Section E:

Evaluating Beneficial Use: Human Health (Fish Contaminants)

2008 Ohio Integrated Report

E1. Background

The State of Ohio has operated a formal fish consumption advisory (FCA) program since 1993. Since July 2002, the program's technical and decision making expertise has been housed at the Ohio Environmental Protection Agency. The risk assessment protocols used were developed in the early 1990s under the auspices of the Great Lakes Governors Association.

Ohio has adopted human health WQS criteria to protect the public from adverse impacts, both carcinogenic and non-carcinogenic, due to exposure via drinking water (applicable at public water supply intakes) and to exposure in the contaminated flesh of sport fish (applicable in all surface waters). The latter criterion is called the non-drinking water human health criterion. The purpose of that criterion is to ensure levels of a chemical in water do not bioaccumulate in fish to levels harmful to people who catch and eat the fish. The relationship of the non-drinking water human health criterion to the FCA risk assessment protocols is explained below.

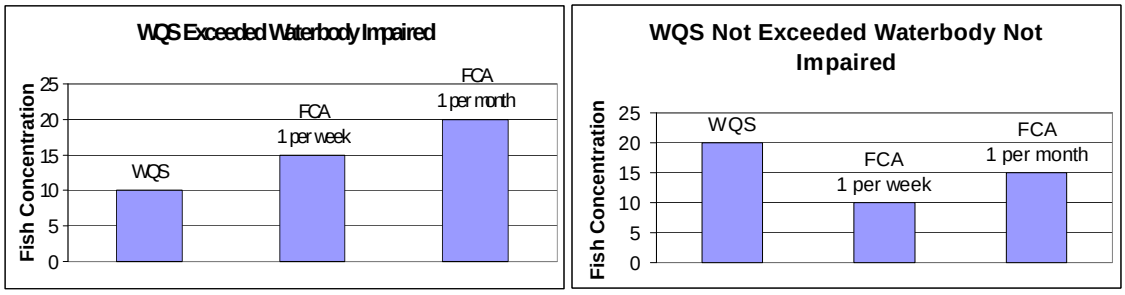
E2. Evaluation Method and Rationale

U.S. EPA's guidance for preparing the 2008 integrated reports states:

> "Although the CWA does not explicitly direct the use of fish and shellfish consumption advisories or NSSP classifications to determine attainment of water quality standards, states are required to consider all existing and readily available data and information to identify impaired segments on their section 303(d) lists. For purposes of determining whether a segment is impaired and should be included on a section 303(d) list, EPA considers a fish or shellfish consumption advisory, a NSSP classification, and the supporting data to be existing and readily available data and information that demonstrates non-attainment of a section 101(a) "fishable" use when:
>
> - the advisory is based on fish and shellfish tissue data;
> - a lower than "Approved" NSSP classification is based on water column and shellfish tissue data (and this is not a precautionary "Prohibited" classification or the state water quality standard does not identify lower than "Approved" as attainment of the standard);
> - the data are collected from the specific segment in question; and
> - the risk assessment parameters (e.g., toxicity, risk level, exposure duration and consumption rate) of the advisory or classification are cumulatively equal to, or less protective than those in the State's WQSs" (U.S. EPA, 2005).

Ohio's WQS regulations do not describe human consumption of sport fish as an explicit element of aquatic life protection. However, the WQS do include human health criteria that are applicable to all surface waters of the State. Certain of these human health criteria are derived using assumptions about the bioaccumulation of chemicals in the food chain, and the criteria are intended to protect people from adverse health impacts that could arise from consuming fish caught in Ohio's waters. To determine when and how waters should be listed as impaired because of FCAs, the risk assessment parameters on which the human health WQS criteria are based were compared with those used in the Ohio FCA program. If the State has issued an advisory for a specific water body and that advisory is equal to or less protective than the State's WQS, then one can assume there is an exceedence of the WQS. On the other hand, if the advisory is more protective than the WQS, one cannot assume that the issuance of the advisory indicates an exceedence of the WQS. Figure E-1 illustrates this point.

Figure E-1. Illustration of the relationship among the water quality standard (WQS) values, the values that trigger issuance of fish consumption advisories (FCAs) and the resulting decision regarding waterbody impairment associated with an FCA.



A fish consumption advisory is determined based on the quantity of a chemical in fish, such as micrograms of chemical per kilogram of fish tissue (µg/kg). WQS, on the other hand, are expressed as the quantity of chemical in water, such as micrograms of chemical per liter of water (µg/l). The information used to calculate the human health non-drinking WQS criterion can be used to calculate a maximum safe fish concentration. That fish concentration value can then be directly compared to the FCA program values to determine whether the advisory is less or more protective than the WQS criterion. The values in the chart below make this comparison for chemicals for which there is both an FCA and an Ohio human health non-drinking water criterion. Because Ohio human health criteria differ between the Lake Erie and Ohio River basins, separate comparisons are presented.

Basin / Parameter	Fish concentration on which the WQS is based [1]	Range of fish concentrations triggering an "eat no more than one meal per week" advisory	Range of fish concentrations triggering an "eat no more than one meal per month" advisory
Lake Erie / PCB	23 µg/kg	50 - 220 µg/kg	221 - 1,000 µg/kg
Ohio River / PCB	54 µg/kg	50 - 220 µg/kg	221 - 1,000 µg/kg
Lake Erie / mercury	350 µg/kg	110 - 220 µg/kg	221 - 1,000 µg/kg
Ohio River / mercury	1,000 µg/kg	110 - 220 µg/kg	221 - 1,000 µg/kg
Lake Erie / DDT	140 µg/kg	500 - 2,188 µg/kg	2,189 – 9,459 µg/kg
Ohio River / DDT	320 µg/kg	500 - 2,188 µg/kg	2,189 – 9,459 µg/kg
Lake Erie / Chlordane	130 µg/kg	500 - 2,188 µg/kg	2,189 – 9,459 µg/kg
Ohio River / Chlordane	310 µg/kg	500 - 2,188 µg/kg	2,189 – 9,459 µg/kg
Lake Erie / hexachlorobenzene	29 µg/kg	800-3,499 µg/kg	3,500-15,099 µg/kg
Ohio River / hexachlorobenzene	67 µg/kg	800 - 3,499 µg/kg	3,500 - 15,099 µg/kg
Lake Erie/ mirex	88 µg/kg	200 – 874 µg/kg	875 – 3,784 µg/kg
Ohio River/ mirex	203 µg/kg	200-874 µg/kg	875-3.784 µg/kg

Values	Advisory is less protective than the WQS criterion, WQS exceeded, waterbody impaired
Values	Advisory is more protective than WQS criterion, WQS not exceeded, no impairment from FCA
Values	Advisory may be more, or less, protective than WQS criterion

[1] See Section E4 for an explanation of how these concentrations were calculated.

These constituents were chosen because both human health WQS criteria and fish advisories are based on them.

The table demonstrates that the levels of fish tissue contaminants that trigger a fish advisory have little relation to the levels of fish tissue contaminants on which the WQS criteria are based. This discrepancy exists because different assumptions about fish consumption rates are made in calculating water quality standards than in issuing fish advisories. As a specific example, the fish consumption rate used to calculate the Ohio River Basin WQS criteria is 6.5 grams per day. The fish consumption rate used to calculate a "one meal per week" advisory recommendation is 32.6 grams per day. These values are not the same because the WQS criteria fish consumption rates are based on nutritional studies that attempt to capture approximately how much sport caught fish people are eating, whereas the fish consumption advisory rates are meant to advise people how much fish they can safely consume.

U.S. EPA stipulates that the risk assessment parameters used to categorize fish tissue contaminant data must be at least as protective as those used in the WQS-based fish concentrations. Fish advisory contaminant levels are not directly related to the WQS criteria contaminant levels, and in some cases are not as protective. Therefore, Ohio EPA has elected to directly compare fish tissue data with the WQS criteria calculations shown in the above table, instead of using advisory based categorizations.

The following steps were utilized to determine an integrated report category for waters based on fish tissue contaminant data:

Step 1: Determine available data

All data in the fish tissue database were evaluated for the 2008 Integrated Report. The most recent 10 years of data collections, 1997-2006, were used for making category 1 and category 5 determinations. In cases where multiple years of data were available in that 10 year window, all data were weighted equally.

Ohio's Credible Data Law states that all data greater than five years in age will be considered historical, and that it can be used as long as justification is provided as to why its use is necessary. In the case of fish tissue, the use of data older than five but ten or fewer years old is necessary.

The use of historical data is necessary because not enough fish tissue samples are gathered from enough locations each year to conduct a thorough assessment of contaminant levels in fish tissue across the state. Frequently, multiple sampling years are needed to make a determination about issuing or rescinding an advisory. Owing to limited staff time and budget resources, it sometimes takes over five years to revisit a location and collect more fish tissue samples. A more complete picture of contaminants in fish tissue is presented when data reaching back 10 years is utilized.

No data newer than 1996 were available for some sampling locations. In those cases, data were classified as category 3C (see sections below for a complete description of each category and subcategory).

Step 2: Determine fish tissue contaminant concentrations

For both streams and inland lakes, a weighted average based on species and trophic level was calculated for each contaminant. One year of data was considered adequate to categorize the fish as impaired or unimpaired.

Step 3: Determine adequate species data

PCBs and other lipophilic compounds

For PCBs and other lipophilic compounds, to list the water as category 1, the average of at least three samples of a "bottom feeder" species such as catfish or carp must be below the threshold that would trigger an impairment. In addition, the weighted average contaminant levels for all samples must be below the threshold that would indicate an impairment. If three samples of a "bottom feeder" species were not available, the water body is categorized as having insufficient data.

Mercury and other non-lipophilic compounds

For mercury and other non-lipophilic compounds, to list the water as category 1, the average of at least three samples of a predator species such as a largemouth or smallmouth bass or a walleye must have contaminant levels below the threshold that would trigger an impairment, and the weighted average contaminant levels for all samples must be below the threshold that would indicate an impairment. If three samples of a predator species were not available, the water body is categorized as having insufficient data.

Step 4: Determine appropriate reach (streams only)

For rivers, most of the data do not reach from the headwaters to the mouth. Therefore, it may be necessary to determine the extent of the reach that is being categorized.

The number of sampling locations needed to determine a reach, or to determine a reporting category, will vary depending on the size and drainage area of the water body.

In other cases, the reach will be limited by the sampling locations. In these cases, it frequently makes sense to extend the reach to the nearest physical barrier, such as a dam, or significant confluence. This determination will be made by Ohio EPA biologists.

Step 5: Categorize Water Body

Category 5 - Impaired
Any water body with three or more samples that has a weighted average fish tissue concentration of PCBs, mercury, DDT, chlordane, or hexachlorobenzene above the WQS-based fish tissue concentration is placed into category 5.

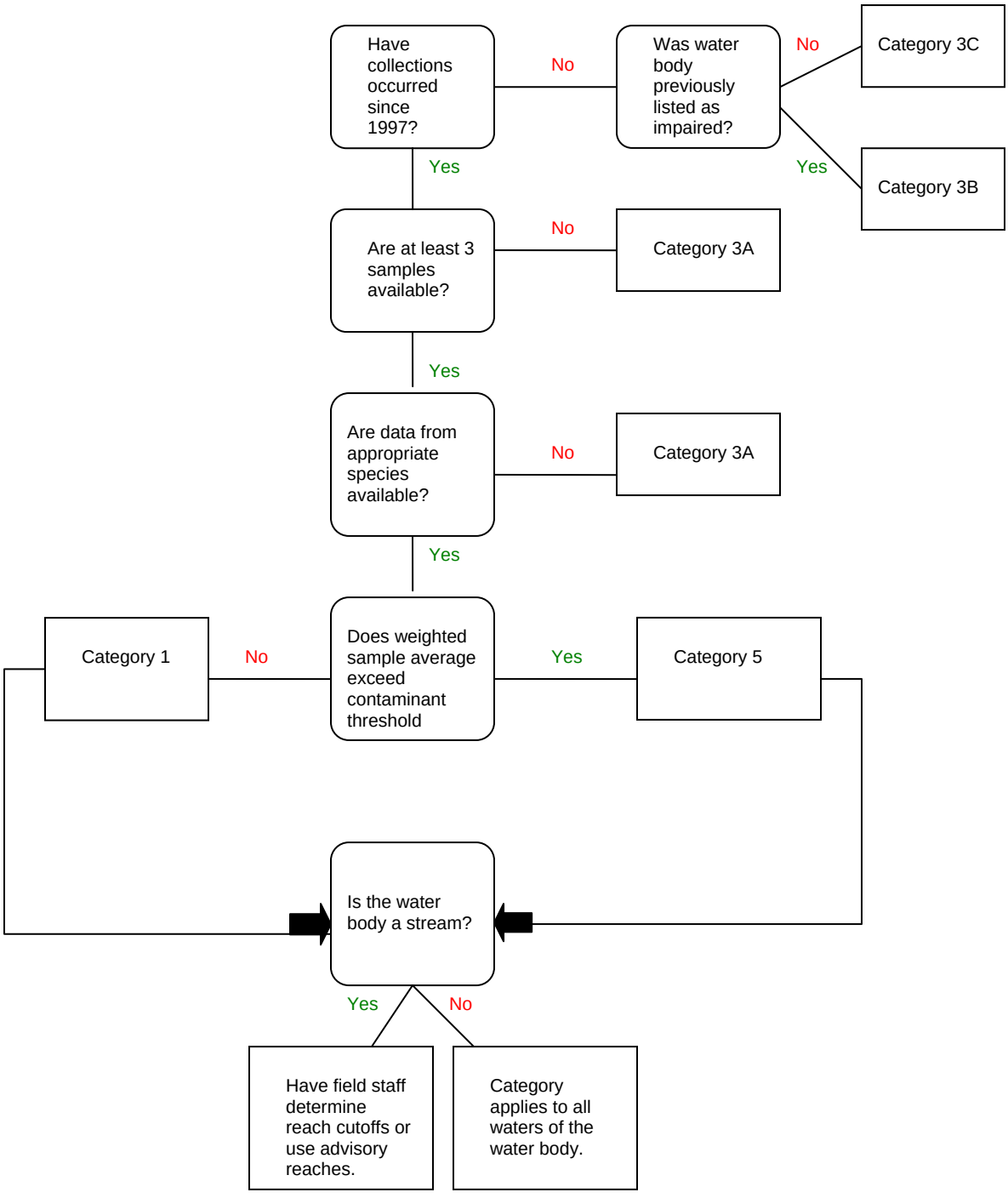
Category 1 – Not Significantly Impaired
To be categorized as Category 1, not significantly impaired, a water body must have at least three samples of a relevant species (i.e., bottom feeders and predators) from a water body, taken since 1997, and the weighted average concentration of a contaminant must be below the threshold that would trigger an impairment.

Category 3 – Insufficient Data
In cases where some of the samples had concentrations in excess of the threshold, but the weighted average concentration is below the threshold, best professional judgment was used to decide if the high concentration(s) was anomalous or if the water body should be categorized as Category 3, insufficient data.

Category 3 has three subcategories: 3A, 3B, and 3C. Any water body where current data are available but those data are insufficient to categorize the water body as category 1 or 5 was listed as category 3A. Any previously uncategorized or category 1 or 3 water body where data were more than 10 years old was listed as category 3C. Any water body previously categorized as impaired, but for which data were more than 10 years old, was listed as category 3B.

Please see Figure E-2 for a summary of the procedure detailed previously.

Figure E-2: Flowchart for the Categorization of Fish Tissue Data for the Integrated Report.



E3. Results

Fish tissue data for six contaminants were reviewed to determine an integrated report category. The methodology for selecting, reviewing, and categorizing fish tissue data is given in Section E1. The six contaminants reviewed were mercury, PCBs, lead, chlordane, mirex and hexachlorobenzene. These contaminants were chosen for review based on current and recent fish consumption advisories in Ohio caused by these contaminants, as well as existing human health WQS criteria for the six contaminants.

Results are presented in Tables E-1 thru E-4 and summarized in more detail by Assessment Unit in Section M. Detailed information on specific fish consumption advisories including geographic extent of the advisory, type and size of fish affected, and consumption advice can be found at http://www.epa.state.oh.us/dsw/fishadvisory/index.html. Table E-2 lists waters impaired because fish tissue levels of PCBs or mercury exceed the threshold level upon which the WQS criterion is based, while Table E-3 includes those not significantly impaired. There are nine water bodies in Ohio with significant pollution resulting in 303(d) listings from other contaminants that affect fish tissue, as shown in Table E-4. Remediation activities on most of these water bodies are underway. Table E-5 lists ten water bodies identified as impaired for this use on a previous 303(d) list whose data no longer meet the constraints in the methodology described in Section E1. The data for all these locations have become historical and new data would need to be collected before a current impairment status can be determined. Since age of data alone is not a reason for delisting, the water bodies remain on the 303(d) list. Table E-6 lists waters with current fish tissue data where inadequate samples exist to determine level of impairment.

In the 2004 Integrated Report, threatened waters were discussed with respect to the human health methodology based on fish consumption advisories. Under the current assessment methodology, all the waters identified as threatened in 2004 continue to be in impaired status for the human health use.

For a statewide perspective, Table E-1 depicts aggregate state statistics for fish contaminant data compared to human health criteria. The stream and river information include both principal stream (50 to 500 square mile drainage) and large rivers (greater than 500 square miles drainage). The lake acres are the total based on publicly owned lakes greater than 5 acres.

Table E-1. Aggregate state statistics for fish contaminant data compared to human health criteria.

	Principal Wadeable Streams and Large Rivers (Miles)	Inland Lakes and Reservoirs (Acres)
All Ohio Miles/Acres	5761	118963
Miles/Acres Monitored	4154	77980
Miles/Acres Full Support	321 (8%)	20736 (27%)
Miles/Acres Impaired	2570 (62%)	29992 (38%)
Miles/Acres Indeterminate	1263 (30%)	27252 (35%)

Table E-2. Waters impaired because levels of PCBs or mercury in fish tissue exceed the threshold level upon which the WQS criterion is based.

Water Body	Assessment Unit	Pollutant
Amicks Reservoir, Powers Reservoir	05060001 090	PCBs
Archbold Reservoir #2	04100006 040	PCBs, Mercury
Ashtabula River, Fields Brook	04110003 050	PCBs
Auglaize River	04100007 001	Mercury
Auglaize River	04100007 010	Mercury
Auglaize River	04100007 020	Mercury
Auglaize River	04100007 060	Mercury
Berlin Lake, Deer Creek Reservoir, Dale Walburn Reservoir	05030103 020	PCBs
Big Cobb Pond, Little Cobb Pond, Kellys Pond	05030103 040	PCBs
Big Darby Creek	05060001 190	PCBs
Big Darby Creek	05060001 200	PCBs
Big Darby Creek, Hellbranch Run	05060001 220	PCBs
Black River, French Creek	04110001 050	PCBs
Blanchard River	04100008 001	PCBs
Blanchard River	04100008 010	PCBs
Blanchard River	04100008 020	PCBs
Blanchard River	04100008 040	PCBs
Blanchard River, Eagle Creek	04100008 030	PCBs
Bucyrus Reservoir #2, P.J. Outhwaite Reservoir	04100011 020	PCBs
Chippewa Creek	05040001 020	PCBs
Cross Creek	05030101 340	PCBs
Cuyahoga River	04110002 001	PCBs
Cuyahoga River	04110002 010	PCBs
Cuyahoga River	04110002 020	PCBs
Cuyahoga River	04110002 040	PCBs
Cuyahoga River, Little Cuyahoga River	04110002 030	PCBs
Delaware Lake	05060001 110	PCBs
Dicks Creek, Hamilton (Ford) Hydraulic Canal	05080002 050	PCBs
Duck Creek, West Fork Duck Creek	05030201 120	PCBs
East Branch Black River	04110001 030	PCBs, Mercury
East Branch Black River	04110001 040	PCBs, Mercury
East Branch Reservoir, Punderson Lake	04110002 010	PCBs
Eastwood Lake	05080001 190	PCBs
Ferguson Res., Lima Lake, Lost Creek Res., Metzger Res., Schoonover Lake	04100007 030	PCBs
Findlay Reservoir #1	04100008 020	PCBs
Findley Lake, Wellington South Reservoir, Wellington Upground Reservoir	04110001 020	PCBs
Grand Lake St. Marys	05120101 020	PCBs

Water Body	Assessment Unit	Pollutant
Grand River	04110004 001	PCBs, Mercury
Grand River	04110004 010	PCBs, Mercury
Grand River	04110004 020	PCBs, Mercury
Grand River	04110004 040	PCBs, Mercury
Great Miami River	05080001 001	PCBs
Greenfield Lake, Rock Mill Reservoir	05030204 010	PCBs
Griggs Reservoir, O'Shaughnessy Reservoir	05060001 001	PCBs
Hamilton (Ford) Hydraulic Canal	05080002 090	PCBs
Hargus Lake	05060002 010	PCBs
Hocking River	05030204 001	PCBs
Hocking River	05030204 010	PCBs
Hocking River	05030204 050	PCBs
Jefferson Lake	05030101 190	PCBs
Killdeer Pond #30, Killdeer Reservoir, Upper Sandusky Res.	04100011 040	PCBs
Lake Erie Central Basin	24 002	PCBs
Lake Erie Western Basin	24 001	PCBs
Lake LaSuAn, Lake Lavere, Lake Sue	04100003 020	Mercury
Lake Logan	05030204 050	PCBs
Little Beaver Creek, North Fork Little Beaver Creek	05030101 090	PCBs
Little Darby Creek	05060001 210	PCBs
Little Miami River	05090202 001	PCBs
Little Miami River	05090202 010	PCBs
Little Miami River	05090202 030	PCBs
Little Miami River, Massies Creek	05090202 020	PCBs
Little Threemile Creek	05090201 060	PCBs
Mad River	05080001 003	PCBs
Mad River	05080001 160	PCBs
Mad River	05080001 180	PCBs
Mad River, Kings Creek	05080001 150	PCBs
Mahoning River	05030103 001	PCBs
Mahoning River, Eagle Creek	05030103 040	PCBs
Mahoning River, West Branch Mahoning River	05030103 030	PCBs
Maumee River	04100001 001	PCBs
Meadowbrook Lake	04110002 040	PCBs
Middle Fork Little Beaver Creek	05030101 070	PCBs
Muskingum River	05040004 001	PCBs
Nesmith Lake	05040001 010	PCBs
Nettle Lake	04100003 030	PCBs
New London Reservoir, Savannah Lake	04100012 050	Mercury
New Lyme Lake	04110004 030	Mercury
Nimishillen Creek, Middle Branch, West Branch, Hurford Run	05040001 050	PCBs

Water Body	Assessment Unit	Pollutant
North Branch Portage River	04100010 050	PCBs
Olentangy River	05060001 090	PCBs
Olentangy River	05060001 110	PCBs
Olentangy River	05060001 120	PCBs
Ottawa River	04100001 020	PCBs
Ottawa River	04100007 030	PCBs
Ottawa River	04100007 040	PCBs
Ottawa River, Sugar Creek	04100007 050	PCBs
Paint Creek	05060003 001	PCBs
Paint Creek	05060003 010	PCBs
Paint Creek	05060003 050	PCBs
Paint Creek Lake	05060003 050	PCBs
Pine Creek	05090103 020	PCBs
Pymatuning Reservoir	05030102 010	PCBs
Rocky Fork Licking River	05040006 050	PCBs
Rocky Fork Mohican River	05040002 020	PCBs
Rocky River, East Branch Rocky River	04110001 070	PCBs
Ross Lake	05060002 060	PCBs
Salt Creek	05060002 070	PCBs
Salt Creek	05060002 100	PCBs
Sandusky River	04100011 001	PCBs
Sandusky River	04100011 020	PCBs
Sandusky River	04100011 040	PCBs
Sandy Creek	05040001 060	PCBs
Sandy Creek, Still Fork Sandy Creek	05040001 040	PCBs
Scioto River	05060001 001	PCBs
Scioto River	05060001 030	PCBs
Scippo Creek	05060002 010	PCBs
Shade River	05030202 040	PCBs
Shank Lake	04100008 030	PCBs
Spencer Lake	04110001 030	PCBs, Mercury
St. Joseph River	04100003 030	PCBs
St. Joseph River	04100003 060	PCBs
St. Marys River	04100004 010	PCBs
St. Marys River	04100004 020	PCBs
St. Marys River	04100004 030	PCBs
Summit Lake, Mogadore Reservoir, Springfield Lake	04110002 030	PCBs
Tiffin River	04100006 001	PCBs, Mercury
Tiffin River	04100006 030	PCBs, Mercury
Tiffin River	04100006 040	PCBs, Mercury
Tinkers Creek	04110002 050	PCBs

Water Body	Assessment Unit	Pollutant
Toussaint Creek	04100010 020	PCBs
Tuscarawas River	05040001 010	PCBs
Tuscarawas River	05040001 030	PCBs
Twin Creek	05080002 030	PCBs
Twin Creek	05080002 040	PCBs
Vermilion River	04100012 050	Mercury
Vermilion River	04100012 060	Mercury
Walhonding River	05040003 001	PCBs
Walnut Creek	05060001 170	PCBs
Walnut Creek	05060001 180	PCBs
Water Works II	05030103 030	PCBs
West Branch Black River	04110001 020	PCBs
West Branch Rocky River	04110001 060	PCBs, Mercury
West Branch St. Joseph River	04100003 020	Mercury
Wheeling Creek	05030106 040	PCBs
Whetstone Creek	05060001 100	PCBs
Whitewater River	05080003 001	PCBs
Wolf Creek, Holes Creek	05080002 010	PCBs
Wolf Run Lake	05030201 120	PCBs
Yellow Creek	05030101 180	PCBs
Yellow Creek, North Fork Yellow Creek	05030101 190	PCBs
Zeppernick Lake	05040001 040	PCBs

Table E-3. Waters not significantly impaired because fish tissue levels of PCBs or mercury do not exceed the threshold level upon which the WQS criterion is based.

Water Body	Assessment Unit
Adams Lake	05090201 050
Alum Creek Reservoir	05060001 150
Buckeye Lake	05040006 040
Caesar Creek Reservoir	05090202 050
Caesar Creek, South Branch Caesar Creek	05090202 050
Cowan Lake	05090202 070
East Fork Little Miami River	05090202 100
East Fork Little Miami River	05090202 120
East Fork Little Miami River, Pleasant Run	05090202 110
East Fork Little Miami River, Stonelick Creek	05090202 130
Fourmile Creek	05080002 070
Highlandtown Lake	05030101 100
Indian Lake	05080001 010
Little Stillwater River	05040001 160
Mill Creek	04110004 050
Ohio Brush Creek	05090201 050
Rocky Fork Paint Creek	05060003 060
Rocky Fork Reservoir	05060003 060
Rush Run Lake	05080002 060
Sevenmile Creek	05080002 060
South Fork Licking River	05040006 040
Stillwater River	05080001 002
Stillwater River	05080001 090
Stillwater River	05080001 100
Tappan Lake	05040001 160
Todd Fork, Cowan Creek, Lytle Creek	05090202 070
Tymochtee Creek	04100011 050
Tymochtee Creek	04100011 060
White Oak Creek	05090201 100
Wills Creek Reservoir	05040005 060

Table E-4. Waters with contaminants that affect fish tissue, not included in Table E-2 for these pollutants (included on the 303(d) list).

Water Body	Assessment Unit	Pollutant
Ashtabula River, Fields Brook	04110003 050	Hexachlorobenzene
Chippewa Creek	05040001 020	Hexachlorobenzene
Duck Creek, West Fork Duck Creek	05030201 120	DDT
Middle Fork Little Beaver Creek	05030101 070	Mirex
Nesmith Lake	05040001 010	Hexachlorobenzene
Tuscarawas River	05040001 010	Hexachlorobenzene
Tuscarawas River	05040001 030	Hexachlorobenzene
Wolf Run Lake	05030201 120	DDT

Table E-5. Waters for which the existing impaired status cannot be confirmed because data have become historical and no new data are available. (The waters remain on the 303(d) list.)

Water Body	Assessment Unit	Pollutant	Data Year
Great Miami River	05080001 030	PCBs	1993, 1994
Great Miami River, Stony Creek	05080001 040	PCBs	1993, 1994
Mill Creek, West Fork Mill Creek	05090203 010	PCBs	1992
Portage River	04100010 060	PCBs	1994
Portage River	04100010 070	PCBs	1994
Wakatomika Creek	05040004 020	PCBs	1996, 2003
Wakatomika Creek, Little Wakatomika Creek	05040004 030	PCBs	1996, 2003
West Fork Mill Creek Lake	05090203 010	PCBs	1995

Table E-6. Waters with current fish tissue data where inadequate samples exist to determine impairment status.

Water Body	Assessment Unit
Anderson Fork	05090202 040
Atwood Lake	05040001 080
Barnesville Reservoir	05030106 110
Beaver Creek	05120101 030
Beaver Creek Reservoir	04100011 110
Belmont Lake	05030106 100
Big Creek	04110004 060
Big Walnut Creek	05060001 130
Big Walnut Creek	05060001 140
Big Walnut Creek, Alum Creek	05060001 160
Black Fork Mohican River	05040002 010
Blue Creek	04100007 100
Blue Creek	04100009 080
Broken Sword Creek	04100011 030

Water Body	Assessment Unit
Buck Creek	05080001 170
Buffalo Fork	05040005 020
C.J. Brown Lake, Clark Lake	05080001 170
Captina Creek	05030106 110
Chagrin River	04110003 020
Chagrin River, Sulfur Springs Creek	04110003 030
Charles Mill Reservoir, Shelby Reservoir	05040002 010
Clear Creek	05030204 040
Clear Fork Mohican River	05040002 030
Clear Fork Mohican River	05040002 040
Clear Fork Reservoir	05040002 030
Conneaut Creek	04120101 010
Conotton Creek	05040001 070
Conotton Creek	05040001 080
Crooked Creek	05040005 050
Daugherty Lake, Fostoria Res. #3, Lake LaComte, Lake Lamberjack, Mosier Lake, Veterans Memorial Res.	04100010 040
Deer Creek	05060002 020
Deer Creek	05060002 030
Deer Creek	05060002 040
Delta Reservoir #1	04100009 040
Dillon Reservoir	05040006 001
Dow Lake	05030204 100
Eagle Creek, E. Fk. Eagle Creek, W. Fk. Eagle Creek	05090201 070
East Branch St. Joseph River	04100003 010
East Fork Duck Creek	05030201 110
Federal Creek	05030204 090
Flatrock Creek	04100007 120
Forked Run Lake	05030202 050
Fox Lake, Lake Snowden	05030204 080
Great Miami River, Tawawa Creek	05080001 070
Green Creek	04100011 110
Greenville Creek	05080001 120
Honey Creek	04100011 080
Honey Creek	05080001 200
Hoover Reservoir	05060001 130
Huron River, East Branch Huron River	04100012 030
Indian Guyan Creek	05090101 070
Jackson Lake	05090101 080
Jonathan Creek	05040004 040
Killbuck Creek	05040003 060

Water Body	Assessment Unit
Kiser Lake	05080001 070
Knox Lake, Kokosing Lake	05040003 020
Kokosing River	05040003 010
Kokosing River	05040003 030
Kokosing River, Jelloway Creek	05040003 040
Lake Alma, Lake Rupert, Wellston City Reservoir	05090101 050
Lake Hamilton, Pine Lake	05030103 080
Lake Hope	05090101 020
Lake Loramie	05080001 050
Lake White	05060002 110
Leatherwood Creek	05040005 030
Licking River	05040006 001
Little Auglaize River	04100007 070
Little Auglaize River	04100007 090
Little Muskingum River	05030201 100
Little Raccoon Creek	05090101 050
Little Scioto River	05060001 040
Little Scioto River	05090103 040
Little Scioto River, Rocky Fork Little Scioto River	05090103 030
Loramie Creek	05080001 050
Lost Creek	05080001 080
Madison Lake	05060002 020
McComb Reservoir #1, McComb Reservoir #2, North Baltimore Reservoir	04100010 030
McMahon Creek	05030106 100
Meander Creek	05030103 070
Meander Creek Reservoir, Lake Girard	05030103 070
Meigs Creek	05040004 080
Middle Branch Portage River, Rocky Ford Creek	04100010 030
Middle Branch Portage River, South Branch Portage River	04100010 040
Middle Branch Shade River	05030202 030
Middle Fork Salt Creek	05060002 080
Mill Creek	05030103 080
Mill Creek	05060001 070
Mosquito Creek	05030103 060
Mosquito Creek Reservoir	05030103 060
Moxahala Creek	05040004 050
Muchinippi Creek	05080001 020
Muddy Creek	04100011 010
Muddy Fork Mohican River	05040002 060
Muskellunge Creek	04100011 120
North Branch Kokosing River	05040003 020

Water Body	Assessment Unit
North Fork Licking River	05040006 010
North Fork Licking River	05040006 020
North Fork Paint Creek	05060003 090
Norwalk Reservoir #3 (Memorial Reservoir)	04100012 030
O'Bannon Creek	05090202 090
Olive Green Creek	05040004 110
Oxbow Lake	04100006 060
Paulding Reservoir	04100007 120
Pike Lake	05060002 130
Pymatuning Creek	05030102 030
Raccoon Creek	04100011 130
Raccoon Creek	05090101 001
Raccoon Creek	05090101 040
Raccoon Creek Reservoir	04100011 130
Rattlesnake Creek	05060003 030
Rush Creek	05030204 030
Rush Creek Lake, Oakthorpe Lake	05030204 030
Salt Creek	05040004 060
Saltlick Creek	05060002 090
Scioto Brush Creek	05060002 150
Short Creek	05030106 010
Shreve Lake	05040003 060
South Branch Wolf Creek	05040004 100
South Fork Sugar Creek	05040001 110
St. Joseph Lake, New Lexington Reservoir	05030204 020
Stillwater Creek	05040001 140
Stillwater Creek	05040001 150
Stillwater Creek	05040001 170
Straight Creek	05090201 080
Sugar Creek	05040001 120
Sunfish Creek	05030201 010
Sunfish Creek	05060002 130
Sycamore Creek	04100011 070
Symmes Creek	05090101 090
Todd Fork	05090202 080
Turkey Creek Lake	05090201 010
Turtle Creek	04100010 010
Tycoon Lake	05090101 060
Van Wert Reservoir, Van Wert Reservoir #2	04100007 090
Veto Lake	05030202 010
Wabash River	05120101 010

Water Body	Assessment Unit
West Branch Huron River	04100012 010
West Branch Huron River	04100012 020
West Branch Wolf Creek	05040004 090
West Fork Little Beaver Creek	05030101 080
Willard Reservoir	04100012 010

E4. Supplemental Information

E4.1 Calculation of Fish Concentrations from Water Quality Standards Inputs

Calculations

For carcinogens:

$$\text{Fish Concentration}(\text{mg/kg}) = \frac{\left[\frac{\text{Cancer Risk Level}}{\text{q1}^{*}\left((\text{mg/kg/d})^{-1}\right)}\right] \times \text{Body Weight (kg)}}{\text{Fish Consumption (kg/d)}}$$

For noncarcinogens:

$$\text{Fish Concentration}(\text{mg/kg}) = \frac{\text{RfD}(\text{mg/kg/d}) \times \text{Body Weight}(\text{kg}) \times \text{RSC}}{\text{Fish Consumption}(\text{kg/d})}$$

For wildlife:

$$\text{Fish Concentration}(\text{mg/kg}) = \text{Wildlife WQC}(\text{mg/L}) \times \text{BAF TL}_{n}(\text{L/kg})$$

Lake Erie Drainage Basin

	Mercury	Chlordane	DDT	PCBs	Hexachloro-benzene	Mirex
HHWQC	3.1 ng/L	2.4 µg/L	0.15 ng/L	0.026 ng/L	0.45 ng/L	0.074 ng/L
Wildlife Criteria	1.3 ng/L	N/A	0.011 ng/L	0.12 ng/L	N/A	N/A
The following inputs on which the WQS are based are used to calculate fish concentrations:						
Reference Dose (RfD)	1E-04 mg/kg/d	N/A	N/A	N/A	N/A	N/A
Slope Factor (q1*)	N/A	0.35 $(mg/kg/d)^{-1}$	0.34 $(mg/kg/d)^{-1}$	2.0 $(mg/kg/d)^{-1}$	1.6 $(mg/kg/d)^{-1}$	0.53 $(mg/kg/d)^{-1}$
Cancer Risk Level	N/A	1E-05	1E-05	1E-05	1E-05	1E-05
Body Weight	65 kg	70 kg	70 kg	70 kg	70 kg	70 kg
Trophic Level Three Bioaccumulation Factor ($BAF\ TL^3$)	27,900	116,600	376,400	520,900	43,690	353,000
Trophic Level Four Bioaccumulation Factor ($BAF\ TL^4$)	140,000	154,200	1,114,000	1,871,000	71,080	1,461,000
Fish Consumption	0.015 kg/d	0.015 kg/d	0.015 kg/d	0.015 kg/d	0.015 kg/d	0.015 kg/d
Relative Source Contribution Factor (RSC)	0.8	N/A	N/A	N/A	N/A	N/A

Source: U.S. EPA. 1995. Great Lakes Water Quality Initiative Criteria Documents for the Protection of Human Health. EPA-820-B-95-006. March 1995.

Derivation of Concentrations

Lake Erie Drainage Basin Mercury Human Health Fish Concentration

$$\frac{1E-04(mg/kg/d)\times 65(kg)\times 0.8}{0.015(kg/d)} = 0.35(mg/kg) = 350(\mu g/kg)$$

Lake Erie Drainage Basin Mercury Wildlife Fish Concentration

Trophic Level 3:

$$1.3E-06(mg/L)\times 27{,}900(L/kg) = 0.036(mg/kg) = 36(\mu g/kg)$$

Trophic Level 4:

$$1.3E-06(mg/L)\times 140{,}000(L/kg) = 0.18(mg/kg) = 180(\mu g/kg)$$

Lake Erie Drainage Basin Chlordane Human Health Fish Concentration

$$\frac{\left[\frac{1E-05}{0.35(mg/kg/d)^{-1}}\right]\times 70(kg)}{0.015(kg/d)} = 0.13(mg/kg) = 130(\mu g/kg)$$

Lake Erie Drainage Basin DDT Human Health Fish Concentration

$$\frac{\left[\frac{1E-05}{0.34(mg/kg/d)^{-1}}\right]\times 70(kg)}{0.015(kg/d)} = 0.14(mg/kg) = 140(\mu g/kg)$$

Lake Erie Drainage Basin DDT Wildlife Fish Concentration

Trophic Level 3:

$$1.1E-08(mg/L)\times 376{,}400(L/kg) = 0.0041(mg/kg) = 4.1(\mu g/kg)$$

Trophic Level 4:

$$1.1E-08(mg/L)\times 1{,}140{,}000(L/kg) = 0.012(mg/kg) = 12(\mu g/kg)$$

Lake Erie Drainage Basin PCB Human Health Fish Concentration

$$\frac{\left[\frac{1E-05}{2.0(mg/kg/d)^{-1}}\right]\times 70(kg)}{0.015(kg/d)} = 0.023(mg/kg) = 23(\mu g/kg)$$

Lake Erie Drainage Basin PCB Wildlife Fish Concentration

Trophic Level 3:

$$1.2E-07(mg/L)\times 520{,}900(L/kg) = 0.062(mg/kg) = 62(\mu g/kg)$$

Trophic Level 4:

$$1.2E-07(mg/L)\times 1{,}871{,}000(L/kg) = 0.22(mg/kg) = 220(\mu g/kg)$$

Lake Erie Drainage Basin Hexachlorobenzene Human Health Fish Concentration

$$\frac{\left[\frac{1E-05}{1.6(mg/kg/d)^{-1}}\right]\times 70(kg)}{0.015(kg/d)} = 0.029(mg/kg) = 29(\mu g/kg)$$

Lake Erie Drainage Basin Mirex Human Health Fish Concentration

$$\frac{\left[\frac{1E-05}{0.53(mg/kg/d)^{-1}}\right]\times 70(kg)}{0.015(kg/d)} = 0.088(mg/kg) = 88(\mu g/kg)$$

Ohio River Drainage Basin

	Mercury	Chlordane	DDT	PCBs	Hexachloro-benzene	Mirex
HHWQC	12 ng/L*	21 ng/L	5.9 ng/L	1.7 ng/L	7.5 ng/L	0.11 ng/L
The following inputs on which the WQS are based are used to calculate fish concentrations:						
Reference Dose (RfD)	N/A	N/A	N/A	N/A	N/A	N/A
Slope Factor (q1*)	N/A	0.35 $(mg/kg/d)^{-1}$	0.34 $(mg/kg/d)^{-1}$	2.0 $(mg/kg/d)^{-1}$	1.6 $(mg/kg/d)^{-1}$	0.53 $(mg/kg/d)^{-1}$
Cancer Risk Level	N/A	1E-05	1E-05	1E-05	1E-05	1E-05
Body Weight	N/A	70 kg	70 kg	70 kg	70 kg	70 kg
Fish Consumption	N/A	0.0065 kg/d	0.0065 kg/d	0.0065 kg/d	0.0065 kg/d	0.0065 kg/d
Relative Source Contribution Factor (RSC)	N/A	N/A	N/A	N/A	N/A	N/A

*Based on the FDA action level of 1 mg/kg divided by the BCF of 83,333 L/kg.

Ohio River Drainage Basin Mercury Fish Concentration

1 mg/kg based on FDA action level

Ohio River Drainage Basin Chlordane Fish Concentration

$$\frac{\left[\frac{1E-05}{0.35(mg/kg/d)^{-1}}\right]\times 70(kg)}{0.0065(kg/d)} = 0.31(mg/kg) = 310(\mu g/kg)$$

Ohio River Drainage Basin DDT Fish Concentration

$$\frac{\left[\frac{1E-05}{0.34(mg/kg/d)^{-1}}\right]\times 70(kg)}{0.0065(kg/d)} = 0.32(mg/kg) = 320(\mu g/kg)$$

Ohio River Drainage Basin PCB Fish Concentration

$$\frac{\left[\frac{1E-05}{2.0(mg/kg/d)^{-1}}\right]\times 70(kg)}{0.0065(kg/d)} = 0.054(mg/kg) = 54(\mu g/kg)$$

Ohio River Drainage Basin Hexachlorobenzene Fish Concentration

$$\frac{\left[\frac{1E-05}{1.6(mg/kg/d)^{-1}}\right]\times 70(kg)}{0.0065(kg/d)} = 0.067(mg/kg) = 67(\mu g/kg)$$

Ohio River Drainage Basin Mirex Fish Concentration

$$\frac{\left[\frac{1E-05}{0.53(mg/kg/d)^{-1}}\right]\times 70(kg)}{0.0065(kg/d)} = 0.20(mg/kg) = 200(\mu g/kg)$$

Fish Tissue Concentrations for Determining Impairment for the 2008 IR (µg/kg)

	Lake Erie HH	Lake Erie – wildlife TL3	Lake Erie – wildlife TL4	Ohio River
Mercury	350	36	180	1000
Chlordane	130	N/A	N/A	310
DDT	140	4.1	12	320
PCBs	23	62	220	54
Hexachlorobenzene	29	N/A	N/A	67
Mirex	88	N/A	N/A	200

E4.2 What's the Difference Between the Fish Consumption Advisory Decision and the Impairment Decision?

Some question may arise as to how the methodology for determining impairment status for the 2008 Integrated Report (2008 IR) for fish tissue relates to the fish advisories issued by the State of Ohio. The methodology for considering fish tissue data changed in 2006. Rather than building on fish consumption advisory decisions, the revised methodology draws directly from the fish tissue contaminant database. This change was possible because of better accessibility to the raw data.

In short, the basis for determining impairment for the IR for fish tissue is similar but unrelated to the basis for determining advisories. The water quality standards calculations assume a certain amount of fish consumption and ensure that level of consumption is safe. The advisory calculations determine what level of fish consumption is safe. Therefore, both are protective of human health. However, advisories and integrated report impairment status are not directly related.

Advisory thresholds are given as one meal per week, one meal per month, one meal every other month, and do not eat. Each threshold is associated with a particular contaminant concentration that is based on consuming an 8 ounce meal. For both PCBs and mercury, those thresholds are 50 parts per billion (ppb) for one meal per week, 220 ppb for one meal per month, 1000 ppb for one meal every other month, and 2000 ppb for do not eat.

The thresholds used for determining IR categories are based on water quality standards for human health. The water quality standards assume that people are eating a certain quantity of different types of fish over time. The Lake Erie basin WQS calculations for mercury and PCBs assume that people are eating 15 grams of fish per day. The Ohio River basin calculations for PCBs and mercury assume that people are eating 6.5 grams of fish per day.

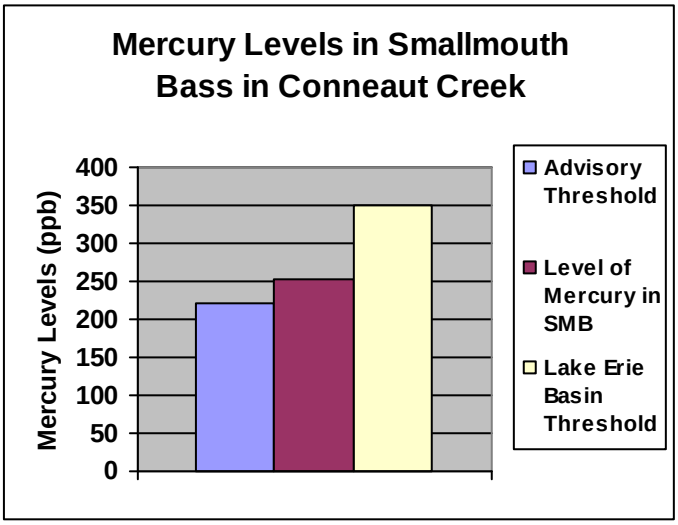
Advisory thresholds are prescriptive, indicating to people how much fish is safe to eat given a certain level of fish contamination. Water quality standard-based thresholds are descriptive, indicating how much contamination is acceptable in fish given that people are eating a certain amount of certain types of fish. In other words, the advisories tell people how much fish they can safely eat, and the water quality standards assume how much fish people are eating and use that information to calculate a "safe" level of contamination in fish.

U.S. EPA, in its guidance on developing the IR, indicates that water quality standards are to be used as the basis for determining impairment categories for fish tissue. Because the assumptions used to calculate the advisories are different than the assumptions used to calculate the water quality standards, this results in cases where some water bodies have advisories against fish consumption but are not listed as impaired, and some water bodies are listed as impaired but no fish advisory is in place. This situation is demonstrated in the following table:

Parameter	Lake Erie Basin	Ohio River Basin	1 meal per week advisory	1 meal per month advisory
Fish Consumed	15 grams/day	6.5 grams/day	32.6 grams/day	7.6 grams/day
Maximum Allowable Fish Concentration				
PCB Threshold	23 ppb	54 ppb	50 ppb	220 ppb
Mercury Threshold	350 ppb	1000 ppb	50 ppb	220 ppb

The reason the thresholds are different between the two basins is that the assumed fish consumption levels are different. The reason the water quality standard thresholds are different from the advisory thresholds is both because the fish consumption levels are different, and because for PCBs, a cancer slope factor is used to calculate the water quality standard criteria, which is more strict than the health protection value used to calculate the advisory threshold.

Data for smallmouth bass in Conneaut Creek provide an example where there is an advisory but the water body is not impaired.



Channel catfish in Pymatuning Reservoir show a case where there is no advisory but the water is listed as impaired.