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RADIONUCLIDE CONCENTRATIONS IN BED SEDIMENT AND FISH TISSUE WITHIN THE RIO GRANDE DRAINAGE BASIN

by

J.L. Booher, P.R. Fresquez, L.F. Carter, B.M. Gallaher, M.A. Mullen

ABSTRACT

In 1992-93, Los Alamos National Laboratory collaborated with the U.S. Geological Survey in an effort to characterize radionuclide concentrations in bed sediment and fish tissue within the Rio Grande drainage basin from Colorado to Texas. Bed sediment was sampled from 18 locations for cesium (^{137}Cs), tritium (^{3}H), strontium (^{90}Sr), plutonium (^{238}Pu and ^{239}Pu), americium (^{241}Am), total uranium (^{tot}U) and alpha, beta, and gamma activity. Fish tissue was sampled from 12 locations for ^{137}Cs, ^{90}Sr, ^{238}Pu, ^{239}Pu, and ^{tot}U.

INTRODUCTION

In 1992-93, Los Alamos National Laboratory (LANL) collaborated with the U.S. Geological Survey (USGS) to characterize radionuclide concentrations in bed sediment and fish tissue within and along the length of the Rio Grande drainage basin (and associated tributaries). This collaboration was an adjunct project to USGS's National Water Quality Assessment (NAWQA) program (Leahy et al., 1993, Ellis et al., 1993). Typically, the NAWQA program does not include an analysis of radionuclide concentrations.

Radionuclides within the Rio Grande drainage basin may originate from natural and anthropogenic sources. Natural radionuclides are either primordial or cosmogenic. Primordial radioisotopes of relevance to this study include uranium. Tritium (^{3}H), a cosmogenic radionuclide, can be produced through nuclear reactions between cosmic rays and nuclei in the atmosphere, soil, and water (Klement, 1982). Anthropogenic sources of environmental radiation include global fallout from nuclear weapons testing, the burn-up of satellite power sources in the atmosphere (Perkins and Thomas, 1980), and in some cases the release of treated radioactive waste effluents from nuclear weapons research and testing facilities like LANL (Fresquez et al., 1994).

This paper reports the occurrence and distribution of selected radionuclides (^{137}Cs, ^{3}H, ^{90}Sr, ^{238}Pu, ^{239}Pu, ^{241}Am, ^{tot}U and alpha, beta, and gamma activity) in bed sediment and fish tissue collected by the USGS in 1992-93 at sampling sites associated with the NAWQA program along the Rio Grande from southern Colorado to El Paso, Texas. Also, this study reports radionuclide concentrations in fish collected at Abiquiu Reservoir (Rio Chama), Cochiti Reservoir, and the Rio Grande near San Ildefonso Pueblo; these locations were independently monitored as a part of the Environmental Surveillance Program at LANL but were added to this report for completeness.

MATERIALS AND METHODS

The Rio Grande Valley encompasses about 45,000 square miles in Colorado, New Mexico, and Texas (Figure 1), and the river traverses approximately 750 stream miles from its headwaters in the San Juan

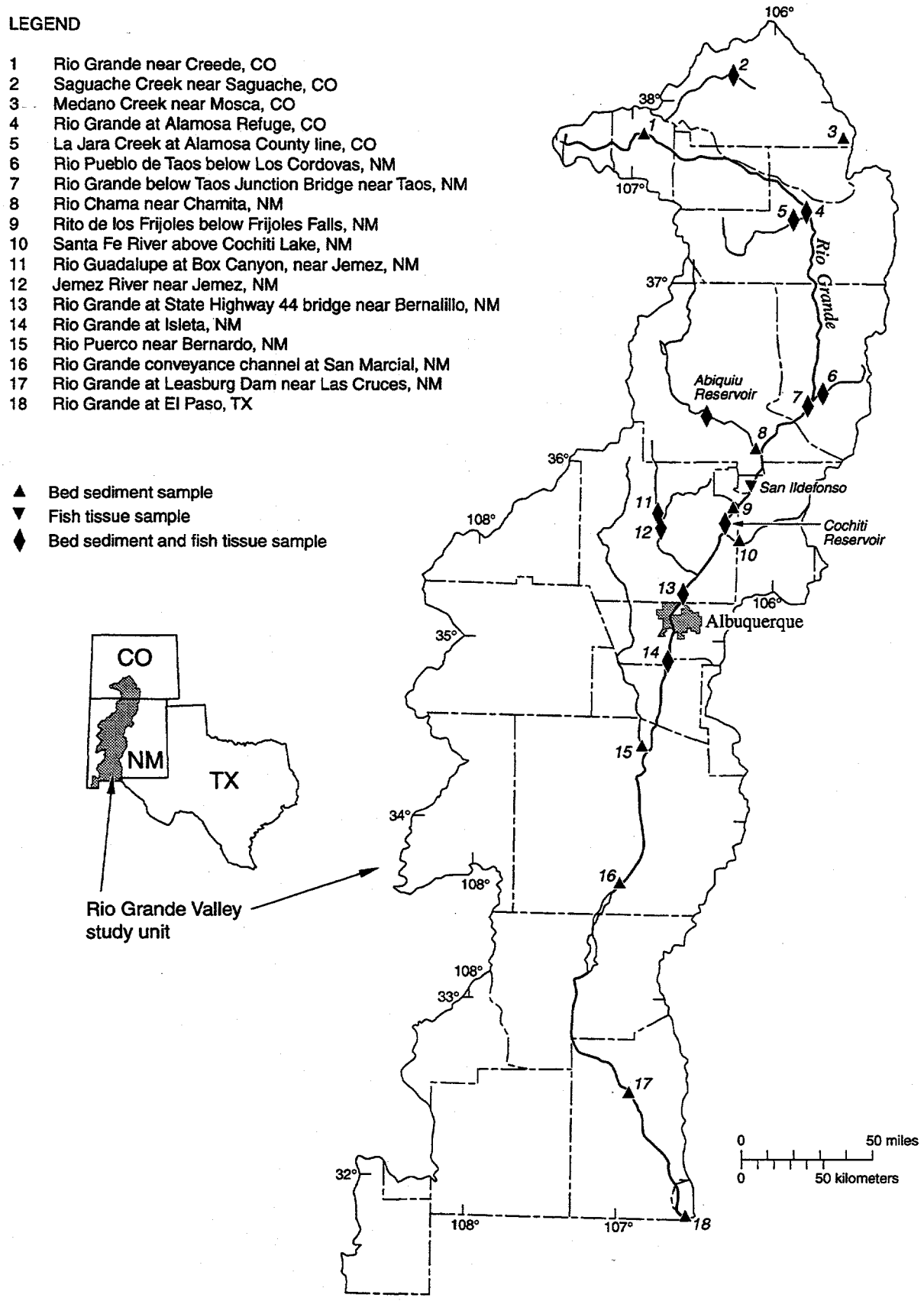

Figure 1. Rio Grande Valley study unit and collection points of sediments and fish.

Mountains in southwestern Colorado to El Paso, Texas. Bed sediment was collected by USGS personnel at 18 sites within the Rio Grande drainage basin between September 1992 and March 1993 (Table 1) (Carter 1997). The sediment samples were collected from depositional areas near streambanks, downstream from obstacles such as large boulders and islands, or wherever fine sediments were deposited. Sampling was confined to the upper two centimeters of sediment. Sediment field processing included two sets of samples: the first set represented sediment (wet) sieved through a 2.0-millimeter stainless steel sieve and was analyzed for ^{137}Cs, ^{3}H, and ^{90}Sr, and alpha, beta, and gamma activity, and the second set, which was sieved through a 63-micrometer sieve, was analyzed for ^{241}Am, ^{238}Pu and ^{239}Pu, and ^{tot}U.

All radionuclide bed sediment analyses were conducted by the Inorganic Trace Analysis group (CST-9) at LANL, with the exception of ^{tot}U. LANL radionuclide analysis procedures are detailed by Gautier, et al. (1987). Total uranium analysis, on the other hand, was performed by a USGS NAWQA laboratory in Denver, Colorado. The analytical method of determination for ^{tot}U is given by Timme (1995). All radionuclides, with the exception of ^{3}H, were expressed in dry weight concentrations. Tritium was expressed as activity per liter of sediment moisture.

Fish tissue samples were collected at 12 sites within the Rio Grande drainage basin (Table 1). Fish from Abiquiu Reservoir, Cochiti Reservoir, and the Rio Grande near San Ildefonso Pueblo were collected by LANL personnel in accordance with LANL's Environmental Surveillance program in June, 1993 (LANL, 1995). Hook and line, trot line, or gill nets were used to capture the fish. USGS personnel collected all additional Rio Grande fish samples from a 150- to 400-meter length of stream by electroshocking between September 1992 and March 1993.

All whole-body fish samples were frozen and submitted to LANL for pre-analysis preparation. Fish samples were separated into two distinct samples: 1) muscle (and associated skeleton) and 2) viscera (and associated head and tail). Approximately 1000 g of either wet muscle or viscera were placed into tarred one-liter beakers and weighed. The beaker contents were oven dried at 80 °C for 120 hours, then weighed and ashed at 500 °C for 120 hours. The sample ash was weighed, pulverized, and homogenized before it was submitted to the CST-9 laboratory for analysis of ^{137}Cs, ^{90}Sr, ^{238}Pu, ^{239}Pu, and ^{tot}U. All methods of radiochemistry have been described previously (Salazar, 1984). Results are reported on an oven dry weight basis.

RESULTS

Radionuclide data for bed sediment collected within the Rio Grande drainage basin are located in Table 2. Both duplicate and replicate samples have been reported. Duplicate samples are represented by different sample numbers at the same sampling location. Replicate samples (the analysis of the same sample number more than once) and their analytical uncertainties have been averaged. These data, with the exception of ^{tot}U analysis, are stored in the Chemical Science and Technology Division's Laboratory Information Management System (CST LIMS) for LANL. Total U analysis and the corresponding QC data for field replicate samples are stored in the USGS New Mexico District National Water Information System data base. Fish tissue radionuclide data are located in Table 3. These data are likewise stored in the CST LIMS data base. Measurements of radiochemical samples at LANL require that analytical or instrumental backgrounds be subtracted to obtain net values. Thus, net values are sometimes obtained that are lower than the minimum detection limit of the utilized analytical technique. This is why individual measurements reported in Tables 2 and 3 are sometimes expressed in values of negative numbers (LANL, 1995).

Table 1. 1992-93 Rio Grande Drainage Basin Sediment Sampling Locations and Fish Collected.

Sampling Locations	Fish Taxa
Rio Grande near Creede, CO	none collected
Saguache Creek near Saguache, CO	White sucker (*Catostomus commersoni*)
Medano Creek near Mosca, CO	none collected
Rio Grande at Alamosa Refuge, CO	common carp (*Cyprinus carpio*)
La Jara Creek at Alamosa County line, CO	common carp
Rio Pueblo de Taos below Los Cordovas, NM	white sucker
Rio Grande below Taos Junction Bridge near Taos, NM	white sucker
Rio Chama near Chamita, NM	none collected
Abiquiu Reservior, NM	Channel catfish (*Ictalurus punctatus*) common carp brown trout (*Salmo trutta*) rainbow trout (*Salmo gairdneri*) walleye (*Stizostedion vitreum*)
Rio Grande at San Ildefonso Pueblo, NM	bass (*Micropterus salmoides*) channel catfish common carp brown trout rainbow trout white sucker
Rito de los Frijoles below Frijoles Falls, NM	none collected
Santa Fe River above Cochiti Reservoir, NM	none collected
Cochiti Reservoir, NM	channel catfish common carp white crappie (*Pomoxis annularis*) white sucker
Rio Guadalupe at Box Canyon, near Jemez Springs, NM	brown trout
Jemez River near Jemez Springs, NM	white sucker
Rio Grande at State Highway 44 bridge near Bernalillo, NM	common carp
Rio Grande at Isleta, NM	common carp
Rio Puerco near Bernardo, NM	none collected
Rio Grande conveyance channel at San Marcial, NM	none collected
Rio Grande at Leasburg Dam, near Las Cruces, NM	none collected
Rio Grande at El Paso, TX	none collected

Table 2. Radionuclide Concentrations (+/- one counting uncertainy) in Bed Sediment Collected along the Length of the Rio Grande Drainage Basin.[1, 2, 3]

Location	Sample Number	α pCi/g	β pCi/g	γ pCi/g	^{3}H pCi/L	^{tot}U[4] µg/g	^{137}Cs 10^{-2} pCi/g	^{238}Pu 10^{-3} pCi/g	^{239}Pu 10^{-3} pCi/g	^{241}Am 10^{-3} pCi/g	^{90}Sr pCi/g
Rio Grande near Creede, CO	92.29768	11.0 (3.0)	4.9 (0.5)	17.0 (2.0)	100.0 (300.0)	5.8	17.10 (4.13)	NA	NA	NA	NA
	92.29773	NA[5]	NA	NA	NA		NA	1.0 (1.0)	10.0 (2.0)	2.4 (2.1)	0.1 (0.3)
Saguache Creek near Saguache, CO	92.29769	15.0 (3.0)	4.6 (0.5)	10.0 (1.0)	400.0 (300.0)	4.7	17.10 (4.21)	0.3 (0.1)	4.3 (0.4)	0.8 (1.6)	NA
	92.29774[6]	NA	NA	NA	NA		NA	0.0 (3.0)	5.0 (2.0)	2.0 (30.0)	0.10 (0.30)
Medano Creek near Mosca, CO	92.29771	6.0 (1.0)	2.5 (0.3)	12.0 (1.0)	0.0 (300.0)	7.4	8.30 (3.42)	0.2 (0.1)	1.45 (0.2)	4.4 (2.9)	NA
	92.29776	NA	NA	NA	NA		NA	14.0 (3.0)	27.0 (4.0)	5.0 (2.7)	0.20 (0.20)
Rio Grande at Alamosa Refuge, CO	92.29770	6.0 (1.0)	3.1 (0.4)	7.5 (1.0)	-200.0 (300.0)	3.7	6.44 (3.01)	0.3 (0.1)	0.7 (0.1)	4.5 (2.3)	NA
	92.29775	NA	NA	NA	NA			0.0 (3.0)	3.0 (2.0)	0.0 (0.0)	0.50 (0.60)
La Jara Creek at Alamosa County line, CO	92.29772	13.0 (3.0)	3.3 (0.4)	9.0 (1.0)	100.0 (300.0)	3.2	8.82 (3.28)	0.1 (0.1)	3.0 (0.3)	6.7 (3.4)	NA
	92.29777	NA	NA	NA	NA		NA	0.0 (3.0)	4.0 (2.0)	0.0 (0.0)	0.10 (0.20)
Rio Pueblo de Taos below Los Cordovas, NM	92.32987	17.0 (4.0)	4.0 (0.5)	6.3 (0.9)	0.0 (300.0)	NA	6.39 (3.21)	9.0 (20.0)	3.0 (20.0)	0.0 (0.0)	0.10 (0.20)
Rio Grande below Taos Junction Bridge near Taos, NM	92.32988	5.0 (1.0)	5.2 (0.6)	4.1 (0.7)	0.0 (300.0)	4.1	7.54 (3.20)	0.0 (20.0)	8.0 (20.0)	0.0 (0.0)	0.90 (0.20)
Rio Chama near Chamita, NM	93.03835	3.9 (0.9)	3.0 (0.4)	3.0 (0.8)	300.0 (300.0)	4.2	11.80 (3.50)	3.0 (30.0)	4.0 (30.0)	0.0 (0.0)	0.20 (0.20)

Table 2 (Cont.).

Abiquiu Reservoir, NM		3.0 (1.0)	2.0 (0.0)	1.0 (0.4)	600.0 (300.0)	1.6 (0.2)	10.00 (10.00)	0.1 (0.0)	0.2 (0.0)	-38.0 (68.0)	0.10 (0.10)
Rito de los Frijoles below Frijoles Falls, NM	92.32991	2.8 (0.7)	5.3 (0.6)	7.0 (0.9)	-100.0 (300.0)	5.6	16.80 (4.35)	1.0 (20.0)	12.0 (20.0)	0.0 (0.0)	0.20 (0.20)
Santa Fe River above Cochiti Lake, NM	92.32989	0.0 (0.0)	0.0 (0.0)	7.1 (0.9)	0.0 (300.0)	6.2	19.70 (4.53)	1.0 (20.0)	8.0 (20.0)	0.0 (0.0)	0.20 (0.20)
Cochiti Reservoir, NM		16.0 (4.0)	7.0 (1.0)	4.1 (0.5)	0.0 (300.0)	4.6 (0.5)	50.00 (10.00)	5.5 (0.4)	37.7 (1.1)	-22.8 (88.0)	0.30 (0.20)
Rio Guadalupe at Box Canyon, near Jemez, NM	92.32990	24.0 (5.0)	7.8 (0.8)	7.2 (0.9)	0.0 (300.0)	5.0	56.40 (9.39)	1.0 (20.0)	16.0 (20.0)	0.0 (0.0)	0.10 (0.20)
Jemez River near Jemez, NM	92.32986	50.0 (10.0)	23.0 (2.0)	10.0 (1.0)	0.0 (300.0)	3.8	117.0 (18.3)	0.0 (20.0)	5.0 (20.0)	0.0 (0.0)	0.10 (0.20)
Rio Grande at State Highway 44 Bridge, near Bernalillo, NM	93.03836	8.0 (2.0)	5.1 (0.6)	5.6 (0.8)	100.0 (300.0)	4.1	13.0 (3.67)	5.0 (30.0)	5.0 (30.0)	0.0 (0.0)	0.20 (0.20)
Rio Grande at Isleta, NM	93.03837	6.0 (1.0)	4.3 (0.5)	5.4 (0.7)	200.0 (300.0)	4.0	-2.2 (2.19)	5.0 (30.0)	4.7 (20.0)	0.0 (0.0)	0.00 (0.20)
Rio Puerco near Bernardo, NM	93.03833	6.0 (1.0)	4.1 (0.5)	0.6 (0.6)	-100.0 (300.0)	4.3	7.33 (3.16)	2.0 (30.0)	1.0 (30.0)	0.0 (0.0)	-0.10 (0.20)
Rio Grande conveyance channel at at San Marcial, NM	93.03834	8.0 (2.0)	4.9 (0.6)	6.6 (0.9)	200.0 (300.0)	4.2	12.0 (3.61)	10.0 (30.0)	3.0 (30.0)	0.0 (0.0)	0.10 (0.20)
Rio Grande at Leasburg Dam, near Las Cruces, NM	93.03838	NA	NA	NA	NA	5.5	NA	2.0 (30.0)	3.0 (30.0)	0.0 (0.0)	NA
Rio Grande at El Paso, TX	93.03832	3.3 (0.9)	2.8 (0.3)	1.5 (0.6)	0.0 (300.0)	3.5	8.77 (3.39)	2.0 (30.0)	2.0 (30.0)	0.0 (0.0)	0.10 (0.20)

[1] +/- σ one counting uncertainty are the uncertainty in the analytical results at the 65% confidence level.
[2] Activities/concentrations reported on a dry weight basis, with the exception of ^{3}H (activity per liter sediment moisture).
[3] Average values of replicate samples reported.
[4] USGS performed all uranium analyses. Analytical uncertainties are not included for µg/g radionuclide measurements.
[5] Not Analyzed.
[6] Samples 92.29744, 92.29775, and 92.29777 were analyzed by leach methods using 100-gram aliquots, and not by standard methods.

Table 3. Radionuclide Concentrations (+/- one counting uncertainty) in Game and Nongame Fish Collected Along the Rio Grande Drainage Basin from Southern Colorado to Central New Mexico, 1992-93.

Sample Type	Sample Number	^{90}Sr 10^{-2} pCi/dry g	^{137}Cs 10^{-2} pCi/dry g	^{tot}U ng/dry g	^{238}Pu 10^{-5} pCi/dry g	^{239}Pu 10^{-5} pCi/dry g
			COLORADO			
			Saguache Creek near Saguache			
Suckers						
Muscle	94.03157	3.4 (1.7)	-0.83 (1.27)	25.33 (5.78)	-17.0 (510.0)	0.0 (340.0)
Muscle	94.03158	3.9 (1.3)	0.33 (1.68)	13.26 (3.51)	0.0 (390.0)	0.0 (260.0)
Viscera	94.03159	5.6 (2.8)	0.21 (0.92)	72.80 (8.12)	28.0 (840.0)	56.0 (560.0)
			Rio Grande at Alamosa Refuge			
Carp						
Muscle	94.03160	5.6 (1.4)	-0.24 (10.60)	16.66 (6.15)	0.0 (420.0)	0.0 (280.0)
Muscle	94.03161	4.8 (1.6)	-1.17 (1.10)	17.76 (4.00)	0.0 (480.0)	0.0 (320.0)
Muscle	94.03165	2.6 (1.3)	-1.88 (1.45)	27.82 (3.65)	-13.0 (390.0)	0.0 (260.0)
Viscera	94.03162	5.6 (2.8)	-0.64 (1.00)	26.60 (8.70)	28.0 (840.0)	0.0 (560.0)
Viscera	94.03163	2.4 (2.4)	-1.11 (1.05)	44.40 (3.85)	0.0 (720.0)	0.0 (480.0)
Viscera	94.03164	2.6 (1.3)	-2.07 (1.15)	33.15 (1.70)	13.0 (390.0)	0.0 (260.0)
			La Jara Creek at Alamosa County Line			
Carp						
Muscle	94.03166	3.8 (1.9)	-3.10 (1.55)	15.77 (1.50)	0.0 (570.0)	0.0 (380.0)
Viscera	94.03167	2.2 (2.2)	-3.72 (2.30)	44.88 (11.20)	0.0 (660.0)	0.0 (440.0)
			NEW MEXICO			
			Rio Pueblo de Taos below Las Cordovas			
Suckers						
Muscle	94.03175	0.0 (0.7)	-0.57 (0.65)	3.43 (0.65)	7.0 (210.0)	0.0 (140.0)
Viscera	94.03174	1.7 (1.7)	-1.24 (1.15)	9.35 (2.55)	0.0 (510.0)	0.0 (340.0)

Table 3 (Cont.).

Rio Grande below Taos Junction Bridge near Taos

Suckers						
Muscle	94.03172	3.3 (1.1)	-5.85 (5.85)	2.97 (0.90)	11.0 (330.0)	-11.0 (220.0)
Viscera	94.03173	1.9 (1.9)	-9.40 (5.75)	17.10 (1.90)	0.0 (570.0)	19.0 (380.0)

Abiquiu Reservoir on the Rio Chama

Trout						
Muscle	93.15891	4.2 (1.4)	-0.01 (1.30)	2.10 (0.30)	0.0 (42.0)	0.0 (28.0)
Muscle	95.15892	2.2 (1.1)	NA	1.65 (0.35)	0.0 (33.0)	22.0 (22.0)
Muscle	95.15893	0.7 (0.7)	-0.69 (0.95)	1.26 (0.15)	0.0 (21.0)	0.0 (14.0)
Muscle	93.15894	0.7 (0.7)	-1.83 (1.05)	6.23 (1.05)	0.0 (21.0)	0.0 (14.0)
Muscle	93.15895	1.8 (0.9)	0.69 (1.00)	2.79 (0.45)	0.0 (27.0)	9.0 (18.0)
Muscle	93.15896	6.0 (1.5)	1.50 (1.30)	3.60 (0.45)	0.0 (45.0)	15.0 (30.0)
Walleye						
Muscle	93.15897	9.1 (1.3)	0.52 (1.05)	9.75 (1.45)	0.0 (39.0)	0.0 (26.0)
Muscle	93.15898	2.0 (1.0)	0.84 (0.90)	0.30 (0.10)	0.0 (30.0)	0.0 (20.0)
Muscle	93.15899	2.8 (1.4)	2.04 (1.40)	1.54 (0.40)	0.0 (42.0)	0.0 (28.0)
Carp						
Muscle	93.15878	9.8 (1.4)	0.75 (1.30)	5.46 (0.70)	14.0 (42.0)	0.0 (28.0)
Muscle	93.15879	6.0 (1.2)	1.14 (1.30)	6.36 (1.30)	0.0 (36.0)	0.0 (24.0)
Muscle	93.15881	7.8 (1.3)	1.30 (1.25)	4.42 (0.80)	0.0 (39.0)	0.0 (26.0)
Muscle	93.15882	2.4 (1.2)	0.87 (1.35)	9.48 (1.20)	0.0 (36.0)	0.0 (24.0)
Muscle	93.15883	6.6 (1.1)	1.85 (1.25)	5.28 (1.30)	11.0 (33.0)	0.0 (22.0)
Muscle	93.15884	7.2 (1.2)	-0.18 (1.10)	3.96 (0.95)	12.0 (36.0)	0.0 (24.0)
Catfish						
Muscle	93.15885	2.7 (0.9)	0.40 (1.20)	4.05 (0.45)	27.0 (27.0)	9.0 (18.0)
Muscle	93.15886	3.6 (0.9)	1.25 (1.25)	1.98 (0.20)	9.0 (27.0)	9.0 (18.0)
Muscle	93.15887	2.8 (0.7)	0.33 (1.15)	1.75 (0.35)	0.0 (21.0)	0.0 (14.0)
Muscle	93.15888	2.1 (0.7)	NA	1.61 (0.15)	0.0 (21.0)	0.0 (14.0)
Muscle	93.15889	2.7 (0.9)	-0.09 (1.00)	2.97 (0.70)	18.0 (27.0)	9.0 (18.0)
Muscle	93.15890	2.4 (0.8)	1.57 (1.25)	4.48 (0.50)	0.0 (24.0)	8.0 (16.0)

Table 3 (Cont.).

Rio Grande at San Ildefonso Pueblo

Trout/Bass						
Muscle	93.15900	3.6 (1.2)	1.51 (1.30)	11.76 (2.65)	12.0 (36.0)	12.0 (24.0)
Viscera	94.08608	3.6 (7.2)	NA	106.20 (27.00)	117.0 (270.0)	135.0 (180.0)
Catfish						
Muscle	93.15901	1.2 (0.6)	0.47 (1.15)	10.08 (0.25)	6.0 (18.0)	0.0 (24.0)
Viscera	94.08609	2.0 (0.6)	NA	31.20 (20.50)	6.0 (6.0)	2.0 (40.0)
Carp						
Muscle	93.15902	4.4 (1.1)	0.76 (1.15)	15.40 (2.20)	0.0 (33.0)	0.0 (22.0)
Sucker						
Muscle	93.15903	8.4 (1.4)	0.49 (1.15)	16.52 (2.50)	0.0 (42.0)	14.0 (28.0)

Cochiti Reservoir on the Rio Grande

Crappie						
Muscle	93.15869	17.1 (1.9)	-5.19 (1.65)	3.80 (0.40)	0.0 (57.0)	0.0 (38.0)
Muscle	93.15870	14.4 (1.6)	1.53 (1.75)	2.08 (0.50)	0.0 (48.0)	0.0 (32.0)
Muscle	93.15871	8.0 (1.6)	-0.05 (1.40)	0.32 (1.90)	0.0 (48.0)	0.0 (32.0)
Muscle	93.15873	9.0 (1.8)	-0.38 (1.50)	0.90 (3.40)	0.0 (54.0)	0.0 (36.0)
Muscle	93.15874	3.4 (1.7)	-3.23 (1.60)	20.74 (2.90)	0.0 (51.0)	0.0 (34.0)
Muscle	93.15875	5.1 (1.7)	0.68 (1.50)	4.59 (0.50)	0.0 (51.0)	17.0 (34.0)
Muscle	93.15876	6.8 (1.7)	-0.19 (1.60)	5.78 (0.50)	0.0 (51.0)	0.0 (34.0)
Muscle	93.15877	10.0 (2.0)	1.68 (2.05)	5.60 (1.20)	40.0 (60.0)	20.0 (40.0)
Catfish						
Muscle	93.15856	2.1 (0.7)	-0.06 (1.15)	13.23 (1.20)	0.0 (21.0)	0.0 (14.0)
Muscle	93.15857	4.0 (0.8)	0.65 (0.10)	13.20 (1.60)	0.0 (24.0)	8.0 (16.0)
Muscle	93.15859	2.1 (0.7)	2.32 (1.35)	4.13 (0.40)	7.0 (21.0)	7.0 (14.0)
Muscle	93.15860	2.7 (0.9)	1.13 (1.50)	9.45 (1.00)	-9.0 (27.0)	0.0 (18.0)
Muscle	93.15861	2.4 (1.2)	-1.07 (1.45)	11.64 (2.65)	0.0 (36.0)	12.0 (24.0)

Table 3 (Cont.).

Cochiti Reservoir on the Rio Grande (Cont.).

Sucker						
Muscle	93.15863	4.2 (1.4)	1.41 (1.60)	11.76 (1.95)	28.0 (42.0)	0.0 (28.0)
Muscle	93.15864	2.2 (1.1)	-1.29 (1.35)	8.69 (1.45)	0.0 (33.0)	0.0 (22.0)
Muscle	93.15865	4.0 (1.0)	1.91 (1.20)	8.90 (1.60)	0.0 (30.0)	10.0 (20.0)
Carp						
muscle	93.15866	3.2 (0.8)	NA	24.32 (6.65)	16.0 (24.0)	8.0 (16.0)
Muscle	93.15868	8.0 (0.8)	-0.20 (1.25)	14.80 (3.50)	0.0 (24.0)	8.0 (16.0)
Rio Guadalupe at Box Canyon near Jemez Springs						
Trout						
muscle	94.03169	30.4 (24.0)	-3.61 (3.10)	0.64 (0.30)	8.0 (240.0)	8.0 (160.0)
viscera	94.03168	35.2 (27.2)	-8.62 (5.00)	12.32 (5.60)	0.0 (480.0)	0.0 (320.0)
Jemez River near Jemez Springs						
Suckers						
muscle	94.03170	15.4 (5.6)	-14.14 (9.70)	4.76 (1.40)	196.0 (420.0)	112.0 (280.0)
viscera	94.03171	19.2 (7.2)	-23.62 (14.70)	26.64 (11.30)	48.0 (720.0)	0.0 (480.0)
Rio Grande at State Highway 44 bridge near Bernalillo						
Carp						
Muscle	94.03184	6.4 (1.6)	-1.05 (1.55)	15.20 (3.85)	0.0 (480.0)	-16.0 (320.0)
Muscle	94.03186	4.5 (1.5)	-1.49 (1.30)	23.40 (2.70)	15.0 (450.0)	0.0 (300.0)
Muscle	94.03187	4.2 (1.4)	-0.98 (1.45)	14.28 (4.20)	0.0 (420.0)	14.0 (280.0)
Viscera	94.03182	0.0 (0.7)	-2.81 (2.00)	57.68 (6.95)	0.0 (210.0)	21.0 (140.0)
Viscera	94.03183	1.0 (1.0)	-1.63 (1.75)	69.80 (2.70)	280.0 (300.0)	200.0 (200.0)
Viscera	94.03185	3.0 (1.5)	-4.08 (3.00)	35.25 (3.60)	0.0 (450.0)	-15.0 (300.0)

Table 3 (Cont.).
Rio Grande at Isleta

Carp						
Muscle	94.03178	2.7 (0.9)	0.32 (1.00)	15.93 (2.25)	9.0 (270.0)	18.0 (180.0)
Muscle	94.03179	3.3 (1.1)	-3.27 (1.20)	26.95 (3.50)	11.0 (330.0)	11.0 (220.0)
Muscle	94.03180	3.3 (1.1)	-4.30 (1.60)	26.29 (2.65)	242.0 (330.0)	55.0 (220.0)
Muscle	94.03181	3.0 (1.0)	-1.87 (0.95)	7.10 (3.30)	30.0 (300.0)	20.0 (200.0)
Viscera	94.03176	1.3 (1.3)	-0.16 (1.30)	95.68 (15.35)	39.0 (390.0)	26.0 (260.0)
Viscera	94.03177	0.0 (0.9)	-3.98 (2.80)	66.96 (6.65)	-9.0 (270.0)	27.0 (180.0)

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