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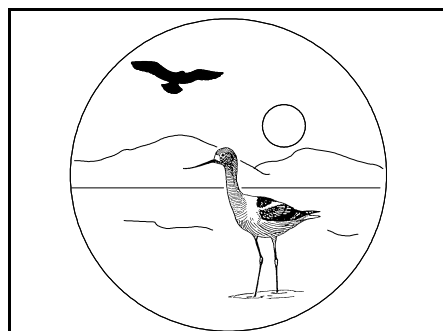
CONTAMINANTS PROGRAM

Follow-up Investigation of Selenium and
Other Trace Elements in Biota from the
Riverton Reclamation Project,
Fremont County, Wyoming

A Report to the
Department of Interior's
National Irrigation Water Quality Program

By
Pedro Ramirez, Jr. and Kim Dickerson

Project #: 94-6-6W23



U.S. FISH AND WILDLIFE SERVICE
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January 1997

ABSTRACT

A reconnaissance study was completed for the Riverton Reclamation Project (Riverton Project) in 1989 by Peterson et al. (1991) showed slightly elevated selenium concentrations in biota at several wetland sites. A follow-up investigation was initiated for the Department of Interior's National Irrigation Water Quality Program in 1994 to verify that selenium concentrations in biota were elevated above levels that cause adverse effects to aquatic migratory birds. Pondweed (*Potamogeton vaginatus*), aquatic invertebrates, bird eggs, and fish were collected from several wetlands managed by the Wyoming Game and Fish Department and analyzed for selenium and other trace elements. Selenium concentrations were lower in biota in 1994 than in 1988. However, aquatic invertebrates from all sites sampled except Ocean Lake were above the 3 µg/g dry weight dietary level known to cause adverse effects in fish and aquatic birds. American coot (*Fulica americana*) and eared grebe (*Podiceps nigricolis*) eggs from North Pavilion Pond had mean selenium concentrations of 10.9 and 13.1 µg/g, respectively, and did not differ appreciably from levels found in coot and grebe eggs in 1988.

USFWS - Region 6 - Environmental Contaminants Report

TABLE OF CONTENTS

	Page
LIST OF TABLES AND FIGURES	iii
INTRODUCTION	1
STUDY AREA DESCRIPTION	3
METHODS	5
RESULTS and DISCUSSION	7
LITERATURE CITED	10
APPENDIX	11

LIST OF TABLES AND FIGURES

	Page
Table 1. Sites within the Riverton Project that contained biota with elevated selenium concentrations (Peterson et al. 1991).	1
Table 2. Biota collected at wetlands within the Riverton Reclamation Project in 1994.	5
Table 3. A comparison of selenium concentrations (in µg/g) in biota collected in 1988 (Peterson et al. 1991) and 1994 at the Riverton Reclamation Project (geometric mean shown for samples with n=>5, average shown for samples with n=>2 and <5).	7
Figure 1. Location of the Riverton Reclamation Project in Fremont County, Wyoming.	3
Figure 2. Location of collection sites at the Riverton Reclamation Project.	5

INTRODUCTION

The U.S. Department of Interior's National Irrigation Water Quality Program (NIWQP) has investigated federal irrigation projects in the western United States since the mid 1980's. The purpose of these studies was to determine if irrigation drainwater is causing adverse effects to migratory birds or federally-listed threatened and endangered species or causing other adverse impacts to the beneficial uses of water. In Wyoming, the NIWQP has completed investigations at the Kendrick Reclamation Project, Natrona County; the Wind River Indian Reservation, Fremont County; and at the Riverton Reclamation Project, also in Fremont County. A reconnaissance study (Phase II) was conducted for the Riverton Reclamation Project (Riverton Project) in 1988 (Peterson et al. 1991). Slightly elevated selenium concentrations were found in some biota at several sites in 1988 (Table 1).

Table 1. Sites within the Riverton Project that contained biota with elevated selenium concentrations (Peterson et al. 1991).

Site	Fish	Pondweed	Invertebrates	Bird Eggs	Bird Livers
	>4*	>3*	>3*	>8*	>10*
Ocean Lake		X	X		
North Pavilion Pond		X	X	X	X
Lake Cameahwait	X				
Middle Depression Lake	X				
Sand Mesa Pond				X	

(*thresholds for adverse effects in µg/g dry weight)

A follow-up investigation was initiated by the NIWQP in 1994 to verify if selenium concentrations in biota were above levels known to cause adverse effects to migratory aquatic birds. The follow-up investigation was designed to achieve the following objectives:

- determine selenium concentrations in biota inhabiting selected wetland habitats influenced by the Riverton Project;
- compare selenium concentrations in biota with those reported in the 1988 reconnaissance study; and
- determine if the selenium concentrations have the potential to cause harmful effects on fish and wildlife.

USFWS - Region 6 - Environmental Contaminants Report

Acknowledgements - We would like to thank the staff of the Wyoming Game and Fish Department at Lander for their cooperation. Thomas Ramirez assisted with the field collections. Dave Skates, U.S. Fish and Wildlife Service, Lander, Wyoming collected fish from the Wind River for this study. Todd Adornato, George T. Allen, Tim Hall and Kirke King of the U.S. Fish and Wildlife Service reviewed the manuscript.

STUDY AREA DESCRIPTION

The Riverton Project is located in Fremont County, Wyoming (Figure 1). Approximately 70,000 acres in the project are irrigated for the production of alfalfa, grains, and sugar beets. Water for the

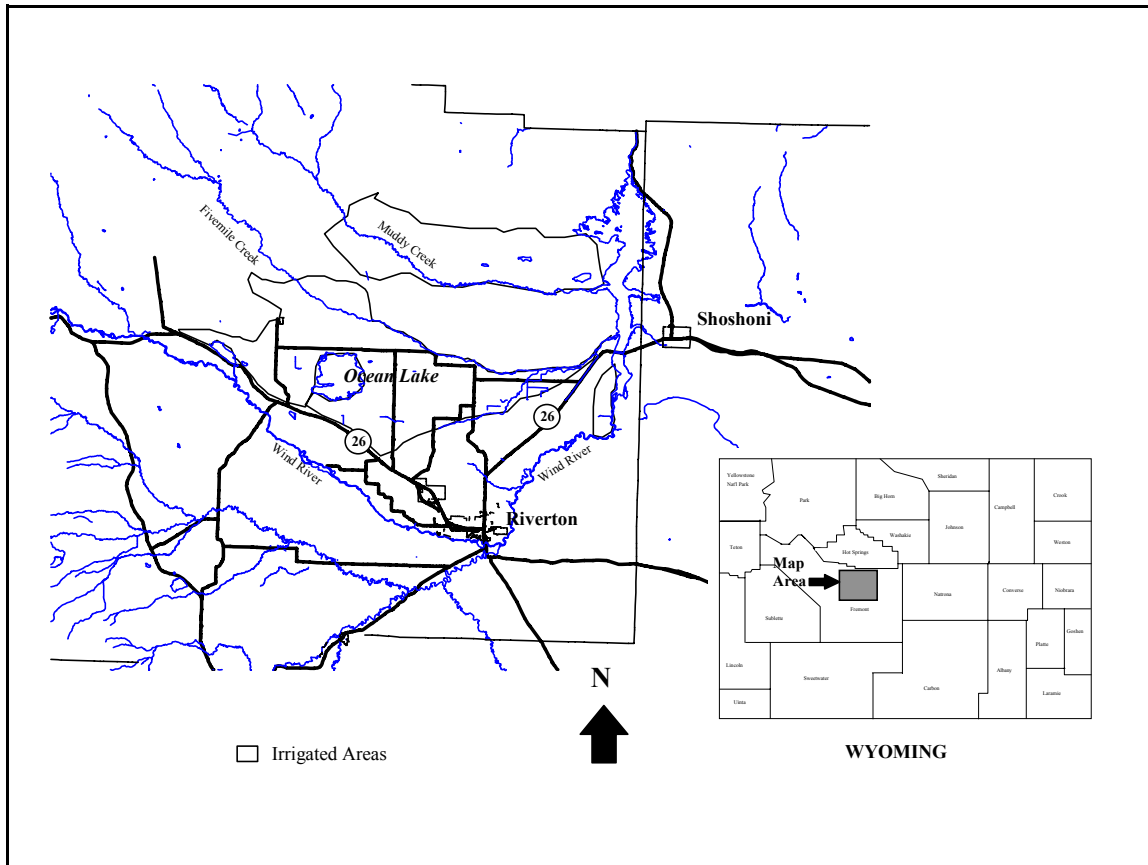


Figure 1. Location of the Riverton Reclamation Project in Fremont County, Wyoming.

Riverton Project is diverted from the Wind River into the Wyoming Canal for distribution to the project lands.

The Riverton Project is characterized by semiarid grasslands and rolling hills. Annual precipitation is approximately eight inches. Cretaceous shale occurs at the headwaters of Fivemile and Muddy creeks (Peterson et al. 1991). The presence of Cretaceous shale is of interest because it is a potential source of selenium (Presser 1994).

The Wyoming Game and Fish Department has developed extensive fisheries and waterfowl management areas in the Riverton Project. Aquatic habitats influenced by the irrigation project include: Ocean Lake, Middle Depression Lake, Lake Cameahwait, Sand Mesa

USFWS - Region 6 - Environmental Contaminants Report

Ponds, and North Pavilion Pond. Fish are present at all lakes and ponds except North Pavilion Pond. Fish inhabiting Ocean Lake include: common carp (*Cyprinus carpio*); white suckers (*Catostomus commersoni*); yellow perch (*Perca flavescens*); walleye (*Stizostedion vitreum vitreum*); black crappie (*Pomoxis nigromaculatus*); bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*). Rainbow trout (*Oncorhynchus mykiss*) and white suckers inhabit Middle Depression Lake. Lake Cameahwait is inhabited by carp, yellow perch, white suckers, brown trout (*Salmo trutta*) and rainbow trout. Aquatic bird nesting occurs at several small ponds immediately east of Ocean Lake and at North Pavilion Pond. Aquatic birds nesting at the Riverton Project include waterfowl (*Anas* spp.), Canada geese (*Branta canadensis*), eared grebes (*Podiceps nigricolis*), and American coots (*Fulica americana*).

USFWS - Region 6 - Environmental Contaminants Report

METHODS

Pondweed (*Potamogeton vaginatus*), aquatic invertebrate, bird egg and fish samples were collected from several wetlands managed by the Wyoming Game and Fish Department (Table 2 and Figure 2).

Table 2. Biota collected at wetlands within the Riverton Reclamation Project in 1994.

Site	Fish	Aquatic Vegetation	Aquatic Invertebrates	Bird Eggs
Ocean Lake	X	X	X	
North Pavilion Pond		X	X	X
Lake Cameahwait	X	X	X	
Middle Depression Lake	X		X	
Sand Mesa Pond	X			

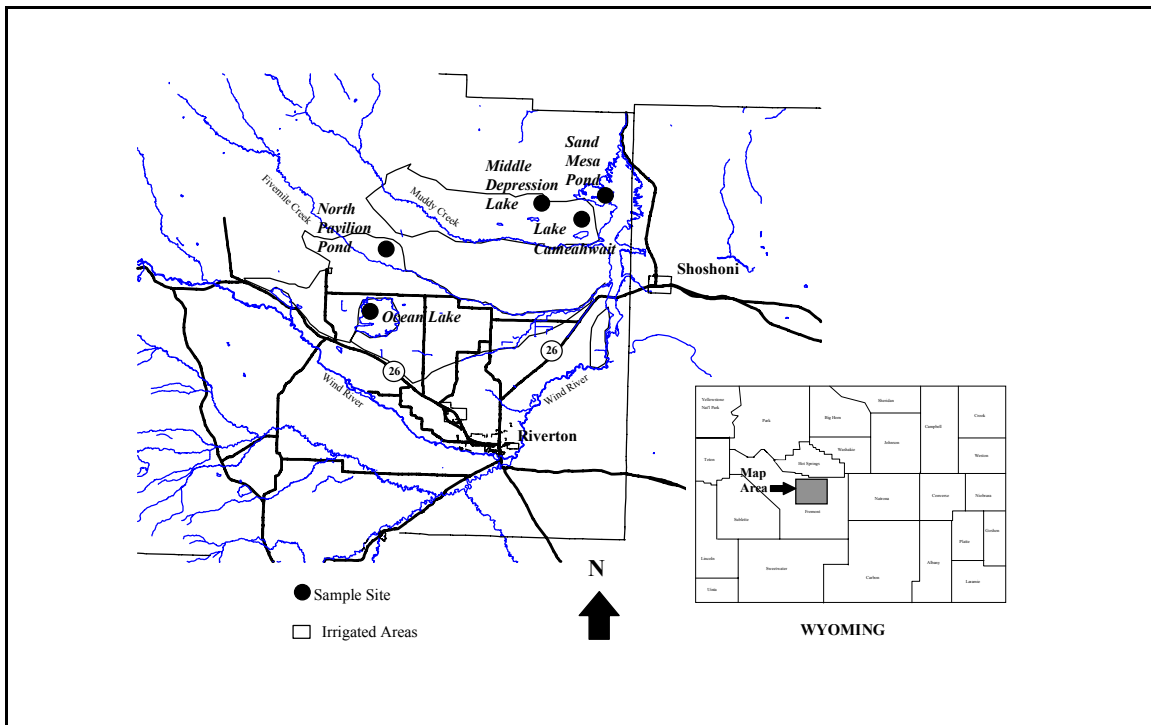


Figure 2. Location of collection sites at the Riverton Reclamation Project.

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Samples were collected between June and August 1994. Pondweed composite samples were collected by hand, placed in whirl-pak bags and immediately frozen. Aquatic invertebrates were collected with dip nets and light traps as described by Espinosa and Clark (1972), separated by taxa, placed in chemically-cleaned glass vials and immediately frozen. Aquatic invertebrates collected included: damselfly larvae (Odonata), amphipods (Amphipoda), water fleas (Cladocera) and waterboatmen (Corixidae). Eared grebe and American coot eggs were collected from North Pavilion Pond. Bird eggs were dissected and examined for deformities. Egg contents were placed in chemically-cleaned glass jars and immediately frozen.

Fish were collected with gill nets. Rainbow trout and suckers were collected from Middle Depression Lake. Common carp were collected from Ocean Lake and the Wind River. Yellow perch were collected from Lake Cameahwait. Large fish such as trout, suckers and carp were individually wrapped in aluminum foil and immediately frozen. Yellow perch were individually placed in whirl-pak bags and frozen. Fish were submitted for individual whole-body residue analysis.

All samples, except fish from the Wind River, were submitted for trace element analyses. Carp from Ocean Lake and the Wind River were submitted for organochlorine compound analyses. Samples were submitted to the Research Triangle Institute Laboratory, Research Triangle Park, North Carolina for selenium and trace element analysis. Arsenic and selenium were analyzed using graphite furnace atomic absorption spectroscopy (AAS). Mercury was analyzed by cold vapor AAS. The remaining trace elements were analyzed by inductively coupled plasma emission spectroscopy. Organochlorine compounds were analyzed by electron capture gas chromatography at the Mississippi State Chemical Laboratory, Starkville, Mississippi. Quality assurance/quality control (QA/QC) was assured by the U.S. Fish and Wildlife Service's Patuxent Analytical Control Facility (PACF). QA/QC was monitored through procedural blanks, duplicate analysis, test recoveries of spiked materials and reference material analyses with oversight by PACF. All trace element and organochlorine compound concentrations are reported in $\mu\text{g/g}$ dry weight unless otherwise specified.

USFWS - Region 6 - Environmental Contaminants Report

RESULTS and DISCUSSION

Data interpretation is limited to selenium in this report as this element was the primary focus of the investigation (Table 3). Other trace element concentrations found in biota are presented in Appendix Tables A1 through A5.

Table 3. A comparison of selenium concentrations (in µg/g) in biota collected in 1988 (Peterson et al. 1991) and 1994 at the Riverton Reclamation Project (geometric mean shown for samples with n=>5, average shown for samples with n=>2 and <5).

Site	Species/ Matrix	Se - 1988 Mean (Range) n	Se - 1994 Mean (Range) n
OL	Pondweed	3.27 (1.8 - 4.75) 2	BDL () 5
	Waterboatmen	5.41 (3.27 - 9.13) 3	NC
	Cladocera	NC	2.28 (BDL - 3.82) 5
	Carp	5.26 (4.41 - 5.21) 5	1.9 (1.38 - 2.05) 6
NP	Pondweed	5.17 (2.9 - 7.44) 2	BDL () 5
	Waterboatmen	8.14 (8.14) 1	5.07 (4.57 - 5.58) 2
	Backswimmers	NC	6.43 (2.11 - 10.75) 2
	Copepods	11.1 (11.1) 1	NC
	Am. Coot Eggs	11.7 (10.3 - 13.1) 2	10.9 (9.69 - 16.18) 7
	Pied-billed Grebe Eggs	16.9 (16.9) 1	NC
	Eared Grebe Eggs	NC	13.1 (9.04 - 17.11) 7
MD	Waterboatmen	NC	5.89 (4.84 - 6.79) 3
	Amphipods	NC	3.88 (3.88) 1
	Odonates	NC	10.6 (10.6) 1
	Rainbow Trout	12.7 (9.2 - 15.2) 5	7.72 (4.96 - 9.84) 6
	Suckers	7.41 (5.2 - 8.8) 5	8.99 (4.34 - 11.36) 7
LC	Pondweed	NC	1.22 (BDL - 3.12) 5
	Cladocera	NC	5.92 (3.55 - 7.9) 5
	Yellow Perch	9.32 (8.41 - 10.4) 3	7.1 (6.07 - 9.48) 4
SM	Yellow Perch	NC	3.2 (1.76 - 3.3) 5

[OL = Ocean Lake; NP = North Pavilion Pond; MD = Middle Depression Lake; LC = Lake Cameahwait; SM = Sand Mesa; BDL = Below Detection Limits; NC = None Collected]

USFWS - Region 6 - Environmental Contaminants Report

Ocean Lake

Selenium concentrations were below detection limits in pondweed collected from Ocean Lake. Aquatic invertebrates (Cladocera) had a mean selenium concentration of 2.28, less than Lemly's (1993) 3 µg/g dietary level that causes impaired reproduction and other adverse effects in fish and wildlife. Carp had a mean whole-body selenium concentration of 1.9 µg/g. Selenium concentrations in pondweed and carp were lower in 1994 than in 1988 (Table 3). One walleye had a whole-body selenium concentration of 4.95 µg/g.

North Pavilion Pond

Selenium in pondweed from North Pavilion Pond was below detection limits. In 1988, pondweed had a mean selenium concentration of 5.17 µg/g (Table 3). Aquatic invertebrates had selenium concentrations ranging from 2.11 to 10.75 µg/g. The mean selenium concentration in waterboatmen was 5.07 µg/g and was lower than the 8.14 µg/g concentration reported for 1988 (Table 3). American coot and eared grebe eggs had mean selenium concentrations of 10.95 and 13.15 µg/g, respectively; levels above the 8 µg/g that Skorupa and Ohlendorf (1991) said causes embryo mortality in aquatic birds. Selenium concentrations in coot and grebe eggs collected in 1994 are of the same magnitude as those reported by Peterson et al. (1991) for eggs collected in 1988, 11.7 and 16.9 µg/g. The mean selenium concentration in eared grebe eggs from North Pavilion Pond was 13.7 µg/g. This level is much lower than the 74 and 78.8 µg/g concentrations reported for eared grebe eggs from the Kendrick Reclamation Project by See et al. (1992) in Natrona County, Wyoming.

Lake Cameahwait

Pondweed from Lake Cameahwait had a mean selenium concentration of 1.22 µg/g, less than the 3 µg/g dietary threshold reported by Lemly (1993). Aquatic invertebrates (Cladocera) had a mean selenium concentration of 5.92 µg/g. Yellow perch had a whole-body mean selenium concentration of 7.1 µg/g, this was slightly lower than the 9.32 µg/g concentration in 1988 (Table 3). One largemouth bass had a whole-body selenium concentration of 9.42 µg/g. Studies have indicated a reproductive impairment threshold of 4 µg/g whole-body selenium in sensitive species of fish (Lemly 1993).

Middle Depression Lake

Aquatic invertebrates had selenium levels higher than the 3 µg/g dietary threshold reported by Lemly (1993). Waterboatmen from Middle Depression Lake had a mean selenium concentration of 5.89 µg/g. One Odonate sample and one amphipod sample had selenium

USFWS - Region 6 - Environmental Contaminants Report

concentrations of 10.56 and 3.88 µg/g, respectively. Rainbow trout had a whole-body mean selenium concentration of 7.72 µg/g, this level was slightly lower than the 12.7 µg/g concentration found in 1988 but above the 4 µg/g whole-body selenium level associated with reproductive impairment by Lemly (1993) (Table 3). Suckers had a whole-body mean selenium concentration of 8.99 µg/g, slightly higher than the level reported in 1988 (Table 3).

Sand Mesa Pond

Yellow perch from Sand Mesa Pond had a whole-body mean selenium concentration of 3.2 µg/g.

Organochlorine Compounds in Carp

Carp collected from Ocean Lake and the Wind River were analyzed for organochlorine (OC) compounds. Polychlorinated biphenyls (PCB's), alpha-chlordane, dieldrin, DDD, DDE, DDT, and trans-nonachlor were detected in carp from the Wind River. Trans-nonachlor and DDE were detected in carp from Ocean Lake. All other OC compounds were not detected. Detectable OC compounds were below the mean concentrations reported for the National Contaminant Biomonitoring Program (Schmitt et al. 1990).

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USFWS - Region 6 - Environmental Contaminants Report

APPENDIX

Table A-1. Trace element concentrations in biota (in µg/g) collected from Ocean Lake at the Riverton Reclamation Project, Wyoming in 1994.

Sample ID	Common Name	Al	As	B	Ba	Be
RPOLAV01	Pondweed	4741.57	3.65	174.16	117.42	0.15
RPOLAV02	Pondweed	5210.52	2.92	184.21	115.79	0.16
RPOLAV03	Pondweed	5214.72	2.76	206.75	115.34	0.15
RPOLAV04	Pondweed	4789.81	2.93	233.12	114.65	0.15
RPOLAV05	Pondweed	4515.34	2.76	239.88	123.31	0.15
RPOLAI01	Water fleas	2508.48	5.59	16.88	51.69	<.34
RPOLAI02	Water fleas	2327.58	3.79	20.69	50.52	<.34
RPOLAI03	Water fleas	2229.51	4.59	19.51	48.2	<.31
RPOLAI04	Water fleas	2757.57	4.55	16.97	50.3	<.3
RPOLAI05	Water fleas	2086.21	4.66	18.97	55.34	<.34
RPOLCC01	Carp	4.05	1.05	<1.33	6.18	<0.07
RPOLCC02	Carp	6.59	0.69	<1.09	3.38	<0.06
RPOLCC03	Carp	25.26	0.67	<1.11	3.52	<0.06
RPOLCC04	Carp	31.48	1.42	<1.21	3.12	<0.06
RPOLCC05	Carp	26.92	1.13	<1.03	4.64	<0.05
RPOLWE01	Walleye	10.78	<0.23	<1.83	4.29	<0.09
Sample ID	Common Name	Cd	Cr	Cu	Fe	Hg
RPOLAV01	Pondweed	<.34	6.29	5.96	3617.98	<.056
RPOLAV02	Pondweed	<.35	6.32	4.86	3608.19	<.058
RPOLAV03	Pondweed	<.36	6.32	5.72	3484.66	<.061
RPOLAV04	Pondweed	<.38	6.22	5.4	3490.45	<.064
RPOLAV05	Pondweed	<.36	6.13	6.87	3368.1	<.061
RPOLAI01	Water fleas	<1.02	6.39	15.66	3457.63	<.169
RPOLAI02	Water fleas	<1.03	5.48	16.17	3379.31	<.172
RPOLAI03	Water fleas	<.95	5.64	18.85	3278.69	<.164
RPOLAI04	Water fleas	<.91	5.88	14.91	3515.15	<.152
RPOLAI05	Water fleas	<1.03	5.47	15.57	3327.58	<.172
RPOLCC01	Carp	<0.20	1.1	1.74	43.92	0.098
RPOLCC02	Carp	<0.16	0.8	3.52	55.68	0.108
RPOLCC03	Carp	<0.17	1.14	2.82	63.69	0.112
RPOLCC04	Carp	<0.18	0.96	3.95	99.69	0.139
RPOLCC05	Carp	<0.15	1.02	3.82	80.51	0.103
RPOLWE01	Walleye	<0.28	2.16	1.72	83.03	1.202
Sample ID	Common Name	Mg	Mn	Mo	Ni	Pb
RPOLAV01	Pondweed	6123.59	126.4	<2.24	4.35	3.76
RPOLAV02	Pondweed	6023.39	128.07	<2.33	4.05	3.06
RPOLAV03	Pondweed	6134.97	130.67	<2.42	4.17	3.37
RPOLAV04	Pondweed	5388.54	129.94	<2.52	4.24	3.81
RPOLAV05	Pondweed	5644.17	129.45	<2.41	4.33	3.33

USFWS - Region 6 - Environmental Contaminants Report

Table A-1. Trace element concentrations in biota (in µg/g) collected from Ocean Lake at the Riverton Reclamation Project, Wyoming in 1994.

Sample ID	Common Name	Mg	Mn	Mo	Ni	Pb
RPOLAI01	Water fleas	2711.87	200	<6.73	3.88	<8.41
RPOLAI02	Water fleas	2637.93	184.48	<6.86	3.86	<8.57
RPOLAI03	Water fleas	2557.37	181.97	<6.3	3.79	<7.87
RPOLAI04	Water fleas	2666.66	190.91	<6.02	4.85	<7.53
RPOLAI05	Water fleas	2689.65	205.17	<6.86	3.64	<8.57
RPOLCC01	Carp	1097.97	4.29	<1.33	<0.4	<1.67
RPOLCC02	Carp	786.7	2.72	<1.09	<0.33	<1.37
RPOLCC03	Carp	1058.66	5.28	<1.11	2.85	<1.39
RPOLCC04	Carp	845.68	3.33	<1.21	5.37	<1.52
RPOLCC05	Carp	861.54	4.59	<1.03	4.56	<1.28
RPOLWE01	Walleye	1674.31	4.72	<1.83	4.43	<2.28
Sample ID	Common Name	Se	Sr	V	Zn	
RPOLAV01	Pondweed	<1.12	440.45	9.21	17.58	
RPOLAV02	Pondweed	<1.16	442.11	9.24	15.96	
RPOLAV03	Pondweed	<1.21	437.42	9.26	15.95	
RPOLAV04	Pondweed	<1.26	419.11	9.68	18.73	
RPOLAV05	Pondweed	<1.21	465.03	9.51	17.18	
RPOLAI01	Water fleas	<3.36	328.81	5.92	102.03	
RPOLAI02	Water fleas	<3.43	291.38	5.6	97.93	
RPOLAI03	Water fleas	3.82	286.88	5.69	93.93	
RPOLAI04	Water fleas	<3.02	300	6.09	97.58	
RPOLAI05	Water fleas	3.69	331.03	5.41	103.1	
RPOLCC01	Carp	2.05	115.88	0.25	251.69	
RPOLCC02	Carp	1.46	61.5	<0.14	233.24	
RPOLCC03	Carp	1.38	101.4	0.3	279.33	
RPOLCC04	Carp	1.97	63.27	0.17	278.09	
RPOLCC05	Carp	1.4	90	0.22	185.9	
RPOLWE01	Walleye	4.95	90.83	<0.23	55.96	

USFWS - Region 6 - Environmental Contaminants Report

Table A-2. Trace element concentrations in biota (in µg/g) collected from North Pavilion Pond at the Riverton Reclamation Project, Wyoming in 1994.

Sample ID	Common Name	Al	As	B	Ba	Be
RPNPAV01	Pondweed	121.1	0.78	560	31.89	<.22
RPNPAV02	Pondweed	185.6	<.56	545.56	35.56	<.22
RPNPAV03	Pondweed	312.2	<.61	546.34	35.98	<.24
RPNPAV04	Pondweed	621.8	1.41	542.31	43.46	<.26
RPNPAV05	Pondweed	344.6	1.57	546.99	41.08	<.24
RPNPPI01	Backswimmers	2.96	0.12	2.67	0.79	<.02
RPNPPI02	Waterboatmen	59.65	0.88	21.87	7.37	<.12
RPNPPI03	Damselfly larvae	97.44	0.77	25.56	5.79	<.17
RPNPPI04	Waterboatmen	49.78	0.55	13.2	8.01	<.11
RPNPPI05	Backswimmers	15.3	0.5	7.2	3.52	<.1
RPNPGE01	Eared grebe egg	<4.44	<.23	<1.78	<.89	<.09
RPNPGE02	Eared grebe egg	<4.5	<.23	<1.8	1.25	<.09
RPNPGE03	Eared grebe egg	<4.53	<.23	<1.81	<.91	<.09
RPNPGE04	Eared grebe egg	<4.54	0.55	3.57	<.91	<.09
RPNPGE05	Eared grebe egg	<4.76	<.24	2.43	1.59	<.1
RPNPGE06	Eared grebe egg	9.82	<.511	<0.48	0.64	<0.097
RPNPGE07	Eared grebe egg	10.16	<.507	<0.50	1.53	<0.101
RPNOCE02	American Coot egg	13.49	<.5	0.69	3.835	<0.100
RPNPCE01	American Coot egg	8.35	<.5	1.62	8.245	<0.099
RPNPCE03	American Coot egg	7.94	<.48	0.77	2.223	<0.101
RPNPCE04	American Coot egg	12.39	<.5	<0.51	5.489	<0.101
RPNPCE05	American Coot egg	13.53	<.5	1.01	5.171	<0.100
RPNPCE06	American Coot egg	11.52	<.5	<0.51	5.584	<0.101
RPNPCE07	American Coot egg	9.48	<.5	<0.50	6.727	<0.100
Sample ID	Common Name	Cd	Cr	Cu	Fe	Hg
RPNPAV01	Pondweed	<.66	1.11	11.11	158.89	<.111
RPNPAV02	Pondweed	<.66	1.4	6.39	190	<.111
RPNPAV03	Pondweed	<.73	1.61	5.57	400	<.122
RPNPAV04	Pondweed	<.76	1.96	5.4	523.08	<.128
RPNPAV05	Pondweed	<.72	1.36	4.35	337.35	<.12
RPNPPI01	Backswimmers	<.06	0.24	6.35	28.7	<.017
RPNPPI02	Waterboatmen	<.35	1.01	14.68	171.93	<.058
RPNPPI03	Damselfly larvae	<.5	1.01	22.14	200.85	<.085
RPNPPI04	Waterboatmen	<.33	0.93	15.86	179.01	<.055
RPNPPI05	Backswimmers	<.3	0.73	25	127	0.075
RPNPGE01	Eared grebe egg	<.27	2.38	3.16	57.92	0.389
RPNPGE02	Eared grebe egg	<.27	3.29	3.41	138.07	0.133
RPNPGE03	Eared grebe egg	<.27	0.84	3.29	148.86	0.288
RPNPGE04	Eared grebe egg	<.27	1.04	3.05	186.64	0.171
RPNPGE05	Eared grebe egg	<.28	3.01	3.07	146.15	0.173

USFWS - Region 6 - Environmental Contaminants Report

Table A-2. Trace element concentrations in biota (in µg/g) collected from North Pavilion Pond at the Riverton Reclamation Project, Wyoming in 1994.

Sample ID	Common Name	Cd	Cr	Cu	Fe	Hg
RPNPG06	Eared grebe egg	<0.1459	<0.486	2.819	131.3	0.1329
RPNPG07	Eared grebe egg	<0.1527	<0.509	3.364	132	0.2879
RPNOCE02	American Coot egg	<0.1512	<0.504	2.751	120.2	0.1416
RPNPCE01	American Coot egg	<0.1485	<0.495	2.744	125.7	0.1248
RPNPCE03	American Coot egg	<0.1527	<0.509	2.607	109.3	0.1378
RPNPCE04	American Coot egg	<0.1515	<0.505	2.712	90.1	<0.1
RPNPCE05	American Coot egg	<0.1503	<0.501	3.162	127.2	0.3163
RPNPCE06	American Coot egg	<0.1518	<0.506	2.991	110.4	0.1006
RPNPCE07	American Coot egg	<0.1509	<0.503	2.85	69.6	0.2908
Sample ID	Common Name	Mg	Mn	Mo	Ni	Pb
RPNPAV01	Pondweed	7011	135.56	<4.4	<1.32	<5.5
RPNPAV02	Pondweed	6978	97.33	<4.38	<1.31	<5.48
RPNPAV03	Pondweed	6915	118.66	<4.84	<1.45	<6.05
RPNPAV04	Pondweed	7295	127.95	<5.08	<1.53	<6.36
RPNPAV05	Pondweed	6892	108.31	<4.78	<1.43	<5.98
RPNPAl01	Backswimmers	392	6.26	<.4	<.12	<.5
RPNPAl02	Waterboatmen	1082	17.19	<2.33	0.98	<2.92
RPNPAl03	Damselfly larvae	1103	13.93	<3.37	1.97	<4.21
RPNPAl04	Waterboatmen	1061	15.3	<2.17	3.16	<2.7
RPNPAl05	Backswimmers	1850	29.05	<1.99	<.6	<2.48
RPNPG01	Eared grebe egg	443.4	4.24	<1.78	2.1	<2.22
RPNPG02	Eared grebe egg	407.8	2.64	<1.8	2.11	<2.25
RPNPG03	Eared grebe egg	371.2	3.23	<1.81	<.54	<2.26
RPNPG04	Eared grebe egg	342.9	1.6	<1.82	0.83	<2.27
RPNPG05	Eared grebe egg	413.9	3.42	<1.9	1.87	<2.38
RPNPG06	Eared grebe egg	425.1	1.878	<0.49	<0.49	<0.97
RPNPG07	Eared grebe egg	464.8	2.403	<0.51	<0.51	<1.01
RPNOCE02	American Coot egg	467	1.59	<0.504	<0.504	<1.0081
RPNPCE01	American Coot egg	423.7	1.686	<0.495	<0.495	<0.9901
RPNPCE03	American Coot egg	473.4	1.394	<0.5092	<0.5092	<1.0183
RPNPCE04	American Coot egg	425.9	1.217	<0.5051	<0.5051	<1.0101
RPNPCE05	American Coot egg	472.4	1.218	<0.501	<0.501	<1.002
RPNPCE06	American Coot egg	481.5	1.191	<0.5061	<0.5061	<1.0121
RPNPCE07	American Coot egg	395.6	1.22	<0.503	<0.503	<1.006
Sample ID	Common Name	Se	Sr	V	Zn	
RPNPAV01	Pondweed	<2.2	312.22	<.56	31.44	
RPNPAV02	Pondweed	<2.19	411.11	<.54	29.78	
RPNPAV03	Pondweed	<2.41	368.29	0.65	26.59	
RPNPAV04	Pondweed	<2.54	437.18	1.28	51.92	
RPNPAV05	Pondweed	<2.39	446.99	0.6	31.33	

USFWS - Region 6 - Environmental Contaminants Report

Table A-2. Trace element concentrations in biota (in µg/g) collected from North Pavilion Pond at the Riverton Reclamation Project, Wyoming in 1994.

Sample ID	Common Name	Se	Sr	V	Zn
RPNP AI01	Backswimmers	2.11	6.88	<.05	25.4
RPNP AI02	Waterboatmen	4.57	23.27	<.29	139.77
RPNP AI03	Damselfly larvae	11.11	32.82	<.42	88.03
RPNP AI04	Waterboatmen	5.58	24.7	<.27	132.04
RPNP AI05	Backswimmers	10.75	32.4	<.25	119.5
RPNP GE01	Eared grebe egg	10.95	11.09	<0.22	47.51
RPNP GE02	Eared grebe egg	9.04	13.94	<0.22	48.62
RPNP GE03	Eared grebe egg	13.52	12.51	<0.23	52.51
RPNP GE04	Eared grebe egg	11.61	9.59	<0.23	47.93
RPNP GE05	Eared grebe egg	15.48	13.99	<0.24	51.44
RPNP GE06	Eared grebe egg	17.11	9.969	<0.4864	47.35
RPNP GE07	Eared grebe egg	16.61	16.04	<0.5092	53.47
RPNP CE02	American Coot egg	9.58	38.46	<0.504	59.88
RPNP CE01	American Coot egg	10.08	28.67	<0.495	61.45
RPNP CE03	American Coot egg	11.03	30.08	<0.5092	48.38
RPNP CE04	American Coot egg	10.15	36.46	<0.5051	56.03
RPNP CE05	American Coot egg	9.69	50.69	<0.501	58.77
RPNP CE06	American Coot egg	11.17	36.36	<0.5061	48.5
RPNP CE07	American Coot egg	16.18	35.5	<0.503	52.98

USFWS - Region 6 - Environmental Contaminants Report

Table A-3. Trace element concentrations in biota (in µg/g) collected from Middle Depression Lake at the Riverton Reclamation Project, Wyoming in 1994.

Sample ID	Common Name	Al	As	B	Ba	Be
RPMDAI03	Odonates	73.36	1.04	27.36	5.62	<.16
RPMDAI05	Waterboatmen	60.43	0.37	8.02	10.7	<.11
RPMDAI06	Waterboatmen	27.28	0.56	9.85	14.15	<.1
RPMDAI07	Waterboatmen	51.58	1.09	15.43	12.53	<.09
RPMDAI08	Amphipods	644.74	2.96	20.33	85.53	<.13
RPMDRT01	Rainbow Trout	<3.17	0.19	<1.27	1.26	<0.06
RPMDRT02	Rainbow Trout	6.59	0.16	<1.28	2.57	<0.06
RPMDRT03	Rainbow Trout	9.08	0.16	1.59	2.35	<0.06
RPMDRT04	Rainbow Trout	<2.91	0.24	<1.16	0.65	<0.06
RPMDRT05	Rainbow Trout	<3.51	0.21	<1.4	0.78	<0.07
RPMDRT06	Rainbow trout	71.02	< .51	1.836	3.243	<0.1
RPMDS01	Sucker	110.5	0.663	0.9445	7.552	<0.0982
RPMDS02	Sucker	123.1	< .4941	1.943	12.2	<0.0969
RPMDS03	Sucker	85.7	< .49	<0.4864	10.69	<0.0973
RPMDS04	Sucker	102.6	< .4902	0.5002	11.97	<0.1
RPMDS05	Sucker	136.7	< .498	0.6569	9.722	<0.0992
RPMDS06	Sucker	54.98	< .495	0.7714	3.007	<0.0998
RPMDS07	Sucker	73.3	< .504	<0.504	9.106	<0.1008
Sample ID	Common Name	Cd	Cr	Cu	Fe	Hg
RPMDAI03	Odonates	<.48	1.29	26	157.6	0.152
RPMDAI05	Waterboatmen	<.32	1.21	21.28	150.8	0.139
RPMDAI06	Waterboatmen	<.3	0.77	23.08	111.79	0.128
RPMDAI07	Waterboatmen	<.27	0.76	21.9	150.68	0.136
RPMDAI08	Amphipods	<.39	2.49	30.92	435.53	<.132
RPMDRT01	Rainbow Trout	<0.19	0.86	9.04	47.13	0.15
RPMDRT02	Rainbow Trout	<0.19	0.67	5.26	59.42	0.13
RPMDRT03	Rainbow Trout	<0.19	0.78	10.6	83.81	0.102
RPMDRT04	Rainbow Trout	<0.17	0.64	5.49	48.08	0.248
RPMDRT05	Rainbow Trout	<0.21	0.76	8.75	43.93	0.15
RPMDRT06	Rainbow trout	<0.14	7.38	2.05	113.7	0.201
RPMDS01	Sucker	<0.1473	6.684	3.741	158.1	<0.1
RPMDS02	Sucker	<0.1453	3.607	3.488	151.1	<0.1
RPMDS03	Sucker	<0.1459	32.12	4.815	261.1	<0.1
RPMDS04	Sucker	<0.15	12.72	5.286	174	<0.1
RPMDS05	Sucker	<0.1488	18.54	5.159	237	<0.1
RPMDS06	Sucker	<0.1497	6.16	1.722	97.74	0.21
RPMDS07	Sucker	<0.1512	3.14	4.515	97.54	<0.10

USFWS - Region 6 - Environmental Contaminants Report

Table A-3. Trace element concentrations in biota (in µg/g) collected from Middle Depression Lake at the Riverton Reclamation Project, Wyoming in 1994.

Sample ID	Common Name	Mg	Mn	Mo	Ni	Pb
RPMDAI03	Odonates	1056	55.28	<3.2	2.46	<4
RPMDAI05	Waterboatmen	967.91	39.09	<2.13	2	<2.66
RPMDAI06	Waterboatmen	1010.26	47.79	<2.02	<.61	<2.53
RPMDAI07	Waterboatmen	977.38	37.6	<1.8	1.09	<2.24
RPMDAI08	Amphipods	1835.53	108.55	<2.61	1.29	<3.26
RPMDRT01	Rainbow Trout	898.09	4.46	<1.27	<0.38	<1.59
RPMDRT02	Rainbow Trout	821.43	8.15	<1.28	<0.39	<1.6
RPMDRT03	Rainbow Trout	815.87	9.68	<1.27	<0.38	<1.57
RPMDRT04	Rainbow Trout	764.01	3.36	<1.16	<0.35	<1.45
RPMDRT05	Rainbow Trout	932.14	3.68	<1.4	8.21	<1.75
RPMDRT06	Rainbow trout	1880	24.9	<0.4941	<0.49	1.5
RPMDS01	Sucker	2084	32.42	<0.4912	<0.4912	1.019
RPMDS02	Sucker	1944	53.56	<0.4845	0.628	1.935
RPMDS03	Sucker	1955	49.29	<0.4864	15.77	1.19
RPMDS04	Sucker	1933	37.92	<0.5	5.062	1.121
RPMDS05	Sucker	1843	31.9	<0.496	6.53	<0.99
RPMDS06	Sucker	1780	23.38	<0.499	<0.499	<0.998
RPMDS07	Sucker	1981	37.88	<0.504	<0.504	<1.00
Sample ID	Common Name	Se	Sr	V	Zn	
RPMDAI03	Odonates	10.56	15.6	0.49	100	
RPMDAI05	Waterboatmen	4.84	9.2	0.35	149.73	
RPMDAI06	Waterboatmen	6.05	11.28	<.25	138.97	
RPMDAI07	Waterboatmen	6.79	10.68	0.28	152.94	
RPMDAI08	Amphipods	3.88	599.34	1.67	62.96	
RPMDRT01	Rainbow Trout	7.9	29.65	<0.16	117.83	
RPMDRT02	Rainbow Trout	9.22	26.49	<0.16	98.7	
RPMDRT03	Rainbow Trout	9.84	27.84	<0.16	77.14	
RPMDRT04	Rainbow Trout	6.46	16.49	<0.14	67.85	
RPMDRT05	Rainbow Trout	4.96	27.43	<0.18	121.79	
RPMDRT06	Rainbow trout	9.27	215.5	<0.49	103.9	
RPMDS01	Sucker	10.57	62.52	<0.4912	93.38	
RPMDS02	Sucker	11.26	90.41	<0.4845	104.3	
RPMDS03	Sucker	10.59	95.95	<0.4864	133.5	
RPMDS04	Sucker	8.56	88.36	<0.5	99.64	
RPMDS05	Sucker	11.36	83.18	<0.496	129.8	
RPMDS06	Sucker	4.34	212.3	<0.499	106.5	
RPMDS07	Sucker	8.98	89.1	<0.504	80.92	

USFWS - Region 6 - Environmental Contaminants Report

Table A-4. Trace element concentrations in biota (in µg/g) collected from Lake Cameahwait at the Riverton Reclamation Project, Wyoming in 1994.

Sample ID	Common Name	Al	As	B	Ba	Be
RPLCAI02	Water fleas	1692.31	3.38	16.92	54.31	<.29
RPLCAI03	Water fleas	1446.77	3.87	29.52	49.35	<.32
RPLCAI04	Water fleas	1179.31	3.62	19.83	47.24	<.34
RPLCAI05	Water fleas	791.53	4.41	29.49	30.17	<.34
RPLCAI06	Water fleas	774.19	3.87	29.03	31.29	<.32
RPLCAV01	Pondweed	1902.91	8.74	744.66	121.36	<.19
RPLCAV02	Pondweed	2613.21	5.09	579.24	124.53	<.19
RPLCAV03	Pondweed	5236.56	7.1	952.69	213.98	<.22
RPLCAV04	Pondweed	1148.94	4.36	698.94	101.49	<.21
RPLCAV05	Pondweed	2433.96	4.25	660.38	117.92	<.19
RPLCB01	Largemouth Bass	4.9	<0.21	<1.64	20.5	0.5
RPLCP01	Yellow Perch	50.97	<0.19	<1.53	7.95	2.06
RPLCP02	Yellow Perch	58.93	0.21	1.69	10.14	2.84
RPLCP03	Yellow Perch	21.83	<0.19	<1.5	11.11	2.91
RPLCP04	Yellow Perch	21.7	<0.19	<1.47	8.67	2.34
Sample ID	Common Name	Cd	Cr	Cu	Fe	Hg
RPLCAI02	Water fleas	<.86	3.51	10.77	1907.69	<.292
RPLCAI03	Water fleas	<.95	3.82	10.63	1903.23	<.194
RPLCAI04	Water fleas	<1.02	3.28	10.5	1775.86	<.172
RPLCAI05	Water fleas	1.27	2.63	18.31	1016.95	0.186
RPLCAI06	Water fleas	1.05	2.5	16.02	916.13	0.177
RPLCAV01	Pondweed	<.58	3.83	8.33	2038.83	<.097
RPLCAV02	Pondweed	<.56	5.73	4.82	3188.68	<.094
RPLCAV03	Pondweed	<.63	9.87	7.76	5559.14	<.108
RPLCAV04	Pondweed	<.63	2.81	3.5	1680.85	<.106
RPLCAV05	Pondweed	<.56	5	5.15	2603.77	<.094
RPLCB01	Largemouth Bass	<0.02	1.88	2.23	35.64	0.556
RPLCP01	Yellow Perch	<0.02	1.88	3.69	82.24	0.336
RPLCP02	Yellow Perch	<0.02	2.25	3.22	89.64	0.618
RPLCP03	Yellow Perch	<0.02	2.29	4.01	107.25	0.511
RPLCP04	Yellow Perch	<0.02	2.07	7.44	60	0.319
Sample ID	Common Name	Mg	Mn	Mo	Ni	Pb
RPLCAI02	Water fleas	1366.15	167.69	<5.72	2.71	<7.17
RPLCAI03	Water fleas	1414.52	149.03	<6.35	2.31	<7.95
RPLCAI04	Water fleas	1375.86	152.24	<6.78	2.45	<8.47
RPLCAI05	Water fleas	1525.43	105.42	<6.64	2.97	<8.32
RPLCAI06	Water fleas	1390.32	97.74	<6.32	2.13	<7.9

USFWS - Region 6 - Environmental Contaminants Report

Table A-4. Trace element concentrations in biota (in µg/g) collected from Lake Cameahwait at the Riverton Reclamation Project, Wyoming in 1994.

Sample ID	Common Name	Mg	Mn	Mo	Ni	Pb
RPLCAV01	Pondweed	5349.51	541.75	<3.86	4.88	<4.83
RPLCAV02	Pondweed	6566.03	486.79	<3.74	4.97	<4.67
RPLCAV03	Pondweed	11182.8	819.35	<4.25	7.22	5.74
RPLCAV04	Pondweed	4446.81	480.85	<4.2	2.5	<5.24
RPLCAV05	Pondweed	7103.77	456.6	<3.74	4.11	<4.67
RPLCB01	Largemouth Bass	1514.4	6.3	<1.64	0.84	<2.05
RPLCP01	Yellow Perch	1498.07	13.71	<1.53	0.8	<1.9
RPLCP02	Yellow Perch	1692.86	20.68	<1.42	0.88	<1.8
RPLCP03	Yellow Perch	1770.99	14.12	<1.5	<0.45	<1.9
RPLCP04	Yellow Perch	1418.52	10.26	<1.47	0.82	<1.8
Sample ID	Common Name	Se	Sr	V	Zn	
RPLCAI02	Water fleas	3.55	53.23	4.37	232.31	
RPLCAI03	Water fleas	5.92	47.1	4.45	233.87	
RPLCAI04	Water fleas	6.64	45.34	3.47	256.9	
RPLCAI05	Water fleas	7.9	107.8	2.25	171.19	
RPLCAI06	Water fleas	6.6	113.39	2.03	153.55	
RPLCAV01	Pondweed	<1.93	293.2	5.42	19.42	
RPLCAV02	Pondweed	<1.87	284.91	7.21	17.92	
RPLCAV03	Pondweed	<2.12	480.65	12.37	24.84	
RPLCAV04	Pondweed	3.12	262.77	4.22	11.28	
RPLCAV05	Pondweed	<1.87	277.36	6.25	15.94	
RPLCB01	Largemouth Bass	9.42	126.34	<0.21	68.31	
RPLCP01	Yellow Perch	7.03	104.25	0.36	81.08	
RPLCP02	Yellow Perch	6.07	161.43	0.36	91.43	
RPLCP03	Yellow Perch	5.84	185.88	0.21	96.18	
RPLCP04	Yellow Perch	9.48	129.63	0.22	80.74	

USFWS - Region 6 - Environmental Contaminants Report

Table A-5. Trace element concentrations in biota (in µg/g) collected from Sand Mesa Pond at the Riverton Reclamation Project, Wyoming in 1994.

Sample ID	Common Name	Al	As	B	Ba	Be
RPSMP01	Yellow Perch	16.6	0.42	2.06	3.09	<0.07
RPSMP02	Yellow Perch	8.36	<0.19	1.85	2.62	<0.08
RPSMP03	Yellow Perch	25.13	<0.18	3.13	3.99	<0.07
RPSMP05	Yellow Perch	<3.61	0.22	2.95	2.65	<0.07

Sample ID	Common Name	Cd	Cr	Cu	Fe	Hg
RPSMP01	Yellow Perch	<0.21	1.71	2.73	51.93	0.179
RPSMP02	Yellow Perch	<0.23	1.82	8.63	43.89	0.286
RPSMP03	Yellow Perch	<0.22	1.91	3.84	62.73	0.266
RPSMP05	Yellow Perch	<0.22	1.41	2.13	10.44	0.266

Sample ID	Common Name	Mg	Mn	Mo	Ni	Pb
RPSMP01	Yellow Perch	1368.42	11.58	<1.39	<0.42	<1.74
RPSMP02	Yellow Perch	1416.03	11.34	<1.5	1.69	<1.88
RPSMP03	Yellow Perch	1553.51	19.08	<1.47	<0.44	<1.83
RPSMP05	Yellow Perch	1427.01	8.94	<1.44	1.03	<1.8

Sample ID	Common Name	Se	Sr	V	Zn
RPSMP01	Yellow Perch	3.3	216.49	<0.18	62.11
RPSMP02	Yellow Perch	2.89	191.98	<0.19	83.21
RPSMP03	Yellow Perch	2.21	215.5	0.32	90.04
RPSMP05	Yellow Perch	1.76	179.2	0.35	47.81