Regional Ambient Fish Tissue Monitoring Program

2016 Data Assessment Report

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.

Greg Michl
Program Coordinator

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I. EXECUTIVE SUMMARY

The Nebraska Department of Environmental Quality (NDEQ) annually samples fish for tissue analyses as part of the U.S. Environmental Protection Agency's (EPA) "Regional Ambient Fish Tissue Monitoring" (RAFTM) program. The EPA's Region VII laboratory in Kansas City, Kansas conducts the chemical analyses of these tissue samples. Historically samples have been analyzed for four heavy metals, nine pesticides and their breakdown products, and three polychlorinated biphenyl compounds (PCBs). In 2013, EPA informed the Region VII States that with the exception of mercury, future analysis for all other contaminants would be discontinued due to their declining trends and/or non-detects in fish tissue samples. Overall this is very positive environmental news for this region. While mercury continues to be the major pollutant of concern in fish tissue statewide, numerous locations remain under "fish consumption advisories" for PCBs. The NDEQ is committed to continue PCB monitoring at those locations using a contract laboratory.

The EPA's primary monitoring and assessment objectives for the RAFTM program are:

- Provide states with data to answer the question "are the fish safe to eat?"
- Provide states with 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.

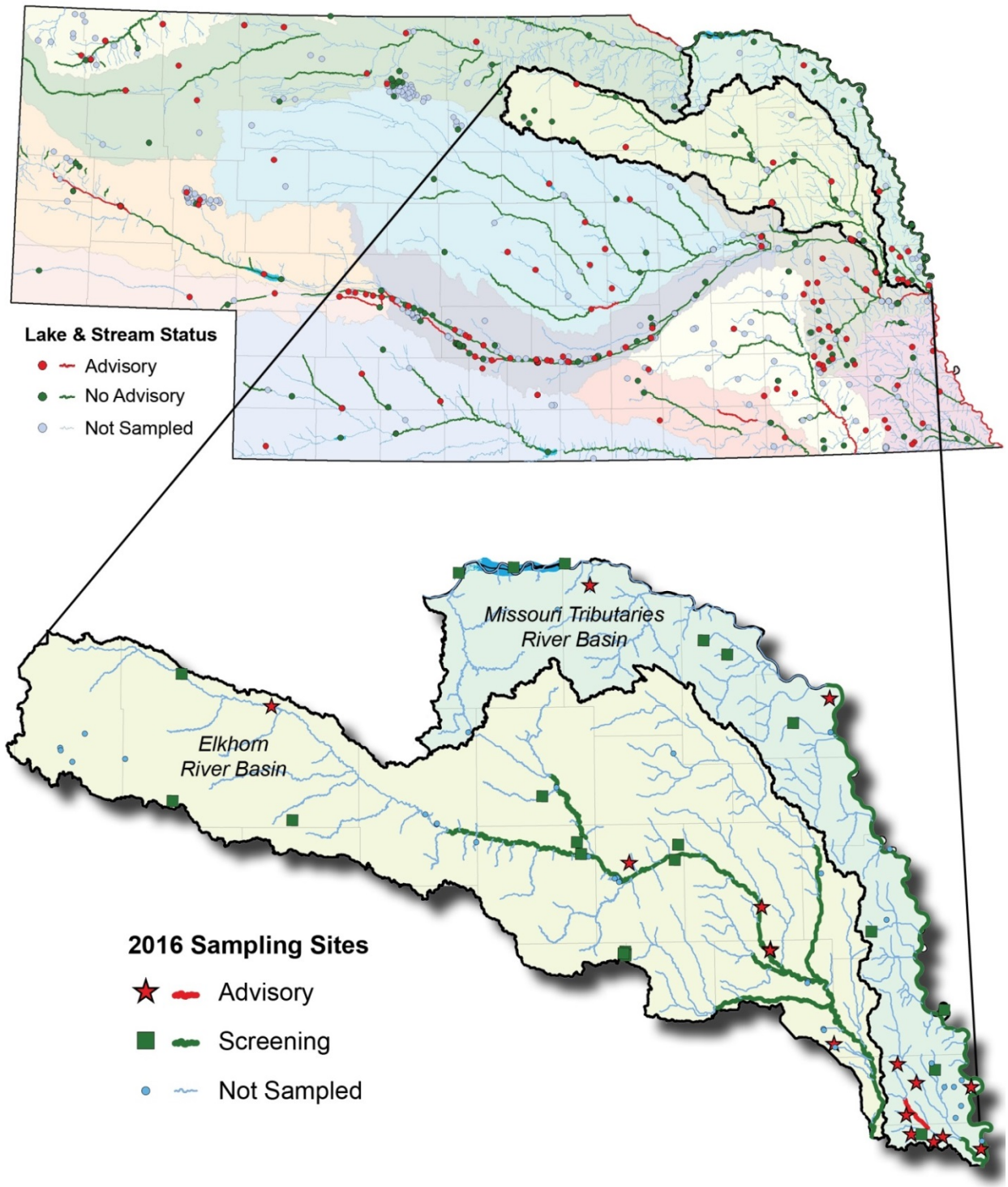
This report details the data assessment results for fish tissue samples collected in 2016 throughout the Elkhorn and Missouri Tributaries River basins. A total of 91 fish tissue samples were collected from 8 streams/rivers and 34 lakes/reservoirs (see Figure 1 and Methods Section for site descriptions).

Currently, Nebraska has 141 state-issued advisories. The primary contaminants of concern in Nebraska fish and most other states continues to be 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 provides the public with an explanation of the State's fish tissue program. One of the primary goals of the program is to ensure the public has as much information as possible regarding the waterbodies that they use for fishing.

Because fish are a high quality protein, low in saturated fat, and high in omega-3 fatty acids, anglers should not be discouraged from consuming fish in moderation. In 2013, the Department of Health and Human Services (NDHHS) in cooperation with the Nebraska Game and Parks Commission (NGPC) and NDEQ jointly released an informational brochure on safely selecting and preparing locally caught, store bought, and restaurant fish. For more information go to: www.nebraska.gov/eatsafefish .

Figure 1. Statewide Waterbody Advisory Status and 2016 Fish Tissue Sampling Sites (see Table 1 for site list).



II. INTRODUCTION

The "Regional Ambient Fish Tissue Monitoring Program – 2016 Data Assessment Report" is written to satisfy the federal fiscal year 2016 State of Nebraska-EPA Agreement, as well as provide information to other governmental agencies, professional organizations, and most importantly to the general public. It is important that anglers and others are informed of potential health risks associated with consuming contaminated fish from certain Nebraska waterbodies.

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.

Under the Region VII EPA Ambient Fish Tissue Monitoring Program (RAFTMP), the NDEQ, in association with its six-year rotating river basin monitoring schedule (see Figure 2), collects fish from state waters annually. The Region VII EPA laboratory in Kansas City, Kansas, analyzes samples for mercury, and the University of Iowa - Hygienic Laboratory in Iowa City, Iowa conducts the PCB analyses.

The EPA's stated objectives of the RAFTMP are:

1. Provide states with data to answer the question "are the fish safe to eat?"
2. Provide states with 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.

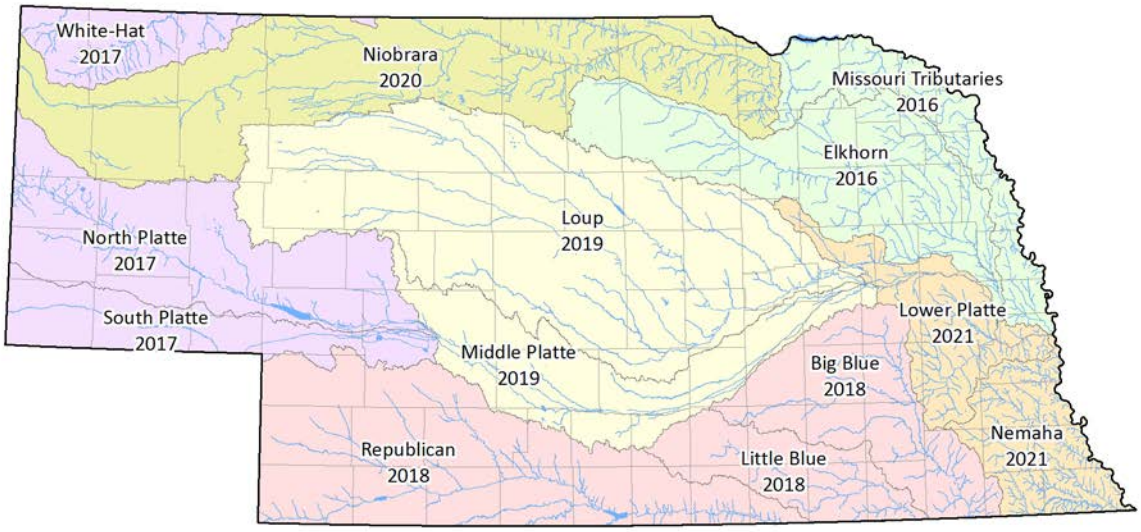
Waterbodies where RAFTMP sampling has revealed exceedances of health risk criteria and subsequent consumption advisories have been issued; are re-sampled following the rotating basin monitoring schedule. Re-sampled sites will be removed from the advisory list if their respective samples indicate contaminant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

Currently the NDHHS, in cooperation with the NDEQ, the NGPC, and NDA, issues fish consumption advisories for waterbodies where concentrations of contaminants may indicate a human 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 26 years. This very conservative approach is designed to not underestimate the risks and is referred to as a "reasonable maximum exposure duration" (EPA, 2016b). 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 ($\geq$ 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 fish tissue monitoring program 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, and 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 may also exist in parameter lists generated

Figure 2. NDEQ's Six-Year Basin Rotation Monitoring Schedule.



because certain 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, and assessments are rarely performed.

Like Nebraska, most states are utilizing a risk-based assessment (RBA) approach similar to that used by the EPA. In the assessment process, in addition to determining if a contaminant poses a potential cancer risk, the potential for adverse health effects or noncarcinogenic effects are also estimated. 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. Nebraska's "Policy for Issuing Nebraska Fish Consumption Advisories" (NDEQ, 2011) explains the rationale behind and the process employed to issue fish consumption advisories.

Risk-based 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. These equations result in values 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 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) − 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.

Exposure Duration (ED) − 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 26 years (EPA, 2016b). Advisories are issued under this assumption, but shorter exposure durations are more likely.

III. SAMPLING METHODS

Sampling sites for the RAFTM program are currently categorized into two 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.

From July through October of 2016, the NDEQ and the UNL collected 91 fish samples from 44 locations (8 streams and 34 lakes). Twenty-eight screening and 16 advisory sites were monitored in accordance with the RAFTMP within the Elkhorn and Missouri Tributaries River basins (see Figure 2). Table 1 identifies each site sampled in 2016.

In small streams, a backpack or pull-barge electo-fishing units were 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.

Considerable sampling effort is given to collect tissue samples from as many "angler-targeted" fish species as possible from screening and advisory sites (i.e., largemouth and smallmouth bass, yellow perch, northern pike, walleye, bluegill, white and black crappie, channel and flathead catfish, carp, etc.). To ensure data comparability at advisory sites, it is a priority to collect the fish species that previously exhibited contaminant concentrations above the State's accepted risk criteria.

Samples collected from screening and advisory sites (see Figure 1) are a composite made up of three to five fish of the same species. Biopsy tissue plugs removed from the dorsal muscle region of each fish were kept for all samples in 2016 for mercury analysis. Additionally, fillets (edible portions) were retained for PCB analysis at six locations. 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.

Length and weight measurements of each fish used in a composite sample were recorded on a field sheet. Fillet samples were prepared in the field with the scales removed from scaled fish and skin removed from catfish and bullhead species. Biopsy tissue samples for mercury analysis were also collected by scraping the scales away from a small area near each fish's dorsal fin before removing the

plug. Samples were frozen as soon as possible after collection. Biopsy tissue samples collected for mercury analysis were analyzed at the Region VII EPA laboratory in Kansas City, Kansas. Fillets samples collected for PCB analysis were analyzed at the University of Iowa - State Hygienic Laboratory in Coralville, Iowa.

Parameter coverage and reporting limits for tissue samples analyzed are listed in Table 3. 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 1. 2016 Advisory and Screening Sites in Nebraska.

WATERBODY	COUNTY	SITE TYPE	# SPECIES/ SAMPLES COLLECTED
Chalkrock Reservoir	Cedar	Advisory	1
West Point City Lake	Cuming	Advisory	3
Crystal Cove Lake	Dakota	Advisory	2
Johnson Lake	Dodge	Advisory	2
Dead Timber Lake	Dodge	Advisory	2
Carter Lake	Douglas	Advisory	3
Prairieview Lake	Douglas	Advisory	2
Standing Bear Lake	Douglas	Advisory	3
Zorinsky Lake	Douglas	Advisory	4
O'Neill City Lake	Holt	Advisory	1
Offutt Lake	Sarpy	Advisory	3
Halleck Park Lake	Sarpy	Advisory	1
Walnut Creek Lake	Sarpy	Advisory	3
Wehrspann Lake	Sarpy	Advisory	2
West Papillion Creek	Sarpy	Advisory	1
Maskenthine Lake	Stanton	Advisory	4
Cottonwood Lake	Cedar	Screening	1
Elkhorn River	Cuming	Screening	1
Kramper Lake	Dakota	Screening	2
Powder Creek Lake	Dixon	Screening	3
Buckskin Hills Lake	Dixon	Screening	4
Pebble Creek	Dodge	Screening	1
Glenn Cunningham Lake	Douglas	Screening	3
Lawrence Youngman Lake	Douglas	Screening	4

Table 1. Continued.

WATERBODY	COUNTY	SITE TYPE	# SPECIES/ SAMPLES COLLECTED
Goose Lake	Holt	Screening	1
Atkinson Lake	Holt	Screening	2
Swan Lake	Holt	Screening	2
Lewis and Clark Lake	Knox	Screening	4
Ta-Ha-Zouka Park Lake	Madison	Screening	2
North Fork Elkhorn River	Madison	Screening	1
Elkhorn River	Madison	Screening	1
Maple Creek Recreation Area Lake	Platte	Screening	3
Prairie Queen Lake	Sarpy	Screening	1
Red Fox Lake	Stanton	Screening	3
Pilger Reservoir	Stanton	Screening	1
DeSoto Lake - (DeSoto NWR)	Washington	Screening	3
Summit Lake	Burt	Screening	3
Logan Creek	Burt	Screening	1
Maple Creek	Dodge	Screening	1
Elkhorn River	Douglas	Screening	1
Skyview Lake	Madison	Screening	1
Willow Creek Lake	Pierce	Screening	2
Papillion Creek	Sarpy	Screening	1
Missouri River	Washington	Screening	1

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
Common 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	-	-

Table 3. Parameter Analysis and Target Reporting Limits of Fish Tissue Samples Analyzed by the EPA Region VII Laboratory and State Hygienic Laboratory – University of Iowa.

PARAMETER	TARGET REPORTING LIMIT (mg/kg)
EPA Region VII Laboratory	
Mercury *(Analysis by Cold Vapor Atomic Absorption)*	0.0181
State Hygienic Laboratory - University of Iowa	
PCB-1248 PCB-1254 PCB-1260 *(Analysis by Gas Chromatograph/Electron Capture - EPA 8082)*	0.020 0.020 0.020

IV. RISK ASSESSMENT

The EPA's risk assessment methodology (EPA, 1989) is 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 by the EPA 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 EPA's IRIS - Integrated Risk Information System database) (EPA, 2017a). The only contaminant included in the risk assessment for screening sites was mercury. Sites currently under advisory for PCBs were also screened for three Aroclors (1248, 1254, and 1260).

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 CSF 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, the EPA's risk assessment guidance recommends a conservative approach to data interpretation, resulting in toxicity values that are more likely to overestimate the true risk posed by exposure to a chemical.

Table 4 presents the contaminants that were assessed for in the State's waterbodies. The oral RfDs and CSFs used for these assessments are from the EPA's regional screening levels (RSLs) summary table (EPA, 2016b).

Table 4. Fish Tissue Contaminants and Associated Risk Assessment Parameters - Reference Dose (RfD) and Cancer Slope Factors (CSF) (EPA, 2017b).

CONTAMINANT	RfD (mg/kg/day)	CSF (mg/kg/day)
Aroclor 1248 – (PCB-1248)	NA	2.0
Aroclor 1254 – (PCB-1254)	0.00002	2.0
Aroclor 1260 – (PCB-1260)	NA	2.0
Methylmercury	0.0001	NA

NA – Not applicable or not available

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 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:

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

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 - 26 years

AF = Absorption Factor - 1.0 (total absorption)

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

*ATnc = Averaging Time -1,560 weeks/26 years for noncarcinogenic (nc) effects

* Note: Advisory determinations were based on a 154 lb. (70 kg) consumer ingesting 8 oz. (0.227 kg) weekly meal portions over a 26 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 any time 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.

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 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).

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

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:

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

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 0.30 mg/kg because Nebraska utilizes a higher consumption rate, eight ounces (0.227 kg) per week as compared to EPA's equivalence of 5.75 ounces (0.163 kg) per week.

V. CRITERIA FOR ISSUING A FISH CONSUMPTION ADVISORY

Authority

At the federal level, both the Food and Drug Administration (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's 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 ($\geq$ 1 in 10,000) or when adverse noncancer health effects may be possible from ingesting fish (Hazard Index $\geq$ 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 the RAFTMP's monitoring and assessment objectives, and follow Nebraska's six-year rotating basin monitoring schedule. 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 located 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).

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 and/or biopsy plugs from 3-5 fish samples of a single species) are found to:

1) have mercury concentrations $\geq$ 0.215 mg/kg; or

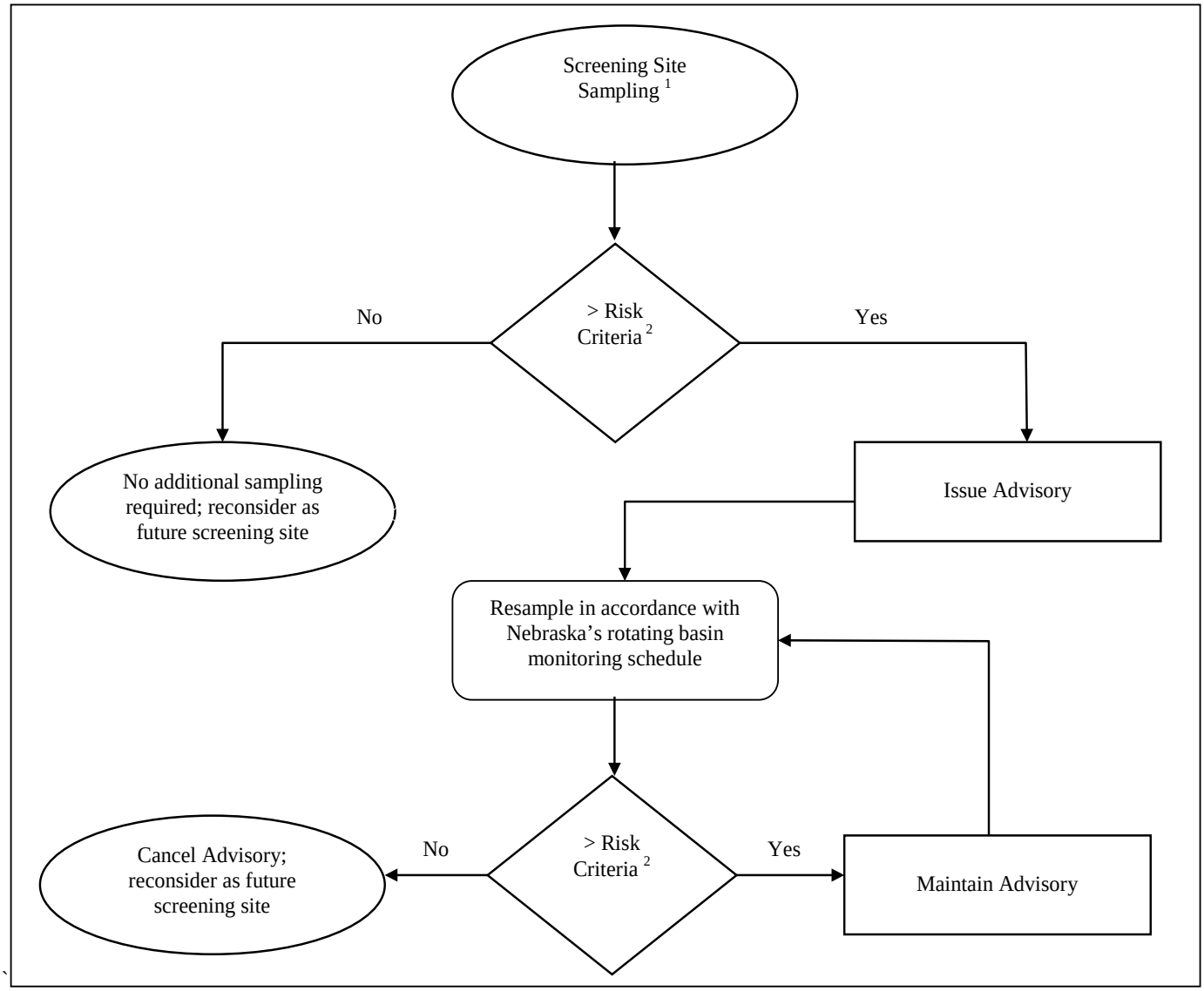
2) when ingested may be associated with adverse health effects, a Hazard Index (summation of Hazard Quotients) ≥ 1.0; or

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 bioconcentrate 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, 2014). 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. 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.

Figure 3. Monitoring Scheme for the Nebraska Fish Tissue Monitoring Program.



[1] Sampling scheme applies to all screening and advisory sites; single fillet/biopsy plug 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

2016 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 2016, the NDEQ collected a total of 91 samples from 44 different sites within the Elkhorn and Missouri Tributaries River basins (Figure 1). At the 28 *screening* and 16 *advisory* sites sampled, tissue samples from one to four species were collected depending on what could be obtained (See Table 1). In all, fish were collected from 8 different streams and 34 lakes/reservoirs.

Contaminants of Concern

Methylmercury and PCBs continue to be the contaminants of primary concern in Nebraska fish. Since fish are an important part of a healthy diet and the public are encouraged to consume them, it is also important to protect individuals from consuming large quantities of fish that have high contaminant levels. The health impacts of ingestion of methylmercury and PCBs are discussed below.

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 developing nervous system (EPA, 2001). 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, 2014). Currently there are no known methods by which one can effectively reduce mercury levels in fish tissue.

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. 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. Aroclor PCB mixtures may consist of over one hundred individual congeners and are named based on the amount of chlorine in them. 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 analyzes 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.

Risk Assessment Results

Table 5 summarizes the findings of the 2016 Regional Ambient Fish Tissue analysis. This includes the 2016 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 (bold text).

Table 5. Fish Tissue Risk Assessment Results for Nebraska Streams and Lakes Monitored in 2016.

WATERBODY	WATER-BODY ID	COUNTY	FISH SPECIES	CANCER RISK (≥0.0001)	HAZARD INDEX (≥1.0)	MERCURY CONC. (≥0.215 mg/kg)
PREVIOUS ADVISORY LOCATIONS						
Chalkrock Reservoir	MT2-L0020	Cedar	Largemouth Bass[1,2]	NA	NA	0.076
West Point City Lake	EL1-L0060	Cuming	Largemouth Bass[1,2]	NA	NA	**0.354**
			Channel Catfish[2]	NA	NA	0.050
			Bluegill[2]	NA	NA	0.163
Crystal Cove Lake	MT1-L0200	Dakota	Largemouth Bass[1,2]	NA	NA	0.156
			Channel Catfish[2]	NA	NA	0.085
Johnson Lake	EL1-L0030	Dodge	Largemouth Bass[1,4]	NA	NA	NA
			Channel Catfish[2]	NA	NA	0.062
			Black Crappie[2]	NA	NA	0.180
Dead Timber Lake	EL1-L0140	Dodge	Largemouth Bass[1,4]	NA	NA	NA
			Bluegill[2]	NA	NA	0.158
			Black Crappie[2]	NA	NA	0.079
Carter Lake	MT1-L0090	Douglas	Largemouth Bass[1,3]	<0.0001	<1.0	0.121
			Common Carp[3]	<0.0001	<1.0	0.015
			Channel Catfish[2]	NA	NA	0.034
Prairieview Lake	MT1-L0135	Douglas	Largemouth Bass[1,2]	NA	NA	**0.508**
			Bluegill[2]	NA	NA	0.176
Standing Bear Lake	MT1-L0100	Douglas	Largemouth Bass[1,2]	NA	NA	**0.301**
			Bluegill[2]	NA	NA	0.095
			Black Crappie[2]	NA	NA	**0.264**
Zorinsky Lake	MT1-L0050	Douglas	Largemouth Bass[1,2]	NA	NA	0.200
			Bluegill[2]	NA	NA	0.147
			Channel Catfish[2]	NA	NA	0.133
			Common Carp[2]	NA	NA	0.156
O'Neill City Lake	EL4-L0060	Holt	Largemouth Bass[1,2]	NA	NA	0.124
Offutt Lake	MT1-L0010	Sarpy	Channel Catfish[1,3]	<0.0001	**3.36**	0.027
			Common Carp[3]	<0.0001	**2.72**	0.038
			Largemouth Bass[2]	NA	NA	0.114
Halleck Park Lake	MT1-L0023	Sarpy	Largemouth Bass[1,2]	NA	NA	0.126

1 – Advisory Species, 2 – Only Mercury Analyzed, 3 – Mercury and PCBs Analyzed, 4 – Species Not Sampled, NA – Not Assessed

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. Cancer risk estimates expressed as <0.0001 were below State criteria. Waterbodies where two trophic level species (i.e., bottom feeder and predator) were collected, the "predator" sample was only assessed for mercury per EPA procedures.

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 any time during one's lifetime, even after the exposure to the carcinogen has ended.

Table 5. Continued.

WATERBODY	WATER-BODY ID	COUNTY	FISH SPECIES	CANCER RISK (≥0.0001)	HAZARD INDEX (≥1.0)	MERCURY CONC. (≥0.215 mg/kg)
PREVIOUS ADVISORY LOCATIONS - CON'T						
Walnut Creek Lake	MT1-L0025	Sarpy	Largemouth Bass[1,2]	NA	NA	**0.279**
			Channel Catfish[2]	NA	NA	0.137
			Bluegill[2]	NA	NA	**0.220**
Wehrspann Lake	MT1-L0030	Sarpy	Largemouth Bass[1,2]	NA	NA	**0.312**
			Channel Catfish[2]	NA	NA	0.045
West Papillion Creek	MT1-10250	Sarpy	Common Carp[1,3]	<0.0001	<1.0	0.068
Maskenthine Lake	EL1-L0080	Stanton	Largemouth Bass[1,2]	NA	NA	**0.392**
			Black Crappie[2]	NA	NA	0.210
			Bluegill[2]	NA	NA	**0.231**
			Channel Catfish[2]	NA	NA	0.043
SCREENING LOCATIONS						
Summit Lake	MT1-L0150	Burt	Largemouth Bass[2]	NA	NA	**0.336**
			Bluegill[2]	NA	NA	0.134
			Black Crappie[2]	NA	NA	0.084
Logan Creek	EL2-10000	Burt	Channel Catfish[2]	NA	NA	0.110
Cottonwood Lake	MT2-L0030	Cedar	Largemouth Bass[2]	NA	NA	0.071
Elkhorn River	EL1-20000	Cuming	Common Carp[2]	NA	NA	0.066
Kramper Lake	MT1-L0185	Dakota	Largemouth Bass[2]	NA	NA	0.193
			Bluegill[2]	NA	NA	0.164
Powder Creek Lake	MT2-L0005	Dixon	Largemouth Bass[2]	NA	NA	0.067
			Channel Catfish[2]	NA	NA	0.013
			Bluegill[2]	NA	NA	0.028
Buckskin Hills Lake	MT2-L0010	Dixon	Largemouth Bass[2]	NA	NA	**0.262**
			Black Crappie[2]	NA	NA	0.063
			Bluegill[2]	NA	NA	0.067
			Channel Catfish[2]	NA	NA	0.020
Pebble Creek	EL1-20100	Dodge	Common Carp[2]	NA	NA	0.069
Maple Creek	EL1-10900	Dodge	Channel Catfish[2]	NA	NA	0.019
Elkhorn River	EL1-10000	Douglas	Common Carp[2]	NA	NA	0.165

1 – Advisory Species, 2 – Only Mercury Analyzed, 3 – Mercury and PCBs Analyzed, 4 – Species Not Sampled, NA – Not Assessed

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. Cancer risk estimates expressed as <0.0001 were below State criteria. Waterbodies where two trophic level species (i.e., bottom feeder and predator) were collected, the "predator" sample was only assessed for mercury per EPA procedures.

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 any time during one's lifetime, even after the exposure to the carcinogen has ended.

Table 5. Continued.

WATERBODY	WATER-BODY ID	COUNTY	FISH SPECIES	CANCER RISK (≥0.0001)	HAZARD INDEX (≥1.0)	MERCURY CONC. (≥0.215 mg/kg)
SCREENING LOCATIONS - CON'T						
Glenn Cunningham Lake	MT1-L0120	Douglas	Largemouth Bass[2]	NA	NA	**0.252**
			Common Carp[2]	NA	NA	0.057
			Bluegill[2]	NA	NA	0.122
Lawrence Youngman Lake	MT1-LXXXX	Douglas	Largemouth Bass[2]	NA	NA	**0.689**
			Black Crappie[2]	NA	NA	**0.320**
			Bluegill[2]	NA	NA	**0.313**
			Redear Sunfish[2]	NA	NA	0.080
Goose Lake	EL4-L0050	Holt	Largemouth Bass[2]	NA	NA	**0.279**
Atkinson Lake	EL4-L0070	Holt	Largemouth Bass[2]	NA	NA	**0.231**
			Common Carp[2]	NA	NA	0.095
Swan Lake	EL4-L0080	Holt	Largemouth Bass[2]	NA	NA	0.119
			Black Bullhead[2]	NA	NA	0.101
Lewis and Clark Lake	MT2-L0040	Knox	Largemouth Bass[2]	NA	NA	0.060
			Smallmouth Bass[2]	NA	NA	0.052
			Flathead Catfish[2]	NA	NA	0.050
			Bluegill[2]	NA	NA	0.056
Ta-Ha-Zouka Park Lake	EL4-L0010	Madison	Largemouth Bass[2]	NA	NA	0.120
			Bluegill[2]	NA	NA	0.021
North Fork Elkhorn River	EL3-20000	Madison	Channel Catfish[2]	NA	NA	0.059
Elkhorn River	EL4-10000	Madison	Channel Catfish[2]	NA	NA	0.164
Skyview Lake	EL4-L0020	Madison	Largemouth Bass[2]	NA	NA	0.171
Willow Creek Lake	EL3-L0010	Pierce	Largemouth Bass[2]	NA	NA	0.146
			Black Crappie[2]	NA	NA	0.041
Maple Creek Recreation Area Lake	EL1-L0095	Platte	Largemouth Bass[2]	NA	NA	**0.662**
			Bluegill[2]	NA	NA	0.176
			Channel Catfish[2]	NA	NA	0.026
Prairie Queen Lake	MT1-L0027	Sarpy	Largemouth Bass[2]	NA	NA	**0.481**
Papillion Creek	MT1-10100	Sarpy	Common Carp[2]	NA	NA	0.085

1 – Advisory Species, 2 – Only Mercury Analyzed, 3 – Mercury and PCBs Analyzed, 4 – Species Not Sampled, NA – Not Assessed

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. Cancer risk estimates expressed as <0.0001 were below State criteria. Waterbodies where two trophic level species (i.e., bottom feeder and predator) were collected, the "predator" sample was only assessed for mercury per EPA procedures.

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 26 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 any time during one's lifetime, even after the exposure to the carcinogen has ended.

Table 5. Continued.

WATERBODY	WATER-BODY ID	COUNTY	FISH SPECIES	CANCER RISK (≥0.0001)	HAZARD INDEX (≥1.0)	MERCURY CONC. (≥0.215 mg/kg)
SCREENING LOCATIONS - CON'T						
Red Fox Lake	EL1-L0075	Stanton	Largemouth Bass[2]	NA	NA	0.117
			Channel Catfish[2]	NA	NA	0.043
			Bluegill[2]	NA	NA	0.047
Pilger Reservoir	EL1-L0070	Stanton	Green Sunfish[2]	NA	NA	0.014
DeSoto Lake - (DeSoto NWR)	MT1-L0140	Washington	Largemouth Bass[2]	NA	NA	0.087
			Bluegill[2]	NA	NA	0.130
			Common Carp[2]	NA	NA	0.073
Missouri River	MT1-10000	Washington	Flathead Catfish[2]	NA	NA	0.097

1 – Advisory Species, 2 – Only Mercury Analyzed, 3 – Mercury and PCBs Analyzed, 4 – Species Not Sampled, NA – Not Assessed

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. Cancer risk estimates expressed as <0.0001 were below State criteria. Waterbodies where two trophic level species (i.e., bottom feeder and predator) were collected, the "predator" sample was only assessed for mercury per EPA procedures.

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 26 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 any time during one's lifetime, even after the exposure to the carcinogen has ended.

VII. SUMMARY

A list of Nebraska streams and lakes monitored in 2016 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 28 screening sites. Tissue samples collected from 20 sites did not exceed any of the State's risk criteria and will not come under advisory.
2. Samples collected at 8 screening sites exceeded the risk criteria for mercury.
3. Sixteen advisory sites were also monitored in 2016. Advisories will be maintained at 7 of the 16 sites based on contaminant levels still exceeding risk criteria.
4. Four sites exceeded the risk criteria for mercury in two or more species.
5. In all, eight new waterbodies monitored in 2016 came under advisory, seven sites that were already under an advisory remained listed, and nine sites were removed.
6. Combined with previous year's assessment, 141 Nebraska waterbodies (13 stream segments and 128 lakes) are now under fish consumption advisories (refer to *Appendix A* for the complete list of advisory sites and location maps).

Table 6. List of Waterbodies with an Advisory Status Change for 2016.

WATERBODY	WATER-BODY ID	COUNTY	FISH SPECIES	ADVISORY ACTION	LISTING REASON[1]
ADVISORY LOCATIONS					
Chalkrock Reservoir	MT2-L0020	Cedar	Largemouth Bass	Remove	<Risk Criteria
West Point City Lake	EL1-L0060	Cuming	Largemouth Bass	Maintain	Mercury
Crystal Cove Lake	MT1-L0200	Dakota	Largemouth Bass / Channel Catfish[3]	Remove	<Risk Criteria
Johnson Lake	EL1-L0030	Dodge	Largemouth Bass[2]/ Black Crappie[3]	Remove	<Risk Criteria
Dead Timber Lake	EL1-L0140	Dodge	Largemouth Bass[2]/ Black Crappie[3]/ Bluegill[3]	Remove	<Risk Criteria
Carter Lake	MT1-L0090	Douglas	Largemouth Bass / Common Carp[3]/ Channel Catfish[3]	Remove	<Risk Criteria
Prairieview Lake	MT1-L0135	Douglas	Largemouth Bass	Maintain	Mercury
Standing Bear Lake	MT1-L0100	Douglas	Largemouth Bass / Black Crappie[3]	Maintain	Mercury
Zorinsky Lake	MT1-L0050	Douglas	Largemouth Bass / Bluegill[3]/ Channel Catfish[3]/ Common Carp[3]	Remove	<Risk Criteria
O'Neill City Lake	EL4-L0060	Holt	Largemouth Bass	Remove	<Risk Criteria
Offutt Lake	MT1-L0010	Sarpy	Channel Catfish / Common Carp[3]	Maintain	PCBs, Mercury
Halleck Park Lake	MT1-L0023	Sarpy	Largemouth Bass	Remove	<Risk Criteria
Walnut Creek Lake	MT1-L0025	Sarpy	Largemouth Bass	Maintain	Mercury
Wehrspann Lake	MT1-L0030	Sarpy	Largemouth Bass	Maintain	Mercury
West Papillion Creek	MT1-10250	Sarpy	Common Carp	Remove	<Risk Criteria
Maskenthine Lake	EL1-L0080	Stanton	Largemouth Bass / Bluegill[3]	Maintain	Mercury
SCREENING LOCATIONS					
Summit Lake	MT1-L0150	Burt	Largemouth Bass	New Advisory	Mercury
Buckskin Hills Lake	MT2-L0010	Dixon	Largemouth Bass	New Advisory	Mercury
Glenn Cunningham Lake	MT1-L0120	Douglas	Largemouth Bass	New Advisory	Mercury
Lawrence Youngman Lake	MT1-LXXXX	Douglas	Largemouth Bass / Black Crappie[3] / Bluegill[3]	New Advisory	Mercury
Goose Lake	EL4-L0050	Holt	Largemouth Bass	New Advisory	Mercury

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

[2] Listed fish species had contaminant levels below human health risk criteria, is no longer present, wasn't collected, and/or in-take is considered insignificant for waterbody.

[3] Additional indicator species collected and analyzed.

Table 6. Continued

WATERBODY	WATER-BODY ID	COUNTY	FISH SPECIES	ADVISORY ACTION	LISTING REASON[1]
SCREENING LOCATIONS					
Atkinson Lake	EL4-L0070	Holt	Largemouth Bass	New Advisory	Mercury
Maple Creek Recreation Area Lake	EL1-L0095	Platte	Largemouth Bass	New Advisory	Mercury
Prairie Queen Lake	MT1-L0027	Sarpy	Largemouth Bass	New Advisory	Mercury

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

[2] Listed fish species had contaminant levels below human health risk criteria, is no longer present, wasn't collected, and/or in-take is considered insignificant for waterbody.

[3] Additional indicator species collected and analyzed.

*Refer to *Appendix A* for the complete list of advisory sites and location maps.

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APPENDIX A

NEBRASKA FISH CONSUMPTION ADVISORIES THROUGH 2016

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 26 years (see maps below).

MAP I.D. #	WATERBODY	ID	FISH TYPE	HEALTH RISK CRITERIA VIOLATED[1]	POLLUTANT OF CONCERN
BIG BLUE RIVER BASIN					
1	Big Blue River	BB1-10000	Common Carp	Cancer Risk, Hazard Index	PCBs, Dieldrin
2	Lake Hastings	BB3-L0050	Common Carp	Cancer Risk, Hazard Index	PCBs
3	Recharge Lake	BB3-L0080	Largemouth Bass	Hazard Index, Mercury	Mercury
4	Rockford Lake	BB1-L0060	Largemouth Bass	Hazard Index, Mercury	Mercury
5	Walnut Creek #2	BB1-L0100	Largemouth Bass	Hazard Index, Mercury	Mercury
6	Swanton Lake (Swan Lake 67)	BB2-L0005	Largemouth Bass	Mercury	Mercury
7	Willard L. Meyer (Swan Creek Lake 5A)	BB2-L0020	Largemouth Bass	Hazard Index, Mercury	Mercury
8	Wolf-Wildcat Lake	BB1-L0050	Largemouth Bass	Hazard Index, Mercury	Mercury
ELKHORN RIVER BASIN					
9	Goose Lake	EL4-L0050	Largemouth Bass	Mercury	Mercury
10	West Point City Lake	EL1-L0060	Largemouth Bass	Mercury	Mercury
11	Atkinson Lake	EL4-L0070	Largemouth Bass	Mercury	Mercury
12	Maskenthine Lake	EL1-L0080	Largemouth Bass / Bluegill	Mercury	Mercury
13	Maple Creek Recreation Area Lake	EL1-L0095	Largemouth Bass	Mercury	Mercury
LITTLE BLUE RIVER BASIN					
14	Crystal Springs NW Lake	LB1-L0020	Channel Catfish	Hazard Index	PCBs, Mercury
15	Lone Star Reservoir	LB1-L0050	Largemouth Bass	Hazard Index, Mercury	Mercury
16	Big Sandy Creek	LB2-10200	Channel Catfish	Hazard Index, Mercury	Mercury
17	Liberty Cove	LB2-L0050	Largemouth Bass	Hazard Index, Mercury	Mercury
LOUP RIVER BASIN					
18	Columbus City Park Pond	LO1-L0010	Largemouth Bass	Hazard Index, Mercury	Mercury
19	Farwell South Reservoir	LO3-L0010	Largemouth Bass / Common Carp	Mercury	Mercury
20	Davis Creek Lake	LO2-L0015	Common Carp / White Bass	Mercury	Mercury
21	Auble Pond	LO2-L0020	Largemouth Bass	Mercury	Mercury
22	Calamus Reservoir	LO2-L0050	Common Carp	Mercury	Mercury
23	Frye Lake - WMA	LO3-L0070	Largemouth Bass	Mercury	Mercury
24	South Loup River	LO4-10000	Channel Catfish	Mercury	Mercury
25	Ansley City Lake	LO4-L0030	Largemouth Bass	Mercury	Mercury
26	Melham Park Lake	LO4-L0040	Largemouth Bass	Mercury	Mercury
27	Pressey Pond - WMA	LO4-LXXXX	Largemouth Bass	Mercury	Mercury
28	Pibel Lake	LO1-L0130	Largemouth Bass	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 – Continued

MAP I.D. #	WATERBODY	ID	FISH TYPE	HEALTH RISK CRITERIA VIOLATED[1]	POLLUTANT OF CONCERN
LOUP RIVER BASIN - CON'T					
29	Ravenna Lake	LO4-L0010	Largemouth Bass	Mercury	Mercury
30	Sherman Reservoir	LO3-L0020	White Bass	Mercury	Mercury
LOWER PLATTE RIVER BASIN					
31	Two Rivers Lake No. 1 - SRA	LP1-L0130	Largemouth Bass	Mercury	Mercury
32	Fremont Lake No. 11 - SRA	LP1-L0210	Largemouth Bass	Mercury	Mercury
33	Fremont Lake No. 20E - SRA	LP1-L0250	Largemouth Bass	Mercury	Mercury
34	Fremont Lake No. 1	LP1-L0290	Largemouth Bass	Mercury	Mercury
35	Memphis Lake	LP2-L0010	Largemouth Bass	Mercury	Mercury
36	Lake Babcock	LP1-L0450	Common Carp	Mercury	Mercury
37	Lake Wanahoo	LP2-L0015	Largemouth Bass	Mercury	Mercury
38	Hedgefield Lake - WMA	LP2-L0020	Largemouth Bass	Mercury	Mercury
39	Cottontail Lake	LP2-L0070	Largemouth Bass	Mercury	Mercury
40	Yankee Hill Lake	LP2-L0090	Largemouth Bass / Bluegill	Mercury	Mercury
41	Bowling Lake	LP2-L0100	Largemouth Bass	Mercury	Mercury
42	Olive Creek Lake	LP2-L0140	Largemouth Bass	Mercury	Mercury
43	Pawnee Lake	LP2-L0160	Largemouth Bass	Mercury	Mercury
44	Merganser Lake	LP2-L0170	Largemouth Bass	Mercury	Mercury
45	Red Cedar Lake	LP2-L0190	Largemouth Bass	Mercury	Mercury
46	Wild Plum Lake	LP2-L0200	Largemouth Bass / White Crappie	Mercury	Mercury
47	Meadowlark Lake	LP2-L0220	Largemouth Bass / Bluegill	Mercury	Mercury
48	Timber Point Lake	LP2-L0250	Largemouth Bass	Mercury	Mercury
49	Czechland Lake	LP2-L0270	Largemouth Bass	Hazard Index, Mercury	Mercury
50	Redtail Lake	LP2-L0280	Largemouth Bass	Mercury	Mercury
51	Holmes Lake	LP2-L0040	Largemouth Bass	Hazard Index, Mercury	Mercury
52	Oak Creek	LP2-20500	Channel Catfish	Hazard Index	Mercury
53	Homestead Lake	LP1-L0335	Largemouth Bass / Bluegill	Mercury	Mercury
54	Platte River	LP1-10000	Channel Catfish	Hazard Index	PCBs, Mercury
55	Wildwood Reservoir	LP2-L0120	Largemouth Bass	Hazard Index, Mercury	Mercury
MIDDLE PLATTE RIVER BASIN					
56	Tri-County Supply Canal - below J1 hydro	MP2-20500	Common Carp	Hazard Index	PCBs
57	Mormon Island Middle Lake - SRA	MP2-L0060	Largemouth Bass	Mercury	Mercury
58	L.E. Ray Lake	MP2-L0030	Largemouth Bass	Mercury	Mercury
59	Cheyenne Lake - SRA	MP2-L0100	Largemouth Bass	Mercury	Mercury
60	Wax Axe Lake - SRA	MP2-L0120	Smallmouth Bass	Mercury	Mercury
61	Bassway Strip Lake No. 5	MP2-L0190	Largemouth Bass	Mercury	Mercury
62	Kea Lake - WMA	MP2-L0320	Largemouth Bass	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.

MAP I.D. #	WATERBODY	ID	FISH TYPE	HEALTH RISK CRITERIA VIOLATED[1]	POLLUTANT OF CONCERN
MIDDLE PLATTE RIVER BASIN - CON'T					
63	Kea West Lake - WMA	MP2-L0340	Largemouth Bass	Mercury	Mercury
64	Cottonmill Lake	MP2-L0360	Largemouth Bass	Mercury	Mercury
65	Union Pacific Lake - SRA	MP2-L0390	Largemouth Bass	Mercury	Mercury
66	Coot Shallows Lake - WMA	MP2-L0400	Largemouth Bass	Mercury	Mercury
67	Sandy Channel Lake - SRA	MP2-L0420	Largemouth Bass	Mercury	Mercury
68	Blue Hole Lake - WMA	MP2-L0430	Largemouth Bass	Mercury	Mercury
69	Dogwood Lake - WMA	MP2-L0460	Largemouth Bass	Mercury	Mercury
70	Phillips Lake	MP2-L0500	Common Carp	Hazard Index, Mercury	Mercury
71	Pawnee Slough Lake	MP2-LXXXX	Largemouth Bass	Mercury	Mercury
72	Yanney Park Lake	MP2-LXXXX	Largemouth Bass	Mercury	Mercury
73	Elwood Reservoir	MP2-L0540	Northern Pike / Largemouth Bass	Mercury	Mercury
74	Darr Lake - WMA	MP2-L0550	Largemouth Bass	Mercury	Mercury
75	Plum Creek Canyon Reservoir	MP2-L0560	Common Carp	Cancer Risk , Hazard Index	PCBs
76	West Cozad Lake - WMA	MP2-L0580	Largemouth Bass	Mercury	Mercury
77	Cozad Lake - WMA	MP2-L0590	Largemouth Bass	Mercury	Mercury
78	East Gothenburg Lake - WMA	MP2-L0630	Largemouth Bass	Mercury	Mercury
79	Fort McPherson Lake	MP2-L0770	Largemouth Bass	Mercury	Mercury
80	Fremont Slough - WMA	MP2-L0840	Largemouth Bass	Mercury	Mercury
MISSOURI TRIBUTARIES RIVER BASIN					
81	Lawrence Youngman Lake	MT1-LXXXX	Largemouth Bass / Black Crappie	Mercury	Mercury
82	Offutt Lake	MT1-L0010	Channel Catfish / Common Carp	Hazard Index	PCBs, Mercury
83	Walnut Creek Lake	MT1-L0025	Largemouth Bass	Mercury	Mercury
84	Prairie Queen Lake	MT1-L0027	Largemouth Bass	Mercury	Mercury
85	Wehrspann Lake	MT1-L0030	Largemouth Bass	Mercury	Mercury
86	Standing Bear Lake	MT1-L0100	Largemouth Bass / Black Crappie	Mercury	Mercury
87	Glenn Cunningham Lake	MT1-L0120	Largemouth Bass	Mercury	Mercury
88	Prairie View Lake	MT1-L0135	Largemouth Bass	Mercury	Mercury
89	Summit Lake	MT1-L0150	Largemouth Bass	Mercury	Mercury
90	Buckskin Hills Lake	MT2-L0010	Largemouth Bass	Mercury	Mercury
NEMAHA RIVER BASIN					
91	Steinart Park Lake	NE1-L0010	Largemouth Bass	Mercury	Mercury
92	Missouri River	NE1-10000	Flathead Catfish	Mercury	Mercury
93	Kirkman's Cove Lake	NE2-L0040	Largemouth Bass / Common Carp	Mercury	Mercury
94	Prairie Knoll Lake	NE2-L0080	Largemouth Bass / Bluegill	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.

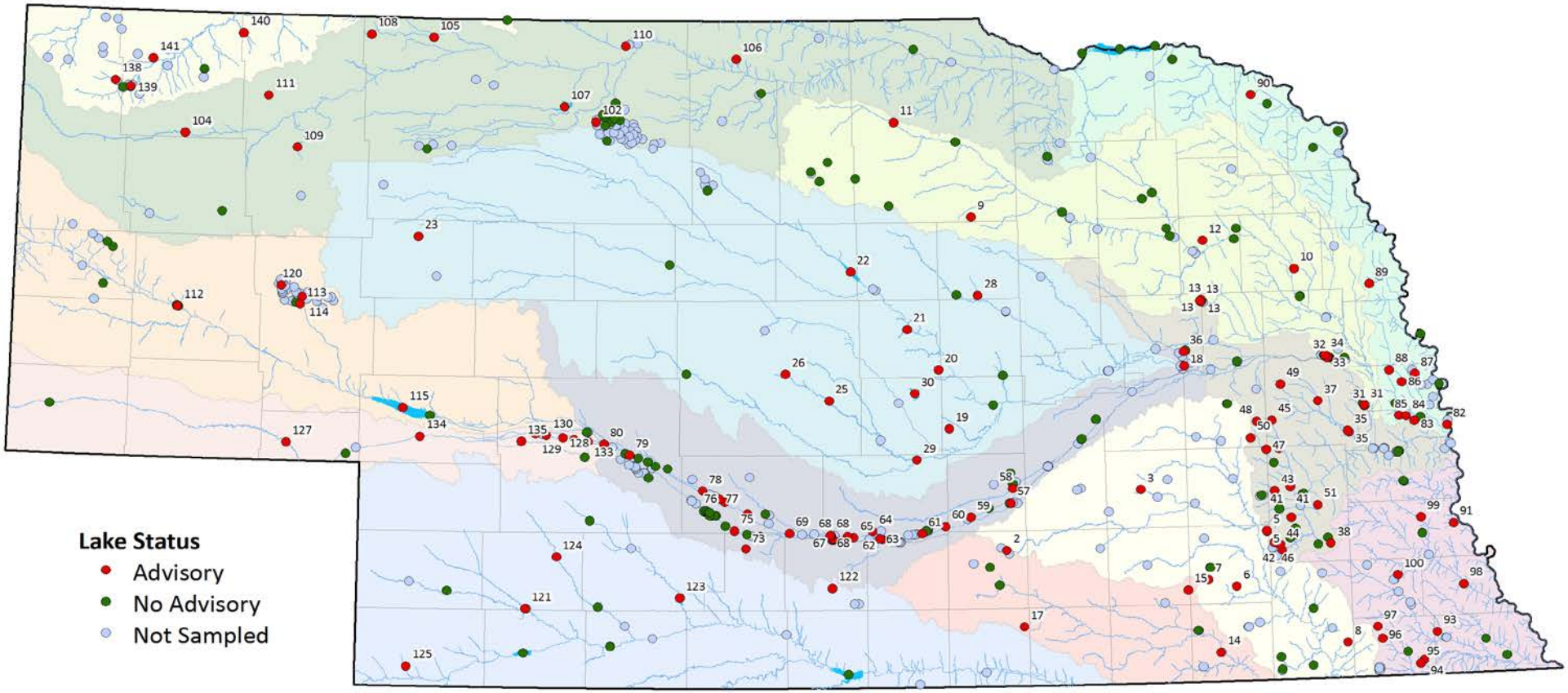
MAP I.D. #	WATERBODY	ID	FISH TYPE	HEALTH RISK CRITERIA VIOLATED[1]	POLLUTANT OF CONCERN
NEMAHA RIVER BASIN - CONT'T					
95	Iron Horse Trail Lake	NE2-L0090	Largemouth Bass	Mercury	Mercury
96	Burchard Lake	NE2-L0120	Largemouth Bass	Mercury	Mercury
97	Mayberry Lake -WMA	NE2-L0195	Largemouth Bass	Mercury	Mercury
98	Auburn Rotary Club Lake	NE3-L0010	Largemouth Bass	Mercury	Mercury
99	Wilson Creek 2X - WMA	NE3-L0040	Largemouth Bass / Black Crappie	Mercury	Mercury
100	Wirth Brothers Lake	NE3-L0045	Largemouth Bass / Black Crappie	Mercury	Mercury
NIOBRARA RIVER BASIN					
101	Missouri River	NI1-10000	Flathead Catfish	Mercury	Mercury
102	Duck Lake	NI3-L0320	Largemouth Bass	Mercury	Mercury
103	Schoolhouse Lake	NI3-LXXXX	Northern Pike / Largemouth Bass / Black Crappie	Mercury	Mercury
104	Box Butte Reservoir	NI4-L0080	Northern Pike / Largemouth Bass	Mercury	Mercury
105	Cottonwood Lake	NI4-L0010	Largemouth Bass	Mercury	Mercury
106	Cub Creek Lake	NI3-L0070	Largemouth Bass	Mercury	Mercury
107	Merritt Reservoir	NI3-L0330	Walleye / Largemouth Bass	Mercury	Mercury
108	Shell Lake	NI4-L0020	Largemouth Bass	Mercury	Mercury
109	Smith Lake	NI4-L0040	Largemouth Bass	Mercury	Mercury
110	Valentine Mill Pond	NI3-L0170	Largemouth Bass / Bluegill	Mercury	Mercury
111	Walgren Lake	NI4-L0050	Largemouth Bass	Mercury	Mercury
NORTH PLATTE RIVER BASIN					
112	Bridgeport Middle Lake	NP3-L0030	Largemouth Bass	Mercury	Mercury
113	Crescent Lake	NP2-L0095	Largemouth Bass	Mercury	Mercury
114	Island Lake	NP2-L0110	Largemouth Bass	Mercury	Mercury
115	Lake McConaughy	NP2-L0010	Walleye	Hazard Index, Mercury	Mercury, Selenium
116	Morrill Sandpit - Southwest	NP2-LXXXX	Largemouth Bass	Mercury	Mercury
117	Morrill Sandpit - North	NP2-LXXXX	Largemouth Bass	Hazard Index, Mercury	Mercury, Selenium
118	North Platte River	NP1-10000	Largemouth Bass	Hazard Index, Mercury	Mercury
119	North Platte River	NP3-10000	Common Carp	Hazard Index	Mercury, Selenium
120	Smith Lake	NP2-L0290	Largemouth Bass	Hazard Index, Mercury	Mercury
REPUBLICAN RIVER BASIN					
121	Frenchman WMA West Lake	RE3-L0084	Largemouth Bass	Hazard Index, Mercury	Mercury
122	Holdrege Park Lake	RE1-L0040	Largemouth Bass	Hazard Index	Mercury, Selenium
123	Medicine Creek Reservoir	RE3-L0010	Largemouth Bass	Mercury	Mercury
124	Hayes Center WMA Lake	RE3-L0080	Largemouth Bass	Mercury	Mercury
125	Rock Creek Lake	RE3-L0120	Largemouth Bass	Hazard Index, Mercury	Mercury
SOUTH PLATTE RIVER BASIN					
126	Birdwood Lake	SP1-L0030	Largemouth Bass	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.

Map I.D. #	WATERBODY	ID	FISH TYPE	HEALTH RISK CRITERIA VIOLATED[1]	POLLUTANT OF CONCERN
SOUTH PLATTE RIVER BASIN - CON'T					
127	Chappell Interstate Lake	SP2-L0010	Largemouth Bass	Hazard Index	Mercury, Selenium
128	East Hershey Lake	SP1-L0040	Largemouth Bass	Mercury	Mercury
129	East Sutherland Lake	SP1-L0070	Largemouth Bass	Mercury	Mercury
130	Hershey Lake	SP1-L0050	Largemouth Bass	Mercury	Mercury
131	Maloney Res. Outlet Canal - above hydro	SP1-10500	Common Carp	Hazard Index	PCBs, Mercury
132	Maloney Res. Outlet Canal - below hydro	SP1-10500	Channel Catfish/ Smallmouth Bass	Cancer Risk, Hazard Index / Mercury	PCBs / Mercury
133	North Platte Interstate Lake	SP1-L0010	Largemouth Bass	Mercury	Mercury
134	Ogallala City Park Lake	SP1-L0090	Channel Catfish	Cancer Risk	PCBs, Chlordane
135	Sutherland Reservoir	SP1-L0080	Common Carp	Hazard Index	PCBs, Mercury
136	Sutherland Cooling Pond	SP1-LXXXX	Common Carp / Largemouth Bass	Hazard Index / Mercury	Mercury, Selenium / Mercury
137	Sutherland Outlet Canal	SP1-10600	Channel Catfish	Hazard Index	PCBs, Mercury
WHITE-HAT CREEK RIVER BASIN					
138	Carter P. Johnson Lake	WH1-L0200	Largemouth Bass	Hazard Index, Mercury	Mercury
139	Grabel Pond #5	WH1-L0170	Largemouth Bass	Hazard Index, Mercury	Mercury, Selenium
140	Isham Dam Lake	WH1-L0010	Largemouth Bass	Hazard Index, Mercury	Mercury
141	Whitney Reservoir	WH1-L0060	White Bass	Mercury	Mercury

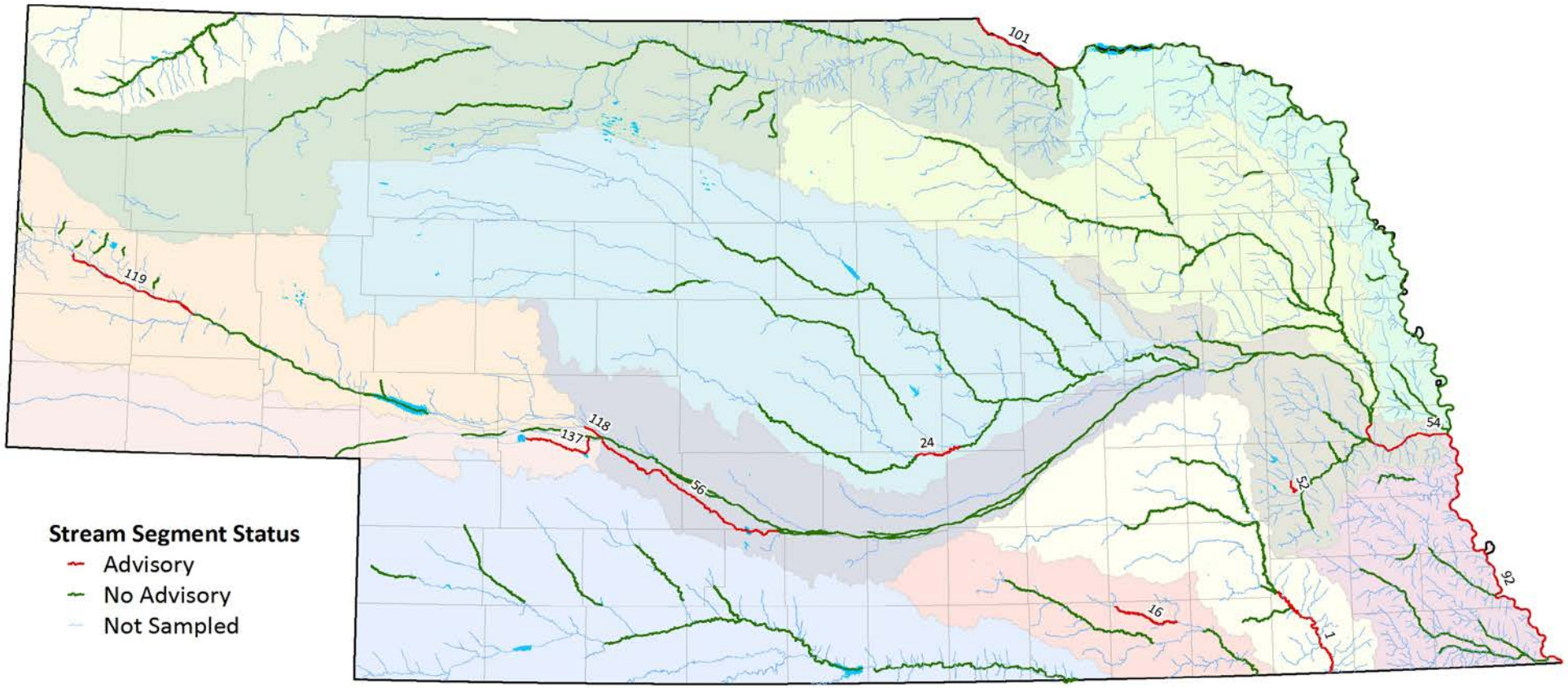
1 The Risk Criteria established by the Nebraska Fish Tissue Advisory Committee include fish tissue that: (1) are found to have mercury concentrations $\geq$ 0.215 mg/kg, (2) have contaminant concentrations that may be associated with adverse health effects (Hazard Index $\geq$ 1.0) or (3) may be associated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

LAKE - FISH CONSUMPTION ADVISORY SITES IN NEBRASKA THROUGH 2016



(See *Appendix A* table for map # I.D. advisory information)

STREAM - FISH CONSUMPTION ADVISORY SITES IN NEBRASKA THROUGH 2016



(See *Appendix A* table for map # I.D. advisory information)