

Health Consultation

A Determination of Inorganic Arsenic Concentrations in Fish
from the North Fork of the American Fork Canyon

AMERICAN FORK CANYON / UINATA NATIONAL FOREST

PLEASANT GROVE, UTAH COUNTY, UTAH

EPA FACILITY ID: UTD988074951

OCTOBER 9, 2003

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

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Prepared by:

Utah Department of Health
Office of Epidemiology
Environmental Epidemiology Program
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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BACKGROUND AND STATEMENT OF ISSUES

The North Fork of the American Fork Canyon is located in the Wasatch Mountains, approximately 40 miles southeast of Salt Lake City, Utah (Figure 1). The American Fork Canyon is easily accessible to the 1.4 million people estimated to live along the Wasatch front range. During the spring and summer months, an average of 2,600 vehicles per day visit the American Fork Canyon - Alpine Loop Recreation Area. Fishing is a common recreational activity in these areas.

Hatchery-reared rainbow trout are stocked yearly in the American Fork River, the Tibble Fork Reservoir, and the Silver Lake Flat Reservoir. In addition to these stocked fish, cutthroat, and brown trout are native to the American Fork River.

A 1999 analysis of metals in fish from the North Fork of the American Fork Canyon revealed a higher than average concentration of total arsenic. Therefore, a fish consumption advisory was issued in June of 2002.

As a continuation of a monitoring program to assess the potential impacts from abandoned mining operations in American Fork Canyon, personnel from the Utah Division of Wildlife Resources collected three species of fish (cutthroat, brown, and rainbow trout) for tissue sampling from the North Fork of the American Fork Canyon in August of 2002. These fish were analyzed for total arsenic, as well as inorganic arsenic. After reviewing this current data, the Environmental Epidemiology Program (EEP) of the Utah Department of Health is recommending that the fish consumption advisory for the North Fork of the American Fork Canyon issued in 2002 be removed.

METHODS

Fifteen whole trout from the North Fork of the American Fork Canyon and five control fish from the Utah State Fish Hatchery in Springville, Utah were collected and delivered to Trace Element Research Laboratory at Texas A&M University for analysis of total and inorganic arsenic. The fish were filleted, with skin on, and analyzed for moisture content and total and inorganic arsenic concentrations. Inorganic arsenic was determined using hydride generation-atomic fluorescence spectroscopy following extraction with hydrochloric acid. Total arsenic was determined by inductively coupled plasma-mass spectroscopy following wet digestion with nitric acid and hydrogen peroxide. Moisture content was reported as a percent of wet sample weight and arsenic concentrations were reported in units of parts per million¹ on a wet weight basis (Table 1).

¹ Parts per million (ppm) can also be reported as milligrams per kilogram (mg/kg). 1 ppm is equal to 1 milligram of arsenic per kilogram fresh fish weight (mg/kg).

RESULTS

Arsenic Concentrations

Total and inorganic arsenic concentrations were determined for two trout species native to the American Fork River, brown and cutthroat, and also for the transplanted rainbow trout species. Concentrations of total arsenic in brown trout ranged from 0.0978 - 0.612 milligram arsenic per kilogram fresh fish weight (mg/kg), with the percent inorganic arsenic ranging from 0.9 - 6.9 percent. The cutthroat trout displayed a narrower range of total arsenic, 0.0618 - 0.137 mg/kg, but a much greater range of percent inorganic arsenic, 1.9 - 12.5 percent. Total arsenic in rainbow trout ranged from 0.0647 - 0.244 mg/kg. Percent inorganic arsenic in rainbow trout ranged from less than 0.6 - 7.4 percent. Fish collected from the Utah State Fish Hatchery in Springville served as the control. The hatchery fish displayed higher amounts of total arsenic content, ranging from 0.413 - 0.748 mg/kg, but had a much lower percent of inorganic arsenic, ranging from 0.3 - 0.7 percent. The complete results are presented in Table 1.

Charts illustrating the mean arsenic concentrations and percentages for the trout analyzed are presented in Figures 3, 4, and 5. The hatchery trout presented the highest mean total arsenic concentration at 0.5348 ppm. Brown trout had the highest mean inorganic arsenic concentration at 0.00486 ppm. The mean percent inorganic arsenic content was comparable between the species, 3.15 percent for brown trout, 4.58 percent for rainbow, and 4.66 percent for cutthroat. The mean percent inorganic arsenic detected in the hatchery trout was 0.52 percent.

Total arsenic versus percent inorganic arsenic is presented in Figure 6. High levels of total arsenic tend to correspond with low levels of percent inorganic arsenic in both species. The relationships between the inorganic arsenic concentration and fish weight and length in the brown and cutthroat trout are graphed in Figures 7 and 8. Inorganic arsenic concentrations in cutthroat trout appear to gradually increase with weight and length.

DISCUSSION

The 1999 analysis of metals in fish from the North Fork revealed high levels of total arsenic, particularly in fish collected from site #2. Because this location is heavily fished, it was determined that the majority of the fish collected for the 2002 sampling be from this site. Five cutthroat and two rainbow trout were selected. The remaining five brown and three rainbow trout were collected a mile and a half upstream from site #2 (UDWR 2002; Figure 2).

Distinction between the types of arsenic present in the fish is essential when determining consumption limits. The organic form of arsenic is usually less harmful than the inorganic form (TOXNET 2000). Consumption limits are set when the concentration of the target analyte exceeds its corresponding screening values (SVs). SVs were developed by the United States Environmental Protection Agency (USEPA) and are used as standards by which levels of contamination can be compared. In this case, the SVs correspond to the concentration of inorganic arsenic in fish tissue that may be harmful to human health.

The 2002 fish advisory for the North Fork was based on the results of the 1999 total metals analysis. Actual inorganic arsenic concentrations were not determined. Inorganic arsenic was estimated to be 10 percent of the total arsenic. It is now evident that this percentage over estimated the actual level of inorganic arsenic in the fish tissue from this fishery. Although a level of total arsenic may be high in a sample, the amount of inorganic arsenic may be low, resulting in a much lower percentage of inorganic arsenic. Conversely, low levels of total arsenic may reveal a high percent of inorganic arsenic, even though the actual inorganic arsenic concentration is very small. The percentage of inorganic arsenic detected within a sample is variable and is dependent upon on the actual concentrations of total and inorganic arsenic. Table 2 presents a comparison between the 1999 and 2002 data.

Results of the 2002 sampling for inorganic arsenic concentrations in fish from the North Fork were compared to the USEPA's SVs. SVs can be calculated for both carcinogenic and non-carcinogenic health effects. The SVs for carcinogenic health effects from inorganic arsenic are calculated in Appendix A. Assumptions made for these calculations are as follows (details in Appendix A):

	Meal Size	Consumption Rate	Body Weight
Sport Fisher	0.227 kg	0.0175 kg/day	70 kg
Child	0.085 kg	0.007 kg/day	16 kg
Subsistence Fisher	0.227 kg	0.1424 kg/day	70 kg

The recreational sport fisher SV for carcinogenic health effects was applied in this analysis because the North Fork is used primarily by sport fishers. There is no evidence of subsistence fishing in the area. The carcinogen SV for sport fishers is 0.027 milligrams inorganic arsenic per kilogram fresh fish weight (mg/kg). The carcinogen SV for children is 0.015 mg/kg. The SV for subsistence fishers is 0.0033 mg/kg (subsistence fishers are defined as those whose diet contains a much greater portion of fish than an average sport fisher). The North Fork fish tissue analysis indicated a range of less than 0.6 - 12.5 percent of the total arsenic concentration and a concentration of inorganic arsenic ranging from less than 0.0015 – 0.0077 mg/kg.

Edible Fish Tissue	Inorganic As (mg/kg)	Screening Values for Inorganic Arsenic	
American Fork Fish			
Highest	0.0077	Sport Fishers (Adults)	0.027 mg/kg
Average	0.0066	Child	0.015 mg/kg
Hatchery Fish		Subsistence Fisher	0.0033 mg/kg
Highest	0.0032		
Average	0.0027		

Fish tissue with the highest concentration of inorganic arsenic (0.0077 mg/kg, in fish from the North Fork) proved to be much lower than the SVs for sport fishers and children. The calculated SV for subsistence fishers was exceeded by the inorganic arsenic concentration in fish from the North Fork, but not by fish from the hatchery. The EEP is unaware of any subsistence fishing in the North Fork of the American Fork Canyon, and because it is a fee area, it is unlikely that any subsistence fishers would frequent the area. Therefore, because the highest concentration of

inorganic arsenic detected does not exceed the SVs for sport fishers or children, the EEP recommends that the fish consumption advisory issued for fish from the North Fork of the American Fork Canyon be removed.

CHILD'S HEALTH CONSIDERATIONS

The Agency of Toxic Substances and Disease Registry recognizes the unique vulnerabilities of infants and children to environmental contaminants. Children are less developed and may have developmental harm from exposure that would not be experienced by a completely developed adult. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages.

The concentration of inorganic arsenic detected in fish from the North Fork of the American Fork is well below the SV for children. The highest concentration of inorganic arsenic present in trout sampled was 0.0077 mg/kg. The SV for children is 0.015 mg/kg. Consumption limits do not apply to levels that do not exceed the SV.

CONCLUSIONS

Upon further analysis of inorganic arsenic observed in fish from the North Fork of the American Fork Canyon, it is recommended that the fish consumption advisory issued in June of 2002 be removed. Average total and inorganic arsenic levels are much lower than those estimated in the 2002 advisory and pose no health hazard. Although the screening value for inorganic arsenic concentration in fish tissue for subsistence fishers has been exceeded, the screening values for sport fishers and children have not. The EEP is unaware of any subsistence fishing in the North Fork and daily use fees in the canyon make this possibility unlikely.

RECOMMENDATIONS

The Environmental Epidemiology Program recommends that the fish consumption advisory for fish caught in the North Fork of the American Fork Canyon issued in 2002 be removed. The EEP also recommends that concentrations of total and inorganic arsenic continue to be monitored, as well as levels of chromium, copper, mercury, selenium, and thallium.

PUBLIC HEALTH ACTION PLAN

The Environmental Epidemiology Program of the Utah Department of Health will continue to work with the Utah Department of Environmental Quality, the Utah County Health Department, the Utah Division of Wildlife Resources, the Utah Department of Natural Resources, and the Agency of Toxic Substances and Disease Registry to notify the public of the findings of this revised health consultation. A press release and fact sheet will be prepared to inform the public of the removal of the fish consumption advisory.

PUBLIC HEALTH ACTION PLAN (continued)

The Environmental Epidemiology Program will continue to work with all applicable agencies to perform additional research on arsenic and other metal concentrations in fish from the North Fork of the American Fork Canyon. The Environmental Epidemiology Program will adjust recommendations as new information becomes available.

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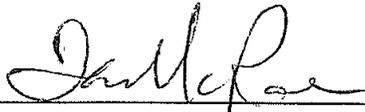
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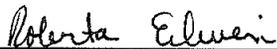
CERTIFICATION

This Health Consultation, A Determination of Inorganic Arsenic Concentrations in Fish from the North Fork of the American Fork Canyon, was prepared by the Utah Department of Health, Environmental Epidemiology Program under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the public health consultation was begun.



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The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with its findings.



Roberta Erlwein
Chief, State Program Section, DHAC, ATSDR

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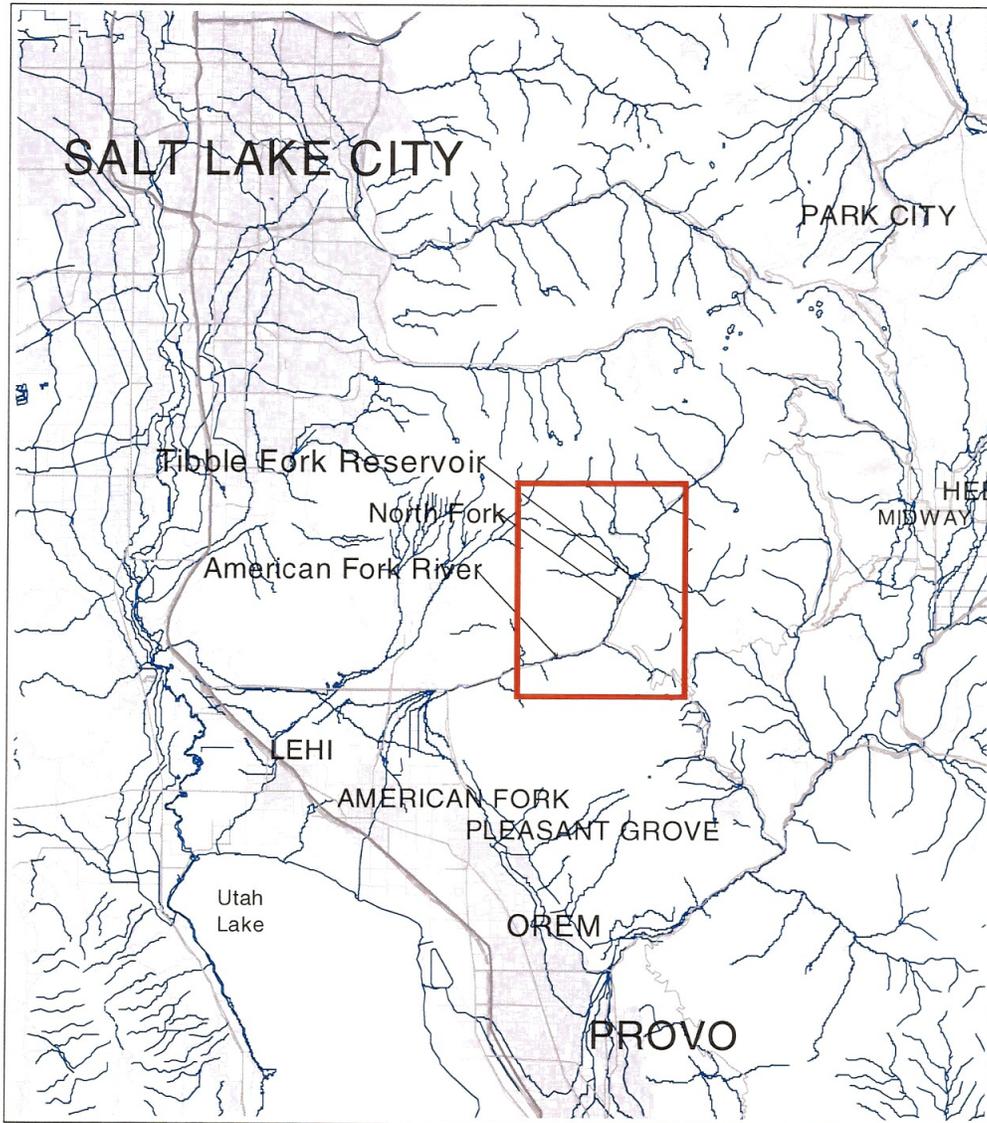
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UDOH 2002. Utah Department of Health. 2002. Health Consultation: Metals in Fish from the North Fork of the American Fork Canyon. EPA Facility ID: UTD988074951.

UDWR 2002. Fax Transmission of Field Data Form. August 19, 2002. To: Betsy Revenaugh and Kori Gunn. From: Doug Sakaguchi, Habitat Manager. Subject: *North Fork American Fork Ck – Fish samples ready to pick-up.*

FIGURES AND TABLES

Figure 1. Location map for the American Fork Canyon Recreational



-  Water Courses
-  Highways and Roads
-  Interstate
-  US Highways
-  County Highways
-  City Roads

4 0 4 8 Miles



Figure 2. Locations of Fish Sampling on the North Fork of the American Fork Canyon, 2002.



★ Trout collected for 2002 sampling were from Site 2 and 1.5 miles upstream (UDWR 2002)

Figure 3. Mean Total Arsenic Concentrations in fish from the North Fork of the American Fork Canyon (based on 2002 sampling analysis).

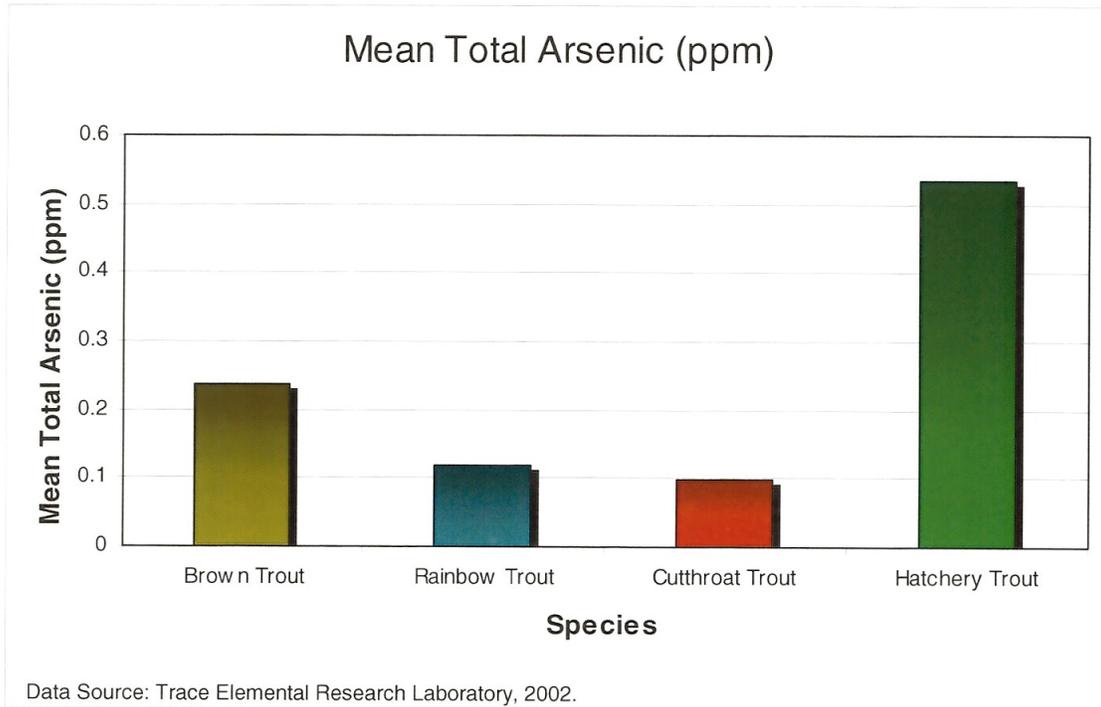


Figure 4. Mean Inorganic Arsenic Concentrations in fish from the North Fork of the American Fork Canyon (based on 2002 sampling analysis).

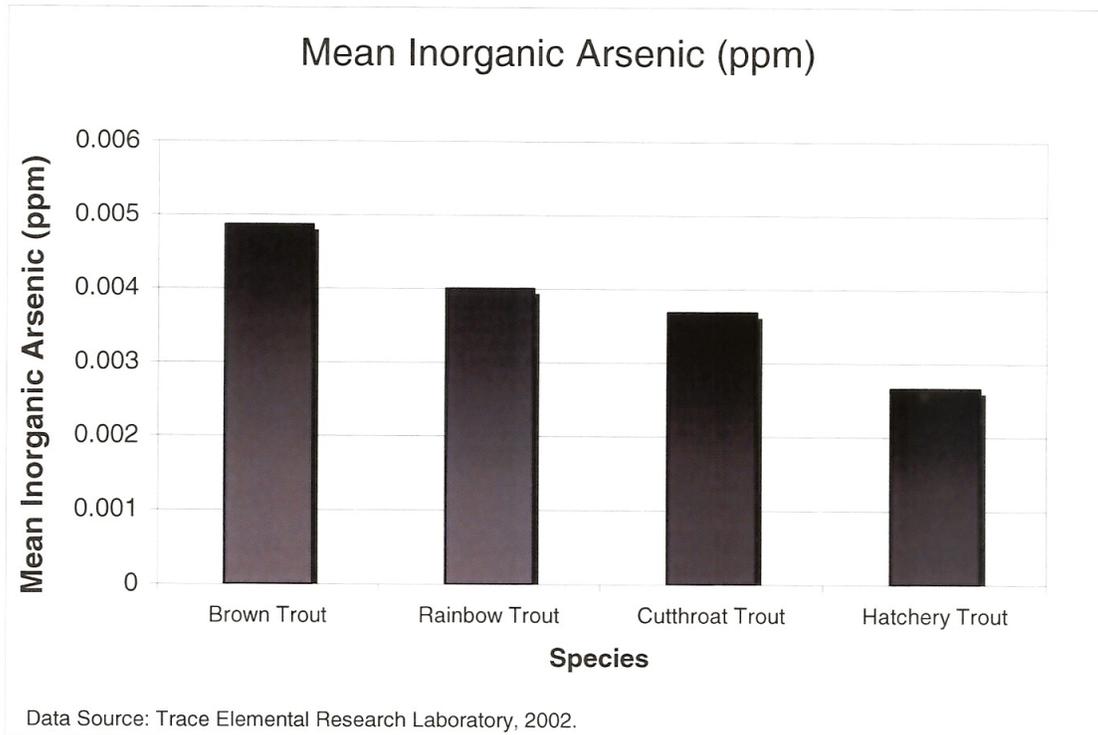


Figure 5. Mean Percent Inorganic Arsenic in fish from the North Fork of the American Fork Canyon (based on 2002 sampling analysis).

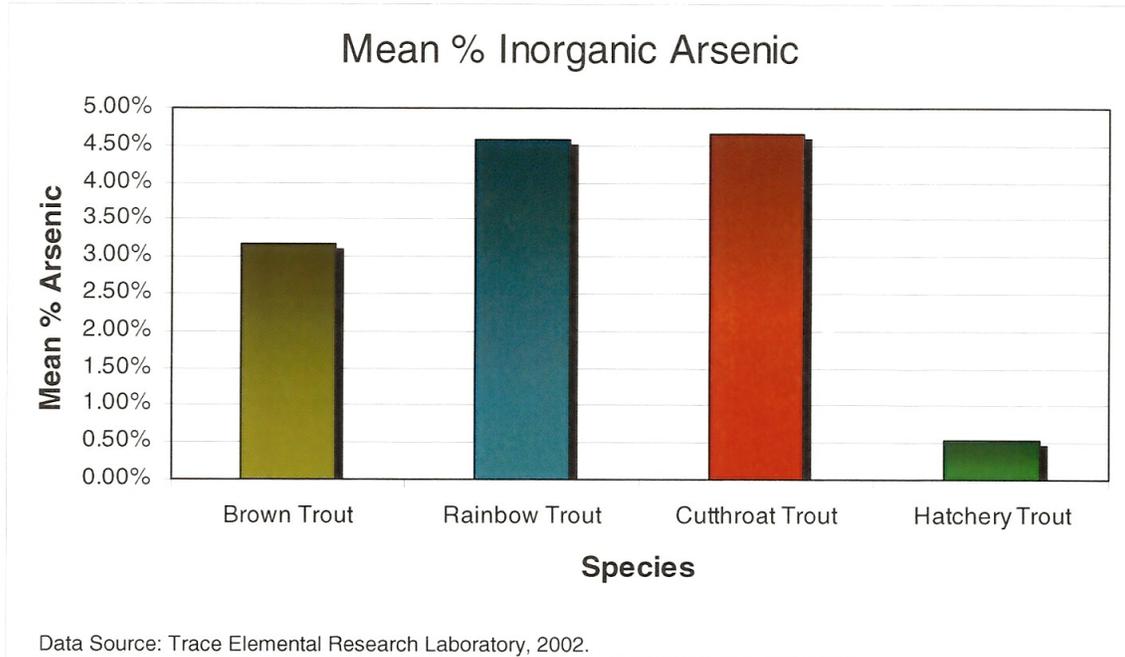


Figure 6. Total Arsenic vs. Percent Inorganic Arsenic in fish from the North Fork of the American Fork Canyon (based on 2002 sampling analysis).

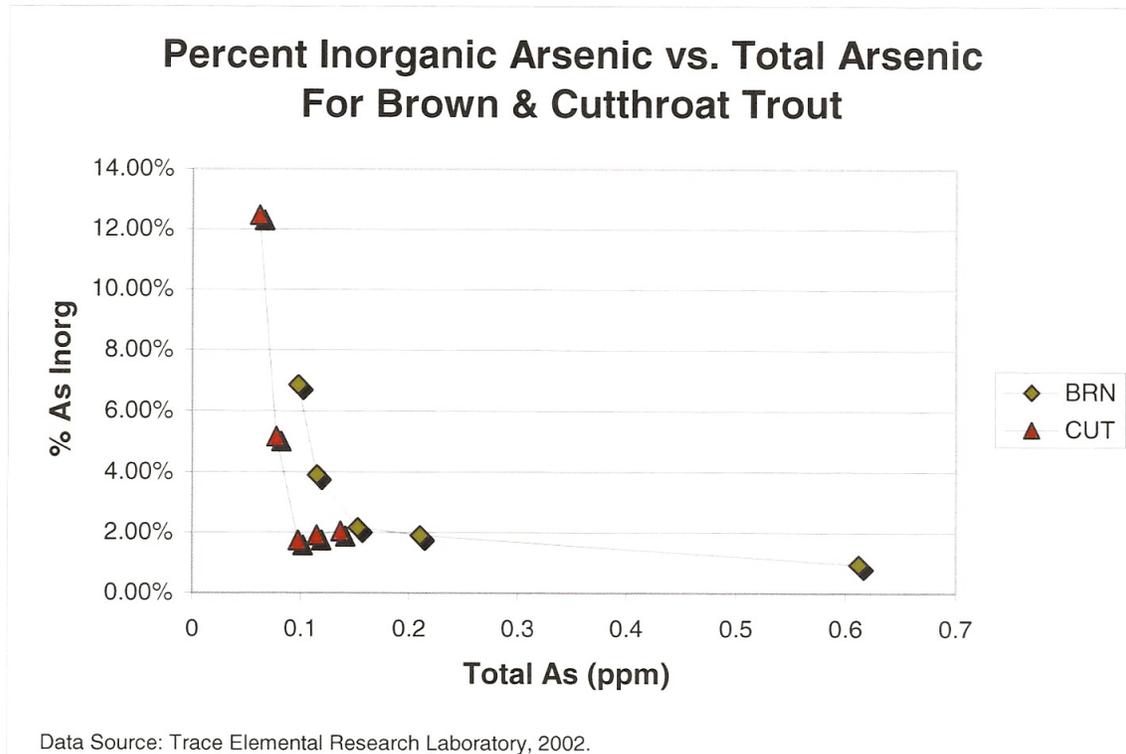


Figure 7. Inorganic Arsenic vs. Fish Weight for Brown and Cutthroat Trout from the North Fork of the American Fork Canyon (based on 2002 sampling analysis).

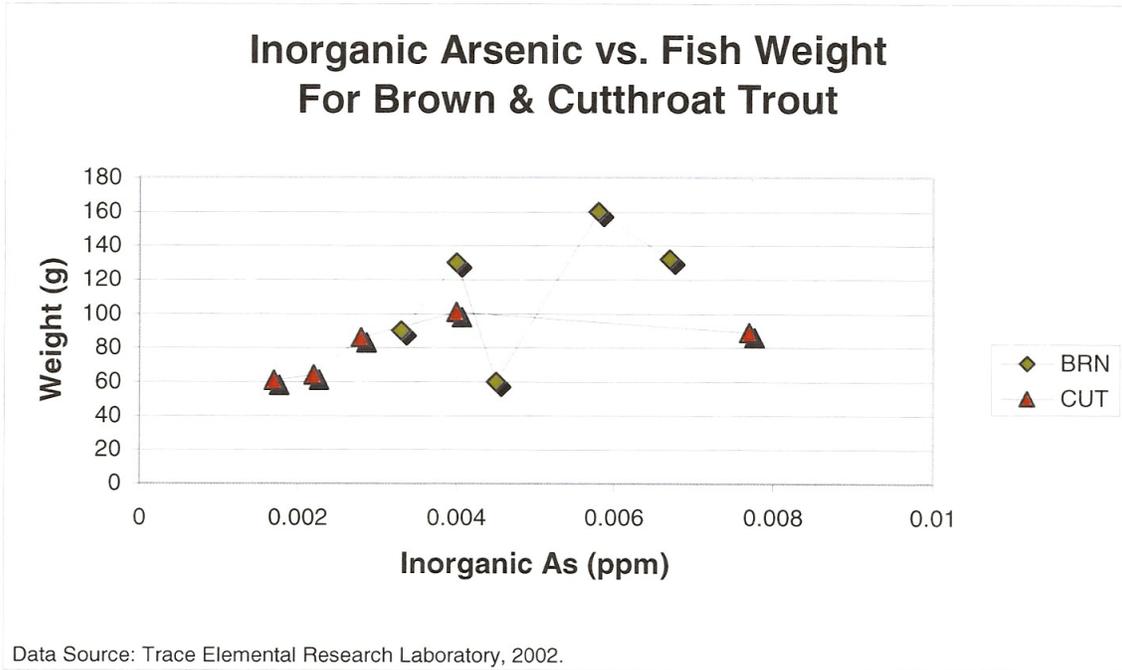


Figure 8. Inorganic Arsenic vs. Fish Length for Brown and Cutthroat Trout from the North Fork of the American Fork Canyon (based on 2002 sampling analysis).

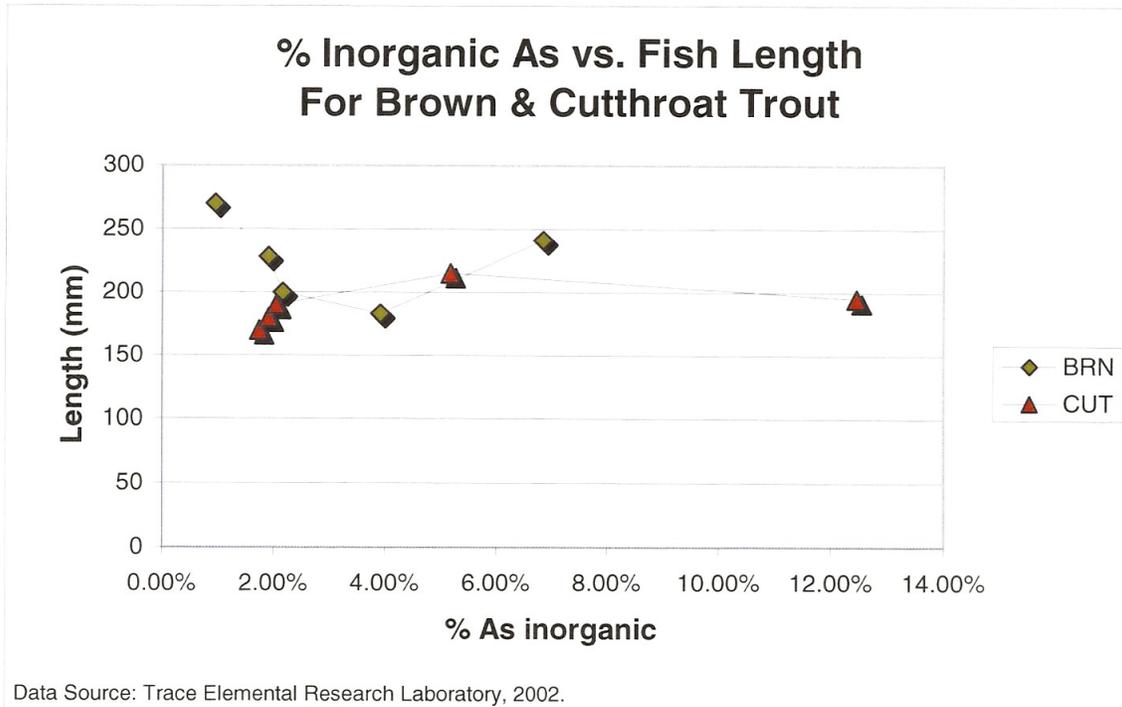


Table 1. 2002 Sampling Data for Fish from the North Fork of the American Fork Canyon

Lab #	Sample ID	Total As ppm ¹ wet weight	Inorganic As ppm wet weight	% Inorganic As	% Moisture
T2068-001	BRN 1	0.153	0.0033	2.2%	78.6
T2068-002	BRN 2	0.210	0.004	1.9%	76.3
T2068-003	BRN 3	0.115	0.0045	3.9%	78
T2068-004	BRN 4	0.612	0.0058	0.9%	79.5
T2068-005	BRN 5	0.0978	0.0067	6.9%	77.4
T2068-006	RBT 1	0.0997	0.0074	7.4%	75.2
T2068-007	RBT 2	0.0673	0.0046	6.8%	75
T2068-008	RBT 3	0.0647	0.0033	5.1%	74.2
T2068-009	RBT 4	0.109	0.0032	2.9%	76.3
T2068-010	RBT 5	0.244	<0.0015	<0.6	78
T2068-011	CUT 1	0.115	0.0022	1.9%	76.8
T2068-012	CUT 2	0.0774	0.004	5.2%	76.4
T2068-013	CUT 3	0.0977	0.0017	1.7%	77.7
T2068-014	CUT 4	0.0618	0.0077	12.5%	76.6
T2068-015	CUT 5	0.137	0.0028	2.0%	77.2
T2068-016	RBT Hatchery 1	0.498	0.0032	0.6%	75.9
T2068-017	RBT Hatchery 2	0.748	0.0027	0.4%	76
T2068-018	RBT Hatchery 3	0.413	0.0026	0.6%	72.5
T2068-019	RBT Hatchery 4	0.485	0.0032	0.7%	75.2
T2068-020	RBT Hatchery 5	0.530	0.0016	0.3%	74.3

¹ppm = parts per million; equivalent to milligrams per kilogram (mg/kg).

Data Source: Trace Elemental Research Laboratory, 2002.

Table 2. Comparison of 2002 and 1999 Sampling Data for Fish from the North Fork of the American Fork Canyon.

Edible Fish Tissue	2002		1999	
	Total As (mg/kg)	Inorganic As (mg/kg)	Total As (mg/kg)	Inorganic As ¹ (mg/kg)
American Fork Fish				
Average	0.151	0.0066	0.272	0.0272
High	0.612	0.0077	0.688	0.0688
Low	0.0618	< 0.0015	0.067	0.0067
Hatchery Fish				
Average	0.5348	0.0267	N/A	N/A
High	0.748	0.0032	N/A	N/A
Low	0.413	0.0016	N/A	N/A

¹Inorganic arsenic was estimated as 10% of total arsenic. This estimate was applied because inorganic arsenic concentrations were not actually evaluated. This estimation was much higher than the actual percent of inorganic arsenic determined in the 2002 analysis.

APPENDICES

Appendix A

Screening Value Calculations (EPA 2000a)

For Carcinogenic Health Effects

$$SV_c = [(RL/SF) * BW] / CR$$

SV_c = Screening value for a carcinogen (in mg/kg or ppm)

RL = Maximum acceptable risk level (dimensionless)

SF = Oral slope factor (mg/kg/d)⁻¹

BW = Mean body weight of the general population or subpopulation of concern (kg).

CR = Mean daily consumption rate of the species of interest by the general population or by the subpopulation of concern averaged over a 70-yr lifetime (in kg/day)

The arsenic SV_c was calculated based on the oral slope factor for inorganic arsenic, the most toxic form of arsenic.

For a sport fisher, the calculation looks like this:

Where:

RL = 1/100,000

SF = 1.5 (mg/kg/d)⁻¹

BW = 70 kg

CR = 0.0175 kg/day

therefore,

SV_c = 0.027 mg/kg

For a subsistence fisher:

Where:

RL = 1/100,000

SF = 1.5 (mg/kg/d)⁻¹

BW = 70 kg

CR = 0.1424 kg/day

Therefore,

SV_c = 0.0033 mg/kg

For a child:

Where:

RL = 1/100,000

SF = 1.5 (mg/kg/d)⁻¹

BW = 16 kg

CR = 0.007 kg/day

therefore,

SV_c = 0.015 mg/kg

Appendix B

For More Information

For more information on health issues -	John Contreras Utah Department of Health 801-538-6191 Tamra Jewkes Utah Department of Health 801-538-6191 Dave Johnson Utah County Health Department 801-370-4525 Jay Pitkin or Dave Wham Utah Department of Environmental Quality Salt Lake City, Utah (801) 538-6052
For more information on mining wastes and National Forest System Lands -	Ted Fitzgerald Uinta National Forest 801-342-5100 Robert Easton Uinta National Forest Pleasant Grove Ranger District 801-785-3563
For more information of fishery issues -	Doug Sakaguchi or Don Wiley Utah Division of Wildlife Resources Central Region 801-491-5678