
**Findings of the 2010 Regional Ambient Fish Tissue
Program in Nebraska**



**Nebraska Department of Environmental Quality
Water Quality Assessment Section**

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

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I. EXECUTIVE SUMMARY

The Nebraska Department of Environmental Quality (NDEQ) 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 (PCBs), 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 is under the guidance of Region VII EPA. The EPA's primary monitoring and assessment objectives for the RAFTM program 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.

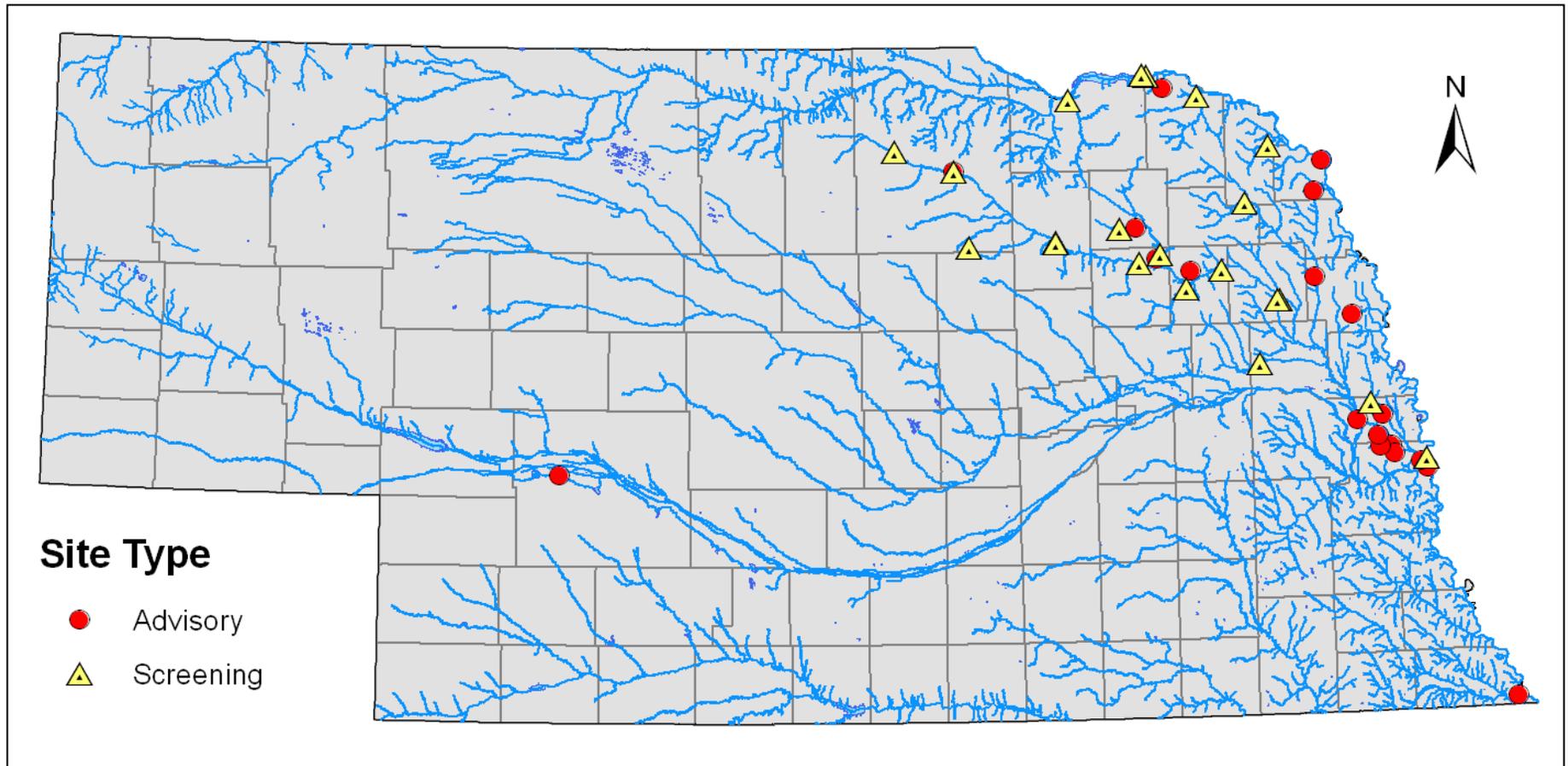
In 2010, a total of 50 samples from 40 locations were collected (see Figure 1 and Methods Section for descriptions). Twenty different streams and 20 lakes/reservoirs were sampled in 2010. Collection locations also included the bi-annual sampling of five waterbodies used for monitoring long-term trends in Regional contaminants. These waterbodies are represented by stream locations near the lower end of their respective drainage basins that have been monitored annually over the past 16-24 years to evaluate trends in the occurrence and concentrations of contaminants in fish tissue. 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

Currently, Nebraska has 78 state-issued advisories. The primary contaminants of concern in fish tissue in Nebraska and most other states are mercury and 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 acids food source, anglers should not be discouraged from consuming fish in moderation.

Figure 1. Nebraska RAFTMP Sampling Locations for 2010.



II. INTRODUCTION

The “Findings of the 2010 Regional Ambient Fish Tissue Program in Nebraska” is written to satisfy the federal fiscal year 2010 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.

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 six-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 EPA’s stated objectives of the RAFTMP are:

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 six-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 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 for over 30 years. This very conservative approach is designed to not underestimate the risk and is referred to as a “reasonable maximum exposure duration” (EPA, 1991). The State issues advisories for mercury levels that equal or exceed 0.215 milligrams of mercury per kilogram of fish tissue, and for other contaminants when the cancer risk estimated equals or exceeds 0.0001 (≥ 1 in 10,000) 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, 2011).

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 be compared to published toxicity values generated from exposure studies in animals, and if available from 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 a 30 year exposure duration period.

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 utilizes what is referred to as a “reasonable maximum exposure duration” of 30 years (EPA, 1991). 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 three 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) *Advisory* – waterbodies that were already under advisory which were re-sampled.
- 3) *Trend* – five established locations where whole fish samples are collected every other year to assess long-term trends in selected contaminants.

From July 2010 through October of 2010, the NDEQ, the NGPC and University of Nebraska – Lincoln (UNL), collected 50 fish samples from 40 locations (20 stream and 20 lakes). Twenty-one *screening* and 19 *advisory* sites were monitored in accordance with the RAFTMP. Table 1 identifies each site sampled in 2010 under the RAFTMP.

In small streams, a backpack or pull-barge type electro-fishing unit was used to collect fish. To collect fish from larger streams, hoop nets and/or a small aluminum boat designed for electro-fishing was used. The nets and electro-fishing gear were employed within a reach one mile above to one mile below the designated site location. Lake and reservoir sampling was conducted using larger electro-fishing boats and/or gill nets. Depending on conditions, direct or alternating current was used to shock the fish.

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 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.

Composite samples ranging from three to five fish of the same species were collected from screening and advisory sites. Only fillets (edible portions) from fish were kept for analyses. 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. 2010 Advisory and Screening Sites in Nebraska.

WATERBODY	LOCATION	SITE TYPE	SAMPLES COLLECTED
Elkhorn River	E of Waterloo, NE	Advisory	1
Maskenthine Lake	N of Stanton, NE	Advisory	1
Logan Creek	W of Lyons, NE	Advisory	1
Willow Creek Lake	SW of Pierce, NE	Advisory	2
Elkhorn River	S of O'Neill, NE	Advisory	2
Skyview Lake	Norfolk, NE	Advisory	1
Missouri River	SE of Bellevue, NE	Advisory	1
Papillion Creek	S of Bellevue, NE	Advisory	1
West Papillion Creek	NW of Papillion, NE	Advisory	1
Omaha Creek	Homer, NE	Advisory	1
Crystal Cove Lake	South Sioux City, NE	Advisory	1
Walnut Creek Lake	Papillion, NE	Advisory	1
Wehrspann Lake	Millard, NE	Advisory	1
Zorinsky Lake	Omaha, NE	Advisory	1
Standing Bear Lake	Omaha, NE	Advisory	1
Summit Lake	W of Tekamah, NE	Advisory	1
Chalkrock Reservoir	NE of Crofton, NE	Advisory	1
Missouri River	Rulo, NE	Advisory	1
Sutherland Outlet Canal	S of Hershey, NE	Advisory	1
West Point City Lake	West Point, NE	Screening	2
Penn Park Lake	Neligh, NE	Screening	1
O'Neill City Lake	O'Neill, NE	Screening	1
Offutt Lake	SE of Bellevue, NE	Screening	2
Lake Bennington	W of Bennington, NE	Screening	1
Maple Creek	N of Fremont, NE	Screening	1
Elkhorn River	W of West Point, NE	Screening	1
Union Creek	SW of Stanton, NE	Screening	1
Red Fox Lake	S of Pilger, NE	Screening	2
South Fork Logan Creek	W of Wakefield, NE	Screening	1
North Fork Elkhorn River	N of Norfolk, NE	Screening	1
Elkhorn River	NE of Battle Creek, NE	Screening	1
Elkhorn River	S of Neligh, NE	Screening	1
Goose Lake	N of Bartlett, NE	Screening	1
Atkinson Lake	W of Atkinson, NE	Screening	1
South Creek	SW of Ponca, NE	Screening	1
Bow Creek	N of Wynot, NE	Screening	1
Bazile Creek	E of Niobrara, NE	Screening	1
Lake Yankton	N of Crofton, NE	Screening	1
Lewis and Clark Lake	N of Crofton, NE	Screening	1
Willow Creek	SW of Pierce, NE	Screening	1

Note: Advisory Site (single composite fillets); Screening Site (bottom feeder and/or predator – 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. Samples collected by the NDEQ, UNL and NGPC were all 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 reporting limits (RLs) in place of method detection limits (MDLs). RLs 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 the total 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 Target Reporting Limits of Fish Tissue Samples Analyzed by the EPA Region VII Laboratory During 2010.

<u>Contaminant</u>	<i>Target Reporting Limit EPA Region VII (mg/kg)</i>
<i>Analysis by Inductively Coupled Plasma Emission Spectroscopy</i>	
Cadmium	0.06
Lead	0.17
Selenium	0.5
<i>Analysis by Cold Vapor Atomic Absorption</i>	
Mercury	0.0181
<i>Analysis by Gas Chromatograph/Electron Capture</i>	
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

**Toxicity values for pentachlorophenol used. Pentachloranisole is a breakdown product of pentachlorophenol.

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-threshold.

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 (mg/kg/day)	CSF (mg/kg/day)
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

NA¹ – Not assessed under the IRIS program

NA² – 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 approach 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 reporting limit (RL). Contaminants not detected - or below the analytical RL are not included in the risk assessment calculations.
- 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:

$$\text{Intake (mg/kg/day)} = \frac{(\text{CC})(\text{IR})(\text{EF})(\text{ED})(\text{AF})}{(\text{BW})(\text{AT})}, \quad \text{where}$$

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 - 30 years

AF = Absorption Factor - 1.0 (total absorption)

*BW = Body Weight: 154 lbs. (70 kg)

*ATnc = Average in Time (1,560 weeks/30 years) for noncarcinogenic effects

* Note: Advisory determinations were based on a 154 lb. (70 kg) consumer ingesting 8 oz. (0.227 kg) weekly meal portions over a 30 year exposure duration. Carcinogenic effects are still averaged over a lifetime of 70 years (3,640 weeks) because it is assumed cancer can develop at anytime during one's lifetime, even after the exposure to the carcinogen has ended.

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.

$$\text{Hazard Quotient (HQ)} = \text{Intake (mg/kg-day)}/\text{RfD (mg/kg-day)}$$

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 noncarcinogenic 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).

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

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, 2010).

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:

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

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. Because 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 the estimated cancer risk equals or exceeds 0.0001 (≥ 1 in 10,000) or when adverse noncancer health effects may be possible from ingesting fish (Hazard Index ≥ 1.0), advisories are issued. Advisories are also issued for mercury levels that equal or exceed 0.215 milligrams of mercury per kilogram of fish tissue.

Sampling Location Requirements

Fish tissue samples are collected annually from selected rivers and lakes in accordance with Nebraska's six-year rotating basin monitoring approach. Trend monitoring of whole fish at five established waterbodies (see Appendix B) is conducted bi-annually and sampling was conducted in 2010. Sites where previous RAFTMP sampling has revealed high levels of contaminants in fish tissue and advisories have been issued are re-sampled every six years. If conditions have improved the advisories are removed and the site will be considered for re-sampling in the future.

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 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 Elkhorn and Missouri Tributaries River basins in 2010. In addition, one advisory site in the South Platte basin was also sampled. 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.

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, 2012). 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.

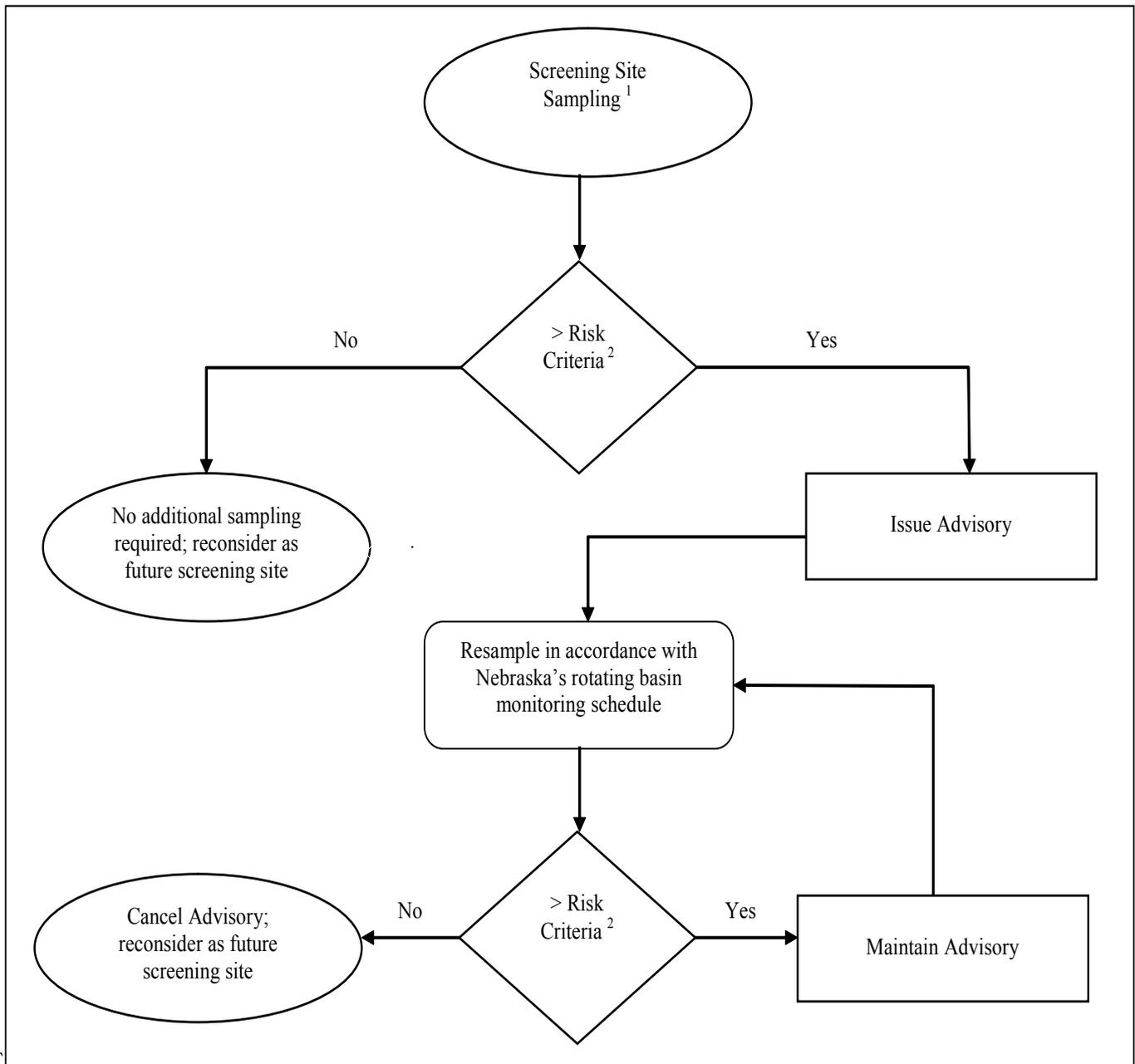
Once an advisory is issued for a waterbody it will remain in effect until additional sampling of that same fish species indicates that a health concern no longer exists. Advisory waters are sampled in accordance with Nebraska's rotating basin monitoring schedule (i.e., every sixth year). If a sample 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 ≥ 0.215 mg/kg, (2) have contaminant concentrations that may be associated with adverse health effects (Hazard Index ≥ 1.0) or (3) may be associated with an excess Cancer Risk ≥ 1 in 10,000 when ingested.

VI. RESULTS AND DISCUSSION

2010 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. In 2010, the NDEQ, UNL, and NGPC collected a total of 50 samples from 40 different sites (Figure 1). Three RAFTMP *screening* sites had single fillet samples of two different fish species collected (i.e., one bottom-feeder and one predatory species) and 18 sites yielded only a single species sample. Seventeen of 19 *advisory* sites had single fish species samples and two yielded a two species sample. Whole fish samples were also collected at the five *trend* site locations in 2010. In all, fish were collected from 16 different streams and 20 lakes.

Contaminants of Concern

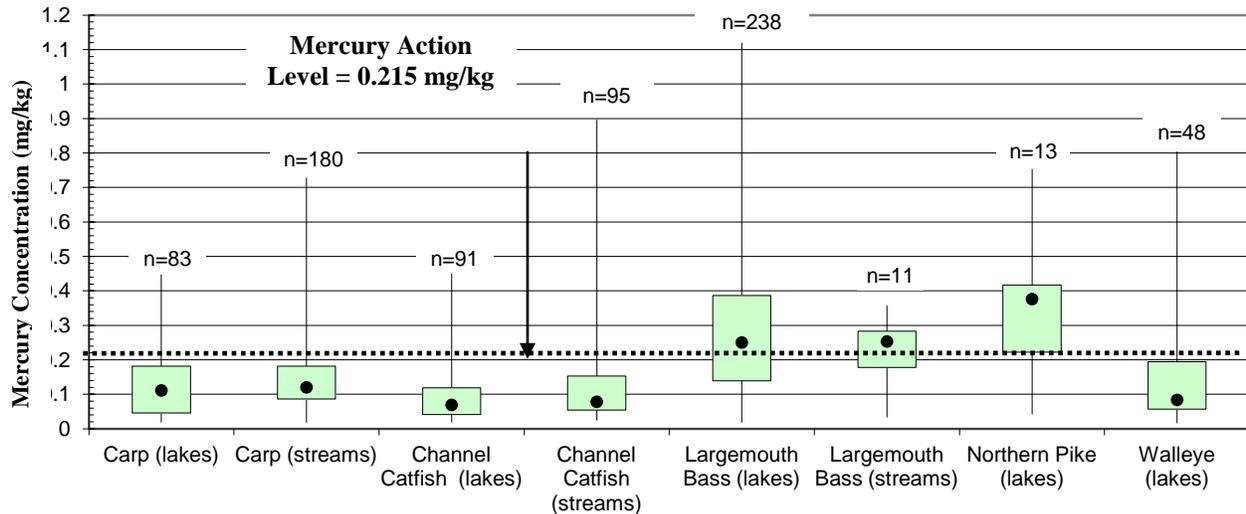
Methylmercury and PCBs are the contaminants of primary concern in Nebraska fish. Dieldrin is also frequently detected in fish tissue samples, but by itself dieldrin concentrations rarely cause human health risk criteria to be exceeded. However, given the cumulative risk calculations that Nebraska produces, 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, 2012). 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.



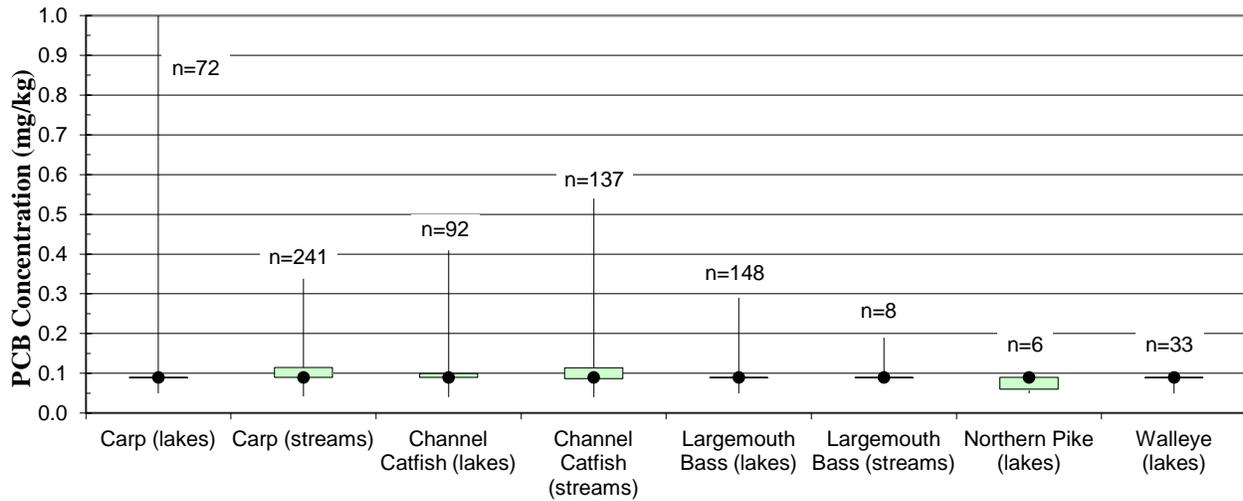
Polychlorinated Biphenyls (PCBs)

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.



Risk Assessment Results

Table 5 summarizes the findings of the 2010 Regional Ambient Fish Tissue analysis. This includes the 2010 screening and previous advisory site locations. 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 2010

WATERBODY	WATER-BODY ID	LOCATION	FISH SPECIES	CANCER RISK (≥0.0001)	HAZARD INDEX (≥1.0)	MERCURY CONC. (≥0.215 mg/kg)
PREVIOUS ADVISORY LOCATIONS						
Elkhorn River	EL1-10000	E of Waterloo, NE	Carp	<0.0001	0.40	0.080
Maskenthine Lake	EL1-L0080	N of Stanton, NE	LM Bass	<0.0001	2.11	0.456
Logan Creek	EL2-10000	W of Lyons, NE	Channel Cat	<0.0001	0.03	0.054
Willow Creek Lake	EL3-L0010	SW of Pierce, NE	Carp	<0.0001	0.62	0.134
			LM Bass	N/A	0.10	0.210
Elkhorn River	EL4-30000	S of O'Neill, NE	Carp	<0.0001	0.70	0.145
			Channel Cat	N/A	0.93	0.202
Skyview Lake	EL4-L0020	Norfolk, NE	LM Bass	<0.0001	0.86	0.086
Missouri River	MT1-10000	SE of Bellevue, NE	Channel Cat	<0.0001	0.55	0.061
Papillion Creek	MT1-10100	S of Bellevue, NE	Carp	<0.0001	0.39	0.054
West Papillion Creek	MT1-10250	NW of Papillion, NE	Carp	<0.0001	1.00	0.040
Omaha Creek	MT1-12100	Homer, NE	Channel Cat	<0.0001	0.23	0.050
Crystal Cove Lake	MT1-L0200	South Sioux City, NE	LM Bass	<0.0001	3.36	0.726
Walnut Creek Lake	MT1-L0025	Papillion, NE	LM Bass	<0.0001	2.09	0.424
Wehrspann Lake	MT1-L0030	Millard, NE	LM Bass	<0.0001	2.11	0.456
Zorinsky Lake	MT1-L0050	Omaha, NE	LM Bass	<0.0001	1.13	0.245
Standing Bear Lake	MT1-L0100	Omaha, NE	LM Bass	<0.0001	2.49	0.537
Summit Lake	MT1-L0150	W of Tekamah, NE	LM Bass	<0.0001	0.98	0.212
Chalkrock Reservoir	MT2-L0020	NE of Crofton, NE	LM Bass	<0.0001	0.73	0.157
Missouri River	NE1-10000	Rulo, NE	Channel Cat	<0.0001	0.42	0.071
Sutherland Outlet Canal	SP1-10600	S of Hershey, NE	Channel Cat	<0.0001	1.47	0.133
SCREENING LOCATIONS						
West Point City Lake	EL1-L0060	West Point, NE	Bluegill	<0.0001	0.71	0.146
			LM Bass	N/A	1.36	0.293
Penn Park Lake	EL4-L0040	Neligh, NE	Carp	<0.0001	0.54	0.071
O'Neill City Lake	EL4-L0060	O'Neill, NE	LM Bass	<0.0001	2.04	0.440
Offutt Lake	MT1-L0010	SE of Bellevue, NE	Channel Cat	0.0002	5.41	0.054
			SM Bass	N/A	0.20	0.043
Lake Bennington	MT1-LXXXX	W of Bennington, NE	LM Bass	<0.0001	3.31	0.690
Maple Creek	EL1-10900	N of Fremont, NE	Channel Cat	<0.0001	0.26	0.042
Elkhorn River	EL1-20000	W of West Point, NE	Carp	<0.0001	0.34	0.058
Union Creek	EL1-21900	SW of Stanton, NE	Channel Cat	<0.0001	0.31	0.057

RL = Analytical results below the target reporting limit are expressed as "less than" the reporting limit.

NOTE: Boldface type indicates risk criteria were exceeded. 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 30 years for calculating health risks (NDEQ, 2011). Carcinogenic effects are still averaged over a lifetime of 70 years because it is assumed cancer can develop at anytime during one's lifetime, even after the exposure to the carcinogen has ended.

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						
Red Fox Lake	EL1-LXXXX	S of Pilger, NE	Channel Cat	<0.0001	0.32	0.070
			LM Bass	N/A	0.88	0.191
South Fork Logan Creek	EL2-20800	W of Wakefield, NE	Channel Cat	<0.0001	0.23	0.042
North Fork Elkhorn River	EL3-20000	N of Norfolk, NE	Carp	<0.0001	0.03	0.044
Elkhorn River	EL4-10000	NE of Battle Creek, NE	Channel Cat	<0.0001	0.66	0.131
Elkhorn River	EL4-20000	S of Neligh, NE	Channel Cat	<0.0001	0.82	0.170
Goose Lake	EL4-L0050	N of Bartlett, NE	LM Bass	<0.0001	0.82	0.177
Atkinson Lake	EL4-L0070	W of Atkinson, NE	Carp	<0.0001	0.77	0.167
South Creek	MT2-10520	SW of Ponca, NE	Channel Cat	<0.0001	0.12	0.027
Bow Creek	MT2-11400	N of Wynot, NE	Channel Cat	<0.0001	0.14	0.031
Bazile Creek	MT2-12400	E of Niobrara, NE	Channel Cat	<0.0001	0.22	0.047
Lake Yankton	MT2-L0030	N of Crofton, NE	Carp	<0.0001	0.04	0.008
Lewis and Clark Lake	MT2-L0040	N of Crofton, NE	SM Bass	<0.0001	0.58	0.102
Willow Creek	EL3-20200	SW of Pierce, NE	Channel Cat	<0.0001	0.65	0.140

RL = Analytical results below the target reporting limit are expressed as "less than" the reporting limit.

NOTE: Boldface type indicates risk criteria were exceeded. 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 30 years for calculating health risks (NDEQ, 2011). Carcinogenic effects are still averaged over a lifetime of 70 years because it is assumed cancer can develop at anytime during one's lifetime, even after the exposure to the carcinogen has ended.

VII. SUMMARY

A list of Nebraska streams and lakes monitored in 2010 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 21 screening sites. Tissue samples collected from 17 sites did not exceed any of the State's risk criteria and will not come under advisory. Samples collected at three sites exceeded the risk criteria for mercury. A fourth lake's sample exceeded the risk criteria with a Hazard Index ≥ 1.0 and the primary contaminant found in fish tissue was PCBs.
2. Nineteen *advisory* sites were monitored in 2010. Advisories will be maintained at eight of the 19 sites based on contaminant levels still exceeding risk criteria. Consumption advisories were removed from the remaining 11 sites as their respective samples indicated contaminant levels below human health risk criteria.
3. In all, 4 waterbodies monitored in 2010 came under advisory, eight sites that were already under an advisory remained listed, and 11 sites were removed.
4. Combined with previous year's assessments, 78 Nebraska waterbodies (12 stream segments and 66 lakes) are now under fish consumption advisories (see *Appendix A* for site list and map).

Table 6. Nebraska Streams and Lakes Monitored in 2010 and Their Advisory Status.

WATERBODY	WATER-BODY ID	LOCATION	FISH TYPE	ADVISORY ACTION	LISTING REASON¹
ADVISORY LOCATIONS					
Elkhorn River	EL1-10000	E of Waterloo, NE	Carp	Remove	< Risk Criteria
Maskenthine Lake	EL1-L0080	N of Stanton, NE	LM Bass	Maintain	H.I., Mercury
Logan Creek	EL2-10000	W of Lyons, NE	Channel Cat	Remove	< Risk Criteria
Willow Creek Lake	EL3-L0010	SW of Pierce, NE	LM Bass	Remove	< Risk Criteria
Elkhorn River	EL4-30000	S of O'Neill, NE	Carp	Remove	< Risk Criteria
Skyview Lake	EL4-L0020	Norfolk, NE	LM Bass	Remove	< Risk Criteria
Missouri River	MT1-10000	SE of Bellevue, NE	Channel Cat	Remove	< Risk Criteria
Papillion Creek	MT1-10100	S of Bellevue, NE	Carp	Remove	< Risk Criteria
West Papillion Creek	MT1-10250	NW of Papillion, NE	Carp	Maintain	H.I.
Omaha Creek	MT1-12100	Homer, NE	Channel Cat	Remove	< Risk Criteria
Crystal Cove Lake	MT1-L0200	South Sioux City, NE	LM Bass	Maintain	H.I., Mercury
Walnut Creek Lake	MT1-L0025	Papillion, NE	LM Bass	Maintain	H.I., Mercury
Wehrspann Lake	MT1-L0030	Millard, NE	LM Bass	Maintain	H.I., Mercury
Zorinsky Lake	MT1-L0050	Omaha, NE	LM Bass	Maintain	H.I., Mercury
Standing Bear Lake	MT1-L0100	Omaha, NE	LM Bass	Maintain	H.I., Mercury
Summit Lake	MT1-L0150	W of Tekamah, NE	LM Bass	Remove	< Risk Criteria
Chalkrock Reservoir	MT2-L0020	NE of Crofton, NE	LM Bass	Remove	< Risk Criteria
Missouri River	NE1-10000	Rulo, NE	Channel Cat	Remove	< Risk Criteria
Sutherland Outlet Canal	SP1-10600	S of Hershey, NE	Channel Cat	Maintain	H.I.
SCREENING LOCATIONS					
West Point City Lake	EL1-L0060	West Point, NE	LM Bass	New Advisory	Mercury
O'Neill City Lake	EL4-L0060	O'Neill, NE	LM Bass	New Advisory	H.I., Mercury
Offutt Lake	MT1-L0010	SE of Bellevue, NE	Channel Cat	New Advisory	C.R., H.I.
Lake Bennington	MT1-Lxxxx	W of Bennington, NE	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.

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APPENDIX A

NEBRASKA FISH CONSUMPTION ADVISORIES THROUGH 2010

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 30 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
Willard L. Meyer / Swan Creek Lake 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
West Point City Lake	EL1-L0060	Largemouth Bass	Mercury	Mercury
Maskenthine Lake	EL1-L0080	Largemouth Bass	Hazard Index, Mercury	Mercury
O'Neill City Lake	EL4-L0060	Largemouth Bass	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				
Bluestem Lake	LP2-L0110	Channel Cat	Hazard Index, Mercury	Mercury
Czechland Lake	LP2-L0270	Largemouth Bass	Hazard Index, Mercury	Mercury
Fremont Lake No. 1	LP1-L0290	Largemouth Bass	Hazard Index, Mercury	Mercury
Holmes Lake	LP2-L0040	Largemouth Bass	Hazard Index, Mercury	Mercury
Johnson Lake	LP1-Lxxxx	Largemouth Bass	Hazard Index, Mercury	Mercury
Memphis Lake	LP2-L0010	Largemouth Bass	Hazard Index	Mercury
Merganser Lake	LP2-L0170	Largemouth Bass	Hazard Index	Mercury
Oak Creek	LP2-20500	Channel Cat	Hazard Index	PCBs, Mercury
Platte River	LP1-10000	Channel Cat	Hazard Index	PCBs, Mercury
Salt Creek	LP2-20000	Carp	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 ≥ 0.215 mg/kg, (2) have contaminant concentrations that may be associated with adverse health effects (Hazard Index ≥ 1.0) or (3) may be associated with an excess Cancer Risk ≥ 1 in 10,000 when ingested.

APPENDIX A – Con’t

WATERBODY	ID	FISH TYPE	HEALTH RISK CRITERIA VIOLATED ¹	POLLUTANT OF CONCERN
LOWER PLATTE RIVER BASIN - Con't				
Stagecoach Lake	LP2-L0050	Largemouth Bass	Hazard Index, Mercury	Mercury
Wagon Train Lake	LP2-L0030	Largemouth Bass	Hazard Index, Mercury	Mercury
Wildwood Reservoir	LP2-L0120	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
Eagle Scout Lake	MP1-L0120	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
Yanney Park Lake	MP2-Lxxxx	Largemouth Bass	Hazard Index, Mercury	Mercury, Selenium
MISSOURI TRIBUTARIES RIVER BASIN				
Carter Lake	MT1-L0090	Largemouth Bass	Hazard Index	PCBs
Crystal Cove Lake	MT1-L0020	Largemouth Bass	Hazard Index, Mercury	Mercury
Offutt Lake	MT1-L0010	Channel Cat	Cancer Risk	PCBs
Halleck Park Lake	MT1-L0023	Largemouth Bass	Hazard Index	Mercury, Selenium
Lake Bennington	MT1-LXXX	Largemouth Bass	Hazard Index, Mercury	Mercury
Standing Bear Lake	MT1-L0100	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	Hazard Index	PCBs, Mercury
Zorinsky Lake	MT1-L0050	Largemouth Bass	Hazard Index, Mercury	Mercury
NEMAHA RIVER BASIN				
Burchard Lake	NE2-L0120	Largemouth Bass	Hazard Index, Mercury	Mercury
Iron Horse Trail Lake	NE2-L0090	Largemouth Bass	Hazard Index, Mercury	Mercury
Kirkman's Cove Lake	NE2-L0040	Largemouth Bass, Carp	Hazard Index, Mercury	Mercury
Mayberry WMA Lake	NE2-Lxxxx	Largemouth Bass	Hazard Index, Mercury	Mercury
Prairie Knoll Lake	NE2-L0080	Largemouth Bass	Hazard Index, Mercury	Mercury
Steinart Park Lake	NE1-L0010	Largemouth Bass	Hazard Index, Mercury	Mercury
Verdon Lake	NE2-L0020	Largemouth Bass	Hazard Index, Mercury	Mercury
Weeping Water City Lake	NE1-L0020	Largemouth Bass	Hazard Index, Mercury	Mercury, Selenium
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

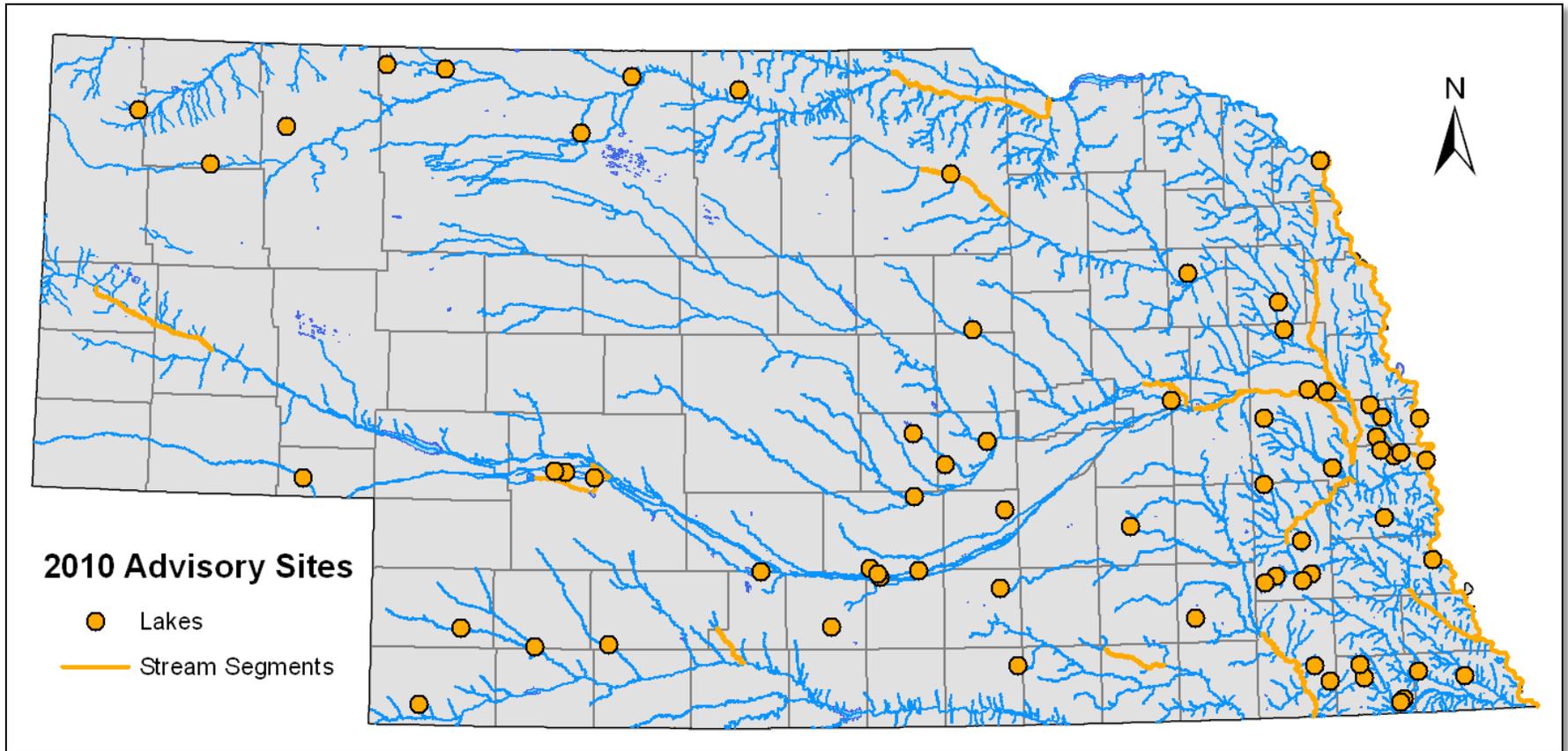
¹ The *Risk Criteria* established by the Nebraska Fish Tissue Advisory Committee include fish tissue that: (1) are found to have mercury concentrations ≥ 0.215 mg/kg, (2) have contaminant concentrations that may be associated with adverse health effects (Hazard Index ≥ 1.0) or (3) may be associated with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

APPENDIX A – Con’t

WATERBODY	ID	FISH TYPE	HEALTH RISK CRITERIA VIOLATED¹	POLLUTANT OF CONCERN
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 Reservoir	RE3-L0100	White Bass	Hazard Index, Mercury	Mercury
Frenchman WMA Lake	RE3-xxxx	Largemouth Bass	Hazard Index, Mercury	Mercury
Holdrege Park Lake	RE1-L0040	Largemouth Bass	Hazard Index	Mercury, Selenium
Hugh Butler / Red Willow 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
North Platte 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	Channel Catfish	Cancer Risk, Hazard Index	PCBs, Mercury
WHITE-HAT CREEK RIVER BASIN				
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 ≥ 0.215 mg/kg, (2) have contaminant concentrations that may be associated with adverse health effects (Hazard Index ≥ 1.0) or (3) may be associated with an excess Cancer Risk ≥ 1 in 10,000 when ingested.

FISH CONSUMPTION ADVISORY SITES IN NEBRASKA THROUGH 2010



APPENDIX B

LOCATION OF TREND SITES IN NEBRASKA

