U.S. Fish and Wildlife Service
Region 2
Contaminants Program

METALS IN FISH COLLECTED FROM ARAVAIPA CREEK, ARIZONA, OCTOBER 1997

by

Kirke A. King and Mike Martinez

U.S. Fish and Wildlife Service
Arizona Ecological Services Field Office
2321 W. Royal Palm Road, Suite 103
Phoenix, Arizona 85021

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THE FOLLOWING REPORT IS THE "FISH SECTION" WHICH WILL BE INCORPORATED INTO LARGER REPORT (TO BE COMPILED BY SCS ENGINEERING) THAT SUMMARIZES THE POTENTIAL IMPACTS OF THE KLONDYKE TAILINGS ON ARAVAIPA CREEK.

The objectives of this study were to, 1) document and assess current levels of selected metal contaminants in fish from Aravaipa Creek, 2) evaluate trends in contaminant concentrations using current data and those collected from the same area in 1993 (Rector 1993), and 3) compare the occurrence of selected contaminants in Aravaipa Creek fish with national averages using national monitoring networks (Schmitt and Brumbaugh 1990) and U.S. Environmental Protection Agency (USEPA) special national studies (USEPA 1992).

METHODS

Sample collections:

Fish were collected from The Nature Conservancy property on Aravaipa Creek on October 28, 1997. Desert sucker (*Catostomus clarki*), Sonora sucker (*Catostomus insignis*) and yellow bullhead (*Ictalurus natalis*) were caught using a Smith-Root Inc. Model 12-B POW backpack electrofisher. Fish were collected from two locations; the upstream site is locally called Schoolhouse site (32°N52'27" 110°W23'37") and is currently used as a Nature Conservancy stream flow measuring station. The Schoolhouse site is the most upstream perennial site where fish are consistently present. The downstream site was located at a creek crossing below the Bill Salazar house and is approximately one-half-mile upstream from Wilderness Area boundary (32°N54'05 110°W26'13"). Fish were weighed and measured on site and individual whole body samples were wrapped in aluminum foil and stored on wet ice until they were transferred to a commercial freezer at the end of the day. Fish were stored frozen until analyzed.

Whole body fish were analyzed for arsenic, cadmium, lead, and mercury at the Arizona Department of Health Services, Phoenix, Arizona. Mercury concentrations were quantified by cold vapor atomic absorption. All other elements were analyzed following preconcentration to lower detection limits by using inductively coupled plasma emission spectroscopy (ICP). Trace element concentrations in are reported in μg/g (parts per million) wet weight to facilitate comparison of results with those of other studies.

Our 1997 data were compared with Schmitt and Brumbaugh's (1990) National Contaminant Biomonitoring Program (NCBP) findings to determine how trace element concentrations in fish from Aravaipa Creek compare to national levels. Concentrations of an element were considered elevated when they exceeded the NCBP 85th percentile of the nationwide geometric mean. The 85th percentile was not based on toxicity hazard to fish, but provides a frame of reference to identify metals of potential concern.

RESULTS AND DISCUSSION

Arsenic was detected in 12 of 14 fish samples and concentrations ranged from not detected to 0.45 μg/g wet weight (Table 1). Arsenic acts as a cumulative poison (Jenkins 1981) and is listed by the USEPA as 1 of 129 priority pollutants (Keith and Telliard 1979). Background arsenic concentrations in biota are usually less than 1 μg/g wet weight (Eisler 1988). Toxic effects of arsenicals on aquatic organisms have been reported at concentrations of 1.3 to 5.0 μg/g wet weight. Although 5 of 14 fish samples (36%) exceeded the NCBP 85th percentile (Schmitt and Brumbaugh 1990), none contained concentrations that approached the toxic threshold. There appears to be little potential for arsenic related problems in fish at the Aravaipa Creek sites we sampled.

Cadmium was recovered in all fish samples (Table 1). Cadmium was present at a much higher frequency of occurrence than that reported by most other authors for fish collected from southern Arizona. Seventy-seven percent of the fish samples from three National Wildlife Refuges (NWR) on the Colorado River contained cadmium (King et al. 1993). Cadmium was detected in 30 to 54% of fish collected from the upper and middle Gila River including Mineral Creek (Baker and King 1994, King and Baker 1995, Andrews and King 1997). Only one of three composite samples of carp, catfish, and bass collected in 1993 from Havasu NWR contained low (0.02 μg/g wet weight) concentrations of cadmium (Andrews et al. 1997); cadmium was detected in 6% of the fish collected in 1995 from the lower Colorado River and irrigation drains in the Yuma Valley (Tadayon et al. 1997). Cadmium concentrations in all but one sample exceeded the NCBP 85th percentile. Most levels, however, were below the 0.27 concentration reported by Rector (1993) in a composite sample of desert sucker collected from Aravaipa Creek in 1993. The generally accepted toxic threshold for whole body vertebrate samples is 5.0 μg/g wet weight. Therefore, even though cadmium in most Aravaipa Creek fish samples exceeded background concentrations, current levels are far below the lethal threshold. Cadmium, acting by itself, is not a contaminant of concern for fish populations in Aravaipa Creek.

Lead was detected in all fish samples and concentrations ranged from 0.21 to 5.0 μg/g wet weight (Table 1). Concentrations in all but one sample exceeded the NCBP 85 percentile. Six samples contained lead levels that exceeded those reported by Rector (1993) for fish collected from Aravaipa Creek in 1993. Interpretation of tissue concentrations of lead in fish tissue is difficult as we were unable to find a single reference that alluded to potentially toxic lead levels in whole body fish. Lead has a low bioaccumulation rate in fish muscle; liver and kidney tissues are better indicators of fish exposure to lead (Holcombe et al. 1976). Reproductive failure occurred at 50 μg/g lead in the liver and 179 μg/g in the kidney. It is unlikely that lead, at current concentrations, is adversely affecting fish health and reproduction.

Mercury was not recovered in any Aravaipa Creek fish samples at a lower limit of detection of 0.25 μg/g wet weight. Mercury concentrations are of special concern because mercury can bioconcentrate in organisms and biomagnify through the aquatic food chain. Mercury has no known biological function and its presence in the cells of living organisms is undesirable and potentially hazardous. Even if mercury were present at the 0.25 $\mu g/g$ detection limit, this concentration would be well within the ≤ 1.0 $\mu g/g$ range generally accepted as the concentration in biota from unpolluted environments (Eisler 1987). There is probably little potential for adverse affects of mercury alone on adult fish survival or reproduction. Mercury, however, when ingested in combination with other compounds and elements such as parathion, cadmium, and copper can have additive or synergistic toxic effects (Hoffman et al. 1990, Calabrese and Baldwin 1993, Eisler 1997).

Selenium was not quantified in the October 1997 fish samples from Aravaipa Creek. Selenium concentrations in samples collected by Rector (1993) exceeded the NCBP 85th percentile level and could present potential problems for fish and wildlife in the area. Quantification of selenium in future samples is recommended.

Aravaipa Creek was sampled under the best of conditions. The last major storm event that may have washed sediments from the Klondyke tailings pile into the creek occurred during the winter of 1992-93. Concentrations of arsenic, cadmium, and lead were above background in 36% (arsenic) to 96% (cadmium and lead) of the samples. Current levels of these contaminants indicate that fish from Aravaipa Creek are highly contaminated, but the effects of this contamination is difficult to quantify. The fact that seven species of native fish thrive in Aravaipa Creek suggests that current levels of contaminants are below adverse effect thresholds. However, should future storm events alter the creek flow so that more tailings enter the watercourse, adverse effects could be expected. Proactive efforts should be made to prevent further contamination of the creek.

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Table 1. Metals in individual whole body fish collected from Aravaipa Creek, Arizona, October 28, 1997

Area and species[2]	Weight (g)	Length (mm)	Element concentration (μg/g wet weight)[1]		
			Arsenic	Cadmium	Lead
NCBP 85th%[3]	NA	NA	0.27	0.05	0.22
ADEQ data[5]	NA	NA	NA	0.27	2.00
Schoolhouse					
S. sucker	217	275	0.17	0.16	3.45
S. sucker	128	235	0.17	0.29	4.06
D. sucker	56	174	0.32	0.10	1.01
D. sucker	62	185	0.32	0.07	1.98
D. sucker	47	154	0.45	0.05	1.27
D. sucker	60	171	0.35	0.05	1.37
Salazar					
Y. bullhead	50	162	<0.10	0.09	0.21
Y. bullhead	22	126	<0.10	0.04	0.26
S. sucker	222	283	0.23	0.16	0.29
S. sucker	189	271	0.21	0.24	3.02
S. sucker	184	270	0.23	0.15	2.26
S. sucker	155	247	0.20	0.37	2.50
S. sucker	144	245	0.22	0.40	5.00
D. sucker	106	229	0.41	0.06	0.64

[1] Mercury was not detected in any sample.

[2] Species: D. sucker = desert sucker, S. sucker = Sonora sucker, Y. bullhead = yellow bullhead.

[3] National Contaminant Biomonitoring Program 85th percentile (Schmitt and Brumbaugh 1990).

[4] NA = NCBP samples were not analyzed for this element.

[5] ADEQ data represent a composite sample of desert suckers collected from Aravaipa Creek during 1993 (Rector 1993).