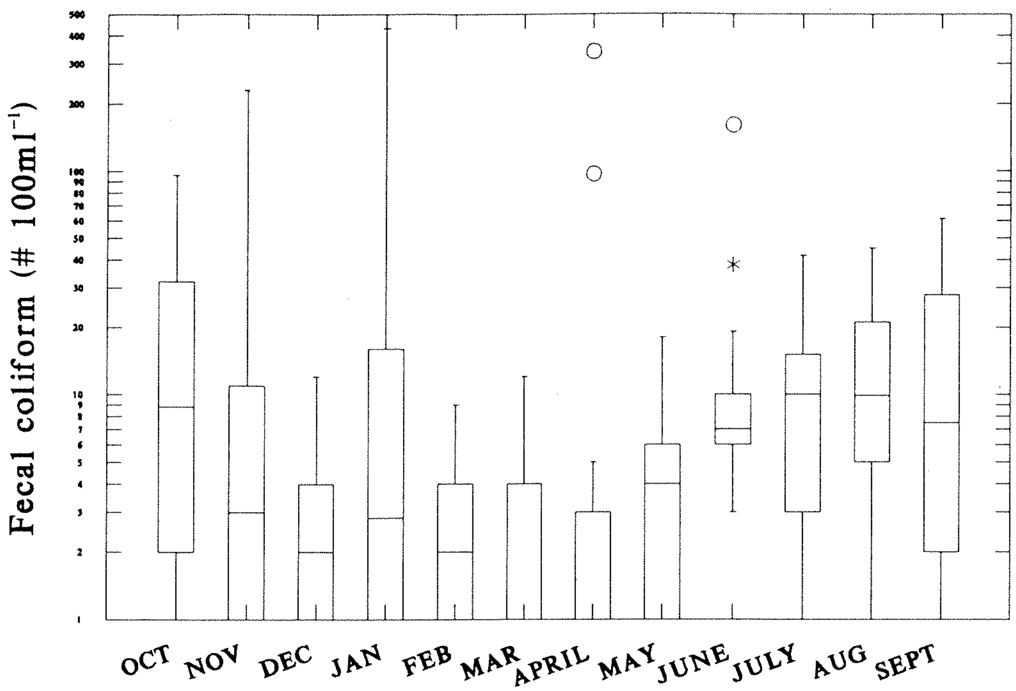

Figure 11. Fecal coliform values by month in the Entiat River, WY78-91.