Maryland Department of the Environment

Risk Based Screening of Metals in Maryland Finfish Tissue

1985-1997

Prepared by:

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Preface

It is the responsibility of the Maryland Department of the Environment (i.e. the Department) to protect its citizens from harm due to exposure to environmental contaminants (Annotated Code of Maryland §5-203 and §5-1108). One potential source of exposure to such contaminants is through ingestion of fish tissue in which environmental contaminants have accumulated. To protect public health from this contaminant exposure pathway, the Department collects fish throughout the state to determine potential human health risks. The Department of Mental Health and Hygiene provided the analytical services for this effort. If the Department concludes that a potential human health risk exists, it evaluates the need to issue a "fish consumption advisory".

A fish consumption advisory is not intended to be a "no fishing" notice. Rather it provides advice to the general public that certain fish species in limited areas are contaminated, and that eating more than a certain amount of those fish pose an increased human health risk. Fish consumption advisories, including details on location, species, and recommended consumption restrictions are included in the information provided with the purchase of a recreational fishing license, the Internet at: http://www.mde.state.md.us/reference/factsheets/fishcontam.html, and a variety of other informational sources.

This report presents the analysis of finfish tissue metals data that have been collected as part of the fish tissue-monitoring program. Future reports will present the results for organic contaminants, and provide a detailed human health risk-based assessment of the concentrations found.

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Executive Summary

This report provides a screening level evaluation of metal contaminants in Maryland finfish tissue from 1985 through 1997. Overall, contaminants in finfish tissue were below established human health risk-based screening values for metals and support the conclusion that finfish from Maryland waters are safe to eat, except where there are consumption advisories. At this time, there are no fish tissue consumption advisories for metal contamination in Maryland waters. However, there are advisories for chlordane in Baltimore Harbor, Back River and Lake Roland, and for PCBs in parts of the Potomac River.

The screening values are derived from human health risk-based assessments for each metal. Samples were taken during routine monitoring (Core) and intensive sampling activities targeted at specific locations and for specific species. The main goal of this screening exercise is to highlight geographic areas or specific substances where concentrations of chemical contaminants in the edible portions of finfish exceed human health risk-based values. This report only made use of a portion of the available data (fillet portion) to assess human health risk associated with the consumption of finfish tissue. This evaluation also provides a tool for the risk assessor to decide if further evaluation, such as the collection of additional data or a more detailed risk assessment, is warranted. Carcinogenic and non-carcinogenic risk were evaluated where appropriate.

Non-carcinogenic risk evaluations assume a threshold value based on a reference dose, which is an estimate of acceptable daily exposure to the general population that is not likely to result in an adverse effect. Carcinogenic risk evaluations assume no such threshold values and that some finite risk of cancer exists even at the lowest conceivable dose. Variables used in deriving cancer screening values include a cancer potency or slope factor (q_1*) for each contaminant of concern and a pre-specified maximum acceptable lifetime risk level (such as 10^{-5}, or one excess case of cancer per 100,000 individuals exposed over a 70-yr lifetime). The US Environmental Protection Agency (US EPA) recognizes an acceptable lifetime risk level range of 10^{-4} through 10^{-7} (US EPA, 1995). To be consistent with Maryland's surface water quality standards program, a risk level of 10^{-5} was used in the development of screening values in this report. Due to the lack of specific screening values for ingestion of lead through consumption of fish, lead results are presented, but not screened against specific values.

No metal concentrations in the fish tissue samples exceeded the screening values for non-carcinogenic risk in the State. The only metal discussed in this report that has the potential to be carcinogenic through ingestion is arsenic. However, the form of arsenic considered to be carcinogenic is the inorganic fraction, which only accounts for a very small percentage of the total arsenic found in fish tissue. The remainder of arsenic in fish tissue is found in the organic fraction, which is considered to be non-toxic. Due to the high cost and technical constraints of analyzing finfish tissue specifically for inorganic arsenic, most states, including Maryland, analyze finfish samples for total arsenic which include both the inorganic and organic forms. Recent scientific findings indicate that the actual percentage of available inorganic arsenic in fish tissue is generally less than 4% (Morrissey et al 1999). In using the most up-to-date science, MDE applies a 4% adjustment factor in calculating the inorganic arsenic fraction in fish tissue used in the derivation of Maryland's inorganic arsenic Ambient Water Quality Criteria for

protecting human health against the ingestion of contaminated aquatic organisms. In being consistent with Maryland's Ambient Water Quality Criteria, MDE also applies 4% as the fraction associated with inorganic arsenic in fish tissue for estimating risk from fish tissue consumption.

The weighted average value of inorganic arsenic for any species did not exceed the screening value for carcinogenic risk. However, individual fish samples from bluefish, striped bass, and white perch within several areas throughout the state did, at times, exceed the screening value for inorganic arsenic. Basins in which these exceedances occurred were Pocomoke (bluefish, 1985), Choptank (striped bass, 1986), Chester (bluefish, 1985), Patapsco (white perch, 1986), Chesapeake Bay mainstem (bluefish, 1985), and Lower Potomac (striped bass, 1986). Subsequent sample data collected from 1990 to 1997 from most of these areas did not exceed the screening value for inorganic arsenic.

Basins entirely without identified problems due to metals contamination include Elk, Bush, Gunpowder, West Chesapeake, Patuxent, Washington Metropolitan, Middle Potomac, Upper Potomac, North Branch Potomac, Nanticoke/Wicomico, and Youghiogheny.

Due to the migratory behavior of both striped bass and bluefish, these fish are considered to be poor sentinel species and are not sampled for contaminants on a regular basis. However, future sampling will include striped bass and bluefish where geographically and temporally appropriate. In addition, reliable methods are being sought that can specifically measure inorganic arsenic in fish tissue thus alleviating the need for the estimated conversion factor of 4% and providing a more accurate assessment of risk.

Nevertheless, it can be safely concluded that Maryland fish are safe to eat and provide an excellent source of protein.

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1. INTRODUCTION

1.1 BACKGROUND

In 1977, the State of Maryland established a Maryland Chesapeake Bay water-quality monitoring network of core sampling stations (Core). This network was developed in response to the federally mandated Clean Water Act that was implemented by the Environmental Protection Agency (EPA) in 1974 to monitor the health of our Nation's waterways. The initial intent of the monitoring program was to collect data through direct sampling of the water column for a select number of water quality parameters (e.g., nutrients, and pH) and chemical contaminants. This type of sampling represents a "snap shot" of detectable contaminant levels within a constantly changing water environment.

Research has shown that aquatic organisms have the ability to concentrate various contaminants through trophic pathways and direct contact with contaminated media to more than 1,000,000 times the concentrations detected in the water column (US EPA, 1992). As a result, whole finfish and shellfish sampling was incorporated into the monitoring program, in addition to direct water column sampling as a more sensitive or "real world" indicator to the presence of contaminants in the water column, sediments, and surrounding environment.

Under this initial monitoring program, whole finfish from Maryland waters were monitored annually from 1977 to 1985 for levels of persistent bioaccumulative substances, which included organochlorine pesticides, polychlorinated biphenyls (PCBs) and various metals. In 1985, a comprehensive analysis of these monitoring data and evaluation of the sampling program was initiated. Results of this effort were published in the Maryland Department of the Environment, Analysis of Basic Water Monitoring Program Fish Tissue Network Report, (MDE, 1988).

This report identified several limitations of the existing monitoring program. These included limited coverage of rural watersheds, no coverage of freshwater impoundments, and inconsistencies in data required to evaluate human health risk associated with the consumption of finfish tissue such as finfish size, tissue type, and species sampled. As a result, several modifications were implemented to resolve these shortcomings.

To address the spatial coverage limitations, several monitoring stations were added to the existing Core stations, as well as, the development of three regional watershed sample areas: Western Maryland, Chesapeake Bay, and Baltimore/Washington Urban - each to be sampled triennially (every third year). A number of commonly frequented impoundments were also included in the monitoring program.

Modifications developed to address human health data requirements included the collection and chemical analysis of legal size game and accumulator finfish fillet samples in addition to the whole accumulator finfish samples already being collected at each station. Although size and length data were collected with the samples, they have not been included in the report because of the enormity of the data.

In 1989, these proposed modifications were implemented in order to enhance the quality of information used by state water-quality managers and risk assessors to effectively evaluate relative levels of contaminants in aquatic resources as well as associated human health risk issues.

As with any "long-term" monitoring program, there are data quantity and geographic coverage limitations. So, in addition to the "long-term" Core monitoring program, "short-term" intensive fish tissue contaminant evaluation screening studies were conducted in situations where there was a need to answer specific questions regarding potential human and ecological health issues.

This report serves as the screening evaluation for the human health risk-based assessment of Maryland finfish fillet tissue trace metal contaminants data from 1985 to 1997 collected through the Core Monitoring Program and associated intensive studies. Thus, data collected for whole fish samples (as opposed to fillet samples) will not be presented in this report. Future reports will address the human health risk-based assessment of organochlorine pesticides, polychlorinated chlorinated biphenyls (PCBs), and other organic contaminants in finfish fillet tissue, as well as additional report on the potential for ecological risk. In addition, the assessment and evaluation of shellfish and whole body finfish tissue contaminants will be presented through future reporting efforts.

2. MATERIALS AND METHODS

2.1. SAMPLE COLLECTION

Finfish samples were collected using a variety of location dependent methods. Finfish sampled in non-tidal areas (freshwater rivers and impoundments) were generally collected by electro-shocking. In tidal areas, where practical, finfish were collected using small otter trawls and/or gill nets. Appendix A presents a detailed description of sample station locations while geo-spatially correct station location maps per watershed basin code are incorporated into the Results section of this report.

Depending on target organism availability and specific project or intensive study requirements, finfish samples were either collected as individual finfish samples and/or a composite sample (generally, 5 finfish of similar size per composite). In general, Core target species sample collection consists of one game (fillet composite sample) and two accumulator finfish species (fillet and whole composite samples) all of which are of legal size. In evaluating human health risk associated with the consumption of finfish tissue, only samples comprised of the fillet or edible portion of game and accumulator finfish are considered in this report. Finfish species included in this report are listed in Table 1.

2.2. SAMPLE HANDLING AND PREPARATION

Station location (latitude and longitude), date, species, physical characteristics (length, weight, sex), and tissue type (fillet or whole body) of all samples were recorded on the "Chain of Custody" form (Appendix B). A "Chain of Custody" form accompanied each sample from the field to the laboratory for quality assurance purposes.

With the exception of catfish samples, which were skinned, whole finfish samples were scaled, wrapped in aluminum foil, labeled and packed in ice for transportation to laboratory facilities for further analysis. Game and accumulator finfish species selected for fillet tissue analysis were scaled and filleted. The left fillet portion of each finfish was wrapped (individual or composite sample) in food grade plastic (bag or wrap), labeled, packed on ice and subsequently frozen for metals analysis. The right fillet portion was used for other analyses that will be discussed in subsequent reports.

Table 1. Game and Accumulator Species Sampled

Finfish (Fillet Only) Species Sampled			
GAME		*ACCUMULATOR*	
Common Name	*Scientific Name*	*Common Name*	*Scientific Name*
Bluefish	*Potmatomus saltatrix*	American Eel*	*Anguilla rostrata*
Bluegill*	*Lepomis macrochirus*	Brown Bullhead Catfish*	*Ictalurus nebulosus*
Brown Trout	*Salmo trutta*	Common Carp*	*Cyprinus carpio*
Brook Trout	*Salvelinus fontinalis*	Channel Catfish*	*Ictalurus punctatus*
Fallfish	*Semotilus corporalis*	White Catfish*	*Ictalurus catus*
Largemouth Bass*	*Micropterus salmoides*	White Sucker	*Catastomus commersoni*
Rainbow Trout	*Salmo gairdneri*	Yellow Bullhead Catfish	*Ictalurus natalis*
Redbreast Sunfish	*Lepomis auritus*		
Rock Bass*	*Ambloplites rupestris*		
Smallmouth Bass*	*Micropterus dolomieui*		
Spot	*Leistomus xanthurus*		
Striped Bass	*Morone saxatilis*		
Walleye*	*Stizostedion vitreum*		
White Perch*	*Morone americana*		
Yellow Perch	*Perca flavecens*		
Golden Redhorse	*Moxostoma erythrurum*		
* *Normal CORE MONITORING PROGRAM species sampled*			

2.3. LABORATORY ANALYSES

The Multi-element Laboratory (formerly the Food Chemistry Laboratory) of the Maryland Department of Health and Mental Hygiene (DHMH) performed all chemical analyses of fish tissue samples. All samples were analyzed for the following metals: arsenic, cadmium, chromium, copper, lead, mercury, nickel, manganese, silver, and zinc. Results for metals are reported in units of parts per million (ppm) wet weight. A summary of analytical methods and detection limits are presented in Table 2.

Table 2. Method and Detection Limits for Metal Analyses

ANALYTE	METHOD		Detection Limits (DL) (ppm)		
	Preparation and Digestion	*Analytical Instrumentation*	*Other*	*GFAA*	*ICP*
Arsenic (As)	Pre-1993: SW-846: 7961/7062 Post-1993: USGS 85-495*	Atomic Absorption Spect.	0.01		
Cadmium (Cd)	FDA 76-2006	EPA 200.7 (ICP) EPA 213.2 (GFAA)[2]		0.005	0.05
Chromium (Cr)	FDA 76-2006	EPA 200.7 (ICP)			0.05
Copper (Cu)	FDA 76-2006	EPA 200.7 (ICP)			0.1
Lead (Pb)	FDA 76-2006	EPA 200.7 (ICP) EPA 239.2 (GFAA)[2]		0.05	0.5
Manganese (Mn)	FDA 76-2006	EPA 200.7 (ICP)			0.05
Mercury (Hg)	AOAC 25.113 and 25.114	EPA 245.1 (CVAA)[1]	0.001		
Nickel (Ni)	FDA 76-2006	EPA 200.7 (ICP)			0.1
Silver (Ag)	FDA 76-2006	EPA 200.7 (ICP)			0.05
Zinc (Zn)	FDA 76-2006	EPA 200.7 (ICP)			0.1

KEY: *GFAA= graphite furnace atomic absorption spectrometry*
ICP = inductively coupled plasma atomic absorption spectrometry
** gaseous (i.e. manual) hydride generation*
CVAA= cold vapor atomic absorption spectrometry

[1] modified for aquatic tissues
[2] performed as follow-up to non-detection's from ICP analysis

The DHMH sample preparation process used for cadmium, chromium, copper, lead, nickel, manganese, silver, and zinc has remained unchanged from the early 1970s (nickel and manganese fish tissue analysis began in 1990) to the present (DHEW Publication FDA 76-2006).

From the early 1970s to late 1993/early 1994, DHMH employed the analytical method of direct flame atomic absorption spectrometry to determine the concentrations cadmium, chromium, copper, lead, manganese, nickel, silver, and zinc in finfish tissue samples (MDE 1990). Since 1993, the analytical method used by DHMH for cadmium, chromium, copper, lead, manganese, nickel, silver, and zinc is a combination of methods consisting of the inductively coupled plasma atomic emission spectrometer (ICP-AES) and a graphite furnace atomic absorption (GFAA) spectrometer.

Generally, all chemical analyses for cadmium, chromium, copper, lead, manganese, nickel, silver, and zinc are initially run using the ICP-AES. If tissue levels are determined to be below the ICP-AES detection limits, the analyses are repeated on graphite furnace atomic absorption (GFAA) spectrometer, a more sensitive, yet labor-intensive method.

From 1980 to late 1993/1994, DHMH used Method SW-846: 7061 and 7062 (also known as EPA 206.3 and 206.5) to analyze arsenic. In late 1993/early 1994, however, DHMH experienced severe arsenic recovery problems. After a series of methods refinement attempts, DHMH revised its sample preparation procedures to specifically match the methods detailed in USGS Method 85-495. Although this is normally a USGS-approved method for water, water-suspended sediment, and bottom material, DHMH adopted it for tissue analysis because they documented consistent recovery of arsenic from tissue during 1994 methods refinement efforts. DHMH considers the procedures detailed in USGS Method 85-495 to be comparable to their previous SW-846: 7061 and 7062 (also cited as EPA 206.3 and 206.5) methods because they employ similar acid digestions and analyze arsenic by converting to gaseous hydride using a manual, sodium boro-hydride generator. These alternative methods have been developed to improve the consistency and reliability of the data.

In the case of mercury, DHMH has been employing the method of Cold Vapor Atomic Absorption Spectrometry published as Method 25.113 and 25.114 (AOAC 1980b) from the 1970s to the present. Minor revisions were incorporated into the mercury analysis protocol in 1993.

2.4. HUMAN HEALTH RISK-BASED SCREENING ANALYSES

Human health risk-based screening analyses are considered the first tier (Tier 1) of a two tiered (Tier 1 – Screening Study and Tier 2 – Intensive Study) strategy developed by the U.S. Environmental Protection Agency (US EPA) for assessing human health risk associated with the consumption of contaminated finfish (US EPA, 1995). The main goal of the human health risk-based screening analyses is to highlight geographic areas where concentrations of chemical contaminants in the edible or fillet portions of finfish exceed specified human health risk-based screening values.

2.4.1 Screening Values

Risk-based screening values are concentrations of target analytes in finfish tissue that are considered to be safe for human consumption (US EPA, 1995). The use of screening values is not intended to replace the more formal human health risk analysis process. Rather, it is a tool for the risk assessor to decide if further evaluation such as the collection of additional data, Tier 2 – Intensive studies, detailed risk assessment, and potential risk management action is warranted.

Screening values are basically a back calculation of human health risk associated with the consumption of finfish tissue using science-based toxicological data and pre-specified human exposure assumptions. These assumptions include human body weight and finfish tissue consumption rates that are representative of the average general population. In screening for the most sensitive segment of the general population, MDE uses EPA recommended child exposure assumptions (US EPA, 1995). Thus, the exposure assumptions for this document include, an average child body weight of 36-kg (79 lbs.) and an average fresh and estuarine finfish tissue consumption rate of 6.5 grams/person/day (assuming year round availability). The average general population adult exposure assumptions include an average body weight of 70-kg (154 lbs.) and an average fresh and estuarine finfish tissue consumption rate of 6.5 grams/person/day (assuming year round availability).

Screening values can be divided into two risk categories, carcinogenic and non-carcinogenic. Risk of cancer is based on the theory that cancer results from a series of interactions between the carcinogenic agent and DNA, with the rate of interaction being linearly related at low dose. In other words, cancer risk is considered zero only if the contaminant exposure concentration is zero and some finite risk of cancer exists even at the lowest conceivable dose.

Variables used in deriving cancer screening values include a science based cancer potency or slope factor (q_1*) for each contaminant of concern and a pre-specified maximum acceptable lifetime risk level (such as, 10^{-5}, or one excess case of cancer per 100,000 individuals exposed over a 70-yr lifetime). The US EPA recognizes an acceptable lifetime risk level range of 10^{-4} through 10^{-7} (US EPA, 1995). To be consistent with Maryland's ambient surface water quality standards program, a risk level of 10^{-5} was used in the development of screening values in this report.

The inorganic form of arsenic is the only metal discussed in this document, which is considered a carcinogen (Group A-Known Human Carcinogen) from the pathway of ingestion. Recent scientific findings indicate that the percentage of available inorganic arsenic in fish tissue is less than 4%, with marine fish being even lower (Morrissey et al 1999). Due to the high cost and technical constraints of analyzing finfish tissue specifically for inorganic arsenic, most states, including Maryland, analyze finfish samples for total arsenic which include both the inorganic and organic forms. To avoid overstating the health risk associated with total arsenic in finfish tissue, Maryland presently applies a 4% adjustment factor to the total arsenic finfish tissue data to arrive at a more realistic estimate of the concentration of inorganic arsenic or the toxic portion in edible finfish tissue. This adjusted total arsenic value can then be compared to the appropriate human health risk-based screening value derived for the inorganic form of arsenic in fish tissue. The Maryland Department of the Environment is in the process of identifying reliable methods that can specifically measure inorganic arsenic in fish tissue thus alleviating the need for the conversion factor of 4% and providing an even more accurate assessment of risk.

Non-carcinogenic risk assumes that toxic effects only occur after exposure exceeds some threshold level. In other words, the body's natural defense mechanisms are able to ensure that a toxic effect is not likely to occur up to some particular level of contaminant exposure or dose. This contaminant level of effect or dose is called the Reference Dose (RfD). The RfD is an estimate of a daily exposure to the human population (including sensitive sub-populations) that should be without appreciable risk of deleterious effects from a chronic exposure (US EPA, 1995). However, concentrations above the RfD do not necessarily indicate that an appreciable risk exists, merely that the potential exists and thus requires further investigation.

Due to limited toxicological data regarding the human consumption of lead specifically associated with finfish tissue ingestion, there is no comparable risk-based screening value for lead. Human health effect studies associated with lead exposure (usually through lead particle ingestion) utilize human blood lead levels from individuals where an effect is observed. Lead exposure from the direct ingestion of lead particles is not representative of lead exposure through the ingestion of lead contaminated finfish tissue. As a result, analytical lead results will be presented but not screened against any specific value in this document.

Conservative screening values were derived using the q_1* and RfD information in combination with pre-specified human exposure assumptions discussed above. The human health risk-based screening values used in this report and a calculation example are presented in Table 3.

Table 3. Risk-Based Human Health Fish Consumption Screening Values for Metals

METALS	**Screening Values (ppm) for Average Child***		**Screening Values (ppm) for Average Adults****	
	Non-Carcinogen	*Carcinogen, $RL=10^{-5}$*	*Non-Carcinogen*	*Carcinogen, $RL=10^{-5}$*
Arsenic	1.66	0.037	3.23	0.072
Cadmium	5.55	N/A	10.77	N/A
Chromium (III)	8,307.69	N/A	16,153.85	N/A
Chromium (VI)	16.62	N/A	32.31	N/A
Copper	221.54	N/A	430.77	N/A
Lead	N/A	N/A	N/A	N/A
Mercury	0.55	N/A	1.08	N/A
Nickel	110.77	N/A	215.38	N/A
Silver	27.69	N/A	53.85	N/A
Zinc	1661.54	N/A	3230.77	N/A
* 36 kg body weight @ 6.5 g/d consumption rate; ** 70 kg body weight @ 6.5 g/d consumption rate				

Example of Average Child Screening Value (SV) Calculation for Inorganic Arsenic (As):

Non-Carcinogen:	**Carcinogen:**
SV_n = (RfD • BW) / CR	SV_c = [(RL / SF) • BW)] / CR
SV_n = (3 x 10^{-4} mg/kg/d • 36 kg) / 0.0065 kg/d	SV_c = [(10^{-5} / 1.5 $(mg/kg/d)^{-1}$) • 36 kg)] / 0.0065 kg/d
SV_n = 1.66 mg/kg (ppm)	SV_c = 0.037 mg/kg (ppm)

RfD	= 3 x 10^{-4}	Oral reference dose (mg/kg/d)	(US EPA, 1995)
SF	= 1.5	Oral slope factor $(mg/kg/d)^{-1}$	(US EPA, 1999)
RL	= 10^{-5}	Maximum acceptable risk level (dimensionless)	(US EPA, 1995)
BW	= 36	Child mean body weight of the general population of concern (kg)	(US EPA, 1995)
CR	= 0.0065	Mean daily consumption rate of finfish tissue by the general population averaged over a 70-yr lifetime (kg/d)	(US EPA, 1995)

Use of screening values is a first step risk screening of finfish fillet tissue data for possible areas of potential human health concern, but is not intended to replace the formal risk analysis process. If areas of concern are identified, they are further evaluated for potential intensive site-specific monitoring efforts and human health risk management considerations.

2.5. DATA ANALYSIS

For screening purposes, analytical results reported below the analytical level of detection were set at one-half the detection level. Analytical results reported as trace levels were set equal to the detection level. All sample (individual and composite) results were screened against the human health risk-based screening values presented in Table 3.

Since the main purpose of this report was to screen for human health risk associated with contaminated finfish tissue consumption, descriptive statistics were only performed on samples that exceeded the human health risk-based screening values. A compilation of all available finfish fillet tissue data utilized in this report is presented in Appendix C. Arsenic results presented in this report, including those in Appendix C, have been adjusted to represent the inorganic or toxic portion (4% of the total).

As the program evolved, new and improved methods were developed to more accurately analyze the fish tissue samples. As such, the reliability and consistency of the data improved as well.

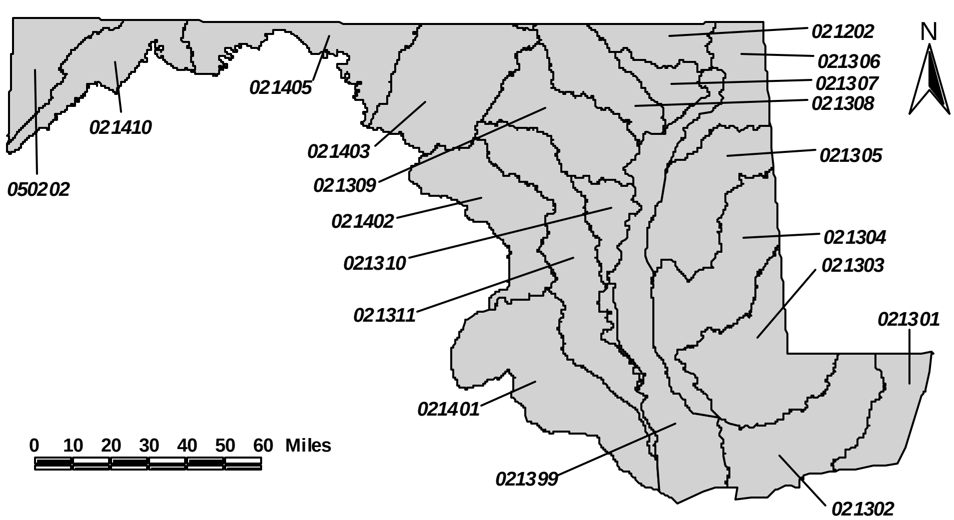
2.5.1 Data Organization and Presentation

Analytical results were grouped into the geographic organizational format of Maryland's surface water six-digit 'sub-basin' categories (Figure 1) as defined in the Code of Maryland Regulations (COMAR, 1997). Within each 'sub-basin', data was separated into Core monitoring program and intensive study data categories. Within each of these two groups, data was sorted by sample station and further sub-grouped into individual finfish species categories. Each individual species sub-group was further sub-divided by sample date and individual trace metal, which includes arsenic-inorganic (As), cadmium (Cd), copper (Cu), chromium (Cr), lead (Pb), mercury (Hg), nickel (Ni), silver (Ag), and zinc (Zn). Analytical results are presented in parts per million (ppm) wet weight. For screening purposes, arsenic results presented in this report, including those in Appendix C, have been adjusted to represent the inorganic or toxic portion (4% of the total).

3. RESULTS

The main purpose of this report is to compare available finfish tissue contaminant data to human health risk-based screening values and identify those situations that may warrant further investigation. In addition to simply identifying screening value exceedances, a summary of sampling effort is also provided in order to facilitate discussion of findings. The organizational format of this section is divided into 19 sub-basin watersheds (Figure 1).

Figure 1. Maryland Six-Digit Basin Code Map



Within each sub-basin section, tables and figures summarize various spatial and temporal characteristics, as well as, quantification of sampling effort and screening value exceedances. If a screening value exceedance was identified, a detailed discussion of the analytical results is presented. A complete list of analytical results for each sample is presented in Appendix C. Unless otherwise noted, arsenic results presented in this report, including those in Appendix C, have been adjusted to represent the inorganic or toxic form (4% of the total).

An example of how the summary tables are organized is provided below.

Example:

Number of samples

Number of fish per composite sample

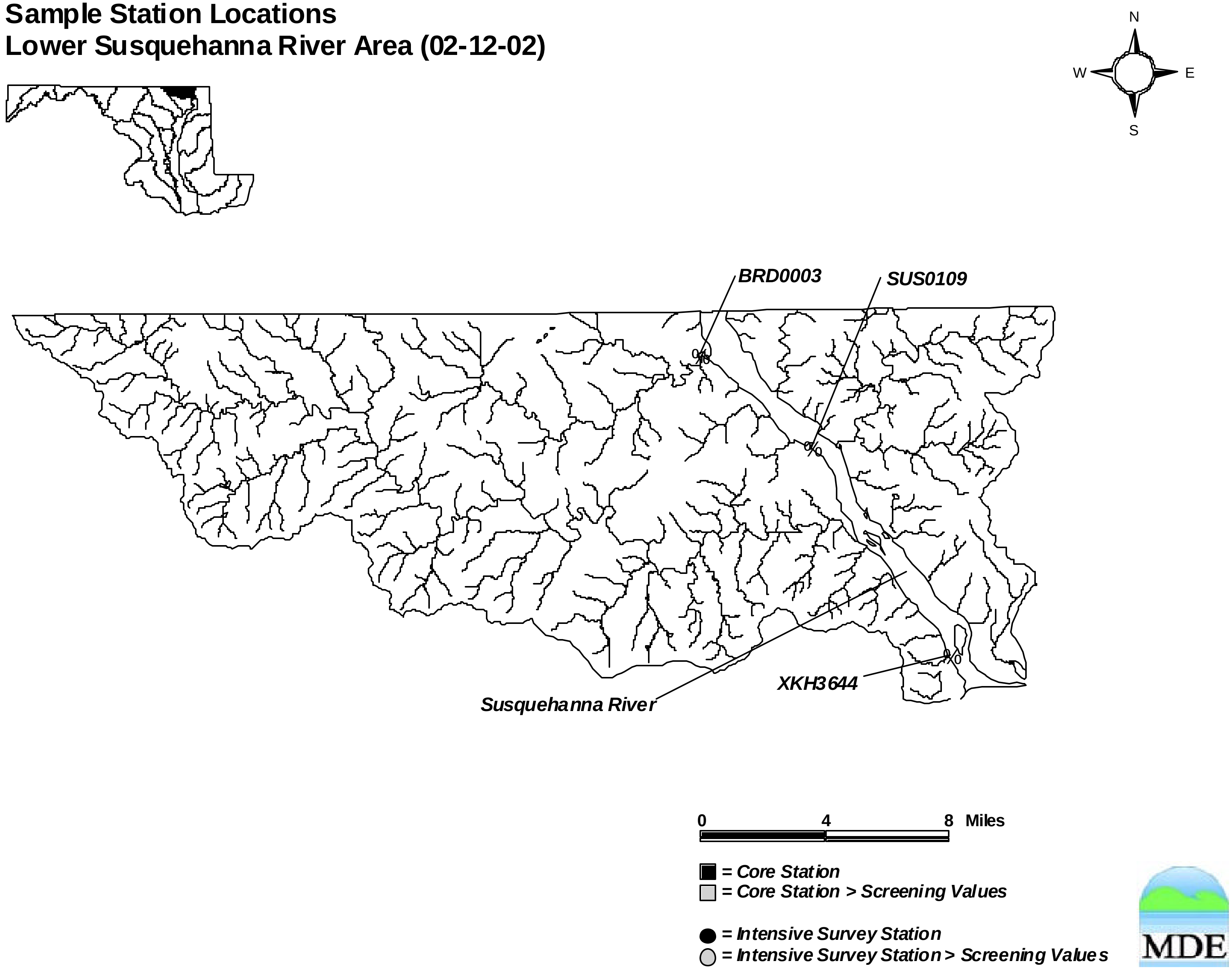
Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
WFL0027	White Perch	1986	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
XGG2143	Bluefish	1985	I		**2/7**	7	7	7	7		7	7
* C – Composite Sample, I – Individual Sample								= Exceeds Screening Value				

Number of samples (individual fish) that exceeded SV

Number of total samples (individual fish) sampled sample

If a composite sample was collected, the total number of samples precedes the number of fish in the composite sample. If an individual sample was collected, the number of samples exceeding the screening value precedes the total number of individual fish samples. If a composite or individual sample exceeded a screening value, the box was shaded to facilitate its identification.

3.1 Sample Station Locations
Lower Susquehanna River Area (02-12-02)



3.1. LOWER SUSQUEHANNA (Basin 02-12-02)

3.1.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
NONE												

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.1.2 CORE MONITORING PROGRAM

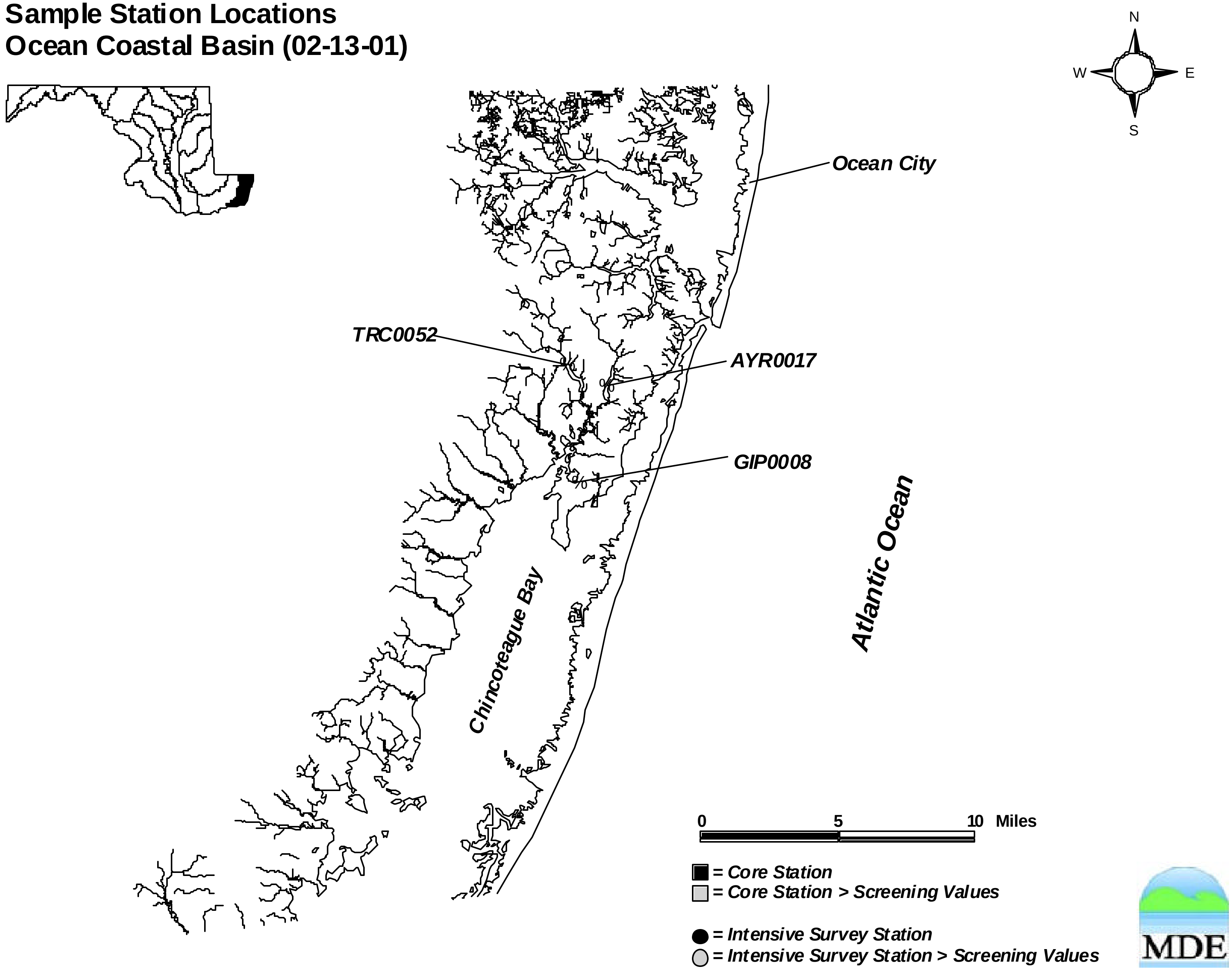
Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
BRD0003	Channel Catfish	1991	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1992	C		1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)
		1995	C	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)
	Largemouth Bass	1991	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1992	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
SUS0109	Channel Catfish	1986	I		5	5	5	5	5		5	5
XKH3644	Carp	1990	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	Largemouth Bass	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	Smallmouth Bass	1990	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1990	I		1	1	1	1	1	1	1	1

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.1.3 DISCUSSION

All data reported are below human health risk-based screening values.

3.2 Sample Station Locations
Ocean Coastal Basin (02-13-01)



3.2. OCEAN COASTAL (Basin 02-13-01)

3.2.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
NONE												

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.2.2 CORE MONITORING PROGRAM

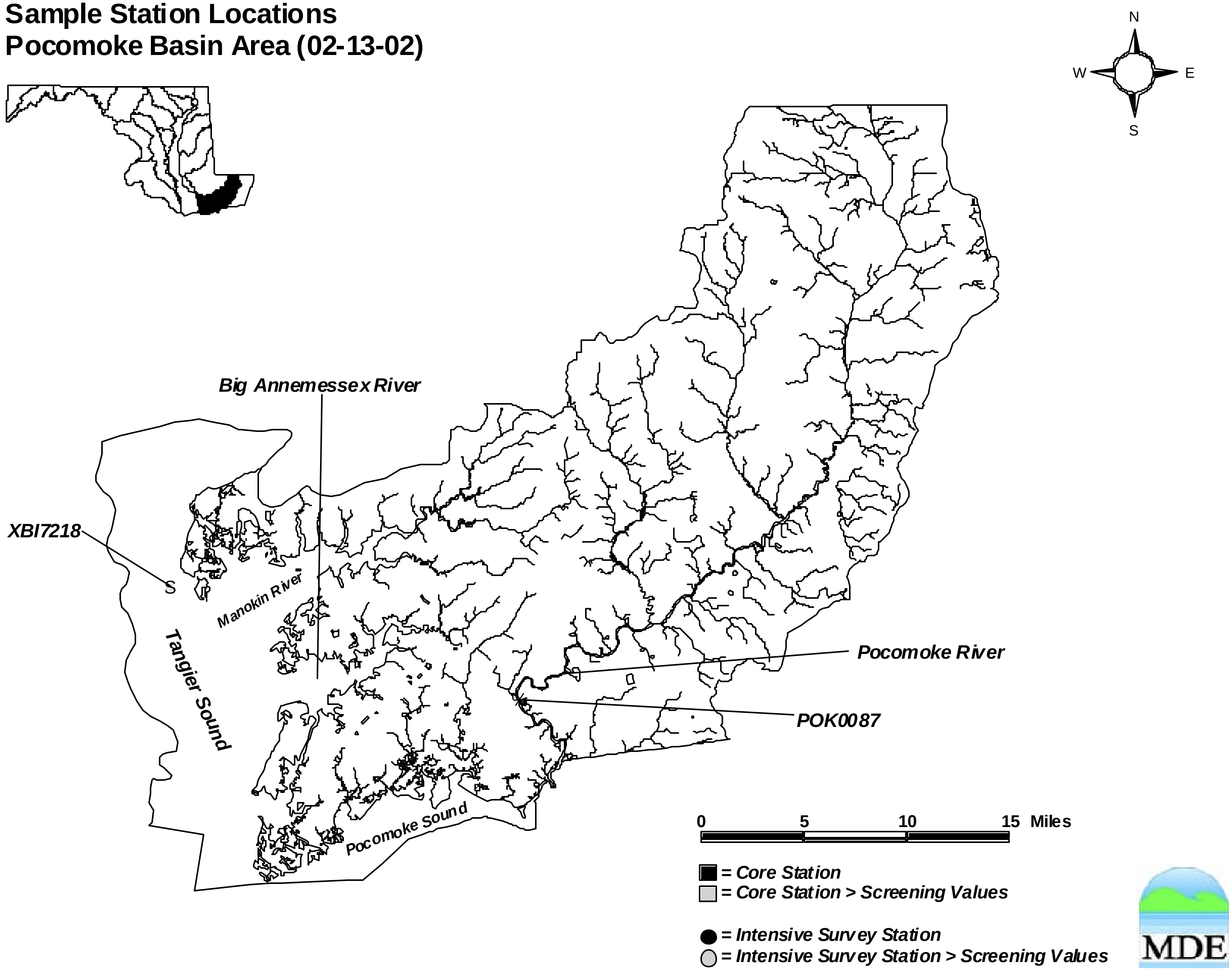
Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
AYR0017	White Perch	1994	C	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
GIP0008	White Perch	1990	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
TRC0052	Carp	1994	C	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.2.3 DISCUSSION

All data reported are below human health risk-based screening values.

3.3 Sample Station Locations
Pocomoke Basin Area (02-13-02)



3.3 POCOMOKE AREA (Basin 02-13-02)

3.3.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
XBI7218	Bluefish	1985	I		**1/2**	2	2	2	2		2	2

* C – Composite Sample, I – Individual Sample   [shaded] = Exceeds Screening Value

3.3.2 CORE MONITORING PROGRAM

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
POK0087	White Catfish	1990	C			1(2)	1(2)	1(2)		1(2)	1(2)	1(2)
		1997	C	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
	White Perch	1990	C			1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1997	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)

* C – Composite Sample, I – Individual Sample   [shaded] = Exceeds Screening Value

3.3.3 DISCUSSION

Intensive Studies

In October of 1985, during a special intensive study (MDEa, 1988), two individual bluefish were sampled from station XBI7218 located within Tangier Sound with approximate inorganic arsenic levels of 0.098 ppm and 0.029 ppm, respectively. The average inorganic arsenic level of these two bluefish is 0.063 ppm.

At the time of this intensive bluefish contaminants study, analytically derived total arsenic levels in finfish tissue were simply compared to total arsenic values recognized by the World Health Organization as characteristic of marine finfish tissue (total arsenic: < 5 ppm – 10 ppm; adjusted for inorganic arsenic: ≈ < 0.2 ppm – 0.4 ppm) (MDEa, 1988). Thus, in 1985 these bluefish total arsenic results were not considered elevated or a threat to human health. Therefore, no further investigation was required.

However, in comparing these results to present-day screening values, we find that the average inorganic arsenic level of these two bluefish samples (0.063 ppm) exceeds the inorganic arsenic screening level of 0.037 ppm. Analytical results for other metals (Cd, Cr, Cu, Hg, and Zn) were below present-day established screening levels.

Core Monitoring

Even though further bluefish samples have not been collected, subsequent sampling of other species have included composite samples of white catfish and white perch sampled in October 1990 and June 1997. In October of 1990, one composite sample of white catfish (two finfish/composite) and one composite sample of white perch (five finfish/composite) were collected from station POK0087 located in the Pocomoke River near the town of Rehobeth. The white catfish composite sample was analyzed for Cd, Cr, Cu, Ni, and Zn. The white perch composite sample was analyzed for Cd, Cr, Cu, Hg, Ni, and Zn. Both composite sample results were below established screening values.

In June of 1997, one composite sample of white catfish (three finfish/composite) and one composite sample of white perch (five finfish/composite) were also collected from station POK0087. Both composite samples were analyzed for Ag, As, Cd, Cr, Cu, Ni, and Zn. Both composite sample results were below established screening values for all metals.

Summary

Even though one bluefish from the Tangier Sound area collected in 1985 exceeded the present-day screening level for inorganic arsenic, there is not enough data to make any kind of general conclusion. Furthermore, additional samples collected from other species (white perch and white catfish) on later dates (1990 and 1997) did not exceed the screening value. With limited data available for inorganic arsenic associated with finfish tissue in this basin code, it is important that future planning include additional samples in order to provide sufficient data to assure the continued protection of human health.

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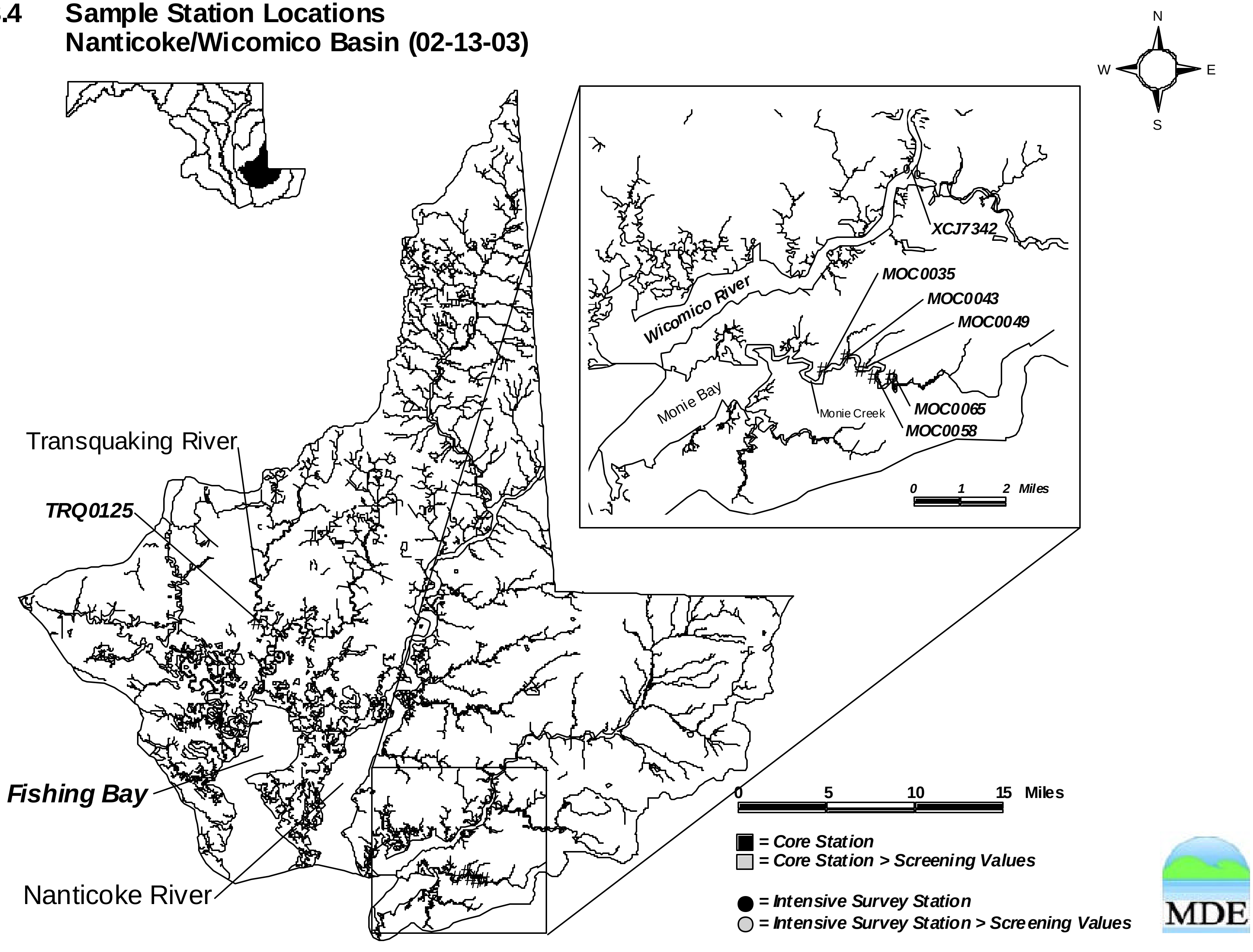
3.4 Sample Station Locations Nanticoke/Wicomico Basin (02-13-03)



3.4 NANTICOKE/WICOMICO AREA (Basin 02-13-03)

3.4.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
MOC0035	White Catfish	1986	I		1	1	1	1	1		1	1
MOC0043	White Catfish	1986	I		11	16	16	16	15		16	16
	White Perch	1986	I		32	32	32	32	32		32	32
MOC0049	White Catfish	1986	I		4	5	5	5	4		5	5
	White Perch	1986	I		3	3	3	3	3		3	3
MOC0058	White Catfish	1986	I		2	2	2	2	2		2	2
MOC0065	White Catfish	1986	I		6	6	6	6	6		6	6
TRQ125	Channel Catfish	1986	C		1(6)	1(6)	1(6)	1(6)	1(6)		1(6)	1(6)
	White Perch	1986	C						1(3)			

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.4.2 CORE MONITORING PROGRAM

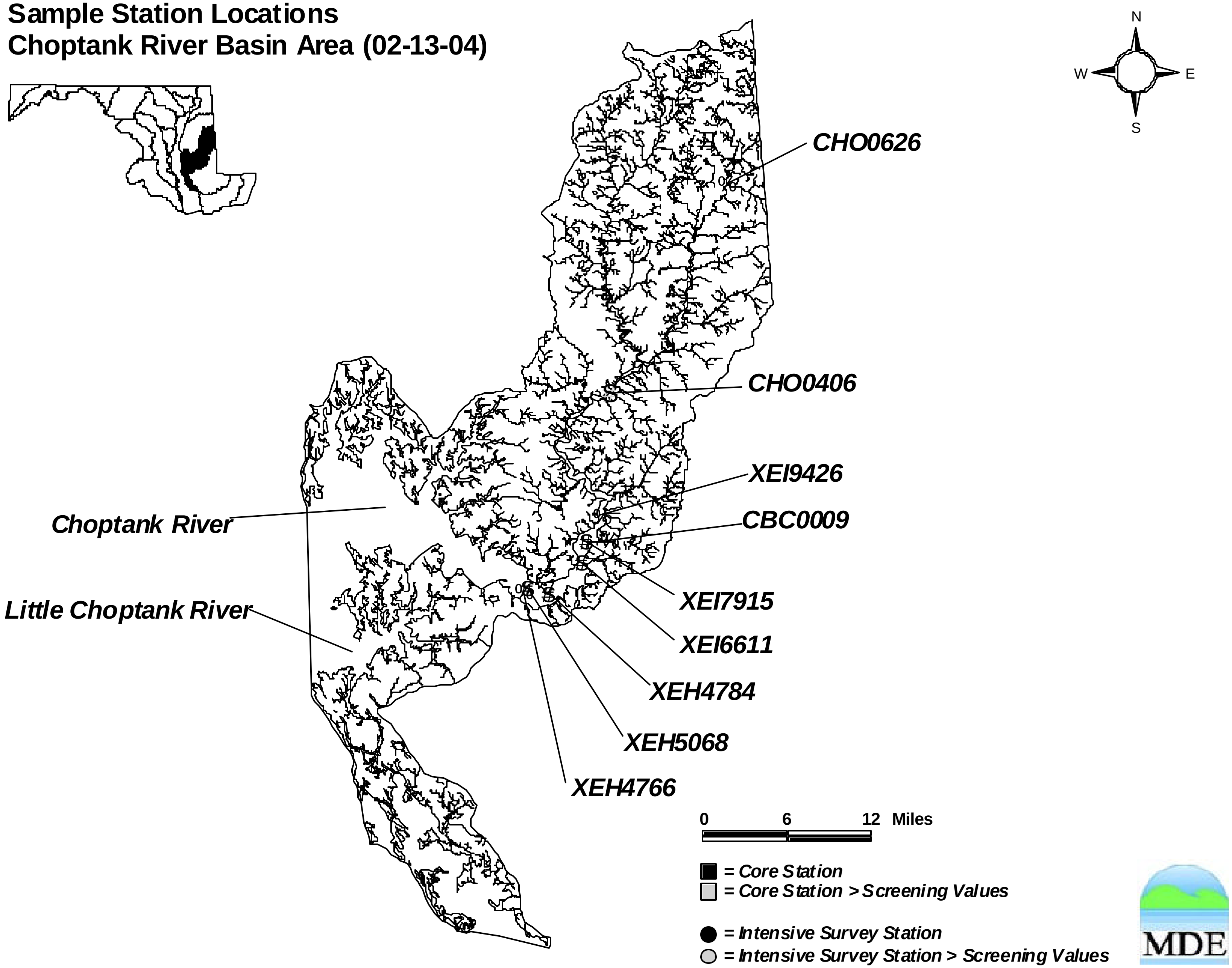
Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
XCJ7342	Channel Catfish	1990	I		2	2	2	2	2	2	2	2
		1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1990	C			2(5)	2(5)	2(5)	1(2)	2(5)	2(5)	2(5)
		1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.4.3 DISCUSSION

All data reported are below human health risk-based screening values.

3.5 Sample Station Locations
Choptank River Basin Area (02-13-04)



3.5 CHOPTANK AREA (Basin 02-13-04)

3.5.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
CHO0406	Striped Bass	1986	I		**1/10**	10	10	10	10		10	10
XEH4784	Striped Bass	1988	I		21	21	21	21	21	21	21	21
XEH5068	Striped Bass	1988	I		4	4	4	4	4	4	4	4
XEI6611	Striped Bass	1988	I		11	11	11	11	11	11	11	11
XEI7915	Striped Bass	1988	I		8	8	8	8	8	8	8	8

* C – Composite Sample, I – Individual Sample   [shaded] = Exceeds Screening Value

3.5.2 CORE MONITORING PROGRAM

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
CBC0009	White Catfish	1990	I		1	1	1	1	1	1	1	1
CHO0626	Channel Catfish	1990	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	Yellow Perch	1990	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XEH4766	White Perch	1990	C			1(4)	1(4)	1(4)		1(4)	1(4)	1(4)
XEI9426	Channel Catfish	1994	C	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)
	White Catfish	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)

* C – Composite Sample, I – Individual Sample   [shaded] = Exceeds Screening Value

3.5.3 DISCUSSION

<u>Intensive Studies</u>

In April/May of 1986, during a special intensive study (MDEb, 1988), ten individual striped bass were sampled from station CHO0406 located in the upper portion of the Choptank River near the mouth of Hog Creek. The average inorganic arsenic level reported from all ten samples is 0.028 ppm.

At the time of this intensive study, analytically derived total arsenic levels in finfish tissue were simply compared to total arsenic values recognized by the World Health Organization as characteristic of marine finfish tissue (total arsenic: < 5 ppm – 10 ppm; adjusted for inorganic arsenic: ≈ < 0.2 ppm – 0.4 ppm) (MDEb, 1988). Thus, in 1986 these striped bass arsenic results were not considered elevated or a threat to human health. Therefore, no subsequent sampling has been conducted at this station.

However, in comparing these results to present-day screening values, we find that one out of these ten striped bass equals the presently accepted screening value for inorganic arsenic with approximate inorganic arsenic tissue level of 0.037 ppm. The average inorganic arsenic level of all ten striped bass samples is 0.028 ppm thus below the inorganic arsenic screening level of 0.037 ppm. Analytical results for other metals (Cd, Cr, Cu, Hg, and Zn) are below present-day established screening levels.

Subsequently, other stations within the Choptank river area have been sampled (XEH4784, XEH5068, XEI6611, and XEI7915) which were well below the inorganic arsenic screening value. In November of 1988, 21 individual striped bass were sampled from station XEH4784, located Mid-Choptank River South of station CHO0406, with an average inorganic arsenic level of 0.006 ppm. In December 1988, striped bass were sampled from stations XEH5068 (four individual striped bass), XEI6611 (11 individual striped bass), and XEI7915 (eight individual striped bass), all located south of station CHO0406, with average inorganic arsenic levels of 0.008 ppm, 0.007 ppm, and 0.007 ppm, respectively. Analytical results for other metals (Cd, Cr, Cu, Hg, Ni, and Zn) are below present-day established screening levels as well.

Core Monitoring

In 1990, composite samples were collected on two occasions (September and October) from three stations (CBC0009, CHO0626, and XEH4766). In September of 1990, one composite (four finfish/composite) of white perch was collected from sample station XEH4766 located within the mid-Choptank River off the old Rt. 50 Bridge. Results for all analyzed metals are below present-day established screening levels.

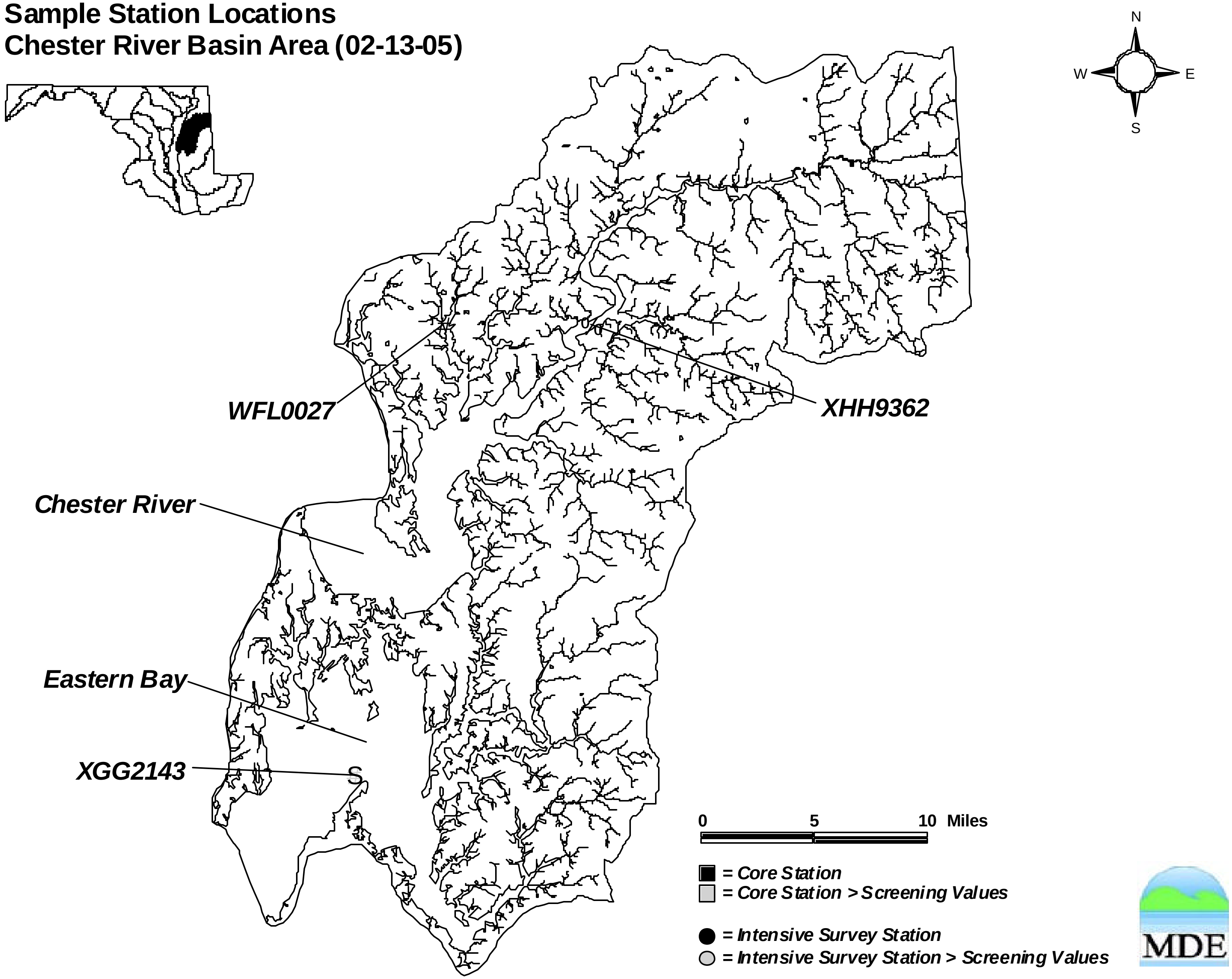
In October of 1990, composite samples of channel catfish (five finfish/composite) and white perch (five finfish/composite) were collected from station CHO0626 (located near Sewell Mills in the extreme upper portion of the Choptank River). In addition, one individual white catfish was collected from sample station CBC0009 (located within Cabin Creek of the upper Choptank River). Results for all metals analyzed are below present day established screening levels.

In October of 1994, composite samples of channel catfish (two finfish/composite), white catfish (five finfish/composite), and white perch (five finfish/composite) were collected from station XEI9426 (located near the mouth of Blinkhorn Creek in the upper Choptank River). For those metals analyzed, results are below present-day established screening levels.

Summary

The data associated with this basin suggest that there are no human health concerns associated with metals contamination of finfish tissue. Except for earliest results with one individual striped bass that slightly exceeded the inorganic arsenic screening value, all other samples were below screening values. Although that station has not been sampled since, subsequent sampling from nearby stations and from various species indicated that arsenic in finfish tissue has possibly subsided over time. Nonetheless, future-monitoring efforts should specifically include striped bass at station CHO0406 to assure the continued protection of human health.

3.6 Sample Station Locations
Chester River Basin Area (02-13-05)



3.6 CHESTER AREA (Basin 02-13-05)

3.6.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
WFL0027	White Perch	1986	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
XGG2143	Bluefish	1985	I		**1/7**	7	7	7	7		7	7
* C – Composite Sample, I – Individual Sample												= Exceeds Screening Value

3.6.2 CORE MONITORING PROGRAM

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
XHH9362	Channel Catfish	1990	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1994	I	1	1	1	1	1	1	1	1	1
	White Catfish	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1990	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
* C – Composite Sample, I – Individual Sample												= Exceeds Screening Value

3.6.3 DISCUSSION

Intensive Studies

In October of 1985, seven individual bluefish were sampled from station XGG2143, located within Eastern Bay North of Tilghman Point (MDEa, 1988). One out of seven individual bluefish exceeded the present-day 0.037-ppm screening level for inorganic arsenic with an approximate inorganic arsenic level of 0.049 ppm. The average inorganic arsenic level of all seven individual bluefish is below the 0.037 screening level at 0.024 ppm. Analytical results for other metals sampled were below present day established screening levels.

At the time of this intensive bluefish contaminants study, analytically derived total arsenic levels in finfish tissue were simply compared to total arsenic values recognized by the World Health Organization as characteristic of marine finfish tissue (total arsenic: < 5 ppm – 10 ppm; adjusted for inorganic arsenic: ≈ < 0.2 ppm – 0.4 ppm) (MDEa, 1988). Thus, in 1985 these bluefish total arsenic results were not considered elevated or a threat to human health. Therefore, no further bluefish samples were taken from this basin code area.

Subsequently, in August of 1986, a composite sample of 10 white perch was collected from station WFL0027 located in the upper Chester River off Walnut Point within the West fork of Langford Creek. For those metals analyzed, results are below present-day established screening levels.

Core Monitoring

In September of 1990, composite samples of white perch (five finfish/composite) and channel catfish (five finfish/composite) were collected form station XHH9362, located in the upper portion of the Chester River just South of Chestertown. For those metals analyzed, results are below present-day established screening levels.

In October of 1994, composite samples of white catfish (five finfish/composite) and white perch (five finfish/composite), as well as, one individual sample of channel catfish were collected from the same station as above (XHH9362). For those metals analyzed, results are below present-day established screening levels.

Summary

The data associated with this basin suggest that there are no human health concerns associated with metals contamination of finfish tissue. Except for the earliest results with one individual bluefish that slightly exceeded the inorganic arsenic screening value, all other samples including the average inorganic arsenic level for bluefish were below screening values. Although that station has not been re-sampled, subsequent sampling from nearby stations and from various species indicated that arsenic in finfish tissue has possibly subsided over time.

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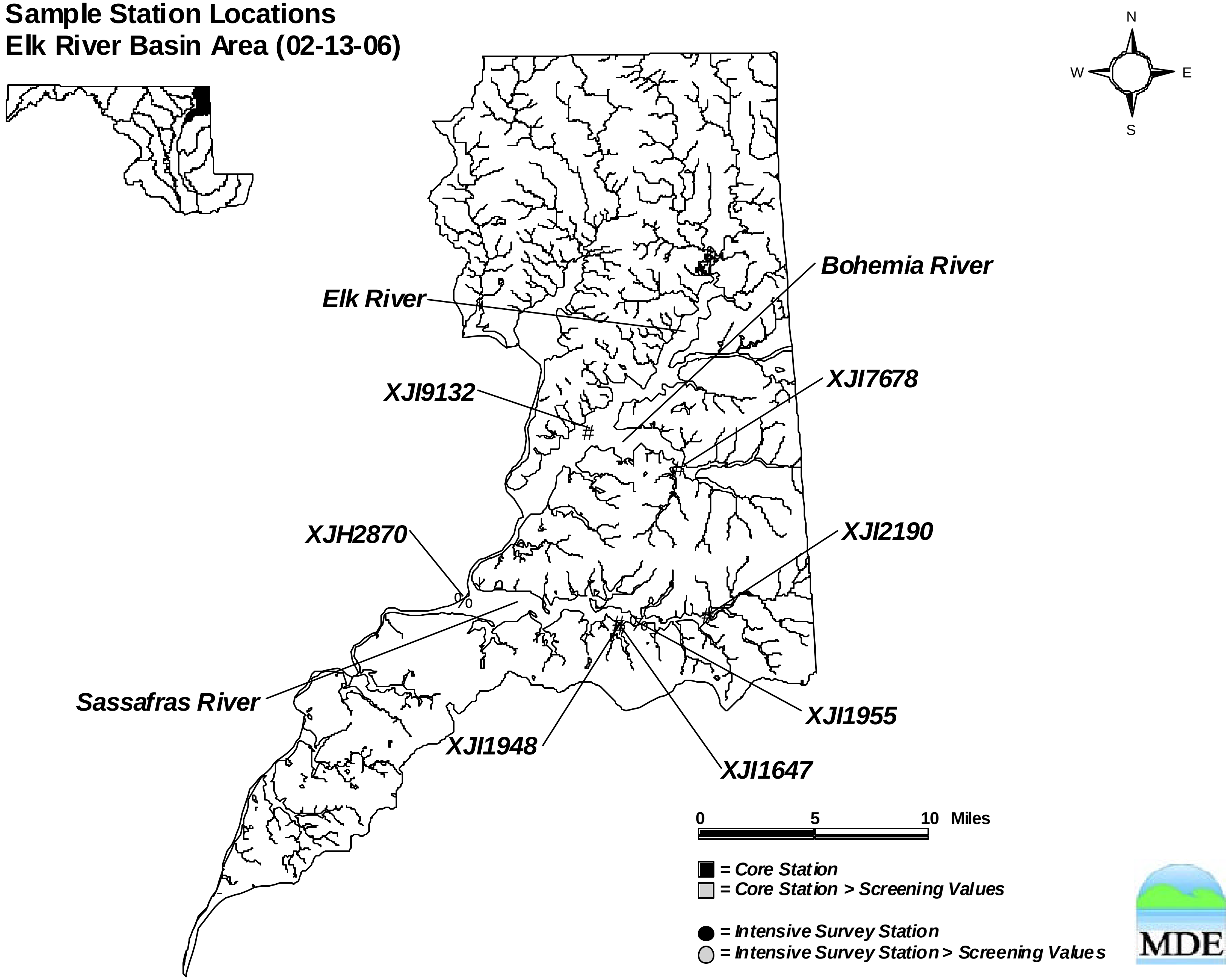
3.7 Sample Station Locations
Elk River Basin Area (02-13-06)



3.7 ELK RIVER AREA (Basin 02-13-06)

3.7.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
XJI1647	Channel Catfish	1986	C		1(4)	1(4)	1(4)	1(4)	1(4)		1(4)	1(4)
XJI1948	White Perch	1986	C		1(3)	1(3)	1(3)	1(3)	1(3)		1(3)	1(3)
XJI2190	Brown Bullhead	1986	C		1(12)	1(12)	1(12)	1(12)	1(12)		1(12)	1(12)
	Channel Catfish	1986	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
	White Perch	1986	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
XJI7678	Brown Bullhead	1986	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
	Channel Catfish	1986	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
	White Perch	1986	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
XJI9132	Channel Catfish	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.7.2 CORE MONITORING PROGRAM

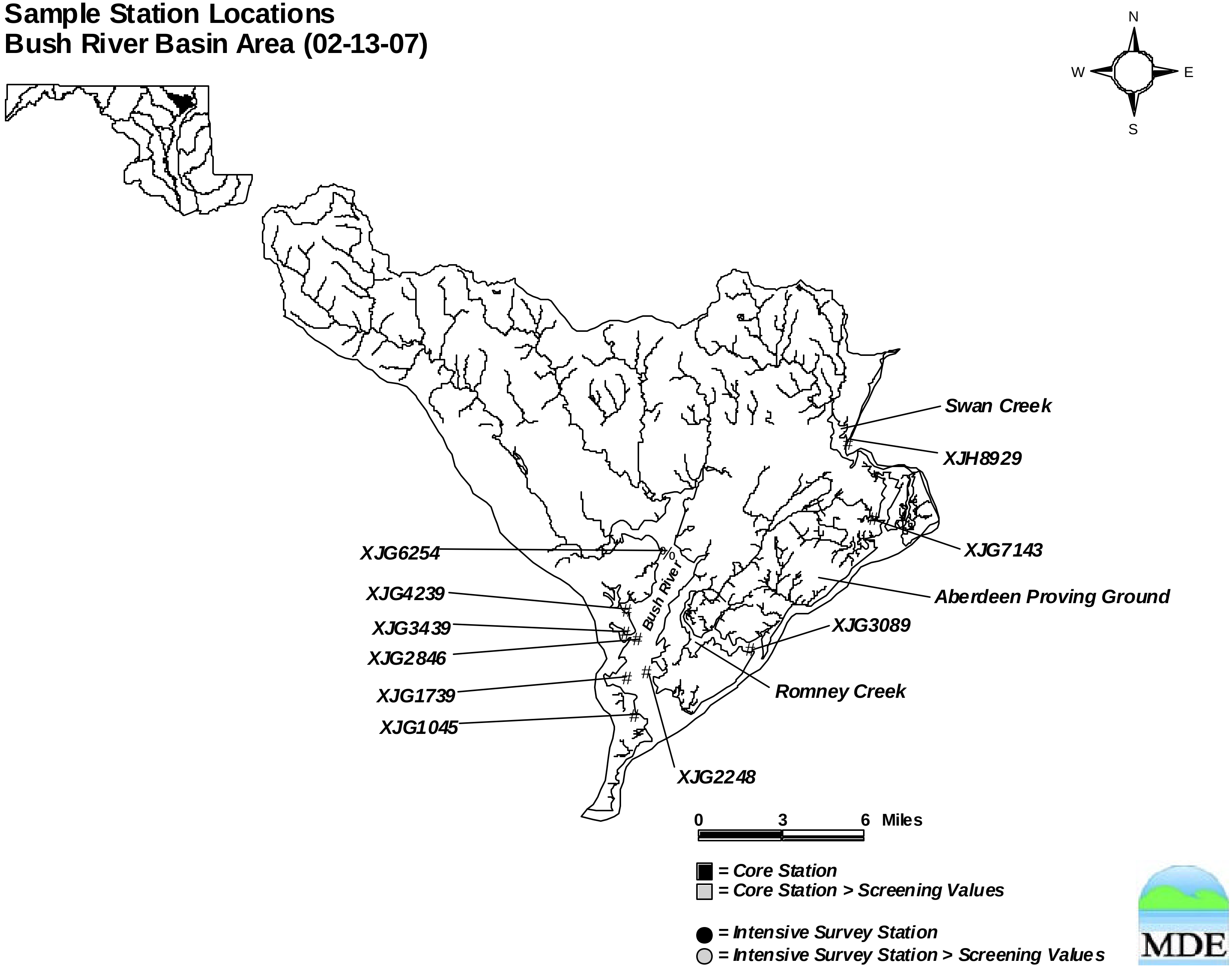
Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
XJH2870	Channel Catfish	1990	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XJI1955	Channel Catfish	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.7.3 DISCUSSION

All data reported are below human health risk-based screening values.

3.8 Sample Station Locations
Bush River Basin Area (02-13-07)



3.8 BUSH RIVER AREA (Basin 02-13-07)

3.8.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
XJG1045	Channel Catfish	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XJG1739	Brown Bullhead	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XJG2248	Channel Catfish	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XJG2846	White Catfish	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
XJG3089	Channel Catfish	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XJG3439	Channel Catfish	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XJG4239	White Catfish	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XJG7143	Brown Bullhead	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XJH8929	Brown Bullhead	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)

* C – Composite Sample, I – Individual Sample   = Exceeds Screening Value

3.8.2 CORE MONITORING PROGRAM

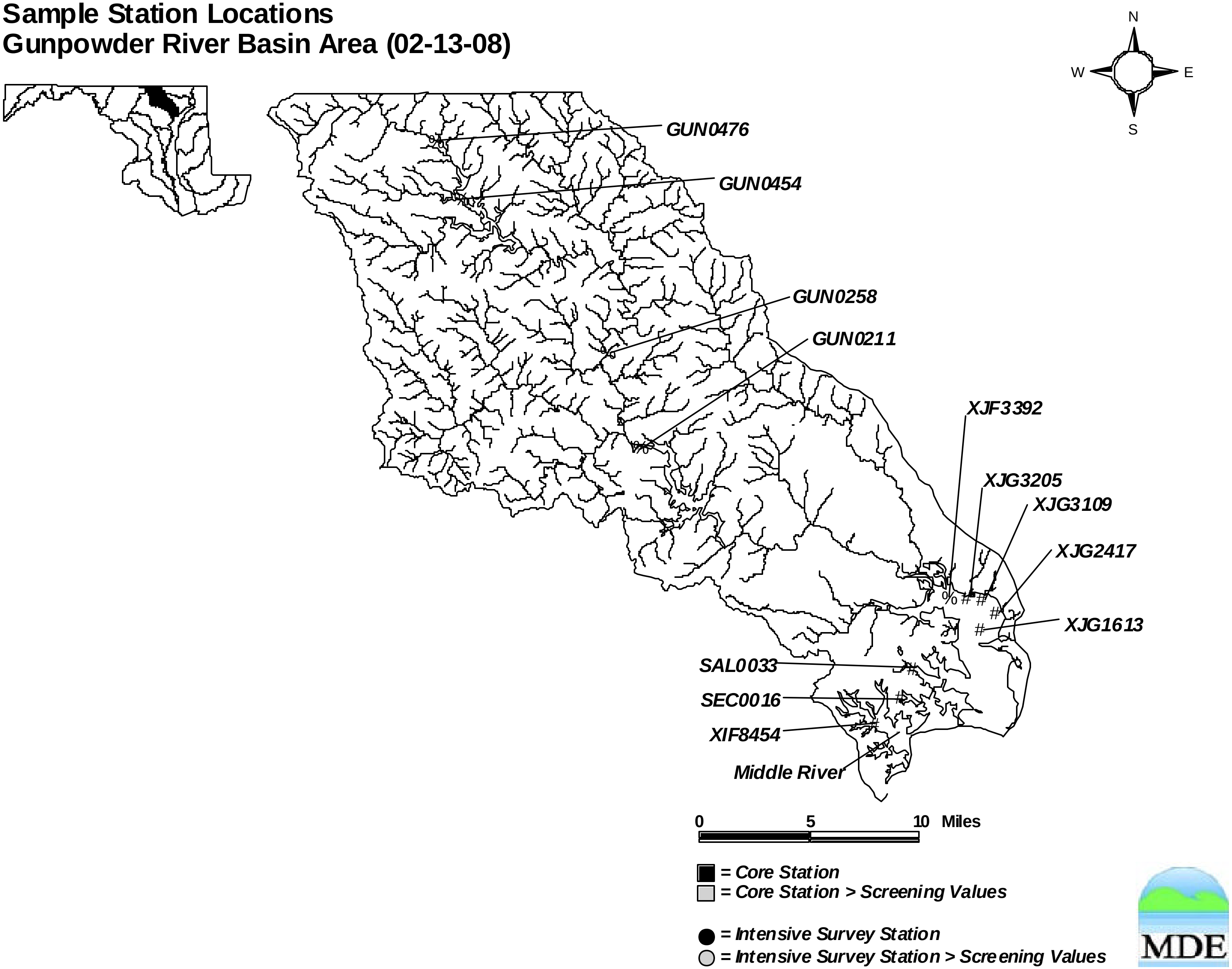
Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
XJG6254	Channel Catfish	1990	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1990	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)

* C – Composite Sample, I – Individual Sample   = Exceeds Screening Value

3.8.3 DISCUSSION

All data reported are below human health risk-based screening values.

3.9 Sample Station Locations
Gunpowder River Basin Area (02-13-08)



3.9 GUNPOWDER RIVER AREA (Basin 02-13-08)

3.9.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
SAL0033	Channel Catfish	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
SEC0016	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XIF8454	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XJG1613	Brown Bullhead	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XJG2417	White Catfish	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XJG3109	White Catfish	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XJG3205	Brown Bullhead	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)

* C – Composite Sample, I – Individual Sample   = Exceeds Screening Value

3.9.2 CORE MONITORING PROGRAM

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
GUN0211	Carp	1992	C		1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)
	Largemouth Bass	1992	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Sucker	1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
GUN0258	Brown Trout	1992	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Sucker	1992	C		1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
		1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
GUN0454	Carp	1992	I		2	2	2	2	2	2	2	2
	Largemouth Bass	1992	C		1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)
		1995	C	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
	White Sucker	1995	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
GUN0476	Smallmouth Bass	1991	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1992	C			1(4)	1(4)	1(4)		1(4)	1(4)	1(4)
		1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Sucker	1992	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XJF3392	Channel Catfish	1990	C		1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)
		1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1990	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)

* C – Composite Sample, I – Individual Sample   = Exceeds Screening Value

3.9.3 DISCUSSION

All data reported are below human health risk-based screening values.

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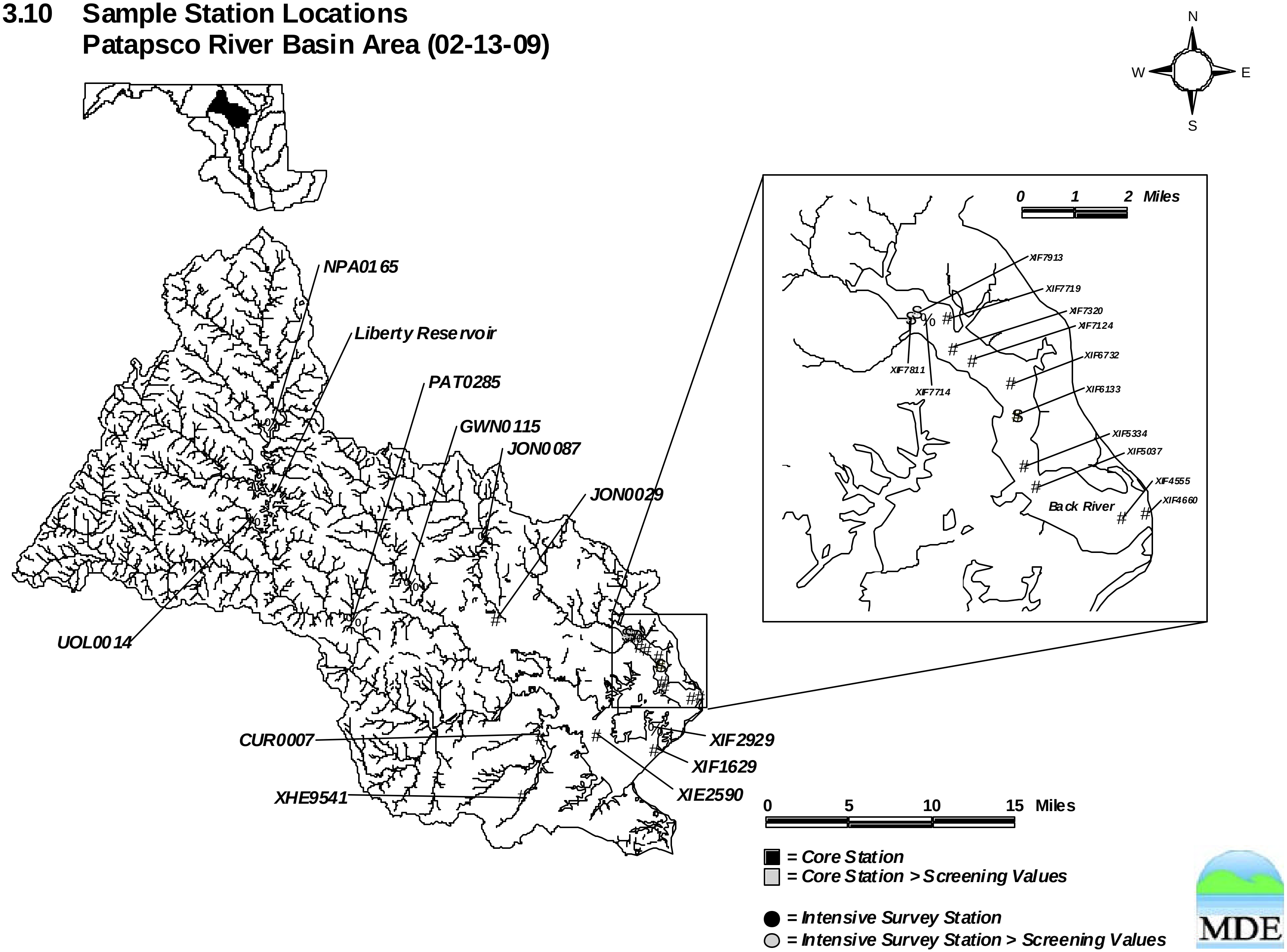
3.10 Sample Station Locations
Patapsco River Basin Area (02-13-09)



3.10 PATAPSCO RIVER AREA (Basin 02-13-09)

3.10.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
CUR0007	White Perch	1986	I			3	3	3	12		3	3
JON0029	White Sucker	1985	I		1	1	1	1	1		1	1
XHE9541	Carp	1985	I		2	2	2	2	2		2	2
XIE2590	Channel Catfish	1985	I		1	1	1	1	1		1	1
XIF1629	Channel Catfish	1985	I		3	3	3	3	3		3	3
	White Catfish	1985	I						1			
	White Perch	1985	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
XIF4555	Brown Bullhead	1985	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
	Channel Catfish	1985	I		16	17	17	17	26		17	17
XIF4660	Brown Bullhead	1985	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
	Channel Catfish	1985	I		1	1	1	1	2		1	1
	White Perch	1985	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
		1985	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
XIF5037	Brown Bullhead	1985	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
	Channel Catfish	1985	I		4	4	4	4	4		4	4
		1985	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
	White Perch	1985	I						1			
		1985	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
		1985	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
XIF5334	Channel Catfish	1986	I		12	12	12	12	12		12	12
	White Perch	1986	I		9	16	16	16	16		16	16
XIF6133	Channel Catfish	1985	I		1	1	1	1	1		1	1
		1985	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
		1986	I		1	1	1	1	1		1	1
	White Perch	1986	I		4							
XIF6732	Brown Bullhead	1985	I						9			
		1985	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
	Channel Catfish	1985	I			1	1	1	2		1	1
XIF7124	Brown Bullhead	1985	I			4	4	4	9		4	4
		1985	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
	Channel Catfish	1985	I		2	2	2	2	2		2	2
	White Perch	1985	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
		1986	I		1							
XIF7320	Channel Catfish	1986	I		4	4	4	4	4		4	4
	White Perch	1986	I		9	9	9	9	9		9	9
XIF7719	Channel Catfish	1985	I		7	9	9	9	9		9	9
		1986	I		4	4	4	4	4		4	4
	White Perch	1985	C		1(10)	1(10)	1(10)	1(10)	1(10)		1(10)	1(10)
		1986	I		2	1	1	1	1		1	1
XIF7811	Channel Catfish	1986	I		1	1	1	1	1		1	1
	White Perch	1986	I		**1/2**							
XIF7913	Brown Bullhead	1986	I		33	30	30	30	30		30	30
	Channel Catfish	1986	I		2	2	2	2	2		2	2
	White Perch	1986	I		**2/9**	4	4	4	4		4	4

* C – Composite Sample, I – Individual Sample   [shaded] = Exceeds Screening Value

3.10.2 CORE MONITORING PROGRAM

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
GWN0115	Rock Bass	1991	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1992	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Sucker	1991	I		1				1			
		1992	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
JON0087	Largemouth Bass	1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Sucker	1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
JON0184	Brown Trout	1991	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1992	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Sucker	1992	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
NPA0165	Smallmouth Bass	1992	C			1(2)	1(2)	1(2)		1(2)	1(2)	1(2)
		1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Sucker	1992	C		1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)
		1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
PAT0285	White Sucker	1992	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1992	I		1	1	1	1	1	1	1	1
	Smallmouth Bass	1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Sucker	1995	C	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)
UOL0014	Carp	1992	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	Channel Catfish	1992	C		1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)
	Largemouth Bass	1991	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1992	C		1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)
		1992	C		1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
		1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XIF2929	Brown Bullhead	1990	C			1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XIF7714	Channel Catfish	1992	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1994	C	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
		1994	C	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)
	White Catfish	1994	C	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)
	White Perch	1992	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)

* C – Composite Sample, I – Individual Sample   = Exceeds Screening Value

3.10.3 DISCUSSION

Due to the established historical sediment contamination, this watershed has been sampled at various stations during numerous investigations throughout the years.

<u>Intensive Studies</u>

To facilitate the discussion of the results in this watershed, we have sub-divided the watershed into three sections (see accompanying map for graphical description);

1. Back River,which considers the following stations XIF7811, XIF7913, XIF7714, XIF7320, XIF7124, XIF6732, XIF6133, XIF5334, XIF5037, XIF4555, and XIF4660.

2. Baltimore Harbor which considers the following stations XIF2929, XIG1629, XIF2590, XHE9541, and CUR0007.

3. The non-tidal portion of the Patapsco watershed which considers the following stations JON0087, JON0029, JON0184, UOL0014, PAT0285, NPA0165, and GWN0115.

The results from the finfish samples collected within the Baltimore Harbor and the non-tidal portion of the Patapsco watershed results are below present-day established screening levels for all metals. With the exception of inorganic arsenic, the results from the finfish samples collected in Back River are also below present-day established screening levels for all metals. As a result, the ensuing discussion will focus on those areas where inorganic arsenic exceeded the screening value.

A total of nine individual samples of white perch were collected in September 1986 from station XIF7913, six of which were collected on September 8 and the remainder on September 9 and 10 1986. Of the six samples collected on September 8, two samples exceeded the 0.037 ppm screening level for inorganic arsenic with tissue levels of 0.060 ppm, and 0.075 ppm, respectively. The average inorganic arsenic level of all six individual white perch is below the screening level at 0.033 ppm. The remaining three samples had inorganic arsenic levels well below the screening value at 0.0064 ppm, 0.0108 ppm, and 0.0060 ppm, respectively. The overall average of inorganic arsenic in white perch at this station is 0.035 ppm.

Other species sampled on September 8th and 9th 1986 from station XIF7913 include 33 individual Brown Bullhead and two individual channel catfish with average inorganic arsenic results of 0.016 ppm and 0.028 ppm, respectively, well below the inorganic arsenic screening value.

At the adjacent sampling station XIF7811, one out of two individual white perch sampled on September 8th 1986 was equal to the 0.037 ppm screening level for inorganic arsenic with an approximate level of 0.037 ppm. The average inorganic arsenic level of both individual white perch, however, is below the screening level at 0.027 ppm. Other species sampled on September 8th 1986 from station XIF7811 include one individual channel catfish with an inorganic arsenic level of 0.016 ppm.

However, numerous individual samples (29) as well as composite samples (4) for different species collected at stations immediately downstream (XIF7719, XIF7320, XIF7124, and XIF6732) from the previously mentioned stations were below the inorganic arsenic screening value.

Further downstream from these stations, four individual white perch sampled from station XIF6133 in September 1986 were below the 0.037 ppm screening level for inorganic arsenic with levels of 0.022 ppm, 0.0280 ppm, 0.0364, and 0.0272 ppm, respectively. The average inorganic arsenic level of all four individual white perch is slightly above the screening level at 0.029 ppm. Other species sampled from this station include two individual channel catfish samples as well as one composite channel catfish sample, all of which were below the inorganic arsenic screening value.

Again, numerous individual samples (42) as well as composite samples (8) for various species collected at stations immediately downstream stations (XIF5534, XIF5037, XIF4555, and XIF4660) from the previously mentioned were all below the inorganic arsenic screening value.

Core Monitoring

Subsequent samples were collected in 1992 and 1994 at station XIF7714 in Back River. This station is immediately downstream from stations XIF7811 and XIF7913 where exceedances of the inorganic arsenic screening value were observed. In 1992, one white perch composite sample and one channel catfish composite sample were collected. In 1994, one white perch composite sample and two channel catfish composite samples were collected. The results of all samples collected from both 1992 and 1994 were all below the inorganic arsenic screening value.

Summary

The existing tissue data in Back River are inconclusive with regards to arsenic contamination. Although inorganic arsenic levels in some tissue samples exceeded the screening value, tissue data from concurrent samples for the same species as well as different species, were below the screening value. Furthermore, samples collected downstream from the affected stations were also below the screening value for inorganic arsenic.

The results from the samples for the remaining metals analyzed, other than arsenic, in Back River as well as for all metals in Baltimore Harbor and the non-tidal portion of the Patapsco watershed are below present-day established screening levels for all metals

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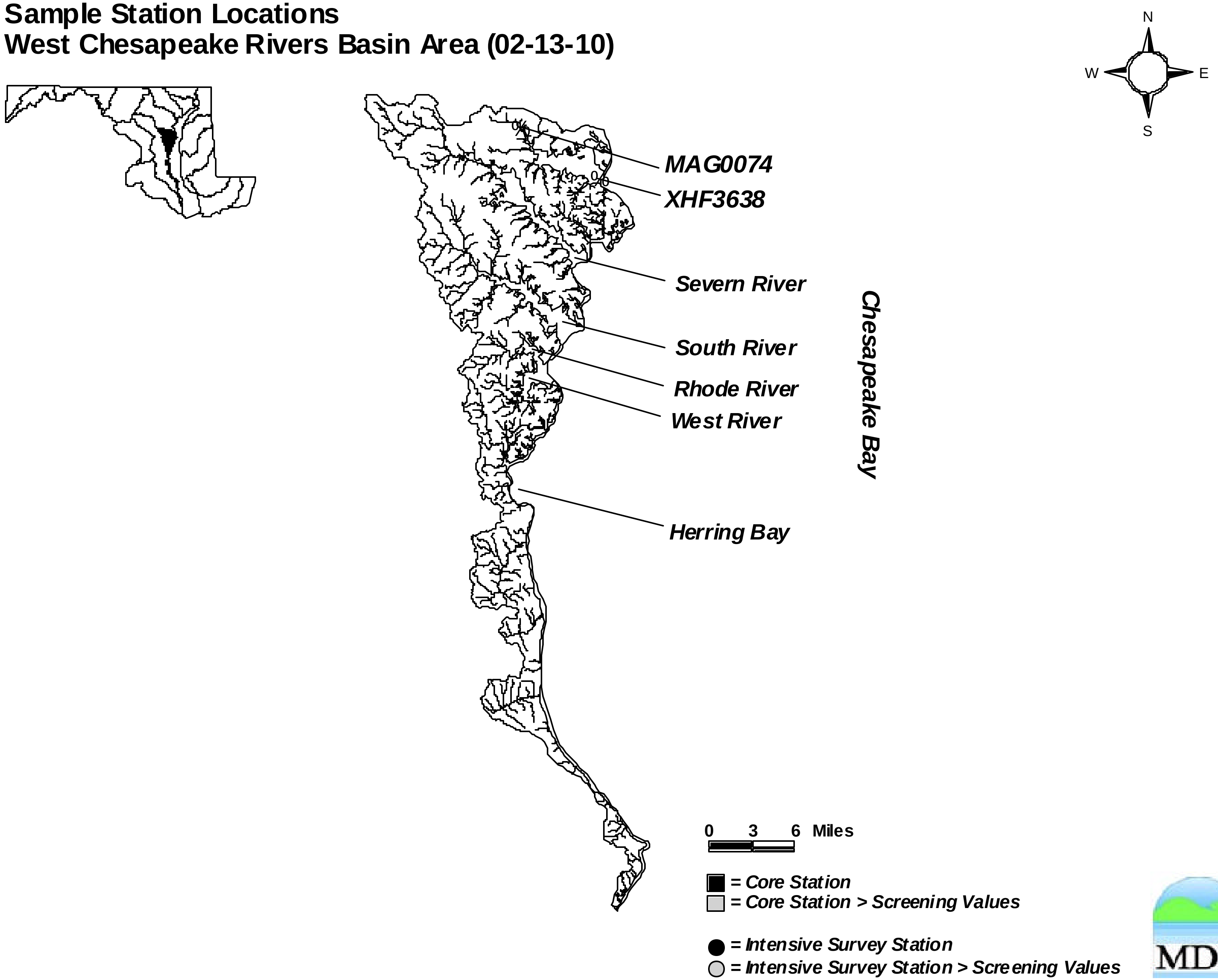
3.11 Sample Station Locations
West Chesapeake Rivers Basin Area (02-13-10)



3.11 WEST CHESAPEAKE AREA (Basin 02-13-10)

3.11.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
NONE												
* C – Composite Sample, I – Individual Sample								= Exceeds Screening Value				

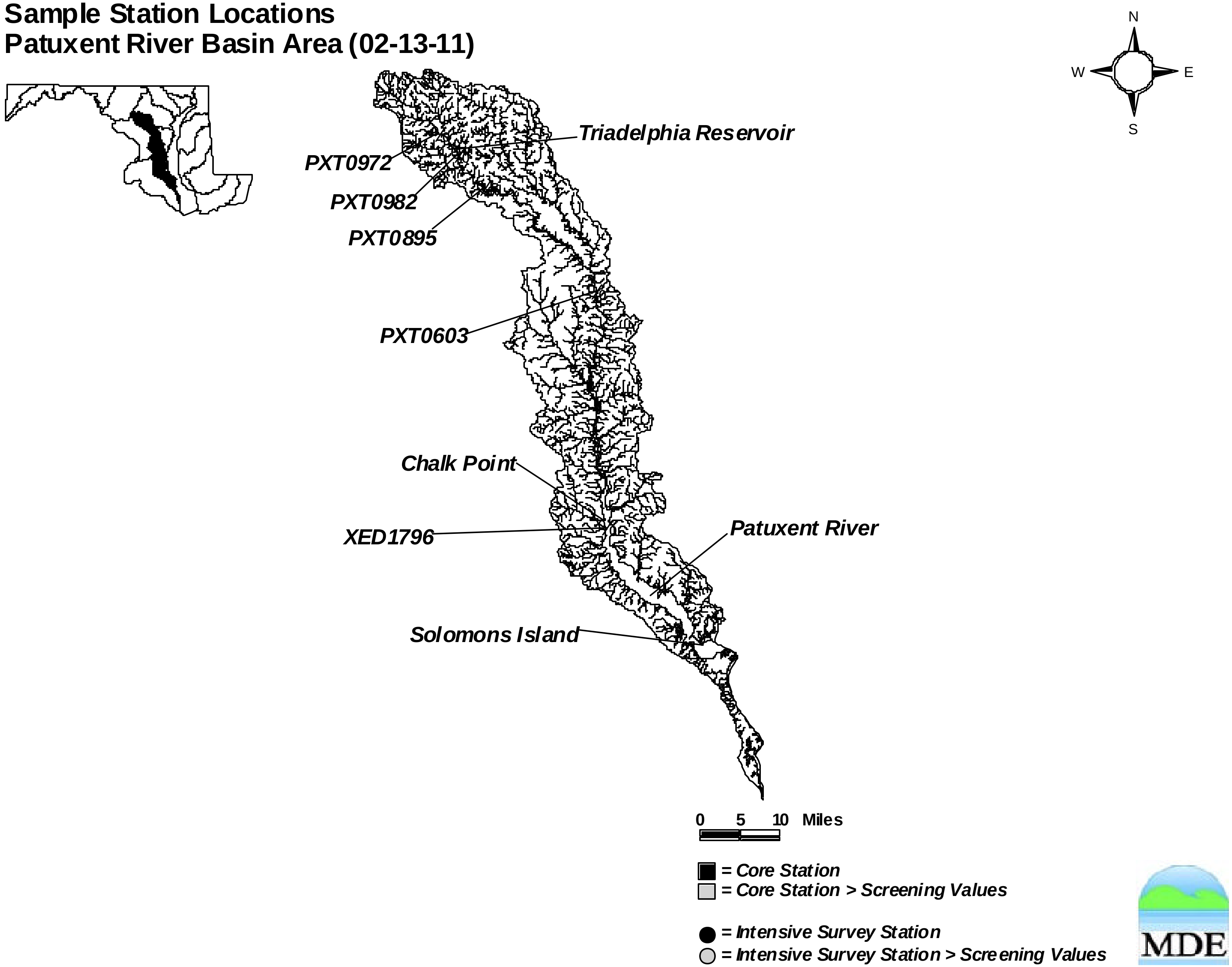
3.11.2 CORE MONITORING PROGRAM

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
MAG0074	Brown Bullhead	1990	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XHF3638	Channel Catfish	1994	C	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)
		1994	C	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
	White Perch	1990	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
* C – Composite Sample, I – Individual Sample								= Exceeds Screening Value				

3.11.3 DISCUSSION

All data reported are below human health risk-based screening values.

3.12 Sample Station Locations
Patuxent River Basin Area (02-13-11)



3.12 PATUXENT RIVER AREA (Basin 02-13-11)

3.12.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
NONE												

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.12.2 CORE MONITORING PROGRAM

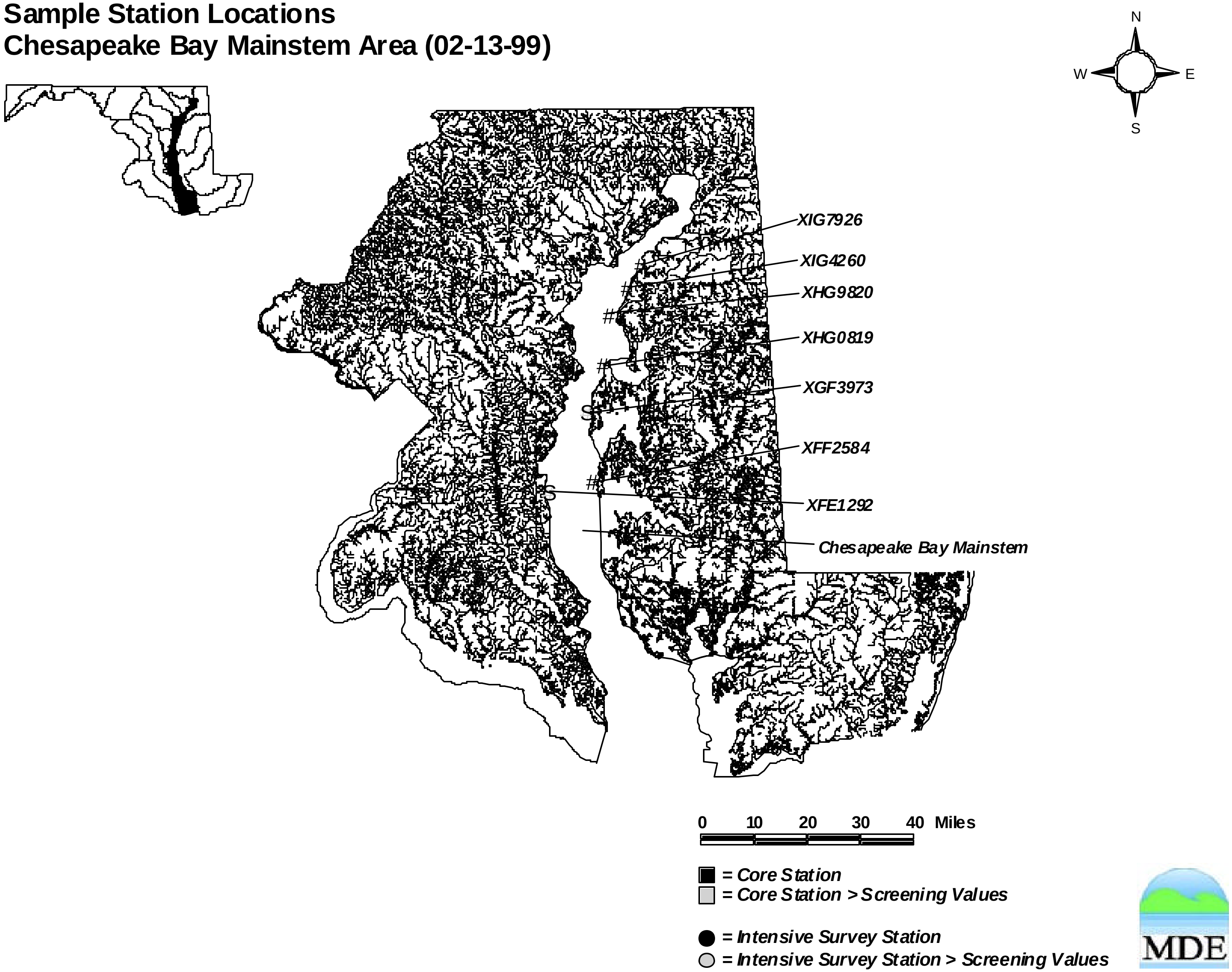
Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
PXT0603	Brown Bullhead	1986	C		1(5)	1(5)	1(5)	1(5)	1(5)		1(5)	1(5)
	Bluegill	1992	C		1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)
	Smallmouth Bass	1992	C		1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)
	White Sucker	1992	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
PXT0895	Channel Catfish	1991	C		1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)
		1992	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	Largemouth Bass	1991	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1992	I		1	1	1	1	1	1	1	1
		1992	C		1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)
		1995	C	2(7)	2(7)	2(7)	2(7)	2(7)	2(7)	2(7)	2(7)	2(7)
PXT0972	Brown Trout	1992	C			1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
	Fallfish	1992	C		1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
	Smallmouth Bass	1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Sucker	1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
PXT0982	Channel Catfish	1991	I		1	1	1	1	1	1	1	1
		1991	C		1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)
	Largemouth Bass	1991	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1992	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Sucker	1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XED1796	Channel Catfish	1994	I	1	1	1	1	1	1	1	1	1
		1994	C	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)
	White Catfish	1990	C		1(3)	2(5)	2(5)	2(5)	1(3)	2(5)	2(5)	2(5)
	White Perch	1990	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.12.3 DISCUSSION

All data reported are below human health risk-based screening values.

3.13 Sample Station Locations
Chesapeake Bay Mainstem Area (02-13-99)



3.13 CHESAPEAKE BAY MAINSTEM (Basin 02-13-99)

3.13.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
XFE1292	Bluefish	1985	I		**2/18**	18	18	18	18		18	18
XFF2584	Bluefish	1985	I		24	24	24	24	24		24	24
XGF3973	Bluefish	1985	I		**2/10**	10	10	10	10		10	10
XHG0819	Striped Bass	1988	I		9	9	9	9	9	9	9	9
XHG9820	Striped Bass	1988	I		37	37	37	37	37	37	37	37
XIG4260	Striped Bass	1988	I		13	14	14	14	13	14	14	14
XIG7926	White Catfish	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.13.2 CORE MONITORING PROGRAM

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
NONE												

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.13.3 DISCUSSION

Intensive Studies

During a 1985 bay wide intensive bluefish contaminants study, a total of 18 individual bluefish were collected from station XFE1292 (six in August and twelve in October). From the samples collected in August, six individual bluefish were sampled resulting in an average inorganic arsenic level of 0.019 ppm, well below the inorganic arsenic screening value of 0.037 ppm. From the samples collected in October, two out of 12 individual bluefish sampled exceeded the 0.037-ppm screening level for inorganic arsenic with approximate levels of 0.045 ppm, and 0.045 ppm. The average inorganic arsenic level of all 12 individual bluefish, however, is below the 0.037 ppm screening level at 0.023 ppm. No subsequent sampling of bluefish has been conducted at this station since, in 1985, these bluefish inorganic arsenic results were not considered elevated or a threat to human health.

Two out of 10 individual bluefish sampled from water quality station XGF3973 in May of 1985 slightly exceeded or equaled the 0.037 ppm screening level for inorganic arsenic with approximate levels of 0.056 ppm and 0.037, respectively. The average inorganic arsenic level of all 10 individual bluefish is below the 0.037 screening level at 0.025 ppm. No subsequent sampling of bluefish has been conducted at this specific sample station since again, in 1985, these bluefish arsenic results were not considered elevated or a threat to human health.

In July of 1985, 24 individual bluefish were sampled from station XFF2584 resulting in an average inorganic arsenic level of 0.002 ppm which is well below the screening value.

Core Monitoring

No Core Monitoring samples were available for this segment.

Summary

Even though four out of 52 bluefish collected in 1985 equaled or exceeded the present-day screening level for inorganic arsenic. The average levels of these individual fish were well below inorganic arsenic screening values. It is important that future planning include additional samples in this area in order to provide sufficient data to assure the continued protection of human health.

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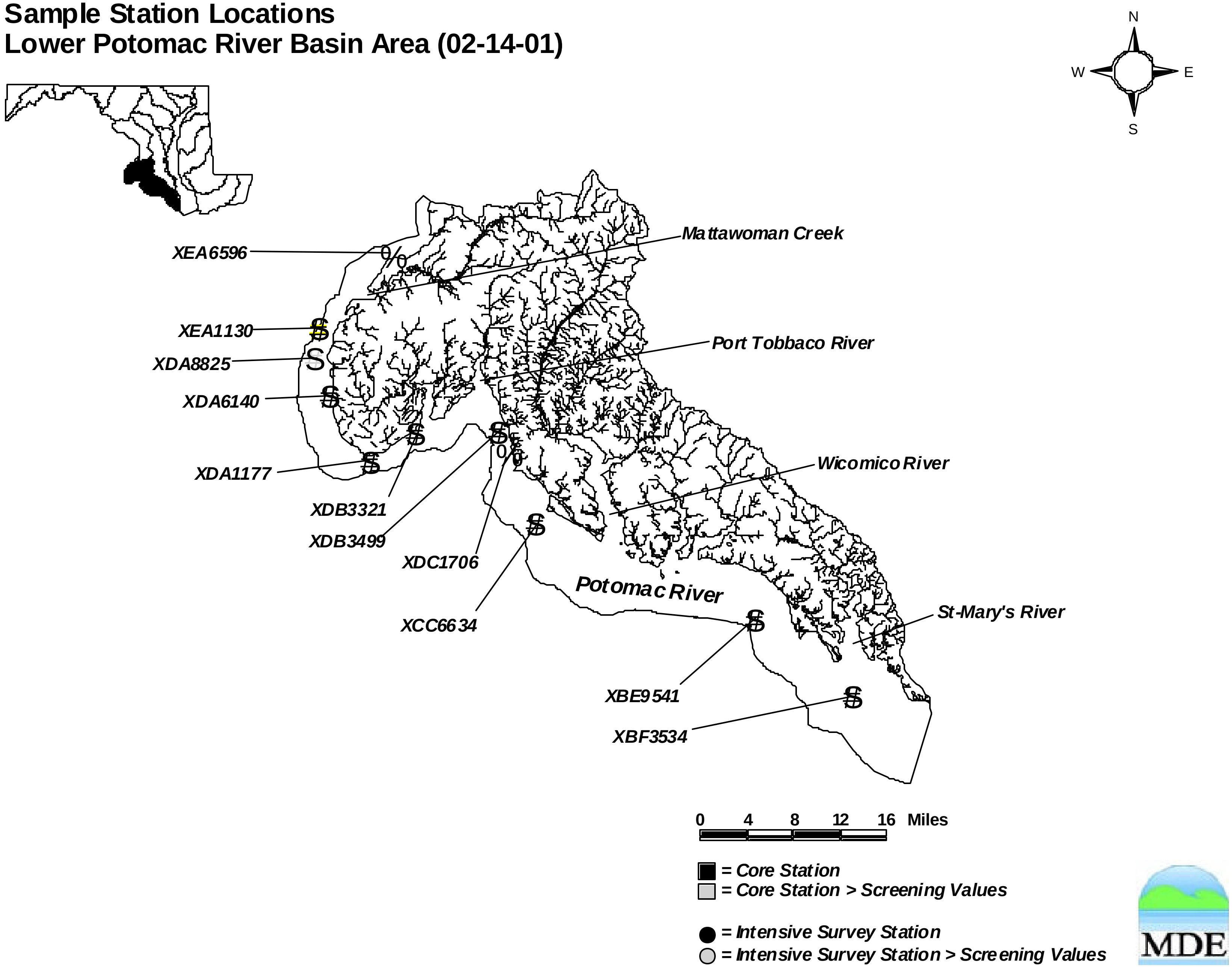
3.14 Sample Station Locations
Lower Potomac River Basin Area (02-14-01)



3.14 LOWER POTOMAC RIVER AREA (Basin 02-14-01)

3.14.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
XBE9541	Striped Bass	1991	I		12	12	12	12	12	12	12	12
XBF3534	Striped Bass	1991	I		11	11	11	11	11	11	11	11
XCC6634	Striped Bass	1993	I		11	19	19	19	19	19	19	19
		1994	I	16	16	16	16	16	16	16	16	16
XDA1177	Striped Bass	1992	I		39	39	39	39	39	39	39	39
XDA6140	Striped Bass	1988	I		34	41	41	41	36	41	41	41
XDA8825	Striped Bass	1986	I		**1/9**	9	9	9	9		9	9
XDB3321	American Eel	1988	I		2	12	12	12	2	2	12	12
	Brown Bullhead	1988	I			4	4	4			4	4
		1988	C			1(12)	1(12)	1(12)		1(12)	1(12)	1(12)
	Channel Catfish	1988	I		16	20	20	20	20		20	20
	White Perch	1988	I			9	9	9		2	9	9
XDB3499	Striped Bass	1991	I		10	10	10	10	10	10	10	10
XDC1706	Striped Bass	1991	I		12	12	12	12	12	12	12	12
XEA1130	Striped Bass	1986	I		13	13	13	13	13		13	13
XEA6596	Striped Bass	1986	I		3	3	3	3	3		3	3

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.14.2 CORE MONITORING PROGRAM

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
XDC1706	Brown Bullhead	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Catfish	1990	C			1(2)	1(2)	1(2)		1(2)	1(2)	1(2)
		1990	C		1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
	White Perch	1990	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
XEA6596	Brown Bullhead	1990	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Catfish	1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Perch	1990	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1994	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.14.3 DISCUSSION

Intensive Studies

The earliest samples collected in this watershed (1986) had inorganic arsenic levels in individual fish samples exceeding the inorganic arsenic screening value. At station XDA8825, one out of nine individual striped bass sampled in May/April of 1986 during an intensive contaminants evaluation study exceeded or equaled the 0.037 ppm screening level for inorganic arsenic with a level of 0.048 ppm. The average inorganic arsenic level of all nine individual striped bass is below the screening level at 0.022 ppm.

At station XEA1130, all 13 individual striped bass sampled in April of 1986 were below the screening level for inorganic arsenic. The average inorganic arsenic level of all 13 individual striped bass is 0.024 ppm.

At station XEA6596, which is located upstream from the two stations previously discussed, three striped bass were sampled in April of 1986. Inorganic arsenic levels in all three fish were below the screening value with an average of 0.018 ppm.

Subsequent samples collected from other stations throughout the Potomac River area for striped bass were found to be well below the screening value for inorganic arsenic. In February of 1991, 12 individual striped bass were sampled from stations XDC1706 and XBE9541 with average inorganic arsenic levels of 0.005 ppm and 0.004 ppm, respectively. In October of 1991, 11 individual striped bass were sampled from station XBF3534 with an average inorganic arsenic level of 0.001-ppm (< detection limit). In December of 1993, 11 individual striped bass were sampled from station XCC6634 with an average inorganic arsenic level of 0.001ppm (< detection limit). Station XCC6634 was sampled again in December of 1994. Sixteen individual striped bass were sampled resulting in an average inorganic arsenic level of 0.001ppm (< detection limit).

Core Monitoring

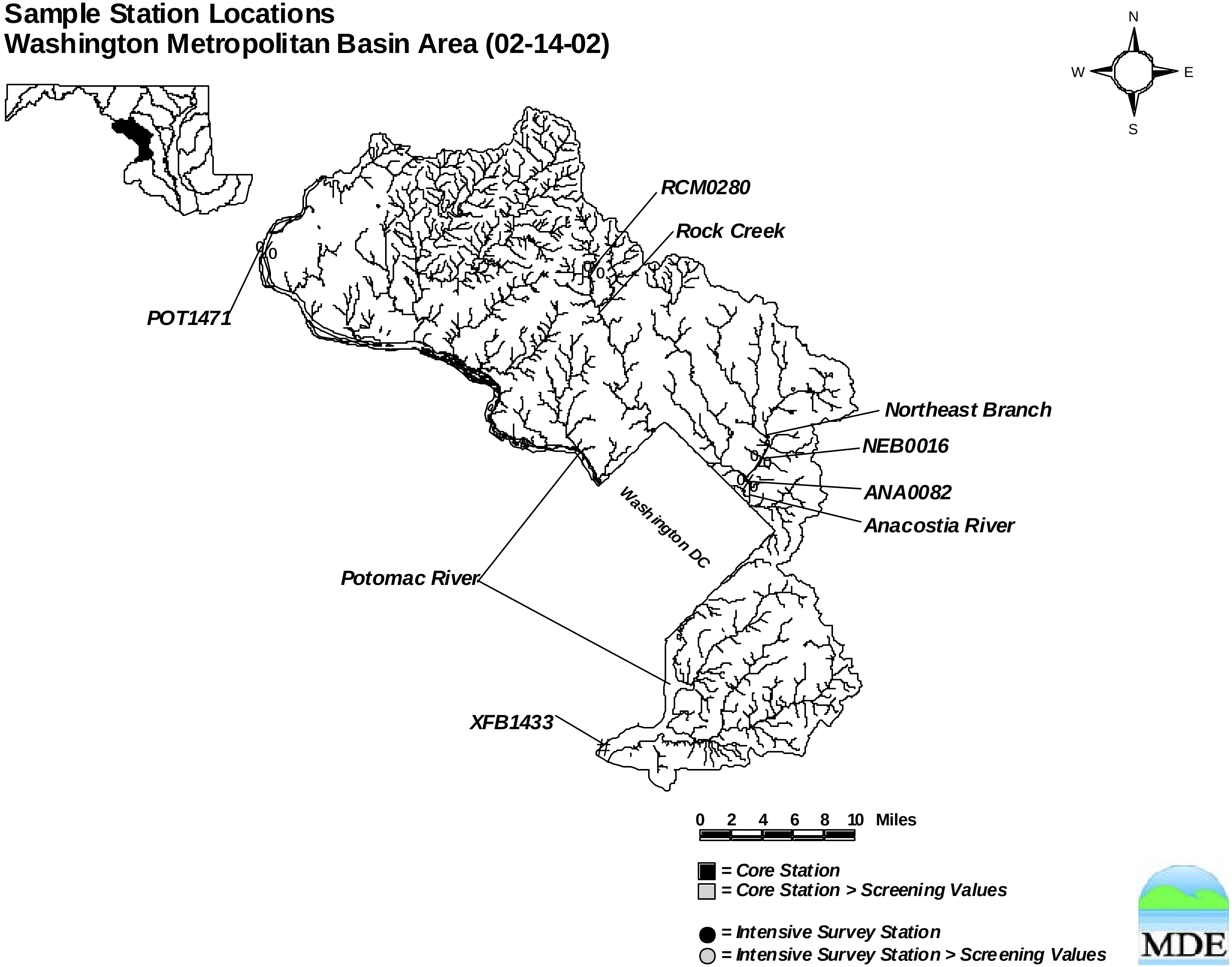
In October of 1990, composite samples of white perch and channel catfish were collected from station XDC1706 and composite samples of white perch and brown bullhead were collected from station XEA6596. For those metals analyzed, results are below present-day established screening levels.

In September of 1994, composite samples of white perch and brown bullhead were collected from station XDC1706 while composite samples of white perch and white catfish were collected from station XEA6596. For those metals analyzed, results are below present-day established screening levels.

Summary

Overall, the data associated with this basin indicate that there are no human health concerns associated with metals contamination of finfish tissue. Except for a limited number of individual fish samples from the earliest intensive studies that slightly exceeded the inorganic arsenic screening value, all other samples were below screening values. In addition, subsequent sampling indicated that arsenic in finfish tissue has possibly subsided over time.

3.15 Sample Station Locations
Washington Metropolitan Basin Area (02-14-02)



3.15 WASHINGTON METROPOLITAN AREA (Basin 02-14-02)

3.15.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
XFB1433	American Eel	1988	I		7	20	20	20	8	20	20	20
	Brown Bullhead	1988	I			19	19	19		19	19	19
	Channel Catfish	1988	I		10	25	25	25	12	25	25	25
	White Perch	1988	I			4	4	4		4	4	4

* C – Composite Sample, I – Individual Sample   = Exceeds Screening Value

3.15.2 CORE MONITORING PROGRAM

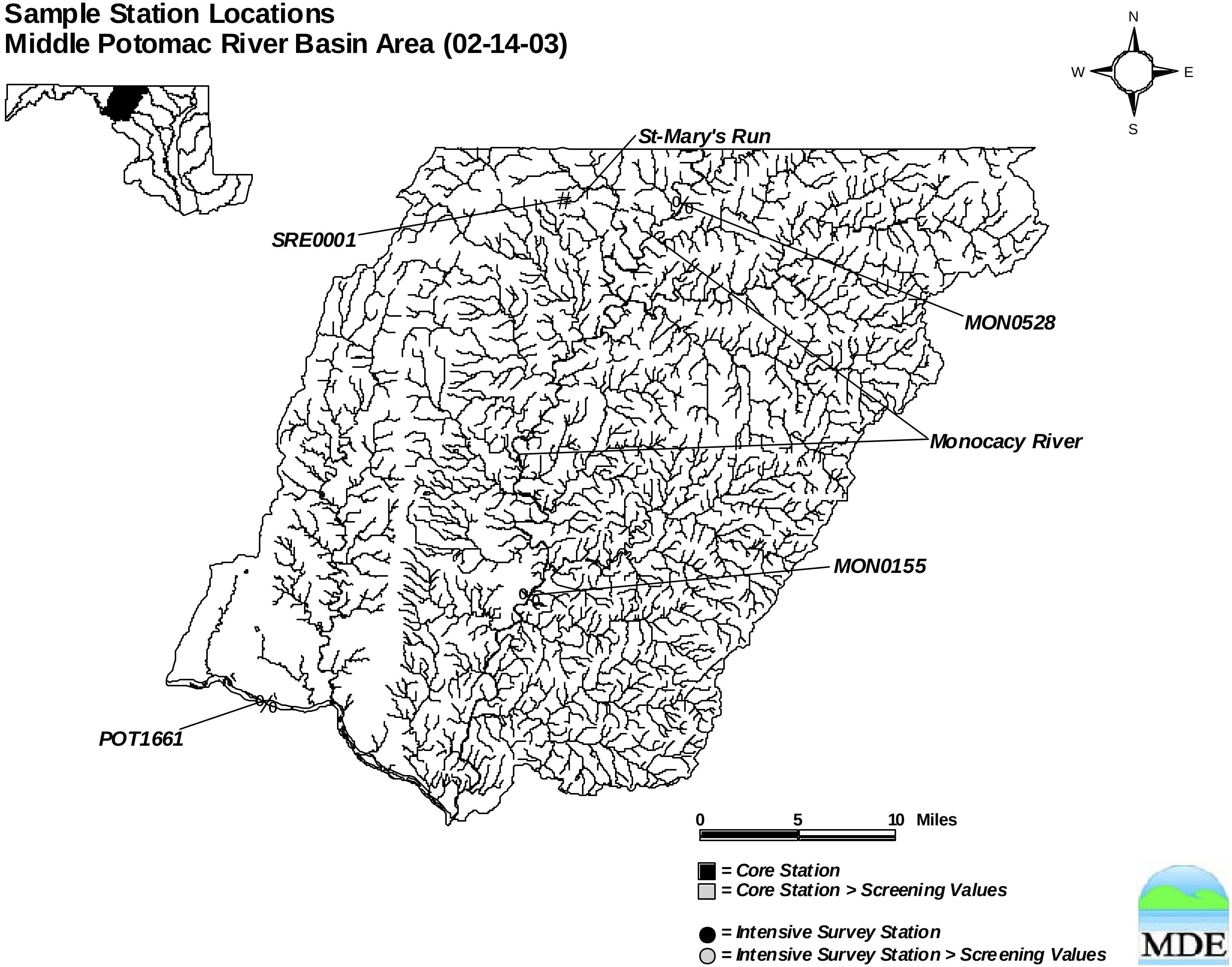
Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
ANA0082	Carp	1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	Striped Bass	1995	C	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
NEB0016	American Eel	1992	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	Largemouth Bass	1992	I			1	1	1	1	1	1	1
	White Sucker	1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
POT1471	Channel Catfish	1989	C		2(5)	2(5)	2(5)	2(5)	2(5)	2(5)	2(5)	2(5)
		1993	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1996	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	Largemouth Bass	1989	C		2(5)	2(5)	2(5)	2(5)	2(5)	2(5)	2(5)	2(5)
		1996	I	2	2	2	2	2	2	2	2	2
	Smallmouth Bass	1993	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
RCM0111	Redbreast Sunfish	1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Sucker	1995	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)

* C – Composite Sample, I – Individual Sample   = Exceeds Screening Value

3.15.3 DISCUSSION

All data reported are below human health risk-based screening values.

3.16 Sample Station Locations
Middle Potomac River Basin Area (02-14-03)



3.16 MIDDLE POTOMAC RIVER AREA (Basin 02-14-03)

3.16.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
SRE0001	Channel Catfish	1985	I			3	3	3	3		3	3

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.16.2 CORE MONITORING PROGRAM

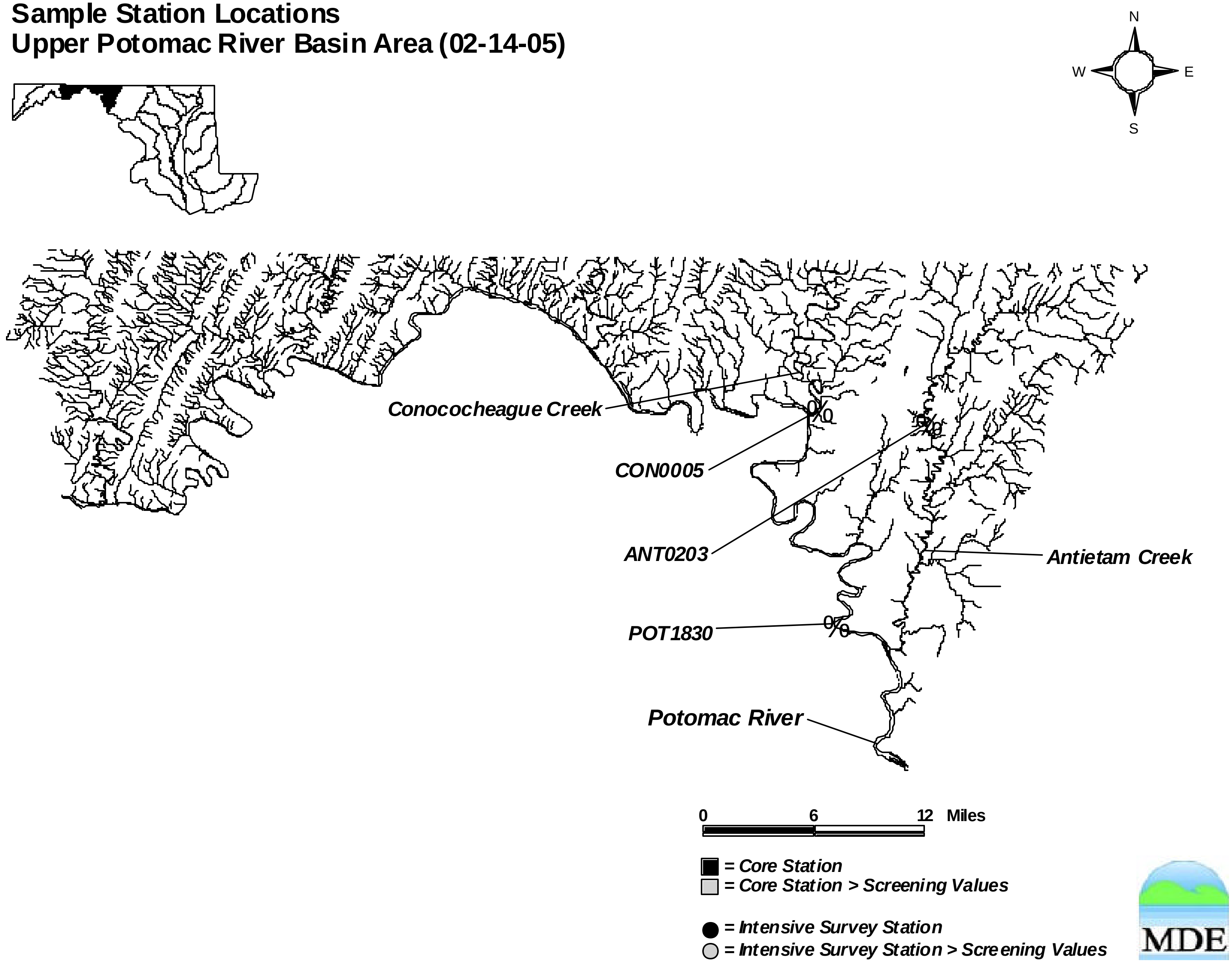
Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
MON0155	Carp	1996	C	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
	Channel Catfish	1989	C		1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)
	Smallmouth Bass	1989	C		1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
		1993	C		1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)
		1993	C		1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
		1996	I	1	1	1	1	1	1	1	1	1
	White Sucker	1993	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	Yellow Bullhead Catfish	1989	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
MON0528	Largemouth Bass	1996	I	2	2	2	2	2	2	2	2	2
	Smallmouth Bass	1987	I		2	2	2	2	2		2	2
		1989	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Sucker	1996	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
POT1661	Channel Catfish	1989	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	Golden Redhorse	1989	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	Largemouth Bass	1989	I			1	1	1		1	1	1
	Smallmouth Bass	1989	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.16.3 DISCUSSION

All data reported are below human health risk-based screening values.

3.17 Sample Station Locations
Upper Potomac River Basin Area (02-14-05)



3.17 UPPER POTOMAC RIVER AREA (Basin 02-14-05)

3.17.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
NONE												

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.17.2 CORE MONITORING PROGRAM

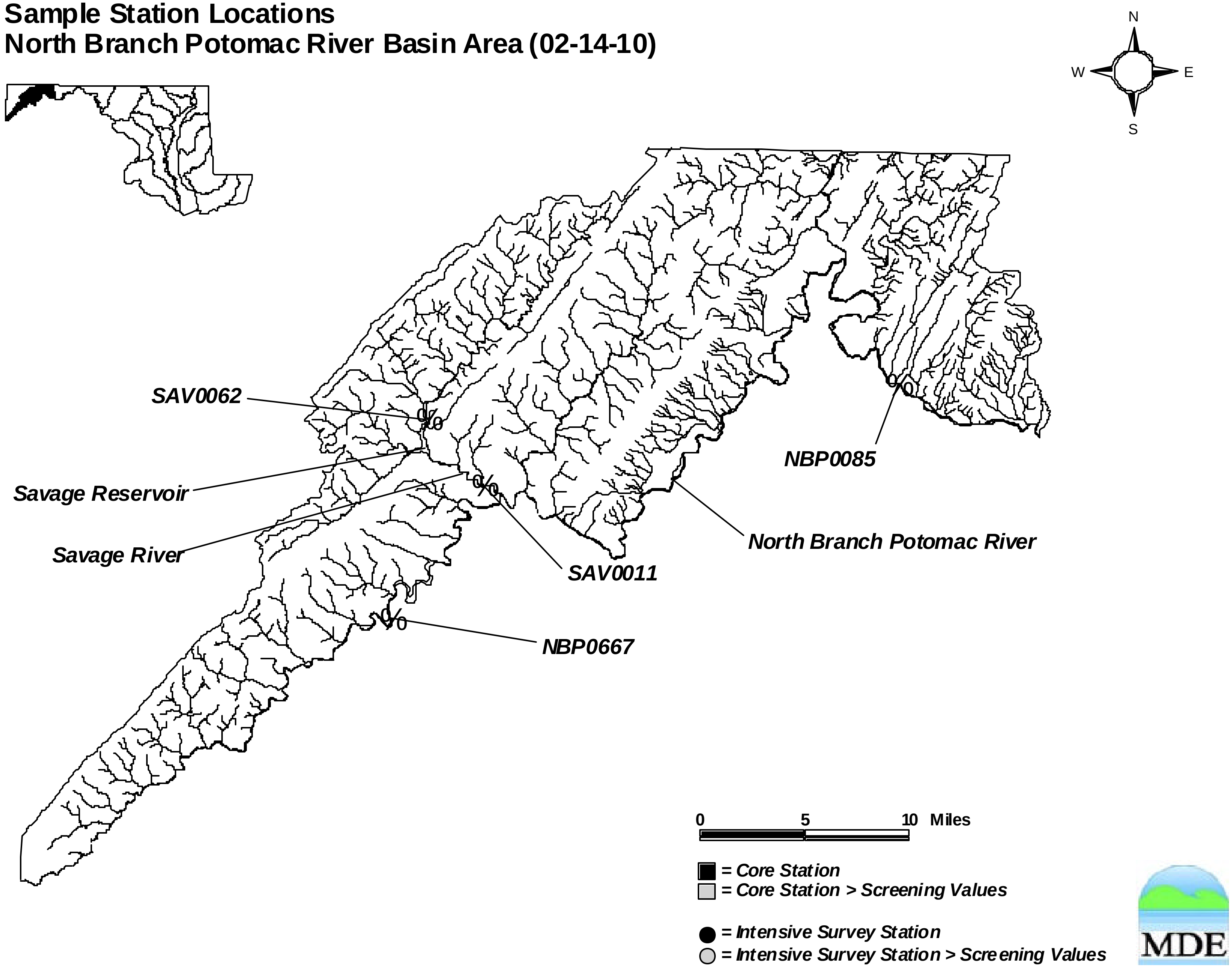
Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
ANT0203	Rainbow Trout	1993	I			1	1	1	1	1	1	1
	Rock Bass	1993	C			1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1996	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	White Sucker	1993	C			1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1996	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
CON0005	Channel Catfish	1989	C		1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)
		1989	C		1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
	Largemouth Bass	1989	C		1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
	Shorthead Redhorse	1993	C			1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	Smallmouth Bass	1993	I			1	1	1	1	1	1	1
		1993	C			1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)
POT1830	Channel Catfish	1989	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1993	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	Golden Redhorse	1996	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	Smallmouth Bass	1989	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1993	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1996	C			1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.17.3 DISCUSSION

All data reported are below human health risk-based screening values.

3.18 Sample Station Locations
North Branch Potomac River Basin Area (02-14-10)



3.18 NORTH BRANCH POTOMAC RIVER AREA (Basin 02-14-10)

3.18.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
NONE												

* C – Composite Sample, I – Individual Sample   = Exceeds Screening Value

3.18.2 CORE MONITORING PROGRAM

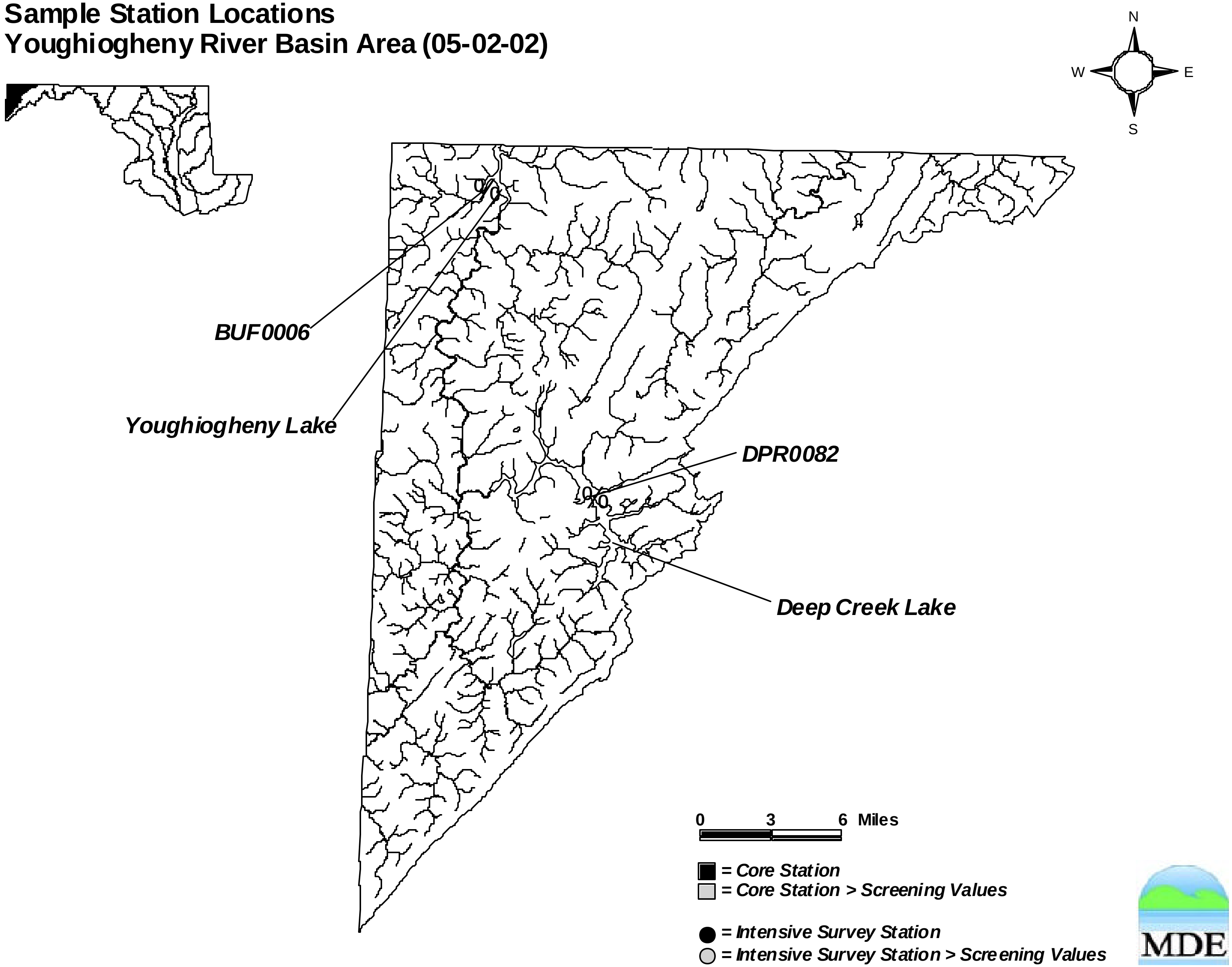
Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
NBP0085	Carp	1989	C		1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
	Smallmouth Bass	1989	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1993	I			2	2	2	1	2	2	2
	Yellow Bullhead	1993	C		1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
NBP0667	Largemouth Bass	1996	I	1	1	1	1	1		1	1	1
	Smallmouth Bass	1996	I	1	1	1	1	1	1	1	1	1
	Walleye	1989	C		1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)
	White Sucker	1996	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
SAV0011	Brook Trout	1993	C			1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)
	Brown Trout	1993	C			1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
SAV0062	Largemouth Bass	1989	C		1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
	Rock Bass	1996	C	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
	Smallmouth Bass	1993	C			1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)
	Walleye	1996	I	1	1	1	1	1	1	1	1	1
	White Sucker	1993	C			1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1996	C	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)	1(2)

* C – Composite Sample, I – Individual Sample   = Exceeds Screening Value

3.18.3 DISCUSSION

All data reported are below human health risk-based screening values.

3.19 Sample Station Locations
Youghiogheny River Basin Area (05-02-02)



3.19 YOUGHIOGHENY AREA (Basin 05-02-02)

3.19.1 INTENSIVE STUDIES

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
NONE												

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.19.2 CORE MONITORING PROGRAM

Sample Station	Species (Common Name)	Year	C/I*	Number of Samples per Analyte (# of Fish per Sample)								
				Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
BUF0006	Largemouth Bass	1989	I		1	1	1	1	1	1	1	1
		1989	C		1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
	Smallmouth Bass	1989	C		1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
	Walleye	1993	C			1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1996	C	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)	1(3)
		1996	I	1	1	1	1	1	1	1	1	1
DPR0082	Brown Bullhead	1989	C		1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)	1(4)
	Smallmouth Bass	1989	C		1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1993	C			1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
		1996	C	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)
	Walleye	1993	C			1(5)	1(5)	1(5)	1(5)	1(5)	1(5)	1(5)

* C – Composite Sample, I – Individual Sample = Exceeds Screening Value

3.19.3 DISCUSSION

All data reported are below human health risk-based screening values.

4.0 CONCLUSION

In conclusion, this comprehensive report serves as the risk-based human health screening study of metals in finfish tissue collected from 1985 to 1997 throughout the Maryland portion of the Chesapeake Bay and associated tributaries. With the exception of inorganic arsenic levels in a few individual bluefish, striped bass, and white perch collected during various intensive studies conducted in 1985 and 1986, Maryland finfish tissue concentrations of As, Ag, Cd, Cr, Cu, Hg, Ni, and Zn did not exceed established conservative human health risk-based screening values.

In 1985 and 1986, intensive studies were commissioned to evaluate metals and PCBs in bluefish and striped bass in Maryland State waters and compare various “clean” to “contaminated” sites. These studies resulted in the generation of two reports (MDEa & MDEb, 1988) indicating that tissue metal levels were not elevated in relation to other marine seafood. These two reports utilized arsenic values (total arsenic: < 5 ppm – 10 ppm; adjusted for inorganic arsenic: ≈ < 0.2 ppm – 0.4 ppm) recognized by the World Health Organization (WHO) as characteristic of marine finfish tissue for comparative values. Subsequently, EPA utilized advances in analytical technology and toxicological study results to derive conservative human health risk-based screening values for the toxic inorganic arsenic species and other contaminants of concern. The previously published striped bass and bluefish data were included in this overall data analysis in order to compare those results to updated present-day human health risk-based screening values.

Additional intensive studies were conducted to evaluate the histology of white perch and other finfish species collected from the Patapsco, Chester, and Pocomoke River areas in 1986. At the time, these results were not compared to human health screening levels but evaluated against relevant histological indices. Subsequent evaluation of these results indicate that inorganic arsenic tissue levels in some of the white perch from these intensive studies were elevated compared to present-day human health screening values.

Due to the migratory behavior of bluefish and striped bass, they are not usually considered a standard target species in Core Monitoring Program. Since bluefish were only sampled during the one intensive study, subsequent inorganic arsenic tissue data for this migratory species are not available. However, the data that are available does not indicate an immediate human health concern regarding inorganic arsenic in bluefish. Although some of the individual bluefish sampled were above the inorganic arsenic screening value, the overall estimated and conservative average of inorganic arsenic in sampled bluefish is 0.016 ppm, well below the screening level of 0.037 ppm.

Subsequent data for all species, including striped bass and white perch, show a reduction in the tissue levels of inorganic arsenic throughout the bay beginning in 1993. Although this seems to indicate a reduction in bay-wide arsenic levels, it is interesting that in the same time frame the analytical laboratory indicated that it was having analytical trouble with the recovery of arsenic and that sample preparation methodologies were modified to adjust for this problem in 1994.

In order to verify these findings, future sampling should specifically include inorganic arsenic in finfish tissue throughout the bay for a wide variety of species. However, speciation of arsenic is a difficult analytical task. In addition, intensive studies focusing on bluefish and striped bass will be included in sampling efforts where geographically and temporally appropriate. Increasing bluefish and striped bass sampling efforts would assist risk assessors in monitoring general contaminant levels associated with these highly mobile bay-wide species and also serve as an additional metric in assessing bay-wide environmental health.

Overall, the finfish tissue data in this report are below established human health risk-based screening values for metals, and support Maryland Department of the Environment's position that finfish are safe to eat in Maryland State waters, except where consumption advisories are in place. At this time, there are no consumption advisories due to metals contamination in the Maryland portion of the Chesapeake Bay.

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