U.S. Fish & Wildlife Service

Investigation of Fish Tissue Contaminant Concentrations at Painted Turtle Pond, Occoquan Bay National Wildlife Refuge, Woodbridge, Virginia

CBFO-C03-05

November 2003

INVESTIGATION OF FISH TISSUE CONTAMINANT CONCENTRATIONS AT PAINTED TURTLE POND, OCCOQUAN BAY NATIONAL WILDLIFE REFUGE, WOODBRIDGE, VIRGINIA

Final Report

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EXECUTIVE SUMMARY

Painted Turtle Pond is a 1.1-hectare (2.7-acre) man-made pond located on the Occoquan Bay National Wildlife Refuge (NWR), Woodbridge, Virginia. This 234-hectare (579-acre) refuge is part of the Potomac River NWR Complex. The Occoquan Bay NWR was established in 1998, through the transfer of the property from the U.S. Army as a result of the Base Realignment and Closure Act (BRAC). The property was formerly known as the Woodbridge Research Facility. Painted Turtle Pond was formerly referred to as Operable Unit 1 Pond.

Under BRAC, contaminant issues on the Refuge have been investigated under the direction of the BRAC Cleanup Team, which includes representatives of the U.S. Fish and Wildlife Service's Chesapeake Bay Field Office (CBFO), U.S. Environmental Protection Agency (EPA), Virginia Department of Environmental Quality (DEQ), and U.S. Army Corps of Engineers (COE). As part of the Long Term Monitoring Program, fish (whole body and fillet) sampling was conducted at Painted Turtle Pond by the COE in 2001. The Service reviewed the results and decided that there was a need to collect additional samples to resolve questions about the quality of the data and to expand the number of species investigated. The Service obtained the necessary funds and conducted the sampling and analysis in 2002. This report describes the sampling program, data analysis, and interpretation.

In March 2002, using an electroshocking boat, the Service obtained channel catfish (*Ictalurus punctatus*), largemouth bass (*Micropterus salmoides*), and bluegill (*Lepomis macrochirus*). There were five samples of each species; bluegill were composite samples of four fish whereas the other species were sampled as individuals. To the extent possible, the size range followed current U.S. Environmental Protection Agency guidance. Samples were stored at 4 EC, filleted, and shipped to Texas A&M University laboratories for analysis of organochlorine pesticides, polychlorinated biphenyls (PCBs) by Aroclor, metals, percent moisture, and percent lipid. Samples met all quality control guidelines. Data were summarized and compared with EPA guidance values and concentrations used by the Virginia Department of Health for establishing consumption advisories.

The greatest human health concern results from the concentrations of mercury in largemouth bass and channel catfish tissues. The mean concentrations were 0.376 ppm and 0.335 parts per million (ppm) wet weight, respectively. One of the five largemouth bass samples had a concentration of 0.682 ppm. This maximum concentration exceeds the Virginia Department of Health (VDH) advisory level of 0.5 ppm. The mean mercury concentrations in bass and catfish also exceed the EPA's 0.3 ppm tissue criterion for the protection of human health, which is an advisory rather than regulatory level. Mean and maximum concentrations in bluegill were less (0.144 and 0.205 ppm, respectively).

Of the other chemicals of potential concern (for which EPA has established risk levels), only total PCBs, total DDT, arsenic, and selenium were detected in the fish tissue samples. Neither mean nor maximum PCB concentrations in any of the species approached the VDH trigger of 0.600 ppm, however the EPA PCB screening value of 0.020 ppm was exceeded. The mean concentrations of total arsenic were 0.147 to 0.190 ppm. If an estimated 10% of total arsenic is considered to be inorganic arsenic, the concentrations approach, but do not exceed, the EPA screening value of 0.026 ppm inorganic arsenic.

Based on these observations, we recommend that this report be submitted to VDH for an evaluation if the Refuge wishes to allow catching and eating of fish from this pond. CBFO recommends that every five years, the Refuge conduct a similar sampling and analysis program to monitor trends in contaminant concentrations and provide updated data to VDH. To avoid the need to estimate inorganic arsenic concentrations, CBFO recommends that fish be analyzed for both inorganic and total arsenic.

ACKNOWLEDGMENTS

The assistance of Gary Swihart, U.S. Fish and Wildlife Service, Gloucester Office for Fisheries Assistance (Gloucester, VA) for the electrofishing is appreciated. Laboratory analyses were conducted by the Texas A&M University Geochemical and Environmental Research Group (GERG) and Trace Element Research Laboratory (TERL), College Station, TX with the oversight of the U.S. Fish and Wildlife Service's Patuxent Analytical Control Facility (PACF, Laurel, MD). We appreciate the assistance of Bob Taylor (TERL), Guy Denoux (GERG), and John Moore (PACF).

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INTRODUCTION

Site Description and History

The Occoquan Bay National Wildlife Refuge (NWR) is a 234-hectare (579-acre) parcel of land located in Woodbridge, Virginia about 40 kilometers (25 miles) southwest of Washington, DC (Figure 1-1). The refuge is part of the Potomac River NWR Complex. It was created in 1998 with the transfer of the former U.S. Army Woodbridge Research Facility to the U.S. Fish and Wildlife Service (Service). Concerns about hazardous waste on the Refuge have been investigated by the Base Realignment and Closure Act (BRAC) Cleanup Team, that includes representatives from the Army Corps of Engineers (COE), the U.S. Environmental Protection Agency (EPA), the Service's Chesapeake Bay Field Office (CBFO), and the Virginia Department of Environmental Quality (DEQ).

As part of the Long Term Monitoring Plan, fish sampling was conducted by the COE in the 1.1-hectare (2.7-acre) Painted Turtle Pond, formerly known as the Operable Unit 1 pond (Figure 1-2). The purpose of the sampling was to evaluate possible ecological and human health risks from consumption of pond fish. A total of 26 bluegill (*Lepomis macrochirus*) were collected by angling on June 21 and July 17, 2001 (COE 2003). These results are summarized in the COE (2003).

Through reviewing the document, the Chesapeake Bay Field Office (CBFO) identified the need to sample additional species such as largemouth bass (*Micropterus salmoides*) and channel catfish (*Ictalurus punctatus*), which tend to accumulate higher contaminant concentrations than bluegill. The Service was also concerned about the reported concentrations of arsenic (mean: 1.33 parts per million (ppm) wet weight). This concentration, when multiplied by 10% to estimate the inorganic fraction, yields a concentration of 0.133 ppm inorganic arsenic which is about five times higher than the EPA's 0.026 ppm screening value (EPA 2000). Based on these concerns, the Service conducted its own sampling and analysis of fish from Painted Turtle Pond in March 2002.

The objective of this project was to determine the concentrations of chemical contaminants in fish tissue samples from Painted Turtle Pond. The data were analyzed and interpreted and risks for human consumers are discussed.

Regulatory Background

The States (D.C., territories and American Indian tribes included in this category) are primarily responsible for evaluating the safety of fish and shellfish obtained by recreational fishermen. The U.S. Food and Drug Administration (FDA) is responsible for evaluating the safety of commercially-obtained fish. States regularly monitor the chemical concentrations in fish through tissue monitoring programs. They apply risk assessment models to establish the need to place restrictions on consumption to protect the public health. EPA has produced a four volume guidance manual to assist the states in these programs. In Volume I of the guidance, EPA (2000)

developed screening values (SVs) for contaminants commonly measured in tissue monitoring programs. A screening value is defined as a concentration that is of potential health concern. Exceedance of a screening value is intended to trigger a more intensive survey and/or an evaluation of human health risk.

There are five major types of advisories that states issue (EPA 2001a):

1. **No consumption advisory for the general population** - issued when chemical contamination in certain species and/or size classes poses risks such that the general population is advised to avoid eating locally caught fish.

2. **No-consumption advisory for sensitive subpopulations** - issued when subpopulations (such as pregnant women and children) are advised to avoid consumption of certain species because chemical contamination poses risks to their health.

3. **Restricted consumption for the general population** - issued when health risks may occur if too much fish is consumed. The public is advised to limit their consumption of certain species because of chemical contamination.

4. **Restricted consumption for sensitive subpopulations** - issued when subpopulations (such as pregnant women and children) are advised to limit consumption of certain species because chemical contamination poses risks to their health.

5. **Commercial fishing ban** - issued when high levels of contaminants are found in fish caught for commercial purposes. Commercial harvest is prohibited.

For many contaminants that bioaccumulate in fish, older and larger fish contain higher concentrations than smaller, younger fish. Restrictions on consumption may be based on specific size classes.

MATERIALS AND METHODS

Fish Collection

On March 22, 2002, fish were collected from Painted Turtle Pond (38E N 38'45", 77E W 14'30") by boat electroshocking (Figures 2, 3), under the direction of Dr. Gary Swihart of the Service's Gloucester Office for Fisheries Assistance (Gloucester, VA). Table 1 provides a listing of the collected samples. The samples were wrapped in aluminum foil, placed in plastic bags, kept in iced coolers, chain of custody was prepared, and the coolers were transported to CBFO.

Fish were filleted according to EPA (2000) procedures, which involved including the skin on the belly flap for the bluegill and bass and removing the skin (with a hemastat) for the catfish. Fish were weighed to the nearest gram and measured to the nearest millimeter. Samples were split into two jars, one for metals and one for organic analyses. A catalog of samples and requested analyses was prepared using the Environmental Contaminants Data Management System (ECDMS) database and accompanied the shipment of samples. Chain of custody procedures were followed for all transfer of samples. All jars were stored at -20 EC until shipment, with dry ice. Chain of custody form, field notes, and chemical catalog information are provided in Appendix A.

Chemical Analysis

All analyses were contracted through USFWS Patuxent Analytical Control Facility (PACF) and conducted by the Geochemical and Environmental Research Group (GERG), Texas A&M University, College Station, TX (for organics) and the Texas A&M Trace Element Research Laboratory (TERL) (for metals). Samples were analyzed for lipid and moisture content, 19 EPA Priority Pollutant trace metals, 23 organochlorine pesticides, Aroclors and total PCBs. All data are reported as wet weight in parts per million. Minimum requested detection limits are indicated in Table 2. Method summaries are included as part of the laboratory reports provided in Appendix B.

Data Analysis

Summary statistics were prepared for all analytes, including the frequency of detection, minimum, maximum, mean, and standard deviation of the mean. Total DDT was determined as the sum of all six o,p'- and p,p'- DDD, DDE, and DDT isomers. Total chlordane was determined as the sum of alpha and gamma chlordane, cis- and trans-nonachlor, and oxychlordane (EPA 2000). Excel spreadsheets prepared from the laboratory data files are provided in Appendix B.

Contaminants of concern (COCs) were determined by comparing the concentrations of the analytes against EPA (2000) screening values. All contaminants for which a single sample exceeded the screening value were designated as COCs and the discussion of risks and various methods for developing advisories are restricted to these COCs. In addition to the EPA screening values, Virginia Department of Health trigger levels, and all available U.S. Food and Drug Administration advisory and tolerance levels are identified and included in the summary tables of the tissue data.

RESULTS AND DISCUSSION

A description of the length and composite weights of the samples is provided in Table 1. Table 3 gives a comparison of the mean and maximum COC concentrations with federal and state risk values. An example of meal restrictions (using Maryland's protocol) that could be applied to these data is shown in Table 4. The following sections discuss risks for mercury, arsenic, and PCBs, which are the primary chemicals detected that approached or exceeded a risk value.

Mercury

The concentrations of mercury reported in channel catfish (average: 0.335 ppm) and largemouth bass (average: 0.376 ppm) raise concern for possible adverse effects on human health. The mean concentrations for both species exceed the 0.3 ppm fish tissue ambient water quality criterion which is an advisory concentration aimed at protecting human health (Table 3). The averages approach the 0.4 ppm concentration used by EPA as a screening value and used as a trigger to limit consumption in many states. The mean concentrations, however, do not exceed the 0.5 ppm concentration used by the Virginia Department of Health for advising the public to limit their consumption. However, the maximum concentration of one of the five bass samples (0.682 ppm) does exceed the VDH limit. As an example of another state's approach regarding mercury, the number of meal restrictions that the Maryland Department of the Environment (MDE) would recommend are calculated (Table 4). States often use different values in their risk assessment equations (such as exposure duration or loss of chemical through cooking) resulting in varying recommendations on meal restrictions.

Mercury was not detected in pond sediments during the Remedial Investigation/Feasibility Study (RI/FS) sampling in 1995 (Stowers *et al.* 1997). At present, it is presumed that mercury concentrations in the Painted Turtle fish tissues result from atmospheric sources, both regional and global.

Arsenic

Mean and maximum concentrations of were 0.162 and 0.188 ppm for bluegill, 0.190 and 0.215 ppm for bass, and 0.147 and 0.158 ppm for channel catfish. All of these concentrations are in terms of total arsenic. The EPA (2000) screening value of 0.026 ppm is as inorganic arsenic. FDA (1993) recommended assuming that inorganic arsenic accounts for 10% of total arsenic in shellfish. EPA (2000) cited one study in six species of freshwater fish in which inorganic arsenic represented from 0.1 to 27 percent of the total arsenic. Thus, for the purposes of this report, the 10% fraction will be used. Both the mean and maximum total arsenic concentrations in the samples collected from Painted Turtle Pond are estimated to be below the 0.026 ppm screening value. Because the estimated concentrations do approach the 0.026 ppm screening value, the Service recommends that any future monitoring of fish at this pond analyze for inorganic as well as total arsenic.

Arsenic was not detected in sediments sampled during the Remedial Investigation/Feasibility Study (RI/FS) in 1995 (Stowers *et al.* 1997). At present, it is unknown whether the arsenic concentrations in the fish samples should be considered elevated because the concentrations cannot be accurately compared with the screening value.

PCBs

Mean and maximum total PCB concentrations were 0.027 and 0.029 ppm for bluegill,0.025 and 0.031 ppm for bass, and 0.061 and 0.110 ppm for channel catfish. The higher concentrations in channel catfish reflected their larger size and greater lipid content (0.8-2.2%) compared with the other species (0.3-0.7%). PCBs and other organochlorine compounds tend to accumulate to a greater extent in fish with higher lipid content (Heber and Keenleyside 1995). All concentrations exceed the EPA screening value of 0.02 ppm but do not exceed the 0.600 ppm concentration used as a trigger by the Virginia Department of Health for restricting consumption. The RI/FS sampling effort did not detect PCBs in pond sediments (Stowers *et al.* 1997).

Comparison of Current Data with COE data

The lengths of the bluegills analyzed in COE (2003) are not reported. Since contaminant concentrations are often higher in older fish, it is difficult to directly compare concentrations from the two studies. Data for the COCs are shown in Table 5, however, for the sake of completeness. Mercury concentrations among the two collections of bluegills were similar, with mean concentrations within 20%. There were dramatic differences in arsenic and selenium concentrations. Arsenic concentrations in the COE (2003) data set are nearly ten times higher than those reported here and selenium concentrations are about three times higher.

RECOMMENDATION

If the refuge is considering opening Painted Turtle Pond to fishing, CBFO recommends that this report be submitted to the Virginia Department of Health to determine if a health advisory for mercury is warranted. CBFO suggests conducting a similar survey every five years to monitor trends. If such a survey is undertaken, CBFO recommends analyzing the same suite of contaminants, in addition to both total and inorganic arsenic (to allow a more accurate assessment of risk).

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U.S. Environmental Protection Agency (EPA). 2001b. Water Quality Criteria: Notice of Availability of Water Quality Criterion for the Protection of Human Health: Methylmercury. Federal Register 66(5), 8 January, 1344-1359.

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TABLES

Table 1. Summary of fish collection data.

Sample ID	Species	# Fish	Total length (mm)	Fillet total weight (g)
OCBG01	Bluegill	4	180,186,180, 171	48
OCBG02	Bluegill	4	160,171,188,176	49
OCBG03	Bluegill	4	176,183,169,182	60
OCBG04	Bluegill	4	171,172,174,172	48
OCBG05	Bluegill	4	162,173,175,184	41
OCLG01	Largemouth bass	1	354	68
OCLG02	Largemouth bass	1	297	62
OCLG03	Largemouth bass	1	300	68
OCLG04	Largemouth bass	1	344	95
OCLG05	Largemouth bass	1	317	73
OCCC01	Channel catfish	1	360	40
OCCC02	Channel catfish	1	432	61
OCCC03	Channel catfish	1	457	52
OCCC04	Channel catfish	1	392	40
OCCC05	Channel catfish	1	395	40

Note: Catfish are skinless fillets, other fillets include skin following EPA (2000). Guidance for assessing chemical contaminant data for use in fish advisories, Volume 1, Fish sampling and analysis, 3rd edition. EPA 823-B-00-007.

Table 2. List of parameters to be analyzed and requested detection limits.

Trace elements	*OC pesticides*
Aluminum	p,p'-DDE
Arsenic	p,p'-DDD
Barium	p,p'-DDT
Beryllium	o,p'-DDE
Boron	o,p'-DDD
Cadmium	o,p'-DDT
Chromium	alpha-BHC
Copper	beta-BHC
Iron	delta-BHC
Lead	gamma-BHC
Magnesium	aldrin
Manganese	dieldrin
Mercury	endosulfan II
Molybdenum	endrin
Nickel	heptachlor
Selenium	heptachlor epoxide
Strontium	oxychlordane
Vanadium	alpha-chlordane
Zinc	gamma-chlordane
	cis-nonachlor
	trans-nonachlor
	mirex
	toxaphene
	pentachloroanisole
	PCBs
	PCB- total and Aroclors 1242, 1248, 1254, 1260, 1268

Requested minimum acceptable detection limits: Metals (dry weight ppm): Be, Cd –0.10; Hg - 0.20; As, Se, Cr, Cu, Ni, Pb, Sr, V - 0.50; Ba, Mn, Zn - 1.0; B, Mo - 2.0; Al, Fe, Mg - 5.0.
Organochlorine pesticides (wet weight ppm): 0.01
Total PCBs (wet weight ppm): 0.05, Aroclors: 0.01 ppm

Table 3. Comparison of fish tissue concentrations with EPA and Virginia guidance values (all values in parts per million wet weight).

Analyte	Species	Freq. of Detec-tion	Mean	Max.	EPA Screening Value[a]	Virginia Dept of Health[b]	EPA Human Health Criterion[c]
Total PCBs	Bluegill	5/5	0.0268	0.0288	0.02	0.600	
	Largemouth Bass	5/5	0.025	0.031			
	Channel Catfish	5/5	0.061	0.110			
Total DDT	Bluegill	0/5			0.117		
	Largemouth Bass	0/5					
	Channel Catfish	4/5	0.0033	0.0060			
Arsenic	Bluegill	5/5	0.162	0.188	0.026[d] (inorganic)		
	Largemouth Bass	5/5	0.190	0.215			
	Channel Catfish	5/5	0.147	0.158			
Mercury	Bluegill	5/5	0.144	0.205	0.4	0.5	0.3
	Largemouth Bass	5/5	0.376	0.682			
	Channel Catfish	5/5	0.355	0.447			
Selenium	Bluegill	5/5	0.402	0.412	20		
	Largemouth Bass	5/5	0.405	0.441			
	Channel Catfish	5/5	0.261	0.367			

[a] EPA (2000) values are default values for states to use when site specific information are not available
[b] Concentrations above which Virginia Department of Health issues advisories urging the public to restrict consumption, thus at these concentrations there would be no recommended meal restrictions
[c] EPA (2001b) numeric concentration recommended for protection of human health

[d] Arsenic screening value is based on inorganic arsenic, U.S. Food and Drug Administration (1993) advised that an estimated 10% of total arsenic is in inorganic form.

Table 4. Maryland Department of the Environment (MDE) recommended meals per month for PCBs and mercury based on average concentrations in Painted Turtle Pond fish.[a]

Analyte	Species	Average concentration (ppm wet weight)	Meals per month		
			Children (0-6)	Women (18-45)	General Pop.
PCBs	Bluegill	0.0268	4	4-8	4-8
	Largemouth Bass	0.025	4-8	4-8	4-8
	Channel Catfish	0.061	2	3	3
Mercury	Bluegill	0.144	2	4	4
	Largemouth Bass	0.376	1	2	2
	Channel Catfish	0.355	1	2	2

[a] Data provided by Joseph Beaman, MDE

Table 5. Comparison of bluegill data with COE (2003) bluegill data for contaminants of concern (ppm wet weight).

Chemical of concern	Current study			COE (2003)		
	Freq	Mean	Max	Freq	Mean	Max
tPCBs	5/5	0.0268	0.0288	0/6		
tDDT	0/5			5/6	0.0022	0.0037
Mercury	5/5	0.144	0.205	6/6	0.12	0.14
Arsenic	5/5	0.162	0.188	6/6	1.33	1.60
Selenium	5/5	0.402	0.412	6/6	1.26	1.40

FIGURES

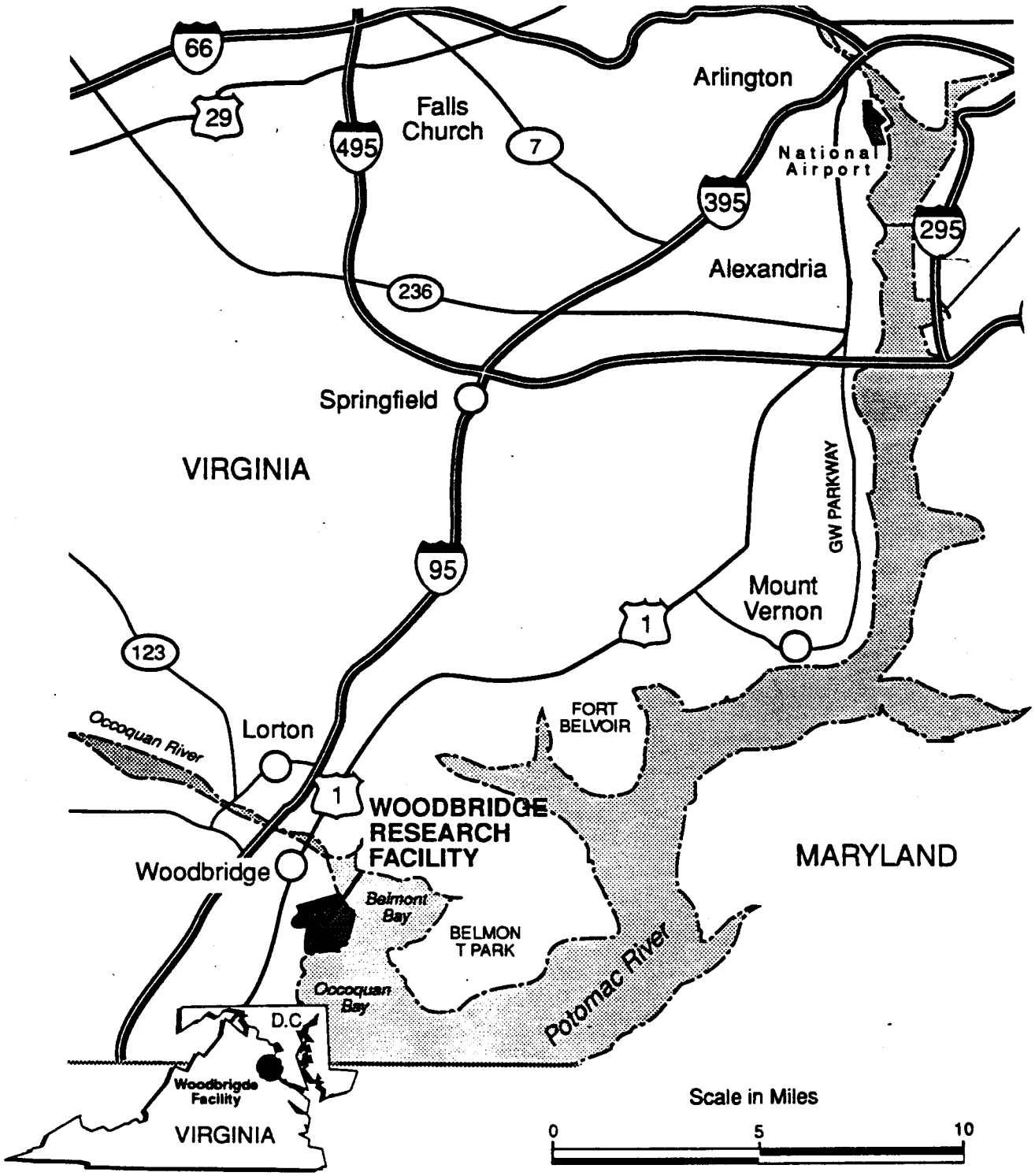
APPENDIX A

CHAIN OF CUSTODY, FIELD NOTEBOOK, AND CHEMICAL CATALOG INFORMATION

APPENDIX B

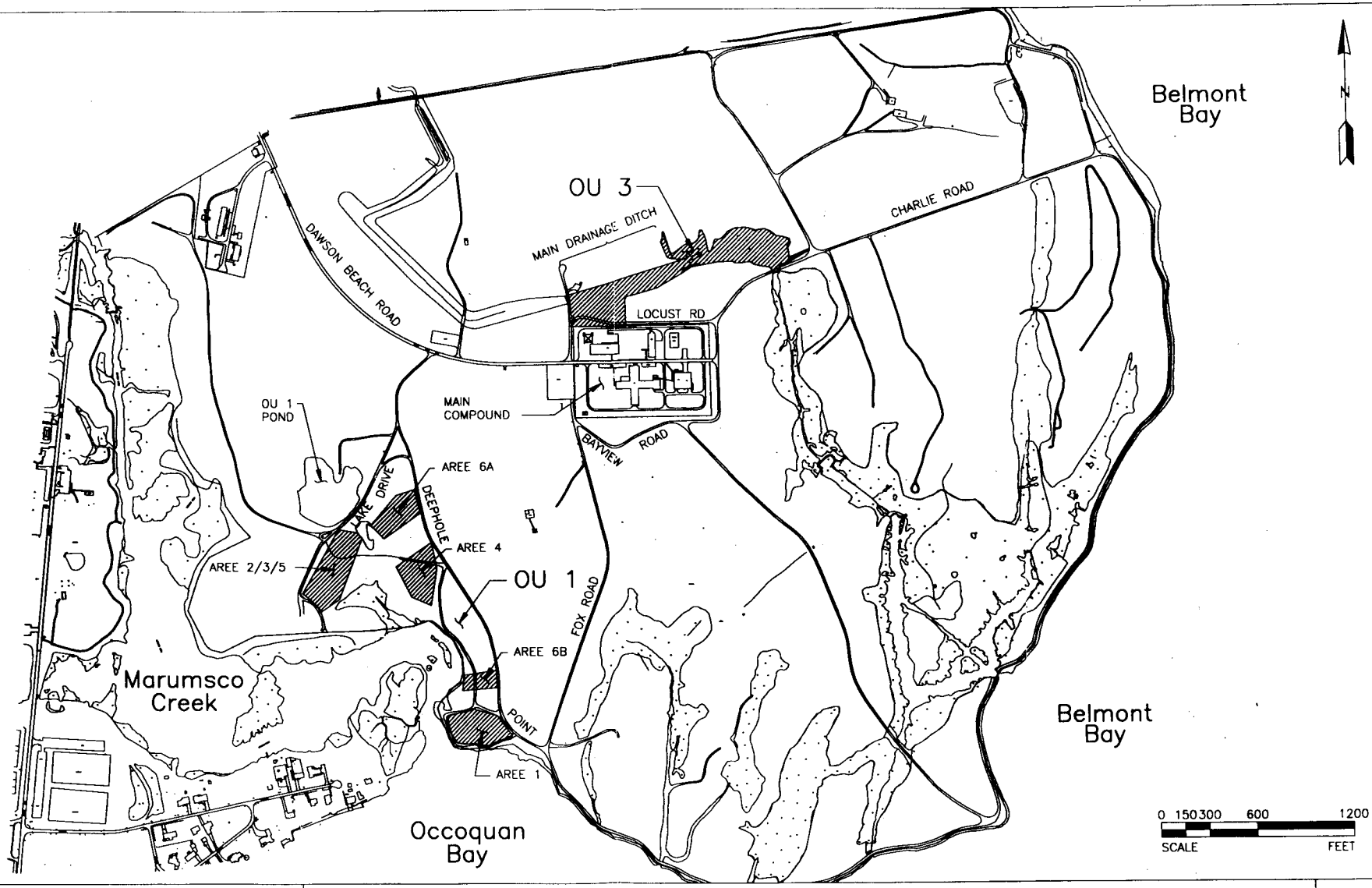
LABORATORY REPORTS, INCLUDING METHOD DESCRIPTIONS AND EXCEL SPREAD SHEET OF ANALYTICAL DATA

EXCEL SPREADSHEET



US ARMY ENVIRONMENTAL CENTER

CONTRACT NO. DACA31-94-D-0064	FIGURE 1-1 WOODBRIDGE RESEARCH FACILITY
ICF KAISER 1301 Continental Drive Suite 101 Abingdon, Maryland 21009 (410) 612-6350	WRF LOCATION MAP
PREPARED / TASK NO: 96220	
CHECKED / ICF DWG NO:	
DATE	



WOOD68.DWG DC-RTG 8/12/99

RADIAN INTERNATIONAL
A DAMES & MOORE GROUP COMPANY

OVERALL SITE PLAN

FIGURE 1-2

FORMER WOODBRIDGE RESEARCH FACILITY, WOODBRIDGE, VA		CONTRACT NO.: DACA 31-96-D-0026	
SCALE: 1" = 600'-0"	DATE: JULY, 1999	USACE - BALTIMORE DISTRICT	DELIVERY ORDER: 0018

Figure 2. Electroshocking at Painted Turtle Pond, Occoquan Bay National Wildlife Refuge, March 22, 2002.

Figure 3. Largemouth bass collected by electroshocking.

5020105	Species	Total Length (mm)	% Moisture	Al	As	B	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	Hg	K
OCBG01M	Bluegill	171-186	**80.7**	**2.26**	**0.135**	0.104	**0.0787**	0.005	**629.**	0.004	0.052	0.052	**0.122**	**4.52**	**0.205**	**3300.**
OCBG02M		160-188	**80.1**	**1.13**	**0.188**	0.105	**0.0438**	0.005	**316.**	0.004	0.052	0.052	**0.179**	**2.81**	**0.122**	**3360.**
OCBG03M		169-183	**80.0**	**4.64**	**0.149**	0.109	**0.0654**	0.005	**388.**	0.004	0.055	**0.170**	**0.135**	**3.98**	**0.142**	**3280.**
OCBG04M		171-174	**79.7**	0.550	**0.175**	0.110	**0.298**	0.006	**286.**	0.004	0.055	**0.534**	0.055	**6.44**	**0.120**	**3330.**
OCBG05M		162-184	**79.3**	**1.65**	**0.162**	0.110	**0.337**	0.006	**292.**	0.004	0.055	**0.528**	0.055	**7.29**	**0.132**	**3330.**
	Freq det			**4/5**	**5/5**	0/5	**5/5**	0/5	**5/5**	0/5	0/5	**3/5**	**3/5**	**5/5**	**5/5**	**5/5**
	min			**0.550**	**0.135**		**0.0438**		**286**			**0.052**	**0.055**	**2.81**	**0.120**	**3280**
	max			**4.64**	**0.188**		**0.337**		**629**			**0.534**	**0.179**	**7.29**	**0.205**	**3360**
	mean			**2.05**	**0.162**		**0.165**		**382**			**0.267**	**0.109**	**5.01**	**0.144**	**3320**
	sd			**1.58**	**0.021**		**0.141**		**144**			**0.246**	**0.054**	**1.83**	**0.035**	**31**
OCCC01M	Channel catfish	360	**81.8**	**13.8**	**0.135**	0.096	**0.622**	0.005	**51.5**	0.004	0.048	**0.440**	**0.246**	**10.5**	**0.289**	**2840.**
OCCC02M		432	**80.1**	**40.8**	**0.158**	0.111	**0.130**	0.006	**66.9**	0.004	0.055	0.055	**0.404**	**6.63**	**0.229**	**3280.**
OCCC03M		457	**81.6**	0.496	**0.155**	0.100	**0.0377**	0.005	**47.7**	0.004	0.050	**0.125**	**0.228**	**6.02**	**0.359**	**3420.**
OCCC04M		392	**82.2**	**1.21**	**0.135**	0.094	**0.215**	0.005	**48.4**	0.003	0.047	**0.240**	**0.214**	**9.31**	**0.447**	**3610.**
OCCC05M		395	**80.4**	0.520	**0.151**	0.104	0.010	0.005	**64.9**	0.003	0.052	**0.263**	**0.231**	**6.51**	**0.349**	**3690.**
	Freq det					0/5		0/5		0/5	0/5	**4/5**	**5/5**	**5/5**	**5/5**	**5/5**
	min			**0.496**	**0.135**		**0.010**		**47.7**			**0.055**	**0.214**	**6.02**	**0.229**	**2840**
	max			**40.8**	**0.158**		**0.622**		**66.9**			**0.440**	**0.404**	**10.5**	**0.447**	**3690**
	mean			**11.4**	**0.147**		**0.203**		**55.9**			**0.225**	**0.265**	**7.79**	**0.335**	**3368**
	sd			**17.4**	**0.011**		**0.248**		**9.3**			**0.147**	**0.079**	**1.99**	**0.082**	**336**
OCLG01M	Largemouth bass	354	**78.7**	0.575	**0.145**	0.115	**0.0347**	0.006	**103.**	0.004	0.058	**0.660**	**0.161**	**6.58**	**0.682**	**3660.**
OCLG02M		297	**79.1**	0.575	**0.192**	0.115	0.012	0.006	**268.**	0.004	0.058	**0.259**	**0.120**	**3.22**	**0.238**	**3510.**
OCLG03M		300	**79.0**	0.575	**0.192**	0.115	0.011	0.006	**194.**	0.004	0.058	**0.169**	**0.119**	**3.23**	**0.191**	**3740.**
OCLG04M		344	**79.5**	0.530	**0.215**	0.106	**0.0275**	0.005	**108.**	0.004	0.053	**0.273**	**0.192**	**3.61**	**0.478**	**3420.**
OCLG05M		317	**79.0**	0.565	**0.208**	0.114	**0.0271**	0.006	**313.**	0.004	0.057	0.057	**0.124**	**2.29**	**0.290**	**3470.**
	Freq det			0/5		0/5		0/5		0/5	0/5	**4/5**	**5/5**	**5/5**	**5/5**	**5/5**
	min				**0.145**		**0.0115**		**103**			**0.057**	**0.119**	**2.29**	**0.191**	**3420**
	max				**0.215**		**0.0347**		**313**			**0.660**	**0.192**	**6.58**	**0.682**	**3740**
	mean				**0.190**		**0.0225**		**197**			**0.284**	**0.143**	**3.79**	**0.376**	**3560**
	sd				**0.027**		**0.0105**		**94**			**0.228**	**0.032**	**1.64**	**0.203**	**135**

5020105	Species	Mg	Mn	Mo	Na	Ni	P	Pb	S	Se	Si	Sr	Ti	V	Zn
OCBG01M	Bluegill	**266.**	**0.232**	0.104	**593.**	0.052	**2030.**	**0.0380**	**1740.**	**0.394**	0.735	**0.836**	0.052	0.104	**12.3**
OCBG02M		**277.**	**0.138**	0.105	**498.**	0.052	**1910.**	**0.0131**	**1920.**	**0.388**	0.745	**0.428**	0.052	0.105	**11.6**
OCBG03M		**280.**	**0.183**	0.109	**502.**	0.055	**1990.**	**0.0193**	**2040.**	**0.408**	0.740	**0.512**	0.055	0.109	**10.9**
OCBG04M		**282.**	**0.171**	0.110	**467.**	0.055	**1880.**	**0.0260**	**2090.**	**0.412**	0.750	**0.359**	0.055	0.110	**9.78**
OCBG05M		**282.**	**0.147**	0.110	**472.**	0.055	**1900.**	**0.0240**	**2150.**	**0.410**	0.820	**0.371**	0.055	0.110	**10.1**
	Freq det	**5/5**	**5/5**	0/5	**5/5**	0/5	**5/5**	**5/5**	**5/5**	**5/5**	0/5	**5/5**	0/5	0/5	**5/5**
	min	**266**	**0.138**		**467**		**1880**	**0.0131**	**1740**	**0.388**		**0.359**			**9.78**
	max	**282**	**0.232**		**593**		**2030**	**0.0380**	**2150**	**0.412**		**0.836**			**12.3**
	mean	**277**	**0.174**		**506**		**1942**	**0.0241**	**1988**	**0.402**		**0.501**			**10.9**
	sd	**7**	**0.037**		**51**		**65**	**0.0092**	**162**	**0.011**		**0.197**			**1.0**
OCCC01M	Channel catfish	**198.**	**0.158**	0.096	**311.**	**0.113**	**1630.**	**0.0608**	**1580.**	**0.273**	**2.13**	**0.0744**	**0.116**	0.096	**4.26**
OCCC02M		**211.**	**0.130**	0.111	**404.**	0.055	**1920.**	**0.0870**	**1910.**	**0.267**	0.765	**0.0903**	0.055	0.111	**5.57**
OCCC03M		**204.**	**0.0933**	0.100	**364.**	0.050	**1840.**	**0.0241**	**1760.**	**0.210**	0.745	**0.0734**	0.050	0.100	**4.08**
OCCC04M		**201.**	**0.127**	0.094	**388.**	0.047	**1920.**	**0.0158**	**1700.**	**0.189**	**1.90**	**0.0543**	0.047	0.094	**4.93**
OCCC05M		**229.**	**0.0958**	0.104	**308.**	0.052	**1960.**	**0.0711**	**1830.**	**0.367**	0.685	**0.0876**	0.052	0.104	**4.25**
	Freq det	**5/5**	**5/5**	0/5	**5/5**	**1/5**	**5/5**	**5/5**	**5/5**	**5/5**	**2/5**	**5/5**	**1/5**	0/5	**5/5**
	min	**198**	**0.0933**		**308**		**1630**	**0.0158**	**1580**	**0.1890**	**0.69**	**0.0543**	**0.047**		**4.08**
	max	**229**	**0.158**		**404**		**1960**	**0.0870**	**1910**	**0.3670**	**2.13**	**0.0903**	**0.116**		**5.57**
	mean	**209**	**0.121**		**355**		**1854**	**0.0518**	**1756**	**0.2612**	**1.25**	**0.0760**	**0.064**		**4.62**
	sd	**12**	**0.027**		**44**		**133**	**0.0306**	**126**	**0.0693**	**0.71**	**0.0143**	**0.029**		**0.62**
OCLG01M	Largemouth bass	**285.**	**0.102**	0.115	**426.**	**0.118**	**1890.**	**0.0201**	**2620.**	**0.426**	0.840	**0.0486**	0.058	0.115	**8.80**
OCLG02M		**293.**	**0.0947**	0.115	**408.**	0.058	**1900.**	**0.0151**	**2780.**	**0.374**	0.750	**0.245**	0.058	0.115	**6.56**
OCLG03M		**304.**	**0.0964**	0.115	**370.**	0.058	**1930.**	**0.0160**	**2810.**	**0.424**	0.800	**0.133**	0.058	0.115	**5.75**
OCLG04M		**277.**	**0.0572**	0.106	**363.**	0.053	**1880.**	**0.0683**	**2380.**	**0.441**	0.750	**0.0697**	0.053	0.106	**6.52**
OCLG05M		**298.**	**0.0836**	0.114	**420.**	0.057	**1930.**	**0.0165**	**2670.**	**0.361**	0.820	**0.372**	0.057	0.114	**6.26**
	Freq det	**5/5**	**5/5**	0/5	**5/5**	**1/5**	**5/5**	**5/5**	**5/5**	**5/5**	0/5	**5/5**	0/5	0/5	**5/5**
	min	**277**	**0.0572**		**363**		**1880**	**0.0151**	**2380**	**0.361**		**0.049**			**5.75**
	max	**304**	**0.1020**		**426**		**1930**	**0.0683**	**2810**	**0.441**		**0.372**			**8.80**
	mean	**291**	**0.0868**		**397**		**1906**	**0.0272**	**2652**	**0.405**		**0.174**			**6.78**
	sd	**11**	**0.0178**		**29**		**23**	**0.0231**	**171**	**0.035**		**0.135**			**1.18**