Findings of the 2006 to 2008 Regional Ambient Fish Tissue Program in Nebraska

Nebraska Department of Environmental Quality

Water Quality Assessment Section

May, 2010

ACKNOWLEDGEMENTS

I would like to thank the staff members of the Nebraska Game and Parks Commission (NGPC) and the Nebraska Department of Environmental Quality (NDEQ) who assisted with field collection activities from 2006 to 2008.

I also want to thank Deanna Collier of the United States Environmental Protection Agency (EPA) Region VII laboratory for her support of Nebraska's fish tissue monitoring and assessment efforts. The EPA provides most of the funding for the field collection activities and provides laboratory analysis of the fish tissue samples at no charge to the State of Nebraska.

I would also like to recognize Sue Dempsey of the Nebraska Department of Health and Human Services (NDHHS) for her review and assistance in completing this report.

Greg Michl
Program Coordinator

FOREWORD

The "Findings of the 2006 to 2008 Regional Ambient Fish Tissue Program in Nebraska" is written to satisfy the federal fiscal years 2006 to 2008 State of Nebraska-EPA Agreement, as well as provide information to other governmental agencies, professional organizations, and most importantly to the general public.

Fish tissue sampling in Nebraska was initiated in the late 1970s, primarily to identify potential pollution concerns throughout the State. Sampling consisted of collecting whole fish samples from major rivers at or near the bottom of their drainage area. In the late 1980s, along with the identification of pollutants, sampling was conducted to determine if there may be a public health concern. Fillet samples were then collected and analyzed as this is the portion of a fish that is most-often consumed. Waters heavily utilized by anglers were generally targeted.

To inform the public about health risk concerns identified, Nebraska began issuing fish consumption advisories in 1990. Currently, Nebraska has 71 state-issued advisories. The primary contaminants of concern in fish tissue in Nebraska and most other states are mercury and polychlorinated biphenyl compounds (PCBs). The EPA has issued a nationwide fish consumption advisory regarding mercury in all fish species. Women of child-bearing age and children under 15 years of age are the population most sensitive to the effects of mercury.

This report is provided in order to provide the public with an understanding of the State's fish tissue program. One of the primary goals of the program is to ensure that members of the public have as much information as possible regarding the waterbodies that they use for fishing. And because fish are a high quality protein, low in saturated fat, and high in omega-3 fatty acid food source, anglers should not be discouraged from consuming fish in moderation.

If you have questions or concerns after reading this report, please contact me at (402) 471-4264 or greg.michl@nebraska.gov for assistance.

Greg Michl
Program Coordinator

TABLE OF CONTENTS

Page

ACKNOWLEDGEMENTS i

FOREWORD ii

LIST OF FIGURES iv

LIST OF TABLES iv

I. EXECUTIVE SUMMARY 1

II. INTRODUCTION 3

III. METHODS 5
- Sampling 5

IV. RISK ASSESSMENT 11
- Hazard Identification 11
- Dose-Response Assessment 11
- Exposure Assessment 14
- Risk Characterization 14

V. CRITERIA FOR ISSUING A PUBLIC HEALTH ADVISORY 16
- Authority 16
- Health Risk Assessment Method 16
- Sampling Requirements 16
- Advisory Criteria 17

VI. RESULTS AND DISCUSSION 19
- 2006 to 2008 Sampling Effort and Purpose 19
- Contaminants of Concern 19
  - Methylmercury 19
  - Polychlorinated Biphenyls 20
- Data Assessment – Trend Sites 21
- Risk Assessment Results 21

VII. SUMMARY 27

LITERATURE CITED 30

Appendix A: Table and Map of Nebraska Fish Consumption Advisories Through 2008 32

Appendix B: Trend Sites – Map and Contaminant Trend Information 36

LIST OF FIGURES

Page

Figure 1. Nebraska Regional Ambient Fish Tissue Monitoring Locations for 2006 to 2008 2

Figure 2. Monitoring Scheme for the Nebraska Fish Tissue Monitoring Program 18

Figure 3. Mercury Concentrations in Fillets of Fish Species Collected from Nebraska Waters 20

Figure 4. PCB Concentrations in Fillets of Fish Species Collected from Nebraska Waters 21

LIST OF TABLES

Page

Table 1. 2006 to 2008 Advisory, Follow-Up, Trend and Screening Sites in Nebraska 6

Table 2. Length Requirements for Fish Collected During RAFTMP Sampling. 9

Table 3. Parameter Analysis and Reporting Limits of Fish Tissue Samples Analyzed by the EPA Region VII Laboratory From 2006 to 2008. 10

Table 4. Fish Tissue Contaminants and Associated Risk Assessment Parameters 13

Table 5. Fish Tissue Risk Assessment Results for Nebraska Streams and Lakes Monitored in 2006 to 2008 22

Table 6. Nebraska Streams and Lakes Monitored in 2006 to 2008 and Their Advisory Status 28

I. EXECUTIVE SUMMARY

The Nebraska Department of Environmental Quality (NDEQ), in cooperation with the Nebraska Game and Parks Commission (NGPC) annually collects fish for tissue analyses. In turn, the U.S. Environmental Protection Agency (EPA) Region VII laboratory in Kansas City, Kansas conducts the chemical analyses of these tissue samples. Currently, Nebraska is allowed to submit samples from approximately 50 waterbodies annually. Samples are analyzed for four heavy metals, eight pesticides and their breakdown products, three polychlorinated biphenyl compounds (referred to as aroclors), and the wood preservative compound pentachloroanisole. These contaminants have been identified as being regionally important pollutants most likely to be found in fish tissue.

Nebraska's "Regional Ambient Fish Tissue Monitoring" (RAFTM) program which is under the guidance of Region VII EPA, underwent changes in 2006 in regard to its primary monitoring and assessment objectives. The "redesigned" RAFTM program's primary monitoring and assessment objectives are:

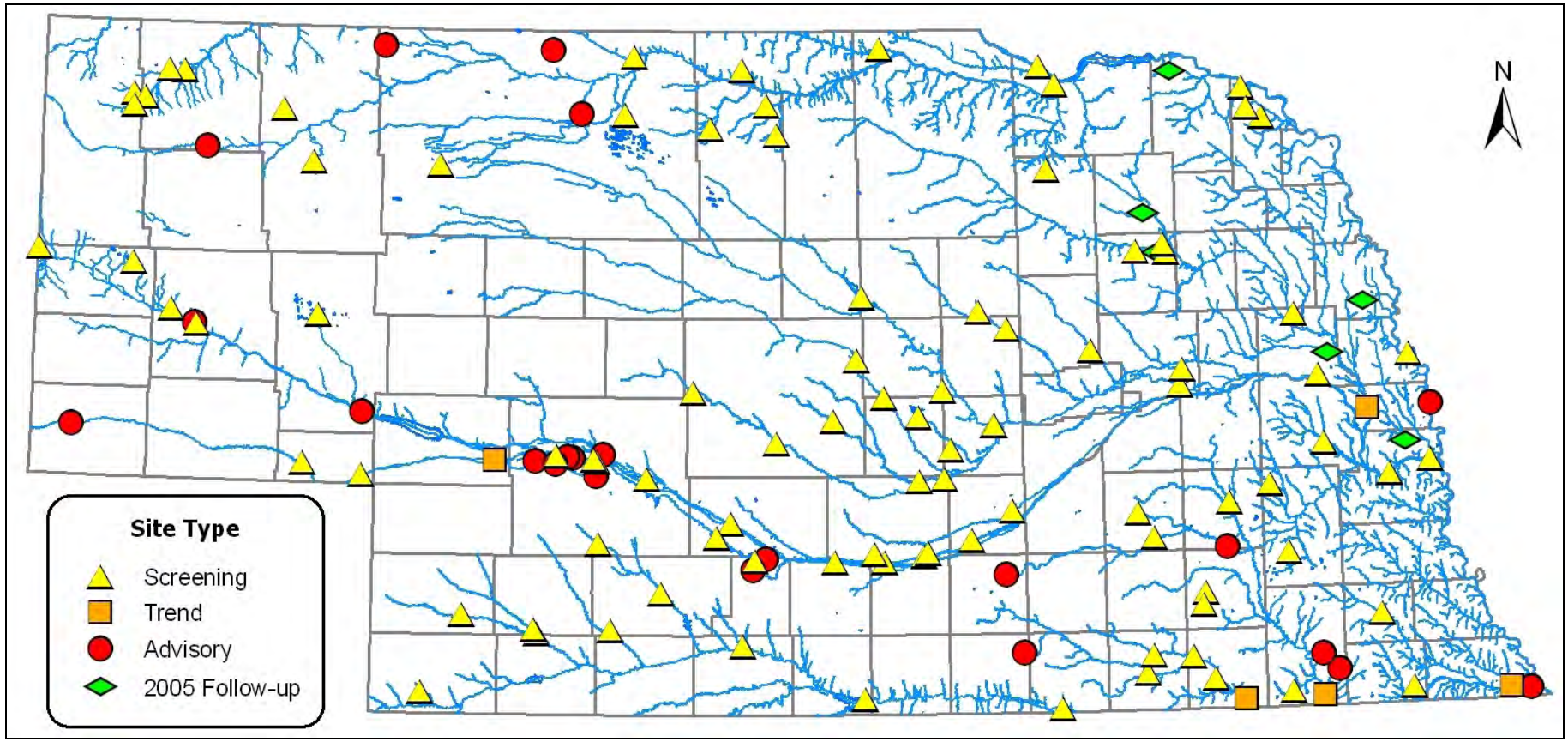
- Provide states with the data to answer the question "are the fish safe to eat?"
- Provide states with the data needed to assess risk to humans from consuming contaminated fish and to post consumption advisories.
- Measure long-term trends in regional contaminants (e.g., pesticides, metals, PCBs, etc.) and monitor for emerging contaminants of concern.

In Nebraska, the redesigned RAFTM program has allowed for sampling of additional *screening* waterbodies across a wider variety of resource classes (e.g., small to large streams, rivers, lakes and reservoirs, including those in urban areas). Notable changes to Nebraska's monitoring program that will continue to allow for expanded monitoring efforts include: 1) switching long-term *trend* site monitoring to every other year instead of annually, and 2) where contaminant concentrations are found to be high, advisories are issued immediately and will remain in place until *follow-up* monitoring is conducted on a scheduled 6-year rotation cycle.

From 2006 to 2008, a total of 179 fish samples from 126 locations were collected (see Figure 1 and Methods Section for descriptions). Thirty-three different streams and 79 lakes/reservoirs were sampled which included the bi-annual (i.e., 2006 and 2008) sampling of five waterbodies used for monitoring long-term trends in Regional contaminants. These waterbodies are represented by stream locations that have been monitored annually over the past 16-24 years in an effort to identify changes, if present, in fish contaminant levels. The waterbodies in Nebraska sampled to assess these trends include (see Appendix B):

- Big Blue River at Barneston
- Big Nemaha River at Preston
- Elkhorn River at Waterloo
- Little Blue River at Steele City
- South Platte River at Paxton

Figure 1. Nebraska RAFTMP Sampling Locations for 2006 to 2008.



II. INTRODUCTION

It is important that anglers and others are informed of potential health risks associated with consuming contaminated fish from certain Nebraska waterbodies. Under the Region VII EPA Ambient Fish Tissue Monitoring Program (RAFTMP), the NDEQ, in association with its 6-year rotating river basin monitoring approach, collects fish from state waters annually. The Region VII EPA laboratory in Kansas City, Kansas, analyzes the NDEQ's fish samples to determine contaminant concentrations.

The objectives of the recently redesigned RAFTMP are to:

1. Provide states with the data to answer the question "are the fish safe to eat?"
2. Provide states with the data needed to assess risk to humans from consuming contaminated fish and to issue consumption advisories.
3. Measure long-term trends in Regional contaminants (e.g., pesticides, metals, PCBs, etc.) and monitor for emerging contaminants of concern.

Waterbodies where RAFTMP sampling has revealed exceedances of health risk criteria and subsequent consumption advisories have been issued are also re-sampled following the 6-year rotating basin monitoring approach. Re-sampled sites will be removed from the advisory list if their respective samples indicate contaminant levels below health risk criteria.

Currently the Nebraska Department of Health and Human Services (NDHHS), in cooperation with the NDEQ, the NGPC, and the Nebraska Department of Agriculture (NDA), issues fish consumption advisories for waterbodies where high concentrations of contaminants may indicate a health risk for consumers. Using risk-based calculations, it is assumed that a consumer will ingest a weekly average of eight or more ounces of fish from the waterbody being assessed, every week over the course of their lifetime (assumed to be 70-years). This very conservative approach is designed to not underestimate the risk. The State issues advisories for high levels of mercury (≥0.215 milligrams of mercury per kilogram of fish tissue), and for other contaminants when excess cancer risk estimates are found to be high or when adverse noncancer health effects may be possible from ingesting fish. Although Nebraska does not issue fishing bans, advisories suggest that individuals consume less than an average of one, eight ounce meal of fish per week from identified waters.

While nearly every state in the U.S. has a monitoring program for fish tissue in place, differences exist in the way fish samples are analyzed and assessed between states. These differences create a lack of comparability between states and can cause confusion for people who enjoy fishing in their home state, shared waters, as well as in other states' waters.

For example, while one state may screen their fish samples for a particular set of contaminants, other states may analyze an entirely different group; and some states will analyze fish tissue only during years when adequate funding is available (EPA, 1999). Differences in parameter lists are generated as some contaminants have regional importance (pesticide usage based on cropping practices), while others (methylmercury) are of national interest. Contaminant lists are also formed based on the variety of industries and their use of chemicals within states. While differences are expected in the contaminant lists submitted for analyses from state to state, there is a strong possibility that several toxicants are overlooked by states due to their obscurity or due to a lack of funding for analytical support. Additionally, some contaminants (e.g. lead) lack reference dose information necessary to determine its toxic effects associated with consuming fish flesh, and assessments are rarely performed.

As indicated, differences in assessment methodologies between states can be profound. As an example, Nebraska has issued a fish consumption advisory for channel catfish taken from a reach of the Missouri River between the Big Sioux River (South Dakota) to the Rulo, Nebraska area; yet Iowa does not have a fish consumption advisory for the same reach. This difference is based on Nebraska's use of the EPA's Risk Assessment Methodology and Iowa's use of Food and Drug Administration (FDA) action levels. Similarly, if ten samples of fish caught in Nebraska were analyzed and the results were sent to ten

different states, the likelihood is that the associated risks would be different - some states would consider the fish safe for unlimited consumption, others may recommend portioned meal sizes, and still others may recommend eliminating consumption altogether.

Like Nebraska, most states are utilizing a risk-based assessment (RBA) similar to that used by the EPA. In the assessment, in addition to determining if a contaminant poses a potential cancer risk, the potential for adverse health effects or noncarcinogenic effects are also assessed. For example, mercury is not considered to be a human carcinogen but exposure to high levels may be associated with adverse effects for the developing nervous system of young children or an unborn baby. The *Policy for Issuing Nebraska Fish Consumption Advisories* explains the rationale behind and the process employed to issue fish consumption advisories (NDEQ, 2007).

Risk assessments utilize standardized equations and estimated exposure parameters, such as ingestion rates and exposure durations, to quantify an individual's risk associated with exposure to a contaminant. The equation results in a value that can compared to published toxicity values generated from exposure studies in animals, and if available epidemiological studies in humans. Below is the exposure parameters that Nebraska utilizes to estimate potential risk associated with ingestion of fish tissue.

Body Weight (BW) − is important because heavier individuals have the ability to assimilate more contaminants than individuals of smaller stature without experiencing adverse health effects. Therefore, children or adults of small stature are at greater risk when consuming fish at a similar rate as a larger individual. All states assume an overall average for consumer body weight when calculating risk - Nebraska utilizes 154 pounds (70 kg).

Ingestion Rate (IR) − fish ingestion rates of individuals in a population vary greatly and health risks increase with higher ingestion rates. The EPA has identified a value of eight ounces (0.227 kg) of uncooked fish fillet per 154 pound (70 kg) as an average weekly meal size for adults for the general populations (EPA, 2000). Nebraska utilizes the eight ounce average (0.227 kg).

Contaminant Absorption Factor (AF) − suggests how much of a contaminant, once ingested, is absorbed in the human body. Nebraska conservatively uses a factor of 1.0, reflecting complete absorption (i.e., no contaminant loss through storage, cooking, or excretion). *Contaminant reduction factors* are used by several states (including most Great Lakes States) to reduce PCB concentrations based on meal preparation procedures. All of the states that use reduction factors apply a 50% reduction for PCBs due to removal via filleting away fatty tissue and cooking in a way which allows fat to drip away from the flesh (i.e., grilling, broiling). Some states also apply reduction factors for dioxins and DDT.

Exposure Frequency (EF) − an exposure frequency is an estimate of how often an individual is exposed to or is ingesting fish from a particular waterbody. Nebraska conservatively assumes that an individual may ingest fish from the same waterbody weekly over the course of their lifetime.

Exposure Duration (ED) − an exposure duration is an estimate of how long an individual is exposed to or is ingesting fish from a particular waterbody. Nebraska conservatively assumes that an individual may ingest fish from the same waterbody over the course of their lifetime, assumed to be 70-years. Advisories are issued under this assumption, but shorter exposure durations are more likely.

III. METHODS

Sampling

Sampling sites for the RAFTM program are currently categorized into four different types. They are:

1) *Screening* – waterbodies selected for screening of contaminants of concern in fish tissue at locations that have never been monitored or have not been sampled for a relatively long period of time.
2) *2005 Follow-up* – this designation only applies to waterbodies monitored in 2005 where fish samples revealed unacceptable risk levels and then were re-sampled in 2006.
3) *Advisory* – waterbodies that were already under advisory which were re-sampled.
4) *Trend* – five established locations where whole fish samples are collected every other year to assess long-term trends in selected contaminants.

From July 2006 through October of 2008, the NDEQ and the NGPC collected 179 fish samples from 126 locations (47 stream and 79 lakes). Ninety-three *screening* sites were monitored in accordance with the RAFTMP, 24 *advisory* sites, seven were 2005 *follow-up* sites, and five were *trend* sites (two of which are under advisory). Table 1 identifies each site sampled from 2006 to 2008 under the RAFTMP.

In streams safe for wading, a backpack or pull-barge type electro-fishing unit was used to collect fish. To collect fish from larger streams, a small aluminum boat designed for electro-fishing and equipped with a motor was used. These electro-fishing techniques were employed within a reach one mile above to one mile below the designated site location. Lake and reservoir sampling was performed by both NDEQ and NGPC personnel using larger electro-fishing boats or gill nets. Depending on conditions, direct or alternating current was used to shock the fish.

Carp (*Cyprinus carpio*) were collected at four trend locations and channel catfish (*Ictalurus punctatus*) was taken from the remaining trend site. Screening sites included the collection of both a predator and a bottom-feeding species, when available. Predators generally collected included largemouth bass (*Micropterus salmoides*) and walleye (*Stizostedion vitreum)*, while bottom-feeding species generally collected included carp and channel catfish. All follow-up sampling at sites under consumption advisories and the 2005 *follow-up* sites targeted the species that previously exhibited contaminant concentrations above accepted risk criteria. To ensure data comparability, fish species collected during initial site visits are always targeted during follow-up investigations.

Each of the five trend sites provided composite samples ranging from two to five fish of the same species. Whole fish samples (which include fatty tissue, organs and flesh) were collected from the trend sites; fillets (edible portions) were collected from the screening, follow-up and advisory sites. The size requirements of fish collected for analyses are provided in Table 2. In all samples, the total length of the smallest specimen was not to be less than 75 percent of the total length of the longest specimen. This criterion was met for every composite sample collected.

Table 1. 2006 to 2008 Advisory, Follow-Up, Trend and Screening Sites in Nebraska.

WATERBODY	LOCATION	SITE TYPE	SAMPLES COLLECTED
Birdwood Lake	W. of North Platte	Advisory	1
Box Butte Reservoir	N. of Hemmingford	Advisory	2
Carter Lake	Omaha	Advisory	1
Cottonwood Lake	Near Merriman	Advisory	1
East Hershey Lake	E. of Hershey	Advisory	1
Elwood Reservoir	Elwood	Advisory	3
Lake Hastings	Hastings	Advisory	1
Liberty Cove	SW of Lawrence	Advisory	1
Maloney Reservoir Outlet Canal	S. of North Platte	Advisory	1
Merritt Reservoir	SW of Valentine	Advisory	1
Missouri River	Near Rulo	Advisory	3
North Platte River	Near North Platte	Advisory	1
North Platte River	Lewellen	Advisory	1
North Platte River	Bridgeport	Advisory	1
Oliver Reservoir	W. of Kimball	Advisory	2
Phillips Lake	S. of Lexington	Advisory	1
Rockford Lake	E. of Beatrice	Advisory	1
Shell Lake	N. of Gordon	Advisory	1
Sutherland Outlet Canal	Sutherland	Advisory	1
Sutherland Reservoir	S. of Sutherland	Advisory	1
West Fork Big Blue River	N. of Dorchester	Advisory	1
Wolf-Wildcat Lake	N. of Liberty	Advisory	1
Chalkrock Reservoir	NE of Crofton	2005 Follow-up	3
Dead Timber Lake	E. of Snyder	2005 Follow-up	1
Elkhorn River	W. of Norfolk	2005 Follow-up	1
Maple Creek	Near Nickerson	2005 Follow-up	1
Summit Lake	W. of Tekamah	2005 Follow-up	3
Walnut Creek Lake	Papillion	2005 Follow-up	3
Willow Creek Lake	Near Pierce	2005 Follow-up	3
Alexandria Lakes	E. of Alexandria	Screening	1
Ansley City Lake	Ansley	Screening	1
Arnold Lake	Arnold	Screening	1
Bassway Strip Lake No. 5	N. of Minden	Screening	1
Battle Creek	Battle Creek	Screening	1
Beaver Creek	NW of Albion	Screening	1
Big Alkali Lake	S. of Valentine	Screening	1
Big Blue River	Seward	Screening	1
Big Indian Creek	NE of Odell	Screening	1
Big Sandy Creek	S. of Belvidere	Screening	1
Branched Oak Lake	NW of Lincoln	Screening	2

Note: Advisory Site (single composite fillets); Trend Site (whole fish composite); Screening Site (bottom feeder and/or predator – single composite fillets); 2005 Follow-up Site (single composite fillets).

Table 1. Continued

WATERBODY	LOCATION	SITE TYPE	SAMPLES COLLECTED
Bridgeport Middle Lake	Bridgeport	Screening	1
Buckskin Hills Lake	SW of Newcastle	Screening	2
Calamus Reservoir	W. of Burwell	Screening	2
Carter P. Johnson Lake	W. of Crawford	Screening	1
Cedar River	Near Spalding	Screening	1
Chappell Interstate Lake	Chappell	Screening	2
Cheyenne Lake	S. of Wood River	Screening	1
Columbus City Park Pond	Columbus	Screening	1
Cottonmill Lake	Near Kearney	Screening	3
Cottonwood-Steverson	N. of Hyannis	Screening	1
Cozad Lake	Cozad	Screening	2
Crystal Springs NW Lake	Fairbury	Screening	1
Cub Creek Lake	W. of Springview	Screening	1
Davis Creek Lake	S. of North Loup	Screening	2
DeSoto Bend Lake	E. of Blair	Screening	1
Enders	Near Enders	Screening	2
Enders	Near Enders	Screening	2
Farwell South Reservoir	N. of Boelus	Screening	2
Fremont Lake No. 1	Fremont	Screening	1
Frenchman WMA Lake	N. of Palisade	Screening	1
Goldeneye Pond	W. of Big Springs	Screening	2
Grand Island L. E. Ray Lake	Grand Island	Screening	1
Grove Lake	N. of Royal	Screening	1
Harlan Co. Reservoir	S. of Republican City	Screening	1
Hershey Lake	S. of Hershey	Screening	2
Hugh Butler Lake	N. of McCook	Screening	1
Interstate Lake	North Platte	Screening	1
Island Lake	N. of Oshkosh	Screening	1
Johnson Lake	S. of Lexington	Screening	2
Kea Lake	Near Kearney	Screening	1
Keller Park No. 2	N. of Long Pine	Screening	1
Keya Paha River	S. of Naper	Screening	1
Killdeer Lake	SW of Lincoln	Screening	1
Lake Minatare	N. of Minatare	Screening	2
Lake North	Columbus	Screening	1
Little Blue River	Hebron	Screening	1
Long Pine Creek	Near Long Pine	Screening	1
Louisville Lake No. 1A	Louisville	Screening	1
Medicine Creek	Stockville	Screening	1
Middle Loup River	SE of Arcadia	Screening	1
Middle Loup River	W. of Comstock	Screening	1

Note: Advisory Site (single composite fillets); Trend Site (whole fish composite); Screening Site (bottom feeder and/or predator – single composite fillets); 2005 Follow-up Site (single composite fillets).

Table 1. Continued

WATERBODY	LOCATION	SITE TYPE	SAMPLES COLLECTED
Midway Canyon-Central	S. of Cozad	Screening	1
Missouri River	Maskell	Screening	1
Missouri River	N. of Verdel	Screening	2
Muddy Creek	Near Arapahoe	Screening	1
Niobrara River	Near Niobrara	Screening	1
North Fork Big Nemaha River	NW of Tecumseh	Screening	1
North Loup River	N. of St. Paul	Screening	1
North Loup SRA Lake	N. of St. Paul	Screening	1
North Platte River	S. of Henry	Screening	1
Pibel Lake	E. of Ericson	Screening	2
Platte River	Plattsmouth	Screening	1
Plum Creek	W. of Johnstown	Screening	1
Powder Creek	SE of Newcastle	Screening	2
Prairie Knoll Lake	NW of DuBois	Screening	1
Ravenna Lake	E. of Ravenna	Screening	2
Recharge Lake	Near York	Screening	1
Recharge Lake	Near York	Screening	1
Red Willow Creek	E. of Bayard	Screening	1
Republican River	W. of Superior	Screening	1
Republican River	W. of Superior	Screening	1
Rock Creek Lake	N. of Parks	Screening	1
Rock Creek Lake	N. of Parks	Screening	1
Sandy Channel Lake	S. of Elm Creek	Screening	1
Sherman Reservoir	NE of Loup City	Screening	2
Skyview Lake	Norfolk	Screening	1
Smith Lake	S. of Rushville	Screening	1
South Loup River	N. of St. Michael	Screening	1
South Loup River	N. of Oconto	Screening	1
South Platte River	North Platte	Screening	1
Stinking Water Creek	N. of Palisade	Screening	1
Swan Creek 5A	NE of Tobias	Screening	1
Swan Creek Lake 2A	E. of Milligan	Screening	1
Ta-Ha-Zouka Park Lagoon	Norfolk	Screening	1
Valentine Mill Pond	Valentine	Screening	1
Wahoo Creek	S. of Ithaca	Screening	1
Walgren Lake	SE of Hay Springs	Screening	1
Wellfleet Lake	Near Wellfleet	Screening	1
West Fork Big Blue River	McCool Junction	Screening	1
West Maxwell WMA Lake	E. of Maxwell	Screening	1
White River	Whitney	Screening	1
White River	SW of Crawford	Screening	1

Note: Advisory Site (single composite fillets); Trend Site (whole fish composite); Screening Site (bottom feeder and/or predator – single composite fillets); 2005 Follow-up Site (single composite fillets).

Table 1. Continued

WATERBODY	LOCATION	SITE TYPE	SAMPLES COLLECTED
White River	Near Fort Robinson	Screening	1
Whitney Reservoir	W. of Whitney	Screening	2
Windmill Lake No. 2	S. of Gibbon	Screening	1
Little Blue River	E. of Steele City	Trend	1
Nemaha River	N. of Preston	Trend	1
Elkhorn River	E. of Waterloo	Trend/Advisory	2
South Platte River	S. of Paxton	Trend/Advisory	2
Big Blue River	W. of Barneston	Trend/Screening	2

Note: Advisory Site (single composite fillets); Trend Site (whole fish composite); Screening Site (bottom feeder and/or predator – single composite fillets); 2005 Follow-up Site (single composite fillets).

Table 2. Length Requirements for Fish Collected During RAFTMP Sampling.

FISH SPECIES	SIZE (Total Length)	FISH SPECIES	SIZE (Total Length)
Bluegill	6 – 8 inches	Largemouth Bass	15 – 20 inches
Buffalo	15 – 24 inches	Northern Pike	24 – 30 inches
Bullhead	8 – 12 inches	Sauger / Saugeye	12 – 18 inches
Carp	14 – 21 inches	Smallmouth Bass	10 – 18 inches
Channel Catfish	14 – 21 inches	Trout (any species)	10 – 14 inches
Crappie (black/white)	8 – 12 inches	Walleye	14 – 20 inches
Flathead Catfish	18 – 24 inches	White Bass	10 –12 inches
Freshwater Drum	10 – 18 inches		

Length and weight measurements of each fish used in a composite were recorded on a field sheet. For whole fish analysis, each fish was individually wrapped in aluminum foil and the composite sample of fish was placed in a plastic bag, labeled, and cooled with ice. Fillet samples were prepared in the field with the scales removed from scaled fish and skin removed from catfish and bullheads. Samples were frozen as soon as possible after collection. All samples collected by the NDEQ and NGPC were analyzed at the Region VII EPA laboratory.

Parameter coverage and reporting limits for tissue samples analyzed are listed in Table 3. The EPA Region VII Laboratory utilizes target reporting limits (TRLs) in place of method detection limits (MDLs). TRLs are higher than MDLs and believed to be more reliable in terms of identifying accurate, measurable data. The MDLs used previously required statistical interpretation of results that resulted in recording data points lower than the sensitivity of the measuring instrument.

Because of the higher cost of methylmercury analysis, the EPA Region VII Laboratory only measures for total mercury in fish tissue. Numerous studies have shown that more than 90 percent of mercury in fish tissue is methylmercury (EPA, 2009). Because this conservative assumption is protective of human health, Nebraska is supportive of this decision.

Table 3. Parameter Analysis and Reporting Limits of Fish Tissue Samples Analyzed by the EPA Region VII Laboratory During 2006 to 2008.

Contaminant	***Reporting Limit EPA Region VII (mg/kg)***
Analysis by Inductively Coupled Plasma Emission Spectroscopy	
Cadmium	0.06
Lead	0.17
Selenium	0.5
Analysis by Cold Vapor Atomic Absorption	
Mercury	0.0181
Analysis by Gas Chromatograph/Electron Capture	
Technical Chlordane	0.03
Heptachlor	0.003
Heptachlor Epoxide	0.003
Gamma Hexachlorocyclohexane (Lindane)	0.002
Dieldrin	0.003
DDT	0.005
DDD	0.004
DDE	0.005
PCB-1248	0.04
PCB-1254	0.03
PCB-1260	0.02
Hexachlorobenzene	0.001
Trifluralin	0.003
Pentachloroanisole	0.001
1,2,4,5,-Tetrachlorobenzene *	0.004
Pentachlorobenzene *	0.001
Mirex *	0.003
Diazinon *	0.04

* Represents LOAEL or Lowest Observed Adverse Effect Level

IV. RISK ASSESSMENT

The EPA's risk assessment methodology (EPA, 1989) was utilized by Nebraska for evaluating potential health risks associated with the ingestion of fish. The EPA method includes the following four steps:

1. Hazard Identification – A qualitative evaluation of the potential for a contaminant to cause an adverse health effect (i.e., birth defect, cancer) in animals or humans.
2. Dose-Response Assessment – A quantitative estimation of the relationship between the dose of a substance and the probability of an adverse health effect.
3. Exposure Assessment – The characterization of an individual's magnitude, frequency, and duration of exposure.
4. Risk Characterization – A combination of the dose-response and exposure assessment steps that provides a quantitative estimation of the risk for the exposed individual.

Hazard Identification

Contaminants selected for assessment were determined based on known usage in the State and/or past detection in the State's waterbodies, and because exposure at high levels may be associated with adverse health effects (as indicated in IRIS - Integrated Risk Information System) (EPA, 2010). Contaminants included in the risk assessment for all *screening* sites were: DDT and its breakdown products DDD and DDE, dieldrin, chlordane and its metabolites, Lindane, heptachlor, heptachlor epoxide, PCBs (Aroclor 1248, 1254 and 1260), hexachlorobenzene, trifluralin, pentachloroanisole, and the heavy metals of selenium, cadmium, lead, and mercury. Samples collected from *trend* sites were screened for each of the above contaminants plus 1,2,4,5-Tetrachlorobenzene, mirex, pentachlorobenzene, and diazinon; trend sites were not screened for chlordane metabolites.

Dose-Response Assessment

Two toxicity values are utilized to determine at what dose or level adverse noncarcinogenic effects and/or cancer may be anticipated from exposure to a contaminant. The concentration of a contaminant found in fish tissue is used to determine an intake (equivalent to an administered dose) for a consumer and this value is compared to its corresponding toxicity value(s) to determine if any risk may be present.

The first is referred to as an oral Reference Dose (RfD). A reference dose is an estimate of a daily exposure level for an individual to a contaminant that is likely not to be associated with adverse health effects. Chronic RfDs that are used in this report are designed to be protective for long-term exposure to a contaminant (seven years to a lifetime) and are protective for even sensitive populations such as small children. It should be noted that for many noncarcinogenic effects, the body has protective mechanisms that must be overcome before the adverse effect appears. In other words, no adverse effect is anticipated until a certain level of exposure to a contaminant is reached, referred to as a threshold level.

The second toxicity value utilized is referred to a Cancer Slope Factor (CSF). A cancer slope factor is an upper-bound estimate of the probability of a response (cancer) associated with the per unit intake of a contaminant over a lifetime. For carcinogens, it is believed that there is no level of exposure that is not associated with, however small, a probability of some carcinogenic response. This concept is referred to as non-threshhold.

It should be noted that varying degrees of uncertainty surround the assessment of the adverse health effects in an exposed individual. For example, there is uncertainty in the dose-response data from experiments on animal populations that are identical, used to predict effects in a diverse human population which display a wide range of sensitivities, and extrapolation of the data from high dose animal studies to low dose human environmental exposure. Because of this, this EPA risk assessment guidance recommends a conservative approach to data interpretation, resulting in toxicity values that are more likely to over-estimate the true risk posed by exposure to a chemical.

Table 4 presents the contaminants that were assessed for in the State's waterbodies and the Reference Doses and Cancer Slope Factors that are available from the EPA.

Table 4. Fish Tissue Contaminants and Associated Risk Assessment Parameters - Reference Dose (RfD) and Cancer Slope Factors (CSF) (EPA, 2010).

CONTAMINANT	RfD	CSF
Cadmium	0.0005	NA[1]
Lead	NA[2]	NA[2]
Selenium	0.005	NA[1]
Chlordane, Technical	0.0005	0.35
cis-Chlordane		0.35
trans-Chlordane		0.35
cis-Nonachlor		0.35
trans-Nonachlor		0.35
Oxychlordane		0.35
Dieldrin	0.00005	16.0
DDT	0.0005	0.34
DDE	NA[1]	0.34
DDD	NA[1]	0.24
Heptachlor	0.0005	4.5
Heptachlor Epoxide	0.000013	9.1
Lindane	0.00033	NA[1]
Mirex	0.00023	NA[1]
Trifluralin	0.0075	0.0077
1,2,4,5-Tetrachlorobenzene	0.00034	NA[1]
Methyl Mercury	0.0001	NA[1]
PCBs (1254)	(0.00002)	2.0
Hexachlorobenzene	0.0008	1.6
Pentachloroanisole	0.03	0.12
Pentachlorobenzene	0.0008	NA[1]

NA[1] – Not assessed under the IRIS program

NA[2] – Information reviewed but value not estimated under the IRIS program

Exposure Assessment

In the exposure assessment, several estimates and assumptions are required to describe the magnitude, frequency, duration, and routes of exposure to a contaminant. The estimates and assumptions that Nebraska has selected include the following:

- Consumption of contaminated fish tissue was the only route of exposure considered. Since the assessment only focuses on risk from contaminated fish, exposure to contaminants in surface water and sediments were not assessed.
- The detected contaminant concentration in the fish tissue assessed was assumed to be the concentration consumed. This approached is very conservative as some of the contaminant is likely lost during meal preparation and cooking, and some is excreted from the body without effect. It should be noted that the laboratory can only accurately quantify the concentration of a contaminant above a certain limit referred to as a target reporting limit (TRL). The contaminant may be present in fish tissue at levels below the TRL. To account for this uncertainty when assessing for trends, one half of the TRL is assumed to be the concentration of the contaminant in the fish tissue reported by the laboratory as non-detect.
- For the purposes of advisory issuance, a 154 lbs (70 kg.) average body weight was used, consistent with EPA guidance (EPA, 2000).
- The average weekly meal size for identified for a 154 lb (70 kg) adult in the general population is eight ounces (0.227 kg) of uncooked fish fillet (EPA, 2000). For the purposes of advisory issuance, Nebraska uses this eight ounce weekly average meal ingestion rate.

Results of the dose-response and exposure assessments are combined to characterize human health risks. Estimated intakes for contaminants assessed are determined using the equation below:

$$\text{Exposure} = \frac{(CC)(IR)(EF)(ED)(AF)}{(BW)(AT)}, \quad \text{where}$$

CC	=	Contaminant Concentration in fish tissue: (mg/kg)
* IR	=	Ingestion Rate (weekly): 8 oz. (0.227 kg)
EF	=	Exposure Frequency (52 weeks/year)
*ED	=	Exposure Duration - 70 years
AF	=	Absorption Factor - 1.0 (total absorption)
*BW	=	Body Weight: 154 lbs. (70 kg)
AT	=	Average in Time (3,640 weeks/lifetime)

* Note: Advisory determinations were based on a 154 lb. (70 kg) consumer ingesting 8 oz. (0.227 kg) weekly meal portions over 70 years.

Risk Characterization

Intakes estimated in the previous step are then compared to published toxicity values for each contaminant identified. As mentioned previously, the toxicity value utilized to assess adverse noncarcinogenic effects is the oral Reference Dose (RfD). The intake is divided by this value to determine a Hazard Quotient (HQ) for the contaminant.

Hazard Quotient (HQ) = Intake (mg/kg-day)/RfD (mg/kg-day)

If more than one contaminant is present in the fish tissue then the HQs are summed to derive a Hazard Index (HI). If the HI is less than 1.0 then adverse noncarcinogencic effects are not anticipated. If the HI equals or exceeds 1.0 then an advisory is issued.

For a contaminant that may also be associated with a Cancer Risk (CR), the estimated intake is multiplied by its specific Cancer Slope Factor (see Table 4).

Cancer Risk (CR) = Intake (mg/kg-day) x CSF $(\text{mg/kg-day})^{-1}$

The resulting CR estimate represents the probability of an individual developing cancer during their lifetime as a result of exposure to the potential carcinogen. If more than one potential carcinogen is present in fish tissue then the risk estimates are summed. Advisories are issued if the estimated CR equals or exceeds 0.0001 (1 in 10,000). The current CR estimate for women in the United States for all cancer types is 1 in 3 and for men is 1 in 2 (ACS, 2009).

While mercury (methylmercury) is a contaminant accounted for in the HI, Nebraska also utilizes a fish tissue residue criterion (TRC) in place of a water column criterion for the protection of human health. This criterion was established based on the EPA's risk-based equation (EPA, 2001) calculated as:

$$TRC = \frac{BW \times RfD}{FI}, \quad \text{where}$$

TRC = "fish" tissue residue criterion in mg/kg

BW = body weight: 154 lbs. (70 kg)

RfD = reference dose of 0.0001 mg/kg body weight/day

FI = fish intake: 8 oz. (0.227 kg) weekly (equal to 0.0324 kg/day)

The resulting TRC represents the mercury (0.215 mg/kg) concentration in fish tissue that should not be exceeded on the basis of a consumption rate of eight ounces (0.227 kg) per week. Advisories are issued if the mercury concentration in fish tissue equals or exceeds the TRC of 0.215 mg/kg.
This criterion is more stringent than EPA's recommended value of 0.3 mg/kg because Nebraska utilizes a higher consumption rate, eight ounces (0.227 kg) per week as compared to their six ounces (0.170 kg) per week.

V. CRITERIA FOR ISSUING A FISH CONSUMPTION ADVISORY

Authority

At the federal level, both the FDA and EPA have jurisdictional authority and roles relating to the regulation and control of toxic or deleterious substances in fish and shellfish. The Federal Food, Drug, and Cosmetic Act (FFDCA) is the principal authority for both the FDA and EPA to take action in regulating the safety of fish as a human food source. Under the FFDCA, federal action can be taken to prevent fish that are unsafe or unfit for human consumption from moving in interstate commerce. However, federal jurisdiction does not extend to fish that are not in interstate commerce. It is left up to each state to protect the health of its citizens by controlling and regulating fish consumption from local fisheries within the state.

Under the FFDCA, the FDA regulation of contaminants has proceeded through the use of action levels that serve as guidance in evaluating contaminants in fish. However, these levels may not be appropriate for states to use in regulating the consumption of contaminated fish since action levels are based on national needs and national fish consumption rates, and consumption rates by local fishermen may not reflect national averages. The action levels also considered economic impacts to commercial industries when they were developed.

In Nebraska, the NDHHS has primary responsibility for issuing public health advisories. Since fish consumption advisories involve other agencies, the NDHHS will issue advisories in collaboration with the NDEQ, NGPC, and NDA.

Health Risk Assessment Method

The EPA risk assessment methods (EPA, 1989) were used in this report to assess potential human health risks from exposure to contaminants in fish tissue. When excess cancer risk estimates are found to be high (≥ 1 in 10,000) or when adverse noncancer health effects may be possible from ingesting fish (Hazard Index ≥ 1.0). Advisories are also issued for high levels of mercury (≥ 0.215 milligrams of mercury per kilogram of fish tissue).

Sampling Requirements

Under the redesigned RAFTMP implemented in 2006, samples are collected annually from selected rivers and lakes in accordance with Nebraska's 6-year rotating basin monitoring approach. Other notable changes to Nebraska's monitoring program that have allowed for expanded monitoring efforts included switching to bi-annual trend site monitoring and the elimination of *follow-up* sampling before a consumption advisory is issued. Historically, *screening* sites that revealed un-acceptable risk levels were automatically re-sampled as *follow-up* sites the next year. This approach severely limited the number of new sites that could be sampled each year, so in 2007, the policy for issuing and removing consumption advisories was changed. Now, advisories are issued for waterbodies where RAFTMP sampling has revealed high levels of contaminants in fish tissue without conducting *follow-up* sampling. These waterbodies then remain under advisory until they are re-sampled in six years, and if conditions have improved the advisories are removed.

Screening sites have historically been selected based on the angling pressure they receive and that they reside within one of the targeted river basins. This approach is still followed, but since 2006 the redesigned RAFTM program has allowed for sampling of additional sites across a wider variety of resource classes (e.g., small to large streams, rivers, lake and reservoirs, including those in urban areas). Fish tissue screening sites were targeted within the Middle Platte, North Platte and South Platte River basins in 2006; the Big Blue, Little Blue, and Republican River basins in 2007; and the White-Hat, Loup, and Niobrara River basins in 2008. Bi-annual trend sampling of whole fish was conducted on the five

established waterbodies (Table 1) in 2006 and 2008. At EPA's request, two composite fillet samples (one for a bottom-dwelling species and another for a predator/game species) were collected from each screening site when possible. While seven *follow-up* sites were sampled in 2006 due to 2005 samples having contaminant levels above human health risk criteria, the current policy as of 2007 is to issue an advisory if the criteria is exceeded (NDEQ, 2007).

Advisory Criteria

The public is made aware of health risks through an advisory issued by the NDHHS and published on the NDEQ and NGPC websites. Advisories are issued for specific waterbodies when fish tissue analyzed (fillets from 3-5 fish samples of a single species) are found to:

1) have mercury concentrations ≥ 0.215 mg/kg; or

2) when ingested may be associated with adverse health effects, a Hazard Index (summation of Hazard Quotients) ≥ 1.0; or

3) when ingested may be associated with an excess Cancer Risk ≥ 1 in 10,000.

Although advisories are issued for only the fish species analyzed, it should be noted that other species of fish inhabiting the same waterbody may bioaccumulate similar levels of contaminants. In rivers and streams, advisory issuances are for segments of that waterbody as defined in Title 117 – Nebraska Surface Water Quality Standards (NDEQ, 2009). Stream segments define specific portions of streams which are relatively homogeneous in regard to their physical conditions (e.g., flow, temperature, substrate, channel characteristics) (NDEQ, 1992). Advisory issuances for lakes/reservoirs always pertain to the entire waterbody. The fish species analyzed and risk criteria violated are listed in the advisory.

Once an advisory is issued for a waterbody it will remain in effect until additional sampling of that same fish species indicates that a health concern no longer exists. Advisory waters are sampled in accordance with Nebraska's rotating basin monitoring schedule (i.e., every sixth year). If a sample collected from an advisory waterbody exceeds risk criteria, the advisory will remain in effect for at least another six years, or until it is re-sampled. This process will repeat itself if the samples continue to exceed criteria. If the single fillet sample collected from an advisory waterbody is below risk criteria, then the advisory will be removed. Figure 2 provides a diagram of the processes involved in assigning and removing fish consumption advisories in Nebraska.

All waterbodies with fish consumption advisories may be prioritized, and if resources allow, special studies may be initiated to identify the contaminant source(s).

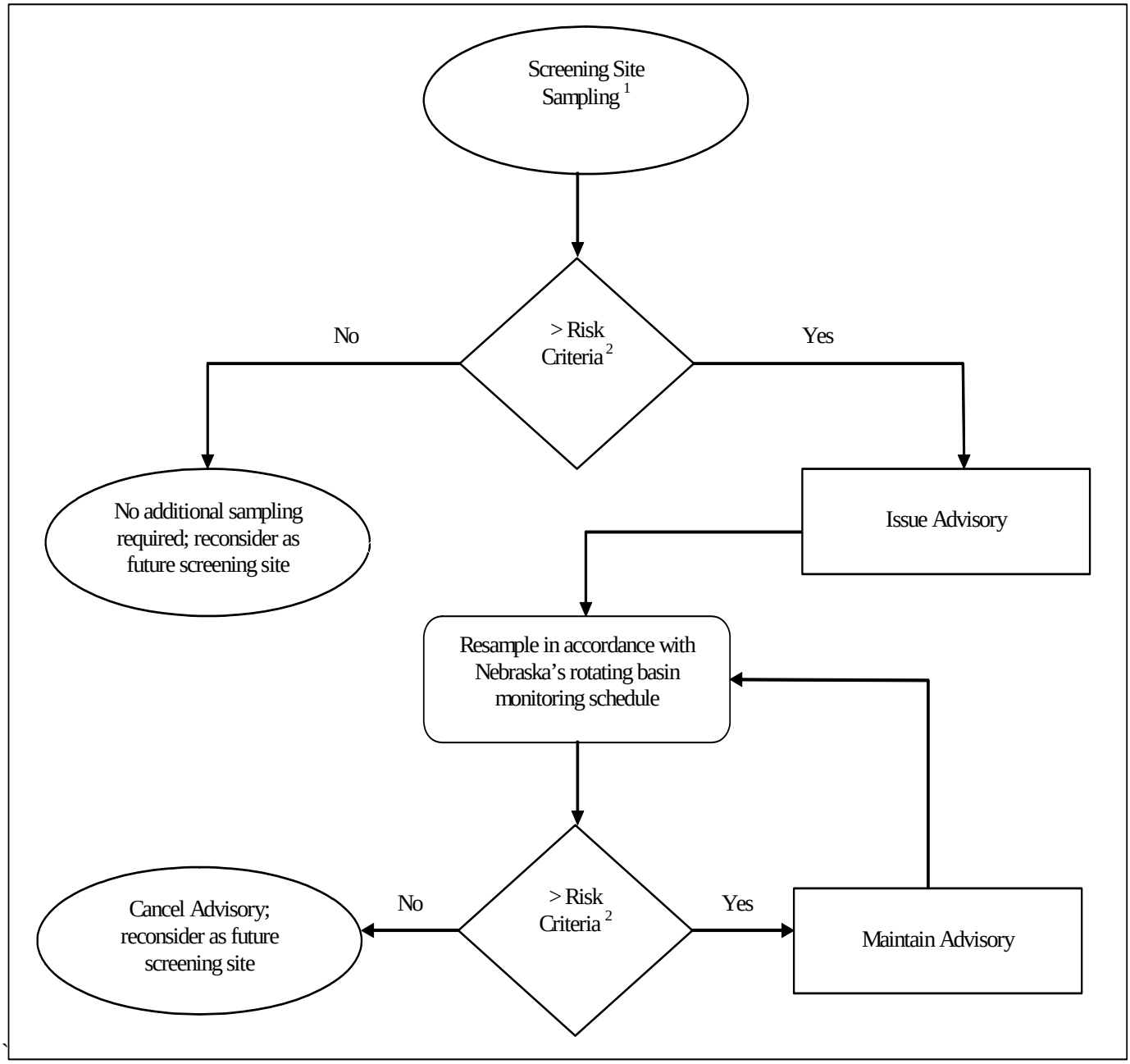
Waterbodies are considered safe when:

1) mercury concentrations < 0.215 mg/kg; or

2) when the Hazard Index < 1.0; or

3) when the Cancer Risk < 1 in 10,000.

Figure 2. Monitoring Scheme for the Nebraska Fish Tissue Monitoring Program.



[1] Sampling scheme applies to all screening and advisory sites; single fillet sample – comprised of 3-5 fish/sample of a single species – often >5 fish/sample are necessary for bluegill, crappie, etc., due to size.

[2] The *Risk Criteria* established by the Nebraska Fish Tissue Advisory Committee include fish tissue that: (1) are found to have mercury concentrations $\geq$ 0.215 mg/kg, (2) have contaminant concentrations that may be associated with adverse health effects (Hazard Index $\geq$ 1.0) or (3) may be associated with an excess Cancer Risk $\geq$ 1 in 10,000 when ingested.

VI. RESULTS AND DISCUSSION

2006 to 2008 Sampling Effort and Purpose

RAFTMP sampling is conducted to examine trends in fish tissue contamination and to identify potential human health concerns associated with fish consumption. For the period 2006 to 2008, the NDEQ and NGPC collected a total of 179 samples from 126 different sites (Figure 1). Seventeen RAFTMP *screening* sites had single fillet samples of two different fish species collected (i.e., one bottom-feeder and one predatory species) and 95 sites yielded only a single species sample. Sampling was also conducted at 24 *advisory* sites and at seven 2005 *follow-up* sites. Whole fish samples were also collected at five *trend* site locations; two of which were also under advisories. In all, fish were collected from 33 different streams and 79 lakes.

Contaminants of Concern

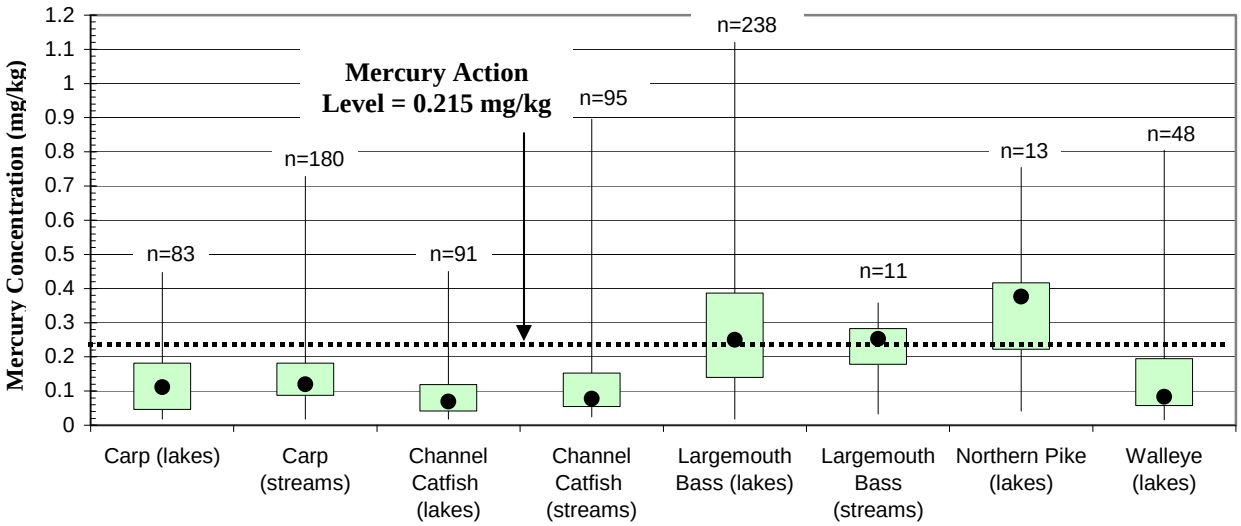
Methyl mercury and PCBs are the contaminants of primary concern in Nebraska fish. Dieldrin is also frequently detected in fish tissue samples, but by itself dieldrin concentrations rarely cause human health risk criteria to be exceeded. However, given the cumulative risk calculations that Nebraska produces, dieldrin concentrations may contribute towards the overall risk. DDE (a breakdown product of DDT) continues to appear frequently in small concentrations in fish tissue samples. Like DDE, many other contaminants are routinely detected in small concentrations and are insignificant contributors to the overall risk calculation.

Methylmercury

Mercury occurs naturally at low levels in rocks, soil, sediments, air and water. In addition, mercury can be released into the environment from mining operations, sanitary landfills, fossil fuel combustion, municipal refuse incineration, industrial waste discharges, and from certain fungicides. Mercury occurs in aquatic systems in three forms: elemental (metallic), organic (methylated), and inorganic (mercurous and mercuric salts) compounds. The organic form, methylmercury (Me-Hg), is the most toxic to both aquatic organisms and humans. In the environment, elemental mercury is oxidized to inorganic mercury that is then converted into Me-Hg by certain microorganisms. Mercury poses a threat to humans as it is stored in the tissues of aquatic organisms in the methylated form (EPA, 1995). Fish absorb Me-Hg from aquatic organisms they eat, and from the water passing over their gills. Predacious fish such as walleye, northern pike, and largemouth bass reside at the top of the aquatic food chain and are prone to exhibiting higher Me-Hg concentrations than less predacious fish such as carp or suckers. Long-term exposure, even to small background concentrations, will lead to higher concentrations in the flesh. Therefore, large fish typically have higher mercury concentrations than small fish.

Exposure to high levels of mercury have been shown to adversely affect the developing nervous system (EPA, 2001). So women of child-bearing age, pregnant women, and children less than 15 years of age are the targeted population of concern. Although mercury is included in the calculation of the Hazard Index because of its prevalence in the environment and the adverse effects that may be associated with exposure, the State has adopted an action level of 0.215 mg/kg for mercury (NDEQ, 2009). Currently there are no known methods by which one can effectively reduce mercury levels in fish tissue. Figure 3 shows the percentile values for mercury regarding various fish species collected from Nebraska waters between 1980 and 2005. Over one-half of the 249 largemouth bass samples and approximately 75% of the 13 northern pike samples produced mercury concentrations above the action level.

Figure 3. Mercury Concentrations in Fillets of Fish Species Collected from Nebraska Waters.



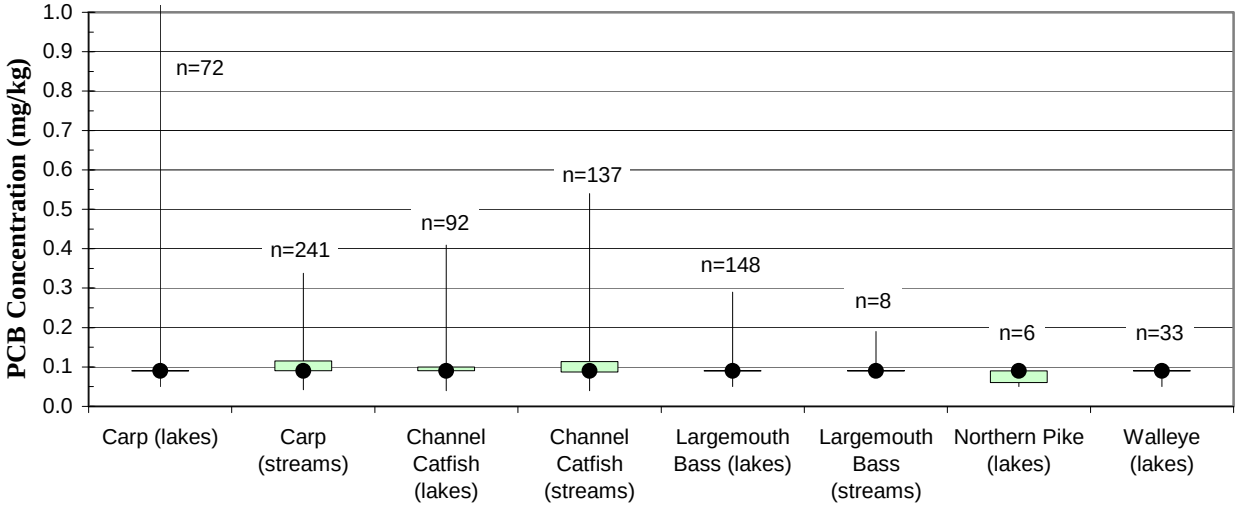
Polychlorinated Biphenyls (PCBs)

PCBs are a class of aromatic organic compounds that were produced and marketed in the United States beginning in 1929. PCBs are represented by a group of 209 individual chemical compounds referred to as congeners. Prior to 1971, PCBs were used as plasticizers, heat transfer fluids, hydraulic fluids, lubricants and wax extenders. Since 1971, PCBs have been limited to use in closed electrical systems such as capacitors and transformers because of their insulating properties. Although PCB production was discontinued in the U.S. in 1977, PCBs are still present in old transformers and capacitors. Although virtually insoluble in water, PCB compounds are readily soluble in lipids and are stored in areas such as the liver, fat, breast milk and skin. Bioconcentration factors for fish have been documented to occur from 3,000 to 247,000 times ambient levels (EPA, 1980).

Commercially, PCBs were sold as mixtures of individual congeners; most of these mixtures were sold under the trade name Aroclor. Aroclors are named based on the amount of chlorine in the total mixture. As the chlorine content increases, the compound becomes more stable and becomes increasingly difficult to break down. It is the highly-chlorinated PCB congeners which are more readily detected in fish tissue samples due to their persistence in the environment. Nebraska has EPA analyze PCBs for three congeners - PCB-1248, -1254, and -1260. PCB-1260 is the most highly chlorinated congener and PCB-1248 is the least chlorinated. PCB-1254 and -1260 are the most frequently detected in Nebraska fish.

Since PCBs are stored in a fish's fatty tissue and organs, there are effective means by which consumers can reduce their PCB intake. The best approach is to trim away all visible fat from the fillet, and grill, broil or bake the fillets in such a way that any remaining fat is allowed to drain or drip away. Figure 4 shows percentile values of PCBs for fish collected in Nebraska from 1980-2005.

Figure 4. PCB Concentrations in Fillets of Fish Species Collected from Nebraska Waters.



Data Assessment – Trend Sites

Appendix B provides a site map and data in the form of column charts for mercury and PCBs. These represent the contaminants of primary concern in Nebraska. These data are based on samples collected and analyzed from 1987-2008 at Nebraska's five trend sites. Mercury concentrations in whole fish samples appear to have remained stable to slightly increasing in the Little Blue River near Steele City; stable to slightly decreasing in the Elkhorn River near Waterloo; and slightly decreasing at the Big Nemaha River at Preston, South Platte River near Paxton, and Big Blue River near Barneston. PCB concentrations have remained relatively stable at each trend site except for the South Platte River where a decreasing trend is apparent.

Risk Assessment Results

Table 5 summarizes the findings of the 2006 to 2008 Regional Ambient Fish Tissue analysis. This includes the 2005 follow-up locations, screening locations, and locations where previous advisories had been issued. Table 5 also highlights the sample locations, the fish species collected and shows where Nebraska Risk Criteria were exceeded.

Table 5. Fish Tissue Risk Assessment Results for Nebraska Streams and Lakes Monitored in 2006 to 2008.

WATERBODY	WATER-BODY ID	LOCATION	FISH SPECIES	CANCER RISK (≥0.0001)	HAZARD INDEX (≥1.0)	MERCURY CONC. (≥0.215 mg/kg)
2005 FOLLOW-UP LOCATIONS						
Chalkrock Reservoir	MT2-L0020	NE of Crofton	LM Bass	<0.0001	**1.2**	0.158
Dead Timber Lake	EL1-L0140	E. of Snyder	LM Bass	<0.0001	**1.8**	**0.405**
Elkhorn River	EL4-10000	W. of Norfolk	Channel Cat	<0.0001	0.7	0.150
Maple Creek	EL1-10900	Near Nickerson	Channel Cat	<0.0001	0.4	0.094
Summit Lake	MT1-L0150	W. of Tekamah	LM Bass	<0.0001	**2.2**	**0.470**
Walnut Creek Lake	MT1-L0025	Papillion	LM Bass	<0.0001	**2.0**	**0.447**
Willow Creek Lake	EL3-L0010	Near Pierce	Carp	<0.0001	**1.1**	**0.235**
PREVIOUS ADVISORY LOCATIONS						
Birdwood Lake	SP1-L0030	W. of North Platte	LM Bass	<0.0001	0.8	0.190
Box Butte Reservoir	NI4-L0080	N. of Hemmingford	N. Pike	<0.0001	**1.5**	**0.343**
			Channel Cat	<0.0001	<0.1	NA
Carter Lake	MT1-L0090	Omaha	LM Bass	<0.0001	**1.1**	0.060
Cottonwood Lake	NI4-L0010	Near Merriman	LM Bass	<0.0001	**2.1**	**0.457**
East Hershey Lake	SP1-L0040	E. of Hershey	LM Bass	<0.0001	**1.3**	**0.290**
Elkhorn River	EL1-10000	E. of Waterloo	Carp	<0.0001	**1.7**	0.130
Elwood Reservoir	MP2-L0540	Elwood	Walleye	<0.0001	0.6	0.140
Lake Hastings	BB3-L0050	Hastings	Carp	**0.00049**	**8.8**	0.031
Maloney Res. Outlet Canal	SP1-10500	S. of North Platte	Carp	<0.0001	**1.4**	**0.260**
Merritt Reservoir	NI3-L0330	SW of Valentine	Walleye	<0.0001	**1.6**	**0.353**
Missouri River	NE1-10000	Near Rulo	Channel Cat	<0.0001	0.2	0.060
North Platte River	NP1-10000	Near North Platte	LM Bass	<0.0001	**1.0**	**0.220**
North Platte River	NP2-10000	Lewellen	Channel Cat	<0.0001	0.7	0.170
North Platte River	NP3-10000	Near North Platte	Channel Cat	<0.0001	0.4	0.100
Oliver Reservoir	SP2-L0030	W. of Kimball	LM Bass	<0.0001	0.8	0.190
			W. Crappie	<0.0001	0.5	0.110
Phillips Lake	MP2-L0500	S. of Lexington	Carp	<0.0001	**1.9**	**0.430**
Shell Lake	NI4-L0020	N. of Gordon	N. Pike	<0.0001	**1.4**	**0.319**
South Platte River	SP1-50000	S. of Paxton	Carp	<0.0001	0.9	0.160
Sutherland Outlet Canal	SP1-10600	Sutherland	Carp	<0.0001	0.7	0.110
Sutherland Reservoir	SP1-L0080	S. of Sutherland	Channel Cat	<0.0001	0.3	0.079
			Walleye	<0.0001	0.2	0.054
West Fork Big Blue River	BB3-10000	N. of Dorchester	Carp	<0.0001	0.5	0.119
Liberty Cove	LB2-L0050	SW of Lawrence	LM Bass	<0.0001	**3.3**	**0.714**
Rockford Lake	BB1-L0090	E. of Beatrice	LM Bass	<0.0001	**1.6**	**0.359**
Wolf-Wildcat Lake	BB1-L0050	N. of Liberty	LM Bass	<0.0001	**2.4**	**0.531**

NOTE: Boldface type indicates risk criteria were exceeded. Whole fish samples collected at "trend sites" were omitted since only fillet samples were utilized for assessing risk. Values appearing in the Cancer Risk and Hazard Index columns were derived by summing the Hazard Quotients and cancer risk estimates for each contaminant found in the fish samples analyzed.

NOTE: The NDEQ's *Policy for Issuing Fish Consumption Advisories* uses an 8-oz weekly meal portion combined with a consumer body weight of 70 kg (154 lbs.), an absorption factor of 1.0 and an exposure period of 70 years for calculating health risks (NDEQ, 2007)

Table 5. Continued.

WATERBODY	WATER-BODY ID	LOCATION	FISH SPECIES	CANCER RISK (≥0.0001)	HAZARD INDEX (≥1.0)	MERCURY CONC. (≥0.215 mg/kg)
SCREENING LOCATIONS						
Alexandria Lakes	LB2-L0030	E. of Alexandria	B. Crappie	<0.0001	0.4	0.089
Ansley City Lake	LO4-L0030	Ansley	LM Bass	<0.0001	0.5	0.114
Arnold Lake	LO4-L0050	Arnold	LM Bass	<0.0001	0.3	0.070
Bassway Strip Lake No. 5	MP2-L0190	N. of Minden	LM Bass	<0.0001	**1.0**	**0.237**
Battle Creek	EL4-10400	Battle Creek	Channel Cat	<0.0001	0.5	0.110
Beaver Creek	LO1-10700	NW of Albion	Channel Cat	<0.0001	0.5	0.071
Big Alkali Lake	NI3-L0220	S. of Valentine	Channel Cat	<0.0001	0.1	0.037
Big Blue River	BB1-10000	W. of Barneston	Carp	<0.0001	**1.8**	**0.240**
			Carp	**0.00013**	**2.0**	0.144
Branched Oak Lake	LP2-L0150	NW of Lincoln	Walleye	<0.0001	0.8	0.040
			W. Crappie	<0.0001	0.9	0.036
Big Blue River	BB4-20000	Seward	Channel Cat	<0.0001	1.0	0.135
Big Indian Creek	BB1-10900	NE of Odell	Channel Cat	<0.0001	0.1	0.210
Big Sandy Creek	LB2-10200	S. of Belvidere	Channel Cat	<0.0001	0.1	**0.230**
Bridgeport Middle Lake	NP3-L0030	Bridgeport	LM Bass	<0.0001	0.9	0.200
Buckskin Hills Lake	MT2-L0010	SW of Newcastle	Channel Cat	<0.0001	<0.1	NA
			LM Bass	<0.0001	0.6	0.145
Calamus Reservoir	LO2-L0050	W. of Burwell	Carp	<0.0001	<0.1	NA
			Walleye	<0.0001	0.2	0.064
Carter P. Johnson Lake	WH1-L0200	W. of Crawford	LM Bass	<0.0001	1.1	**0.247**
Cedar River	LO1-30300	Near Spalding	Carp	<0.0001	0.4	0.103
Chappell Interstate Lake	SP2-L0010	Chappell	LM Bass	<0.0001	**1.0**	0.190
			Bluegill	<0.0001	0.6	0.130
Cheyenne Lake	MP2-L0100	S. of Wood River	Bluegill	<0.0001	0.5	0.068
Columbus City Park Pond	LO1-L0010	Columbus	LM Bass	<0.0001	**1.2**	**0.277**
Cottonmill Lake	MP2-L0360	Near Kearney	LM Bass	<0.0001	**3.3**	**0.730**
			Channel Cat	<0.0001	0.5	0.124
			LM Bass	<0.0001	**3.2**	**0.696**
Cottonwood-Steverson	NI3-XXXX	N. of Hyannis	Walleye	<0.0001	0.9	0.209
Cozad Lake	MP2-L0580	Cozad	Bluegill	<0.0001	0.3	0.073
			LM Bass	<0.0001	0.7	0.164
Crystal Springs NW Lake	LB1-L0020	Fairbury	LM Bass	<0.0001	0.2	0.060
Cub Creek Lake	NI3-L0070	W. of Springview	LM Bass	<0.0001	**1.7**	**0.381**
Davis Creek Lake	LO2-L0015	S. of North Loup	Carp	<0.0001	<0.1	NA
			W. Crappie	<0.0001	0.7	0.154

NOTE: Boldface type indicates risk criteria were exceeded. Whole fish samples collected at "trend sites" were omitted since only fillet samples were utilized for assessing risk. Values appearing in the Cancer Risk and Hazard Index columns were derived by summing the Hazard Quotients and cancer risk estimates for each contaminant found in the fish samples analyzed.

NOTE: The NDEQ's *Policy for Issuing Fish Consumption Advisories* uses an 8-oz weekly meal portion combined with a consumer body weight of 70 kg (154 lbs.), an absorption factor of 1.0 and an exposure period of 70 years for calculating health risks (NDEQ, 2007)

Table 5. Continued.

WATERBODY	WATER-BODY ID	LOCATION	FISH SPECIES	CANCER RISK (≥0.0001)	HAZARD INDEX (≥1.0)	MERCURY CONC. (≥0.215 mg/kg)
SCREENING LOCATIONS– Con't						
DeSoto Bend Lake	MT1-L0140	E. of Blair	Channel Cat	<0.0001	0.1	0.030
Enders	RE3-L0100	Near Enders	Channel Cat	<0.0001	0.2	0.053
			White Bass	<0.0001	**1.0**	**0.227**
Farwell South Reservoir	LO3-L0010	N. of Boelus	Channel Cat	<0.0001	<0.1	NA
			LM Bass	<0.0001	**1.4**	**0.310**
Fremont Lake No. 1	LP1-L0290	Fremont	LM Bass	<0.0001	**1.4**	**0.317**
Frenchman WMA Lake	RE3-XXXX	N. of Palisade	LM Bass	<0.0001	**1.4**	**0.258**
Goldeneye Pond	SP1-L0100	W. of Big Springs	LM Bass	<0.0001	0.6	0.066
			Channel Cat	<0.0001	<0.1	0.010
Grand Island L. E. Ray Lake	MP2-L0030	Grand Island	Bluegill	<0.0001	0.5	0.067
Grove Lake	NI2-L0060	N. of Royal	LM Bass	<0.0001	0.9	0.201
Harlan Co. Reservoir	RE2-L0010	S. of Republican City	Walleye	<0.0001	0.3	0.075
Hershey Lake	SP1-L0050	S. of Hershey	Channel Cat	<0.0001	<0.1	NA
			LM Bass	<0.0001	**1.9**	**0.417**
Hugh Butler Lake	RE3-L0060	N. of McCook	N. Pike	<0.0001	**2.7**	**0.604**
Interstate Lake	SP1-L0010	North Platte	LM Bass	<0.0001	**2.0**	**0.447**
Island Lake	NP2-L0110	N. of Oshkosh	Y. Perch	<0.0001	0.2	0.044
Johnson Lake	MP2-L0520	S. of Lexington	Walleye	<0.0001	0.7	0.110
Kea Lake	MP2-L0320	Near Kearney	LM Bass	<0.0001	**1.2**	**0.220**
Keller Park No. 2	NI3-L0030	N. of Long Pine	Bluegill	<0.0001	0.1	0.038
Keya Paha River	NI3-10100	S. of Naper	Channel Cat	<0.0001	0.5	0.111
Killdeer Lake	LP2-L0080	SW of Lincoln	Channel Cat	<0.0001	0.5	0.113
Lake Minatare	NP3-L0060	N. of Minatare	Channel Cat	<0.0001	<0.1	NA
			Walleye	<0.0001	0.4	0.088
Lake North	LP1-L0440	Columbus	W. Crappie	<0.0001	0.6	0.139
Little Blue River	LB2-20000	Hebron	Carp	<0.0001	0.5	0.125
Little Blue River	LB1-10000	E. of Steele City	Flathead Cat	<0.0001	0.9	0.189
Long Pine Creek	NI3-12400	Near Long Pine	Brown Trout	<0.0001	0.6	0.134
Louisville Lake No. 1A	LP1-L0010	Louisville	Bluegill	<0.0001	0.2	0.063
Medicine Creek	RE3-10200	Stockville	Channel Cat	<0.0001	0.6	0.140
Middle Loup River	LO3-30000	SE of Arcadia	Channel Cat	<0.0001	0.7	0.152
Middle Loup River	LO3-40000	W. of Comstock	Channel Cat	<0.0001	0.8	0.180
Midway Canyon-Central	MP2-L0620	S. of Cozad	Carp	<0.0001	0.2	0.056
Missouri River	MT2-10000	Maskell	Channel Cat	<0.0001	0.1	0.030

NOTE: Boldface type indicates risk criteria were exceeded. Whole fish samples collected at "trend sites" were omitted since only fillet samples were utilized for assessing risk. Values appearing in the Cancer Risk and Hazard Index columns were derived by summing the Hazard Quotients and cancer risk estimates for each contaminant found in the fish samples analyzed.

NOTE: The NDEQ's *Policy for Issuing Fish Consumption Advisories* uses an 8-oz weekly meal portion combined with a consumer body weight of 70 kg (154 lbs.), an absorption factor of 1.0 and an exposure period of 70 years for calculating health risks (NDEQ, 2007)

Table 5. Continued.

WATERBODY	WATER-BODY ID	LOCATION	FISH SPECIES	CANCER RISK (≥0.0001)	HAZARD INDEX (≥1.0)	MERCURY CONC. (≥0.215 mg/kg)
SCREENING LOCATIONS– Con't						
Missouri River	NI1-10000	N. of Verdel	Channel Cat	<0.0001	<0.1	NA
			White Bass	<0.0001	0.5	0.126
Muddy Creek	RE2-11400	Near Arapahoe	Channel Cat	<0.0001	**4.6**	**1.000**
Niobrara River	NI2-10000	Near Niobrara	Channel Cat	<0.0001	0.1	0.042
Niobrara River	NI2-10000	West of Niobrara	Carp	<0.0001	**1.1**	0.190
N. Fork Big Nemaha River	NE2-12500	NW of Tecumseh	Carp	<0.0001	0.8	0.190
North Loup River	LO2-10000	N. of St. Paul	Channel Cat	<0.0001	0.4	0.075
North Loup SRA Lake	LO2-L0010	N. of St. Paul	LM Bass	<0.0001	**1.2**	0.207
North Platte River	NP3-50000	S. of Henry	Carp	<0.0001	0.2	0.064
Pibel Lake	LO1-L0130	E. of Ericson	Bluegill	<0.0001	<0.1	NA
			LM Bass	<0.0001	**2.2**	**0.492**
Powder Creek	MT2-L0005	SE of Newcastle	Channel Cat	<0.0001	<0.1	NA
			LM Bass	<0.0001	0.6	0.135
Prairie Knoll Lake	NE2-L0080	NW of DuBois	LM Bass	<0.0001	**1.9**	**0.426**
Ravenna Lake	LO4-L0010	E. of Ravenna	Channel Cat	<0.0001	<0.1	NA
			LM Bass	<0.0001	**1.6**	**0.358**
Recharge Lake	BB3-L0080	Near York	LM Bass	<0.0001	**3.3**	**0.730**
Red Willow Creek	NP3-11100	E. of Bayard	Brown Trout	<0.0001	0.7	0.170
Republican River	RE1-10000	W. of Superior	Channel Cat	<0.0001	0.5	0.128
Rock Creek Lake	RE3-L0120	N. of Parks	LM Bass	<0.0001	**1.0**	**0.230**
Sandy Channel Lake	MP2-L0420	S. of Elm Creek	LM Bass	<0.0001	0.9	0.120
Sherman Reservoir	LO3-L0020	NE of Loup City	W. Crappie	<0.0001	<0.1	NA
			Walleye	<0.0001	**1.3**	**0.287**
Skyview Lake	EL4-L0020	Norfolk	LM Bass	<0.0001	**1.2**	0.112
Smith Lake	NI4-L0040	S. of Rushville	N. Pike	<0.0001	0.5	0.122
South Loup River	LO4-10000	N. of St. Michael	Channel Cat	<0.0001	0.5	0.116
South Loup River	LO4-10000	E. of Ravenna	Channel Cat	<0.0001	0.6	0.150
South Loup River	LO4-20000	N. of Oconto	Channel Cat	<0.0001	0.4	0.104
South Platte River	SP1-20000	North Platte	Channel Cat	<0.0001	0.4	0.100
Stinking Water Creek	RE3-20220	N. of Palisade	Channel Cat	<0.0001	0.6	0.129
Swan Creek 5A	BB2-L0020	NE of Tobias	LM Bass	<0.0001	**2.2**	**0.481**
Swan Creek Lake 2A	BB2-L0010	E. of Milligan	Channel Cat	<0.0001	0.3	0.086
Ta-Ha-Zouka Park Lagoon	EL4-L0010	Norfolk	LM Bass	<0.0001	0.5	0.128
Valentine Mill Pond	NI3-L0170	Valentine	LM Bass	<0.0001	**2.0**	**0.453**
Wahoo Creek	LP2-10100	S. of Ithaca	Channel Cat	<0.0001	0.3	0.081

NOTE: Boldface type indicates risk criteria were exceeded. Whole fish samples collected at "trend sites" were omitted since only fillet samples were utilized for assessing risk. Values appearing in the Cancer Risk and Hazard Index columns were derived by summing the Hazard Quotients and cancer risk estimates for each contaminant found in the fish samples analyzed.

NOTE: The NDEQ's *Policy for Issuing Fish Consumption Advisories* uses an 8-oz weekly meal portion combined with a consumer body weight of 70 kg (154 lbs.), an absorption factor of 1.0 and an exposure period of 70 years for calculating health risks (NDEQ, 2007)

Table 5. Continued.

WATERBODY	WATER-BODY ID	LOCATION	FISH TYPE	CANCER RISK (≥0.0001)	HAZARD INDEX (≥1.0)	MERCURY CONC. (≥0.215 mg/kg)
SCREENING LOCATIONS – Con't						
Walgren Lake	NI4-L0050	SE of Hay Springs	LM Bass	<0.0001	**3.6**	**0.782**
Wellfleet Lake	RE3-L0070	Near Wellfleet	LM Bass	<0.0001	0.7	0.152
West Fork Big Blue River	BB3-20000	McCool Junction	Channel Cat	<0.0001	0.4	0.105
West Maxwell WMA Lake	MP2-L0750	E. of Maxwell	Channel Cat	<0.0001	0.1	0.032
White River	WH1-10000	Whitney	Carp	<0.0001	0.9	0.200
White River	WH1-20000	E. of Fort Robinson	Brown Trout	<0.0001	0.4	0.089
White River	WH1-30000	S. of Fort Robinson	Brown Trout	<0.0001	0.9	0.200
Whitney Reservoir	WH1-L0060	W. of Whitney	Carp	<0.0001	<0.1	NA
			Walleye	<0.0001	0.6	0.138

NOTE: Boldface type indicates risk criteria were exceeded. Whole fish samples collected at "trend sites" were omitted since only fillet samples were utilized for assessing risk. Values appearing in the Cancer Risk and Hazard Index columns were derived by summing the Hazard Quotients and cancer risk estimates for each contaminant found in the fish samples analyzed.

NOTE: The NDEQ's *Policy for Issuing Fish Consumption Advisories* uses an 8-oz weekly meal portion combined with a consumer body weight of 70 kg (154 lbs.), an absorption factor of 1.0 and an exposure period of 70 years for calculating health risks (NDEQ, 2007)

VII. SUMMARY

A list of Nebraska streams and lakes monitored in 2006 to 2008 along with their advisory status is presented in Table 6. A summary of the risk assessment results are as follows:

1. Fish tissue samples were collected and analyzed from 93 screening sites. Tissue samples collected from 64 sites did not exceed any of the State's risk criteria. These waterbodies will not come under advisory. Samples collected at 24 sites exceeded the risk criteria for mercury and had a Hazard Index ≥1.0. At four sites, samples exceeded the risk criteria with a Hazard Index ≥1.0. The primary contaminants found in fish tissue at these sites included mercury and selenium. One site's fish tissue sample had a cancer risk ≥ 1 in 10,000 and a Hazard Index ≥1.0. The primary contaminants found in fish tissue at this site included PCBs and dieldrin.
2. Five of seven 2005 *follow-up* sites sampled in 2006 also exceeded acceptable risk levels and will come under advisory. Samples collected at four of five sites exceeded risk criteria for mercury and had a Hazard Index ≥1.0. One site's sample exceeded the risk criteria with a Hazard Index ≥1.0. The primary contaminants found in fish tissue at this site included mercury and selenium.
3. Twenty-four *advisory* sites were monitored from 2006 to 2008. Advisories will be maintained at 17 of the 24 sites based on contaminant levels still exceeding risk criteria. Consumption advisories were removed from the remaining seven sites as their respective samples indicated contaminant levels below human health risk criteria.
4. In all, 34 waterbodies monitored from 2006 to 2008 came under advisory, 17 sites that were already under an advisory remained listed, and 7 sites were removed.
5. Currently, 71 Nebraska waterbodies (21 stream segments and 50 lakes) are now under fish consumption advisories (see *Appendix A* for site list and map).

Table 6. Nebraska Streams and Lakes Monitored in 2006 to 2008 and Their Advisory Status.

WATERBODY	WATER-BODY ID	LOCATION	FISH TYPE	ADVISORY ACTION	LISTING REASON[1]
2005 FOLLOW-UP SITES					
Dead Timber Lake	EL1-L0140	E. of Snyder	LM Bass	New Advisory	H.I., Mercury
Willow Creek Lake	EL3-L0010	Near Pierce	Carp	New Advisory	H.I., Mercury
Walnut Creek Lake	MT1-L0025	Papillion	LM Bass	New Advisory	H.I., Mercury
Summit Lake	MT1-L0150	W. of Tekamah	LM Bass	New Advisory	H.I., Mercury
Chalkrock Reservoir	MT2-L0020	NE of Crofton	LM Bass	New Advisory	H.I.
ADVISORY SITES					
Wolf-Wildcat Lake	BB1-L0050	N. of Liberty	LM Bass	Maintain	H.I., Mercury
Rockford Lake	BB1-L0090	E. of Beatrice	LM Bass	Maintain	H.I., Mercury
West Fork Big Blue River	BB3-10000	N. of Dorchester	Carp	Remove	< Risk Criteria
Lake Hastings	BB3-L0050	Hastings	Carp	Maintain	C.R., H.I.
Elkhorn River	EL1-10000	E. of Waterloo	Carp	Maintain	H.I.[2]
Liberty Cove	LB2-L0050	SW of Lawrence	LM Bass	Maintain	H.I., Mercury
Phillips Lake	MP2-L0500	S. of Lexington	Carp	Maintain	H.I., Mercury
Elwood Reservoir	MP2-L0540	Elwood	Walleye	Remove	< Risk Criteria
Carter Lake	MT1-L0090	Omaha	LM Bass	Maintain	H.I.
Missouri River	NE1-10000	Near Rulo	Channel Cat	Maintain	C.R., H.I.[2]
Merritt Reservoir	NI3-L0330	SW of Valentine	Walleye	Maintain	H.I., Mercury
Cottonwood Lake	NI4-L0010	Near Merriman	LM Bass	Maintain	H.I., Mercury
Shell Lake	NI4-L0020	N. of Gordon	N. Pike	Maintain	H.I., Mercury
Box Butte Reservoir	NI4-L0080	N. of Hemmingford	N. Pike	Maintain	H.I., Mercury
North Platte River	NP1-10000	Near North Platte	LM Bass	Maintain	H.I., Mercury
North Platte River	NP2-10000	Lewellen	Channel Cat	Remove	< Risk Criteria
North Platte River	NP3-10000	Bridgeport	Channel Cat	Maintain	H.I.[2]
Maloney Res. Outlet Canal	SP1-10500	S. of North Platte	Carp	Maintain	H.I., Mercury
Sutherland Outlet Canal	SP1-10600	Sutherland	Carp	Maintain	C.R., H.I.[2]
South Platte River	SP1-50000	S. of Paxton	Carp	Remove	< Risk Criteria
Birdwood Lake	SP1-L0030	W. of North Platte	LM Bass	Remove	< Risk Criteria
East Hershey Lake	SP1-L0040	E. of Hershey	LM Bass	Maintain	H.I., Mercury
Sutherland Reservoir	SP1-L0080	S. of Sutherland	Channel Cat	Remove	< Risk Criteria
Oliver Reservoir	SP2-L0030	W. of Kimball	LM Bass	Remove	< Risk Criteria
SCREENING SITES					
Big Blue River	BB1-10000	W. of Barneston	Carp	New Advisory	C.R., H.I.
Swan Creek 5A	BB2-L0020	NE of Tobias	LM Bass	New Advisory	H.I., Mercury
Recharge Lake	BB3-L0080	Near York	LM Bass	New Advisory	H.I., Mercury
Skyview Lake	EL4-L0020	Norfolk	LM Bass	New Advisory	H.I.
Big Sandy Creek	LB2-10200	S. of Belvidere	Channel Cat	New Advisory	H.I., Mercury
Pibel Lake	LO10L0130	E. of Ericson	LM Bass	New Advisory	H.I., Mercury
Columbus City Park Pond	LO1-L0010	Columbus	LM Bass	New Advisory	H.I., Mercury

[1] Sites listed with H.I. (Hazard Index), C.R. (Cancer Risk), or Mercury had contaminant levels above human health risk criteria.

[2] Site remained listed due to error associated with laboratory analyses or field sampling.

Table 6. Continued.

WATERBODY	WATER-BODY ID	LOCATION	FISH TYPE	ADVISORY ACTION	LISTING REASON[1]
SCREENING SITES Con't					
North Loup SRA Lake	LO2-L0010	N. of St. Paul	LM Bass	New Advisory	H.I.
Farwell South Reservoir	LO3-L0010	N. of Boelus	LM Bass	New Advisory	H.I., Mercury
Sherman Reservoir	LO3-L0020	NE of Loup City	Walleye	New Advisory	H.I., Mercury
Ravenna Lake	LO4-L0010	E. of Ravenna	LM Bass	New Advisory	H.I., Mercury
Fremont Lake No. 1	LP1-L0290	Fremont	LM Bass	New Advisory	H.I., Mercury
Bassway Strip Lake No. 5	MP2-L0190	N. of Minden	LM Bass	New Advisory	H.I., Mercury
Kea Lake	MP2-L0320	Near Kearney	LM Bass	New Advisory	H.I., Mercury
Cottonmill Lake	MP2-L0360	Near Kearney	LM Bass	New Advisory	H.I., Mercury
Prairie Knoll Lake	NE2-L0080	NW of DuBois	LM Bass	New Advisory	H.I., Mercury
Niobrara River	NI2-10000	West of Niobrara	Carp	New Advisory	H.I.
Cub Creek Lake	NI3-L0070	W. of Springview	LM Bass	New Advisory	H.I., Mercury
Valentine Mill Pond	NI3-L0170	Valentine	LM Bass	New Advisory	H.I., Mercury
Walgren Lake	NI4-L0050	SE of Hay Springs	LM Bass	New Advisory	H.I., Mercury
Muddy Creek	RE2-11400	Near Arapahoe	Channel Cat	New Advisory	H.I., Mercury
Hugh Butler Lake	RE3-L0060	N. of McCook	N. Pike	New Advisory	H.I., Mercury
Enders	RE3-L0100	Near Enders	White Bass	New Advisory	H.I., Mercury
Rock Creek Lake	RE3-L0120	N. of Parks	LM Bass	New Advisory	H.I., Mercury
Frenchman WMA Lake	RE3-XXXX	N. of Palisade	LM Bass	New Advisory	H.I., Mercury
Interstate Lake	SP1-L0010	North Platte	LM Bass	New Advisory	H.I., Mercury
Hershey Lake	SP1-L0050	S. of Hershey	LM Bass	New Advisory	H.I., Mercury
Chappell Interstate Lake	SP2-L0010	Chappell	LM Bass	New Advisory	H.I.
Carter P. Johnson Lake	WH1-L0200	W. of Crawford	LM Bass	New Advisory	H.I., Mercury

[1] Sites listed with H.I. (Hazard Index), C.R. (Cancer Risk), or Mercury had contaminant levels above human health risk criteria. Those listed as having a *Data Issue* means the sites should be re-sampled due to error associated with laboratory analyses or field sampling.

[2] Site remained listed due to error associated with laboratory analyses or field sampling.

VIII. LITERATURE CITED

ACS. 2009. “Cancer Facts and Figures 2009.” American Cancer Society.

Barnes, D.G., et al. 1989. "Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and Dibenzofurans (CDDs and CDFs) and 1989 Update". Risk Assessment Forum. U.S. Environmental Protection Agency. Washington, D.C. 20460.

EPA. 1980. Ambient Water Quality Criteria for Polychlorinated Biphenyls. Office of Water Regulations and Standards. U.S. Environmental Protection Agency. Washington, D.C. 20460. EPA Document Number 440/5-80-068.

EPA. 1989. The Decision-Making Process: Risk Assessment, Risk Management, Risk Communication.

EPA. 1994. "Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish: A Guidance Manual." Office of Water Regulations and Standards. U.S. Environmental Protection Agency. Washington, D.C. 20460.

EPA. 1995. *Proceedings* of the National Forum on Mercury in Fish. Office of Water. Washington, D.C. 20460. EPA Document Number 823-R-95-002.

EPA. 1999. Proceedings of the 1999 American Fisheries Society Forum on Contaminants in Fish.

EPA. 2000. "Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories.” Office of Water. U.S. Environmental Protection Agency. Washington, D.C. 20460. EPA Document Number 823-B-00-008.

EPA. 2001. “Water Quality Criterion for the Protection of Human Health: Methymercury” Office of Water. U.S. Environmental Protection Agency. Washington, D.C. 20460. EPA Document Number 823-R-01-001.

EPA. 2009. "Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion” Office of Water. U.S. Environmental Protection Agency. Washington, D.C. 20460. EPA Document Number 823-R-09-002.

EPA. 2010. Integrated Risk Information System (IRIS) Program. www.epa.gov/iris.

Goyer, Robert A. 1986. Toxic effects of metals In: Casarett and Doull's Toxicology - The Basic Science of Poisons, 3rd edition, C.D. Vlaassen, M.O. Amdur, and J. Doull, Eds., pp. 605-609.

Harada, H. 1978. Congenital minamata disease: Intrauterine methylmercury poisoning. Teratology 18: 285-288.

NDEQ. 1992. "Nebraska Stream Inventory." Nebraska Department of Environmental Quality. Lincoln, NE 68509

NDEQ. 2007. "Policy for Issuing Nebraska Fish Consumption Advisories." Nebraska Department of Environmental Quality. Lincoln, NE 68509.

VIII. LITERATURE CITED – Con't

NDEQ. 2009. Title 117 – Nebraska Surface Water Quality Standards. Nebraska Department of Environmental Quality. Lincoln, NE 68509.

APPENDIX A

NEBRASKA FISH CONSUMPTION ADVISORIES THROUGH 2008

Important Note: Fish consumption advisories are not bans on eating fish, rather they provide information on the potential risks associated with the consumption of specified fish from certain waterbodies. Nebraska's *Risk Criteria* for issuing fish consumption advisories are based on an 8-oz weekly fillet meal portion combined with a consumer body weight of 70 kg (154 lbs), assuming 100% contaminant absorption, and an exposure period of 70 years.

WATERBODY	ID	FISH TYPE	HEALTH RISK CRITERIA VIOLATED[1]	POLLUTANT OF CONCERN
BIG BLUE RIVER BASIN				
Big Blue River	BB1-10000	Carp	Cancer Risk, Hazard Index	PCBs, Dieldrin
Lake Hastings	BB3-L0050	Carp	Cancer Risk, Hazard Index	PCBs
Recharge Lake	BB3-L0080	Largemouth Bass	Hazard Index, Mercury	Mercury
Rockford Lake	BB1-L0090	Largemouth Bass	Hazard Index, Mercury	Mercury
Swan Creek 5A	BB2-L0020	Largemouth Bass	Hazard Index, Mercury	Mercury
Wolf-Wildcat Lake	BB1-L0050	Largemouth Bass	Hazard Index, Mercury	Mercury
ELKHORN RIVER BASIN				
Dead Timber Lake	EL1-L0140	Largemouth Bass	Hazard Index, Mercury	Mercury
Elkhorn River	EL1-10000	Carp	Hazard Index	PCBs, Dieldrin
Elkhorn River	EL4-30000	Carp	Hazard Index, Mercury	Mercury
Logan Creek	EL2-10000	Channel Catfish	Cancer Risk, Hazard Index	PCBs, Dieldrin
Maskenthine Lake	EL1-L0080	Largemouth Bass	Hazard Index, Mercury	Mercury
Skyview Lake	EL4-L0020	Largemouth Bass	Hazard Index	Mercury, Selenium
Willow Creek Lake	EL3-L0010	Carp	Hazard Index, Mercury	Mercury
LITTLE BLUE RIVER BASIN				
Big Sandy Creek	LB2-10200	Channel Catfish	Hazard Index, Mercury	Mercury
Liberty Cove	LB2-L0050	Largemouth Bass	Hazard Index, Mercury	Mercury
LOUP RIVER BASIN				
Columbus City Park Pond	LO1-L0010	Largemouth Bass	Hazard Index, Mercury	Mercury
Farwell South Reservoir	LO3-L0010	Largemouth Bass	Hazard Index, Mercury	Mercury
North Loup SRA Lake	LO2-L0010	Largemouth Bass	Hazard Index	Mercury, Selenium
Pibel Lake	LO1-L0130	Largemouth Bass	Hazard Index, Mercury	Mercury
Ravenna Lake	LO4-L0010	Largemouth Bass	Hazard Index, Mercury	Mercury
Sherman Reservoir	LO3-L0020	Walleye	Hazard Index, Mercury	Mercury
LOWER PLATTE RIVER BASIN				
Czechland Lake	LP2-L0270	Largemouth Bass	Hazard Index, Mercury	Mercury
Fremont Lake No. 1	LP1-L0290	Largemouth Bass	Hazard Index, Mercury	Mercury
Loup River Power Canal	LP1-21800	Carp	Hazard Index	PCBs
Platte River	LP1-20000	Carp	Cancer Risk, Hazard Index	PCBs
Salt Creek	LP2-10000	Carp	Hazard Index	PCBs
Salt Creek	LP2-20000	Carp	Cancer Risk, Hazard Index, Mercury	PCBs, Mercury
Wagon Train Lake	LP2-L0030	Largemouth Bass	Hazard Index, Mercury	Mercury
MIDDLE PLATTE RIVER BASIN				
Bassway Strip Lake No. 5	MP2-L0190	Largemouth Bass	Hazard Index, Mercury	Mercury
Cottonmill Lake	MP2-L0360	Largemouth Bass	Hazard Index, Mercury	Mercury
Kea Lake	MP2-L0320	Largemouth Bass	Hazard Index, Mercury	Mercury
Phillips Lake	MP2-L0500	Carp	Hazard Index, Mercury	Mercury

[1] The *Risk Criteria* established by the Nebraska Fish Tissue Advisory Committee include fish tissue that: (1) are found to have mercury concentrations $\geq$ 0.215 mg/kg, (2) have contaminant concentrations that may be associated with adverse health effects (Hazard Index $\geq$ 1.0) or (3) may be associated with an excess Cancer Risk $\geq$ 1 in 10,000 when ingested.

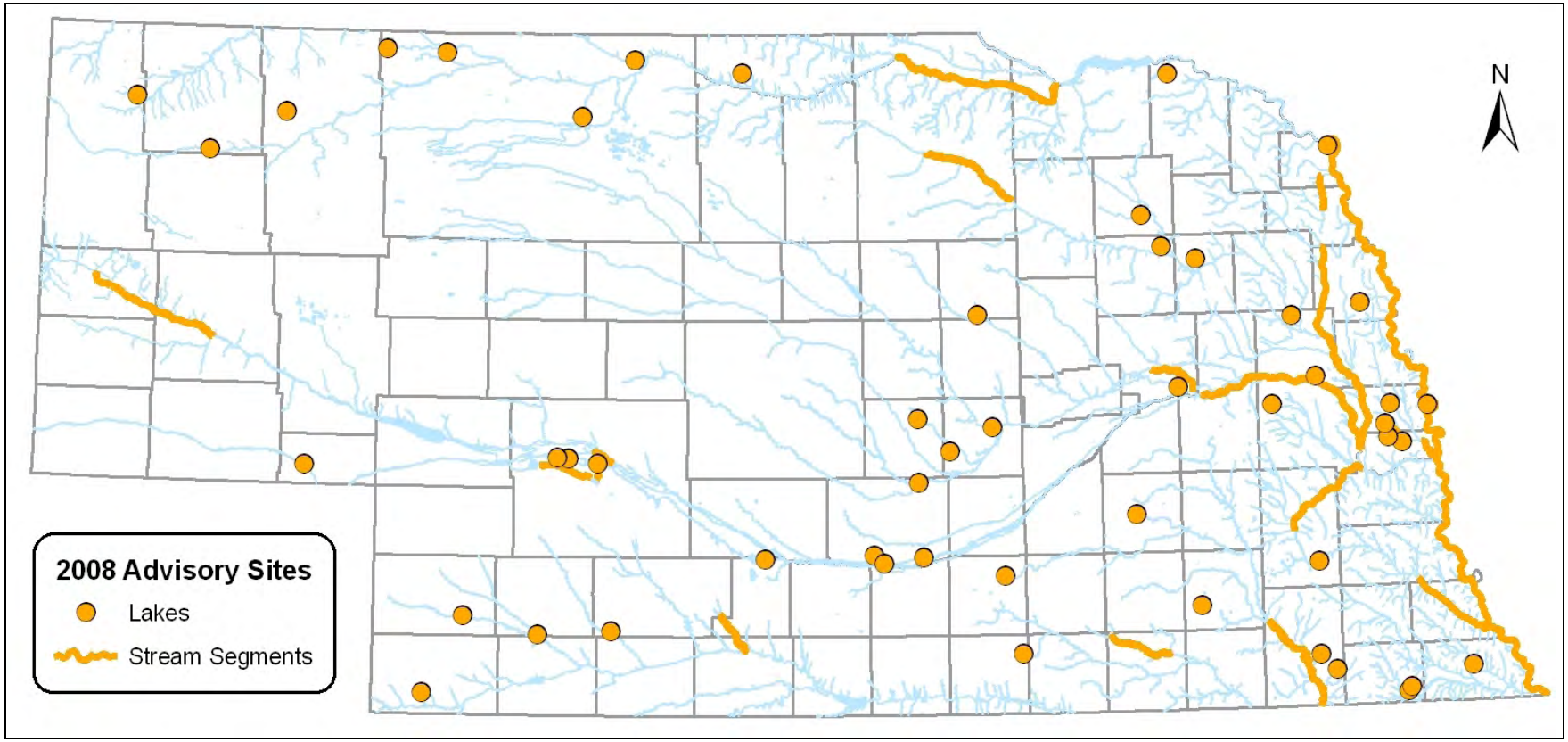
WATERBODY	ID	FISH TYPE	HEALTH RISK CRITERIA VIOLATED[1]	POLLUTANT OF CONCERN
MISSOURI TRIBUTARIES RIVER BASIN				
Carter Lake	MT1-L0090	Largemouth Bass	Hazard Index	PCBs
Chalkrock Reservoir	MT2-L0020	Largemouth Bass	Hazard Index	Mercury, Selenium
Crystal Cove Lake	MT1-L0020	Largemouth Bass	Hazard Index, Mercury	Mercury
Missouri River	MT1-10000	Channel Catfish	Cancer Risk, Hazard Index	PCBs, Dieldrin
Omaha Creek	MT1-12100	Channel Catfish	Cancer Risk, Hazard Index	PCBs, Dieldrin, Chlordane
Papillion Creek	MT1-10100	Carp	Cancer Risk, Hazard Index	PCBs, Dieldrin
Standing Bear Lake	MT1-L0100	Largemouth Bass	Hazard Index, Mercury	Mercury
Summit Lake	MT1-L0150	Largemouth Bass	Hazard Index, Mercury	Mercury
Walnut Creek Lake	MT1-L0025	Largemouth Bass	Hazard Index, Mercury	Mercury
Wehrspann Lake	MT1-L0030	Largemouth Bass	Hazard Index, Mercury	Mercury
West Papillion Creek	MT1-10250	Carp	Cancer Risk, Hazard Index	PCBs, Dieldrin
Zorinsky Lake	MT1-L0050	Largemouth Bass	Hazard Index, Mercury	Mercury
NEMAHA RIVER BASIN				
Iron Horse Trail Lake	NE2-L0090	Largemouth Bass	Hazard Index, Mercury	Mercury
Little Nemaha River	NE3-10000	Channel Catfish	Cancer Risk, Hazard Index	PCBs, Dieldrin
Missouri River	NE1-10000	Channel Catfish	Cancer Risk, Hazard Index	PCBs, Dieldrin, Chlordane
Prairie Knoll Lake	NE2-L0080	Largemouth Bass	Hazard Index, Mercury	Mercury
Verdon Lake	NE2-L0020	Largemouth Bass	Hazard Index, Mercury	Mercury
NIOBRARA RIVER BASIN				
Box Butte Reservoir	NI4-L0080	Northern Pike	Hazard Index, Mercury	Mercury
Cottonwood Lake	NI4-L0010	Largemouth Bass	Hazard Index, Mercury	Mercury
Cub Creek Lake	NI3-L0070	Largemouth Bass	Hazard Index, Mercury	Mercury
Merritt Reservoir	NI3-L0330	Walleye	Hazard Index, Mercury	Mercury
Niobrara River	NI2-10000	Carp	Hazard Index	Mercury, Selenium
Shell Lake	NI4-L0020	Northern Pike	Hazard Index, Mercury	Mercury
Valentine Mill Pond	NI3-L0170	Largemouth Bass	Hazard Index, Mercury	Mercury
Walgren Lake	NI4-L0050	Largemouth Bass	Hazard Index, Mercury	Mercury
NORTH PLATTE RIVER BASIN				
North Platte River	NP1-10000	Largemouth Bass	Hazard Index, Mercury	Mercury
North Platte River	NP3-10000	Carp	Hazard Index	Mercury, Selenium
REPUBLICAN RIVER BASIN				
Enders	RE3-L0100	White Bass	Hazard Index, Mercury	Mercury
Frenchman WMA Lake	RE3-XXXX	Largemouth Bass	Hazard Index, Mercury	Mercury
Hugh Butler Lake	RE3-L0060	Northern Pike	Hazard Index, Mercury	Mercury
Muddy Creek	RE2-11400	Channel Catfish	Hazard Index, Mercury	Mercury
Rock Creek Lake	RE3-L0120	Largemouth Bass	Hazard Index, Mercury	Mercury
SOUTH PLATTE RIVER BASIN				
Chappell Interstate Lake	SP2-L0010	Largemouth Bass	Hazard Index	Mercury, Selenium
East Hershey Lake	SP1-L0040	Largemouth Bass	Hazard Index, Mercury	Mercury
Hershey Lake	SP1-L0050	Largemouth Bass	Hazard Index, Mercury	Mercury
Interstate Lake	SP1-L0010	Largemouth Bass	Hazard Index, Mercury	Mercury
Maloney Res. Outlet Canal	SP1-10500	Carp	Hazard Index, Mercury	Mercury
Sutherland Outlet Canal	SP1-10600	Carp	Cancer Risk, Hazard Index	PCBs, Mercury

[1] The *Risk Criteria* established by the Nebraska Fish Tissue Advisory Committee include fish tissue that: (1) are found to have mercury concentrations $\geq$ 0.215 mg/kg, (2) have contaminant concentrations that may be associated with adverse health effects (Hazard Index $\geq$ 1.0) or (3) may be associated with an excess Cancer Risk $\geq$ 1 in 10,000 when ingested.

WATERBODY	ID	FISH TYPE	HEALTH RISK CRITERIA VIOLATED[1]	POLLUTANT OF CONCERN
WHITE-HAT CREEK RIVER BASIN – Con't				
Carter P. Johnson Lake	WH1-L0200	Largemouth Bass	Hazard Index, Mercury	Mercury

[1] The *Risk Criteria* established by the Nebraska Fish Tissue Advisory Committee include fish tissue that: (1) are found to have mercury concentrations $\geq$ 0.215 mg/kg, (2) have contaminant concentrations that may be associated with adverse health effects (Hazard Index $\geq$ 1.0) or (3) may be associated with an excess Cancer Risk $\geq$ 1 in 10,000 when ingested.

FISH CONSUMPTION ADVISORY SITES IN NEBRASKA THROUGH 2008

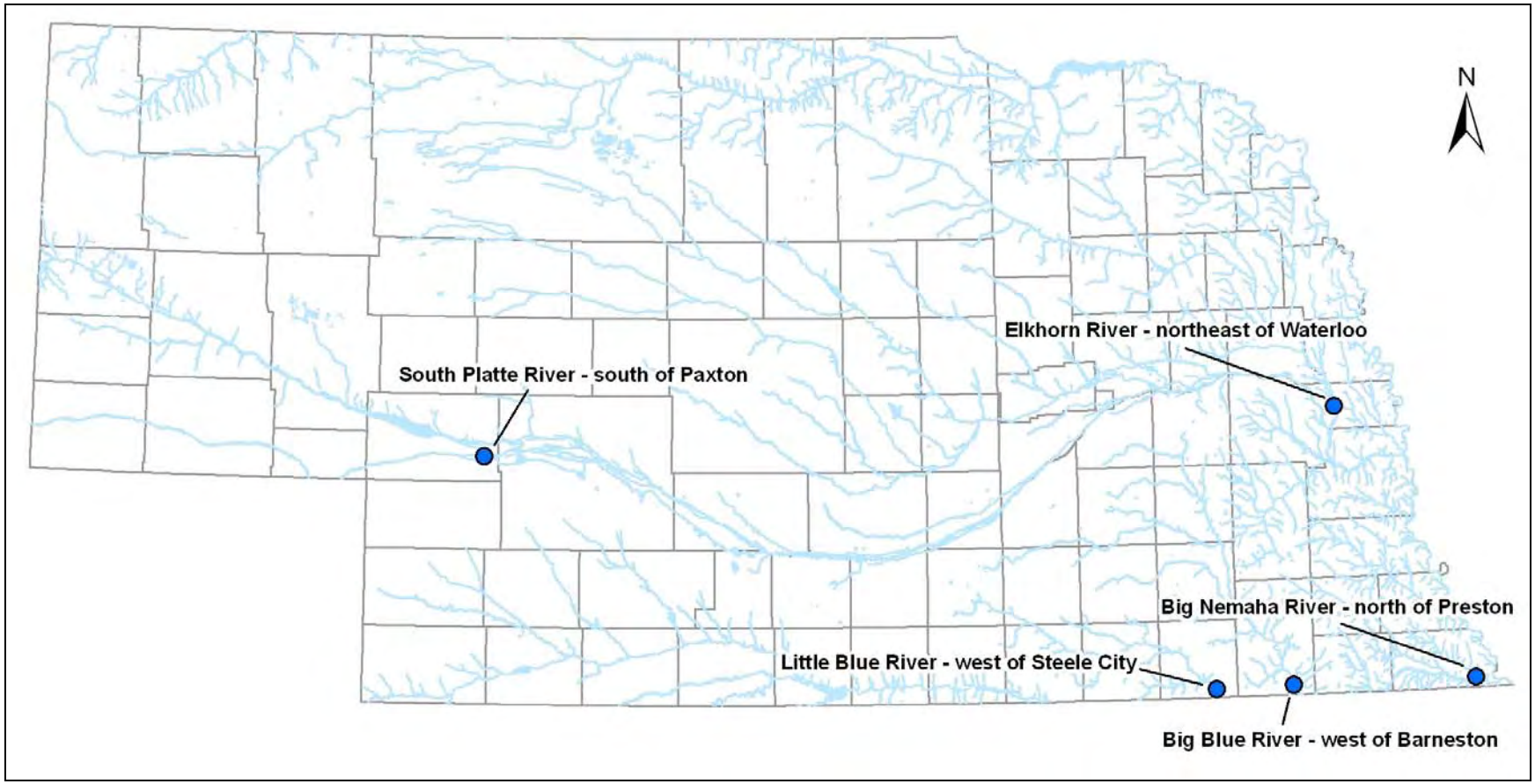


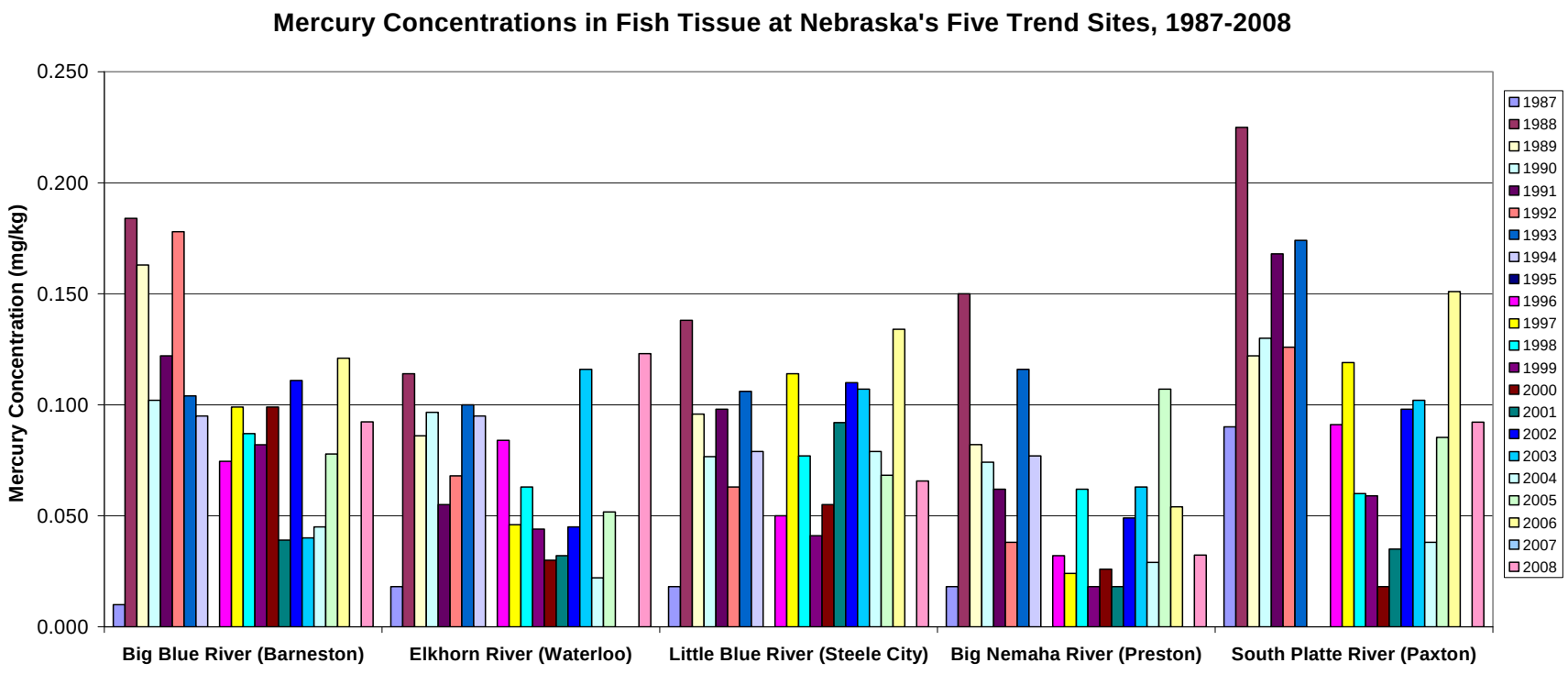
APPENDIX B

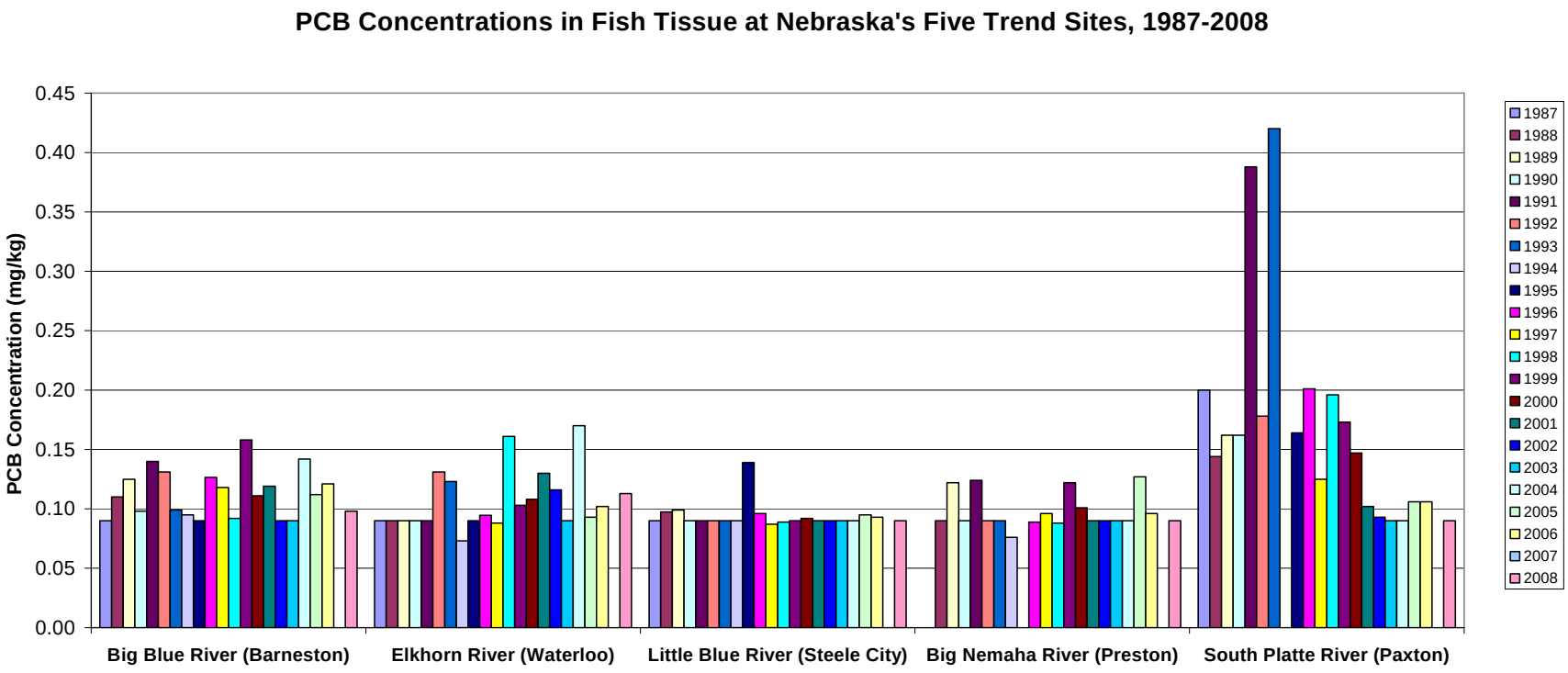
Trend Sites − Map and Contaminant Trend Information

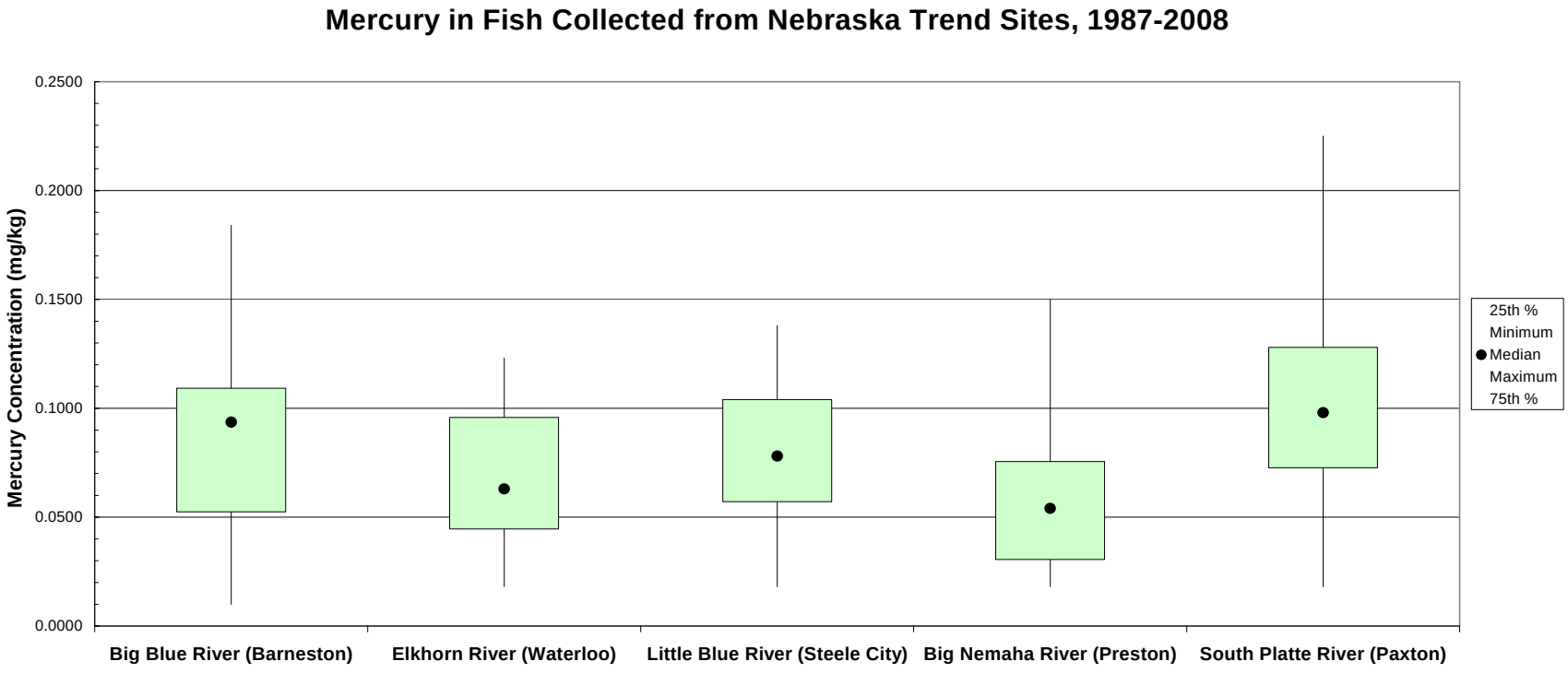
Big Blue River west of Barneston
Elkhorn River northeast of Waterloo
Little Blue River west of Steele City
Big Nemaha River north of Preston
South Platte River south of Paxton

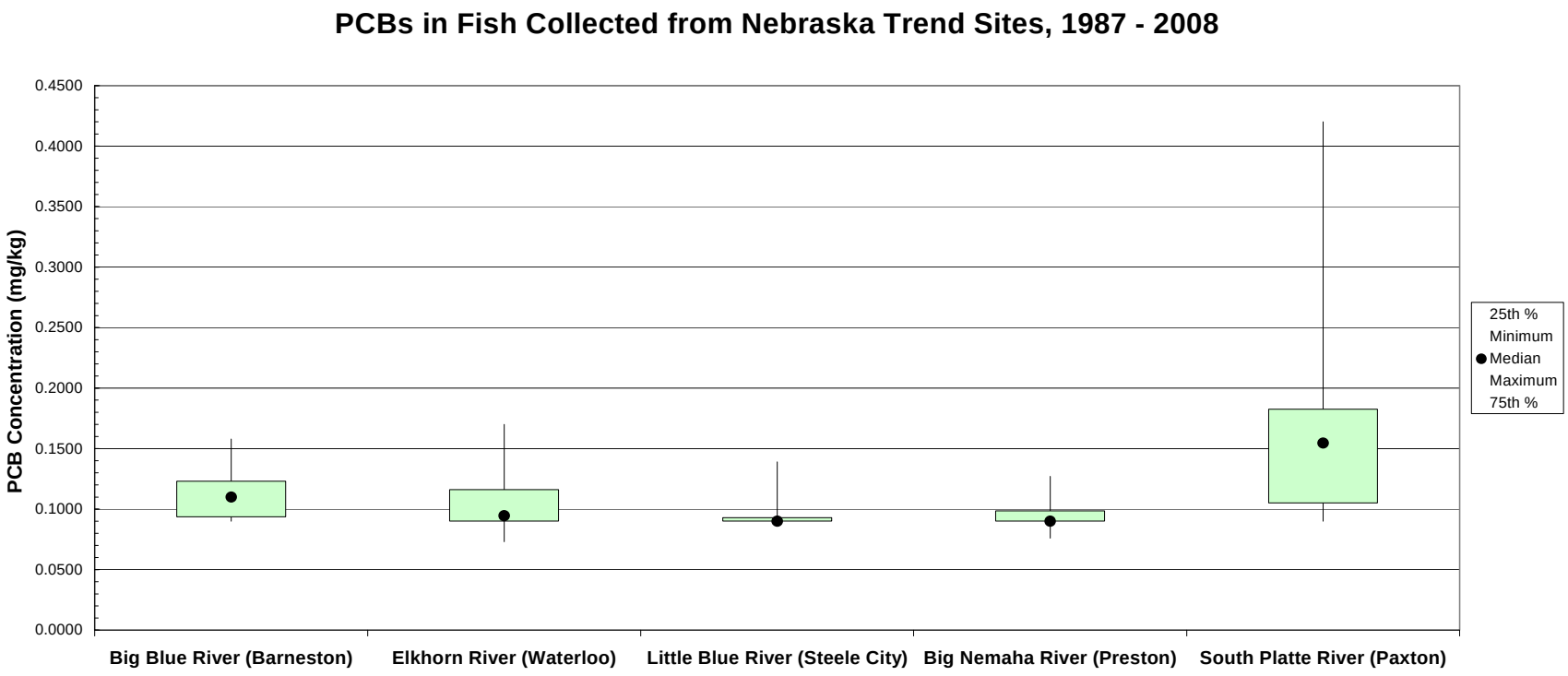
LOCATION OF TREND SITES IN NEBRASKA




Mercury Concentrations in Fish Tissue at Nebraska's Five Trend Sites, 1987-2008
Mercury Concentration (mg/kg)
0.250
0.200
0.150
0.100
0.050
0.000
Big Blue River (Barneston)
Elkhorn River (Waterloo)
Little Blue River (Steele City)
Big Nemaha River (Preston)
South Platte River (Paxton)
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008


PCB Concentrations in Fish Tissue at Nebraska's Five Trend Sites, 1987-2008
PCB Concentration (mg/kg)
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Big Blue River (Barneston)
Elkhorn River (Waterloo)
Little Blue River (Steele City)
Big Nemaha River (Preston)
South Platte River (Paxton)
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008


Mercury in Fish Collected from Nebraska Trend Sites, 1987-2008
Mercury Concentration (mg/kg)
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Big Blue River (Barneston)
Elkhorn River (Waterloo)
Little Blue River (Steele City)
Big Nemaha River (Preston)
South Platte River (Paxton)
25th %
Minimum
Median
Maximum
75th %


PCBs in Fish Collected from Nebraska Trend Sites, 1987 - 2008
PCB Concentration (mg/kg)
0.4500
0.4000
0.3500
0.3000
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Big Blue River (Barneston)
Elkhorn River (Waterloo)
Little Blue River (Steele City)
Big Nemaha River (Preston)
South Platte River (Paxton)
25th %
Minimum
Median
Maximum
75th %