U.S. Fish & Wildlife Service

Contaminant Survey Of Mescalero And Dexter National Fish Hatcheries In New Mexico - July 1995

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

by

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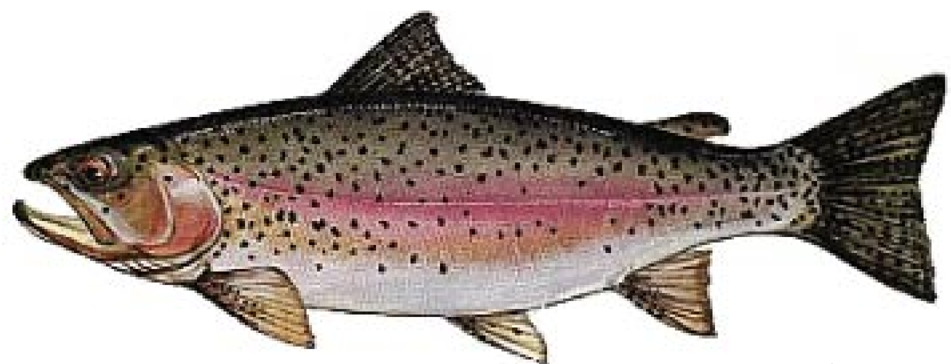
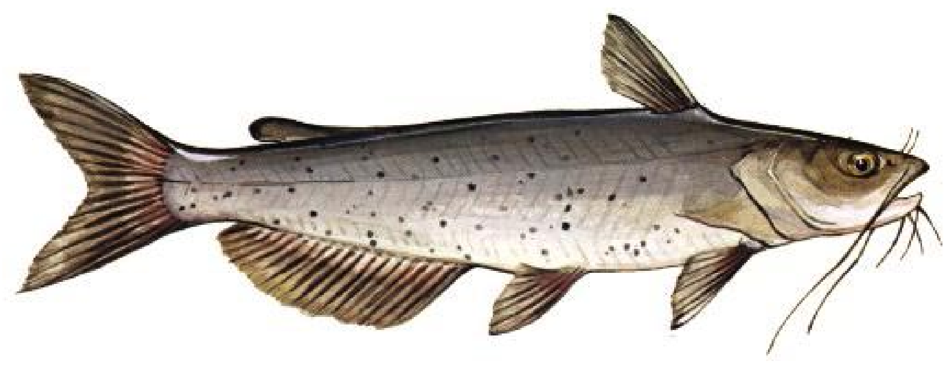


Rainbow Trout
(*Onchorhynchus mykiss)*



Yaqui Catfish
(*Ictalarus pricei*)

June 1998

ABBREVIATIONS AND CONVERSION FACTORS

Abbreviations

liter	L
milliliter	mL
kilogram	kg
gram	g
parts per million	ppm
parts per billion	ppb
parts per trillion	ppt
milligrams per kilogram	mg/kg
micrograms per gram	µg/g
micrograms per milliliter	µg/mL
micrograms per liter	µg/L
micrograms per kilogram	µg/kg
nanograms per liter	ng/L
Fahrenheit	F
Centigrade or Celsius	C
foot	Ft
reference dose	RfD

Conversions

milligrams per kilogram	ppm
micrograms per gram	ppm
micrograms per milliliter	ppm
micrograms per liter	ppb
micrograms per kilogram	ppb
nanograms per liter	ppt
degree Fahrenheit	(C÷5/9) +32
oz/day	kg/day*35.3

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EXECUTIVE SUMMARY

Water supplies utilized by national fish hatcheries are generally presumed to be uncontaminated. However, sublethal concentrations of potentially toxic substances in water used for fish rearing could go undetected in routine surveys of water quality. Therefore, surface water, groundwater, sediment, algae, and fish were sampled at Dexter National Fish Hatchery and Technology Center (NFTC) and the Mescalero National Fish Hatchery (NFH) in New Mexico. These samples were tested for metals and selected organic compounds and the analytical results were compared to national and regional background concentrations and various criteria correlated with adverse effects to fish, fish predators, and anglers that might consume those fish.

Contaminants that could adversely affect fish and/or wildlife or humans consuming those fish at Dexter NFTC include mercury and selenium. PCBs, DDE, and DDD were also detected in a Yaqui catfish egg mass, but were not found in hatchery sediments, so the most likely source for these contaminants is the Yaqui River (where fish were originally collected). The sources of the slightly elevated selenium concentrations in water and fish tissues are likely feed and groundwater. Selenium concentrations could be minimized by increasing water use from Well #4 (which had below detection limit selenium concentrations); mercury concentrations could be minimized by switching to a low trace-metal content feed.

Potential contaminants of concern at Mescalero NFH are arsenic, copper, and mercury. Again, switching to a low trace-metal content feed would probably be the simplest way to reduce fish trace-metal body burdens of arsenic and mercury. These elevated trace-metal concentrations could adversely affect fish health, and, based on the limited data collected for this study, arsenic may pose a risk to anglers consuming large numbers of fish stocked at Isleta lakes.

Aside from the elevated arsenic concentrations in fish at Mescalero NFH and selenium concentrations at Dexter NFTC, trace-metals do not appear to be a widespread problem at either hatchery.

INTRODUCTION

The Mescalero National Fish Hatchery (NFH) is located in the south fork of the Tularosa Canyon, within the western boundary of the Mescalero Apache Indian Reservation in southeast New Mexico. This 30-acre cold-water fish rearing facility produces approximately 350,000 rainbow trout (*Onchorhynchus mykiss*) per year for release in streams and lakes of the Mescalero Apache Reservation and various Pueblo Indian Reservations in New Mexico. Mescalero NFH is also a critically important refugium and rearing facility for the federally-listed, endangered Gila trout (*Onchorhynchus gilae*). The water supply for this hatchery consists of about six mountain springs on the Mescalero Apache Reservation.

Dexter National Fish Hatchery and Technology Center (NFTC) is located in the Pecos River Valley in South-central New Mexico, near the Town of Dexter. This hatchery holds and rears thousands of fish that have been listed as threatened or endangered species to help with recovery efforts in the southwestern United States. The water supply for the hatchery comes from groundwater pumped from wells.

Water supplies utilized by national fish hatcheries are generally presumed to be uncontaminated. However, sublethal concentrations of potentially toxic substances in water used for fish-rearing (e.g., industrial discharges, abandoned mine waste effluent, etc.) could go undetected in routine surveys of water quality (e.g., ammonia, biological oxygen demand, temperature, pH, etc.). Also, in certain instances, some types of contaminants (e.g., PCBs) can be below detectable concentrations (with standard analytical chemistry techniques) in water and still bioconcentrate to harmful concentrations in biota. Specialized analytical chemistry methodologies are necessary for detecting potentially toxic substances such as pesticides, various metals and metalloid elements, PCB's, PAH's and other organic compounds that might pose a threat to both hatchery-raised fish and public health.

Because undetected contaminants could enter the water supplies that Mescalero NFH and Dexter NFTC utilize for fish rearing, the U.S. Fish and Wildlife Service's (Service) Environmental Contaminants and Fisheries Programs initiated a study to assess if hazardous contaminant concentrations were present in the hatchery's fish stocks, fish food, algae, sediments, and waters. Also, two composite samples of rainbow trout were collected from one of the Isleta lakes (a public pay-to-fish lake complex on Isleta Pueblo that receives fish from Mescalero NFH) to compare baseline contaminant concentrations in hatchery fish to those in fish collected from a release site. The specific objectives of this study were to:

1) Establish baseline measurements of contaminant residues in fish stocks produced at Mescalero and Dexter National Fish Hatcheries;
2) Determine if the water supplies, fish feed or other aspects of the ambient aquatic environmental conditions present at Mescalero and Dexter National Fish Hatcheries were contaminated with potentially toxic metals, metalloids or organic compounds that would typically go undetected in routine surveys of water quality;
3) Determine if federally-reared sport fish in New Mexico contain concentrations of contaminants that might pose health risks to piscivorus wildlife or the angling public.

MATERIALS AND LOCATIONS SAMPLED

Samples were collected from various sites at both Mescalero and Dexter NFHs (Figures A-1 and A-2, and Table A-1). The sample collection sites were selected in discussions with the managers of Mescalero and Dexter NFHs as giving the best representation of water used for fish rearing purposes at the two hatcheries.

Water samples were collected from several locations at each hatchery. A blank containing distilled water from Dexter NFH's laboratory was also submitted as a QA/QC measure (DEXW07). The East Source Spring (MESW01) sample was collected approximately 600 meters (one-third of a mile) upgradient from Mescalero NFH, immediately above the water intake pipe leading to the fish rearing facility. Carillo Springs (sample MESW02) flows into the "main ditch" leading toward the hatchery immediately above the hatchery's water intake pipe. Sample MESW03 was collected from the main ditch prior to the hatchery's water intake pipe. The Church Spring (MESW04) sample was collected from the water intake box located on Mescalero NFH property. This site was of special importance as endangered Gila trout at the hatchery are reared exclusively in water emanating from Church Spring.

Water samples (MESW05 & 06) were also collected from raceway C-6 at Mescalero NFH. This was one of the lowest raceways in the operational system at Mescalero NFH, at the time this study was being conducted. Raceway C-6 was far enough downstream in the operational water supply system to provide a good representative sample of whatever contaminants might be added by fish rearing operations at Mescalero NFH.

Dexter NFH uses groundwater for its fish-rearing operations. Groundwater was collected from two wells: Sample DEXW03, from well #5, which serves the "A ponds" complex, and sample DEXW04, from well number #4, which serves the "B and C pond" complexes. Samples were pumped from the wells (the sampling pump was operated for 5 minutes to clear the line before collection of any groundwater), then filtered into cubitainers using a 0.5 micron Geotech peristaltic filter assembly. Water was also collected near the Southeast Sump (DEXW05 & 06), which is the outfall for the discharged wastewater from fish rearing operations at Dexter, and the fish holding house (DEXW01 & 02).

Figure A-1.

Mescalero National Fish Hatchery
Center Map and Sampling Locations

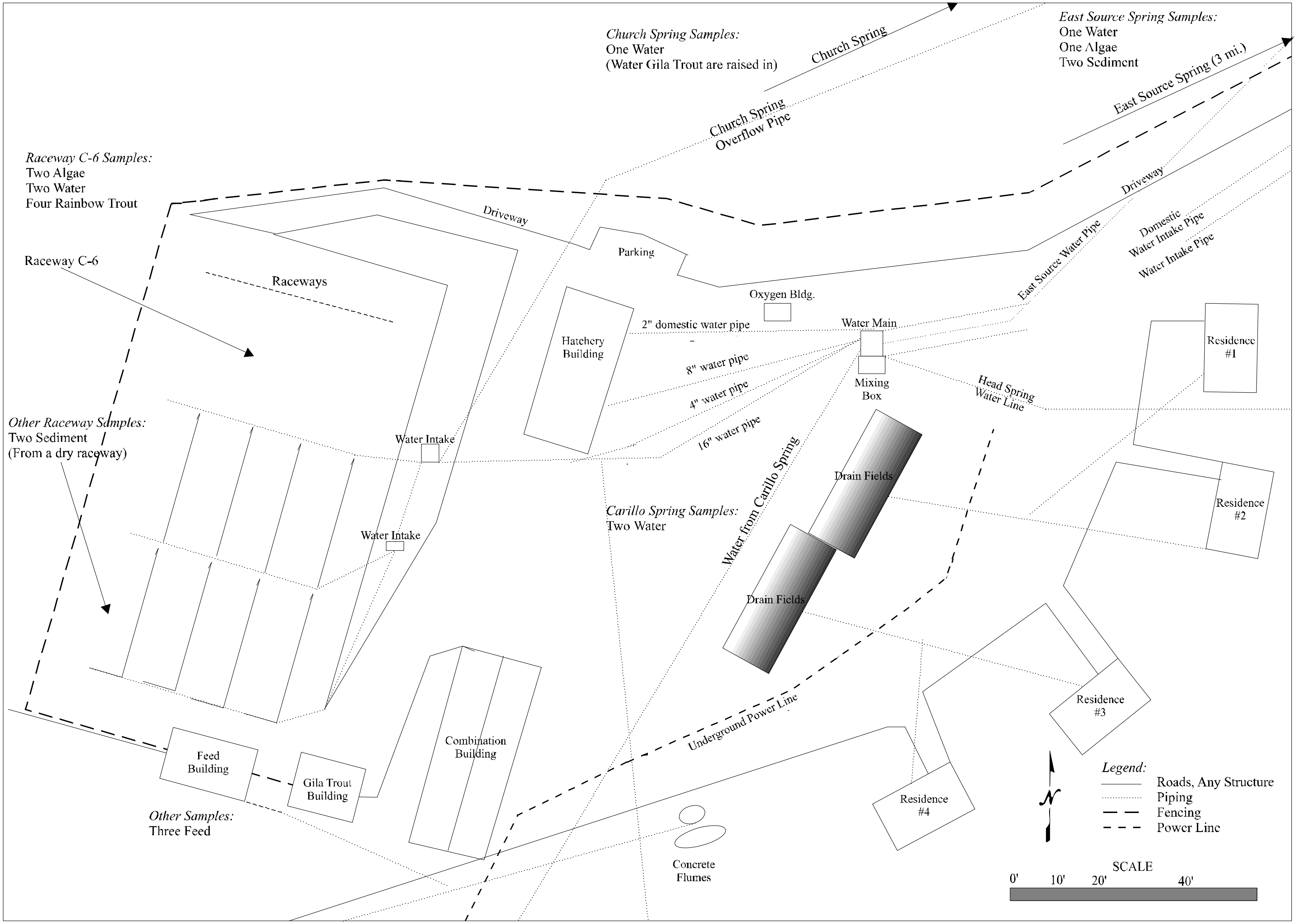

Figure A-2.

Dexter National Fish Technology Center
Center Map and Sampling Locations

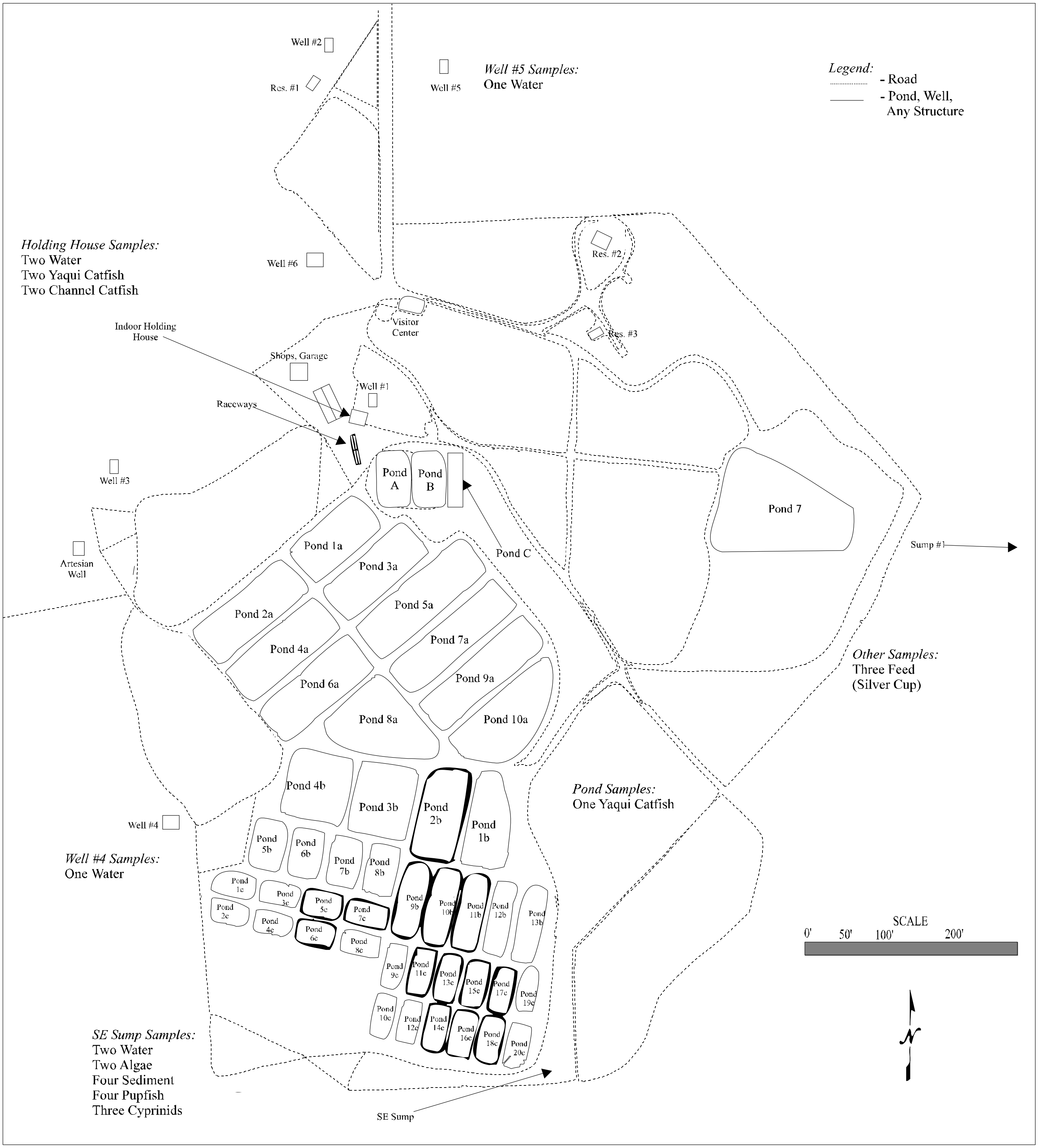

Table A-1. Sample information for biological, water, and sediment samples from Dexter NFTC, Mescalero NFH, and Isleta lake, 1995. Note: N/A denotes not applicable; N, number.

Sample ID Code	Site	Location	Date Collected	Type of Sample	Common Name	Sample Wt. (grams)	N	Avg. Wt. (grams)	Avg. Lgth. (cm)
DEXD01	Dexter	Feed	7-27-95	Feed	Silver Cup Crumbles	60.47	1		
DEXD02	Dexter	Feed	7-27-95	Feed	Silver Cup Pellets	55.78	1		
DEXD03	Dexter	Feed	7-27-95	Feed	Silver Cup Starter	64.18	1		
MESD01	Mescalero	Feed	7-26-95	Feed	Grower Pellets Intermediate	73.44	1		
MESD02	Mescalero	Feed	7-26-95	Feed	Grower Pellets Finisher	60.1	1		
MESD03	Mescalero	Feed	7-26-95	Feed	Grower Pellets Starter	37.41	1		
DEXCCF04	Dexter	Hatchery Pond	7-27-95	Muscle	ChannelCatfish	37.87	1		
DEXCCF10	Dexter	Holding House	7-27-95	Muscle	ChannelCatfish	59.98	1		
DEXYC05	Dexter	Hatchery Pond	7-27-95	Muscle	YaquiCatfish	20.52	1		
DEXYC10	Dexter	Holding House	7-27-95	Muscle	YaquiCatfish	96.54	1		
DEXYC14	Dexter	Holding House	7-27-95	Muscle	YaquiCatfish	63.39	1		
MESFF01	Mescalero	Church Spring	7-26-95	Muscle	RainbowTrout	67.85	5	13.57	
MESFF02	Mescalero	Church Spring	7-26-95	Muscle	RainbowTrout	79.35	5	15.87	
DEXS01	Dexter	S.E. Sump	7-27-95	Sediments		326.38	1		
DEXS02	Dexter	S.E. Sump	7-27-95	Sediments		356.21	1		
DEXS03	Dexter	Below SE Sump	7-27-95	Sediments			1		
DEXS04	Dexter	Below SE Sump	7-27-95	Sediments			1		
MESS01	Mescalero	East Source Spring	7-26-95	Sediments		108.17	1		
MESS02	Mescalero	Church Spring	7-26-95	Sediments		105.35	1		
MESS03	Mescalero	Church Spring	7-26-95	Sediments			1		
MESS04	Mescalero	East Source Spring	7-26-95	Sediments			1		
DEXP01	Dexter	S.E. Sump	7-27-95	Vegetation	Algae	20.26	1		
DEXP02	Dexter	S.E. Sump	7-27-95	Vegetation	Algae	24.02	1		
MESP01	Mescalero	East Source Spring	7-26-95	Vegetation	Algae	35.34	1		
MESP02	Mescalero	Church Spring	7-26-95	Vegetation	Algae	79.43	1		
MESP03	Mescalero	Church Spring	7-26-95	Vegetation	Algae	79.85	1		
DEXW01	Dexter	Holding House	7-27-95	Water			N/A		
DEXW02	Dexter	Holding House	7-27-95	Water			N/A		
DEXW03	Dexter	Well #5	7-27-95	Water			N/A		
DEXW04	Dexter	Well #4	7-27-95	Water			N/A		
DEXW05	Dexter	S.E. Sump	7-27-95	Water			N/A		
DEXW06	Dexter	S.E. Sump	7-27-95	Water			N/A		
DEXW07	Dexter	Blank	7-27-95	Water			N/A		
MESW01	Mescalero	East Source Spring	7-26-95	Water			N/A		
MESW02	Mescalero	Carillo Springs	7-26-95	Water			N/A		
MESW03	Mescalero	Carillo Springs	7-26-95	Water			N/A		
MESW04	Mescalero	Church Spring	7-26-95	Water			N/A		
MESW05	Mescalero	Raceway C-6	7-26-95	Water			N/A		
MESW06	Mescalero	Raceway C-6	7-26-95	Water			N/A		
DEXCCF06	Dexter	Hatchery Pond	7-27-95	Whole Body	ChannelCatfish	439.3	1		54.5

Sample ID Code	Site	Location	Date Collected	Type of Sample	Common Name	Sample Wt. (grams)	N	Avg. Wt. (grams)	Avg. Lgth. (cm)
DEXCCF11	Dexter	Holding House	7-27-95	Whole Body	ChannelCatfish	427.81	1		53.5
DEXFW01	Dexter	S.E. Sump	7-27-95	Whole Body	Leon Springs Pupfish	11.25	N/A		
DEXFW02	Dexter	S.E. Sump	7-27-95	Whole Body	Leon Springs Pupfish	10.53	N/A		
DEXFW03	Dexter	S.E. Sump	7-27-95	Whole Body	Chihuahua Chub	67.21	N/A		
DEXFW04	Dexter	S.E. Sump	7-27-95	Whole Body	Chihuahua Chub	65.48	N/A		
DEXFW05	Dexter	S.E. Sump	7-27-95	Whole Body	Leon Springs Pupfish	58.03	N/A		
DEXFW06	Dexter	S.E. Sump	7-27-95	Whole Body	Leon Springs Pupfish	48.07	N/A		
DEXFW07	Dexter	S.E. Sump	7-27-95	Whole Body	Chihuahua Chub	15.59	N/A		
MESFP01	Mescalero	Church Spring	7-26-95	Partial Body	RainbowTrout	423.58	5	84.716	25.44
MESFP02	Mescalero	Church Spring	7-26-95	Partial Body	RainbowTrout	398.07	5	79.614	24.14
MESFW01	Mescalero	Church Spring	7-26-95	Whole Body	RainbowTrout	411.23	5	82.246	23.58
MESFW02	Mescalero	Church Spring	7-26-95	Whole Body	RainbowTrout	79.36	2	39.68	16.4
DEXCCF1	Dexter	Hatchery Pond	7-27-95	Integrated Fish	ChannelCatfish	494.43	1		54.5
DEXCCF2	Dexter	Holding House	7-27-95	Integrated Fish	ChannelCatfish	501.49	1		53.5
MESFFP1	Mescalero	Church Spring	7-26-95	Integrated Fish	RainbowTrout	491.43	1		25.44
MESFFP2	Mescalero	Church Spring	7-26-95	Integrated Fish	RainbowTrout	477.72	1		24.14
SJILFF01	Isleta	Isleta	10-25-95	Muscle	RainbowTrout	98.4	4	24.6	
SJILFF02	Isleta	Isleta	10-25-95	Muscle	RainbowTrout	86.8	4	21.7	
SJILFP01	Isleta	Isleta	10-25-95	Whole Body	RainbowTrout	619.7	4	154.9	263
SJILFP02	Isleta	Isleta	10-25-95	Whole Body	RainbowTrout	781.8	4	195.5	281.5
SJILFI01	Isleta	Isleta	10-25-95	Integrated Fish	RainbowTrout	718.1	4	179.5	263
SJILFI02	Isleta	Isleta	10-25-95	Integrated Fish	RainbowTrout	868.6	4	217.2	281.5

Samples of filamentous green algae were collected by hand at two locations at Mescalero NFH, the East Source Spring and raceway C-6 (MESP01 and MESP02 & 03). The East Source Spring represented a probable clean site and raceway C-6 represented the potentially most polluted site (because of its lowermost position with the system of fish rearing operations) examined at Mescalero NFH. An algae sample was also collected from the plunge pool at the Southeast Sump at Dexter NFTC (DEXP01 & 02), which may have been the most polluted site at Dexter because it received the facility wastewater discharges.

Sediment samples (MESS01 & 04) were collected from the East Source Spring at Mescalero NFH, and dried sediment (MESS02 & 03) was collected from an inoperational (closed for cleaning) raceway at the southwest corner of the fish rearing facility (Figure A-1). Sediment was collected at two locations near the Southeast Sump at Dexter NFTC. Composite samples of sediment for metals analysis were collected at the plunge-pool immediately below the discharge pipe (DEXS01), and from the outflow stream approximately a hundred meters downstream from the outfall plunge pool (DEXS02). Two composite samples of sediment (DEXS03 and DEXS04) also were collected at the second location (approximately 100 meters below the outfall to the Southeast Sump) to analyze for organochlorine compounds such as pesticides, PCBs, and triazine herbicides.

Samples of each of three different dried (crumbles or pelletized) fish diets (fish chow) used at Mescalero and Dexter fish rearing facilities were collected and weighed in labeled, tared, 4-ounce chemically cleaned jars (DEXD01, 02, & 03 and MESD01, 02, & 03). In 1995, Mescalero and Dexter NFHs each used three separate dried fish diets (fish chow) in their fish rearing operations. The diets varied by protein content and the fineness of the grind (smaller fish are fed a finer grind product). Mescalero NFH used Grower Pellets feeds, consisting of (1) a finely-ground starter diet containing 45% protein for trout fry, (2) an intermediate-grind grower pellets mix containing 43% protein for medium-sized trout, and coarsely-ground brood pellets containing 47.5% protein for ready-to-stock-sized trout. Dexter NFH used Silver Cup feeds, consisting of (1) fish diet starter containing 52% protein, (2) trout crumbles containing 45% protein for intermediate-sized fish, and (3) trout pellets (even though Dexter does not raise trout) containing 40% protein for the larger-sized fish at the facility.

Seven composite samples (DEXFW01-07) of small fish (Leon Springs pupfish (*Cyprinodon bovinisus*) and Chihuahua chubs (*Gila nigrescens*)) were collected from the Southeast Sump plunge pool at Dexter NFTC using minnow traps baited with dry dog food pellets. Since this is the discharge point for the water used in fish rearing operations at Dexter, investigators believed that fish from this location might potentially contain the highest tissue concentrations of contaminants.

Four composite samples (consisting of five fish) of catchable-sized rainbow trout were collected at Mescalero NFH (MESFP01 & 02 and MESFW01 & 02). The larger-sized fish were selected for analysis because older, larger fish have a potentially greater exposure to any contaminants present in the hatchery's fish rearing water supply. In addition, these were fish that would be stocked for the public to catch and (probably) consume, and, therefore, data would be useful in evaluating any potential human health risks relative to anglers eating fish raised at Mescalero NFH. The Service is also generally concerned about potential ecological risks associated with piscivorus birds and other wildlife that may eat fish raised in national fish hatcheries, although studies have shown that most catchable-sized trout stocked primarily for recreational angling are caught and removed from the aquatic ecosystem within a short time and thus, pose little risk to wildlife.

On July 26 and 27, 1997, while the Service was sampling at Dexter NFTC, two Yaqui female catfish (PIT tags #7F7F1F163E and #7F7F1F0E76) that had been at the facility for 5 years died in one of the hatchery ponds due to aggressive spawning behavior from a male Yaqui catfish. These two female Yaqui catfish (DEXYC10 & 14), an excess male Yaqui catfish (PIT tag #7F7F1FOF74; DEXYC05), and two channel catfish (DEXCCF06 & 11), were sampled. The channel catfish sacrificed for this study were collected for comparative purposes; they were originally hatched and reared at Uvalde NFH in Texas, but had been at Dexter NFTC for about 15 months.

To further evaluate potential human health risks relative to anglers eating fish raised at Mescalero NFH, two composite (consisting of four fish) samples of catchable-sized rainbow trout were collected from one of the Isleta recreational fishing lakes (SJILFF01 & 02, SJILFP01 & 02, and SJILFI01 & 02). Samples were processed and analyzed identically to trout samples collected from Mescalero NFH.

SAMPLE PREPARATION AND ANALYTICAL METHODS

Grab water samples were collected in chemically cleaned glass containers. A 12-volt battery-operated peristaltic pump, manufactured by Geotech® Environmental Equipment, Inc., was used to force water samples (including the blank - DEXW07) through a 0.5 micron polycarbonate filter. The filtrate was collected in 1 quart polyethylene cubitainers. The samples were weighed to obtain an approximate volume and then acidified to a pH of less than 2.0 with 70% nitric acid.

A stainless steel spoon was used to collect samples from approximately the top ten centimeters (four inches) of sediment at each sample site. Individual spoonfuls of sediment collected from each sampling area were composited in a stainless steel bowl, transferred to a pre-labeled plastic bag, then weighed. Upon return to the laboratory, the sediment samples were pressed through a 0.589 mm stainless steel sieve to remove organic detritus (between the filtration of each sample, the stainless steel screen was washed with deionized water until visibly clean). The filtrate/fine sediment was collected in chemically cleaned, 16-ounce, tared glass jars. After sample processing, the filtered sediment was weighed and labeled.

Filamentous green algae samples were swished in site water to remove sediment and any visible detritus, and aquatic invertebrates were removed with forceps. The samples were placed in labeled, tared, plastic bags and weighed.

The rainbow trout from Mescalero NFH, and the Yaqui and channel catfish from Dexter NFTC were weighed and measured (total length). Each fish was then euthanized and laid on a piece of aluminum foil for further processing.

The five fish in both composite samples MESFP01 & 02, each had a skinless fillet removed from the right side. The fillets were individually weighed on an analytical scale, composited in a chemically cleaned glass jar, and tagged with a waterproof label. These five fillets were combined into a corresponding composite fillet sample (MESFF01 & 02) and analyzed separately. The remaining partial-body (minus the right-side fillet) fish were individually wrapped in the aluminum foil sheet they were lying on.

A five fish composite sample (MESFW01) of catchable-sized whole (no fillets removed) rainbow trout also was collected at Mescalero NFH. This was done as a rough quality assurance measure to verify the precision of mathematically integrating the composite samples of partial fish (MESFP01 & 02) with their corresponding composite fillet samples (MESFF01 &02).

All catfish samples were prepared by removing a skinless fillet. Each fillet was individually weighed and placed in a separate, chemically cleaned, 24-ounce glass container. An egg mass was also taken from one of the moribund Yaqui catfish. The remaining partial-body (minus the muscle fillets) were individually wrapped in the aluminum foil sheet they were lying on, composited, double bagged in plastic, and labeled.

Small fish, (e.g., Leon Springs pupfish and Chihuahua chubs) were sorted by species, and composited into a prelabeled, tared, chemically clean, 24 ounce container and then weighed.

All water, sediment, algae, fish, and fish fillet samples were kept on ice while in the field, then placed in refrigerators at 4 ^{o}C or in locked freezers upon returning to the field office laboratory. Water samples were shipped at approximately 4 ^{o}C and biological samples were shipped on dry ice (in Styrofoam lined shipping containers) to contract analytical laboratories.

Chemical Analyses

Inorganics

Inorganic analyses were performed by Hazleton Environmental Services, Incorporated (HAZL). Each sample underwent 21 inorganic analyses and a percent moisture determination. All elements excluding mercury, arsenic, and selenium were analyzed using Inductively Coupled Plasma Spectroscopy (ICP). Mercury was analyzed using Cold Vapor Atomic Absorption (CVAA). Arsenic and selenium were analyzed using Graphite Furnace Atomic Absorption (GFAA). Percent moisture was determined by oven-drying at 100EC for approximately 12 to 18 hours. A more detailed description of analytical methods for inorganics can be found in Appendix B-1.

Organics

Organic analysis was performed by Mississippi State Chemical Laboratory (MSCL). Five samples, including one Yaqui catfish egg mass (DEXYC07) and four sediment samples (DEXS03, DEXS04, MESS03, MESS04), were submitted for organic analysis. Each sample was analyzed for moisture and 22 other organic compounds and their isomers. Additionally, all sediment samples were analyzed for total organic carbon. Samples MESS03 and MESS04 also underwent analysis for 13 triazine and pyrethroid herbicide compounds (sample DEXS04 was also scanned for four additional triazine compounds). The egg mass sample from Dexter (DEXYC07) was also analyzed for percent lipid content (organic contaminants have a natural affinity to concentrate in lipids; percent lipids would supply an accurate representation of the expected degree of organic contaminant bioaccumulation). A more detailed description of the chemical analyses for organics can be found in Appendix B-2.

Quality Assurance/Quality Control (QA/QC) of analytical results

Each lab, HAZL and MSCL, performed a variety of QA/QC analyses, including a run of procedural blanks, a duplicate sampling of a random set of samples, and an analysis of spike recoveries. In addition, an analysis of standard reference materials was also conducted by HAZL for the inorganic results. All results reported and included in data analyses met QA/QC criteria.

Data Analysis

Inorganic Data

Inorganic data was entered into a Quattro Pro® spreadsheet, codified according to site, habitat specification, matrix, species, and trophic guild. All Dexter NFTC and Mescalero NFH analytical data was reported as both wet and dry weights. Data from the Isleta Lakes site, however, was reported in dry weight only. In order to make wet weight (ww) comparisons, dry weight results were converted to wet weights by the following equation:

Equation A-1. - Dry to wet weight conversion

$$\text{Wet weight} = (\text{Dry weight})[1 - (\text{percent moisture}/100)]$$

After Isleta fish dry weight concentrations had been converted to wet weight, all fish which had fillets removed and corresponding whole body samples submitted for analysis were "integrated" (as the sum of weighted concentrations of the parts of a fish) to yield "whole" fish analytical concentrations. This allows comparisons with other whole body samples as well as with other studies which reported whole body sample contaminant residues.

An example of the "integrated-fish" calculation method is provided below in Equation A-2. Each integrated-fish sample was assigned an identification number similar to the one assigned to the fillet and partial-body samples. For example, SJILFI01 is the sample identification number assigned to the integrated-fish sample that combined the fillet sample, SJILFF01, with the partial-body sample, SJILFP01, according to Equation A-2 below. If a particular analyte concentration was below the reporting limit in the fillet but not in the partial body, then a value of one-half the reporting-limit concentration was assigned during the calculation of the integrated-fish concentration. If both the fillet sample and partial-body sample had an analyte concentration that was below the reporting limit, then the higher of the two reporting limits, preceded by a < symbol, was presented in the data tables (Tables B-1 through B-8) as the integrated-fish concentration.

Equation A-2. - Equation used to reintegrate fillets with remaining partial body fish.

Integrated fish concentration = [(fM/wM) x cF] + [(pM/wM) x cP]

where:
fM mass of a fillet (g)
wM whole body mass = mass of fillet + mass of partial body (g)
cF contaminant concentration in a fillet (mg/kg)
pM mass of partial body (g)
cP contaminant concentration in partial body (mg/kg)

example:
Given:
fM = 20 g
pM = 180 g
wM = fM + pM = 200 g
cF = 0.5 mg/kg
cP = 2.8 mg/kg
Then:
integrated fish concentration = ((20g/200g) x 0.5mg/kg) + ((180g/200g) x 2.8mg/kg)
= 2.57 mg/kg

Fish residue data was integrated for both dry and wet weight determinations. After integration, each sample with a value below the detection limit (<) was divided by two. Additionally, for statistical comparisons, data was natural log transformed. All raw inorganic data are presented in Appendix A-1.

Organic Data

Organic data did not require integration or dry to wet weight conversion. Moreover, organic data underwent little statistical analysis due to limited sample numbers. All raw organic data are presented in Appendix A-2.

INORGANIC RESULTS

Aluminum

Dexter NFTC

Water contained concentrations of aluminum from below detectable concentrations to 0.04 mg/L (Table B-1; unless otherwise noted, inorganic results are wet weight concentrations). Dexter water had a mean of 0.02 mg/L, only slightly above the detection limit for aluminum. Water in ponds at Dexter contained the highest relative concentrations of aluminum.

Concentrations of aluminum in algae ranged from 252 to 255 mg/kg, with a mean of 254 mg/kg. Dexter feed had values of 20.5, 27.1, and 38.1 mg/kg aluminum. The Silver Cup Pellets (feed for developed fish) contained the highest concentrations, whereas the Silver Cup Crumbles, an intermediate life-stage feed, contained only 20.5 mg/kg of aluminum. Sediment at Dexter had a mean concentration of 3197 mg/kg. The sediment was collected from the same ponds which had the higher concentrations of aluminum in water.

Aluminum was undetectable in all channel catfish (*Ictalarus punctatus)*, and was at concentrations of 4.53 and 3.94 mg/kg in Leon Springs pupfish (*Cyprinodon bovinisus)* and Chihuahua chubs (*Gila nigrescens*), respectively. Catfish were collected from a holding house raceway which contained no sediment, while pupfish and chubs were collected from the plunge pool at the hatchery outfall.

Mescalero NFH

Water aluminum concentrations ranged from below detectable concentrations to 0.03 mg/L. Concentrations were relatively similar, as both raceway water and spring water contained the same range of concentrations.

Algae had a mean concentration of 487 mg/kg. Feed contained concentrations of 40.9 to 103.5 mg/kg, and the starter feed, Grower Pellets Starter, contained the highest concentration. Sediment, which was collected at raceway B-6, had a mean concentration of 5825 mg/kg.

Whole body trout concentrations ranged from 1.29 to 28.3 mg/kg of aluminum. Fish fillets had concentrations below the detection limit.

Isleta Lakes Fish

Whole body fish had a mean concentration of 10.96 mg/kg aluminum with a range of 8.95 to 12.97 mg/kg. Fillets had a mean concentration of 6.41 mg/kg with a range of 3.18 to 9.63 mg/kg aluminum.

Spatial Trends

Although water concentrations were similar at both sites, there was a substantial difference between Dexter and Mescalero algae, feed, and sediment aluminum concentrations. Aluminum concentrations in fish followed a similar trend. Although both hatcheries had the same pattern of aluminum bioaccumulation in water, fish, feed, algae, and sediment, the aluminum concentrations in Mescalero were roughly twice that of Dexter. Moreover, the higher aluminum concentrations at Mescalero appear to be uniform and seem largely independent of site or habitat differences. Overall, the elevated aluminum concentrations in fish at Mescalero corresponded to generally higher concentrations of aluminum in feed, algae, and sediment.

Although whole body fish at Mescalero had a mean aluminum concentration approximately twice that of Dexter, fillets at both Dexter and Mescalero were below detection levels. Pupfish and chubs had similar concentrations of aluminum to rainbow trout, despite living in an environment which possessed roughly half the aluminum. Fillet aluminum concentrations in Isleta fish were roughly 12 times those of Mescalero fish.

Table B-1. Geometric means and ranges of aluminum concentrations (mg/kg, wet weight, except water, which is measured in mg/L) in water, sediment, and biological samples collected from Dexter National Fish Technology Center and Mescalero National Fish Hatchery, New Mexico, 1995. Note: gmean = geometric mean; ------- = no value available; S.C.= Silver Cup; G.P.= Biodiet Grower Pellets.

DEXTER NFTC				*MESCALERO NFH*			
matrix	**N**	**gmean**	**range**	**matrix**	**N**	**gmean**	**range**
Water	***6***	***0.02***	***<0.02 - 0.04***	***Water***	***6***	***0.02***	***<0.02 - 0.03***
Raceways	2	0.02	0.02 - 0.02	Spring water	4	0.02	<0.02 - 0.03
Wells	2	0.02	<0.02 - 0.02	Raceways	2	0.02	<0.02 - 0.03
Ponds	2	0.03	0.03 - 0.04	-------	-	-------	-------
Algae	***2***	***254***	***252 - 255***	***Algae***	***3***	***487***	***368 - 713***
Feed	***3***	***27.66***	***20.49 - 38.09***	***Feed***	***3***	***56.8***	***40.9 - 103.5***
S.C. crumbles	1	20.5	-------	G.P. starter	1	104	-------
S.C. starter	1	27.1	-------	G.P. intermediate	1	43.5	-------
S.C. pellets	1	38.1	-------	G.P. finisher	1	40.9	-------
Sediment (Ponds)	***2***	***3197***	***2835 - 3604***	***Sediment (Raceways)***	***2***	***5825***	***5115 - 6700***
Whole Body Fish	***9***	***2.61***	***<0.98 - 5.61***	***Whole Body Fish***	***4***	***4.71***	***1.29 - 28.3***
Channel catfish	2	<0.98	<0.98 - <0.98	Rainbow Trout	4	4.71	1.29 - 28.3
Pupfish	4	4.53	3.53 - 5.58	-------	-	-------	-------
Cyprinids	3	3.94	3.22 - 5.21	-------	-	-------	-------
Fish Fillets	***5***	***<0.98***	***<0.98 - <0.98***	***Fish Fillets***	***2***	***<0.98***	***<0.98 - <0.98***
Yaqui catfish	3	<0.98	<0.98 -<0.98	Rainbow Trout	2	<0.98	<0.98 -<0.98
Channel catfish	2	<0.98	<0.98 -<0.98	-------	-	-------	-------
Isleta Lakes Fish							
Fish Fillets	***2***	***6.41***	***3.18 - 9.63***	***Whole Body Fish***	***2***	***10.96***	***8.95 - 12.97***
Rainbow Trout	2	6.41	3.18 - 9.63	Rainbow Trout	2	10.96	8.95 - 12.97

Arsenic

Dexter NFTC

All six water samples collected at Dexter contained detectable concentrations of arsenic, (Table B-2) with a mean of 0.002 mg/L and a range of 0.001 to 0.005 mg/L. Arsenic was highest in ponds, with a mean four times that of well water.

Algae at Dexter had a mean of 0.99 mg/kg, and ranged from 0.86 to 1.15 mg/kg. Feed had a mean of 2.25 mg/kg. Silver Cup Starter contained the highest concentration, and Silver Cup Pellets had the lowest concentration of arsenic (0.76 mg/kg). Dexter sediment had a mean arsenic concentration of 0.91 mg/kg, and ranged between 0.90 and 0.93 mg/kg.Whole body fish had a mean arsenic concentration of 0.14 mg/kg. Concentrations in channel catfish and Leon Springs pupfish were similar, whereas Chihuahua chubs had a slightly higher whole body arsenic burden (0.18 mg/kg). Channel catfish had similarly low fillet concentrations (0.04 mg/kg), while Yaqui catfish accumulated more arsenic (0.10 mg/kg).

Mescalero NFH

Water was nearly arsenic free. Samples analyzed for arsenic contained concentrations at or below the detection limit. Algae had a mean of 0.55 mg/kg, and ranged from 0.46 to 0.72 mg/kg. Feed had concentrations of arsenic ranging from 2.61 mg/kg (Grower Pellets Finisher) to 3.78 mg/kg (Grower Pellets Starter). Raceway sediment ranged from 0.27 to 1.86 mg/kg arsenic.

Fish from Mescalero contained slightly higher concentrations of arsenic in their fillets than in their whole body. Trout fillets contained 1.01 mg/kg arsenic while whole body trout had a mean concentration of 0.82 mg/kg.

Isleta Lakes Fish

Whole body trout at Isleta contained 0.80 mg/kg arsenic, and fillets had a mean concentration of 0.95 mg/kg, almost identical to the tissue arsenic concentrations found in fish at Mescalero.

Spatial Trends

Although Dexter water, algae, and sediment contained approximately twice the arsenic load of samples collected from Mescalero, Mescalero contained higher concentrations of arsenic in its feed. This may explain the higher concentrations seen in fish whole body and fillet samples. Mescalero trout fillets contained significantly ($p < 0.05$) higher amounts of arsenic than fish from Dexter. Moreover, Mescalero whole body trout samples contained roughly five times more arsenic than Dexter fish. Yet ratios of whole body to fillet concentrations remained similar. Dexter fish had a whole body to fillet ratio of two while Mescalero fish had a ratio slightly less than one.

Another interesting trend is the pattern of accumulation at both hatcheries. Dexter's pattern was: water < fish < sediment < algae < feed. On the other hand, Mescalero's pattern of accumulation was: water < algae < sediment < fish < feed. Fish and algae alternated places in terms of arsenic bioaccumulation (i.e., fish at Mescalero accumulated arsenic similarly to algae in Dexter). The significance of this is uncertain, however, as these differences could be due to many factors, such as feeding behavior and species specific accumulation patterns.

Cadmium

Dexter NFTC

Water, algae, and sediment had cadmium concentrations below the detection limit (Table B-3). Feed, though, had a mean cadmium concentration of 0.09 mg/kg. Silver Cup Starter and Pellets had concentrations of 0.16 and 0.17 mg/kg, respectively.

The cadmium within Dexter feed did not bioaccumulate in fish. All fish fillets and whole bodies contained cadmium below detectable concentrations.

Table B-2. Geometric mean and range of arsenic concentrations (mg/kg, wet weight, except water, which is measured in mg/L) in water, sediment, and biological samples collected from Dexter National Fish Technology Center and Mescalero National Fish Hatchery, New Mexico, 1995. Note: gmean = geometric mean; ------- = non-available value; S.C.= Silver Cup diet; G.P.= Biodiet Grower Pellets.

DEXTER NFTC				*MESCALERO NFH*			
matrix	**N**	**gmean**	**range**	**matrix**	**N**	**gmean**	**range**
Water	***6***	***0.002***	***0.001 - 0.005***	***Water***	***6***	***0.001***	***<0.001 - 0.001***
Raceways	2	0.003	0.003 - 0.003	Spring water	4	0.001	<0.001-0.001
Wells	2	0.001	0.001 - 0.002	Raceways	2	<0.001	<0.001-<0.001
Ponds	2	0.004	0.003 - 0.005	-------	-	-------	-------
Algae	***2***	***0.99***	***0.86 - 1.15***	***Algae***	***3***	***0.55***	***0.46 - 0.72***
Feed	***3***	***2.25***	***0.76 - 4.95***	***Feed***	***3***	***3.16***	***2.61 - 3.78***
S.C. crumbles	1	3.03	-------	G.P. starter	1	3.78	-------
S.C. starter	1	4.94	-------	G.P. intermediate	1	3.15	-------
S.C. pellets	1	0.76	-------	G.P. finisher	1	2.61	-------
Sediment (Ponds)	***2***	***0.91***	***0.90 - 0.93***	***Sediment (Raceways)***	***2***	***0.70***	***0.27 - 1.86***
Whole Body Fish	***9***	***0.14***	***0.07 - 0.24***	***Whole Body Fish***	***4***	***0.82***	***0.64 - 1.19***
Channel catfish	2	0.12	0.11 - 0.13	Rainbow Trout	4	0.82	0.64 - 1.19
Pupfish	4	0.13	0.07 - 0.24	-------	-	-------	-------
Cyprinids	3	0.18	0.16 - 0.19	-------	-	-------	-------
Fish Fillets	***5***	***0.07***	***0.04 - 0.18***	***Fish Fillets***	***2***	***1.01***	***0.85 - 1.20***
Yaqui catfish	3	0.10	0.08 - 0.18	Rainbow Trout	2	1.01	0.85 - 1.20
Channel catfish	2	0.04	0.04 - 0.04	-------	-	-------	-------
Isleta Lakes Fish							
Fish Fillets	***2***	***0.95***	***0.84 - 1.05***	***Whole Body Fish***	***2***	***0.80***	***0.67 - 0.93***
Rainbow Trout	2	0.95	0.84 - 1.05	Rainbow Trout	2	0.80	0.67 - 0.93

Mescalero NFH

Mescalero water, algae and sediment had cadmium concentrations below the detectable level. Feed had a mean concentration of 0.19 mg/kg for cadmium, ranging from 0.17 mg/kg in GP Finisher to 0.20 mg/kg in GP Starter. Fish, however, did not accumulate cadmium.

Isleta Lakes Fish

Whole body samples and one of two trout fillet samples from Isleta Lake had non-detectable levels of cadmium. The other Isleta trout fillet had a mean cadmium concentration of 0.02 mg/kg.

Spatial Trends

No spatial trends were evident.

Copper

Dexter NFTC

Water had a mean copper concentration of 0.003 mg/L (Table B-4). Copper was below detection in water from both raceways and ponds, but was found in one sample taken from a source well. The well sample represents the only detectable concentration of copper found in Dexter water.

Algae had a mean concentration of 1.03 mg/kg, and ranged from 0.95 to 1.11 mg/kg. Feed had a mean concentration of 6.62 mg/kg copper. Silver Cup Pellets feed contained the highest concentration of copper (10.49 mg/kg) while the intermediate life-stage feed, Silver Cup Crumbles, had the lowest concentration of copper (4.35 mg/kg). Sediment had a mean concentration of 10.91 mg/kg copper.

The mean copper concentration in whole body fish was 0.72 mg/kg. Mean fillet concentrations were similar (0.81 mg/kg). Copper concentrations were highest in the pupfish, lower in the chubs, and near the detection limit in channel catfish. Channel catfish fillets had a copper concentration of 1.27 mg/kg and Yaqui catfish fillets contained 0.60 mg/kg copper.

Mescalero NFH

Mescalero water had a mean copper concentration of 0.004 mg/L. Copper concentrations in springs and raceways were similar.

Algae did not contain detectable concentrations of copper. Feed had copper ranging from 5.93 to 21.11 mg/kg. The Grower Pellets Finisher grade had a copper concentration of 21.11 mg/kg, roughly three times the next highest concentration found in the Grower Pellets Starter grade of feed. Sediment had a mean of 51.83 mg/kg copper, ranging from 2.16 to 101.49 mg/kg.

Whole body fish had a mean concentration of 1.80 mg/kg, while trout fillets had a mean concentration of 2.27 mg/kg. Whole body samples and fillets had copper concentrations ranging from 1.59 to 2.24 mg/kg and 1.82 to 2.80 mg/kg, respectively.

Isleta Lakes Fish

Mean fillet copper concentrations were 0.46 mg/L, and whole body concentrations ranged from 1.63 to 2.79 mg/kg (mean of 2.21 mg/kg).

Spatial Trends

Copper concentrations in water and algae samples were similar at Dexter and Mescalero. Mescalero water samples did, however, have a few more detectable concentrations of copper. Feed was quite similar between sites except for Mescalero's adult grade of feed, which contained nearly twice the copper concentration found in Dexter feed. Furthermore, the mean sediment copper concentration at Mescalero was nearly five times that measured in Dexter.

The higher concentrations of copper in feed and sediment may explain the higher concentrations of copper observed in fillets and whole body samples from Mescalero. Although Mescalero copper concentrations were twice that of Dexter, both hatcheries had similar whole body to fillet ratios of copper. Rainbow trout accumulated more copper than channel catfish, but accumulated copper similarly to Dexter pupfish. The whole body to fillet ratio for channel catfish was 0.2, nearly a quarter of the overall whole body to fillet ratio in Dexter fish.

Table B-3. Geometric mean and range of cadmium concentrations (mg/kg, wet weight, except water, which is measured in mg/L) in water, sediment, and biological samples collected from Dexter National Fish Technology Center and Mescalero National Fish Hatchery, New Mexico, 1995. Note: gmean = geometric mean; ------- = non-available value; S.C.= Silver Cup diet; G.P.= Biodiet Grower Pellets.

DEXTER NFTC				*MESCALERO NFH*			
matrix	***N***	***gmean***	***range***	***matrix***	***N***	***gmean***	***range***
Water	***6***	***<0.001***	***<0.001 - <0.002***	***Water***	***6***	***<0.001***	***<0.001 - <0.002***
Raceways	*2*	*<0.001*	*<0.001 - <0.001*	*Spring water*	*4*	*<0.001*	*<0.001 - <0.002*
Wells	*2*	*<0.001*	*<0.001 - <0.002*	*Raceways*	*2*	*<0.001*	*<0.001 - <0.001*
Ponds	*2*	*<0.001*	*<0.001 - <0.002*	-------	-	-------	-------
Algae	***2***	***<0.06***	***<0.06 - <0.06***	***Algae***	***3***	***<0.06***	***<0.06 - <0.06***
Feed	***3***	***0.09***	***<0.06 - 0.17***	***Feed***	***3***	***0.19***	***0.17 - 0.20***
S.C. crumbles	*1*	*<0.06*	-------	*G.P. starter*	*1*	*0.20*	-------
S.C. starter	*1*	*0.16*	-------	*G.P. intermediate*	*1*	*0.19*	-------
S.C. pellets	*1*	*0.17*	-------	*G.P. finisher*	*1*	*0.17*	-------
Sediment (Ponds)	***2***	***<0.14***	***<0.14 - <0.15***	***Sediment (Raceways)***	***2***	***<0.14***	***<0.14 - <0.15***
Whole Body Fish	***9***	***<0.06***	***<0.06 - <0.06***	***Whole Body Fish***	***4***	***<0.06***	***<0.06 - <0.06***
Channel catfish	*2*	*<0.03*	*<0.03 - <0.06*	*Rainbow Trout*	*4*	*<0.06*	*<0.06 - <0.06*
Pupfish	*4*	*<0.06*	*<0.06 - <0.06*	-------	-	-------	-------
Cyprinids	*3*	*<0.06*	*<0.06 - <0.06*	-------	-	-------	-------
Fish Fillets	***5***	***<0.06***	***<0.06 - <0.06***	***Fish Fillets***	***2***	***<0.06***	***<0.06 - <0.06***
Yaqui catfish	*3*	*<0.06*	*<0.06 - <0.06*	*Rainbow Trout*	*2*	*<0.06*	*<0.06 - <0.06*
Channel catfish	*2*	*<0.06*	*<0.06 - <0.06*	-------	-	-------	-------
			Isleta Lakes Fish				
Fish Fillets	***2***	***0.01***	***<0.02 - 0.02***	***Whole Body Fish***	***2***	***<0.02***	***<0.02 - <0.02***
Rainbow Trout	*2*	*0.01*	*<0.02 - 0.02*	*Rainbow Trout*	*2*	*<0.02*	*<0.02 - <0.02*

Trout introduced to Isleta Lakes maintained the same whole body copper concentrations as fish from Mescalero, but copper concentrations in their fillets decreased by almost three times. The whole body to fillet ratio for Isleta Lakes fish was 4.8, six times that of Dexter and Mescalero.

Lead

Dexter NFTC, Mescalero NFH, and Isleta Lakes

Dexter, Mescalero, and Isleta Lakes had no detectable concentrations of lead in its water, algae, feed, whole body fish, or fish fillets (Table B-5). Detectable concentrations of lead were found in Dexter and Mescalero sediments, at mean concentrations of 1.68 and 1.46 mg/kg, respectively.

Mercury

Dexter NFTC

Five out of the six water samples collected at Dexter had mercury concentrations below the detection limit (Table B-6). The sixth sample, however, had a mercury concentration of 0.0006 mg/L. This sample was taken from the southeast sump location.

Algae had a mean mercury concentration of 0.021 mg/kg. Feed had a mean concentration of 0.070 mg/kg, and the final grade, Silver Cup Pellets, contained the lowest concentration (0.043 mg/kg). Both the beginning and intermediate grades of feed contained similar concentrations of mercury, 0.088 and 0.091 mg/kg, respectively. Sediment had a mean concentration of 0.026 mg/kg.

Whole body fish had a mean mercury concentration of 0.034 mg/kg. The two channel catfish contained mercury concentrations ranging from 0.025 to 0.037 mg/kg, and pupfish ranged from 0.012 to 0.157 mg/kg. Chihuahua chubs had a mean concentration of 0.051 mg/kg. Fillets had a mean concentration of 0.081 mg/kg, and Yaqui catfish contained mercury from 0.039 to 0.239 mg/kg. Channel catfish contained a mean mercury concentration of 0.054 mg/kg.

Mescalero NFH

Only one water sample contained a detectable mercury concentration, 0.0002 mg/L, and was collected from a raceway. Algae had a mean of 0.013 mg/kg, ranging from 0.012 to 0.016 mg/kg. Feed had mean of 0.120 mg/kg. The Grower Pellets Intermediate feed contained mercury at a concentration of 0.181 mg/kg. The other two grades of feed, Grower Pellets Starter and Intermediate, had concentrations of 0.089 and 0.108 mg/kg, respectively. Sediment samples had a mean concentration of 0.034 mg/kg, ranging from 0.018 mg/kg to 0.065 mg/kg.

Concentrations of mercury in trout were consistent, ranging from 0.080 to 0.088 mg/kg. Likewise, fillets had concentrations ranging from 0.094 to 0.108 mg/kg with a mean of 0.100 mg/kg.

Isleta Lakes Fish

Both fish sampled from Isleta Lakes had whole body mercury concentrations of 0.05 mg/kg. Fillets from the same fish had an average concentration of 0.08 mg/kg and a range of values from 0.07 to 0.08 mg/kg mercury.

Table B-4. Geometric mean and range of copper concentrations (mg/kg, wet weight, except water, which is measured in mg/L) in water, sediment, and biological samples collected from Dexter National Fish Technology Center and Mescalero National Fish Hatchery, New Mexico, 1995. Note: gmean = geometric mean; ------- = non-available value; S.C.= Silver Cup diet; G.P.= Biodiet Grower Pellets.

DEXTER NFTC				MESCALERO NFH			
matrix	***N***	***gmean***	***range***	***matrix***	***N***	***gmean***	***range***
Water	***6***	***0.003***	***<0.007 - 0.003***	***Water***	***6***	***0.004***	***<0.002 - 0.006***
Raceways	*2*	*<0.007*	*<0.007 - <0.007*	*Spring water*	*4*	*0.004*	*<0.002 - 0.005*
Wells	*2*	*0.003*	*<0.007 - 0.003*	*Raceways*	*2*	*0.004*	*0.003 - 0.006*
Ponds	*2*	*<0.007*	*<0.007 - <0.007*	-------	-	-------	-------
Algae	***2***	***1.03***	***0.95 - 1.11***	***Algae***	***3***	***<1.79***	***<1.78 - <1.79***
Feed	***3***	***6.62***	***4.35 - 10.49***	***Feed***	***3***	***9.87***	***5.93 - 21.11***
S.C. crumbles	*1*	*4.35*	-------	*G.P. starter*	*1*	*7.65*	-------
S.C. starter	*1*	*6.39*	-------	*G.P. intermediate*	*1*	*5.93*	-------
S.C. pellets	*1*	*10.49*	-------	*G.P. finisher*	*1*	*21.11*	-------
Sediment (Ponds)	***2***	***10.91***	***7.21 - 16.61***	***Sediment (Raceways)***	***2***	***51.83***	***2.16 - 101.49***
Whole Body Fish	***9***	***0.72***	***<0.30 - 2.61***	***Whole Body Fish***	***4***	***1.80***	***1.59 - 2.24***
Channel catfish	*2*	*0.25*	*<0.30 -0.35*	*Rainbow Trout*	*4*	*1.80*	*1.59 - 2.24*
Pupfish	*4*	*1.67*	*0.69 - 2.61*	-------	-	-------	-------
Cyprinids	*3*	*0.94*	*0.37 - 2.25*	-------	-	-------	-------
Fish Fillets	***5***	***0.81***	***0.30 - 1.43***	***Fish Fillets***	***2***	***2.27***	***1.82 - 2.80***
Yaqui catfish	*3*	*0.60*	*0.30 -1.28*	*Rainbow Trout*	*2*	*2.27*	*1.82 - 2.80*
Channel catfish	*2*	*1.27*	*1.13 -1.43*	-------	-	-------	-------
			Isleta Lakes Fish				
Fish Fillets	***2***	***0.46***	***0.46 - 0.46***	***Whole Body Fish***	***2***	***2.21***	***1.63 - 2.79***
Rainbow Trout	*2*	*0.46*	*0.46 - 0.46*	*Rainbow Trout*	*2*	*2.21*	*1.63 - 2.79*

Spatial Trends

Five of the six samples collected from each site had mercury concentrations below the detection limit.

Algae sampled at Dexter had approximately one and a half times higher mercury concentrations than algae sampled at Mescalero. Both Dexter and Mescalero feeds were relatively similar (discounting the one outlying feed sample (G.P. Intermediate) measured at Mescalero). Mescalero sediment mercury concentrations were also slightly higher than Dexter's.

Whole body fish mercury concentrations at Mescalero were higher than those at Isleta and Dexter. Even the pupfish and chubs, which typically contain higher metal body burdens, contained concentrations of mercury approximately half that of trout from Mescalero. The whole body to fillet ratios for Dexter channel catfish and for Isleta fish were approximately 0.6, while the whole body to fillet ratio for Mescalero was 0.85.

Selenium

Dexter NFTC

All except one water sample collected at Dexter had detectable concentrations of selenium (Table B-7). Raceway water selenium concentrations ranged from 0.004 to 0.015 mg/L. Well water had one non-detectable concentration and one at 0.009 mg/kg. Pond water ranged from 0.007 to 0.010 mg/L selenium. Raceway and pond water contained the highest concentrations of selenium.

Algae had a mean selenium concentration of 3.86 mg/kg, ranging from 3.76 to 3.98 mg/kg. Feed had selenium values ranging from 1.33 to 5.99 mg/kg. Silver Cup Crumbles had a concentration of 1.33 mg/kg while Silver Cup Starter and Pellets had concentrations of 5.27 and 5.99 mg/kg, respectively. The mean selenium concentration for feed was 3.49 mg/kg. Sediment had a mean selenium concentration of 2.25 mg/kg.

Whole body fish had a mean concentration of 7.76 mg/kg. Channel catfish only contained 1.58 mg/kg selenium, while the pupfish had a mean concentration of 14.44 mg/kg. Chubs contained 9.78 mg/kg selenium. Fillets from the same channel catfish had a mean selenium concentration of 1.45 mg/kg, and fillets from the Yaqui catfish had a mean concentration of 2.77 mg/kg.

Mescalero NFH

All but one water sample collected contained non-detectable concentrations of selenium, with a maximum value of 0.003 mg/L from a spring sample.

Algae had a mean selenium concentration of 1.01 mg/kg, ranging from 0.76 to 1.26 mg/kg. Feed had a mean concentration of 1.99 mg/kg. The Grower Pellets Intermediate had the lowest concentration, 0.95 mg/kg. The Grower Pellets Finisher had 2.48 mg/kg, while the beginning grade, Grower Pellets Starter, had 3.41 mg/kg. Sediment had a mean selenium concentration of 0.76 mg/kg, with a range from 0.52 to 1.11 mg/kg.

Whole body trout had a mean concentration of 1.52 mg/kg, ranging from 1.11 to 2.08 mg/kg. Fillets had slightly higher concentrations, with a mean of 1.92 mg/kg and a range of 1.65 to 2.23 mg/kg.

Isleta Lakes Fish

Both samples of fish stocked at Isleta Lakes had a mean whole body concentration of 1.25 mg/kg, selenium. Fillets from the same fish had 0.80 and 0.90 mg/kg Se.

Spatial Trends

Water from all Dexter sites had a mean selenium concentration slightly greater than that of Mescalero water; sediment at Dexter had selenium concentrations which were nearly three times that found at Mescalero, and algae at Dexter had a mean selenium concentration almost four times that found at Mescalero (water to algae concentration ratios at Dexter and Mescalero were 1.55×10^{-3} and 1.98×10^{-3}, respectively). Intermediate grades of feed were

Table B-5. Geometric mean and range of lead concentrations (mg/kg, wet weight, except water, which is measured in mg/L) in water, sediment, and biological samples collected from Dexter National Fish Technology Center and Mescalero National Fish Hatchery, New Mexico, 1995. Note: gmean = geometric mean; ------- = non-available value; S.C.= Silver Cup diet; G.P.= Biodiet Grower Pellets.

	DEXTER NFTC				MESCALERO NFH		
matrix	N	gmean	range	matrix	N	gmean	range
Water	**6**	**<0.011**	**<0.010 - <0.013**	**Water**	**6**	**<0.010**	**<0.010 - <0.013**
Raceways	2	<0.010	<0.010 - <0.010	Spring water	4	<0.011	<0.010 - <0.013
Wells	2	<0.010	<0.010 - <0.010	Raceways	2	<0.010	<0.010 - <0.010
Ponds	2	<0.013	<0.013 - <0.013	-------	-	-------	-------
Algae	**2**	**<0.49**	**<0.49 - <0.49**	**Algae**	**3**	**<0.50**	**<0.49 - <0.50**
Feed	**3**	**<0.49**	**<0.49 - <0.49**	**Feed**	**3**	**<0.49**	**<0.49 - <0.49**
S.C. crumbles	1	<0.49	-------	G.P. starter	1	<0.49	-------
S.C. starter	1	<0.49	-------	G.P. intermediate	1	<0.49	-------
S.C. pellets	1	<0.49	-------	G.P. finisher	1	<0.49	-------
Sediment (Ponds)	**2**	**1.68**	**1.57 - 1.79**	**Sediment (Raceways)**	**2**	**1.46**	**<1.20 - 3.56**
Whole Body Fish	**9**	**<0.49**	**<0.49 - <0.50**	**Whole Body Fish**	**4**	**<0.49**	**<0.49 - <0.49**
Channel catfish	2	<0.49	<0.49 - <0.50	Rainbow Trout	4	<0.49	<0.49 -<0.49
Pupfish	4	<0.49	<0.49 - <0.49	-------	-	-------	-------
Cyprinids	3	<0.49	<0.49 - <0.49	-------	-	-------	-------
Fish Fillets	**5**	**<0.49**	**<0.49 - <0.49**	**Fish Fillets**	**2**	**<0.49**	**<0.49 - <0.49**
Yaqui catfish	3	<0.49	<0.49 - <0.49	Rainbow Trout	2	<0.49	<0.49 - <0.49
Channel catfish	2	<0.49	<0.49 - <0.49	-------	-	-------	-------
			Isleta Lakes Fish				
Fish Fillets	**2**	**<0.50**	**<0.50 - <0.50**	**Whole Body Fish**	**2**	**<0.50**	**<0.50 - <0.50**
Rainbow Trout	2	<0.50	<0.50 - <0.50	Rainbow Trout	2	<0.50	<0.50 - <0.50

Table B-6. Geometric mean and range of mercury concentrations (mg/kg, wet weight, except water, which is measured in mg/L) in water, sediment, and biological samples collected from Dexter National Fish Technology Center and Mescalero National Fish Hatchery, New Mexico, 1995. Note: gmean = geometric mean; ------- = non-available value; S.C.= Silver Cup diet; G.P.= Biodiet Grower Pellets.

	DEXTER NFTC				MESCALERO NFH		
matrix	**N**	**gmean**	**range**	**matrix**	**N**	**gmean**	**range**
Water	***6***	***0.0001***	***<0.0002 - 0.0006***	***Water***	***6***	***<0.0002***	***<0.0002 - 0.0002***
Raceways	2	<0.0002	<0.0002 -<0.0002	Spring water	4	<0.0002	<0.0002 - <0.0002
Wells	2	<0.0002	<0.0002 -<0.0002	Raceways	2	<0.0002	<0.0002 - 0.0002
Ponds	2	0.0002	<0.0002 - 0.0006	-------	-	-------	-------
Algae	***2***	***0.021***	***0.019 - 0.025***	***Algae***	***3***	***0.013***	***0.012 - 0.016***
Feed	***3***	***0.070***	***0.043 - 0.091***	***Feed***	***3***	***0.120***	***0.089 - 0.181***
S.C. crumbles	1	0.091	-------	G.P. starter	1	0.089	-------
S.C. starter	1	0.088	-------	G.P. intermediate	1	0.181	-------
S.C. pellets	1	0.043	-------	G.P. finisher	1	0.108	-------
Sediment (Ponds)	***2***	***0.026***	***0.024 - 0.029***	***Sediment (Raceways)***	***2***	***0.034***	***0.018 - 0.065***
Whole Body Fish	***9***	***0.034***	***0.012 - 0.227***	***Whole Body Fish***	***4***	***0.085***	***0.080 - 0.088***
Channel catfish	2	0.031	0.025 - 0.037	Rainbow Trout	4	0.085	0.080 - 0.088
Pupfish	4	0.026	0.012 - 0.157	-------	-	-------	-------
Cyprinids	3	0.051	0.019 - 0.227	-------	-	-------	-------
Fish Fillets	***5***	***0.081***	***0.026 - 0.239***	***Fish Fillets***	***2***	***0.100***	***0.094 - 0.108***
Yaqui catfish	3	0.107	0.039 - 0.239	Rainbow Trout	2	0.100	0.094 - 0.108
Channel catfish	2	0.054	0.026 - 0.112	-------	-	-------	-------
				Isleta Lakes Fish			
Fish Fillets	***2***	***0.08***	***0.07 - 0.08***	***Whole Body Fish***	***2***	***0.05***	***0.05 - 0.05***
Rainbow Trout	2	0.08	0.07 - 0.08	Rainbow Trout	2	0.05	0.05 - 0.05

similar at both hatcheries, but the beginning and finishing grades of feed from Dexter contained nearly twice the selenium load of feed from Mescalero.

Mean selenium concentrations in whole body samples were significantly higher at Dexter than at Mescalero ($p < 0.05$). The Leon Springs pupfish and Chihuahua chubs from Dexter had the highest tissue selenium concentrations, while the two channel catfish (whole body and fillet) had extremely similar selenium concentrations to rainbow trout from Mescalero. Yaqui catfish at Dexter also accumulated more selenium than trout from Mescalero. Whole body to fillet ratios for channel catfish at Dexter are near one, but catfish and the smaller fish collected as a group had a whole body to fillet ratio of 3.6. The whole body to fillet ratios for Mescalero and Isleta are roughly 0.80 and 1.5, respectively. Selenium concentrations in fish stocked at Isleta Lakes are lower than fish from Mescalero.

Zinc

<u>Dexter NFTC</u>

Most water contained detectable concentrations of zinc, with a mean of 0.017 mg/kg (Table B-8). Raceway water had a mean of 0.023 mg/L, well water a mean of 0.019 mg/L, and pond water a mean of 0.011 mg/kg. The highest zinc concentration was found in a well water sample, at a concentration of 0.027 mg/kg.

Algae had a mean zinc concentration of 11.0 mg/kg, ranging from 10.2 to 12.0 mg/kg. Feed had a mean of 64.56 mg/kg. The Silver Cup beginning grade of feed contained 1.29 mg/kg, the Silver Cup intermediate grade contained 81.4 mg/kg, and the Silver Cup finishing grade contained 111 mg/kg. Sediment had a mean zinc concentration of 38.1 mg/kg, with a maximum value of 47.7 mg/kg.

Whole body fish had a mean concentration of 25.9 mg/kg. Channel catfish had the lowest concentration, 14.1 mg/kg, while Leon Springs pupfish and Chihuahua chubs had mean concentrations of 24.5 and 41.7 mg/kg, respectively. Fillets from the same channel catfish had a mean zinc concentration of 8.17 mg/kg, and Yaqui catfish had a mean concentration of 9.30 mg/kg, ranging from 8.25 to 11.59 mg/kg.

<u>Mescalero NFH</u>

Water had a mean zinc concentration of 0.013 mg/L. Spring water ranged from 0.009 to 0.022 mg/L and raceway water ranged from 0.011 to 0.012 mg/L.

The three algae samples had a mean of 2.9 mg/kg with a maximum concentration of 3.8 mg/kg. Mescalero feed had a mean zinc concentration of 131.6 mg/kg. The Grower Pellets beginning grade of feed contained 130 mg/kg zinc, the intermediate grade had 93.6 mg/kg, and the finishing grade had 189.0 mg/kg. Mescalero sediment had a mean concentration of 15.3 mg/kg.

Whole body trout had a mean zinc concentration of 36.0 mg/kg ranging from 27.7 to 49.4 mg/kg. Fillets from two of the same fish had a mean zinc concentration of 3.56 mg/kg, ranging from 3.39 to 3.74 mg/kg.

<u>Isleta Lakes Fish</u>

Whole body rainbow trout had a mean zinc concentration of 37.06 mg/kg. Fillets from the same fish had a mean concentration of 4.37 mg/kg with a range from 3.85 to 4.89 mg/kg.

Table B-7. Geometric mean and range of selenium concentrations (mg/kg, **dry weight**, except water, which is measured in mg/L) in water, sediment, and biological samples collected from Dexter National Fish Technology Center and Mescalero National Fish Hatchery, New Mexico, 1995. Note: gmean = geometric mean; ------- = non-available value; S.C.= Silver Cup diet; G.P.= Biodiet Grower Pellets.

DEXTER NFTC				*MESCALERO NFH*			
matrix	**N**	**gmean**	**range**	**matrix**	**N**	**gmean**	**range**
Water	***6***	***0.006***	***<0.002 - 0.015***	***Water***	***6***	***0.002***	***<0.002 - 0.003***
Raceways	2	0.008	0.004 - 0.015	Spring water	4	0.002	<0.002 - 0.003
Wells	2	0.003	<0.002 - 0.009	Raceways	2	0.002	0.002 - 0.002
Ponds	2	0.008	0.007 - 0.010	-------	-	-------	-------
Algae	***2***	***3.86***	***3.76 - 3.98***	***Algae***	***3***	***1.01***	***0.76 - 1.26***
Feed	***3***	***3.49***	***1.34 - 5.99***	***Feed***	***3***	***1.99***	***0.95 - 3.42***
S.C. crumbles	1	1.33	-------	G.P. starter	1	3.41	-------
S.C. starter	1	5.27	-------	G.P. intermediate	1	0.95	-------
S.C. pellets	1	5.99	-------	G.P. finisher	1	2.48	-------
Sediment (Ponds)	***2***	***2.25***	***2.04 - 2.48***	***Sediment (Raceways)***	***2***	***0.76***	***0.52 - 1.11***
Whole Body Fish	***9***	***7.76***	***1.55 - 17.74***	***Whole Body Fish***	***4***	***1.52***	***1.11 - 2.08***
Channel catfish	2	1.58	1.55 - 1.60	Rainbow Trout	4	1.52	1.11 - 2.08
Pupfish	4	14.44	12.30 - 17.81	-------	-	-------	-------
Cyprinids	3	9.78	7.39 - 12.94	-------	-	-------	-------
Fish Fillets	***5***	***2.14***	***1.01 - 3.63***	***Fish Fillets***	***2***	***1.92***	***1.65 - 2.23***
Yaqui catfish	3	2.77	2.14 - 3.63	Rainbow Trout	2	1.92	1.65 - 2.23
Channel catfish	2	1.45	1.01 - 2.10	-------	-	-------	-------
Isleta Lakes Fish							
Fish Fillets	***2***	***0.85***	***0.80 - 0.90***	***Whole Body Fish***	***2***	***1.25***	***1.25 - 1.25***
Rainbow Trout	2	0.85	0.80 - 0.90	Rainbow Trout	2	1.25	1.25 - 1.25

Spatial Trends

Zinc concentrations in water samples were relatively the same between Dexter and Mescalero. Zinc concentrations in Dexter algae were 3.8 times higher than Mescalero algae. Zinc in Mescalero feed was nearly double that of Dexter's, with every grade of feed containing higher amounts of zinc than those found at Dexter. Dexter sediment had concentrations of zinc more than double those found at Mescalero.

Chubs and pupfish had concentrations similar to the rainbow trout found at Mescalero, but channel catfish had much lower zinc concentrations. Both Yaqui and channel catfish had similar concentrations of zinc. Rainbow trout from Mescalero had considerably less zinc in their fillets than in whole body samples. Whole body to fillet concentration ratios were 1.72 for channel catfish and 10.11 for Mescalero trout. Zinc concentrations in trout did not change upon introduction to Isleta.

Table B-8. Geometric mean and range of zinc concentrations (mg/kg, wet weight, except water, which is measured in mg/L) in water, sediment, and biological samples collected from Dexter National Fish Technology Center and Mescalero National Fish Hatchery, New Mexico, 1995. Note: gmean = geometric mean; ------- = non-available value; S.C.= Silver Cup diet; G.P.= Biodiet Grower Pellets.

DEXTER NFTC				*MESCALERO NFH*			
matrix	**N**	**gmean**	**range**	**matrix**	**N**	**gmean**	**range**
Water	***6***	***0.017***	***<0.013 - 0.027***	***Water***	***6***	***0.013***	***0.009 - 0.022***
Raceways	2	0.023	0.022 - 0.023	Spring water	4	0.013	0.009 - 0.022
Wells	2	0.019	0.014 - 0.027	Raceways	2	0.011	0.011 - 0.012
Ponds	2	0.011	<0.013 - 0.018	-------	-	-------	-------
Algae	***2***	***11.0***	***10.2 - 12.0***	***Algae***	***3***	***2.9***	***1.8 - 3.8***
Feed	***3***	***64.56***	***1.29 - 111***	***Feed***	***3***	***131.6***	***93.6 - 189.0***
S.C. crumbles	1	81.4	-------	G.P. starter	1	130.0	-------
S.C. starter	1	1.29	-------	G.P. intermediate	1	93.6	-------
S.C. pellets	1	111	-------	G.P. finisher	1	189.0	-------
Sediment (Ponds)	***2***	***38.1***	***30.2 - 47.7***	***Sediment (Raceways)***	***2***	***15.3***	***15.0 - 15.6***
Whole Body Fish	***9***	***25.9***	***11.8 - 61.0***	***Whole Body Fish***	***4***	***36.0***	***27.7 - 49.4***
Channel catfish	2	14.1	11.8 - 16.7	Rainbow Trout	4	36.0	27.7 - 49.4
Pupfish	4	24.5	12.8 - 32.5	-------	-	-------	-------
Cyprinids	3	41.7	22.6 - 61.0	-------	-	-------	-------
Fish Fillets	***5***	***8.85***	***7.24 - 11.59***	***Fish Fillets***	***2***	***3.56***	***3.39 - 3.74***
Yaqui catfish	3	9.30	8.25 - 11.59	Rainbow Trout	2	3.56	3.39 - 3.74
Channel catfish	2	8.17	7.24 - 9.30	-------	-	-------	-------
Isleta Lakes Fish							
Fish Fillets	***2***	***4.37***	***3.85 - 4.89***	***Whole Body Fish***	***2***	***37.06***	***34.53 - 39.58***
Rainbow Trout	2	4.37	3.85 - 4.89	Rainbow Trout	2	37.06	34.53 - 39.58

ORGANICS RESULTS

Only compounds at or above the detection limit are reported below.

PCBs

Only one sample, DEXYC07, the Yaqui catfish egg mass from Dexter, had detectable concentrations of PCBs (Appendix A-2). The egg mass had a PCB concentration of 0.23 mg/kg, with a lipid percentage of 19.9 percent (this lipid percentage is shown in Table B-9, along with other national lipid data queried from the Service's Environmental Contaminants Data Management System (ECDMS) database).

p,p'-DDD, p,p'-DDE

Only one sample, the Yaqui catfish egg mass from Dexter, had detectable concentrations of both p,p'-DDD and p,p'-DDE (Appendix A-2). For p,p'-DDD, the egg mass had a concentration of 0.015 mg/kg, and a p,p'-DDE concentration of 0.082 mg/kg.

Table B-9. Lipid percentages (%) found in egg masses for the catfish family (Ictaluridae) nationally. The fish's common name, taxonomy, lipid percentage, and the mean lipid percentage for its species are given (excepting theYaqui catfish, all data is from the Service's Environmental Contaminants Data Management System (ECDMS) database)

Common Name	Taxonomic name	Lipid Percentage (%) [a]	Mean for species (%)
Black bullhead catfish	*Ictalarus melas*	4.47	4.47
Blue catfish	*Ictalarus furcatus*	16.38	9.80
Blue catfish	*Ictalarus furcatus*	3.21	9.80
Brown bullhead catfish	*Ictalarus nebulosus*	3.28	1.94
Brown bullhead catfish	*Ictalarus nebulosus*	1.85	1.94
Brown bullhead catfish	*Ictalarus nebulosus*	1.55	1.94
Brown bullhead catfish	*Ictalarus nebulosus*	2.09	1.94
Brown bullhead catfish	*Ictalarus nebulosus*	0.93	1.94
Channel catfish*	*Ictalarus punctatus*	3.80	7.16
Channel catfish	*Ictalarus punctatus*	9.70	7.16
Channel catfish	*Ictalarus punctatus*	7.97	7.16
Flathead catfish	*Pylodictis olivaris*	3.03	3.58
Flathead catfish	*Pylodictis olivaris*	4.13	3.58
Yaqui catfish [b]	*Ictalarus pricei*	19.90	19.90
Yellow bullhead catfish	*Ictalarus natalis*	2.04	1.83
Yellow bullhead catfish	*Ictalarus natalis*	2.52	1.83
Yellow bullhead catfish	*Ictalarus natalis*	0.93	1.83
Mean lipid percentage for all catfish samples in ECDMS database (%)			4.24

* Channel catfish are considered the best histological representation of Yaqui catfish.

a From data compiled at Patuxent Analytical Control Facility.

b Determined in this study.

INORGANICS DISCUSSION

Aluminum

Interpretation

Mescalero had higher aluminum concentrations than Dexter in algae, feed, sediment, and whole body fish. Water and fillet concentrations of aluminum were equal between sites. The higher feed and sediment aluminum concentrations in Mescalero could explain the higher whole body fish aluminum concentrations measured in Mescalero rainbow trout. However, any conclusion about differences in fish tissue metal content must consider species differences (i.e., feeding behavior, physiology), trophic level, or histogenic factors affecting metal accumulation. For instance, even though the pupfish and chubs typically accumulated higher concentrations of metals (relative to Dexter catfish), the Leon Springs pupfish and Chihuahua chubs had aluminum body burdens similar to rainbow trout, demonstrating that numerous, complex mechanisms influence metal accumulation, and these mechanisms vary according to the metal.

Upon introduction to Isleta Lakes, concentrations of aluminum in rainbow trout increased in both whole body and muscle samples. The reason for this is unknown, but one possibility is that Isleta Lakes contained higher concentrations of aluminum in the sediment and the water than at the Mescalero NFH, which resulted in increased aluminum ingestion and subsequent tissue uptake. No sediments, however, were sampled at Isleta Lakes for this study.

Comparison

Water aluminum concentrations at both sites are well below the most stringent criteria, 0.05 mg/L, established by the British Columbia Ministry of Environment Lands and Parks (BCMOELP) in 1994 for the protection of aquatic life (the criteria is applicable assuming a pH above 6.5; Dexter and Mescalero have pHs ranging from 8.0 to 8.5. Also, see Table B-10 for a comparison of water metal concentrations to State of New Mexico water quality standards). Sediment aluminum concentrations from both sites are also well below the United States background of 5,000 to 10,000 mg/kg (Shacklette and Boerngen, 1985). Dexter and Mescalero fish tissue concentrations of aluminum were also well below the concentration known to adversely effect predatory birds consuming them, 200 mg/kg wet weight (NRC, 1980), and the USFWS Southwestern regional mean, 30 mg/kg (Tables B-11 and B-12). Although aluminum concentrations in Isleta Lakes fish were higher than those of Dexter and Mescalero, they were not elevated to concentrations of concern for fish health or human and predator consumption.

Arsenic

Interpretation

The slightly higher concentrations of arsenic in Dexter waters correspond to slightly elevated arsenic concentrations in algae. But even though water, sediment, and algae arsenic concentrations were lower in Mescalero than in Dexter, Mescalero fish had roughly six times the tissue arsenic concentrations than fish from Dexter. One potential source of this arsenic was the feed. On average, arsenic concentrations in the Mescalero feed were slightly greater than in Dexter's. Adult feeds from Mescalero had over three times more arsenic than adult feed from Dexter.

An alternative explanation for the differences in tissue arsenic concentrations between hatcheries is that arsenic biliary excretion is enhanced seven to tenfold in the presence of selenium (NRC Canada, 1978; National Library of Medicine, 1988). Thus, the high selenium concentrations in Dexter may promote greater arsenic excretion, and thus lower tissue concentrations than Mescalero. Ultimately, however, both selenium and arsenic synergism, species-specific arsenic bioaccumulation tendencies, and differences in bioavailable concentrations of arsenic, probably contribute to the differences observed in arsenic concentrations between sites.

Table B-10. Comparison of water quality data from Dexter NFTC and Mescalero NFH in 1995 with State of New Mexico or EPA acute and chronic water quality standards (mg/L). Note: ND = number of detections; gmean = geometric mean; exceedences = number of times water exceeds standards.

		Dexter NFTC			*Mescalero NFH*		
Element	**NM Standard**	**ND**	**gmean**	**exceedences**	**ND**	**gmean**	**exceedences**
Aluminum							
Acute	0.75	5	0.02	0	4	0.02	0
Chronic	0.087	5	0.02	0	4	0.02	0
Arsenic							
Acute	0.360	6	0.002	0	2	0.001	0
Chronic	0.190	6	0.002	0	2	0.001	0
Cadmium*							
Acute	0.019	0	<0.001	0	0	<0.001	0
Chronic	0.0034	0	<0.001	0	0	<0.001	0
Copper*							
Acute	0.065	1	0.003	0	3	0.004	0
Chronic	0.039	1	0.003	0	3	0.004	0
Lead*							
Acute	0.48	0	<0.011	0	0	<0.010	0
Chronic	0.019	0	<0.011	0	0	<0.010	0
Mercury							
Acute	0.0024	0	0.0001	0	0	<0.0002	0
Chronic	0.000012	1	0.0001	1	0	<0.0002	0
Selenium							
Acute	0.02	5	0.006	0	5	0.002	0
Chronic	0.002	5	0.006	5	5	0.002	1
Zinc*							
Acute	0.38	5	0.017	0	6	0.013	0
Chronic	0.34	5	0.017	0	6	0.013	0

*Values have been determined assuming a hardness value of >400 mg/L

Table B-11. Trace-metal concentrations in whole body fish samples (mg/kg wet weight) .

Element	*Dexter*[a]	*Mescalero*[b]	*Isleta*[b]	*USFWS*[c] *Southwest (± 2*SE)*	*NCBP*[d] *85th Percentile*	*Adverse Effect Threshold*[e]
Al	2.61	4.71	10.96	29.85 (± 11.42)	NA	NA
As	0.14	0.82	0.80	0.16 (± 0.04)	0.27	0.50 (health impairment)
Cd	< 0.06	< 0.06	< 0.02	0.02 (± 0.01)	0.05	0.10 (reproductive impairment)
Cu	0.72	1.80	2.21	1.68 (± 0.32)	1.00	NA
Pb	< 0.49	< 0.49	< 0.50	0.10 (± 0.04)	0.22	NA
Hg	0.034	0.085	0.050	ND	0.17	0.50 (health impairment)
Se	2.33	0.46	0.38	1.04 (± 0.19)	0.73	3.0 (health impairment) [g]
Zn	25.90	36.00	37.06	23.09 (± 2.16)	34.20	NA

Table B-12. Trace-metal concentrations in fish muscle fillets (mg/kg wet weight).

Element	*Dexter*	*Mescalero*	*Isleta*	*USFWS Southwest (± 2*SE)*
Al	< 0.98	< 0.98	6.41	2.62 (± 1.18)
As	0.07	1.01	0.95	0.10 (± 0.02)
Cd	< 0.06	< 0.06	0.01	0.03 (± 0.02)
Cu	0.81	2.27	0.46	0.37 (± 0.07)
Pb	< 0.49	< 0.49	< 0.50	0.17 (± 0.06)
Hg	0.081	0.100	0.080	NA
Se	0.64	0.58	0.26	0.48 (± 0.08)
Zn	8.85	3.56	4.37	4.64 (± 0.82)

a Combined geometric mean from channel catfish, pupfish, and cyprinids.
b Rainbow trout geometric means.
c Samples collected by USFWS Contaminant Programs in Nevada, New Mexico, and Utah.
d Schmitt and Brumbaugh (1990), National Contaminant Biomonitoring Program, 1985.
e Irwin (1998); The "Adverse Effect Threshold" is the approximate concentration that has been associated with various sublethal impairments to the fish, such as decreased reproductive capacity or growth.
f NA = Not Available.
[g] Lemly, 1993.

Comparison

Both Dexter and Mescalero have water arsenic concentrations below the most stringent guideline for the protection of aquatic life, 0.05 mg/L (MENVIQ, 1990). Some of this arsenic is bioaccumulated in algae, but not to concentrations greater than typical background values. Sediment from both Dexter and Mescalero is also below the 3 mg/kg "no effect" threshold for the protection of aquatic life (Environment Canada, 1992) and similar to typical background concentrations from uncontaminated areas in the Southwest. Feed from both sites is also below the "no effect" threshold for a rainbow trout diet, 10 mg/kg (Eisler, 1988), suggesting that although tissue arsenic concentrations are elevated in fish from Mescalero, there should not be any adverse effects to the fish themselves.

Nonetheless, rainbow trout from Mescalero exceed the NCBP 85th percentile value for arsenic in whole body fish, 0.27 mg/kg (Schmitt and Brumbaugh, 1990), the USFWS Southwestern regional whole body and fillet tissue concentrations (0.16 mg/kg and 0.10 mg/kg, respectively), and the 0.5 mg/kg maximum tissue concentration recommended to protect fish and the predators consuming them (Walsh et al., 1977). Site-specific factors affecting arsenic toxicity and bioconcentration must be determined, however, before any decisions can be made on how to reduce fish tissue arsenic concentrations at Mescalero NFH and in Isleta lakes.

Cadmium

Comparison

Only feed and trout from Isleta contained detectable concentrations of cadmium. Feed concentrations of cadmium were below the standard of 0.5 mg/kg established for fishery use by six different countries (Klots, 1966; Pastorok, 1987), and trout had cadmium concentrations below the avian risk threshold of 0.1 mg/kg (Eisler, 1985). Cadmium concentrations in hatchery feeds and introduced rainbow trout do not appear to be of concern.

Copper

Interpretation

Copper concentrations in water, algae, and feed are similar between Dexter and Mescalero. But raceway sediment from Mescalero had five times more copper than sediment from Dexter. The elevated whole body copper concentrations measured in Mescalero trout may be due to fish scavenging for food in the sediments. Copper burdens in the Leon Springs pupfish, however, were also elevated even though sediment copper concentrations were not. Pupfish, though, have been known to bioaccumulate higher tissue metal concentrations than many other species of fish (Personal Communication between Bill Radke and Joe Skorupa, USFWS, 1997).

Both the channel catfish from Dexter and the rainbow trout from Mescalero have high whole body to fillet ratios. The high ratio may be explained by the physiological mechanisms regulating copper distribution in the tissues, the medium through which copper uptake occurs, in this case, sediment, and various other factors affecting copper bioavailability.

Trout introduced to Isleta Lakes have lower fillet concentrations of copper than fish from Mescalero, but increased whole body concentrations. This change may be due to reduced dietary uptake, changes in depuration rates, and other factors such as decreased copper bioavailability. Lower water copper concentrations in Isleta may also contribute to the disparity between whole body and fillet concentrations of copper.

Comparison

Assuming a hardness greater than 400 mg/L, all water samples are below the New Mexico Water Quality Control Commission's protective standard for aquatic life, 0.039 mg /L (hardness was determined using calcium and magnesium data). All but one sediment sample had copper concentrations below the no effects threshold, 28 mg/kg (Environment Canada, 1992). One Mescalero sediment sample, though, contained 101.49 mg/kg copper, which not only exceeds the no effects threshold, but could have potentially adverse effects on water quality, fish, and wildlife (ODEQ, 1991). Sediment at or greater than 110 mg/kg copper is considered a severe effect level (BCMOELP, 1994). The toxicity and bioaccumulation of elevated amounts of copper, though, could potentially be buffered by the high hardness at Mescalero NFH. Whole body Leon Springs pupfish from Dexter NFTC and rainbow trout from both Mescalero and Isleta all exceeded NCBP 85th percentile values for 1979 (1.14 mg/kg) and 1984 (1.00 mg/kg) (Schmitt and

Brumbaugh, 1990), and USFWS Southwestern regional tissue values. None of the samples taken exceed the 300 mg/kg criterion for the protection of avian species ingesting these fish (NRC, 1980).

Lead

Interpretation

Lead was present in Dexter and Mescalero sediments. Lead within the sediment, though, did not appear to translate to lead concentrations in benthic feeding organisms, such as channel catfish.

Comparison

Lead concentrations in sediment at both Dexter and Mescalero are all below the "lowest effect level," 31 mg/kg. (BCMOELP, 1994)

Mercury

Interpretation

Water concentrations of mercury are relatively equal at both sites. Dexter has slightly more mercury in its algae, but less mercury in feed and sediment. Mescalero's higher concentrations of mercury in feed and sediment are two potential sources of bioavailable methyl mercury. This may explain the higher mercury concentrations found in whole body fish from Mescalero. Mercury accumulation in muscle appears to be the same at both sites, as fillet concentrations of mercury are relatively similar. Mescalero's higher whole body concentrations, then, may have been the result of mercury residing in the gut from feed or sediment.

Isleta rainbow trout appear to lose mercury when compared to trout remaining at Mescalero NFH. Possible causes of the decrease are lower concentrations of mercury at Isleta Lakes, and/or, the loss of fish dependence on hatchery feed, which may be a leading source of mercury in Mescalero fish.

Comparison

One Dexter water sample exceeded the mercury chronic water quality standard for the protection of fish, 0.000012 mg/L (USEPA, 1993). All sediment concentrations were below the most stringent sediment quality criteria no effects threshold, 0.05 mg Hg/kg (BCMOELP, 1994). None of the whole body fish samples exceeded the NCBP mean value for mercury, 0.11 mg/kg (Schmitt and Brumbaugh, 1990). One rainbow trout and two Yaqui catfish fillets, though, do exceed the dietary threshold concentration 0.1 mg/kg, for consumption by avian species (Eisler, 1987).

Selenium

Interpretation

Whole body selenium concentrations in Dexter fish were five times greater than those in Mescalero. Fillet concentrations, however, were similar to those of Mescalero trout. The high selenium concentrations in Dexter water, sediment, algae, and feed all probably contribute to the higher whole body selenium concentrations noted in Dexter. Furthermore, pupfish and chubs have been known to bioaccumulate more selenium than other species of fish (Correspondence from Joe Skorupa to Bill Radke, USFWS, 1997). And although still elevated, selenium concentrations in Isleta whole body and fillet samples were lower than in fish from Mescalero NFH.

The similar fillet concentrations between hatcheries are more difficult to explain. Perhaps selenium transport, residence, and excretion processes in the two different species sampled at each hatchery (catfish and trout) may take place at different rates. Selenium uptake to fish tissues may also depend on the chemical species of selenium present. The primary species of selenium present at Dexter may be preferentially accumulated in whole body tissues rather than muscle tissues.

Comparison

Five out of six water samples from Dexter NFTC exceeded the New Mexico State water quality chronic criteria standard, 0.002 mg/L, while only one out of six water samples collected from Mescalero NFH exceeded state water quality chronic criteria for selenium (NMWQCC, 1995). At these concentrations, some chronic effects, such as reproductive failure, could occur at Dexter (Lemly and Smith, 1987). Feed selenium concentrations were also elevated at Dexter but not at Mescalero. Two out of the three feed samples collected had selenium concentrations above levels of concern for adverse effects to fish, 5 mg/kg dry weight (Lemly and Smith, 1987).

While selenium did not bioaccumulate to concentrations of concern at Mescalero, it was elevated in several samples collected from Dexter. Algae exceeds the maximum background freshwater algae concentration, 1.5 mg/kg dry weight (Skorupa, 1997); sediment concentrations are slightly above typical background concentrations; and fish whole body samples exceed NCBP and USFWS Southwestern regional background tissue concentrations (Table B-11). Concentrations in fish tissues did not exceed criteria of concern for the fish reproductive health, but pupfish and chubs exceeded dietary threshold concentrations for the protection of birds consuming them, 3.0 mg/kg dry weight (Lemly and Smith, 1987).

Zinc

Interpretation

Dexter had higher water, algal, and sediment concentrations of zinc than in Mescalero. However, Mescalero had higher concentrations of zinc within its feed. This could explain the higher whole body concentrations of zinc in Mescalero trout, although accumulation could also be related to species differences in zinc bioaccumulation. According to Knox et. al., 1982, trout are extremely zinc tolerant, and a diet of 683 mg/kg zinc produced little or no adverse effect. In contrast to the differences in whole body zinc concentrations, Dexter had much higher fillet concentrations than did Mescalero.

Comparison

All water samples were below the most stringent guideline for zinc, 0.03 mg/L, the criterion for the protection of aquatic life (CCREM, 1987). Feed at both sites was also below the 30-day no effect threshold for rainbow trout, 440 mg/kg (Wekell et al., 1983). Sediment from both sites was also below the most stringent toxicological value, 47.7 mg/kg (Shortelder et al., 1989). Whole body fish from all three sites were below the avian dietary risk threshold, 44.5 mg/kg (Eisler, 1993), although Dexter had much higher fillet concentrations than did Mescalero, and exceeded USFWS Southwestern regional tissue concentrations. Like copper and cadmium, the adverse effects of zinc may be buffered by the high hardness at Dexter and Mescalero.

ORGANICS DISCUSSION

PCBs, p,p'-DDD, p,p'-DDE

Interpretation

Although PCBs, DDD, and DDE were not identified in sediments, they were found in the Yaqui catfish egg mass sampled. The organic concentrations found within the egg mass may, however, be attributed to the tendency of a fatty egg mass to bioconcentrate extremely low concentrations of relatively water insoluble compounds such as PCBs, DDD, and DDE. The Yaqui catfish egg mass has a lipid percentage approximately five times that of other catfish nationally, and three times that of other channel catfish from the same region (See Table B-9). PCBs have high organic- or octanol-water partition coefficients, and water solubility coefficients have been measured as low as 1×10^{-3} (Smith et. al., 1988). For this reason, PCBs, which are extremely lipophilic, are readily absorbed from the water environment into organism fat reserves. Therefore, high lipid content is often linearly correlated with high PCB concentrations (Niimi, 1979; Smith et al., 1988). Similarly, the DDT family in general has a solubility coefficient of 1×10^{-2} (Smith et al., 1988). DDD and DDE (DDT breakdown products) are thus also very lipophilic. Bioconcentration factors of both DDD and DDE range from 100 to 1000 (Smith et al., 1988).

Assuming a linear relationship between lipid content and organic bioaccumulation, one would expect the Yaqui catfish sampled to have a bioconcentration factor anywhere from 2 to 4 times that of other channel catfish regionally or other catfish nationally. So, certainly these organics exist in the Yaqui's environment, but not at the dangerous concentrations a cursory glance at the data might suggest. It is likely that other fish, with a more average egg mass lipid composition, would have one-half to one-fourth the detected concentration of these compounds, and would thus be considered at negligible risk.

Comparison

Despite the unusually high egg mass lipid content, organic concentrations in the Yaqui catfish do not exceed any known criteria of adverse effects. Very few data exist for PCB or DDT metabolite concentrations in fish egg masses. Ignoring the high egg mass lipid composition, baltic flounder (*Platichthys flesus*) have undergone egg mortality when egg mass concentrations of PCBs exceeded 0.12 mg/kg (Ernst, 1984). Yet rainbow trout survivability did not diminish in conditions of 1.6 mg/kg PCBs (Hendricks et. al., 1980). Taking egg mass lipid composition into account, though, the possibility for reproductive failure is greatly decreased. However, assuming concentrations are one-half the original concentration, that is, 0.115 mg/kg, this concentration could cause egg mass toxicity.

The only data available on the effects of DDD or DDE on the reproductivity of fish showed that lake trout mortality occurred when DDT/DDE concentrations in the egg mass exceeded 2.9 mg/kg (Burdick et al., 1964). Synergism between PCBs, DDD, and DDE in the Yaqui catfish egg mass could also enhance toxicity. For example, mortalities greater than fifty percent have been reported in North Sea whiting that contained 0.1 to 0.85 mg/kg PCBs along with DDE concentrations of up to 2 mg/kg (Cameron et al., 1988). Fifty-percent mortality was also reported in Baltic Sea flounder when PCB concentrations were as high as 0.12 mg/kg and DDT was as high as 0.092 mg/kg (von Westernhagen et al., 1981). Interactions between the three organic compounds could increase the risk to hatchery fish.

HUMAN HEALTH RISK ASSESSMENT

Introduction

Trace element concentrations found in rainbow trout collected in 1995 from both Mescalero NFH and Isleta Lakes were used to evaluate the potential risk to humans consuming fish from Isleta Lakes or other sites stocked with fish from Mescalero NFH. (Dexter was not evaluated because of its focus solely on endangered species; consumption of these fish was and still is both unlikely and illegal). Several potential human exposure pathways were considered (Table C-1). The most stringent scenario was of a child, age 1 to 6, consuming 0.085 kg (~3 oz) of fish a day for 156 days out of the year (3 times/week). This scenario was believed to be the most stringent for a risk assessment of the human consumption of fish from either Mescalero NFH or Isleta Lakes, as children are believed to be one of the most sensitive bio-indicator of contaminant-related risk.

This risk assessment, however, does not provide a complete picture of contaminant-related risk at either Mescalero or Isleta. It is based on a small number of fish samples, and should be viewed as a preliminary screening of potential risk. Furthermore, any risk assessment makes assumptions and does not take into account factors which deviate from the norm, such as daily fishing and consumption of fish, additional ingestion of water and sediment from recreational use, or irregular fishing patterns. This risk assessment assumes "average" conditions and should therefore only be deemed as a fair assessment of the risk associated with the ingestion of fish from either Mescalero NFH or Isleta Lakes. This risk assessment also does not take into account such factors as the bioavailability of contaminants and the method of food preparation.

Table C-1. Summary of parameters for estimating daily intake of trace elements in humans

Subpopulation	Fish Ingestion Rate (kg/day)[a]	Exposure Frequency (days/year)[b]	Body Mass (kg)[a]
ages 1 - 6	0.085	14	14.5
ages 1 - 6	0.085	156	14.5
adults	0.114	14	70.0
adults	0.114	156	70.0

a Based on USEPA (1994) suggested "meal sizes" and typical body weights.

b Estimates for recreational fishing = 14 days/yr, and subsistence fishing = 156 days/year (3 days/week). These assumptions are *not* based on actual creel surveys of fishing patterns at Isleta.

Methods

Estimates of risks to human consumers of fish were evaluated according to United States Environmental Protection Agency (USEPA) and other published data. The calculation of potential human daily intakes of trace elements due to fish ingestion was calculated according to the following formula:

Equation B-1. Equation used to estimate daily contaminant intakes due to ingestion of fish items.

$$\text{Intake} = \frac{C_m \times SFIR \times EF}{BW \times AT}$$

where:

Intake	contaminant intake rate (mg/kg-day)
C_m	contaminant m concentration in fish (mg/kg)
SFIR	subpopulation (e.g., adults vs. children) fish ingestion rate (kg/day)
EF	exposure frequency (days/year)
BW	body mass (kg)
AT	averaging time (days/year)

Contaminant concentrations used to estimate daily intake values were obtained from the mean concentration for each of the elements used in the risk assessment. It is typically recommended that the 85th percentile concentration be used, but the low number of samples collected inherently limited the available percentile values. It was assumed here that only fillets were to be consumed from fish.

Once the contaminant intake rate was calculated, it was divided by USEPA oral ingestion related risk Reference Doses (RfDs) to obtain a Hazard Quotient (HQ). RfDs were obtained from chronic daily intake levels above which adverse health effects can occur. A RfD is a concentration at which humans are unlikely to experience an appreciable risk of noncarcinogenic deleterious effects over a lifetime. Inherent in the RfDs are uncertainty factors. An uncertainty factor of 10 has been calculated into the RfD values derived from the USEPA No Observed Adverse Effect Level (NOAEL) for individual elements to account for variation between animals studied in the laboratory and the human population. Another factor of 10 was used if the value is based on the Lowest Observed Adverse Effect Level (LOAEL). An additional factor of 10 was added to account for sensitive subpopulations, such as children, pregnant women, or smaller than average adults. The RfDs for the elements used in this risk assessment are listed below in Table C-2.

Table C-2. Oral reference doses for elements used in risk assessment calculations and USEPA reference.

Element	Oral RfD (mg/kg-day)	Reference
Arsenic	0.0003	IRIS
Cadmium	0.0005	IRIS
Copper	0.0371	HEAST
Mercury	0.0003	IRIS
Selenium	0.005	IRIS
Zinc	0.3	IRIS

HEAST -- USEPA Health Effects Assessment Summary Tables, 1992
IRIS -- USEPA Integrated Risk Information Service, 1998

Based on these data, a hazard quotient was calculated for each element. If the HQ obtained was above one, risk associated with the consumption of fish might be elevated. In obtaining a hazard quotient, one in essence obtains an individual characterization of risk for a particular element. These individual characterizations can be excellent indicators of potential contaminant-related problems, but do not adequately express the combined risk from all elements in the fillets. Therefore, from these individual element HQs, an aggregate Hazard Index (HI) was obtained, which shows the combined effect of contaminants, by adding together the individual element hazard quotients. If a hazard index is less than one, chronic adverse effects from ingestion of fish are unlikely to occur. The hazard index assumes that a threshold exists (i.e., HI $\geq$ 1) below which exposure does not cause adverse effects. The hazard index used here assumes elements act additively, and does not take into account synergistic or antagonistic interactions between elements, or other more complex biological processes, such as organ transport.

Risk Characterization

Hazard indices and hazard quotients for adult and child recreational anglers at Mescalero NFH and Isleta Lakes were below one (See Tables C-3 and C-4), and therefore, given the assumptions of these calculations, no risk should be attributed to the consumption of fish from either Mescalero or Isleta by recreational anglers. Among the calculated hazard indices, arsenic was responsible for approximately two-thirds of the hazard index, and mercury was responsible for the remaining one-third. Contribution from other elements, including those not presented in Tables C-3 and C-4, was minimal.

Hazard indices and hazard quotients for adult subsistence fishers were approximately one or less, indicating minimal risk. Children, however, and adults consuming fish more than 3 times weekly, may be at risk given the assumptions of these calculations (See Tables C-3 and C-4). Again, among the calculated hazard indices, arsenic was responsible for approximately two-thirds of the hazard index, and mercury was responsible for the remaining third.

This risk characterization should be considered as preliminary, as it was only applied to average or assumed scenarios (ultimately, worst case). Creel surveys, and other methods to quantify actual fish consumption rates, are necessary to confirm several of the assumptions of consumption rates used in these calculations. Furthermore, it did not take into account the potential effects of organics, bioavailability, or of synergism between elements, and it did not account for the influences of contaminant pathways and transport. For example, most of the arsenic present in fish fillets is organically bound, and is generally considered non-toxic. Inorganic arsenic species account for only <1 to 30 percent of the total arsenic concentrations present (USEPA, 1995). Because only "total arsenic" was measured in this study, we conservatively assumed that 30 percent of the total arsenic concentrations measured were inorganic, which would result in a greater hazard quotient for arsenic, and thus a greater calculated risk. If a less conservative, but possibly more realistic, percentage was chosen (e.g., 10%), then risk assessment calculations would indicate a much lower risk potential. Nonetheless, based on the results of this preliminary assessment, fish consumption rates for subsistence anglers consuming rainbow trout should be limited to approximately 4-oz./week for children, and 18-oz./week for adults (Table C-5). Recreational anglers (fishing only 14 days/year) do not need to limit consumption.

Table C-3. Hazard quotients (HQ) and hazard indices (HI) for Mescalero NFH.

Child Recreational Consumption

Element	*Fish conc mg/kg*	*Consumption (kg/day)*	*Days/yr exposure*	*Body mass (kg)*	*Days/yr*	*Intake (mg/kg-day)*	RfD	HQ
As*	0.303	0.085	14	14.5	365	6.81285E-05	0.0003	0.227094946
Cd	0	0.085	14	14.5	365	0	0.0005	0
Cu	2.27	0.085	14	14.5	365	0.000510402	0.0371	0.013757453
Hg	0.1	0.085	14	14.5	365	2.24846E-05	0.0003	0.074948827
Se	0.58	0.085	14	14.5	365	0.000130411	0.005	0.026082192
Zn	3.56	0.085	14	14.5	365	0.000800453	0.3	0.002668178

Hazard Index 0.344551596

Child Subsistence Consumption

Element	*Fish conc mg/kg*	*Consumption (kg/day)*	*Days/yr exposure*	*Body mass (kg)*	*Days/yr*	*Intake (mg/kg-day)*	RfD	HQ
As*	0.303	0.085	156	14.5	365	0.000759146	0.0003	2.530486538
Cd	0	0.085	156	14.5	365	0	0.0005	0
cu	2.27	0.085	156	14.5	365	0.005687331	0.0371	0.153297335
Hg	0.1	0.085	156	14.5	365	0.000250543	0.0003	0.835144072
Se	0.58	0.085	156	14.5	365	0.001453151	0.005	0.290630137
Zn	3.56	0.085	156	14.5	365	0.008919339	0.3	0.029731129

Hazard Index 3.83928921

Adult Recreational Anglers

Element	*Fish conc mg/kg*	*Consumption (kg/day)*	*Days/yr exposure*	*Body mass (kg)*	*Days/yr*	*Intake (mg/kg-day)*	RfD	HQ
As*	0.303	0.114	14	70	365	1.89271E-05	0.0003	0.063090411
Cd	0	0.114	14	70	365	0	0.0005	0
Cu	2.27	0.114	14	70	365	0.000141797	0.0371	0.003822029
Hg	0.1	0.114	14	70	365	6.24658E-06	0.0003	0.020821918
Se	0.58	0.114	14	70	365	3.623OIE-05	0.005	0.007246027
Zn	3.56	0.114	14	70	365	0.000222378	0.3	0.00074126

Hazard Index 0.095721645

Adult Subsistence Anglers

Element	*Fish conc mg/kg*	*Consumption (kg/day)*	*Days/yr exposure*	*Body mass (kg)*	*Days/yr*	*Intake (mg/kg-day)*	RfD	HQ
As*	0.303	0.114	156	70	365	0.000210902	0.0003	0.703007436
Cd	0	0.114	156	70	365	0	0.0005	0
cu	2.27	0.114	156	70	365	0.001580027	0.0371	0.042588318
Hg	0.1	0.114	156	70	365	6.96047E-05	0.0003	0.232015656
Se	0.58	0.114	156	70	365	0.000403707	0.005	0.080741448
Zn	3.56	0.114	156	70	365	0.002477927	0.3	0.008259757

Hazard Index 1.066612616

* Expressed as inorganic arsenic concentrations; As tissue concentrations were analyzed as total arsenic, then converted to inorganic arsenic by multiplying by 0.3 (assumes 30% total arsenic is inorganic).

Table C-4. Hazard quotients (HQ) and hazard indices (HI) for Isleta Lakes.

Child Recreational Consumption

Element	*Fish conc mg/kg*	*Consumption (kg/day)*	*Days/yr exposure*	*Body mass (kg)*	*Days/yr*	*Intake (mg/kg-day)*	RfD	HQ
As*	0.28	0.085	14	14.5	365	6.2957E-05	0.0003	0.209856715
Cd	0.01	0.085	14	14.5	365	2.24846E-06	*0.0005*	0.00449693
Cu	0.46	0.085	14	14.5	365	0.000103429	0.0371	0.002787854
Hg	0.08	0.085	14	14.5	365	1.79877E-05	0.0003	0.059959062
Se	0.26	0.085	14	14.5	365	5.84601E-05	0.005	0.011692017
Zn	4.37	0.085	14	14.5	365	0.000982579	0.3	0.003275264

Hazard Index 0.292067841

Child Subsistence Consumption

Element	*Fish conc mg/kg*	*Consumption (kg/day)*	*Days/yr exposure*	*Body mass (kg)*	*Days/yr*	*Intake (mg/kg-day)*	RfD	HQ
As*	0.28	0.085	156	14.5	365	0.000701521	0.0003	2.338403401
Cd	0.01	0.085	156	14.5	365	2.50543E-05	0.0005	0.050108644
Cu	0.46	0.085	156	14.5	365	0.001152499	0.0371	0.031064658
Hg	0.08	0.085	156	14.5	365	0.000200435	0.0003	0.668115257
Se	0.26	0.085	156	14.5	365	0.000651412	0.005	0.130282475
Zn	4.37	0.085	156	14.5	365	0.010948739	0.3	0.036495796

Hazard Index 3.254470232

Adult Recreational Anglers

Element	*Fish conc mg/kg*	*Consumption (kg/day)*	*Days/yr exposure*	*Body mass (kg)*	*Days/yr*	*Intake (mg/kg-day)*	RfD	HQ
As*	0.28	0.114	14	70	365	1.74904E-05	0.0003	0.05830137
Cd	0.01	0.114	14	70	365	6.24658E-07	0.0005	0.001249315
Cu	0.46	0.114	14	70	365	2.87342E-05	0.0371	0.000774508
Hg	0.08	0.114	14	70	365	4.99726E-06	0.0003	0.016657534
Se	0.26	0.114	14	70	365	1.624IIE-05	0.005	0.003248219
Zn	4.37	0.114	14	70	365	0.000272975	0.3	0.000909918

Hazard Index 0.081140864

Adult Subsistence Anglers

Element	*Fish conc mg/kg*	*Consumption (kg/day)*	*Days/yr exposure*	*Body mass (kg)*	*Days/yr*	*Intake (mg/kg-day)*	RfD	HQ
As*	0.28	0.114	156	70	365	0.000194893	0.0003	0.649643836
Cd	0.01	0.114	156	70	365	6.960-47E-06	0.0005	0.013920939
Cu	0.46	0.114	156	70	365	0.000320182	0.0371	0.008630232
Hg	0.08	0.114	156	70	365	5.56838E-05	0.0003	0.185612524
Se	0.26	0.114	156	70	365	0.000180972	0.005	0.036194442
Zn	4.37	0.114	156	70	365	0.003041725	0.3	0.010139084

Hazard Index 0.904141058

* Expressed as inorganic arsenic concentrations; As tissue concentrations were analyzed as total arsenic, then converted to inorganic arsenic by multiplying by 0.3 (assumes 30% total arsenic is inorganic).

Table C-5a. Maximum recommended consumption rates for children. Values in bold indicate the element resulting in the lowest recommended consumption rate. This value is also the overall maximum recommended consumption rate (considering that all elements listed occur together in the same fillet).

Element	RfD (mg/kg-day)	Body weight (kg)	Fish Conc. (mg/kg)	Maximum Recommended Consumption (oz/day)[a]	Maximum Recommended Consumption (oz/week)[a]
As	0.0003	14.5	0.285	**0.5**	**3.8**
Cd	0.0005	14.5	0.01	25.6	179.0
Cu	0.0371	14.5	0.46	41.3	288.8
Hg	0.0003	14.5	0.08	1.9	13.4
Se	0.005	14.5	0.26	9.8	68.9
Zn	0.3	14.5	4.37	35.1	245.8

a Calculated using the following equation: $CR_{\lim} = \frac{RfD * BW}{C_m}$, where:

CR_{lim} = maximum allowable fish consumption rate (kg/day; converted to oz/day & oz/week)

RfD = Reference dose (mg/kg-day)

BW = body weight (kg)

C_m = concentration of contaminant m in fish fillet (mg/kg).

Table C-5b. Maximum recommended consumption rates for adults. Values in bold indicate the element resulting in the lowest recommended consumption rate. This value is also the overall maximum recommended consumption rate (considering that all elements listed occur together in the same fillet).

Element	RfD (mg/kg-day)	Body weight (kg)	Fish Conc. (mg/kg)	Maximum Recommended Consumption (oz/day)	Maximum Recommended Consumption (oz/week)
As	0.0003	70.0	0.285	**2.6**	**18.2**
Cd	0.0005	70.0	0.01	123.5	864.2
Cu	0.0371	70.0	0.46	199.1	1394.0
Hg	0.0003	70.0	0.08	9.3	64.8
Se	0.005	70.0	0.26	47.5	332.4
Zn	0.3	70.0	4.37	169.5	1186.5

CONCLUSIONS

None of the samples collected had concentrations of aluminum, cadmium, lead, or zinc above known criteria for adverse effects. Arsenic, copper, mercury, and selenium, however, were elevated to concentrations of concern in some samples. Contaminants that could adversely affect fish and/or wildlife or humans consuming those fish at Dexter include mercury and selenium. Potential contaminants of concern at Mescalero were arsenic, copper, and mercury. Selenium appears to be pervasive at Dexter, as are arsenic and mercury at Mescalero.

Arsenic concentrations in trout from Mescalero NFH exceeded recommended maximum safe tissue levels, the NCBP 85th percentile, and USFWS Southwest regional background concentrations. Tissue concentrations of arsenic were also higher in fish from Mescalero than in fish from Dexter NFTC, even though arsenic concentrations in water, algae, and sediment were lowest at Mescalero. Feed arsenic concentrations, however, were higher at Mescalero than at Dexter, suggesting that feed was the primary source of the elevated arsenic concentrations in fish. These differences may also be related to differences in metal uptake, retention, and depuration characteristics between trout, pupfish, chubs, and catfish.

In general, copper concentrations in water, algae, and sediments were not elevated at either hatchery (one sediment sample from Mescalero was slightly elevated). Tissue copper concentrations were, however, notably elevated in trout collected at Mescalero and fish stocked in Isleta. These elevated tissue concentrations may have been due to elevated copper in sediments at Mescalero, and/or copper within the feed. Copper was also elevated in Leon Springs pupfish collected from Dexter. Because water, algae, and sediment copper concentrations were low at Dexter, the copper in the pupfish tissues was probably coming from the feed. This suggests that feed may also have been the source of elevated tissue copper in fish from Mescalero and those stocked to Isleta lake.

Mercury concentrations in water, algae, and sediments were not elevated at either hatchery. Mescalero, however, had higher concentrations of mercury in its feed, and this likely contributed to the elevated mercury concentrations measured in trout fillets. One Mescalero trout and two Yaqui catfish from Dexter exceeded recommended maximum safe tissue concentrations for mercury, suggesting that these fish may be at risk for adverse health and reproductive effects.

Dexter had consistently higher selenium concentrations than Mescalero in all media sampled. Five Dexter and one Mescalero water sample exceeded NMWQCC chronic toxicity standards for selenium; algae, sediment, and two out of three feed samples from Dexter also exceed protective criterion for selenium; and fish from Dexter exceed maximum safe tissue concentrations for consumption by birds. The most likely source of the elevated selenium was water and feed.

PCBs, DDE, and DDD were present in the Yaqui catfish egg mass. The egg mass appears to have bioaccumulated more insoluble lipophilic organics such as PCBs and DDT metabolites because of its high lipid content. Although no criteria for adverse effects are exceeded, the presence of these compounds is still of concern. The source of these compounds is probably the Yaqui river (where these fish were originally collected). Nonetheless, as a first step in locating the origin of these organics, Dexter NFTC should examine surrounding land use practices to determine if there are any likely sources of pesticides to hatchery water supplies.

A preliminary human health risk assessment was also performed. For recreational anglers (adults and children consuming fish 14 days/year), there is no risk associated with consumption of fish stocked at Isleta lakes. However, adults, and especially children, consuming these fish regularly (3 days/week) may be at some risk due to elevated arsenic and, secondarily, mercury in fillets. Although arsenic is naturally elevated in the Southwest, concentrations of arsenic in trout fillets collected from Isleta are almost ten times higher than USFWS Southwest regional tissue concentrations (risk calculations using USFWS Southwest regional concentration values indicate no risk). Because risk calculations involving arsenic are sensitive to the exact chemical species of arsenic measured, further testing of fish tissues, where exact arsenic species are measured, should be performed to confirm the results of this preliminary examination. These results suggest that fish consumption rates may need to be limited to approximately 4-oz./week for children, and 18-oz./week for adults (Table C-5).

Nonetheless, both hatcheries have conditions conducive to fish rearing and propagation, although Mescalero needs to determine the cause of the elevated fish arsenic concentrations. Because water, sediment, and algae samples generally contained low concentrations of most trace-metals, the most direct solution to the elevated fish tissue concentrations of arsenic, copper, mercury, and selenium is to change to a low trace-metal content feed.

RECOMMENDATIONS

1) The presence of PCBs and DDT metabolites in the Yaqui catfish egg mass is of minor concern. Dexter NFTC should investigate the source of PCBs and DDT metabolites, perhaps by further sampling of other fish at the hatchery, and from locations where the Yaqui catfish were originally collected. Fish may have encountered contamination in the Yaqui River before introduction to Dexter.

2) Dexter NFTC should attempt to minimize selenium concentrations at the hatchery. For example, selenium concentrations were lowest in Well #4 water, so increased draw from this well could lower overall hatchery selenium loads.

3) Elevated fish tissue metal residues may be due to elevated metal concentrations in feed. Switching to a low trace-metal content feed may reduce these metal body burdens, improve fish health, and be more protective of humans and wildlife consuming these fish. However, because feed trace-metal content may vary by both brand of feed and specific production lots of a particular brand, feed samples should be submitted for metals analysis before large volumes are purchased. Coordinated feed purchasing efforts among State and Federal fish hatcheries planning to use the same brand and production lots could reduce expenses associated with metals analyses.

4) Both hatcheries should maintain current water supplies, but might consider reducing water hardness to improve fish health (upon writing, Mescalero NFH has made significant efforts to reduce hardness and carbon dioxide at the Gila trout production facility).

5) The elevated copper in one sediment sample from Mescalero NFH is of concern. Additional sediment samples should be collected to confirm this study's results, and to determine the extent of this potential problem.

6) A joint study between Mescalero NFH and the Pueblo of Isleta may be necessary to further evaluate the potential risks from consumption of arsenic rich fish from Isleta lakes. The following should be considered:

   - Mescalero needs to identify its arsenic source(s). The most plausible source is the feed. As a first step, change brands of feed or switch to a different production lot, then reassess fish tissue arsenic concentrations. If changing feed results in arsenic fillet concentrations that no longer pose a risk to anglers consuming them, further action may not be necessary. NOTE: Since this study was conducted, Mescalero NFH has switched to Silver Cup feed (the same feed used at Dexter NFTC), and samples of this feed and several rainbow trout will be submitted for metals analysis (results of these analyses are not expected until winter of 1998, and therefore will not be included in this report).

   - Additional stocked trout and other resident fish species should be collected from Isleta lakes to verify the elevated arsenic concentrations measured in this study. Various size/age classes should be sampled if available, and sufficient sample numbers should be collected to allow reasonably robust statistical analyses.

   - Although it requires a more expensive chemical analysis process, inorganic tissue arsenic concentrations should be determined instead of total concentrations. Inorganic arsenic is the chemical species relevant to human risk assessments.

   - Trout and other fish species consumption patterns should be determined for anglers using Isleta lakes, via mailed surveys, creel counts, and review of existing records.

   - A preliminary survey should be conducted to determine if any other locations receiving fish from Mescalero NFH present a risk to the angling public.

LITERATURE CITED

BCMOELP (British Columbia Ministry of Environment Lands and Parks). 1994. Approved and working criteria for water quality - 1994. Water Quality Branch. Environmental Protection Department. British Columbia Ministry of Environment Lands and Parks. ISBN 0-7726-2061-X. Victoria, British Columbia.

Burdick, G.E., E.J. Harris, H.J. Walker, T.M. Walker, J. Skea, and D. Colby. 1964. The accumulation of DDT in lake trout and the effect on reproduction. *Trans. Am. Fisheries Soc.*, 93, 127.

Cameron, P., V. Dethlefsen, H. von Westerhagen, and D. Janssen. 1988. Chromosomal and morphological investigations on whiting (*Merlangius merlangus*) embryos from the North Sea in relation to organochlorine contamination. *Aquat. Toxicol.* 11:428-429.

CCREM (Canadian Council of Resource and Environment Ministers). 1987. Canadian water quality guidelines. Task Force on Water Quality Guidelines. Ottawa, Canada.

Eisler, R. 1985. Cadmium hazards to fish, wildlife, and invertebrates: A synoptic review. U.S. Fish and Wildl. Serv. Biol. Rep., 85 (1.2).

Eisler, R. 1987. Mercury hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildl. Serv. Biol. Rep. 85/1.10:1-90.

Eisler, R. 1988. Arsenic hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish Wildl.Serv. Biol. Rep. 85 (1.12):1-92.

Eisler, R. 1993. Zinc hazards to fish, wildlife, and invertebrates - A synoptic review: U.S. Fish and Wildl. Serv. Biol. Rep. 10.

Environment Canada. 1992. Interim criteria for quality assessment of St. Lawrence River sediment. ISBN 0-662-19849-2. St. Lawrence Action Plan. St. Lawrence Center and Quebec Ministry of the Environment.

Ernst, W. 1984. Pesticides and technical organic chemicals. *Marine Ecology*, Vol. 4:4. ed., Kinne, O. John Wiley and Sons, New York.

Hendricks, J.D., T.P. Putman, and R.O. Sinnhuber. 1980. Null effect of dietary Aroclor 1254 on heptacellular carcinoma incidence in rainbow trout (*Salmo gairdneri*) exposed to aflatoxin B_1 as embryos. *J. Environ. Toxicol. Pathol.*, 4,9.

Irwin, R.J. M. VanMouwerik, L. Stevens, M.D. Seese, and W. Basham. 1998. Environmental Contaminants Encyclopedia. National Park Service, Water Resources Division, Fort Collins, Colorado. Distributed on the Internet via the Nature Net portion of the Park Service Home Page (www.nps.gov). Also distributed by the NPS and/or NTIS via CD-ROM.

Klots, E.B. 1966. The new field book of freshwater life. G.P. Putnam's Sons, New York.

Knox, D. C.B. Cowey, and J.W. Adron. 1982. Effects of dietary copper and copper:zinc ratio on rainbow trout (*Salmo gairdneri*). *Aquaculture* 27:111-119.

Lemly, A.D. and G.J. Smith. 1987. Aquatic cycling of selenium - Implications for fish and wildlife: U.S. Fish and Wildlife Service Leaflet 12.

Lemly, A.D. 1993. Guidelines for Evaluating Selenium From Aquatic Monitoring and Assessment Studies. U.S. Forest Service, Blacksburg, Virginia.

MENVIQ (Quebec Ministry of the Environment). 1990. Water Quality Criteria. EMA 88-09. Quebec Government, Quebec City, Quebec.

National Library of Medicine. 1988. Hazardous Substances Data Bank (HSDB), Vol. 7. Micromedex Inc., Denver, Colorado.

National Research Council (NRC) Canada. 1978. Effect of Arsenic in the Canadian Environment. NRCC No. 15391.

Niimi, A.J. 1979. Hexachlorobenzene (HCB) levels in Lake Ontario salmonids. *Bull. Environ. Contam. Toxicol.*, v. 23.

NMWQCC (New Mexico Water Quality Control Commission). 1995. Standards for interstate and intrastate streams: New Mexico Administrative Code 20 NMAC 6.1.

NRC (National Research Council), Subcommittee on Mineral Toxicity in Animals. 1980. Mineral tolerance of domestic animals. Washington, D.C., National Academy Press.

ODEQ (Oregon Department of Environmental Quality). 1989. State-wide water quality management plan: beneficial uses, policies, standards, and treatment criteria for Oregon.Regulations Relating to Water Quality Control - Oregon Administrative Rules. Portland, Oregon.

Pastorok, P. 1987. Guidance manual for assessing human health risks from chemically contaminated fish and shellfish. PTI Environmental Service's submission to Battelle New England for EPA, Washington, D.C., PTI Environmental Draft Report C737-01, Bellevue, WA.

Schmitt, C.J. and W.B. Brumbaugh. 1990. National Contaminant Biomonitoring Program: Concentrations of arsenic, cadmium, copper, lead, mercury, selenium, and zinc in U.S. freshwater fish, 1976-1984. *Arch. Environ. Contam. Toxicol*., 19:731-747.

Shacklette H.T., and Boerngen, J.G.. 1984. Element concentrations in soils and other surficial materials of the conterminous United States. U.S. Geol. Surv. Prof. Pap. 1270.

Shortelder, P.B., M.A. van der Gaag, and L.A. van der Kooij. 1989. "Perspectives for water organisms." An ecotoxicological basis for quality objectives for water and sediment. Part 1. Results and Calculations. DBW/RIZA Memorandum N. 89.016a. (English version August 1991) Institute for Inland Water Management and Waster Water Treatment. The Netherlands.

Skorupa, J. 1997. Constituents of Concern - Selenium. Guidelines for Data Interpretation for Selected Constituents. U.S. Fish and Wildlife Service, National Irrigation Water Quality Program Sacramento, California.

Smith, J.A., P.J. Witkowski, and T.V. Fusillo. 1988. Manmade Organic Compounds in the Surface Waters of the United States - A Review of Current Understanding. U.S. Geological Survey Circular 1007. Denver, Colorado.

USEPA. 1992. Health Effects Assessment Summary Tables. Environmental Criteria and Assessment Office. Cincinnati, Ohio.

USEPA. 1993. Wildlife Exposures Handbook. USEPA Office of Research and Development, Washington, D.C. EPA/600/R-93/187a.

USEPA. 1994. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume II: Risk Assessment and Fish Consumption Limits. Office of Science and Technology, Office of Water,Washington, D.C.

USEPA. 1995. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume I: Fish Sampling and Analysis. Office of Science and Technology, Office of Water,Washington, D.C.

USEPA. 1998. Integrated Risk Information Service Database. Distributed on the Internet via the USEPA home page (http://www.epa.gov/ngispgm3/iris/subst-fl.htm).

von Westernhagen, H., H. Rosenthal, V. Dethlefsen, W. Ernst, U. Harms, and P.-D Hansen. 1981. Bioaccumulating substances and reproductive success in Baltic Flounder. *Aquatic Toxicol.* 1:85-99.

Walsh, D.F., B.L. Berger, and J.R. Bean. 1977. Mercury, arsenic, lead, cadmium, and selenium residues in fish. 1971-1973 National Pesticide Monitoring Program. *Pestic. Monit. J.* 11:5-34.

Wekell, J.C., K.D. Shearer, and C.R. Houle. 1983. High zinc supplementation of rainbow trout diets. *Prog. Fish. Cult.* 45:144-147.

Appendix A-1. Moisture content and trace-element concentrations in biological, water and sediment samples from Dexter NFTC, Mescalero NFH and Isleta Reservoir, 1995. Element concentrations are in Fg/g dry weight, except for water which is in Fg/L.

Sample ID Code	Site	Location	Date	Type of sample	Common Name	Moisture content (percent)	Alum-inum	Arsenic	Barium	Beryl-lium	Boron	Cad-mium	Calcium	Chro-mium	Copper	Iron
DEXD01	Dexter	Feed	7-27-95	Feed	Silver Cup Crumbles	5.1	21.6	3.19	4.25	<0.02	8.15	<0.06	233.93	0.8	4.58	200.21
DEXD02	Dexter	Feed	7-27-95	Feed	Silver Cup Pellets	7.1	41.01	0.82	12.81	<0.02	11.3	0.19	9892.36	0.78	11.3	122.71
DEXD03	Dexter	Feed	7-27-95	Feed	Silver Cup Starter	5.1	28.56	5.21	3.92	<0.02	5.62	0.17	14436.25	0.72	6.73	107.48
MESD01	Mescalero	Feed	7-26-95	Feed	Grower Pellets Intermediate	4.1	45.36	3.28	4.24	<0.02	5.51	0.2	12930.13	0.96	6.18	115.75
MESD02	Mescalero	Feed	7-26-95	Feed	Grower Pellets Finisher	14.8	48	3.06	7.82	<0.02	3.65	0.2	10446.01	0.89	24.77	312.21
MESD03	Mescalero	Feed	7-26-95	Feed	Grower Pellets Starter	2.1	106.23	3.86	16.75	<0.02	4.4	0.2	20939.73	1.13	7.81	493.36
DEXCCF05	Dexter	Hatchery Pond	7-27-95	Fish Gills	Channel Catfish	72.5	5.53	<0.25	<0.71	<0.07	4.62	<0.21	36363.64	1.67	4.33	163.64
DEXCCF09	Dexter	Holding House	7-27-95	Fish Gills	Channel Catfish	68.7	3.99	0.48	<1.86	<0.06	2.28	<0.19	57188.49	1.79	4.12	117.57
DEXYC03	Dexter	Hatchery Pond	7-27-95	Fish Gills	Yaqui Catfish	72.5	7.64	0.47	<2.13	<0.07	3.43	<0.21	65454.55	1.64	3.1	136.73
DEXYC09	Dexter	Holding House	7-27-95	Fish Gills	Yaqui Catfish	74.7	9.72	0.4	<0.77	<0.08	3.12	<0.23	94071.14	0.82	10.4	86.56
DEXYC13	Dexter	Holding House	7-27-95	Fish Gills	Yaqui Catfish	68.4	3.29	0.41	<1.83	<0.06	2.79	<0.18	70886.06	<0.93	4.75	92.09
DEXCCF07	Dexter	Holding House	7-27-95	Fish Kidney	Channel Catfish	87.1	<7.69	0.62	<1.53	<0.16	3.82	<0.47	92.25	0.84	1.26	67.52
DEXYC02	Dexter	Hatchery Pond	7-27-95	Fish Kidney	Yaqui Catfish	75.8	14.67	0.45	<0.8	<0.08	<1.6	2.09	300.41	0.83	7.52	524.79
DEXYC08	Dexter	Holding House	7-27-95	Fish Kidney	Yaqui Catfish	76.4	6.4	<0.04	<0.83	<0.08	4.08	1.03	542.37	0.63	7.42	728.81
DEXYC11	Dexter	Holding House	7-27-95	Fish Kidney	Yaqui Catfish	73.5	5.02	0.53	<0.74	<0.08	1.65	1.51	304.91	0.5	5.36	321.51
DEXCCF01	Dexter	Hatchery Pond	7-27-95	Fish Kidney	Channel Catfish	73.5	<3.73	0.57	<0.75	<0.08	<1.49	<0.22	112.45	<0.37	1.72	415.09
DEXCCF02	Dexter	Hatchery Pond	7-27-95	Fish Liver	Channel Catfish	73.9	4.33	0.57	<0.74	<0.07	<1.49	0.23	233.33	1.06	19.35	357.85
DEXCCF08	Dexter	Holding House	7-27-95	Fish Liver	Channel Catfish	70.4	8.51	0.54	<0.66	<0.07	2.9	<0.2	115.54	0.76	8.99	252.03
DEXYC01	Dexter	Hatchery Pond	7-27-95	Fish Liver	Yaqui Catfish	79	16.29	0.67	<0.94	<0.1	<1.88	0.35	742.86	0.66	18.57	3042.86
DEXYC06	Dexter	Holding House	7-27-95	Fish Liver	Yaqui Catfish	70.1	3.27	0.37	<0.65	<0.07	<1.31	<0.2	91.97	<0.33	1.95	251.84
DEXYC12	Dexter	Holding House	7-27-95	Fish Liver	Yaqui Catfish	72.4	10.36	0.25	<0.71	<0.07	3.06	<0.21	218.12	0.49	30.11	503.62
DEXCCF04	Dexter	Hatchery Pond	7-27-95	Fish Fillet	Channel Catfish	74.3	<3.84	<0.27	<0.77	<0.08	<1.53	<0.23	245.53	0.53	4.4	12.76
DEXCCF10	Dexter	Holding House	7-27-95	Fish Fillet	Channel Catfish	80.4	<5.01	<0.36	<1	<0.1	2.76	<0.3	1454.08	0.79	7.3	23.93
DEXYC05	Dexter	Hatchery Pond	7-27-95	Fish Fillet	Yaqui Catfish	73.7	<3.76	0.3	<0.75	<0.08	<1.5	<0.22	314.45	0.4	4.87	55.89
DEXYC10	Dexter	Holding House	7-27-95	Fish Fillet	Yaqui Catfish	71.3	<3.43	0.63	<0.69	<0.07	<1.37	<0.21	257.14	0.43	1.06	7.56
DEXYC14	Dexter	Holding House	7-27-95	Fish Fillet	Yaqui Catfish	71.1	<3.43	0.28	<0.69	<0.07	<1.37	<0.21	275.78	0.45	1.93	12.49
MESFF01	Mescalero	Church Spring	7-26-95	Fish Fillet	Rainbow Trout	75.8	<4.06	3.51	<0.81	<0.08	3.02	<0.24	1231.41	0.69	7.52	21.12
MESFF02	Mescalero	Church Spring	7-26-95	Fish Fillet	Rainbow Trout	74.5	<3.86	4.71	<0.77	<0.08	<1.55	<0.23	1639.22	0.63	11.02	17.73
DEXS01	Dexter	S.E. Sump	7-27-95	Sediments		47.9	5451.1	1.73	55.47	0.26	10.27	<0.28	111516.31	9.02	31.86	4798.46

Appendix A-1. Moisture content and trace-element concentrations in biological, water and sediment samples from Dexter NFTC, Mescalero NFH and Isleta Reservoir, 1995. Element concentrations are in Fg/g dry weight, except for water which is in Fg/L.

Sample ID Code	Site	Location	Date	Type of sample	Common Name	Moisture content (percent)	Alum-inum	Arsenic	Barium	Beryl-lium	Boron	Cad-mium	Calcium	Chro-mium	Copper	Iron
DEXS02	Dexter	S.E. Sump	7-27-95	Sediments		49	7058.8	1.82	59.61	0.31	16.31	<0.29	106862.75	8.43	14.2	5529.41
MESS01	Mescalero	East Source Spring	7-26-95	Sediments		40.2	8561.9	3.09	79.1	0.47	4.88	<0.24	62207.35	10.47	170.57	11889.63
MESS02	Mescalero	Church Spring	7-26-95	Sediments		22.7	8641.7	0.35	47.99	0.32	5.67	<0.19	22768.43	7.48	<5.6	5407.5
DEXP01	Dexter	S.E. Sump	7-27-95	Algae	Algae	89.1	2311.9	10.55	23.12	0.25	127.52	<0.54	122018.42	8.61	10.18	3284.41
DEXP02	Dexter	S.E. Sump	7-27-95	Algae	Algae	91.2	2897.7	9.77	53.64	0.31	143.18	<0.67	123863.59	7.09	10.78	3750
MESP01	Mescalero	East Source Spring	7-26-95	Algae	Algae	79	3390.5	3.43	57.14	0.13	98.1	<0.29	270476.19	<8.52	<8.52	3204.76
MESP02	Mescalero	Church Spring	7-26-95	Algae	Algae	76.1	1866.1	1.92	48.54	<0.08	11.92	<0.25	251882.91	<7.45	<7.45	1912.13
MESP03	Mescalero	Church Spring	7-26-95	Algae	Algae	78.8	1735.9	2.36	1.29	<0.09	12.36	<0.28	273584.94	<8.4	<8.4	2089.62
DEXW01	Dexter	Holding House	7-27-95	Water		100	0.021	0.003	<0.013	0	0.172	<0.001	572	<0.007	<0.007	0.065
DEXW02	Dexter	Holding House	7-27-95	Water		100	0.024	0.003	<0.013	0	0.181	<0.001	594	<0.007	<0.007	0.023
DEXW03	Dexter	Well #5	7-27-95	Water		100	<0.02	0.002	0.005	0	0.137	<0.001	204	<0.002	0.003	<0.02
DEXW04	Dexter	Well #4	7-27-95	Water		100	0.025	0.001	<0.013	0	0.178	<0.001	562	<0.007	<0.007	1.8
DEXW05	Dexter	S.E. Sump	7-27-95	Water		100	0.039	0.005	<0.013	0	0.202	<0.002	882	<0.007	<0.007	0.066
DEXW06	Dexter	S.E. Sump	7-27-95	Water		100	0.029	0.003	<0.013	0	0.17	<0.002	547	<0.007	<0.007	0.027
DEXW07	Dexter	Blank	7-27-95	Water		100	0.032	<0.001	<0.005	0	0.043	<0.002	3.91	<0.003	0.004	0.026
MESW01	Mescalero	East Source Spring	7-26-95	Water		100	0.02	0.001	0.032	0	0.053	<0.001	109	<0.002	0.005	0.027
MESW02	Mescalero	Carillo Springs	7-26-95	Water		100	0.031	0.001	0.024	0	0.052	<0.002	146	<0.003	0.004	<0.025
MESW03	Mescalero	Carillo Springs	7-26-95	Water		100	0.031	<0.001	0.024	0	0.056	<0.001	135	<0.002	<0.002	<0.02
MESW04	Mescalero	Church Spring	7-26-95	Water		100	<0.02	<0.001	0.014	0	0.045	<0.001	140	<0.002	0.003	<0.02
MESW05	Mescalero	Raceway C-6	7-26-95	Water		100	0.027	<0.001	0.023	0	0.117	<0.001	121	<0.002	0.006	<0.02
MESW06	Mescalero	Raceway C-6	7-26-95	Water		100	<0.02	<0.001	0.021	0	0.041	<0.001	120	<0.002	0.003	0.069
DEXCCF06	Dexter	Hatchery Pond	7-27-95	Part Body	Channel Catfish	70.7	<3.37	0.51	<0.68	<0.07	2.41	<0.2	14573.38	0.96	0.83	29.42
DEXCCF11	Dexter	Holding House	7-27-95	Part Body	Channel Catfish	68.7	<3.17	0.45	<1.9	<0.06	2.34	<0.19	28945.68	<0.95	<0.95	40.26
DEXFW01	Dexter	S.E. Sump	7-27-95	Whole Body	Leon Springs Pupfish	78.4	24.86	1.11	<2.7	<0.09	4.51	<0.27	42222.21	<1.35	11.85	119.91
DEXFW02	Dexter	S.E. Sump	7-27-95	Whole Body	Leon Springs Pupfish	79.4	27.23	0.34	<2.86	<0.1	5.97	<0.29	41213.58	<1.43	8.06	89.32
DEXFW03	Dexter	S.E. Sump	7-27-95	Whole Body	Chihuahua Chub	76.8	22.54	0.69	<2.55	<0.09	1.88	<0.25	35086.21	<1.27	4.35	102.59
DEXFW04	Dexter	S.E. Sump	7-27-95	Whole Body	Chihuahua Chub	75.5	13.1	0.78	<0.8	<0.08	1.82	<0.24	11795.92	0.93	1.52	16.86
DEXFW05	Dexter	S.E. Sump	7-27-95	Whole Body	Leon Springs Pupfish	79.2	19.04	0.53	<0.95	<0.1	<1.9	<0.28	32451.92	1.17	12.6	116.83
DEXFW06	Dexter	S.E. Sump	7-27-95	Whole Body	Leon Springs Pupfish	74.7	13.87	0.63	<0.77	<0.08	2.08	<0.23	8181.82	0.99	2.72	14.19

Appendix A-1. Moisture content and trace-element concentrations in biological, water and sediment samples from Dexter NFTC, Mescalero NFH and Isleta Reservoir, 1995. Element concentrations are in Fg/g dry weight, except for water which is in Fg/L.

Sample ID Code	Site	Location	Date	Type of sample	Common Name	Moisture content (percent)	Alum- inum	Arsenic	Barium	Beryl- lium	Boron	Cad- mium	Calcium	Chro- mium	Copper	Iron
DEXFW07	Dexter	S.E. Sump	7-27-95	Whole Body	Chihuahua Chub	67.7	11.11	0.59	<0.61	<0.06	1.88	<0.18	29411.76	0.88	6.97	99.38
MESFP01	Mescalero	Church Spring	7-26-95	Part Body	Rainbow Trout	61.2	4.25	1.78	<0.51	<0.05	2.36	<0.15	12190.72	0.49	4.18	51.03
MESFP02	Mescalero	Church Spring	7-26-95	Part Body	Rainbow Trout	70.3	7.21	2.59	<0.66	<0.07	3.12	<0.2	15151.52	0.91	5.29	218.52
MESFW01	Mescalero	Church Spring	7-26-95	Whole Body	Rainbow Trout	68.7	90.42	3.8	1.28	<0.06	2.36	<0.19	16421.72	0.94	7.16	178.27
MESFW02	Mescalero	Church Spring	7-26-95	Whole Body	Rainbow Trout	72.4	30.14	2.32	<2.15	<0.07	4.93	<0.21	10072.46	1.14	5.76	93.48
DEXCCF1	Dexter	Hatchery Pond	7-27-95	Integrated Fish	Channel Catfish	71.07	<3.29	0.45	<0.68	<0.07	2.02	<0.20	13265.95	0.91	1.27	39.19
DEXCCF2	Dexter	Holding House	7-27-95	Integrated Fish	Channel Catfish	70.22	<3.23	0.36	<1.78	<0.06	2.40	<0.20	25725.67	<0.68	0.19	40.95
MESFFP1	Mescalero	Church Spring	7-26-95	Integrated Fish	Rainbow Trout	63.22	3.10	2.02	<0.55	<0.05	2.45	<0.16	10677.61	0.52	4.64	46.90
MESFFP2	Mescalero	Church Spring	7-26-95	Integrated Fish	Rainbow Trout	71.00	5.37	2.94	<0.67	<0.07	2.34	<0.20	12905.70	0.86	6.24	185.15
SJILFF01	Isleta	Isleta	10-25-95	Fish Fillet	Rainbow Trout	75.54	13	4.30	1.00	0.10	15.00	0.10		0.50	1.90	34.00
SJILFF02	Isleta	Isleta	10-25-95	Fish Fillet	Rainbow Trout	75.92	40	3.50	1.00	0.10	13.00	0.10		1.90	1.90	55.00
SJILFP01	Isleta	Isleta	10-25-95	Part Body	Rainbow Trout	66.74	39	2.80	2.00	0.10	29.00	0.10		0.50	8.40	165.00
SJILFP02	Isleta	Isleta	10-25-95	Part Body	Rainbow Trout	68.03	28	2.10	1.00	0.10	26.00	0.10		0.50	5.10	129.00
SJILFI01	Isleta	Isleta	10-25-95	Integrated Fish	Rainbow Trout	67.95	35.44	3.01	1.86	0.10	27.08	0.10		0.50	7.51	147.05
SJILFI02	Isleta	Isleta	10-25-95	Integrated Fish	Rainbow Trout	68.82	29.20	2.24	1.00	0.10	24.70	0.10		0.64	4.78	121.61

Sample ID Code	Site	Location	Date	Type of Sample	Common Name	Lead	Magnesium	Man- ganese	Mercury	Molyb- denum	Nickel	Potassium	Selenium	Strontium
DEXD01	Dexter	Feed	7-27-95	Feed	Silver Cup Crumbles	<0.52	1633.3	17.6	0.096	0.42	0.86	8429.93	1.33	32.46
DEXD02	Dexter	Feed	7-27-95	Feed	Silver Cup Pellets	<0.53	2142.09	62	0.046	0.75	3.65	10979.55	5.27	30.25
DEXD03	Dexter	Feed	7-27-95	Feed	Silver Cup Starter	<0.52	1127.5	35.3	0.093	<0.42	3.4	9125.4	5.99	35.09
MESD01	Mescalero	Feed	7-26-95	Feed	Grower Pellets Intermediate	<0.51	946.82	83.32	0.189	0.46	1.29	7340.98	0.95	41.61
MESD02	Mescalero	Feed	7-26-95	Feed	Grower Pellets Finisher	<0.58	1126.76	127.93	0.127	<0.46	1.56	5504.7	2.48	44.37
MESD03	Mescalero	Feed	7-26-95	Feed	Grower Pellets Starter	<0.5	1062.31	114.4	0.091	<0.4	0.76	6373.85	3.41	76.61
DEXCCF05	Dexter	Hatchery Pond	7-27-95	Fish Gills	Channel Catfish	<1.77	1010.91	5.13	0.095	<1.42	0.44	6000	2.73	109.82
DEXCCF09	Dexter	Holding House	7-27-95	Fish Gills	Channel Catfish	<1.55	1252.4	13.8	0.08	<1.24	0.6	5175.72	2.62	160.38
DEXYC03	Dexter	Hatchery Pond	7-27-95	Fish Gills	Yaqui Catfish	<1.77	1585.45	11.45	0.247	<1.42	0.48	5200	3.93	201.45
DEXYC09	Dexter	Holding House	7-27-95	Fish Gills	Yaqui Catfish	<1.91	2296.44	6.28	0.383	<1.53	5.89	3940.71	6.09	349.8

Appendix A-1. Moisture content and trace-element concentrations in biological, water and sediment samples from Dexter NFTC, Mescalero NFH and Isleta Reservoir, 1995. Element concentrations are in Fg/g dry weight, except for water which is in Fg/L.

Sample ID Code	Site	Location	Date	Type of Sample	Common Name	Lead	Magnesium	Man-ganese	Mercury	Molyb-denum	Nickel	Potassium	Selenium	Strontium
DEXYC13	Dexter	Holding House	7-27-95	Fish Gills	Yaqui Catfish	<1.53	1487.34	3.48	<0.123	<1.25	<0.37	4335.44	6.87	246.52
DEXCCF07	Dexter	Holding House	7-27-95	Fish Kidney	Channel Catfish	<3.84	103.1	<0.77	0.225	<3.08	1.19	1589.15	10.39	0.78
DEXYC02	Dexter	Hatchery Pond	7-27-95	Fish Kidney	Yaqui Catfish	<2	450.41	1.47	2.438	<1.6	1.34	6652.89	10.91	2.51
DEXYC08	Dexter	Holding House	7-27-95	Fish Kidney	Yaqui Catfish	<2.07	677.97	3.4	0.831	<1.66	<0.5	6186.44	10.17	6.19
DEXYC11	Dexter	Holding House	7-27-95	Fish Kidney	Yaqui Catfish	<1.85	524.53	1.56	3.849	<1.48	7.62	8301.89	21.74	2.48
DEXCCF01	Dexter	Hatchery Pond	7-27-95	Fish Kidney	Channel Catfish	<1.86	183.4	0.52	0.211	<1.49	0.46	3249.06	9.4	1.45
DEXCCF02	Dexter	Hatchery Pond	7-27-95	Fish Liver	Channel Catfish	<1.85	689.66	4.44	0.249	<1.49	1.8	11647.51	10.54	2.1
DEXCCF08	Dexter	Holding House	7-27-95	Fish Liver	Channel Catfish	<1.65	318.92	1.91	0.22	<1.32	<0.4	5810.81	21.42	1.1
DEXYC01	Dexter	Hatchery Pond	7-27-95	Fish Liver	Yaqui Catfish	<2.34	842.86	4.32	16.19	<1.88	4.45	14047.62	15.1	7.86
DEXYC06	Dexter	Holding House	7-27-95	Fish Liver	Yaqui Catfish	<1.63	113.71	0.68	0.987	<1.31	<0.39	1260.87	5.89	0.78
DEXYC12	Dexter	Holding House	7-27-95	Fish Liver	Yaqui Catfish	<1.76	557.97	3.73	3.587	<1.44	2.78	11268.11	15.98	1.59
DEXCCF04	Dexter	Hatchery Pond	7-27-95	Fish Fillet	Channel Catfish	<1.92	750.97	1.77	0.101	<1.53	<0.46	12023.35	1.01	1.07
DEXCCF10	Dexter	Holding House	7-27-95	Fish Fillet	Channel Catfish	<2.51	1112.24	<0.5	0.571	<2.01	<0.6	13877.55	2.09	16.94
DEXYC05	Dexter	Hatchery Pond	7-27-95	Fish Fillet	Yaqui Catfish	<1.88	661.6	<0.38	0.913	<1.5	0.84	7794.68	2.13	2.25
DEXYC10	Dexter	Holding House	7-27-95	Fish Fillet	Yaqui Catfish	<1.71	780.49	<0.34	0.136	<1.37	1.46	13414.64	3.62	1.4
DEXYC14	Dexter	Holding House	7-27-95	Fish Fillet	Yaqui Catfish	<1.72	923.88	<0.34	0.457	<1.37	5.5	12456.75	2.8	1.21
MESFF01	Mescalero	Church Spring	7-26-95	Fish Fillet	Rainbow Trout	<2.03	1293.39	0.53	0.446	<1.62	<0.49	20000	2.23	2.17
MESFF02	Mescalero	Church Spring	7-26-95	Fish Fillet	Rainbow Trout	<1.93	1243.14	0.61	0.369	<1.55	<0.46	18862.75	1.65	2.97
DEXS01	Dexter	S.E. Sump	7-27-95	Sediments		3.01	11247.6	73.32	0.056	<1.85	4.95	1222.65	2.48	420.35
DEXS02	Dexter	S.E. Sump	7-27-95	Sediments		3.51	13156.86	92.75	0.047	<1.91	4.53	1619.61	2.04	411.76
MESS01	Mescalero	East Source Spring	7-26-95	Sediments		5.95	6923.08	155.69	0.109	<1.62	15.02	1354.51	0.52	88.96
MESS02	Mescalero	Church Spring	7-26-95	Sediments		<1.55	4566.62	148.77	0.023	<1.24	6.74	1358.34	1.1	549.81
DEXP01	Dexter	S.E. Sump	7-27-95	Algae	Algae	<4.5	10550.46	107.34	0.229	<3.61	6.19	13669.73	3.76	851.38
DEXP02	Dexter	S.E. Sump	7-27-95	Algae	Algae	<5.6	10545.45	108.41	0.216	<4.48	10.49	15568.18	3.98	935.23
MESP01	Mescalero	East Source Spring	7-26-95	Algae	Algae	<2.36	5571.43	141.43	0.076	<1.89	6.67	7285.71	0.76	557.14
MESP02	Mescalero	Church Spring	7-26-95	Algae	Algae	<2.07	3635.98	88.7	0.05	<1.65	2.28	1343.1	1.26	849.37
MESP03	Mescalero	Church Spring	7-26-95	Algae	Algae	<2.33	3367.92	117.92	0.066	<1.87	3.54	1599.06	1.08	1014.15
DEXW01	Dexter	Holding House	7-27-95	Water		<0.01	174	<0.007	<0.0002	<0.008	<0.002	3.68	0.004	2.87
DEXW02	Dexter	Holding House	7-27-95	Water		<0.01	180	<0.007	<0.0002	<0.008	<0.002	3.49	0.015	3.98
DEXW03	Dexter	Well #5	7-27-95	Water		<0.01	136	<0.002	<0.0002	<0.008	<0.002	1.97	0.009	4.12

Appendix A-1. Moisture content and trace-element concentrations in biological, water and sediment samples from Dexter NFTC, Mescalero NFH and Isleta Reservoir, 1995. Element concentrations are in Fg/g dry weight, except for water which is in Fg/L.

Sample ID Code	Site	Location	Date	Type of Sample	Common Name	Lead	Magnesium	Man-ganese	Mercury	Molyb-denum	Nickel	Potassium	Selenium	Strontium
DEXW04	Dexter	Well #4	7-27-95	Water		<0.01	161	0.706	<0.0002	<0.008	0.003	3.17	<0.002	3.37
DEXW05	Dexter	S.E. Sump	7-27-95	Water		<0.013	192	<0.007	<0.0002	<0.01	<0.003	3.69	0.01	5.88
DEXW06	Dexter	S.E. Sump	7-27-95	Water		<0.013	172	<0.007	0	<0.01	<0.003	3.32	0.007	5.13
DEXW07	Dexter	Blank	7-27-95	Water		<0.013	1.69	<0.003	0	<0.01	<0.003	0.51	<0.002	0.053
MESW01	Mescalero	East Source Spring	7-26-95	Water		<0.01	30	0	<0.0002	<0.008	<0.002	1.1	<0.002	0.801
MESW02	Mescalero	Carillo Springs	7-26-95	Water		<0.013	39.1	0.01	<0.0002	<0.01	<0.003	0.908	0.002	1.5
MESW03	Mescalero	Carillo Springs	7-26-95	Water		<0.01	38.1	0	<0.0002	<0.008	<0.002	1.04	0.002	1.7
MESW04	Mescalero	Church Spring	7-26-95	Water		<0.01	43.9	<0.002	<0.0002	<0.008	<0.002	1.39	0.003	1.55
MESW05	Mescalero	Raceway C-6	7-26-95	Water		<0.01	34.9	0	<0.0002	<0.008	<0.002	1.3	0.002	1.25
MESW06	Mescalero	Raceway C-6	7-26-95	Water		<0.01	34.7	0	0	<0.008	<0.002	0.978	0.002	1.25
DEXCCF06	Dexter	Hatchery Pond	7-27-95	Part Body	Channel Catfish	<1.69	955.63	2.34	0.082	<1.35	<0.41	9897.61	1.4	56.66
DEXCCF11	Dexter	Holding House	7-27-95	Part Body	Channel Catfish	<1.58	964.86	3.45	0.086	<1.27	<0.38	8753.99	1.25	74.44
DEXFW01	Dexter	S.E. Sump	7-27-95	Whole Body	Leon Springs Pupfish	<2.25	1560.18	9.12	0.727	<1.8	18.38	10972.22	12.31	176.85
DEXFW02	Dexter	S.E. Sump	7-27-95	Whole Body	Leon Springs Pupfish	<2.38	1796.12	9.08	0.083	<1.91	<0.57	11504.85	13.54	161.16
DEXFW03	Dexter	S.E. Sump	7-27-95	Whole Body	Chihuahua Chub	<2.12	1896.55	6.12	0.978	<1.7	<0.51	12327.59	12.93	145.26
DEXFW04	Dexter	S.E. Sump	7-27-95	Whole Body	Chihuahua Chub	<2	1551.02	2.33	0.078	<1.6	7.35	11755.1	9.88	136.73
DEXFW05	Dexter	S.E. Sump	7-27-95	Whole Body	Leon Springs Pupfish	<2.37	1591.35	8.51	0.058	<1.9	23.7	11298.07	17.74	147.6
DEXFW06	Dexter	S.E. Sump	7-27-95	Whole Body	Leon Springs Pupfish	<1.94	1418.97	2.6	0.055	<1.55	1.77	11146.24	14.66	136.76
DEXFW07	Dexter	S.E. Sump	7-27-95	Whole Body	Chihuahua Chub	<1.52	1260.06	5.94	0.096	<1.21	2.89	7894.74	7.37	147.06
MESFP01	Mescalero	Church Spring	7-26-95	Part Body	Rainbow Trout	<1.27	734.54	3.14	0.219	<1.01	1.57	7835.05	0.93	25.26
MESFP02	Mescalero	Church Spring	7-26-95	Part Body	Rainbow Trout	<1.66	1026.94	5.42	0.279	<1.33	<0.4	11010.1	1.68	31.52
MESFW01	Mescalero	Church Spring	7-26-95	Whole Body	Rainbow Trout	<1.57	1191.69	9.9	0.281	<1.26	<0.38	13354.63	2.08	36.74
MESFW02	Mescalero	Church Spring	7-26-95	Whole Body	Rainbow Trout	<1.79	1460.14	5.83	0.29	<1.43	<0.43	13115.94	1.38	56.52
DEXCCF1	Dexter	Hatchery Pond	7-27-95	Integrated Fish	Channel Catfish	<1.71	923.0359	2.296	0.087	<1.37	<0.37	9905.85	1.60	51.36
DEXCCF2	Dexter	Holding House	7-27-95	Integrated Fish	Channel Catfish	<1.70	977.5176	3.0974	0.1456	<1.37	<0.38	9251.02	1.55	67.95
MESFFP1	Mescalero	Church Spring	7-26-95	Integrated Fish	Rainbow Trout	<1.37	811.6984	2.7796	0.2503	<1.09	1.29	9514.62	1.11	22.07
MESFFP2	Mescalero	Church Spring	7-26-95	Integrated Fish	Rainbow Trout	<1.70	1062.874	4.6206	0.294	<1.37	<0.41	12315.26	1.68	26.77
SJILFF01	Isleta	Isleta	10-25-95	Fish Fillet	Rainbow Trout	0.5	1240	1	0.3	2	0.50		0.90	1.40
SJILFF02	Isleta	Isleta	10-25-95	Fish Fillet	Rainbow Trout	0.5	1200	1	0.32	2	0.50		0.80	1.40
SJILFP01	Isleta	Isleta	10-25-95	Part Body	Rainbow Trout	0.5	975	8	0.16	2	0.90		1.30	55.00

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Sample ID Code	Site	Location	Date	Type of Sample	Common Name	Lead	Magnesium	Man-ganese	Mercury	Molyb-denum	Nickel	Potassium	Selenium	Strontium
SJILFP02	Isleta	Isleta	10-25-95	Part Body	Rainbow Trout	0.5	1270	3	0.17	2	0.50		1.30	37.60
SJILFI01	Isleta	Isleta	10-25-95	Integrated Fish	Rainbow Trout	0.5	1011.312	7.0408	0.1792	2	0.85		1.25	47.66
SJILFI02	Isleta	Isleta	10-25-95	Integrated Fish	Rainbow Trout	0.5	1263.005	2.8001	0.185	2	0.50		1.25	33.98

Sample ID Code	Site	Location	Date	Type of Sample	Common Name	Vanadium	Zinc
DEXD01	Dexter	Feed	7-27-95	Feed	Silver Cup Crumbles	0.93	85.77
DEXD02	Dexter	Feed	7-27-95	Feed	Silver Cup Pellets	1.43	119.48
DEXD03	Dexter	Feed	7-27-95	Feed	Silver Cup Starter	1.33	1.36
MESD01	Mescalero	Feed	7-26-95	Feed	Grower Pellets Intermediate	2.02	97.6
MESD02	Mescalero	Feed	7-26-95	Feed	Grower Pellets Finisher	2.72	221.83
MESD03	Mescalero	Feed	7-26-95	Feed	Grower Pellets Starter	2.23	132.79
DEXCCF05	Dexter	Hatchery Pond	7-27-95	Fish Gills	Channel Catfish	0.27	61.82
DEXCCF09	Dexter	Holding House	7-27-95	Fish Gills	Channel Catfish	0.3	71.57
DEXYC03	Dexter	Hatchery Pond	7-27-95	Fish Gills	Yaqui Catfish	0.18	98.18
DEXYC09	Dexter	Holding House	7-27-95	Fish Gills	Yaqui Catfish	0.29	96.84
DEXYC13	Dexter	Holding House	7-27-95	Fish Gills	Yaqui Catfish	0.16	56.96
DEXCCF07	Dexter	Holding House	7-27-95	Fish Kidney	Channel Catfish	0.54	14.03
DEXYC02	Dexter	Hatchery Pond	7-27-95	Fish Kidney	Yaqui Catfish	9.71	48.35
DEXYC08	Dexter	Holding House	7-27-95	Fish Kidney	Yaqui Catfish	8.14	71.19
DEXYC11	Dexter	Holding House	7-27-95	Fish Kidney	Yaqui Catfish	6.91	60
DEXCCF01	Dexter	Hatchery Pond	7-27-95	Fish Kidney	Channel Catfish	0.69	26.87
DEXCCF02	Dexter	Hatchery Pond	7-27-95	Fish Liver	Channel Catfish	1.85	122.99
DEXCCF08	Dexter	Holding House	7-27-95	Fish Liver	Channel Catfish	1.06	59.12
DEXYC01	Dexter	Hatchery Pond	7-27-95	Fish Liver	Yaqui Catfish	5.57	92.86
DEXYC06	Dexter	Holding House	7-27-95	Fish Liver	Yaqui Catfish	0.22	10.1
DEXYC12	Dexter	Holding House	7-27-95	Fish Liver	Yaqui Catfish	2.52	90.22
DEXCCF04	Dexter	Hatchery Pond	7-27-95	Fish Fillet	Channel Catfish	<0.19	28.25
DEXCCF10	Dexter	Holding House	7-27-95	Fish Fillet	Channel Catfish	<0.25	47.24
DEXYC05	Dexter	Hatchery Pond	7-27-95	Fish Fillet	Yaqui Catfish	<0.19	44.11

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Sample ID Code	Site	Location	Date	Type of Sample	Common Name	Vanadium	Zinc
DEXYC10	Dexter	Holding House	7-27-95	Fish Fillet	Yaqui Catfish	<0.17	28.75
DEXYC14	Dexter	Holding House	7-27-95	Fish Fillet	Yaqui Catfish	<0.17	29
MESFF01	Mescalero	Church Spring	7-26-95	Fish Fillet	Rainbow Trout	<0.2	14.05
MESFF02	Mescalero	Church Spring	7-26-95	Fish Fillet	Rainbow Trout	<0.19	14.63
DEXS01	Dexter	S.E. Sump	7-27-95	Sediments		11.38	57.97
DEXS02	Dexter	S.E. Sump	7-27-95	Sediments		14.22	93.53
MESS01	Mescalero	East Source Spring	7-26-95	Sediments		25.25	25.08
MESS02	Mescalero	Church Spring	7-26-95	Sediments		12.38	20.18
DEXP01	Dexter	S.E. Sump	7-27-95	Algae	Algae	8.44	110.09
DEXP02	Dexter	S.E. Sump	7-27-95	Algae	Algae	9.92	115.91
MESP01	Mescalero	East Source Spring	7-26-95	Algae	Algae	8.05	18.24
MESP02	Mescalero	Church Spring	7-26-95	Algae	Algae	4.81	<14.9
MESP03	Mescalero	Church Spring	7-26-95	Algae	Algae	5.19	17.22
DEXW01	Dexter	Holding House	7-27-95	Water		0.004	0.022
DEXW02	Dexter	Holding House	7-27-95	Water		0.004	0.023
DEXW03	Dexter	Well #5	7-27-95	Water		0.003	0.014
DEXW04	Dexter	Well #4	7-27-95	Water		<0.001	0.027
DEXW05	Dexter	S.E. Sump	7-27-95	Water		0.003	0.018
DEXW06	Dexter	S.E. Sump	7-27-95	Water		0.003	<0.013
DEXW07	Dexter	Blank	7-27-95	Water		<0.001	0.015
MESW01	Mescalero	East Source Spring	7-26-95	Water		0.001	0.022
MESW02	Mescalero	Carillo Springs	7-26-95	Water		<0.001	0.015
MESW03	Mescalero	Carillo Springs	7-26-95	Water		<0.001	0.01
MESW04	Mescalero	Church Spring	7-26-95	Water		0.001	0.009
MESW05	Mescalero	Raceway C-6	7-26-95	Water		<0.001	0.012
MESW06	Mescalero	Raceway C-6	7-26-95	Water		<0.001	0.011
DEXCCF06	Dexter	Hatchery Pond	7-27-95	Part Body	Channel Catfish	<0.17	41.3
DEXCCF11	Dexter	Holding House	7-27-95	Part Body	Channel Catfish	<0.16	56.87
DEXFW01	Dexter	S.E. Sump	7-27-95	Whole Body	Leon Springs Pupfish	<0.23	150.93
DEXFW02	Dexter	S.E. Sump	7-27-95	Whole Body	Leon Springs Pupfish	<0.24	154.85

Appendix A-1. Moisture content and trace-element concentrations in biological, water and sediment samples from Dexter NFTC, Mescalero NFH and Isleta Reservoir, 1995. Element concentrations are in Fg/g dry weight, except for water which is in Fg/L.

Sample ID Code	Site	Location	Date	Type of Sample	Common Name	Vanadium	Zinc
DEXFW03	Dexter	S.E. Sump	7-27-95	Whole Body	Chihuahua Chub	<0.21	227.16
DEXFW04	Dexter	S.E. Sump	7-27-95	Whole Body	Chihuahua Chub	<0.2	92.24
DEXFW05	Dexter	S.E. Sump	7-27-95	Whole Body	Leon Springs Pupfish	<0.24	131.25
DEXFW06	Dexter	S.E. Sump	7-27-95	Whole Body	Leon Springs Pupfish	<0.19	50.59
DEXFW07	Dexter	S.E. Sump	7-27-95	Whole Body	Chihuahua Chub	0.22	188.85
MESFP01	Mescalero	Church Spring	7-26-95	Part Body	Rainbow Trout	<0.13	88.14
MESFP02	Mescalero	Church Spring	7-26-95	Part Body	Rainbow Trout	<0.16	109.43
MESFW01	Mescalero	Church Spring	7-26-95	Whole Body	Rainbow Trout	0.28	157.83
MESFW02	Mescalero	Church Spring	7-26-95	Whole Body	Rainbow Trout	<0.18	148.55
DEXCCF1	Dexter	Hatchery Pond	7-27-95	Integrated Fish	Channel Catfish	<0.14	40.71
DEXCCF2	Dexter	Holding House	7-27-95	Integrated Fish	Channel Catfish	<0.15	55.69
MESFFP1	Mescalero	Church Spring	7-26-95	Integrated Fish	Rainbow Trout	<0.14	77.91
MESFFP2	Mescalero	Church Spring	7-26-95	Integrated Fish	Rainbow Trout	<0.16	93.67
SJILFF01	Isleta	Isleta	10-25-95	Fish Fillet	Rainbow Trout	0.5	20
SJILFF02	Isleta	Isleta	10-25-95	Fish Fillet	Rainbow Trout	0.5	16
SJILFP01	Isleta	Isleta	10-25-95	Part Body	Rainbow Trout	0.5	119
SJILFP02	Isleta	Isleta	10-25-95	Part Body	Rainbow Trout	0.50	108.00
SJILFI01	Isleta	Isleta	10-25-95	Integrated Fish	Rainbow Trout	0.50	105.43
SJILFI02	Isleta	Isleta	10-25-95	Integrated Fish	Rainbow Trout	0.50	98.81

Appendix A-2.--Sample weight, moisture content, and organic compound concentrations in one biological and four sediment samples from Dexter NFTC and Mescalero NFH, 1995. Concentrations are in µg/g wet weight; TOC,= total organic carbon; see text for correlations to abbreviated chemical names.

Sample ID	Site	Location	Date	Matrix	Common Name	Sample Weight	%Moisture	%Lipid	%TOC	2,4,5-T	2,4-D	2,4-DB	Atrazine
DEXYC07	Dexter	Holding House	7-27-95	Egg Mass	Yaqui Catfish	9.7	59.9	19.9					
DEXS03	Dexter	SE Sump	7-27-95	Sediment		403	46.6		1.8				
DEXS04	Dexter	SE Sump	7-27-95	Sediment		399	47		1.2				<0.05
MESS03	Mescalero	Raceway	7-26-95	Sediment		127	22.8		1.8	<0.01	<0.01	<0.01	<0.05
MESS04	Mescalero	East Source	7-26-95	Sediment		105	35.2		0.96	<0.01	<0.01	<0.01	<0.05

Sample ID	Cypermethrin	Fenvalerate	HCB	Metribuzin	PCB Total	Permethrin	Propazine	Simazine	alpha BHC	alpha chlordane	beta BHC	cis-nonachlor	delta BHC	dicambra	dichlor-propanol	dieldrin
DEXYC07			<0.01		0.23				<0.01	<0.01	<0.01	<0.01	<0.01			<0.01
DEXS03			<0.01		<0.05				<0.01	<0.01	<0.01	<0.01	<0.01			<0.01
DEXS04			<0.01	<0.05	<0.05		<0.05	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01			<0.01
MESS03	<0.01	<0.01	<0.01	<0.05	<0.05	<0.01	<0.05	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
MESS04	<0.01	<0.01	<0.01	<0.05	<0.05	<0.01	<0.05	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.013	<0.01

Sample ID	endrin	gamma BHC	gamma chlordane	heptachlor epoxide	mirex	o,p'-DDD	o,p'-DDE	o,p'-DDT	oxychlordane	p,p'-DDD	p,p'-DDE	p,p'-DDT	silvex	toxaphene	trans-nonachlor
DEXYC07	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.015	0.082	<0.01		<0.05	<0.01
DEXS03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.05	<0.01
DEXS04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.05	<0.01
MESS03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01
MESS04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.05	<0.01

APPENDIX B-1

Analytical Methods for Trace Element Analyses

Analysis of all samples collected in 1995 for trace elements was conducted by Hazleton Laboratories of America (HAZL), Incorporated in Madison, Wisconsin. The following is a description of the analytical methodology submitted by HAZL.

Elemental Analysis by Inductively Coupled Plasma Spectroscopy

This method is applicable to plant and animal tissue, soil/sediment, and water.

Sample Preparation:

Plant and Animal Tissue:

Digest 5.00 g of tissue in Teflon vessel with 5 mL nitric acid in microwave digester. Transfer into 50 mL volumetric flask and dilute to volume with 0.005% Triton X-100 solution. Filter.

Soil and Sediment:

Digest 1.00 g in covered Teflon beaker on hot plate using 10 mL nitric acid. Add 30% hydrogen peroxide in 1 mL aliquots until effervescence no longer occurs. Add 1.25 mL hydrochloric acid, heat 10 minutes, and transfer to a 50 mL volumetric flask. Dilute to volume with DDI water. Filter.

Water

Digest 100.0 mL sample in Teflon beaker on hot plate with 0.5 mL nitric acid and 2.5 mL hydrochloric acid. Reduce volume to 15 to 20 mL. Transfer into 50 mL volumetric flask. Dilute to volume with DDI water. Filter.

Principle:

Each analyte concentration in the sample solution is determined by comparing its emission intensity with the emission intensities of a known series of analyte standards. The analytical wavelengths are tabulated with the raw concentration data. Analytical data is corrected for background and interfering element effects by the spectrometer program. The detection limit of each analyte is listed in the data report with each respective unknown value, it is a function of the instrument detection limit (IDL), and the sample mass and volume to which it is diluted. With each batch of 20 samples of the same matrix type, at least one duplicate, one sample spike, one analytical blank, and one appropriate reference material are assayed.

References:

1. Test Methods for Evaluating Solid Waste - EPA Publication No. SW-846, 3rd edition, Methods (3030, 3040, or 3050) and 6010, US EPA, Washington DC (revised December 1987).

2. Dahlquist, R.L. and Knoll, J.W., "Inductively coupled Plasma - Atomic Emission Spectrometry: Analysis of Biological Materials and Soils for Major, Trace, and Ultra-Trace Elements," Applied Spectroscopy, 32 (1) 1-29 (January/February 1978).

3. Official Methods of Analysis - 14th Edition, method 43.292-43.296, AOAC: Arlington, Virginia (1984).

4. Official Methods of Analysis - 1st Supplement, 14th Edition, Method 3.A01-3.A04, AOAC, Arlington, Virginia (1985).

5. U.S. Environmental Protection Agency Contract Laboratory program, Statement of Work, Inorganic Analysis, Multimedia, Multi-concentration, S.O.W. 7/88.

6. "Inductively Coupled Plasma-Atomic Emission Spectrometric Method of Trace Element Analysis of Water and Wastes," Method 200.7, edited by Theodore D. Martin and John F. Kopp, U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio.

7. "Method Procedures, Analytical Chemistry Department, Inorganic Chemistry." Method MP-ICPS-MA, Hazleton Laboratories America, Inc., Madison, Wisconsin.

Mercury by Cold Vapor Atomic Absorption

This method is applicable to most materials including animal tissues, plants, soils.
Principle:

Sample weight: 2.00 g
Sample volume: 100 mL.

Samples are digested with a mixture of sulfuric and nitric acid. Mercury is reduced with sodium borohydride for determination. The amount of mercury is determined at a wavelength of 253.7 nm by comparing the signal of the unknown sample, measured by the atomic absorption spectrophotometer with the MHS-20 hydride generation unit, with the signal of the standard solutions.

Using a 2.0-g sample, the lowest detection limit of this assay is 0.025 ppm.

References:

1. Digestion: Analyst, 86:608 (1961) with modifications.

2. Determination: Analytical Chemistry, 40:2085 (1968).

3. Test Methods for Evaluating Solid Waste, EPA Publication No. SW-846, 2nd Ed., Methods 3030, 3040 or 3050 and 7470, U.S. EPA: Washington, D.C. (revised April 1984).

Mercury in Water by Cold Vapor Atomic Absorption

This method is applicable to drinking, surface, saline, and waste waters, and effluents.

Principle:

Sample volume for digest: 50 mL
Final volume: 100 mL

Samples are digested with sulfuric acid, potassium permanganate, and potassium persulfate. Mercury is reduced with sodium borohydride for determination. The amount of mercury is determined at a wavelength of 253.7 nm by comparing the signal of the unknown sample, measured by the atomic absorption spectrophotometer with the MHS-20 hydride generation unit, with the signal of the standard solutions.

Using a 50-mL sample, the lowest detection limit of this assay is 0.0004 mg/L.

References:

1. Method for Chemical Analysis of Water and Wastes, EPA Publication No. 600/4-79-020, Metals 1-19 and Method 245.2, U.S. EPA: Cincinnati, Ohio.

2. Test Methods for Evaluating Solid Waste, EPA Publication No. SW-846, 2nd Ed., Methods 3020 and 7470, U.S. EPA: Washington, D.C. (revised April 1984).

Arsenic by Graphite Furnace

This method is applicable to animal tissues, plants, sediments, sludges, and soils.

Sample Preparation:

Animal or Plant Tissue
Digest 1.00 g with nitric acid in a microwave digestor. Transfer to 100 mL.

Sediment or Soil
Digest 1.00 g with nitric acid and 30% hydrogen peroxide using covered glass beakers on hot plates. Transfer to 100 mL.

Principle:

The amount of arsenic is determined at a wave length of 193.7 nm by comparing the signal of the unknown sample, measured by the graphite furnace atomic absorption spectrophotometer, with the signal of the standard solutions. The method of standard additions is used where interferences are indicated. Nickel matrix modification is employed in the analysis.

Using a 1.00-g sample, the lowest detection limit of this assay is 0.1 ppm.

References:

1. Test Methods for Evaluating Solid Waste, EPA Publication No. SW-846, 2nd Ed., Methods 3030, 3040 or 3050 and 7060, U.S. EPA: Washington, D.C. (revised April 1984).

2. Contract Laboratory Program Statement of Work No. 785, Method 206.2 CLP-M, U.S. EPA: Cincinnati, Ohio.

Arsenic in Water by Graphite Furnace

This method is applicable to waters and aqueous wastes.

Sample Preparation:

Sample volume: 25 mL
Final volume: 25 mL

Digest the sample with nitric acid and 30% hydrogen peroxide using covered glass beakers and hot plates. Transfer to 25 mL.

Principle:

The amount of arsenic is determined at a wavelength of 193.7 nm by comparing the signal of the unknown sample, measured by the graphite furnace atomic absorption spectrophotometer, with the signal of the standard solutions. The method of standard additions is used where interferences are indicated. Nickel matrix modification is employed in the analysis.

Using a 25-mL sample, the lowest detection limit of this assay is 1 mg/L.

References:

1. Methods for Chemical Analysis of Water and Wastes, EPA Publication No.600/4-79-020, Metals 1-19 and Method 206.2, U.S. EPA: Cincinnati, Ohio.

2. Test Methods for Evaluating Solid Waste, EPA Publication No. SW-846, 2nd Ed., Methods 3020 and 7060, U.S. EPA: Washington, D.C. (revised April 1984).

Selenium by Graphite Furnace

This method is applicable to animal tissues, plants, sediments, sludges, and soils.

Sample Preparation:

Animal or Plant Tissue
Digest 1.00 g with nitric acid in a microwave digestor. Transfer to 100 mL.

Sediment or Soil
Digest 1.00 g with nitric acid and 30% hydrogen peroxide using covered glass beakers on hot plates. Transfer to 100 mL.

Principle:

The amount of selenium is determined at a wavelength of 196.0 nm by comparing the signal of the unknown sample, measured by the graphite furnace atomic absorption spectrophotometer, with the signal of the standard solutions. The method of standard additions is used along with nickel matrix modification in the analysis.

Using a 1.00-g sample, lowest detect limit of this assay is 0.1 ppm.

Reference:

1. Test Methods for Evaluating Solid Waste, EPA Publication No. SW-846, 2nd Ed., Methods 3030, 3040, or 3050 and 7740, U.S. EPA: Washington, D.C. (revised April 1984).

Selenium in Water by Graphite Furnace

Sample Preparation:

Sample volume: 25 mL (minimum)
Final volume: 25 mL

Digest the sample with nitric acid and 30% hydrogen peroxide using covered glass beakers and hot plates. Transfer to 25 mL.

Principle:

The amount of selenium is determined at a wavelength of 196.0 nm by comparing the signal of the unknown sample, measured by the graphite furnace atomic absorption spectrophotometer, with the signal of the standard solutions. The method of standard additions is used along with nickel matrix modification in the analysis.

Using a 25-mL sample, the lowest detection limit of this assay is 2 Fg/L.

References:

1. Methods for Chemical Analysis of Water and Wastes, EPA PublicationNo. 600/4-79-020, Metals 1-19, and Method 270.2, U.S. EPA: Cincinnati, Ohio.

2. Test Methods for Evaluating Solid Waste, EPA Publication No. SW-846, 2nd Ed., Methods 3020 and 7060, U.S. EPA: Washington, D.C. (revised April 1984).

Determination of Percent Moisture

This method covers the gravimetric determination of percent moisture in soil, sediment and biological tissue samples.

Procedure:

One to 10 g of the sample is placed into a preweighed aluminum weighing pan. The pan is weighed again with the sample in it. The pan and sample are then placed into an oven at 105 C for 16 hours. The sample is allowed to cool in a desiccator and then weighed again. The following equation is used to calculate the percent moisture:

((mass(g) pan + wet sample) - (mass(g) pan + dry sample))x100=% moisture
----
grams of sample

If samples are to be calculated based on dry weight, the percent moisture is converted to a correction factor (M). The calculation of the factor is:

100 / (100 - % moisture) = M

References:

1. Environmental Protection Agency, "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods - EPA Publication No. SW-846," Method 3550, Office of Solid Waste and Emergency Response, Washington, D.C. (September 1986)

2. "Determination of Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs) in Soils and Sedients." Method MP-FWSS-MA, Hazleton Laboratories America, Inc., Madison, Wisconsin.

APPENDIX B-2

Analytical Methods for Organic Compound Analyses

Analysis of soil and ovarian samples collected in 1995 for organic compound analysis was conducted by Mississippi State Chemical Laboratory (MSCL), Mississippi State, Mississippi. The following is a description of analytical methodology submitted by MSCL.

<u>Analysis For Organochlorine Pesticides and PCBs In Animal and Plant Tissue</u>

Sample Preparation:

Ten gram tissue samples are thoroughly mixed with anhydrous sodium sulfate and soxhlet extracted with hexane for seven hours. The extract is concentrated by rotary evaporation; transferred to a tared test tube, and further concentrated to dryness for lipid determination. The weighed lipid sample is dissolved in petroleum ether and extracted four times with acetonitrile saturated with petroleum ether. Residues are partitioned into petroleum ether which is washed, concentrated, and transferred to a glass chromatographic column containing 20 grams of Florisil. The column is eluted with 200 mL 6% diethyl ether/94% petroleum ether (Fraction I) followed by 200 mL 15% diethyl ether/85% petroleum ether (Fraction II). Fraction II is concentrated to appropriate volume for quantification of residues by packed or capillary column electron capture gas chromatography. Fraction I is concentrated and transferred to a Silicic acid chromatographic column for additional cleanup required for separation of PCBs from other organochlorines. Three fractions are eluted from the silicic acid column. Each is concentrated to appropriate volume for quantification of residues by packed or megabore column, electron capture gas chromatography. PCBs are found in Fraction II.

<u>Analysis for Organochlorine Pesticides, Aliphatic and Polynuclear Aromatic Hydrocarbons, and Chlorophenoxy Acid Herbicides in Soil and Sediment</u>

Sample Preparation:

Weigh 20 g soil into a PRQ centrifuge bottle. (Add 10 mL PRQ H_2O to dry samples) Adjust pH to # 2 with PRQ 12N sulfuric acid (about 1 mL). Add 50 mL acetone and shake 6 times over a one and one-half hour period (about every 15 mins.). Add 50 mL of a 1:1 petroleum ether/ ethyl ether mixture and repeat shaking. Centrifuge and decant liquid into a 500 mL separatory funnel containing 200 mL PRQ water. Re- extract soil by shaking one minute with 50 mL 1:1 PE:EtoEt (may need to add 10 mL H_2O & adjust to pH < 2), then centrifuge and decant liquid into sep. funnel.

Using PRQ 6N KOH (5 mL), adjust contents of sep. funnel to pH $ 12. Shake vigorously 2 min, then allow to stand 30 min. with intermittent shaking. Drain water layer and reserve ether layer. Re-extract H_2O layer with 100 mL 1:1 PE:EtoEt. Cap and reserve combined ether extracts.(This contains organochlorine pesticides, aliphatic and polynuclear aromatic hydrocarbons.)

Adjust aqueous layer to pH # 2 using 3 mL of PRQ 12 N sulfuric acid and extract with 100 mL 1:1 PE:EtoEt. Reserve this extract and re-extract H_2O with 100 mL 1:1 PE:EtoEt. Combine extracts (these extracts contain chlorophenoxy acid herbicides).

Concentrate acid and basic extracts with Kuderna-Danish evaporators and reduce volume to adequate size for column clean-up.

Column Clean-up:

Basic fraction (N/P and Organochlorine pesticides, Aliphatic and Polynuclear aromatic hydrocarbons) - adjust sample extract to exact volume and remove an appropriate aliquot for column clean-up techniques specific to analyte; for pesticides use Mini-florisil (described in Method 2), for hydrocarbons use 1% deactivated silica gel (described in Method 4).

Acid Fraction (Chlorophenoxy acid herbicides):

Derivitization: Reduce sample volume to approximately 0.5mL and ethylate using diazoethane (15 min.). Exchange to hexane (N-EVAP) and reduce volume to 0.2mL.

Column clean-up: Place 2.0g of 1% deactivated silica gel in a 7mm i.d. chromatography column (#22 Kontes). Top with 1cm Na_2SO_4 and prewet column with 10mL hexane. Collect sample eluents in three fractions as follows:

Fraction A: add sample and rinse container with two 0.5mL washes of 20% benzene in hexane. Elute with 9mL of the same solution.(Contains PCP.)

Fraction B: add 10mL 40% benzene in hexane. Add 10mL 60%benzene in hexane.(Contains Dalapon, PNP, Silvex, Dinoseb, portion of Dicamba.)

Fraction C: add 10mL 80% benzene in hexane. Add 10mL 100% benzene.(Contains remaining Dicamba, Dichlorprop, 2,4-D,2,4,5-T, 2,4-DB, Bentazon, Blazer.)

References:

1. Shafik, T. A.,H. C. Sullivan, H. R. Enos, 1973." Multiresidue Procedure for Halo- and Nitrophenols. Measurement of Exposure to Biodegradable Pesticides Yielding These Compounds as Metabolites." J. Agr. Food Chem. 21:295-298.

Grain Size

Sample Preparation:

Disperse sample of soil or sediment to pass 2 mm sieve and place a weighed 40 gram in a 600 mL beaker. Take additional 30 gram sample for moisture determination so that air-dried weight may be corrected to oven-dried weight. Add 50 mL 10% "Calgon" solution (sodium meta-phosphate with sufficient sodium carbonate to give a pH of approximately 8.3 in a 10% solution) to 40 gram sample and allow to soak for at least 10 minutes. After soaking, quantitatively transfer sample with distilled water to Waring blender cup so that cup is approximately half full. Blend for four minutes and transfer suspension to sedimentation cylinder adjusting liquid level to 1000 mL mark with distilled water. Place cylinder in constant temperature water bath (approximately $38^{o}C$). Prepare sample "blank" by adding 50 mL 10% "Calgon" solution to second sedimentation cylinder and add distilled water to the 1000 mL mark. When the suspension reaches water bath temperature, the mixture is thoroughly stirred prior initiation of sedimentation. The time that stirring ceases is noted as the zero settling time. At the end of eighthours, lower the hydrometer (ASTM 152 H) gently into the suspension and read the scale at the end of the meniscus. Record the time of hydrometer reading, the hydrometer reading, and water bath temperature. After thorough mixing, record the hydrometer reading in the sample "blank" solution of water and "Calgon". After hydrometer readings are recorded, pour the suspension onto a 270 mesh, 53 micron sieve and wash all silt and clay out with the water. Transfer sample material remaining on the sieve into an evaporating dish; place in $110^{o}C$ oven and allow to dry for 24 hours. After cooling, weigh the sample to determine the weight of oven-dry sand left on the sieve. Using moisture data determined, correct sample air-dry weight to oven-dry weight. Calculate the concentration of suspension in grams per liter from the following equation:

C = R - R< where C = concentration (gm/liter)
R = hydrometer reading in suspension
R<=hydrometer reading in "Calgon" solution.

Calculate the Clay percentage, PC from the following:

Pc = (100)*C/Co where Co represents the oven-dry weight of soil per liter of suspension.

Calculate the Sand percentage, Ps from the following:

Ps = 100*S/Co   where S is the weight of the oven-dry sand left on screen and Co is as in the Clay formula.

Silt percentage is 100 - Pc - Ps

Total Organic Carbon

Sample Preparation:

Weigh approximately 0.35 g sample into a numbered glazed ceramic boat. Record the weights and boat numbers. In an acid safe hood, add 1:1 HCl dropwise to each sample until completely moistened, usually 5 to 10 drops. Observe the samples for any bubbling, and note this. Heat the samples on a hot plate until dry. The addition of HCl and hot plate drying must be repeated until no further bubbling occurs. Dry samples in a drying oven at 100^{o}C for 1 hour.

Samples were analyzed using a Leco CR-412 Carbon Analyzer. The instrument was calibrated using $CaCO_3$. The right anhydrone tube of the furnace was replaced with a chlorine trap before TOC samples were analyzed.

Analysis For Selected Organophosphate and Synthetic Pyrethroid Pesticides and Triazine Herbicides in Soil and Sediment.

This method is suitable for the extraction and quantitation of the following analytes: 1) Organophosphate pesticides- chlorpyrifos, diazinon, EPN, ethyl parathion, malathion, methyl chlorpyrifos, and methyl parathion, 2) synthetic pyrethroids- cypermethrin and fenvalerate, 3) Triazine herbicides- atrazine, metribuzin, propazine, simazine, 4) Other herbicides- alachlor and metolachlor.

Sample Preparation:

Twenty gram soil or sediment samples are extracted with acetone, followed by petroleum ether, by allowing to soak one hour in each with intermittent shaking. A final acetone/petroleum ether extraction is done, and the extracts are combined, centrifuged, and transferred to a separatory funnel containing sufficient water to facilitate partitioning of residues into petroleum ether portion. The petroleum ether is washed twice with water and concentrated by Kuderna-Danish to appropriate volume. An aliquot of the concentrated extract for pesticide determination is transfered to a 1.6 gram Florisil mini-column topped with 1.6 grams sodium sulfate. Residues are eluted from the column in two elution fractions. Fraction I consists of 12 milliliters hexane followed by 12 milliliters of 1%. methanol in hexane, and Fraction II consists of an additional 24 milliliters of 1% methanol in hexane. megabore columns, electron capture gas chromatography and by TSD (thermionic specific detector), to detect N and P containing compounds.

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