LAKE ERIE

LAKEWIDE MANAGEMENT PLAN

Lake Erie Lakewide Management Plan (LaMP) Technical Report Series

Impairment Assessment of Beneficial Uses: Restrictions on Fish and Wildlife Consumption

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Technical Report 2

Restrictions on Fish And Wildlife Consumption

Prepared for the Lake Erie LaMP
Preliminary Beneficial Use Impairment Assessment
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NOTE TO THE READER:

This technical report was prepared as one component of Stage 1, or "Problem Definition," for the Lake Erie LaMP. This report provides detailed technical and background information that provides the basis for the impairment conclusions recorded in the Lake Erie LaMP *Status Report*.

This document has been extensively reviewed by the government agencies that are partnering to produce the LaMP, outside experts, and the Lake Erie LaMP Public Forum, a group of approximately of 80 citizen volunteers. This review was designed to answer two questions:

- Is the document technically sound and defensible?
- Do the reviewers agree with the document conclusions and format?

In its present form, this report has been revised to address the comments received during that review process, and there is consensus agreement with the impairment conclusions presented.

2.1 Fish Consumption Restrictions

2.1.1 Listing Criteria

According to the International Joint Commission (IJC), fish consumption restriction impairments occur when contaminant levels in fish exceed current standards, objectives or guidelines, or when public health advisories are in effect for human consumption of fish or

wildlife (IJC, 1989).

2.1.2 Scope of the Assessment

The geographic scope of the Lake Erie LaMP beneficial use impairment assessment (BUIA) includes open lake waters, nearshore areas, river mouths and embayments, and the lake effect zone of Lake Erie tributaries. The lake effect zone is defined as that zone where the waters of the lake and tributary river are mixed. Detroit River impairments in the Lake Erie LaMP will be evaluated on a case by case basis and will be included where relevant to potential impacts in Lake Erie.

It is recognized that the reasons for Lake Erie sport fish consumption advisories and the severity of some advisories, particularly those caused by mercury, has changed since the 1970s. However, this document does not address changes in advisories over time, nor does it attempt to analyze what these changes tell us about improvement or lack of improvement in the contaminant situation in the lake. The sole purpose of this assessment it to identify impairments due to fish and wildlife consumption advisories in existence today.

Current sport fish and wildlife consumption advisories and commercial fishing restrictions are covered, as applicable, in this assessment. Fish consumption advisories are applicable to **sport** fish and are recommended consumption levels to protect human health. The choice of which fish to consume, how frequently, how much, and how to prepare the fish for consumption remains the choice of the individual consumer. In contrast, **commercial** fishermen are prohibited from catching certain species and size classes of fish when contaminant levels are judged to be a risk to human health. These commercial fishing restrictions are enforceable standards and are therefore mandatory.

Per the listing criteria, existing objectives and guidelines are also outlined in sections 2.1.4 and 2.2.2 and evaluated as they apply to impairment conclusions in sections 2.1.6 and 2.2.3.

2.1.3 Purpose of Sport Fish Consumption Advisories

According to a 1995 State of the Lakes Ecosystem Conference Report, there are a number of pathways by which humans in the Great Lakes basin can be exposed to persistent toxic contaminants. The major route of human exposure to PCBs, dioxins, furans, organochlorine pesticides, and certain heavy metals is food consumption, particularly consumption of contaminated fish (USEPA/EC, 1995) . People who regularly eat sport fish, women of childbearing age, and children are particularly susceptible to contaminants that build up over time (PADEP, 1996).

The purpose of sport fish consumption advisories is to protect human health by minimizing

human exposure to chemical contaminants present in fish tissue. Sport fish consumption advisories are issued as educational tools designed to assist sport fish consumers in making consumption choices to protect their health. The goal is to: a) identify the geographic locations where fish are affected, b) inform the fish consumer of fish species/size classes that are known to be prone to contain higher levels of chemical contaminants, c) offer recommendations on suggested frequency of consumption, and d) provide recommendations on preparation and cooking techniques that reduce the risk of exposure to toxic contaminants. The choice of which fish to consume, how frequently to consume, and how to prepare remains with the individual.

The presence of mercury in fish has been of particular concern because it accumulates in the tissue of the fish rather than the fat. Food preparation methods such as trimming fat and skin, and broiling rather than frying do not reduce exposure to mercury. Therefore, the only effective options to minimize exposure to mercury present in fish tissue are to follow fish consumption advisories and to avoid eating the internal organs of the fish (Mortimer, 1996).

2.1.4 Fish Consumption Advisory Criteria and Objectives

Bi-national Objectives

Two binational organizations have established objectives for fish consumption in the Great Lakes, the International Joint Commission (IJC) and the Great Lakes Fishery Commission.

The IJC, through Annex 1 of the Great Lakes Water Quality Agreement (GLWQA), developed specific objectives for concentrations of persistent toxics in fish flesh. A number of these contaminant thresholds were chosen as objectives with the aim of protecting human consumers of fish from the Great Lakes. These objectives are summarized in table 2.1.

Table 2.1, GLWQA Objectives for Contaminant Levels in Great Lakes Fish Flesh (IJC,

1988).

Chemical	GLWQA Objective
Aldrin/Dieldrin	Sum of concentrations of aldrin & dieldrin in edible portions of fish should not exceed **0.3 microgram/gram** (wet weight basis)
Endrin	Concentration in edible portion of fish should not exceed **0.3 microgram/gram** (wet weight basis)
Heptachlor/Heptachlor epoxide	Sum of concentrations of heptachlor & heptachlor epoxide in edible portions of fish should not exceed **0.3 microgram/gram** (wet weight basis)
Lindane	Concentration in edible portions of fish should not exceed **0.3 microgram/gram** (wet weight basis)
Unspecified Organic Compounds	For other organic contaminants, for which specific objectives have not been defined (by GLWQA), but which can be demonstrated to be persistent and are likely to be toxic, the concentrations of such compounds in water or aquatic organisms should be substantially absent, i.e., less than detection levels as determined by the best scientific methodology available.

In 1993, the IJC established an "Indicators for Evaluation" Task Force to identify indicators to evaluate Great Lakes Water Quality Agreement Progress. In 1996 the IJC Task Force identified 9 desired outcomes for the Great Lakes Basin Ecosystem. The first desired outcome states: "***Safe for Fishing****: There shall be no restrictions on the human consumption of fish in the waters of the Great Lakes Basin Ecosystem resulting from human inputs of persistent toxic substances"* (IJC, 1996).

The Great Lakes Fishery Commission directed its Lake Committees to prepare fish community objectives for each of the Great Lakes. Among the fish community objectives developed by the Lake Erie Committee is the following: "*Reduce contaminants in all fish species to levels that require **no advisory** for human consumption and no detrimental effect on fish-eating wildlife, fish behavior/productivity and fish reproduction"* (emphasis added, Lake Erie Fish Community Goals and Objectives, 1997).

Regional Advisory Protocol

In September 1993, a Great Lakes Sport Fish Advisory Task Force, composed of representatives from public health, environmental or natural resource agencies from the eight states bordering the Great Lakes (New York, Pennsylvania, Ohio, Michigan, Indiana, Illinois, Wisconsin, and Minnesota), submitted a proposed protocol for a uniform sport fish consumption advisory for the Great Lakes Basin to the Council of Great Lakes Governors. Other participants have included the Canadian Province of Ontario, the USEPA, and Native American organizations.

The foundation of the proposed protocol is the premise that the current Food and Drug Administration (FDA) tolerances for market fish are not adequately protective of public health, particularly for consumers of sport fish. Recent angler surveys have found that the frequency of fish consumption among anglers far exceeds the frequencies assumed by the

FDA when they established the tolerances. In addition, anglers tend to concentrate their fishing in specific geographical locations which eliminates the nationwide contaminant dilution factor assumed in FDA tolerance setting.

The Task Force chose to focus the advisory protocol on PCBs, the chemical contaminant most frequently encountered in Great Lakes fish. The advisory uses a weight-of-evidence derived individual health protection value (HPV) of 0.05ug/kg/day for PCB residue ingested from fish tissue. The HPV is intended to encompass acceptable cancer and reproductive/developmental risk. A risk analysis shows that this protection value is reasonable and within the margins of exposure for no observed adverse effect levels (NOAEL) for both laboratory animal and human effects (Great Lakes Sport Fish Advisory Task Force, 1993).

Although not all Lake Erie jurisdictions have adopted the Task Force's specific proposed guidance for establishing fish consumption advisories, all jurisdictions do include fish cooking and cleaning guidelines very similar, if not identical, to those found in the 1993 Proposed Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory. These guidelines: a) emphasize the importance of removing fat prior to cooking and discarding any fat drippings prior to consumption to reduce the risk of exposure to organochlorines; b) point out which types of fish are more likely to accumulate contaminants; and c) point out that mercury is found in the muscle and cannot be removed. Therefore, the amount of fish eaten must be reduced to reduce exposure to mercury.

U.S. Federal

In September 1995, the U.S. Fish & Wildlife Service completed a Great Lakes Fishery Resources Restoration Study. This study was conducted as a requirement of Section 2005 (a) of the Great Lakes Fish and Wildlife Restoration Act, P.L. 101-537. The study concludes that "when viable and productive stocks of native and other desired fish species are available, bald eagles successfully reproduce and inhabit shoreline, mink and otter once again claim their habitat, chemical and other stress-induced deformities in fish and wildlife are eliminated, and *fish and wildlife can be consumed with* ***little or no risk*** *to human health*, then restoration goals for the Great Lakes Basin will have been met (emphasis added, USFWS, 1995)."

Michigan

Michigan's fish consumption advisory program was initiated in 1970 with the discovery of elevated mercury levels in fish from the St. Clair River, Lake St. Clair, the Detroit River, and Lake Erie. As of 1996, the Michigan Department of Public Health (MDPH) has been using the list of contaminants and associated trigger levels shown in Table 2.2 to establish consumption advisories.

Table 2.2 Contaminant/Trigger Levels Used to Establish Fish Consumption Advisories For

Michigan and New York (MDPH, 1996; NYSDH, 1995-1996).

Chemical	Michigan	New York
Chlordane	0.3 ppm	0.3 ppm
DDT	5.0 ppm	5.0 ppm
Dieldrin	0.3 ppm	0.3 ppm
Dioxin	10.0 ppt (total TEQs are used for all dioxins/furans)	10.0 ppt (total TEQs are used for all 2,3,7,8- chlorine substituted dioxins and furans)
Endrin	0.3 ppm	0.3 ppm
Heptachlor	0.3 ppm	0.3 ppm (heptachlor/heptachlor epoxide)
Mercury	0.5 ppm (total mercury)*	1.0 ppm (total mercury) *
Mirex	0.1 ppm	0.1 ppm (mirex/photomirex)
PCB	2.0 ppm	2.0 ppm
Toxaphene	5.0 ppm	5.0 ppm

N/A = Not Applicable

ppm = parts per million

* For mercury, the FDA tolerance of 1.0 ppm is based on methyl mercury. New York and Michigan use total mercury since fish contain mercury primarily in the methylated form.

For any of the organic contaminants (including PCBs, DDT, chlordane, dieldrin, dioxin, and others), when between 11 and 49 percent of samples exceed a MDPH trigger level, a "restrict consumption" advisory is issued. When 50 percent or more exceed a trigger level, a "no consumption" advisory is issued. Attempts are made to provide size specific advice wherever possible. For mercury, fish tissue mercury levels falling in the range of 0.5 to 1.5 ppm are placed in the "restrict consumption" advisory category. Fish tissue with mercury levels exceeding 1.5 ppm are placed in the "no consumption" category. When data are too limited to judge the necessity for an advisory, but where some indication of contamination exists, an advisory is usually not issued but additional samples are requested (MDPH, 1996).

New York

In New York State, contamination of fish by mercury to levels in excess of FDA action levels was discovered in late 1969 and early 1970. The first fish consumption advisories were established in 1971 (NYSDEC, 1985). The New York State Department of Health (NYSDH) uses the list of contaminants and associated trigger levels shown in Table 2.2 to establish fish consumption advisories.

Ohio

The Ohio Department of Health (ODH) issues fish consumption advisories with input from the Ohio Environmental Protection Agency (OEPA) and the Ohio Department of Natural Resources (ODNR). Ohio uses a modified version of the protocol for a Uniform Great Lakes Sport Fish Consumption Advisory to establish fish consumption advisories

for PCBs, mercury, and lead. Use of this protocol is based on different criteria for each of the three contaminants, as shown in Table 2.3. Table 2.4 details the levels of PCBs, mercury and lead that govern the meal frequency advice for each advisory issued in Ohio.

Table 2.3 Criteria for Establishing Fish Consumption Advisories in Ohio for PCBs, Lead, and Mercury (ODH, 1997)

PCBs	Mercury	Lead
Health Protection Value = 0.05 ug PCB/kg/day	Reference Dose (RfD) = 0.1 ug/kg/day	Provisional Total Tolerable Daily Intake (PTTD) = 6 ug lead/day
Average Meal = 227 grams/8 ounces (uncooked fish)	Average Meal = 227 grams/8 ounces (uncooked fish)	Average meal = 113.4 grams/4 ounces (uncooked fish)
Representative target consumer is a 70 kg adult.	Representative target consumer is a 70 kg adult.	Representative target consumer is a child, 0-6 years in age.
Five advisory meal rates: unrestricted (225/yr); 1/wk; 1/mo; 6/yr; none	Two advisory meal rates: 1/month ; none	Five advisory rates: unrestricted (225/yr); 1/wk; 1/mo; 6/yr; none
Assume skinning/ trimming fat/ cooking reduces PCB residues by 50% from raw, skin-on fillet	Skinning/trimming fat/cooking ***does not*** reduce mercury residues.	Skinning/trimming fat/cooking ***does not* reduce** lead residues.

Pennsylvania

Fish tissue contaminant issues in Pennsylvania are addressed by an interagency workgroup consisting of representatives of the Department of Health, the Fish and Boat Commission, and the Department of Environmental Protection (PADEP, 1996). Monitoring of toxic pollutants in Pennsylvania fish tissue began in 1976. This effort includes both special studies and routine monitoring.

Pennsylvania is using the Proposed Uniform Great Lakes Fish Advisory Protocol for PCBs in Lake Erie and the Presque Isle Bay Area of Concern (AOC). Table 2.4 details the levels of PCBs that govern the meal frequency advice for each Lake Erie associated advisory issued in Pennsylvania.

Ontario

The Ontario Ministry of Environment and Energy (OMEE) develops fish consumption advisories for Ontario based on research and review of toxicological data. Health Canada has established human "tolerable daily intakes" for an extensive list of contaminants. It is then determined what proportion of the tolerable daily intake can come from each of the environmental pathways (e.g. air, water, different types of food) including sport fish consumption. It is assumed that the average-sized adult consumes 227 g (8 ounces) of fish per meal (OMEE, 1995-1996). Specific levels of PCBs, dioxins, mercury, mirex, DDT and toxaphene that govern meal frequency advice for Ontario are summarized in Table 2.4.

Table 2.4, Contaminant Levels in Raw Fish Fillets Related to Meal Advice Given for Ohio, Pennsylvania, and Ontario (Estenik, OEPA, 1996; Ohio Department of Health, 1997; Sivarajah, PADH, 1996; Howell, OMEE, 1995; Cox and Vaillancourt, OMEE, 1996).

Type of Advisory	Chemical	Concentration for Ohio	Concentration for Ontario	Concentration for Pennsylvania
DO NOT EAT	PCBs	> 1.900 ppm	> 4.0 ppm	> 1.90 ppm
Six Meals/Year	PCBs	1.001 - 1.900 ppm	N/A	1.1 - 1.9 ppm
One Meal/Month	PCBs	0.301 - 1.000 ppm	2.0 - 4.0 ppm*	0.31 - 1.0 ppm
Two Meals/Month	PCBs	N/A	1.0 - 2.0 ppm	N/A
One Meal/Week	PCBs	0.051 - 0.300 ppm	0.50 - 1.0 ppm	0.06 - 0.30 ppm
Unrestricted	PCBs	0 - 0.050 ppm	<0.50 ppm *****	0 - 0.05 ppm
DO NOT EAT	Mercury**	> 1.00 ppm	> 1.5 ppm ****	N/A
One Meal/Month	Mercury**	0.201 - 1.00 ppm	N/A	N/A
Two Meals/Month	Mercury**	N/A	1.0 - 1.5 ppm	N/A
One Meal/Week	Mercury**	0.051- 0.200 ppm	0.5 - 1.0 ppm	N/A
Unrestricted	Mercury**	0 - 0.0500 ppm	< 0.5 ppm*****	N/A
DO NOT EAT	Dioxins***	N/A	80.4 ppt	N/A
One Meal/Month	Dioxins***	N/A	40.2 - 80.4 ppt*	N/A
Two Meals/Month	Dioxins***	N/A	20.1 - 40.2 ppt	N/A
One Meal/Week	Dioxins***	N/A	10.1 -20.1 ppt	N/A
Unrestricted	Dioxins**	N/A	< 10.1 ppt *****	N/A
DO NOT EAT	Mirex/photomirex	N/A	> 0.56 ppm	N/A
One Meal/Month	Mirex/photomirex	N/A	0.28 - 0.56 ppm*	N/A
Two Meals/Month	Mirex/photomirex	N/A	0.14 - 0.28 ppm	N/A
One Meal /Week	Mirex/photomirex	N/A	0.07 - 0.14 ppm	N/A
Unrestricted	Mirex/photomirex	N/A	< 0.07 ppm *****	N/A
DO NOT EAT	DDT	N/A	5.0 ppm	N/A
DO NOT EAT	Toxaphene	N/A	> 1.6 ppm	N/A
One Meal/Month	Toxaphene	N/A	0.8 - 1.6 ppm*	N/A
Two Meals/Month	Toxaphene	N/A	0.4 - 0.8 ppm	N/A

Type of Advisory	Chemical	Concentration for Ohio	Concentration for Ontario	Concentration for Pennsylvania
One Meal/Week	Toxaphene	N/A	0.2 - 0.4 ppm	N/A
Unrestricted	Toxaphene	N/A	< 0.2 ppm *****	N/A
One Meal/Month	Lead	0.373 - 1.069 ppm	N/A	N/A
One Meal/Week	Lead	0.087 - 0.372 ppm	N/A	N/A
Unrestricted	Lead	0 - 0.086 ppm	N/A	N/A

* Women of childbearing age and children under 15 in Ontario are advised not to consume fish in the one meal per month category.

** Women of childbearing age and children less than 6 years old in Ohio are advised not to consume more than 1 meal per month when mercury is the contaminant causing the advisory.

*** For toxicity equivalents of 2, 3, 7, 8 TCDD

**** Ontario has an advisory for mercury for subsistence fishermen. If the concentration of mercury is **0.2 ppm or higher**, it is recommended that subsistence fishermen **do not** eat the catch.

***** In Ontario, the unrestricted category was based on survey results that indicate the average sports fisherman eats no more than 8 meals of sport fish per month.

N/A = Not Applicable; ppm - parts per million; ppt = parts per trillion

2.1.5 Status

There is a **commercial** fishing restriction due to PCBs on carp that are 32 cm or greater in Ontario waters of Lake Erie (Hendzel, 1996). A summary of existing **sport** fish consumption advisories, by jurisdiction and Lake Erie basin, is provided in Table 2.5.

In reviewing Table 2.5, it is important to keep the following points in mind.

- All fish species do not accumulate contaminants at the same rate due to differing feeding habits, habitats, growth rates, and physiology. For example, when testing fish for mercury in a specific area, the practice is initially to select those species which are top predators, as they will usually indicate the highest mercury levels likely to be found. In testing for organic contaminants such as PCBs and mirex, species with high fat levels such as salmon, lake trout, smelt, and perch, are selected since organic chemicals usually tend to accumulate in fatty tissue (OMEE, 1995-1996).

- Bottom feeders such as carp and channel catfish are often used as an indication of the contaminant content of bottom sediments. Carp and channel catfish are also good indicators of contaminant concentrations because they are fatty and long-lived.

- Certain subsets of overall fish consumers are at greater risk of adverse impacts due to contaminant exposure. These groups are women of childbearing age, children under 15 years of age, certain cultural and immigrant groups, and subsistence anglers. Certain cultural and/or immigrant groups include Great Lakes fish as a staple in their diet and traditional food preparation may include eating the fat and organs. Initial surveys show that certain cultural and immigrant groups may be eating up to 3 meals per week of Great Lakes fish (Mortimer, 1996).

- Risk assessment methods are more widely used in establishing advisories, providing more detailed information to the sport fish consumer than has been available in the past. A list of the chemical parameters that each Lake Erie jurisdiction routinely monitors in sport fish tissue is included in Appendix 2A.

- There are **human contact** advisories in effect for segments of the Ottawa and Black Rivers that fall within AOC boundaries. In the case of the Black River, the reason for the contact advisory is PAHs, whereas the reason for the fish consumption advisories is PCBs. For the Ottawa River, both the fish consumption advisories and the contact advisory are due to PCBs.

Table 2.5 Summary of Lake Erie Related Sport Fish Consumption Advisories (MDPH, 1996; NYSDOH, 1996; ODH, 1997; ODNR, 1996; OMEE, 1995-1996; PADEP, 1996)

Location/Basin	Fish Species/Size Affected	Details of Advisory/ Numbers of Meals Suggested	Cause(s) of Advisory
LAKE ERIE OPEN WATERS	*LAKE ERIE OPEN WATERS*	*LAKE ERIE OPEN WATERS*	*LAKE ERIE OPEN WATERS*
Lake Erie (all **Michigan** waters)/Western Basin	Carp, channel catfish	**DO NOT EAT**	**PCBs**
Lake Erie (all **Ohio** waters)/Western and Central Basins	All Species	*For women of childbearing age and children age 6 and under:* One Meal Per Week (52 meals/year)	This is a general precautionary advisory which is in place for all Ohio freshwaters. It has been issued to avoid excess exposure to **mercury** which is present at low background levels in nearly all Ohio fish samples tested.
Lake Erie (all **Ohio** waters)/Western and Central Basins	Walleye, freshwater drum, chinook salmon under 19"	One Meal Per Week (52 meals/year)	**PCBs**
Lake Erie (all **Ohio** waters)/Western and Central Basins	Carp under 20", white perch, steelhead trout, coho salmon, chinook salmon 19" and over, small mouth and white bass	One Meal Per Month (12 meals/year)	**PCBs**
Lake Erie (all **Ohio** waters)/Western and Central Basins	Carp 20" and over, channel catfish, lake trout	Six Meals Per year (1 meal /2 months)	**PCBs**
Lake Erie (all **Pennsylvania** waters)/Central and Eastern Basins	Walleye under 23", freshwater drum	One Meal Per Week (52 meals/year)	**PCBs, Chlordane**
Lake Erie (all **Pennsylvania** waters)/Central and Eastern Basins	Walleye over 23", coho salmon* steelhead (rainbow trout)*, smallmouth bass, white perch, white bass, lake whitefish, carp under 20"	One Meal Per Month (12 meals/year)	**PCBs**
Lake Erie (all **Pennsylvania** waters)/Central and Eastern Basins	Carp over 20", lake trout, channel catfish	One Meal Every Two Months (6 meals/year)	**PCBs**
LAKE ERIE OPEN WATERS	*LAKE ERIE OPEN WATERS*	*LAKE ERIE OPEN WATERS*	*LAKE ERIE OPEN WATERS*

Location/Basin	Fish Species/Size Affected	Details of Advisory/ Numbers of Meals Suggested	Cause(s) of Advisory
Lake Erie (all **New York** waters)/Eastern Basin	All Species	One Meal Per Week (52 meals/year)	This is a general precautionary advisory which is in place for all New York State freshwaters. It has been issued to avoid excessive exposure to contaminants which may be present but have not yet been measured.
Lake Erie (**Ontario** Western Basin Waters)	Coho salmon (22-26"/55-65 cm), small mouth bass (14-18"/35-45 cm), whitefish (22-26"/55-65 cm), white bass (12-14"/30-35 cm, carp (18-22"/45-55 cm), freshwater drum (14-18"/35-45 cm)	Four Meals Per Month	**PCBs**
Lake Erie (**Ontario** Western Basin Waters)	White bass (14-18"/35-45 cm), carp (22-30"/55-75 cm)	Two Meals Per Month	**PCBs**
Lake Erie (**Ontario** Western Basin Waters)	Channel catfish (12-22"/30-55 cm), carp (>30"/>75 cm)	One Meal Per Month***	**PCBs** (both species); **Dioxin** (catfish);
Lake Erie (**Ontario** Central Basin Waters)	White bass (14-18"/35-45 cm), carp (18-26"/45-65 cm), channel catfish (12-14"/30-35 cm)	Four Meals Per Month	**PCBs**
Lake Erie (**Ontario** Central Basin Waters)	Carp (26-30"/65-75 cm)	Two Meals Per Month	**PCBs**
Lake Erie (**Ontario** Central Basin Waters)	Channel catfish (14-22"/35-55 cm)	One Meal Per Month***	**PCBs**
Lake Erie (**Ontario** Eastern Basin Waters)	Coho salmon (26-30"/65-75 cm), lake trout (22-26"/55-65 cm), walleye (26-30"/65-75 cm), white bass (14-18"/35-45 cm), channel catfish (26" and above/65 cm and above), freshwater drum (18-22"/45-55 cm)	Four Meals Per Month	**PCBs** (Coho salmon, lake trout, channel catfish)**Mercury** (walleye and white bass, freshwater drum
WESTERN BASIN TRIBUTARIES	*WESTERN BASIN TRIBUTARIES*	*WESTERN BASIN TRIBUTARIES*	*WESTERN BASIN TRIBUTARIES*
Maumee Bay, **Ohio****	Carp	Six Meals Per Year (1 meal /2 months)	**PCBs**
WESTERN BASIN TRIBUTARIES	*WESTERN BASIN TRIBUTARIES*	*WESTERN BASIN TRIBUTARIES*	*WESTERN BASIN TRIBUTARIES*
Maumee Bay, **Ohio****	Channel catfish	**DO NOT EAT**	**PCBs**

Location/Basin	Fish Species/Size Affected	Details of Advisory/ Numbers of Meals Suggested	Cause(s) of Advisory
Maumee River, **Ohio**, All Waters **	Carp, smallmouth bass	One Meal Per Month (12 meals/year)	**PCBs** (carp), **mercury** (smallmouth bass)
Maumee River, **Ohio**, Waterville to the Indiana Border**	Channel Catfish	One Meal Per Week (52 meals/year)	**PCBs**
Maumee River, **Ohio**, Mouth to Waterville**	Freshwater Drum, Largemouth Bass	One Meal Per Week (52 meals/year)	**PCBs**
Maumee River, **Ohio**, Mouth to Waterville**	Channel Catfish	**DO NOT EAT**	**PCBs**
Ottawa River, **Ohio**, from I-475 N. of Wildwood Preserve Toledo to Maumee Bay, Lake Erie**	All species	**DO NOT EAT**	**PCBs**
Portage River, **Ohio** Turnpike to Lake Erie**	Largemouth bass, smallmouth bass	One Meal Per Week (52 meals/year)	**Lead, PCBs**
Portage River, **Ohio** Turnpike to Lake Erie**	Carp, channel catfish	One Meal Per Month (12 meals/year)	**PCBs**
Sandusky River, **Ohio**, All Waters**	Carp	One Meal Per Week (52 meals/year)	**PCBs**
Sandusky River, **Ohio**, All Waters**	Channel catfish, largemouth bass	One Meal Per Month (12 meals/year)	**PCBs, mercury**
Detroit River (**MI** advisory)	Carp	**DO NOT EAT**	**PCBs**
Detroit River (**MI** advisory)	Freshwater drum over 14"	One Meal Per Week (52 meals/year);Nursing mothers, pregnant women, women who intend to have children, and children under age 15, One Meal Per Month (12 meals/year)	**Mercury**
Lower Detroit River (**Ontario** advisory)	Walleye (22-26"/55-65 cm), channel catfish (12-18"/30-45 cm), carp (14-18"/35-45 cm)	Four Meals Per Month	**PCBs** (carp, channel catfish)**Mercury** (walleye)
Lower Detroit River (**Ontario** advisory)	Carp (18-22"/45-55 cm)	One Meal Per Month***	**PCBs**
Lower Detroit River (**Ontario** advisory)	Carp (22-26"/55-65 cm)	**DO NOT EAT**	**PCBs**
WESTERN BASIN TRIBUTARIES	*WESTERN BASIN TRIBUTARIES*	*WESTERN BASIN TRIBUTARIES*	*WESTERN BASIN TRIBUTARIES*
River Raisin, **Michigan**, downstream from	Carp, white bass over 11"	**DO NOT EAT**	**PCBs**

Location/Basin	Fish Species/Size Affected	Details of Advisory/ Numbers of Meals Suggested	Cause(s) of Advisory
Winchester Bridge			
CENTRAL BASIN TRIBUTARIES	*CENTRAL BASIN TRIBUTARIES*	*CENTRAL BASIN TRIBUTARIES*	*CENTRAL BASIN TRIBUTARIES*
Black River, **Ohio**, from 31st Street Bridge, Sheffield to Lake Erie**	Brown bullhead, freshwater drum	One Meal Per Week (52 meals/year)	**PCBs**
Black River, **Ohio**, from 31st Street Bridge, Sheffield to Lake Erie**	Carp	One Meal Per Month (12 meals/year)	**PCBs**
Cuyahoga River, **Ohio**, Ohio Edison Dam Pool to Lake Erie**	White sucker under 11",	One Meal Per Week (52 meals/year)	**PCBs**
Cuyahoga River, **Ohio,** Ohio Edison Dam Pool to Lake Erie**	Carp, white sucker 11" and over, largemouth bass	One Meal Per Month (12 meals/year)	**PCBs** (carp, white sucker), **mercury** (largemouth bass)
Cuyahoga River, **Ohio**, Ohio Edison Dam Pool to Lake Erie**	Brown and yellow bullhead	Six Meals Per Year (1 meal/2 months)	**PCBs**
Chagrin River, **Ohio**, All Waters**	Rock bass, smallmouth bass	One Meal Per Month (12 meals/year)	**Mercury, Lead**
Ashtabula River from 24th St. Bridge, Ashtabula, **Ohio** to Lake Erie**	Smallmouth bass	One Meal Per Week (52 meals/year)	**PCBs**
Ashtabula River from 24th St. Bridge, Ashtabula, **Ohio** to Lake Erie**	Largemouth bass, walleye	One Meal Per Month (12 meals/year)	**Mercury, PCBs**
Ashtabula River from 24th St. Bridge, Ashtabula, **Ohio** to Lake Erie**	Channel catfish, carp	Six Meals Per Year (1 meal/2 months)	**PCBs**
Conneaut Creek, **Ohio**, All Waters**	Smallmouth bass	One Meal Per Month (12 meals/year)	**Mercury**
Rondeau Bay, **Ontario**	Large mouth bass (14-18"/35-45 cm), channel catfish (14-18"/35-45 cm), carp (18-26"/45-65 cm), freshwater drum (14-18"/35-45 cm)	Four Meals Per Month	**PCBs** (Channel catfish, carp)**Mercury** (Large mouth bass, freshwater drum)
Rondeau Bay, **Ontario**	Cap (26-30"/65-75 cm)	Two Meals Per Month	**PCBs**
EASTERN BASIN TRIBUTARIES	*EASTERN BASIN TRIBUTARIES*	*EASTERN BASIN TRIBUTARIES*	*EASTERN BASIN TRIBUTARIES*
Presque Isle Bay, **Pennsylvania**	Largemouth bass, walleye	One Meal Per Week (52 Meals/Year)	**PCBs**
EASTERN BASIN TRIBUTARIES	*EASTERN BASIN TRIBUTARIES*	*EASTERN BASIN TRIBUTARIES*	*EASTERN BASIN TRIBUTARIES*
Buffalo River/Harbor, **New York**	Carp (all consumers); all other fish species (women of childbearing age, infants and children under the age of	**DO NOT EAT**	**PCBs**

Location/Basin	Fish Species/Size Affected	Details of Advisory/ Numbers of Meals Suggested	Cause(s) of Advisory
Long Point Bay, **Ontario**	15) Coho salmon (22" and above/55 cm and above), lake trout (22-26"/55-65 cm), walleye (26" and above/65 cm and above), white bass (14-18"/35-45 cm), white sucker (22-26"/55-65 cm), bowfin (18-26"/45-65 cm)	Four Meals Per Month	**PCBs** (Coho salmon, lake trout, white bass)**Mercury** (walleye, white sucker, bowfin)
Long Point Bay, **Ontario**	Carp (26-30"/65-75 cm), freshwater drum (18-22"/45-55 cm)	Two Meals Per Month	**PCBs** (Carp)**Mercury** (Freshwater drum)
Long Point Bay, **Ontario**	Freshwater drum (22-26"/55-65 cm)	**DO NOT EAT**	**Mercury**

* The Pennsylvania advisory states: "salmon and trout are migratory. They may be found seasonally in Presque Isle Bay or Lake Erie tributary streams. Trout, salmon, and other fish that have lived in Lake Erie, whether caught in the lake or elsewhere should be treated as Lake Erie fish".

** Low background levels of mercury were found in nearly all fish tissue samples tested from various Ohio bodies of water. Therefore, women of childbearing age and children 6 years and under are advised to eat not more than one meal per week of any species of fish from any Ohio body of water.

*** Women of childbearing age and children under 15 are advised not to consume fish in Ontario's one meal per month category.

2.1.6 Summary of Fish Consumption Restriction Impairment Conclusions

Impairment to human consumption of Lake Erie fish is occurring. Fish consumption restriction impairments occur when contaminant levels in fish exceed current standards, objectives or guidelines, or public health advisories are in effect for human consumption of fish or wildlife.

Public health advisories for human consumption of sport fish are in place for many geographic locations within Lake Erie waters (see Table 2.5). The presence of contaminants in Lake Erie, which are the basis for these advisories, exceed the Lake Erie Committee (LEC) draft objective related to fish consumption advisories. The goal of this objective is to "reduce contaminants in all fish species to levels that require **no advisory** for human consumption. . . ." Similarly, the presence of fish consumption advisories does not meet the IJC objective of no restrictions on the human consumption of fish in waters of the Great Lakes Basin Ecosystem.

A summary of Lake Erie/Lake Erie tributary fish consumption impairments and the associated causes is included in Table 2.6. The species most commonly affected are carp, channel catfish, and freshwater drum. The most common cause of a sport fish consumption advisory/commercial catch restriction in Lake Erie, regardless of its severity, is PCBs. The second most common cause of a sport fish consumption advisory is mercury. Fish consumption advisories based on levels of lead, chlordane, and dioxins are occurring in localized areas.

Bioaccumulation makes PCBs in fish especially hazardous to humans. Some PCBs in the body retain biological activity after exposure stops. Bioaccumulated PCBs appear to be more toxic than commercial PCBs and appear to be more persistent in the body. For exposure through the food chain, risks can be higher than for other exposures (USEPA/USDH&HS-ATSDR, 1996).

DO NOT EAT consumption advisories are in effect for certain species/size classes of fish in Lake Erie, Maumee and Long Point Bays, the Maumee, Detroit, Raisin, and Rouge River AOCs, and the Buffalo River/Harbor area. Human contact advisories are also in effect for the segments of the Black and Ottawa Rivers that fall within AOC boundaries. Human contact advisories are issued by the Ohio Department of Health and mean that it is not safe to go into the waters in these areas.

Table 2.6, Summary of Sport Fish Consumption Advisories and Causes by Lake Erie Basin.

Location/Geographic Extent of Impairment					
W. Basin Nearshore	**W. Basin Offshore**	**C. Basin Nearshore**	**C. Basin Offshore**	**E. Basin Nearshore**	**E. Basin Offshore**
Impaired. Fish advisories for Maumee, Portage, Sandusky, Raisin, Rouge, Detroit, and Ottawa River tributaries and Maumee Bay.	Impaired Fish advisories for Lake Erie waters of all jurisdictions bordering this basin.	Impaired. Fish advisories for Black, Cuyahoga, Ashtabula, Chagrin River and Conneaut Creek tributaries and Rondeau Bay.	Impaired. Fish advisories for Lake Erie waters of all jurisdictions bordering this basin.	Impaired. Fish advisories for Presque Isle Bay, Buffalo River/Harbor and Long Point Bay.	Impaired. Fish advisories for Lake Erie waters of all jurisdictions bordering this basin.
Causes of Impairment - PCBs, mercury, lead, chlordane, and dioxins.					

2.1.7 Emerging Issues

An important issue related to potential routes of contaminant transfer to fish may be emerging in Ohio nearshore waters of the central basin. Round goby populations, an exotic species, have exploded within the last two years in the Grand River Harbor, Ohio portion of the Lake Erie central basin (exclusive of the Grand River proper). Round gobies feed principally on zebra mussels (approximately 80% of their diet) and compete with sculpins and crayfish for habitat. Smallmouth bass primarily feed on sculpins and crayfish, but with the abundance of round gobies in their feeding territory, smallmouth bass are now preying on round gobies. This appears to have led to dramatic increases in smallmouth bass populations in the Grand River Harbor nearshore area of Lake Erie.

It has been noted that smallmouth bass in Grand River Harbor have greater body burdens of PCBs than smallmouth bass in other Ohio EPA Lake Erie fish tissue samples. Tissue analysis of smallmouth bass from the Grand River Harbor areas has yielded the highest concentrations of PCBs measured by the Ohio EPA for this species in Lake Erie waters. The Grand River Harbor nearshore is relatively contaminant free, especially in comparison to Ohio's four AOCs. Therefore, there is concern that the rate of PCB bioaccumulation, in certain species which prey on round gobies, may increase in more contaminated areas when round goby ranges expand (Thoma, 1996).

However, it is currently difficult to use the above-mentioned limited data to make definitive statements about the implications of these findings. These higher contaminant levels may be a result of late season sampling or the larger size of the fish examined to date. Larger sized smallmouth bass are more frequently observed in this area. It should also be noted that Ohio Department of Natural Resources monitoring of smallmouth bass in offshore waters of the central basin near the Grand River Harbor indicates that smallmouth are not currently consuming gobies in offshore waters (Ohio Sea Grant, 1996). Therefore, whatever dynamic is occurring between smallmouth and round gobies is currently limited to the nearshore zone.

Further research is needed to determine the details of how and to what extent contaminants are being transferred to smallmouth bass. This research needs to look at PCBs and other contaminants and identify whether contaminants are approaching levels of concern for human consumption.

Because most of the existing Lake Erie sport fish consumption advisories are based on the presence of unacceptable levels of PCBs in fish tissues, there is the suggestion that once the issue of PCB contamination is resolved, the resulting beneficial use impairment will be eliminated. However, because of the analytical costs involved, most agencies only target the contaminant currently responsible for consumption restrictions. Unfortunately, there is likely to be a series of underlying contaminant restrictions, so that once the most predominant chemical declines, the next one on the scale moves up the priority list. This

issue will need attention, before fish consumption advisory restrictions are lifted (Estenik and Whittle, 1996).

Research is underway to quantify the levels of microcystin present in fish tissue collected in areas where the 1996 *Microcystis* bloom occurred. Microcystin is a potent liver toxin. In addition to evaluating the effect of microcystin levels on fish health, the results of the current research will identify whether microcystin is present in fish tissue at levels that impact the health of human consumers (Culver, 1996).

2.2 Wildlife Consumption Restrictions

2.2.1 Listing Criteria

According to the International Joint Commission wildlife consumption restriction impairments occur when contaminant levels in wildlife populations exceed current standards, objectives, or guidelines, or public health advisories are in effect for human consumption of wildlife (IJC, 1989).

2.2.2 Scope of the Assessment

The geographic scope of the Lake Erie LaMP beneficial use impairment assessment (BUIA) includes open lake waters, nearshore areas, river mouths and embayments, and the lake effect zone of Lake Erie tributaries. The lake effect zone is defined as that zone where the waters of the lake and tributary river are mixed. Detroit River impairments in the Lake Erie LaMP will be evaluated on a case by case basis and will be included where relevant to potential impacts in Lake Erie.

2.2.3 Wildlife Consumption Restriction Criteria and Objectives

Wildlife contaminant level research in the Great Lakes has been extensive. However, much of this research has focused on wildlife contaminant levels as they relate to wildlife health, not human health. For example, in New York contaminant levels standards have been established to protect the health of pisciverous wildlife (NYDEC, 1987). Recently, the issue of contaminant levels as related to hormone mimics and endocrine disruptors in all Great Lakes species has gained increasing attention. With this interest, there has been a similar interest in contaminant levels in wildlife that are consumed by humans and the potential associated human health impacts.

Existing criteria, objectives, and research results that pertain to contaminant levels in wildlife consumed by humans is outlined below.

U.S. Federal

In September 1995 the U.S. Fish & Wildlife Service completed a Great Lakes Fishery Resources Study. This study was conducted as a requirement of Section 2005 (a) of the Great Lakes Fish and Wildlife Restoration Act, P.L. 101-537. The study concludes that "when viable and productive stocks of native and other desired fish species are available, bald eagles successfully reproduce and inhabit shoreline, mink and otter once again claim their habitat, chemical and other stress-induced deformities in fish and wildlife are eliminated, *and fish and wildlife can be consumed with* ***little or no risk*** *to human health,* then restoration goals for the Great Lakes Basin will have been met (emphasis added, USFWS, 1995)."

Local Lake Erie Jurisdictions

With the exception of New York, none of the Lake Erie jurisdictions have established any criteria for implementing wildlife consumption restrictions.

2.2.4 Wildlife Contaminant Level Studies

Canada and Michigan have done research to evaluate the potential need for wildlife consumption advisories in game species of waterfowl. Ohio has research underway to evaluate the potential need for consumption advisories for snapping turtles. Summaries of these research efforts are provided below.

2.2.4.1 Canadian Wildlife Service Survey

In 1988 a national survey of contaminants in waterfowl and other game birds was developed and initiated to address the question of whether or not birds harvested in Canada, particularly Ontario and Quebec were safe to eat. See Appendix 2C for a map showing the general boundaries of the areas surveyed.

The objectives of the study were:

1) To provide a comprehensive data base on contaminants in waterfowl to Health Canada so that the risk to human health of eating those waterfowl may be assessed, and so that consumption guidelines may be issued, if necessary.

2) To provide information to consumers on the levels of toxic chemical residues in waterfowl, and to make recommendations for further work to complement the information presently available.

The intensive survey for the province of Ontario occurred during 1990-91 and 602 specimens representing 19 species of waterfowl and one other harvested species were

collected. Species chosen to be analyzed for contaminant residues were chosen to represent the waterfowl most frequently shot by hunters. Collection of 10 birds per species per location, representative of the hunted population, was requested in most locations. Birds were collected during the regular fall hunting season, except in areas of native hunting.

Since human health implications of consuming waterfowl were of primary concern, breast muscle, as representative of the edible portion of waterfowl, was targeted for chemical analysis. During sample preparation, all birds were examined for lead shot embedded in the tissue and any fragments found were removed. Samples of breast muscle were analyzed for moisture and lipid content, organochlorines, PCBs (both Arochlor 1254:1260 & congener specific basis), total mercury (Hg), Cadmium (Cd), Lead (Pb), arsenic (As) and selenium (Se). Selected pools of samples were also analyzed for dioxins (PCDDs) and furans (PCDFs). Samples were analyzed on a pooled basis (ideally 5-10 birds per pool) for each species collected from each sampling site within a specified time period. Therefore, the residue values are representative of the average value for the pool and there is no estimate of variation among birds in the pool.

A summary of survey information for areas relevant to the Lake Erie LaMP is included in Table 2.7.

Those species which feed at the top of the food chain contained the highest levels of contaminants. The exception to this was lead, where elevated lead levels were measured in a variety of species due to undetected fragments of lead shot left embedded in the flesh after hunting and cleaning. Generally, however, the levels found were not unusual from a wildlife health point of view. Many of the species hunted in eastern Canada, particularly in Ontario and Quebec, are exposed to contaminants during overwintering or stop-over periods in the Great Lakes (Braune, 1995).

Table 2.7, Waterfowl Species Sampled from the Lake Erie Basin Area of Ontario (Braune, 1995)

Location	Basin	Waterfowl Type	Year Sampled
Detroit River	Connecting Channel	Bufflehead, Mallard	1990
Rondeau	Central Basin	Mallard	1990
Rondeau Park	Central Basin	Canada Goose	1990
Long Point	Eastern Basin	Mallard, Greater Scaup, Lesser Scaup, Black Duck	1988
Long Point	Eastern Basin	Bufflehead	1990
Lower Grand River	Eastern Basin	Mallard	1989
Lowbanks	Eastern Basin	Bufflehead, Greater Scaup	1990

Based on the 1988-92 data evaluated (plus some earlier data from 1985-86), Health Canada concluded that, with the exception of Glaucous Gull breast muscle and/or eggs

from Kuujjuarapik, Quebec, the contaminant levels reported in the various waterfowl samples analyzed were either non-detectable or very low and would not be considered to pose a hazard to the health of human consumers (Braune, 1995).

2.2.4.2 Canadian Organic Contaminants Study

Canadian research has been conducted regarding zebra mussels as a new food source for ducks at Point Pelee, Long Point, Big Creek, the Detroit River and western Lake Erie (Hamilton, 1994; Knapton, unpublished; Mazak, unpublished). The Detroit River/western Lake Erie research is specifically looking at whether a zebra mussel diet may be influencing levels of contaminant accumulation in ducks that eat them. Because humans consume game duck from Lake Erie, the results of this research are reported here. The results of this study are the first step in determining whether zebra mussels are changing contaminant transfer patterns in a part of the Lake Erie food web that involves human consumers.

The diets of six species of waterfowl (greater and lesser scaup, bufflehead, canvasback, mallard and redhead) in the lower Great Lakes (Fighting Island, Detroit River, western Lake Erie, and Big Creek) were evaluated. The study compared those species that consume primarily zebra mussels with those that do not. Lesser and greater scaup from Fighting Island had, on average, 85 and 67% zebra mussel diet content. Other taxa consumed little (6%-bufflehead) or no (0%- canvasback, mallard, redhead) zebra mussels. Zebra mussel was the primary food source of lesser scaup (100%), greater scaup (97%), and bufflehead (72%) in western Lake Erie.

A representative group of low- (pentachlorobenzene [QCB], polychlorinated biphenyl [PCB] #28), mid- (PCBs # 105, 153) and high- (PCBs # 194, 206) K_{ow} compounds were examined in liver tissues for each group of waterfowl. In each case, mussel-consumers had elevated concentrations of these compounds relative to individuals that avoided zebra mussels. Among zebra mussel consumer species, all six compounds, except QCB were present in significantly higher concentrations in lake individuals.

Appendix 2D contains a summary comparison of contaminant level results from this study and others. Results from this study indicate that concentrations of most contaminants biomagnify in waterfowl that consume zebra mussels as a primary food source. Consequently, zebra mussels may serve as both an energy source and conduit for transfer of persistent organic contaminants to higher trophic levels in the Great Lakes. However, it is not clear whether consumption of zebra mussel portends adverse reproductive effects in Great Lakes waterfowl (Mazak, 1995).

2.2.4.3 Michigan Waterfowl Survey

Michigan hunter surveys have indicated that the amount of wild duck meat consumed per

person per year is similar to the amount of Michigan fish consumed per person per year. Therefore, the Michigan Department of Health (MPDH) used their 1992 fish consumption advisory trigger levels for contaminants (see Table 2.8) to evaluate risks to hunters eating wild duck meat. (It should be noted that 1992 and 1996 consumption advisory trigger levels are identical). Based upon the results of a 1989 survey of 754 Michigan hunters, mallards comprise 50% of the ducks harvested and Canada geese make up 99% of all geese harvested (Michigan DNR, 1993).

Table 2.8, 1992 MPDH Fish Consumption Advisory Trigger Levels (MDNR, 1993)

Chemical	MPDH Advisory Trigger Level
Chlordane	0.3 ppm
DDT	5.0 ppm
Dieldrin	0.3 ppm
Dioxin	10.0 ppt
Heptachlor	0.3 ppm
Mercury	0.5 ppm
PCB	2.0 ppm
Toxaphene	5.0 ppm

A 1992 evaluation was made of contaminant data from 6 different species of ducks (59 mallards, 12 ringneck ducks, 11 scaup, 10 green-winged teal, 7 wood duck, and 1 blue-winged teal) collected between 1988 and 1990 from 20 areas around the state of Michigan. Tissue samples were of several different types: liver, breast muscle with skin attached, and breast muscle without skin attached.

During this evaluation ducks were collected from one area within the geographic scope of the Lake Erie LaMP: Pointe Mouillee State Game Area (SGA) at the mouth of the Huron River. Mean concentrations of mercury and total PCBs in Pointe Mouillee samples were non-detect (no. individuals = 20; no. species =2) and 0.282 ppm (no. individuals = 71; no. species = 4) respectively. The MDPH consumption advisory trigger level of 2.0 ppm for total PCBs was exceeded in one tissue sample (breast muscle with skin attached) from a juvenile mallard collected during the non-hunting season within the confined disposal facility at the Pointe Mouillee SGA (2.284 ppm).

Ducks collected from within the confined disposal facility at the Pointe Mouillee SGA had detectable tissue concentrations of hexachlorobenzene, p,p-DDE, p,p-DDT, octachlorostyrene, hexachlorostyrene, heptachlorostyrene, oxychlordane, heptachlor epoxide, trans-nonachlor, cis-nonachlor, dieldrin, and gamma-BHC. For organochlorine contaminants with MDPH trigger levels, none were exceeded.

Pointe Mouillee ducks, in general, tended to exhibit higher tissue concentrations of total PCBs and other contaminants than ducks from other areas in the state. Wildlife and water quality experts speculate that the Pointe Mouillee ducks have been exposed to

contaminated dredge spoils at the Pointe Mouillee confined disposal facility (MDNR, 1993).

2.2.4.4 New York Contaminants Study

The New York State Department of Health (NYSDH) provides the following advice to those considering eating snapping turtles or waterfowl from New York.
Snapping turtles retain contaminants in their fat, liver, eggs and, to a lesser extent, muscle. If you choose to consume snapping turtles, you can reduce your exposure by carefully trimming away all fat and discarding the fat, liver and eggs prior to cooking the meat or preparing soup (to reduce exposure). Women of childbearing age, infants and children under the age of 15 should avoid eating snapping turtles or soups made with their meat. The contaminant of concern for this advisory is PCBs.

Mergansers are the most heavily contaminated waterfowl species and should not be eaten. Other waterfowl should be skinned and all fat removed before cooking; stuffing should be discarded after cooking; limit eating to two meals per month. Monitoring data indicate that wood ducks and Canada geese are less contaminated than other waterfowl species and diving ducks are more contaminated than dabbling ducks. The contaminants of concern for this advisory are PCBs, mirex, chlordane, and DDT (NYSDH, 1995-1996).

2.2.4.5 Ohio Contaminants Studies

Ohio does not currently have any wildlife consumption advisories. Two research projects are underway that will look at contaminant levels in certain wildlife species as related to human consumption. One study is looking at the levels of microcystin present in Lake Erie mallards that died in 1996. The other study is looking at contaminant levels in Lake Erie snapping turtles as related to human consumption.

Microcystis blooms occurred in the western basin of Lake Erie in the late summer and early fall of 1995 and 1996. Besides the aesthetic impact of the alga bloom on Lake Erie, there is also concern about *Microcystis*' tendency under certain conditions, to produce microcystin. Microcystin is a potent hepatic (liver) toxin. At elevated concentrations, microcystin is suspected to cause bird and fish kills as well as severe gastrointestinal problems in humans (Ohio Lake Erie Office, 1995). Since microcystins are normally confined within the cyanobacterial cells, and do not enter the water until lysis or cell death, the relationship between the age and condition of a bloom and the public health consequences is particularly important (Carmichael, 1992).

Because the *Microcystis* blooms occurred so recently and were not expected, it is not yet known if any aquatic organism mortality due to microcystins occurred in 1995 or 1996. Eleven mallards were collected from *Microcystis* bloom areas during 1996. These mallards were all very sick with severe diarrhea. The stomachs from each duck were

examined to see if they contained microcystin. None was detected, presumably due to the severe diarrhea which preceded the stomach analysis. Liver tissue from each duck is currently under analysis to see if the tissue contains microcystin and if, so, what level of microcystin. This data will be used to determine if microcystin levels in ducks are high enough to be a health issue for human consumers (Culver, 1996).

The snapping turtle, *Chelydra serpentina*, accumulates organochlorines mainly in its fat, liver and eggs, due to the high lipid content of these tissues (EC, 1991). Because snapping turtles are long-lived (up to 50 years) and omnivorous, they are considered good indicators of contaminant levels in the environment over time (Estenik and Fisher, 1996). Because turtles eat plants, as well as fish, a portion of their diet is directly representative of the contaminant levels in the area where they feed (Estenik, 1996).

A research project titled "Turtles as Environmental Monitors of Priority Pollutants and Significance to Human Consumers," is underway in Ohio. The study is intended to test the general hypothesis that contaminant concentrations in snapping turtles reflect concentrations in environmental media and can be used to predict exposure and possible effects in other organisms. Specific study objectives are: 1) to analyze PCB and dioxin levels in fat and blood of field-collected snapping turtles. Turtles will be obtained from sites with varying degrees of known contaminants so that it can be determined whether concentrations in turtle tissue are reflective of environmental exposure; 2) to measure levels of key reproductive hormones in exposed and control turtles in order to correlate level of contamination with potential reproductive impairment; 3) to measure contaminant loads in turtle eggs; 4) to quantify PCB exposure and identify effect as total Arochlor versus specific congeners; 5) to evaluate blood concentrations of PCBs and dioxins as predictors of organ distribution of contaminants; and 6) if, as expected, the contaminant levels in turtles are high, the risk to human consumers will be verified in a follow-up study by measuring PCB and dioxin levels in blood samples of humans who eat snapping turtles (Fisher, 1996).

2.2.4.6 Ontario Contaminants Studies

Ontario is unique among the Lake Erie jurisdictions in having snapping turtle harvesting data. In 1982 the annual harvest of snapping turtles in Ontario was 5,000 to 8,333 turtles. Biological supply companies commercial fish buyers, pet wholesalers and retailers, and fish markets were surveyed to determine the principle buyers of turtles, their sources of supply, and information on retail and wholesale prices. 1982 data showed that the major markets for wholesaling turtles as food items were the larger fish markets in the U.S. including Detroit, Chicago, and New York city. Data from 1982 also indicated the need for regulation of turtle harvesting to protect the turtles during the nesting season, which lasts from late May until the end of June (Lovisek, 1982).

Ontario has also studied contaminant levels in common snapping turtle eggs in the lower

Great Lakes-St. Lawrence River Basin in the early to late 1980s. Two of the Canadian sites studied are on Lake Erie -- Big Creek National Wildlife Area, and Rondeau Provincial Park near the marsh at Point aux Pins.

The focus of these studies was on the use of snapping turtle eggs as an indicator of contaminant levels in wetland habitats rather than on the potential impacts to humans of consuming the eggs. However, this data will be relevant, from a historical standpoint, when the results of the Ohio study become available, and is therefore reported here. Contaminant levels in snapping turtle eggs from the Canadian sample sites is included in Tables 2.9 through 2.11 in Appendix 2B (Struger, et. al., 1993).

2.2.5 Wildlife Consumption Restriction Impairment Conclusions

Although contaminant level studies in Great Lakes wildlife are extensive, the amount of information available regarding the human health impacts of consuming Lake Erie wildlife is limited, but growing. This fact makes it difficult to reach a definitive conclusion regarding the significance and extent of wildlife consumption problems in Lake Erie. An additional confounding factor in the analysis of wildlife contaminant levels versus fish contaminant levels, is their broader range. Whereas the fish environment is exclusively aquatic and usually limited to the Lake Erie basin, wildlife, particularly migratory waterfowl, can pick up contaminants quite distant from Lake Erie. In the case of snapping turtles, although their range is much more limited than waterfowl, the range of the fish that they eat can be quite large, making it difficult to pinpoint the origin of the contaminants they ingest.

Many of the wildlife contaminant level studies have been related to waterfowl, suggesting that further research may be needed into contaminant levels in other wildlife consumed by humans. In addition, the reasons for the studies varied. For example, the study of Lake Erie ducks that eat zebra mussels looked at contaminant bioaccumulation in liver tissue (which is not normally consumed by humans) and potential associated reproductive effects in the waterfowl. However, since humans consume greater and lesser scaup and bufflehead, the results of this study may indicate the need for monitoring of the levels of contaminants in breast tissue for these species. This is particularly needed since zebra mussels are relatively new to Lake Erie and their impact on contaminant transfer up the food chain is not yet well understood.

Despite the above-mentioned limitations to our knowledge, some wildlife consumption impairment conclusions can be drawn for Lake Erie. Lake Erie contaminant level studies conducted to date show the following.

Waterfowl in Michigan and Ontario have not shown levels that would require issuance of human consumption advisories in or near Lake Erie.

Public health advisories for human consumption of snapping turtles and waterfowl are in place for New York waters of Lake Erie. This is an impairment to human consumption of these wildlife species. The contaminants causing these advisories are PCBs, mirex, chlordane, and DDTs.

The Great Lakes Fishery Restoration Study (GLFRS) contains the following objective related to wildlife consumption advisories, "*restoration goals for the Great Lakes Basin will have been met when wildlife can be consumed with **little or no risk** to human health*." No concrete definition for "little or no risk" to human health has been developed. Information to date suggests that unacceptable human health risks related to human consumption of wildlife only exist in New York waters of Lake Erie. However, research underway on mallards and snapping turtles may show otherwise. Therefore, the Lake Erie LaMP process has not reached a conclusion regarding whether the GLFRS objective has been met.

2.2.6 Monitoring Needs

The state of our knowledge regarding contaminant levels in Lake Erie wildlife as related to human consumption is much less advanced than it is for sport fish. Therefore, it is recommended that, at a minimum, the Lake Erie LaMP process support, sponsor, and/or coordinate monitoring of contaminant levels in muskrat, snapping turtles, and the breast tissue of waterfowl that eat zebra mussels, in the areas within the geographic scope of the LaMP. The focus of this contaminant level monitoring should be on identifying contaminant levels in tissue eaten by humans to determine if consumption advisories are needed. In particular, it is recommended that the results of research currently underway in Ohio (and any similar projects), when available, be used to reevaluate the status of wildlife consumption restrictions in Lake Erie.

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Appendix 2A

Routine Chemical Parameters Monitored
in Lake Erie Fish, by Jurisdiction

Michigan

(Source: Sweet, 1996)

Hexachlorobenzene
Aldrin
4,4'-DDE
4,4'-DDT
Mercury
gamma-Chlordane
alpha-Chlordane
Octochlorostyrene
Heptachlorostyrene
Heptachlor
Toxaphene
PBB (FF-1, BP-6)
gamma-BHC (Lindane)
Dieldrin
4,4'-DDD
Heptachlor Epoxide
Oxychlordane
trans-Nonachlor
cis-Nonachlor
Hexachlorostyrene
Pentachlorostyrene
Terphenyl
Mirex
PCBs (Alochlors 1242, 1248, 1254, & 1260)

Other chemical parameters are analyzed for on a site specific basis in Michigan.

New York

(Source: Skinner, 1996)

Arochlor 1248/1242
DDE
DDD
Mirex
Transnonachlor
trans-chlordane
Dieldrin
Moisture
Arochlor 1254/1260
DDT
Hexachlorobenzene
Photomirex
cis-chlordane
Oxychlordane
Mercury
Lipid content

Ohio

(Source: Paul Vandermeer, Ohio EPA, Division of Surface Water, 1994)

Aldrin
alpha-BHC
delta-BHC
Cadmium
Benzene Hexachloride (BHC)
beta-BHC
gamma-BHC (Lindane)
4-4' DDT, 4-4' DDE, 4-4' DDD

Ohio (continued)

Dieldrin
Endosulfan II
Endrin
Heptachlor Epoxide
Lead
Methoxychlor
Endosulfan I
Endosulfan Sulfate
Heptachlor
Hexachlorobenzene (HCB)
Mercury
Mirex
Chlordane (isomers and breakdown products including alpha, gamma and oxychlordane, cis-nonachlor, and trans-nonachlor)
PCBs (Arochlor 1060, 1221, 1232, 1242, 1248, 1254, 1260)

Ontario

(Source: OMEE, 1995-1996)

The chemicals for which Ontario fish are analyzed vary by species and location. Fish may be analyzed for one or more of the following:

Mercury
Mirex
Dioxins
Chlorinated Phenols
Polynuclear aromatic hydrocarbons (PAHs)
PCBs
Pesticides
Furans
Chlorinated Benzenes

Pennsylvania

(Source: PADEP, 1991)

PCBs
Aldrin
Endrin
Cadmium
Copper
Chlordane
DDT
Dieldrin
Mercury
Chromium
Lead

Appendix 2B

Summary of Organochlorine Residues in Snapping Turtle Eggs

Big Creek National Wildlife Area
and
Rondeau Provincial Park
Ontario, Canada

Table 2.9, Absolute and Mean Concentrations (mg/kg wet weight) and Coefficient of Variation (CV) of Organochlorine Residues in Snapping Turtle Eggs 1981 and 1984 (from Struger et al., 1993).

Sample Location	Ratio of PCB 1254 to1260	Total PCBs	DDE	Mirex	HCB	Dieldrin	Oxy-chlordane	Cis-chlordane	Trans-Nonachlor	Heptachlor Epoxide	B-HCB	Percentage Lipid
Big Creek Nat'l. Wildlife Area*	0.6500 0.9901 0.0205 0.7502 0.2902 0.140 **CV% 88.3**	0.306 0.465 0.479 2.702 1.076 1.006 **CV % 88.3**	0.070 0.040 0.080 0.225 0.070 0.097 **CV % 67.4**	0.005 0.005 0.005 0.020 0.010 0.0098 **CV % 64.8**	0.003 0.003 0.002 0.006 0.004 0.004 **CV % 37.7**	0.010 0.010 0.020 0.030 0.020 0.018 **CV % 41.6**	0.010 0.020 0.020 0.050 0.020 0.024 **CV % 56.5**	0.005 0.005 ND 0.005 0.005 0.004 **CV % 50.0**	0.005 0.005 ND 0.005 ND 0.003 **CV % 81.6**	0.010 ND ND 0.005 ND 0.003 **CV % 133.3**	ND 0.040 ND ND ND 0.008 **CV % 200.0**	67.0 6.4 7.7 7.2 7.2
Rondeau Provincial Park **	4.300 0.350 2.840 2.630 1.510 2.326 **CV % 57.1**	2.021 0.164 1.335 1.236 0.710 1.093 **CV % 57.1**	0.080 0.010 0.070 0.030 0.020 0.042 **CV % 66.3**	0.010 ND 0.005 0.005 0.005 0.005 **CV % 63.2**	0.004 ND 0.005 0.004 0.002 0.003 **CV % 59.6**	0.020 0.005 0.010 0.010 0.010 0.011 **CV % 44.5**	0.030 0.005 0.005 0.020 0.010 0.014 **CV % 69.3**	0.005 ND 0.010 0.005 0.005 0.005 **CV % 63.2**	0.005 ND 0.005 0.010 0.005 0.005 **CV % 63.2**	0.010 ND 0.005 0.005 0.005 0.005 **CV % 63.2**	0.010 0.010 0.010 0.020 0.020 0.014 **CV% 63.2**	4.8 4.8 6.3 4.1 4.7 **CV % 35.0**

* Eggs were collected in 1981, 4 clutches were sampled, 5 eggs were collected per clutch.

** Eggs were collected in 1984, 5 clutches were sampled, 10 eggs were collected per clutch.

Table 2.10, Mean Organochlorine Concentrations (PPB, wet weight+/-standard deviation) in Snapping Turtle Eggs from Big Creek Marsh, 1986 (EC, 1991)

Number of Clutches*	Hexachlorobenzene	alpha-Chlordane	p,p-DDE	Total PCBs**
5	3.1+/-1.5 B***	2.1+/-0.8 B***	69.8+/-9.9 A***	689.9+/-124.3 B***

* Five eggs were collected from each clutch, pooled and analyzed for residues.
** Total PCBs = sum concentrations of PCB congeners found in eggs.
*** Letters refer to significant differences between sites for each year.

Table 2.11, Mean Organochlorine Concentrations (PPB, wet weight) in Snapping Turtle Eggs from Lake Erie Populations, 1988 and 1989 (EC, 1991)

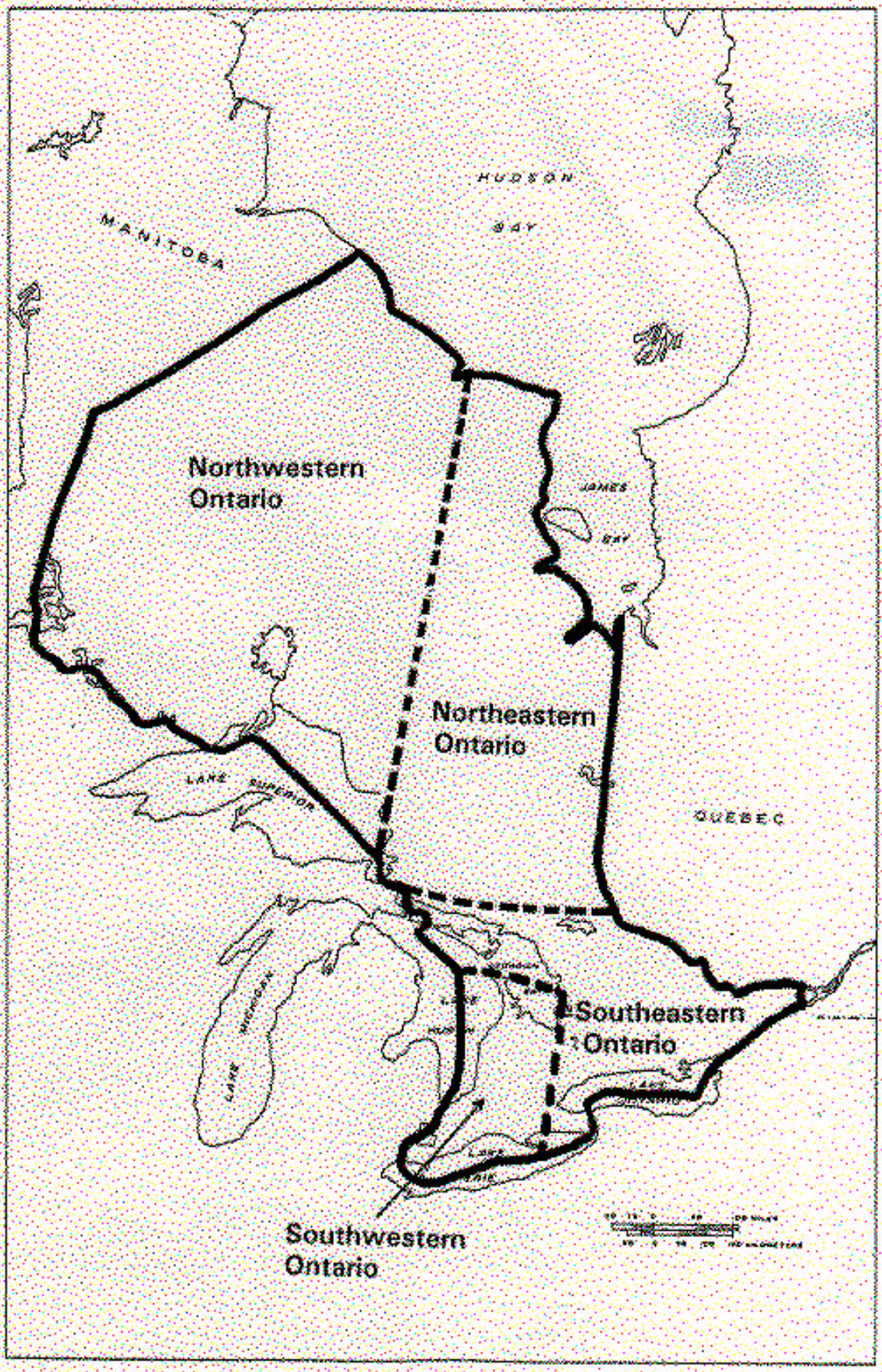
Sample Locations	Number of Clutches*	p,p-DDE	Mirex	PCBs**
Big Creek Marsh	7	43.9+/-28.0 D***	1.4+/-0.68 C***	754+/-486 D***
Rondeau Provincial Park	7	36.9+/-24.4 D***	1.9+/-1.3 C***	1420+/-910 C***

* Five eggs were collected from each clutch, pooled and analyzed for residues.
** PCB concentrations are based on Aroclor 1254/1260 1:1 mixture.
*** Letters refer to significant differences between sites for each year.

Appendix 2C

Areas of Waterfowl Contaminant Level Sampling In Ontario

AREAS OF WATERFOWL SAMPLING IN ONTARIO



Appendix 2D

Comparison of Waterfowl Contaminant Levels

From:Mazak, Edward John. 1995. Organic Contaminants in Lower Great Lakes' Waterfowl in Relation to Diet, with Particular Reference to Dreissena polymorpha, a Thesis Submitted to the Faculty of Graduate Studies and Research, Department of Biological Sciences, University of Windsor, Ontario.

Table 2.12 Comparison of Contaminant Level Results from This Study and Others. All values given in g/kg wet weight with mean in parenthesis. * Taken from Gebauer and Weseloh (1993).

REFERENCE & LOCATION OF STUDY	WATERFOWL SPECIES/TISSUE	HCB	T-NONACHLOR	DDE	OXYCHLORDANE	DIELDRIN	PCBS
This Study							
Middle Sister Island, Ontario	bufflehead/liver	1.4-2.9 (1.8)	1.3-2.7 (2.3)	10.7-32.6 (21.0)	0.68-1.7 (1.0)	-----	147-308 (237)
Middle Sister Island, Ontario	greater scaup/liver	0.35-3.4 (1.6)	0.38-1.1 (0.66)	7.6-71.5 (22.7)	0.54-7.8 (3.3)	7.3-26.9 (16.2)	120-487 (241)
Middle Sister Island, Ontario	lesser scaup/liver	0.55-1.7 (1.1)	0.45-1.7 (0.83)	5.5-32.5 (13.6)	0.41-3.1 (1.1)	4.4-11.4 (7.9)	38.7-241 (133)
Fighting Island, Detroit River, Ontario	bufflehead/liver	0.54-1.7 (1.1)	0.25-0.55 (0.39)	1.3-8.3 (5.2)	0.58-1.1 (0.80)	2.6-5.9 (4.6)	9.5-47.6 (26.1)
Fighting Island, Detroit River, Ontario	greater scaup/liver	0.24-0.81 (0.48)	0.06-0.07 (0.07)	0.51-0.84 (0.70)	0.13-0.22 (0.16)	0.51-1.1 (0.60)	5.6-7.3 (6.6)
Fighting Island, Detroit River, Ontario	lesser scaup/liver	0.35-0.61 (0.45)	0.05-0.06 (0.06)	0.19-1.6 (0.76)	0.05-0.33 (0.18)	0.30-0.94 (0.65)	2.4-20.9 (8.2)
Dobos et al. 1991*							
Thunder Bay CDF, Ontario	domestic mallards/muscle	-----	-----	-----	-----	-----	2.6-12.3
Foley 1992							
Statewide, New York	mallard/muscle	(3.1)	-----	ND-190 (20)	(15.0)	(5.9)	ND-300 (80)
	bufflehead/muscle	(7.7)	-----	ND-70 (20)	(34.9)	(26.4)	ND-600 (150)
	scaup/muscle	(5.9)	-----	ND-30 (20)	(19.9)	(17.3)	ND-500 (130)
Kim et al. 1984							
Statewide New York	mallard/liver	-----	-----	(24)	-----	-----	(520)
	bufflehead/liver	-----	-----	(5)	-----	-----	(75)
	greater scaup/liver	-----	-----	(43)	-----	-----	(1,200)
Miles and Ohlendorf 1993							
San Francisco Bay, California	canvasback/carcass	-----	(13)	(386)	(11)	(17)	(1,079)
REFERENCE & LOCATION	WATERFOWL	HCB	T-	DDE	OXYCHLORDANE	DIELDRIN	PCBS

OF STUDY	SPECIES/TISSUE		NONACHLOR				
Hebert et al. 1990*							
Walpole Island, Ontario	non migratory mallards and redheads/liver	(20.0-29.6)	-----	-----	-----	-----	-----
Smith et al. 1985*							
Detroit River, Ontario	lesser and greater scaup, goldeneye/whole carcass	330-1,700	81-330	480-1,300	-----	-----	7,800-11,000
Swift et al. 1993							
Niagara River, New York	common goldeneye/muscle	0.0-0.0 (0.0)	0.0-0.0 (0.0)	10-20 (20)	0.0-0.0 (0.0)	0.0-0.0 (0.0)	70-120 (90)
	common goldeneye/fat	10-40 (20)	10-40 (20)	630-970 (780)	30-90 (60)	100-200 (140)	2,470-4,830 (3,450)
Weseloh 1986*							
St. Clair River, Ontario	mallard, goldeneye, common merganser/muscle	10-276	1-26	21-398	2-22	2-54	225-2,855
Weseloh et al. 1992*							
Windemere Basin, Ontario	pekin ducks/liver	2-18	4-14	27-132	8-139	25-73	1,214-7,555
Walpole Island, Ontario	pekin ducks/liver	21-48	1-2	8-11	ND-1	2-10	34-214