Report for 2003TX94B: Natural Remediation of Contaminants Along the Forgotten River Stretch of the Rio Grande

- Other Publications:
  - Ordonez, C., and Bain, L.J. "Impact of heavy metals on macroinvertebrates and fish along the forgotten stretch f the Rio Grande," presented at the 1st Annual Desert Southwest Society of Environmental Toxicology and Chemistry meeting, June 25-26, 2004.

Report Follows

Natural Remediation of Contaminants along the Forgotten River Stretch of the Rio Grande

The purpose of this study was to measure the chemical and ecological gradient in the Forgotten River from Fort Quitman down to Presidio. This study included several sampling times during the year to asses the levels of metals, the chemical parameters and the impact on the benthic macroinvertebrate communities. As part of the investigation conducted under the TWRI-USGS grant that was provided, two sampling periods were performed, and a third one is planned for February 2004. The sampling times were modified from the original proposal due to the fact that seasonality could play an important role on modifying the hydrology of the river. Therefore, four sampling times per year, one in each season, for two years are planned to complete this project. The first sampling time was conducted in July 2003 and the second one in October 2003. The goal was to sample 6-10 site along the Forgotten River, but due to the inaccessibility of the roads, only 5 sites were sampled (Figure 1). These sites included one directly upstream from the cities of Presidio/Ojinaga (Site 1, GPS N 29° 36.219', W 104° 27.118'), one site near Candelaria (Site 2, GPS N 30° 8.005', W 104° 4.351'), two sites that were accessed through farms roads (Site 3 GPS N 30° 22.017', W 104° 48.708' and Site 4 GPS N 30° 35.113, W 104° 53.570), and one site at the International Boundary and Water Commission (IBWC) monitoring station at Fort Quitman (Site 5, GPS N 31° 5.252' W 105°36.578). Each sampling period included measurements of water chemistry utilizing an YSI Model 85 oxygen, conductivity, salinity and temperature meter. These parameters were examined because they are relevant for metal speciation and bioavailability as well as for

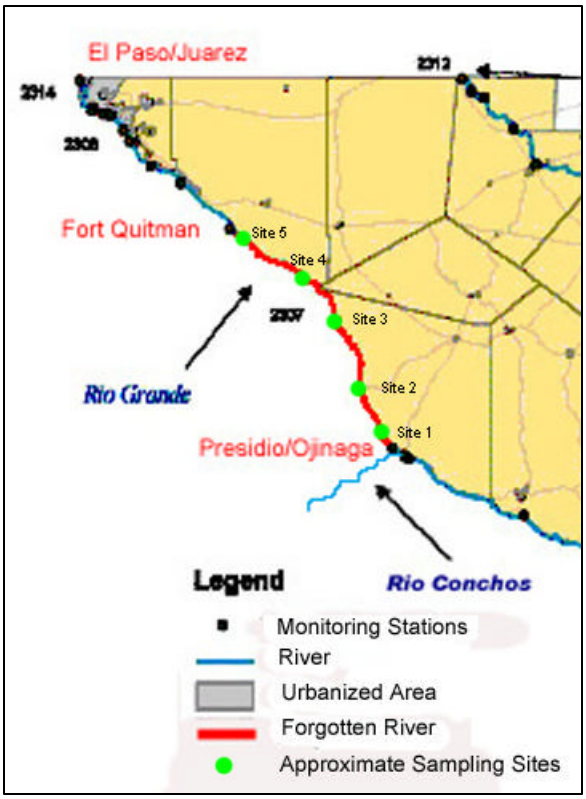

Figure 1. Forgotten River map showing approximate sampling sites.

existence of aquatic life. River physical parameters were also analyzed such as river width, depth and flow. This was done using a measuring tape and a graduated pole. The flow was approximated by allowing a floating object to flow for 10 meters and timing it, or where possible the measurements were takes from the IBWC real time measurements web page. These measurements will then be compared with other sites as well as with the same site at different sampling times. From the analysis of these parameters a correlation of metal concentration at different sites and chemical/physical parameters is expected. This will be important in determining if the presence of more water, i.e. more dilution, allows for the reduction of concentration of metals, along the gradient. Also, the parameters are going to form part of the analysis of the impact of the metals on the community. It might be possible to see that not only the presence of the metals can be disturbing the community but also the lack of water, the high salinity, or the temperature could be playing an important role.

For the collection of water and sediments there were a total of two composite samples along the width of the river at two different points in every sampling site. The water was collected by grab using 500 ml plastic bottles. All of the samples were taken facing upstream to avoid contamination. After the collection, they were acidified using two milliliters of pure nitric acid to maintain the metals in solution. They were stored on ice until arrival to the laboratory where they were stored at 4 °C. Before the metals were analyzed the samples were filtered using a 0.45µm Millipore filter, and then they were analyzed using a Perkin-Elmer Inductively Coupled Plasma spectrometer (Optima 4300 DV ICP-OES) (EPA 200.7). The metals that were analyzed (As, Cr, Cu, Ni, Pb, Zn, Cd, and Fe) were determined from looking at previous studies done in the river. The EPA found high levels of these metals in sites near El Paso/Juarez and downstream of the Forgotten River in sediments, but metals were also detected in water and fish tissue (EPA, 1997). Another study found high levels of lead and zinc in the El Paso/Juarez region, and the rest of the metals were also detected mainly in the sediments (Rios-Arana et al, 2003). In order to be able to determine if there is a concentration gradient due to the fact that the river flows undisturbed for 200 miles, the same metals that have been found in previous studies were analyzed.

The sediments were collected using a bottom sampling dredge. They were placed in 500 ml plastic bottles, and stored on ice until arrival to the laboratory where they were kept at -20°C. To analyze the sediments following EPA method 200.7, 15 ml plastic tubes were filled with

sediments from each site, and then placed in a lyophilizer to freeze dry them for 48 hours. After the sediments were freeze dried, one gram per sample was microwave digested in pure nitric acid following EPA method 3051. The same metals that were analyzed in the water samples were also analyzed in the sediments utilizing the ICP/OAS.

Figure 2. Benthic macroinvertebrate sampling along the bank of the river in site 1 along the Forgotten River.

The collection of benthic macroinvertebrates was done according to EPA standards using a rectangular dipnet sampling along bank vegetation of the river (Figure 2). There were approximately 100 dips at each site. The macroinvertebrates were stored in glass jars containing 70% ethanol. In the laboratory, the organisms from each site were counted and identified to the family level. Benthic macroinvertebrates were used because they can be used as representatives of a particular site, in other words, drift of organisms from other areas is minimized. Analysis of biodiversity and species richness of benthic macroinvertebrates was done to determine the health of the system. The overall number of organisms was determined to show species richness at each site. For the biodiversity indices, the total number of species at each site was assessed. The numbers were predicted to be lowered as the site is more impacted, e.g. closer to El Paso/Juarez. The purpose of sampling macroinvertebrates was to determine if there is a shift in community compositions that is reflective of the metal pollution gradient. Several studies have shown that elevated levels of metals correspond with reduced species diversity and species richness (Clements et al, 2002). This part of the study will show the degree of impact of metals on community structure of macroinvertebrates following a pollution gradient. An interpretation of the results obtained from the indices, can be that the chemical/physical conditions of the river and the concentration of metals in the water and sediments are impacting the community structure of invertebrates.

Figure 3. Collection of fish using a seine at site 4 in the Forgotten River.

The collection of fish, proved to be a much harder task than it was expected. The water levels at the different sampling sites were very low, and thus the fish that were collected were small. The sampling was done using seines, and 10-20 fish of several species were collected at each site (Figure 3). The fish were euthanized with an overdose of MS-222 (1g/L) on site, and they were stored in dry ice until they were brought to the laboratory, where they were placed in a -80°C freezer. Biomarker expression, such as serum vitallogenin, hepatic metallothionein levels, and hepatic glutathione is still pending to be analyzed in these fish to assess metal exposure.

Preliminary Results

The chemical and physical parameters obtained from the two sampling times can be observed on table 1. From the measurements takes it can be observe that conductivity and salinity is much higher at site number 5, which is the site that is closest to El Paso. The other parameters seem to

		July 29 & 29 2003					October 18 & 19 2003				
		Site 1	Site 2	Site 3	Site 4	Site 5	Site 1	Site 2	Site 3	Site 4	Site 5
Chemical Parameters	Water Temperature (°C)	23.3	20.1	22.8	23.3	32.8	22.5	17.2	18.4	16.1	25.6
	Dissolved Oxygen (mg/L)	5.9	7.2	5.85	5.6	10.7	6.22	6.92	6.1	4.27	12.49
	Conductivity (uS)	755	519	209.9	988	6330	1532	568	668	791	5470
	Salinity (ppt)	0.4	0.3	0.1	0.5	2.9	0.8	0.3	0.3	0.4	3
Physical Parameters	Flow estimate (cm/sec)	100	58.8	0.865	0.4035	0.88	N/A	stagnant	stagnant	stagnant	N/A
	Depth Average (cm)	38	63	21	57	19	19	17.5	16	36	16.25
	Width Average (m)	10.1	6.53	14	6	25.4	18.3	5.35	8.6	3.92	14.34

Table 1. Chemical and physical parameters obtained from the two sampling times (July and October) at the five different sites along the Forgotten River stretch.
N/A= Not available

vary among the sites, but in general site 3 seems to have lower levels of the chemical

measurements taken. Further analysis and more sampling periods are necessary to determine if in fact a pattern or a gradient exists as you get further away from El Paso/Juarez.

When total dissolved metals in the water were analyzed from the July sampling, the levels were undetectable for many metals except for Fe, which was also found at high levels during the October sampling (data not shown). When sediments were analyzed, many metals were detected as expected. Both sampling times reveal a pattern of higher concentration of metals in site 3.

All the benthic macroinvertebrates were analyzed to family and the data is pending to be analyzed. Nevertheless, figure 5 shows how many families (showing diversity) were found at each site in July and October. The number of families seems to decrease with closeness to El Paso, but this needs to be further analyzed to see if in fact we find a correlation with the concentration of metals in the sediments and a decreased biodiversity.

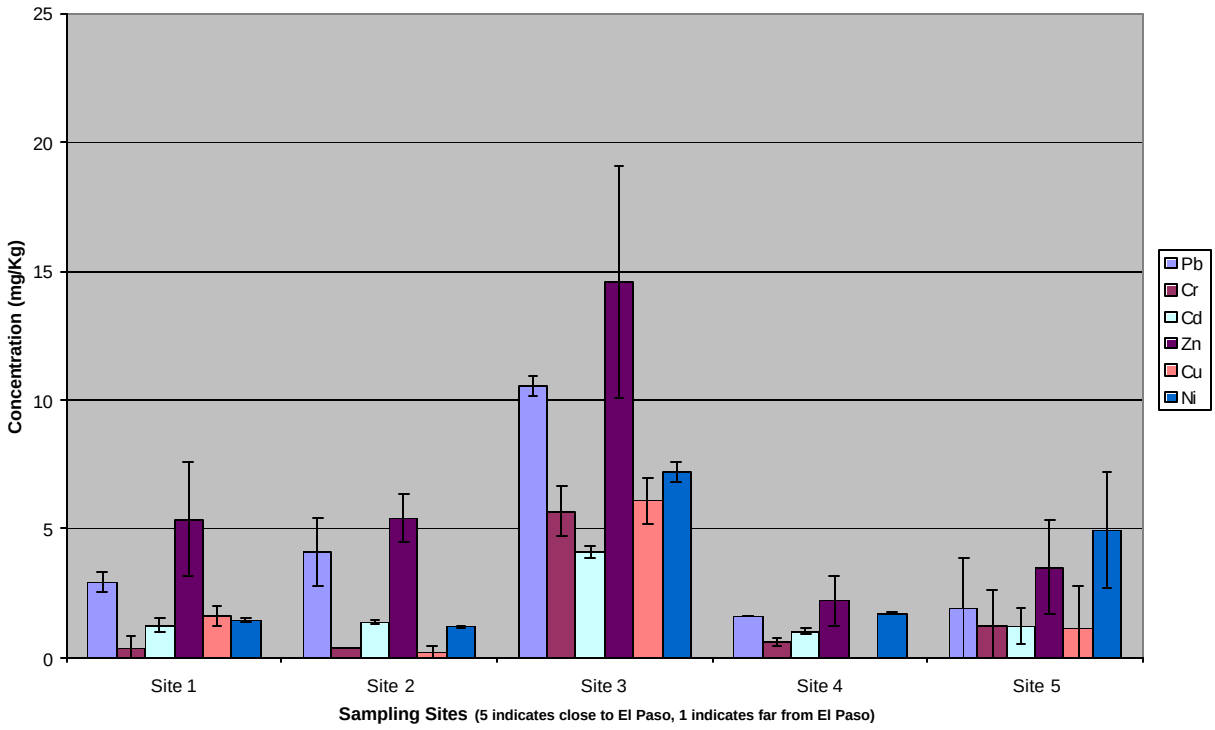

Figure 3. Total recoverable metals from sediments obtained in July. Bars indicate mean ± SD.

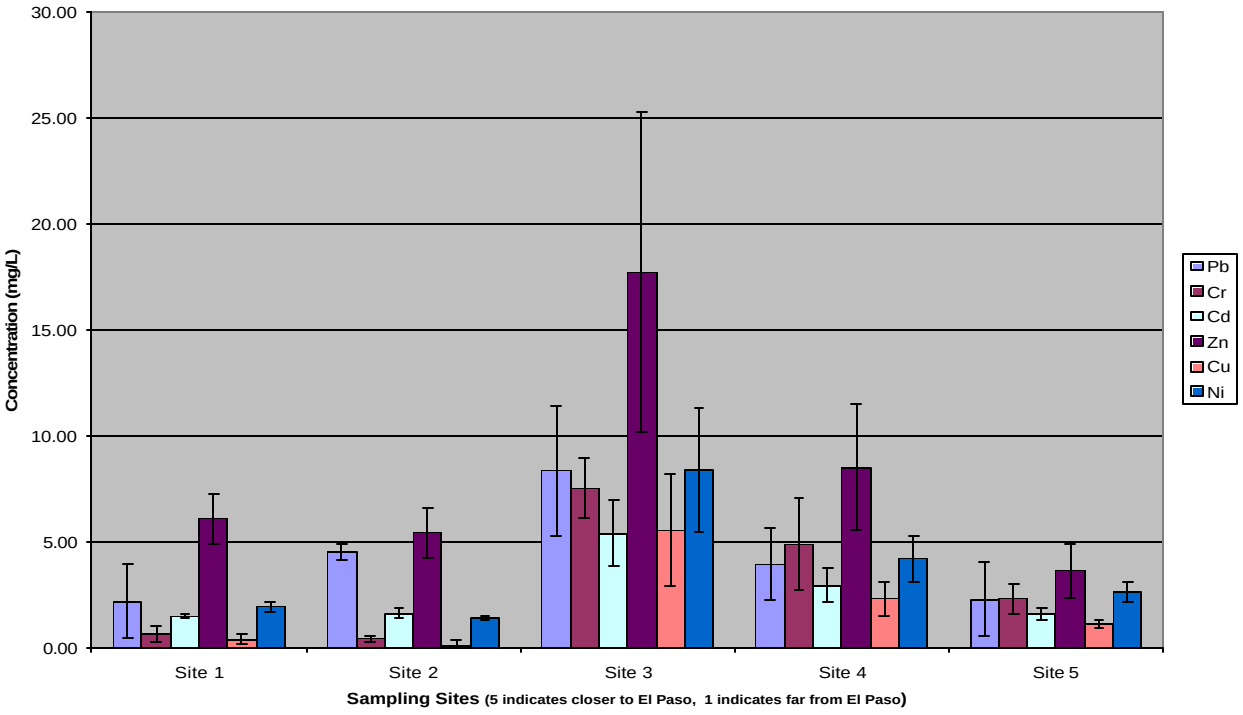

Figure 4. Total recoverable metals from sediments obtained in October. Bars indicate mean ± SD.

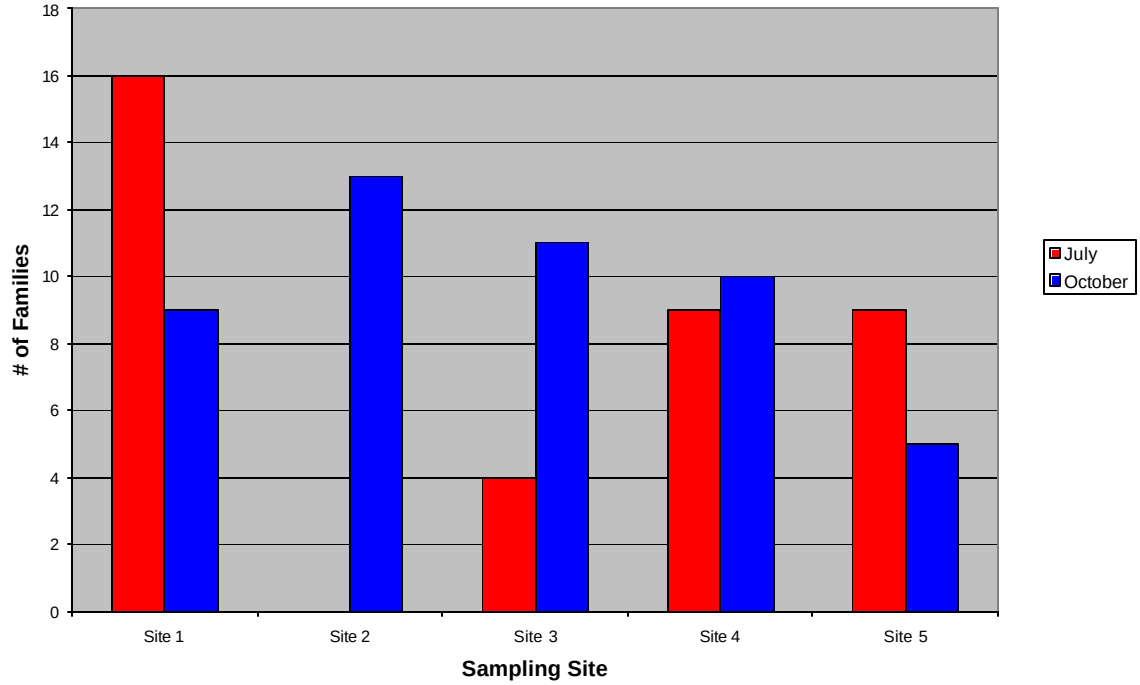

Figure 5. Total number of families of benthic macroinvertebrates present at each site in July and October.

The funds that were provided by this grant were used for the sampling times previously mentioned. A third sampling time will be taking place during February 20th and 21st using the rest of the funds. Also funds were used for supplies such as nets, bottles, nitric acid, and tubes.

Thanks to this grant I was able to gather data to have a solid dissertation proposal presentation which I will defend at the end of this semester. The funds provided were essential in carrying out the activities mentioned in this report, and have left me with an incredible satisfaction and enthusiasm for what comes next; wrapping up the study and hopefully provide a baseline study to develop a restoration plan for the river which is much needed.