Recommendations for Deer Lake AOC Fish Contaminant Monitoring

The Deer Lake AOC includes 3 waterbodies: Carp Creek from Ishpeming downstream to Deer Lake, Deer Lake, and the Carp River downstream of Deer Lake to Lake Superior. Each waterbody is covered by a fish consumption advisory due to elevated concentrations of mercury. The amount and age of fish contaminant data varies by waterbody. The current database for the AOC is sufficient for some fish populations, but should be updated for others.

Carp Creek

Brook trout: The 2007 advisory recommends restricted consumption of brook trout larger than 10 inches, based on samples collected in 2005 (Figure 1). We have 2 samples of fish just over 10 inches; 1 had a Hg concentration of 0.56 ppm, exceeding the 0.5 ppm restrict consumption trigger level. If larger brook trout existed in the AOC reach of Carp Creek it would be worthwhile to sample them, however it is highly unlikely that many fish larger than 10 inches are there. I see no need to target brook trout from Carp Creek.

White sucker*:* The 2007 advisory recommends no consumption of suckers larger than 10 inches, based on samples collected in 2005 (the MDCH groups all suckers together based on the premise that the general public does not differentiate between species). In earlier advisories Carp Creek suckers were included in “all other species” and the MDCH recommended no consumption, since no sample data were available. The 2005 data suggests that suckers less than 10 inches have Hg concentration well below the 0.5 ppm trigger level, and that fish larger than 14 inches may be likely to exceed that concentration (Figure 2).

Additional white suckers at least 10 inches in length should be analyzed. Any large suckers in Carp Creek are likely to be part of a spring spawning run from Deer Lake. Past (limited) collections from Deer Lake have included white suckers up to 20 inches. The additional samples of large white suckers could be collected with shocking gear in Carp Creek during the spring spawning run, or could be taken from Deer Lake using nets later in the year, since they very likely represent the same population.

All other species**:** The 2007 advisory recommends no consumption of any other species from Carp Creek. The advisory recommends this because the human health risk associated with eating other species is unknown. However, it is unlikely that species other than white sucker or brook trout from Carp Creek are caught and eaten by anglers.

Deer Lake

The 2007 advisory recommends that no one eat any fish from Deer Lake. The advisory has been in place since the early 1980’s. Intensive sampling has been conducted since 1984, with regular analysis of northern pike, walleye, and yellow perch fillet samples.

Northern pike : The maximum Hg concentrations in northern pike were measured in samples collected in 1997, 1998, and 1999 in fish over 30 inches in length. A comparison of concentrations in pike over time is complicated by the variation in size of fish collected from year to year. Limiting comparisons to pike between 20 and 26 inches yielded a useful data set, and indicates that the median Hg concentration in that size range of pike has declined since 1993 (Figure 3).

If the Deer Lake northern pike advisory were to be based strictly on the two most recent samples (2001 & 2003; Figure 4), the MDCH would likely recommend that no one should eat northern pike larger than 26 inches, that the general population should eat no more than 1 meal per week of fish less than 26 inches, and women and children should eat no more than 1 meal per month of northern pike less than 26 inches. This (hypothetical) advice is more restrictive than the general statewide advice and is driven by 1 fish measuring 38 inches with a Hg concentration of 2.2 ppm.

Additional samples are needed before any advisory relaxation is possible. It has been 5 years since the last samples were collected; concentrations may have declined somewhat in that time, and a better sample of northern pike larger than 28 inches is needed. Given that there is evidence that the top predator in the Deer Lake fish community has changed from northern pike to walleye, large northern pike may be rare. A good effort should be made to collect a reasonable sample. If a reasonable effort does not result in a good sample of large pike, we might conclude that the northern pike population is no longer significant, and the decision to de-list may need to be based on walleye alone.

The MDCH would need to see a minimum of 1 and more likely 2 samples with Hg concentrations consistently below 1.5 ppm. If suitable samples are collected in 2008 (MDEQ/MDNR) and again in 2011 (by CCI per the amendment to the consent judgment), and the Hg concentrations are consistently less than 1.5 ppm, I believe the MDCH will be convinced that relaxation of the advisory is appropriate. If no samples are collected until 2011, relaxation of the advisory probably wouldn't occur until after the second CCI collection, scheduled for 2016.

***Walleye**:* The maximum Hg concentrations in walleye were measured in samples collected in 1997, 1998, and 1999. As with the northern pike, a comparison of concentrations in walleye over time is complicated by the variation in size of fish collected from year to year. Limiting comparisons to walleye between 16 and 20 inches yielded a useful data set, and indicates that the median Hg concentration in that size range of walleye has remained relatively unchanged since 1993 (Figure 5).

If the Deer Lake walleye advisory were to be based strictly on the two most recent samples (2001 & 2003; Figure 6), the MDCH would likely recommend following the general statewide advice, that is, no one should eat more than 1 meal per week, and women and children should not eat more than 1 meal per month. Less than 10% of all Deer Lake walleye samples had Hg concentrations near or exceeding 1.5 ppm, and the maximum observed concentration was "only" 1.7 ppm. However, given the history of Deer Lake the MDCH is unlikely to relax the walleye advisory without significant evidence that concentrations have declined and appear to be stable.

As with the northern pike, it has been 5 years since the last samples were collected, and additional walleye samples are needed. The MDCH might be convinced to relax the advisory somewhat based on one more suitable sample, but is unlikely to remove all "do not eat" advice without 2 more samples and an adequate passage of time. Probably the best scenario would be to collect samples in 2008 (MDEQ/MDNR) and 2011 (CCI).

Yellow perch: Suitable samples of yellow perch were collected from Deer Lake in 1984, 1998, 1999, and 2001. Mercury concentrations in perch were consistent over the last 3 sample years; fish less than 11 inches had Hg concentrations below 0.5 ppm, and most of the perch larger than 11 inches had concentrations ranging from 0.4 to 0.9 ppm (Figure 7). If the Deer Lake yellow perch advisory were based strictly on the most recent 3 years of data, the advice would be no different than the statewide general Hg advisory for lakes and impoundments.

One additional yellow perch sample verifying the moderate Hg concentrations should be sufficient to justify relaxation of the consumption advice. If other collections of other species are made in 2008, it would be appropriate to collect yellow perch as well.

Carp River

Brook trout**:** The 2007 advisory does not put a limit on consumption of Carp River brook trout. Brook trout were sampled in 1993, 1999, and 2004, and the Hg concentrations have been consistently low (less than 0.3 ppm; Figure 8). No new samples are needed in the near future.

Northern pike: The 2007 advisory recommends restricted consumption of Carp River northern pike. The most recent samples were collected in 1999 and included 8 legal size fish (24-inch limit) with 2 pike larger than 32 inches (Figure 9). Mercury concentrations in the 1999 samples were all between 0.5 and 1.5 ppm.

By comparison, northern pike were collected from the Tahquamenon River in Luce County near Slater's Landing in 1988 (a non-impounded river reach). The sample included only 6 fish, 1 measuring 25 inches and the rest less than the 24-inch size limit (Figure 9), but the comparison suggests that mercury concentrations in pike from the Tahquamenon are similar to those observed in the 1999 Carp River samples. Further investigation of this is recommended.

There is some question as to whether a significant northern pike population remains in the Carp River. In addition, the pike collected in 1999 were taken from the Carp River Basin; since it is an impoundment, somewhat elevated Hg concentrations would be expected even without the influence of Deer Lake, and would be covered under the statewide general advisory. Since the concentrations measured in the 1999 sample were all less than 1.5 ppm, the current MDCH advice for Carp River basin pike is no different than the general advisory.

If an impoundment still exists on the Carp River, then an attempt to collect more northern pike to verify the level of Hg contamination would be worthwhile. If impoundments no longer exist, a special effort to sample pike is probably unnecessary as the population is likely to be small, scattered, and difficult to collect. If legal size pike are captured in the process of other sampling efforts, they should be kept and analyzed.

White sucker: The 2007 advisory does not put a limit on consumption of Carp River suckers. Ten white sucker fillets were analyzed in 2004 and the Hg concentrations were consistently low (0.2 ppm median concentration; Figure 10). In 1984, four white suckers were analyzed as whole samples and 1 was analyzed as a fillet sample. Concentrations in all samples were low and indicated that consumption restrictions were not needed.
No new samples are needed in the near future.

All Other Species: The 2007 advisory recommends no consumption of any other species from the Carp River. The advisory recommends this because the human health risk associated with eating other species is unknown.

MDNR survey work indicates that largemouth bass, yellow perch, and sunfish occur in the Carp River. There have been reports of brown trout being caught by local anglers as well. Populations of these species may not be significant, and if so, collection of a significant sample may be difficult. If suitable samples cannot be collected, we may conclude that the human health risk is small or suggest basing advisories on suitable surrogate species.

<u>Summary</u>

Samples of large (10 to 20 inch) white suckers should be collected from either Carp Creek or Deer Lake to evaluate the possibility of relaxing the Carp Creek advisory for that species. This species is not included in the CCI consent judgment amendment and thus collection and analysis would have to be coordinated by the MDEQ.

Samples of northern pike, walleye, and yellow perch should be collected from Deer Lake to evaluate the possibility of relaxing advisories for those species. These species are to be collected and analyzed by CCI every 5 years beginning in 2011. The results of two sampling events are likely to be required by the MDCH to justify relaxation of the advisory, meaning that relaxation would not be likely until 2016. This timetable could be shortened if samples were collected in 2008 (by MDEQ/MDNR).

The argument can be made that mercury concentrations in Carp River fish are no longer related to conditions in Deer Lake. Northern pike from the Carp River Basin exhibited elevated Hg concentrations in 1993, but fish collected in 1999 had concentrations in the range considered normal for an impoundment, and possibly similar to other un-impounded UP stream populations. The current status of northern pike and other sportfish should be evaluated. Carp River collections are not included in the CCI consent judgment amendment; collection and analysis of Carp River fish would have to be coordinated by the MDEQ.

Joe Bohr
Aquatic Biologist
MDEQ/Water Bureau

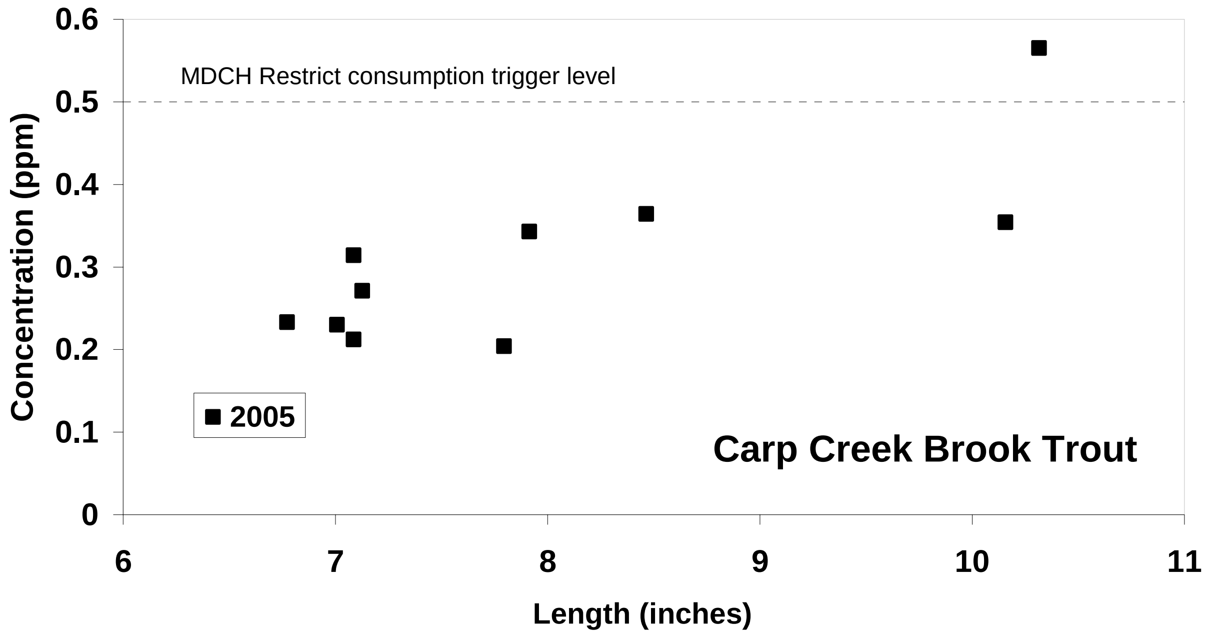

Figure 1. Mercury concentration in brook trout collected from Carp Creek upstream of Deer Lake, Marquette County.

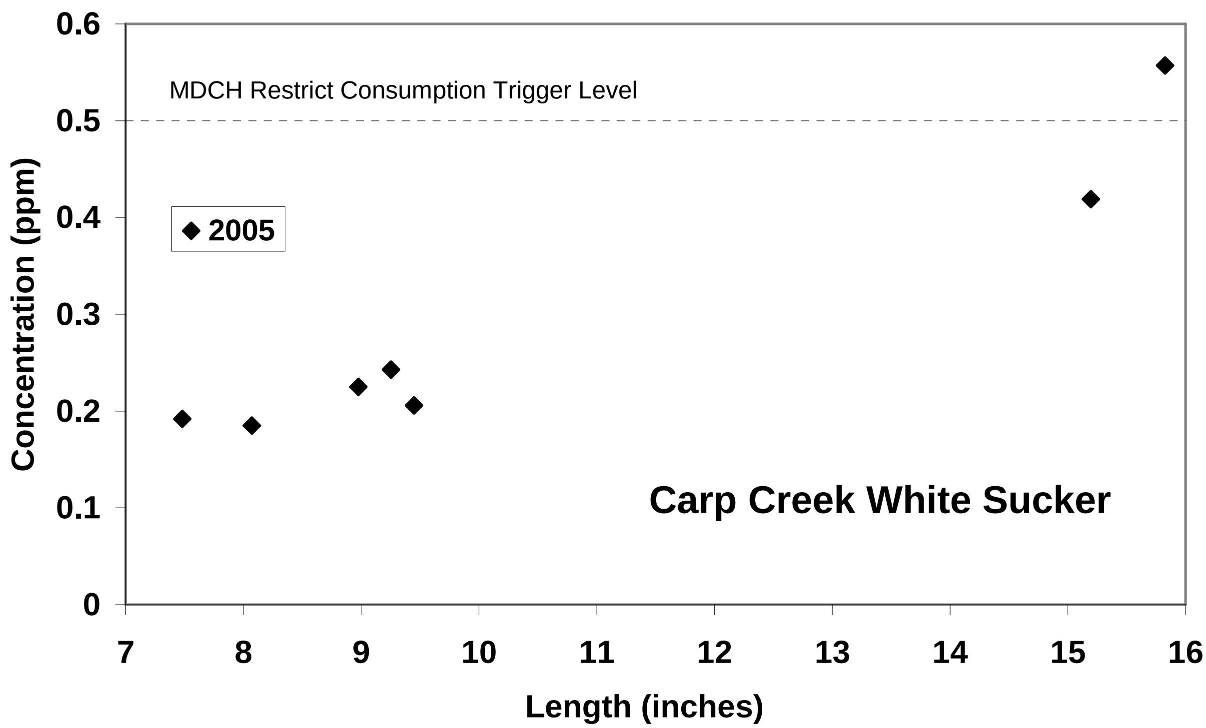

Figure 2. Mercury concentration in white sucker collected from Carp Creek upstream of Deer Lake, Marquette County.

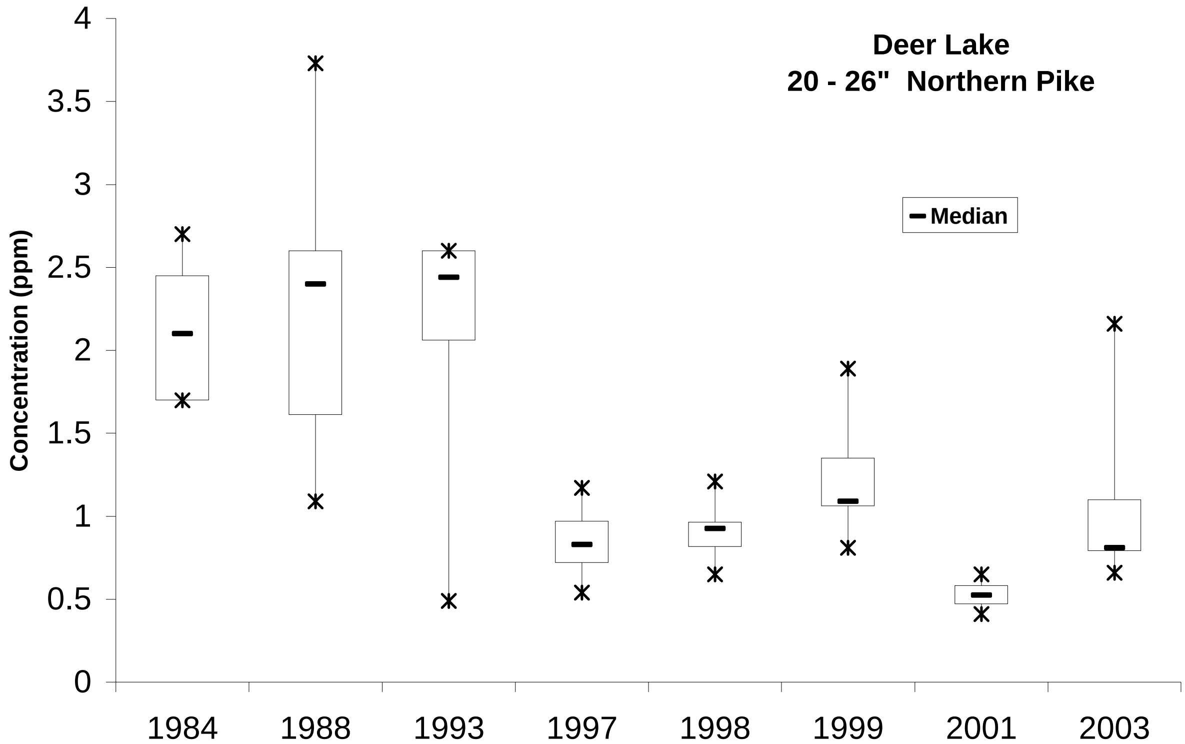

Figure 3. A comparison of mercury concentrations in 20 to 26 inch northern pike collected from Deer Lake between 1984 and 2003.

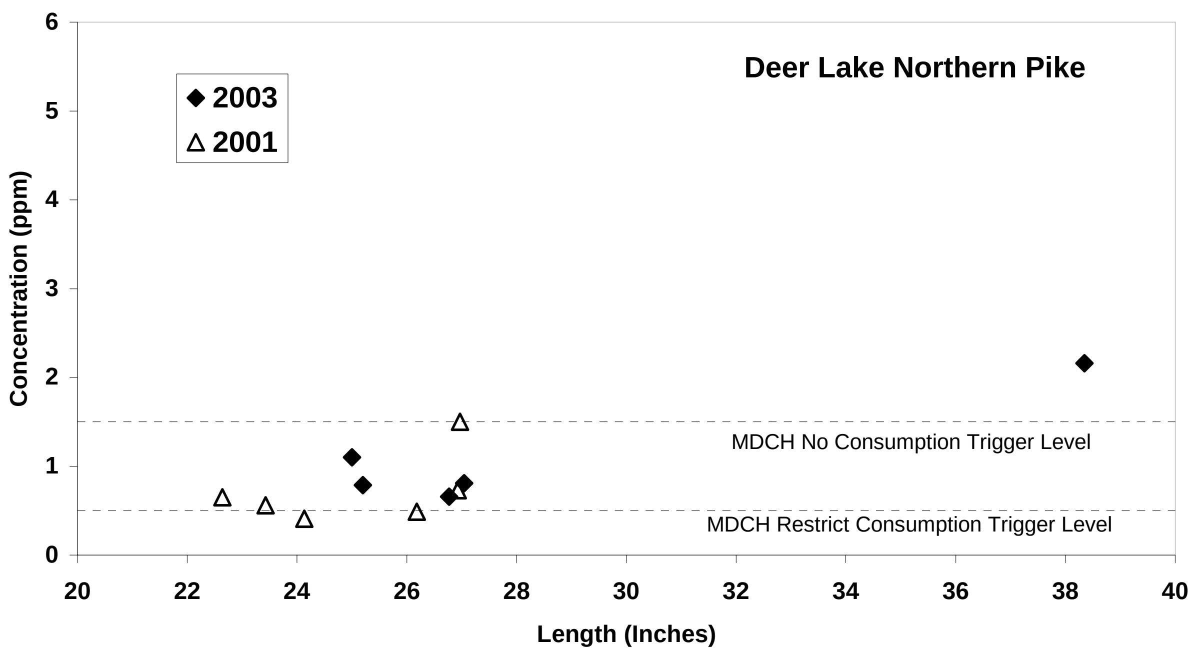

Figure 4. Mercury concentrations in Deer Lake northern pike collected in 2001 and 2003.

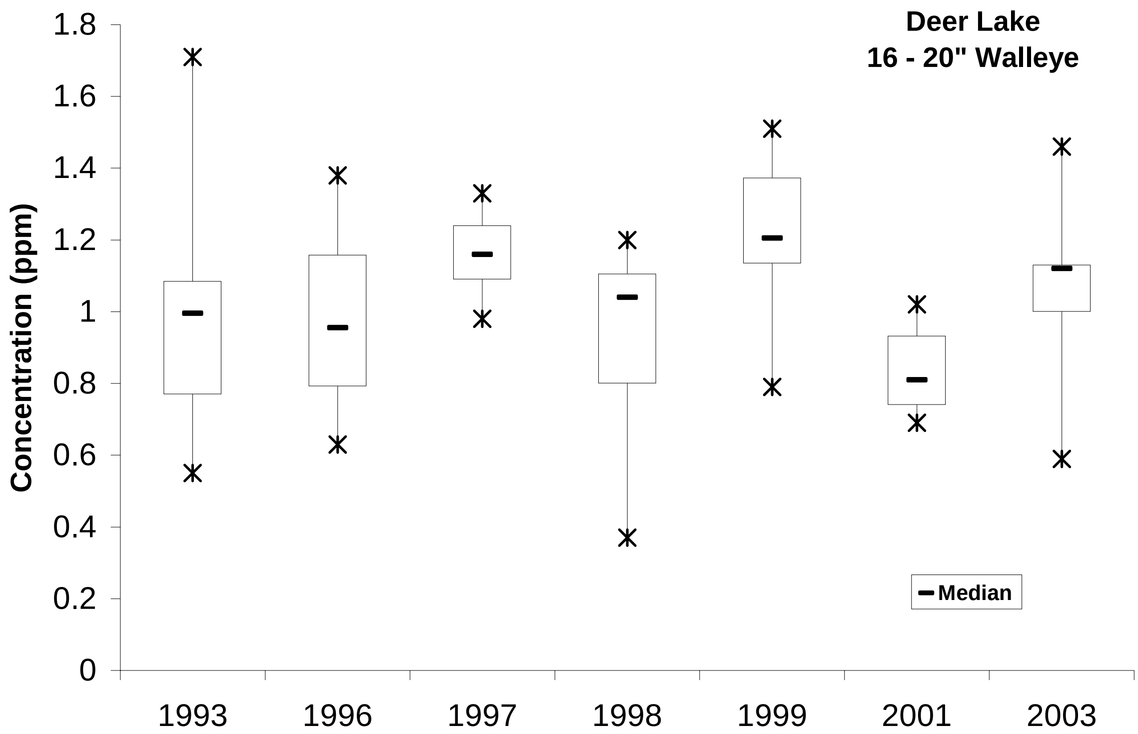

Figure 5. A comparison of mercury concentrations in 16 to 20 inch walleye collected from Deer Lake between 1993 and 2003.

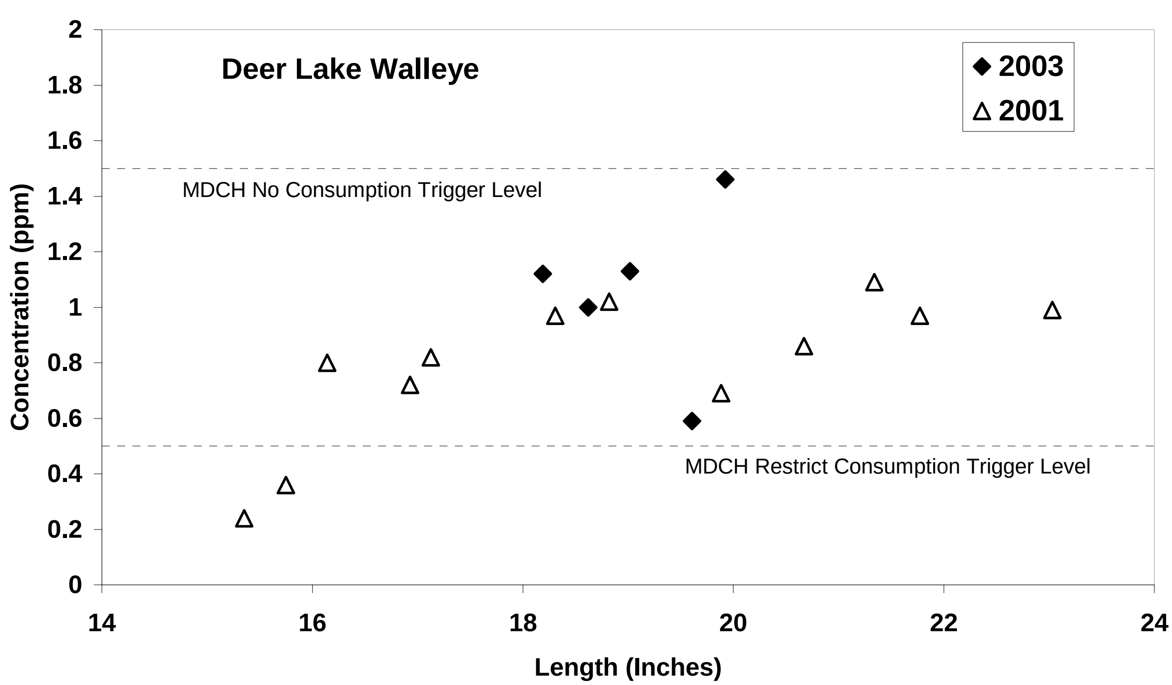

Figure 6. Mercury concentrations in Deer Lake walleye collected in 2001 and 2003.

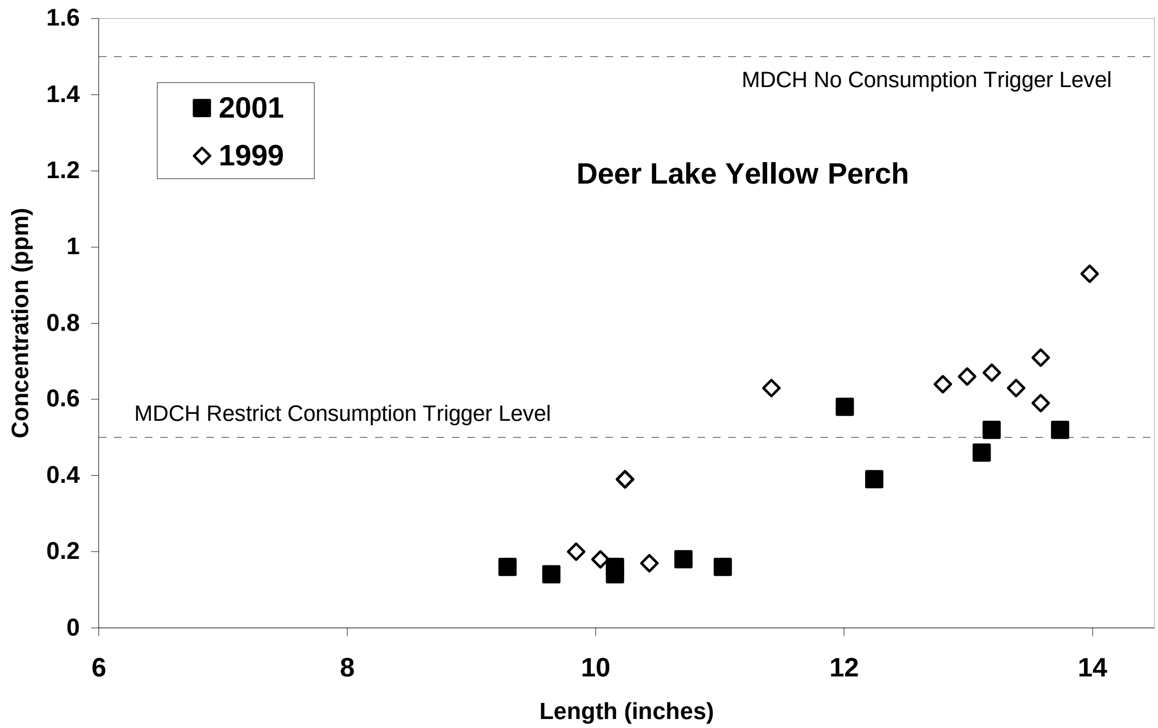

Figure 7. Mercury concentrations in Deer Lake yellow perch collected in 1999 and 2001.

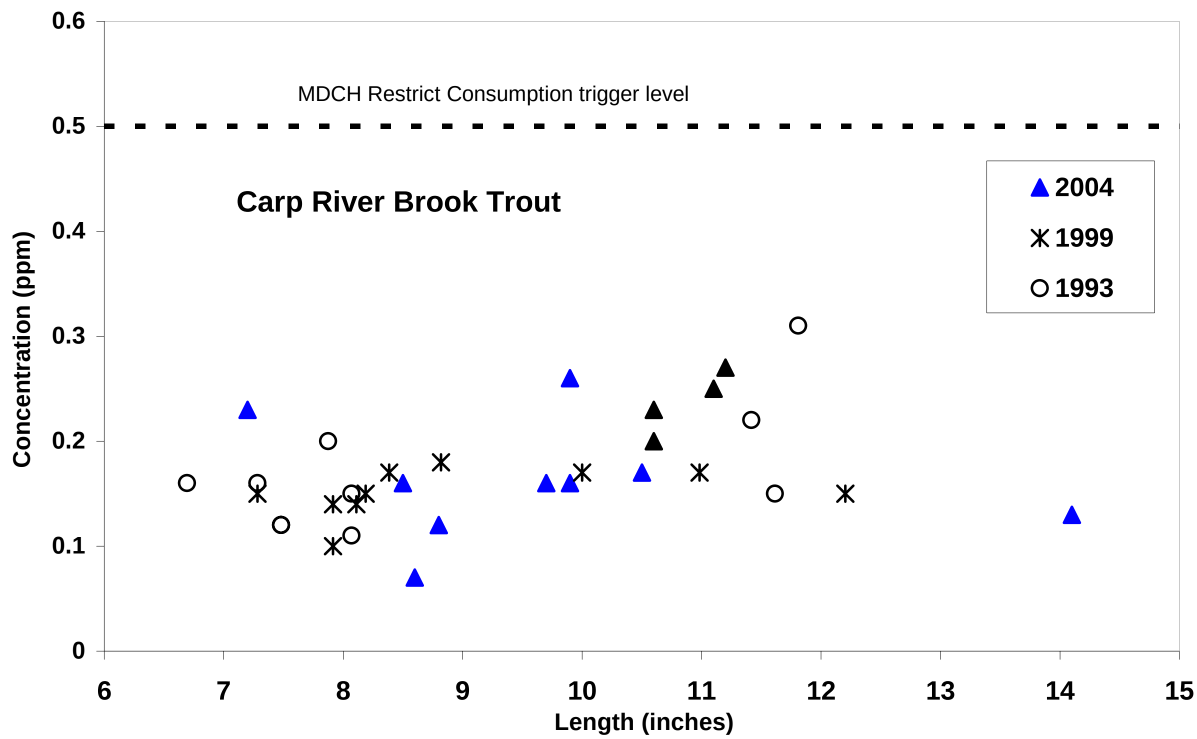

Figure 8. Mercury concentrations in Carp River brook trout collected in 1993, 1999, and 2004.

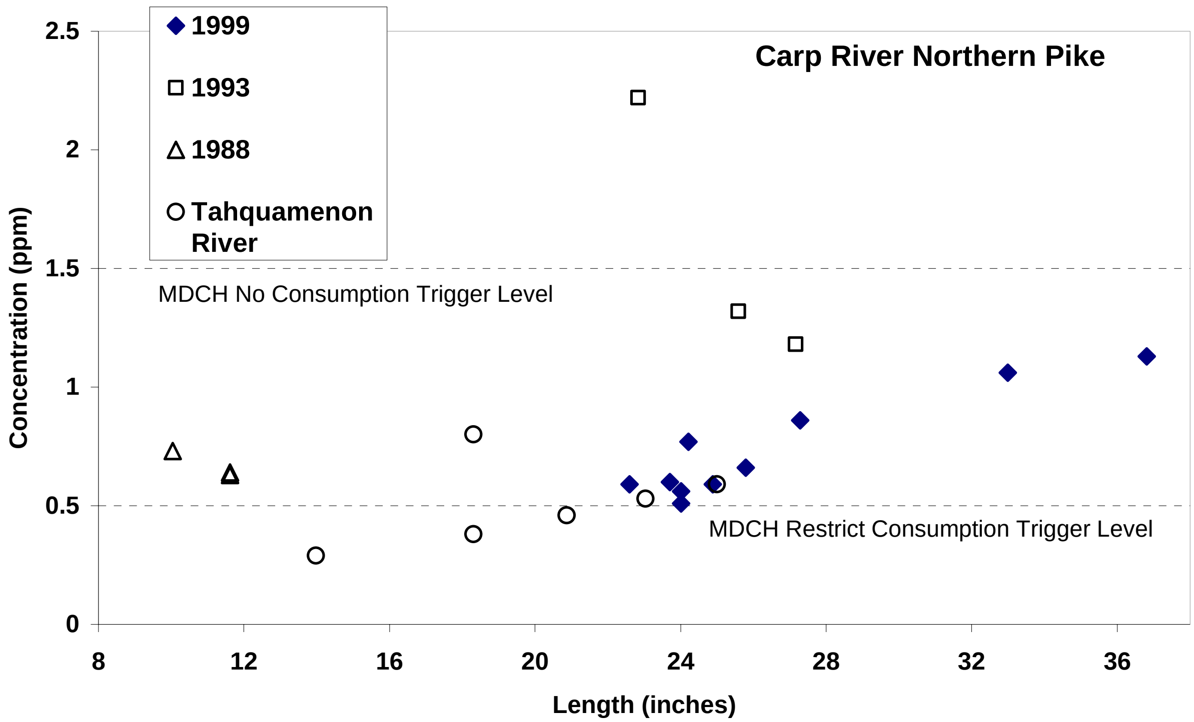

Figure 9. Mercury concentrations in Carp River northern pike collected in 1988, 1993, and 1999, and in the Tahquamenon River in 1988.

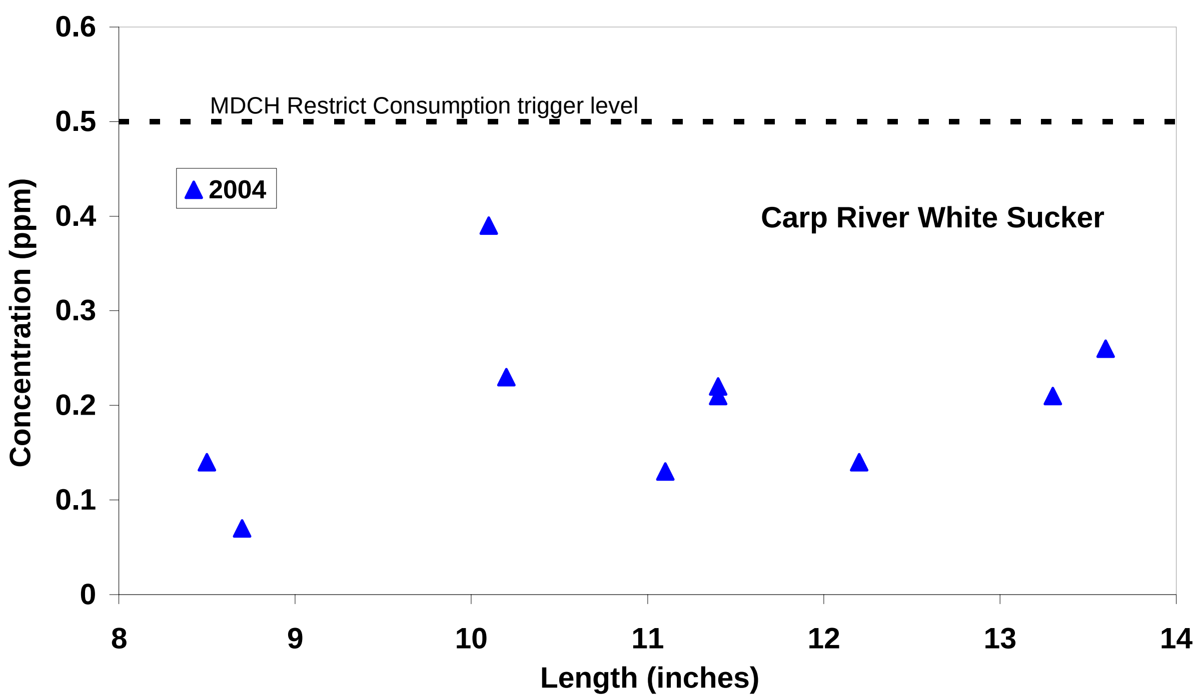

Figure 10. Mercury concentrations in Carp River white sucker collected in 2004.

Menominee River Area of Concern

Status of the Restrictions on Fish and Wildlife Consumption BUI

Sampling Plan

The Menominee River Area of Concern (MR AOC) includes the river from the Park Mill (second dam from the river mouth, also known as Upper Scott) downstream to the river mouth. The river forms part of the boundary between the states of Michigan and Wisconsin. The beneficial use Restrictions on Fish and Wildlife Consumption is listed as impaired for the MR AOC.

Both Michigan and Wisconsin have issued fish consumption advisories for the Menominee River. The current Michigan Department of Community Health (MDCH) fish consumption advisory recommends limited consumption of carp, lake sturgeon, suckers, and walleye upstream of the Menominee Dam (aka Lower Scott Dam) due to PCBs and mercury; the advice is based primarily on samples collected well upstream of the MR AOC, with the most recent samples taken from the Chalk Hills impoundment in 2010. The only fish contaminant samples taken by Michigan from between dams 1 and 2 were walleye and rock bass collected in 1990. The MDCH also recommends limited consumption of sport caught fish taken from the river downstream of the Menominee Dam due to elevated levels of mercury, PCBs, and dioxin, based on samples taken from nearby waters of Green Bay.

To determine the status of the Fish Consumption BUI in the MR AOC we will compare the concentrations of key contaminants in one or more species of fish collected from 2 areas within the AOC and from an appropriate reference site. The comparisons will be made using 10 fillets from a similar size range of the same species from each of the 3 sites. All samples will be analyzed for mercury, total PCBs, and the standard suite of contaminants normally measured for the Michigan DEQ fish contaminant monitoring program. In addition, samples of one species of fish from the Menominee Dam impoundment and from the lower Menominee River will be analyzed for dioxin, furan, and dioxin-like PCB congeners. The dioxin issue is discussed in the attached Menominee River TEQ summary.

<u>Fish Species for Contaminant Analysis</u>
We will collect and analyze contaminants in 2 species of fish from the MR AOC and the same 2 species from a reference water body for comparison. The following species were considered:

- Carp
    - Pros: existing advisory on the species; carp tend to have the highest PCB burdens for a given water body; consumed by some anglers; relatively ubiquitous species; some historic data available for comparison
    - Cons: may range outside of the AOC to some extent; not a popular sport fish

- Northern Pike
    - Pros: existing advisory on the species in the lower Menominee River; popular sport fish; consumed by many anglers; species has relatively

good site fidelity and thus would represent AOC conditions well; top predator and good indicator for mercury concentrations
    - Cons: may be relatively difficult to collect an adequate sample size without special collection efforts; no (Michigan) historic data available for MR AOC

- Redhorse Sucker
    - Pros: regularly taken and consumed by a segment of the sport fishing population
    - Cons: may not have good site fidelity in lower Menominee River and may not represent AOC conditions as well as other species

- Rock Bass or other small centrarchid species
    - Pros: popular and regularly consumed panfish; high site fidelity and thus will represent AOC conditions; fairly ubiquitous species that should allow several choices for reference sites; relatively easy to collect where present; some historic data available
    - Cons: populations may be found only in localized zones; the species does not generally accumulate high levels of contaminants

- Smallmouth Bass
    - Pros: popular and regularly consumed sport fish; fairly high site fidelity and thus will represent AOC conditions
    - Cons: samples collected downstream of 1st dam may spend significant part of life outside of AOC

- Walleye
    - Pros: very popular and regularly consumed sport fish; existing advisory on the species; could be collected at several potential reference sites; some historic data available for comparison
    - Cons: the species ranges very widely and will not necessarily represent conditions in the AOC well

- Yellow Perch
    - Pros: popular species for consumption; fairly ubiquitous
    - Cons: more widely ranging than rock bass and other small centrarchids; may be more difficult to collect in the AOC due to habitat preferences; the species does not generally accumulate high levels of contaminants

We will use carp as one of the target species because it represents the worst case for PCB contamination and because the species should be relatively easy to collect from both the MR AOC and the reference site.

We will use rock bass or smallmouth bass as a second target species for the reasons noted above. We will also collect northern pike and yellow perch as available. These supplementary species may not be analyzed initially but could provide additional evidence to support a BUI removal decision if needed.

In addition, although we plan to analyze 10 fish of each species from each site, we will attempt to collect additional (up to 10) fish per species at each site. This will increase

our ability to match length ranges between sites and will allow us the option of analyzing additional samples should the initial results prove inconclusive.

In summary, we will analyze a minimum of 20 samples from each of three areas (between dams 1 & 2, lower Menominee River, reference site) for a total of 60 samples.

<u>Potential Reference Sites</u>
An appropriate reference water body will support the selected target fish species and will not be another Area of Concern or have other known legacy contamination issues. Ideally, in the interest of efficiency and budgetary savings, the reference site will be one that the MDNR Fisheries Division or Wisconsin DNR samples regularly.

In addition, an ideal reference site will have contaminant inputs from sources outside of the AOC that are similar to the inputs affecting the AOC. Mercury, PCBs, and other contaminants of concern are transported into the MR AOC watershed atmospherically and through other non-point sources. The magnitude of these inputs varies regionally; for example, industrialized and urbanized areas tend to emit and discharge higher levels of PCBs and mercury than less developed regions. The MR AOC is exposed to non-AOC inputs from the Fox River and Green Bay AOC and thus is likely to have somewhat elevated contaminant levels even without sources within the MR AOC.

The following sites were considered:

- Little Bay de Noc (northwest Lake Michigan)
    - Pros: MDNR samples the lake regularly and should be able to provide several species of fish; we have a good historic database available allowing analysis of contaminant trends; similar regional contaminant inputs
    - Cons: none

- Regional Inland Lake (specific lake to be determined)
    - Pros: would provide a comparison incorporating non-AOC regional contaminant inputs
    - Cons: may not be a suitable comparison for mercury since mercury tends to be elevated in inland lake fish as compared to Great lakes fish; would require a special collection effort

- Regional River (Menominee River u/s of AOC or other to be determined)
    - Pros: would provide a comparison incorporating non-AOC regional contaminant inputs
    - Cons: would require a special collection effort

Little Bay de Noc will be used as the reference water body for the MR AOC. The MDNR Fisheries Division samples the area regularly, the target species are available there, and the regional influences should not be significantly different.

Special collection efforts may be needed to sample the lower Scott impoundment and the lower Menominee River. The Wisconsin DNR may be available to conduct these collections.

<u>Other Considerations</u>

This sampling plan does not take into account fish contaminant sampling that may have been conducted recently by the state of Wisconsin or by industry. If recent appropriate data are available the need for new sampling may be reduced. North East Wisconsin Hydro, for example, operates hydroelectric projects on the Menominee River and is required through their federal license to periodically analyze mercury and PCBs in fish affected by their projects. Samples from the upper and lower Scott impoundments and from the lower Menominee River were collected in 2011 and these samples may help inform the BUI status decision.

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Michigan Department of Environmental Quality

River Raisin Area of Concern

Status of the Fish Consumption BUI

Sampling Plan

The River Raisin Area of Concern (RR AOC) is located in southeastern Michigan and includes the river downstream from the low-head dam (Dam #6) at Winchester Bridge in the City of Monroe. The RR AOC also extends into Lake Erie and along the nearshore zone north and south of the river mouth. Michigan has issued fish consumption advisories for this reach of the River Raisin beginning in the 1980's and continuing to the present. PCBs are the primary contaminant driving consumption advisories on fish taken from the lower River Raisin.

The 2013 Michigan Department of Community Health fish consumption advisory recommends that no one eat carp, channel catfish, or larger black buffalo and white bass, and recommends limits on consumption of smallmouth bass and freshwater drum. The RR AOC was most recently sampled in 2008 when carp, channel catfish, freshwater drum, smallmouth bass, and white bass were collected.

To determine the status of the Fish Consumption BUI in the RR AOC we will compare the concentrations of key contaminants in one or more species of fish collected from the AOC to concentrations in samples from an appropriate reference site. The comparisons will be made using 10 fillets from a similar size range of the same species from each of the sites. All samples will be analyzed for mercury, total PCBs, and the standard suite of contaminants normally measured for the Michigan DEQ fish contaminant monitoring program (Table 1). In addition, 10 samples of a select species from each site will be assayed for dioxin TEQ, including dioxin-like PCB congeners, in order to update the fish consumption advisory.

<u>Fish species</u>
We will collect and analyze contaminant concentrations in at least 2 species of fish from the RR AOC and the same species from a reference water body for comparison. The following species were considered:

- Carp
    - Pros: existing advisory on the species; carp tend to have the highest PCB burdens for a given water body; consumed by some anglers; relatively ubiquitous species
    - Cons: may range outside of the AOC to some extent; not a popular sport fish

- Freshwater Drum
    - Pros: existing advisory on the species; consumed by some anglers
    - Cons: may range outside of the AOC to some extent; not highly sought after; choices for reference sites are limited

- Smallmouth Bass
    - Pros: existing advisory on the species; popular sportfish and consumed by some anglers; good site fidelity and thus will represent AOC

conditions; fairly ubiquitous species that allows several choices for reference sites; relatively easy to collect where present

- Rock Bass or other small centrarchid species
  - o Pros: popular and regularly consumed panfish; high site fidelity and thus will represent AOC conditions; fairly ubiquitous species that should allow several choices for reference sites; relatively easy to collect where present
  - o Cons: populations may be found only in localized backwater zones;

- Yellow Perch
  - o Pros: popular species for consumption; fairly ubiquitous
  - o Cons: lower site fidelity than rock bass and other small centrarchids; may be more difficult to collect in the AOC due to habitat preferences; the species does not generally accumulate high levels of PCBs

Carp will be one of the target species because it represents the worst case for PCB contamination and because the species should be relatively easy to collect from both the RR AOC and the reference site. Carp also represent the worst case for dioxin TEQ contamination and will be analyzed for that set of chemicals.

Smallmouth bass, rock bass (or a related centrarchid species), or both will also be target species. These species would provide a reasonable representation of conditions in the RR AOC and should be available at the reference site. We will attempt to collect sufficient specimens of at least 2 target species in addition to the carp; although not all samples will necessarily be analyzed this would give us options for additional comparisons with fish from the reference site.

In addition, although we plan to analyze 10 fish of each species from each site, we will attempt to collect additional (up to 10) fish per species at each site. If successful this would increase our ability to match length ranges between sites and will allow us the option of analyzing additional samples should the initial results prove inconclusive.

<u>Potential Reference Sites</u>
An appropriate reference water body will support the selected target fish species and will not be another Area of Concern or have other known legacy contamination issues.

In addition, an ideal reference site will have contaminant inputs from sources outside of the AOC that are similar to the inputs affecting the AOC. Mercury, PCBs, and other contaminants of concern are transported into the RR AOC watershed atmospherically and through other non-point sources. The magnitude of these inputs varies regionally; for example, industrialized and urbanized areas tend to emit and discharge higher levels of PCBs and mercury than less developed regions. The RR AOC is exposed to non-AOC inputs from Lake Erie and from the Detroit River AOC and thus is likely to have somewhat elevated contaminant levels even without sources within the RR AOC.

The following sites were considered as reference sites:

- Huron River (downstream of Rockwood to river mouth)
  - o Pros: near the RR AOC and would provide a comparison incorporating non-AOC regional contaminant inputs

    - Cons: requires a special collection effort

- Lake Erie (Western basin)
    - Pros: MDNR samples the lake regularly and would be able to provide several species of fish; we have a good historic database available allowing analysis of contaminant trends; would provide a comparison incorporating non-AOC regional contaminant inputs
    - Cons: too strongly influenced by inputs from the RR AOC; individuals of some potential target species may range into the RR AOC for part of their lives therefore we could be sampling essentially the same population at both sites

- Little Bay de Noc (northwest Lake Michigan)
    - Pros: MDNR samples the lake regularly and should be able to provide several species of fish; we have a good historic database available allowing analysis of contaminant trends; relatively pristine area
    - Cons: regional contaminant inputs are likely to be very different than those in the RR AOC area

We will use the Huron River as the reference site for comparison with the RR AOC. The Huron River is in the same heavily urbanized and industrialized area and is exposed to atmospheric and other non-point contaminant sources similar to those affecting the RR AOC.

Joe Bohr

10/14/2013

Table 1. Contaminants quantified in edible portion fish tissue samples for the Michigan Fish Contaminant Monitoring Program.

Standard Analyses	Level of Quantification
Hexachlorobenzene	0.001 ppm
gamma-BHC (Lindane)	0.001 ppm
Aldrin	0.001 ppm
Dieldrin	0.001 ppm
4,4'-DDE	0.001 ppm
4,4'-DDD	0.001 ppm
4,4'-DDT	0.001 ppm
2,4'-DDE	0.001 ppm
2,4'-DDD	0.001 ppm
2,4'-DDT	0.001 ppm
Heptachlor Epoxide	0.001 ppm
Mercury	0.010 ppm
Selenium	0.010 ppm
Oxychlordane	0.001 ppm
gamma-Chlordane	0.001 ppm
trans-Nonachlor	0.001 ppm
alpha-Chlordane	0.001 ppm
cis-Nonachlor	0.001 ppm
Octachlorostyrene	0.001 ppm
Hexachlorostyrene	0.001 ppm
Heptachlorostyrene	0.001 ppm
Pentachlorostyrene	0.001 ppm
Heptachlor	0.001 ppm
Terphenyl	0.250 ppm
Toxaphene	0.050 ppm
Mirex	0.001 ppm
PBB (FF-1, BP-6)	0.001 ppm
Total PCB (congener method)	0.001 ppm

Rouge River Area of Concern
Status of the Restrictions on Fish and Wildlife Consumption BUI

Sampling Plan

Background

The Rouge River Area of Concern (RR AOC) includes the entire main branch as well as the lower, middle, and upper branches of the river. The RR AOC is listed for 14 beneficial use impairments, including Restrictions on Fish and Wildlife Consumption.

The current Michigan Department of Community Health fish consumption advisory includes varying recommendations for restricted consumption depending on species and location on the river. The primary contaminant driving the fish consumption advisories in the Rouge watershed is PCBs. The most recent fish contaminant monitoring conducted in the watershed was in 2005 when carp and a few other species were collected from several areas. PCB concentrations tended to be the highest in Newburgh Lake (Middle Branch Rouge River), the Lower Branch Rouge River, and Main Branch of the Rouge downstream of the Ford Dam.

A significant sediment remediation project was conducted in 1998, removing 400,000 cubic yards of contaminated sediment from Newburgh Lake. While fish contaminant monitoring indicates that PCB concentrations in several species have declined, fish consumption advisories remain in place for the lake and periodic fish tissue monitoring should continue there for the foreseeable future.

Sampling Plan

To determine the status of the Fish Consumption BUI in the RR AOC we will compare the concentrations of key contaminants in two or more species of fish collected from 2 areas within the AOC and from an appropriate reference site. The comparisons will be made using 10 fillets from a similar size range of the same species from each of the 3 sites. All samples will be analyzed for mercury, total PCBs, and the standard suite of contaminants normally measured for the Michigan DEQ fish contaminant monitoring program (Table 1).

An appropriate reference water body will support the selected target fish species and will not be another Area of Concern or have other known significant legacy contamination issues. In addition, the reference site will have contaminant inputs from sources outside of the AOC that are similar to those inputs affecting the AOC. Mercury, PCBs, and other contaminants of concern are transported into the RR AOC watershed atmospherically and through other non-point sources. The magnitude of these inputs varies regionally; for example, industrialized and urbanized areas tend to emit and discharge higher levels of PCBs and mercury than less developed regions. The RR AOC is exposed to non-AOC inputs from the southeast Michigan region and thus is likely to have somewhat elevated contaminant levels even without sources within the RR AOC.

We will collect fish for contaminant analysis from 2 reaches of the Rouge River and 1 reference area. Fish will be collected from:

1. Newburgh Lake (an impoundment of the Middle Branch Rouge River) has had legacy PCB contamination and in the recent past has been covered by fairly restrictive fish consumption advisories. A sediment remediation project has taken place, and subsequent monitoring indicates that PCB concentrations in fish have declined but remain somewhat elevated since that work was completed.
2. The Lower Branch and Main Branch Rouge River downstream of the Ford Dam; several species of fish from these river reaches have had do not eat advisories.
3. Ford Lake (impoundment of the Huron River) is a nearby waterbody without a significant legacy contamination issue that supports good populations of several potential target species and would be an appropriate reference site.

We will collect a minimum of two and ideally three species of fish for contaminant analysis from each of the 3 sampling areas. An ideal species is ubiquitous and is caught and consumed regularly by anglers. An ideal target species will also have good site fidelity making it to some degree representative of the water quality in the reach of river where it was collected.

Carp will be considered the primary target species. Although carp are not a popular sport fish in general, they do tend to have the highest PCB burdens for a given waterbody, they are consumed by some anglers, and they are relatively ubiquitous.

Secondary target species will include:

- Channel catfish are a fairly popular food fish and tend to have PCB and other contaminant concentrations similar to what is found in carp from the same water. However, the species is not as ubiquitous and tends might not be collected in sufficient numbers to allow an adequate comparison.
- Rock bass are a popular and regularly consumed panfish. The species is fairly ubiquitous and has good site fidelity.
- Largemouth and smallmouth bass are a popular sportfish, are fairly ubiquitous, and have good site fidelity.
- White sucker are regularly taken and consumed by a segment of the angling population and should be available from all of the proposed sampling sites.
- Northern pike are a popular top predator game fish although they not be available in sufficient numbers at all proposed sampling sites.

In summary, we plan to collect and analyze a minimum of 10 carp and 10 fish of a secondary species from each of 3 sampling sites, 2 within the Rouge watershed plus a reference site, for a total of 60 samples. We also recommend collection of up to 10 samples each of one or more of the other species discussed, as available. These latter samples may not be analyzed initially but could provide additional evidence to support a BUI retention or removal decision if needed.

In addition, although we plan to analyze 10 fish of a species from each site, we will attempt to collect additional (up to 10) fish per species at each site. This will increase our ability to match length ranges between sites and will allow us the option of analyzing additional samples should the initial results prove inconclusive.

Joseph Bohr
October 14, 2013

Table 1. Contaminants quantified in edible portion fish tissue samples for the Michigan Fish Contaminant Monitoring Program.

Standard Analyses	Level of Quantification
Hexachlorobenzene	0.001 ppm
gamma-BHC (Lindane)	0.001 ppm
Aldrin	0.001 ppm
Dieldrin	0.001 ppm
4,4'-DDE	0.001 ppm
4,4'-DDD	0.001 ppm
4,4'-DDT	0.001 ppm
2,4'-DDE	0.001 ppm
2,4'-DDD	0.001 ppm
2,4'-DDT	0.001 ppm
Heptachlor Epoxide	0.001 ppm
Mercury	0.010 ppm
Selenium	0.010 ppm
Oxychlordane	0.001 ppm
gamma-Chlordane	0.001 ppm
trans-Nonachlor	0.001 ppm
alpha-Chlordane	0.001 ppm
cis-Nonachlor	0.001 ppm
Octachlorostyrene	0.001 ppm
Hexachlorostyrene	0.001 ppm
Heptachlorostyrene	0.001 ppm
Pentachlorostyrene	0.001 ppm
Heptachlor	0.001 ppm
Terphenyl	0.250 ppm
Toxaphene	0.050 ppm
Mirex	0.001 ppm
PBB (FF-1, BP-6)	0.001 ppm
Total PCB (congener method)	0.001 ppm

Plan for Collection and Analysis of Fish and Wildlife To Evaluate the Status of the Fish and Wildlife Consumption Beneficial Use Impairment In the St. Clair River Area of Concern

The St. Clair River Area of Concern (SCR-AOC) includes the entire river from the source at the southern tip of Lake Huron to the mouth, including an extensive delta and wetland area at Lake St. Clair. The river forms part of the boundary between Michigan and Ontario, hence it is a bi-national AOC. Both Michigan and Canada have issued fish consumption advisories for the St. Clair River beginning in the 1970's and continuing to the present.

The current Michigan Department of Community Health (MDCH) fish consumption advisory recommends limited consumption of carp, freshwater drum, gizzard shad, and walleye from the St. Clair River due to elevated concentrations of mercury and PCBs. The advice is based on carp samples collected most recently in 2006, freshwater drum collected in 1994, and walleye collected in 2006. The MDEQ does not have the data supporting the gizzard shad advisory. Neither Michigan nor Ontario has issued any consumption advisories for wildlife taken from the SCR-AOC.

The sample collections are planned for 2012 and are in support of theEPA Great Lakes Restoration Initiative grant-funded project *Assessing Michigan's Beneficial Use of Sport-Caught Fish* awarded to the MDCH*.* To determine the status of the Fish Consumption Beneficial Use Impairment in the SCR- AOC we need to compare the concentrations of key contaminants in one or more species of fish collected from the AOC and from one or more appropriate reference sites. The comparisons will be made using 10 fillets from a similar size range of the same species from each of the sites. All samples will be analyzed for mercury, total PCBs, and the standard suite of contaminants normally measured for the Michigan DEQ fish contaminant monitoring program. In addition, 10 samples of a select species from each site will be assayed for dioxin TEQ, including dioxin-like PCB congeners, in order to update the fish consumption advisory.

Lastly, muskrat and snapping turtle from the SCR-AOC are harvested for human consumption. Concentrations of mercury, total PCBs, and the standard suite of contaminants should be measured in those species unless sufficient data are already available.

<u>Species</u>
We will collect and analyze contaminant concentrations in at least 2 species of fish from the SCR AOC and in the same species from a reference water body for comparison. The following species were considered:

- Carp
    - Pros: existing advisory on the species; carp tend to have the highest PCB burdens for a given water body; consumed by some anglers; relatively ubiquitous species
    - Cons: may range outside of the AOC to some extent; not a popular sport fish

3/22/2012

- Walleye
  - Pros: very popular and regularly consumed sport fish; existing advisory on the species; could be collected at several potential reference sites
  - Cons: species ranges very widely and likely will not be a good representative of conditions in the AOC

- Freshwater Drum
  - Pros: existing advisory on the species; consumed by some anglers
  - Cons: may range outside of the AOC to some extent; not highly sought after; choices for reference sites may be somewhat limited

- Gizzard Shad
  - Pros: existing advisory on species
  - Cons: use as a food fish questionable; limited choices for reference sites

- Smallmouth Bass
  - Pros: popular gamefish; species tends not to move great distances (good site fidelity) and will represent sampling area conditions; fairly ubiquitous where appropriate habitat is present
  - Cons: may be difficult to collect in the SCR-AOC

- Rock Bass or other small centrarchids species
  - Pros: popular and regularly consumed panfish; high site fidelity and thus will represent AOC conditions; fairly ubiquitous species that should allow several choices for reference sites; relatively easy to collect where present
  - Cons: populations may be found only in localized backwater zones;

- Yellow Perch
  - Pros: popular species for consumption; fairly ubiquitous
  - Cons: more widely ranging than rock bass and other small centrarchids; may be more difficult to collect in the AOC due to habitat preferences; the species does not generally accumulate high levels of PCBs

We will collect carp as one target species because it represents the worst case for PCB contamination and because the species should be relatively easy to collect from both the SCR AOC and the reference site.

We will also collect at least two species of game fish that tend to have relatively high site fidelity. Smallmouth bass, rock bass, pumpkinseed (or a related "sunfish" species), or yellow perch are all suitable target species. These species would provide a reasonable representation of conditions in the SCR AOC and should be available at most of the likely choices for a reference site. We will collect sufficient specimens of at least 2 potential target species in addition to the carp; not all samples will necessarily be analyzed, but this will give us options for additional comparisons with fish from the reference site.

In addition, although we plan to analyze 10 fish of each species from each site, we will attempt to collect additional (up to 10) fish per species at each site. This will increase

our ability to match length ranges between sites and will allow us the option of analyzing additional samples should the initial results prove inconclusive.

Lastly, we will evaluate the contaminant concentrations in muskrat and snapping turtle taken from the SCR-AOC. A literature search will be conducted to determine if such analyses have already been conducted either in the SCR-AOC or in areas that could serve as reference sites. If sufficient analyses have not been conducted, we will either enlist a local trapper to collect samples from the SCR-AOC or request samples of muskrat and snapping turtle previously taken from the area. We will analyze one composite sample of muscle tissue from 2 or 3 animals of each species collected from the SCR-AOC. If the results indicate the potential for human health risk we will determine the need for additional sampling and for comparisons to an appropriate reference site.

<u>Potential Reference Sites</u>

An appropriate reference water body will support the selected target fish species and will not be another Area of Concern or have other known legacy contamination issues. Ideally, in the interest of efficiency and budgetary savings, the reference site will be one that the MDNR Fisheries Division samples regularly.

In addition, an ideal reference site will have contaminant inputs from sources outside of the AOC that are similar to the inputs affecting the AOC. Mercury, PCBs, and other contaminants of concern are transported into the SCR-AOC watershed atmospherically and through other non-point sources. The magnitude of these inputs varies regionally; for example, industrialized and urbanized areas tend to emit and discharge higher levels of PCBs and mercury than less developed regions. The SCR-AOC is exposed to non-AOC inputs from urbanized/industrialized south-east Michigan and thus is likely to have somewhat elevated contaminant levels even without sources within the AOC.

The following sites were considered:

- Lake St. Clair (Anchor Bay)
    - Pros: MDNR samples the lake regularly and should be able to provide several species of fish; we have a good historic database available allowing analysis of contaminant trends; would provide a comparison incorporating non-AOC regional contaminant inputs
    - Cons: could be seen as a site too strongly influenced by inputs from the SCR AOC; individuals of some potential target species may range into the SCR AOC for part of their lives therefore we could be sampling essentially the same population at both sites

- Little Bay de Noc (northwest Lake Michigan)
    - Pros: MDNR samples the lake regularly and should be able to provide several species of fish; we have a good historic database available allowing analysis of contaminant trends
    - Cons: regional contaminant inputs are likely to be different than those in the SCR AOC area

- Les Cheneaux Islands area (northern Lake Huron)
    - Pros: fish species diversity and productivity is relatively high

    - Cons: a special collection effort would be required; little historic data is available for comparisons; regional contaminant inputs are likely to be different than those in the SCR AOC area

- Grand Traverse Bay (Lake Michigan) or Thunder Bay (Lake Huron)
    - Pros: MDNR samples the Bay areas regularly and should be able to provide several species of fish; we have a good historic database available allowing analysis of contaminant trends
    - Cons: regional contaminant inputs are likely to be different than those in the SCR AOC area; species complex is different and matching target species may be more difficult (e.g. carp and rock bass are not as numerous in either Bay compared to other potential sites)

- Regional Inland Lake (specific lake to be determined)
    - Pros: would provide a comparison incorporating non-AOC regional contaminant inputs
    - Cons: may not be a suitable comparison for mercury since mercury tends to be elevated in inland lake fish as compared to Great lakes fish; would require a special collection effort

- Regional River (specific river to be determined)
    - Pros: would provide a comparison incorporating non-AOC regional contaminant inputs
    - Cons: would require a special collection effort; most potential river sites have some level of legacy contamination issue

We will use Little Bay de Noc, the Les Cheneaux Island area, or both as reference sites. Both areas should provide a good diversity of species for comparison with the SCR-AOC. Neither area is subject to regional inputs similar to those affecting the SCR-AOC however alternative sites closer to the SCR-AOC are problematic for reasons noted above.

Joseph Bohr
Aquatic Biologist Specialist
Water Resources Division
Michigan Department of Environmental Quality

St. Marys River Area of Concern

Status of the Fish Consumption and the Fish Tumor BUIs

Sampling Plan

The St. Marys River Area of Concern (SMR AOC) includes the entire river from the source at the eastern end of Lake Superior to the mouth at the straits of Detour. The river forms part of the boundary between Michigan and Ontario, hence it is a bi-national AOC. Restrictions on Fish and Wildlife Consumption and Fish Tumors or other deformities are 2 of the beneficial use impairments listed for the SMR AOC.

Both Michigan and Canada have issued fish consumption advisories for the St. Marys River. The current Michigan Department of Community Health fish consumption advisory recommends limited consumption of carp due to PCBs, northern pike due to mercury, and walleye due to both PCBs and mercury. The advice is based on northern pike and walleye samples collected most recently in 2004, and carp samples collected most recently in 1995.

To determine the status of the Fish Consumption BUI in the SMR AOC we will compare the concentrations of key contaminants in two species of fish collected from the AOC and from an appropriate reference site. The comparisons will be made using 10 fillets from a similar size range of the same species from each of the sites. All samples will be analyzed for mercury, total PCBs, and the standard suite of contaminants normally measured for the Michigan DEQ fish contaminant monitoring program. In addition, 10 samples of a selected species from each site will be assayed for dioxin TEQ, including dioxin-like PCB congeners, in order to update the fish consumption advisory.

<u>Fish Species for Contaminant and Tumor Analysis</u>
We will collect and analyze contaminants in 2 species of fish from the SMR AOC and the same 2 species from at least one reference water body for comparison. The following species were considered:

- Carp
    - Pros: existing advisory on the species; carp tend to have the highest PCB burdens for a given water body; consumed by some anglers; relatively ubiquitous species; historic data available for comparison
    - Cons: may range outside of the AOC to some extent; not a popular sport fish

- Walleye
    - Pros: very popular and regularly consumed sport fish; existing advisory on the species; could be collected at several potential reference sites; historic data available for comparison
    - Cons: the species ranges very widely and likely will not be represent conditions in the AOC well

- Northern Pike
    - Pros: existing advisory on the species; popular sport fish; consumed by many anglers; species has relatively good site fidelity and thus would

represent AOC conditions well; top predator and good indicator for mercury concentrations; historic data available for comparison
    - Cons: may be relatively difficult to collect an adequate sample size without special collection efforts

- Rock Bass or other small centrarchid species
    - Pros: popular and regularly consumed panfish; high site fidelity and thus will represent AOC conditions; fairly ubiquitous species that should allow several choices for reference sites; relatively easy to collect where present
    - Cons: populations may be found only in localized zones; no historic data available for comparison

- Yellow Perch
    - Pros: popular species for consumption; fairly ubiquitous; historic data available for comparison
    - Cons: more widely ranging than rock bass and other small centrarchids; may be more difficult to collect in the AOC due to habitat preferences; the species does not generally accumulate high levels of PCBs

We will target carp for collection because it represents the worst case for PCB contamination and because the species should be relatively easy to collect from both the SMR AOC and the reference site.

We will target northern pike as a second species for the reasons noted above. We will also collect rock bass and yellow perch as available. These supplementary species may not be analyzed initially but could provide additional evidence to support a delisting decision if needed.

In addition, although we plan to analyze 10 fish of each species from each site, we will attempt to collect up to 10 additional fish per species at each site. This will increase our ability to match length ranges between sites and will allow us the option of analyzing additional samples should the initial results prove inconclusive.

Lastly, a minimum of 20 bullhead should be collected from the SMR AOC and from the reference site(s) to assess the status of the fish tumor BUI; additional samples (up to 20 from each site) would be preferable. Bullhead are the species most likely to develop tumors when exposed to contaminants. Both black bullhead and brown bullhead are likely to live in the SMR AOC; either one species or a combination of both would provide a suitable sample for this purpose.

MDEQ staff will conduct the collections in the SMR AOC.

<u>Potential Reference Sites</u>
An appropriate reference water body will support the selected target fish species and will not be another Area of Concern or have other known legacy contamination issues. Ideally, in the interest of efficiency and budgetary savings, the reference site will be one that the MDNR Fisheries Division samples regularly. The following sites were considered:

- Little Bay de Noc (northwest Lake Michigan)
    - Pros: MDNR samples the lake regularly and should be able to provide several species of fish; we have a good historic database available allowing analysis of contaminant trends
    - Cons: regional contaminant inputs may be different than those in the SMR AOC area

- Les Cheneaux Islands area (northern Lake Huron)
    - Pros: proximity to SMR AOC thus regional contaminant inputs should be similar
    - Cons: a special collection effort would be required; no historic data available for comparisons

We will use Little Bay de Noc as the primary reference water body for the SMR AOC. The MDNR Fisheries Division samples the area regularly, the target species are available there, and the regional influences should not be significantly different. In addition, MDEQ staff will attempt to collect the target species from the Les Cheneaux Islands.

Joseph Bohr
MDEQ Water Resources Division
4/13/2012

Torch Lake Area of Concern
Status of the Restrictions on Fish and Wildlife Consumption BUI
Sampling Plan

Background

Historically, the Torch Lake region (Houghton County) has been an area of copper mining, ore processing, and copper reclamation activities. For over one hundred years, mining and copper processing wastes were released into Torch Lake and surrounding bodies of water. Accidental spills or poor waste disposal methods by area industries may have introduced PCBs to the watershed; sediment and water sampling in Torch Lake has detected scattered low-level PCB contamination. Torch Lake is currently listed as a Great Lakes Area of Concern by the United States Environmental Protection Agency (USEPA), in part because of elevated levels of polychlorinated biphenyls (PCBs) in fish.

The PCB concentrations in fish collected from Torch Lake have been consistently higher than in fish found in nearby inland lakes. A fish consumption advisory due to elevated levels of PCBs was first issued for Torch Lake fish by the Michigan Department of Community Health (MDCH) in 1998. The most recent advisory, based on samples collected most recently in 2007, recommends restricting consumption of northern pike, smallmouth bass, and walleye from the lake.

A comparison study conducted in 2007 indicated that Torch Lake walleye had higher PCB concentrations than walleye collected from Huron Bay in Lake Superior. In addition to having significantly higher PCB concentrations, the higher concentrations warranted a more restrictive consumption advisory for the Torch Lake fish. We propose to repeat the study to evaluate the current status of the Torch Lake Fish and Wildlife Consumption BUI.

Sampling Plan

We propose to target walleye for collection from Torch Lake and from Lake Superior (Huron Bay, Baraga County). This will allow a comparison of conditions in Torch Lake with conditions in a reference water body, as well as an evaluation of PCB concentration temporal trends.

We recommend collection of at least one secondary target species. This will allow for a weight of evidence approach to any BUI removal decision as well as provide data for fish consumption advisory updates. Northern pike and smallmouth bass should be collected from both Torch Lake and Huron Bay, if possible.

A minimum of 10 fish of at least 2 species should be collected from each water body for analysis. Attempts should be made to collect up to 10 additional specimens of each species from each water body. This will increase our ability to match length ranges between sites and will allow us the option of analyzing additional samples, if necessary.

In summary, a minimum of 10 walleye will be collected from Torch Lake in a range of lengths, along with a minimum of 10 walleye from Huron Bay in a similar size range. Ideally, additional walleye will be collected from both water bodies along with a minimum of 10 each of northern pike, smallmouth bass, or both, from both water bodies.

Samples will be analyzed for PCBs, mercury, and the standard suite of chlorinated organic compounds.

Joseph Bohr / MDEQ / 9 January 2013

Quality Assurance Project Plan: Assessing Michigan's Beneficial Use of Sport-Caught Fish

August 20, 2012

Michigan Department of Community Health

MDCH

Great Lakes RESTORATION

DEQ

Contact: Michelle Bruneau, Project Coordinator, MDCH
201 Townsend St, Lansing, MI 48913 ● 1-800-648-6942 ● bruneaum@michigan.gov

Title: Detroit River Fish Collection and Fillet Analysis for Bioaccumulative Chemicals Quality Assurance Project Plan (QAPP)

Effective Date: February 14, 2010

Version: 1

Organization: Michigan Department of Community Health, Lansing, Michigan.

A. Project Management

1A. Approvals

Elizabeth Murphy: Elizabeth Murphy Date: 1/26/2011
U.S. EPA Project Manager

Louis Blume: L Blume Date: 1/26/2011
U.S. EPA, Quality Assurance Officer

Bonita Taffe: Bonita Taffe Date: 2/10/2011
MDCH Analytical Chemistry Laboratory Manager

Joseph Bohr: [signature] Date: 2/10/2011
DNRE Fish Contaminant Specialist

Linda Dykema: Linda D Dykema Date: 1-27-2011
MDCH Toxicology and Response Section Manager

Kory Groetsch: Kory J Groetsch Date: 2/14/2011
MDCH QA Project Manager

2A. Table of Contents

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3A. Distribution List

Elizabeth Murphy, U.S. EPA Project s Officer
Louis Blume, U.S. EPA, Quality Assurance Officer
Linda Dykema, MDCH Toxicology and Response Section Manager
Bonita Taffe, MDCH Analytical Chemistry Laboratory Manager
Tammy Newcomb, DNRE Fisheries Manager
Joseph Bohr, DNRE Fish Contaminant Specialist
Kory Groetsch, MDCH QA Project Manager

4A. Project/Task Organization

Below is a list of individuals and organizations that will participate in this project including specific roles and responsibilities.

1. Elizabeth Murphy, EPA Grant Manager
   a. Administration
2. Linda Dykema, MDCH Toxicology and Response Section Manager
   a. Review final reports and general administration
   b. Communicate with EPA
3. Joseph Bohr, MDNRE Fish Contaminant Specialist
   a. Implement the QAPP
   b. Contact person for the analytical laboratory
   c. Data entry, validation
   d. Data analysis and interpretation
   e. Final report

4. Bonita Taffe, MDCH Analytical Chemistry Laboratory Manager
   a. Oversee sample analysis
   b. Independent quality assurance unit
   c. Provide a complete data and QC/QA report
5. Kory Groetsch, MDCH QA Project Manager
   a. Write QAPP
   b. Conduct independent project QA management

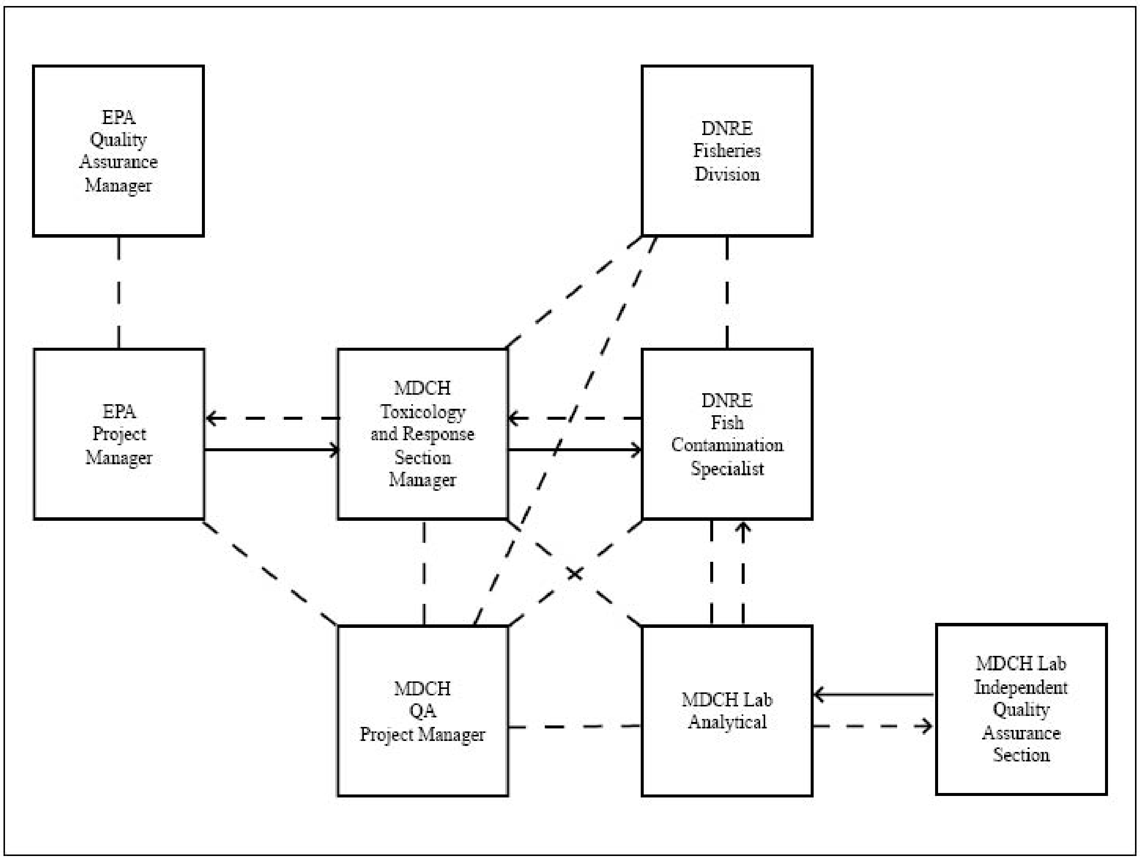

Figure 1. Organizational chart where dotted lines show communication (with arrow is reporting) and solid lines with arrow show providing direction.

5A. Problem Definition/Background

The Detroit River flows through a heavy populated area of Michigan (e.g. Great Detroit Area) and is designated a Great Lakes Area of Concern due to chemical contamination (Figure 2). The Detroit River is a popular fishery used by tens of thousands of anglers. Many low income or minority anglers fish this river and eat their catch. Both Michigan and Ontario issue public health fish consumption advisories on Detroit River fish. The data collected from this project will be used to update the Michigan Fish Advisory. The current Michigan Detroit River fish contaminant fillet data is limited, dated, and void of dioxin-like chemical measurements (Figure 3).

This project will collect multiple species of fish commonly harvested and eaten by anglers from the Detroit River. The resulting fish fillet contaminant data will be evaluated though the Michigan Fish Consumption Advisory Program. The process of evaluation is described in the annual Michigan Fish Contaminant Monitoring Program report (http://www.michigan.gov/documents/deq/wb-swas-fcmp-2008report_284691_7.pdf). All advisories are reviewed by MDCH management prior to issuance. The Michigan Fish Advisory is used for people eating fish from Michigan waters who wish to limit their exposure to persistent chemical contamination.

Figure 2. Map of the Detroit River within the state of Michigan.

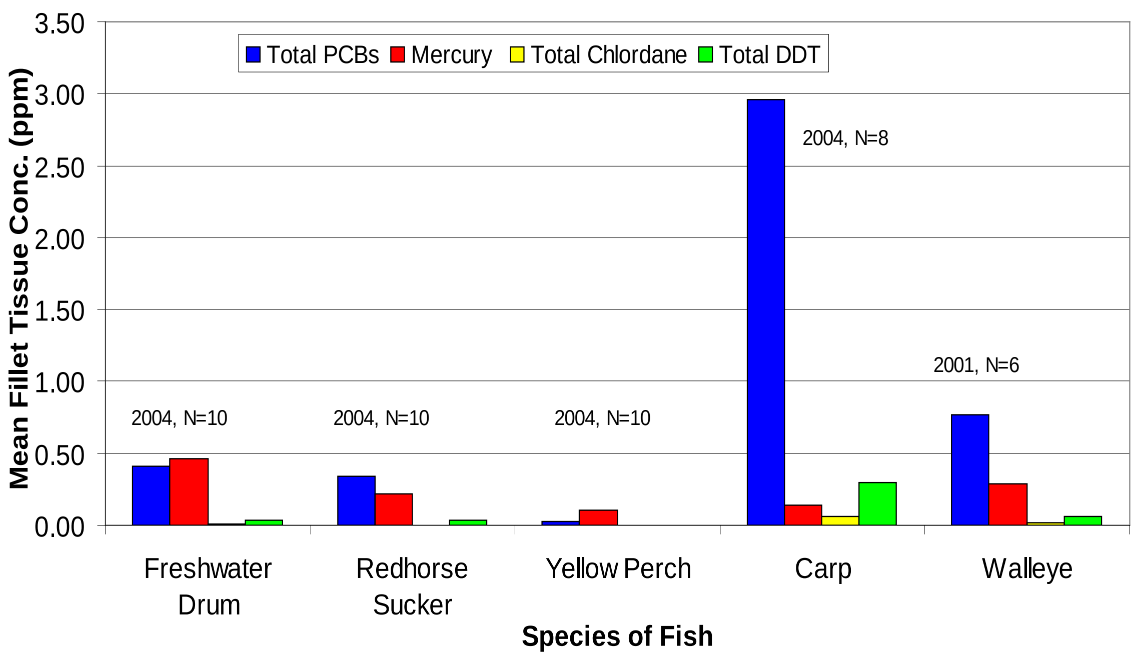

Figure 3. Mean chemical concentrations in fillets from five species of Detroit River fish collected between 2001 and 2004.

6A. Project/Task Description

The project will determine the concentrations of persistent bioaccumulative chemicals, in commonly harvested fish from the Detroit River (Figure 2). The Michigan Department of Natural Resources and Environment (MDNRE) will collect 10 fish of each species (Table 1) within the legally harvestable size range. Each fillet will be individually homogenized and analyzed for persistent bioaccumulative chemicals. All samples will be analyzed for compounds 1 through 17 in Table 2; selected species will also be analyzed for dioxins, furans, dioxin-like PCBs (TEQ). The project will be completed by trained and qualified staff (Section 8A) and will comply with all field and lab standard operating procedures.

Table 1 Target species, sample size, and size range of fish to be collected from the Detroit River for contaminant analysis.

No.	Species of Fish	Number of Samples	Minimum Size
1	Channel Catfish	10	12 inches
2	Northern pike	10	24 inches
3	Rock Bass	10	5 inches
4	Smallmouth Bass	10	14 inches
5	White Bass	10	5 inches

Table 2 List of chemical groups to be analyzed in fish tissue samples.

No.	Chemical Groups
1	Hexachlorobenzene
2	Beta- and gamma-BHC (Lindane)
3	Aldrin / dieldrin
4	DDT and Metabolites (2,4’-, and 4,4’- DDT and DDD, 4,4’-DDE)
5	Heptachlor Epoxide
6	Mercury
7	Total Chlordane(cis- and trans-Nonachlor, alpha- and gamma-Chlordane, Heptachlor)
8	Octachlorostyrene
9	Hexachlorostyrene
10	Heptachlorostyrene
11	Pentachlorostyrene
12	Oxychlordane
14	Toxaphene Congeners (Parlar-26, 32, 38, 40, 41, 44, 50 and 62, Hex-SED and Hep-SED)
15	Mirex
16	PBB (IUPAC, Congener PBB-153)
17	Polychlorinated Biphenyl (PCBs) Congeners (numbering is Ballschmitter and Zell, BZ)
18	Dioxins, Furans, dioxin-like PCBs (TEQ)

Table 3 Time line for completion of project tasks.

	Task	Start Date	End Date
1	Approved QAPP	NA	August 22, 2010
2	Collect fish samples	August 23, 2010	December 1, 2010
3	Sample Processing	January 1, 2011	February 1, 2011
4	Sample Analysis, Verification, and Final Data	February 1, 2011	June 1st , 2011
5	Data Entry	June 1st , 2011	June 30th ,2011
6	Data Analysis and Summary	July 1st, 2011	September 15, 2011
8	Final Contaminant Report	September 15, 2011	September 30, 2011

7A. Quality Objectives and Criteria

The data collected for this project will comply with the data quality objectives outlined in Table 4. These include objectives for precision, bias, representativeness of the fish samples to the sampled fish population, comparability, completeness, and sensitivity. With the exception of representativeness, these objectives apply to the analytical methods.

Table 4 Quality Objectives and Criteria for Measurement Data

Data Quality Indicator	Measurement	Data Quality Objective
Precision	10 % Samples in Duplicate	%RSD< 15 % for native analytes
Bias	12% Spiked QCs Samples plus 2 Analyses of a Standard Reference Material	Compliance based on comparison to individual analyte objectives described in Method AC.35.01_for QCs spikes and reporting percent recovery relative to known amount to be within □±3 standard deviations.
Accuracy	2 analyses of NIST certified Reference Material	Reporting percent recovery relative to known amount to be within □ 2 star deviations
Representativeness (of samples relative to the fish population)	(Number of samples for a given species /10) * 100	80% or greater collected.
Comparability	Analytical work to be conducted by MDCH and/or a qualified contracted laboratory (such as Pace Analytical or	Laboratory will provide verification that methods were properly implemented and results meet QA/QC

	Test America) and evaluated by the MDCH Analytical Chemistry Laboratory	standards
Completeness	[Total number of samples analyzed found to meet or exceed quality control criteria / total number of samples analyzed] * 100	100% samples should pass quality control criteria
Sensitivity	Determination of the estimated detection limit which is the concentration of a given analyte required to produce a signal with a peak height of at least 3 times the background signal to noise.	Target detection limits for solids (relative to 5.0 grams)

8A. Special Training Requirements/Certification

MDCH Analytical Chemistry

Bonita Taffe, PhD, MPH, DABT, MLS(ASCP)^{CM}- is the manager of Analytical Chemistry, a board certified Toxicologist and a Certified medical technologist. She is responsible for the overall operation of the project within the laboratory: overseeing the implementation of project activities, coordination with other agencies, development of materials, provisions of in service and training, conducting meetings; directing the gathering, tabulating and interpreting of required data, responsible for overall program evaluation and for staff performance evaluation; and is the responsible authority for ensuring necessary laboratory reports and documentation are produced.

Richard Scheel, PhD, Senior Scientist Specialist, coordinates tandem Mass Spectrometry lab operations and has over 25 years experience in the field of Mass Spectrometry. Dr Scheel has extensive experience in dioxin analysis for the laboratory and will hold primary responsibility for evaluation of contract laboratory Dioxin and Furan data quality assurance. In addition, he has had extensive training at the CDC during this time at MDCH. He is a member of Sigma Xi Research Society of North America, ACS and the American Society of Mass Spectrometry.

Matthew Geiger, MS – Unit Manager for Fish Monitoring Program – 14 years with AC-Laboratory analyzing fish tissue and biological samples for bioaccumulating compounds by GC-ECD and GC/MS.

Mike O’Keefe – Laboratory Scientist 13 – 30 years with AC-Laboratory analyzing fish tissue and biological samples for bioaccumulating compounds by GC-ECD and GC/MS.

Dean Walker – Laboratory Scientist 12 – 10 years with AC-Laboratory analyzing fish tissue and biological samples for bioaccumulating compounds by GC-ECD and GC/MS.

Scott Forysth – Laboratory Scientist 12 – 6 years with AC-Laboratory analyzing fish tissue and biological samples for bioaccumulating compounds by GC-ECD and GC/MS

Tim Karrer – Laboratory Scientist 10 – 1.5 years with AC-Laboratory analyzing fish tissue and biological samples for bioaccumulating compound by GC-ECD and GC/MS.

Diane Gartung – Laboratory Technician 10 – 23 years with AC-Laboratory extracting and cleaning-up fish tissue samples for analysis by GC-ECD and GC/MS.

David Elliott – Laboratory Technician 10 – 10 years with AC-Laboratory extracting and cleaning-up fish tissue samples for analysis by GC-ECD and GC/MS.

Kory Groetsch, M.S. – MDCH Toxicologist 12 – 14 years experience with fish sampling plans including QAPPs for biota tissue sampling.

9A. Documents and Records

The final original approved QAPP will be retained by MDCH-DEH in Lansing, Michigan. A copy of the plan will be distributed to the U.S. EPA grant manager and the MDCH Analytical Chemistry Laboratory manager. The final data package compiled and retained by the Analytical Chemistry Laboratory will include:

Chain of Custody, electronic or hard copy.
Sample preparation work sheets, electronic or hard copy.
Chromatograms of calibrators, QCs and samples, electronic or hard copy.
Quality control data, electronic or hard copy.

B. DATA GENERATION AND ACQUISITION

1B. Sampling Process Design

Sample collection will occur for one season. Targeted fish species (10 fish per species) will be collected from the Detroit River and individual fillets will be analyzed for predetermined set of analytes. Given that fish can move throughout the Detroit River and specimens will be collected throughout the river system at locations most amenable to electrofishing, MDCH assumes that the fish collected will be adequately representative of each species population sampled. Latitude and longitude for each sample location will be recorded. The length range of fish will be within the legally harvestable size range for a given species. The analytic results will be compared to health based screening values in accordance with MDCH fish consumption advisory program methods and to available historic fish tissue data from the Detroit River. [See Table 1 for species, number of samples, and fish length range targeted.]

2B.Sampling Methods

The target species of fish will be collected from the Detroit River by MDNRE Fisheries Division personnel using electrofishing equipment following standard operating procedures. Fish will be placed on ice in the field, packed in labeled polyethylene bags, and frozen. The fish will be transported to the Water Resources Division facility in Lansing where they will be held frozen until processing.

The fish will be thawed and processed as fillet samples according to MDNRE Great Lakes Environmental Assessment Section Procedure 31 (Appendix B). Each fish will be measured (total length), weighed, and prepared as standard edible portions. Each sample will be individually wrapped in aluminum foil, placed in a plastic bag, labeled, and frozen until analysis.

3B. Sample Handling and Custody

Chain of custody documentation tracks the transfer of samples from their collection through laboratory analysis. The forms will be completed by the field technician and will accompany the samples to the laboratories. The forms will be signed by the sample provider and by the receiver every time the samples change hands. Chain of custody records will become part of the permanent project documentation.

Documentation of sample handling and custody will include the following:

- Project name,
- Sample location and depth,
- MDNRE assigned sample identification number,
- Sample collection date and time,
- Analysis to be performed,
- Storage specifications, and
- Special remarks.

4B. Analytical Methods

The critical parameters are listed in Table 5.

The analytical method standard operating procedures found in Appendix A are**:**

AC.08.07	Macro-Florisil Clean-up of Fish Extracts for PBBS, PCBs and Chlorinated Pesticides
AC.13.05	Silica Gel-60 Fractionation of Biological Tissue (Fish) for Polybrominated Biphenyls (PBBs), Polychlorinated Biphenyls (PCBs) and Chlorinated Pesticides
AC.29.02	Quality Assurance and Quality Control for Balances
AC.31.04	Extraction of Biological Tissue (Fish) for PBBs, PCBs and Chlorinated Pesticides Utilizing the Dionex ASE® 300 Accelerated Solvent Extractor
AC.35.01	Capillary Gas Chromatography Electron Capture Analysis of Extracts for Polychlorinated Biphenyl Congeners
LS.12.02	Lancer Washer Operation

Note: Method AC.74 (Glassware washing) has been replaced with the Bureau wide laboratory service method, LS.12.02

The method for balance quality assurance (AC.29.02) is incorrectly identified as AC.81 in methods 31, 8 and 13.

These corrections are in progress.

Table 5 List of chemicals to be analyzed for in fish fillets

No.	Chemical Group	Estimated IDL
	Hexachlorobenzene	0.5 µg/Kg
	Beta- and gamma-BHC (Lindane)	0.5 µg/Kg
	Aldrin	0.5 µg/Kg
	Dieldrin	0.5 µg/Kg
	4,4'-DDE	0.5 µg/Kg
	4,4'-DDD	0.5 µg/Kg
	4,4'-DDT	0.5 µg/Kg
	2,4'-DDD	0.5 µg/Kg
	2,4'-DDT	0.5 µg/Kg
	Heptachlor Epoxide	0.5 µg/Kg
	Mercury	0.01 µg/Kg
	Oxychlordane	0.5 µg/Kg
	gamma-Chlordane	0.5 µg/Kg
	trans-Nonachlor	0.5 µg/Kg
	alpha-Chlordane	0.5 µg/Kg
	cis-Nonachlor	0.5 µg/Kg
	Octachlorostyrene	0.5 µg/Kg
	Hexachlorostyrene	0.5 µg/Kg
	Heptachlorostyrene	0.5 µg/Kg
	Pentachlorostyrene	0.5 µg/Kg
	Heptachlor	0.5 µg/Kg
	Toxaphene Congeners(Parlar-26, 32, 38, 40, 41, 44, 50 and 62, Hex-SED and Hep-SED)	Varies based on congener response Ranges from 0.8 to 2.0 µg/Kg
	Mirex	0.5 µg/Kg
	PBB (IUPAC, Congener PBB-153)	1.0 µg/Kg
	Polychlorinated Biphenyl Congeners including dioxin-like congeners (numbering is Ballschmitter and Zell, BZ)	Varies based on congener response. Ranges from 0.25 to 1.0 µg/Kg
	2,3,7,8,-TCDD	1.0 ng/Kg
	1,2,3,7,8-PeCDD	5.0 ng/Kg
	1,2,3,4,7,8-HxCDD	5.0 ng/Kg
	1,2,3,6,7,8-HxCDD	5.0 ng/Kg
	1,2,3,7,8,9-HxCDD	5.0 ng/Kg

	1,2,3,4,6,7,8-HpCDD	5.0 ng/Kg
	OCDD	10.0 ng/Kg
	2,3,7,8,-TCDF	1.0 ng/Kg
	1,2,3,7,8-PeCDF	5.0 ng/Kg
	2,3,4,7,8-PeCDF	5.0 ng/Kg
	1,2,3,4,7,8-HxCDF	5.0 ng/Kg
	1,2,3,6,7,8-HxCDF	5.0 ng/Kg
	1,2,3,7,8,9-HxCDF	5.0 ng/Kg
	2,3,4,6,7,8-HxCDF	5.0 ng/Kg
	1,2,3,4,6,7,8-HpCDF	5.0 ng/Kg
	1,2,3,4,7,8,9-HpCDF	5.0 ng/Kg
	OCDF	10.0 ng/Kg

5B. Quality Control

Table 6 Quality Control Acceptance Criteria for Blanks, Controls, Spikes and Samples.

	Quality Control Criteria
Reagent Blank	Percent Recoveries for surrogate analytes spiked into the blank should be between ± 3 Standard Deviation of the established mean for each analyte. Surrogate analytes are tetrachloro-m-xylene (TCMX), Polybrominated Biphenyl (PBB) Congener 155, *alpha*-Hexachlorocyclohexane (a-BHC) and tetradifon. Method detections are based on the amount of lipid extracted from a 5.0 gram composite sample. No reportable analytes should be present in the Reagent Blank. Up to 3 analytes may be present at levels below ½ target detection limit (TDL) as long as the compounds were not reported in the previous set run. Carry Over: For reagents blanks associated with high level samples, the analyte level in the blank must be < 5% of the quantity present in the samples.

LCS	Laboratory Control Spike (LCS) is Cod Liver Oil (CLO) spiked at four different levels with the analytes listed in Table 2, except for Hexa-, Hepta-, and Pentachlorostyrene. Percent recoveries of all analytes should be between ± 3 Standard Deviation of the established mean for each analyte. No more than 3 analytes may be out of range per analytical run. Percent Recoveries for surrogate analytes spiked into the LCS should be between ± 3 Standard Deviation of the established mean for each analyte. Surrogate analytes are tetrachloro-m-xylene (TCMX), Polybrominated Biphenyl (PBB) Congener 155, *alpha*-Hexachlorocyclohexane (a-BHC) and tetradifon. If the recovery criteria in LCS is not met: a) evaluate data for possible matrix influence b) if cause of non-compliance is not determined, re-extract sample batch
Samples	Percent Recoveries for surrogate analytes spiked into the Samples should be between ± 3 Standard Deviation of the established mean for each analyte. Surrogate analytes are tetrachloro-m-xylene (TCMX), Polybrominated Biphenyl (PBB) Congener 155, *alpha*-Hexachlorocyclohexane (a-BHC) and tetradifon. If the method blank contains reportable analytes but those analytes are not detected in the sample, the sample data may be reported. If the analytes are detected in the sample, the sample data may be reported if the sample peak area is greater than or equal to 3 times the peak area seen in the blank. Samples which fail acceptance criteria listed above or are associated with failing reagent blank or LCS listed above must be re-extracted and reanalyzed. Exceptions may be made for sample matrices which have limited sample available.

6B. Instrument/Equipment Testing, Inspection, and Maintenance

The GC-ECD testing, inspection and maintenance is handled in many different ways.

Injector monitoring is performed by monitoring the injection of a DDT breakdown standard and when the percent difference between the sum of 4,4’-DDE and 4,4’-DDD divided by 4,4’- DDE, minus DDD minus DDT is greater than 15% the injector insert is changed. Also, injector septa are changed at the beginning of each analytical run.

The electrochemical detectors (ECDs) are monitored monthly by checking the contact potential of each detector. If the contact potential is outside the established range listed by the manufacture the ECD is replaced and the depleted detector is returned to the manufacture for re-foiling.

The analytical columns are monitored for replacement by monitoring chromatographic separation of certain critical analytes and analyte peak shape. If the separation is not maintained the temperature program and pressure are adjusted to try and re-establish the separation. If these changes do not correct the problem the columns are replaced. If peak shape changes to where there is excesses tailing of peaks the columns are replaced.

Syringe issues are monitored by the injection of retention time reference peaks. These compounds are injected with all the calibrators, QCs and samples. If the area counts for these peaks change great than 15% from the beginning of the analytical run to the end, the syringe is either cleaned or replaced with a new one and the analytical run is re-inject from the beginning.

7B. Instrument/Equipment Calibration and Frequency

Calibration is performed at the beginning of each analytical run. The calibration curve is a 5 point curve for both pesticide and PCB Congener analysis.

The calibration is verified by an Initial Calibration Verification sample (ICV). If the analytes of interest are outside a 15% difference window from the target value the standard is re-injected. If the re-injection results in the analytes still being outside a 15 % different window the calibration is re-run. If the ICV passes the run continues on to the Continuing Calibration Verification (CCV).

The CCV monitor the calibration curve through out the analytical run. One CCV is injected before the first sample and after every five samples for the pesticides and after every seven for the PCB congeners. If any of the analytes of interest are outside a 20% difference window from the target value the standard is re-injected. If the re-injection results in the analytes still outside the 20% difference window the calibration is re-run and any sample run after the last passing CCV are re-run.

8B. Inspection/Acceptance of Supplies and Consumables

The inspection and acceptance of Supplies and consumables are as follows:

1. Solvents: Lot tested by condensing 500:1 and analyzing on GC-ECD for contaminants.
2. Sorbents: Lot tested by analysis of a know matrix spike to verify elution patterns and to make adjustments if needed to the Sorbent amount used or solvent volumes.
3. Calibrator: New calibrators are analyzed against old calibrators to verify that the concentrations are the same.

9B. Non-direct Measurements

Previously verified fillet contaminant data will be used, when available, to provide context to new contaminant data. For example, previous data will be used to determine if the current contaminants were found in previously sampled fillets. The previous data will have been generated by the MDCH analytical chemistry laboratory and thus will be comparable to the data that are to be collected.

10B. Data Management

Laboratory data (raw data) generated is stored electronically on the Galaxie server and backed up to an independent storage drive weekly. When the chromatographic data analysis is approved by the unit manager, the data (result data) is exported to EXCEL. This data is uploaded to Starlims for storage on a secured server backed up and maintained by the Michigan Department of Information Technology. A Final Report workbook is generated where all results from the different (fraction) analyses, lipid data, and other parameters are combined to produce a single report. Final reports may be generated by StarLims or in EXCEL. Once the final report is reviewed and approved by the section manager, data is sent electronically in a form compatible with the MDNRE database to the MDNRE Fish Contaminant Specialist for review.

C. ASSESSMENT AND OVERSIGHT

1C. Assessments and Response Actions

Upon approval of the quality assurance project plan, MDNRE will conduct fish collection, transport, and removal of fillets. MDCH Analytical Chemistry Laboratory will oversee all processing and analytical analysis of fish fillet tissue. All actions will follow MDNRE and MDCH SOPs. The MDNRE Fish Contaminant Specialist will coordinate sample collection and transport with MDNRE fisheries biologists. The Fish Contaminant Specialist will oversee sample processing and provide fillets to MDCH Analytical Chemistry Laboratory. The MDCH Analytical Chemistry Laboratory Manager will oversee all analytical analyses of fillet tissues. Either the Fish Contaminant Specialist or Analytical Chemistry Laboratory Manager will inform the MDCH Toxicology and Response Section Manager of events that endanger the completion of the project as stated in this quality assurance plan.

The responsibility for maintenance of quality for a project lies with every field and laboratory staff member associated with this project. All project personnel shall aid in identifying perceived problems that may affect quality and report such problems to the supervisor and to the QA lab officer. Obvious or common laboratory problems will be reported to the assigned lab project manager, who in turn will consult with the quality assurance unit as needed (depending on the nature of the problem). Complex issues regarding the extraction, cleanup and analysis of the samples will be discussed with the laboratory management for an appropriate corrective action. All issues that occur with the samples will be documented in the laboratory management system.

The assessments (Table 7) will be conducted by the appropriate staff. The project QA update will be requested by the QA Project Manager quarterly by e-mail to inquire about project status and existing quality assurance issues. The MDCH Analytical Laboratory and DNRE FCMP managers will provide a report to the QA Project Manager.

Table 7 Type, number and frequency of assessments.

	Type	Number	Frequency
1	Analytical Lab Status Update	3-4	Quarterly
2	FCMP Status Update	3-4	Quarterly
3	Project QA Update	3-4	Quarterly

The EPA Grant manager will be contacted via e-mail or telephone at the time of QAPP submission and in the final report.

2C. Reports to Management

Every six months, the Fish Contaminant Specialist and/or Analytical Laboratory Manager will provide the QA Project Manager, upon request, a brief update on:

1. Project status,
2. Overview of results of performance evaluations & audits,
3. Overview of results of periodic data quality assessments,
4. Any significant QA problems.

The QA Project Manager will inform the MDCH Toxicology and Response Manager of ongoing progress and any significant problems. Either the QA Project Manager or the MDCH Toxicology and Response Manager will inform the EPA Project Manager of any significant problems that will impact the outcome of the project.

D. DATA VALIDATION AND USABILITY

1D. Data Review, Verification, and Validation

Analytical results will be reviewed by laboratory personnel for quality assurance/quality control purposes prior to release to the MDNRE-WRD. The results will be reported electronically to the MDNRE-WRD in a format suitable for addition to the MDNRE database. NOTE: Use of the Ballschmitter and Zell numbering system for PCBs allows direct comparison with all previously reported data.

Upon receipt of the final data and data package deliverables, the Fish Contaminant Specialist will enter the data into a Microsoft Access database which will be stored in two locations not on the same computer. The analytical results will be checked for completeness and correct reporting units using Access queries. The data will then be reviewed by the Fish Contaminant Specialist for unusual or outlier results. Any questionable results will be reviewed with analytical laboratory staff; selected samples may be re-analyzed to resolve problems. The quality control samples will be compared to the quality control criteria in Tables 6 and 7 above. Also note, that the quality control samples will be compared to the control criteria after each batch is completed and shared with the project director as described above in section C2.

2D. Reconciliation with User Requirements

The results of the fish contaminant analyses will be used to revise the current MDCH fish consumption advice for fish caught in the Detroit River. The fish consumption advisories are developed based on an evaluation of the relationship between contaminant concentrations and MDCH screening values across all size ranges of fish of a given species taken from specific locations. Where possible, linear regression analyses are used to predict lengths at which the concentrations in fish species are likely to exceed screening values. However, contaminant concentrations and fish total length data often either do not conform to the underlying assumptions of this statistical method or the method does not produce a statistically significant line. In those cases, the appropriate advisory is determined using either median concentrations or the percentage of samples exceeding the screening level, depending on the contaminant being considered.

In cases where contaminant concentrations are less than the quantification level (QL) averages will be calculated using half of the QL. The calculated average will be considered an estimated value when quantitative concentrations were not available. If all of the concentrations are below the quantification level, then the mean will be reported as half of the quantification level and the median will be reported as less than the quantification level.

Total PCB concentration will be estimated by summing the concentrations of PCB congeners. Individual congeners below the QL will be assigned a concentration equal to 0 for the purpose of calculating a total PCB concentration. Also, congener analyses that do not meet retention time criteria or are subject to analytical interference will be assigned a concentration equal to 0 for the purpose of calculating a total PCB concentration. If the results of an individual congener analysis do not meet all of the quantification requirements, then the congener will be assigned a concentration equal to the estimated concentration for the purpose of calculating a total PCB concentration. If all of the congeners are below the detection level, then the total PCB concentration will be reported as less than the detection level of the individual congeners.

Total chlordane concentration will be estimated by summing the concentrations of 5 isomers: alpha-chlordane, gamma-chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane. In some cases, individual isomers may be below the QL. Individual isomers below the QL will be assigned a concentration equal to 0 for the purpose of calculating a total chlordane concentration. If all 5 isomers are below the QL, then the total chlordane concentration will be reported as less than the QL of the individual isomers.

Total dichlorodiphenyl trichloroethane (DDT) concentrations will be calculated by summing concentrations of the para, para' and ortho, para' forms of the following chemicals: DDT dihydrochloride (DDE), and 1,1-bis(4-chlorophenyl)-2,2-dichloroethane (DDD). Individual chemicals below the QL will be assigned a concentration equal to 0 for the purpose of calculating a total DDT concentration. If all 6 components are below the QL the total DDT concentration will be reported as less than the lowest QL of the metabolites.

Total 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) toxic equivalents will be calculated using the 2005 World Health Organization toxic equivalency factors for 7 dioxin, 10 dibenzofuran, and 12 dioxin-like PCB (dl-PCB) congeners (Van den Berg et al., 2006). The concentrations of individual dioxin and dibenzofuran congeners in a fish sample will be multiplied by toxic equivalency factors and the resulting products summed to calculate a 2,3,7,8-TCDD toxic equivalent (TEQ) concentration. Individual congener concentrations less than the QL will be assigned a value of 0 for the purpose of calculating the dioxin TEQ.

The MDNRE Fish Contaminant Specialist will use established protocol to compare contaminant concentrations to the appropriate MDCH screening values and will develop draft recommendations for changes to the Michigan Fish Consumption Advisory based on those comparisons. These recommendations will be reviewed by the MDCH Health Assessor, modified if necessary, and incorporated into the advisory by the MDCH.

Attachment 1 Analytical Chemistry Standard Operating Procedures and Certificates

AC.08.07	Macro-Florisil Clean-up of Fish Extracts for PBBS, PCBs and Chlorinated Pesticides
AC.13.05	Silica Gel-60 Fractionation of Biological Tissue (Fish) for Polybrominated Biphenyls (PBBs), Polychlorinated Biphenyls (PCBs) and Chlorinated Pesticides
AC.29.02	Quality Assurance and Quality Control for Balances
AC.31.04	Extraction of Biological Tissue (Fish) for PBBs, PCBs and Chlorinated Pesticides Utilizing the Dionex ASE® 300 Accelerated Solvent Extractor
AC.35.01	Capillary Gas Chromatography Electron Capture Analysis of Extracts for Polychlorinated Biphenyl Congeners
LS.12.02	Lancer Washer Operation

CLIA Certificate of Compliance

Note: Method AC.74 (Glassware washing) has been replaced with the Bureau wide laboratory service method, LS.12.02

The method for balance quality assurance (AC.29.02) is incorrectly identified as AC.81 in methods 31, 8 and 13.

These corrections are in progress.

Attachment 2 Fish Fillet Collection and Processing Standard Operating Procedure

Recommendations for Deer Lake AOC Fish Contaminant Monitoring

The Deer Lake AOC includes 3 waterbodies: Carp Creek from Ishpeming downstream to Deer Lake, Deer Lake, and the Carp River downstream of Deer Lake to Lake Superior. Each waterbody is covered by a fish consumption advisory due to elevated concentrations of mercury. The amount and age of fish contaminant data varies by waterbody. The current database for the AOC is sufficient for some fish populations, but should be updated for others.

Carp Creek

Brook trout: The 2007 advisory recommends restricted consumption of brook trout larger than 10 inches, based on samples collected in 2005 (Figure 1). We have 2 samples of fish just over 10 inches; 1 had a Hg concentration of 0.56 ppm, exceeding the 0.5 ppm restrict consumption trigger level. If larger brook trout existed in the AOC reach of Carp Creek it would be worthwhile to sample them, however it is highly unlikely that many fish larger than 10 inches are there. I see no need to target brook trout from Carp Creek.

***White sucker**:* The 2007 advisory recommends no consumption of suckers larger than 10 inches, based on samples collected in 2005 (the MDCH groups all suckers together based on the premise that the general public does not differentiate between species). In earlier advisories Carp Creek suckers were included in “all other species” and the MDCH recommended no consumption, since no sample data were available. The 2005 data suggests that suckers less than 10 inches have Hg concentration well below the 0.5 ppm trigger level, and that fish larger than 14 inches may be likely to exceed that concentration (Figure 2).

Additional white suckers at least 10 inches in length should be analyzed. Any large suckers in Carp Creek are likely to be part of a spring spawning run from Deer Lake. Past (limited) collections from Deer Lake have included white suckers up to 20 inches. The additional samples of large white suckers could be collected with shocking gear in Carp Creek during the spring spawning run, or could be taken from Deer Lake using nets later in the year, since they very likely represent the same population.

***All other species*:** The 2007 advisory recommends no consumption of any other species from Carp Creek. The advisory recommends this because the human health risk associated with eating other species is unknown. However, it is unlikely that species other than white sucker or brook trout from Carp Creek are caught and eaten by anglers.

Deer Lake

The 2007 advisory recommends that no one eat any fish from Deer Lake. The advisory has been in place since the early 1980’s. Intensive sampling has been conducted since 1984, with regular analysis of northern pike, walleye, and yellow perch fillet samples.

Northern pike : The maximum Hg concentrations in northern pike were measured in samples collected in 1997, 1998, and 1999 in fish over 30 inches in length. A comparison of concentrations in pike over time is complicated by the variation in size of fish collected from year to year. Limiting comparisons to pike between 20 and 26 inches yielded a useful data set, and indicates that the median Hg concentration in that size range of pike has declined since 1993 (Figure 3).

If the Deer Lake northern pike advisory were to be based strictly on the two most recent samples (2001 & 2003; Figure 4), the MDCH would likely recommend that no one should eat northern pike larger than 26 inches, that the general population should eat no more than 1 meal per week of fish less than 26 inches, and women and children should eat no more than 1 meal per month of northern pike less than 26 inches. This (hypothetical) advice is more restrictive than the general statewide advice and is driven by 1 fish measuring 38 inches with a Hg concentration of 2.2 ppm.

Additional samples are needed before any advisory relaxation is possible. It has been 5 years since the last samples were collected; concentrations may have declined somewhat in that time, and a better sample of northern pike larger than 28 inches is needed. Given that there is evidence that the top predator in the Deer Lake fish community has changed from northern pike to walleye, large northern pike may be rare. A good effort should be made to collect a reasonable sample. If a reasonable effort does not result in a good sample of large pike, we might conclude that the northern pike population is no longer significant, and the decision to de-list may need to be based on walleye alone.

The MDCH would need to see a minimum of 1 and more likely 2 samples with Hg concentrations consistently below 1.5 ppm. If suitable samples are collected in 2008 (MDEQ/MDNR) and again in 2011 (by CCI per the amendment to the consent judgment), and the Hg concentrations are consistently less than 1.5 ppm, I believe the MDCH will be convinced that relaxation of the advisory is appropriate. If no samples are collected until 2011, relaxation of the advisory probably wouldn't occur until after the second CCI collection, scheduled for 2016.

***Walleye**:* The maximum Hg concentrations in walleye were measured in samples collected in 1997, 1998, and 1999. As with the northern pike, a comparison of concentrations in walleye over time is complicated by the variation in size of fish collected from year to year. Limiting comparisons to walleye between 16 and 20 inches yielded a useful data set, and indicates that the median Hg concentration in that size range of walleye has remained relatively unchanged since 1993 (Figure 5).

If the Deer Lake walleye advisory were to be based strictly on the two most recent samples (2001 & 2003; Figure 6), the MDCH would likely recommend following the general statewide advice, that is, no one should eat more than 1 meal per week, and women and children should not eat more than 1 meal per month. Less than 10% of all Deer Lake walleye samples had Hg concentrations near or exceeding 1.5 ppm, and the maximum observed concentration was "only" 1.7 ppm. However, given the history of Deer Lake the MDCH is unlikely to relax the walleye advisory without significant evidence that concentrations have declined and appear to be stable.

As with the northern pike, it has been 5 years since the last samples were collected, and additional walleye samples are needed. The MDCH might be convinced to relax the advisory somewhat based on one more suitable sample, but is unlikely to remove all "do not eat" advice without 2 more samples and an adequate passage of time. Probably the best scenario would be to collect samples in 2008 (MDEQ/MDNR) and 2011 (CCI).

Yellow perch: Suitable samples of yellow perch were collected from Deer Lake in 1984, 1998, 1999, and 2001. Mercury concentrations in perch were consistent over the last 3 sample years; fish less than 11 inches had Hg concentrations below 0.5 ppm, and most of the perch larger than 11 inches had concentrations ranging from 0.4 to 0.9 ppm (Figure 7). If the Deer Lake yellow perch advisory were based strictly on the most recent 3 years of data, the advice would be no different than the statewide general Hg advisory for lakes and impoundments.

One additional yellow perch sample verifying the moderate Hg concentrations should be sufficient to justify relaxation of the consumption advice. If other collections of other species are made in 2008, it would be appropriate to collect yellow perch as well.

Carp River

***Brook trout*:** The 2007 advisory does not put a limit on consumption of Carp River brook trout. Brook trout were sampled in 1993, 1999, and 2004, and the Hg concentrations have been consistently low (less than 0.3 ppm; Figure 8). No new samples are needed in the near future.

Northern pike: The 2007 advisory recommends restricted consumption of Carp River northern pike. The most recent samples were collected in 1999 and included 8 legal size fish (24-inch limit) with 2 pike larger than 32 inches (Figure 9). Mercury concentrations in the 1999 samples were all between 0.5 and 1.5 ppm.

By comparison, northern pike were collected from the Tahquamenon River in Luce County near Slater's Landing in 1988 (a non-impounded river reach). The sample included only 6 fish, 1 measuring 25 inches and the rest less than the 24-inch size limit (Figure 9), but the comparison suggests that mercury concentrations in pike from the Tahquamenon are similar to those observed in the 1999 Carp River samples. Further investigation of this is recommended.

There is some question as to whether a significant northern pike population remains in the Carp River. In addition, the pike collected in 1999 were taken from the Carp River Basin; since it is an impoundment, somewhat elevated Hg concentrations would be expected even without the influence of Deer Lake, and would be covered under the statewide general advisory. Since the concentrations measured in the 1999 sample were all less than 1.5 ppm, the current MDCH advice for Carp River basin pike is no different than the general advisory.

If an impoundment still exists on the Carp River, then an attempt to collect more northern pike to verify the level of Hg contamination would be worthwhile. If impoundments no longer exist, a special effort to sample pike is probably unnecessary as the population is likely to be small, scattered, and difficult to collect. If legal size pike are captured in the process of other sampling efforts, they should be kept and analyzed.

White sucker: The 2007 advisory does not put a limit on consumption of Carp River suckers. Ten white sucker fillets were analyzed in 2004 and the Hg concentrations were consistently low (0.2 ppm median concentration; Figure 10). In 1984, four white suckers were analyzed as whole samples and 1 was analyzed as a fillet sample. Concentrations in all samples were low and indicated that consumption restrictions were not needed. No new samples are needed in the near future.

All Other Species: The 2007 advisory recommends no consumption of any other species from the Carp River. The advisory recommends this because the human health risk associated with eating other species is unknown.

MDNR survey work indicates that largemouth bass, yellow perch, and sunfish occur in the Carp River. There have been reports of brown trout being caught by local anglers as well. Populations of these species may not be significant, and if so, collection of a significant sample may be difficult. If suitable samples cannot be collected, we may conclude that the human health risk is small or suggest basing advisories on suitable surrogate species.

Summary

Samples of large (10 to 20 inch) white suckers should be collected from either Carp Creek or Deer Lake to evaluate the possibility of relaxing the Carp Creek advisory for that species. This species is not included in the CCI consent judgment amendment and thus collection and analysis would have to be coordinated by the MDEQ.

Samples of northern pike, walleye, and yellow perch should be collected from Deer Lake to evaluate the possibility of relaxing advisories for those species. These species are to be collected and analyzed by CCI every 5 years beginning in 2011. The results of two sampling events are likely to be required by the MDCH to justify relaxation of the advisory, meaning that relaxation would not be likely until 2016. This timetable could be shortened if samples were collected in 2008 (by MDEQ/MDNR).

The argument can be made that mercury concentrations in Carp River fish are no longer related to conditions in Deer Lake. Northern pike from the Carp River Basin exhibited elevated Hg concentrations in 1993, but fish collected in 1999 had concentrations in the range considered normal for an impoundment, and possibly similar to other un-impounded UP stream populations. The current status of northern pike and other sportfish should be evaluated. Carp River collections are not included in the CCI consent judgment amendment; collection and analysis of Carp River fish would have to be coordinated by the MDEQ.

Joe Bohr
Aquatic Biologist
MDEQ/Water Bureau

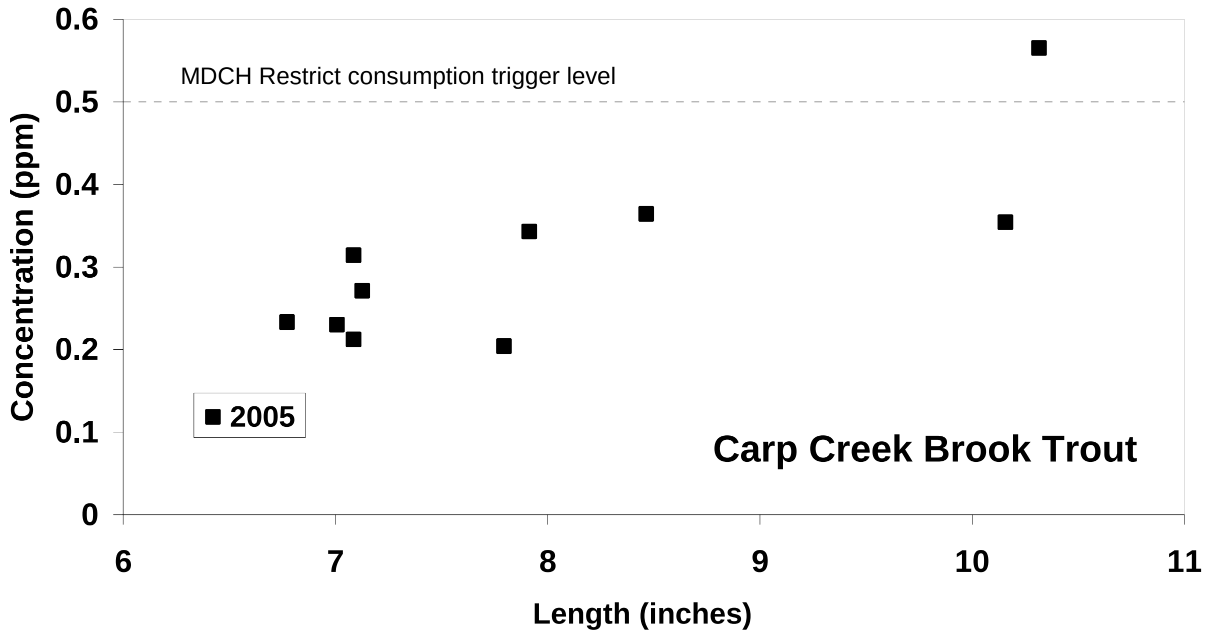

Figure 1. Mercury concentration in brook trout collected from Carp Creek upstream of Deer Lake, Marquette County.

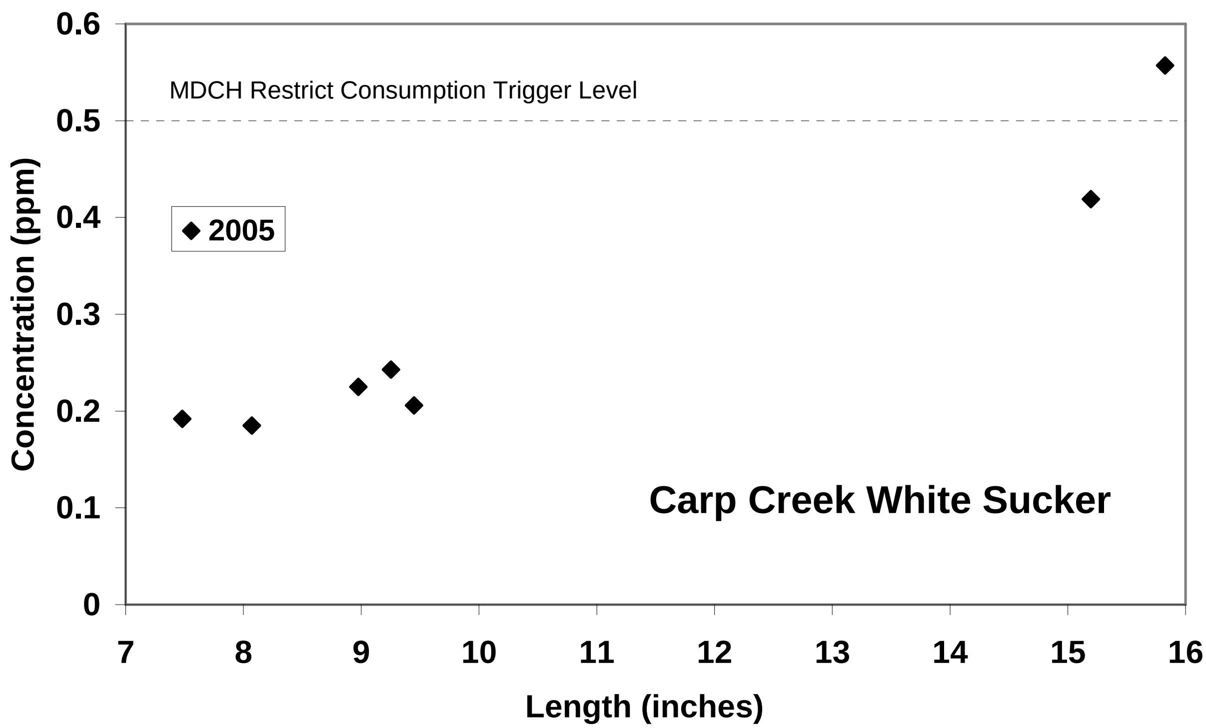

Figure 2. Mercury concentration in white sucker collected from Carp Creek upstream of Deer Lake, Marquette County.

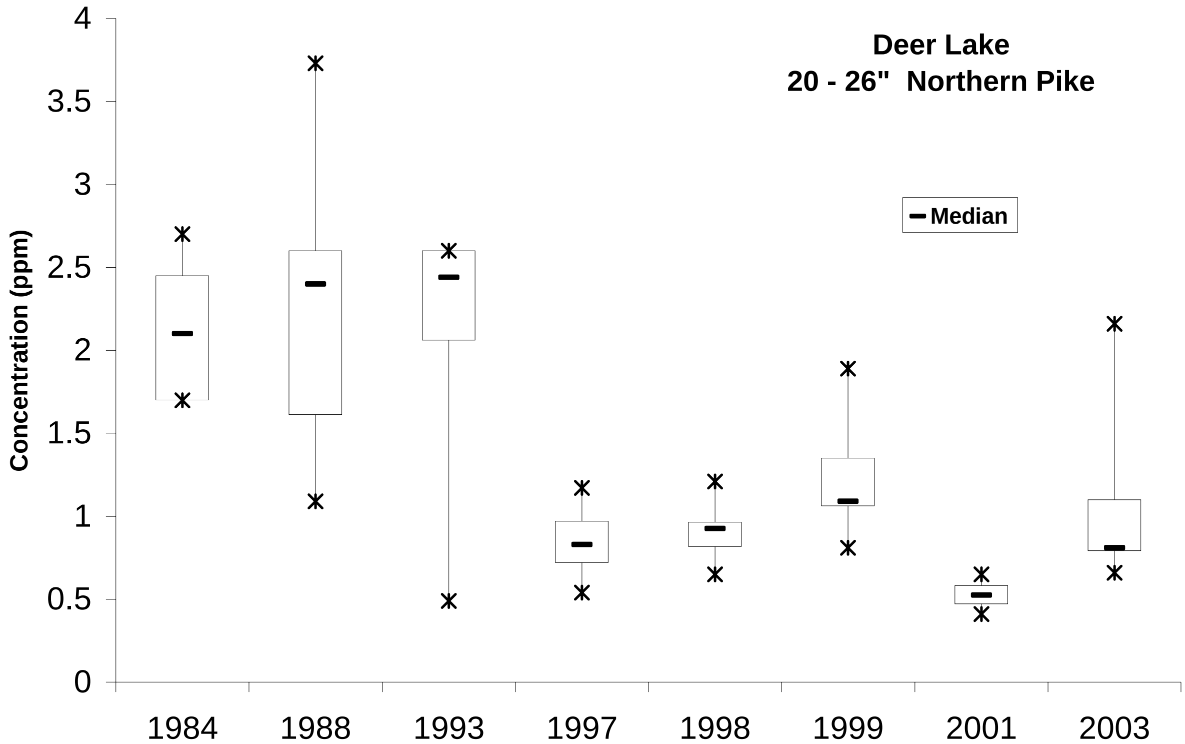

Figure 3. A comparison of mercury concentrations in 20 to 26 inch northern pike collected from Deer Lake between 1984 and 2003.

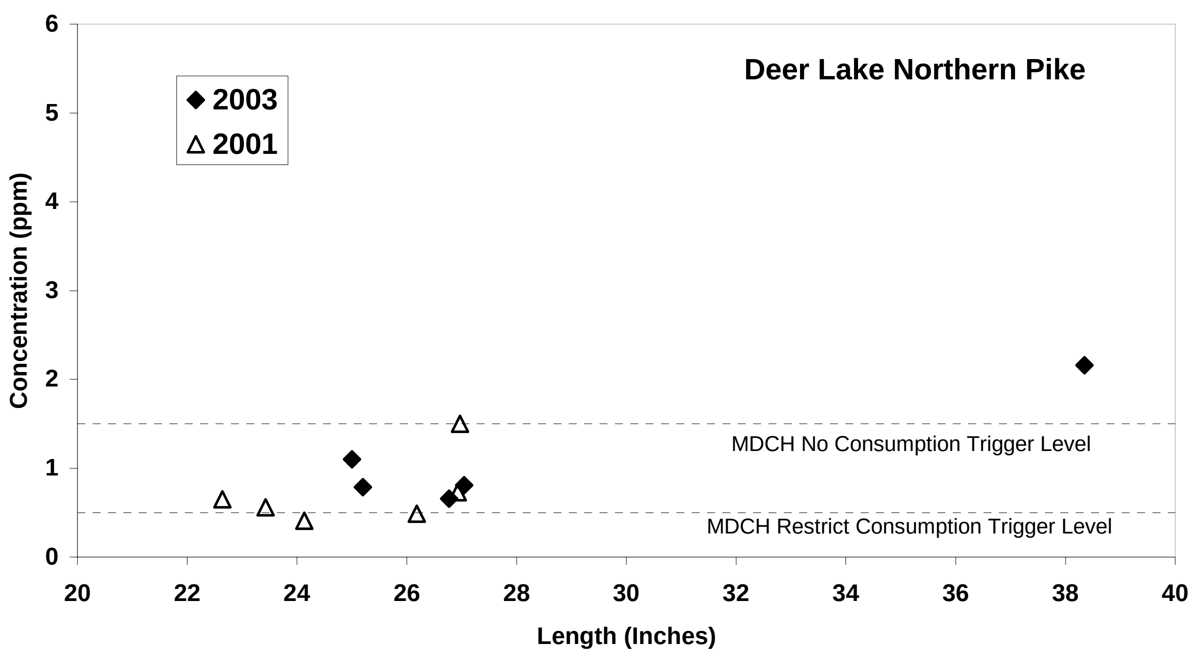

Figure 4. Mercury concentrations in Deer Lake northern pike collected in 2001 and 2003.

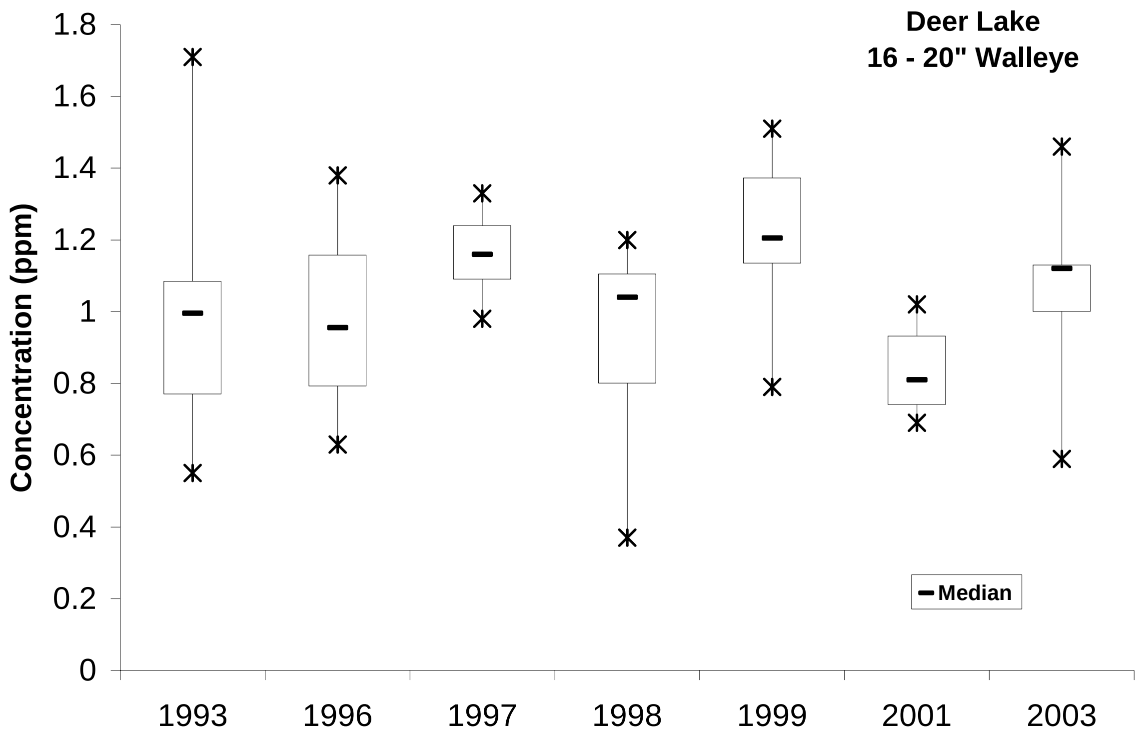

Figure 5. A comparison of mercury concentrations in 16 to 20 inch walleye collected from Deer Lake between 1993 and 2003.

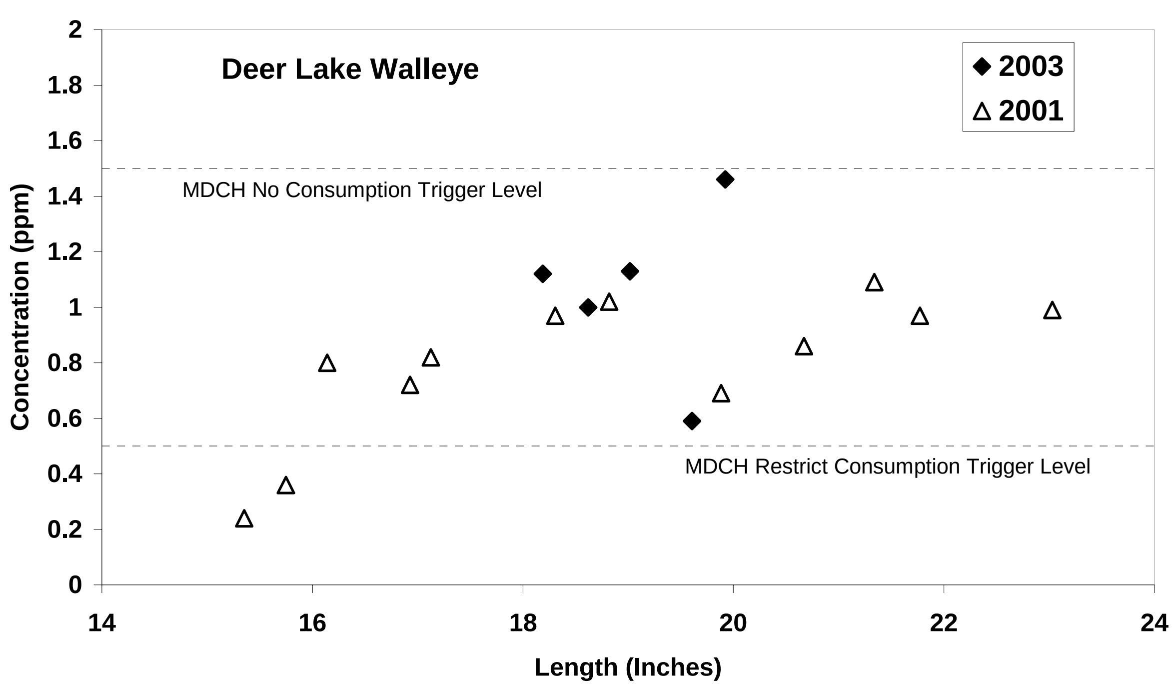

Figure 6. Mercury concentrations in Deer Lake walleye collected in 2001 and 2003.

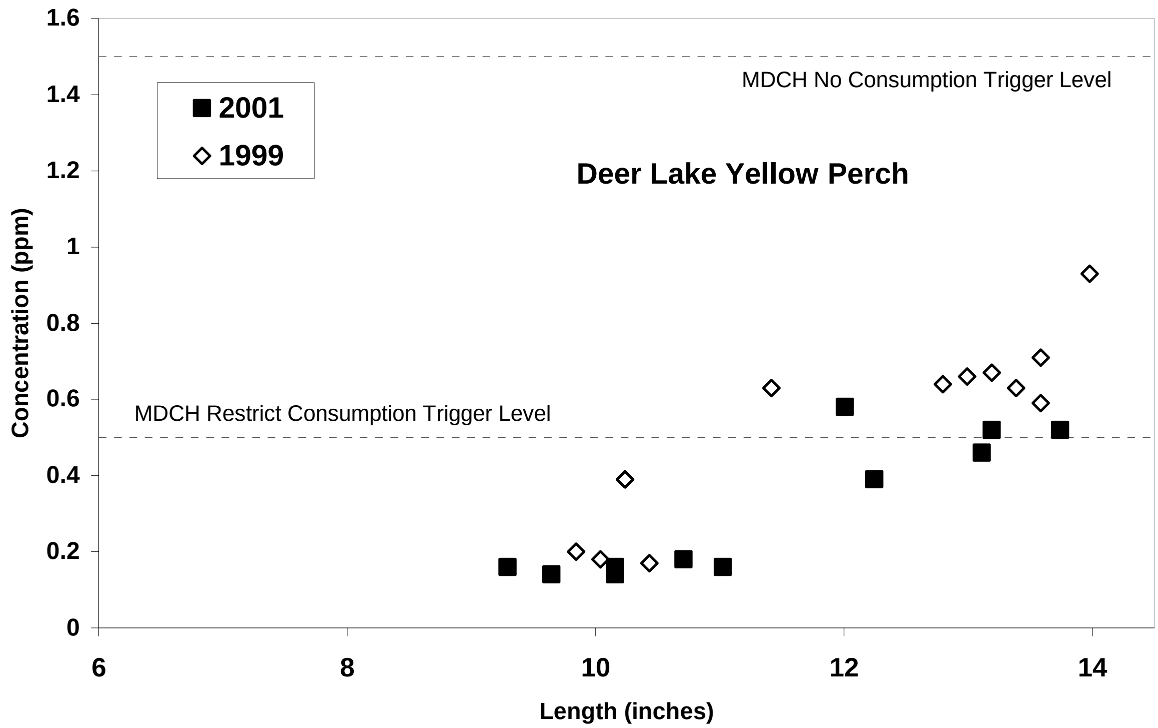

Figure 7. Mercury concentrations in Deer Lake yellow perch collected in 1999 and 2001.

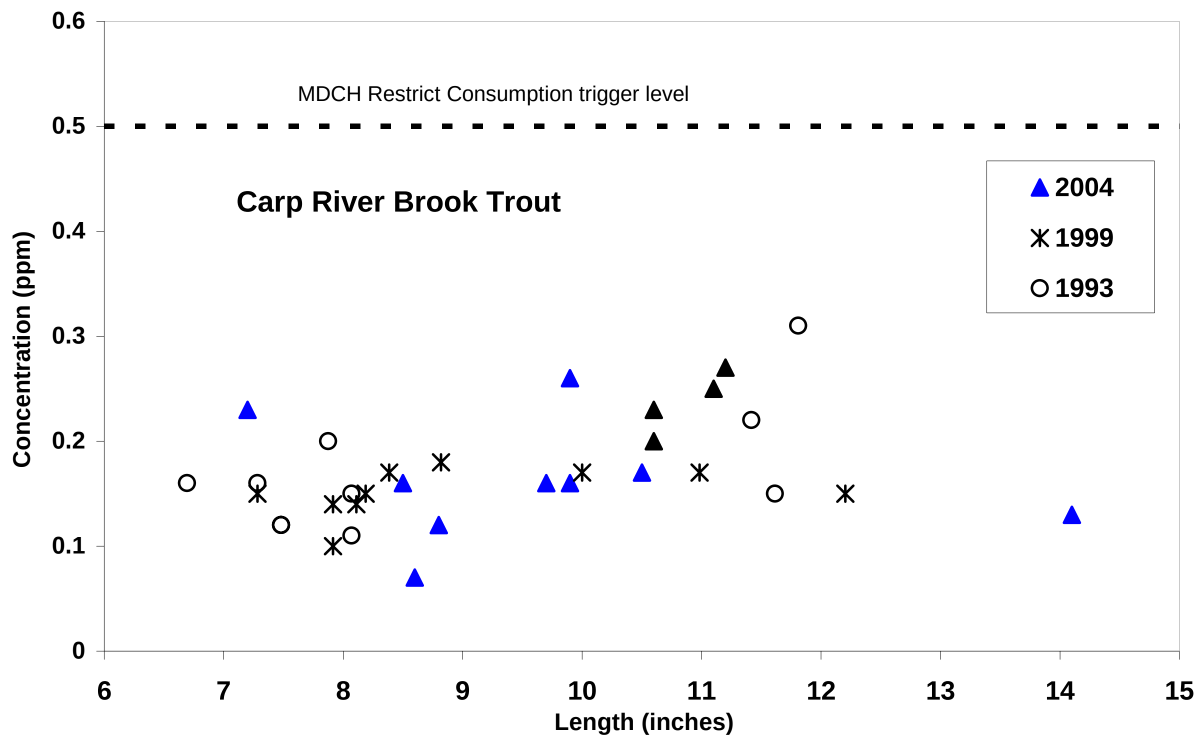

Figure 8. Mercury concentrations in Carp River brook trout collected in 1993, 1999, and 2004.

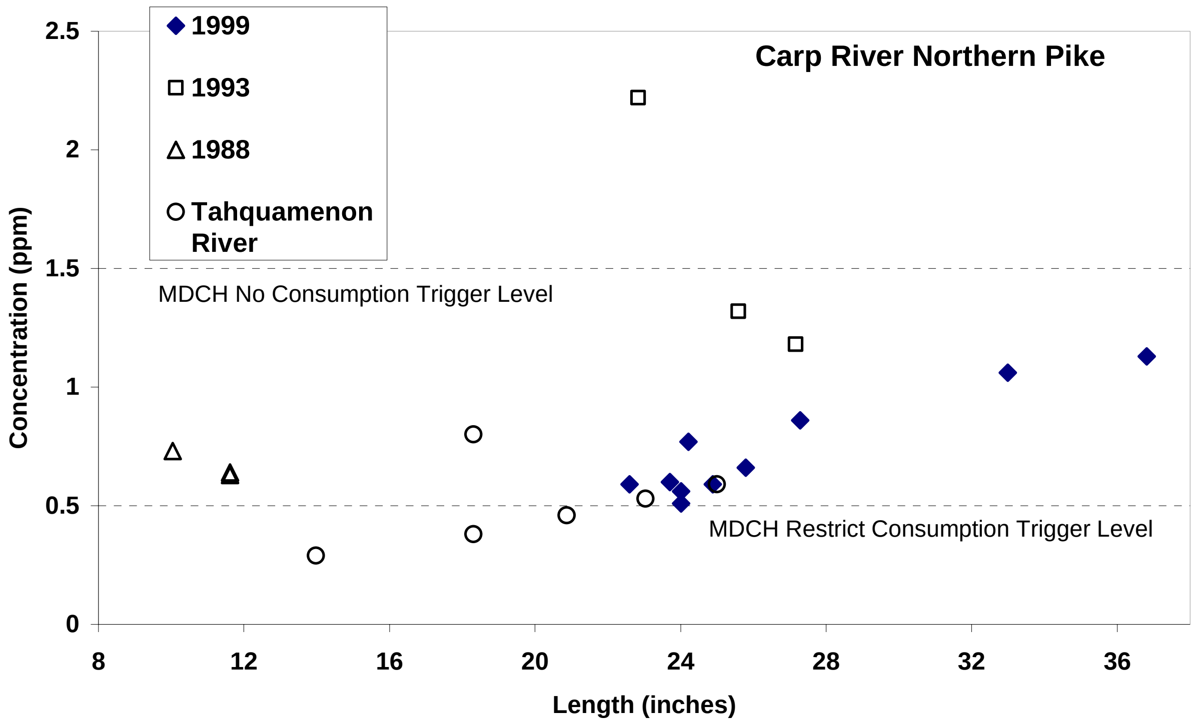

Figure 9. Mercury concentrations in Carp River northern pike collected in 1988, 1993, and 1999, and in the Tahquamenon River in 1988.

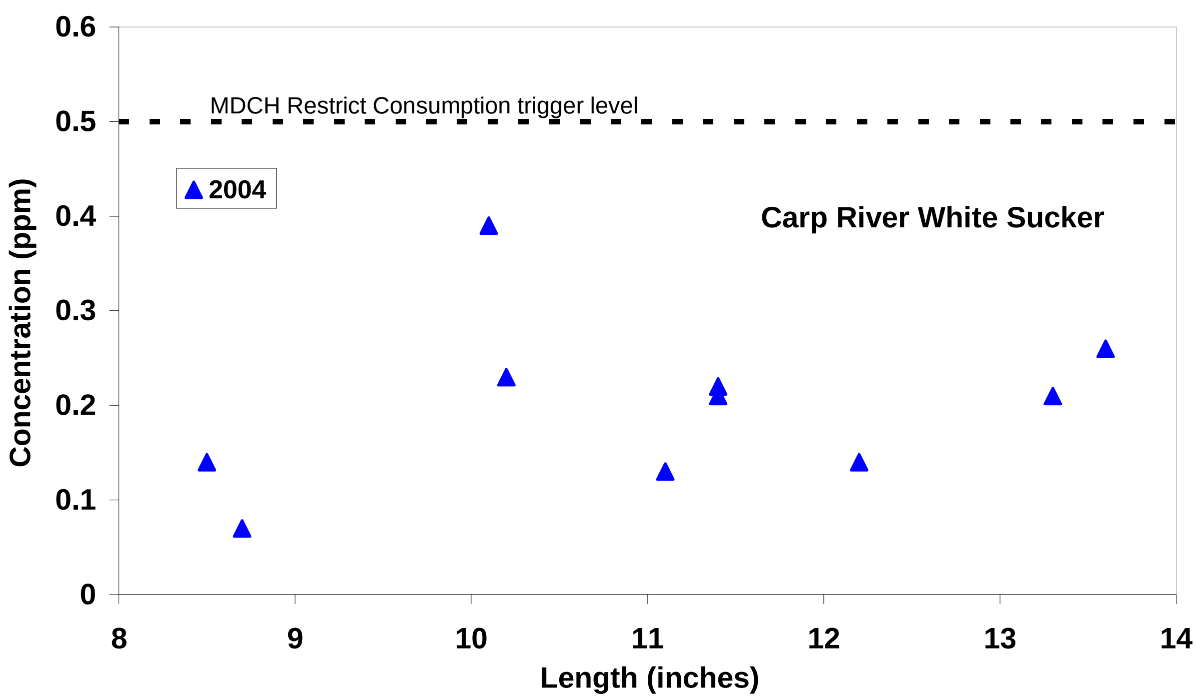

Figure 10. Mercury concentrations in Carp River white sucker collected in 2004.

Deer Lake Sampling Status and Recommendations Update

The Deer Lake Area of Concern includes the lake, Carp Creek upstream of Deer Lake, and the entire Carp River downstream of Deer Lake. Samples of sport fish taken from the lake have been analyzed for mercury on a regular basis since the early 1980s. The goal of continued fish sampling in the AOC is to determine if mercury levels in sport fish have declined and stabilized to a point that the Fish Consumption BUI can be removed.

Recent sampling by state agencies and by Cliffs Natural Resources (CNR) indicates that mercury concentrations in northern pike and walleye from the lake may have stabilized at levels similar to those found in those species from other lakes in the region. Additional lake samples may verify this conclusion. A good sample of several species was collected from the lake by the MDNR in 2011.

Since the AOC boundaries include both Carp Creek and Carp River, additional samples are needed from those waters before it can be determined that the BUI has been restored. In 2008 I recommended collection of large white suckers from either Carp Creek or Deer Lake in order to determine if the Carp Creek advisory could be relaxed. White suckers were collected from the creek in 2010 and from the lake in 2011. We have results from the 2010 samples but will wait until the 2011 samples are analyzed before making advisory recommendations for the creek.

I also recommended collecting samples from the Carp River basin, a small impoundment downstream of Deer Lake. In 2011 we were able to collect a sample of 12 northern pike, 2 walleye, 1 yellow perch, and 10 white suckers. We plan to analyze all of the samples for mercury. Only 4 of the 12 pike were of legal size, but the current consumption advice for the species is identical to the statewide mercury advisory for fish taken from impoundments and inland lakes. Hopefully the northern pike samples will serve to validate that advice and indicate that mercury levels are stable or declining.

If mercury levels in fish from Carp Creek and Carp River are the same or lower than in previous samples then it will probably not be necessary to sample those streams in the near future. Deer Lake is scheduled to be sampled by CNR every 5 years (next sampling event in 2015). It is possible that a final decision on the status of the BUI would have to wait until the results of that sampling effort are available.

Joe Bohr
November 18, 2011

Detroit River Area of Concern

Status of the Fish Tumor and Other Deformities Beneficial Use Impairment

Sampling Plan

Background

The Detroit River is a 32-mile international connecting channel linking Lake St. Clair to Lake Erie and is a binational Area of Concern. The Detroit River Area of Concern (DR AOC) is listed for 11 beneficial use impairments, including “Fish Tumors or Other Deformities”. Several studies have associated internal and external tumors in fish with carcinogens in sediment and water at several locations in North America, and they were summarized by Baumann et al. (1996). Specifically, epidermal and liver tumors in brown bullhead and white sucker are strongly correlated with the presence of polynuclear aromatic hydrocarbons (PAH). It has been recommended that one or both species should be used to monitor tumor prevalence (Baumann 2002).

A study of 5 species of fish collected in Michigan waters of the Detroit River in 1986 and 1987 found a 10.2% rate of dermal or oral neoplasms in bullhead (Kreis et al. 1987). The prevalence of external lesions in brown bullhead from 3 relatively pristine areas ranges from 2.5% to 15.0% (Baumann et al., 1996) with an overall average of 5.5%. The elevated incidence of lesions in fish from the Detroit River led to the determination that the Fish Tumor beneficial use is impaired.

The US Fish & Wildlife Service (USFWS), in partnership with USGS and USEPA, is analyzing a series of chemical and physical indicators in fish samples from several areas of the Great Lakes, including the Detroit River. One factor being analyzed is the incidence of dermal and liver lesions. The sample collection and analysis is ongoing.

Recommendations

A fish collection and analysis effort is needed to determine current conditions. While the USFWS effort mentioned above promises to be rigorous and informative, results may not be available for several months. Examination of fish samples collected as part of other ongoing monitoring activities will be helpful in determining the status of the Fish Tumor BUI. Bullhead collected at relatively pristine Great Lakes sites (e.g. St. Marys River, Little Bay De Noc) should be kept and examined; the tumor prevalence at these sites can be considered a background rate.

Sampling Plan

The MDNR Fisheries Division collected samples of fish from several areas of the Detroit River in 2010 and 2011. Samples of both brown and black bullhead were kept and examined for external and gross internal lesions.

A total of 21 bullhead were collected during fisheries survey work in the Detroit River. In addition, bullhead will be collected as encountered during survey work at other sites around the state. The latter samples will be used to determine the background rate of lesion incidence.

Fish samples will be inspected for internal and external lesions (tumors). The prevalence of lesions observed in the Detroit River samples will be compared statistically to lesion rates observed in literature and, if collected, in reference site samples.

Joseph Bohr
Water Resources Division
Michigan department of Environmental Quality

<u>References</u>

Baumann, P. C. 2002. *Fish tumor BUI Criteria: Determining numbers for the delisting process*. Downloaded from www.glc.org/spac/proceedings/pdf/15Baumann.pdf on 4/2/2012.

Baumann, P.C., I.R. Smith, and C.D. Metcalfe. 1996. *Linkages between chemical contaminants and tumors in benthic Great Lakes fish.* J. Great lakes Res. 22(2):131-152.

Kreis, R. G. Jr., J. E. Rathbun, A. E. Maccubbin, R. A. Hites, V. E. Smith, M. J. Mac, J. C. Filkins, F. A. Rudolph, M. D. Mullin, K. A. Vargo, and K. P. McGunagle. 1989. An investigation of neoplasia in Detroit River fish and its relationship to sediment contamination. USEPA, Office of Research and Development, ERL-Duluth, MN, and LLRS-Grosse Ile, MI. 110 pp.

Menominee River Area of Concern

Status of the Restrictions on Fish and Wildlife Consumption BUI

Sampling Plan

The Menominee River Area of Concern (MR AOC) includes the river from the Park Mill (second dam from the river mouth, also known as Upper Scott) downstream to the river mouth. The river forms part of the boundary between the states of Michigan and Wisconsin. The beneficial use Restrictions on Fish and Wildlife Consumption is listed as impaired for the MR AOC.

Both Michigan and Wisconsin have issued fish consumption advisories for the Menominee River. The current Michigan Department of Community Health (MDCH) fish consumption advisory recommends limited consumption of carp, lake sturgeon, suckers, and walleye upstream of the Menominee Dam (aka Lower Scott Dam) due to PCBs and mercury; the advice is based primarily on samples collected well upstream of the MR AOC, with the most recent samples taken from the Chalk Hills impoundment in 2010. The only fish contaminant samples taken by Michigan from between dams 1 and 2 were walleye and rock bass collected in 1990. The MDCH also recommends limited consumption of sport caught fish taken from the river downstream of the Menominee Dam due to elevated levels of mercury, PCBs, and dioxin, based on samples taken from nearby waters of Green Bay.

To determine the status of the Fish Consumption BUI in the MR AOC we will compare the concentrations of key contaminants in one or more species of fish collected from 2 areas within the AOC and from an appropriate reference site. The comparisons will be made using 10 fillets from a similar size range of the same species from each of the 3 sites. All samples will be analyzed for mercury, total PCBs, and the standard suite of contaminants normally measured for the Michigan DEQ fish contaminant monitoring program. In addition, samples of one species of fish from the Menominee Dam impoundment and from the lower Menominee River will be analyzed for dioxin, furan, and dioxin-like PCB congeners. The dioxin issue is discussed in the attached Menominee River TEQ summary.

<u>Fish Species for Contaminant Analysis</u>
We will collect and analyze contaminants in 2 species of fish from the MR AOC and the same 2 species from a reference water body for comparison. The following species were considered:

- Carp
  - Pros: existing advisory on the species; carp tend to have the highest PCB burdens for a given water body; consumed by some anglers; relatively ubiquitous species; some historic data available for comparison
  - Cons: may range outside of the AOC to some extent; not a popular sport fish

- Northern Pike
  - Pros: existing advisory on the species in the lower Menominee River; popular sport fish; consumed by many anglers; species has relatively

good site fidelity and thus would represent AOC conditions well; top predator and good indicator for mercury concentrations
  - Cons: may be relatively difficult to collect an adequate sample size without special collection efforts; no (Michigan) historic data available for MR AOC

- Redhorse Sucker
  - Pros: regularly taken and consumed by a segment of the sport fishing population
  - Cons: may not have good site fidelity in lower Menominee River and may not represent AOC conditions as well as other species

- Rock Bass or other small centrarchid species
  - Pros: popular and regularly consumed panfish; high site fidelity and thus will represent AOC conditions; fairly ubiquitous species that should allow several choices for reference sites; relatively easy to collect where present; some historic data available
  - Cons: populations may be found only in localized zones; the species does not generally accumulate high levels of contaminants

- Smallmouth Bass
  - Pros: popular and regularly consumed sport fish; fairly high site fidelity and thus will represent AOC conditions
  - Cons: samples collected downstream of 1st dam may spend significant part of life outside of AOC

- Walleye
  - Pros: very popular and regularly consumed sport fish; existing advisory on the species; could be collected at several potential reference sites; some historic data available for comparison
  - Cons: the species ranges very widely and will not necessarily represent conditions in the AOC well

- Yellow Perch
  - Pros: popular species for consumption; fairly ubiquitous
  - Cons: more widely ranging than rock bass and other small centrarchids; may be more difficult to collect in the AOC due to habitat preferences; the species does not generally accumulate high levels of contaminants

We will use carp as one of the target species because it represents the worst case for PCB contamination and because the species should be relatively easy to collect from both the MR AOC and the reference site.

We will use rock bass or smallmouth bass as a second target species for the reasons noted above. We will also collect northern pike and yellow perch as available. These supplementary species may not be analyzed initially but could provide additional evidence to support a BUI removal decision if needed.

In addition, although we plan to analyze 10 fish of each species from each site, we will attempt to collect additional (up to 10) fish per species at each site. This will increase

our ability to match length ranges between sites and will allow us the option of analyzing additional samples should the initial results prove inconclusive.

In summary, we will analyze a minimum of 20 samples from each of three areas (between dams 1 & 2, lower Menominee River, reference site) for a total of 60 samples.

Potential Reference Sites

An appropriate reference water body will support the selected target fish species and will not be another Area of Concern or have other known legacy contamination issues. Ideally, in the interest of efficiency and budgetary savings, the reference site will be one that the MDNR Fisheries Division or Wisconsin DNR samples regularly.

In addition, an ideal reference site will have contaminant inputs from sources outside of the AOC that are similar to the inputs affecting the AOC. Mercury, PCBs, and other contaminants of concern are transported into the MR AOC watershed atmospherically and through other non-point sources. The magnitude of these inputs varies regionally; for example, industrialized and urbanized areas tend to emit and discharge higher levels of PCBs and mercury than less developed regions. The MR AOC is exposed to non-AOC inputs from the Fox River and Green Bay AOC and thus is likely to have somewhat elevated contaminant levels even without sources within the MR AOC.

The following sites were considered:

- Little Bay de Noc (northwest Lake Michigan)
    - Pros: MDNR samples the lake regularly and should be able to provide several species of fish; we have a good historic database available allowing analysis of contaminant trends; similar regional contaminant inputs
    - Cons: none

- Regional Inland Lake (specific lake to be determined)
    - Pros: would provide a comparison incorporating non-AOC regional contaminant inputs
    - Cons: may not be a suitable comparison for mercury since mercury tends to be elevated in inland lake fish as compared to Great lakes fish; would require a special collection effort

- Regional River (Menominee River u/s of AOC or other to be determined)
    - Pros: would provide a comparison incorporating non-AOC regional contaminant inputs
    - Cons: would require a special collection effort

Little Bay de Noc will be used as the reference water body for the MR AOC. The MDNR Fisheries Division samples the area regularly, the target species are available there, and the regional influences should not be significantly different.

Special collection efforts may be needed to sample the lower Scott impoundment and the lower Menominee River. The Wisconsin DNR may be available to conduct these collections.

Other Considerations
This sampling plan does not take into account fish contaminant sampling that may have been conducted recently by the state of Wisconsin or by industry. If recent appropriate data are available the need for new sampling may be reduced. North East Wisconsin Hydro, for example, operates hydroelectric projects on the Menominee River and is required through their federal license to periodically analyze mercury and PCBs in fish affected by their projects. Samples from the upper and lower Scott impoundments and from the lower Menominee River were collected in 2011 and these samples may help inform the BUI status decision.

Joseph Bohr
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Water Resources Division
Michigan Department of Environmental Quality

Plan for Collection and Analysis of Fish and Wildlife To Evaluate the Status of the Fish and Wildlife Consumption Beneficial Use Impairment In the St. Clair River Area of Concern

The St. Clair River Area of Concern (SCR-AOC) includes the entire river from the source at the southern tip of Lake Huron to the mouth, including an extensive delta and wetland area at Lake St. Clair. The river forms part of the boundary between Michigan and Ontario, hence it is a bi-national AOC. Both Michigan and Canada have issued fish consumption advisories for the St. Clair River beginning in the 1970's and continuing to the present.

The current Michigan Department of Community Health (MDCH) fish consumption advisory recommends limited consumption of carp, freshwater drum, gizzard shad, and walleye due to elevated concentrations of mercury and PCBs. The advice is based on carp samples collected most recently in 2006, freshwater drum collected in 1994, and walleye collected in 2006. The MDEQ does not have the data supporting the gizzard shad advisory.

The sample collections are planned for 2012 and are in support of the GLRI grant funded project *Enhanced Michigan Fish Contaminant Monitoring and Advisories* awarded to the MDCH. To determine the status of the Fish Consumption Beneficial Use Impairment in the SCR- AOC we need to compare the concentrations of key contaminants in one or more species of fish collected from the AOC and from one or more appropriate reference sites. The comparisons will be made using 10 fillets from a similar size range of the same species from each of the sites. All samples will be analyzed for mercury, total PCBs, and the standard suite of contaminants normally measured for the Michigan DEQ fish contaminant monitoring program. In addition, 10 samples of a select species from each site will be assayed for dioxin TEQ, including dioxin-like PCB congeners, in order to update the fish consumption advisory.

Lastly, muskrat from the SCR-AOC are harvested for human consumption. Concentrations of mercury, total PCBs, and the standard suite of contaminants should be measured in that species.

<u>Species</u>
We will collect and analyze contaminant concentrations in at least 2 species of fish from the SCR AOC and in the same species from a reference water body for comparison. The following species were considered:

- Carp
    - Pros: existing advisory on the species; carp tend to have the highest PCB burdens for a given water body; consumed by some anglers; relatively ubiquitous species
    - Cons: may range outside of the AOC to some extent; not a popular sport fish

- Walleye
    - Pros: very popular and regularly consumed sport fish; existing advisory on the species; could be collected at several potential reference sites

3/13/2012

- Cons: species ranges very widely and likely will not be a good representative of conditions in the AOC

- Freshwater Drum
  - Pros: existing advisory on the species; consumed by some anglers
  - Cons: may range outside of the AOC to some extent; not highly sought after; choices for reference sites may be somewhat limited

- Gizzard Shad
  - Pros: existing advisory on species
  - Cons: use as a food fish questionable; limited choices for reference sites

- Smallmouth Bass
  - Pros: popular gamefish; species tends not to move great distances (good site fidelity) and will represent sampling area conditions; fairly ubiquitous where appropriate habitat is present
  - Cons: may be difficult to collect in the SCR-AOC

- Rock Bass or other small centrarchids species
  - Pros: popular and regularly consumed panfish; high site fidelity and thus will represent AOC conditions; fairly ubiquitous species that should allow several choices for reference sites; relatively easy to collect where present
  - Cons: populations may be found only in localized backwater zones;

- Yellow Perch
  - Pros: popular species for consumption; fairly ubiquitous
  - Cons: more widely ranging than rock bass and other small centrarchids; may be more difficult to collect in the AOC due to habitat preferences; the species does not generally accumulate high levels of PCBs

We will collect carp as one target species because it represents the worst case for PCB contamination and because the species should be relatively easy to collect from both the SCR AOC and the reference site.

We will also collect at least two species of game fish that tend to have relatively high site fidelity. Smallmouth bass, rock bass, pumpkinseed (or a related “sunfish” species), or yellow perch are all suitable target species. These species would provide a reasonable representation of conditions in the SCR AOC and should be available at most of the likely choices for a reference site. We will collect sufficient specimens of at least 2 potential target species in addition to the carp; although not all samples will necessarily be analyzed this will give us options for additional comparisons with fish from the reference site.

In addition, although we plan to analyze 10 fish of each species from each site, we will attempt to collect additional (up to 10) fish per species at each site. This will increase our ability to match length ranges between sites and will allow us the option of analyzing additional samples should the initial results prove inconclusive.

Lastly, we will evaluate the contaminant concentrations in muskrat taken from the SCR-AOC. A literature search will be conducted to determine if such analyses have already been conducted either in the SCR-AOC or in areas that could serve as reference sites. If sufficient analyses have not been conducted we will either enlist a local trapper to collect muskrat from the SCR-AOC or request samples of muskrat previously taken from the area. We will analyze one composite sample of muscle tissue from 2 or 3 muskrats collected from the SCR-AOC. If the results indicate the potential for human health risk we will determine the need for additional sampling and for comparisons to an appropriate reference site.

<u>Potential Reference Sites</u>
An appropriate reference water body will support the selected target fish species and will not be another Area of Concern or have other known legacy contamination issues. Ideally, in the interest of efficiency and budgetary savings, the reference site will be one that the MDNR Fisheries Division samples regularly.

In addition, an ideal reference site will have contaminant inputs from sources outside of the AOC that are similar to the inputs affecting the AOC. Mercury, PCBs, and other contaminants of concern are transported into the SCR-AOC watershed atmospherically and through other non-point sources. The magnitude of these inputs varies regionally; for example, industrialized and urbanized areas tend to emit and discharge higher levels of PCBs and mercury than undeveloped regions. The SCR-AOC is exposed to non-AOC inputs from urbanized/industrialized south-east Michigan and thus is likely to have somewhat elevated contaminant levels even without sources within the AOC.

The following sites were considered:

- Lake St. Clair (Anchor Bay)
    - Pros: MDNR samples the lake regularly and should be able to provide several species of fish; we have a good historic database available allowing analysis of contaminant trends; would provide a comparison incorporating non-AOC regional contaminant inputs
    - Cons: could be seen as a site too strongly influenced by inputs from the SCR AOC; individuals of some potential target species may range into the SCR AOC for part of their lives therefore we could be sampling essentially the same population at both sites

- Little Bay de Noc (northwest Lake Michigan)
    - Pros: MDNR samples the lake regularly and should be able to provide several species of fish; we have a good historic database available allowing analysis of contaminant trends
    - Cons: regional contaminant inputs are likely to be different than those in the SCR AOC area

- Les Cheneaux Islands area (northern Lake Huron)
    - Pros: fish species diversity and productivity is relatively high
    - Cons: a special collection effort would be required; little historic data is available for comparisons; regional contaminant inputs are likely to be different than those in the SCR AOC area

- Grand Traverse Bay (Lake Michigan) or Thunder Bay (Lake Huron)
    - Pros: MDNR samples the Bay areas regularly and should be able to provide several species of fish; we have a good historic database available allowing analysis of contaminant trends
    - Cons: regional contaminant inputs are likely to be different than those in the SCR AOC area; species complex is different and matching target species may be more difficult (e.g. carp and rock bass are not as numerous in either Bay compared to other potential sites)

- Regional Inland Lake (specific lake to be determined)
    - Pros: would provide a comparison incorporating non-AOC regional contaminant inputs
    - Cons: may not be a suitable comparison for mercury since mercury tends to be elevated in inland lake fish as compared to Great lakes fish; would require a special collection effort

- Regional River (specific river to be determined)
    - Pros: would provide a comparison incorporating non-AOC regional contaminant inputs
    - Cons: would require a special collection effort; most potential river sites have some level of legacy contamination issue

We will use Little Bay de Noc, the Les Cheneaux Island area, or both as reference sites. Both areas should provide a good diversity of species for comparison with the SCR-AOC. Neither area is subject to regional inputs similar to those affecting the SCR-AOC however alternative sites closer to the SCR-AOC are problematic for reasons noted above.

Joseph Bohr
Aquatic Biologist Specialist
Water Resources Division
Michigan Department of Environmental Quality

St. Marys River Area of Concern

Status of the Fish Consumption and the Fish Tumor BUIs

Sampling Plan

The St. Marys River Area of Concern (SMR AOC) includes the entire river from the source at the eastern end of Lake Superior to the mouth at the straits of Detour. The river forms part of the boundary between Michigan and Ontario, hence it is a bi-national AOC. Restrictions on Fish and Wildlife Consumption and Fish Tumors or other deformities are 2 of the beneficial use impairments listed for the SMR AOC.

Both Michigan and Canada have issued fish consumption advisories for the St. Marys River. The current Michigan Department of Community Health fish consumption advisory recommends limited consumption of carp due to PCBs, northern pike due to mercury, and walleye due to both PCBs and mercury. The advice is based on northern pike and walleye samples collected most recently in 2004, and carp samples collected most recently in 1995.

To determine the status of the Fish Consumption BUI in the SMR AOC we will compare the concentrations of key contaminants in two species of fish collected from the AOC and from an appropriate reference site. The comparisons will be made using 10 fillets from a similar size range of the same species from each of the sites. All samples will be analyzed for mercury, total PCBs, and the standard suite of contaminants normally measured for the Michigan DEQ fish contaminant monitoring program. In addition, 10 samples of a selected species from each site will be assayed for dioxin TEQ, including dioxin-like PCB congeners, in order to update the fish consumption advisory.

<u>Fish Species for Contaminant and Tumor Analysis</u>
We will collect and analyze contaminants in 2 species of fish from the SMR AOC and the same 2 species from at least one reference water body for comparison. The following species were considered:

- Carp
  - Pros: existing advisory on the species; carp tend to have the highest PCB burdens for a given water body; consumed by some anglers; relatively ubiquitous species; historic data available for comparison
  - Cons: may range outside of the AOC to some extent; not a popular sport fish

- Walleye
  - Pros: very popular and regularly consumed sport fish; existing advisory on the species; could be collected at several potential reference sites; historic data available for comparison
  - Cons: the species ranges very widely and likely will not be represent conditions in the AOC well

- Northern Pike
  - Pros: existing advisory on the species; popular sport fish; consumed by many anglers; species has relatively good site fidelity and thus would

represent AOC conditions well; top predator and good indicator for mercury concentrations; historic data available for comparison
    - Cons: may be relatively difficult to collect an adequate sample size without special collection efforts

- Rock Bass or other small centrarchid species
    - Pros: popular and regularly consumed panfish; high site fidelity and thus will represent AOC conditions; fairly ubiquitous species that should allow several choices for reference sites; relatively easy to collect where present
    - Cons: populations may be found only in localized zones; no historic data available for comparison

- Yellow Perch
    - Pros: popular species for consumption; fairly ubiquitous; historic data available for comparison
    - Cons: more widely ranging than rock bass and other small centrarchids; may be more difficult to collect in the AOC due to habitat preferences; the species does not generally accumulate high levels of PCBs

We will target carp for collection because it represents the worst case for PCB contamination and because the species should be relatively easy to collect from both the SMR AOC and the reference site.

We will target northern pike as a second species for the reasons noted above. We will also collect rock bass and yellow perch as available. These supplementary species may not be analyzed initially but could provide additional evidence to support a delisting decision if needed.

In addition, although we plan to analyze 10 fish of each species from each site, we will attempt to collect up to 10 additional fish per species at each site. This will increase our ability to match length ranges between sites and will allow us the option of analyzing additional samples should the initial results prove inconclusive.

Lastly, a minimum of 20 bullhead should be collected from the SMR AOC and from the reference site(s) to assess the status of the fish tumor BUI; additional samples (up to 20 from each site) would be preferable. Bullhead are the species most likely to develop tumors when exposed to contaminants. Both black bullhead and brown bullhead are likely to live in the SMR AOC; either one species or a combination of both would provide a suitable sample for this purpose.

MDEQ staff will conduct the collections in the SMR AOC.

Potential Reference Sites

An appropriate reference water body will support the selected target fish species and will not be another Area of Concern or have other known legacy contamination issues. Ideally, in the interest of efficiency and budgetary savings, the reference site will be one that the MDNR Fisheries Division samples regularly. The following sites were considered:

- Little Bay de Noc (northwest Lake Michigan)
    - Pros: MDNR samples the lake regularly and should be able to provide several species of fish; we have a good historic database available allowing analysis of contaminant trends
    - Cons: regional contaminant inputs may be different than those in the SMR AOC area

- Les Cheneaux Islands area (northern Lake Huron)
    - Pros: proximity to SMR AOC thus regional contaminant inputs should be similar
    - Cons: a special collection effort would be required; no historic data available for comparisons

We will use Little Bay de Noc as the primary reference water body for the SMR AOC. The MDNR Fisheries Division samples the area regularly, the target species are available there, and the regional influences should not be significantly different. In addition, MDEQ staff will attempt to collect the target species from the Les Cheneaux Islands.

Joseph Bohr
MDEQ Water Resources Division
4/13/2012

Quality Assurance Project Plan: Assessing Michigan's Beneficial Use of Sport-Caught Fish V2

December 12, 2013

Michigan Department of Community Health

MDCH

Great Lakes RESTORATION

DEQ

Bruneau, Michelle (DHHS)

From:	Murphy, Elizabeth <Murphy.Elizabeth@epa.gov>
Sent:	Thursday, December 19, 2013 3:41 PM
To:	Bruneau, Michelle (DCH)
Subject:	RE: Addendum to the QAPP

Michelle, It doesn't sound like we need to pass the document back through the signature chain. However, please make sure that the addendums are labeled with the correct version and data.

Do I have the final version then?

Beth

From: Bruneau, Michelle (DCH) [mailto:BruneauM@michigan.gov]
Sent: Tuesday, December 17, 2013 11:03 AM
To: Murphy, Elizabeth
Subject: RE: Addendum to the QAPP

Hi Beth:

I can't find in my emails that we ever touched base on this again…and I apologize if we did…
However, did you find out if the additional signatures were needed or are we good to go with the QAPP addendum as is?

Thank you!

><{{{'> www.michigan.gov/eatsafefish <'}}}><

Michelle Bruneau, MA
Michigan Department of Community Health
Project Coordinator & Health Educator
(517) 335-8984
bruneaum@michigan.gov

From: Murphy, Elizabeth [mailto:Murphy.Elizabeth@epa.gov]
Sent: Monday, October 28, 2013 2:15 PM
To: Bruneau, Michelle (DCH)
Subject: RE: Addendum to the QAPP

Thanks Michelle. Let me find out if additional signatures are needed and get those to you, if necessary.

Beth

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Elizabeth Murphy, MPH
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US Environmental Protection Agency
Great Lakes National Program Office
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From: Bruneau, Michelle (DCH) [mailto:BruneauM@michigan.gov]
Sent: Tuesday, October 22, 2013 2:42 PM
To: Murphy, Elizabeth
Cc: Dykema, Linda D. (DCH)
Subject: Addendum to the QAPP

Hi Beth:

In our original QAPP dated August 1, 2011 (approved Feb 2011), I had stated that additional sampling plans would be submitted at a later date as an addendum due to ongoing projects within two targeted AOCs.

As promised, please find the additional sampling plans attached to this email, submitted as an addendum to the original QAPP for the MDCH *Assessing Beneficial Use of Sport-Caught Fish* GLRI project.

I wasn't sure if you needed signatures again, or if the addendum would just be added to the original document. Please let me know, and I'll take care of getting the signatures ASAP, if necessary…

Thank you!

><{{{'> www.michigan.gov/eatsafefish <'}}}><

Michelle Bruneau, MA
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Title: Assessing Michigan's Beneficial Use of Sport-Caught Fish Quality Assurance Project Plan (QAPP)
EPA Grant Number: 00E00869

Effective Date: August 1, 2011

Version: Addendum to MDCH Version 1

Organization: Michigan Department of Community Health (MDCH), Lansing, Michigan

MDCH will continue to follow the QAPP entitled *Detroit River Fish Collection and Filet Analysis for Bioaccumulative Chemicals Quality Assurance Project Plan (QAPP)* as approved February 2011. The following fish collection plans are in addition to those submitted with the original QAPP document:

Attachment 8: River Raisin
Attachment 9: Rouge River

A. Project Management

1A. Approvals

Elizabeth Murphy: ____ **Date:** _______________
U.S. EPA, Project Manager

Louis Blume: ____ **Date:** _______________
U.S. EPA, Quality Assurance Officer

Bonita Taffe: ____ **Date:** _______________
MDCH, Analytical Chemistry Laboratory Manager

Joseph Bohr: ____ **Date:** _______________
MDEQ, Fish Contaminant Specialist

Linda Dykema: ____ **Date:** _______________
MDCH, Toxicology and Response Section Manager

Kory Groetsch: ____ **Date:** _______________
MDCH, QA Project Manager

River Raisin Area of Concern

Status of the Fish Consumption BUI

Sampling Plan

The River Raisin Area of Concern (RR AOC) is located in southeastern Michigan and includes the river downstream from the low-head dam (Dam #6) at Winchester Bridge in the City of Monroe. The RR AOC also extends into Lake Erie and along the nearshore zone north and south of the river mouth. Michigan has issued fish consumption advisories for this reach of the River Raisin beginning in the 1980's and continuing to the present. PCBs are the primary contaminant driving consumption advisories on fish taken from the lower River Raisin.

The 2013 Michigan Department of Community Health fish consumption advisory recommends that no one eat carp, channel catfish, or larger black buffalo and white bass, and recommends limits on consumption of smallmouth bass and freshwater drum. The RR AOC was most recently sampled in 2008 when carp, channel catfish, freshwater drum, smallmouth bass, and white bass were collected.

To determine the status of the Fish Consumption BUI in the SCR AOC we need to compare the concentrations of key contaminants in one or more species of fish collected from the AOC and from an appropriate reference site. The comparisons should be made using 10 fillets from a similar size range of the same species from each of the sites. All samples should be analyzed for mercury, total PCBs, and the standard suite of contaminants normally measured for the Michigan DEQ fish contaminant monitoring program. In addition, 10 samples of a select species from each site should be assayed for dioxin TEQ, including dioxin-like PCB congeners, in order to update the fish consumption advisory.

<u>Fish species</u>
I propose that we collect and analyze contaminant concentrations in at least 2 species of fish from the RR AOC and the same species from a reference water body for comparison. The following species should be considered:

- Carp
  - Pros: existing advisory on the species; carp tend to have the highest PCB burdens for a given water body; consumed by some anglers; relatively ubiquitous species
  - Cons: may range outside of the AOC to some extent; not a popular sport fish

- Freshwater Drum
  - Pros: existing advisory on the species; consumed by some anglers
  - Cons: may range outside of the AOC to some extent; not highly sought after; choices for reference sites may be somewhat limited

- Smallmouth Bass
  - Pros: existing advisory on the species; popular sportfish and consumed by some anglers; good site fidelity and thus will represent AOC

conditions; fairly ubiquitous species that should allow several choices for reference sites; relatively easy to collect where present

- Rock Bass or other small centrarchids species
    - Pros: popular and regularly consumed panfish; high site fidelity and thus will represent AOC conditions; fairly ubiquitous species that should allow several choices for reference sites; relatively easy to collect where present
    - Cons: populations may be found only in localized backwater zones;

- Yellow Perch
    - Pros: popular species for consumption; fairly ubiquitous
    - Cons: lower site fidelity than rock bass and other small centrarchids; may be more difficult to collect in the AOC due to habitat preferences; the species does not generally accumulate high levels of PCBs

I recommend selecting carp as one of the target species because it represents the worst case for PCB contamination and because the species should be relatively easy to collect from both the RR AOC and the reference site.

I recommend either smallmouth bass or rock bass (or a related centrarchid species), or both as additional target species. These species would provide a reasonable representation of conditions in the SCR AOC and should be available at most of the likely choices for a reference site. I suggest that we collect sufficient specimens of at least 2 potential target species in addition to the carp; although not all samples will necessarily be analyzed this would give us options for additional comparisons with fish from the reference site.

In addition, although we plan to analyze 10 fish of each species from each site, I recommend we attempt to collect additional (up to 10) fish per species at each site. This would increase our ability to match length ranges between sites and will allow us the option of analyzing additional samples should the initial results prove inconclusive.

<u>Potential Reference Sites</u>
An appropriate reference water body will support the selected target fish species and will not be another Area of Concern or have other known legacy contamination issues. Ideally, in the interest of efficiency and budgetary savings, the reference site will be one that the MDNR Fisheries Division samples regularly.

In addition, an ideal reference site will have contaminant inputs from sources outside of the AOC that are similar to the inputs affecting the AOC. Mercury, PCBs, and other contaminants of concern are transported into the RR AOC watershed atmospherically and through other non-point sources. The magnitude of these inputs varies regionally; for example, industrialized and urbanized areas tend to emit and discharge higher levels of PCBs and mercury than less developed regions. The RR AOC is exposed to non-AOC inputs from Lake Erie and from the Detroit River AOC and thus is likely to have somewhat elevated contaminant levels even without sources within the RR AOC.

The following sites should be considered:

- Huron River (downstream of Rockwood to river mouth)
    - Pros: near the RR AOC and would provide a comparison incorporating non-AOC regional contaminant inputs
    - Cons: would require a special collection effort

- Lake Erie (Western basin)
    - Pros: MDNR samples the lake regularly and should be able to provide several species of fish; we have a good historic database available allowing analysis of contaminant trends; would provide a comparison incorporating non-AOC regional contaminant inputs
    - Cons: too strongly influenced by inputs from the RR AOC; individuals of some potential target species may range into the RR AOC for part of their lives therefore we could be sampling essentially the same population at both sites

- Little Bay de Noc (northwest Lake Michigan)
    - Pros: MDNR samples the lake regularly and should be able to provide several species of fish; we have a good historic database available allowing analysis of contaminant trends; relatively pristine area
    - Cons: regional contaminant inputs are likely to be very different than those in the RR AOC area

I recommend either the Huron River or Little Bay de Noc area as potential reference sites. The Huron River is probably the most appropriate since it is in the same heavily urbanized and industrialized area and is exposed to atmospheric and other non-point contaminant sources similar to those affecting the RR AOC.

Joe Bohr

9/23/2013

Rouge River Area of Concern
Status of the Restrictions on Fish and Wildlife Consumption BUI

Sampling Plan

Background

The Rouge River Area of Concern (RR AOC) includes the entire main branch as well as the lower, middle, and upper branches of the river. The RR AOC is listed for 14 beneficial use impairments, including Restrictions on Fish and Wildlife Consumption.

The current Michigan Department of Community Health fish consumption advisory includes varying recommendations for restricted consumption depending on species and location on the river. The primary contaminant driving the fish consumption advisories in the Rouge watershed is PCBs. The most recent fish contaminant monitoring conducted in the watershed was in 2005 when carp and a few other species were collected from several areas. PCB concentrations tended to be the highest in Newburgh Lake (Middle Branch Rouge River), the Lower Branch Rouge River, and Main Branch of the Rouge downstream of the Ford Dam.

A significant sediment remediation project was conducted in 1998, removing 400,000 cubic yards of contaminated sediment from Newburgh Lake. While fish contaminant monitoring indicates that PCB concentrations in several species have declined, fish consumption advisories remain in place for the lake and periodic fish tissue monitoring should continue there for the foreseeable future.

Sampling Plan

To determine the status of the Fish Consumption BUI in the RR AOC we will compare the concentrations of key contaminants in two or more species of fish collected from 2 areas within the AOC and from an appropriate reference site. The comparisons will be made using 10 fillets from a similar size range of the same species from each of the 3 sites. All samples will be analyzed for mercury, total PCBs, and the standard suite of contaminants normally measured for the Michigan DEQ fish contaminant monitoring program (Table 1).

An appropriate reference water body will support the selected target fish species and will not be another Area of Concern or have other known significant legacy contamination issues. In addition, the reference site will have contaminant inputs from sources outside of the AOC that are similar to those inputs affecting the AOC. Mercury, PCBs, and other contaminants of concern are transported into the RR AOC watershed atmospherically and through other non-point sources. The magnitude of these inputs varies regionally; for example, industrialized and urbanized areas tend to emit and discharge higher levels of PCBs and mercury than less developed regions. The RR AOC is exposed to non-AOC inputs from the southeast Michigan region and thus is likely to have somewhat elevated contaminant levels even without sources within the RR AOC.

We will collect fish for contaminant analysis from 2 reaches of the Rouge River and 1 reference area. Fish will be collected from:

1. Newburgh Lake (an impoundment of the Middle Branch Rouge River) has had legacy PCB contamination and in the recent past has been covered by fairly restrictive fish consumption advisories. A sediment remediation project has taken place, and subsequent monitoring indicates that PCB concentrations in fish have declined but remain somewhat elevated since that work was completed.
2. The Lower Branch and Main Branch Rouge River downstream of the Ford Dam; several species of fish from these river reaches have had do not eat advisories.
3. Ford Lake (impoundment of the Huron River) is a nearby waterbody without a significant legacy contamination issue that supports good populations of several potential target species and would be an appropriate reference site.

We will collect a minimum of two and ideally three species of fish for contaminant analysis from each of the 3 sampling areas. An ideal species is ubiquitous and is caught and consumed regularly by anglers. An ideal target species will also have good site fidelity making it to some degree representative of the water quality in the reach of river where it was collected.

Carp will be considered the primary target species. Although carp are not a popular sport fish in general, they do tend to have the highest PCB burdens for a given waterbody, they are consumed by some anglers, and they are relatively ubiquitous.

Secondary target species will include:

- Channel catfish are a fairly popular food fish and tend to have PCB and other contaminant concentrations similar to what is found in carp from the same water. However, the species is not as ubiquitous and tends might not be collected in sufficient numbers to allow an adequate comparison.
- Rock bass are a popular and regularly consumed panfish. The species is fairly ubiquitous and has good site fidelity.
- Largemouth and smallmouth bass are a popular sportfish, are fairly ubiquitous, and have good site fidelity.
- White sucker are regularly taken and consumed by a segment of the angling population and should be available from all of the proposed sampling sites.
- Northern pike are a popular top predator game fish although they not be available in sufficient numbers at all proposed sampling sites.

In summary, we plan to collect and analyze a minimum of 10 carp and 10 fish of a secondary species from each of 3 sampling sites, 2 within the Rouge watershed plus a reference site, for a total of 60 samples. We also recommend collection of up to 10 samples each of one or more of the other species discussed, as available. These latter samples may not be analyzed initially but could provide additional evidence to support a BUI retention or removal decision if needed.

In addition, although we plan to analyze 10 fish of a species from each site, we will attempt to collect additional (up to 10) fish per species at each site. This will increase our ability to match length ranges between sites and will allow us the option of analyzing additional samples should the initial results prove inconclusive.

Joseph Bohr
October 14, 2013

Table 1. Contaminants quantified in edible portion fish tissue samples for the Michigan Fish Contaminant Monitoring Program.

Standard Analyses	Level of Quantification
Hexachlorobenzene	0.001 ppm
gamma-BHC (Lindane)	0.001 ppm
Aldrin	0.001 ppm
Dieldrin	0.001 ppm
4,4'-DDE	0.001 ppm
4,4'-DDD	0.001 ppm
4,4'-DDT	0.001 ppm
2,4'-DDE	0.001 ppm
2,4'-DDD	0.001 ppm
2,4'-DDT	0.001 ppm
Heptachlor Epoxide	0.001 ppm
Mercury	0.010 ppm
Selenium	0.010 ppm
Oxychlordane	0.001 ppm
gamma-Chlordane	0.001 ppm
trans-Nonachlor	0.001 ppm
alpha-Chlordane	0.001 ppm
cis-Nonachlor	0.001 ppm
Octachlorostyrene	0.001 ppm
Hexachlorostyrene	0.001 ppm
Heptachlorostyrene	0.001 ppm
Pentachlorostyrene	0.001 ppm
Heptachlor	0.001 ppm
Terphenyl	0.250 ppm
Toxaphene	0.050 ppm
Mirex	0.001 ppm
PBB (FF-1, BP-6)	0.001 ppm
Total PCB (congener method)	0.001 ppm

Status of the Fish Tumor Beneficial Use Impairment In the Rouge River Area of Concern

Background

The Rouge River Area of Concern (RR AOC) includes the entire main branch as well as the lower, middle, and upper branches of the river. The RR AOC is listed for 14 beneficial use impairments, including fish tumors or other deformities. Several studies have associated internal and external tumors in fish with carcinogens in sediment and water at several locations in North America, and they were summarized by Baumann et al. (1996). Specifically, epidermal and liver tumors in brown bullhead and white sucker are strongly correlated with the presence of polynuclear aromatic hydrocarbons (PAH). It has been recommended that one or both species should be used to monitor tumor prevalence (Baumann 2002).

A fish community survey of the Rouge River watershed was conducted in 1986 by the Michigan Department of Natural Resources (SEMCOG, 1989). During that study the incidence of external lesions on the fish was recorded. Three species of bullhead (brown, black, and yellow) were collected during the survey but only 12 bullhead were collected overall, and none of the bullhead had external tumors. White sucker were much more numerous with 579 collected, 23 of which (4%) had external lesions. A spatial trend in the distribution of those fish with lesions was apparent: white suckers in the Upper Branch of the Rouge River had an occurrence rate of 6.5%, and white suckers in the Main Branch (between Troy at the upstream end and Detroit downstream) had an occurrence rate of 6.3%. No lesions were observed on white suckers collected in the Middle and Lower Branches. It is important to note that age data are not available for these fish; tumors are more likely to occur in older fish (Bauman 2002).

The prevalence of external lesions in white suckers from 3 relatively pristine areas ranges from 3.4% to 8.6% (Baumann et al., 1996) with an overall average of 5.2%.

Recommendations

Although the incidence of external lesions in fish from the RR AOC may be low we should conduct a follow-up study to verify the 1986 results.

Few bullhead of any species were collected during the relatively intense survey of the Rouge River conducted in 1986, and there is no reason to suspect that collections would be any more successful now. White sucker are likely to be more numerous and should be the target species. Any bullhead collected, regardless of species, should also be kept for examination.

At a minimum, collections should be attempted in the Upper Branch and the Main Branch of the Rouge River, as white sucker from these areas had measurable rates of tumor incidence in the 1986 survey. Collection of white sucker from a reference site should also be considered. Sufficient data are available in the literature for brown bullhead but similar data may not be available for white sucker.

Dr. Baumann (2002) has recommended an external tumor rate of 12% as a criterion for an Area of Recovery. A minimum of 100 white suckers should be collected from both

the Upper Branch and Main Branch of the Rouge River in order to be sufficiently confident that the rate of tumor incidence in the RR AOC is no greater than the background rate at a reference site or sites.

Age of the fish should be determined in order to help in the interpretation of results. This can be done by collecting scale samples from the white sucker and otoliths (inner-ear structures) from bullhead.

Sampling Plan Summary

A. Fish Collection Sites:
1. Upper Branch Rouge River between Farmington Hills and Wayne
2. Main Branch Rouge River between Troy and Detroit
3. Reference Area - need for site to be determined; possibilities would include the Huron River (Washtenaw, Wayne, and Monroe Counties)

B. Number of Samples: Up to 100 white suckers will be collected from both the Upper and Main Branches of the Rouge River. Bullhead collected incidentally to the white sucker collection will also be kept for analysis.

C. Sample Processing: Fish samples will be inspected for external lesions (tumors). Lesions will be described as to location on the body and photographed. Twenty white sucker will be randomly selected from each river reach; scale samples will be collected from those fish and total length will be recorded.

D. Data Analysis: The proportion and 95% confidence limits on the proportion of the incidence of external lesions will be calculated for each river reach. The Rouge River proportions will be compared to each other and to literature values. Fish age & length data will be reported.

Joseph Bohr
10/14/2013

References

Baumann, P. C. 2002. *Fish tumor BUI Criteria: Determining numbers for the delisting process*. Downloaded from www.glc.org/spac/proceedings/pdf/15Baumann.pdf on 4/2/2012.

Baumann, P.C., I.R. Smith, and C.D. Metcalfe. 1996. *Linkages between chemical contaminants and tumors in benthic Great Lakes fish.* J. Great lakes Res. 22(2):131-152.

Southeast Michigan Council of Governments and Michigan Department of Natural Resources. 1989. Remedial action plan for the Rouge River Basin.

Quality Assurance Project Plan: Assessing Michigan's Beneficial Use of Sport-Caught Fish V3

January 12, 2015

Michigan Department of Community Health

MDCH

Great Lakes RESTORATION

DEQ

APPENDIX B - QAPPs

Title: Assessing Michigan's Beneficial Use of Sport-Caught Fish Quality Assurance Project Plan (QAPP)
EPA Grant Number: 00E00869

Effective Date: August 1, 2011

Version: Addendum to MDCH Version 2.0

Organization: Michigan Department of Community Health (MDCH), Lansing, Michigan

MDCH will continue to follow the QAPP entitled *Detroit River Fish Collection and Filet Analysis for Bioaccumulative Chemicals Quality Assurance Project Plan (QAPP)* as approved February 2011. The following addendums are in addition to those submitted with the original QAPP document and version 2.0 in 2014:

Attachment 10: Clinton River
Attachment 11: Saginaw Bay/River
Attachment 12: Torch Lake
Attachment 13: Lab Personnel Update

A. **Project Management**

1A. Approvals

Elizabeth Murphy: Elizabeth Murphy ______ **Date:** 1/27/15
U.S. EPA, Project Manager

Louis Blume: L J Blume ______ **Date:** 1/27/15
U.S. EPA, Quality Assurance Officer

Matthew Geiger: Matthew J Geiger ______ **Date:** 1/16/15
MDCH, Analytical Chemistry Laboratory Manager

Joseph Bohr: ______ **Date:** 1/26/2015
MDEQ, Fish Contaminant Specialist

Kory Groetsch: ______ **Date:** 1/12/15
MDCH, Toxicology and Response Section Manager

Michelle Bruneau: Michelle Bruneau ______ **Date:** 1/12/15
MDCH, QA Project Manager

APPENDIX B - QAPPs

ATTACHMENT 10

Clinton River Area of Concern
Status of the Restrictions on Fish and Wildlife Consumption BUI

Sampling Plan

Background

The Clinton River Area of Concern (CR-AOC) includes the entire watershed as well as a portion of Lake St. Clair immediately downstream of the river mouth. The watershed includes areas of Oakland, Macomb, St. Clair, and Lapeer Counties. The CR-AOC is listed for eight beneficial use impairments, including Restrictions on Fish and Wildlife Consumption.

The current Michigan Department of Community Health fish consumption advisory includes varying recommendations for restricted consumption depending on species and location in the watershed. Consumption advice for fish taken downstream of the Yates Dam (near Oakland/Macomb County line) is based on elevated PCB and mercury concentrations. Mercury is the primary contaminant causing consumption advice for fish taken from Stony Creek Lake (an impoundment of Stony Creek), although PCBs could cause an advisory in the absence of mercury.

The most recent fish contaminant data available for the CR-AOC include carp, northern pike, rock bass, and white sucker collected from the main branch at Ryan Road near Utica in 2004, and northern pike collected from Stony Creek Lake in 2007 and 2008. In 2013 carp, largemouth bass, and rock bass were collected from the Clinton River at Mt. Clemens, rock bass were collected from the North Branch Clinton River at Wolcott Mill, and carp were collected from Red Run Drain. The fish collected in 2013 have been filleted and are ready to be analyzed.

Proposed Sampling Plan

To determine the status of the Fish Consumption BUI in the CR-AOC we will compare the concentrations of key contaminants in fish collected from three areas within the AOC and from a reference site. The comparisons will be made using 10 fillets from a similar size range of the same species from each of the sites. All samples will be analyzed for mercury, total PCBs, and the standard suite of contaminants normally measured for the Michigan DEQ fish contaminant monitoring program (Table 1).

A. Species

We will collect up to three species of fish for contaminant analysis from each of the three sampling areas. An ideal species is ubiquitous and is caught and consumed regularly by anglers. An ideal target species will also have good site fidelity making it to some degree representative of the water quality in the reach of river where it was collected.

Carp will be considered the primary target species. Although carp are not a popular sport fish in general, they do tend to have the highest PCB burdens for a given waterbody, they are consumed by some anglers, and they are relatively ubiquitous. Northern pike will also be a primary target species in Stony Creek Lake since they have been collected there regularly, are a popular top predator game fish, and are covered by a fish consumption advisory.

Secondary target species will include:

- Rock bass are a popular and regularly consumed panfish. The species is fairly ubiquitous and in general has good site fidelity.
- Largemouth and smallmouth bass are a popular sportfish, are fairly ubiquitous, and have good site fidelity.

B. Sampling Sites

We plan to compare contaminant concentrations in fish from four areas in the CR-AOC and one reference area. Fish have been or will be collected from:

1. The Clinton River from the Clinton River Spillway downstream to the Crocker Blvd bridge
2. Red Run upstream of the Clinton River confluence
3. Stony Creek Lake
4. North Branch Clinton River (Wolcott Mill)

An appropriate reference water body will support the selected target fish species and will not be another Area of Concern or have other known significant legacy contamination issues. In addition, the reference site will have contaminant inputs from sources outside of the AOC that are similar to those inputs affecting the AOC. Mercury, PCBs, and other contaminants of concern are transported into the CR-AOC watershed atmospherically and through other non-point sources. The magnitude of these inputs varies regionally; for example, industrialized and urbanized areas tend to emit and discharge higher levels of PCBs and mercury than less developed regions. The CR-AOC is exposed to non-AOC inputs from the southeast Michigan region and thus is likely to have somewhat elevated contaminant levels even without sources within the AOC.

The following sites should be considered:

1. Huron River: The Huron River is in the same region as the Clinton River, is exposed to similar atmospheric inputs and typical urban nonpoint source contamination, and supports a similar fish community. The Huron River near the river mouth should be similar to the Clinton River near Mt. Clemens. In addition, the Huron River has several impoundments that provide good comparisons to Stony Creek Lake.
2. Grand River: The Grand River also would be a reasonable reference water body, being relatively close to the Clinton. However, the watershed is considerably larger than both the Clinton and Huron watersheds and is relatively less urbanized than the other two rivers.

I recommend using the Huron River, specifically Ford Lake and the river reach downstream of the dam at Flat Rock as reference sites for Stony Creek Lake and free-flowing reaches of the Clinton River, respectively.

ATTACHMENT 10

C. Sample Collection Status

Fish samples were collected in 2013 in anticipation of sampling needs for evaluation of the BUI status. MDNR Fisheries Division staff conducted survey work in the Clinton River watershed, collecting carp from the Red Run drain and rock bass from the North Branch Clinton River at Wolcott Mill. MDEQ Surface Water Assessment Section biologists collected carp, rock bass, and largemouth bass from the Clinton River in Mt. Clemens upstream of I-94.

Carp, smallmouth bass, and rock bass were collected for other projects in 2013 from the Huron River at Ford Lake and in a free-running reach downstream of Rockwood. These can serve as reference samples for the Clinton River AOC evaluation without additional staff time or analytical costs.

A sampling effort in Stony Creek Lake is planned for 2014.

<u>Sampling Plan Summary</u>

In summary, we will collect and analyze a minimum of 10 fish of one species, and where possible 10 fish of a secondary species from each of six sampling sites, including the main branch Clinton, Red Run, North Branch Clinton, and Stony Creek Lake within the CR-AOC watershed, and an impoundment and free-running reach of a reference river. Carp will be a primary target species at all sites. Northern pike will be a target species both in Stony Creek Lake and the reference impoundment. We also recommend collection of up to 10 samples each of one or more of the other species discussed, as available. These latter samples may not be analyzed initially but could provide additional evidence to support a BUI retention or removal decision, if needed.

In addition, although we plan to analyze 10 fish of a species from each site, we will attempt to collect additional (up to 10) fish per species at each site. This will increase our ability to match length ranges between sites and will allow us the option of analyzing additional samples should the initial results prove inconclusive.

Joseph Bohr
June 20, 2014

ATTACHMENT 10

Table 1. Contaminants quantified in edible portion fish tissue samples for the Michigan Fish Contaminant Monitoring Program.

Standard Analyses	Level of Quantification
Hexachlorobenzene	0.001 ppm
gamma-BHC (Lindane)	0.001 ppm
Aldrin	0.001 ppm
Dieldrin	0.001 ppm
4,4'-DDE	0.001 ppm
4,4'-DDD	0.001 ppm
4,4'-DDT	0.001 ppm
2,4'-DDE	0.001 ppm
2,4'-DDD	0.001 ppm
2,4'-DDT	0.001 ppm
Heptachlor Epoxide	0.001 ppm
Mercury	0.010 ppm
Selenium	0.010 ppm
Oxychlordane	0.001 ppm
gamma-Chlordane	0.001 ppm
trans-Nonachlor	0.001 ppm
alpha-Chlordane	0.001 ppm
cis-Nonachlor	0.001 ppm
Octachlorostyrene	0.001 ppm
Hexachlorostyrene	0.001 ppm
Heptachlorostyrene	0.001 ppm
Pentachlorostyrene	0.001 ppm
Heptachlor	0.001 ppm
Terphenyl	0.250 ppm
Toxaphene	0.050 ppm
Mirex	0.001 ppm
PBB (FF-1, BP-6)	0.001 ppm
Total PCB (congener method)	0.001 ppm

ATTACHMENT 11

Saginaw River and Bay Area of Concern
Status of the Restrictions on Fish and Wildlife Consumption BUI

Sampling Plan

Background

The Saginaw River/Bay Area of Concern (SRB-AOC) includes the entire 22-mile length of the Saginaw River and all of Saginaw Bay. The Saginaw Bay watershed includes areas of 22 counties. The SRB-AOC is listed for 12 beneficial use impairments, including Restrictions on Fish and Wildlife Consumption.

The current Michigan Department of Community Health fish consumption advisory includes varying recommendations for restricted consumption depending on species, including a do not eat advisory for carp (*Cyprinus carpio*), channel catfish (*Ictaluras punctatus*), and white bass (*Morone chrysops*). PCBs and dioxins are the primary contaminants causing consumption advice for fish taken from both the River and Bay.

The most recent fish contaminant data available for the SRB-AOC include carp collected from the Saginaw River at Bay City in 2004, carp, channel catfish, white sucker, and yellow perch collected from Saginaw Bay in 2004, and walleye and white bass collected from Saginaw Bay in 2008. In addition carp, smallmouth bass, pumpkinseed, and rock bass were collected from the Saginaw River near the river mouth in 2013; those fish have been filleted and are ready to be analyzed.

Proposed Sampling Plan

To determine the status of the Fish Consumption BUI in the SBR-AOC we will compare the concentrations of key contaminants in two or more species of fish collected from within the AOC and from a reference site. The comparisons will be made using 10 fillets from a similar size range of the same species from each of the sites. All samples will be analyzed for mercury, total PCBs, and the standard suite of contaminants normally measured for the Michigan DEQ fish contaminant monitoring program (Table 1). In addition, ten samples each of two species will be analyzed for dioxins, furans, and dioxin-like PCBs. All results for samples collected from the SRB-AOC will be compared to results for samples to the same species collected from an appropriate reference site.

A. Species

We will collect a minimum of two and ideally three species of fish for contaminant analysis from the SRB-AOC and from a reference site. An ideal species is ubiquitous and is caught and consumed regularly by anglers. An ideal target species will also have good site fidelity making it to some degree representative of the water quality in the reach of river where it was collected.

Carp will be considered the primary target species. Although carp are not a popular sport fish in general, they do tend to have the highest PCB and dioxin burdens for a given waterbody, they are consumed by some anglers, and they are relatively ubiquitous.

ATTACHMENT 11

Secondary target species will include:

- Rock bass (*Ambloplites rupestris*) are a popular and regularly consumed panfish. The species is fairly ubiquitous and has good site fidelity.
- Smallmouth bass (*Micropterus dolomieu*) are a popular sportfish, are fairly ubiquitous, and have good site fidelity.

B. Sampling Sites

We plan to compare contaminant concentrations in fish from the SBR-AOC with fish from a reference area. Fish were collected from the Saginaw River near the river mouth in 2013; if necessary MDNR should be able to collect additional samples from Saginaw Bay during regular survey work.

An appropriate reference water body will support the selected target fish species and will not be another Area of Concern or have other known significant legacy contamination issues. In addition, the reference site will have contaminant inputs from sources outside of the AOC that are similar to those inputs affecting the AOC. Dioxins, PCBs, mercury, and other contaminants of concern are transported into the SBR-AOC watershed atmospherically and through other non-point sources. The magnitude of these inputs varies regionally; for example, industrialized and urbanized areas tend to emit and discharge higher levels of PCBs and mercury than less developed regions. The SBR-AOC is exposed to non-AOC inputs from the southeast Michigan region and thus is likely to have somewhat elevated contaminant levels even without sources within the AOC.

The following sites should be considered:

1. Little Bay De Noc (northwest Lake Michigan)
   a. Pros: MDNR samples the lake regularly and should be able to provide several species of fish; we have a good historic database available allowing analysis of contaminant trends; similar regional contaminant inputs
   b. Cons: distance from SRB-AOC may mean regional contaminant inputs differ
2. Thunder Bay (Lake Huron)
   a. Pros: MDNR samples the Thunder Bay area of Lake Huron regularly and should be able to provide several species of fish; we have a good historic database available allowing analysis of contaminant trends
   b. Cons: regional contaminant inputs may be different than those in the SRB-AOC area; species complex is different and matching secondary target species may be more difficult.
3. Huron River: The Huron River is in the same general region as the Saginaw River, is exposed to similar atmospheric inputs and typical urban nonpoint source contamination, and supports a similar fish community.

I recommend using Thunder Bay (northern Lake Huron) as the primary reference site. In the past, MDNR has been able to provide carp collected during regular Thunder Bay survey work, but smallmouth bass and rock bass may be more problematic. If necessary, samples of the latter species collected from the lower Huron River, from Little Bay De Noc, or from both areas could be used for comparison with SBR-AOC samples.

ATTACHMENT 11

Sampling Plan Summary

In summary, we will collect and analyze a minimum of 10 carp and 10 fish of at least one secondary species from SBR-AOC and the same from a reference site or sites. In addition, although we plan to analyze 10 fish of a species from each site, we will attempt to collect additional (up to 10) fish per species at each site. This will increase our ability to match length ranges between sites and will allow us the option of analyzing additional samples should the initial results prove inconclusive.

Joseph Bohr
May 12, 2014

ATTACHMENT 11

Table 1. Contaminants quantified in edible portion fish tissue samples for the Michigan Fish Contaminant Monitoring Program.

Standard Analyses	Level of Quantification
Hexachlorobenzene	0.001 ppm
gamma-BHC (Lindane)	0.001 ppm
Aldrin	0.001 ppm
Dieldrin	0.001 ppm
4,4'-DDE	0.001 ppm
4,4'-DDD	0.001 ppm
4,4'-DDT	0.001 ppm
2,4'-DDE	0.001 ppm
2,4'-DDD	0.001 ppm
2,4'-DDT	0.001 ppm
Heptachlor Epoxide	0.001 ppm
Mercury	0.010 ppm
Selenium	0.010 ppm
Oxychlordane	0.001 ppm
gamma-Chlordane	0.001 ppm
trans-Nonachlor	0.001 ppm
alpha-Chlordane	0.001 ppm
cis-Nonachlor	0.001 ppm
Octachlorostyrene	0.001 ppm
Hexachlorostyrene	0.001 ppm
Heptachlorostyrene	0.001 ppm
Pentachlorostyrene	0.001 ppm
Heptachlor	0.001 ppm
Terphenyl	0.250 ppm
Toxaphene	0.050 ppm
Mirex	0.001 ppm
PBB (FF-1, BP-6)	0.001 ppm
Total PCB (congener method)	0.001 ppm

ATTACHMENT 12

Torch Lake Area of Concern
Status of the Restrictions on Fish and Wildlife Consumption BUI
Sampling Plan

Background

Historically, the Torch Lake region (Houghton County) has been an area of copper mining, ore processing, and copper reclamation activities. For over one hundred years, mining and copper processing wastes were released into Torch Lake and surrounding bodies of water. Accidental spills or poor waste disposal methods by area industries may have introduced PCBs to the watershed; sediment and water sampling in Torch Lake has detected scattered low-level PCB contamination. Torch Lake is currently listed as a Great Lakes Area of Concern by the United States Environmental Protection Agency (USEPA), in part because of elevated levels of polychlorinated biphenyls (PCBs) in fish.

The PCB concentrations in fish collected from Torch Lake have been consistently higher than in fish found in nearby inland lakes. A fish consumption advisory due to elevated levels of PCBs was first issued for Torch Lake fish by the Michigan Department of Community Health (MDCH) in 1998. The most recent advisory, based on samples collected most recently in 2007, recommends restricting consumption of northern pike, smallmouth bass, and walleye from the lake.

A comparison study conducted in 2007 indicated that Torch Lake walleye had higher PCB concentrations than walleye collected from Huron Bay in Lake Superior. In addition to having significantly higher PCB concentrations, the higher concentrations warranted a more restrictive consumption advisory for the Torch Lake fish. We propose to repeat the study to evaluate the current status of the Torch Lake Fish and Wildlife Consumption BUI.

Sampling Plan

We propose to target walleye for collection from Torch Lake and from Lake Superior (Huron Bay, Baraga County). This will allow a comparison of conditions in Torch Lake with conditions in a reference water body, as well as an evaluation of PCB concentration temporal trends.

We recommend collection of at least one secondary target species. This will allow for a weight of evidence approach to any BUI removal decision as well as provide data for fish consumption advisory updates. Northern pike and smallmouth bass should be collected from both Torch Lake and Huron Bay, if possible.

A minimum of 10 fish of at least 2 species should be collected from each water body for analysis. Attempts should be made to collect up to 10 additional specimens of each species from each water body. This will increase our ability to match length ranges between sites and will allow us the option of analyzing additional samples, if necessary.

In summary, a minimum of 10 walleye will be collected from Torch Lake in a range of lengths, along with a minimum of 10 walleye from Huron Bay in a similar size range. Ideally, additional walleye will be collected from both water bodies along with a minimum of 10 each of northern pike, smallmouth bass, or both, from both water bodies.

Samples will be analyzed for PCBs, mercury, and the standard suite of chlorinated organic compounds.

Joseph Bohr / MDEQ / 9 January 2013

ATTACHMENT 13

8A.Special Training Requirements/Certification

MDCH Analytical Chemistry

Matthew Geiger, MS- is the manager of Acting Section Manager of Analytical Chemistry (AC). He is responsible for the overall operation of the project within the laboratory: overseeing the implementation of project activities, coordination with other agencies, development of materials, provisions of in service and training, conducting meetings; directing the gathering, tabulating and interpreting of required data, responsible for overall program evaluation and for staff performance evaluation; and is the responsible authority for ensuring necessary laboratory reports and documentation are produced. He has over 18 year of experience with the AC Laboratory analyzing fish tissue and biological samples for bioaccumulating compounds by GC-ECD and GC/MS. He also has experience in analyzing biological sample for chemical agents by LC/MS/MS, GC/MS and GC/MS/MS.

Piotr Pawlak, PhD, Scientist Specialist, coordinates High Resolution Mass Spectrometry system and has 4 years' experience in the field of Mass Spectrometry. Dr. Pawlak also has experience in running the laboratories GC single quadrapole and triple quandrapole systems that are used in part for the Laboratory Resposnse Network for chemical exposure.

Mike O'Keefe – Laboratory Scientist 13 – 35 years with AC-Laboratory analyzing fish tissue and biological samples for bioaccumulating compounds by GC-ECD and GC/MS.

Dean Walker – Laboratory Scientist 12 – 14 years with AC-Laboratory analyzing fish tissue and biological samples for bioaccumulating compounds by GC-ECD and GC/MS.

Emily Moreno – Laboratory Scientist 11 – 3 years with AC-Laboratory analyzing fish tissue and biological samples for bioaccumulating compounds by GC-ECD and GC/MS

Tim Karrer – Laboratory Scientist 12 – 6 years with AC-Laboratory analyzing fish tissue and biological samples for bioaccumulating compound by GC-ECD and GC/MS.

Ronald Kulwicki – Laboratory Technician 10 – 4 years with AC-Laboratory extracting and cleaning-up fish tissue samples for analysis by GC-ECD and GC/MS.

David Elliott – Laboratory Technician 10 – 10 years with AC-Laboratory extracting and cleaning-up fish tissue samples for analysis by GC-ECD and GC/MS.

Kory Groetsch, M.S. – MDCH Section Area Manager 1 – 20 years of experience with fish sampling plans including QAPPs for biota tissue sampling.

Jennifer Gray, Ph.D. – MDCH Toxicologist 12 – 7 years of experience evaluating environmental data and sampling plans

APPENDIX B - QAPPs

APPENDIX C - FISH SAMPLING COUNTS

Collection Date	Waterbody Name	Location	Species					N			
				GRANT FUNDING				ACTUAL ANALYSIS			
				# of Fish Proposed in Grant	MERCURY (approx $120 per sample)	PCBs (approx ~$600 per sample)	TEQ (approx $1050 per sample)	# of Fish Actually Sampled	MERCURY (approx $120 per sample)	PCBs (approx ~$600 per sample)	TEQ (approx $1050 per sample)
	Deer Lake	**AOC**	**Determined By Sampling Plan**	**20.00**	**$ 2,400.00**						
03-May-11	Deer Lake	Marquette County	Northern Pike					10	$ 1,200.00	$ 6,000.00	
03-May-11	Deer Lake	Marquette County	Walleye					11	$ 1,320.00	$ 6,600.00	
Environmental Summit	Deer Lake	Marquette County	White Sucker					10	$ 1,200.00	$ 6,000.00	
03-May-11	Deer Lake	Marquette County	Yellow Perch					15	$ 1,800.00	$ 9,000.00	
	Menominee River	**AOC**	**Determined By Sampling Plan**	**40.00**	**$ 4,800.00**	**$ 24,000.00**	**$ -**				
01-Oct-12	Menominee River	Lower Scott Flowage	Carp					5	$ 600.00	$ 3,000.00	$ 5,250.00
20-May-13	Menominee River	Lower Scott Flowage	Carp					1	$ 120.00	$ 600.00	$ 1,050.00
05-Aug-14	Menominee River	Lower Scott Flowage	Carp					5	$ 600.00	$ 3,000.00	$ 5,250.00
01-Oct-12	Menominee River	Lower Scott Flowage	Redhorse Sucker					5	$ 600.00	$ 3,000.00	
01-Oct-12	Menominee River	Lower Scott Flowage	Rock Bass					10	$ 1,200.00	$ 6,000.00	
01-Oct-12	Menominee River	Lower Scott Flowage	Smallmouth Bass					1	$ 120.00	$ 600.00	
20-May-13	Menominee River	Lower Scott Flowage	Smallmouth Bass					9	$ 1,080.00	$ 5,400.00	
15-May-12	Menominee River	Menominee, river	Black Crappie					10	$ 1,200.00	$ 6,000.00	
15-May-12	Menominee River	Menominee, river	Bluegill					10	$ 1,200.00	$ 6,000.00	
15-May-12	Menominee River	Menominee, river	Carp					10	$ 1,200.00	$ 6,000.00	
15-May-12	Menominee River	Menominee, river	Northern Pike					9	$ 1,080.00	$ 5,400.00	
15-May-12	Menominee River	Menominee, river	Smallmouth Bass					8	$ 960.00	$ 4,800.00	
04-Jul-13	Menominee River	Menominee, river	Smallmouth Bass					2	$ 240.00	$ 1,200.00	
15-May-12	Menominee River	Menominee, river	Yellow Perch					9	$ 1,080.00	$ 5,400.00	
	Raisin River	**AOC**	**Determined By Sampling Plan**	**20.00**	**$ 2,400.00**	**$ 12,000.00**					
28-Oct-13	Raisin River	Monroe, below	Carp					10	$ 1,200.00	$ 6,000.00	
28-Oct-13	Raisin River	Monroe, below Winchester Bridge	Largemouth Bass					10	$ 1,200.00	$ 6,000.00	
	Rouge River	**AOC**	**Determined By Sampling Plan**	**10.00**	**$ 1,200.00**	**$ 6,000.00**	**$ 10,500.00**				
09-Oct-13	Rouge River	d/s Lower Rouge confluence	Carp					10	$ 1,200.00	$ 6,000.00	
09-Oct-13	Rouge River	d/s Lower Rouge	Largemouth Bass					7	$ 840.00	$ 4,200.00	
09-Oct-13	Rouge River	d/s Lower Rouge	Rock Bass					10	$ 1,200.00	$ 6,000.00	
09-Oct-13	Rouge River	d/s Lower Rouge	Smallmouth Bass					3	$ 360.00	$ 1,800.00	
30-Oct-13	Rouge River, Middle Branch	Newburgh Lake	Bluegill					5	$ 600.00	$ 3,000.00	
30-Oct-13	Rouge River, Middle Branch	Newburgh Lake	Carp					10	$ 1,200.00	$ 6,000.00	$ 10,500.00
30-Oct-13	Rouge River, Middle Branch	Newburgh Lake	Largemouth Bass					10	$ 1,200.00	$ 6,000.00	
30-Oct-13	Rouge River, Middle Branch	Newburgh Lake	Pumpkinseed					5	$ 600.00	$ 3,000.00	
	St Clair River	**AOC**	**Determined By Sampling Plan**	**20.00**	**$ 2,400.00**	**$ 12,000.00**	**$ 10,500.00**				
15-Jun-12	St. Clair River	Algonac	Carp					10	$ 1,200.00	$ 6,000.00	$ 10,500.00
15-Jun-12	St. Clair River	Algonac	Rock Bass					10	$ 1,200.00	$ 6,000.00	
15-Jun-12	St. Clair River	Algonac	Smallmouth Bass					10	$ 1,200.00	$ 6,000.00	
15-Jun-12	St. Clair River	Algonac	Yellow Perch					10	$ 1,200.00	$ 6,000.00	
	St Marys River	**AOC**	**Determined By Sampling Plan**	**20.00**	**$ 2,400.00**	**$ 12,000.00**	**$ 10,500.00**				
16-May-12	St. Marys River	Munuscong Bay	Carp					10	$ 1,200.00	$ 6,000.00	$ 10,500.00
14-Jun-14	St. Marys River	Munuscong Bay	Northern Pike					10	$ 1,200.00	$ 6,000.00	
16-May-12	St. Marys River	Munuscong Bay	Pumpkinseed					10	$ 1,200.00	$ 6,000.00	
16-May-12	St. Marys River	Munuscong Bay	Redhorse Sucker					7	$ 840.00	$ 4,200.00	
16-May-12	St. Marys River	Munuscong Bay	Rock Bass					10	$ 1,200.00	$ 6,000.00	
14-Jun-14	St. Marys River	Munuscong Bay	Rock Bass					6	$ 720.00	$ 3,600.00	
16-May-12	St. Marys River	Munuscong Bay	Smallmouth Bass					10	$ 1,200.00	$ 6,000.00	
16-May-12	St. Marys River	Munuscong Bay	Walleye					8	$ 960.00	$ 4,800.00	
14-Jun-14	St. Marys River	Munuscong Bay	White Perch					10	$ 1,200.00	$ 6,000.00	
16-May-12	St. Marys River	Munuscong Bay	Yellow Perch					10	$ 1,200.00	$ 6,000.00	
	Torch Lake	**AOC**	**Determined By Sampling Plan**	**20.00**	**$ 2,400.00**	**$ 12,000.00**	**$ -**				
23-May-13	Torch Lake	Houghton County	Northern Pike					7	$ 840.00	$ 4,200.00	
01-Aug-13	Torch Lake	Houghton County	Northern Pike					3	$ 360.00	$ 1,800.00	
01-Aug-13	Torch Lake	Houghton County	Smallmouth Bass					10	$ 1,200.00	$ 6,000.00	
23-May-13	Torch Lake	Houghton County	Walleye					5	$ 600.00	$ 3,000.00	
01-Aug-13	Torch Lake	Houghton County	Walleye					5	$ 600.00	$ 3,000.00	
	REFERENCE SITES		**Determined By Sampling Plan**								
03-Sep-14	Menominee River	Big Quinnesec Falls	Smallmouth Bass					10	$ 1,200.00	$ 6,000.00	
28-Jul-14	Menominee River	Chalk Hills	Redhorse Sucker					10	$ 1,200.00	$ 6,000.00	
28-Jul-14	Menominee River	Chalk Hills	Walleye					5	$ 600.00	$ 3,000.00	
18-Sep-14	Menominee River	Kingsford Flowage	Largemouth Bass					2	$ 240.00	$ 1,200.00	
18-Sep-14	Menominee River	Kingsford Flowage	Smallmouth Bass					8	$ 960.00	$ 4,800.00	
18-Sep-14	Menominee River	Kingsford Flowage	White Sucker					10	$ 1,200.00	$ 6,000.00	
15-Sep-14	Menominee River	Twin Falls Flowage	Largemouth Bass					10	$ 1,200.00	$ 6,000.00	
15-Sep-14	Menominee River	Twin Falls Flowage	Northern Pike					10	$ 1,200.00	$ 6,000.00	
02-Sep-14	Menominee River	White Rapids	Largemouth Bass					2	$ 240.00	$ 1,200.00	
02-Sep-14	Menominee River	White Rapids	Redhorse Sucker					10	$ 1,200.00	$ 6,000.00	
02-Sep-14	Menominee River	White Rapids	Smallmouth Bass					8	$ 960.00	$ 4,800.00	
17-May-12	Lake Huron	Les Cheneaux	Carp					10	$ 1,200.00	$ 6,000.00	$ 10,500.00
17-May-12	Lake Huron	Les Cheneaux	Largemouth Bass					7	$ 840.00	$ 4,200.00	
17-May-12	Lake Huron	Les Cheneaux	Pumpkinseed					10	$ 1,200.00	$ 6,000.00	
17-May-12	Lake Huron	Les Cheneaux	Rock Bass					10	$ 1,200.00	$ 6,000.00	
17-May-12	Lake Huron	Les Cheneaux	Smallmouth Bass					10	$ 1,200.00	$ 6,000.00	
17-May-12	Lake Huron	Les Cheneaux	Yellow Perch					10	$ 1,200.00	$ 6,000.00	
09-Apr-12	Lake Michigan	Little Bay De Noc	Carp					9	$ 1,080.00	$ 5,400.00	$ 9,450.00
09-Apr-12	Lake Michigan	Little Bay De Noc	Redhorse Sucker					10	$ 1,200.00	$ 6,000.00	
09-Apr-12	Lake Michigan	Little Bay De Noc	Smallmouth Bass					10	$ 1,200.00	$ 6,000.00	
09-Apr-12	Lake Michigan	Little Bay De Noc	Walleye					10	$ 1,200.00	$ 6,000.00	
29-Apr-14	Lake Michigan	Little Bay De Noc	Northern Pike					10	$ 1,200.00	$ 6,000.00	
27-Jun-13	Huron River	Ford Lake	Bluegill					10	$ 1,200.00	$ 6,000.00	
27-Jun-13	Huron River	Ford Lake	Carp					10	$ 1,200.00	$ 6,000.00	
27-Jun-13	Huron River	Ford Lake	Largemouth Bass					3	$ 360.00	$ 1,800.00	
27-Jun-13	Huron River	Ford Lake	Rock Bass					10	$ 1,200.00	$ 6,000.00	
27-Jun-13	Huron River	Ford Lake	Smallmouth Bass					7	$ 840.00	$ 4,200.00	
29-Oct-13	Huron River	Rockwood	Carp					10	$ 1,200.00	$ 6,000.00	
29-Oct-13	Huron River	Rockwood	Largemouth Bass					9	$ 1,080.00	$ 5,400.00	
29-Oct-13	Huron River	Rockwood	Rock Bass					10	$ 1,200.00	$ 6,000.00	
29-Oct-13	Huron River	Rockwood	Smallmouth Bass					1	$ 120.00	$ 600.00	
	Torch Lake Reference Site		**Determined By Sampling Plan**	**20.00**	**$ 2,400.00**	**$ 12,000.00**					
30-May-13	Lake Superior	Keweenaw Bay, L'Anse Bay	Northern Pike					13	$ 1,560.00	$ 7,800.00	
20-Sep-13	Lake Superior	Huron Bay	Northern Pike					7	$ 840.00	$ 4,200.00	
20-Sep-13	Lake Superior	Huron Bay	Walleye					12	$ 1,440.00	$ 7,200.00	
			Totals:	**150.00**	**$ 20,400.00**	**$ 90,000.00**	**$ 31,500.00**	**674.00**	**$ 80,880.00**	**$ 404,400.00**	**$ 63,000.00**
					Total Proposed:	**$ 141,900.00**			**Total Leveraged:**	**$ 548,280.00**	

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION
JUNE 2013

STAFF REPORT

TEMPORAL TRENDS IN DEER LAKE FISH TISSUE MERCURY CONCENTRATIONS 1984 - 2011

INTRODUCTION

Deer Lake is a 900 acre impoundment of the Carp River in Marquette County near Ishpeming, Michigan (Figure 1). Carp Creek is a primary tributary to the Deer Lake impoundment. The Carp Creek, Deer Lake, Carp River system was designated as an Area of Concern (AOC) by the International Joint Commission, the Great Lakes National Program Office, and the State of Michigan in part because of elevated levels of mercury in fish tissue. The Michigan Department of Public Health (now the Department of Community Health) issued a “no consumption” advisory for fish from Carp Creek, Deer Lake, and the Carp River in 1981. The no consumption advisory remains in effect for Deer Lake but has been relaxed for selected species from Carp Creek and Carp River.

Iron mining activities were the major source of mercury to the Deer Lake system. Mercury containing blasting cap residues from the mines and waste reagents from the mine laboratory were released into the sewer system or washed into Carp Creek and ultimately into Deer Lake (Michigan Department of Natural Resources (MDNR), 1987). In addition wastes from gold mining activity near the northwest shore of Deer Lake contributed mercury to the system. Over time the contaminant built up to high levels in the Deer Lake sediments and aquatic biota.

Major mercury discharges from the Ishpeming WWTP ended in 1981 although other less significant inputs from the watershed continued. A study conducted in 2000 by Michigan State University estimated that mercury concentrations in Deer Lake surficial sediments would return to background levels around the year 2024 as existing sediments are gradually buried through natural processes (Fett et al. 2003).

Mercury in fish from the Deer Lake AOC has been monitored frequently since 1984. Concentrations of mercury in fillets of walleye and northern pike from Deer Lake collected in 1999 were higher than in fillets from those species collected from Greenwood Reservoir and Nawakwa Lake which have similar watershed and limnological characteristics (Day, 2000). Monitoring results since 1999 suggest that mercury concentrations in Deer Lake fish have been gradually declining. The purpose of this report is to determine the statistical significance of changes in fish tissue mercury concentration over the monitoring period.

SUMMARY

1. Fillet samples of brook trout, northern pike, walleye, white sucker, and yellow perch collected from the Deer Lake AOC between 1984 and 2011 were analyzed for total mercury.

2. Northern pike were collected from Deer Lake on 11 dates, walleye on 10 dates, and yellow perch on 8 dates; these data were sufficient for the evaluation of temporal trends in Deer Lake fish tissue mercury concentration.

3. Mercury concentrations in northern pike, walleye, white sucker, and yellow perch have all declined over the period of study.

4. Northern pike showed the most dramatic decline in mercury with an average annual rate of decline of 6.9% between 1984 and 2011.

5. Mercury concentrations in northern pike, walleye, and yellow perch from Deer Lake appear to have stabilized since about 2000.

6. Mercury concentrations in northern pike collected from Carp River Basin in 2011 were lower than the concentrations in northern pike collected there in 1999.

7. Mercury concentrations in Deer Lake fish have declined at a rate comparable to the rate of decline observed in walleye from Lake Gogebic, and at a higher rate than observed in walleye from South Manistique Lake.

METHODS

Fish were collected by the MDNR or the Michigan Department of Environmental Quality (MDEQ) from Deer Lake on 14 dates from 1984 through 2011, from Carp Creek on 2 dates (August 2005 and August 2010), and from the Carp River on 8 dates from 1984 through 2011. Fish were collected using electrofishing gear, fyke nets, and gillnets.

A total of 44 brook trout (*Salvelinus fontinalis*), 1 brown bullhead (*Amieurus nebulosis*), 169 northern pike (*Esox lucius*), 153 walleye (*Sander vitreus*), 53 white sucker (*Catostomus commersonii*), and 80 yellow perch (*Perca flavescens*) were collected from the Deer Lake AOC by state agencies and analyzed as fillet samples between 1984 and 2011 (Tables 1 through 5). Northern pike were collected from Deer Lake on 11 dates between 1984 and 2011, from the Carp River at the Carp River Basin on 3 dates, and from the Carp River at Eagle Mills on 2 dates. Walleye were collected from Deer Lake on 10 dates between 1990 and 2011; 2 walleye were collected from the Carp River at the Carp River Basin on one date in 2011. White sucker were collected from Carp Creek or Deer Lake on 4 dates between 1984 and 2011 and from the Carp River in 1984, 2004 , and 2011. Yellow perch were collected from Deer Lake on 8 dates between 1984 and 2011; 1 yellow perch was collected from the Carp River near Eagle Mills in 1984 and 1 was collected from the Carp River at the Carp River Basin in 2011.

The fish were processed as standard edible portions in accordance with the Great Lakes and Environmental Assessment Section Procedure 31. Standard edible portions are untrimmed, skin-on fillets for walleye, white sucker, yellow perch, and brook trout and untrimmed, skin-off fillets for northern pike. Each sample was individually wrapped in aluminum foil, appropriately labeled and frozen until analyzed.

Deer Lake AOC fish tissue samples were analyzed for total mercury by the Michigan Department of Natural Resources Environmental Laboratory between 1984 and 1988 and by the Michigan Department of Community Health Analytical Chemistry Laboratory after 1988. Both of these analytical laboratories have quality assurance programs and used peer-reviewed methods of sample digestion and quantification. Total mercury is referred to as "mercury" throughout the report.

MDEQ fish contaminant results are entered in an Access database and are available on-line at http://www.deq.state.mi.us/fcmp/default.asp. The results used for this report are included in Appendix A.

Mercury concentration generally increases with fish age. Since fish increase in length with age the length of a fish can be used as a surrogate for age. The length of fish in collections will vary from year to year and comparisons between years must account for differences in age/length of the fish.

Multiple linear regression analyses were used to evaluate the relationship between mercury concentration, fish length, and sample date. Mercury concentrations were transformed using natural logarithms in order to meet the assumptions of the statistical tests. After transformation the Deer Lake northern pike, walleye, and white sucker data met the normality and homogeneity of variance assumptions; the Deer Lake yellow perch data were normalized by the natural log transformation but the variance was not consistent across the data set. An exponential decay rate model was used to obtain estimates of average annual rates of change for each species/waterbody data set. The temporal trend was considered to be statistically significant if the p-value for the date coefficient was ≤ 0.05. Statistical analyses were completed using the Minitab 15 software package.

In addition, mercury concentrations in a standard length fish were calculated. Regression lines were calculated for each collection (species/year combination), plotting mercury concentration on the vertical axis versus fish length on the horizontal axis. The lines represent the best estimate of mercury concentration per unit length and can be used to predict the concentration in a given size fish. The mercury concentrations in a standard size northern pike, walleye, white sucker, and yellow perch were estimated for each year those species were collected.

Northern pike and walleye from Deer Lake provide the best data sets for the evaluation of temporal trends in fish tissue mercury concentrations. White sucker and yellow perch data for Deer Lake were also used to evaluate temporal trends but samples of those species were not collected regularly over the time period; conclusions based on those species are not strong. Data for other species or from other parts of the AOC were not sufficient for trend analyses.

The overall average size of northern pike in the Deer Lake AOC collections was 23 inches; 24 inches was chosen as the standard size northern pike since this is the minimum size that anglers can legally take from most Michigan waters. The overall average length of walleye in the Deer Lake AOC collection was 17.5 inches; 18 inches was chosen as the standard size for the species. The overall average length of white sucker collected from the Deer Lake AOC was 14.7 inches; 15 inches was chosen as the standard size for the species. The overall average length of yellow perch collected from the Deer Lake AOC was 10.3 inches; 10 inches was chosen as the standard size yellow perch.

The results for fish collected from Deer Lake were treated separately from results for samples from the Carp River. Although the Carp River is included as part of the Deer Lake AOC, fish in Deer Lake have been most directly exposed to legacy mercury contamination and historically have had significantly higher concentrations of mercury in the fillets. In addition, Carp River samples have been collected a significant distance downstream of the Deer Lake dam and probably represent distinct populations.

RESULTS

Northern Pike

Mercury concentrations in Deer Lake northern pike declined between 1984 and 2011 at an average annual rate of 6.9% based on the multiple regression results (Figure 2; Table 6). The estimated mercury concentration in 24-inch northern pike declined from a peak of 2.3 ppm in 1988 to an estimated 0.9 ppm in 2011, an overall change of -61%. The estimated mercury concentration in standard size northern pike has been relatively stable since 2001. A mercury concentration versus fish length regression line based on the data collected between 2001 and 2011 yields an estimated mercury concentration of 0.64 ppm in a 24-inch Deer Lake northern pike. This represents a change of -72% from the peak concentration observed in 1988.

A change in mercury concentrations was also measured in northern pike collected downstream of Deer Lake at the Carp River Basin. Eight northern pike ranging in length from 22.5 to 27.3 inches (mean length 24.6) were collected in 1999 and 11 fish ranging from 21.4 to 28.9 inches (mean length 23.6) were collected in 2011. A t-test comparing the northern pike of equivalent size showed that the mercury concentration in the 2011 samples (mean = 0.42 ppm) was significantly less ($p=0.001$) than the concentration measured in the 1999 samples (mean = 0.64 ppm). Two larger fish were collected in 1999 and 1 smaller fish was collected in 2011; these were not used in the comparison to avoid biasing the result.

Walleye

Mercury concentrations in Deer Lake walleye declined between 1990 and 2011 at an average annual rate of 3.8% based on the multiple regression results (Figure 3; Table 6). The estimated mercury concentration in 18-inch walleye declined from a peak of 1.12 ppm in 1997 to an estimated 0.99 ppm in 2011, an overall change of -12%. A visual evaluation of the estimated concentrations in 18-inch walleye suggests that concentrations may have increased slightly from 1990 through 1997 after which concentrations stabilized or declined gradually. Regression analysis of the two periods independently indicated there was no significant trend from 1990 through 1997; this was followed by a decline of 2.7% per year from 1997 through 2011.

White Sucker

White sucker collected from Carp Creek were treated as part of the Deer Lake population because there is no impediment to fish movement between the water bodies and some migration is likely. Mercury concentrations in Deer Lake white sucker declined between 1984 and 2011 at an average annual rate of 2.5% based on the multiple regression results (Figure 4; Table 6). The estimated mercury concentration in 15-inch white sucker declined from 0.41 ppm in 1984 to an estimated 0.15 ppm in 2011, an overall change of -63%.

The estimated mercury concentration in a 15-inch white sucker collected in 1984 has relatively wide confidence limits largely because of the small sample size for that year (n=5). In addition, no white sucker samples were collected from Deer Lake between 1984 and 2005. Both of these factors make the evaluation of a temporal trend somewhat suspect.

Yellow Perch

Mercury concentrations in yellow perch declined between 1984 and 2011 at an average annual rate of 6.7% based on the multiple regression results (Figure 5; Table 6). The estimated mercury concentration in 10-inch yellow perch declined from a peak of 1.65 ppm in 1984 to an estimated 0.34 ppm in 2011, an overall change of -79%.

The estimated mercury concentration in 10-inch yellow perch was approximately the same in 2011 as it was in 1998/1999. Statistically speaking, the yellow perch trend line is the least reliable of the 4 species evaluated because the data were furthest from being normally distributed and the variance was not homogenous across the data set. In addition, as with the white sucker data set, yellow perch were not adequately sampled for a lengthy period of time leaving a 14-year data gap between 1984 and 1998.

DISCUSSION

The northern pike, walleye, white sucker, and yellow perch data all indicate to varying degrees that mercury levels have declined in Deer Lake fish tissue since regular monitoring began in 1984. By comparison, the MDEQ has regularly monitored contaminant levels in fish from selected inland lakes and impoundments since 1990 to evaluate temporal trends. Of 12 inland water bodies monitored statewide, mercury concentrations in fish have increased in 1, decreased in 4, and remained unchanged in 7 (Bohr 2013). Two inland lakes in the Upper Peninsula are monitored as part of the temporal trend assessment. Mercury in Lake Gogebic (Gogebic/Ontonagon Counties) walleye has declined since 1990 at a rate of 4.7% per year; this may in part be attributed to reductions in mercury emissions from a nearby copper smelting facility. No measurable temporal trend in mercury concentrations in walleye from South Manistique Lake (Mackinac County) was observed over the period. Reductions in fish tissue mercury in Deer Lake compare favorably to these lakes.

One conclusion that can be drawn from the apparent decline in fish tissue mercury is that the legacy mercury contamination in Deer Lake is becoming less available for bioaccumulation. In order to conclude this we need to make several assumptions:

1. Fish growth rates have been stable over the period of study. Changes in growth rate can alter mercury concentrations in fish (Harris and Bodaly 1998; Trudel and Rasmussen 2006).

2. The food web has been stable over the period of study. Changing the length of the food chain of a predator fish will affect the amount of mercury accumulated by that species (Johnston et al. 2003).
3. Water chemistry and other in-lake physical processes affect mercury methylation rates (Mattieu et al. 2013) and we assume these have been stable over the period of study.

These and possibly other assumptions must be kept in mind. If in fact the availability of the legacy mercury has not changed and one or more of the assumptions is not true, fish tissue mercury could increase again if physical or biological conditions in the lake change.

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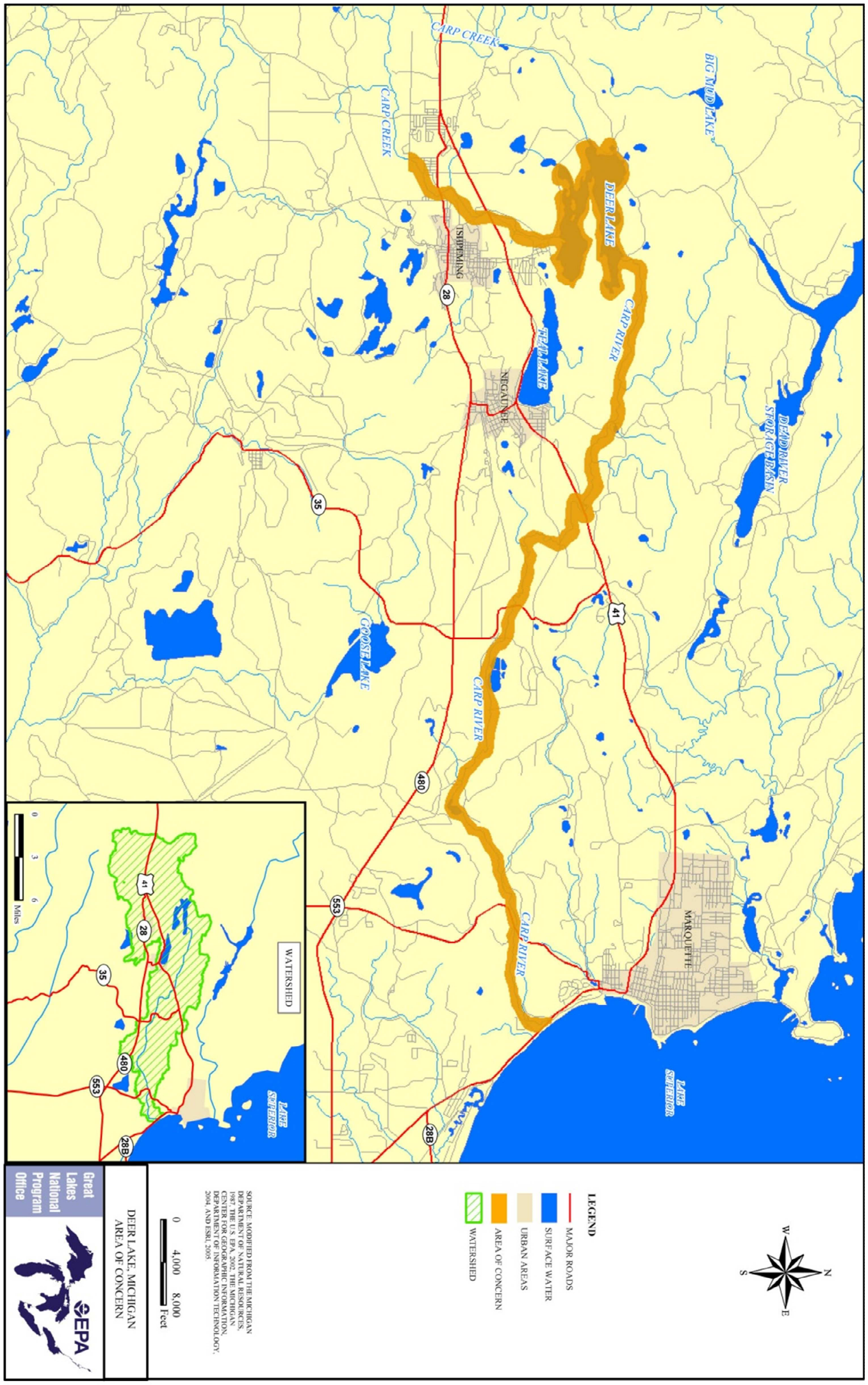

Figure 1. Map of Deer Lake Area of Concern.

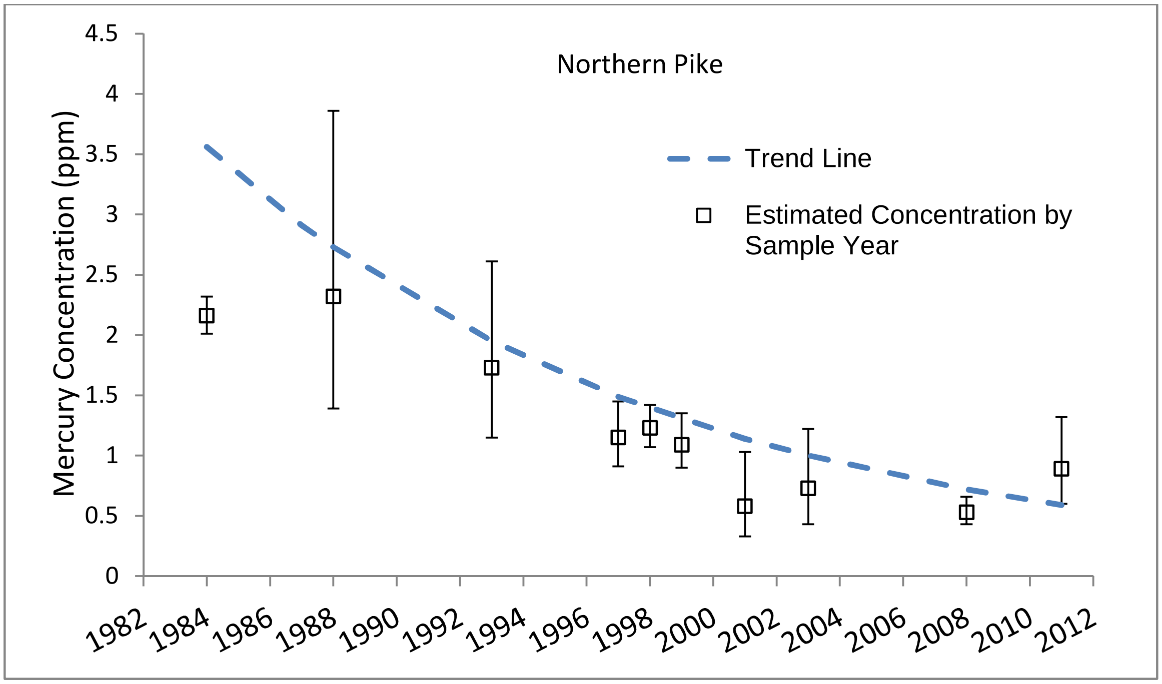

Figure 2. Temporal trend and estimated mercury concentrations in 24-inch northern pike collected from Deer Lake, Marquette County, Michigan, from 1984 through 2011. Error bars represent 95% confidence intervals.

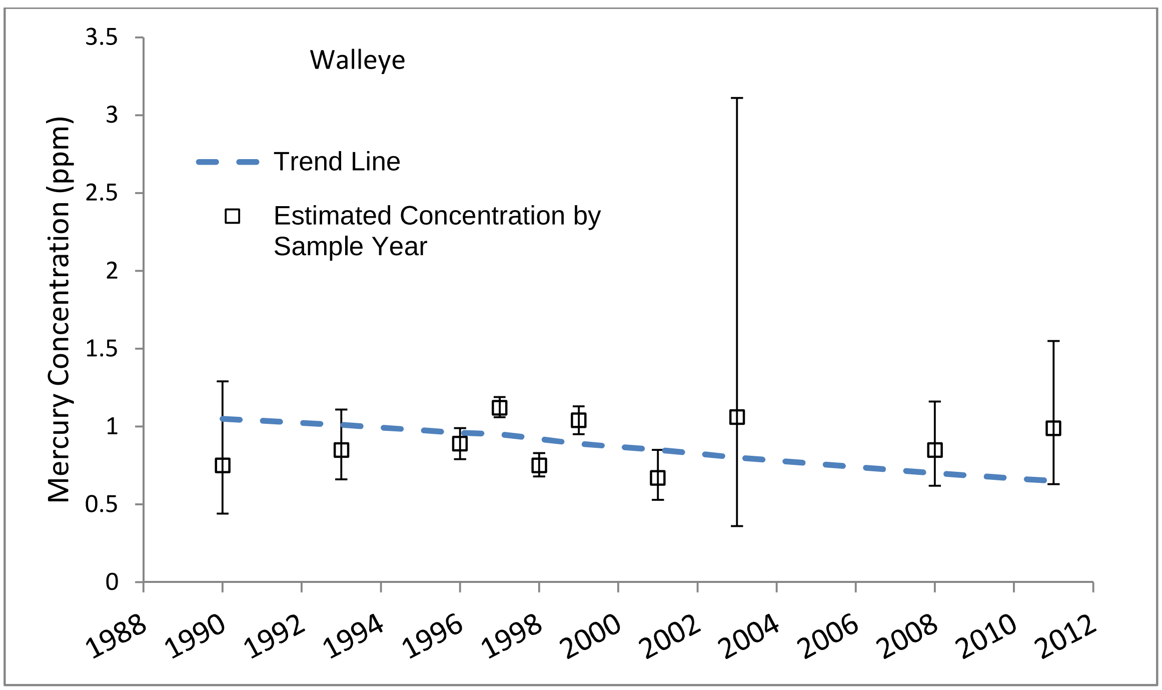

Figure 3. Temporal trend and estimated mercury concentrations in 18-inch walleye collected from Deer Lake, Marquette County, Michigan, from 1990 through 2011. Error bars represent 95% confidence intervals.

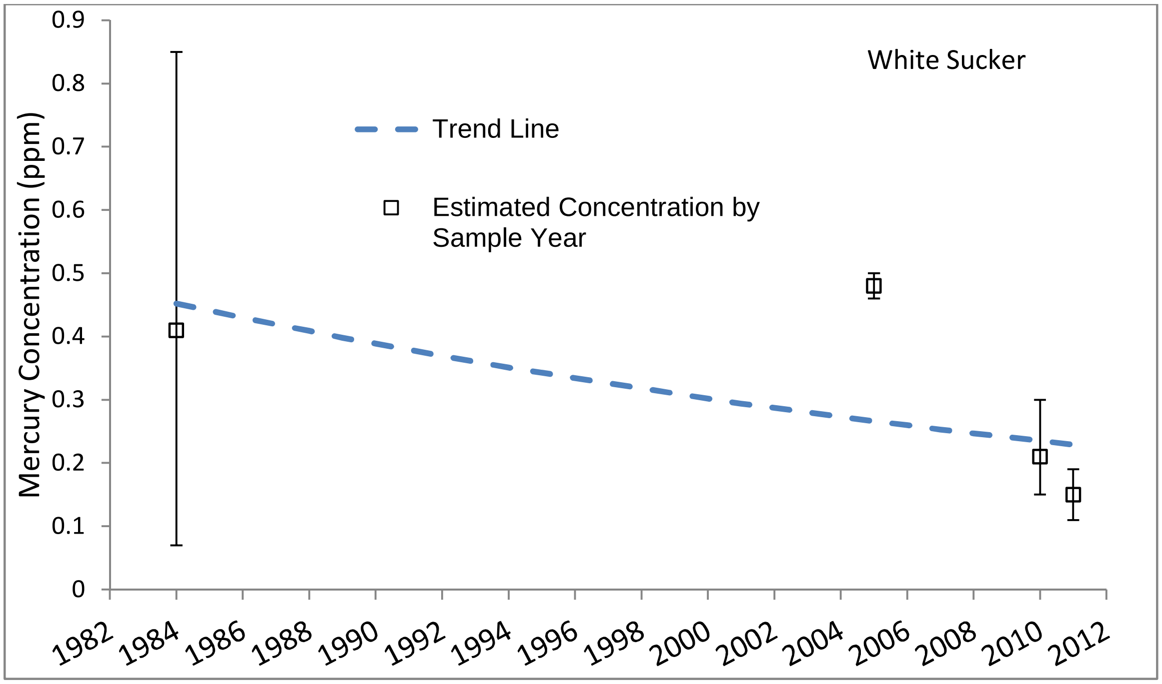

Figure 4. Temporal trend and estimated mercury concentrations in 15-inch white sucker collected from Carp Creek and Deer Lake, Marquette County, Michigan, from 1984 through 2011. Error bars represent 95% confidence intervals.

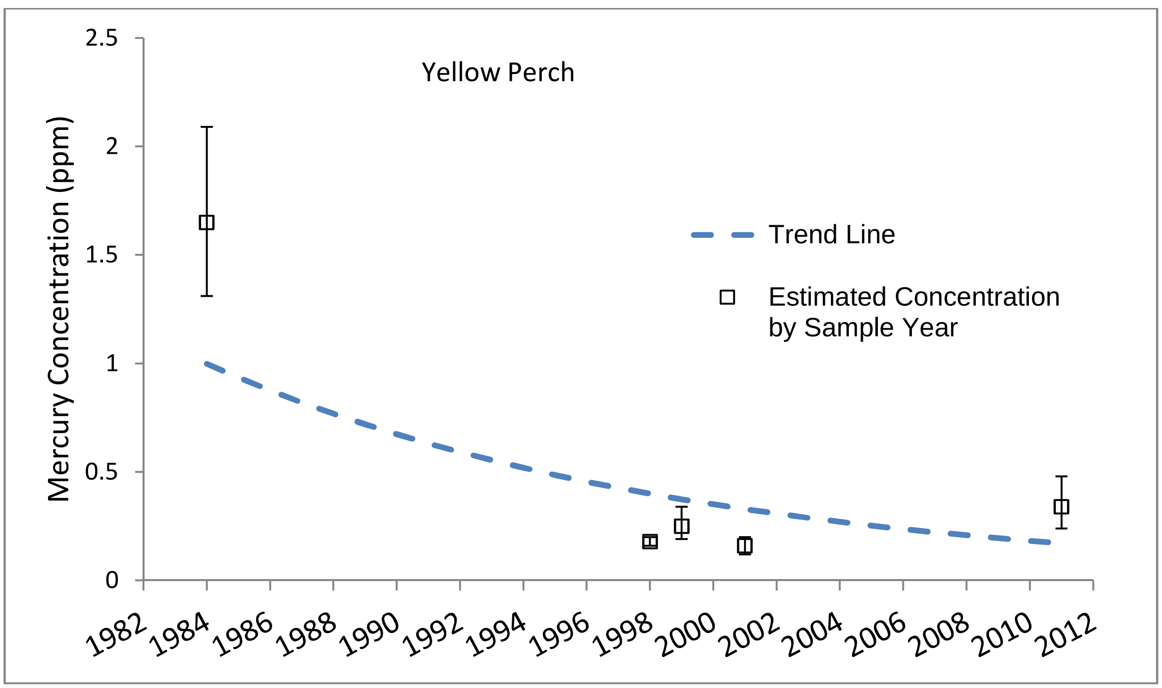

Figure 5. Temporal trend and estimated mercury concentrations in 10-inch yellow perch collected from Deer Lake, Marquette County, Michigan, from 1984 through 2011. Error bars represent 95% confidence intervals.

Table 1. Summary of brook trout samples collected by the MDNR and MDEQ from the Deer Lake Area of Concern between 1984 and 2005.

Waterbody	Location	Collection Date	N	Length (Inches)			Mercury Concentration (ppm)		
				Minimum	Mean	Maximum	Minimum	Mean	Maximum
Carp Creek	u/s Deer Lake	25-Aug-05	10	6.8	8.0	10.3	0.2	0.3	0.6
Carp River	Carp River Basin	20-Aug-99	10	7.3	9.0	12.2	0.1	0.2	0.2
Carp River	Eagle Mills	23-Jul-93	10	6.7	8.8	11.8	0.1	0.2	0.3
Carp River	Landfill Rd.	18-Aug-04	4	10.6	10.9	11.2	0.2	0.2	0.3
Carp River	M-35	27-Sep-84	1	9.5	9.5	9.5	0.4	0.4	0.4
Carp River	M-35	17-Aug-04	9	7.2	9.7	14.1	0.1	0.2	0.3

Table 2. Summary of northern pike samples collected by the MDNR and MDEQ from the Deer Lake Area of Concern between 1984 and 2011.

Waterbody	Location	Collection Date	N	Length (Inches)			Mercury Concentration (ppm)		
				Minimum	Mean	Maximum	Minimum	Mean	Maximum
Deer Lake	Marquette County	09-Oct-84	16	10.6	19.0	30.3	0.8	1.7	3.2
Deer Lake	Marquette County	26-Oct-87	18	12.6	15.7	17.6	2.1	3.1	4.4
Deer Lake	Marquette County	06-Oct-88	19	17.5	20.4	24.2	0.7	2.0	3.7
Deer Lake	Marquette County	14-Sep-93	10	20.5	26.4	33.9	0.5	2.0	2.6
Deer Lake	Marquette County	02-Oct-97	13	20.2	24.8	34.0	0.5	1.7	5.7
Deer Lake	Marquette County	09-Oct-98	20	16.9	21.9	35.6	0.3	1.3	10.5
Deer Lake	Marquette County	04-May-99	18	19.3	27.4	34.6	0.4	2.1	5.9
Deer Lake	Marquette County	01-May-01	6	22.6	25.0	27.0	0.4	0.7	1.5
Deer Lake	Marquette County	03-May-03	5	25.0	28.5	38.3	0.7	1.1	2.2
Deer Lake	Marquette County	14-Sep-08	5	20.9	25.1	33.8	0.3	0.8	2.1
Deer Lake	Marquette County	03-May-11	10	22.4	31.1	41.6	0.7	2.8	5.5
Carp River	Carp River Basin	20-Aug-99	10	22.6	26.6	36.8	0.5	0.7	1.1
Carp River	Carp River Basin	04-Aug-10	1	19.8	19.8	19.8	0.3	0.3	0.3
Carp River	Carp River Basin	29-Sep-11	12	18.5	23.2	28.8	0.3	0.4	0.5
Carp River	Eagle Mills	06-Oct-88	3	10.0	11.1	11.6	0.6	0.7	0.7
Carp River	Eagle Mills	23-Jul-93	3	22.8	25.2	27.2	1.2	1.6	2.2

Table 3. Summary of walleye samples collected by the MDNR and MDEQ from the Deer Lake Area of Concern between 1990 and 2011.

Waterbody	Location	Collection Date	N	Length (Inches)			Mercury Concentration (ppm)		
				Minimum	Mean	Maximum	Minimum	Mean	Maximum
Deer Lake	Marquette County	02-Nov-90	16	10.0	11.4	13.4	0.6	0.7	0.9
Deer Lake	Marquette County	14-Sep-93	10	10.6	16.4	20.5	0.3	0.8	1.7
Deer Lake	Marquette County	02-Oct-96	10	16.2	18.5	20.3	0.6	1.0	1.4
Deer Lake	Marquette County	02-Oct-97	10	16.7	18.8	23.0	1.0	1.2	1.3
Deer Lake	Marquette County	09-Oct-98	20	15.1	18.8	21.7	0.3	1.0	1.5
Deer Lake	Marquette County	04-May-99	35	14.6	18.6	23.6	0.4	1.2	1.7
Deer Lake	Marquette County	01-May-01	12	15.4	18.8	23.0	0.2	0.8	1.1
Deer Lake	Marquette County	03-May-03	5	18.2	19.1	19.9	0.6	1.1	1.5
Deer Lake	Marquette County	14-Sep-08	22	13.7	15.9	18.4	0.1	0.4	0.9
Deer Lake	Marquette County	03-May-11	11	19.0	20.0	21.3	0.9	1.3	1.6
Carp River	Carp River Basin	29-Sep-11	2	19.1	19.5	19.8	0.5	0.5	0.6

Table 4. Summary of white sucker samples collected by the MDNR and MDEQ from the Deer Lake Area of Concern between 1984 and 2011.

Waterbody	Location	Collection Date	N	Length (Inches)			Mercury Concentration (ppm)		
				Minimum	Mean	Maximum	Minimum	Mean	Maximum
Carp Creek	u/s Deer Lake	25-Aug-05	7	7.5	10.6	15.8	0.2	0.3	0.6
Carp Creek	u/s Deer Lake	04-Aug-10	10	10.9	15.6	18.7	0.1	0.2	0.4
Carp River	Carp River Basin	29-Sep-11	10	12.6	16.0	19.8	0.1	0.3	0.5
Carp River	M-35	27-Sep-84	1	11.1	11.1	11.1	0.3	0.3	0.3
Carp River	M-35	17-Aug-04	10	8.5	11.1	13.6	0.1	0.2	0.4
Deer Lake	Marquette County	09-Oct-84	5	15.7	18.2	19.7	0.4	0.5	0.8
Deer Lake	Marquette County	03-May-11	10	12.0	17.6	21.5	0.1	0.3	0.7

Table 5. Summary of yellow perch samples collected by the MDNR and MDEQ from the Deer Lake Area of Concern between 1990 and 2011.

Waterbody	Location	Collection Date	N	Length (Inches)			Mercury Concentration (ppm)		
				Minimum	Mean	Maximum	Minimum	Mean	Maximum
Carp River	Carp River Basin	29-Sep-11	1	7.9	7.9	7.9	0.1	0.1	0.1
Carp River	M-35	27-Sep-84	1	8.0	8.0	8.0	1.0	1.0	1.0
Deer Lake	Marquette County	09-Oct-84	20	6.9	8.3	10.0	0.6	1.2	2.2
Deer Lake	Marquette County	06-Oct-88	1	9.4	9.4	9.4	0.7	0.7	0.7
Deer Lake	Marquette County	02-Oct-97	1	8.2	8.2	8.2	0.2	0.2	0.2
Deer Lake	Marquette County	09-Oct-98	15	8.5	10.3	12.0	0.2	0.2	0.4
Deer Lake	Marquette County	04-May-99	13	9.8	12.0	14.0	0.2	0.5	0.9
Deer Lake	Marquette County	01-May-01	11	9.3	11.4	13.7	0.1	0.3	0.6
Deer Lake	Marquette County	12-Apr-10	2	8.5	9.4	10.2	0.2	0.2	0.2
Deer Lake	Marquette County	03-May-11	15	9.6	11.4	12.6	0.2	0.4	0.8

Table 6. Regression statistics for northern pike, walleye, white sucker, and yellow perch collected from Deer Lake, Marquette County, between 1984 and 2011.

Northern Pike

Regression Equation ln Hg = 4.79 - 0.000183 Date + 0.0873 Length (Inches)

Predictor	Coefficient	SE of Coefficient	T-Value	P
Constant	4.79	0.625	7.66	<0.001
Date	-0.000183	0.000021	-8.77	<0.001
Length (Inches)	0.0873	0.00956	9.14	<0.001
	S=0.55	R^2=42.3%		

Walleye

Regression Equation ln Hg = 1.26 - 0.000104 Date + 0.133 Length (Inches)

Predictor	Coefficient	SE of Coefficient	T-Value	P
Constant	1.26	0.5238	2.4	0.018
Date	-0.000104	0.000015	-6.86	<0.001
Length (Inches)	0.133	0.0103	13	<0.001
	S=0.37	R^2=54.5%		

White Sucker

Regression Equation ln Hg = - 0.024 - 0.000069 Date + 0.0869 Len (Inches)

Predictor	Coefficient	SE of Coefficient	T-Value	P
Constant	-0.0241	0.9855	-0.02	0.981
Date	-0.000068	0.000023	-2.97	0.006
Length (Inches)	0.08686	0.01998	4.35	<0.001
	S=0.44	R^2=52.3%		

Yellow Perch

Regression Equation ln Hg = 3.91 - 0.000179 Date + 0.158 Length (Inches)

Predictor	Coefficient	SE of Coefficient	T-Value	P
Constant	3.91	0.7073	5.53	<0.001
Date	-0.000179	0.0000245	-7.32	<0.001
Length (Inches)	0.158	0.0455	3.48	<0.001
	S=0.58	R^2=42.3%		

APPENDIX A.

Mercury results…

MI/DEQ/WRD-16/005
DRAFT REVISION

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION
MARCH 2016

STAFF REPORT

STATUS OF FISH CONTAMINANT LEVELS IN THE LOWER MENOMINEE RIVER AREA OF CONCERN

INTRODUCTION

The Lower Menominee River Area of Concern (MR-AOC) includes the lower three miles (4.8 km) of the river from the Park Mill (Wisconsin) Dam (aka Upper Scott Dam) downstream to the river mouth and approximately 3.1 miles (5 km) north and south of the mouth along the adjacent shoreline of Green Bay (GB). The Lower Scott Flowage (LSF), an impoundment formed by the Menominee Dam (aka Lower Scott Dam and Hattie Street Dam), is included in the AOC (Figure 1). The AOC watershed is shared between Michigan and Wisconsin.

Both Michigan and Wisconsin have issued consumption advisories for certain species of fish from the MR-AOC. Those advisories date back to 1976 (Zander, 1995) and are primarily due to elevated levels of polychlorinated biphenyls (PCBs). The MR-AOC is relatively close to the Lower GB and Fox River AOC. A large part of the problem in that AOC is due to historic discharges of PCB from numerous paper mills along the lower Fox River, and the MR-AOC may be impacted to some degree by that legacy contamination. The Lake Michigan Mass Balance Project (United States Environmental Protection Agency (U.S. EPA), 2006) estimated PCB loadings by major tributaries to the lake and compared PCB concentrations in Lake Michigan sediments. Based on that study it is believed that the Menominee River is a minor source of PCBs to GB, contributing roughly 20 times less than the Fox River. The mass balance study also estimated that the PCB loading from the Menominee River is only slightly higher than loadings from the Muskegon, Pere Marquette, and Manistique Rivers. A water quality study conducted on the Menominee River in 2011 found no evidence of a significant PCB source within the MR-AOC (Bohr, 2012).

Mercury is also a contaminant of concern and is a primary cause of fish consumption advisories covering the full length of the Menominee River. The source of mercury is most likely air-borne emissions, primarily from regional and global fossil fuel combustion, with subsequent atmospheric deposition throughout the watershed.

The pesticide DDT has a history of extensive use worldwide. The compound or its degradation products are present in measurable quantities in nearly all fish sampled from Michigan waters, including the Menominee River; if DDT was the only contaminant of concern it would cause a fish consumption advisory for the Menominee River downstream of the Menominee Dam. The source of DDT to the Menominee River watershed is likely a combination of atmospheric deposition and runoff from agricultural fields treated with the pesticide prior to its being banned in 1972.

Dioxins and furans are by-products of paper pulp bleaching, waste incineration, and the production of chlorinated chemicals. They have been measured in fish tissue samples from the Menominee River upstream of the Park Mill Dam, downstream of the Menominee Dam (DMD), and in fish from GB and Little Bay De Noc (LBDN). Currently, dioxins would cause fish consumption advisories in the upper Menominee River and in the MR-AOC if it was the only contaminant of concern.

Fish move freely between GB and the Menominee River up to the first dam, and it is thought that the primary source of PCBs and perhaps other contamination lies outside of the MR-AOC (Zander, 1995). Fish in the LSF are isolated from GB and the Menominee River downstream of the Menominee Dam. One goal of this project is to determine if the MR-AOC is a source of the contaminants causing fish consumption advisories in the AOC by comparing contaminant concentrations in fish from the LSF with concentrations in fish from DMD, and LBDN. The latter site is considered to be a reference site in that the area is sufficiently far from any AOC, but should be subject to the same regional climate and atmospheric contaminant inputs as the MR-AOC.

SUMMARY

1. Three species of fish were collected from the MR-AOC and LBDN from 2012 through 2014 and analyzed for mercury, PCBs, and chlorinated pesticides. Rock bass collected in 2008 from LBDN were compared to the same species collected from LSF in 2012.
2. Dioxin toxic equivalence (TEQ) was measured in carp collected from LSF and LBDN in 2014 and 2012, respectively. The results were compared to TEQ measurements in carp collected from DMD in 2006, GB in 2000, and upstream of the MR-AOC in 1991 and 1996.
3. Carp and smallmouth bass were collected in the LSF, DMD, and LBDN. Total PCB concentrations in both species were lowest in the LSF and highest in the DMD. The differences were statistically significant for both species.
4. Carp, northern pike, and smallmouth bass were collected from both DMD and LBDN. Total PCB concentrations in all three species were higher in the samples from DMD compared to LBDN, and the differences were statistically significant. The fish consumption guidance based on those results also differed for all three species.
5. Mercury concentrations in fish collected from upstream of the Menominee Dam were consistently higher than in fish of the same species collected from DMD or from LBDN.
6. Total DDT would be a secondary cause of fish consumption advisories for carp from both DMD and LBDN. Concentrations were slightly higher in carp from DMD than from LBDN but the projected consumption guidance was the same for both areas. Total DDT concentrations were low in all other fish populations sampled for this project and would not cause fish consumption advisories for those species.
7. Dioxin TEQ concentrations in carp from LSF were higher than measured in LBDN and GB. Dioxin TEQ concentrations in carp from DMD were not significantly different than in carp from LBDN. Sources of dioxins are most likely upstream of the MR-AOC.
8. The results of this project, in combination with previous studies, supports the hypothesis that PCBs and dioxins measured in fish collected from the MR-AOC are primarily from sources outside of the AOC.

METHODS

Carp (*Cyprinus carpio*) and smallmouth bass (*Micropterus dolomieu*) were the primary target species and were collected in both areas of the MR-AOC (LSF and DMD) and in LBDN, providing the best overall between site comparisons (Table 1). Carp were selected as a target species because they tend to have high PCB burdens relative to other species in a given water body, they are relatively ubiquitous, and results from previous sampling are available. Smallmouth bass were selected because they are a popular sport fish and have good site fidelity.

Northern pike (*Esox lucius*) and rock bass (*Ambloplites rupestris*) were collected at varying sites and provide additional between-site comparisons. Both species are popular with anglers and have good site fidelity.

Fish from the MR-AOC were collected by the Wisconsin Department of Natural Resources (WiDNR) primarily in 2012. Collections of sufficient numbers of carp and smallmouth bass were problematic and necessitated additional effort in 2013 and 2014. Fish from LBDN were collected by the Michigan Department of Natural Resources (MDNR) in 2012 and 2014. Rock bass collected from LBDN in 2008 were used for comparisons with fish collected from LSF in 2012. In addition, mercury concentrations in smallmouth bass collected in 2014 by We Energies from Menominee River impoundments to meet hydroelectric facility licensing requirements were used for comparison with fish collected from LSF.

Table 1. Number of fish samples collected from the Lower Menominee River AOC and Little Bay De Noc and analyzed by the MDHHS Laboratory (years of collection in parentheses). Little bay De Noc samples provided by MDNR, all others provided by the WiDNR.

Species	Lower Scott Flowage	Menominee River d/s Menominee Dam	Little Bay De Noc
Carp	11	10	9
	(2012, '13, '14)	(2012)	(2012)
Smallmouth Bass	10	10	10
	(2012, '13)	(2012, '13)	(2012)
Northern Pike	0	9	10
		(2012)	(2014)
Rock Bass	10		14
	(2012)		(2008)

The fish were processed as standard edible portions in accordance with the MDEQ, Water Resources Division, Fish Contaminant Monitoring Fish Collection Procedure WRD-SWAS-004. Total length was measured to the nearest millimeter and converted to inches for reporting. Length data are presented in Appendix A1. Total weight was measured to the nearest 10 grams and gender was recorded. Standard edible portions are untrimmed, skin-on fillets for rock bass and smallmouth bass, and untrimmed, skin-off fillets for carp, northern pike and redhorse sucker. Each sample was individually wrapped in aluminum foil, appropriately labeled, and frozen until preparation for analysis. A total of 65 fillet samples from the MR-AOC, 10 from CHF, and 53 from LBDN were analyzed (Table 1).

Table 2. Standard suite of contaminants quantified in fish tissue samples for the MDEQ Fish Contaminant Monitoring Program.

2,4'-DDD	*gamma*-Chlordane
2,4'-DDT	*trans*-Nonachlor
4,4'-DDD	*alpha*-Chlordane
4,4'-DDE	*cis*-Nonachlor
4,4'-DDT	Hexachlorobenzene
Aldrin	Mercury
Dieldrin	Mirex
gamma-BHC (Lindane)	Octachlorostyrene
Heptachlor	PBB (FF-1, BP-6)
Heptachlor Epoxide	Pentachlorostyrene
Heptachlorostyrene	Terphenyl
Hexachlorostyrene	Toxaphene
Oxychlordane	
Total PCB (as congeners; Aroclors prior to 2000)	

Since 2000, the MDHHS Laboratory has measured PCB concentrations using the congener method; total PCB concentration was estimated by summing the concentrations of PCB congeners. Individual congeners below the quantification level were assigned a concentration equal to 0 for the purpose of calculating a total PCB concentration. Also, congener analyses that did not meet retention time criteria or were subject to analytical interference were assigned a concentration equal to 0 for the purpose of calculating a total PCB concentration. All fillet and whole fish samples were analyzed for a standard suite of contaminants including total mercury, organochlorinated pesticides (Table 2), and PCB congeners (Table 3) by the Michigan Department of Health and Human Services (MDHHS) Analytical Chemistry Laboratory.

Table 3. PCB structure and corresponding identification number of congeners assayed in fish tissue samples.

Structure	BZ#	Structure	BZ#	Structure
TRICHLOROBIPHENYLS		PENTACHLOROBIPHENYLS		HEPTACHLOROBIPHENYLS
2,2',4	82	2,2',3,3',4	170	2,2',3,3',4,4',5
2,2',5	84	2,2',3,3',6	171	2,2',3,3',4,4',6
2,3,4'	87	2,2',3,4,5'	172	2,2',3,3',4,5,5'
2,3',4	90	2,2',3,4',5	174	2,2',3,3',4,5,6'
2,3',5	91	2,2',3,4',6	175	2,2',3,3',4,5',6
2,4,4'	92	2,2',3,5,5'	177	2,2',3,3',4',5,6
2,4',5	95	2,2',3,5',6	178	2,2',3,3',5,5',6
2,4',6	97	2,2',3',4,5	179	2,2',3,3',5,6,6'
2',3,4	99	2,2',4,4',5	180	2,2',3,4,4',5,5'
3,4,4'	100	2,2',4,4',6	182	2,2',3,4,4',5,6'
	101	2,2',4,5,5'	183	2,2',3,4,4',5',6
TETRACHLOROBIPHENYLS	105	2,3,3',4,4'	185	2,2',3,4,5,5',6
2,2',3,3'	110	2,3,3',4',6	187	2,2',3,4',5,5',6
2,2',3,4'	118	2,3',4,4',5	190	2,3,3',4,4',5,6
2,2',3,5'	126	3,3',4,4',5	193	2,3,3',4',5,5',6
2,2',3,6				
2,2',4,4'		HEXACHLOROBIPHENYLS		OCTACHLOROBIPHENYLS
2,2',4,5'	128	2,2',3,3',4,4'	194	2,2',3,3',4,4',5,5'
2,2',5,5'	130	2,2',3,3',4,5'	195	2,2',3,3',4,4',5,6
2,3,3',4'	132	2,2',3,3',4,6'	196	2,2',3,3',4,4',5,6'
2,3,4,4'	135	2,2',3,3',5,6'	198	2,2',3,3',4,5,5',6
2,3',4',5	136	2,2',3,3',6,6'	199	2,2',3,3',4,5,6,6'
2,3,4',6	137	2,2',3,4,4',5	201	2,2',3,3',4,5,5',6'
2,3',4,4'	138	2,2',3,4,4',5'	203	2,2',3,4,4',5,5',6
2,3',4',5	141	2,2',3,4,5,5'	205	2,3,3',4,4',5,5',6
2,3',4',6	144	2,2',3,4,5',6		
2,4,4',5	146	2,2',3,4',5,5'		NONACHLOROBIPHENYLS
3,3',4,4'	149	2,2',3,4',5',6	206	2,2',3,3',4,4',5,5',6
	151	2,2',3,5,5',6		
	153	2,2',4,4',5,5'		
	156	2,3,3',4,4',5		
	157	2,3,3',4,4',5'		
	158	2,3,3',4,4',6		
	163	2,3,3',4',5,6		
	167	2,3',4,4',5,5'		

BZ# = identification numbers adopted by the International Union of Pure and Applied Chemists (IUPAC)

Total DDT concentrations were calculated by summing concentrations of the para, para' and ortho, para' forms of DDT, dichlorodiphenyldichloroethylene (DDE), and 1,1-bis(4-chlorophenyl)-2,2-dichloroethane (DDD). Individual chemicals below the quantification level were assigned a concentration equal to 0 for the purpose of calculating a total DDT concentration. If all six components were below the quantification level, then the total DDT concentration was reported as less than the lowest quantification level of the metabolites.

Dioxin, dibenzofuran (furan), and dioxin-like PCB congener concentrations were measured in carp collected from LSF and LBDN (Tables 4a and 4b). In addition, dioxin and furan results are available for carp collected in 2006 from DMD. Total 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) TEQ was calculated for those samples using toxic equivalency factors developed by the World Health Organization (Van den Berg et al., 2006). The concentrations of individual dioxin, furan, and dioxin-like PCB congeners in a fish sample were multiplied by chemical-specific toxic equivalency factors and the resulting products summed to calculate a TCDD TEQ concentration. Individual congener concentrations less than the detection level were assigned a value of 0 for the purpose of calculating the dioxin TEQ. Dioxin TEQ was measured in carp collected from CHF in 1991 and 1996 (n=12), from LSF in 2014 (n=5), from DMD in 2006 (n=7), from GB in 2000 (n=10), and from LBDN in 2012 (n=9).

The complete dataset is available electronically (by request) or through the Fish Contaminant Monitoring Program Web site (www.deq.state.mi.us/fcmp).

The MDHHS, Division of Environmental Health, develops fish consumption advice following protocols described in the *Michigan Fish Consumption Advisory Program Guidance Document*. That document along with links to supporting documentation and other related reports is available online at http://www.michigan.gov/eatsafefish (Reports & Science button). The guidance was used in this report to predict the likely fish consumption advice based only on the most recent analytical results. Specifically, the projected advice was determined by comparing the 95 percent upper confidence limit (95% UCL) on the mean concentration in legal-size fish for each species/site/contaminant combination with the appropriate MDHHS screening value for that contaminant. The screening values developed by the MDHHS are presented in Appendix B. It is important to note that the projected consumption advice reported here may not be the final advice put forth by the MDHHS; the MDHHS bases consumption guidance on the most current analytical results in combination with previous data for the water body as well as knowledge of legacy or ongoing contamination issues.

The MDHHS fish consumption guidance is presented as a recommended number of meals per month of a given species. The meal categories range from 16 meals per month to a “Do Not Eat” category; the latter category is reserved for those species and water bodies where the estimated contaminant concentration in a single meal would exceed the annual safe level of exposure. In addition the MDHHS has designated a “Limited” category; healthy adults may eat 1 or 2 meals per year of fish in this category but it is recommended that women of childbearing age, young children, and adults with a chronic health condition not eat these fish.

Contaminant loads in fish are sometimes positively correlated with the age of the fish, and fish length is generally used as a surrogate for age. In addition, chlorinated contaminants such as PCBs, DDT, and dioxins tend to accumulate preferentially in lipids. Since the length range and lipid content of fish can vary from site to site, a simple comparison of contaminant concentrations has the potential to be biased. To compensate for the potential bias, statistical comparisons were conducted using a Generalized Linear Model (GLM) with lipid content, gender, and fish length as covariates for the chlorinated contaminant concentrations, and fish length and gender as covariates for mercury concentrations. Contaminant concentrations were transformed using the natural log in order to meet assumptions of the GLM.

In addition, chlorinated contaminant results were lipid normalized by dividing the contaminant concentration by the lipid content and compared using the Kruskal-Wallis (KW) and Mann-Whitney statistical tests, the nonparametric equivalent of Analysis of Variance, and the t-test, respectively.

Statistical tests were considered significant at $p \leq 0.05$. The software package Minitab 15 was used to perform the statistical tests.

Table 4a. Chlorinated dibenzo-p-dioxin (CDD) and chlorinated dibenzofuran (CDF) congeners quantified in fish tissue samples.

CDD	Quantification Limit (ppt)	TEF*
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1.0	1
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PCDD)	1.0	1
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	1.0	0.1
1,2,3,6,7,8-HxCDD	1.0	0.1
1,2,3,7,8,9-HxCDD	1.0	0.1
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	1.0	0.01
1,2,3,4,6,7,8,9,-Octachlorodibenzo-p-dioxin (OCDD)	1.0	0.003
CDF		
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	1.0 ppt	0.1
1,2,3,7,8-Pentachlorodibenzofuran (PCDF)	1.0 ppt	0.03
2,3,4,7,8-PCDF	1.0 ppt	0.3
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	1.0 ppt	0.1
1,2,3,6,7,8-HxCDF	1.0 ppt	0.1
1,2,3,7,8,9-HxCDF	1.0 ppt	0.1
2,3,4,6,7,8-HxCDF	1.0 ppt	0.1
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	1.0 ppt	0.01
1,2,3,4,7,8,9-HpCDF	1.0 ppt	0.01
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)	1.0 ppt	0.0003

Table 4b. Coplanar PCB congeners analyzed for Michigan's Fish Contaminant Monitoring Program.

BZ#	Structure	Quantification Limit (ppt)	TEF*
	TETRACHLOROBIPHENYLS		
77	3,3'4,4'	50	0.0001
81	3,4,4',5	50	0.0003
	PENTACHLOROBIPHENYLS		
105	2,3,3',4,4'	50	0.00003
114	2,3,4,4',5	50	0.00003
118	2,3',4,4',5	50	0.00003
123	2',3,4,4',5	50	0.00003
126	3,3',4,4',5	50	0.1
	HEXACHLOROBIPHENYLS		
156	2,3,3',4,4',5	50	0.00003
157	2,3,3',4,4',5'	50	0.00003
167	2,3',4,4',5,5'	50	0.00003
169	3,3',4,4',5,5'	50	0.03
	HEPTACHLOROBIPHENYLS		
189	2,3,3',4,4',5,5'	50	0.00003

* - World Health Organization 2,3,7,8 TCDD Toxic Equivalency Factors (Van den Berg et al., 2006)

RESULTS AND DISCUSSION

The following discussion includes between-site comparisons of results for total PCBs, mercury, total DDT, and dioxin. Elevated levels of PCBs, mercury, or both have led to the need for consumption advisories for certain species of fish taken from the MR-AOC since the early 1990s. While DDT has not caused advisories for MR-AOC fish, it is either known or likely to be present at concentrations high enough to cause advisories under the revised MDHHS advisory protocol now in use.

PCBs

PCBs were quantified in all fish collected from the DMD, and in all carp regardless of sampling site (Table 5). Otherwise, rates of quantification varied somewhat by species and sampling site. The highest PCB concentrations were measured in carp, regardless of sampling site; concentrations in northern pike, rock bass, and smallmouth bass were considerably lower (Table 6; Appendix A2). This pattern of concentrations between species is typical of other water bodies where these species coexist.

Table 5. Percentage of fish samples with quantifiable levels of total PCBs from the Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), and Little Bay De Noc (LBDN).

Species	LSF	DMD	LBDN
Carp	100	100	100
Northern Pike	--	100	70
Rock Bass	60	--	40
Smallmouth Bass	90	100	100

Table 6. Median total PCB and median lipid-normalized total PCB concentrations in fish collected from the Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), and Little Bay De Noc (LBDN).

Species	Median Total PCB (mg/kg)			Median Lipid-Normalized Total PCB (mg/kg)		
	LSF	DMD	LBDN	LSF	DMD	LBDN
Carp	0.04	1.83	0.67	0.02	0.29	0.12
Northern Pike	--	0.02	0.002	--	0.10	0.01
Rock Bass	0.002	--	0.002	0.004	--	0.008
Smallmouth Bass	0.002	0.05	0.008	0.02	0.13	0.02

There was no significant relationship between fish length and total PCB concentrations in carp from any of the three sampling sites in 2012, and the size range of carp collected at all sites was similar (Figure 2; Appendix A1). Gender was not a significant factor in the carp total PCB GLM. There was a strong correlation between lipid content and total PCB concentrations ($r=0.6$; $p<0.001$). The median total PCB and median lipid-normalized total PCB concentrations in carp from DMD were higher than in carp from LBDN (Table 6; Figure 3). Those differences were not statistically significant, although a larger sample size would probably indicate statistical significance. PCB concentrations in carp from both DMD and LBDN were significantly higher than concentrations in carp from LSF. These relationships were verified using the GLM. The projected consumption advice based on PCBs for carp from DMD and LBDN differs substantially from advice for carp from LSF (Table 7).

The northern pike collected from DMD and LBDN did not provide a good comparison due to the difference in lengths of the fish collected (Appendix A1). The northern pike from DMD were mostly clustered between 22 and 25 inches, while those from LBDN were fairly evenly spaced between 24 and 35 inches in length (Figure 4). Both total PCB and lipid-normalized PCB concentrations in the northern pike from DMD are higher than in northern pike from LBDN (Table 6; Figure 5), and the differences were statistically significant. Analysis using the GLM also indicated a significant difference between PCB concentrations in northern pike from the two areas. Gender was not a significant factor in the northern pike total PCB GLM. In addition, the projected consumption advice based on PCBs for northern pike from DMD is substantially more restrictive than for pike from LBDN (Table 7).

Table 7. The 95% UCL on the mean total PCB concentration and projected consumption advice due to total PCBs, based only on the most recent results for fish collected from the Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), and Little Bay De Noc (LBDN).

Species	95% UCL (ppm)			Meals per Month		
	LSF	DMD	LBDN	LSF	DMD	LBDN
Carp	0.12	2.85	2.06	1	DNE	Limited
Northern Pike	--	0.16	0.01	--	1	16
Rock Bass	0.01	--	0.003	16	--	16
Smallmouth Bass	0.07	0.09	0.02	2	2	12

DNE = Do Not Eat; MDHHS recommends that no one ever eat the fish in this category
Limited = Healthy adults may safely eat one or two meals per year of fish in this category. MDHHS recommends that women of childbearing age, young children, or adults with a chronic health condition should not eat these fish.
Note: *Meals per Month presented here do not represent the final MDHHS determinations*

Rock bass were collected from LSF in 2012 and from LBDN in 2008. Total PCB concentrations in rock bass from the two sites were not significantly different. Lipid-normalized total PCB concentrations in LSF rock bass were higher than in LBDN rock bass, although there was not a strong correlation between total PCBs and lipid content. The difference was due to an unusually high concentration measured in one fish from LSF (Figures 6 and 7). Gender was not a significant factor in the rock bass total PCB GLM. The projected consumption advice based on PCBs for rock bass from LSF is the same as for rock bass from LBDN (Table 7).

There was no significant relationship between fish length and total PCB concentrations in smallmouth bass from any of the three sites sampled in 2012 and 2013. Lipid content and total PCB concentrations were not strongly correlated in smallmouth bass. Gender was not a significant factor in the smallmouth bass total PCB GLM. Total PCB and lipid-normalized total PCB concentrations in smallmouth bass from DMD were higher than in both LSF and LBDN (Table 6; Figures 8 and 9), and the differences were statistically significant based on the KW tests. Total PCB concentrations in smallmouth bass from LSF were not different from bass from LBDN. The relationships were verified using the GLM. Overall, based on graphical interpretation and statistical analysis it appears that smallmouth bass from DMD have slightly higher concentrations of PCBs than those fish from LSF and LBDN. In addition, the projected consumption advice based on PCBs for smallmouth bass from the MR-AOC (both LSF and DMD) was more restrictive than for smallmouth bass from LBDN (Table 7).

Mercury

Total mercury was quantified in all samples from all sampling sites. The species having the highest median mercury concentration varied by sampling site (Table 8; Appendix A3). The interspecies pattern of mercury concentrations is unusual; generally a top predator (e.g., northern pike or smallmouth bass) has significantly higher mercury concentrations compared to species lower in the food web, but the median concentration in redhorse sucker from LSF was higher than in smallmouth bass from the same water body.

Table 8. Median total mercury in fish collected from the Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), and Little Bay De Noc (LBDN).

Species	Median Total Mercury (mg/kg)		
	LSF	DMD	LBDN
Carp	0.44	0.20	0.29
Northern Pike	--	0.22	0.49
Rock Bass	0.16	--	0.08
Smallmouth Bass	0.50	0.33	0.28

There was no significant relationship between fish length and total mercury in carp from any of the three sites sampled in 2012 (Figure 10). Gender was not a significant factor in the carp total mercury GLM. The highest mercury concentrations in carp were measured in samples taken from LSF (Table 8; Figure 11); the concentrations in all three sites were significantly different from each other, both using the KW and GLM statistical methods. The most restrictive projected consumption advice for carp is for fish from LSF while the least restrictive advice for carp is for fish from DMD (Table 9). This, along with results for other species, suggests that the mercury concentration in carp from the MR-AOC is not strongly related to mercury sources within the AOC. It might also indicate that the carp collected from DMD may have spent time in GB, outside of the Menominee River.

Table 9. The 95% UCL on the mean total mercury concentration and projected consumption advice due to mercury, based only on the most recent results for fish collected from the Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), and Little Bay De Noc (LBDN).

Species	95% UCL (ppm)			Meals per Month		
	LSF	DMD	LBDN	LSF	DMD	LBDN
Carp	0.57	0.25	0.38	1	4	2
Northern Pike	--	0.47	0.55	--	2	1
Rock Bass	0.24	--	0.11	4	--	8
Smallmouth Bass	0.69	0.42	0.36	1	2	2

Note: *Meals per Month presented here do not represent the final MDHHS determinations*

The northern pike samples do not provide an adequate between site comparison since the length ranges of fish collected from DMD and LBDN are not similar (Figures 12 and 13). However, if we assume northern pike from the two areas either intermingle or are exposed to similar levels of mercury we can combine the datasets and evaluate the relationship between fish length and mercury concentration. A regression of mercury concentration on fish length using the combined dataset produced a line with a statistically significant slope (Figure 12). Using the GLM with fish length as a covariate indicates that mercury concentrations in northern pike from DMD are higher than in those fish from LBDN. Gender was not a significant factor in the northern pike total mercury GLM. If advice for consumption of northern pike were based only on the mercury results for these sample sets, the advice for DMD would be less restrictive than for LBDN (Table 9).

Mercury concentrations in rock bass from LSF were significantly higher than in rock bass from LBDN (Figures 14 and 15). Mercury concentrations were positively correlated to fish length in both rock bass populations, and regressions of mercury concentration on fish length were significant for both populations. Gender was not a significant factor in the rock bass total mercury GLM. The projected consumption advice based only on these mercury results is more restrictive for rock bass from LSF as compared to LBDN (Table 9).

Both KW and GLM statistical methods indicate that mercury concentrations in smallmouth bass from DMD and LBDN were similar, and concentrations in smallmouth bass from LSF were significantly higher than in those fish from the other two sites (Figures 16 and 17). Mercury concentrations were weakly positively correlated with fish length in all three smallmouth bass populations. Gender was not a significant factor in the smallmouth bass total mercury GLM. The projected consumption advice based only on these mercury results is equivalent for smallmouth bass from DMD and LBDN and most restrictive for fish from LSF (Table 9).

Concentrations measured in the LSF are not unusual compared to other impoundments upstream on the Menominee River; smallmouth bass from LSF had mercury levels equivalent to concentrations in smallmouth bass from Big Quinnesec Flowage and slightly higher than levels in the White Rapids Flowage (Figure 18).

DDT

Total DDT was quantified in nearly all carp samples regardless of sampling site, but spatial differences were apparent for the other species sampled (Table 10; Appendix A4). Based on the rates of detection and the 95% UCL (Table 11) DDT concentrations are lowest in fish from LSF; concentrations in fish from DMD and LBDN are roughly equivalent.

Table 10. Percentage of fish samples with quantifiable levels of total DDT from the Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), and Little Bay De Noc (LBDN).

Species	LSF	DMD	LBDN
Carp	91	100	100
Northern Pike	--	80	40
Rock Bass	0	--	7
Smallmouth Bass	10	100	100

There was no significant relationship between fish length and total DDT in carp from any of the three sites sampled in 2012 (Figure 19), but there was a strong positive correlation between lipid content and total DDT concentrations ($r=0.70$; $p<0.001$). Lipid normalized total DDT concentrations in carp from DMD did not differ from concentrations in carp from LBDN, but carp from LSF had significantly lower concentrations than fish from the other two sites. The projected consumption advice based on these total DDT results for carp from DMD and LBDN differs substantially from advice for carp from LSF (Table 11).

There was no significant relationship between fish length or lipid content and total DDT concentrations in northern pike collected from DMD or LBDN (Figure 20). Based on these results, total DDT would not cause a fish consumption advisory for northern pike from either site that is more restrictive than 16 meals per month (Table 11).

Total DDT was not quantified in any of the rock bass collected from LSF and in only 1 of 14 rock bass collected from LBDN (Table 10). Based on the results, total DDT would not cause a fish consumption advisory for rock bass from either site more restrictive than 16 meals per month (Table 11).

Table 11. The 95% UCL on the mean total DDT concentration and projected consumption advice due to total DDT, based only on the most recent results for fish collected from the Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), Little Bay De Noc (LBDN), and the Chalk Hill Flowage (CHF).

Species	95% UCL (ppm)			Meals per Month		
	LSF	DMD	LBDN	LSF	DMD	LBDN
Carp	0.004	0.45	0.28	16	4	4
Northern Pike	--	0.01	0.003	--	16	16
Rock Bass	0.001	--	0.001	16	--	16
Smallmouth Bass	0.001	0.008	0.004	16	16	16

Note: *Meals per Month presented here do not represent the final MDHHS determinations*

Total DDT was quantified in all smallmouth bass samples from both DMD and LBDN, but in only 1 of 10 smallmouth bass collected from LSF (Table 10). There was a positive correlation between total DDT and fish length (r=0.5; p=0.03) and between total DDT and lipid content (r=0.6; p=0.006) for smallmouth bass collected at DMD and LBDN (Figure 21). Both total DDT and lipid normalized concentrations in smallmouth bass from DMD were higher than in those fish from LBDN, and the differences were statistically significant. Based on these results total DDT would not cause a fish consumption advisory for smallmouth bass from either site that was more restrictive than 16 meals per month (Table 11).

<u>Dioxin TEQ</u>

Since dioxins and furans may have sources independent of PCB sources, TCDD TEQ was calculated without dioxin-like PCB congeners. The dioxin-like PCB concentrations were assayed only in the carp from LSF and LBDN, and were not used for between-site comparisons. The complete set of 7 dioxin, 10 furan, and 12 dioxin-like PCB congeners are used by the MDHHS to develop fish consumption advice whenever those results are available.

Quantifiable concentrations of 2,3,7,8 TCDD TEQs were measured in all carp analyzed to-date from the CHF, LSF, DMD, GB, and LBDN. Lipid content was strongly correlated with TEQ across all samples (r=0.8; p<0.001), but fish length was only correlated with TEQ for the GB samples (r=0.7; p=0.02). Dioxin TEQ concentrations were highest in DMD and lowest in LSF (Table 12; Figure 22), but differences were not statistically different. Lipid normalized TEQ concentrations in carp were highest in LSF, CHF, and DMD (Figure 23); the concentrations at those sites were not significantly different but those concentrations were significantly different than the lipid normalized TEQ concentrations in carp from GB. Lipid-normalized TEQ concentrations in LSF carp were higher than in both LBDN and GB, and the difference was statistically different.

Table 12. The 95% UCL on the mean dioxin TEQ concentration and projected consumption advice due to dioxin TEQ, based only on the most recent results for carp collected from the Chalk Hill Flowage (CHF), the Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), Green Bay (GB), and Little Bay De Noc (LBDN).

95% UCL (ppt)					Meals per Month				
CHF	LSF	DMD	GB	LBDN	CHF	LSF	DMD	GB	LBDN
7.7	3.9	11.4	5.6	4.7	0.5	1	0.5	1	1

Note: *Meals per Month presented here do not represent the final MDHHS determinations*

Historically, dioxin TEQ was also assayed in a limited number of walleye from the Menominee River, including three samples from the Badwater Impoundment (upstream of Iron Mountain) collected in 1992 and four samples from the CHF collected in 1991. No quantifiable concentrations were measured in the walleye samples from the Badwater Impoundment, while all four samples from the CHF had low but quantifiable concentrations. Although the small sample size prevents a definitive comparison, the results suggest a dioxin source downstream of the Badwater Impoundment and upstream of the MR-AOC.

Lastly, 2,3,7,8 TCDD was assayed in walleye collected in 1989 from the upper Menominee River upstream and downstream of the Champion International Paper – Quinnesec Mill (Taft, 1991). Dioxin was not detected in the fish collected upstream of the mill, but measurable quantities were found in the fish collected downstream. This suggests that the paper mill was a possible dioxin source and provides further evidence that there have been sources upstream of the MR-AOC.

SYNOPSIS

Total PCB concentrations in fish from DMD were consistently higher than the concentrations in the same species from LBDN and from the Menominee River upstream of the Menominee Dam. This pattern held for lipid-normalized total PCB concentrations as well. These results support the hypothesis that PCB contamination in GB is a likely source of contamination in the MR-AOC.

Total mercury concentrations in fish from the LSF were consistently higher than in fish from DMD and LBDN. It is unlikely that elevated mercury levels in the LSF are due to mercury sources within the MR-AOC; rather, higher concentrations in the LSF are most likely due to favorable conditions for mercury methylation within the LSF or the Menominee River watershed in general.

Total DDT concentrations were low in all fish populations sampled, and were lowest in fish from LSF. There are no known or likely point sources for DDT within the MR-AOC, with atmospheric deposition and agricultural runoff being the most likely inputs to the Menominee River watershed.

Previous sampling indicated that legacy paper mill discharges from upstream of the AOC are the most likely source of dioxin contamination observed in fish collected in DMD.

The MDHHS issues consumption guidance based on the contaminant(s) causing the most restrictive advice. Based on this evaluation, PCBs are the primary cause of advisories for carp and northern pike caught in the DMD (Table 13). Mercury would be the primary contaminant causing advisories for rock bass, and smallmouth bass caught in the LSF. Total PCBs and mercury would together be primary causes of consumption advice for carp from the LSF and for smallmouth bass from DMD. It is important to reiterate that the projected consumption advice reported here may not be the final advice put forth by the MDHHS; the MDHHS bases consumption guidance on the most current analytical results in combination with previous data for the water body as well as knowledge of legacy or ongoing contamination issues.

Table 13. Projected consumption advice based on samples collected in 2010, 2012, and 2013, and contaminants causing the advice for fish collected from the Chalk Hill Flowage (CHF), the Lower Scott Flowage (LSF), the Menominee River downstream of the Menominee Dam (DMD), and Little Bay De Noc (LBDN).

Species		Sampling Site			
		CHF	LSF	DMD	LBDN
Carp	Meals/Month	1	1	DNE	Limited
	Cause	TEQ	PCBs, TEQ & Mercury	PCBs	PCBs
Northern Pike	Meals/Month	--	--	1	1
	Cause	--	--	PCBs	Mercury
Rock Bass	Meals/Month	--	4	--	8
	Cause	--	Mercury	--	Mercury
Smallmouth Bass	Meals/Month	--	1	2	2
	Cause	--	Mercury	PCBs & Mercury	Mercury

DNE = Do Not Eat; MDHHS recommends that no one ever eat the fish in this category.
Limited = Healthy adults may safely eat one or two meals per year of fish in this category. MDHHS recommends that women of childbearing age, young children, or adults with a chronic health condition should not eat these fish.
Note: *Meals per Month presented here do not represent the final MDHHS determination.*

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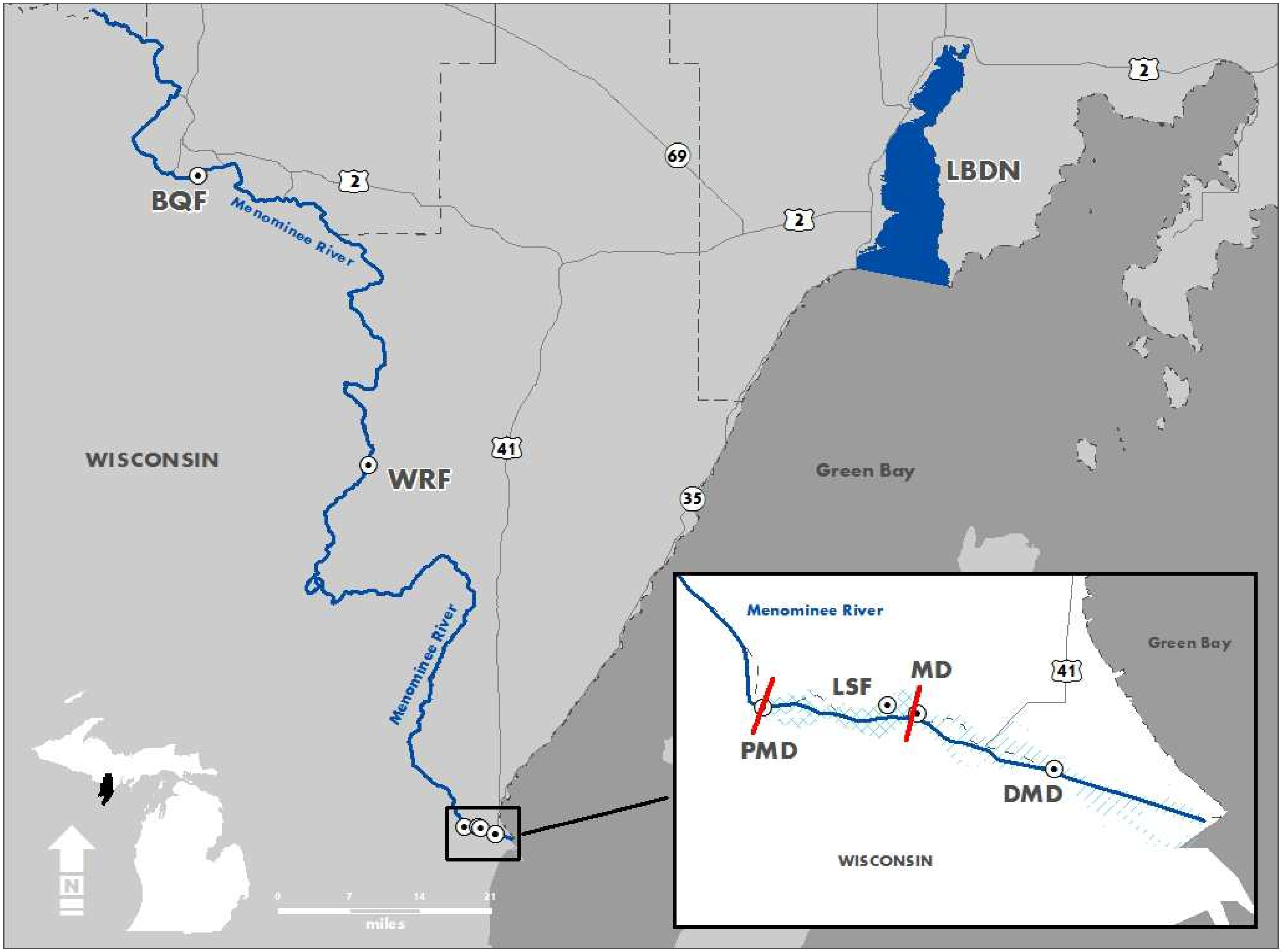

Figure 1. Map of Menominee River AOC (crosshatched in inset) indicating locations of the Park Mill Dam (PMD) and Menominee Dam (MD), and fish collection locations at Big Quinnesec Flowage (BQF), White Rapids Flowage (WRF), Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), and Little Bay De Noc (LBDN).

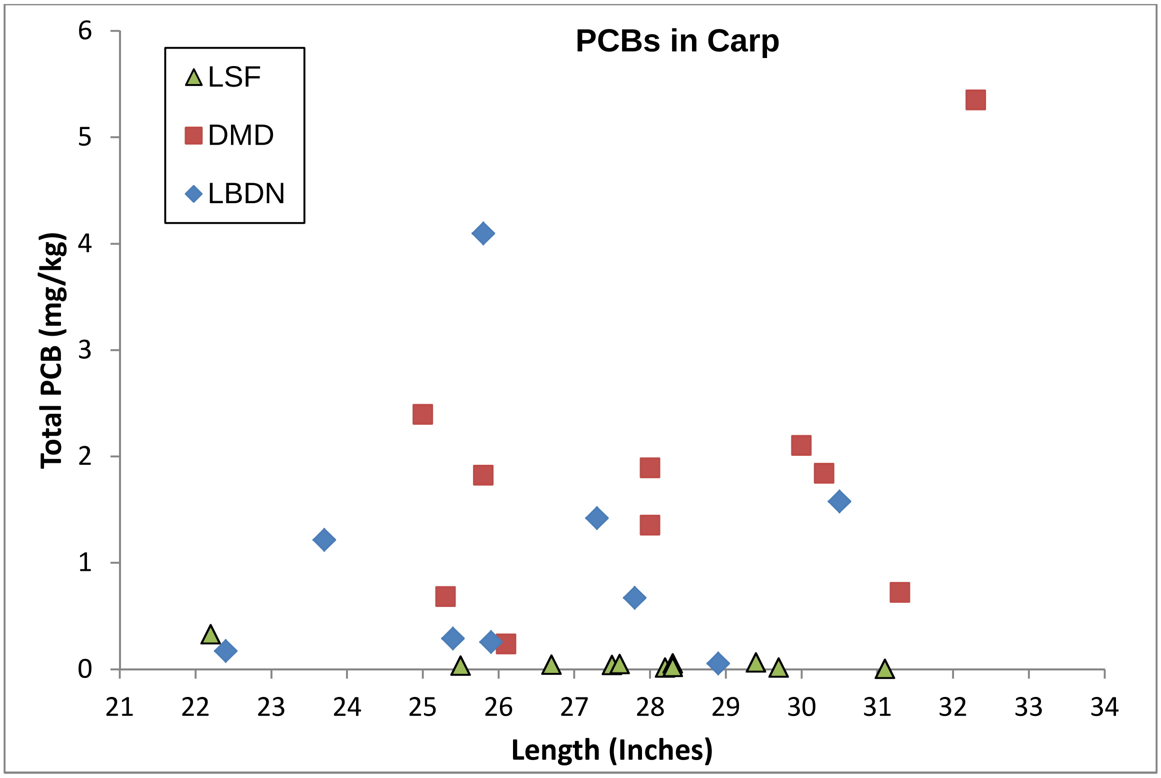

Figure 2. Length versus total PCB concentration in carp collected from Lower Scott Flowage (LSF), the Menominee River downstream of the Menominee Dam (DMD), and Little Bay De Noc (LBDN).

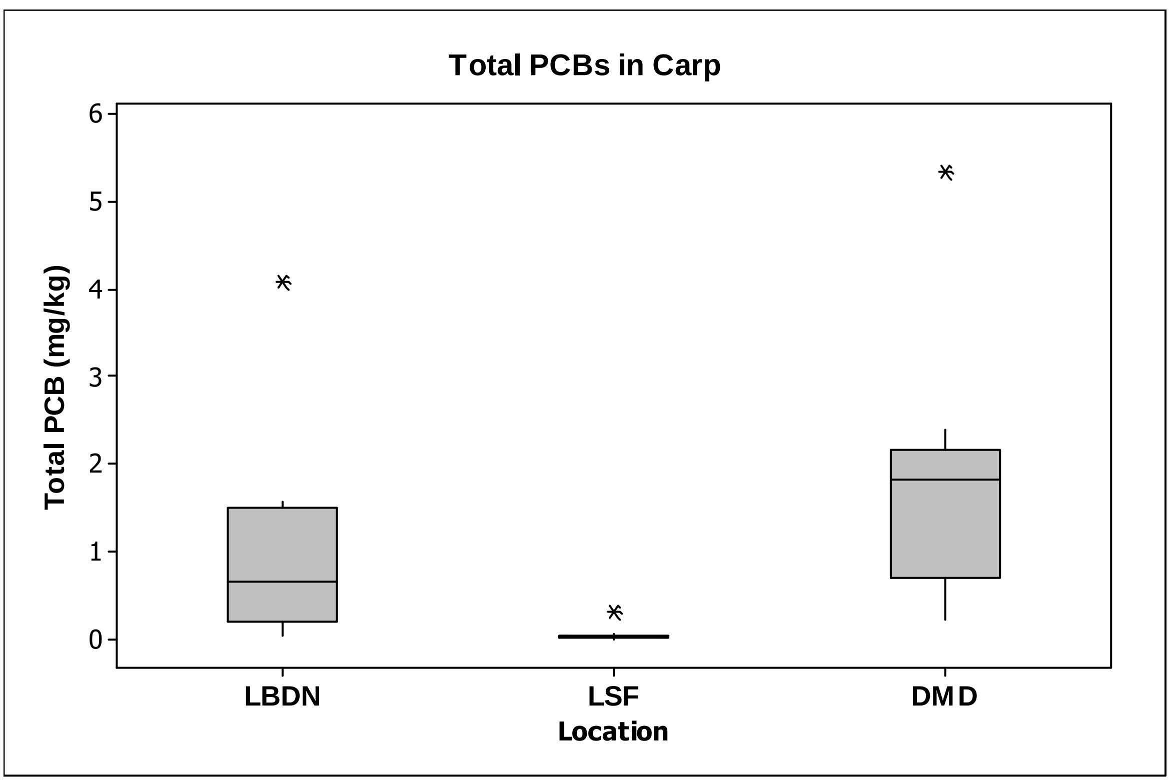

Figure 3. Boxplots of total PCB concentrations in fillets of carp from Little Bay De Noc (LBDN), Lower Scott Flowage (LSF), and the Menominee River downstream of the Menominee Dam (DMD).

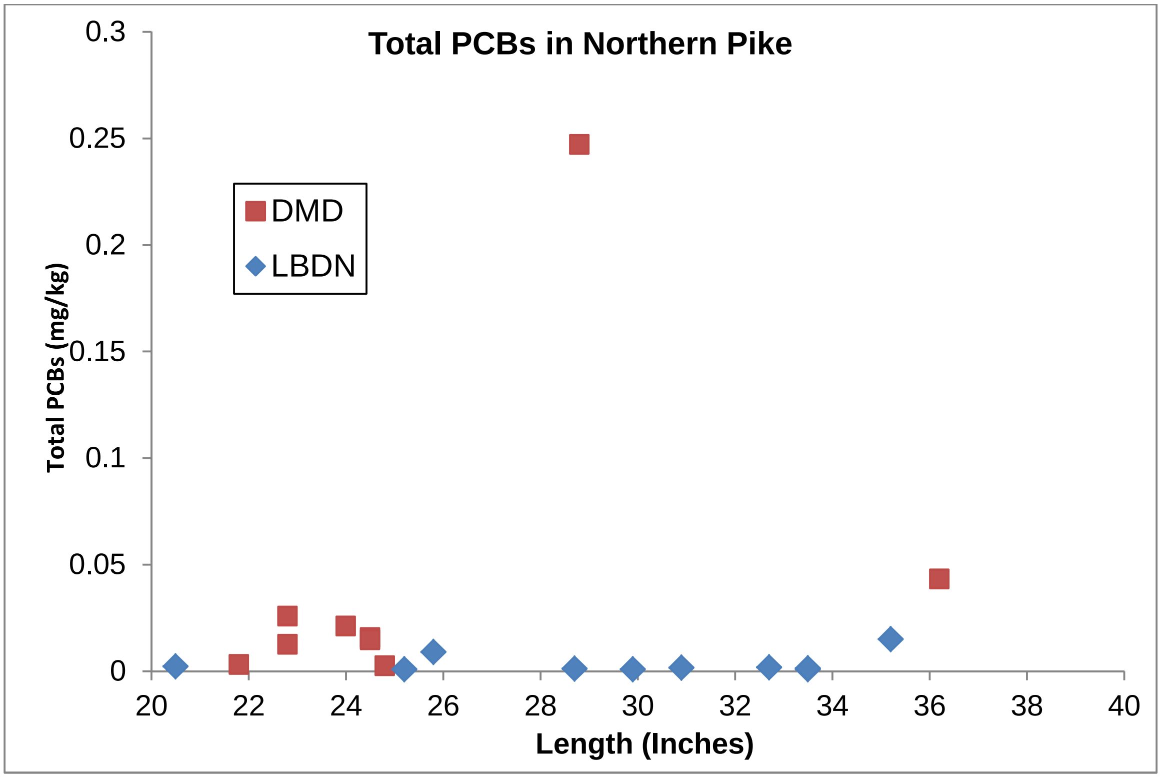

Figure 4. Length versus total PCB concentration in northern pike collected from the Menominee River downstream of the Menominee Dam (DMD), and Little Bay De Noc (LBDN).

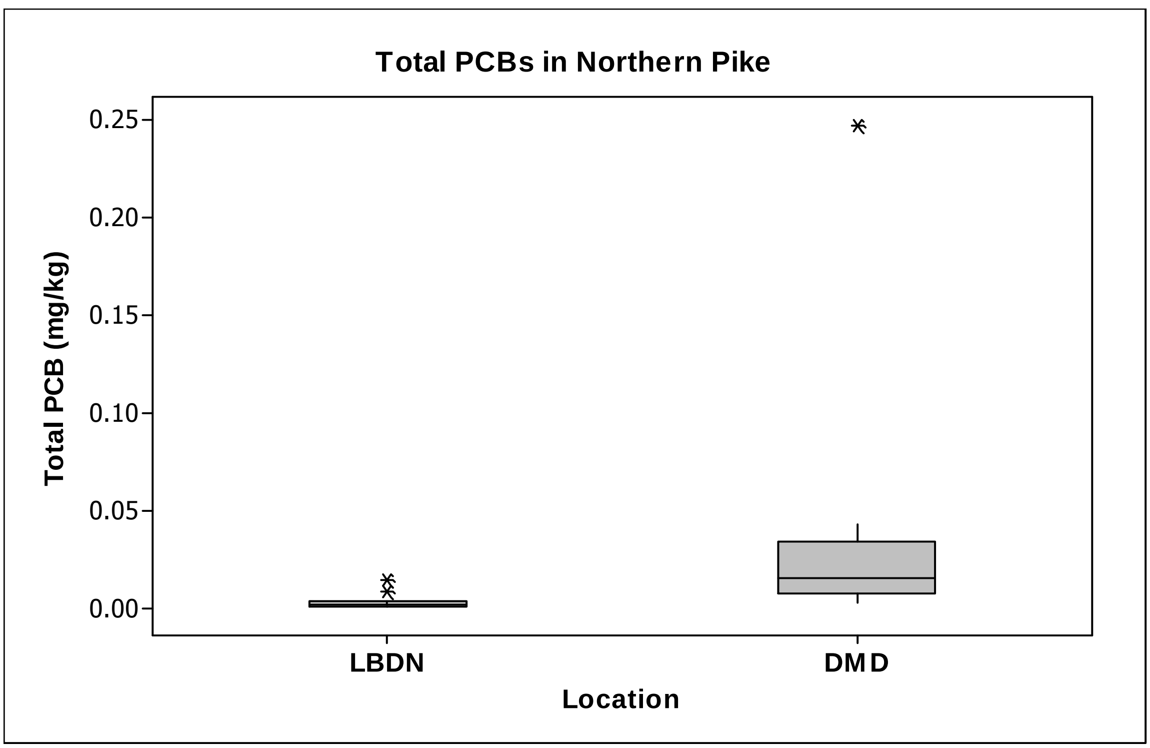

Figure 5. Boxplots of total PCB concentrations in fillets of northern pike from Little Bay De Noc (LBDN) and the Menominee River downstream of the Menominee Dam (DMD).

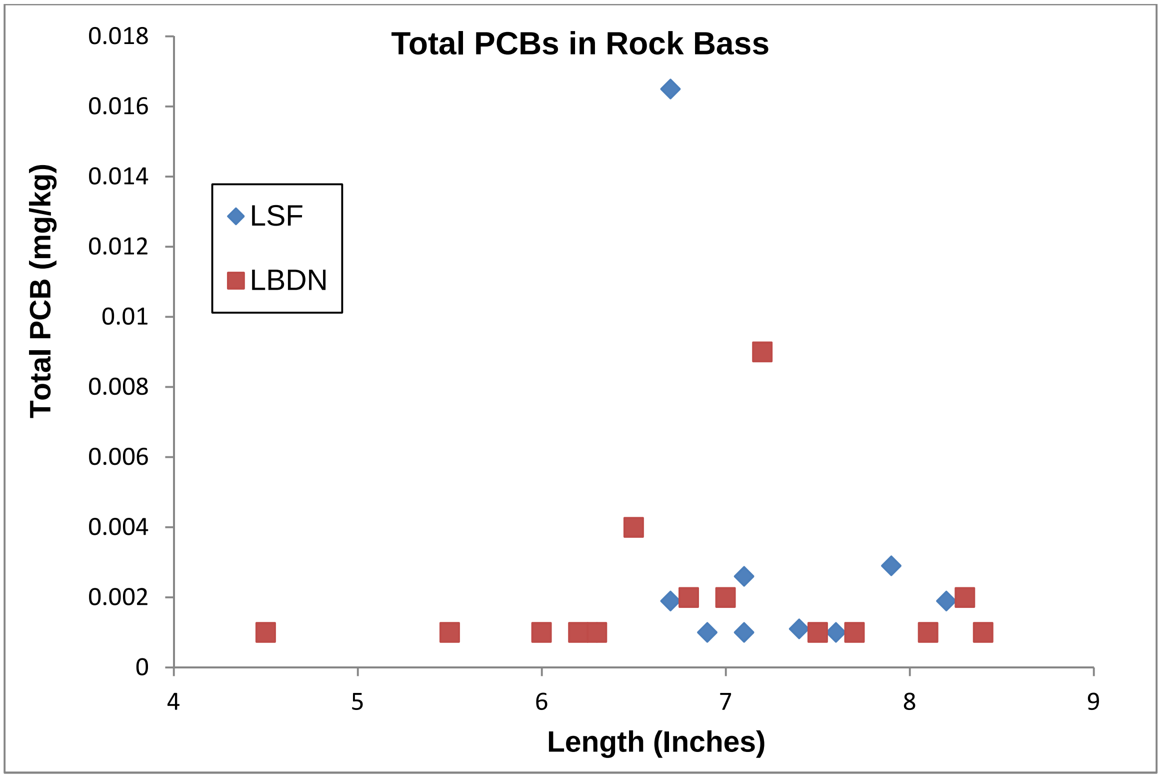

Figure 6. Length versus total PCB concentration in rock bass collected from Lower Scott Flowage (LSF) and Little Bay De Noc (LBDN).

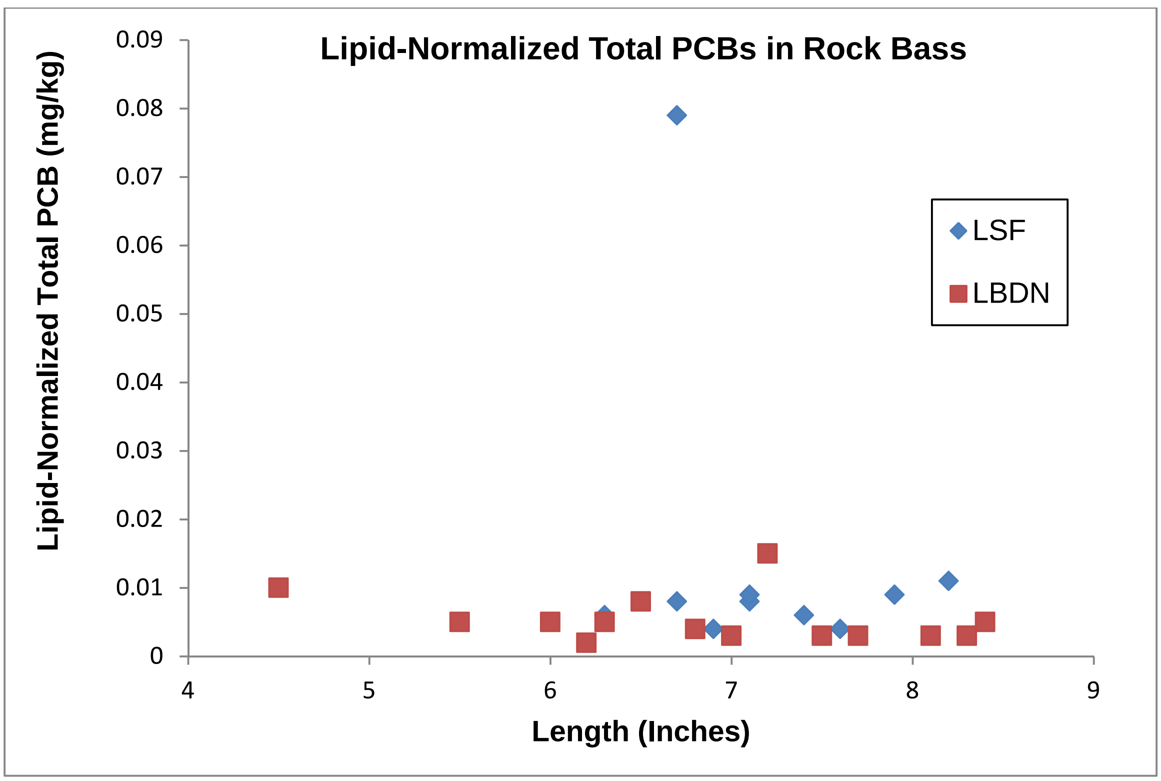

Figure 7. Length versus lipid-normalized total PCB concentration in rock bass collected from Lower Scott Flowage (LSF) and Little Bay De Noc (LBDN).

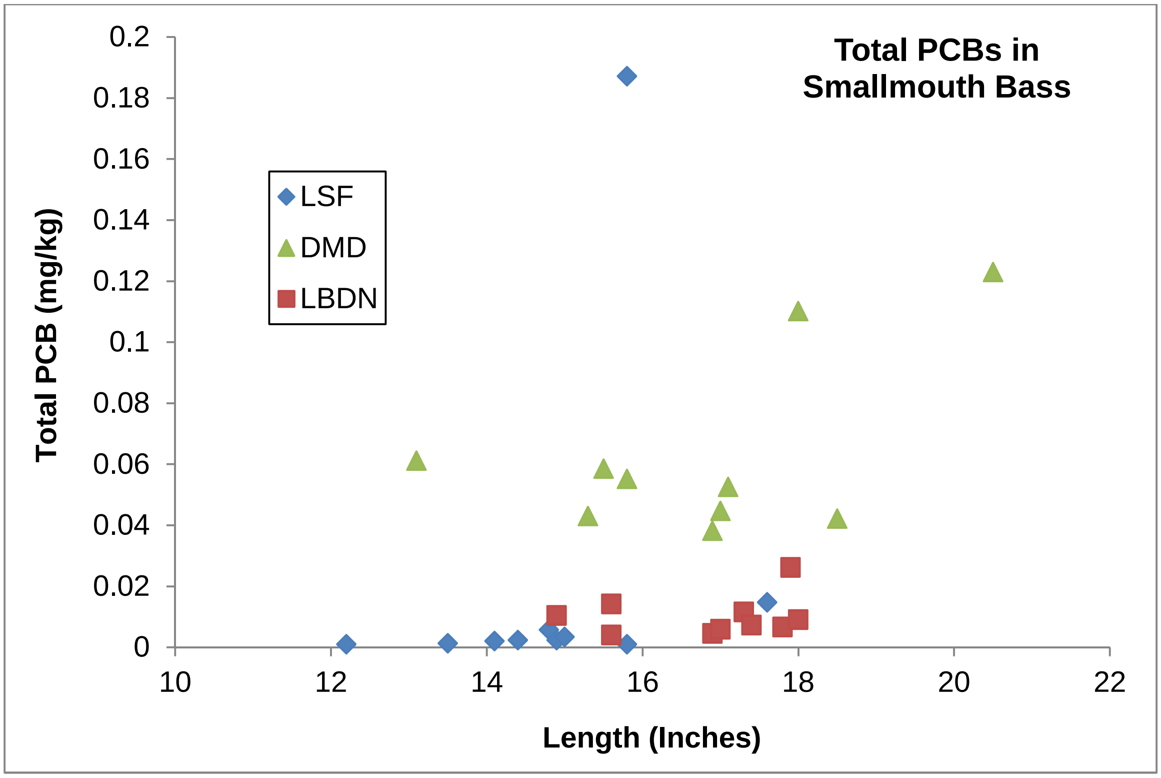

Figure 8. Length versus total PCB concentration in smallmouth bass collected from Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), and Little Bay De Noc (LBDN).

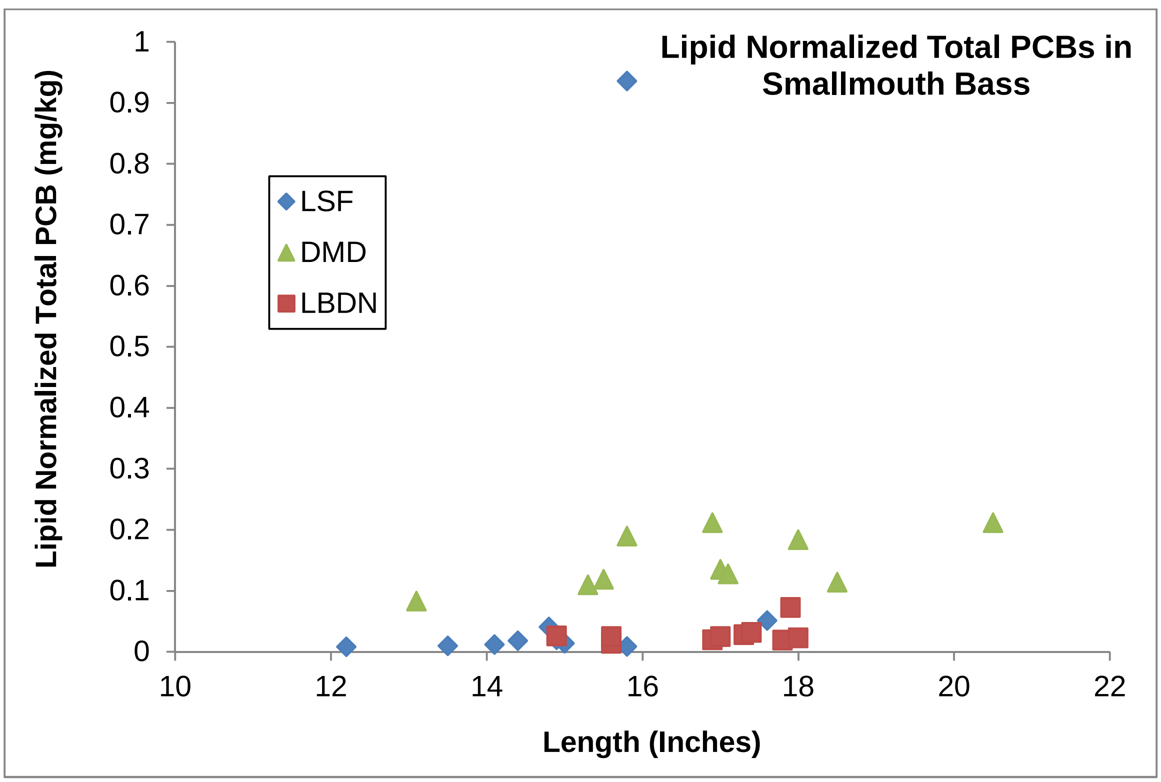

Figure 9. Length versus lipid-normalized total PCB concentration in smallmouth bass collected from Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), and Little Bay De Noc (LBDN).

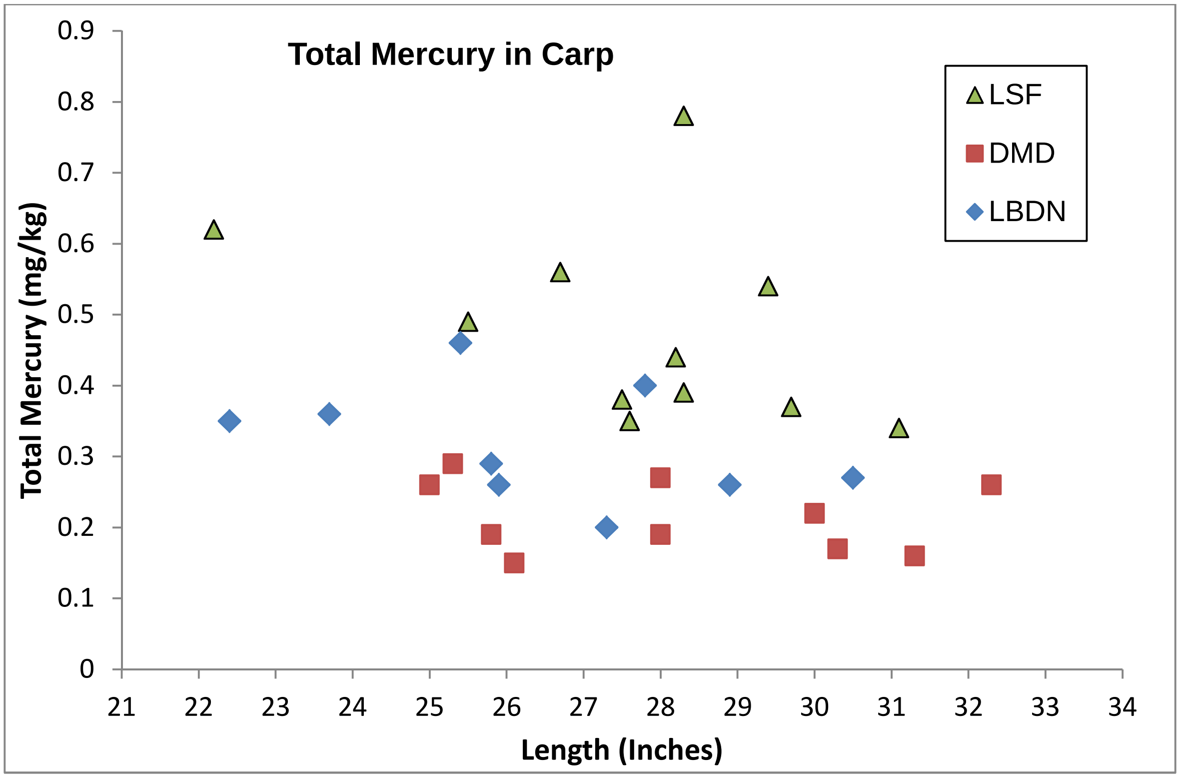

Figure 10. Length versus total mercury concentration in carp collected from Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), and Little Bay De Noc (LBDN).

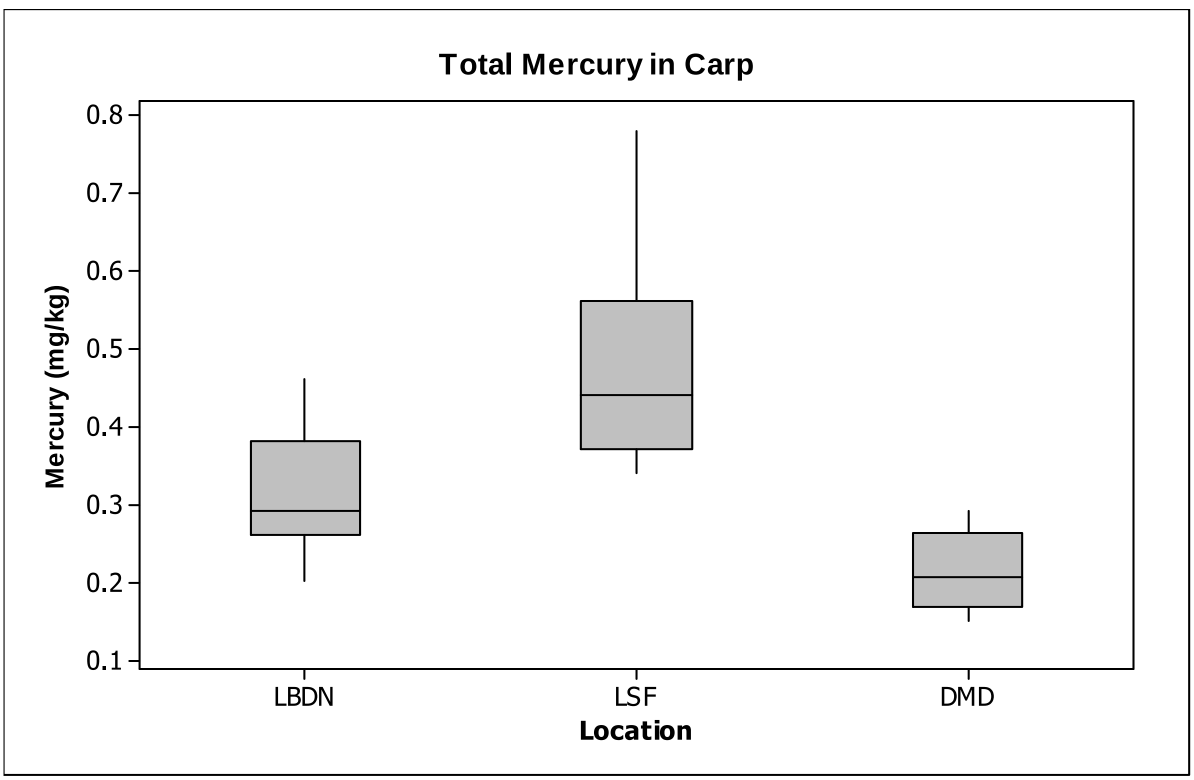

Figure 11. Boxplots of total mercury concentrations in fillets of carp from Little Bay De Noc (LBDN), Lower Scott Flowage (LSF), and the Menominee River downstream of the Menominee Dam (DMD).

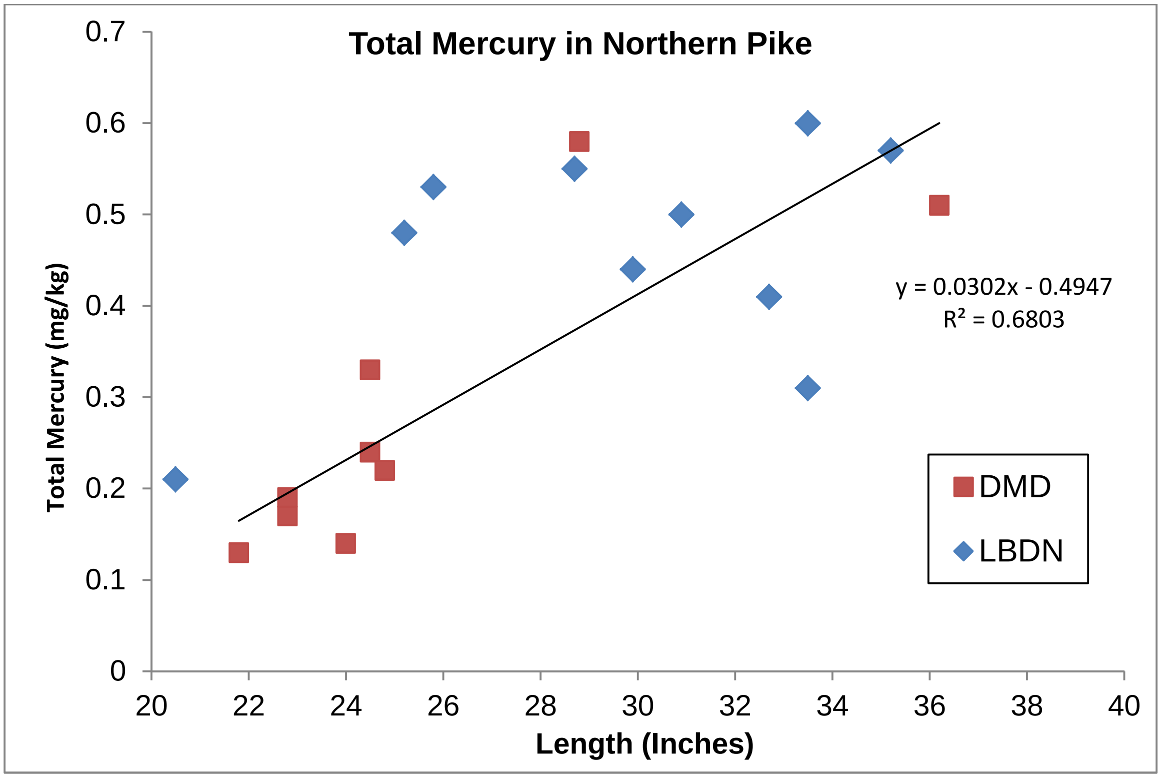

Figure 12. Length versus total mercury concentration in northern pike collected from the Menominee River downstream of the Menominee Dam (DMD) and Little Bay De Noc (LBDN).

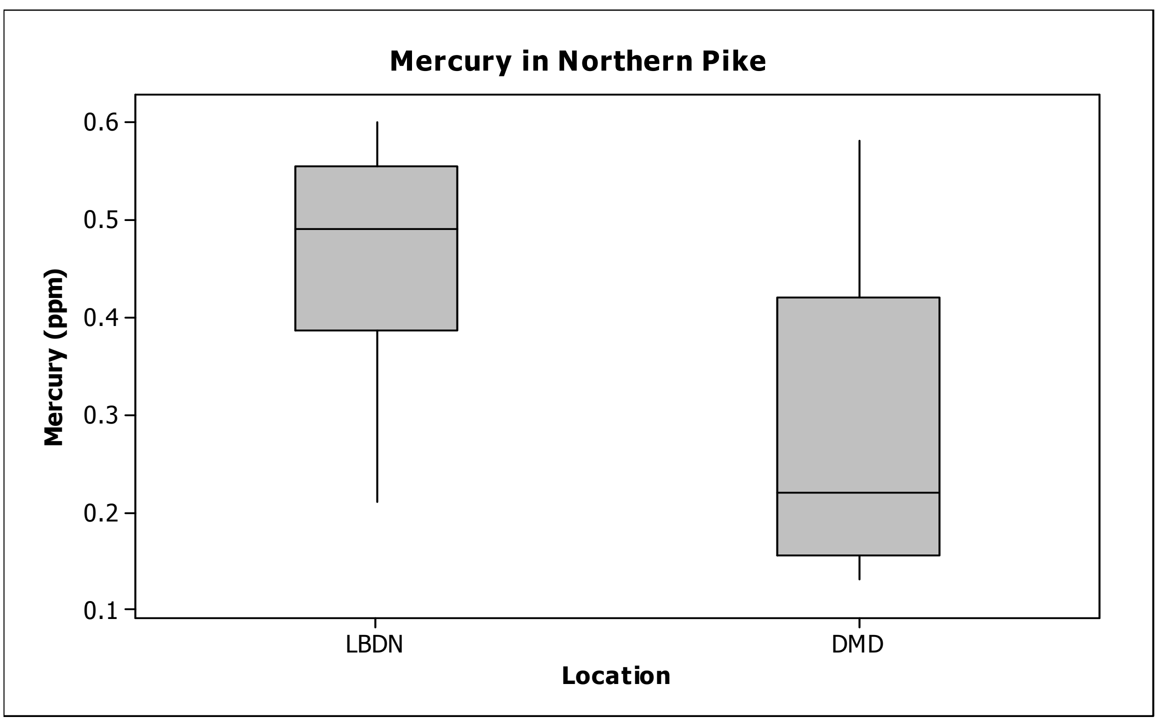

Figure 13. Boxplots of total mercury concentrations in fillets of northern pike from Little Bay De Noc (LBDN) and the Menominee River downstream of the Menominee Dam (DMD).

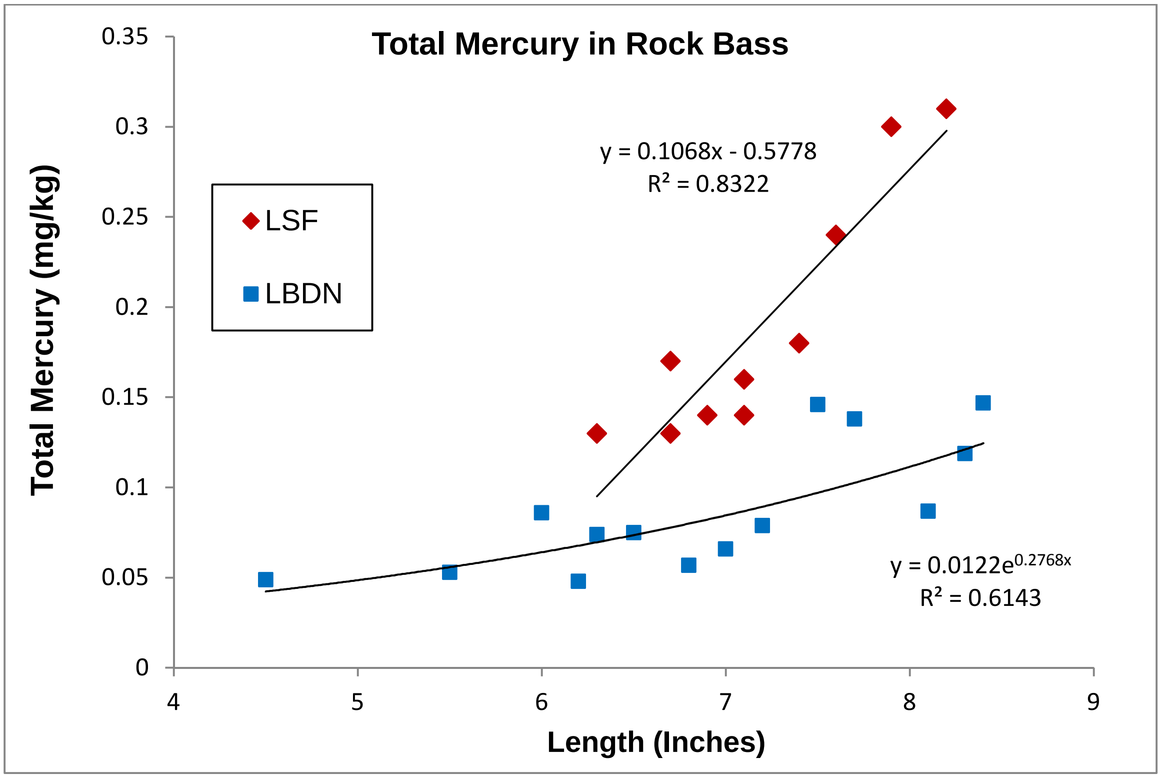

Figure 14. Length versus total mercury concentration in rock bass collected from the Lower Scott Flowage (LSF) and Little Bay De Noc (LBDN).

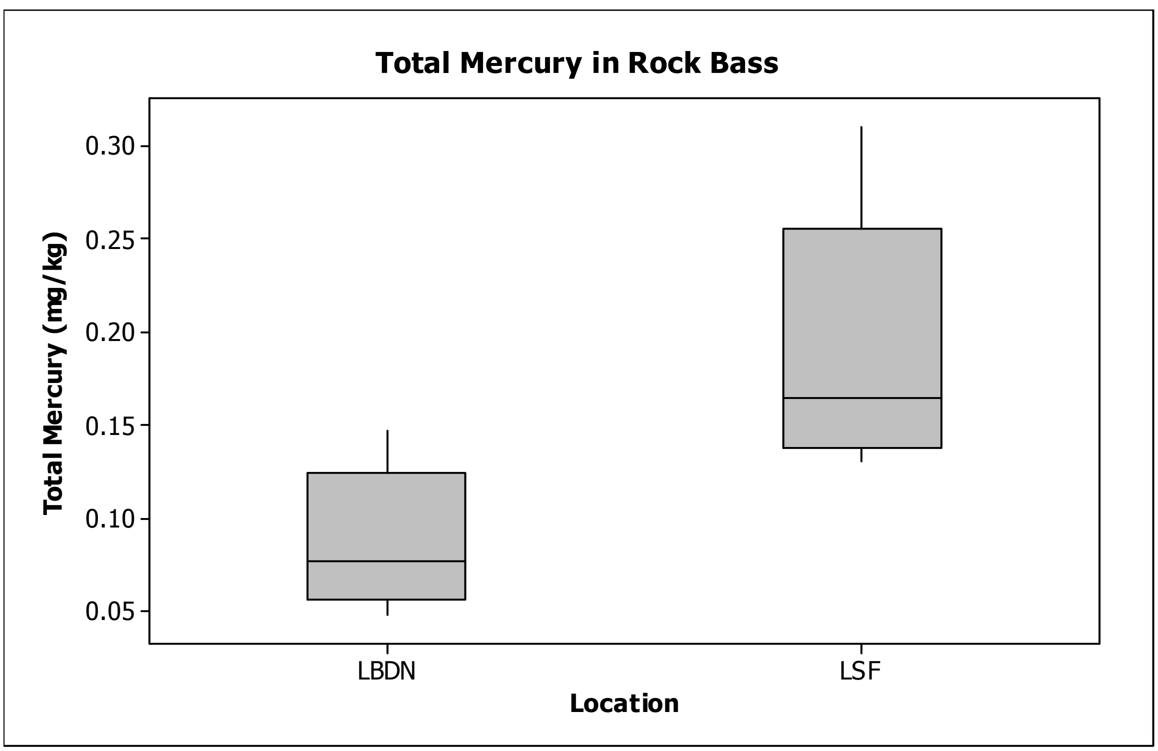

Figure 15. Boxplots of total mercury concentrations in fillets of rock bass from Little Bay De Noc (LBDN) and the Lower Scott Flowage (LSF).

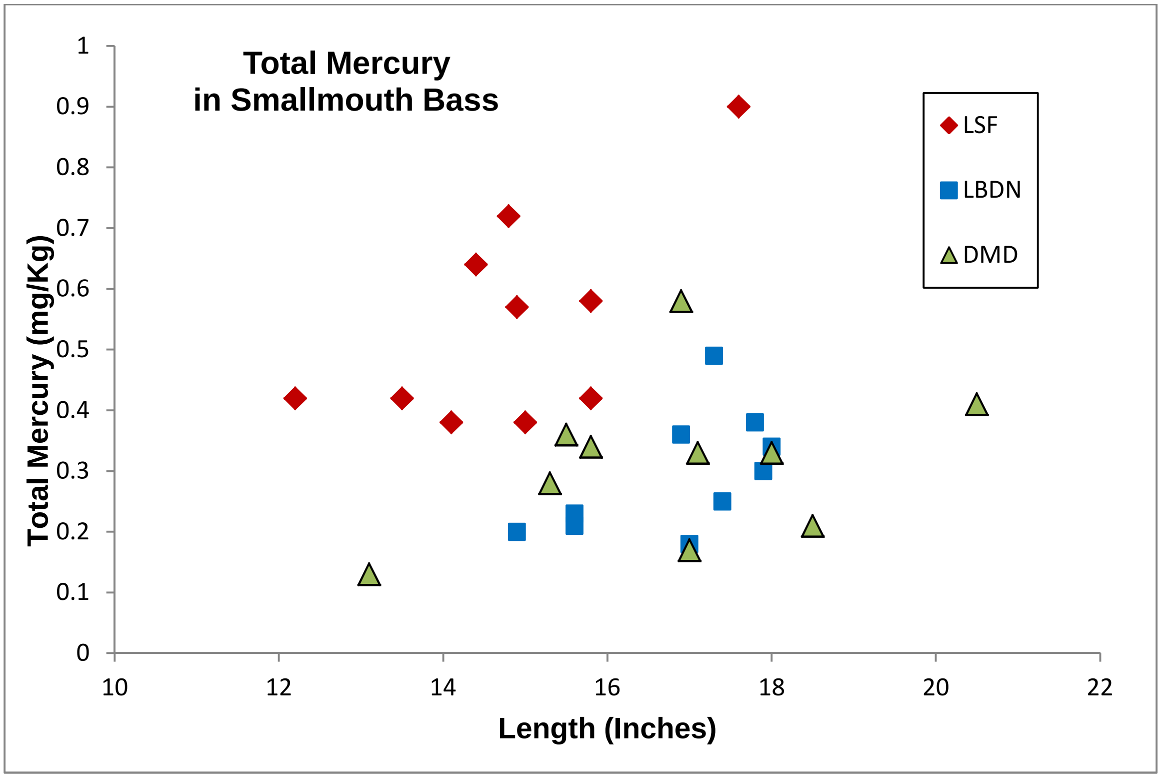

Figure 16. Length versus total mercury concentration in smallmouth bass collected from Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), and Little Bay De Noc (LBDN).

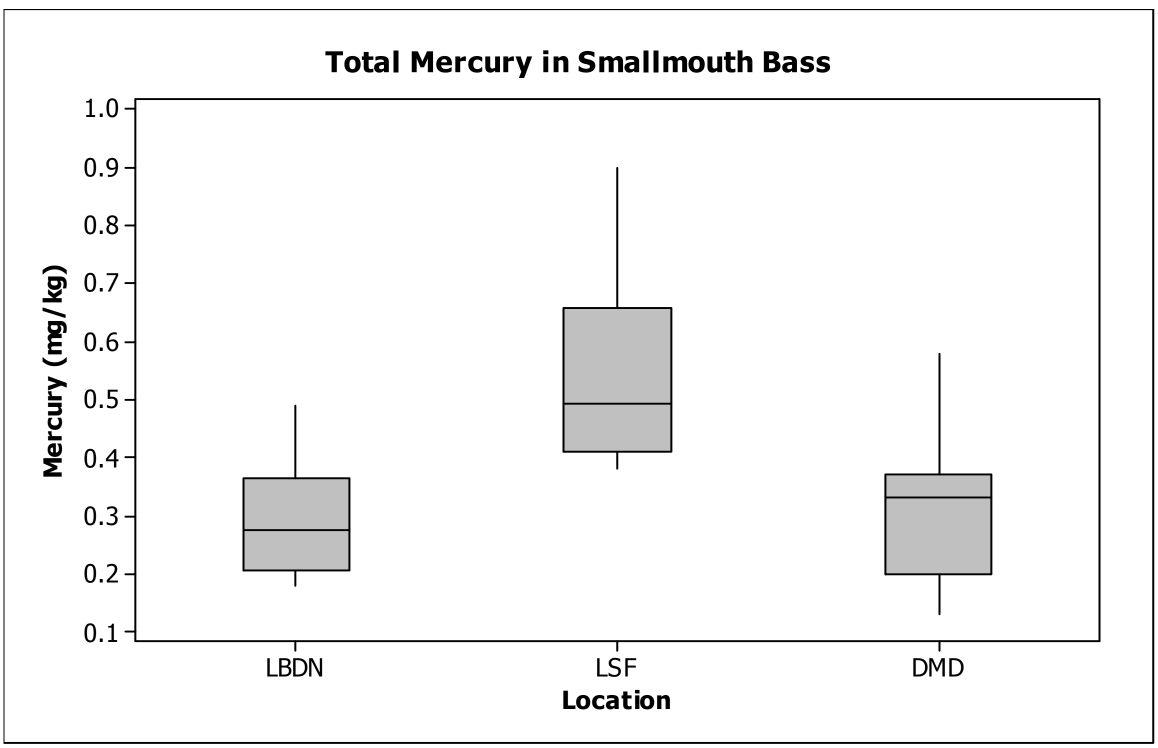

Figure 17. Boxplots of total mercury concentrations in fillets of smallmouth bass from Little Bay De Noc (LBDN), Lower Scott Flowage (LSF), and the Menominee River downstream of the Menominee Dam (DMD).

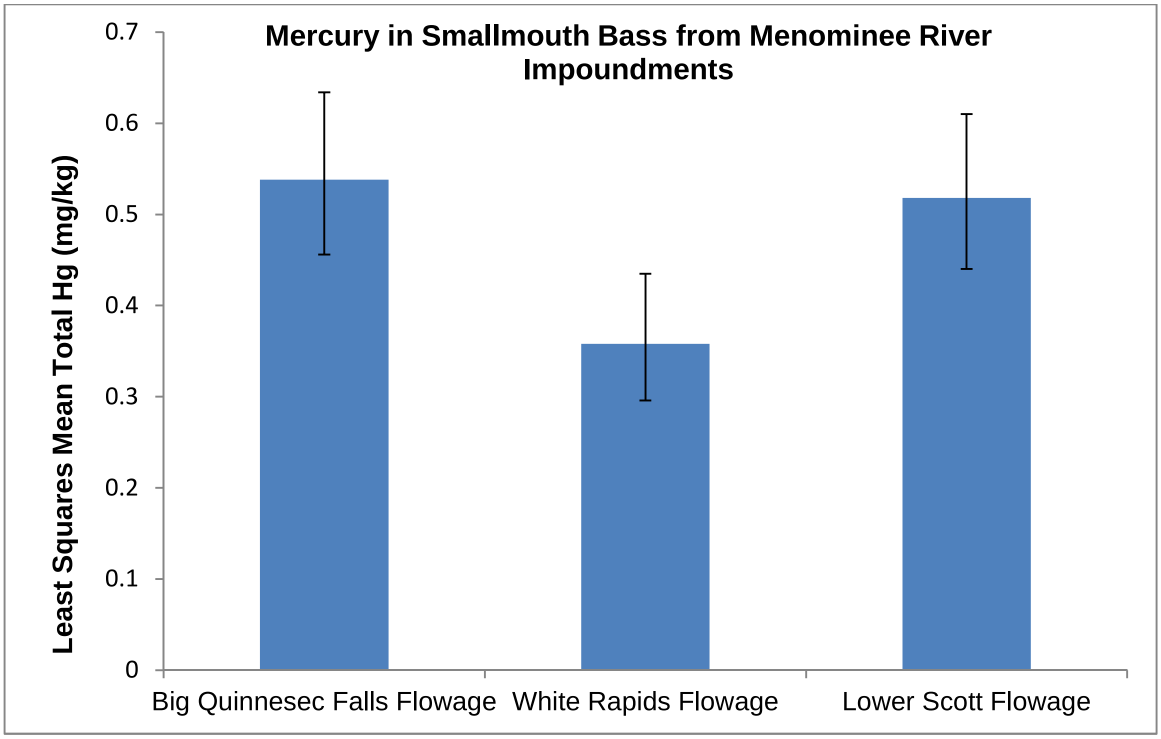

Figure 18. Least squares mean total mercury concentrations in smallmouth bass collected from three impoundments of the Menominee River in 2013 and 2014.

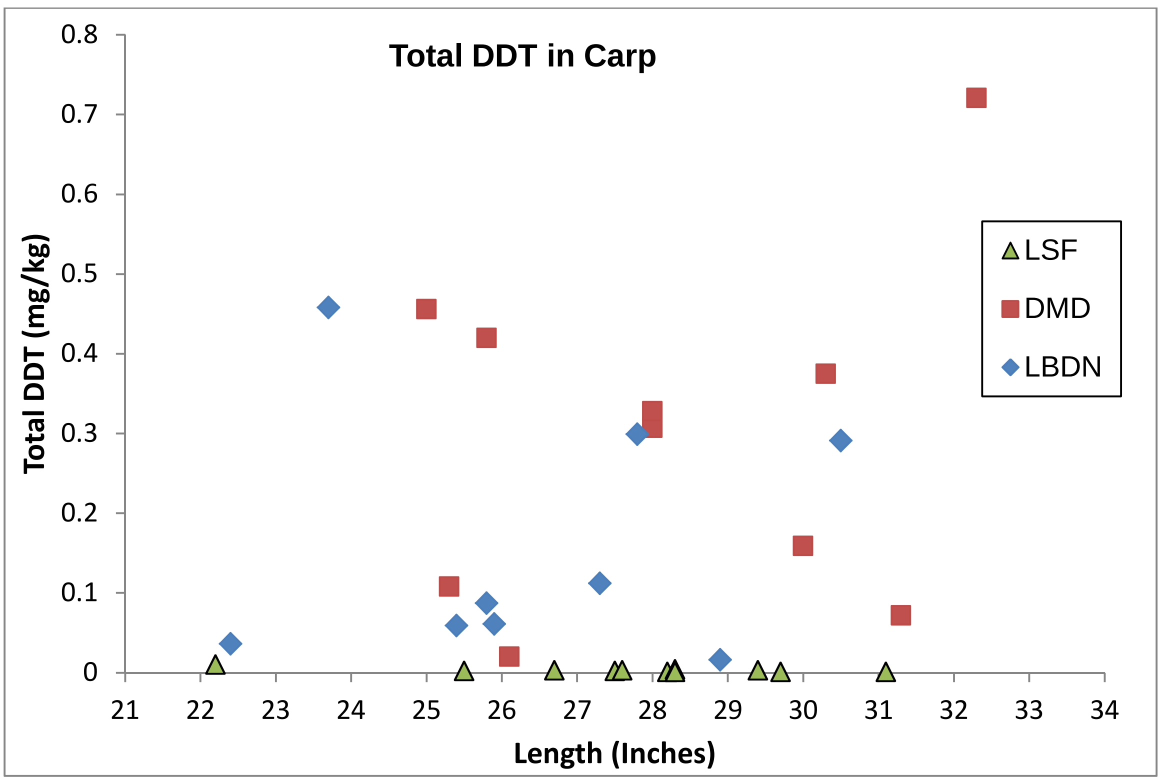

Figure 19. Length versus total DDT concentration in carp collected from Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), and Little Bay De Noc (LBDN).

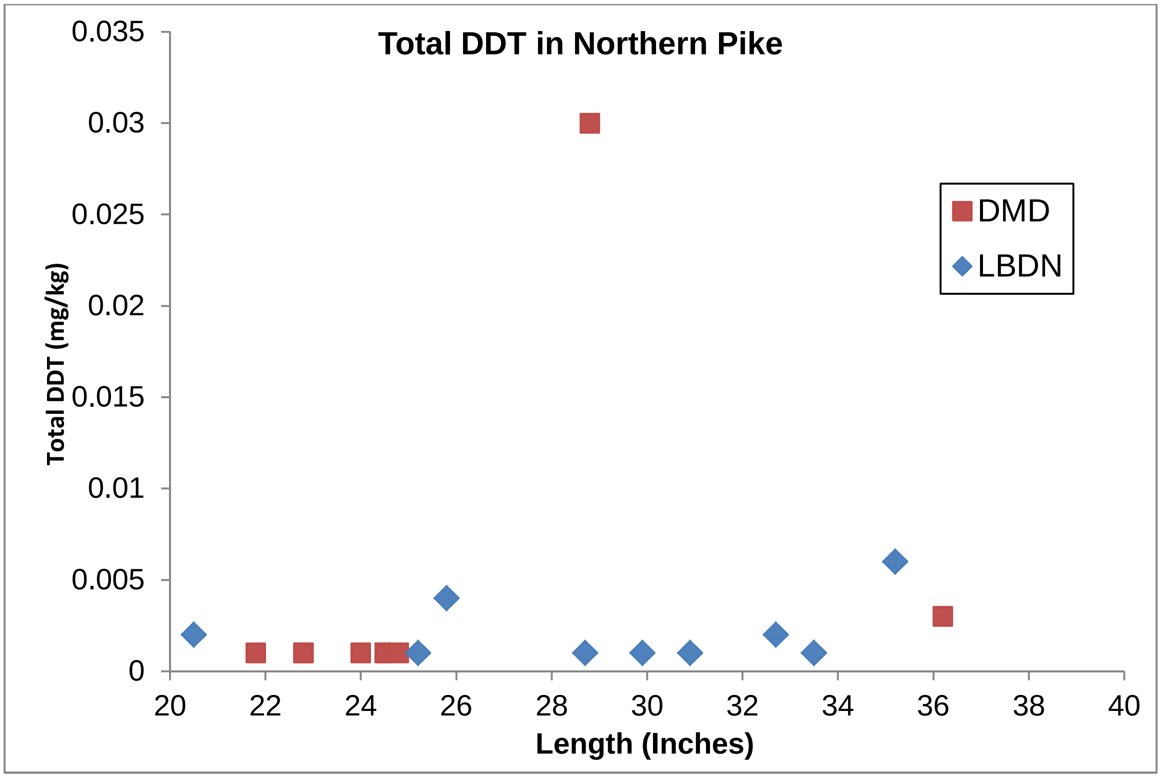

Figure 20. Length versus total DDT concentration in carp collected from Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), and Little Bay De Noc (LBDN).

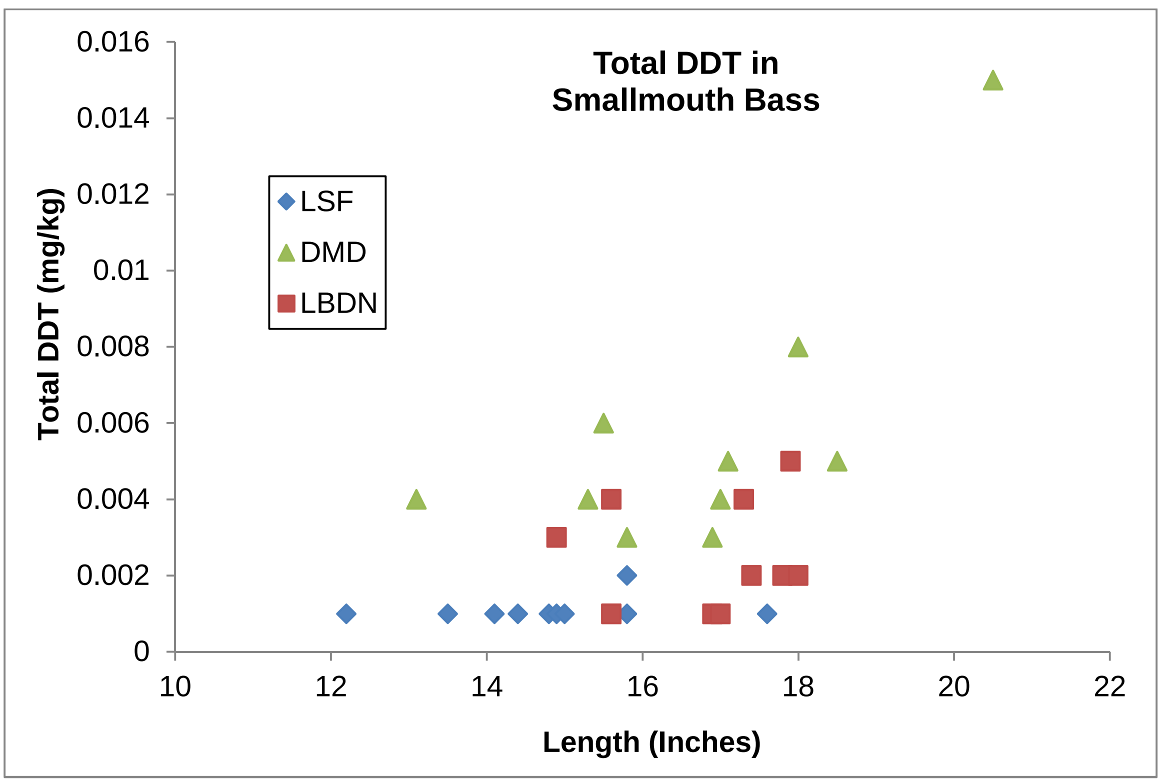

Figure 21. Length versus total DDT concentration in smallmouth bass collected from Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), and Little Bay De Noc (LBDN).

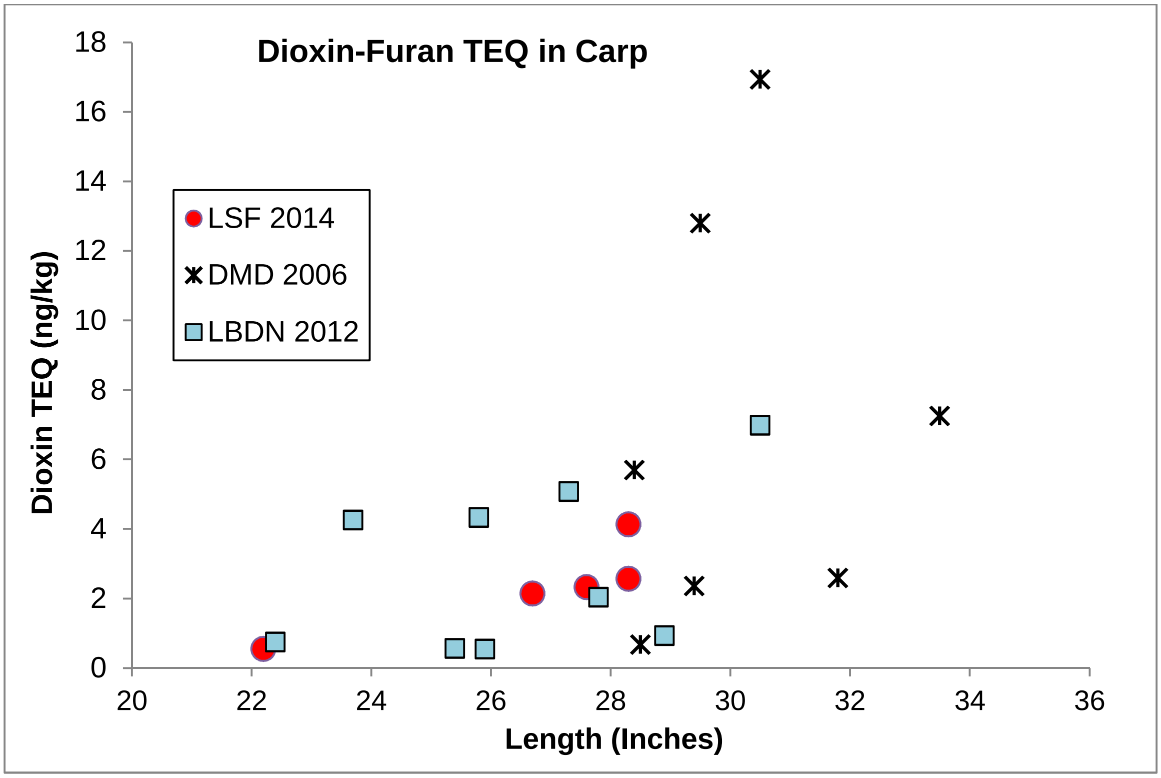

Figure 22. Length versus dioxin TEQ concentration in carp collected from Lower Scott Flowage in 2014 (LSF 2014), Menominee River downstream of the Menominee Dam in 2006 (DMD 2006), and the Little Bay De Noc in 2012 (LBDN 2012).

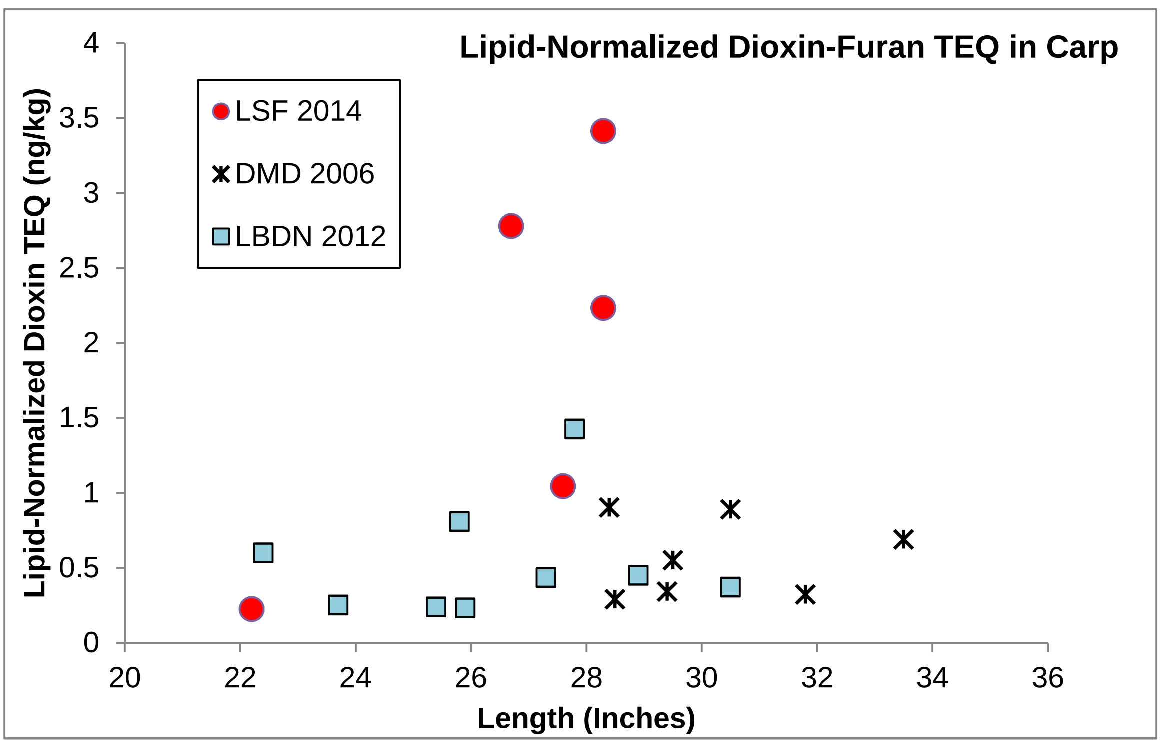

Figure 23. Length versus lipid-normalized dioxin TEQ concentration in carp collected from Lower Scott Flowage in 2014 (LSF 2014), Menominee River downstream of the Menominee Dam in 2006 (DMD 2006), and the Little Bay De Noc in 2012 (LBDN 2012).

Appendix A1.

Summary statistics for lengths of fish samples collected from the Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), Little Bay De Noc (LBDN), and Chalk Hill Flowage (CHF).

Species	Length (Inches)						
	Site	Median	Mean	St Dev	Min	Max	N
Carp	LSF	28.2	27.7	2.4	22.2	31.1	11
	DMD	28.0	28.2	2.6	25.0	32.3	10
	LBDN	25.9	26.4	2.5	22.4	30.5	9
Northern Pike	DMD	24.5	25.6	4.4	21.8	36.2	9
	LBDN	30.4	29.6	4.6	20.5	35.2	10
Redhorse Sucker	LSF	20.5	20.2	0.6	19.4	20.9	5
	LBDN	22.9	22.7	1.8	20.2	25.4	10
	CHF	21.3	19.9	3.6	12.4	23.0	10
Rock Bass	LSF	7.1	7.2	0.6	6.3	8.2	10
	LBDN	6.9	6.8	1.1	4.5	8.4	14
Smallmouth Bass	LSF	14.9	14.8	1.5	12.2	17.6	10
	DMD	17.0	16.8	2.0	13.1	20.5	10
	LBDN	17.2	16.8	1.1	14.9	18.0	10

Appendix A2.

Summary statistics for total PCB concentrations fish samples collected from the Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), Little Bay De Noc (LBDN), and Chalk Hill Flowage (CHF).

Species	Total PCB Concentration (mg/kg)						
	Site	Median	Mean	St Dev	Min	Max	N
Carp	LSF	0.04	0.06	0.09	0.003	0.33	11
	DMD	1.83	1.84	1.42	0.24	5.35	10
	LBDN	0.67	1.08	1.27	0.06	4.10	9
Northern Pike	DMD	0.02	0.04	0.08	0.003	0.25	9
	LBDN	0.002	0.004	0.005	0.001	0.015	10
Redhorse Sucker	LSF	0.006	0.009	0.006	0.004	0.02	5
	LBDN	0.03	0.05	0.04	0.006	0.13	10
	CHF	0.002	0.008	0.01	0.001	0.03	10
Rock Bass	LSF	0.002	0.003	0.005	0.001	0.31	10
	LBDN	0.001	0.002	0.002	0.001	0.15	14
Smallmouth Bass	LSF	0.002	0.02	0.06	0.001	0.19	10
	DMD	0.054	0.06	0.03	0.038	0.12	10
	LBDN	0.008	0.01	0.01	0.004	0.03	10

Appendix A3.

Summary statistics for total mercury concentrations fish samples collected from the Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), Little Bay De Noc (LBDN), and Chalk Hill Flowage (CHF).

Species	Total Mercury Concentration (mg/kg)						
	Site	Median	Mean	St Dev	Min	Max	N
Carp	LSF	0.44	0.48	0.14	0.34	0.78	11
	DMD	0.20	0.22	0.05	0.15	0.29	10
	LBDN	0.29	0.32	0.08	0.20	0.46	9
Northern Pike	DMD	0.22	0.28	0.16	0.13	0.58	9
	LBDN	0.49	0.46	0.12	0.21	0.60	10
Redhorse Sucker	LSF	0.81	0.77	0.33	0.27	1.10	5
	LBDN	0.28	0.37	0.27	0.09	0.85	10
	CHF	0.82	0.71	0.32	0.11	1.10	10
Rock Bass	LSF	0.16	0.19	0.07	0.13	0.31	10
	LBDN	0.08	0.09	0.04	0.05	0.15	14
Smallmouth Bass	LSF	0.50	0.54	0.17	0.38	0.90	10
	DMD	0.33	0.31	0.13	0.13	0.58	10
	LBDN	0.28	0.29	0.10	0.18	0.49	10

Appendix A4.

Summary statistics for total DDT concentrations fish samples collected from the Lower Scott Flowage (LSF), Menominee River downstream of the Menominee Dam (DMD), Little Bay De Noc (LBDN), and Chalk Hill Flowage (CHF).

Species	Total DDT Concentration (mg/kg)						
	Site	Median	Mean	St Dev	Min	Max	N
Carp	LSF	0.002	0.003	0.003	0.001	0.010	11
	DMD	0.318	0.297	0.213	0.020	0.721	10
	LBDN	0.087	0.158	0.154	0.016	0.458	9
Northern Pike	DMD	0.001	0.004	0.010	0.001	0.030	9
	LBDN	0.001	0.002	0.002	0.001	0.006	10
Redhorse Sucker	LSF	0.001	0.001	0.000	0.001	0.001	5
	LBDN	0.010	0.016	0.015	0.002	0.050	10
	CHF	0.001	0.001	0.000	0.001	0.001	10
Rock Bass	LSF	0.001	0.001	0.000	0.001	0.001	10
	LBDN	0.001	0.001	0.000	0.001	0.002	14
Smallmouth Bass	LSF	0.001	0.001	0.000	0.001	0.002	10
	DMD	0.005	0.006	0.004	0.003	0.015	10
	LBDN	0.002	0.003	0.001	0.001	0.005	10

Appendix B. Michigan Department of Health and Human Services Fish Consumption Screening Values for DDT plus metabolites, dioxin-like chemicals, mercury, PCBs, PFOS, selenium, and toxaphene.

Meal Category	**DDT, DDE, DDD**	**Dioxins/Furans & co-planar PCBs**	**Mercury**	**PCBs**
meals per month	*μg/g (ppm)*	*pg TEQ/g (ppt-TEQ)*	*μg/g (ppm)*	*μg/g (ppm)*
16	≤ 0.11	≤ 0.5	≤ 0.07	≤ 0.01
12	>0.11 to 0.15	>0.5 to 0.6	>0.07 to 0.09	>0.01 to 0.02
8	>0.15 to 0.23	>0.6 to 0.9	>0.09 to 0.13	>0.02 to 0.03
4	>0.23 to 0.45	>0.9 to 1.9	>0.13 to 0.27	>0.03 to 0.05
2	>0.45 to 0.91	>1.9 to 3.7	>0.27 to 0.53	>0.05 to 0.11
1	>0.91 to 1.8	>3.7 to 7.5	>0.53 to 1.1	>0.11 to 0.21
6 meals per year	>1.8 to 3.7	>7.5 to 15	>1.1 to 2.2	>0.21 to 0.43
Limited	>3.7 to 20	>15 to 90	NA	>0.43 to 2.7
Do Not Eat	>20	>90	>2.2	>2.7

Meal Category	**PFOS (provisional)**	**Selenium**	**Total "Apparent" Toxaphene**	**Toxaphene Parlars 26, 50, 62 (Σ3PC26,50,62)**
meals per month	*μg/g (ppm)*	*μg/g (ppm)*	*μg/g (ppm)*	*μg/g (ppm)*
16	≤ 0.009	≤ 2.3	≤ 0.02	≤ 0.001
12	>0.009 to 0.013	>2.3 to 3.1	>0.02 to 0.03	>0.001 to 0.002
8	>0.013 to 0.019	>3.1 to 4.6	>0.03 to 0.05	>0.002 to 0.003
4	>0.019 to 0.038	>4.6 to 9.2	>0.05 to 0.09	>0.003 to 0.006
2	>0.038 to 0.075	>9.2 to 17	>0.09 to 0.18	>0.006 to 0.011
1	>0.075 to 0.15	NA	>0.18 to 0.36	>0.011 to 0.023
6 meals per year	>0.15 to 0.3	NA	>0.36 to 0.73	>0.023 to 0.046
Limited	NA	NA	>0.73 to 4.5	>0.046 to 0.28
Do Not Eat	>0.3	>17	>4.5	>0.28

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION
JANUARY 2016

STAFF REPORT

STATUS OF FISH CONTAMINANT LEVELS IN THE RIVER RAISIN AREA OF CONCERN 2013

BACKGROUND

The River Raisin Area of Concern (RR-AOC) is located in southeastern Michigan and includes the river downstream from the low-head dam (Dam #6) at Winchester Bridge in the city of Monroe. The RR-AOC also extends into Lake Erie and along the nearshore zone north and south of the river mouth (Figure 1). The lower River Raisin was designated as an AOC in large part due to polychlorinated biphenyl (PCB) contamination from local industrial activity. As a result of the contamination, Michigan has issued fish consumption advisories for this reach of the River Raisin beginning in the 1980s and continuing to the present. PCBs are the primary contaminant driving consumption advisories for fish taken from the lower River Raisin. A contaminated sediment removal project was conducted in 1997, and another project is ongoing. Caged fish studies, conducted most recently in 2011, indicate that PCB concentrations in the River Raisin have declined over time, but remain elevated compared to other rivers (Bohr and Zbytowski, 2006).

Plum Creek is a small Lake Erie tributary that drains to an embayment adjacent to the RR-AOC. While not included in the RR-AOC, Plum Creek is connected to the River Raisin through a man-made canal constructed to provide cooling water to the DTE Energy Company Monroe Power Plant. Fish can move readily between Plum Creek and the lower River Raisin.

The 2015 Michigan Department of Health and Human Services (MDHHS; formerly Department of Community Health) "Eat Safe Fish" guidance recommends limits on consumption of several species of fish from the River Raisin, Plum Creek, and Lake Erie, including carp, channel catfish, smallmouth bass, and freshwater drum. The current advice is based on samples collected through 2008.

This report is an evaluation of fish samples collected in 2013 from the RR-AOC, from seven other Michigan AOCs, and from several non-AOC comparison sites, in support of the United States Environmental Protection Agency (USEPA) Great Lakes Restoration Initiative (GLRI) grant-funded project, *Assessing Michigan's Beneficial Use of Sport-Caught Fish*, awarded to the MDHHS. A sampling plan was developed with a goal of assessing the current levels of contamination in RR-AOC relative to contamination in fish from reference sites. Carp (*Cyprinus carpio*) were selected as a target species because it represents a worst case for PCB contamination and because the species is relatively ubiquitous. Smallmouth bass (*Micropterus dolomieu*), largemouth bass (*M. salmoides*), or a combination of the two species were also targeted because they are top predators, have good site fidelity, and are popular sportfish.

The Huron River near the river mouth was selected as the primary reference site. The site is roughly 13 miles from the RR-AOC; being in such close proximity allows comparison with fish that are exposed to similar regional non-AOC contaminant inputs. Samples from the RR-AOC are also compared to fish from several other sites statewide to provide a broader perspective.

SUMMARY

1. Carp and largemouth bass were collected from the RR-AOC in 2013. Reference samples of carp and either largemouth bass or smallmouth bass were collected from 14 other Michigan water bodies in 2012 and 2013. Samples collected from two areas in Lake Erie were also used for comparison.
2. PCBs were quantified in all samples from the RR-AOC and in nearly all samples from the comparison sites. Mercury was quantified in all samples from the RR-AOC and all but one sample from the comparison sites. Dichlorodiphenyl trichloroethane (DDT) or its metabolites were quantified in almost all samples evaluated for this report.
3. Intra-species length ranges were similar across most sampling sites, although length was a significant explanatory factor only for mercury in bass. Lipid content was a significant explanatory factor for total PCBs and total DDT.
4. Lipid-normalized total PCB concentrations in RR-AOC carp were higher than in all other carp populations sampled except carp from Lake Allegan. Bass from the RR-AOC had the third highest lipid-normalized total PCB concentrations, but the concentrations were not significantly higher than most other populations sampled. Lipid-normalized total PCBs in both species were higher than in those species from the Huron River reference site.
5. Total mercury concentrations in RR-AOC carp and bass were low compared to the other populations sampled.
6. Lipid-normalized total DDT in carp and bass from the RR-AOC were not elevated compared to the other sample sites.

METHODS

Fish were collected by the Michigan Department of Natural Resources or by the Michigan Department of Environmental Quality (MDEQ) to monitor water quality statewide or to assess the status of several AOCs, as part of regular annual monitoring or as special efforts in support of GLRI-funded projects. The fish were processed as standard edible portions in accordance with the MDEQ, Water Resources Division, Fish Contaminant Monitoring Fish Collection Procedure WRD-SWAS-004. Standard edible portions are untrimmed, skin-on fillets for largemouth bass and smallmouth bass, and untrimmed, skin-off fillets for carp. Each sample was individually wrapped in aluminum foil, appropriately labeled, and frozen until preparation for analysis. A total of 175 carp and 185 smallmouth or largemouth bass samples were collected from the RR-AOC and 16 other sites in 2012 and 2013 (Table 1). Analytical results available for carp and smallmouth bass collected in 2006 from Lake Erie near Monroe, and carp and largemouth bass collected in 2006 from North Maumee Bay, were also used for comparison with River Raisin samples.

Largemouth bass and smallmouth bass are closely related species; both are top predators and MDEQ data show the species to have similar contaminant body burdens when they inhabit the same water bodies. The two species are used interchangeably for this evaluation and are referred to collectively as bass.

All fillet samples were analyzed for a standard suite of contaminants including total mercury, organochlorinated pesticides (Table 2), and PCB congeners (Table 3) by the MDHHS Analytical Chemistry Laboratory.

Table 1. Number of carp and smallmouth or largemouth bass (Bass) samples collected from the RR-AOC and comparison sites.

Water Body	Location	Year	Carp	Bass
			N	
River Raisin *	Monroe, d/s Winchester Bridge	2013	10	10
Huron River	Ford Lake	2013	10	10
Huron River	River mouth	2013	10	10
Kalamazoo River *	Lake Allegan	2013	10	10
Lake Erie	N. Maumee Bay	2006	10	10
Lake Erie	off Monroe	2006	10	8
Lake Huron	Les Cheneaux Islands	2012	10	17
Lake Michigan	Little Bay De Noc	2012	9	10
Lake St. Clair	Rio Vista/Lakecrest	2013	10	10
Manistique River *	d/s Manistique Papers Dam	2012	10	10
Menominee River *	Lower Scott Flowage	2013	6	10
Menominee River *	River mouth	2012	10	10
Rouge River *	d/s Lower Rouge confluence	2013	10	10
Rouge River, Middle Branch *	Newburgh Lake	2013	10	10
Saginaw River *	Essexville	2013	10	10
St. Clair River *	Algonac	2012	10	10
St. Marys River *	Munuscong Bay	2012	10	10
St. Joseph River	u/s Benton Harbor	2013	10	10

* - AOC with a “Restrictions On Fish And Wildlife Consumption” Beneficial Use Impairment

Since 2000, the MDHHS Analytical Chemistry Laboratory has measured PCB concentrations using the congener method; total PCB concentration was estimated by summing the concentrations of PCB congeners. Individual congeners below the reporting level (1 microgram per kilogram [µg/kg]) were assigned a concentration equal to 0 for the purpose of calculating a total PCB concentration. Also, congener analyses that did not meet retention time criteria or were subject to analytical interference were assigned a concentration equal to 0 for the purpose of calculating a total PCB concentration.

Total DDT concentrations were calculated by summing concentrations of the para, para’ and ortho, para’ forms of DDT, dichlorodiphenyldichloroethylene (DDE), and 1,1-bis(4-chlorophenyl)-2,2-dichloroethane (DDD). Individual chemicals below the reporting level (1 µg/kg) were assigned a concentration equal to 0 for the purpose of calculating a total DDT concentration. If all six components were below the reporting level, then the total DDT concentration was reported as less than the lowest reporting level of the metabolites.

Analytical results were reviewed and entered into the MDEQ, Fish Contaminant Monitoring Program (FCMP) database. The complete dataset is available electronically (by request) or through the FCMP Web site (www.deq.state.mi.us/fcmp).

Table 2. Standard suite of contaminants assayed in fish tissue samples for the MDEQ, FCMP.

2,4'-DDD	*gamma*-Chlordane
2,4'-DDT	*trans*-Nonachlor
4,4'-DDD	*alpha*-Chlordane
4,4'-DDE	*cis*-Nonachlor
4,4'-DDT	Hexachlorobenzene
Aldrin	Mercury
Dieldrin	Mirex
gamma-BHC (Lindane)	Octachlorostyrene
Heptachlor	PBB (FF-1, BP-6)
Heptachlor Epoxide	Pentachlorostyrene
Heptachlorostyrene	Terphenyl
Hexachlorostyrene	Toxaphene
Oxychlordane	
Total PCB (as congeners; Aroclors prior to 2000)	

The MDHHS, Division of Environmental Health, develops fish consumption advice following protocols described in the *Michigan Fish Consumption Advisory Program Guidance Document*. That document along with links to supporting documentation and other related reports is available online at: http://www.michigan.gov/eatsafefish (Reports & Science button). The guidance was used in this report to predict the likely fish consumption advice based on the analytical results for the samples collected in 2013. Specifically, the projected advice was determined by comparing the 95 percent upper confidence limit (95% UCL) on the mean concentration in legal-size fish for each species/site/contaminant combination with the appropriate MDHHS screening value for that contaminant (MDHHS requires a minimum of five legal-size samples). It is important to note that the projected consumption advice reported here may not be the final advice put forth by the MDHHS; the MDHHS bases consumption guidance on the most current analytical results in combination with previous data for the water body as well as knowledge of legacy or ongoing contamination issues.

The MDHHS fish consumption guidance is presented as a recommended number of meals per month of a given species. The meal categories range from 16 meals per month to a “Do Not Eat” category; the latter category is reserved for those species and water bodies where the estimated contaminant concentration in a single meal would exceed the annual safe level of exposure. In addition the MDHHS has designated a “Limited” category; healthy adults may eat 1 or 2 meals per year of fish in this category but it is recommended that women of childbearing age, young children, and adults with a chronic health condition not eat these fish.

Contaminant loads in fish are sometimes positively correlated with the age of the fish, and fish length is generally used as a surrogate for age. One goal of the project was to collect fish in a similar range of sizes for a given species from each sampling site in order to minimize variation due to differences in length ranges between sites. However, mean length and length ranges did vary between sites (Appendices A1 and A2); the need to adjust the concentrations to compensate for size-related bias was investigated.

Linear regression was used to determine if a significant relationship existed between fish length and contaminant concentration. If the fish length/contaminant concentration regression was significant ($p \leq 0.05$) the contaminant concentrations were length-normalized. This was accomplished by using the slope of the concentration versus length regression line to adjust the contaminant concentration to a level estimated to occur in a fish of a standard length for the species. Regressions of fish length versus mercury, total PCBs, and total DDT concentrations across all sampling sites were statistically significant for both carp and bass; however, within each sampling site fish length was not a significant explanatory factor for any contaminant in carp. Fish length was a significant explanatory factor within sampling sites for mercury concentrations in bass. Between-site comparisons for bass were made with length-normalized mercury concentrations. The average length of all samples was used as the standard length and was set at 16 inches for bass. The formula for length-normalization is:

$$C_{LN} = C_A - S \times (L - St)$$

Where C_{LN} = Length-normalized concentration,
C_A = actual concentration,
S = slope of the concentration versus length line,
L = fish length, and
St = standard length for the species.

Chlorinated contaminants such as PCBs and DDT tend to accumulate preferentially in lipids. Since the lipid content of fish can vary from site to site a simple comparison of contaminant concentrations has the potential to be biased. Linear regression analyses were conducted on each dataset to determine if the lipid to contaminant relationship was significant. Lipid content was a significant explanatory factor for PCBs and DDT in nearly all of the carp sample sets and in about half of the bass sample sets; between site comparisons were made using lipid normalized PCB and DDT concentrations. Results were lipid normalized by dividing the contaminant concentration by the lipid content.

Table 3. PCB structure and corresponding identification number of congeners assayed in fish tissue samples.

BZ#	Structure	BZ#	Structure	BZ#	Structure
	TRICHLOROBIPHENYLS		PENTACHLOROBIPHENYLS		HEPTACHLOROBIPHENYLS
17	2,2',4	82	2,2',3,3',4	170	2,2',3,3',4,4',5
18	2,2',5	84	2,2',3,3',6	171	2,2',3,3',4,4',6
22	2,3,4'	87	2,2',3,4,5'	172	2,2',3,3',4,5,5'
25	2,3',4	90	2,2',3,4',5	174	2,2',3,3',4,5,6'
26	2,3',5	91	2,2',3,4',6	175	2,2',3,3',4,5',6
28	2,4,4'	92	2,2',3,5,5'	177	2,2',3,3',4',5,6
31	2,4',5	95	2,2',3,5',6	178	2,2',3,3',5,5',6
32	2,4',6	97	2,2',3',4,5	179	2,2',3,3',5,6,6'
33	2',3,4	99	2,2',4,4',5	180	2,2',3,4,4',5,5'
37	3,4,4'	100	2,2',4,4',6	182	2,2',3,4,4',5,6'
		101	2,2',4,5,5'	183	2,2',3,4,4',5',6
	TETRACHLOROBIPHENYLS	105	2,3,3',4,4'	185	2,2',3,4,5,5',6
40	2,2',3,3'	110	2,3,3',4',6	187	2,2',3,4',5,5',6
42	2,2',3,4'	118	2,3',4,4',5	190	2,3,3',4,4',5,6
44	2,2',3,5'	126	3,3',4,4',5	193	2,3,3',4',5,5',6
45	2,2',3,6				
47	2,2',4,4'		HEXACHLOROBIPHENYLS		OCTACHLOROBIPHENYLS
49	2,2',4,5'	128	2,2',3,3',4,4'	194	2,2',3,3',4,4',5,5'
52	2,2',5,5'	130	2,2',3,3',4,5'	195	2,2',3,3',4,4',5,6
56	2,3,3',4'	132	2,2',3,3',4,6'	196	2,2',3,3',4,4',5,6'
60	2,3,4,4'	135	2,2',3,3',5,6'	198	2,2',3,3',4,5,5',6
63	2,3',4',5	136	2,2',3,3',6,6'	199	2,2',3,3',4,5,6,6'
64	2,3,4',6	137	2,2',3,4,4',5	201	2,2',3,3',4,5,5',6'
66	2,3',4,4'	138	2,2',3,4,4',5'	203	2,2',3,4,4',5,5',6
70	2,3',4',5	141	2,2',3,4,5,5'	205	2,3,3',4,4',5,5',6
71	2,3',4',6	144	2,2',3,4,5',6		
74	2,4,4',5	146	2,2',3,4',5,5'		NONACHLOROBIPHENYLS
77	3,3',4,4'	149	2,2',3,4',5',6	206	2,2',3,3',4,4',5,5',6
		151	2,2',3,5,5',6		
		153	2,2',4,4',5,5'		
		156	2,3,3',4,4',5		
		157	2,3,3',4,4',5'		
		158	2,3,3',4,4',6		
		163	2,3,3',4',5,6		
		167	2,3',4,4',5,5'		

BZ# = identification numbers adopted by the International Union of Pure and Applied Chemists (IUPAC)

Between site comparisons were made using the Kruskal-Wallis Multiple Comparison Dunn's Test. The software package Minitab 15 was used to perform the statistical tests. Statistical tests were considered significant at $p \leq 0.05$.

RESULTS AND DISCUSSION

The following discussion includes between-site comparisons of results for total PCB, mercury, and total DDT. Elevated levels of PCBs, mercury, or both have led to the need for consumption advisories for certain species of fish taken from the RR-AOC since the mid-to-late-1980s. While DDT has not caused advisories for RR-AOC fish, it is known or likely to be present in concentrations high enough to cause advisories in some species that can be found in the AOC.

Total PCBs

Total PCB concentrations were above the reporting limit of 1 µg/kg in all carp and bass samples from the RR-AOC, and in over 99% of carp and over 95% of bass from comparison sites. The highest PCB concentrations were measured in carp, regardless of sampling site; concentrations in largemouth and smallmouth bass were considerably lower (Appendices B1 and B2).

The highest lipid-normalized total PCB concentrations measured for this report were found in carp from the RR-AOC, although the median concentration for those fish was slightly lower than in carp from Lake Allegan (Figure 2). Lipid-normalized total PCBs in the RR-AOC carp were statistically significantly higher than those concentrations in carp from the Huron River reference site and all other comparison sites except the Kalamazoo River at Lake Allegan. In contrast, the median lipid-normalized total PCB concentration for RR-AOC bass was third highest of the 18 sites evaluated; the concentrations were significantly less than concentrations in bass from Lake Allegan and Lake St. Clair, but significantly greater than concentrations in bass from the Huron River reference site, the St. Clair River, St. Marys River, Little Bay De Noc, Lower Scott Flowage, and Les Cheneaux Islands (Figure 3).

Carp from the RR-AOC had the highest 95% UCL total PCB concentration compared to carp from all comparison sites, based on the most recent results (Table 4). Note that the second highest concentration was for Lake Erie carp samples collected in 2006, while the RR-AOC carp were collected in 2013; it is likely that PCB concentrations in the Lake Erie population declined between those years, making the difference between the two populations even larger. The projected consumption advice due to PCBs for RR-AOC carp based on the most recent results is the same as for carp from Lake Erie and the Menominee River mouth, but more restrictive than for carp from the Huron River reference site and the other comparison sites.

Bass from the RR-AOC had the sixth highest 95% UCL total PCB concentration overall (Table 5). The projected consumption advice due to PCBs for RR-AOC bass based on the most recent results is more restrictive than for bass from ten of the comparison sites (including the Huron River reference site), and equivalent to projected advice for bass from four of the comparison sites (Table 5).

Table 4. The 95% UCL on the mean total PCB concentration in carp fillets from the RR-AOC and 16 other water bodies sampled recently, and projected consumption advice due to total PCB (based only on the most recent sampling results).

Water Body (sample year)	95% UCL (mg/kg)	Meals / Month
River Raisin AOC (2013)	**7.54**	**DNE**
Lake Erie (2006)	4.87	DNE
Menominee River mouth (2012)	2.86	DNE
Little Bay De Noc (2012)	2.06	Limited
Manistique River (2012)	2.02	Limited
Lake Allegan (2013)	2.00	Limited
Les Cheneaux Islands (2012)	1.88	Limited
Lake St. Clair (2013)	1.07	Limited
Ford Lake (2013)	0.88	Limited
N. Maumee Bay (2006)	0.88	Limited
Huron River mouth	***0.84***	***Limited***
Rouge River (2013)	0.82	Limited
St. Clair River (2012)	0.75	Limited
St. Marys River (2012)	0.64	Limited
Saginaw River (2013)	0.62	Limited
Newburgh Lake (2013)	0.55	Limited
St. Joseph River (2013)	0.50	Limited
Lower Scott Flowage (2012)	0.05	4

DNE = Do Not Eat; MDHHS recommends that no one ever eat the fish in this category.
Limited = Healthy adults may safely eat one or two meals per year of fish in this category. MDHHS recommends that women of childbearing age, young children, or adults with a chronic health condition should not eat these fish.

Table 5. The 95% UCL on the mean total PCB concentration in bass fillets from the RR-AOC and 15 other water bodies sampled recently, and projected consumption advice due to total PCB (based only on the most recent sampling results). *Sites with less than five legal-size bass were not included, based on MDHHS protocol.*

Water Body (sample year)	95% UCL (mg/kg)	Meals / Month
Lake Erie (2006)	0.8	Limited
Lake Allegan (2013)	0.6	Limited
Newburgh Lake (2013)	0.19	1
Lake St. Clair (2013)	0.16	1
Manistique River (2012)	0.15	1
River Raisin AOC (2013)	**0.12**	**1**
St. Joseph River (2013)	0.1	2
Menominee River mouth (2012)	0.08	2
Huron River mouth (2013)	***0.06***	***2***
Lower Scott Flowage (2013)	0.06	2
Saginaw River (2013)	0.06	2
Ford Lake (2013)	0.03	8
St. Clair River (2012)	0.03	8
Les Cheneaux Islands (2012)	0.01	16
Little Bay De Noc (2012)	0.01	16
St. Marys River (2012)	0.01	16

Limited = Healthy adults may safely eat one or two meals per year of fish in this category. MDHHS recommends that women of childbearing age, young children, or adults with a chronic health condition should not eat these fish.

Mercury

Total mercury concentrations were above the reporting limit of 10 µg/kg in all RR-AOC samples, and in all but one sample from the comparison sites. Mercury concentrations were generally higher in bass as compared to carp from the same sampling site (Appendices C1 and C2).

Mercury concentrations in carp were not adjusted for fish length since there were no significant length-concentration relationships at any of the sampling sites. The median total mercury concentration in carp from the RR-AOC ranked 13th highest among the 16 sites compared for this report (Figure 4). Total mercury concentrations in carp from the RR-AOC were lower than concentrations in carp from the Lower Scott Flowage (Menominee River), Lake Allegan, Little Bay De Noc, and the Manistique River, and higher than concentrations in carp from the Lower Rouge River, Newburgh Lake, and North Maumee Bay. Mercury results for the Huron River reference site were not available for this report.

Table 6. The 95% UCL on the mean total mercury concentration in carp fillets from the RR-AOC and 15 other water bodies sampled recently, and projected consumption advice due to total mercury (based only on the most recent sampling results).

Water Body (sample year)	95% UCL (mg/kg)	Meals / Month
Lower Scott Flowage (2012)	0.51	2
Lake Erie (2006)	0.49	2
Little Bay De Noc (2012)	0.38	2
Lake Allegan (2013)	0.38	2
Manistique River (2012)	0.37	2
St. Marys River (2012)	0.36	2
St. Clair River (2012)	0.33	2
Les Cheneaux Islands (2012)	0.30	2
Ford Lake (2013)	0.30	2
Menominee River mouth (2012)	0.25	4
River Raisin AOC (2013)	**0.24**	**4**
Saginaw River (2013)	0.24	4
St. Joseph River (2013)	0.23	4
Newburgh Lake (2013)	0.11	8
N. Maumee Bay (2006)	0.09	12
Rouge River (2013)	0.09	12

Table 7. The 95% UCL on the mean total mercury concentration in legal size bass fillets from the River Raisin AOC and 13 other water bodies sampled recently, and projected consumption advice due to total mercury (based only on the most recent sampling results). *Sites with less than five legal-size bass were not included, based on MDHHS protocol.*

Water Body (sample year)	95% UCL (mg/kg)	Meals / Month
Lower Scott Flowage (2013)	0.69	1
St. Clair River (2012)	0.53	2
St. Joseph River (2013)	0.52	2
St. Marys River (2012)	0.44	2
Saginaw River (2013)	0.43	2
Les Cheneaux Islands (2012)	0.42	2
Menominee River mouth (2012)	0.41	2
Manistique River (2012)	0.40	2
Newburgh Lake (2013)	0.39	2
Lake Allegan (2013)	0.38	2
River Raisin AOC (2013)	**0.36**	**2**
Little Bay De Noc (2012)	0.36	2
Ford Lake (2013)	0.35	2
Lake Erie (2006)	0.29	2

Mercury concentrations in bass were standardized to a 16-inch (40.6 centimeter) fish to adjust for differences in fish size between sampling sites. The median total mercury in standard size bass from the RR-AOC ranked 12th highest among the 16 sites compared for this report (Figure 5), and concentrations were significantly lower than in bass from the Lower Scott Flowage, St. Clair River, Lake Allegan, St. Marys River, St. Joseph River, and the Les Cheneaux Islands. Mercury results for the Huron River reference site were not available for this report.

The 95% UCL for total mercury in carp from the RR-AOC ranked 11th highest compared to all sites, based on the most recent results (Table 6). The projected consumption advice due to mercury for RR-AOC carp based only on these results is less restrictive than for carp from nine comparison sites, and more restrictive than for carp from three comparison sites.

The 95% UCL for total mercury in bass from the RR-AOC ranked 11th highest compared to all sites, based on the most recent results (Table 7). The projected consumption advice due to mercury for RR-AOC bass based only on these results is less restrictive than for bass from the Lower Scott Flowage, and equivalent to the advice for bass from the 12 comparison sites with at least five legal-size samples.

<u>Total DDT</u>

Total DDT concentrations were above the reporting limit of 1 μg/kg in all carp and in 9 of 10 bass samples from the RR-AOC, and in 99% of carp and over 80% of bass from comparison sites. The highest DDT concentrations were measured in carp, regardless of sampling site; concentrations in largemouth and smallmouth bass were considerably lower (Appendices D1 and D2).

The median lipid-normalized total DDT concentration in RR-AOC carp ranked 13th highest of the 18 sites evaluated for this report (Figure 6). Lipid-normalized total DDT concentrations in RR-AOC carp were significantly less than in carp from Newburgh Lake, Ford Lake, and Lake Allegan, but higher than in carp from the Lower Scott Flowage. Concentrations in RR-AOC carp were lower than in carp from the Huron River reference site, but the difference was not statistically significant.

The median lipid-normalized total DDT concentration for RR-AOC bass ranked 11th highest of the 18 sites evaluated for this report (Figure 7), and concentrations were significantly lower than concentrations in bass from Newburgh Lake, Ford Lake, the Lower Rouge River, Lake Allegan, and Lake St. Clair, but were not significantly different than concentrations in bass from the Huron River reference site. The lipid-normalized total DDT in bass from the RR-AOC was significantly higher than in bass from the Les Cheneaux Islands, Lower Scott Flowage, St. Marys River, Little Bay De Noc, and the St. Clair River.

Carp from the RR-AOC had the 11th highest 95% UCL total DDT concentration compared to carp from all comparison sites, based on the most recent results (Table 8). If the MDHHS “Eat Safe Fish” guidance for carp from the RR-AOC were based only on the 2013 samples, total DDT would not cause consumption restrictions.

Bass from the RR-AOC had the 9th highest 95% UCL total DDT concentration compared to bass from all comparison sites, based on the most recent results (Table 9). None of the bass populations used in this comparison had concentrations high enough to warrant advice restricting consumption based on the most recent total DDT results.

Table 8. The 95% UCL on the mean total DDT concentration in carp fillets from the RR-AOC and 16 other water bodies sampled recently, and projected consumption advice due to total DDT (based only on the most recent sampling results).

Water Body (sample year)	95% UCL (mg/kg)	Meals / Month
Ford Lake (2013)	0.63	2
Newburgh Lake (2013)	0.63	2
Menominee River mouth (2012)	0.45	4
Les Cheneaux Islands (2012)	0.42	4
Manistique River (2012)	0.34	4
Little Bay De Noc (2012)	0.28	4
Lake Erie (2006)	0.25	4
Rouge River (2013)	0.25	4
Huron River mouth (2013)	***0.16***	***8***
St. Marys River (2012)	0.14	12
River Raisin AOC (2013)	***0.11***	***16***
St. Clair River (2012)	0.11	16
Saginaw River (2013)	0.11	16
Lake Allegan (2013)	0.1	16
St. Joseph River (2013)	0.08	16
Lake St. Clair (2013)	0.07	16
N. Maumee Bay (2006)	0.07	16
Lower Scott Flowage (2012)	0.003	16

Table 9. The 95% UCL on the mean total DDT concentration in bass fillets from the RR-AOC and 16 other water bodies sampled recently, and projected consumption advice due to total DDT (based only on the most recent sampling results). *Sites with less than five legal-size bass were not included, based on MDHHS protocol*.

Water Body (sample year)	95% UCL (mg/kg)	Meals / Month
Huron River mouth (2013)	***0.07***	***16***
Newburgh Lake (2013)	0.05	16
Ford Lake (2013)	0.04	16
Lake Erie (2006)	0.04	16
Manistique River (2012)	0.02	16
Saginaw River (2013)	0.02	16
Lake St. Clair (2013)	0.01	16
Menominee River mouth (2012)	0.009	16
River Raisin AOC (2013)	***0.007***	***16***
Little Bay De Noc (2012)	0.004	16
St. Clair River (2012)	0.003	16
Les Cheneaux Islands (2012)	0.002	16
St. Marys River (2012)	0.001	16
Lower Scott Flowage (2012)	0.001	16

SYNOPSIS

Carp from the RR-AOC had higher concentrations of PCBs (adjusted for lipids) than carp from all other water bodies sampled for this evaluation except Lake Allegan. Bass from the RR-AOC had lower PCB concentrations (adjusted for lipids) than bass from Lake Allegan and Lake St. Clair, but the concentrations were higher than in bass from the five water bodies with the lowest levels. Total PCB concentrations in both species were higher than in those species from the Huron River reference site. These results indicate that PCB concentrations in the RR-AOC sediments and water are elevated compared to most sites in Michigan.

Neither mercury nor total DDT is present in unusual concentrations in RR-AOC fish compared to other water bodies in Michigan.

River Raisin sediment remediation projects are complete or near completion, but the impact of the removal of contaminated sediments may not be measurable in RR-AOC biota for several years. Contaminant concentrations in RR-AOC fish should be monitored periodically to determine the effectiveness of the remediation and to evaluate the need for changes in fish consumption guidance.

Report By: Joseph Bohr
Surface Water Assessment Section
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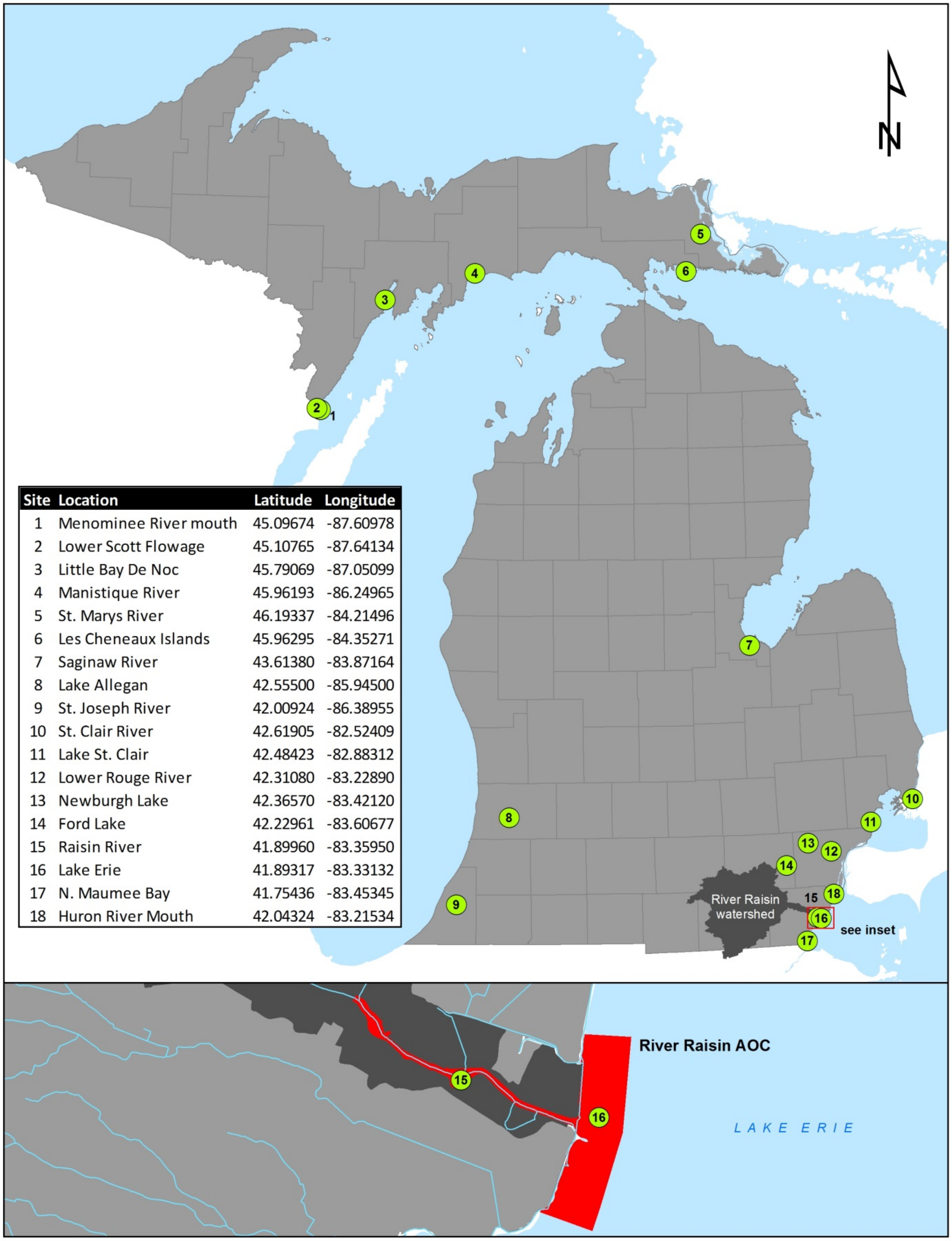
Acknowledgements: Partial funding for field work and sample analysis was provided through a USEPA GLRI grant awarded to the MDHHS. Samples were collected by the Michigan Department of Natural Resources, Fisheries Division, and by the MDEQ, Water Resources Division.

LITERATURE CITED

Bohr, J., and J. Zbytowski. 2006. Michigan Fish Contaminant Monitoring Program, 2005 Annual Report. MDEQ Staff Report #MI/DEQ/WB-06/091.



Site	Location	Latitude	Longitude
1	Menominee River mouth	45.09674	-87.60978
2	Lower Scott Flowage	45.10765	-87.64134
3	Little Bay De Noc	45.79069	-87.05099
4	Manistique River	45.96193	-86.24965
5	St. Marys River	46.19337	-84.21496
6	Les Cheneaux Islands	45.96295	-84.35271
7	Saginaw River	43.61380	-83.87164
8	Lake Allegan	42.55500	-85.94500
9	St. Joseph River	42.00924	-86.38955
10	St. Clair River	42.61905	-82.52409
11	Lake St. Clair	42.48423	-82.88312
12	Lower Rouge River	42.31080	-83.22890
13	Newburgh Lake	42.36570	-83.42120
14	Ford Lake	42.22961	-83.60677
15	Raisin River	41.89960	-83.35950
16	Lake Erie	41.89317	-83.33132
17	N. Maumee Bay	41.75436	-83.45345
18	Huron River Mouth	42.04324	-83.21534

Figure 1. Map of Michigan with fish contaminant sampling sites in the RR-AOC and comparison sites statewide.

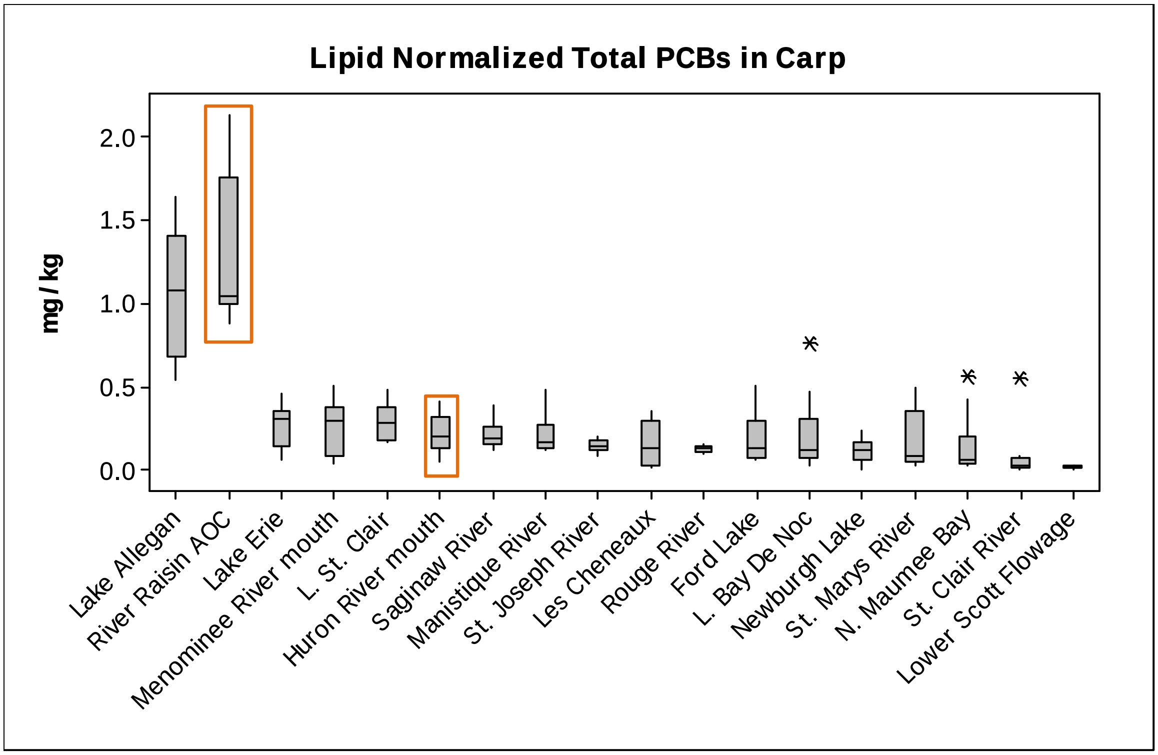


Figure 2. Boxplots of lipid-normalized total PCB concentrations in fillets of carp from the RR-AOC and 17 other sites sampled in 2012 and 2013 (Lake Erie and North Maumee Bay sampled in 2006). Plots are in order from highest to lowest median concentration, with RR-AOC and reference site (Huron River mouth) highlighted.

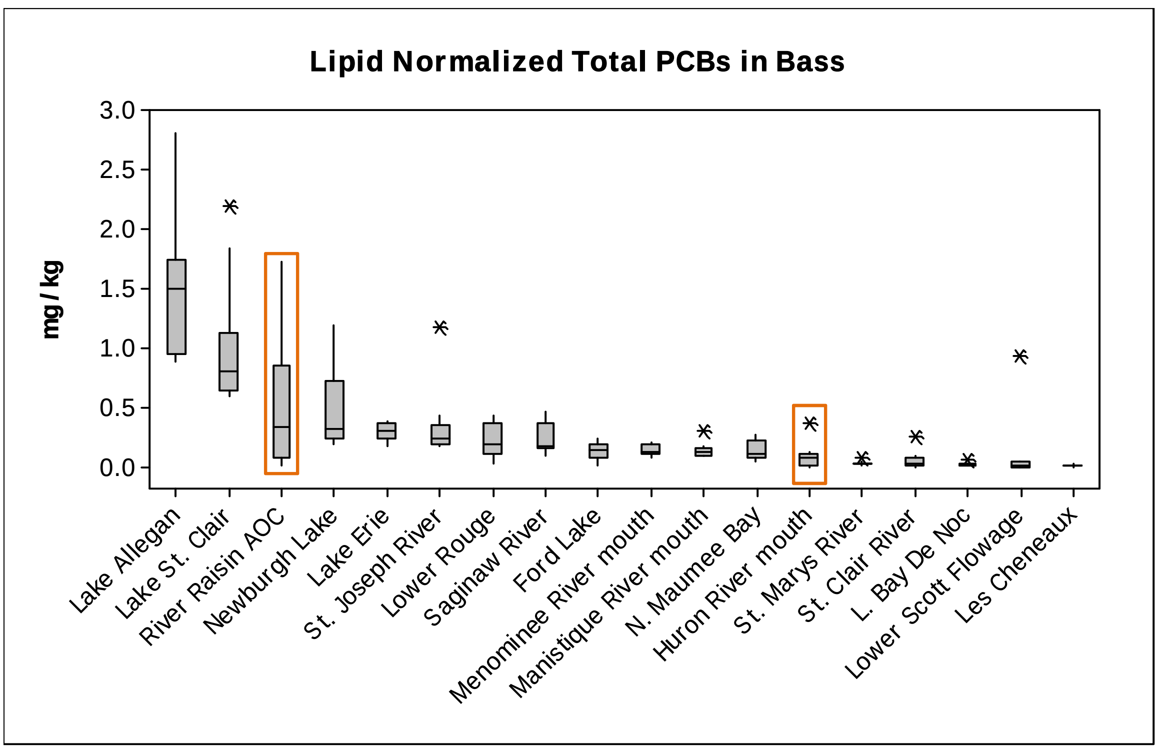


Figure 3. Boxplots of lipid-normalized total PCB concentrations in fillets of largemouth and smallmouth bass from the RR-AOC and 17 other sites sampled in 2012 and 2013 (Lake Erie and North Maumee Bay sampled in 2006). Plots are in order from highest to lowest median concentration, with RR-AOC and reference site (Huron River mouth) highlighted.

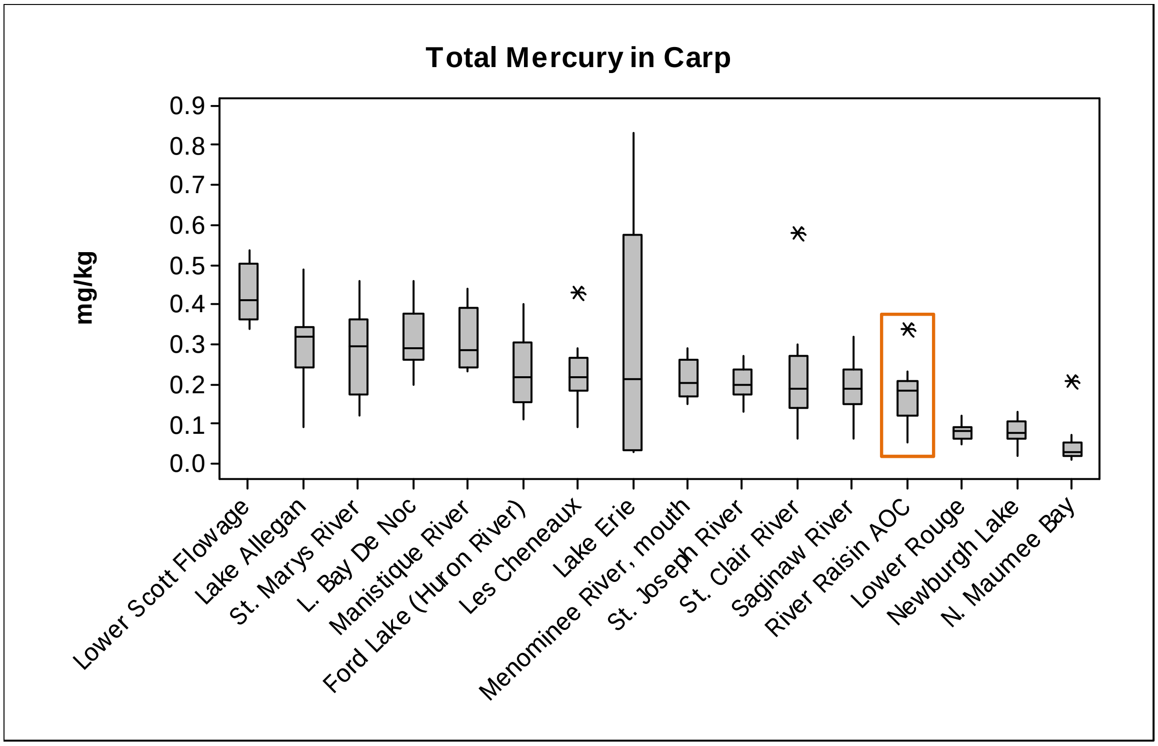


Figure 4. Boxplots of total mercury concentrations in fillets of carp from the RR-AOC and 15 other sites sampled in 2012 and 2013 (Lake Erie and North Maumee Bay sampled in 2006). Plots are in order from highest to lowest median concentration, with RR-AOC highlighted (results for reference site [Huron River mouth] not available).

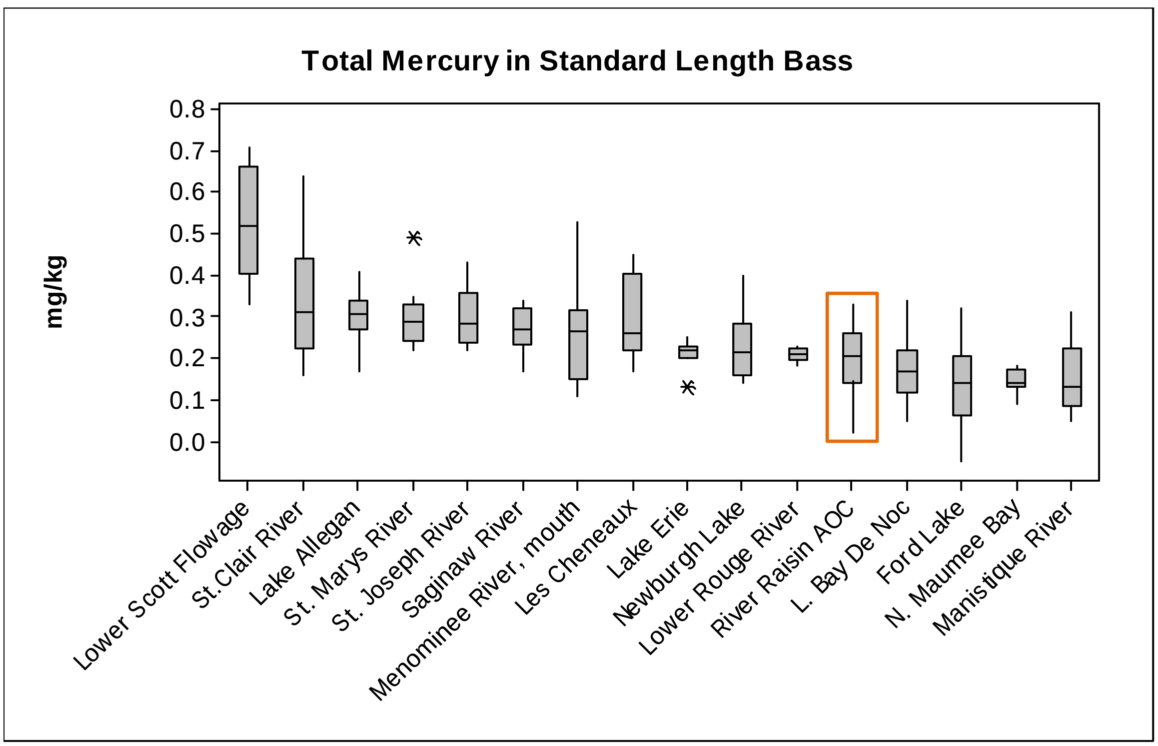


Figure 5. Boxplots of total mercury concentrations in fillets of bass from the RR-AOC and 15 other sites sampled in 2012 and 2013 (Lake Erie and North Maumee Bay sampled in 2006). Plots are in order from highest to lowest median concentration, with RR-AOC highlighted (results for reference site [Huron River mouth] not available).

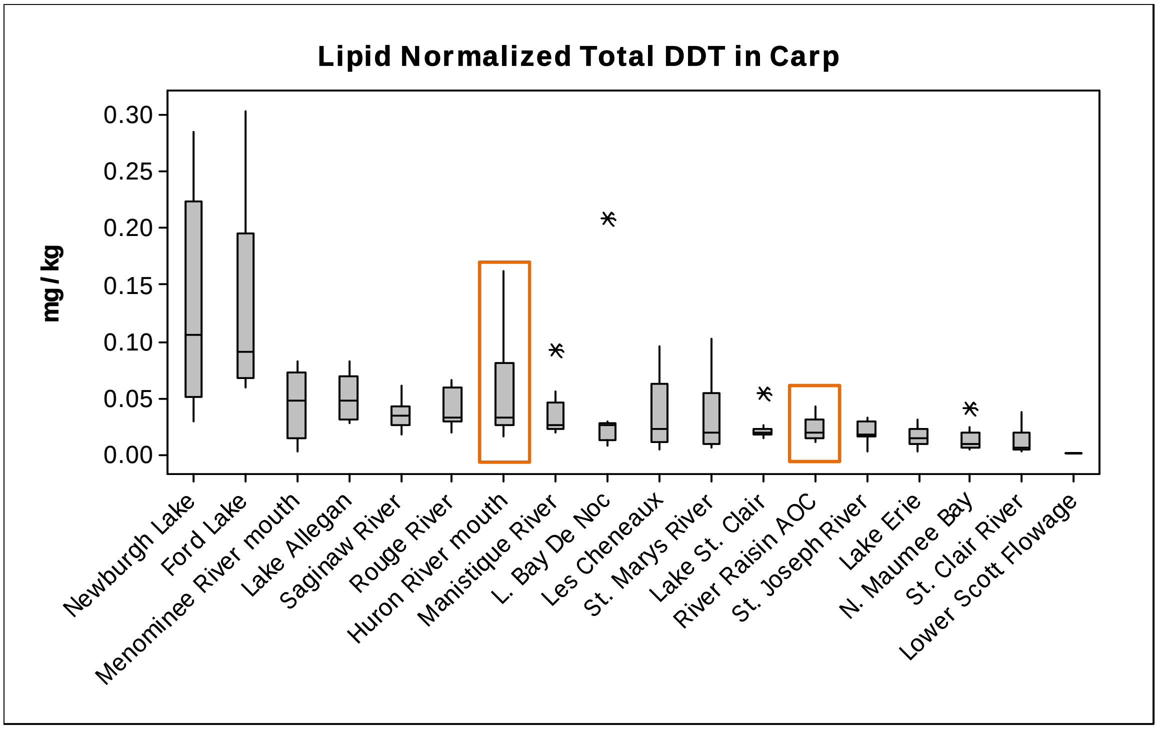


Figure 6. Boxplots of lipid-normalized total DDT concentrations in fillets of carp from the RR-AOC and 17 other sites sampled in 2012 and 2013 (Lake Erie and North Maumee Bay sampled in 2006). Plots are in order from highest to lowest median concentration, with RR-AOC and reference site (Huron River mouth) highlighted.

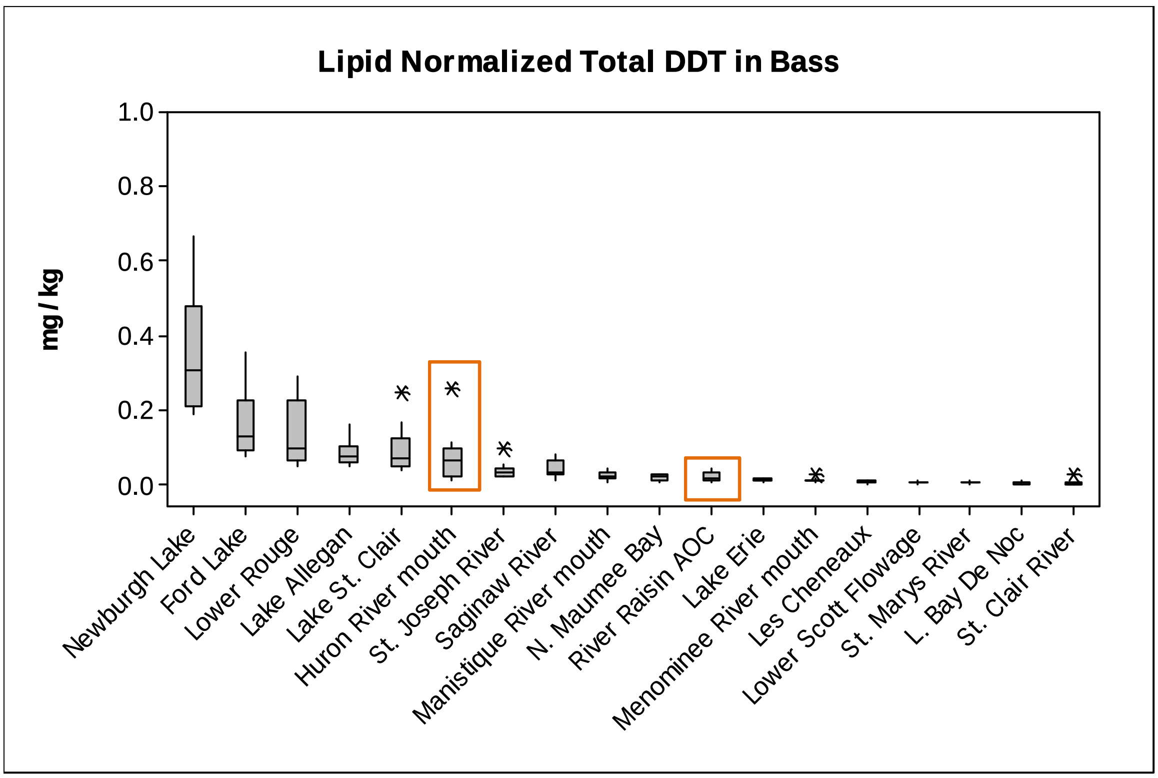


Figure 7. Boxplots of lipid-normalized total DDT concentrations in fillets of bass from the RR-AOC and 17 other sites sampled in 2012 and 2013 (Lake Erie and North Maumee Bay sampled in 2006). Plots are in order from highest to lowest median concentration, with RR-AOC and reference site (Huron River mouth) highlighted.

Appendix A1.
Summary statistics for lengths (inches) of carp collected from the RR-AOC and 17 comparison sites.

Water Body	Sample Year	Mean	St. Dev	Median	Min	Max	N
Ford Lake	2013	25	3.27	24.6	19.5	30.6	10
Huron River mouth	**2013**	**20.1**	**2.30**	**21.9**	**18.4**	**26.5**	**10**
Lake Allegan	2013	17.6	2.8	17.2	14.7	24.3	10
Lake Erie	2006	19.6	6.28	18.9	12.1	27.2	9
Lake St. Clair	2013	20.1	2.97	21.1	15	24.1	10
Les Cheneaux Islands	2012	27.3	2.63	27.9	23.6	31.4	10
Little Bay De Noc	2012	26.4	2.51	25.9	22.4	30.5	9
Lower Scott Flowage	2013	28.6	1.95	28.8	25.5	31.1	6
Manistique River	2012	27.9	1.83	28.1	24.6	30.7	10
Menominee River mouth	2012	28.2	2.65	28	25	32.3	10
N. Maumee Bay	2006	16.5	3.87	15.1	10.8	23.2	10
Newburgh Lake	2013	24.4	2.65	24.4	19.5	28	9
River Raisin AOC	**2013**	**21.5**	**2.26**	**21.5**	**17.3**	**25.4**	**10**
Rouge River	2013	22.3	2.26	22.7	17.9	24.9	10
Saginaw River	2013	20.4	1.49	20.5	18.5	23.3	10
St. Clair River	2012	25	4.53	24.4	16.1	32.1	10
St. Joseph River	2013	20.8	1.61	20.6	19.1	24.2	10
St. Marys River	2012	27.5	1.65	27.5	25.2	29.9	10

Appendix A2.
Summary statistics for lengths (inches) of largemouth and smallmouth bass (combined) collected from the RR-AOC and 17 comparison sites.

Water Body	Sample Year	Mean	St. Dev	Median	Min	Max	N
Ford Lake	2013	15.3	1.25	15.1	14	18.1	10
Huron River mouth	**2013**	**14.4**	**2.11**	**14.4**	**10.7**	**18.3**	**10**
Lake Allegan	2013	13.1	0.96	13.4	11.8	14.4	10
Lake Erie	2006	14.9	1.06	15.1	12.8	16.2	8
Lake St. Clair	2013	14.8	0.63	14.7	13.6	15.6	10
Les Cheneaux Islands	2012	15.8	1.12	16.1	13.6	17.4	17
Little Bay De Noc	2012	16.8	1.09	17.2	14.9	18	10
Lower Scott Flowage	2013	14.8	1.45	14.9	12.2	17.6	10
Manistique River	2012	16.3	1.24	16.3	14.2	18.7	10
Menominee River mouth	2012	16.8	2.02	17	13.1	20.5	10
N. Maumee Bay	2006	12.3	2.21	11.5	10.2	16.9	10
Newburgh Lake	2013	15.2	2.3	15	11.2	18.7	10
River Raisin AOC	**2013**	**15**	**1.93**	**15.3**	**11.7**	**17.4**	**10**
Rouge River	2013	11.2	1.76	10.8	8.3	14.4	10
Saginaw River	2013	14	1.65	13.8	11	16.2	10
St. Clair River	2012	14.8	0.63	14.7	13.6	15.6	10
St. Joseph River	2013	12.6	2.22	12.7	8.9	15.9	10
St. Marys River	2012	15.5	1.06	15.8	13.3	16.9	10

Appendix B1.
Summary statistics for total PCB concentrations in carp samples collected from the RR-AOC and 17 comparison sites, ranked by mean concentration.

Water Body	Mean	St. Dev	Median	Min	Max	N
River Raisin AOC	**3.70**	**5.373**	**2.28**	**0.400**	**18.67**	**10**
Lake Erie	2.75	2.961	1.95	0.040	7.21	10
Menominee River mouth	1.84	1.418	1.83	0.238	5.35	10
Manistique River	1.22	1.121	0.89	0.142	4.10	10
Lake Allegan	1.19	1.128	0.85	0.194	3.59	10
Little Bay De Noc	1.08	1.267	0.67	0.055	4.10	9
Les Cheneaux Islands	0.98	1.247	0.26	0.042	3.44	10
Lake St. Clair	0.62	0.639	0.46	0.155	2.37	10
Rouge River	0.61	0.287	0.57	0.265	1.35	10
Ford Lake	0.58	0.413	0.52	0.079	1.20	10
Huron River mouth	**0.55**	**0.406**	**0.469**	**0.032**	**1.351**	**10**
Saginaw River	0.43	0.270	0.47	0.040	1.02	10
N. Maumee Bay	0.42	0.643	0.11	0.034	2.03	10
St. Marys River	0.39	0.355	0.27	0.094	1.16	10
Newburgh Lake	0.35	0.255	0.37	0.025	0.71	9
St. Clair River	0.35	0.556	0.13	0.001	1.55	10
St. Joseph River	0.24	0.366	0.10	0.072	1.27	10
Lower Scott Flowage	0.03	0.021	0.02	0.003	0.06	6

Appendix B2.
Summary statistics for total PCB concentrations in largemouth and smallmouth bass (combined) collected from the RR-AOC and 17 comparison sites, ranked by mean concentration.

Water Body	Mean	St. Dev	Median	Min	Max	N
Lake Erie	0.624	0.209	0.612	0.391	1.012	8
Lake Allegan	0.421	0.243	0.377	0.185	1.042	10
Lake St. Clair	0.110	0.063	0.084	0.056	0.239	10
N. Maumee Bay	0.100	0.045	0.105	0.024	0.172	10
Manistique River	0.098	0.073	0.067	0.026	0.263	10
Newburgh Lake	0.093	0.131	0.051	0.026	0.460	10
River Raisin AOC	**0.068**	**0.072**	**0.032**	**0.002**	**0.214**	**10**
St. Joseph River	0.064	0.044	0.056	0.016	0.165	10
Menominee River mouth	0.063	0.029	0.054	0.038	0.123	10
Rouge River	0.061	0.046	0.051	0.005	0.142	10
Saginaw River	0.044	0.018	0.041	0.016	0.084	10
Huron River mouth	**0.030**	**0.044**	**0.018**	**0.001**	**0.026**	**10**
Ford Lake	0.024	0.015	0.024	0.002	0.044	10
Lower Scott Flowage	0.022	0.058	0.002	0.001	0.187	10
St. Clair River	0.019	0.012	0.019	0.001	0.036	10
Little Bay De Noc	0.010	0.007	0.008	0.004	0.026	10
St. Marys River	0.007	0.005	0.005	0.003	0.019	10
Les Cheneaux Islands	0.004	0.004	0.003	0.001	0.012	17

Appendix C1.
Summary statistics for total mercury concentrations in carp collected from the RR-AOC and 17 comparison sites, ranked by mean concentration.

Water Body	Mean	St. Dev	Median	Min	Max	N
Lower Scott Flowage	0.43	0.077	0.41	0.34	0.54	6
Lake Erie	0.32	0.297	0.21	0.03	0.84	9
Little Bay De Noc	0.32	0.082	0.29	0.20	0.46	9
Manistique River	0.31	0.078	0.29	0.23	0.44	10
Lake Allegan	0.30	0.115	0.32	0.09	0.49	10
St. Marys River	0.28	0.112	0.30	0.12	0.46	10
Les Cheneaux Islands	0.23	0.089	0.22	0.09	0.43	10
Ford Lake	0.23	0.095	0.22	0.11	0.40	10
St. Clair River	0.22	0.145	0.19	0.06	0.58	10
Menominee River mouth	0.22	0.051	0.21	0.15	0.29	10
St. Joseph River	0.20	0.043	0.20	0.13	0.27	10
Saginaw River	0.19	0.071	0.19	0.06	0.32	10
River Raisin AOC	**0.18**	**0.078**	**0.19**	**0.05**	**0.34**	**10**
Newburgh Lake	0.08	0.033	0.08	0.02	0.13	9
Rouge River	0.08	0.021	0.08	0.05	0.12	10
N. Maumee Bay	0.05	0.059	0.03	0.01	0.21	10
Huron River mouth	--	--	--	--	--	0
Lake St. Clair	--	--	--	--	--	0

Appendix C2.
Summary statistics for total mercury concentrations in largemouth and smallmouth bass (combined) collected from the RR-AOC and 17 comparison sites, ranked by mean concentration.

Water Body	Mean	St. Dev	Median	Min	Max	N
Lower Scott Flowage	0.54	0.173	0.50	0.38	0.90	10
St. Clair River	0.41	0.176	0.33	0.21	0.70	10
Les Cheneaux	0.36	0.115	0.32	0.20	0.58	17
St. Marys River	0.36	0.102	0.38	0.18	0.53	10
Menominee River mouth	0.31	0.129	0.33	0.13	0.58	10
Manistique River	0.30	0.140	0.26	0.17	0.66	10
Little Bay De Noc	0.29	0.098	0.28	0.18	0.49	10
Newburgh Lake	0.26	0.121	0.19	0.14	0.42	10
Saginaw River	0.24	0.098	0.20	0.15	0.39	10
Lake Allegan	0.23	0.078	0.22	0.13	0.36	10
River Raisin AOC	**0.22**	**0.133**	**0.20**	**0.06**	**0.47**	**10**
Ford Lake	0.22	0.178	0.18	0.11	0.72	10
St. Joseph River	0.22	0.113	0.18	0.12	0.44	10
Lake Erie	0.21	0.068	0.22	0.12	0.29	7
Rouge River	0.16	0.027	0.17	0.11	0.20	10
N. Maumee Bay	0.09	0.057	0.08	0.04	0.23	10
Huron River mouth	--	--	--	--	--	0
Lake St. Clair	--	--	--	--	--	0

Appendix D1.
Summary statistics for total DDT concentrations in carp collected from the RR-AOC and 17 comparison sites, ranked by mean concentration.

Water Body	Mean	St. Dev	Median	Min	Max	N
Ford Lake	0.44	0.268	0.52	0.043	0.82	10
Newburgh Lake	0.41	0.281	0.40	0.041	0.88	9
Menominee River mouth	0.30	0.213	0.32	0.020	0.72	10
Les Cheneaux Islands	0.21	0.294	0.11	0.011	0.88	10
Manistique River	0.21	0.191	0.18	0.017	0.71	10
Rouge River	0.18	0.095	0.18	0.060	0.36	10
Lake Erie	0.16	0.172	0.12	0.001	0.45	10
Little Bay De Noc	0.16	0.154	0.09	0.016	0.46	9
Huron River mouth	**0.10**	**0.08**	**0.08**	**0.03**	**0.29**	**10**
St. Marys River	0.08	0.074	0.06	0.012	0.20	10
Saginaw River	0.08	0.046	0.08	0.004	0.16	10
River Raisin AOC	**0.06**	**0.077**	**0.04**	**0.004**	**0.27**	**10**
Lake Allegan	0.06	0.056	0.04	0.010	0.19	10
St. Clair River	0.05	0.075	0.03	0.001	0.25	10
Lake St. Clair	0.05	0.048	0.03	0.016	0.17	10
N. Maumee Bay	0.03	0.044	0.01	0.005	0.15	10
St. Joseph River	0.03	0.060	0.01	0.004	0.20	10
Lower Scott Flowage	0.002	0.001	0.002	0.001	0.003	6

Appendix D2.
Summary statistics for total DDT concentrations in largemouth and smallmouth bass (combined) collected from the RR-AOC and 17 comparison sites, ranked by mean concentration.

Water Body	Mean	St. Dev	Median	Min	Max	N
Newburgh Lake	0.060	0.056	0.042	0.023	0.216	10
Rouge River	0.036	0.030	0.028	0.008	0.113	10
Lake Erie	0.029	0.011	0.027	0.014	0.043	7
Ford Lake	0.028	0.012	0.027	0.013	0.043	10
Lake Allegan	0.025	0.014	0.021	0.008	0.061	10
Huron River mouth	**0.025**	**0.030**	**0.014**	**0.002**	**0.106**	**10**
Manistique River	0.017	0.012	0.014	0.001	0.039	10
N. Maumee Bay	0.016	0.009	0.012	0.007	0.035	10
Lake St. Clair	0.009	0.004	0.009	0.004	0.015	10
Saginaw River	0.009	0.005	0.008	0.002	0.022	10
St. Joseph River	0.008	0.005	0.008	0.002	0.016	10
Menominee River mouth	0.006	0.004	0.005	0.003	0.015	10
River Raisin AOC	**0.003**	**0.003**	**0.003**	**0.001**	**0.011**	**10**
Little Bay De Noc	0.003	0.001	0.002	0.001	0.005	10
St. Clair River	0.002	0.001	0.002	0.001	0.003	10
Les Cheneaux Islands	0.002	0.001	0.001	0.001	0.004	17
Lower Scott Flowage	0.001	0.000	0.001	0.001	0.002	10
St. Marys River	0.001	0.000	0.001	0.001	0.002	10

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION
JANUARY 2016

STAFF REPORT

STATUS OF FISH CONTAMINANT LEVELS IN THE ROUGE RIVER AREA OF CONCERN 2013

BACKGROUND

The Rouge River Area of Concern (RR-AOC) includes the entire Main Branch as well as the Lower, Middle, and Upper Branches of the river (Figure 1). The RR-AOC is currently listed for nine beneficial use impairments, including Restrictions on Fish and Wildlife Consumption. The State of Michigan has placed consumption advisories on fish from the Rouge River since the mid-1980s. The current Michigan Department of Health and Human Services (MDHHS) fish consumption advisory includes varying recommendations for restricted consumption depending on species and location on the river. The primary contaminant driving the fish consumption advisories in the Rouge River watershed is PCBs.

Periodic sampling has found high concentrations of PCBs in sediments in Newburgh Lake (an impoundment of the Middle Branch Rouge River), as well as PCB-contaminated deposits in the Lower and Main Branches of the Rouge River (Kosek, 1992). A significant sediment remediation project was completed in 1998, removing 400,000 cubic yards of contaminated sediment from Newburgh Lake (Selzer, 2008). While fish contaminant monitoring indicates that PCB concentrations in several species have declined, fish consumption advisories remain in place for the lake.

Prior to the present study, the most recent fish contaminant monitoring conducted in the watershed was in 2005, when carp and a few other species were collected from several areas. At that time PCB concentrations tended to be the highest in Newburgh Lake (Middle Branch Rouge River), the Lower Branch Rouge River, and Main Branch of the Rouge River downstream of the Ford Dam.

This report is an evaluation of fish samples collected from the RR-AOC, from four other Michigan AOCs, and from several non-AOC comparison sites, in support of the United States Environmental Protection Agency (USEPA) Great Lakes Restoration Initiative (GLRI) grant-funded project *Assessing Michigan's Beneficial Use of Sport-Caught Fish* awarded to the MDHHS. A sampling plan was developed with a goal of assessing the current levels of contamination in RR-AOC relative to contamination in fish from reference sites. Carp (*Cyprinus carpio*) were selected as a target species because it represents a worst case for PCB contamination and because the species is relatively ubiquitous. Smallmouth bass (*Micropterus dolomieu*), largemouth bass (*M. salmoides*), or a combination of the two species were also targeted because they are top predators, have good site fidelity, and are popular sportfish.

Newburgh Lake was chosen as a sampling site because it has had legacy PCB contamination and has been covered by fairly restrictive fish consumption advisories in the recent past. Monitoring indicates that PCB concentrations in fish have declined since the sediment remediation project was completed. The Main Branch Rouge River downstream of the Ford Dam was selected as a sampling site to represent riverine sections of the RR-AOC;

several species of fish from that river reach have had Do Not Eat advisories issued by the MDHHS. Samples were collected from the Main Branch Rouge River near the confluence with the Lower Branch Rouge River, but upstream of the concrete-lined channel. No samples were collected from the river between the turning basin and the Detroit River confluence, since fish there are more likely to have contaminant loads influenced by conditions in the Detroit River.

Ford Lake (an impoundment of the Huron River) in Washtenaw County is a nearby water body without a known legacy contamination issue that supports good populations of the target species and was selected as the primary reference site for Newburgh Lake. The Huron River near the river mouth was selected as the primary reference site for the riverine portion of the Rouge River sampling. Both reference sites are in relatively close proximity to the RR-AOC allowing comparison with fish that are exposed to similar regional non-AOC contaminant inputs. Samples from the RR-AOC are also compared to fish from several other sites statewide to provide a broader perspective.

SUMMARY

1. Carp, largemouth bass, and smallmouth bass were collected from two sampling sites in the RR-AOC in 2013. Samples of carp and either largemouth bass or smallmouth bass were collected from two primary reference sites and eight other Michigan water bodies in 2012 and 2013. Samples collected in 2006 from two areas in Lake Erie were also used for comparison.
2. PCBs were quantified in all samples from the RR-AOC and in most samples from the comparison sites. Mercury was quantified in all bass and nearly all carp analyzed for this report. Dichlorodiphenyl trichloroethane (DDT) was quantified in all samples from the RR-AOC and in nearly all samples from the comparison sites.
3. Total PCB concentrations in carp from the Main Branch Rouge River and Newburgh Lake were not statistically different than concentrations measured in carp from the respective reference sites. However, total PCB concentrations in bass from the two RR-AOC sampling sites were higher than in bass from the reference sites.
4. Total mercury concentrations in RR-AOC carp were low compared to carp from the other water bodies sampled. Mercury concentrations in bass from the Newburgh Lake were similar to concentrations in Ford Lake bass, but Main Branch Rouge River bass had higher mercury concentrations than bass from the Huron River mouth reference site.
5. Total DDT concentrations in both carp and bass from the Main Branch Rouge River and Newburgh Lake were not statistically different than concentrations measured in fish from the respective reference sites.
6. Projected fish consumption advice for RR-AOC carp (solely for this report) is equivalent to advice for carp from reference sites, but projected advice for RR-AOC bass is more restrictive than for bass from the reference sites.
7. Contaminant concentrations in Newburgh Lake largemouth bass have declined significantly since the 1998 sediment remediation project.

METHODS

Fish were collected by the Michigan Department of Natural Resources or by the Michigan Department of Environmental Quality (MDEQ) to monitor water quality statewide or to assess the status of several AOCs, as part of regular annual monitoring or as special efforts in support of GLRI-funded projects. A total of 96 carp and 107 smallmouth or largemouth bass samples were collected from the RR-AOC and 9 other sites in 2012 and 2013 (Table 1; Figure 1). Analytical results available for carp and smallmouth bass collected in 2006 from Lake Erie near

Monroe, and carp and largemouth bass collected in 2006 from North Maumee Bay, were also used for comparison with Rouge River samples.

Table 1. Number of carp and smallmouth or largemouth bass (Bass) samples collected from the Rouge River AOC (in bold) and comparison sites. *Primary reference sites are italicized.*

Waterbody	Location	Year	Carp	Bass
			N	
Main Branch Rouge River *	**d/s Lower Rouge confluence**	**2013**	**10**	**10**
Rouge River, Middle Branch *	**Newburgh Lake**	**2013**	**10**	**10**
Huron River	***Ford Lake***	***2013***	***10***	***10***
Huron River	***River mouth***	***2013***	***10***	***10***
Lake Erie	N. Maumee Bay	2006	10	10
Lake Erie	off Monroe	2006	9	8
Lake Huron	Les Cheneaux Islands	2012	10	17
Manistique River*	River mouth	2012	10	10
Menominee River*	Lower Scott Flowage	2012	6	10
St. Clair River *	Algonac	2012	10	10
St. Joseph River	u/s Benton Harbor	2013	10	10
St. Marys River*	Munuscong Bay	2012	10	10

* - Area of Concern with a “Restrictions On Fish And Wildlife Consumption” Beneficial Use Impairment;

The fish were processed as standard edible portions in accordance with the MDEQ, Water Resources Division, Fish Contaminant Monitoring Fish Collection Procedure WRD-SWAS-004. Standard edible portions are untrimmed, skin-on fillets for largemouth bass and smallmouth bass, and untrimmed, skin-off fillets for carp. Each sample was individually wrapped in aluminum foil, appropriately labeled, and frozen until preparation for analysis.

Largemouth bass and smallmouth bass are closely related and both are top predator species. MDEQ data show the species to have similar contaminant body burdens when they inhabit the same water bodies. The two species are used interchangeably for this evaluation and are referred to collectively as bass.

All fillet samples were analyzed for a standard suite of contaminants including total mercury, organochlorinated pesticides (Table 2), and PCB congeners (Table 3) by the MDHHS Analytical Chemistry Laboratory (ACL).

Since 2000, the MDHHS-ACL has measured PCB concentrations using the congener method; total PCB concentration was estimated by summing the concentrations of PCB congeners.

Table 2. Standard suite of contaminants assayed in fish tissue samples for the MDEQ Fish Contaminant Monitoring Program.

2,4'-DDD	*gamma*-Chlordane
2,4'-DDT	*trans*-Nonachlor
4,4'-DDD	*alpha*-Chlordane
4,4'-DDE	*cis*-Nonachlor
4,4'-DDT	Hexachlorobenzene
Aldrin	Mercury
Dieldrin	Mirex
gamma-BHC (Lindane)	Octachlorostyrene
Heptachlor	PBB (FF-1, BP-6)
Heptachlor Epoxide	Pentachlorostyrene
Heptachlorostyrene	Terphenyl
Hexachlorostyrene	Toxaphene
Oxychlordane	
Total PCB (as congeners; Aroclors prior to 2000)	

Individual congeners below the reporting level (0.001 milligram per kilogram [mg/kg]) were assigned a concentration equal to 0 for the purpose of calculating a total PCB concentration. Also, congener analyses that did not meet retention time criteria or were subject to analytical interference were assigned a concentration equal to 0 for the purpose of calculating a total PCB concentration.

Table 3. PCB structure and corresponding identification number of congeners assayed in fish tissue samples.

BZ#	Structure	BZ#	Structure	BZ#	Structure
	TRICHLOROBIPHENYLS		PENTACHLOROBIPHENYLS		HEPTACHLOROBIPHENYLS
17	2,2',4	82	2,2',3,3',4	170	2,2',3,3',4,4',5
18	2,2',5	84	2,2',3,3',6	171	2,2',3,3',4,4',6
22	2,3,4'	87	2,2',3,4,5'	172	2,2',3,3',4,5,5'
25	2,3',4	90	2,2',3,4',5	174	2,2',3,3',4,5,6'
26	2,3',5	91	2,2',3,4',6	175	2,2',3,3',4,5',6
28	2,4,4'	92	2,2',3,5,5'	177	2,2',3,3',4',5,6
31	2,4',5	95	2,2',3,5',6	178	2,2',3,3',5,5',6
32	2,4',6	97	2,2',3',4,5	179	2,2',3,3',5,6,6'
33	2',3,4	99	2,2',4,4',5	180	2,2',3,4,4',5,5'
37	3,4,4'	100	2,2',4,4',6	182	2,2',3,4,4',5,6'
		101	2,2',4,5,5'	183	2,2',3,4,4',5',6
	TETRACHLOROBIPHENYLS	105	2,3,3',4,4'	185	2,2',3,4,5,5',6
40	2,2',3,3'	110	2,3,3',4',6	187	2,2',3,4',5,5',6
42	2,2',3,4'	118	2,3',4,4',5	190	2,3,3',4,4',5,6
44	2,2',3,5'	126	3,3',4,4',5	193	2,3,3',4',5,5',6
45	2,2',3,6				
47	2,2',4,4'		HEXACHLOROBIPHENYLS		OCTACHLOROBIPHENYLS
49	2,2',4,5'	128	2,2',3,3',4,4'	194	2,2',3,3',4,4',5,5'
52	2,2',5,5'	130	2,2',3,3',4,5'	195	2,2',3,3',4,4',5,6
56	2,3,3',4'	132	2,2',3,3',4,6'	196	2,2',3,3',4,4',5,6'
60	2,3,4,4'	135	2,2',3,3',5,6'	198	2,2',3,3',4,5,5',6
63	2,3',4',5	136	2,2',3,3',6,6'	199	2,2',3,3',4,5,6,6'
64	2,3,4',6	137	2,2',3,4,4',5	201	2,2',3,3',4,5,5',6'
66	2,3',4,4'	138	2,2',3,4,4',5'	203	2,2',3,4,4',5,5',6
70	2,3',4',5	141	2,2',3,4,5,5'	205	2,3,3',4,4',5,5',6
71	2,3',4',6	144	2,2',3,4,5',6		
74	2,4,4',5	146	2,2',3,4',5,5'		NONACHLOROBIPHENYLS
77	3,3',4,4'	149	2,2',3,4',5',6	206	2,2',3,3',4,4',5,5',6
		151	2,2',3,5,5',6		
		153	2,2',4,4',5,5'		
		156	2,3,3',4,4',5		
		157	2,3,3',4,4',5'		
		158	2,3,3',4,4',6		
		163	2,3,3',4',5,6		
		167	2,3',4,4',5,5'		

BZ# = identification numbers adopted by the International Union of Pure and Applied Chemists (IUPAC)

Total DDT concentrations were calculated by summing concentrations of the para, para' and ortho, para' forms of DDT, dichlorodiphenyldichloroethylene (DDE), and 1,1-bis(4-chlorophenyl)-2,2-dichloroethane (DDD). Individual chemicals below the reporting level (0.001 mg/kg) were assigned a concentration equal to 0 for the purpose of calculating a total DDT concentration. If all six components were below the reporting level, then the total DDT concentration was reported as less than the lowest reporting level of the metabolites.

Analytical results were reviewed and entered into the MDEQ Fish Contaminant Monitoring Program (FCMP) database. Summary statistics for total PCBs, mercury, and total DDT are presented in Appendices B1 and B2, C1 and C2, and D1 and D2, respectively. The complete dataset is available upon request or through the FCMP Web site (www.deq.state.mi.us/fcmp).

The MDHHS, Division of Environmental Health, develops fish consumption advice following protocols described in the *Michigan Fish Consumption Advisory Program Guidance Document*. That document along with links to supporting documentation and other related reports is available online at http://www.michigan.gov/eatsafefish (Reports & Science button). The guidance was used in this report to predict the likely fish consumption advice based on the analytical results for the samples collected in 2013. Specifically, the projected advice was determined by comparing the 95 percent upper confidence limit (95% UCL) on the mean concentration in legal-size fish for each species/site/contaminant combination with the appropriate MDHHS screening value for that contaminant (MDHHS requires a minimum of five legal-size samples).

It is important to note that the projected consumption advice reported here may not be the final advice put forth by the MDHHS. The MDHHS bases consumption guidance on the most current analytical results in combination with previous data for the water body, as well as knowledge of legacy or ongoing contamination issues.

The MDHHS fish consumption guidance is presented as a recommended number of servings per month of a given species. The serving categories range from 16 servings per month to a “Do Not Eat” category; the latter category is reserved for those species and water bodies where the estimated contaminant concentration in a single serving would exceed a safe level of exposure for a full year. In addition, the MDHHS has designated a “Limited” category; healthy adults may eat 1 or 2 servings per year of fish in this category but it is recommended that women of childbearing age, young children, and adults with a chronic health condition not eat these fish.

Contaminant loads in fish are sometimes positively correlated with the age of the fish, and fish length is generally used as a surrogate for age. In addition, chlorinated contaminants such as PCBs, DDT, and dioxins tend to accumulate preferentially in lipids. Since the length range and lipid content of fish can vary from site to site a simple comparison of contaminant concentrations has the potential to be biased. To compensate for the potential bias, statistical comparisons were conducted using a Generalized Linear Model (GLM) with lipid content and fish length as covariates for the chlorinated contaminant concentrations, and fish length as a covariate for mercury concentrations. Results were transformed using the natural log in order to meet assumptions of the GLM, converted back to standard units and presented as least squares means. The least squares means are the sample location means adjusted through the GLM for the effects of the covariates (lipid content and/or fish length).

Summary statistics for fish lengths are presented in Appendices A1 and A2.

Analytical results for several sampling years are available for carp and largemouth bass from Newburgh Lake, and the data were used to evaluate temporal trends. Carp were collected in 2001, 2002, 2005, and 2013; largemouth bass were collected in 1995, 2001, and 2013. Multiple regression along with the GLM was used with fish length and lipid content as covariates, as appropriate, to determine if contaminant concentrations changed over the sampling period.

RESULTS AND DISCUSSION

The following discussion includes between-site comparisons of results for total PCB, mercury, and total DDT. Elevated levels of PCBs, mercury, or both have led to the need for consumption advisories for certain species of fish taken from the RR-AOC since the mid- to late-1980s. While DDT has not caused advisories for RR-AOC fish, it is known or likely to be present in concentrations high enough to cause advisories in some species that can be found in the AOC.

Total PCBs

Total PCB concentrations were above the reporting limit of 0.001 mg/kg in all carp and bass samples from the RR-AOC, and in over 99% of carp and about 88% of bass from statewide comparison sites. All carp and 95% of the bass collected from the Huron River reference sites had total PCB concentrations above the reporting limit. The highest PCB concentrations were measured in carp, regardless of sampling site; concentrations in largemouth and smallmouth bass were considerably lower (Appendices B1 and B2). Fish length and percent lipid were significant covariates in the GLM for both carp and bass.

Table 4. The 95% UCL on the mean total PCB concentration and projected consumption advice based on those concentrations for fish collected from the Rouge River AOC (Newburgh Lake and Main Branch Rouge River) and two reference sites in 2013.

	95% UCL (mg/kg)	Servings per Month†
CARP		
Newburgh Lake	0.55	Limited
Ford Lake	0.89	Limited
Main Br. Rouge River	0.82	Limited
Huron River mouth	0.84	Limited
BASS		
Newburgh Lake	0.08	2
Ford Lake	0.04	4
Main Br. Rouge River	0.12*	1
Huron River mouth	0.10	2

* - insufficient legal size bass (14-inch minimum) for an appropriate evaluation
† - not actual MDHHS guidance; based on 2013 data only

Carp collected from the Main Branch Rouge River in 2013 had the highest least squares mean total PCB concentration of all comparison carp populations, but the level was only slightly higher than that measured in carp from the Huron River reference site, and that difference was not statistically different (Figure 2). The total PCB concentrations in Main Branch Rouge River carp were significantly higher than in carp from the St. Clair River and the Lower Scott Flowage (Menominee River). The least square mean total PCB concentration in carp from Newburgh Lake was nominally lower than in carp from the Ford Lake reference site, but the difference was not statistically significant (Figure 2). Total PCB concentrations in Newburgh Lake carp were significantly higher than in carp from the Lower Scott Flowage.

Bass collected from Newburgh Lake and the Main Branch Rouge River in 2013 had the second and third highest least squares mean total PCB concentrations, respectively, compared to the other ten sites sampled (Figure 3). Only the St. Joseph River bass had higher concentrations; that difference was not statistically significant. The total PCB concentrations in bass from the Main Branch Rouge River and from Newburgh Lake were higher than in bass from the Huron River mouth and Ford Lake, the respective reference sites. Those differences were statistically significant.

The projected consumption advice for RR-AOC carp based on the 95% UCL on mean total PCB concentrations is the same as for carp from the reference sites (Table 4). In contrast, the projected consumption advice for bass from the RR-AOC is more restrictive than for bass from the respective reference sites. The advice for Main Branch Rouge River bass is more restrictive than for the Huron River mouth bass even though 9 of 10 bass from the former were smaller than the 14-inch legal size limit. Presumably larger bass would have even higher contaminant concentrations.

Temporal Trends in Total PCB Concentrations

Statistical analysis indicated that PCB concentrations in Newburgh Lake carp did not decline significantly between 2001 and 2013 (Figure 4). Largemouth bass were first collected from Newburgh Lake in 1995, prior to the sediment remediation project (completed in 1998); total PCB concentrations in the bass declined significantly between the 1995 and 2001 sampling events (Figure 5). PCB concentrations in bass collected from Newburgh Lake in 2013 were not significantly different than concentrations in the bass collected in 2001.

<u>Mercury</u>

Total mercury concentrations were above the 0.01 mg/kg reporting limit in all carp and bass samples from the RR-AOC, and in 99% of the carp and all of the bass from the statewide comparison sites. The highest mercury concentrations were measured in bass, regardless of sampling site; concentrations in carp were considerably lower (Appendix C1). Fish length was a significant covariate in the GLM for both carp and bass.

Table 5. The 95% UCL on the mean total mercury concentration and projected consumption advice based on those concentrations for fish collected from the Rouge River AOC (Newburgh Lake and Main Branch Rouge River) and two reference sites in 2013.

	95% UCL (mg/kg)	Servings per Month†
CARP		
Newburgh Lake	0.10	8
Ford Lake	0.30	2
Main Br. Rouge River	0.09	12
Huron River mouth	0.21	4
BASS		
Newburgh Lake	0.39	2
Ford Lake	0.35	2
Main Br. Rouge River	0.18*	4
Huron River mouth	0.31	2

* - insufficient legal size bass (14-inch minimum) for an appropriate evaluation

† - not actual MDHHS guidance; based on 2013 data only

Carp collected from the RR-AOC had the lowest least squares mean mercury concentrations compared to carp from nearly all of the other sites (Figure 6). Newburgh Lake carp had the lowest concentrations overall; the concentrations in those fish were significantly less than in carp from the Ford Lake reference site and all other sites except North Maumee Bay and the Main Branch Rouge River. Mercury concentrations in carp from the Main Branch Rouge River were nominally lower than in carp from the Huron River mouth reference site, but the difference was not significant. Main Branch Rouge River carp had significantly lower mercury concentrations than carp from Lake Erie, the Lower Scott Flowage, and the St. Joseph River; those concentrations were not significantly different than mercury concentrations in carp from the other sites sampled.

Bass collected from the Main Branch Rouge River had the third highest least squares mean mercury concentration (Figure 7), and the concentrations were significantly greater than in bass from the Huron River mouth reference site, Ford Lake, and North Maumee Bay. The concentrations were significantly less than the concentrations in bass from the Lower Scott Flowage. Bass collected from Newburgh Lake had a relatively low least squares mean mercury concentration, with a concentration significantly less than in Lower Scott Flowage bass and significantly greater than in North Maumee Bay bass. Mercury concentrations in Newburgh Lake bass were nominally higher but did not differ significantly from concentrations in bass collected from the Ford Lake reference site.

The projected consumption advice for RR-AOC carp based on the 95% UCL on mean total mercury concentrations is less restrictive than for carp from the reference sites (Table 5). The projected consumption advice for bass from Newburgh Lake is the same as for bass from the Ford Lake reference site. The projected consumption advice for bass from the Main Branch Rouge River is less restrictive than for bass from the Huron River mouth reference site; however, the Rouge River sample set did not have a sufficient number of legal sized fish to meet the MDHHS protocol.

Temporal Trends in Total Mercury Concentrations

Statistical analysis indicated that mercury concentrations in Newburgh Lake carp did not change significantly between 2001 and 2013, although the concentrations did fluctuate over that time period (Figure 8). Mercury concentrations in Newburgh Lake largemouth bass declined between 1995 and 2001, but increased slightly between 2001 and 2013 (Figure 9). The between year differences were statistically significant.

<u>Total DDT</u>

Total DDT concentrations were above the reporting limit of 0.001 mg/kg in all carp and bass samples from the RR-AOC, and in 98% of carp and about 71% of bass from statewide comparison sites. All carp and bass collected from the Huron River reference sites had total DDT concentrations above the reporting limit. The highest DDT concentrations at each sampling site were measured in carp; concentrations in largemouth and smallmouth bass were considerably lower (Appendices D1 and D2). Fish length and percent lipid were significant covariates in the GLM for both carp and bass.

Table 6. The 95% UCL on the mean total DDT concentration and projected consumption advice based on those concentrations for fish collected from the Rouge River AOC (Newburgh Lake and Main Branch Rouge River) and two reference sites in 2013.

	95% UCL (mg/kg)	Servings per Month†
CARP		
Newburgh Lake	0.60	2
Ford Lake	0.63	2
Main Br. Rouge River	0.25	4
Huron River mouth	0.16	8
BASS		
Newburgh Lake	0.10	16
Ford Lake	0.04	16
Main Br. Rouge River	0.06*	16
Huron River mouth	0.05	16

* - insufficient legal size bass (14-inch minimum) for an appropriate evaluation

† - not actual MDHHS guidance; based on 2013 data only

Carp collected from Newburgh Lake and from the Main Branch Rouge River had the highest and third highest least squares mean total DDT concentrations, respectively, compared to the other ten comparison sites (Figure 10). Total DDT concentrations in carp from both RR-AOC sample sites were not significantly different than in carp from the respective reference sites.

Bass collected from Newburgh Lake and from the Main Branch Rouge River had the highest and second highest least squares mean total DDT concentrations, respectively, compared to the other ten comparison sites (Figure 11). Total DDT concentrations in bass from both RR-AOC sample sites were not significantly different than in bass from the respective reference sites.

The projected consumption advice for Newburgh Lake carp based on the 95% UCL on mean total DDT concentrations is the same as for carp from the Ford Lake reference site (Table 6), but projected advice for carp from the Main Branch Rouge River based on total DDT is more restrictive than for carp from the Huron River mouth reference site. In contrast, the projected consumption advice based on total DDT in bass from the RR-AOC is the same as for bass from the respective reference sites, although there were too few legal size bass to meet the MDHHS protocol.

Temporal Trends in Total DDT Concentrations

Total DDT concentrations in Newburgh Lake carp declined slightly between 2001 and 2013 (Figure 12), although the difference was not statistically significant. Total DDT concentrations in Newburgh Lake largemouth bass declined between 1995 and 2001 (Figure 13), and the difference was statistically significant. No significant change between 2001 and 2012 was measured.

SYNOPSIS

PCBs have been the primary bioaccumulative contaminant of concern in the RR-AOC, and continue to be the principal cause of fish consumption advisories. Concentrations of PCBs in carp from the RR-AOC are not significantly different than concentrations in carp from the reference sites selected for this evaluation. In contrast, total PCB concentrations in bass from the RR-AOC are higher than in bass from the selected reference sites, and the difference translates into more restrictive consumption advice for that species (Table 7).

Neither mercury nor total DDT is present in unusual concentrations in RR-AOC fish compared to other water bodies in Michigan. Mercury is the primary cause of consumption advice for Ford Lake bass, and causes an advisory equivalent to that caused by PCBs in Newburgh Lake bass (Table 7).

It is important to reiterate that the projected consumption advice reported here may not be the final advice put forth by the MDHHS; the MDHHS bases consumption guidance on the most current analytical results in combination with previous data for the water body as well as knowledge of legacy or ongoing contamination issues.

Newburgh Lake carp did not show statistically significant temporal trends in PCBs, mercury, or DDT, although both PCBs and DDT did show nominal declines between 2001 and 2013. Largemouth bass from Newburgh Lake were sampled in 1995, prior to the sediment remediation project, and subsequent sampling did show statistically significant declines in all three contaminants.

Table 7. Projected fish consumption advice for the Rouge River AOC and two reference sites based only on contaminant sampling results for 2013.

	Newburgh Lake	Ford Lake	Main Branch Rouge River	Huron River mouth
CARP				
Servings/Month	Limited	Limited	Limited	Limited
Cause	PCBs	PCBs	PCBs	PCBs
BASS				
Servings/Month	2	2	1	2
Cause	PCBs/Mercury	Mercury	PCBs	PCBs

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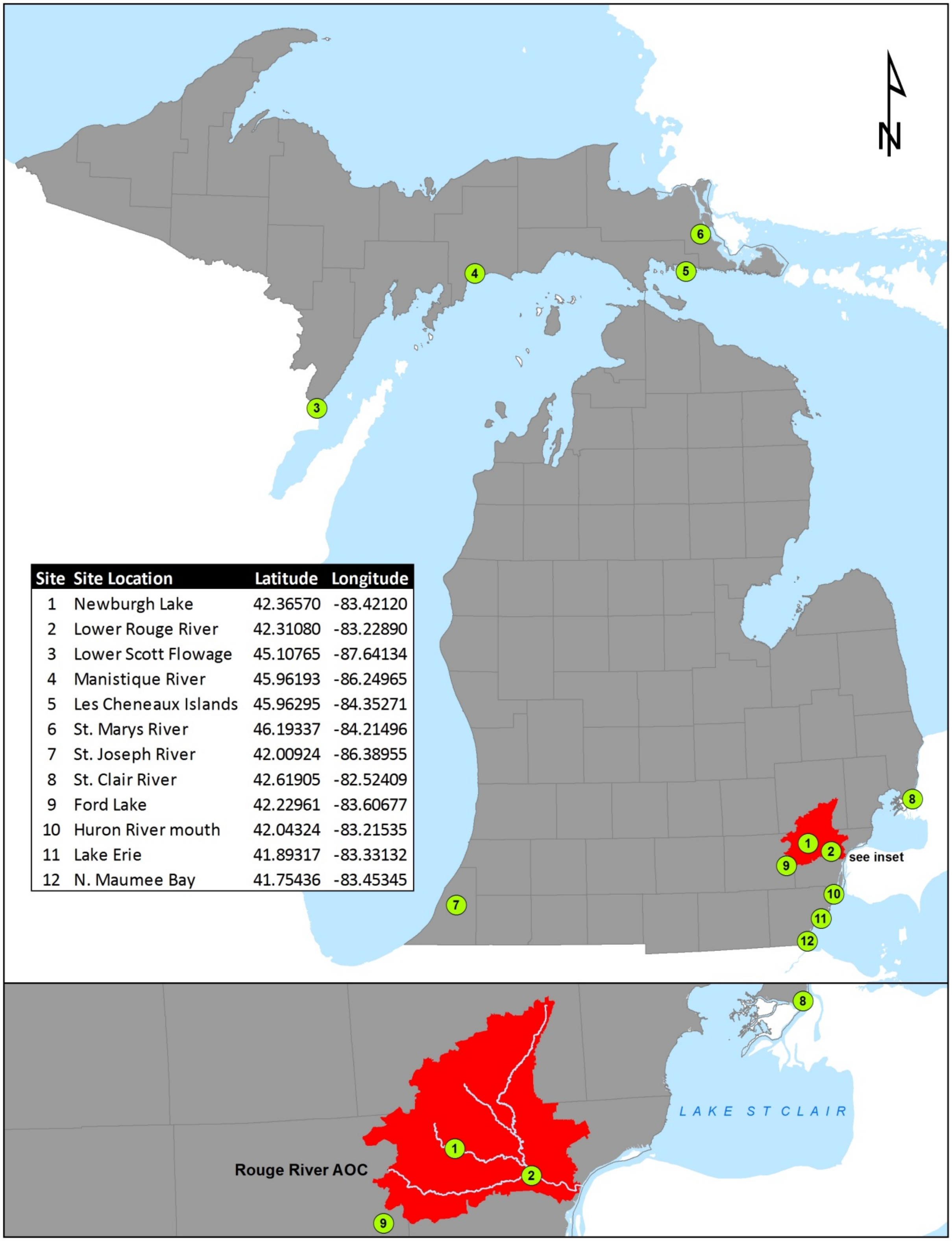

Site	Site Location	Latitude	Longitude
1	Newburgh Lake	42.36570	-83.42120
2	Lower Rouge River	42.31080	-83.22890
3	Lower Scott Flowage	45.10765	-87.64134
4	Manistique River	45.96193	-86.24965
5	Les Cheneaux Islands	45.96295	-84.35271
6	St. Marys River	46.19337	-84.21496
7	St. Joseph River	42.00924	-86.38955
8	St. Clair River	42.61905	-82.52409
9	Ford Lake	42.22961	-83.60677
10	Huron River mouth	42.04324	-83.21535
11	Lake Erie	41.89317	-83.33132
12	N. Maumee Bay	41.75436	-83.45345

Figure 1. Map of Michigan with fish contaminant sampling sites in the Rouge River Area of Concern and comparison sites statewide.

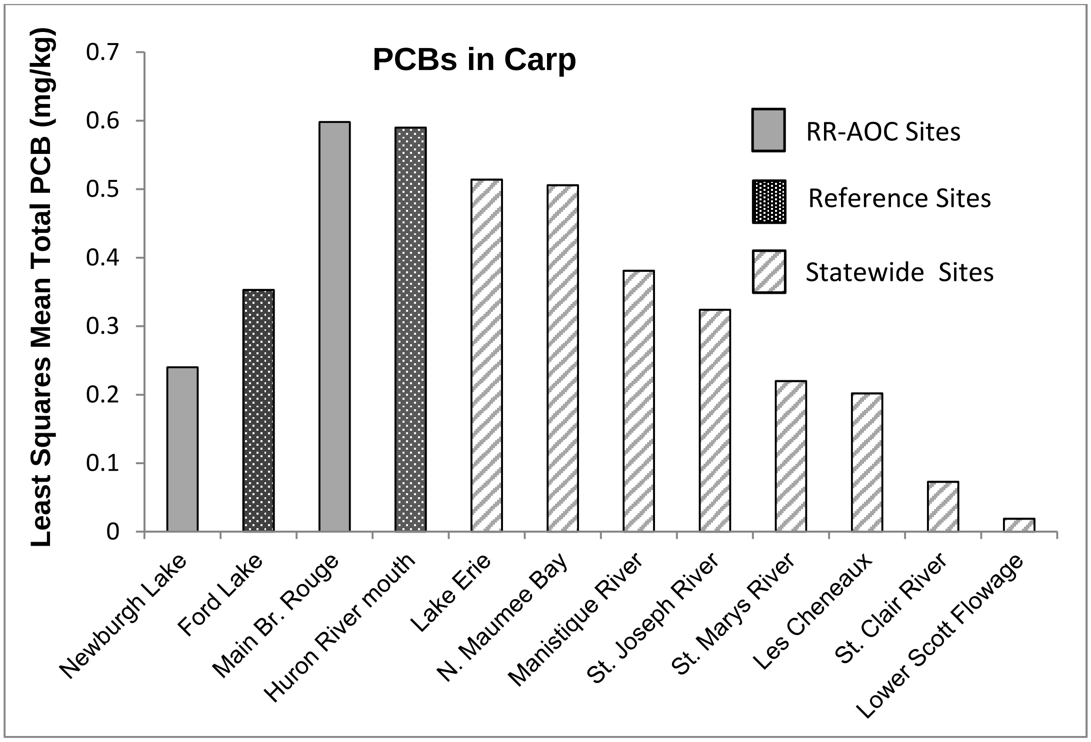

Figure 2. A comparison of least squares mean total PCB concentrations in carp collected from two sites in the Rouge River Area of Concern, two reference sites on the Huron River, and eight sites statewide.

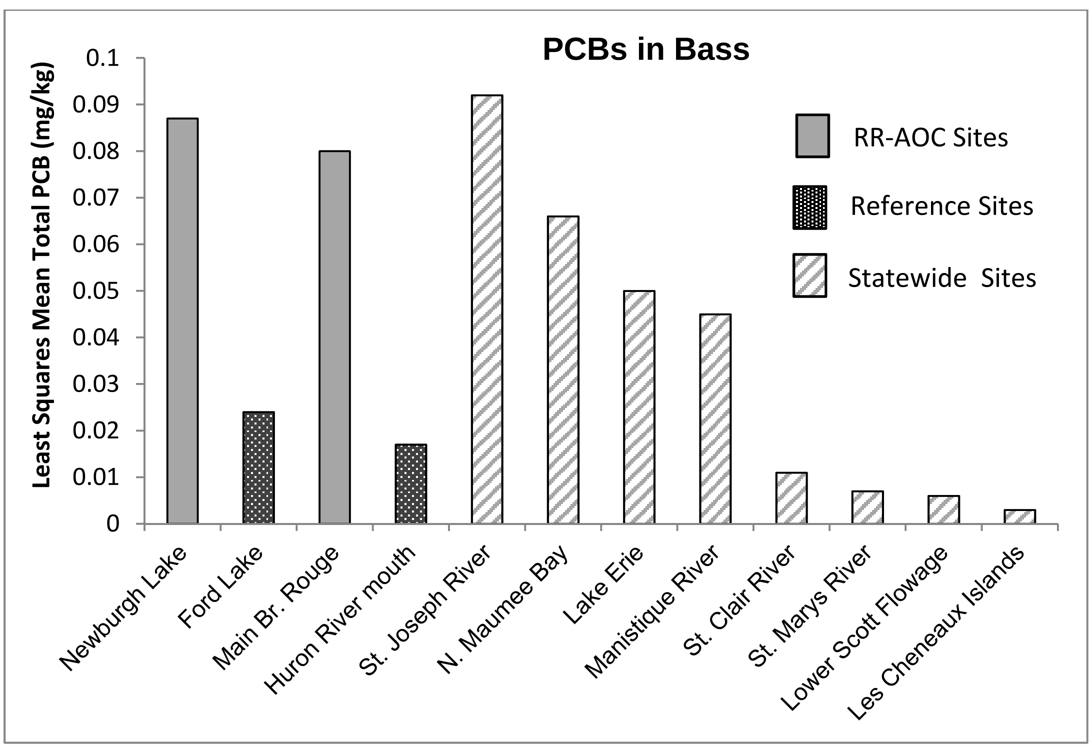

Figure 3. A comparison of least squares mean total PCB concentrations in largemouth and smallmouth bass collected from two sites in the Rouge River Area of Concern, two reference sites on the Huron River, and eight sites statewide.

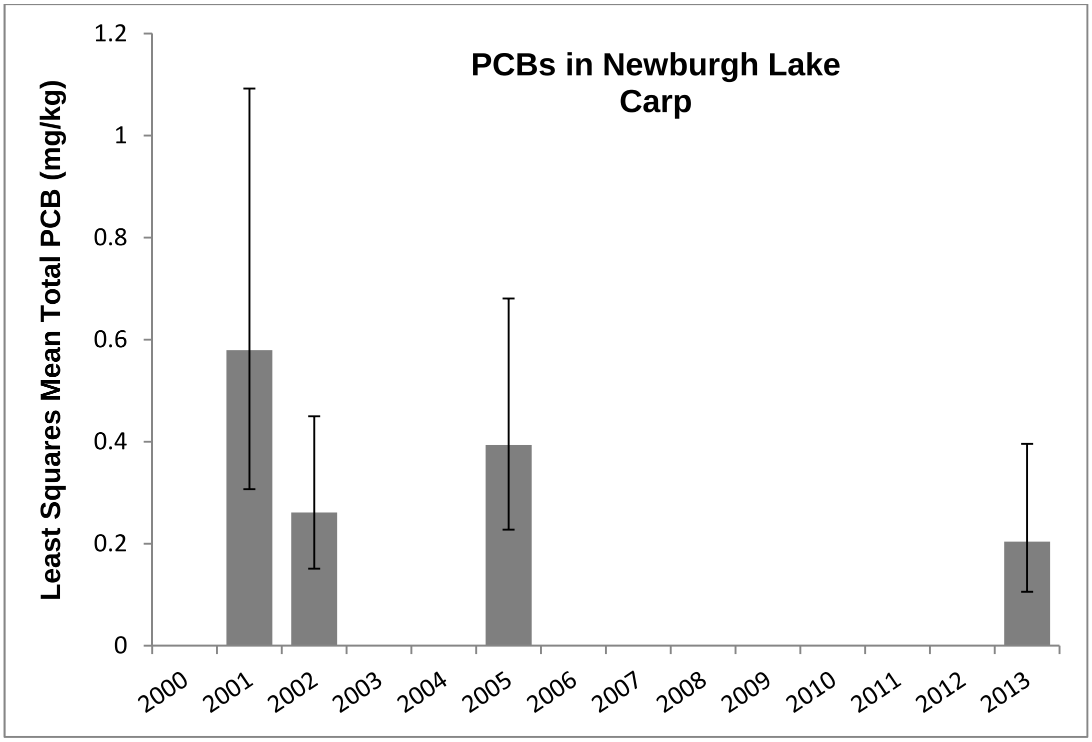

Figure 4. Least squares mean total PCB concentrations over time in carp collected from Newburgh Lake. Error bars represent 95% confidence limits on the means.

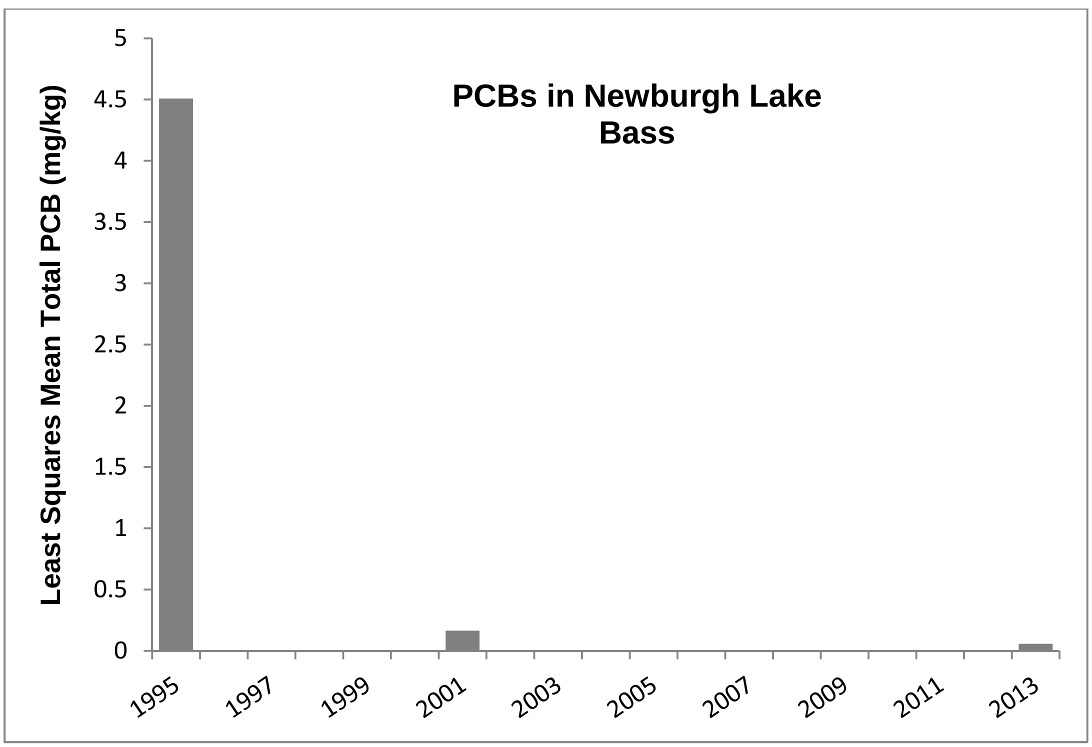

Figure 5. Least squares mean total PCB concentrations over time in largemouth bass collected from Newburgh Lake. Error bars were not included in order to retain a readable scale.

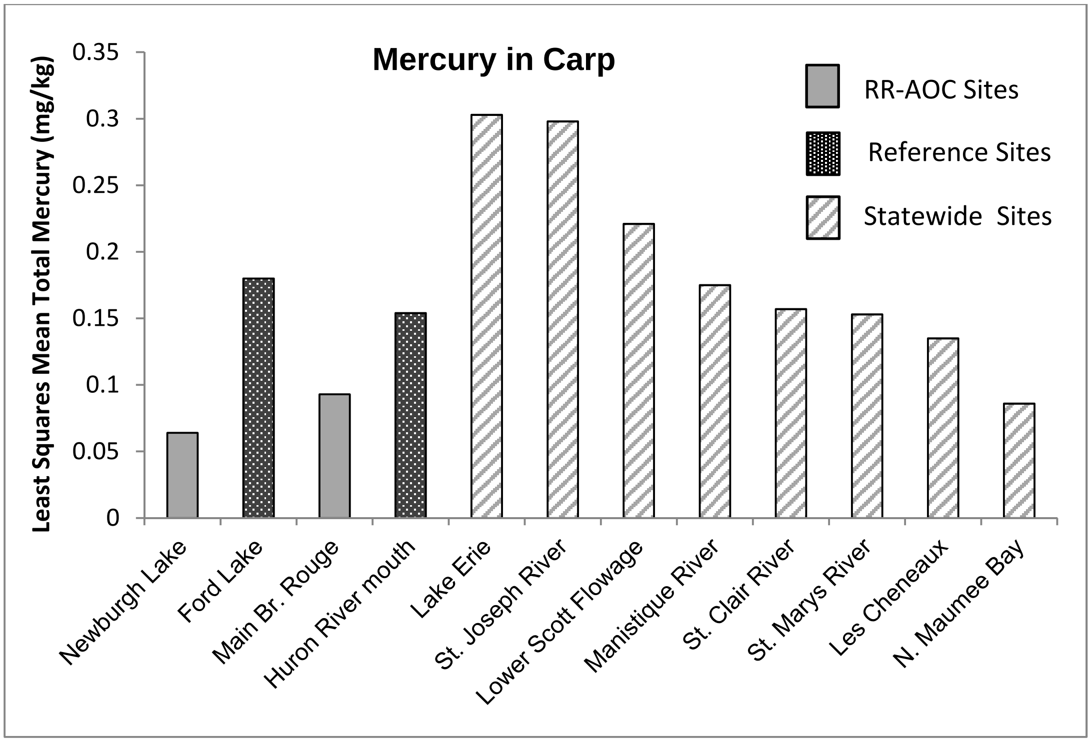

Figure 6. A comparison of least squares mean total mercury concentrations in carp collected from two sites in the Rouge River Area of Concern, two reference sites on the Huron River, and eight sites statewide.

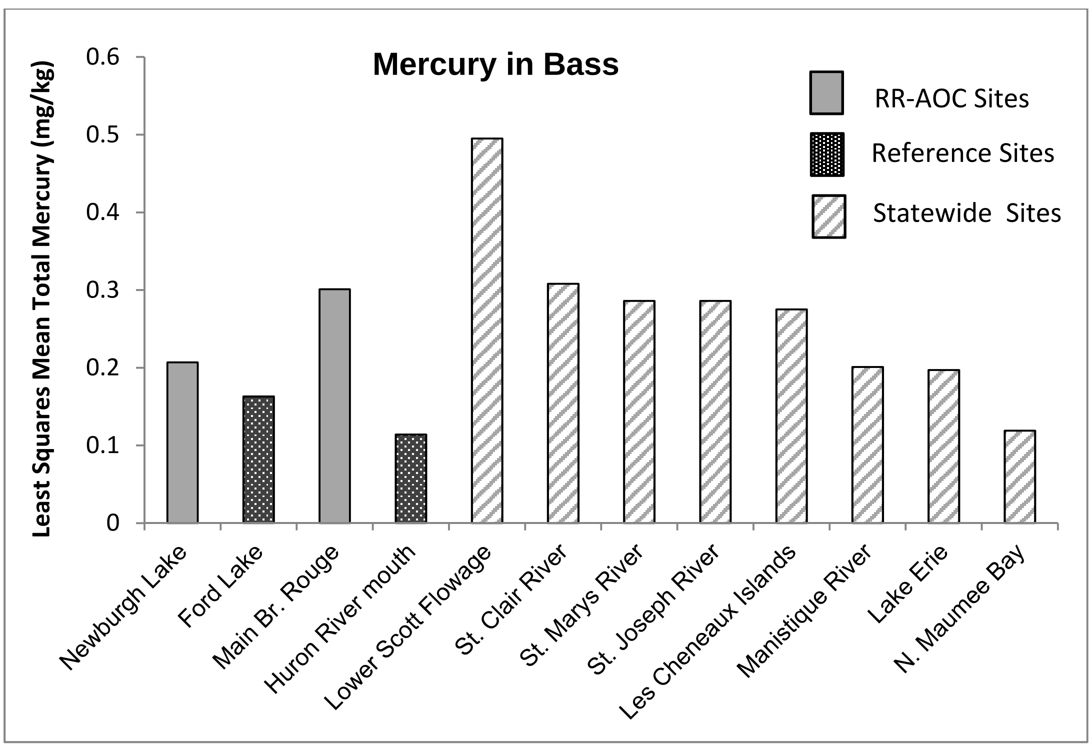

Figure 7. A comparison of least squares mean total mercury concentrations in largemouth and smallmouth bass collected from two sites in the Rouge River Area of Concern, two reference sites on the Huron River, and eight sites statewide.

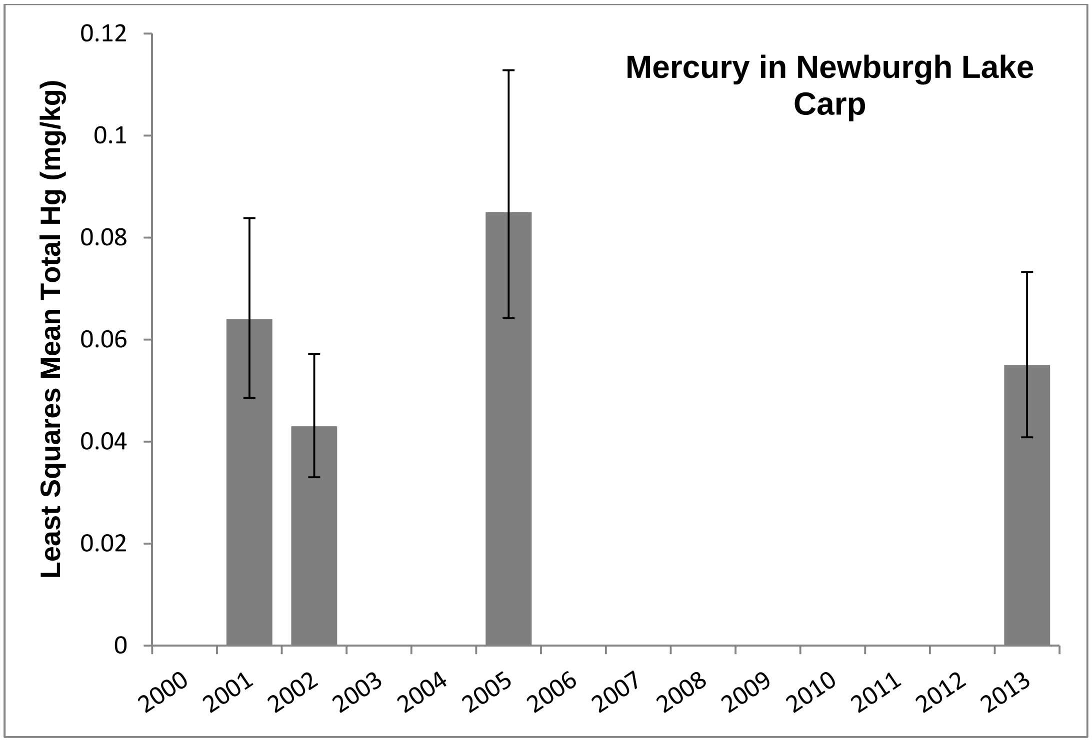

Figure 8. Least squares mean total mercury concentrations over time in carp collected from Newburgh Lake. Error bars represent 95% confidence limits on the means.

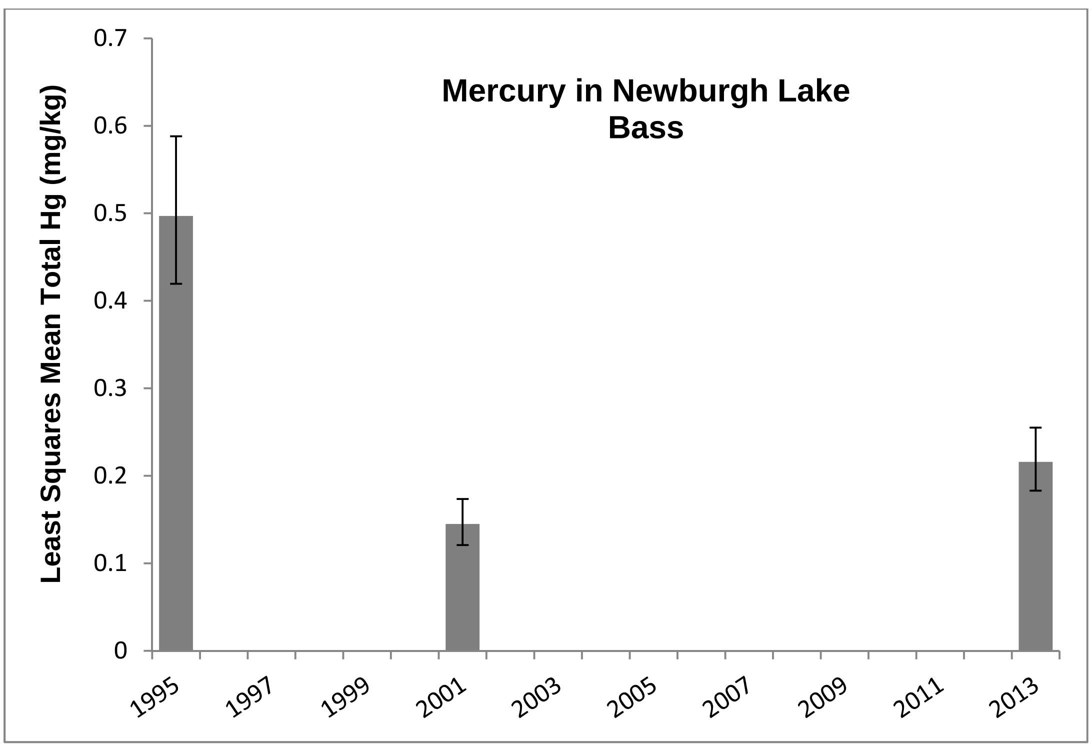

Figure 9. Least squares mean total mercury concentrations over time in largemouth bass collected from Newburgh Lake. Error bars represent 95% confidence limits on the means.

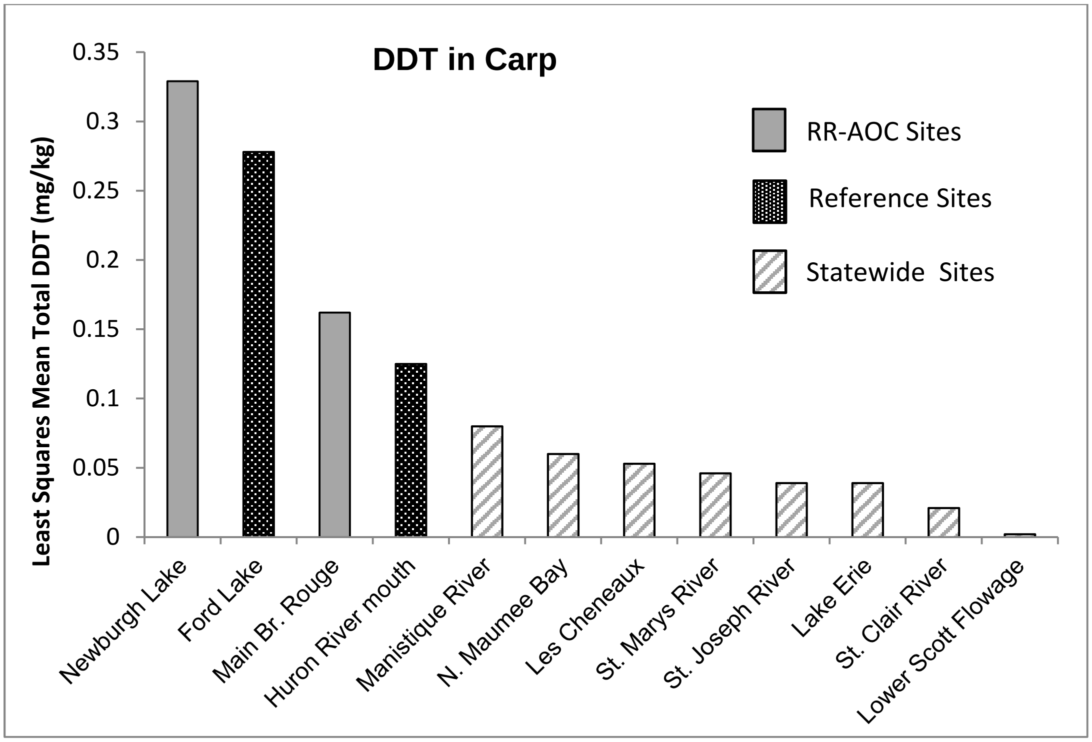

Figure 10. A comparison of least squares mean total DDT concentrations in carp collected from two sites in the Rouge River Area of Concern, two reference sites on the Huron River, and eight sites statewide.

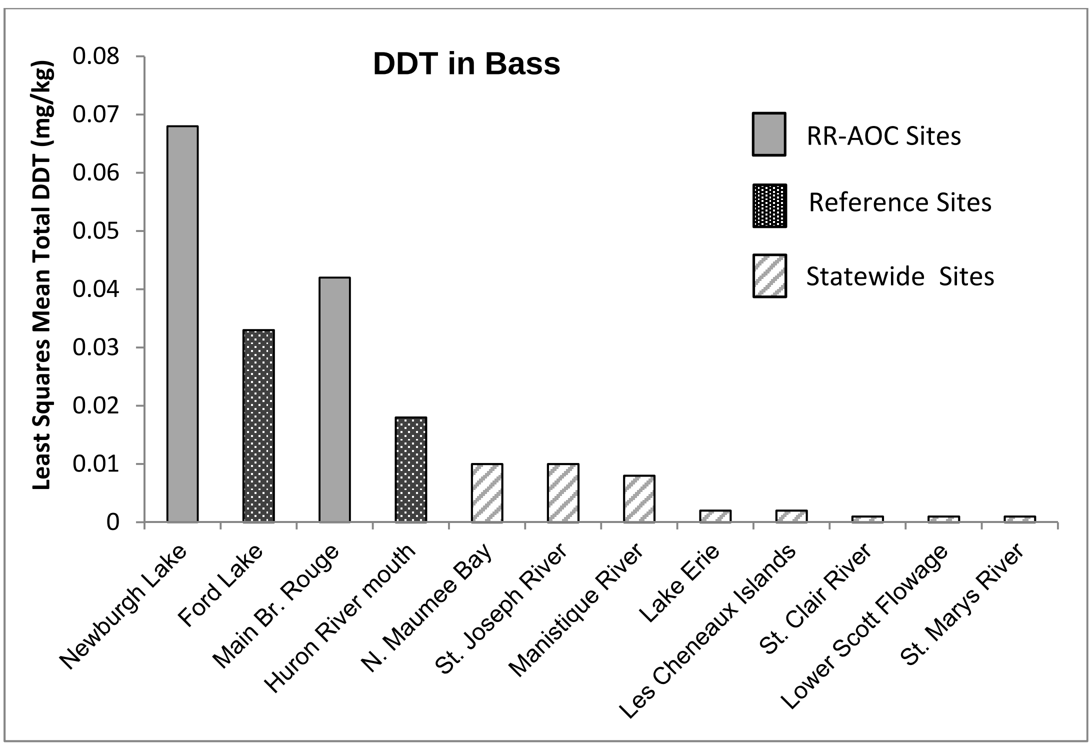

Figure 11. A comparison of least squares mean total DDT concentrations in carp collected from two sites in the Rouge River Area of Concern, two reference sites on the Huron River, and eight sites statewide.

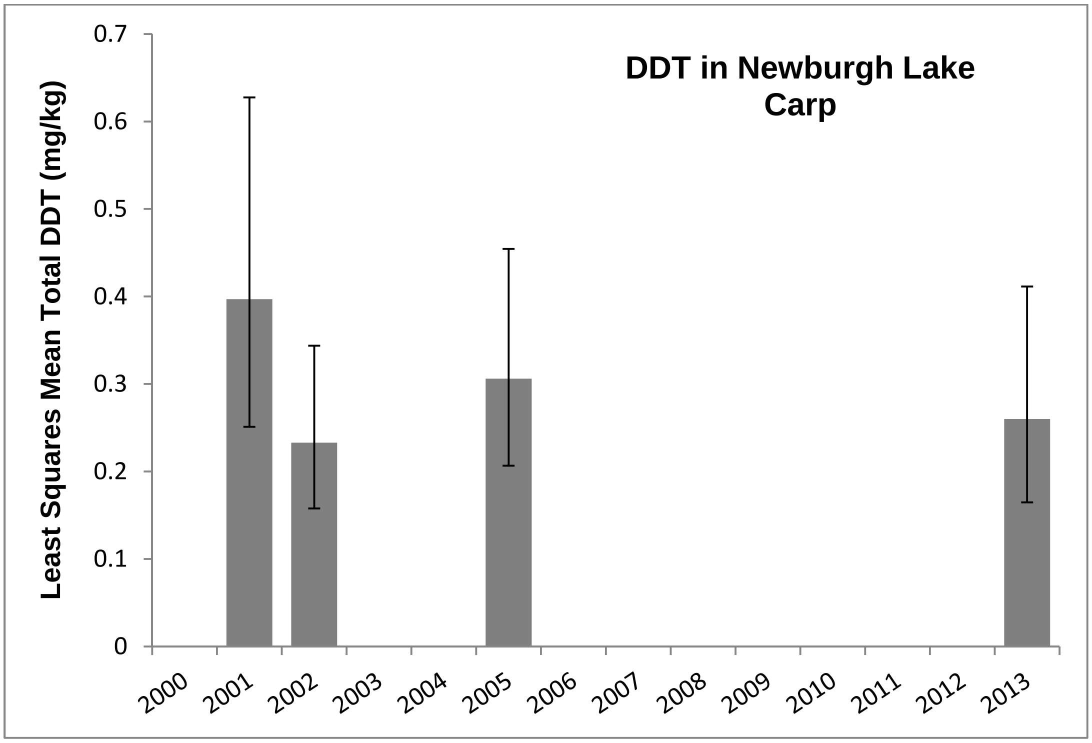

Figure 12. Least squares mean total DDT concentrations over time in carp collected from Newburgh Lake. Error bars represent 95% confidence limits on the means.

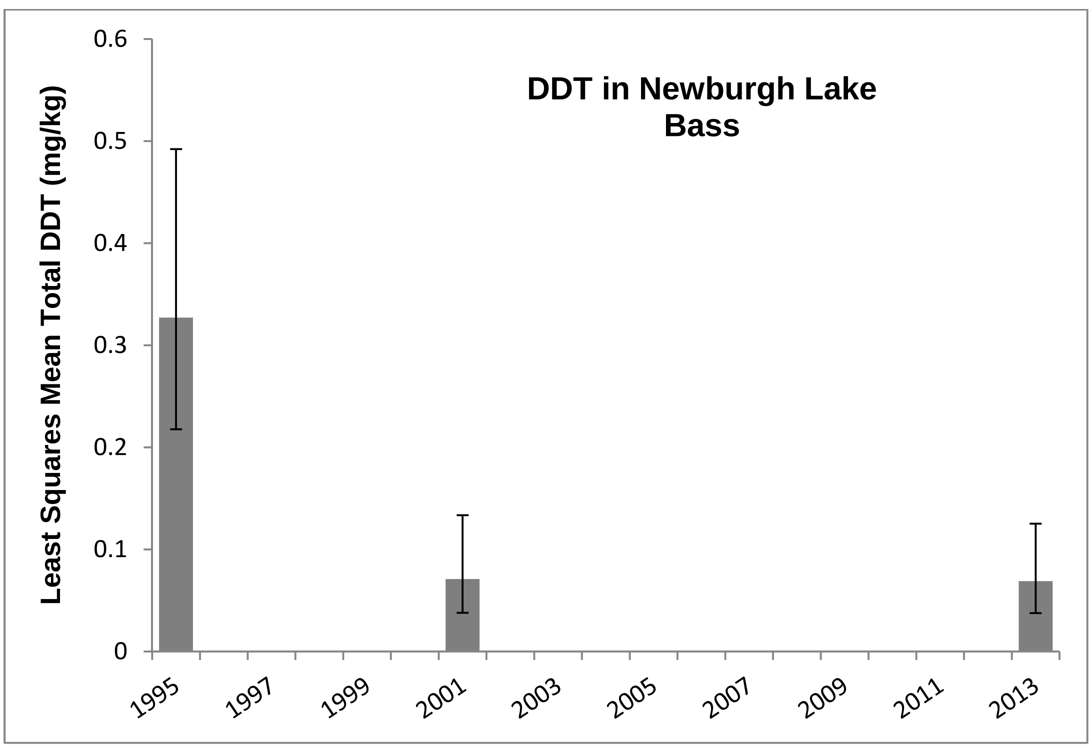

Figure 13. Least squares mean total DDT concentrations over time in carp collected from Newburgh Lake. Error bars represent 95% confidence limits on the means.

Appendix A1.
Summary statistics for lengths (inches) of carp collected from two sites in the Rouge River AOC and ten comparison sites (*primary reference sites italicized*).

Water Body	Sample Year	Mean	St. Dev	Median	Min	Max	N
Ford Lake	***2013***	***25.0***	***3.27***	***24.6***	***19.5***	***30.6***	***10***
Huron River mouth	***2013***	***20.1***	***2.30***	***21.9***	***18.4***	***26.5***	***10***
Lake Erie	2006	19.6	6.28	18.9	12.1	27.2	9
Les Cheneaux Islands	2012	27.3	2.63	27.9	23.6	31.4	10
Lower Scott Flowage	2013	28.6	1.95	28.8	25.5	31.1	6
Manistique River	2012	27.9	1.83	28.1	24.6	30.7	10
N. Maumee Bay	2006	16.5	3.87	15.1	10.8	23.2	10
Newburgh Lake	**2013**	**24.4**	**2.65**	**24.4**	**19.5**	**28**	**9**
Rouge River, Main Br.	**2013**	**22.3**	**2.26**	**22.7**	**17.9**	**24.9**	**10**
St. Clair River	2012	25	4.53	24.4	16.1	32.1	10
St. Joseph River	2013	20.8	1.61	20.6	19.1	24.2	10
St. Marys River	2012	27.5	1.65	27.5	25.2	29.9	10

Appendix A2.
Summary statistics for lengths (inches) of largemouth and smallmouth bass (combined) collected from two sites in the Rouge River AOC and ten comparison sites (*primary reference sites italicized*).

Water Body	Sample Year	Mean	St. Dev	Median	Min	Max	N
Ford Lake	***2013***	***15.3***	***1.25***	***15.1***	***14***	***18.1***	***10***
Huron River mouth	***2013***	***14.4***	***2.11***	***14.4***	***10.7***	***18.3***	***10***
Lake Erie	2006	14.9	1.06	15.1	12.8	16.2	8
Les Cheneaux Islands	2012	15.8	1.12	16.1	13.6	17.4	17
Lower Scott Flowage	2013	14.8	1.45	14.9	12.2	17.6	10
Manistique River	2012	16.3	1.24	16.3	14.2	18.7	10
N. Maumee Bay	2006	12.3	2.21	11.5	10.2	16.9	10
Newburgh Lake	**2013**	**15.2**	**2.3**	**15**	**11.2**	**18.7**	**10**
Rouge River, Main Br.	**2013**	**11.2**	**1.76**	**10.8**	**8.3**	**14.4**	**10**
St. Clair River	2012	14.8	0.63	14.7	13.6	15.6	10
St. Joseph River	2013	12.6	2.22	12.7	8.9	15.9	10
St. Marys River	2012	15.5	1.06	15.8	13.3	16.9	10

Appendix B1.
Summary statistics for total PCB concentrations in carp samples collected from two sites in the Rouge River AOC and ten comparison sites, ranked by mean concentration (*primary reference sites italicized*).

Water Body	Mean	St. Dev	Median	Min	Max	N
Lake Erie	2.75	2.961	1.95	0.040	7.21	10
Manistique River	1.22	1.121	0.89	0.142	4.10	10
Les Cheneaux Islands	0.98	1.247	0.26	0.042	3.44	10
Rouge River, Main Br.	**0.61**	**0.287**	**0.57**	**0.265**	**1.35**	**10**
Ford Lake	***0.58***	***0.413***	***0.52***	***0.079***	***1.20***	***10***
Huron River mouth	***0.55***	***0.406***	***0.469***	***0.032***	***1.351***	***10***
N. Maumee Bay	0.42	0.643	0.11	0.034	2.03	10
St. Marys River	0.39	0.355	0.27	0.094	1.16	10
Newburgh Lake	**0.35**	**0.255**	**0.37**	**0.025**	**0.71**	**9**
St. Clair River	0.35	0.556	0.13	0.001	1.55	10
St. Joseph River	0.24	0.366	0.10	0.072	1.27	10
Lower Scott Flowage	0.03	0.021	0.02	0.003	0.06	6

Appendix B2.
Summary statistics for total PCB concentrations in largemouth and smallmouth bass (combined) collected from two sites in the Rouge River AOC and ten comparison sites, ranked by mean concentration (*primary reference sites italicized*).

Water Body	Mean	St. Dev	Median	Min	Max	N
Lake Erie	0.624	0.209	0.612	0.391	1.012	8
N. Maumee Bay	0.100	0.045	0.105	0.024	0.172	10
Manistique River	0.098	0.073	0.067	0.026	0.263	10
Newburgh Lake	**0.093**	**0.131**	**0.051**	**0.026**	**0.460**	**10**
St. Joseph River	0.064	0.044	0.056	0.016	0.165	10
Rouge River, Main Br.	**0.061**	**0.046**	**0.051**	**0.005**	**0.142**	**10**
Huron River mouth	***0.030***	***0.044***	***0.018***	***0.001***	***0.026***	***10***
Ford Lake	***0.024***	***0.015***	***0.024***	***0.002***	***0.044***	***10***
Lower Scott Flowage	0.022	0.058	0.002	0.001	0.187	10
St. Clair River	0.019	0.012	0.019	0.001	0.036	10
St. Marys River	0.007	0.005	0.005	0.003	0.019	10
Les Cheneaux Islands	0.004	0.004	0.003	0.001	0.012	17

Appendix C1.

Summary statistics for total mercury concentrations in carp collected from two sites in the Rouge River AOC and ten comparison sites, ranked by mean concentration (*primary reference sites italicized*).

Water Body	Mean	St. Dev	Median	Min	Max	N
Lower Scott Flowage	0.43	0.077	0.41	0.34	0.54	6
Lake Erie	0.32	0.297	0.21	0.03	0.84	9
Manistique River	0.31	0.078	0.29	0.23	0.44	10
St. Marys River	0.28	0.112	0.30	0.12	0.46	10
Les Cheneaux Islands	0.23	0.089	0.22	0.09	0.43	10
Ford Lake	***0.23***	***0.095***	***0.22***	***0.11***	***0.40***	***10***
St. Clair River	0.22	0.145	0.19	0.06	0.58	10
St. Joseph River	0.20	0.043	0.20	0.13	0.27	10
Newburgh Lake	**0.08**	**0.033**	**0.08**	**0.02**	**0.13**	**9**
Rouge River, Main Br.	**0.08**	**0.021**	**0.08**	**0.05**	**0.12**	**10**
N. Maumee Bay	0.05	0.059	0.03	0.01	0.21	10
Huron River mouth	--	--	--	--	--	*0*

Appendix C2.

Summary statistics for total mercury concentrations in largemouth and smallmouth bass (combined) collected from two sites in the Rouge River AOC and ten comparison sites, ranked by mean concentration (*primary reference sites italicized*).

Water Body	Mean	St. Dev	Median	Min	Max	N
Lower Scott Flowage	0.54	0.173	0.50	0.38	0.90	10
St. Clair River	0.41	0.176	0.33	0.21	0.70	10
Les Cheneaux	0.36	0.115	0.32	0.20	0.58	17
St. Marys River	0.36	0.102	0.38	0.18	0.53	10
Manistique River	0.30	0.140	0.26	0.17	0.66	10
Newburgh Lake	**0.26**	**0.121**	**0.19**	**0.14**	**0.42**	**10**
Ford Lake	***0.22***	***0.178***	***0.18***	***0.11***	***0.72***	***10***
St. Joseph River	0.22	0.113	0.18	0.12	0.44	10
Lake Erie	0.21	0.068	0.22	0.12	0.29	7
Rouge River, Main Br.	**0.16**	**0.027**	**0.17**	**0.11**	**0.20**	**10**
N. Maumee Bay	0.09	0.057	0.08	0.04	0.23	10
Huron River mouth	--	--	--	--	--	*0*

Appendix D1.
Summary statistics for total DDT concentrations in carp collected from two sites in the Rouge River AOC and ten comparison sites, ranked by mean concentration (*primary reference sites italicized*).

Water Body	Mean	St. Dev	Median	Min	Max	N
Ford Lake	***0.44***	***0.268***	***0.52***	***0.043***	***0.82***	***10***
Newburgh Lake	**0.41**	**0.281**	**0.40**	**0.041**	**0.88**	**9**
Les Cheneaux Islands	0.21	0.294	0.11	0.011	0.88	10
Manistique River	0.21	0.191	0.18	0.017	0.71	10
Rouge River, Main Br.	**0.18**	**0.095**	**0.18**	**0.060**	**0.36**	**10**
Lake Erie	0.16	0.172	0.12	0.001	0.45	10
Huron River mouth	***0.10***	***0.08***	***0.08***	***0.03***	***0.29***	***10***
St. Marys River	0.08	0.074	0.06	0.012	0.20	10
St. Clair River	0.05	0.075	0.03	0.001	0.25	10
N. Maumee Bay	0.03	0.044	0.01	0.005	0.15	10
St. Joseph River	0.03	0.060	0.01	0.004	0.20	10
Lower Scott Flowage	0.002	0.001	0.002	0.001	0.003	6

Appendix D2.
Summary statistics for total DDT concentrations in largemouth and smallmouth bass (combined) collected from two sites in the Rouge River AOC and ten comparison sites, ranked by mean concentration (*primary reference sites italicized*).

Water Body	Mean	St. Dev	Median	Min	Max	N
Newburgh Lake	**0.060**	**0.056**	**0.042**	**0.023**	**0.216**	**10**
Rouge River, Main Br.	**0.036**	**0.030**	**0.028**	**0.008**	**0.113**	**10**
Lake Erie	0.029	0.011	0.027	0.014	0.043	7
Ford Lake	***0.028***	***0.012***	***0.027***	***0.013***	***0.043***	***10***
Huron River mouth	***0.025***	***0.030***	***0.014***	***0.002***	***0.106***	***10***
Manistique River	0.017	0.012	0.014	0.001	0.039	10
N. Maumee Bay	0.016	0.009	0.012	0.007	0.035	10
St. Joseph River	0.008	0.005	0.008	0.002	0.016	10
St. Clair River	0.002	0.001	0.002	0.001	0.003	10
Les Cheneaux Islands	0.002	0.001	0.001	0.001	0.004	17
Lower Scott Flowage	0.001	0.000	0.001	0.001	0.002	10
St. Marys River	0.001	0.000	0.001	0.001	0.002	10

MI/DEQ/WRD-14/016

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION
MARCH 2014

STAFF REPORT

STATUS OF FISH CONTAMINANT LEVELS IN THE ST. CLAIR RIVER AREA OF CONCERN 2012

INTRODUCTION

The St. Clair River Area of Concern (SCR-AOC) includes the entire river from the source at the southern tip of Lake Huron to the mouth, including an extensive delta and wetland area at Lake St. Clair (Figure 1). The river forms part of the boundary between Michigan and Ontario, hence it is a binational AOC. Both Michigan and Canada have issued fish consumption advisories for the St. Clair River beginning in the 1970s and continuing to the present.

The current Michigan Department of Community Health (MDCH) fish consumption advisory recommends limited consumption of carp, freshwater drum, gizzard shad, and walleye from the St. Clair River due to elevated concentrations of mercury and polychlorinated biphenyls (PCB). The advice is based on carp samples collected most recently in 2006, freshwater drum collected in 1994, and walleye collected in 2006. The Michigan Department of Environmental Quality (MDEQ) does not have contaminant data on any other species from the river, including data supporting the gizzard shad advisory. Neither Michigan nor Ontario has issued any consumption advisories for wildlife taken from the SCR-AOC.

Fish samples were collected in 2012 from the St. Clair River and from 2 non-AOC reference sites in support of the United States Environmental Protection Agency (USEPA) Great Lakes Restoration Initiative grant-funded project *Assessing Michigan's Beneficial Use of Sport-Caught Fish* awarded to the MDCH. Several fish species were collected allowing for comparisons of key contaminant concentrations between sites as well as a temporal trend evaluation.

SUMMARY

1. Carp, rock bass, smallmouth bass, and yellow perch samples were collected from the SCR-AOC in 2012. Reference samples of the same species were collected from either the Les Cheneaux Islands area of northern Lake Huron, from Little Bay De Noc in northern Lake Michigan, or both areas in 2012. Rock bass collected from Little Bay De Noc in 2008 were used in the comparison.

2. PCBs were quantified in nearly all carp and smallmouth bass samples from the SCR-AOC and in all samples from the reference sites. Mercury was quantified in all samples used in this evaluation. Total dichlorodiphenyl trichloroethane (DDT) was quantified in nearly all carp samples and in most smallmouth bass samples but the rates of quantification in other species varied by sampling site. Dioxin toxic equivalent (TEQ) was assayed in carp and quantified in all samples.

3. Intra-species length ranges by sampling site were similar for all species sampled, although carp and smallmouth bass from the SCR-AOC tended to be somewhat smaller

and rock bass tended to be larger than those from the reference sites. Mercury concentrations were generally positively correlated with fish length at all sampling sites. PCBs, DDT, and dioxin TEQ concentrations were not correlated with fish length.

4. Total PCB and lipid normalized PCB concentrations in carp, rock bass, and yellow perch from the SCR-AOC were not greater than concentrations in those fish from Les Cheneaux Islands and Little Bay De Noc. Total PCB concentrations in smallmouth bass from the SCR-AOC were greater than in smallmouth bass from Les Cheneaux Islands, but lipid normalized concentrations were not significantly different.

5. Total mercury concentrations in carp, smallmouth bass, and yellow perch collected from the SCR-AOC were not significantly different from concentrations in those species collected from the reference sites. Total mercury concentrations in rock bass from the SCR-AOC were higher than in rock bass from Little Bay De Noc but not significantly different from those collected from Les Cheneaux Islands. Length standardized mercury concentrations in fish from the SCR-AOC were not significantly different than concentrations in fish from Les Cheneaux Islands but tended to be higher than in fish from Little Bay De Noc.

6. Total DDT concentrations in samples from the SCR-AOC were less than the concentrations measured at either Les Cheneaux Islands or Little Bay De Noc. All carp samples were analyzed for dioxin TEQ and the concentrations in those fish collected from the SCR-AOC were less than the concentrations in carp from Les Cheneaux Islands and Little Bay De Noc.

7. Fish consumption advice was projected based on the contaminant concentrations in samples collected in 2012. The projected advice for rock bass from SCR-AOC was more restrictive than for rock bass from Les Cheneaux Islands and Little Bay De Noc but the projected advice for the other species was the same across sampling sites.

METHODS

Fish were collected in 2012 by the Michigan Department of Natural Resources or by the MDEQ from the SCR-AOC, Little Bay De Noc, and Les Cheneaux Islands. Carp and smallmouth bass were collected from all three sampling sites in 2012; yellow perch and rock bass were collected from SCR-AOC and Les Cheneaux Islands.

The fish were processed as standard edible portions in accordance with the Great Lakes and Environmental Assessment Section Procedure 31. Standard edible portions are untrimmed, skin-on fillets for rock bass, smallmouth bass, and yellow perch, and untrimmed, skin-off fillets for carp. Each sample was individually wrapped in aluminum foil, appropriately labeled, and frozen until preparation for analysis. A total of 40 fillet samples each from SCR-AOC and Les Cheneaux Islands and 33 samples from Little Bay De Noc were analyzed (Table 1). In addition, carp have been collected from the St. Clair River periodically since 1992 and analyzed

Table 1. Fish samples collected from the St. Clair River AOC and two reference sites in 2012.

Species	St. Clair River	Les Cheneaux Islands	Little Bay De Noc
Carp	10	10	9
Rock Bass	10	10	14*
Smallmouth Bass	10	10	10
Yellow Perch	10	10	0

* - samples collected in 2008

as whole fish as part of the temporal trend element of the Michigan Fish Contaminant Monitoring Program (FCMP).

All fillet and whole fish samples were analyzed for a standard suite of contaminants including total mercury, organochlorinated pesticides (Table 2), and PCB congeners (Table 3) by the MDCH Analytical Chemistry Laboratory. Carp samples from all three sites sampled in 2012 were also analyzed for dioxin, furan, and coplanar PCB congeners by PACE Analytical.

Table 2. Standard suite of contaminants quantified in fish tissue samples for the MDEQ Fish Contaminant Monitoring Program.

2,4'-DDD	*gamma*-Chlordane
2,4'-DDT	*trans*-Nonachlor
4,4'-DDD	*alpha*-Chlordane
4,4'-DDE	*cis*-Nonachlor
4,4'-DDT	Hexachlorobenzene
Aldrin	Mercury
Dieldrin	Mirex
gamma-BHC (Lindane)	Octachlorostyrene
Heptachlor	PBB (FF-1, BP-6)
Heptachlor Epoxide	Pentachlorostyrene
Heptachlorostyrene	Terphenyl
Hexachlorostyrene	Toxaphene
Oxychlordane	
Total PCB (as congeners; Aroclors prior to 2000)	

Since 2000, the MDCH Laboratory has measured PCB concentrations using the congener method; total PCB concentration was estimated by summing the concentrations of PCB congeners. Individual congeners below the quantification level were assigned a concentration equal to 0 for the purpose of calculating a total PCB concentration. Also, congener analyses that did not meet retention time criteria or were subject to analytical interference were assigned a concentration equal to 0 for the purpose of calculating a total PCB concentration. Prior to 2000, PCB was measured as total Aroclors; results using both methods were compared and found to be equivalent before changing to use the congener method.

Total DDT concentrations were calculated by summing concentrations of the para, para' and ortho, para' forms of DDT, dichlorodiphenyldichloroethylene (DDE) and 1,1-bis(4-chlorophenyl)-2,2-dichloroethane (DDD). Individual chemicals below the quantification level were assigned a concentration equal to 0 for the purpose of calculating a total DDT concentration. If all six components were below the quantification level, then the total DDT concentration was reported as less than the lowest quantification level of the metabolites.

Total chlordane concentration was estimated by summing the concentrations of five chlordane breakdown products: *alpha*-chlordane, *gamma*-chlordane, *cis*-nonachlor, *trans*-nonachlor, and oxychlordane. Individual compounds below the quantification level were assigned a concentration equal to 0 for the purpose of calculating a total chlordane concentration. If all five compounds were below the quantification level, then the total chlordane concentration was reported as less than the quantification level of the individual compounds.

Total 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) TEQs were calculated using toxic equivalency factors developed by the World Health Organization (Van den Berg et al., 2006). The concentrations of individual dioxin, dibenzofuran, and dioxin-like PCB congeners in a fish sample were multiplied by chemical-specific toxic equivalency factors and the resulting products summed to calculate a 2,3,7,8-TCDD (dioxin) TEQ concentration. Individual congener concentrations less than the detection level were assigned a value of 0 for the purpose of calculating the dioxin TEQ.

Analytical results were reviewed and entered into the FCMP database. Results for total PCBs, mercury, total DDT, and dioxin TEQ are presented in Appendix A. The complete dataset is available electronically (by request) or through the FCMP Web site (www.deq.state.mi.us/fcmp)

The MDCH, Division of Environmental Health, develops fish consumption advice following protocols described in the *Michigan Fish Consumption Advisory Program Guidance Document*. That document along with links to supporting documentation and other related reports is available online at: http://www.michigan.gov/eatsafefish (Reports & Science button). The guidance was used in this report to predict the likely fish consumption advice based on the analytical results for the samples collected in 2012. Specifically, the projected advice was determined by comparing the 95 percent upper confidence limit (95% UCL) on the mean concentration in legal-size fish for each species/site/contaminant combination with the appropriate MDCH screening value for that contaminant. It is important to note that the projected consumption advice reported here may not be the final advice put forth by the MDCH; the MDCH bases consumption guidance on the most current analytical results in combination with previous data for the water body as well as knowledge of legacy or ongoing contamination issues.

The MDCH fish consumption guidance is presented as a recommended number of meals per month of a given species. The meal categories range from 16 meals per month to a “Do Not Eat” category reserved for those species and water bodies where consumption of a single meal will contain at least one year of exposure to a contaminant. In addition the MDCH has designated a “Limited” category; healthy adults may eat 1 or 2 meals per year of fish in this category but it is recommended that women of childbearing age, young children, and adults with a chronic health condition not eat these fish.

Contaminant loads in fish are sometimes positively correlated with the age of the fish, and fish length is generally used as a surrogate for age. One goal of the project was to collect fish in a similar range of sizes for a given species from each sampling site in order to minimize the variation due to differences in length ranges between sites. Fish lengths between sampling sites were compared statistically using either a 2-sample t-test or analysis of variance (ANOVA) if a species was collected from all three sites. Differences were considered significant at $p \le 0.05$. Power analysis was used to estimate the minimum detectable difference for those cases where differences in the mean were not significant. In addition linear regression was used to determine if a significant relationship existed between fish length and contaminant concentration.

If the fish length/contaminant concentration regression was significant ($p \le 0.05$) the contaminant concentrations were length-normalized. This was accomplished by using the slope of the concentration versus length regression line to adjust the contaminant concentration to a level estimated to occur in a fish of a standard length for the species. The average length of all samples for each species was used as the standard length and was set at 26 inches for carp, 7 inches for rock bass, 16 inches for smallmouth bass, and 8 inches for yellow perch. The formula for length-normalization is:

$$C_{LN} = C_A - S \times (L - St)$$

Where C_{LN} = Length-normalized concentration,
C_A = actual concentration,
S = slope of the concentration versus length line,
L = fish length, and
St = standard length for the species.

Chlorinated contaminants such as PCBs, DDT, and dioxins tend to accumulate preferentially in lipids. Since the lipid content of fish can vary from site to site a simple comparison of contaminant concentrations has the potential to be biased. Statistical comparisons for the chlorinated contaminant concentrations were conducted using results that were lipid normalized by dividing the contaminant concentration by the lipid content. Comparisons were made using ANOVA or t-tests when the data followed a normal distribution or the nonparametric equivalents (Kruskal-Wallis; Mann-Whitney) if the data could not be made normal by transformation. Using the natural log of the contaminant concentrations generally transformed the dataset to a normal distribution.

Stepwise multiple regression was used to evaluate temporal trends in contaminant concentrations using results of whole fish collected for the FCMP trend element; fish length, weight, lipid content for non-mercury contaminants, and collection date were evaluated as factors in the regression equation. The same multiple regression technique was used to evaluate temporal trends using the St. Clair River carp fillet dataset.

The software package Minitab 15 was used to perform the statistical tests.

Table 3. PCB structure and corresponding identification number of congeners quantified in fish tissue samples.

BZ#	Structure	BZ#	Structure
	TRICHLOROBIPHENYLS		HEXACHLOROBIPHENYLS
17	2,2',4	128	2,2',3,3',4,4'
18	2,2',5	130	2,2',3,3',4,5'
22	2,3,4'	132	2,2',3,3',4,6'
25	2,3',4	135	2,2',3,3',5,6'
26	2,3',5	136	2,2',3,3',6,6'
28	2,4,4'	137	2,2',3,4,4',5
31	2,4',5	138	2,2',3,4,4',5'
32	2,4',6	141	2,2',3,4,5,5'
33	2',3,4	144	2,2',3,4,5',6
37	3,4,4'	146	2,2',3,4',5,5'
		149	2,2',3,4',5',6
	TETRACHLOROBIPHENYLS	151	2,2',3,5,5',6
40	2,2',3,3'	153	2,2',4,4',5,5'
42	2,2',3,4'	156	2,3,3',4,4',5
44	2,2',3,5'	157	2,3,3',4,4',5'
45	2,2',3,6	158	2,3,3',4,4',6
47	2,2',4,4'	163	2,3,3',4',5,6
49	2,2',4,5'	167	2,3',4,4',5,5'
52	2,2',5,5'		
56	2,3,3',4'		HEPTACHLOROBIPHENYLS
60	2,3,4,4'	170	2,2',3,3',4,4',5
63	2,3',4',5	171	2,2',3,3',4,4',6
64	2,3,4',6	172	2,2',3,3',4,5,5'
66	2,3',4,4'	174	2,2',3,3',4,5,6'
70	2,3',4',5	175	2,2',3,3',4,5',6
71	2,3',4',6	177	2,2',3,3',4',5,6
74	2,4,4',5	178	2,2',3,3',5,5',6
77	3,3',4,4'	179	2,2',3,3',5,6,6'
		180	2,2',3,4,4',5,5'
	PENTACHLOROBIPHENYLS	182	2,2',3,4,4',5,6'
82	2,2',3,3',4	183	2,2',3,4,4',5',6
84	2,2',3,3',6	185	2,2',3,4,5,5',6
87	2,2',3,4,5'	187	2,2',3,4',5,5',6
90	2,2',3,4',5	190	2,3,3',4,4',5,6
91	2,2',3,4',6	193	2,3,3',4',5,5',6
92	2,2',3,5,5'		
95	2,2',3,5',6		OCTACHLOROBIPHENYLS
97	2,2',3',4,5	194	2,2',3,3',4,4',5,5'
99	2,2',4,4',5	195	2,2',3,3',4,4',5,6
100	2,2',4,4',6	196	2,2',3,3',4,4',5,6'
101	2,2',4,5,5'	198	2,2',3,3',4,5,5',6
105	2,3,3',4,4'	199	2,2',3,3',4,5,6,6'
110	2,3,3',4',6	201	2,2',3,3',4,5,5',6'
118	2,3',4,4',5	203	2,2',3,4,4',5,5',6
126	3,3',4,4',5	205	2,3,3',4,4',5,5',6
			NONACHLOROBIPHENYLS
		206	2,2',3,3',4,4',5,5',6

BZ# = identification numbers adopted by the International Union of Pure and Applied Chemists (IUPAC).

RESULTS AND DISCUSSION

The following discussion includes between-site comparisons of results for total PCB, mercury, total DDT, and dioxin TEQ. Elevated levels of PCBs, mercury, or both have led to the need for consumption advisories for certain species of fish taken from the SCR-AOC since the mid- to late-1970s. While DDT and dioxin TEQ have not caused advisories for SCR-AOC fish, both contaminants are either known or likely to be present in concentrations high enough to cause advisories under the revised MDCH advisory protocol due to be in place in 2014.

The within species mean lengths across sampling sites were not statistically different for any of the four species being compared. However, the SCR-AOC length ranges for carp and smallmouth bass were biased toward smaller fish as compared to the reference sites, while the SCR-AOC rock bass length range was biased toward larger fish (Appendix B1). Length versus contaminant concentration regressions were statistically significant for mercury but not for total PCB, total DDT, or dioxin TEQ.

PCBs

Total PCB was quantified in fewer samples from the SCR-AOC compared to the reference sites (Table 4). The highest PCB concentrations were measured in carp, regardless of sampling site; concentrations in rock bass, smallmouth bass, and yellow perch were significantly lower. This pattern of relative concentrations between species is typical of other water bodies where these species coexist.

Table 4. Percentage of fish samples with quantifiable levels of PCB from the SCR-AOC and two reference sites in 2012.

Species	St. Clair River	Les Cheneaux Islands	Little Bay De Noc
Carp	90	100	100
Rock Bass	22	30	50*
Smallmouth Bass	90	100	100
Yellow Perch	20	40	--
All Species Combined	56	64	87

* - samples collected in 2008

There was no significant relationship between fish length and total PCB concentrations in carp from any of the three sampling sites in 2012, and the size range of carp collected at all sites was similar (Figure 2; Appendices B1, B2). Total PCB and lipid normalized PCB concentrations in carp from SCR-AOC were less than concentrations in carp from Little Bay De Noc but were not significantly different than concentrations in carp from Les Cheneaux Islands.

Table 5. The 95% UCL on the mean total PCB concentration and projected consumption advice based on those concentrations for fish collected from the St. Clair River AOC (SCR), the Les Cheneaux Islands (LCI), and Little Bay De Noc (LBDN) in 2012.

Species	95% UCL (ppm)			Meals per Month		
	SCR	LCI	LBDN	SCR	LCI	LBDN
Carp	1.55	1.88	2.06	Limited	Limited	Limited
Rock Bass	0.002	0.001	0.003*	16	16	16*
Smallmouth Bass	0.03	0.01	0.01	8	16	16
Yellow Perch	0.003	0.002	--	16	16	--

* - samples collected in 2008

The projected consumption advice for carp collected in 2012 based on the 95% UCL of the mean total PCB concentration is “Limited” for all three sampling sites (Table 5).

There was no significant relationship between length and total PCB concentration in rock bass at any of the three sampling sites, and the size range of fish collected at all sites was similar (Figure 3; Appendices B1, B2). Total PCB and lipid normalized PCB concentrations in rock bass from the SCR-AOC were not significantly different from concentrations in rock bass from either Les Cheneaux Islands or Little Bay De Noc.

The projected consumption advice for rock bass based on the 95% UCL of the mean total PCB concentration is “16 meals per month” for all three sampling sites (Table 5).

There was no significant relationship between length and total PCB concentration in smallmouth bass at any of the three sampling sites, and the size range of fish collected at all sites was similar, although the fish from the SCR-AOC were smaller on average (Figure 4; Appendix B1, B2). Total PCB concentrations in smallmouth bass from the SCR-AOC were significantly higher than concentrations in smallmouth bass from Les Cheneaux Islands, but lipid normalized concentrations were not significantly different.

The projected consumption advice for SCR-AOC based on the 95% UCL of the mean total PCB concentration in smallmouth bass collected in 2012 is “8 meals per month;” the projected advice for those fish collected in either Les Cheneaux Islands or Little Bay De Noc is “16 meals per month.”

There was no significant relationship between length and total PCB concentration in yellow perch at either SCR-AOC or Les Cheneaux Islands, and the size range of fish collected at both sites was similar (Figure 5; Appendices B1, B2). Total PCB and lipid normalized PCB concentrations in yellow perch from the SCR-AOC were not significantly different from concentrations in yellow perch from Les Cheneaux Islands.

The projected consumption advice for yellow perch based on the 95% UCL of the mean total PCB concentration is “16 meals per month” for both sampling sites (Table 5).

PCB Temporal Trend

Carp were collected from the SCR-AOC between 1992 and 2012 and analyzed as whole fish for the FCMP temporal trend element. No significant temporal trend in PCB concentration was detected using the dataset, at least in part due to variability in the sample lipid content and in fish length. Based on the evaluation of the whole fish total PCB concentrations in SCR-AOC carp are unlikely to have changed at a rate greater than 4.5 percent per year (MDEQ, in draft). Significant declines have been measured in whole carp from several other Great Lake trend sites, although whole carp from Little Bay De Noc have not shown a significant change (Figure 6). It is important to note that although total PCB concentrations in the SCR-AOC whole carp have not shown a significant decline, on average PCB concentrations in those fish have been lower than the average concentrations measured at the other trend sites (Figure 6).

Carp were also collected from the SCR-AOC in 1986, 1994, and 2006 and analyzed as skin-off fillets. Multiple regression of those results along with the 2012 data resulted in a line with a significant slope (p=0.002) and an average annual decline of 7.7 percent (Figure 7). The fillet dataset is not as robust as the whole fish trend samples since samples were not collected as frequently, but the evaluation indicates that PCB concentrations are tending to decline in the SCR-AOC.

Table 6. The 95% UCL on the mean total mercury concentration and projected consumption advice based on those concentrations for fish collected from the St. Clair River AOC (SCR), the Les Cheneaux Islands (LCI), and Little Bay De Noc (LBDN) in 2012.

Species	95% UCL (ppm)			Meals per Month		
	SCR	LCI	LBDN	SCR	LCI	LBDN
Carp	0.33	0.30	0.38	2	2	2
Rock Bass	0.22	0.12	0.11*	4	8	8*
Smallmouth Bass	0.53	0.42	0.36	2	2	2
Yellow Perch	0.11	0.11	--	8	8	--

* - samples collected in 2008

<u>Mercury</u>

Total mercury was quantified in all 99 fillet samples collected in 2012 from the SCR-AOC, Les Cheneaux Islands, and Little Bay De Noc, as well as in all 14 rock bass collected from Little Bay De Noc in 2008. The mean and 95% UCL of the mean total mercury concentration in carp, smallmouth bass, and yellow perch collected from the SCR-AOC were not significantly different from those concentrations measured in the same species collected from Les Cheneaux Islands and Little Bay De Noc; the projected consumption advice based on the mercury concentrations for those species is the same across all sampling sites (Table 6). Summary statistics are presented in Appendix B3.

The mean and 95% UCL of the mean total mercury concentration in rock bass collected from the SCR-AOC was higher than those concentrations in Little Bay De Noc rock bass but not significantly different than fish collected from Les Cheneaux Islands. The projected consumption advice due to mercury for rock bass from the SCR-AOC is more restrictive than for rock bass from the reference sites (Table 6).

Analysis of length standardized concentrations also indicates that mercury concentrations in fish from the SCR-AOC tend to be similar to those in Les Cheneaux Islands but higher than in fish from Little Bay De Noc. Carp are an exception to this pattern (Figure 8a); length standardized mercury concentrations in Little Bay De Noc carp were significantly greater than the concentrations in both Les Cheneaux Islands and SCR-AOC carp. Length standardized total mercury in SCR-AOC and Les Cheneaux Islands carp were not significantly different. The length standardized total mercury concentrations in rock bass, smallmouth bass, and yellow perch from the SCR-AOC were not significantly different from Les Cheneaux Islands concentrations; yellow perch were not collected from Little Bay De Noc but both rock bass and smallmouth bass from that site had length standardized total mercury concentrations significantly lower than concentrations measured in those species from both the SCR-AOC and Les Cheneaux Islands (Figures 8b, 8c, 8d).

<u>Mercury Temporal Trend</u>

Mercury concentrations in whole carp from the SCR-AOC analyzed as part of the FCMP temporal trend element declined slightly between 1992 and 2012, although that change was not significant (regression slope $p = 0.06$). The average annual rate of change based on that regression analysis was -1.7 percent, similar to the average rate measured in Lake St. Clair carp between 1990 and 2011 (Figure 9); however, the minimum detectable trend at $\alpha = 0.05$ is ±1.8% per year. Whole carp in the Detroit River show an average decline of 5.0 percent per year; in contrast whole carp from Lake Erie had an average annual increase of 3.6 percent between 1990 and 2010.

Carp were also collected periodically since 1990 from Saginaw Bay and Thunder Bay in Lake Huron, Grand Traverse Bay and Little Bay De Noc in Lake Michigan, and the St. Marys River, and analyzed as whole fish. Trend analysis of those samples indicates that mercury levels in carp from those sites have not changed significantly over the time period.

Multiple regression was run on mercury concentrations in the skin-off fillets of carp collected from the SCR-AOC in 1986, 1994, 2006, and 2012. No significant temporal trend was detected, and based on the regression results total mercury concentrations in SCR-AOC carp are unlikely to have increased or decreased at a rate greater than 1.5 percent per year. This result fits well with the analysis of whole fish from the SCR-AOC.

Table 7. Percentage of fish samples with quantifiable levels of total DDT from the SCR-AOC and two reference sites in 2012.

Species	St. Clair River	Les Cheneaux Islands	Little Bay De Noc
Carp	90	100	100
Rock Bass	0	10	7*
Smallmouth Bass	60	90	100
Yellow Perch	0	20	--
All Species Combined	38	44	75

* - samples collected in 2008

<u>DDT</u>

Total DDT was quantified in all but 1 of the 29 carp collected from the 3 sampling sites in 2012. No quantifiable DDT was measured in rock bass or yellow perch from the SCR-AOC. Total DDT was quantified in smallmouth bass from the SCR-AOC at a rate lower than either Les Cheneaux Islands or Little Bay De Noc (Table 7).

Table 8. The 95% UCL on the mean total DDT concentration and projected consumption advice based on those concentrations for fish collected from the St. Clair River AOC (SCR), the Les Cheneaux Islands (LCI), and Little Bay De Noc (LBDN) in 2012.

Species	95% UCL (ppm)			Meals per Month		
	SCR	LCI	LBDN	SCR	LCI	LBDN
Carp	0.11	0.42	0.28	16	4	4
Rock Bass	ND	ND	0.001*	16	16	16*
Smallmouth Bass	0.002	0.003	0.004	16	16	16
Yellow Perch	ND	ND	--	16	16	--

ND – below quantification level; * - samples collected in 2008

As with total PCB, concentrations of total DDT were consistently higher in carp than in the other species regardless of sampling site. Total DDT concentrations measured in the other species tended to be at or near the quantification limit of 0.001 parts per million (ppm). Total DDT concentrations in fish collected from the SCR-AOC were consistently lower than those measured in the same species from both Les Cheneaux Islands and Little Bay De Noc (Table 8). Based on the 95% UCL of the mean DDT concentrations the contaminant would not cause consumption advisories for any species at any of the 3 sampling sites, with the exception of carp. Based on the 95% UCL the projected consumption advice for carp from the SCR-AOC is less restrictive than the advice for carp from either Les Cheneaux Islands or Little Bay De Noc.

Dioxin TEQ

Quantifiable concentrations of 2,3,7,8 TCDD TEQs were measured in all carp collected from all three sampling sites in 2012. Dioxin analysis was not conducted on samples of any other species from the SCR-AOC, Les Cheneaux Islands, or Little Bay De Noc collected in 2012.

The mean and 95% UCL of the mean dioxin TEQ concentration in carp from the SCR-AOC was lower than those concentrations measured in both Les Cheneaux Islands and Little Bay De Noc; however, the projected consumption advice based on dioxin TEQ is the same for all three sampling sites (Table 9).

Table 9. The 95% UCL on the mean total 2,3,7,8 TCDD TEQ concentration and projected consumption advice based on those concentrations for carp collected from the St. Clair River AOC (SCR), the Les Cheneaux Islands (LCI), and Little Bay De Noc (LBDN) in 2012.

95% UCL (ppt)			Meals per Month		
SCR	LCI	LBDN	SCR	LCI	LBDN
21.5	83.9	35.8	Limited	Limited	Limited

SYNOPSIS

Mean concentrations and 95% UCL of the mean concentrations of total PCB, total DDT, and dioxin TEQ measured in carp, rock bass, and yellow perch from the SCR-AOC were consistently less than or equal to those concentrations measured in the same species collected from both Les Cheneaux Islands and Little Bay De Noc. In addition, the projected MDCH fish consumption advice based on those contaminants for those species collected from the SCR-AOC is consistently the same or less restrictive than the projected advice for fish from the two reference sites. In contrast, the mean and 95% UCL of the mean total PCB concentration in smallmouth bass from the SCR-AOC was higher than that in the reference sites, and results in a projected MDCH recommendation that would be more restrictive for the SCR-AOC compared to the other sites. However, lipid normalized PCB concentrations in SCR-AOC smallmouth bass were not significantly different than those at the reference site; this suggests that overall PCB contamination in the SCR-AOC is not significantly different than at the reference sites.

Length adjusted mercury concentrations in rock bass, smallmouth bass, and yellow perch from the SCR-AOC were similar to the concentrations measured in those fish collected from Les Cheneaux Islands, and concentrations in fish from both sites were elevated as compared to Little Bay De Noc. In contrast, length adjusted mercury concentrations in carp from Little Bay De Noc were higher than those concentrations in carp from both the SCR-AOC and Les Cheneaux Islands.

The MDCH issues consumption guidance based on the contaminant(s) causing the most restrictive advice. In this evaluation total PCBs and dioxin TEQ concentrations each lead to a “Limited” advisory for carp at all 3 sampling sites (Table 10). Mercury would cause the most restrictive consumption advice for all other species/location combinations. Projected consumption advice and the contaminant(s) causing the advice would be the same for all species sampled from all 3 sites with the exception of rock bass (Table 10).

Temporal trend analysis indicates that total PCB and total mercury concentrations in carp from the SCR-AOC have been tending to decline since about 1991, although those changes are not necessarily statistically significant.

Table 10. Projected consumption advice based on samples collected in 2012 and contaminant causing the advice for fish collected from the St. Clair River AOC (SCR), the Les Cheneaux Islands (LCI), and Little Bay De Noc (LBDN).

Species		Sampling Site		
		SCR	LCI	LBDN
Carp	Meals/Month	Limited	Limited	Limited
	Cause	PCBs & TEQ	PCBs & TEQ	PCBs & TEQ
Rock Bass	Meals/Month	4	8	8
	Cause	Mercury	Mercury	Mercury
Smallmouth Bass	Meals/Month	2	2	2
	Cause	Mercury	Mercury	Mercury
Yellow Perch	Meals/Month	8	8	--
	Cause	Mercury	Mercury	--

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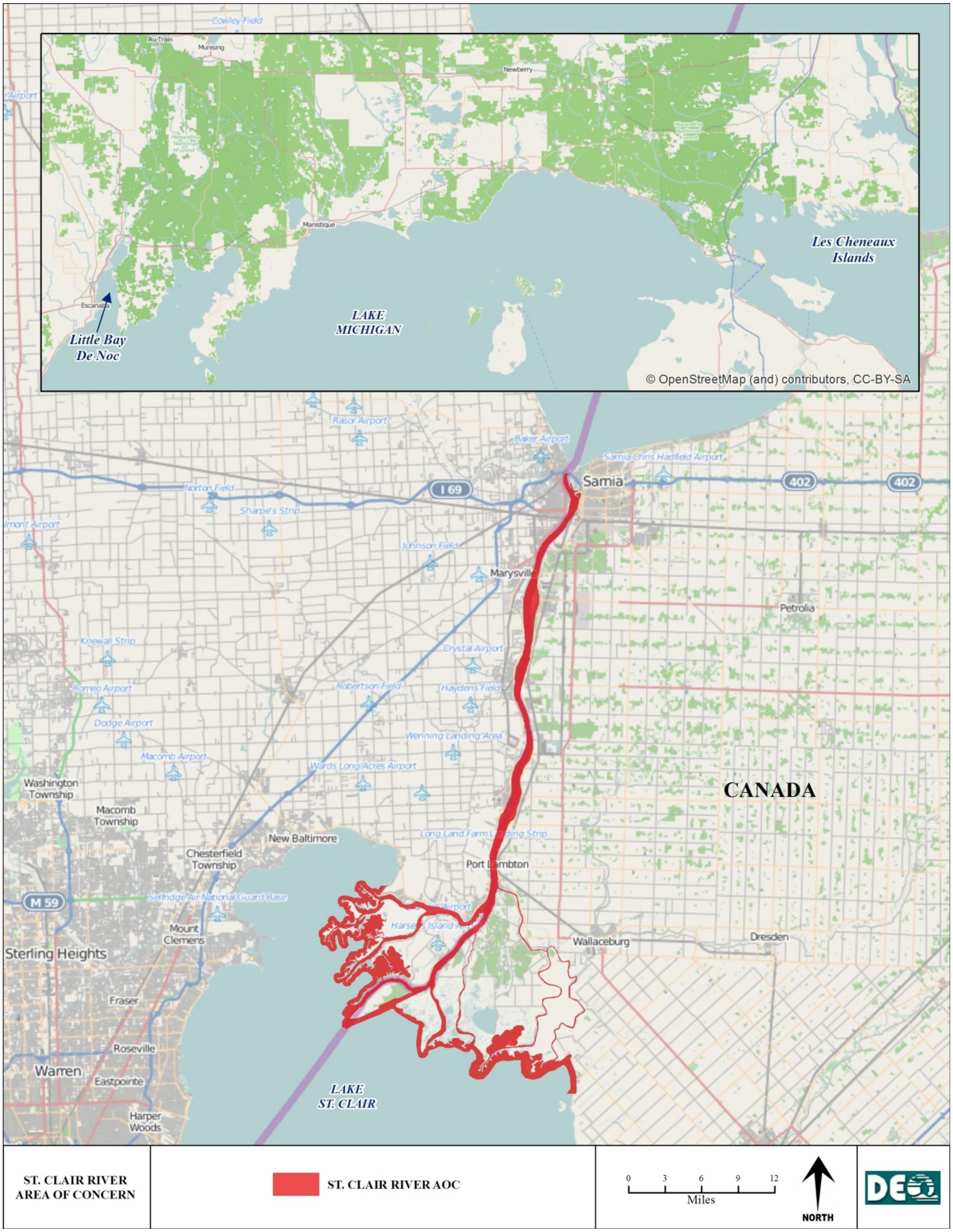


Figure 1. Map of St. Clair River Area of Concern showing location of the Les Cheneaux Island and Little Bay De Noc reference collection sites.

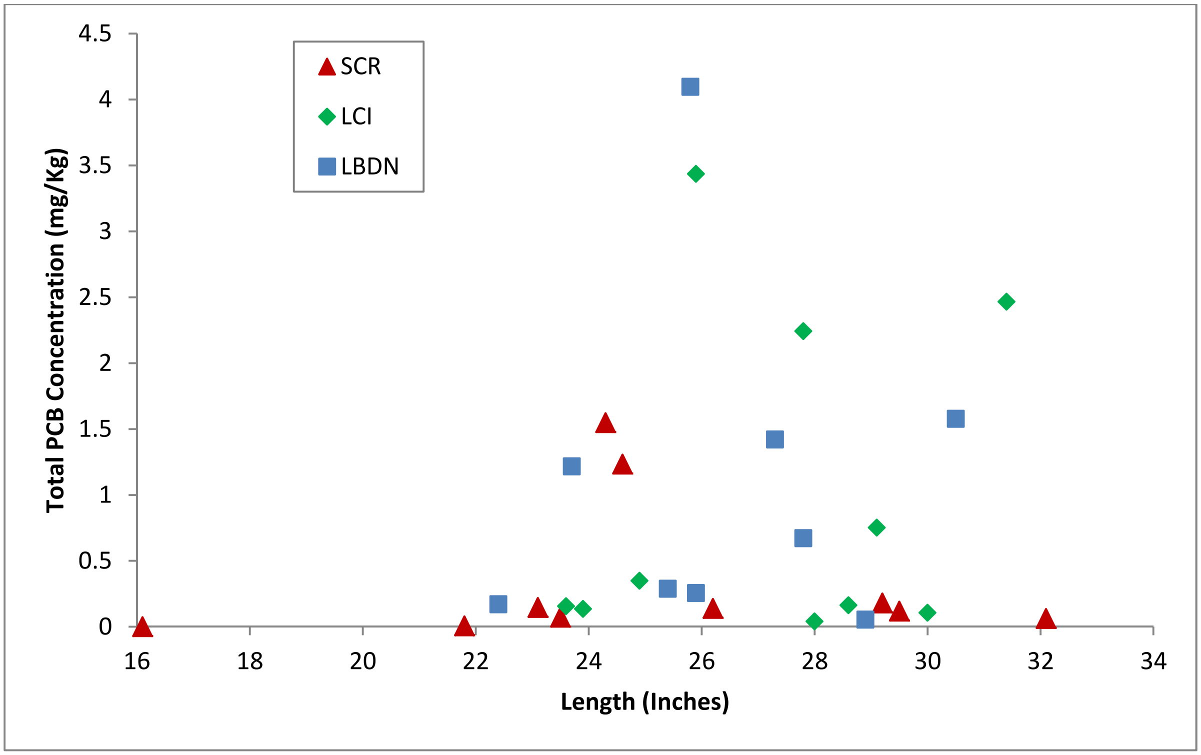


Figure 2. Length versus total PCB concentration in carp collected from the St. Clair River, Les Cheneaux Islands, and Little Bay De Noc in 2012.

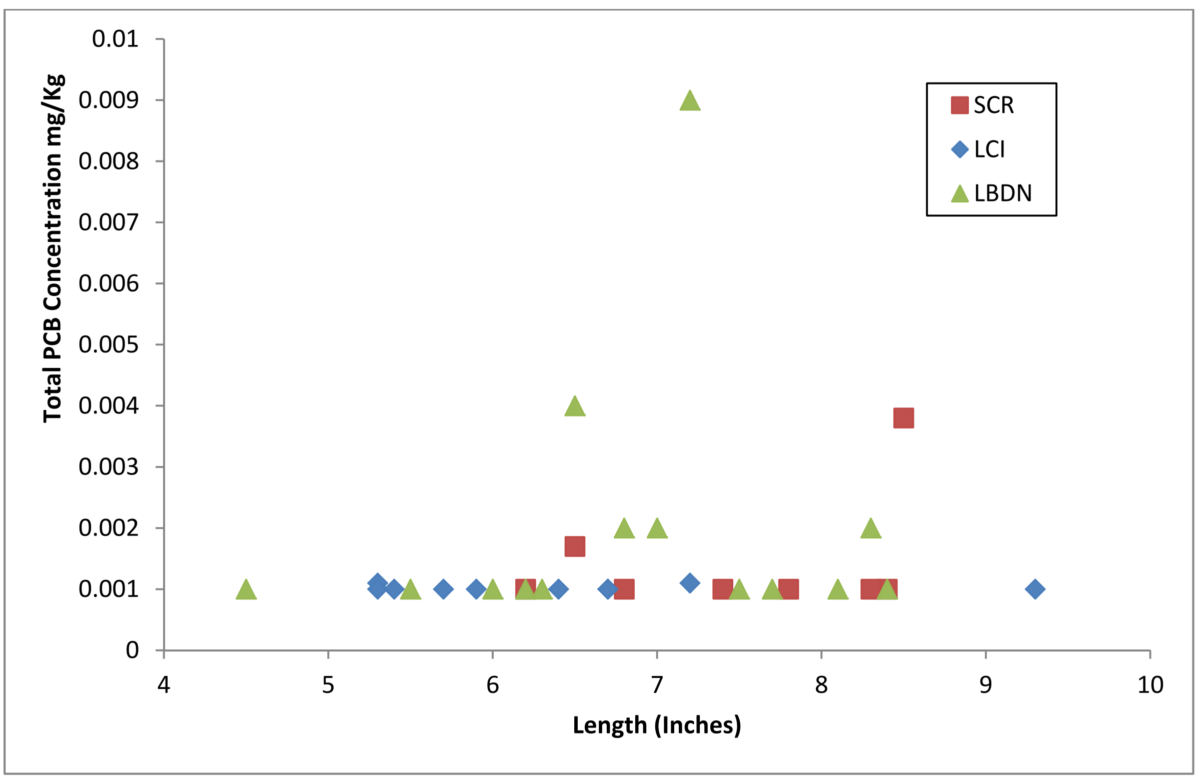


Figure 3. Length versus total PCB concentration in rock bass collected from the St. Clair River, and Les Cheneaux Islands in 2012, and Little Bay De Noc in 2008.

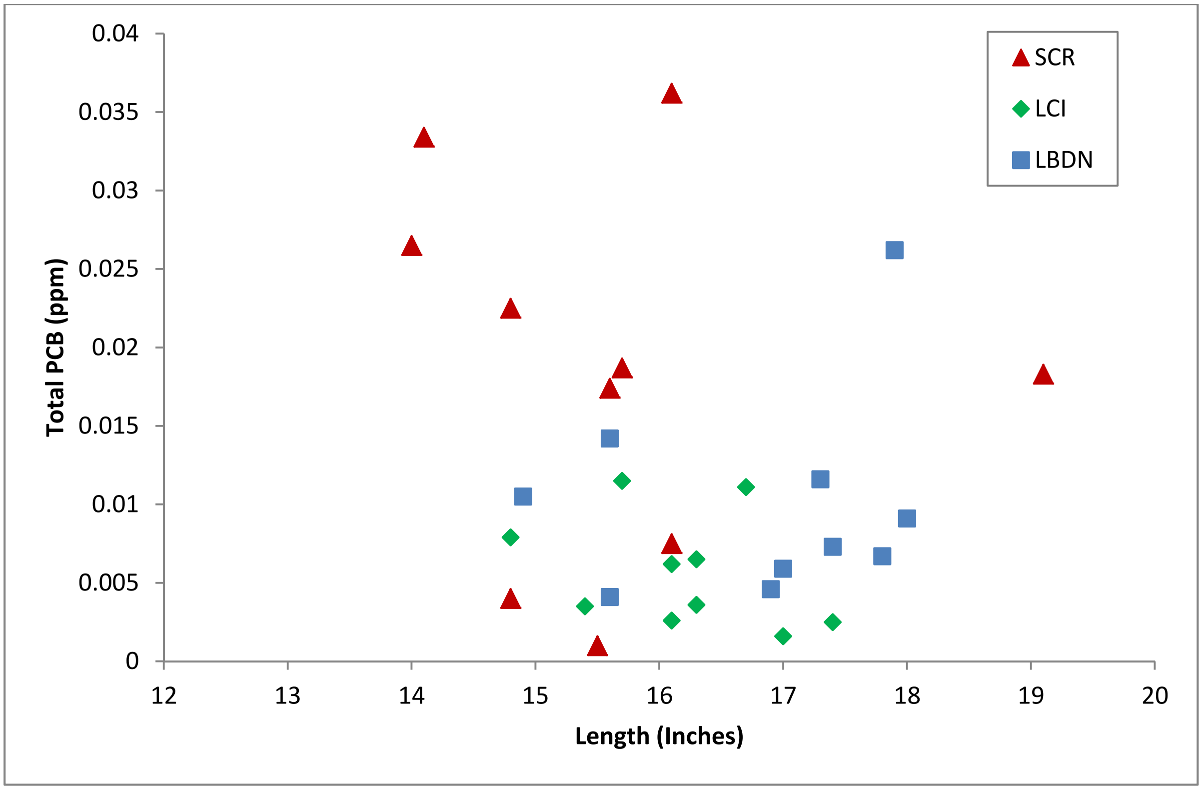


Figure 4. Length versus total PCB concentration in smallmouth bass collected from the St. Clair River, Les Cheneaux Islands, and Little Bay De Noc in 2012.

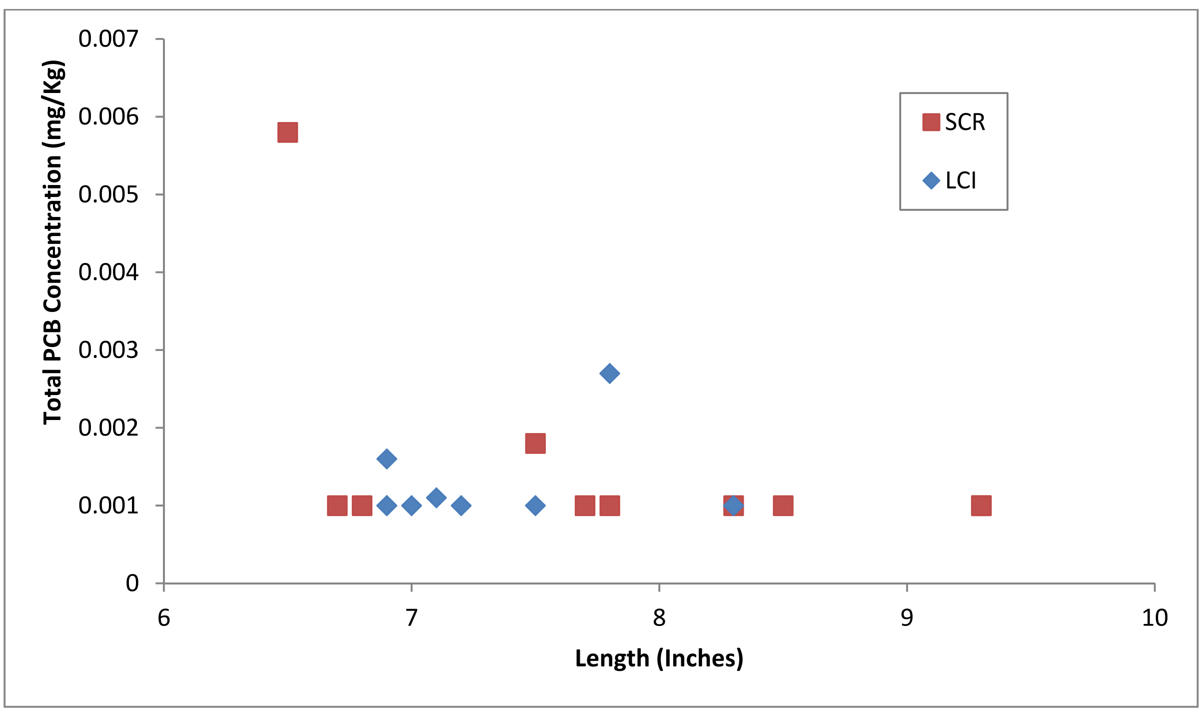


Figure 5. Length versus total PCB concentration in yellow perch collected from the St. Clair River and Les Cheneaux Islands in 2012.

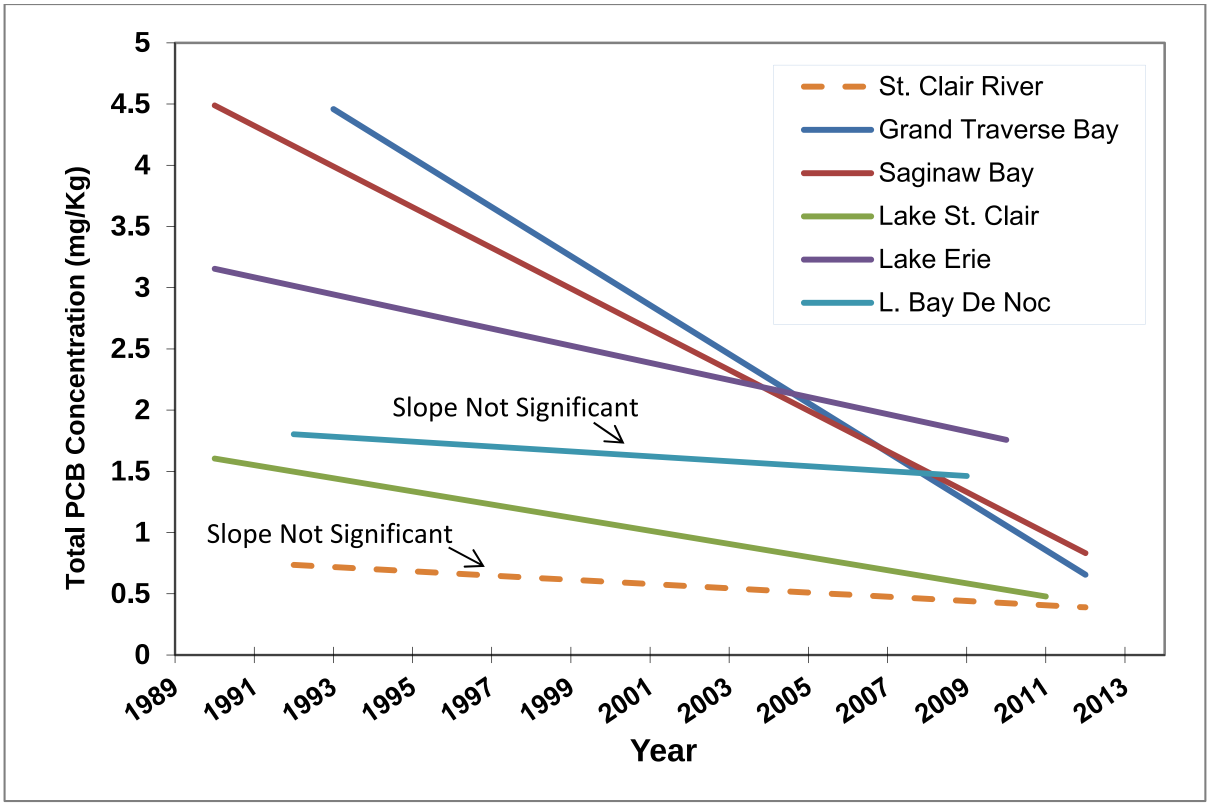


Figure 6. Temporal changes in total PCB concentrations in whole carp from Great Lake and connecting channel trend monitoring sites.

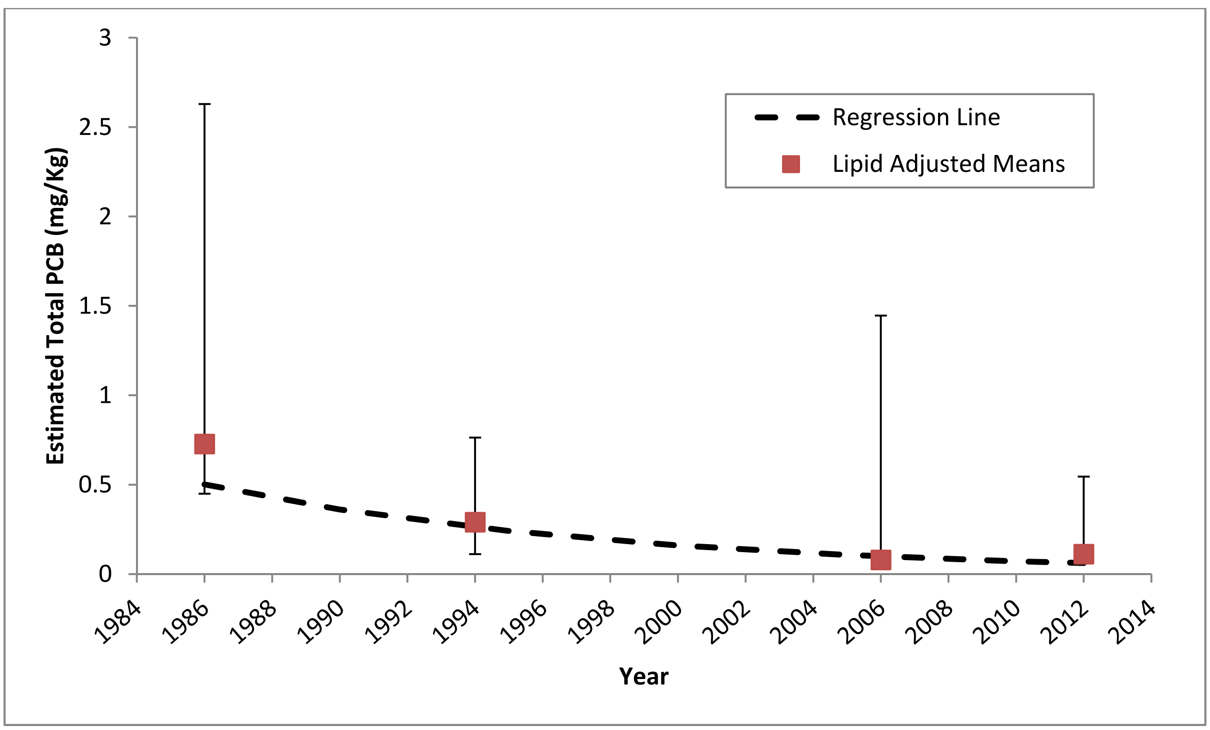
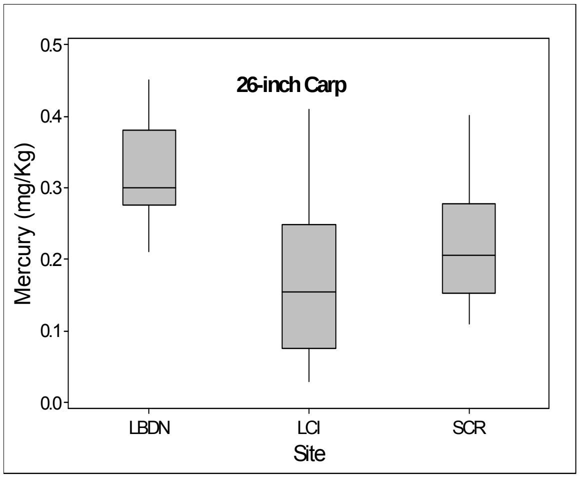


Figure 7. Temporal changes in total PCB concentrations in fillets of carp collected from the St. Clair River in 1986, 1994, 2006, and 2012.



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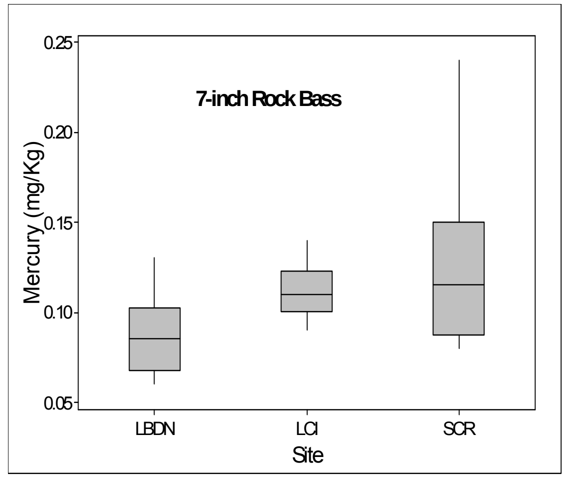

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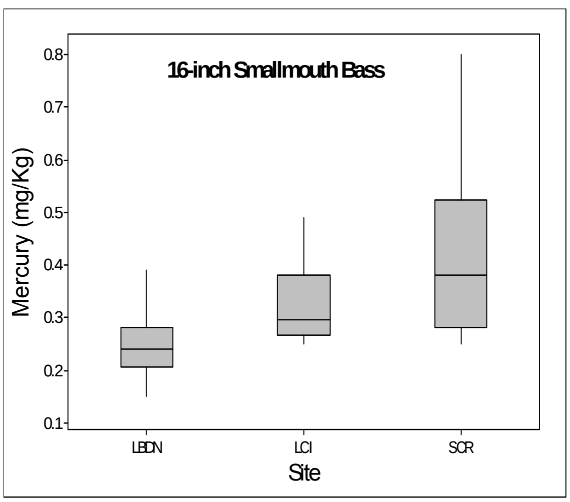

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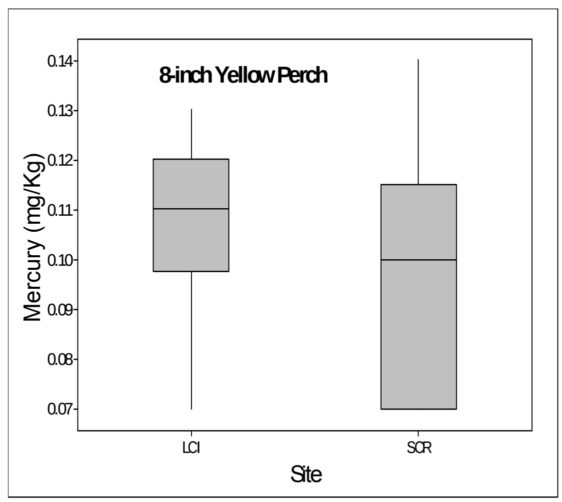

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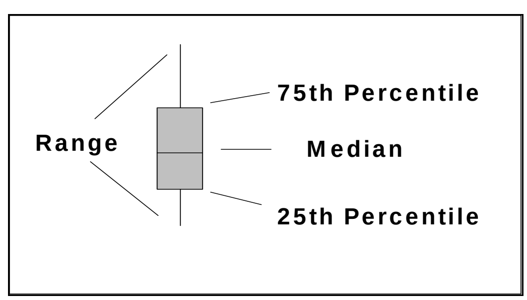
Figure 8. Boxplots of length-standardized mercury concentrations in fish collected from the St. Clair River AOC (SCR), Little Bay De Noc (LBDN), and the Les Cheneaux Islands (LCI) in 2012.

Boxplot diagram:



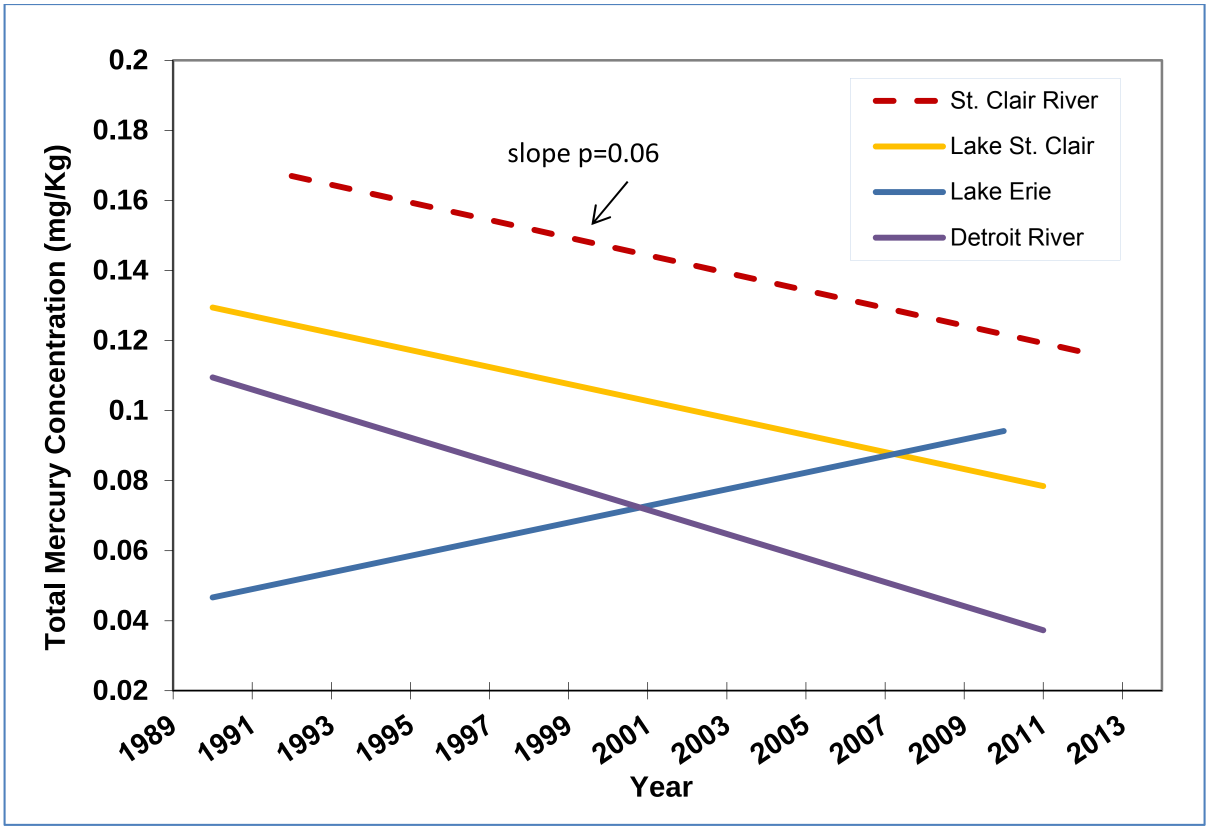


Figure 9. Temporal changes in total mercury concentrations in whole carp from Great Lake and connecting channel trend monitoring sites.

Appendix A. Concentrations of key contaminants in carp, rock bass, smallmouth bass, and yellow perch collected from the St. Clair River, Les Cheneaux Islands, and Little Bay De Noc.

Visit ID	Sample ID#	Water Body Name	Location	Collection Date	Species	Length (In)	Lipid (%)	Mercury (ppm)	Hg Code	Total PCB (ppm)	PCB Code	Total DDT (ppm)	DDT Code	Total Chlordane (ppm)	Chlor Code
2012215	2012215-S01	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	6.9	0.14	0.095		0.001	K	0.001	K	0.001	K
2012215	2012215-S02	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	7.1	0.14	0.089		0.0011		0.001	K	0.001	K
2012215	2012215-S03	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	6.9	0.16	0.059		0.001	K	0.001	K	0.001	K
2012215	2012215-S04	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	7.2	0.17	0.094		0.001	K	0.001	K	0.001	K
2012215	2012215-S05	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	7	0.22	0.093		0.001	K	0.001	K	0.001	K
2012215	2012215-S06	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	6.9	0.23	0.081		0.0016	J	0.001	K	0.001	
2012215	2012215-S07	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	7.5	0.18	0.096		0.001	K	0.001	K	0.001	K
2012215	2012215-S08	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	7.8	0.23	0.12		0.0027		0.001	K	0.001	
2012215	2012215-S09	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	8.3	0.33	0.099		0.001		0.001	K	0.001	K
2012215	2012215-S10	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	8.3	0.24	0.11		0.001	K	0.001	K	0.001	K
2012215	2012215-S21	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	5.3	0.33	0.098		0.0011		0.001	K	0.001	
2012215	2012215-S22	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	5.3	0.27	0.079		0.001		0.001	K	0.001	K
2012215	2012215-S23	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	5.4	0.3	0.081		0.001	K	0.001	K	0.001	K
2012215	2012215-S25	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	5.9	0.21	0.12		0.001	K	0.001	K	0.001	K
2012215	2012215-S26	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	5.7	0.27	0.095		0.001	K	0.001	K	0.001	K
2012215	2012215-S32	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	6.4	0.25	0.094		0.001	K	0.001	K	0.001	K
2012215	2012215-S34	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	7.2	0.25	0.13		0.0011		0.001	K	0.001	K
2012215	2012215-S35	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	6.7	0.49	0.11		0.001	K	0.001	K	0.001	K
2012215	2012215-S36	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	6.7	0.27	0.089		0.001	K	0.001	K	0.001	K
2012215	2012215-S37	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	9.3	0.15	0.15		0.001	K	0.001	K	0.001	K
2012215	2012215-S41	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	14.8	0.37	0.2		0.0079		0.001	K	0.002	
2012215	2012215-S42	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	16.1	0.13	0.26		0.0026		0.001	K	0.001	
2012215	2012215-S43	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	15.4	0.13	0.32		0.0035		0.001	K	0.001	
2012215	2012215-S44	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	15.7	0.77	0.29		0.0115		0.001	K	0.003	
2012215	2012215-S45	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	16.7	0.41	0.34		0.0111		0.001	K	0.004	
2012215	2012215-S46	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	16.3	0.26	0.34		0.0065		0.001	K	0.002	
2012215	2012215-S47	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	16.3	0.32	0.28		0.0036		0.001	K	0.002	
2012215	2012215-S48	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	17	0.21	0.36		0.0016		0.001	K	0.001	K
2012215	2012215-S49	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	16.1	0.2	0.5		0.0062		0.001	K	0.002	
2012215	2012215-S50	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	17.4	0.18	0.56		0.0025		0.001	K	0.001	
2012215	2012215-S71	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	23.6	1.02	0.22		0.1566		0.002		0.037	
2012215	2012215-S72	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	23.9	5.78	0.093		0.1355		0.009		0.139	
2012215	2012215-S73	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	24.9	11.61	0.29		0.3489		0.005		0.071	
2012215	2012215-S74	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	25.9	9.76	0.26		3.4356		0.092		0.878	
2012215	2012215-S75	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	27.8	6.36	0.26		2.2426		0.026		0.61	
2012215	2012215-S76	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	28.6	1.33	0.19		0.1632		0.001		0.024	
2012215	2012215-S77	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	28	2.39	0.19		0.0416		0.001	K	0.011	
2012215	2012215-S78	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	29.1	2.76	0.43		0.7529		0.008		0.146	
2012215	2012215-S79	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	30	1.22	0.22		0.1065		0.001		0.024	
2012215	2012215-S80	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	31.4	12.27	0.17		2.4664	J	0.009		0.146	

Visit ID	Sample ID#	Water Body Name	Location	Collection Date	Species	Length (In)	Lipid (%)	Mercury (ppm)	Hg Code	Total PCB (ppm)	PCB Code	Total DDT (ppm)	DDT Code	Total Chlordane (ppm)	Chlor Code
2012217	2012217-S01	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	16.1	0.6	0.13		0.0223	J	0.002		0.042	
2012217	2012217-S02	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	17.2	0.63	0.22		0.0676		0.004		0.012	
2012217	2012217-S03	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	16.9	0.42	0.13		0.0312		0.001		0.005	
2012217	2012217-S04	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	16.9	0.75	0.31		0.0544		0.002		0.01	
2012217	2012217-S05	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	17.7	0.48	0.45		0.0305		0.001	K	0.007	
2012217	2012217-S06	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	18.7	1.05	0.12		0.0757	J	0.004		0.013	
2012217	2012217-S07	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	19.1	1.61	0.67		0.0764	J	0.009		0.066	
2012217	2012217-S08	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	20.7	1.42	0.23		0.2162	J	0.011		0.036	
2012217	2012217-S09	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	20	1.61	0.61		0.4093	J	0.022		0.08	
2012217	2012217-S10	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	24.6	0.88	0.84		0.6186	J	0.022		0.095	
2012217	2012217-S11	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	14.9	0.41	0.2		0.0105		0.001	K	0.003	
2012217	2012217-S12	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	15.6	0.29	0.21		0.0041	J	0.001	K	0.001	
2012217	2012217-S13	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	15.6	0.56	0.23		0.0142	J	0.001	K	0.004	
2012217	2012217-S14	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	16.9	0.23	0.36		0.0046	J	0.001	K	0.001	
2012217	2012217-S15	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	17.3	0.41	0.49		0.0116		0.001	K	0.004	
2012217	2012217-S16	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	17.8	0.35	0.38		0.0067		0.001	K	0.002	
2012217	2012217-S17	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	17.4	0.23	0.25		0.0073		0.001	K	0.002	
2012217	2012217-S18	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	17	0.24	0.18		0.0059		0.001	K	0.001	
2012217	2012217-S19	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	17.9	0.36	0.3		0.0262		0.001	K	0.005	
2012217	2012217-S20	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	18	0.39	0.34		0.0091		0.001	K	0.002	
2012217	2012217-S21	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	20.4	1.96	0.094		0.0371	J	0.001		0.05	
2012217	2012217-S22	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	20.2	1.94	0.26		0.0142	J	0.001	K	0.004	
2012217	2012217-S23	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	20.7	1.12	0.14		0.0275	J	0.0005		0.009	
2012217	2012217-S24	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	22.5	0.42	0.44		0.0057	J	0.001	K	0.002	
2012217	2012217-S25	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	23.4	1.41	0.23		0.072	J	0.002		0.016	
2012217	2012217-S26	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	23.2	0.31	0.81		0.0285	J	0.001	K	0.007	
2012217	2012217-S27	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	24.9	0.84	0.43		0.0458	J	0.001		0.011	
2012217	2012217-S28	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	22.6	0.46	0.16		0.0078		0.001	K	0.004	
2012217	2012217-S29	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	23.3	1.96	0.3		0.1344	J	0.002		0.029	
2012217	2012217-S30	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	25.4	1.31	0.85		0.122	J	0.001		0.026	
2012217	2012217-S31	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	22.4	1.25	0.35		0.1707	J	0.002		0.036	
2012217	2012217-S32	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	23.7	16.79	0.36		1.2175	J	0.037		0.458	
2012217	2012217-S33	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	25.8	5.34	0.29		4.0968	J	0.006		0.087	
2012217	2012217-S34	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	25.4	2.34	0.46		0.2885	J	0.003		0.059	
2012217	2012217-S35	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	25.9	2.32	0.26		0.2554	J	0.002		0.061	
2012217	2012217-S36	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	27.3	11.64	0.2		1.4218	J	0.01		0.112	
2012217	2012217-S37	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	27.8	1.43	0.4		0.6725	J	0.015		0.299	
2012217	2012217-S38	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	30.5	18.77	0.27		1.5777		0.023		0.291	
2012217	2012217-S39	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	28.9	2.06	0.26		0.0545		0.001		0.016	

Visit ID	Sample ID#	Water Body Name	Location	Collection Date	Species	Length (In)	Lipid (%)	Mercury (ppm)	Hg Code	Total PCB (ppm)	PCB Code	Total DDT (ppm)	DDT Code	Total Chlordane (ppm)	Chlor Code
2012228	2012228-S01	St. Clair River	Algonac	15-Jun-12	Carp	16.1	0.32	0.06		0.001	K	0.001	K	0.001	K
2012228	2012228-S02	St. Clair River	Algonac	15-Jun-12	Carp	21.8	0.71	0.084		0.0072		0.001	K	0.004	
2012228	2012228-S04	St. Clair River	Algonac	15-Jun-12	Carp	23.1	2.2	0.18		0.1471		0.007		0.037	
2012228	2012228-S05	St. Clair River	Algonac	15-Jun-12	Carp	23.5	5.11	0.16		0.0728		0.005		0.024	
2012228	2012228-S06	St. Clair River	Algonac	15-Jun-12	Carp	24.3	2.81	0.3		1.5487	J	0.016		0.104	
2012228	2012228-S10	St. Clair River	Algonac	15-Jun-12	Carp	24.6	14.27	0.17		1.2338	J	0.071		0.251	
2012228	2012228-S13	St. Clair River	Algonac	15-Jun-12	Carp	26.2	6.23	0.26		0.1391		0.005		0.025	
2012228	2012228-S14	St. Clair River	Algonac	15-Jun-12	Carp	29.5	1.91	0.58		0.1188		0.003		0.045	
2012228	2012228-S15	St. Clair River	Algonac	15-Jun-12	Carp	29.2	4.87	0.22		0.1808		0.002		0.026	
2012228	2012228-S16	St. Clair River	Algonac	15-Jun-12	Carp	32.1	4.39	0.2		0.0631		0.006		0.016	
2012228	2012228-S21	St. Clair River	Algonac	15-Jun-12	Yellow Perch	6.5	0.08	0.11		0.0058		0.001	K	0.001	K
2012228	2012228-S23	St. Clair River	Algonac	15-Jun-12	Yellow Perch	6.7	0.12	0.075		0.001	K	0.001	K	0.001	K
2012228	2012228-S25	St. Clair River	Algonac	15-Jun-12	Yellow Perch	6.8	0.09	0.066		0.001	K	0.001	K	0.001	K
2012228	2012228-S27	St. Clair River	Algonac	15-Jun-12	Yellow Perch	7.5	0.15	0.13		0.0018	J	0.001	K	0.001	K
2012228	2012228-S31	St. Clair River	Algonac	15-Jun-12	Yellow Perch	7.7	0.16	0.072		0.001	K	0.001	K	0.001	K
2012228	2012228-S32	St. Clair River	Algonac	15-Jun-12	Yellow Perch	7.8	0.1	0.11		0.001	K	0.001	K	0.001	K
2012228	2012228-S34	St. Clair River	Algonac	15-Jun-12	Yellow Perch	8.5	0.14	0.099		0.001	K	0.001	K	0.001	K
2012228	2012228-S36	St. Clair River	Algonac	15-Jun-12	Yellow Perch	8.3	0.11	0.069		0.001	K	0.001	K	0.001	K
2012228	2012228-S38	St. Clair River	Algonac	15-Jun-12	Yellow Perch	9.3	0.1	0.12		0.001	K	0.001	K	0.001	K
2012228	2012228-S39	St. Clair River	Algonac	15-Jun-12	Yellow Perch	9.3	0.1	0.12		0.001	K	0.001	K	0.001	K
2012228	2012228-S42	St. Clair River	Algonac	15-Jun-12	Smallmouth Bass	14	0.1	0.61		0.0265		0.001	K	0.003	
2012228	2012228-S46	St. Clair River	Algonac	15-Jun-12	Smallmouth Bass	14.1	1.01	0.31		0.0334		0.001		0.003	
2012228	2012228-S47	St. Clair River	Algonac	15-Jun-12	Smallmouth Bass	14.8	0.82	0.21		0.0225		0.001	K	0.003	
2012228	2012228-S48	St. Clair River	Algonac	15-Jun-12	Smallmouth Bass	14.8	0.39	0.25		0.004		0.001	K	0.001	K
2012228	2012228-S49	St. Clair River	Algonac	15-Jun-12	Smallmouth Bass	15.5	0.11	0.34		0.001	K	0.001	K	0.001	K
2012228	2012228-S50	St. Clair River	Algonac	15-Jun-12	Smallmouth Bass	15.6	0.57	0.47		0.0174		0.001	K	0.002	
2012228	2012228-S51	St. Clair River	Algonac	15-Jun-12	Smallmouth Bass	15.7	0.62	0.32		0.0187		0.001	K	0.002	
2012228	2012228-S54	St. Clair River	Algonac	15-Jun-12	Smallmouth Bass	16.1	0.37	0.25		0.0362		0.001	K	0.002	
2012228	2012228-S57	St. Clair River	Algonac	15-Jun-12	Smallmouth Bass	16.1	0.39	0.6		0.0075		0.001	K	0.001	K
2012228	2012228-S58	St. Clair River	Algonac	15-Jun-12	Smallmouth Bass	19.1	0.25	0.7		0.0183		0.001	K	0.001	K
2012228	2012228-S61	St. Clair River	Algonac	15-Jun-12	Rock Bass	5.9		0.19							
2012228	2012228-S62	St. Clair River	Algonac	15-Jun-12	Rock Bass	6.2	0.29	0.098		0.001	K	0.001	K	0.001	K
2012228	2012228-S63	St. Clair River	Algonac	15-Jun-12	Rock Bass	6.5	0.35	0.077		0.0017		0.001	K	0.001	K
2012228	2012228-S64	St. Clair River	Algonac	15-Jun-12	Rock Bass	6.8	0.19	0.089		0.001	K	0.001	K	0.001	K
2012228	2012228-S70	St. Clair River	Algonac	15-Jun-12	Rock Bass	7.4	0.25	0.15		0.001	K	0.001	K	0.001	K
2012228	2012228-S72	St. Clair River	Algonac	15-Jun-12	Rock Bass	8.4	0.2	0.11		0.001	K	0.001	K	0.001	K
2012228	2012228-S73	St. Clair River	Algonac	15-Jun-12	Rock Bass	8.5	0.1	0.17		0.0038		0.001	K	0.001	K
2012228	2012228-S75	St. Clair River	Algonac	15-Jun-12	Rock Bass	7.8	0.16	0.13		0.001	K	0.001	K	0.001	K
2012228	2012228-S76	St. Clair River	Algonac	15-Jun-12	Rock Bass	8.3	0.27	0.11		0.001	K	0.001	K	0.001	K
2012228	2012228-S77	St. Clair River	Algonac	15-Jun-12	Rock Bass	10.6	0.1	0.39		0.001	K	0.001	K	0.001	K

Visit ID	Sample ID#	Water Body Name	Location	Collection Date	Species	Length (In)	Lipid (%)	Mercury (ppm)	Hg Code	Total PCB (ppm)	PCB Code	Total DDT (ppm)	DDT Code	Total Chlordane (ppm)	Chlor Code
2008232	2008232-S01	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	4.5	0.1	0.049		0.001	K	0.001	K	0.001	K
2008232	2008232-S02	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	5.5	0.2	0.053		0.001	K	0.001	K	0.001	K
2008232	2008232-S03	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	6	0.2	0.086		0.001	K	0.001	K	0.001	K
2008232	2008232-S04	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	6.2	0.5	0.048		0.001		0.001	K	0.001	K
2008232	2008232-S05	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	6.3	0.2	0.074		0.001	K	0.001	K	0.001	K
2008232	2008232-S06	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	6.5	0.5	0.075		0.004		0.001	K	0.001	K
2008232	2008232-S07	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	6.8	0.5	0.057		0.002		0.002		0.001	K
2008232	2008232-S08	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	7	0.7	0.066		0.002		0.001	K	0.001	K
2008232	2008232-S09	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	7.2	0.6	0.079		0.009		0.001	K	0.001	K
2008232	2008232-S10	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	7.5	0.4	0.146		0.001	K	0.001	K	0.001	K
2008232	2008232-S11	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	7.7	0.4	0.138		0.001	K	0.001	K	0.001	K
2008232	2008232-S12	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	8.1	0.4	0.087		0.001		0.001	K	0.001	K
2008232	2008232-S13	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	8.3	0.6	0.119		0.002		0.001	K	0.001	K
2008232	2008232-S14	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	8.4	0.2	0.147		0.001	K	0.001	K	0.001	K

Appendix B1.

Summary statistics for lengths of fish samples collected from the Les Cheneaux Islands (LCI), Little Bay De Noc (LBDN), and St. Clair River (SCR) in 2012.

Species	Length (Inches)							
	Min Diff*	Site	Median	Mean	St Dev	Min	Max	N
Carp	6.6	LCI	27.9	27.2	2.64	23.6	31.4	10
		LBDN	25.9	26.4	2.52	22.4	30.5	9
		SCR	24.4	25.0	4.54	16.1	32.1	10
Rock Bass	2.0	LCI	6.2	6.4	1.22	5.3	9.3	10
		LBDN	6.9	6.8	1.11	4.5	8.4	14
		SCR	7.6	7.6	1.40	5.9	10.6	10
Smallmouth Bass	2.0	LCI	16.2	16.2	0.76	14.8	17.4	10
		LBDN	17.2	16.8	1.09	14.9	18.0	10
		SCR	15.6	15.6	1.45	14.0	19.1	10
Yellow Perch	1.3	LCI	7.2	7.4	0.56	6.9	8.3	10
		SCR	7.8	7.8	1.01	6.5	9.3	10

* - estimated minimum detectable difference at power = 0.8

Appendix B2.

Summary statistics for total PCB concentrations fish samples collected from the Les Cheneaux Islands (LCI), Little Bay De Noc (LBDN), and St. Clair River (SCR) in 2012.

Species	Total PCB Concentration (mg/Kg)							
	Min Diff*	Site	Median	Mean	St Dev	Min	Max	N
Carp	1.5	LCI	0.26	0.98	1.25	0.04	3.44	10
		LBDN	0.67	1.08	1.27	0.05	4.10	9
		SCR	0.13	0.35	0.56	0.001	1.55	10
Rock Bass	0.001	LCI	0.001	0.001	0.00004	ND	0.001	10
		LBDN	0.001	0.002	0.002	0.001	0.009	14
		SCR	0.001	0.001	0.0009	ND	0.004	10
Smallmouth Bass	0.01	LCI	0.005	0.006	0.004	0.002	0.011	10
		LBDN	0.008	0.010	0.006	0.004	0.026	10
		SCR	0.02	0.02	0.012	ND	0.036	10
Yellow Perch	0.001	LCI	0.001	0.001	0.0005	ND	0.003	10
		SCR	0.001	0.002	0.002	ND	0.006	10

* - estimated minimum detectable difference at power = 0.8

Appendix B3.

Summary statistics for total mercury concentrations fish samples collected from the Les Cheneaux Islands (LCI), Little Bay De Noc (LBDN), and St. Clair River (SCR) in 2012.

Species	Total Mercury Concentration (mg/Kg)							
	Min Diff*	Site	Median	Mean	St Dev	Min	Max	N
Carp	0.16	LCI	0.22	0.23	0.09	0.09	0.43	10
		LBDN	0.29	0.32	0.08	0.20	0.46	9
		SCR	0.19	0.22	0.14	0.06	0.58	10
Rock Bass	0.09	LCI	0.10	0.10	0.02	0.08	0.15	10
		LBDN	0.08	0.09	0.04	0.05	0.15	14
		SCR	0.12	0.15	0.09	0.08	0.39	10
Smallmouth Bass	0.20	LCI	0.33	0.34	0.11	0.20	0.56	10
		LBDN	0.28	0.29	0.10	0.18	0.49	10
		SCR	0.33	0.41	0.18	0.21	0.70	10
Yellow Perch	0.03	LCI	0.09	0.09	0.02	0.06	0.12	10
		SCR	0.10	0.10	0.02	0.07	0.13	10

* - estimated minimum detectable difference at power = 0.8

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MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION
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STAFF REPORT

STATUS OF CONTAMINANT LEVELS IN FISH FROM THE ST. MARYS RIVER AREA OF CONCERN 2012

INTRODUCTION

The St. Marys River Area of Concern (SMR-AOC) is a binational AOC and includes the entire river from Whitefish Bay downstream to Humbug Point on the Ontario side and the straits of De Tour on the Michigan side (Figure 1). Both Michigan and Ontario have issued fish consumption advisories for the St. Marys River beginning in the 1980s and continuing to the present.

The current Michigan Department of Community Health (MDCH) advisory recommends varying limits on the consumption of carp, northern pike, and walleye from the St. Marys River due to elevated concentrations of mercury and polychlorinated biphenyls (PCB). The advice is based on carp samples collected most recently in 1995, and northern pike and walleye collected in 2004. In addition, white sucker were sampled in 1987 and yellow perch were sampled most recently in 1995. The MDCH has not issued any consumption advisories for wildlife taken from the SMR-AOC; the Ontario Ministry of Natural Resources advises against eating liver and kidney of moose, black bear, and deer because of elevated cadmium levels.

Fish samples were collected in 2012 from the St. Marys River and from two non-AOC reference sites in support of the United States Environmental Protection Agency (USEPA) Great Lakes Restoration Initiative grant-funded project *Assessing Michigan's Beneficial Use of Sport-Caught Fish* awarded to the MDCH. Several fish species were collected allowing for comparisons of key contaminant concentrations between sites.

SUMMARY

1. Carp, pumpkinseed, redhorse sucker, rock bass, smallmouth bass, walleye, and yellow perch samples were collected from the SMR-AOC in 2012. Reference samples were collected from the Les Cheneaux Islands area of northern Lake Huron and from Little Bay De Noc in northern Lake Michigan.

2. PCBs were quantified in all carp and smallmouth bass samples regardless of sampling site, but rates of quantification in other species varied by sampling site. Mercury was quantified in all samples from each sampling site. Total dichlorodiphenyl trichloroethane (DDT) was quantified in all carp samples but rates of quantification in other species varied by sampling site. Dioxin toxic equivalent (TEQ) was assayed in carp and quantified in all samples.

3. Intra-species length ranges by sampling site were similar for all fish species sampled except for redhorse sucker and walleye. The latter species collected from the SMR-AOC tended to be smaller than the samples from Little Bay De Noc.

4. Total PCB concentrations in fish samples collected from the SMR-AOC were the same or lower than the concentrations measured in samples from either Les Cheneaux Islands or Little Bay De Noc.

5. Total mercury concentrations in carp, pumpkinseed, redhorse sucker, smallmouth bass, and walleye from the SMR-AOC were the same or lower than the concentrations measured in those species from one or both of the reference sites. Total mercury concentrations in rock bass and yellow perch were higher than the concentrations measured at the reference sites.

6. Total DDT concentrations in samples from the SMR-AOC were less than the concentrations measured at either Les Cheneaux Islands or Little Bay De Noc.

7. Fish consumption advice was projected based on the contaminant concentrations in samples collected in 2012. The projected advice for fish from the SMR-AOC was the same or less restrictive than the advice projected for Les Cheneaux Islands and Little Bay De Noc for all species except rock bass and yellow perch.

8. Temporal trends in total PCB and mercury concentrations in walleye and carp from the SMR-AOC are similar to the trends measured at other Michigan Great Lakes trend sites.

METHODS

Fish were collected in 2012 by the Michigan Department of Natural Resources, Fisheries Division, or by the Michigan Department of Environmental Quality (MDEQ), Water Resources Division, from Munuscong Lake in the SMR-AOC, Little Bay De Noc, and Les Cheneaux Islands. Carp (*Cyprinus carpio*) and smallmouth bass (*Micropterus dolomieu*) were collected from all three sampling sites in 2012; pumpkinseed (*Lepomis gibbosus*), rock bass (*Ambloplites rupestris*), and yellow perch (*Perca flavescens*) were collected from the SMR-AOC and Les Cheneaux Islands, while redhorse sucker (*Moxostoma* sp) and walleye (*Sander vitreus*) were collected from the SMR-AOC and Little Bay De Noc in 2012. An additional 14 rock bass collected from Little Bay De Noc in 2008 were also used for comparisons.

Table 1. Fish samples collected from the St. Marys River AOC and two reference sites in 2012.

Species	St. Marys River	Les Cheneaux Islands	Little Bay De Noc
Carp	10	10	9
Pumpkinseed	10	10	0
Redhorse Sucker	7	0	10
Rock Bass	10	10	14*
Smallmouth Bass	10	10	10
Walleye	8	0	10
Yellow Perch	10	10	0

* - samples collected in 2008

Northern pike (*Esox lucius*) had been selected as a target species but were not collected from either reference area; smallmouth bass, another top predator species, were used as a substitute.

The fish were processed as standard edible portions in accordance with the Great Lakes and Environmental Assessment Section Procedure 31. Standard edible portions are untrimmed, skin-on fillets for pumpkinseed, rock bass, smallmouth bass, walleye, and yellow perch, and untrimmed, skin-off fillets for carp and redhorse sucker. Each sample was individually wrapped in aluminum foil, appropriately labeled, and frozen until preparation for analysis. A total of 65 samples from the SMR-AOC, 50 samples from Les Cheneaux Islands, and 53 samples from Little Bay De Noc were analyzed (Table 1).

In addition, carp and walleye have been collected periodically from the SMR-AOC and from Little Bay De Noc since 1991. These samples were analyzed as whole fish samples as part of the temporal trend element of the Michigan Fish Contaminant Monitoring Program (FCMP).

All fillet and whole fish samples were analyzed for a standard suite of contaminants including total mercury, organochlorinated pesticides (Table 2), and PCB congeners (Table 3) by the MDCH Analytical Chemistry Laboratory. Carp samples from all three sites sampled in 2012 were also analyzed for dioxin, furan, and coplanar PCB congeners by PACE Analytical.

Table 2. Standard suite of contaminants quantified in fish tissue samples for the MDEQ Fish Contaminant Monitoring Program.

2,4'-DDD	Oxychlordane
2,4'-DDE	*gamma*-Chlordane
2,4'-DDT	*trans*-Nonachlor
4,4'-DDD	*alpha*-Chlordane
4,4'-DDE	*cis*-Nonachlor
4,4'-DDT	Hexachlorobenzene
Aldrin	Mercury
Dieldrin	Mirex
gamma-BHC (Lindane)	Octachlorostyrene
Heptachlor	PBB (FF-1, BP-6)
Heptachlor Epoxide	Pentachlorostyrene
Heptachlorostyrene	Terphenyl
Hexachlorostyrene	Toxaphene
Total PCB (as congeners; Aroclors prior to 2000)	

The MDCH Laboratory has measured PCB concentrations using the congener method since 2000; total PCB concentration was estimated by summing the concentrations of PCB congeners. Individual congeners below the quantification level were assigned a concentration equal to zero for the purpose of calculating a total PCB concentration. Also, congener analyses that did not meet retention time criteria or were subject to analytical interference were assigned a concentration equal to zero for the purpose of calculating a total PCB concentration. Prior to 2000, PCB was measured as total Aroclors; results using both methods were compared and found to be equivalent before changing to the congener method.

Total DDT concentrations were calculated by summing concentrations of the para, para' and ortho, para' forms of DDT, dichlorodiphenyldichloroethylene (DDE), and 1,1-bis(4-chlorophenyl)-2,2-dichloroethane (DDD). Individual chemicals below the quantification level were assigned a concentration equal to zero for the purpose of calculating a total DDT concentration. If all six components were below the quantification level, then the total DDT concentration was reported as less than the lowest quantification level of the metabolites.

Total chlordane concentration was estimated by summing the concentrations of five chlordane breakdown products: *alpha*-chlordane, *gamma*-chlordane, *cis*-nonachlor, *trans*-nonachlor, and oxychlordane. Individual compounds below the quantification level were assigned a concentration equal to zero for the purpose of calculating a total chlordane concentration. If all five compounds were below the quantification level, then the total chlordane concentration was reported as less than the quantification level of the individual compounds.

Total 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) TEQ was calculated using toxic equivalency factors developed by the World Health Organization (Van den Berg et al., 2006). The concentrations of individual dioxin, dibenzofuran, and dioxin-like PCB congeners in a fish sample were multiplied by chemical-specific toxic equivalency factors and the resulting products summed to calculate a 2,3,7,8-TCDD (dioxin) TEQ concentration. Individual congener concentrations less than the detection level were assigned a value of zero for the purpose of calculating the dioxin TEQ.

Analytical results were reviewed and entered into the MDEQ, Water Resources Division, FCMP database. Results for total PCBs, mercury, total DDT, and dioxin TEQ are presented in Appendix A. The complete data set is available electronically (by request) or through the FCMP Web site (www.deq.state.mi.us/fcmp)

The MDCH, Division of Environmental Health, develops fish consumption advice following protocols described in the *Michigan Fish Consumption Advisory Program Guidance Document*. That document along with links to supporting documentation and other related reports is available online at: http://www.michigan.gov/eatsafefish (Reports & Science button). The guidance was used in this report to predict the likely fish consumption advice based on the analytical results for the samples collected in 2012. Specifically, the projected advice was determined by comparing the 95 percent upper confidence limit (95% UCL) on the mean concentration in legal-size fish for each species/site/contaminant combination with the appropriate MDCH screening value for that contaminant. It is important to note that the projected consumption advice reported here may not be the final advice put forth by the MDCH; the MDCH bases consumption guidance on the most current analytical results in combination with previous data for the water body as well as knowledge of legacy or ongoing contamination issues.

The MDCH fish consumption guidance is presented as a recommended number of meals per month of a given species. The meal categories range from 16 meals per month to a “Do Not Eat” category reserved for those species and water bodies where consumption of a single meal will contain at least one year of exposure to a contaminant. In addition, the MDCH has designated a “Limited” category; healthy adults may eat one or two meals per year of fish in this category, but it is recommended that women of childbearing age, young children, and adults with a chronic health condition not eat these fish.

Contaminant loads in fish are often positively correlated with the age of the fish, and fish length is generally used as a surrogate for age. One goal of the project was to collect fish in a similar range of sizes for a given species from each sampling site. Fish lengths between sampling sites were compared statistically using either a 2-sample t-test or analysis of variance (ANOVA) if a species was collected from all three sites. Differences were considered significant at $p \leq 0.05$. Power analysis was used to estimate the minimum detectable difference for those cases where differences in the mean were not significant.

Chlorinated contaminants such as PCBs, DDT, and dioxins tend to accumulate preferentially in lipids. Since the lipid content of fish can vary from site to site, a simple comparison of contaminant concentrations has the potential to be biased. Statistical comparisons for the chlorinated contaminant concentrations were conducted using results that were normalized by dividing the contaminant concentration by the lipid content. Comparisons were made using ANOVA or t-tests when the data followed a normal distribution or the nonparametric equivalents (Kruskal-Wallis; Mann-Whitney) if the data could not be made normal by transformation.

Regressions were calculated for each species-sample site combination to determine if contaminant concentrations could be predicted by fish length. Lipid content was used as a factor in the regression calculation when appropriate.

The software package Minitab 15 was used to perform the statistical tests.

Table 3. PCB structure and corresponding identification number of congeners quantified in fish tissue samples.

BZ#	Structure	BZ#	Structure
	TRICHLOROBIPHENYLS		HEXACHLOROBIPHENYLS
17	2,2',4	128	2,2',3,3',4,4'
18	2,2',5	130	2,2',3,3',4,5'
22	2,3,4'	132	2,2',3,3',4,6'
25	2,3',4	135	2,2',3,3',5,6'
26	2,3',5	136	2,2',3,3',6,6'
28	2,4,4'	137	2,2',3,4,4',5
31	2,4',5	138	2,2',3,4,4',5'
32	2,4',6	141	2,2',3,4,5,5'
33	2',3,4	144	2,2',3,4,5',6
37	3,4,4'	146	2,2',3,4',5,5'
		149	2,2',3,4',5',6
	TETRACHLOROBIPHENYLS	151	2,2',3,5,5',6
40	2,2',3,3'	153	2,2',4,4',5,5'
42	2,2',3,4'	156	2,3,3',4,4',5
44	2,2',3,5'	157	2,3,3',4,4',5'
45	2,2',3,6	158	2,3,3',4,4',6
47	2,2',4,4'	163	2,3,3',4',5,6
49	2,2',4,5'	167	2,3',4,4',5,5'
52	2,2',5,5'		
56	2,3,3',4'		HEPTACHLOROBIPHENYLS
60	2,3,4,4'	170	2,2',3,3',4,4',5
63	2,3',4',5	171	2,2',3,3',4,4',6
64	2,3,4',6	172	2,2',3,3',4,5,5'
66	2,3',4,4'	174	2,2',3,3',4,5,6'
70	2,3',4',5	175	2,2',3,3',4,5',6
71	2,3',4',6	177	2,2',3,3',4',5,6
74	2,4,4',5	178	2,2',3,3',5,5',6
77	3,3',4,4'	179	2,2',3,3',5,6,6'
		180	2,2',3,4,4',5,5'
	PENTACHLOROBIPHENYLS	182	2,2',3,4,4',5,6'
82	2,2',3,3',4	183	2,2',3,4,4',5',6
84	2,2',3,3',6	185	2,2',3,4,5,5',6
87	2,2',3,4,5'	187	2,2',3,4',5,5',6
90	2,2',3,4',5	190	2,3,3',4,4',5,6
91	2,2',3,4',6	193	2,3,3',4',5,5',6
92	2,2',3,5,5'		
95	2,2',3,5',6		OCTACHLOROBIPHENYLS
97	2,2',3',4,5	194	2,2',3,3',4,4',5,5'
99	2,2',4,4',5	195	2,2',3,3',4,4',5,6
100	2,2',4,4',6	196	2,2',3,3',4,4',5,6'
101	2,2',4,5,5'	198	2,2',3,3',4,5,5',6
105	2,3,3',4,4'	199	2,2',3,3',4,5,6,6'
110	2,3,3',4',6	201	2,2',3,3',4,5,5',6'
118	2,3',4,4',5	203	2,2',3,4,4',5,5',6
126	3,3',4,4',5	205	2,3,3',4,4',5,5',6
			NONACHLOROBIPHENYLS
		206	2,2',3,3',4,4',5,5',6

BZ# = identification numbers adopted by the International Union of Pure and Applied Chemists (IUPAC).

RESULTS AND DISCUSSION

The following discussion includes between-site comparisons of results for total PCB, mercury, total DDT, and dioxin TEQ. Elevated levels of PCBs, mercury, or both have led to the need for consumption advisories for fish taken from the SMR-AOC since the mid- to late-1980s. While DDT and dioxin TEQ have not caused advisories for SMR-AOC fish, both contaminants are either known or likely to be present in concentrations high enough to cause advisories under the revised MDCH advisory protocol due to be in place in 2014.

The within-species length ranges and mean lengths were equivalent across sampling sites for carp, pumpkinseed, rock bass, smallmouth bass, and yellow perch (Appendix B). The length ranges of redhorse sucker and walleye from SMR-AOC were different than the length ranges of those species from Little Bay De Noc, and the mean lengths of SMR-AOC samples were significantly less than the means of those species from Little Bay De Noc. Between-site comparisons using the latter two species were made but should not be the basis for decisions since the length differences may bias the evaluations.

PCBs

Total PCB was quantified in all 29 carp and 30 smallmouth bass samples collected in 2012 from the three sampling sites. No quantifiable PCB was measured in the pumpkinseed, rock bass, or yellow perch collected from the SMR-AOC in 2012 (Table 4). Both the mean and 95% UCL of the mean total PCB concentration in all species collected from the SMR-AOC were equal to or less than the mean and 95% UCL measured in those species from both Les Cheneaux Islands and Little Bay De Noc (Table 5).

Table 4. Percentage of fish samples with quantifiable levels of PCB from the SMR-AOC and two reference sites in 2012.

Species	St. Marys River	Les Cheneaux Islands	Little Bay De Noc
Carp	100	100	100
Pumpkinseed	0	10	--
Redhorse Sucker	43	--	100
Rock Bass	0	30	50*
Smallmouth Bass	100	100	100
Walleye	88	--	100
Yellow Perch	0	40	--
All Species Combined	46	64	87

* - samples collected in 2008

The highest PCB concentrations were measured in carp, followed by walleye, redhorse sucker, and smallmouth bass, regardless of sampling site. Pumpkinseed, rock bass, and yellow perch from all sites had PCB concentrations at or near the quantification level. This pattern of relative concentrations between species is typical of other water bodies where these species coexist.

Total PCB concentrations in carp exhibited the greatest difference between sampling sites, although none of the differences were statistically significant. In addition, lipid normalized PCB concentrations in carp were not significantly different between sampling sites. There was no significant relationship between fish length and total PCB concentrations in carp from any of the three sampling sites in 2012 (Figure 2).

The projected consumption advice for carp based on the 95% UCL of the mean total PCB concentration is “Limited” for all three sampling sites (Table 5).

Table 5. The 95% UCL on the mean total PCB concentration and projected consumption advice based on those concentrations for fish collected from the St. Marys River AOC (SMR), the Les Cheneaux Islands (LCI) and Little Bay De Noc (LBDN) in 2012.

Species	95% UCL (ppm)			Meals per Month		
	SMR	LCI	LBDN	SMR	LCI	LBDN
Carp	0.64	1.88	2.06	Limited	Limited	Limited
Pumpkinseed	ND	0.004	--	16	16	--
Redhorse Sucker	0.01	--	0.08	16	--	2
Rock Bass	ND	0.001	0.003*	16	16	16*
Smallmouth Bass	0.01	0.01	0.01	16	16	16
Walleye	0.01	--	0.30	16	--	0.5
Yellow Perch	ND	0.002	--	16	16	--

ND – below quantification level; * - samples collected in 2008

There was no significant relationship between length and total PCB concentration in smallmouth bass at any of the three sampling sites, and the range of sizes collected at all sites was similar (Figure 3; Appendix B). The projected consumption advice for smallmouth bass based on the 95% UCL of the mean total PCB concentration is 16 meals per month for all three sampling sites (Table 5).

PCB concentrations in SMR-AOC redhorse sucker and walleye were both significantly lower than PCB concentrations in those species collected in Little Bay De Noc in 2012, however, samples of those species from Little Bay De Noc were larger than the fish from the SMR-AOC making a comparison difficult (Figures 4 and 5; Appendix B).

There would not be a consumption advisory due to PCBs for any species other than carp in the SMR-AOC or in Les Cheneaux Islands based on the 95% UCL of the mean total PCB concentration for all samples collected in 2012. PCBs would cause an advisory for redhorse sucker and walleye from Little Bay De Noc.

Data collected from the SMR-AOC for the Michigan FCMP temporal trend element indicate that total PCBs in walleye have declined at an average rate of over nine percent per year since that study began in 1991 (MDEQ, in draft). Estimated total PCB concentrations in whole walleye collected from the SMR-AOC between 1991 and 2010 are presented in Figure 6. Similar declines have been detected in at least one species from all nine other Great Lakes trend sampling sites. Figure 7 compares temporal trends in PCB concentrations in walleye from the SMR-AOC and Little Bay De Noc. Carp samples were also collected from the SMR-AOC for trend analysis, but no significant trend has been detected due to higher variation in PCB concentrations and between year differences in fish length and lipid content.

Mercury

Total mercury was quantified in all 154 fillet samples collected in 2012 from the SMR-AOC, Les Cheneaux Islands, and Little Bay De Noc, as well as in all 14 rock bass collected from Little Bay De Noc in 2008. The mean and 95% UCL of the mean total mercury concentration in carp, pumpkinseed, and smallmouth bass collected from the SMR-AOC was equal to or differed only slightly from those concentrations measured in the same species collected from Les Cheneaux Islands and Little Bay De Noc, such that the projected consumption advice based on those concentrations is the same across all three sampling sites (Table 6).

Fish length was not a factor between sites and there was no significant relationship between length and mercury concentrations for carp, pumpkinseed, or smallmouth bass (Figures 8, 9, and 10; Appendix B).

Table 6. The 95% UCL on the mean total mercury concentration and projected consumption advice based on those concentrations for fish collected from the St. Marys River AOC (SMR), the Les Cheneaux Islands (LCI) and Little Bay De Noc (LBDN) in 2012.

Species	95% UCL (ppm)			Meals per Month		
	SMR	LCI	LBDN	SMR	LCI	LBDN
Carp	0.36	0.3	0.38	2	2	2
Pumpkinseed	0.08	0.08	--	12	12	--
Redhorse Sucker	0.14	--	0.56	4	--	1
Rock Bass	0.26	0.12	0.11*	**4**	**8**	**8***
Smallmouth Bass	0.44	0.42	0.36	2	2	2
Walleye	0.43	--	0.56	2	--	1
Yellow Perch	0.18	0.11	--	**4**	**8**	--

* - samples collected in 2008

Redhorse sucker and walleye collected from the SMR-AOC had mean and 95% UCL of the mean total mercury concentrations lower than those concentrations measured in the same species collected from Little Bay De Noc in 2012; the difference was statistically significant for the redhorse sucker; however, samples of both walleye and redhorse sucker from Little Bay De Noc were larger than those from the SMR-AOC making comparisons difficult (Figures 11 and 12). The projected consumption advice for redhorse sucker and walleye from the SMR-AOC based on mercury concentrations is less restrictive than for Little Bay De Noc (Table 6).

In contrast, both the mean and 95% UCL of the mean total mercury in both rock bass and yellow perch from the SMR-AOC were higher than those concentrations measured in Les Cheneaux Islands and Little Bay De Noc; the differences were statistically significant and fish length was not a factor (Figures 13 and 14). The projected consumption advice for the two species is more restrictive for the SMR-AOC than Les Cheneaux Islands, and Little Bay De Noc in the case of rock bass, and Les Cheneaux Islands in the case of yellow perch (projected meals in bold in Table 6).

No significant temporal trend in mercury concentrations has been detected in either walleye or carp collected from the SMR-AOC since 1991 (MDEQ; in draft). Estimated mercury concentrations in whole walleye collected from the SMR-AOC between 1991 and 2010 are presented in Figure 15; that graph suggests that mercury concentrations have not changed over the sampling period. Statistical analysis indicates that mercury concentrations could be either increasing or decreasing at a rate of up to 1.5 percent per year. Mercury concentrations at the other Great Lakes trend sites are tending to increase or remain the same over the sampling period (MDEQ; in draft).

DDT

Total DDT was quantified in all 29 carp collected in 2012 from the three sampling sites. No quantifiable DDT was measured in rock bass or yellow perch from the SMR-AOC, or in pumpkinseed from either the SMR-AOC or Les Cheneaux Islands (Table 7). While DDT was quantified in redhorse sucker, smallmouth bass, and walleye from the SMR-AOC, the rate of detection was consistently higher in both Les Cheneaux Islands and Little Bay De Noc than in samples from the SMR-AOC.

Table 7. Percentage of fish samples with quantifiable levels of total DDT from the SMR-AOC and two reference sites in 2012.

Species	St. Marys River	Les Cheneaux	Little Bay De Noc
Carp	100	100	100
Pumpkinseed	0	0	--
Redhorse Sucker	14	--	100
Rock Bass	0	10	7*
Smallmouth Bass	10	90	100
Walleye	50	--	100
Yellow Perch	0	20	--
All Species Combined	24	44	75

* - samples collected in 2008

As with total PCB, concentrations of total DDT were consistently higher in carp than in other species regardless of sampling site. Total DDT concentrations measured in the other species tended to be near the quantification limit of 0.001 part per million (ppm).

Total DDT concentrations in fish collected from the SMR-AOC were consistently lower than those measured in the same species from both Les Cheneaux Islands and Little Bay De Noc (Table 8). Based on the 95% UCL of the mean DDT concentrations the contaminant would not cause consumption advisories for any species at any of the three sampling sites, with the exception of carp. Based on the 95% UCL the projected consumption advice for carp from the SMR-AOC is less restrictive than the advice for carp from either Les Cheneaux Islands or Little Bay De Noc.

Table 8. The 95% UCL on the mean total DDT concentration and projected consumption advice based on those concentrations for fish collected from the St. Marys River AOC (SMR), the Les Cheneaux Islands (LCI), and Little Bay De Noc (LBDN) in 2012.

Species	95% UCL (ppm)			Meals per Month		
	SMR	LCI	LBDN	SMR	LCI	LBDN
Carp	0.14	0.42	0.28	12	4	4
Pumpkinseed	ND	ND	--	16	16	--
Redhorse Sucker	0.002	--	0.03	16	--	16
Rock Bass	ND	ND	0.001*	16	16	16*
Smallmouth Bass	0.001	0.003	0.004	16	16	16
Walleye	0.003	--	0.06	16	--	16
Yellow Perch	ND	ND	--	16	16	--

ND – below quantification level; * - samples collected in 2008

Dioxin TEQ

Quantifiable concentrations of 2,3,7,8 TCDD TEQ were measured in all carp collected from all three sampling sites in 2012. Dioxin analysis was not conducted on samples of any other species from the SMR-AOC, Les Cheneaux Islands, or Little Bay De Noc collected in 2012.

The mean and 95% UCL of the mean dioxin TEQ concentration in carp from the SMR-AOC was lower than those concentrations measured in both Les Cheneaux Islands and Little Bay De Noc;

however, the projected consumption advice based on dioxin TEQ is the same for all three sampling sites (Table 9).

Table 9. The 95% UCL on the mean total 2,3,7,8 TCDD TEQ concentration and projected consumption advice based on those concentrations for carp collected from the St. Marys River AOC (SMR), the Les Cheneaux Islands (LCI), and Little Bay De Noc (LBDN) in 2012.

95% UCL (ppt)			Meals per Month		
SMR	LCI	LBDN	SMR	LCI	LBDN
24.9	83.9	35.8	Limited	Limited	Limited

SYNOPSIS

Mean concentrations and 95% UCL of the mean concentrations of total PCB, total DDT, and dioxin TEQ in fish collected from the SMR-AOC were consistently less than or equal to those concentrations measured in the same species collected from both Les Cheneaux Islands and Little Bay De Noc. In addition, the projected MDCH fish consumption advice based on those contaminants for those species collected from the SMR-AOC is consistently the same or less restrictive than the projected advice for fish from the two reference sites. Lastly, whole fish trend data indicates that PCB concentrations in walleye from the SMR-AOC are lower than in walleye from Little Bay De Noc and have been declining at a rate similar to fish from other trend sites.

Mean concentrations and 95% UCL of the mean concentrations of total mercury in carp, pumpkinseed, and smallmouth bass collected from the SMR-AOC were less than or equivalent to those concentrations in the same three species from Les Cheneaux Islands or Little Bay De Noc. The projected consumption advice based on mercury for those species for the SMR-AOC is the same as the projected advice for Les Cheneaux Islands and Little Bay De Noc.

Total mercury concentrations in redhorse sucker and walleye from the SMR-AOC were less than the concentrations in those species collected from Little Bay De Noc. However, the samples of both species from the SMR were generally smaller than the samples from Little Bay De Noc and this probably biased the comparison.

Mean concentrations and 95% UCL of the mean concentrations of total mercury in rock bass were higher in the fish from the SMR-AOC compared to both Les Cheneaux Islands and Little Bay De Noc; the projected consumption advice based on those concentrations is higher for SMR-AOC rock bass compared to rock bass from the two reference sites. Mercury concentrations in yellow perch were higher in the SMR-AOC samples compared to Les Cheneaux Islands and the projected consumption advice based on those concentrations is more restrictive for yellow perch from the SMR-AOC than for those from Les Cheneaux Islands.

It is important to note that smallmouth bass, rock bass, and pumpkinseed have good site fidelity relative to the other species sampled. As such, those three species provide the best measure of conditions at the respective sampling sites.

The MDCH issues consumption guidance based on the contaminant(s) causing the most restrictive advice. In this evaluation total PCBs and dioxin TEQ concentrations each lead to a "Limited" advisory for carp at all three sampling sites (Table 10). Mercury would cause the most restrictive consumption advice for all other species/location combinations except for walleye from Little Bay De Noc where PCBs would drive the advice.

Table 10. Projected consumption advice based on samples collected in 2012 and contaminant causing the advice for fish collected from the St. Marys River AOC (SMR), the Les Cheneaux Islands (LCI), and Little Bay De Noc (LBDN). Species with more restrictive projected advice for SMR are highlighted.

Species		Sampling Site		
		SMR	LCI	LBDN
Carp	Meals/Month	Limited	Limited	Limited
	Cause	PCBs & TEQ	PCBs & TEQ	PCBs & TEQ
Pumpkinseed	Meals/Month	12	12	--
	Cause	Mercury	Mercury	--
Redhorse Sucker*	Meals/Month	4	--	1
	Cause	Mercury	--	Mercury
Rock Bass	Meals/Month	4	8	8
	Cause	Mercury	Mercury	Mercury
Smallmouth Bass	Meals/Month	2	2	2
	Cause	Mercury	Mercury	Mercury
Walleye*	Meals/Month	2	--	1
	Cause	Mercury	--	PCBs
Yellow Perch	Meals/Month	4	8	--
	Cause	Mercury	Mercury	--

* - between-site length ranges were not comparable.

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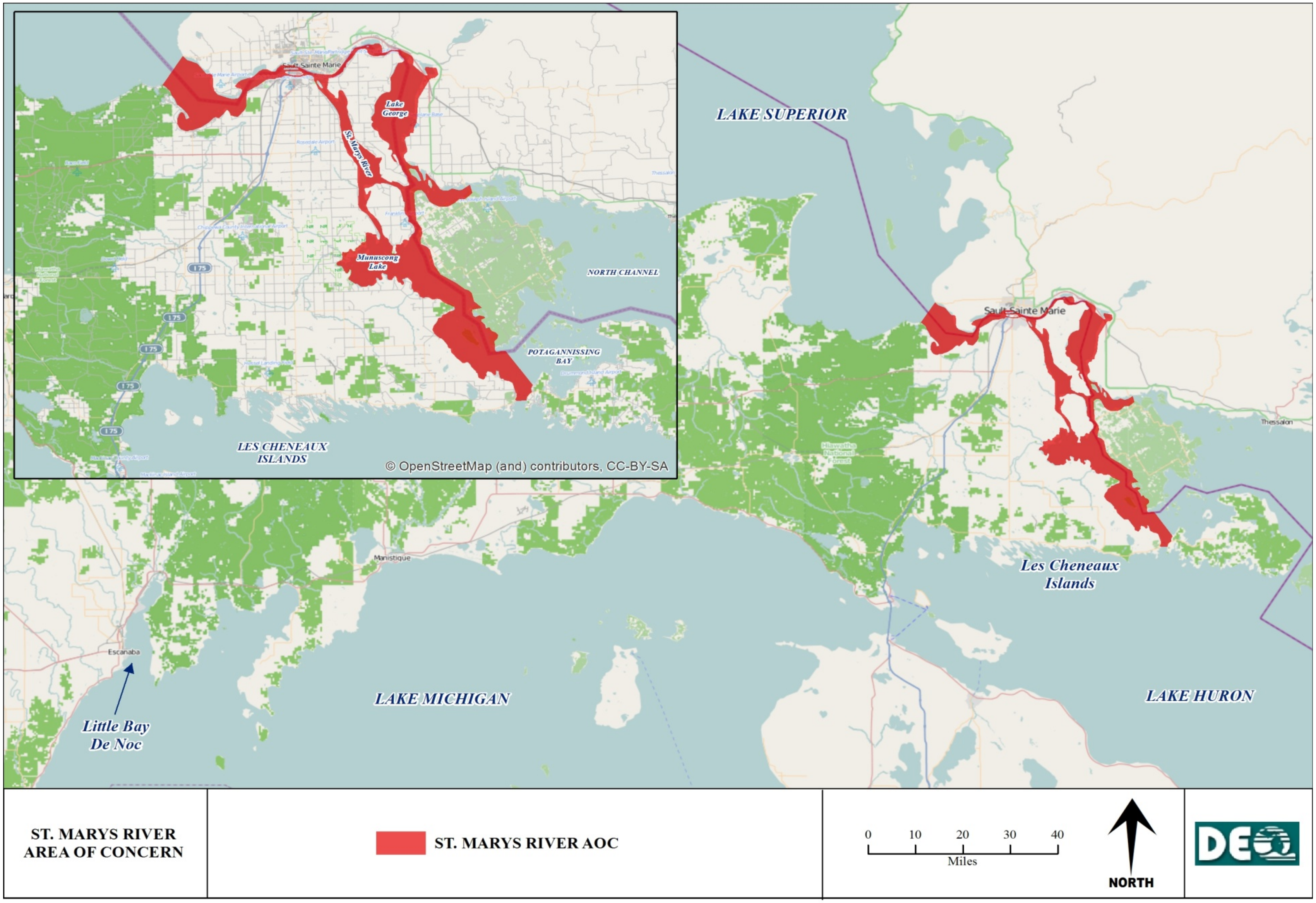

Figure 1. Map of St. Marys River Area of Concern showing location of the Les Cheneaux Island and Little Bay De Noc reference collection sites.

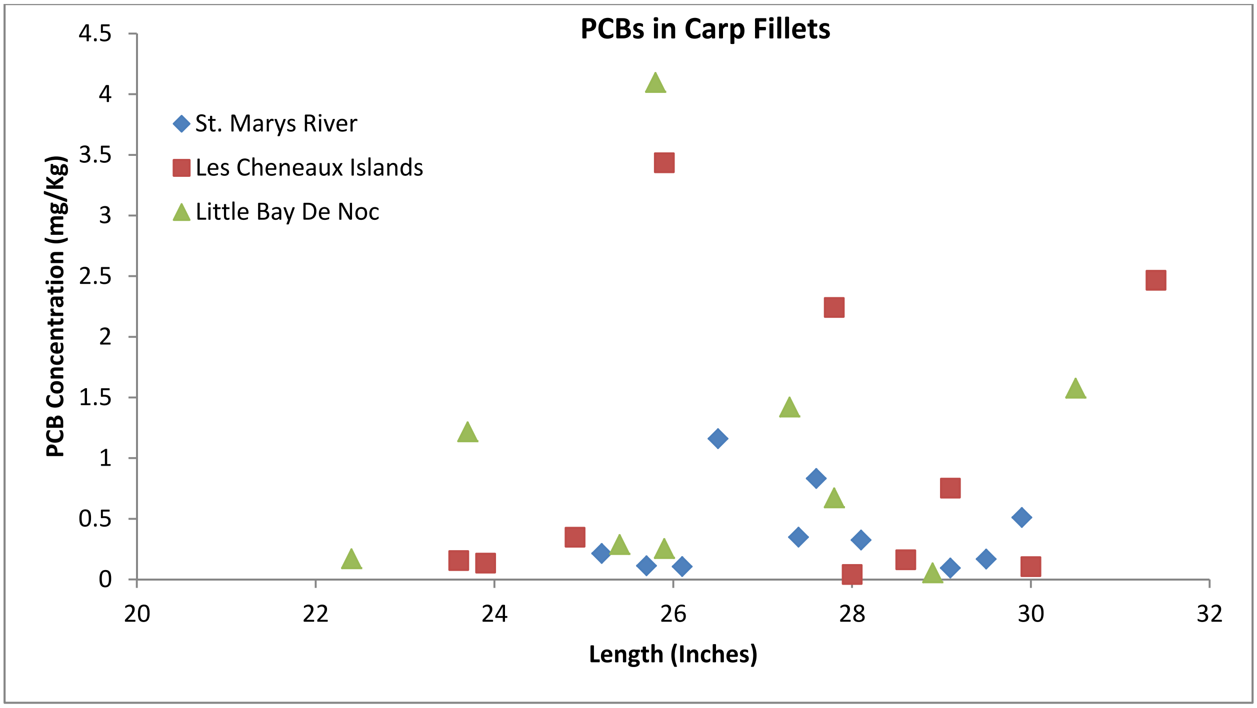

Figure 2. Length versus total PCB concentration in carp collected from the St. Marys River, Les Cheneaux Islands, and Little Bay De Noc in 2012.

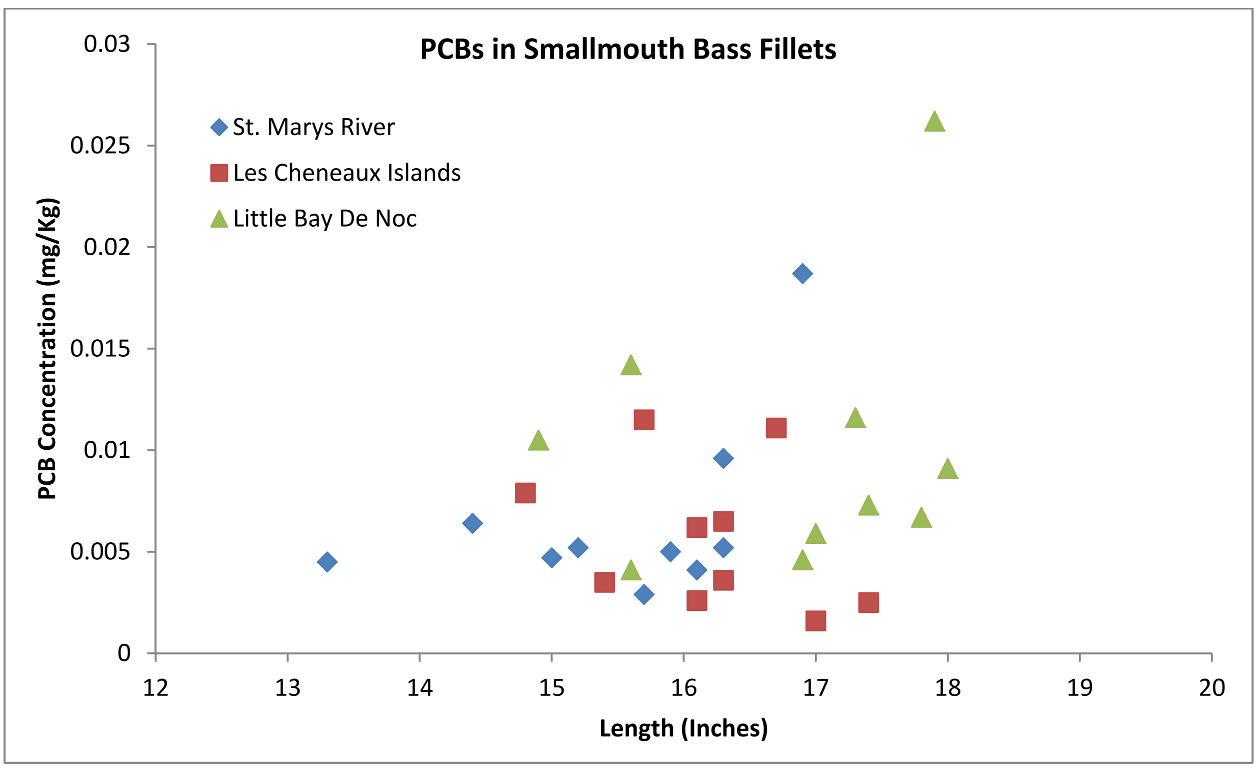

Figure 3. Length versus total PCB concentration in smallmouth bass collected from the St. Marys River, Les Cheneaux Islands, and Little Bay De Noc in 2012.

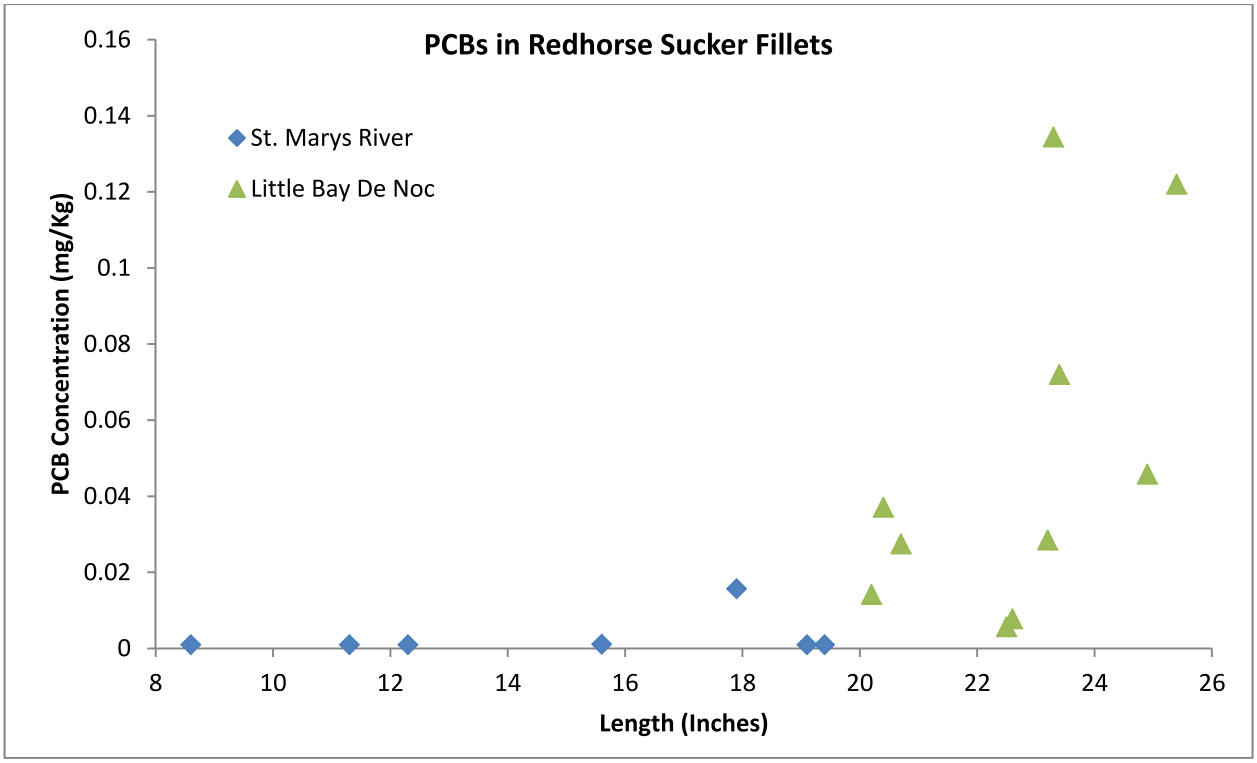

Figure 4. Length versus total PCB concentration in redhorse sucker collected from the St. Marys River and Little Bay De Noc in 2012.

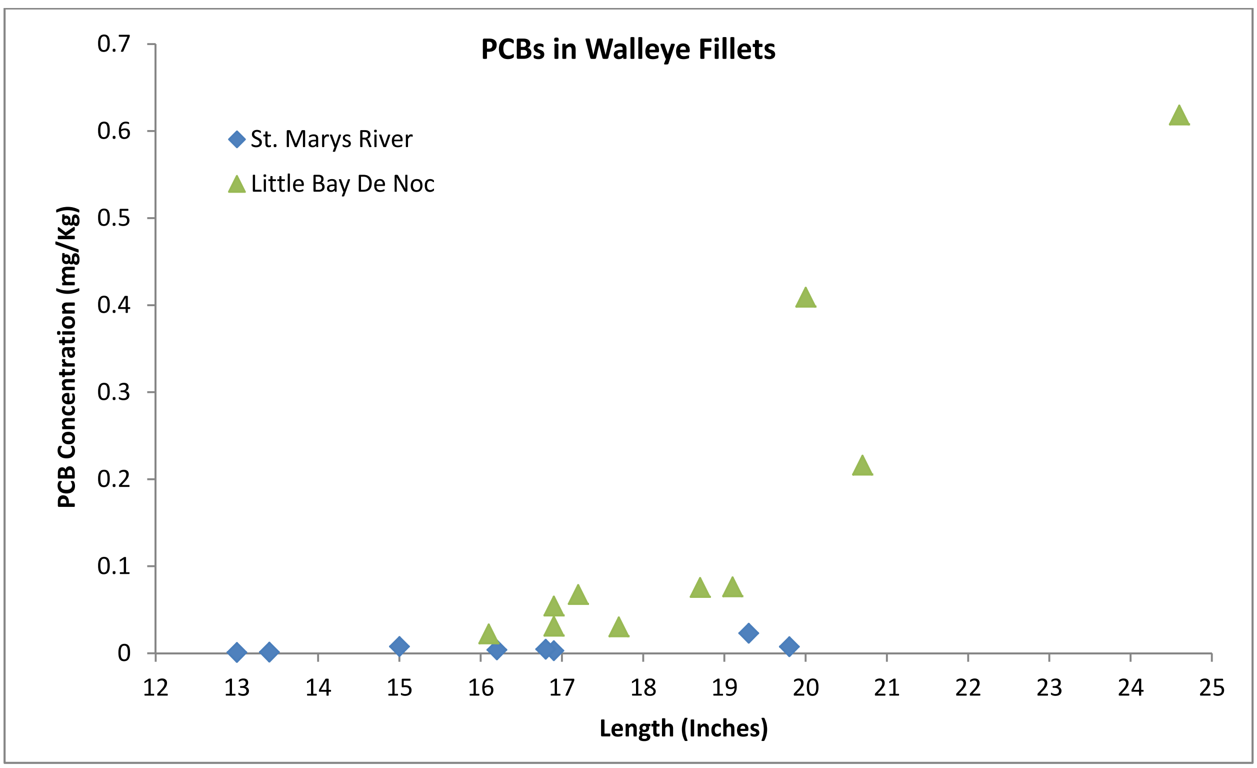

Figure 5. Length versus total PCB concentration in walleye collected from the St. Marys River and Little Bay De Noc in 2012.

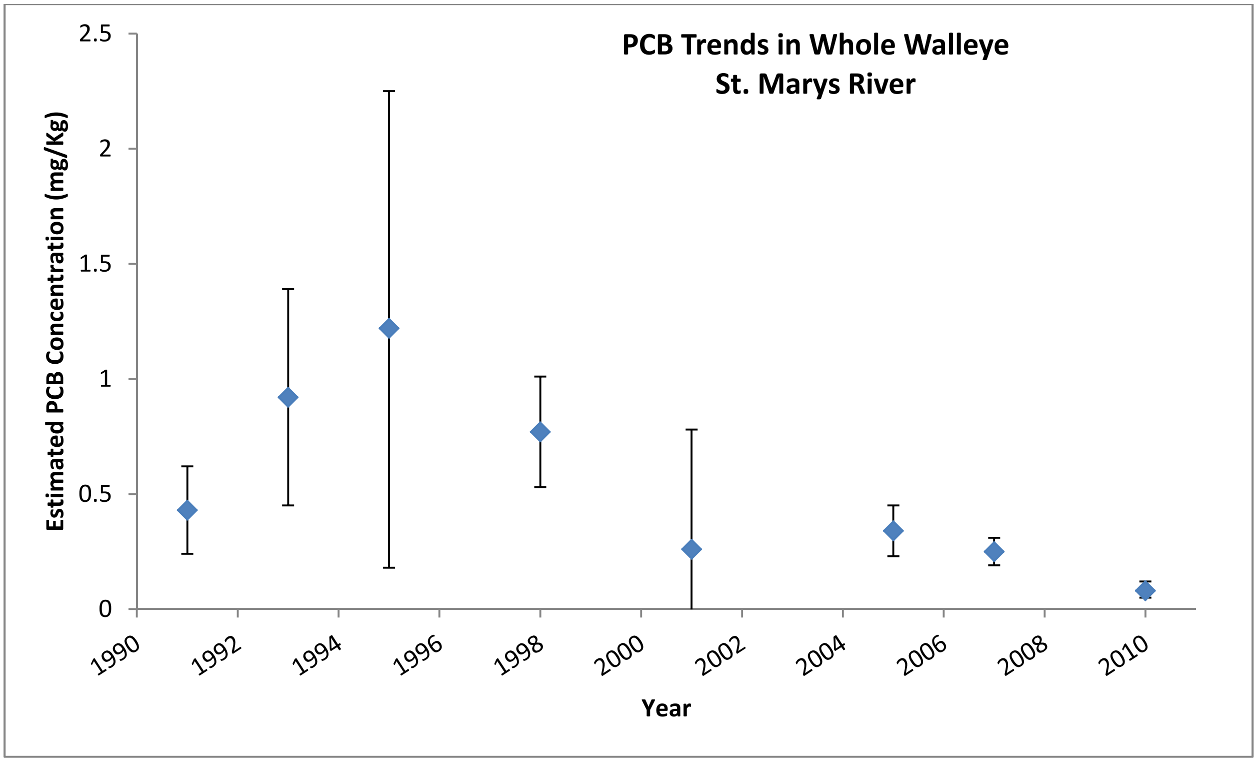

Figure 6. Estimated total PCB concentrations in whole 20-inch walleye collected from the St. Marys River between 1991 and 2010. Error bars represent the 95 percent confidence limit on the estimated concentration.

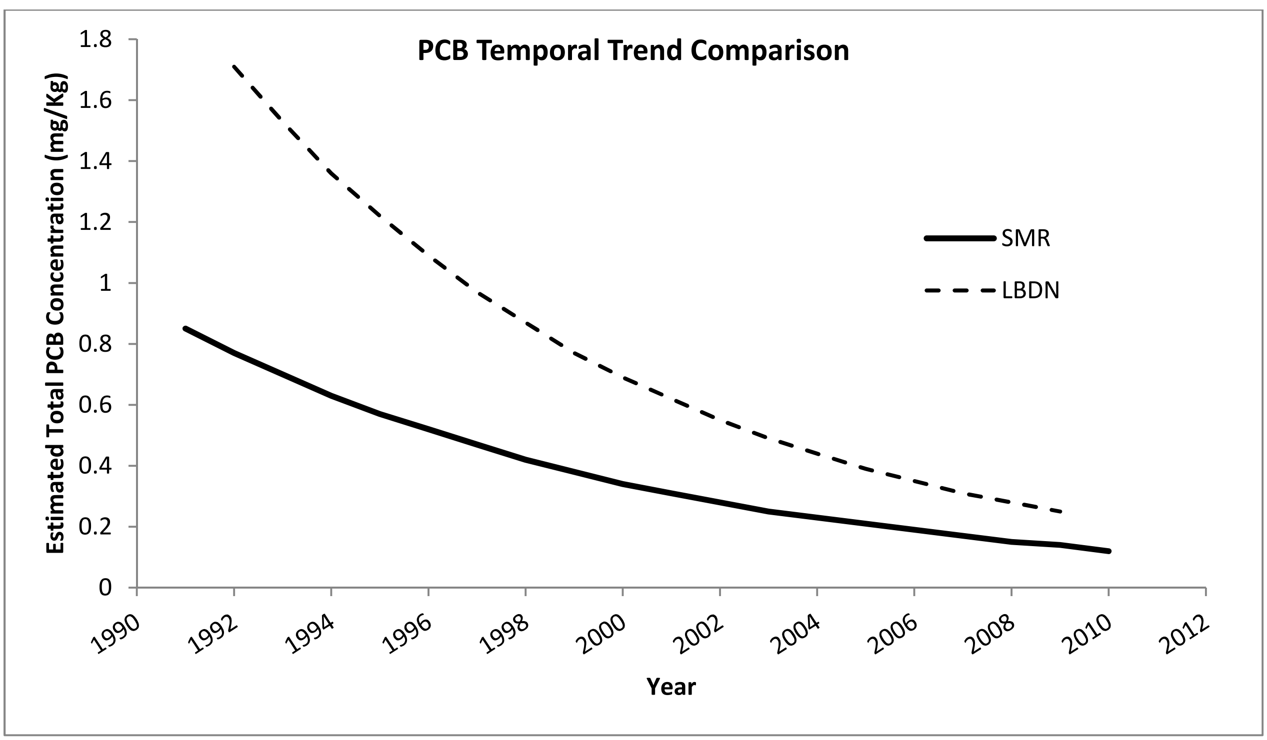

Figure 7. Estimated total PCB concentrations in whole 20-inch walleye collected from the St. Marys River (SMR) and Little Bay De Noc (LBDN) between 1991 and 2010.

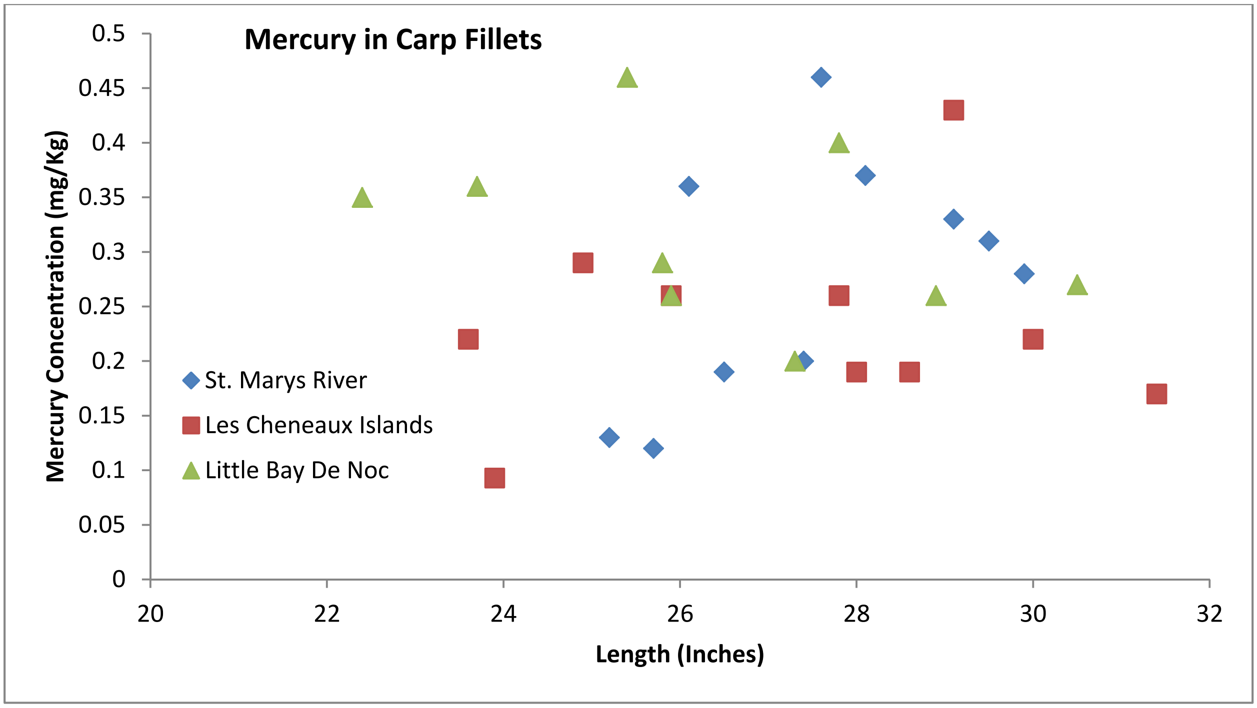

Figure 8. Length versus total mercury concentration in carp collected from the St. Marys River, Les Cheneaux Islands, and Little Bay De Noc in 2012.

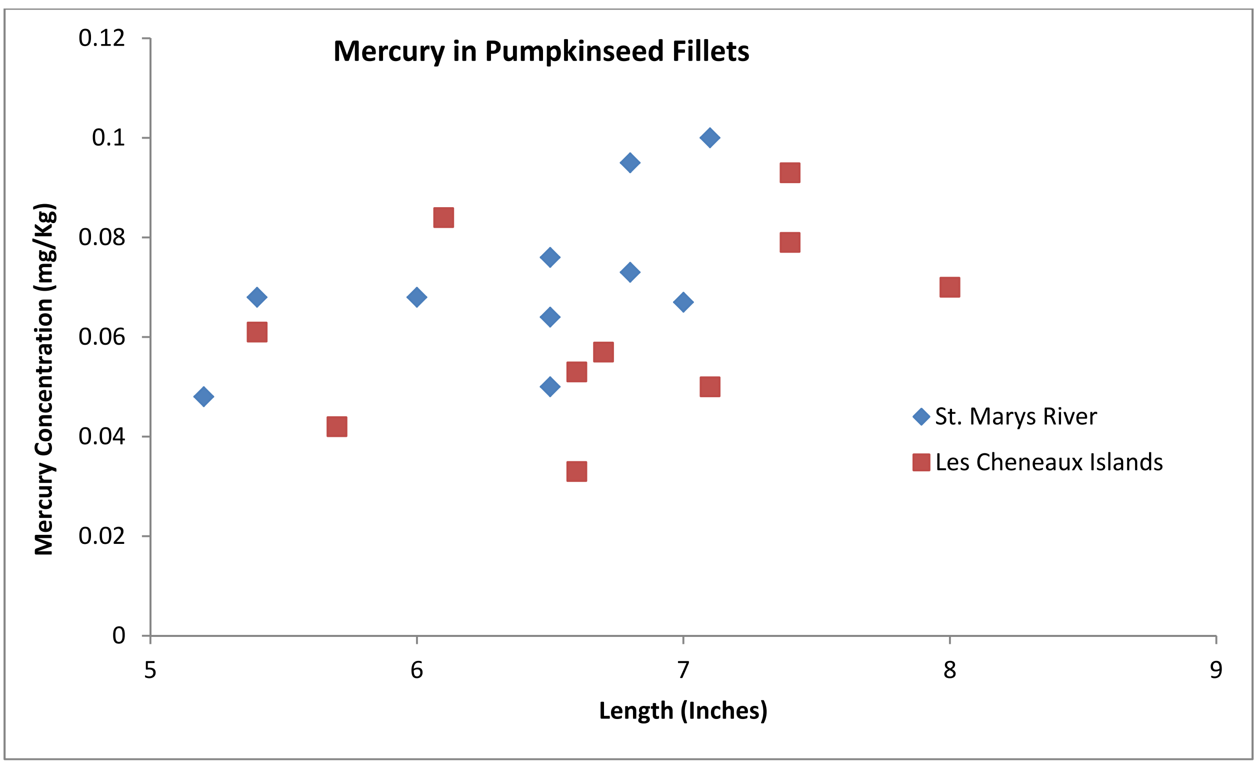

Figure 9. Length versus total mercury concentration in pumpkinseed collected from the St. Marys River and Les Cheneaux Islands in 2012.

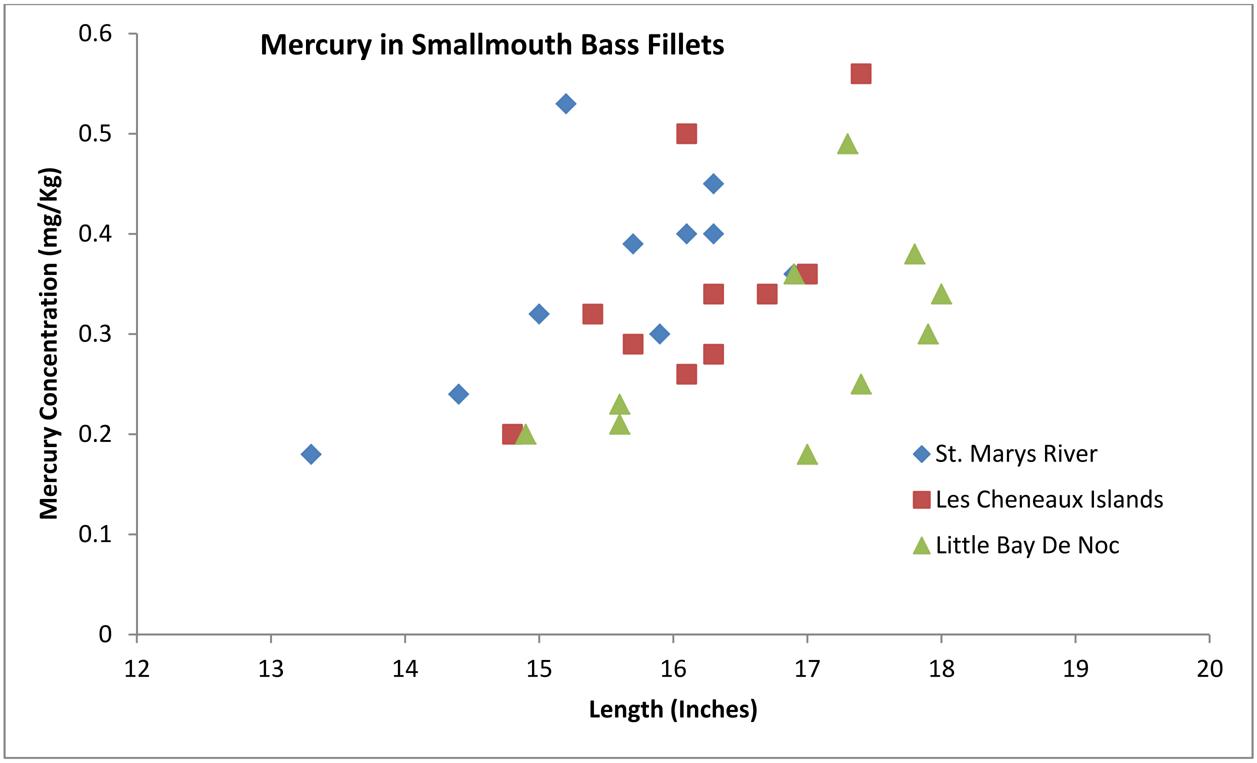

Figure 10. Length versus total mercury concentration in smallmouth bass collected from the St. Marys River, Les Cheneaux Islands, and Little Bay De Noc in 2012.

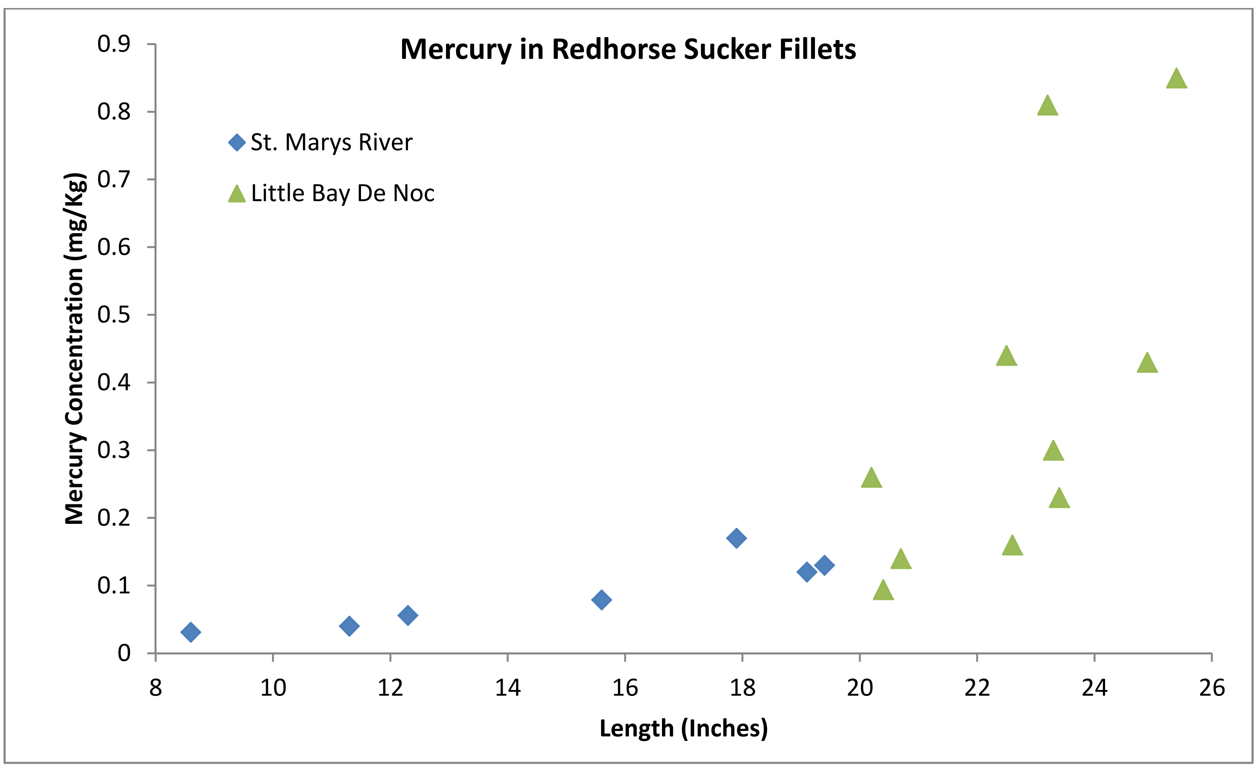

Figure 11. Length versus total mercury concentration in redhorse sucker collected from the St. Marys River and Little Bay De Noc in 2012.

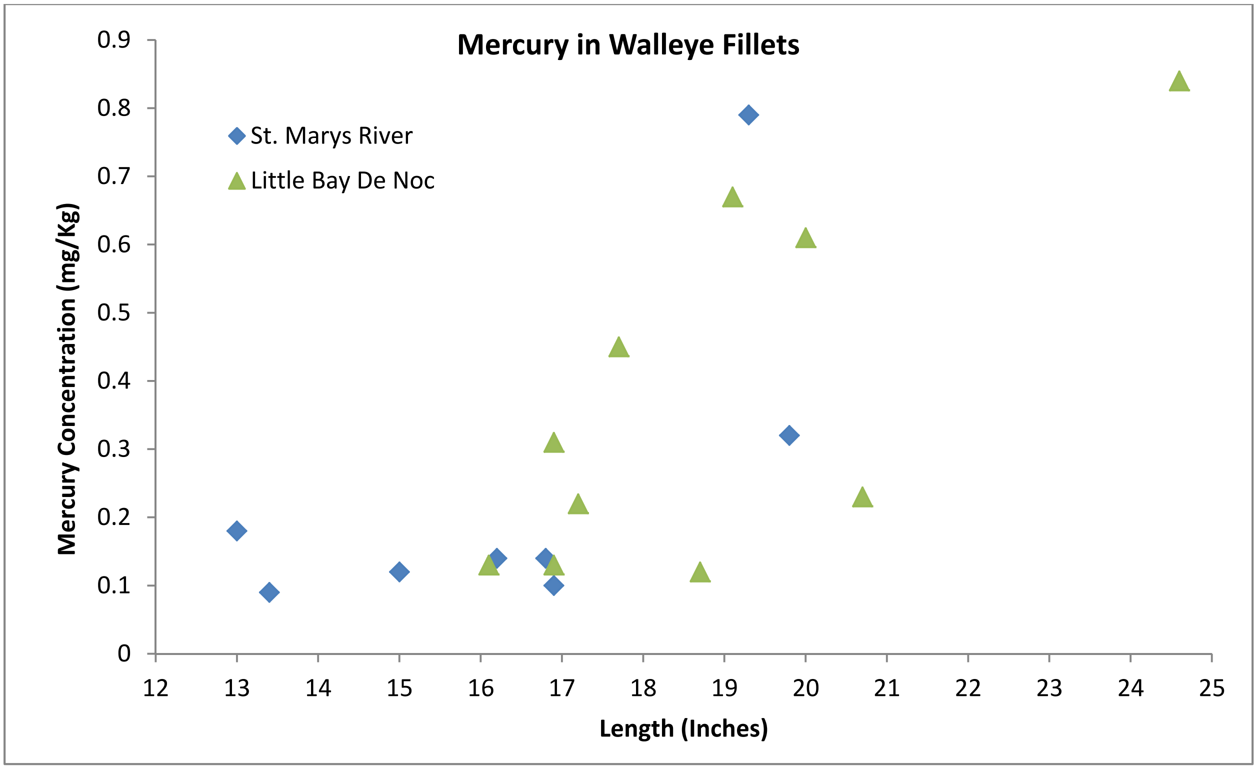

Figure 12. Length versus total mercury concentration in walleye collected from the St. Marys River and Little Bay De Noc in 2012.

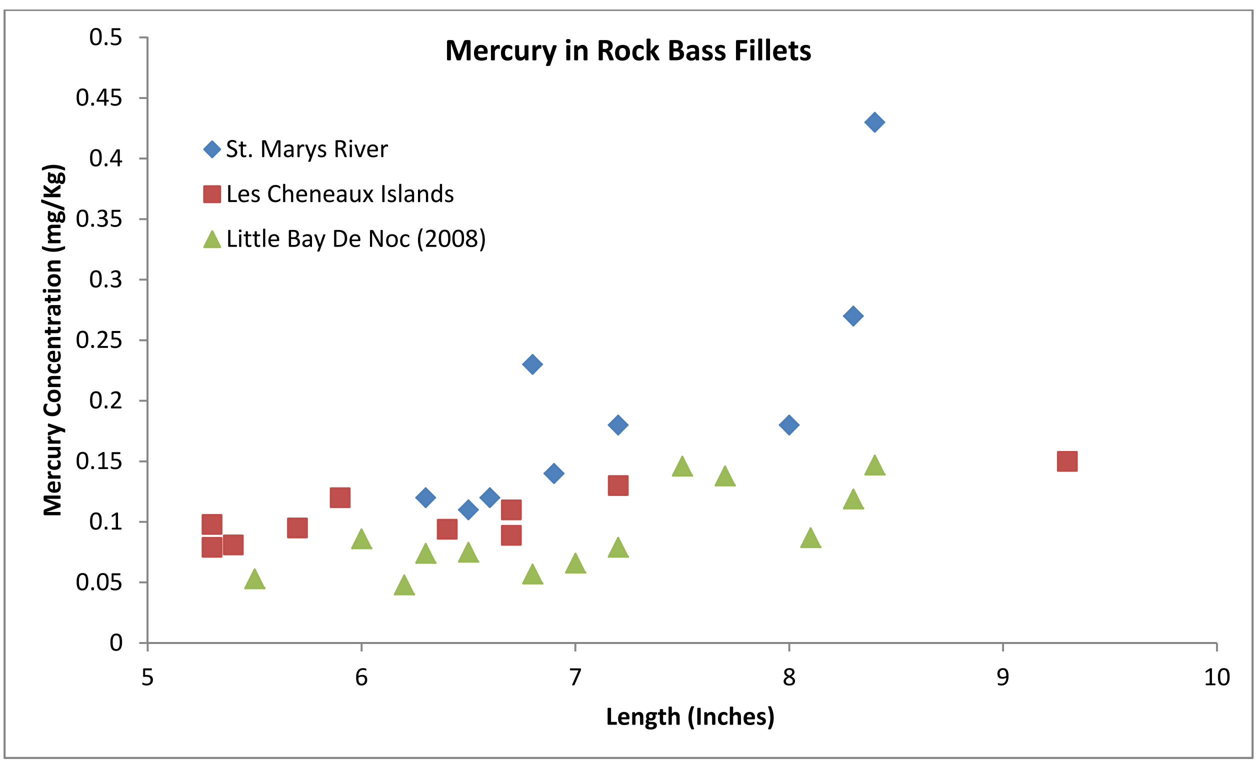

Figure 13. Length versus total mercury concentration in rock bass collected from the St. Marys River and Les Cheneaux Islands in 2012, and Little Bay De Noc in 2008.

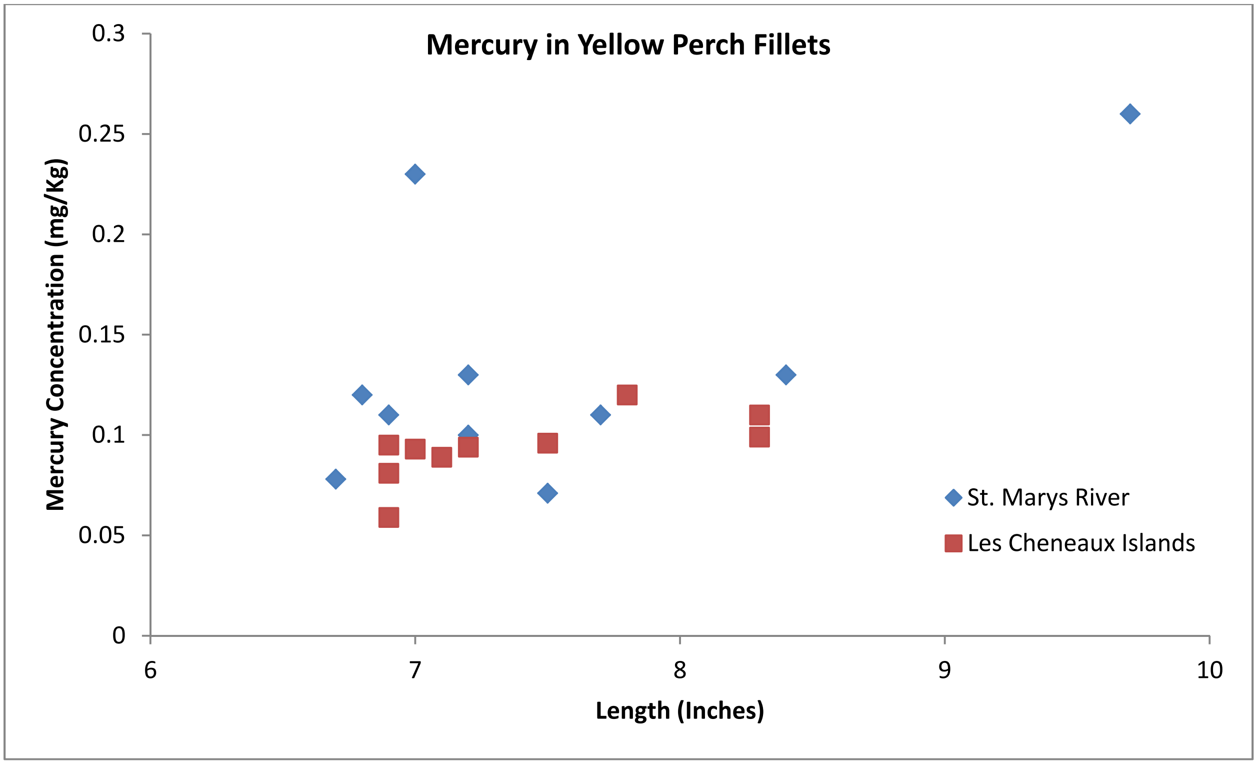

Figure 14. Length versus total mercury concentration in yellow perch collected from the St. Marys River and Les Cheneaux Islands in 2012.

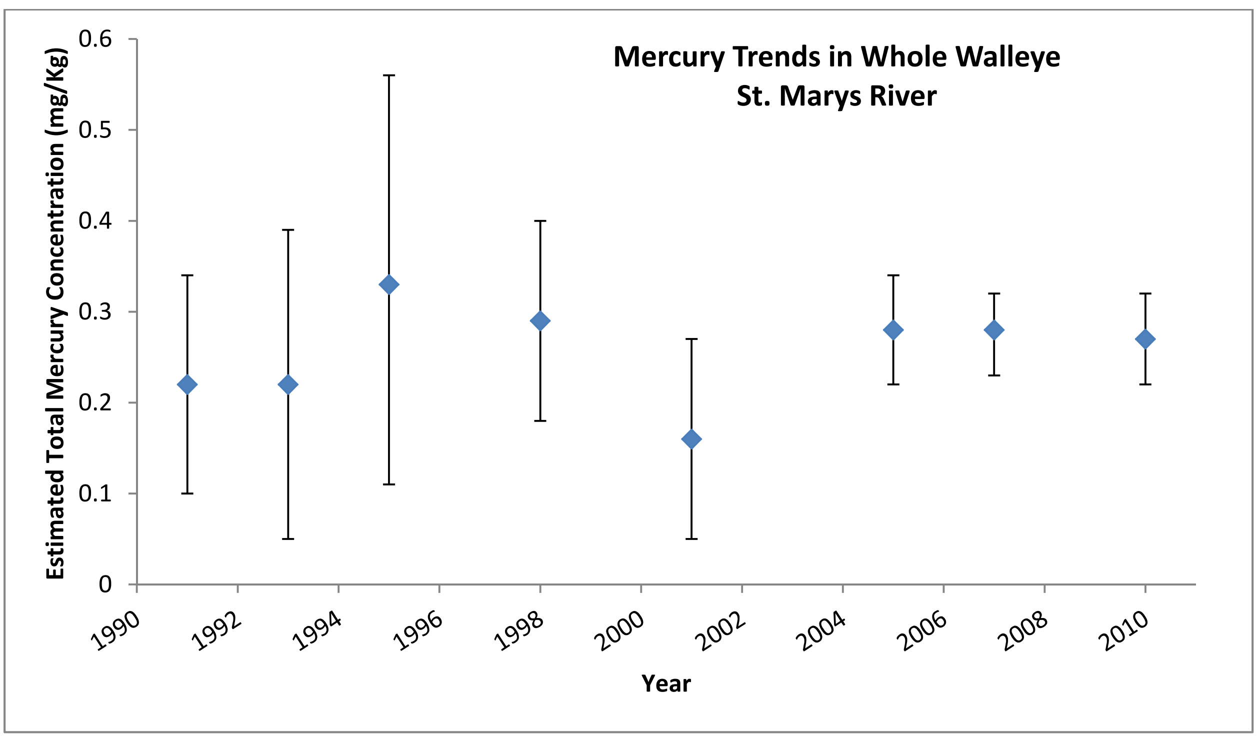

Figure 15. Estimated total mercury concentrations in whole 20-inch walleye collected from the St. Marys River between 1991 and 2010. Error bars represent the 95 percent confidence limit on the estimated concentration.

Appendix A. Concentrations of key contaminants in carp, pumpkinseed, redhorse sucker, rock bass, smallmouth bass, walleye, and yellow perch collected from the St. Marys River, Les Cheneaux Islands, and Little Bay De Noc in 2012.

Visit ID	Sample ID#	Water Body Name	Location	Collection Date	Species	Length (In)	Lipid (%)	Mercury (ppm)	Hg Code	Total PCB (ppm)	PCB Code	Total DDT (ppm)	DDT Code	TEQ (ppt)
2012215	2012215-S71	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	23.6	1.02	0.22		0.1566		0.037		8.65
2012215	2012215-S72	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	23.9	5.78	0.093		0.1355		0.139		6.68
2012215	2012215-S73	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	24.9	11.61	0.29		0.3489		0.071		
2012215	2012215-S74	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	25.9	9.76	0.26		3.4356		0.878		186.93
2012215	2012215-S75	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	27.8	6.36	0.26		2.2426		0.61		64.74
2012215	2012215-S76	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	28.6	1.33	0.19		0.1632		0.024		6.72
2012215	2012215-S77	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	28	2.39	0.19		0.0416		0.011		3.76
2012215	2012215-S78	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	29.1	2.76	0.43		0.7529		0.146		35.92
2012215	2012215-S79	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	30	1.22	0.22		0.1065		0.024		8.68
2012215	2012215-S80	Lake Huron	Les Cheneaux Islands	17-May-12	Carp	31.4	12.27	0.17		2.4664	J	0.146		24.65
2012215	2012215-S11	Lake Huron	Les Cheneaux Islands	17-May-12	Pumpkinseed	5.4	0.38	0.061		0.001	K	0.001	K	
2012215	2012215-S12	Lake Huron	Les Cheneaux Islands	17-May-12	Pumpkinseed	5.7	0.32	0.042		0.001	K	0.001	K	
2012215	2012215-S13	Lake Huron	Les Cheneaux Islands	17-May-12	Pumpkinseed	6.1	0.27	0.084		0.001	K	0.001	K	
2012215	2012215-S14	Lake Huron	Les Cheneaux Islands	17-May-12	Pumpkinseed	6.6	0.39	0.053		0.0114		0.001	K	
2012215	2012215-S15	Lake Huron	Les Cheneaux Islands	17-May-12	Pumpkinseed	6.6	0.18	0.033		0.001	K	0.001	K	
2012215	2012215-S16	Lake Huron	Les Cheneaux Islands	17-May-12	Pumpkinseed	6.7	0.18	0.057		0.001	K	0.001	K	
2012215	2012215-S17	Lake Huron	Les Cheneaux Islands	17-May-12	Pumpkinseed	7.4	0.18	0.093		0.001	K	0.001	K	
2012215	2012215-S18	Lake Huron	Les Cheneaux Islands	17-May-12	Pumpkinseed	7.4	0.2	0.079		0.001	K	0.001	K	
2012215	2012215-S19	Lake Huron	Les Cheneaux Islands	17-May-12	Pumpkinseed	7.1	0.19	0.05		0.001	K	0.001	K	
2012215	2012215-S20	Lake Huron	Les Cheneaux Islands	17-May-12	Pumpkinseed	8	0.18	0.07		0.001	K	0.001	K	
2012215	2012215-S21	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	5.3	0.33	0.098		0.0011		0.001		
2012215	2012215-S22	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	5.3	0.27	0.079		0.001		0.001	K	
2012215	2012215-S23	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	5.4	0.3	0.081		0.001	K	0.001	K	
2012215	2012215-S25	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	5.9	0.21	0.12		0.001	K	0.001	K	
2012215	2012215-S26	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	5.7	0.27	0.095		0.001	K	0.001	K	
2012215	2012215-S32	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	6.4	0.25	0.094		0.001	K	0.001	K	
2012215	2012215-S34	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	7.2	0.25	0.13		0.0011		0.001	K	
2012215	2012215-S35	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	6.7	0.49	0.11		0.001	K	0.001	K	
2012215	2012215-S36	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	6.7	0.27	0.089		0.001	K	0.001	K	
2012215	2012215-S37	Lake Huron	Les Cheneaux Islands	17-May-12	Rock Bass	9.3	0.15	0.15		0.001	K	0.001	K	
2012215	2012215-S41	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	14.8	0.37	0.2		0.0079		0.002		
2012215	2012215-S42	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	16.1	0.13	0.26		0.0026		0.001		
2012215	2012215-S43	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	15.4	0.13	0.32		0.0035		0.001		
2012215	2012215-S44	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	15.7	0.77	0.29		0.0115		0.003		
2012215	2012215-S45	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	16.7	0.41	0.34		0.0111		0.004		
2012215	2012215-S46	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	16.3	0.26	0.34		0.0065		0.002		
2012215	2012215-S47	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	16.3	0.32	0.28		0.0036		0.002		
2012215	2012215-S48	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	17	0.21	0.36		0.0016		0.001	K	
2012215	2012215-S49	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	16.1	0.2	0.5		0.0062		0.002		
2012215	2012215-S50	Lake Huron	Les Cheneaux Islands	17-May-12	Smallmouth Bass	17.4	0.18	0.56		0.0025		0.001		
2012215	2012215-S01	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	6.9	0.14	0.095		0.001	K	0.001	K	
2012215	2012215-S02	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	7.1	0.14	0.089		0.0011		0.001	K	
2012215	2012215-S03	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	6.9	0.16	0.059		0.001	K	0.001	K	
2012215	2012215-S04	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	7.2	0.17	0.094		0.001	K	0.001	K	
2012215	2012215-S05	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	7	0.22	0.093		0.001	K	0.001	K	
2012215	2012215-S06	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	6.9	0.23	0.081		0.0016	J	0.001		

Visit ID	Sample ID#	Water Body Name	Location	Collection Date	Species	Length (In)	Lipid (%)	Mercury (ppm)	Hg Code	Total PCB (ppm)	PCB Code	Total DDT (ppm)	DDT Code	TEQ (ppt)
2012215	2012215-S07	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	7.5	0.18	0.096		0.001	K	0.001	K	
2012215	2012215-S08	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	7.8	0.23	0.12		0.0027		0.001		
2012215	2012215-S09	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	8.3	0.33	0.099		0.001		0.001	K	
2012215	2012215-S10	Lake Huron	Les Cheneaux Islands	17-May-12	Yellow Perch	8.3	0.24	0.11		0.001	K	0.001	K	
2012217	2012217-S31	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	22.4	1.25	0.35		0.1707	J	0.036		4.69
2012217	2012217-S32	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	23.7	16.79	0.36		1.2175	J	0.458		46.64
2012217	2012217-S33	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	25.8	5.34	0.29		4.0968	J	0.087		40.52
2012217	2012217-S34	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	25.4	2.34	0.46		0.2885	J	0.059		7.93
2012217	2012217-S35	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	25.9	2.32	0.26		0.2554	J	0.061		6.27
2012217	2012217-S36	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	27.3	11.64	0.2		1.4218	J	0.112		30.71
2012217	2012217-S37	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	27.8	1.43	0.4		0.6725	J	0.299		29.86
2012217	2012217-S38	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	30.5	18.77	0.27		1.5777		0.291		33.97
2012217	2012217-S39	Lake Michigan	Little Bay De Noc	09-Apr-12	Carp	28.9	2.06	0.26		0.0545		0.016		4.61
2012217	2012217-S21	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	20.4	1.96	0.094		0.0371	J	0.05		
2012217	2012217-S22	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	20.2	1.94	0.26		0.0142	J	0.004		
2012217	2012217-S23	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	20.7	1.12	0.14		0.0275	J	0.009		
2012217	2012217-S24	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	22.5	0.42	0.44		0.0057	J	0.002		
2012217	2012217-S25	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	23.4	1.41	0.23		0.072	J	0.016		
2012217	2012217-S26	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	23.2	0.31	0.81		0.0285	J	0.007		
2012217	2012217-S27	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	24.9	0.84	0.43		0.0458	J	0.011		
2012217	2012217-S28	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	22.6	0.46	0.16		0.0078		0.004		
2012217	2012217-S29	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	23.3	1.96	0.3		0.1344	J	0.029		
2012217	2012217-S30	Lake Michigan	Little Bay De Noc	09-Apr-12	Redhorse Sucker	25.4	1.31	0.85		0.122	J	0.026		
2008232	2008232-S01	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	4.5	0.1	0.049		0.001	K	0.001	K	
2008232	2008232-S02	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	5.5	0.2	0.053		0.001	K	0.001	K	
2008232	2008232-S03	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	6	0.2	0.086		0.001	K	0.001	K	
2008232	2008232-S04	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	6.2	0.5	0.048		0.001		0.001	K	
2008232	2008232-S05	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	6.3	0.2	0.074		0.001	K	0.001	K	
2008232	2008232-S06	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	6.5	0.5	0.075		0.004		0.001	K	
2008232	2008232-S07	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	6.8	0.5	0.057		0.002		0.002		
2008232	2008232-S08	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	7	0.7	0.066		0.002		0.001	K	
2008232	2008232-S09	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	7.2	0.6	0.079		0.009		0.001	K	
2008232	2008232-S10	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	7.5	0.4	0.146		0.001	K	0.001	K	
2008232	2008232-S11	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	7.7	0.4	0.138		0.001	K	0.001	K	
2008232	2008232-S12	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	8.1	0.4	0.087		0.001		0.001	K	
2008232	2008232-S13	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	8.3	0.6	0.119		0.002		0.001	K	
2008232	2008232-S14	Lake Michigan	Little Bay De Noc	22-Apr-08	Rock Bass	8.4	0.2	0.147		0.001	K	0.001	K	
2012217	2012217-S11	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	14.9	0.41	0.2		0.0105		0.003		
2012217	2012217-S12	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	15.6	0.29	0.21		0.0041	J	0.001		
2012217	2012217-S13	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	15.6	0.56	0.23		0.0142	J	0.004		
2012217	2012217-S14	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	16.9	0.23	0.36		0.0046	J	0.001		
2012217	2012217-S15	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	17.3	0.41	0.49		0.0116		0.004		
2012217	2012217-S16	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	17.8	0.35	0.38		0.0067		0.002		
2012217	2012217-S17	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	17.4	0.23	0.25		0.0073		0.002		
2012217	2012217-S18	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	17	0.24	0.18		0.0059		0.001		
2012217	2012217-S19	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	17.9	0.36	0.3		0.0262		0.005		

Visit ID	Sample ID#	Water Body Name	Location	Collection Date	Species	Length (In)	Lipid (%)	Mercury (ppm)	Hg Code	Total PCB (ppm)	PCB Code	Total DDT (ppm)	DDT Code	TEQ (ppt)
2012217	2012217-S20	Lake Michigan	Little Bay De Noc	09-Apr-12	Smallmouth Bass	18	0.39	0.34		0.0091		0.002		
2012217	2012217-S01	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	16.1	0.6	0.13		0.0223	J	0.042		
2012217	2012217-S02	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	17.2	0.63	0.22		0.0676		0.012		
2012217	2012217-S03	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	16.9	0.42	0.13		0.0312		0.005		
2012217	2012217-S04	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	16.9	0.75	0.31		0.0544		0.01		
2012217	2012217-S05	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	17.7	0.48	0.45		0.0305		0.007		
2012217	2012217-S06	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	18.7	1.05	0.12		0.0757	J	0.013		
2012217	2012217-S07	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	19.1	1.61	0.67		0.0764	J	0.066		
2012217	2012217-S08	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	20.7	1.42	0.23		0.2162	J	0.036		
2012217	2012217-S09	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	20	1.61	0.61		0.4093	J	0.08		
2012217	2012217-S10	Lake Michigan	Little Bay De Noc	09-Apr-12	Walleye	24.6	0.88	0.84		0.6186	J	0.095		
2012229	2012229-S71	St. Marys River	Munuscong Bay	16-May-12	Carp	25.2	2.49	0.13		0.2145		0.017		3.44
2012229	2012229-S72	St. Marys River	Munuscong Bay	16-May-12	Carp	27.4	1.06	0.2		0.3487		0.055		14.26
2012229	2012229-S73	St. Marys River	Munuscong Bay	16-May-12	Carp	26.5	2.37	0.19		1.1606		0.139		42.98
2012229	2012229-S74	St. Marys River	Munuscong Bay	16-May-12	Carp	26.1	1.88	0.36		0.1056		0.013		2.85
2012229	2012229-S75	St. Marys River	Munuscong Bay	16-May-12	Carp	27.6	2	0.46		0.8328		0.204		34.87
2012229	2012229-S76	St. Marys River	Munuscong Bay	16-May-12	Carp	25.7	1.25	0.12		0.1128		0.012		4.33
2012229	2012229-S77	St. Marys River	Munuscong Bay	16-May-12	Carp	29.1	1.85	0.33		0.0939		0.019		8.34
2012229	2012229-S78	St. Marys River	Munuscong Bay	16-May-12	Carp	28.1	5.02	0.37		0.3256		0.16		14.82
2012229	2012229-S79	St. Marys River	Munuscong Bay	16-May-12	Carp	29.9	5.6	0.28		0.5109		0.159		15.46
2012229	2012229-S80	St. Marys River	Munuscong Bay	16-May-12	Carp	29.5	5.43	0.31		0.1679		0.06		11.13
2012229	2012229-S01	St. Marys River	Munuscong Bay	16-May-12	Pumpkinseed	5.4	0.23	0.068		0.001	K	0.001	K	
2012229	2012229-S02	St. Marys River	Munuscong Bay	16-May-12	Pumpkinseed	5.2	0.29	0.048		0.001	K	0.001	K	
2012229	2012229-S03	St. Marys River	Munuscong Bay	16-May-12	Pumpkinseed	6	0.22	0.068		0.001	K	0.001	K	
2012229	2012229-S04	St. Marys River	Munuscong Bay	16-May-12	Pumpkinseed	6.5	0.24	0.076		0.001	K	0.001	K	
2012229	2012229-S05	St. Marys River	Munuscong Bay	16-May-12	Pumpkinseed	6.5	0.17	0.064		0.001	K	0.001	K	
2012229	2012229-S06	St. Marys River	Munuscong Bay	16-May-12	Pumpkinseed	6.5	0.31	0.05		0.001	K	0.001	K	
2012229	2012229-S07	St. Marys River	Munuscong Bay	16-May-12	Pumpkinseed	6.8	0.17	0.095		0.001	K	0.001	K	
2012229	2012229-S08	St. Marys River	Munuscong Bay	16-May-12	Pumpkinseed	6.8	0.18	0.073		0.001	K	0.001	K	
2012229	2012229-S09	St. Marys River	Munuscong Bay	16-May-12	Pumpkinseed	7.1	0.16	0.1		0.001	K	0.001	K	
2012229	2012229-S10	St. Marys River	Munuscong Bay	16-May-12	Pumpkinseed	7	0.2	0.067		0.001	K	0.001	K	
2012229	2012229-S51	St. Marys River	Munuscong Bay	16-May-12	Redhorse Sucker	8.6	0.23	0.031		0.001	K	0.001	K	
2012229	2012229-S52	St. Marys River	Munuscong Bay	16-May-12	Redhorse Sucker	11.3	0.34	0.04		0.001	K	0.001	K	
2012229	2012229-S53	St. Marys River	Munuscong Bay	16-May-12	Redhorse Sucker	12.3	0.68	0.056		0.001	J	0.001	K	
2012229	2012229-S54	St. Marys River	Munuscong Bay	16-May-12	Redhorse Sucker	15.6	1.34	0.079		0.0011		0.001	K	
2012229	2012229-S55	St. Marys River	Munuscong Bay	16-May-12	Redhorse Sucker	17.9	0.81	0.17		0.0157	J	0.004		
2012229	2012229-S56	St. Marys River	Munuscong Bay	16-May-12	Redhorse Sucker	19.1	0.67	0.12		0.001	K	0.001	K	
2012229	2012229-S57	St. Marys River	Munuscong Bay	16-May-12	Redhorse Sucker	19.4	0.48	0.13		0.001	K	0.001	K	
2012229	2012229-S23	St. Marys River	Munuscong Bay	16-May-12	Rock Bass	6.3	0.14	0.12		0.001	K	0.001	K	
2012229	2012229-S24	St. Marys River	Munuscong Bay	16-May-12	Rock Bass	6.8	0.12	0.23		0.001	K	0.001	K	
2012229	2012229-S25	St. Marys River	Munuscong Bay	16-May-12	Rock Bass	6.5	0.17	0.11		0.001	K	0.001	K	
2012229	2012229-S26	St. Marys River	Munuscong Bay	16-May-12	Rock Bass	6.6	0.15	0.12		0.001	K	0.001	K	
2012229	2012229-S27	St. Marys River	Munuscong Bay	16-May-12	Rock Bass	6.9	0.14	0.14		0.001	K	0.001	K	
2012229	2012229-S28	St. Marys River	Munuscong Bay	16-May-12	Rock Bass	6.9	0.13	0.14		0.001	K	0.001	K	
2012229	2012229-S29	St. Marys River	Munuscong Bay	16-May-12	Rock Bass	7.2	0.15	0.18		0.001	K	0.001	K	
2012229	2012229-S30	St. Marys River	Munuscong Bay	16-May-12	Rock Bass	8	0.19	0.18		0.001	K	0.001	K	

Visit ID	Sample ID#	Water Body Name	Location	Collection Date	Species	Length (In)	Lipid (%)	Mercury (ppm)	Hg Code	Total PCB (ppm)	PCB Code	Total DDT (ppm)	DDT Code	TEQ (ppt)
2012229	2012229-S31	St. Marys River	Munuscong Bay	16-May-12	Rock Bass	8.4	0.22	0.43		0.001	K	0.001	K	
2012229	2012229-S32	St. Marys River	Munuscong Bay	16-May-12	Rock Bass	8.3	0.21	0.27		0.001	K	0.001	K	
2012229	2012229-S41	St. Marys River	Munuscong Bay	16-May-12	Smallmouth Bass	13.3	0.14	0.18		0.0045		0.001	K	
2012229	2012229-S42	St. Marys River	Munuscong Bay	16-May-12	Smallmouth Bass	14.4	0.22	0.24		0.0064	J	0.001	K	
2012229	2012229-S43	St. Marys River	Munuscong Bay	16-May-12	Smallmouth Bass	15	0.16	0.32		0.0047		0.001	K	
2012229	2012229-S44	St. Marys River	Munuscong Bay	16-May-12	Smallmouth Bass	15.2	0.12	0.53		0.0052		0.001	K	
2012229	2012229-S45	St. Marys River	Munuscong Bay	16-May-12	Smallmouth Bass	15.9	0.13	0.3		0.005		0.001	K	
2012229	2012229-S46	St. Marys River	Munuscong Bay	16-May-12	Smallmouth Bass	15.7	0.07	0.39		0.0029		0.001	K	
2012229	2012229-S47	St. Marys River	Munuscong Bay	16-May-12	Smallmouth Bass	16.3	0.4	0.45		0.0096		0.001	K	
2012229	2012229-S48	St. Marys River	Munuscong Bay	16-May-12	Smallmouth Bass	16.3	0.21	0.4		0.0052		0.001	K	
2012229	2012229-S49	St. Marys River	Munuscong Bay	16-May-12	Smallmouth Bass	16.1	0.11	0.4		0.0041		0.001	K	
2012229	2012229-S50	St. Marys River	Munuscong Bay	16-May-12	Smallmouth Bass	16.9	0.23	0.36		0.0187		0.002		
2012229	2012229-S33	St. Marys River	Munuscong Bay	16-May-12	Walleye	13	0.25	0.18		0.001	K	0.001	K	
2012229	2012229-S34	St. Marys River	Munuscong Bay	16-May-12	Walleye	13.4	0.43	0.09		0.0014		0.001	K	
2012229	2012229-S35	St. Marys River	Munuscong Bay	16-May-12	Walleye	15	0.76	0.12		0.0079	J	0.002		
2012229	2012229-S36	St. Marys River	Munuscong Bay	16-May-12	Walleye	16.2	0.57	0.14		0.0039	J	0.001		
2012229	2012229-S37	St. Marys River	Munuscong Bay	16-May-12	Walleye	16.9	1.36	0.1		0.0031		0.001	K	
2012229	2012229-S38	St. Marys River	Munuscong Bay	16-May-12	Walleye	16.8	0.48	0.14		0.0047		0.002		
2012229	2012229-S39	St. Marys River	Munuscong Bay	16-May-12	Walleye	19.3	0.31	0.79		0.023	J	0.004		
2012229	2012229-S40	St. Marys River	Munuscong Bay	16-May-12	Walleye	19.8	0.3	0.32		0.0076		0.001	K	
2012229	2012229-S11	St. Marys River	Munuscong Bay	16-May-12	Yellow Perch	6.7	0.16	0.078		0.001	K	0.001	K	
2012229	2012229-S12	St. Marys River	Munuscong Bay	16-May-12	Yellow Perch	6.9	0.14	0.11		0.001	K	0.001	K	
2012229	2012229-S13	St. Marys River	Munuscong Bay	16-May-12	Yellow Perch	7.2	0.11	0.13		0.001	K	0.001	K	
2012229	2012229-S14	St. Marys River	Munuscong Bay	16-May-12	Yellow Perch	6.8	0.2	0.12		0.001	K	0.001	K	
2012229	2012229-S15	St. Marys River	Munuscong Bay	16-May-12	Yellow Perch	7	0.22	0.23		0.001	K	0.001	K	
2012229	2012229-S16	St. Marys River	Munuscong Bay	16-May-12	Yellow Perch	7.2	0.1	0.1		0.001	K	0.001	K	
2012229	2012229-S17	St. Marys River	Munuscong Bay	16-May-12	Yellow Perch	7.5	0.1	0.071		0.001	K	0.001	K	
2012229	2012229-S18	St. Marys River	Munuscong Bay	16-May-12	Yellow Perch	7.7	0.1	0.11		0.001	K	0.001	K	
2012229	2012229-S19	St. Marys River	Munuscong Bay	16-May-12	Yellow Perch	8.4	0.21	0.13		0.001	K	0.001	K	
2012229	2012229-S20	St. Marys River	Munuscong Bay	16-May-12	Yellow Perch	9.7	0.12	0.26		0.001	K	0.001	K	

Appendix B.

Comparison of mean and range of lengths of fish samples collected from the Les Cheneaux Islands (LCI), Little Bay De Noc (LBDN), and St. Marys River (SMR) in 2012.

Species	Length (Inches)						
	Min Diff*	Site	Mean	St Dev	Min	Max	N
Carp	3.8	LCI	27.3	2.64	23.6	31.4	10
		LBDN	26.4	2.52	22.4	30.5	9
		SMR	27.5	1.64	25.2	29.9	10
Pumpkinseed	1.0	LCI	6.7	0.81	5.4	8	10
		SMR	6.4	0.65	5.2	7.1	10
Redhorse	5.3	LBDN	22.7	1.79	20.2	25.4	10
		SMR	14.9	4.22	8.6	19.4	7
Rock Bass	1.8	LCI	6.4	1.22	5.3	9.3	10
		LBDN	6.9	1.12	4.5	8.4	14
		SMR	7.2	0.77	6.3	8.4	10
Smallmouth Bass	1.6	LCI	16.2	0.76	14.8	17.4	10
		LBDN	16.8	1.09	14.9	18	10
		SMR	15.5	1.06	13.3	16.9	10
Walleye	3.3	LBDN	18.8	2.52	16.1	24.6	10
		SMR	16.3	2.47	13	19.8	8
Yellow Perch	1.3	LCI	7.4	0.56	6.9	8.3	10
		SMR	7.5	0.92	6.7	9.7	10

* - estimated minimum detectable difference at power = 0.8

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION
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STAFF REPORT

STATUS OF CONTAMINANT LEVELS IN FISH FROM THE ST. MARYS RIVER AREA OF CONCERN 2014 UPDATE

BACKGROUND

The St. Marys River Area of Concern (SMR-AOC; Figure 1) has several Beneficial Use Impairments, including “Restrictions on Fish and Wildlife Consumption”. Both Michigan and Ontario have issued fish consumption advisories for the St. Marys River beginning in the 1980s and continuing to the present. Initially mercury was the contaminant causing consumption advisories in Michigan waters; PCBs were added as a cause in fish from Michigan waters in 1998.

Evaluation of contaminant levels in seven species of fish collected in 2012 indicated that total PCB concentrations in fish from the St. Marys River were the same or less than concentrations in fish from two reference areas, Little Bay De Noc (LBDN) in northern Lake Michigan and the Les Cheneaux Islands (LCI) in northern Lake Huron (Bohr 2014). The study also indicated that mercury levels in carp (*Cyprinus carpio*), pumpkinseed (*Lepomis gibbosus*), redhorse sucker (*Moxostoma* spp), smallmouth bass (*Micropterus dolomieu*), and walleye (*Sander vitreus*) from the SMR-AOC were the same or lower than the concentrations measured in those species from the reference sites. However two of the seven species sampled from the St. Marys River, rock bass (*Ambloplites rupestris*) and yellow perch (*Perca flavescens*), were higher than in those species from the reference sites.

All fish exhibit some amount of daily movement and seasonal migration, both as individuals and as populations. The movements are driven by spawning and feeding behaviors, and are also affected by a tendency of individual fish to seek an area of optimal water temperature on a seasonal basis. Fish species have differing scales of movement, both in terms of distance traveled and time spent in a given area. Rock bass, pumpkinseed, and smallmouth bass are territorial, especially during spawning periods, and tend to have good site fidelity overall compared to the other species sampled in 2012 (Becker 1983; Scott and Crossman 1975). Consequently these three species provide the best between site contaminant comparisons of the seven species sampled in 2012.

The mercury results for SMR-AOC rock bass collected in 2012 were not consistent with the pumpkinseed and smallmouth bass results. The pumpkinseed and smallmouth bass collected from the SMR-AOC had mercury concentrations similar to the concentrations in those species collected in the LCI area reference site. In contrast, the SMR-AOC rock bass had higher mercury concentrations than rock bass from LCI, and the difference was statistically significant.

Additional samples of rock bass along with samples of northern pike (*Esox lucius*) were collected in 2014 and analyzed in 2015. The goal of the additional sampling was to improve our confidence in the statistical analysis of mercury concentrations.

SUMMARY

1. Rock bass and northern pike were collected from the SMR-AOC in 2014 and analyzed for mercury as a follow-up to sampling conducted in 2012. Northern pike were also collected from LBDN in 2014 and analyzed for mercury.
2. The rock bass had mercury concentrations similar to what was measured in the samples collected in 2012. The 2012 and 2014 samples indicate mercury concentrations in the SMR-AOC rock bass were elevated compared to rock bass from LCI.
3. Mercury concentrations in northern pike were nominally higher in the SMR-AOC than in LBDN but the difference was not statistically significant.
4. Additional monitoring of SMR-AOC and LCI rock bass is recommended.

METHODS

Six rock bass and ten northern pike were collected from Munuscong Lake in the SMR-AOC in 2014 by the Water Resources Division of the Michigan Department of Environmental Quality (MDEQ-WRD) and the Fisheries Division of the Michigan Department of Natural Resources (DNR). Ten northern pike (*Esox lucius*) were collected from LBDN in 2014 by the DNR. Fish were iced in the field and then held frozen until processing.

The fish were processed as standard edible portions in accordance with the MDEQ Procedure WRD-SWAS-003. Standard edible portions are untrimmed, skin-on fillets for rock bass and untrimmed, skin-off fillets for northern pike. Each sample was individually wrapped in aluminum foil, labeled and frozen until preparation for analysis.

All samples were analyzed for a standard suite of contaminants including total mercury, PCBs, and organochlorinated pesticides by the Michigan Department of Health and Human Services (formerly Department of Community Health) Analytical Chemistry Laboratory. Analytical results were reviewed and entered into the MDEQ WRD Fish Contaminant Monitoring Program (FCMP) database. The complete data set is available electronically (by request) or through the FCMP web site (www.deq.state.mi.us/fcmp).

Mercury loads in fish are sometimes positively correlated with the age of the fish, and fish length is generally used as a surrogate for age. Since the length range of fish can vary from site to site, a simple comparison of mercury concentrations has the potential to be biased. To compensate for the potential bias, statistical comparisons were conducted using a Generalized Linear Model (GLM) with fish length as a covariate. Mercury concentrations were transformed using the natural log in order to meet assumptions of the GLM.

In addition, mercury concentrations in rock bass were length-normalized for statistical and graphical comparisons. This was accomplished by using the slope of a concentration versus length regression line to adjust the contaminant concentration to a level estimated to occur in a fish of a standard length for the species. The average length of all samples was used as the standard length and was set at 7 inches for rock bass. Mercury concentrations were not normalized for the northern pike samples since they did not exhibit a significant length-concentrations relationship. The formula for length-normalization is:

$$C_{LN} = C_A - S \times (L - St)$$

Where C_{LN} = Length-normalized concentration
C_A = actual concentration
S = slope of the concentration versus length line
L = fish length
St = standard length for the species

Between site length-normalized mercury concentrations in the rock bass were compared using the Mann-Whitney nonparametric test.

Statistical tests were considered significant at $p \leq 0.05$. The software package Minitab 15 was used to perform the statistical tests.

RESULTS

Rock Bass

The rock bass collected from the SMR-AOC in 2012 and 2014 ranged in length from 5.9 to 9.4 inches, with mercury concentrations ranging from 0.1 to 0.43 mg/kg (Figure 2). The rock bass collected from LCI in 2012 ranged in length from 5.3 to 9.3 inches, with mercury concentrations ranging from 0.08 to 0.15 mg/kg.

The additional rock bass samples collected in 2014 had slightly lower mercury concentrations than rock bass of similar size collected in 2012 (Figure 2). However, the combined 2012/2014 samples set still indicates that the mercury concentrations in the SMR-AOC rock bass is slightly higher than in the LCI rock bass. Both the GLM and Mann-Whitney statistical tests indicated the concentrations were significantly different.

The GLM accounts for differences in fish length to a certain extent, but the results may be still be somewhat biased by the difference in lengths of fish collected from the two sampling areas. Although the length ranges were similar, most of the LCI fish were less than 7 inches (median length = 6.1 inches) while the SMR-AOC rock bass were distributed more evenly across the range (median length = 6.9). Linear regression suggests that rock bass from LCI accumulate mercury at a slower rate than those from the SMR-AOC, but since the LCI regression slope is largely driven by one sample result (Figure 2) this may not be the case.

A comparison of mercury concentrations in rock bass from the SMR-AOC with those from LCI over a reduced common length range (outlined points in Figure 2; expanded in Figure 3) showed no statistically significant difference, however statistical power is low due to the small sample size ($\beta<0.7$). Given the low statistical power we do not have reasonable confidence that the concentrations are not different.

Northern Pike

The northern pike collected from the SMR-AOC in 2014 ranged in length from 18.1 to 34.4 inches, with mercury concentrations ranging from 0.24 to 0.77 mg/kg. The northern pike collected from LBDN in 2014 ranged in length from 24.1 to 32.5 inches, with mercury concentrations ranging from 0.18 to 0.95 mg/kg. There was not a strong correlation between fish length and mercury concentration in northern pike from either location.

The mean mercury concentration in northern pike from the SMR-AOC was 0.46 mg/kg, slightly higher than the mean of 0.41 mg/kg measured in fish from LBDN. The difference was not statistically significant. Mercury concentrations in the northern pike samples were also compared using only those samples of legal size (at least 24-inches); three fish from the SMR-AOC were less than the legal size (Figure 5) and would have biased the comparison to some degree. The mean mercury concentration in legal size SMR-AOC northern pike was 0.50 mg/kg, nominally higher than the 0.41 mg/kg measured in legal size LBDN northern pike. The difference was not statistically significant.

DISCUSSION

Rock bass are mid-level predators, between the smaller, lower-level predator pumpkinseed and the dominant predator smallmouth bass. It is common that the levels of mercury concentrations in rock bass are somewhere between the other two species where all three are present in the fish community. Figures 6 and 7 present boxplots of the mercury concentrations measured in those three species collected from the SMR-AOC and LCI. Results for yellow perch, another mid-level predator collected in the same sampling efforts, are also included. The boxplots indicate that the concentrations in rock bass follow the typical pattern relative to pumpkinseed and smallmouth bass at both sampling sites.

The boxplots also indicate graphically that the mercury concentrations in the SMR-AOC rock bass are elevated compared to the concentrations observed in rock bass from LCI and in pumpkinseed and smallmouth bass from both the SMR-AOC and the LCI. The medians and ratios of medians are presented in Table 1. Comparison of the ratios supports the conclusion that the SMR-AOC rock bass have elevated mercury levels compared to rock bass from LCI.

Table 1. A comparison of median mercury concentrations in three species of fish collected from the St. Marys River AOC and the Les Cheneaux Islands.

	Median Mercury Concentration (mg/kg)	
Species	SMR-AOC	LCI
Smallmouth Bass	0.38	0.33
Rock Bass	0.16	0.10
Pumpkinseed	0.07	0.06
	Ratio of Medians	
	SMR-AOC	LCI
SMB:RKB	2.3	3.3
RKB:PSD	2.4	1.7

It is possible that there is a difference in rock bass growth rates between the SMR-AOC and LCI. The difference in mercury concentrations could be explained by faster growth in the LCI population which would lead to younger fish at a given length. Age data would be useful.

In conclusion, mercury concentrations in fish from SMR-AOC are somewhat elevated compared to the reference sites, but a statistically significant difference is evident only in the rock bass. Additional collection and analysis of mercury levels in rock bass from both the SMR-AOC and from the LCI reference site, along with age analysis of those fish should be conducted.

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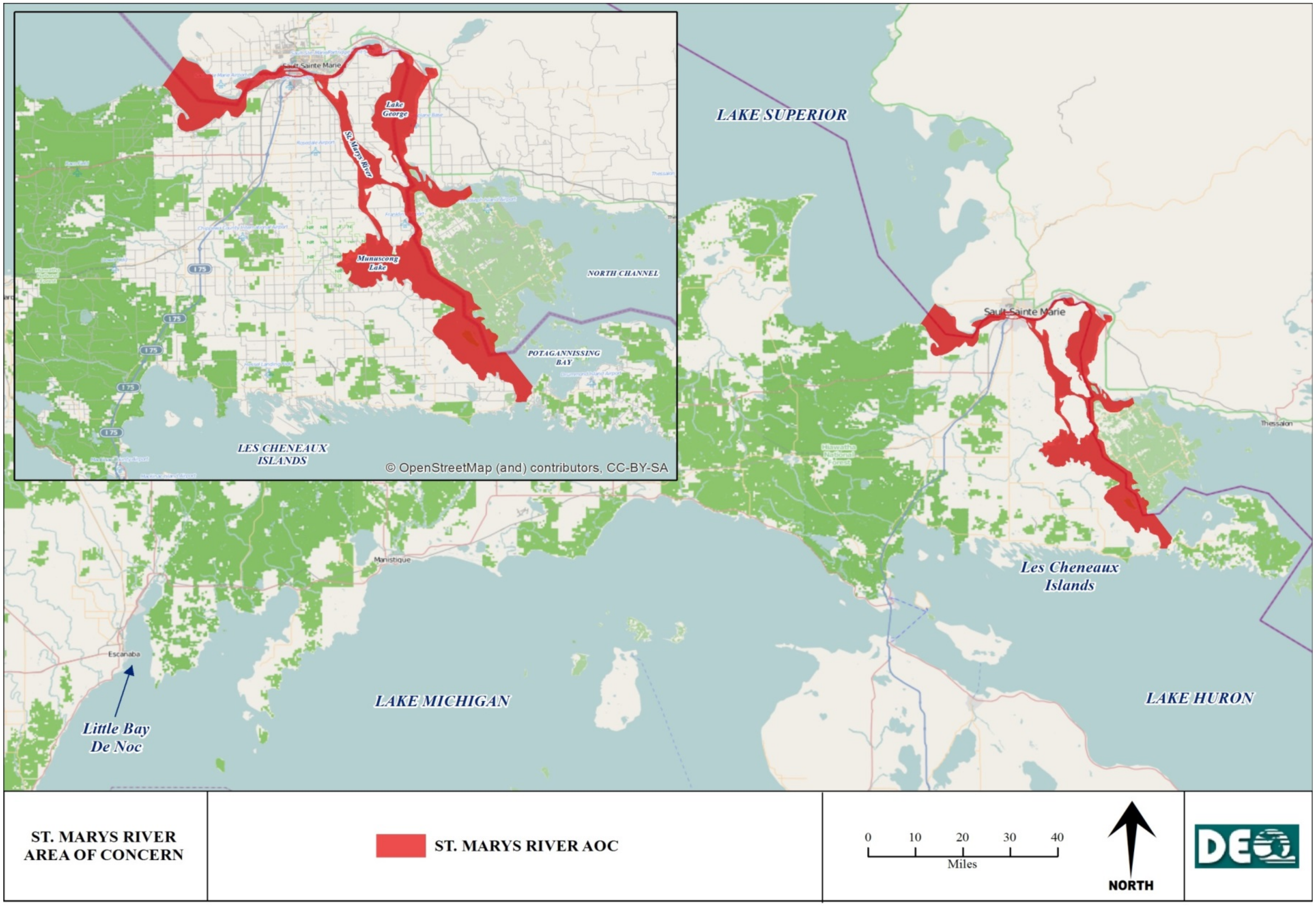

Figure 1. Map of St. Marys River Area of Concern showing location of the Les Cheneaux Island and Little Bay De Noc reference collection sites.

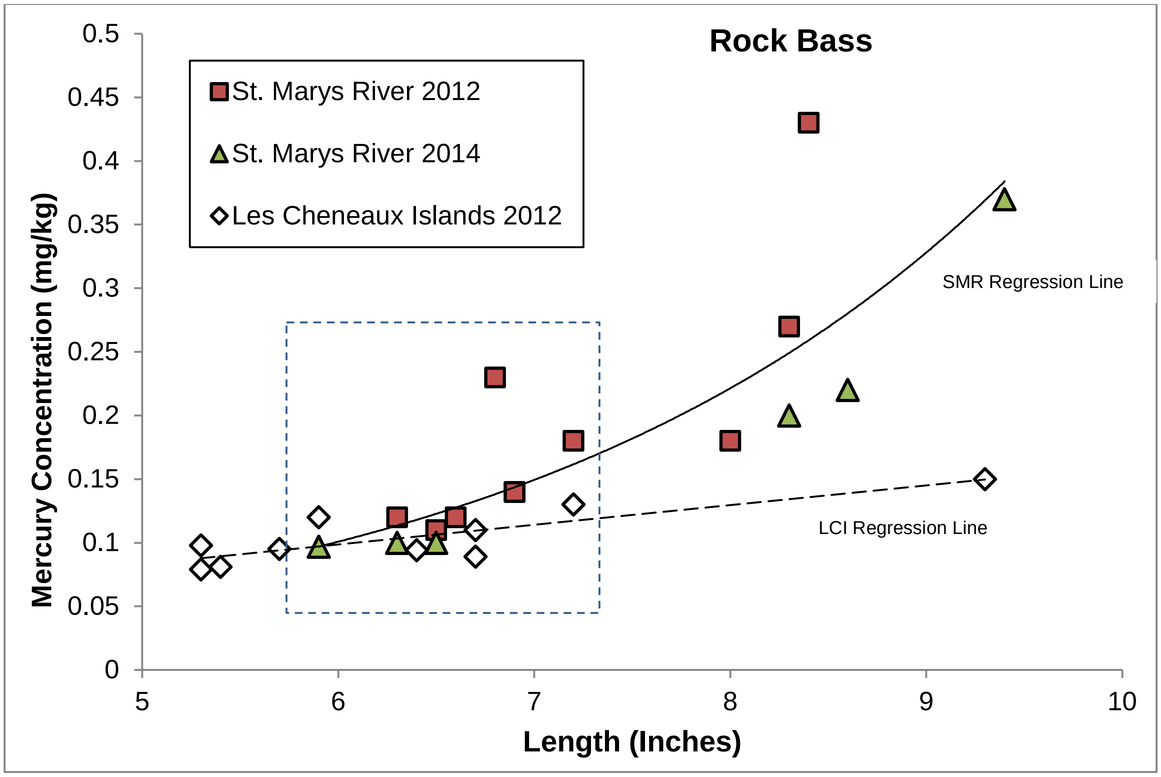

Figure 2. Length versus total mercury concentration in rock bass collected from the St. Marys River in 2012 and 2014 and from the Les Cheneaux Islands in 2012. Samples in rectangle are expanded in Figure 2.

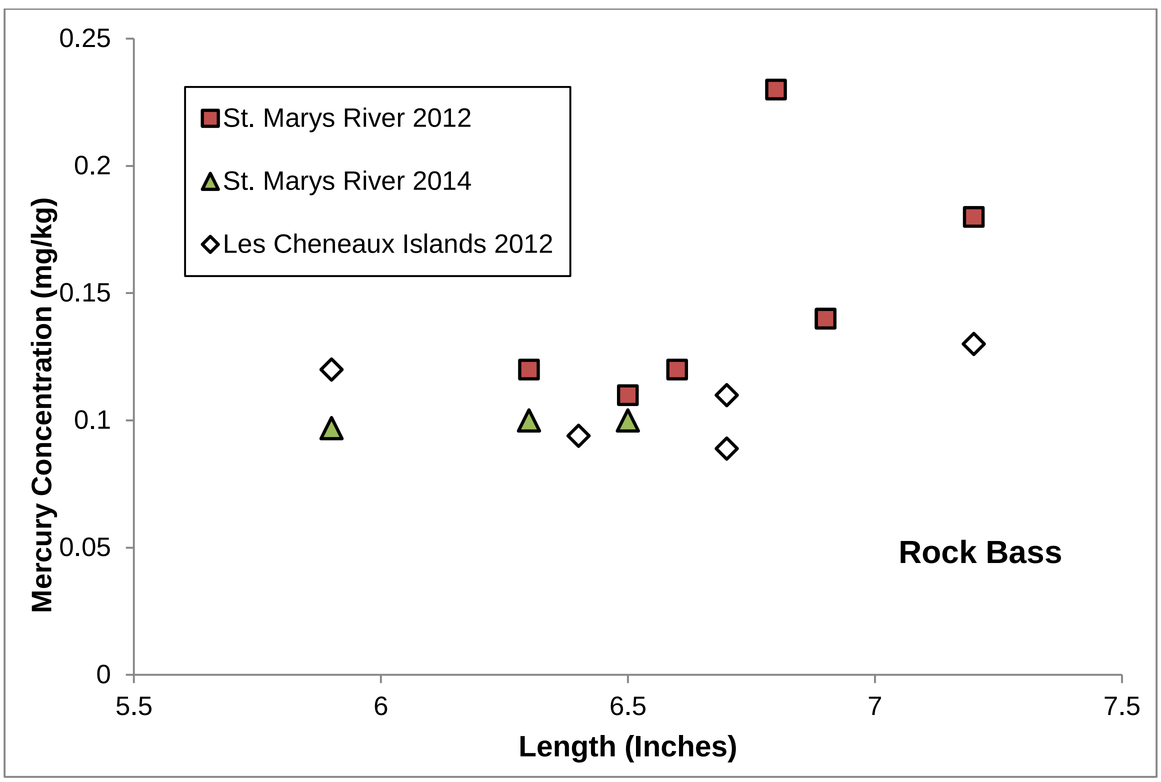

Figure 3. Length versus total mercury concentration in rock bass collected from the St. Marys River in 2012 and 2014 and from the Les Cheneaux Islands in 2012 in the same length range (expansion of data points in Figure 2 rectangular outline).

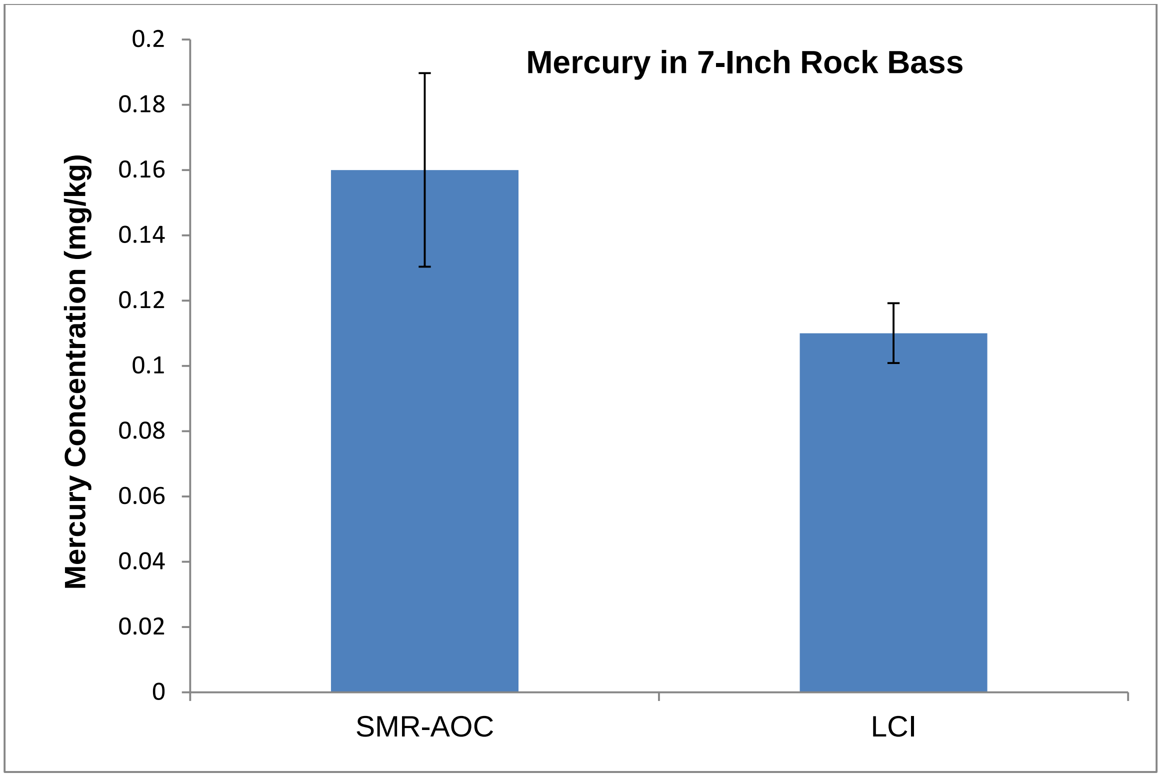

Figure 4. Comparison of estimated total mercury concentrations in length-normalized rock bass collected from the Les Cheneaux Islands in 2012 and from the St. Marys River in 2012 and 2014.

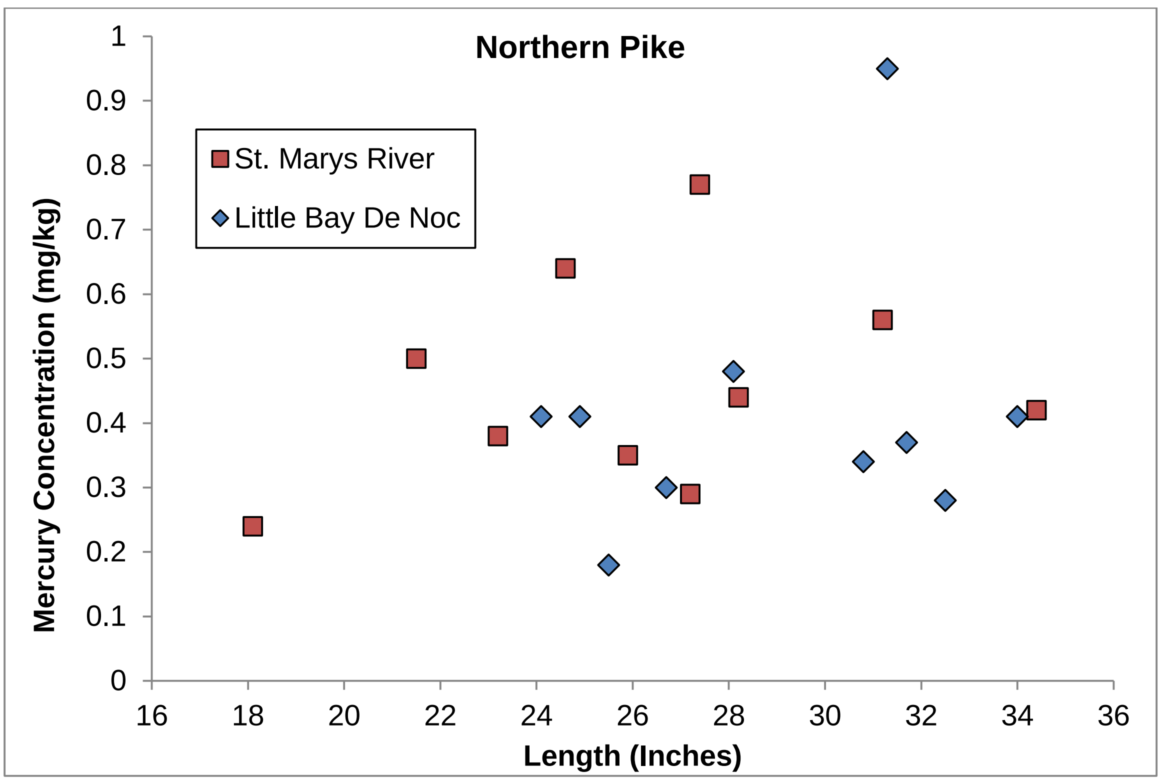

Figure 5. Length versus total mercury concentration in northern pike collected from the St. Marys River Little Bay De Noc in 2014.

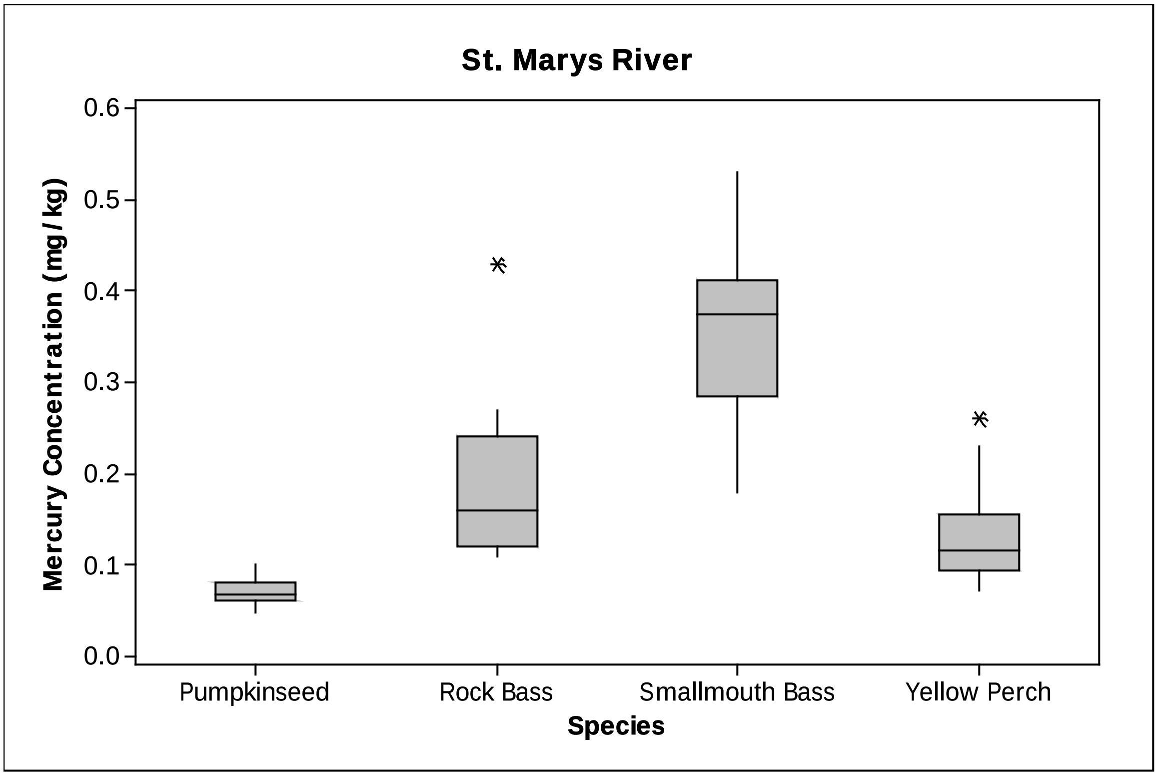

Figure 6. Boxplots of mercury concentrations in four species of fish collected from the SMR-AOC in 2012 and 2014.

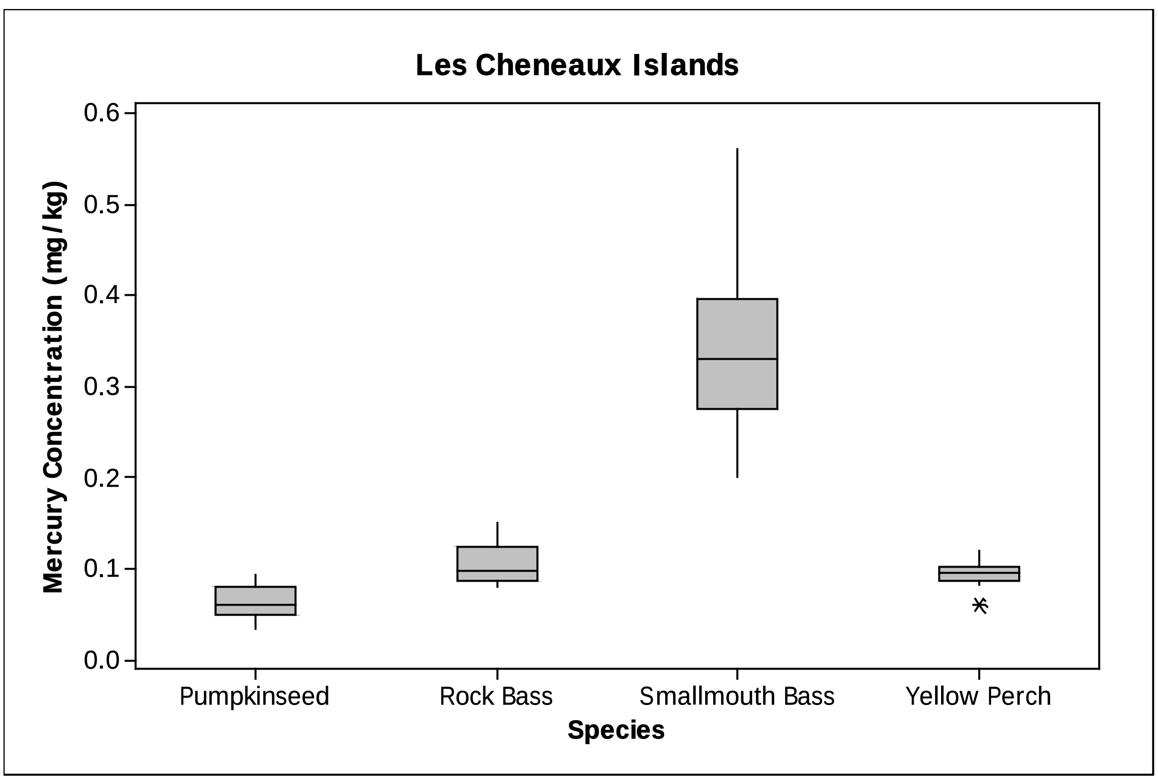

Figure 7. Boxplots of mercury concentrations in four species of fish collected from the LCI in 2012.

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION
JANUARY 2016

STAFF REPORT

STATUS OF FISH CONTAMINANT LEVELS IN THE TORCH LAKE AREA OF CONCERN 2013

BACKGROUND

The Torch Lake Area of Concern (TL-AOC) is located on the Keweenaw Peninsula in Houghton County, Michigan (Figure 1). It is listed as an AOC in part because of elevated levels of polychlorinated biphenyls (PCBs) in fish. Historically, the TL region has been an area of copper mining, ore processing, and copper reclamation activities. For over 100 years, mining and copper processing wastes were released into TL and surrounding bodies of water. Accidental spills or poor waste disposal methods by area industries may have introduced PCBs to the watershed, and those potential sources have not been thoroughly investigated. Sediment sampling in TL has detected scattered low-level PCB contamination (United States Environmental Protection Agency [USEPA], 2001; Alexander, 2008). A water column PCB concentration study was conducted in 2005 using semi-permeable membrane devices, and the results of that study suggested that a source of PCBs does exist in the TL watershed (Bohr, 2006). In addition, walleye (*Sander vitreus*) collected from TL had significantly higher PCB concentrations than walleye collected from Lake Superior (Bohr, 2008).

PCB concentrations in fish collected from TL have been consistently higher than in fish found in nearby inland lakes. A fish consumption advisory due to elevated levels of PCBs was first issued for TL fish by the Michigan Department of Health and Human Services (MDHHS) (formerly Department of Community Health) in 1998. The current advisory, based on samples collected most recently in 2013, recommends restricting consumption of northern pike, smallmouth bass, walleye, and white sucker from the lake.

This report provides an update of the status of contaminant concentrations using fish samples collected in 2013 from TL and from two Lake Superior reference sites. The collections and analyses were conducted in support of the USEPA Great Lakes Restoration Initiative (GLRI) grant-funded project, *Assessing Michigan's Beneficial Use of Sport-Caught Fish*, awarded to the MDHHS. Fish were collected to allow comparisons of key contaminant concentrations between sites as well as temporal trend evaluations.

SUMMARY

1. Northern pike, smallmouth bass, and walleye were collected from the TL-AOC in 2013. Reference samples of walleye were collected from Huron Bay, and reference samples of northern pike were collected from Huron Bay and L'Anse Bay. Smallmouth bass were not found at the references sites.
2. PCBs were quantified in 80 to 100% of the fish collected from TL, but in less than 60% of the samples collected from reference sites.
3. Northern pike collected from TL were somewhat smaller than those collected from the reference sites, but the differences were not statistically significant. Walleye collected from TL were similar in length to those collected from Huron Bay.

4. Between-site comparisons of contaminant concentrations were made using statistical techniques to adjust for differences in fish length and lipid content, as appropriate.
5. Total PCB concentrations in fish collected from TL were higher than in the same species collected in Huron Bay and L'Anse Bay. Total PCB concentrations in TL northern pike and walleye were elevated compared to levels in those species collected in recent years from inland lakes in both the Upper and Lower Peninsulas, although the differences were not always statistically significant.
6. Total PCB concentrations in fish from TL have decreased since monitoring began in 1988.
7. Total mercury concentrations in TL northern pike were higher than in northern pike collected from L'Anse Bay, but were not statistically different than in those fish from Huron Bay. Total mercury concentrations in TL walleye were significantly higher than walleye collected from Huron Bay. Northern pike, smallmouth bass, and walleye from TL had mercury concentrations similar to the concentrations in those species from other inland lakes.
8. Total mercury concentrations in TL fish have tended to increase since monitoring began in 1988.
9. Dichlorodiphenyl trichloroethane (DDT) levels in TL fish are very low and similar to concentrations measured in other northern Michigan fish populations.
10. Fish consumption advice was projected based only on contaminant concentrations in the fish collected in 2013. Projected consumption advice based on PCB concentrations in TL northern pike and walleye is more restrictive than for those fish sampled from Huron Bay or L'Anse Bay.

METHODS

Walleye and northern pike (*Esox lucius)* were the target species and were collected in both TL and in Huron Bay, the selected reference site. Additional samples of northern pike were collected from L'Anse Bay (Figure 1). The Keweenaw Bay Indian Community provided samples from all three areas, and the Michigan Department of Natural Resources (MDNR), Fisheries Division, collected additional samples from TL. The MDNR also collected smallmouth bass (*Micropterus dolomieu*) from TL in 2013. Samples were placed on ice in the field and later frozen before being transported to Michigan Department of Environmental Quality (MDEQ) storage freezers in Lansing.

The fish were thawed and processed as standard edible portions in accordance with the MDEQ, Water Resources Division, Fish Contaminant Monitoring Program (FCMP), Fish Collection Procedure WRD-SWAS-004. Total length was measured to the nearest millimeter and converted to inches for reporting. Length data are presented in Appendix A1. Standard edible portions are untrimmed, skin-on fillets for walleye and smallmouth bass, and untrimmed, skin-off fillets for northern pike. Each sample was individually wrapped in aluminum foil, labeled, and frozen until preparation for analysis. A total of 30 fillet samples from TL, 19 from Huron Bay, and 13 from L'Anse Bay were analyzed (Table 1).

Table 1. Number of fish samples collected from the TL-AOC and two reference sites in 2013.

Species	Torch Lake	Huron Bay	L'Anse Bay
Northern Pike	10	7	13
Smallmouth Bass	10	--	--
Walleye	10	12	--

All samples were analyzed for a standard suite of contaminants including total mercury, organochlorinated pesticides (Table 2), and PCB congeners (Table 3) by the MDHHS Analytical

Chemistry Laboratory. Analytical results were reviewed and entered into the FCMP database. The complete dataset is available electronically (by request) or through the FCMP Web site (www.deq.state.mi.us/fcmp).

Since 2000, the MDHHS Laboratory has measured PCB concentrations using the congener method, and total PCB concentration was estimated by summing the concentrations of PCB congeners. Individual congeners below the quantification level were assigned a concentration equal to 0 for the purpose of calculating a total PCB concentration. Also, congener analyses that did not meet retention time criteria or were subject to analytical interference were assigned a concentration equal to 0 for the purpose of calculating a total PCB concentration.

Table 2. Standard suite of contaminants quantified in fish tissue samples for the MDEQ FCMP.

2,4'-DDD	*gamma*-Chlordane
2,4'-DDT	*trans*-Nonachlor
4,4'-DDD	*alpha*-Chlordane
4,4'-DDE	*cis*-Nonachlor
4,4'-DDT	Hexachlorobenzene
Aldrin	Mercury
Dieldrin	Mirex
gamma-BHC (Lindane)	Octachlorostyrene
Heptachlor	PBB (FF-1, BP-6)
Heptachlor Epoxide	Pentachlorostyrene
Heptachlorostyrene	Terphenyl
Hexachlorostyrene	Toxaphene
Oxychlordane	
Total PCB (as congeners; Aroclors prior to 2000)	

Total DDT concentrations were calculated by summing concentrations of the para, para' and ortho, para' forms of DDT, dichlorodiphenyldichloroethylene (DDE), and 1,1-bis(4-chlorophenyl)-2,2-dichloroethane (DDD). Individual chemicals below the quantification level were assigned a concentration equal to 0 for the purpose of calculating a total DDT concentration. If all six components were below the quantification level, then the total DDT concentration was reported as less than the lowest quantification level of the metabolites.

The MDHHS, Division of Environmental Health, develops fish consumption advice following protocols described in the *Michigan Fish Consumption Advisory Program Guidance Document*. That document along with links to supporting documentation and other related reports is available online at http://www.michigan.gov/eatsafefish (Reports & Science button). The guidance was used in this report to predict the likely fish consumption advice based on the analytical results for the samples collected in 2013. Specifically, the projected advice was determined by comparing the 95 percent upper confidence limit (95% UCL) on the mean concentration in legal-size fish for each species/site/contaminant combination with the appropriate MDHHS screening value for that contaminant. It is important to note that the projected consumption advice reported here may not be the final advice put forth by the MDHHS; the MDHHS bases consumption guidance on the most current analytical results in combination with previous data for the water body as well as knowledge of legacy or ongoing contamination issues.

The MDHHS fish consumption guidance is presented as a recommended number of meals per month of a given species. The meal categories range from 16 meals per month to a “Do Not Eat” category; the latter category is reserved for those species and water bodies where the estimated contaminant concentration in a single meal would exceed the annual safe level of exposure. In addition the MDHHS has designated a “Limited” category; healthy adults may eat 1 or 2 meals per year of fish in this category but it is recommended that women of childbearing age, young children, and adults with a chronic health condition not eat these fish.

Comparisons of contaminant concentrations were made for each species collected from TL with samples collected from Huron Bay, and L'Anse Bay, as well as with combined samples collected since 2007 from Upper Peninsula and Lower Peninsula inland lakes and impoundments (sample year 2007 was chosen arbitrarily to provide a meaningful number of samples). Sites with known legacy contamination were not included in the latter comparisons.

Contaminant loads in fish are sometimes positively correlated with the age of the fish, and fish length is generally used as a surrogate for age. In addition, chlorinated contaminants such as PCBs, DDT, and dioxins tend to accumulate preferentially in lipids. Since the length range and lipid content of fish can vary from site to site a simple comparison of contaminant concentrations has the potential to be biased. To compensate for the potential bias, statistical comparisons were conducted using a General Linear Model (GLM) with lipid content and fish length as covariates for the chlorinated contaminant concentrations, and fish length as a covariate for mercury concentrations. Results were transformed using the natural log in order to meet assumptions of the GLM.

In addition, chlorinated contaminant results were lipid normalized by dividing the contaminant concentration by the lipid content and compared using the Kruskal-Wallis (KW) and Mann-Whitney statistical tests, the nonparametric equivalents of Analysis of Variance and the t-test, respectively.

Mercury concentrations were length-normalized for graphical comparisons. This was accomplished by using the slope of the concentration versus length regression line to adjust the contaminant concentration to a level estimated to occur in a fish of a standard length for the species. The average length of all samples for each species was used as the standard length and was set at 24 inches for northern pike, 16 inches for smallmouth bass, and 19 inches for walleye. The formula for length-normalization is:

$$C_{LN} = C_A - S \times (L - St)$$

Where C_{LN} = Length-normalized concentration,
C_A = actual concentration,
S = slope of the concentration versus length line,
L = fish length, and
St = standard length for the species.

Temporal trends in total PCBs, total mercury, and total DDT concentrations were evaluated using multiple regression techniques to account for variation due to lipid content and fish length. Natural log transformed contaminant concentrations (wet weight) were used to fit the data into exponential decay rate models and obtain estimates of annual rates of change. The trend model for each subset of data was developed using an iterative process. The initial multiple linear regression model included length and collection year as explanatory variables for mercury concentrations. The model for organic contaminant concentrations used length, lipids, and collection year as explanatory variables. A final multiple linear regression model was developed for each subset by successively eliminating variables that did not have a statistically significant relationship ($p<0.05$) to contaminant concentration.

The software package Minitab 15 was used to perform the statistical tests, and tests were considered significant at $p \leq 0.05$.

Table 3. PCB structure and corresponding identification number of congeners quantified in fish tissue samples.

BZ#	Structure
	CHLOROBIPHENYLS
1	2
3	4
	DICHLOROBIPHENYL
8	2,4’
11	3,3’
	TRICHLOROBIPHENYLS
16	2,2’,3
17	2,2',4
18	2,2',5
22	2,3,4'
25	2,3',4
26	2,3',5
27	2,3’,6
28	2,4,4'
31	2,4',5
32	2,4',6
33	2',3,4
37	3,4,4'
	TETRACHLOROBIPHENYLS
40	2,2',3,3'
42	2,2',3,4'
44	2,2',3,5'
45	2,2',3,6
47	2,2',4,4'
48	2,2’,4,5
49	2,2',4,5'
52	2,2',5,5'
56	2,3,3',4'
60	2,3,4,4'
63	2,3',4',5
64	2,3,4',6
66	2,3',4,4'
70	2,3',4',5
71	2,3',4',6
74	2,4,4',5
77	3,3',4,4'
81	3,4,4’,5
	PENTACHLOROBIPHENYLS
82	2,2',3,3',4
83	2,2’,3,3’,5
84	2,2',3,3',6
87	2,2',3,4,5'
90	2,2',3,4',5
91	2,2',3,4',6
92	2,2',3,5,5'
95	2,2',3,5',6
97	2,2',3',4,5
99	2,2',4,4',5
100	2,2',4,4',6
101	2,2',4,5,5'
105	2,3,3',4,4'
110	2,3,3',4',6
114	2,3,4,4’,5
118	2,3',4,4',5
123	2,3’,4,4’,5’
126	3,3',4,4',5
	HEXACHLOROBIPHENYLS
128	2,2',3,3',4,4'
130	2,2',3,3',4,5'
132	2,2',3,3',4,6'
134	2,2’,3,3’,5,6
135	2,2',3,3',5,6'
136	2,2',3,3',6,6'
137	2,2',3,4,4',5
138	2,2',3,4,4',5'
141	2,2',3,4,5,5'
144	2,2',3,4,5',6
146	2,2',3,4',5,5'
149	2,2',3,4',5',6
151	2,2',3,5,5',6
153	2,2',4,4',5,5'
156	2,3,3',4,4',5
157	2,3,3',4,4',5'
158	2,3,3',4,4',6
160	2,3,3’,4,5,6
163	2,3,3',4',5,6
167	2,3',4,4',5,5'
169	3,3’,4,4’,5,5’
	HEPTACHLOROBIPHENYLS
170	2,2',3,3',4,4',5
171	2,2',3,3',4,4',6
172	2,2',3,3',4,5,5'
174	2,2',3,3',4,5,6'
175	2,2',3,3',4,5',6
177	2,2',3,3',4',5,6
178	2,2',3,3',5,5',6
179	2,2',3,3',5,6,6'
180	2,2',3,4,4',5,5'
182	2,2',3,4,4',5,6'
183	2,2',3,4,4',5',6
185	2,2',3,4,5,5',6
187	2,2’,3,4’,5,5’,6
189	2,3,3’,4,4’,5,5’
190	2,3,3',4,4',5,6
193	2,3,3',4',5,5',6
	OCTACHLOROBIPHENYLS
194	2,2',3,3',4,4',5,5'
195	2,2',3,3',4,4',5,6
196	2,2',3,3',4,4',5,6'
198	2,2’,3,3’,4,5,5’,6
199	2,2',3,3',4,5,6,6'
200	2,2'3,3’,4,5’,6,6’
201	2,2',3,3',4,5,5',6'
203	2,2',3,4,4',5,5',6
205	2,3,3',4,4',5,5',6
	NONACHLOROBIPHENYLS
206	2,2',3,3',4,4',5,5',6
207	2,2’,3,3’,4,4’,5,6,6’

BZ# = identification numbers adopted by the International Union of Pure and Applied Chemists.

RESULTS AND DISCUSSION

The following discussion includes between-site comparisons of results for total PCB, mercury, and total DDT. Elevated levels of PCBs, mercury, or both have led to the need for consumption advisories for certain species of fish taken from TL since the early 1990s. While DDT has not caused advisories for TL fish, it is present in measurable quantities in nearly all fish samples tested in Michigan and may be present in higher concentrations in TL samples relative to Lake Superior samples.

PCBs

PCBs were quantified in the majority of fish collected from TL (Table 4). The highest PCB concentrations were measured in walleye, regardless of sampling site (Appendix A2).

Table 4. Percentage of fish samples collected in 2013 from Torch Lake (TL), Huron Bay (HB), and L'Anse Bay (LB) with quantifiable levels of total PCB.

Species	TL	HB	LB
Northern Pike	100	57	54
Smallmouth Bass	90	--	--
Walleye	80	58	--

Concentrations of total PCBs and lipid-normalized PCBs in northern pike collected from TL in 2013 were higher than in northern pike collected in Huron Bay and L'Anse Bay (Table 5; Figure 2; Appendix A2). They were also higher than in northern pike collected since 2007 from Upper Peninsula and Lower Peninsula inland lakes and impoundments. Both the GLM and KW tests indicated that the differences were statistically significant.

The projected consumption advice for TL northern pike based on the 95% UCL of the mean total PCB concentration is "4 meals per month," while the projected advice for those fish collected from both Huron Bay and L'Anse Bay is "16 meals per month" (Table 6).

Table 5. Median total PCB and median lipid-normalized total PCB concentrations in fish collected in 2013 from Torch Lake (TL), Huron Bay (HB), and L'Anse Bay (LB), and from Upper Peninsula (UP) and Lower Peninsula (LP) inland lakes and impoundments since 2007.

Species	Median Total PCB (µg/kg)				
	TL	HB	LB	UP	LP
Northern Pike	15	1	1	1	1
Smallmouth Bass	10	--	--	2	7
Walleye	46	3	--	3	2
Species	**Median Lipid-Normalized Total PCB (µg/kg)**				
	TL	HB	LB	UP	LP
Northern Pike	40	8	5	10	6
Smallmouth Bass	39	--	--	12	55
Walleye	59	4	--	12	14

Concentrations of total PCBs and lipid-normalized PCBs in smallmouth bass collected from TL in 2013 were higher than in smallmouth bass collected since 2007 from other Upper Peninsula inland lakes and impoundments (Table 5; Figure 3; Appendix A2), and both the GLM and KW tests indicated that the difference was statistically significant. In contrast, neither total PCB nor lipid-normalized PCB concentrations in the TL smallmouth bass differed significantly from concentrations measured in smallmouth bass collected from Lower Peninsula inland lakes and impoundments.

The projected consumption advice for TL smallmouth bass based on the 95% UCL of the mean total PCB concentration is "12 meals per month" (Table 6); this advice is less restrictive than the current advice for smallmouth bass from the impoundments of the Menominee River between the Twin Falls Dam (near Iron Mountain), which is also based on PCBs. We have no other data for this species from other non-AOC Upper Peninsula water bodies.

Table 6. The 95% UCL on the mean total PCB and projected consumption advice based on those concentrations for fish collected from the Torch Lake AOC (TL), Huron Bay (HB), and L'Anse Bay (LB) in 2013.

Species	95% UCL (mg/kg)		
	TL	HB	LB
Northern Pike	0.036	0.005	0.002
Smallmouth Bass	0.018	--	--
Walleye	0.188	0.005	--
	Meals per Month		
	TL	HB	LB
Northern Pike	4	16	16
Smallmouth Bass	12	--	--
Walleye	1	16	--

Concentrations of total PCBs and lipid-normalized PCBs in walleye collected from TL in 2013 were higher than in walleye collected in Huron Bay (Table 5; Figure 4; Appendix A2), and both the GLM and KW tests indicated that the difference was statistically significant. Concentrations of total PCBs and lipid-normalized PCBs in walleye collected from TL in 2013 were also nominally higher than the concentrations in walleye collected since 2007 from inland lakes and impoundments in both the Upper and Lower Peninsulas of Michigan, but the differences were not statistically significant.

The projected consumption advice for TL walleye based on the 95% UCL of the mean total PCB concentration is "1meal per month," while the projected advice for those fish collected from Huron Bay is "16 meals per month" (Table 6).

Temporal Trends in PCB Concentrations

Analysis with regression and the GLM indicates that PCB concentrations in TL northern pike have declined at a rate of approximately 4% per year since 1988, although there was no decline apparent between 1988 and 2000 (Figure 5). Total PCB concentrations in smallmouth bass show a similar pattern, with no significant change between 1988 and 2000 and a decline in levels between 2000 and 2013 (Figure 6). In contrast, total PCB concentrations in walleye collected from TL declined slightly since 1988, but have not declined since 2000 (Figure 7). Walleye exhibit much less site fidelity than northern pike and smallmouth bass and therefore are less reliable as indicators of localized contamination.

Table 7. Median total mercury and median length-normalized total mercury concentrations in fish collected in 2013 from Torch Lake (TL), Huron Bay (HB), and L'Anse Bay (LB), and from Upper Peninsula (UP) and Lower Peninsula (LP) inland lakes and impoundments since 2007.

Species	Median Total Mercury (mg/kg)				
	TL	HB	LB	UP	LP
Northern Pike	0.39	0.38	0.18	0.53	0.53
Smallmouth Bass	0.37	--	--	0.49	0.32
Walleye	0.54	0.25	--	0.53	0.33

Species	Median Length-Normalized Total Mercury (mg/kg)		
	TL	HB	LB
Northern Pike	0.40	0.39	0.23
Walleye	0.69	0.21	--

Regression analysis indicated that total PCB concentrations in TL walleye declined at an overall rate of approximately 4% per year since 1988. In comparison, walleye collected regularly from Lake Gogebic between 1992 and 2009 and analyzed as whole fish show a decline in total PCB concentrations at a rate of approximately 14% per year (Figure 7), and concentrations have been consistently lower than in TL walleye.

Torch Lake walleye probably spend time in nearby waters of Keweenaw Bay, Lake Superior, and may be influenced by conditions there. Keweenaw Bay lake trout have been sampled regularly to monitor temporal trends in contaminant levels. Between species comparisons are difficult due to differences in trophic level, physiology, and age of the fish, but the results suggest that both the lake trout and TL walleye may have been affected by a similar decline in regional PCB inputs (Figure 7).

Mercury

Total mercury was quantified in all fish collected from TL in 2013, as well as in all fish collected in Huron Bay and L'Anse Bay in 2013.

Total mercury and length-normalized total mercury concentrations in TL northern pike were not significantly different than the concentrations in northern pike from Huron Bay (Table 7; Figure 8; Appendix A3). In contrast, mercury and length-normalized mercury concentrations in northern pike from L'Anse Bay were significantly less than in the northern pike from TL. Length-normalized mercury concentrations were not calculated for fish collected from inland lakes, but the GLM indicated that mercury concentrations in northern pike from TL were lower than in those fish from other Upper Peninsula inland lakes, and the difference was significantly different.

Table 8. The 95% UCL on the mean total mercury and projected consumption advice based on those concentrations for fish collected from the Torch Lake AOC (TL), Huron Bay (HB), and L'Anse Bay (LB) in 2013.

Species	95% UCL (mg/kg)		
	TL	HB	LB
Northern Pike	0.58	0.53	0.26
Smallmouth Bass	0.08	--	--
Walleye	0.96	0.31	--
	Meals per Month		
	TL	HB	LB
Northern Pike	1	2	4
Smallmouth Bass	12	--	--
Walleye	1	2	--

The projected consumption advice for TL northern pike based on the 95% UCL of the mean total mercury concentration is "1 meal per month," while the projected advice for those fish collected from both Huron Bay and L'Anse Bay is more relaxed, at "2 meals per month" and "4 meals per month," respectively (Table 8). The TL advice is similar to the "Statewide Safe Fish Guidelines" for northern pike from rivers and inland lakes, which is based on statewide average mercury concentrations.

The median total mercury concentration in smallmouth bass from TL was lower than the median concentration of all other Upper Peninsula inland lakes combined (Table 7; Figure 9; Appendix A3), and the concentrations were significantly different. The median total mercury concentration in TL smallmouth bass was nominally higher than the median concentration in smallmouth bass from Lower Peninsula inland lakes, but a statistically significant difference was not measured.

The projected consumption advice for TL smallmouth bass based on the 95% UCL of the mean total mercury concentration is “12 meals per month” (Table 8), significantly less restrictive than the “2 meals per month” recommended under the “Statewide Safe Fish Guidelines” for smallmouth bass from rivers and inland lakes.

The median total mercury and length-normalized total mercury concentrations in TL walleye were significantly higher than concentrations in walleye from Huron Bay (Table 7; Figure 10; Appendix A3). However, total mercury concentrations in TL walleye were not significantly different than in walleye from Upper Peninsula or Lower Peninsula inland lakes and impoundments.

The projected consumption advice for TL walleye based on the 95% UCL of the mean total mercury concentration is “1 meal per month,” slightly more restrictive than advice due to mercury for walleye from Huron Bay (Table 8), and similar to the “Statewide Safe Fish Guidelines.”

Table 9. Percentage of fish samples collected in 2013 from Torch Lake (TL), Huron Bay (HB), and L’Anse Bay (LB) with quantifiable levels of total DDT.

Species	TL	HB	LB
Northern Pike	89	86	31
Smallmouth Bass	90	--	--
Walleye	70	58	--

Temporal Trends in Mercury Concentrations

Regression analysis indicates that mercury concentrations in TL northern pike have increased at a rate of approximately 2% per year between 1988 and 2013 (Figure 11). Mercury concentrations in TL smallmouth bass have also increased over the same time period, at a rate of approximately 2% (Figure 12).

Mercury concentrations in TL walleye have tended to increase since monitoring began in 1988, but the changes over time have not been statistically significant. Mercury concentrations in walleye collected regularly from Little Bay De Noc (northern Lake Michigan) are also tending to increase, but again the change is not statistically significant (Figure 13).

Table 10. Median total DDT and median lipid-normalized total DDT concentrations in fish collected in 2013 from Torch Lake (TL), Huron Bay (HB), and L’Anse Bay (LB), and from Upper Peninsula (UP) and Lower Peninsula (LP) inland lakes and impoundments since 2007.

Species	Median Total DDT (µg/kg)				
	TL	HB	LB	UP	LP
Northern Pike	2	1	1	4	11
Smallmouth Bass	2	--	--	1	4
Walleye	6	2	--	1	2
Species	**Median Lipid-Normalized Total DDT (µg/kg)**				
	TL	HB	LB	UP	LP
Northern Pike	7	6	4	40	33
Smallmouth Bass	9	--	--	6	33
Walleye	10	2	--	4	8

<u>DDT</u>

DDT was quantified in the majority of samples collected in TL, but only a low percentage of the northern pike collected in L’Anse Bay had quantifiable levels (Table 9). The maximum concentration was measured in walleye from TL (Appendix A4).

Concentrations of total DDT and lipid-normalized total DDT in northern pike collected from TL were lower than concentrations in those fish from inland lakes in both the Upper and Lower Peninsulas (Table 10; Figure 14; Appendix A4); however, only one Upper Peninsula lake is represented. DDT concentrations in northern pike from TL, Huron Bay, and L'Anse Bay were all relatively low and differences were not statistically significant.

Concentrations of total DDT and lipid-normalized total DDT in smallmouth bass collected in 2013 from TL were lower than in those fish collected in inland lakes in the Lower Peninsula (Table 10; Figure 15; Appendix A4). The median total DDT concentration in the TL smallmouth bass was nominally higher than in other Upper Peninsula lakes, but the difference was not statistically significant.

Table 11. The 95% UCL on the mean total DDT and projected consumption advice based on those concentrations for fish collected from the Torch Lake AOC (TL), Huron Bay (HB), and L'Anse Bay (LB) in 2013.

Species	95% UCL (mg/kg)		
	TL	HB	LB
Northern Pike	0.004	0.002	0.001
Smallmouth Bass	0.003	--	--
Walleye	0.028	0.002	--
	Meals per Month		
	TL	HB	LB
Northern Pike	16	16	16
Smallmouth Bass	16	--	--
Walleye	16	16	--

Concentrations of total DDT and lipid-normalized total DDT in walleye collected from TL in 2013 were higher than in walleye collected in Huron Bay (Table 10; Figure 16; Appendix A4), and both the GLM and KW tests indicated that the difference was statistically significant.

The concentrations of total DDT are not high enough to cause the need for fish consumption advisories for any of the fish populations sampled in 2013 (Table 11).

Temporal Trends in DDT Concentrations

Analysis with regression and the GLM indicates that DDT concentrations in TL northern pike and smallmouth bass have declined at a rate of approximately 5% per year since 1988 (Figures 17 and 18). In contrast, total DDT concentrations in walleye collected from TL declined at a lower rate (Figure 19). These trends mirror findings with other species in other water bodies statewide.

SYNOPSIS

Overall, the evidence indicates that total PCB concentrations in TL fish remain elevated compared to other water bodies in northern Michigan, even though levels have declined since monitoring began in 1988. Mercury concentrations in TL fish have not declined since monitoring began in 1988 and may have increased over that time; however, mercury levels are lower than in fish from other Upper Peninsula inland lakes.

The MDHHS issues consumption guidance based on the contaminant(s) causing the most restrictive advice. In this evaluation, which is based only on the most recent analytical results, total PCBs and mercury concentrations each lead to a "1 meal per month" advisory for TL walleye and a "12 meal per month" advisory for TL smallmouth bass (Table 12). Mercury would cause the most restrictive consumption advice for TL northern pike and for Huron Bay walleye. It is important to reiterate that the projected consumption advice reported here may not be the final advice put forth by the MDHHS; the MDHHS bases consumption guidance on the most current analytical results in combination with previous data for the water body as well as knowledge of legacy or ongoing contamination issues.

Table 12. Projected consumption advice based on samples collected in 2013 and contaminant causing the advice for fish collected from the Torch Lake AOC (TL), Huron Bay (HB), and L'Anse Bay (LB).

Species		Sampling Site		
		TL	HB	LB
Northern Pike	Meals/Month	1	2	4
	Cause	Mercury	Mercury	Mercury
Smallmouth Bass	Meals/Month	12	--	--
	Cause	PCBs & Mercury	--	--
Walleye	Meals/Month	1	2	--
	Cause	PCBs & Mercury	Mercury	--

Report By: Joseph Bohr
Surface Water Assessment Section
Water Resources Division

Acknowledgements: Partial funding for field work and sample analysis was provided through a USEPA GLRI grant awarded to the MDHHS. Samples were collected by the Keweenaw Bay Indian Community, and the MDNR, Fisheries Division.

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Alexander, M. 2008. A Sediment Chemistry Survey of Torch Lake, Houghton County, Michigan, August 7, 8, and 9, 2007. Michigan Dept of Environmental Quality, Water Bureau Staff Report MI/DEQ/WB-08/011

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USEPA, 2001. Baseline study report, Torch Lake Superfund site, Houghton County, Michigan. USEPA Region 5, Chicago, Illinois, (August 2001).

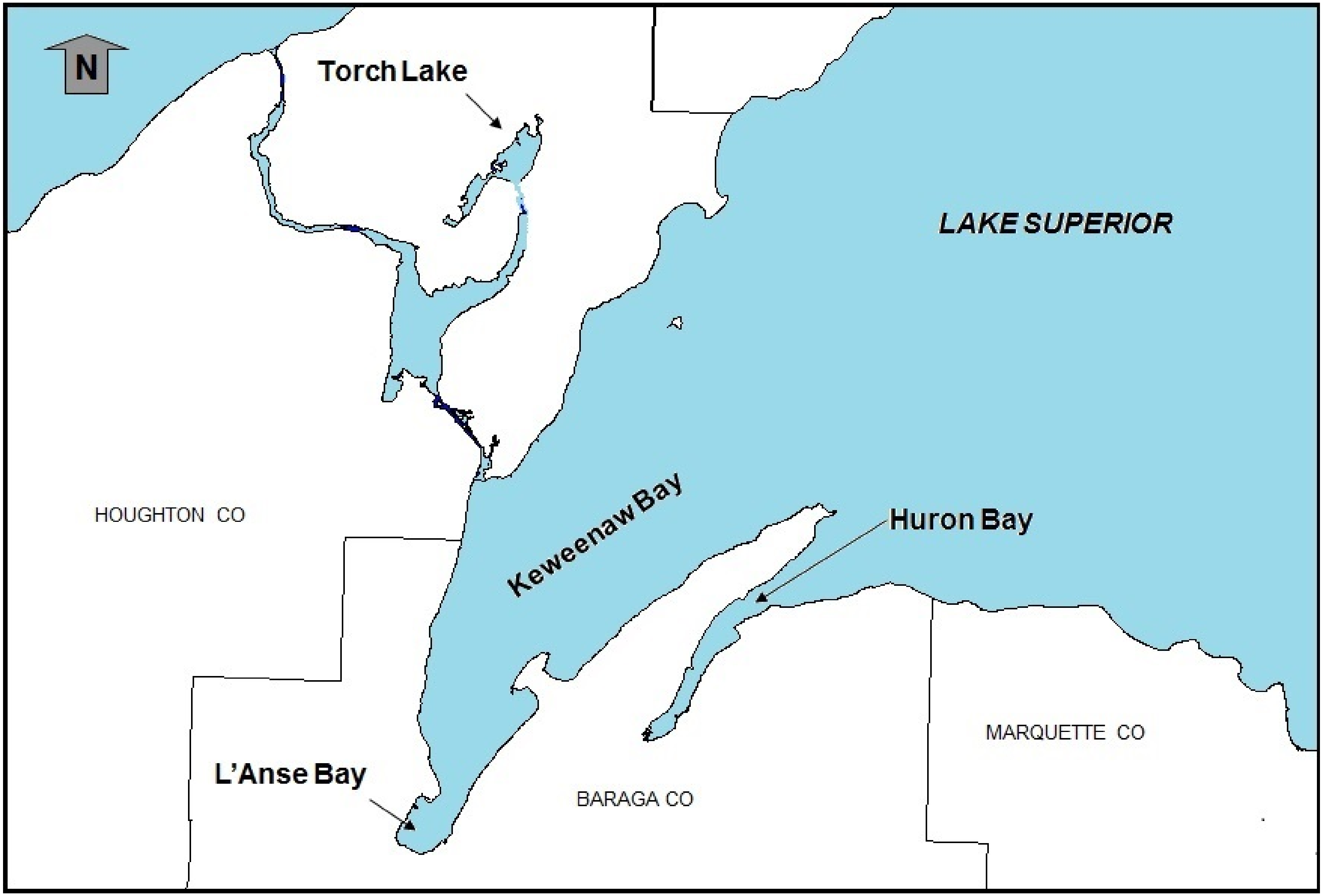

Figure 1. Map depicting Torch Lake and associated fish collection sites.

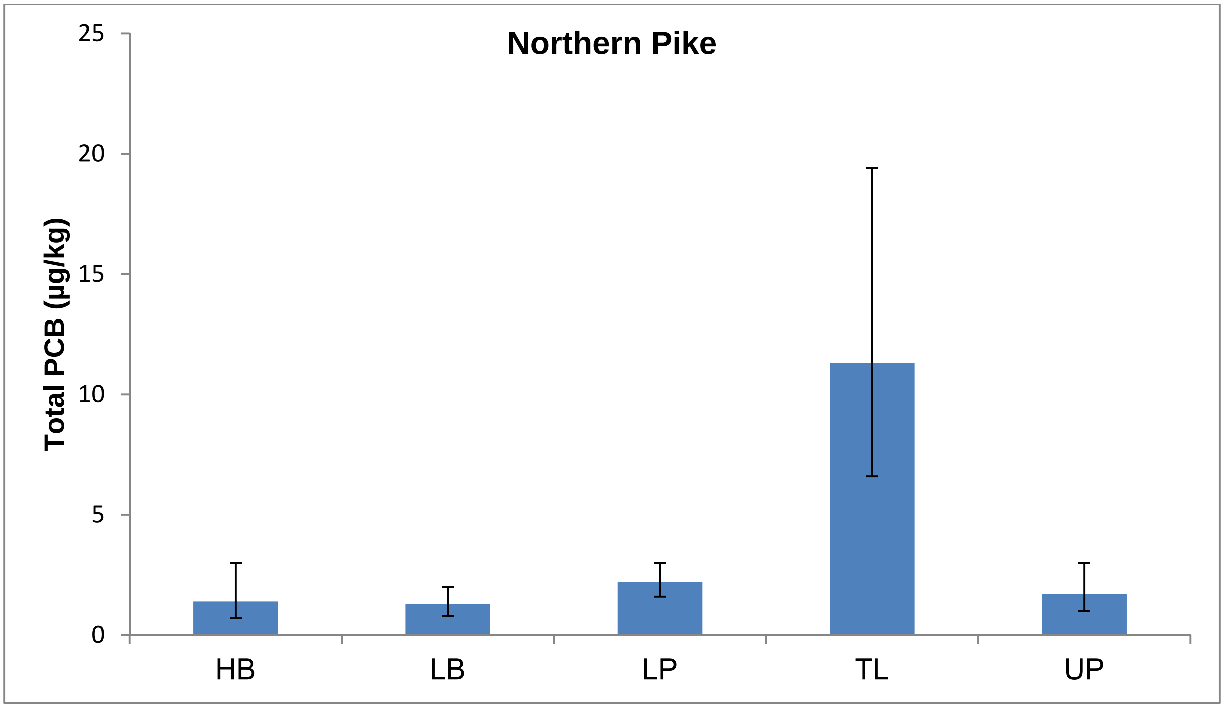

Figure 2. Estimated mean total PCBs in northern pike from Huron Bay (HB), L'Anse Bay (LB), Lower Peninsula lakes (LP), Torch Lake (TL), and Upper Peninsula lakes (UP). Values are least squares means and confidence limits estimated with the GLM using length and lipid content as covariates.

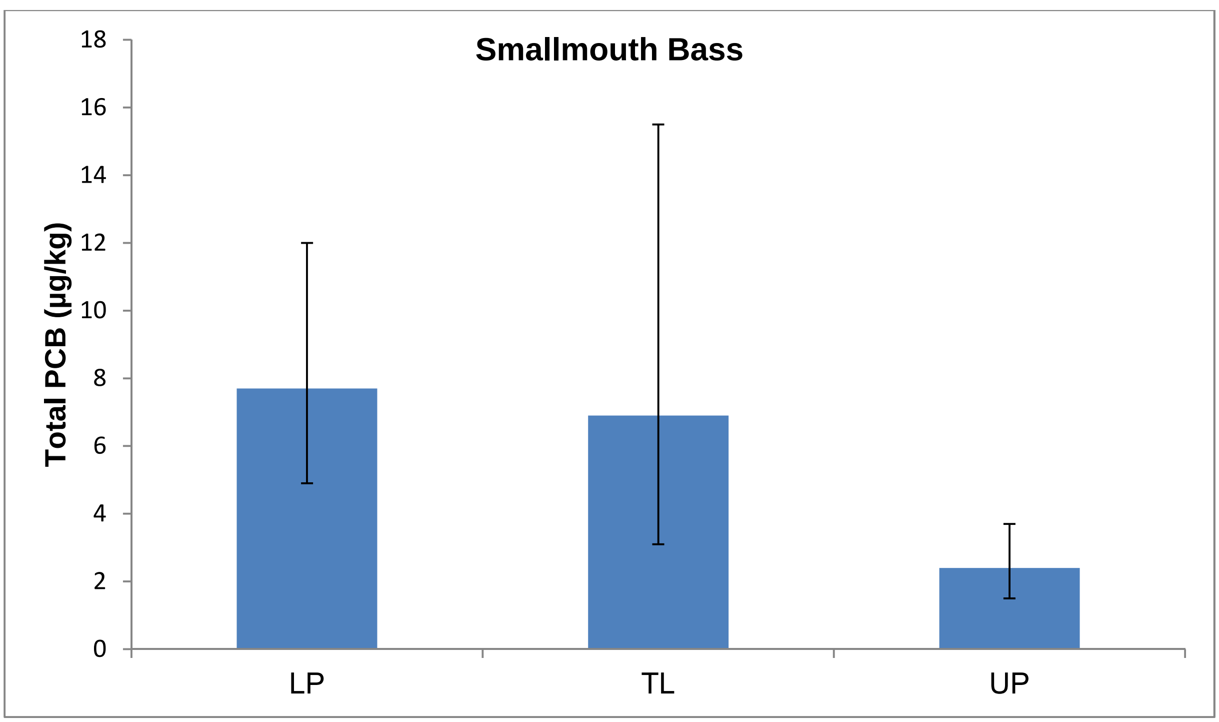

Figure 3. Estimated mean total PCB in smallmouth bass from Lower Peninsula lakes (LP), Torch Lake (TL), and Upper Peninsula lakes (UP). Values are least squares means and confidence limits estimated with the GLM (Length and lipids were significant covariates).

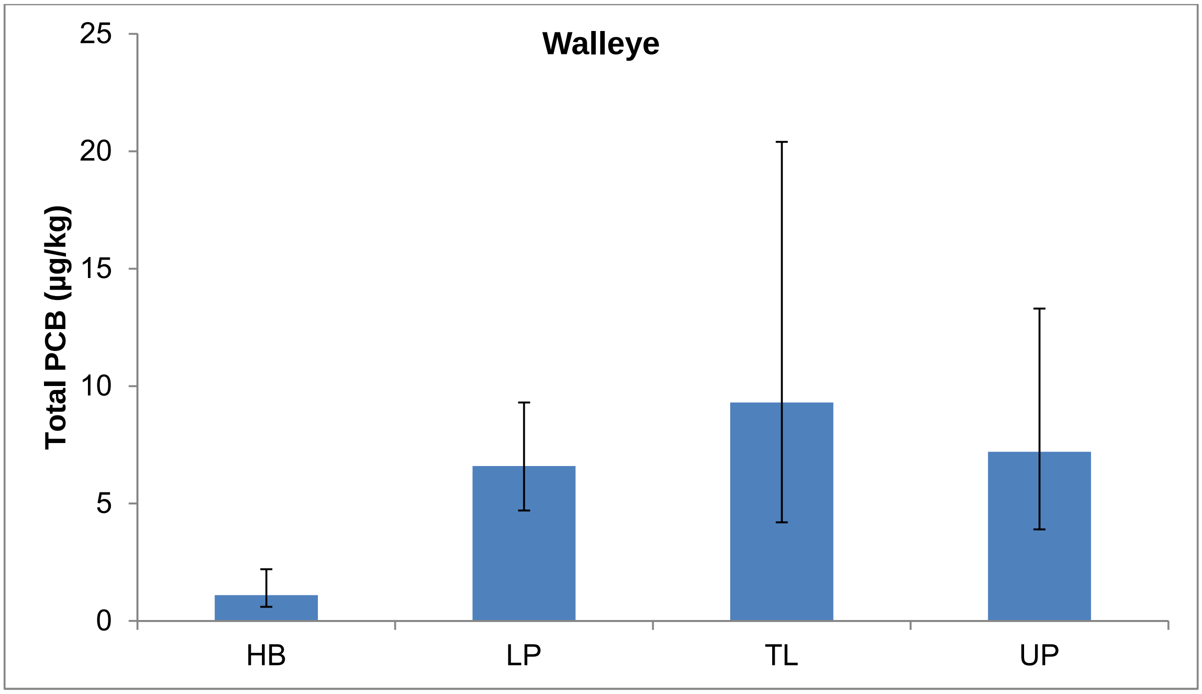

Figure 4. Estimated mean total PCB in walleye from Huron Bay (HB), Lower Peninsula lakes (LP), Torch Lake (TL), and Upper Peninsula lakes (UP). Values are least squares means and confidence limits estimated with the GLM using lipid content as a covariate (Length was not a significant covariate).

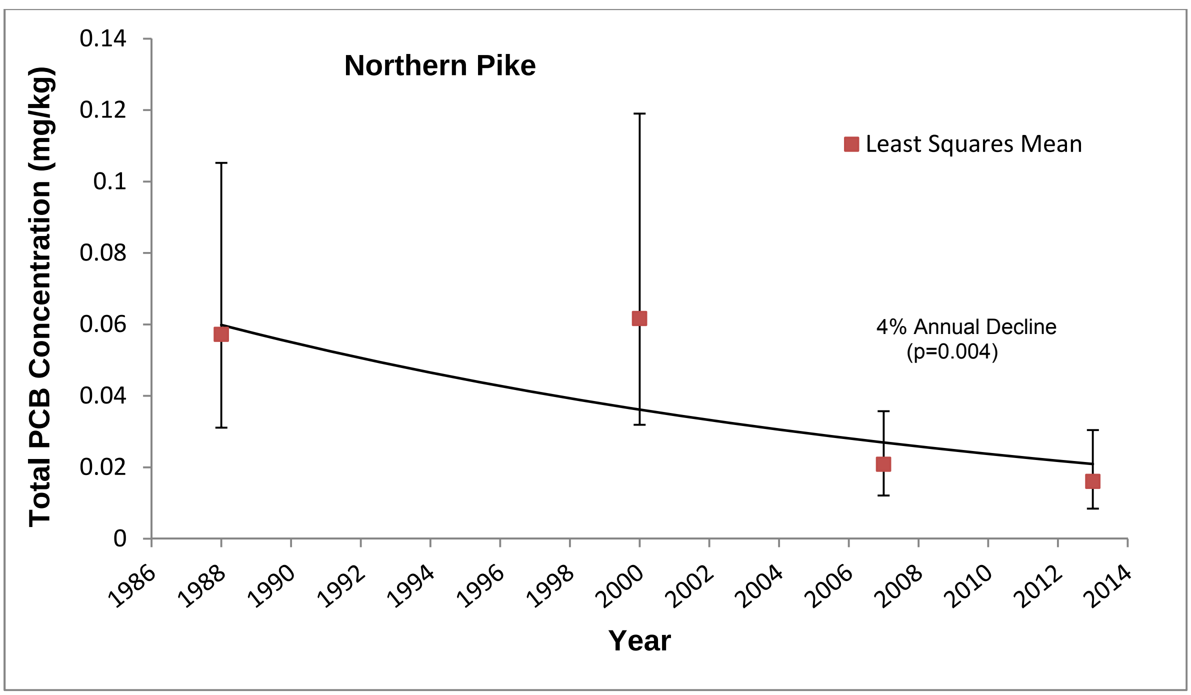

Figure 5. Estimated mean total PCB concentrations in Torch Lake northern pike over time. Least squares means and confidence limits were estimated using GLM with lipids as a covariate. The trend line was developed using a least squares regression model with lipids as a factor. (Length was not a significant covariate/factor).

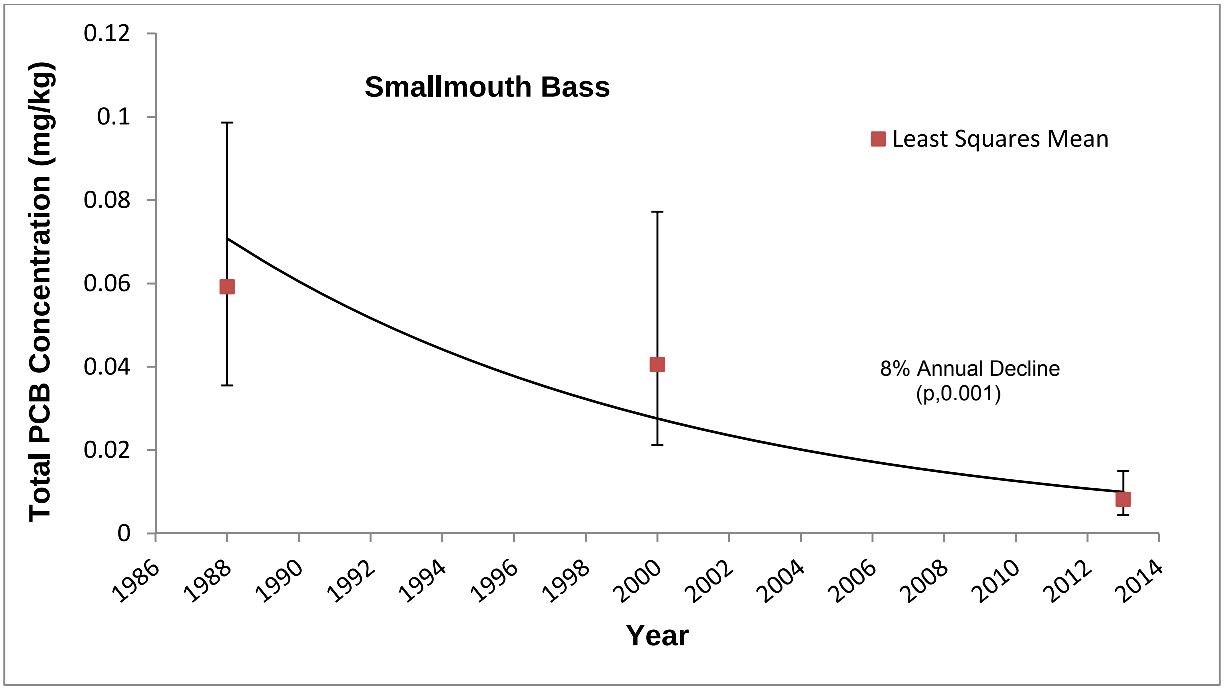

Figure 6. Estimated mean total PCB concentrations in Torch Lake smallmouth bass over time. Least squares means and confidence limits were estimated using GLM with length as a covariate. The trend line was developed using a least squares regression model with length as a factor. (Lipid content was not a significant covariate/factor).

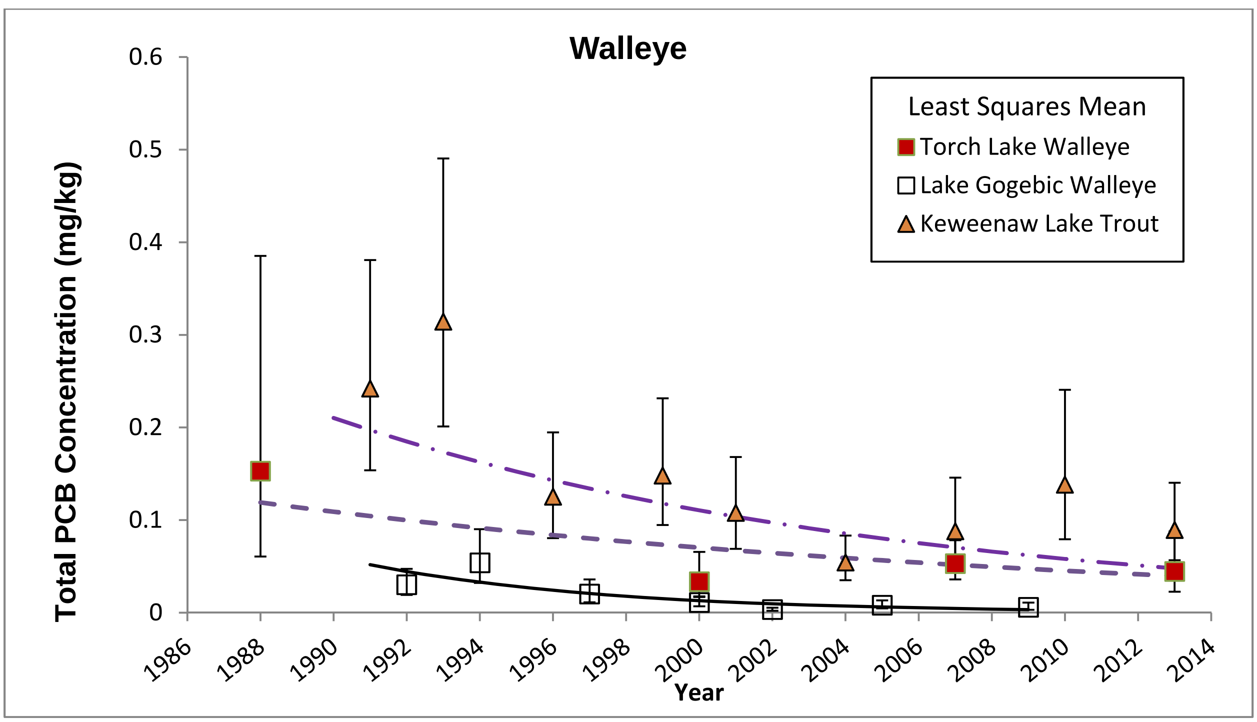

Figure 7. Estimated mean total PCB concentrations in Torch Lake walleye compared with Lake Gogebic walleye and Keweenaw Bay lake trout over time. Least squares means and confidence limits were estimated using GLM with length and lipid content as covariates. The trend lines were developed using a least squares regression model with length and lipids as factors.

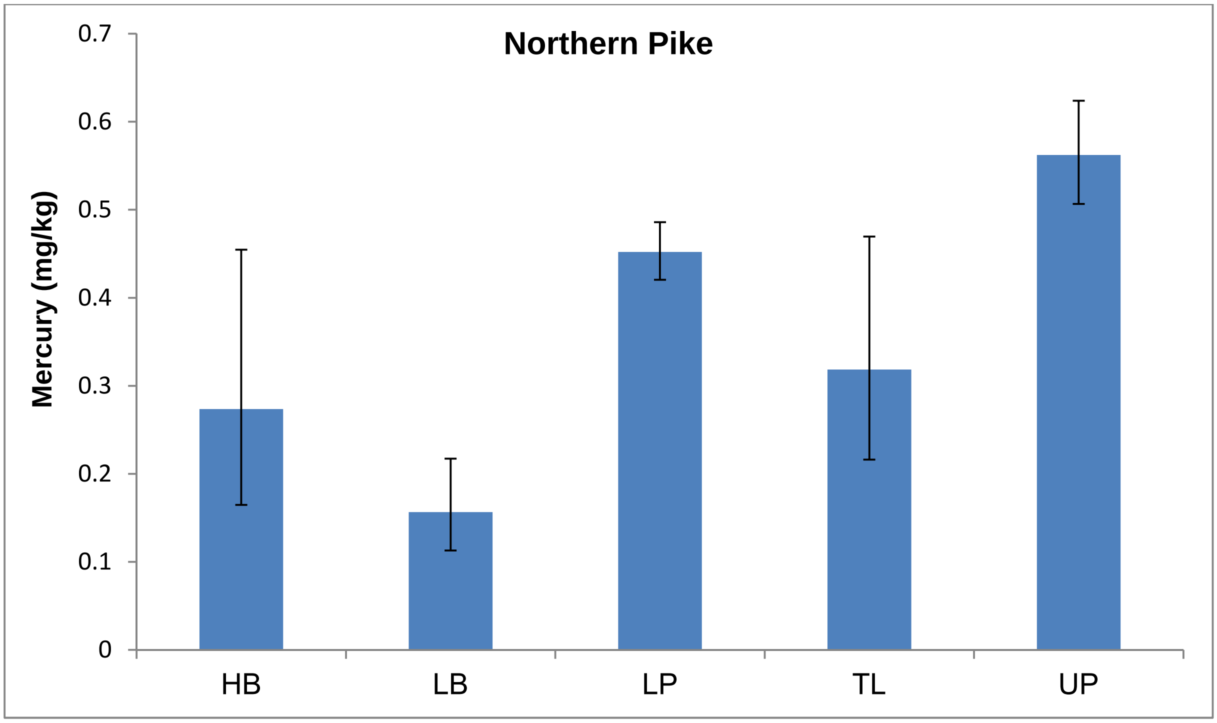

Figure 8. Estimated mean total mercury in northern pike from Huron Bay (HB), L'Anse Bay (LB), Lower Peninsula lakes (LP), Torch Lake (TL), and Upper Peninsula lakes (UP). Values are least squares means and confidence limits estimated with the GLM using length as a covariate.

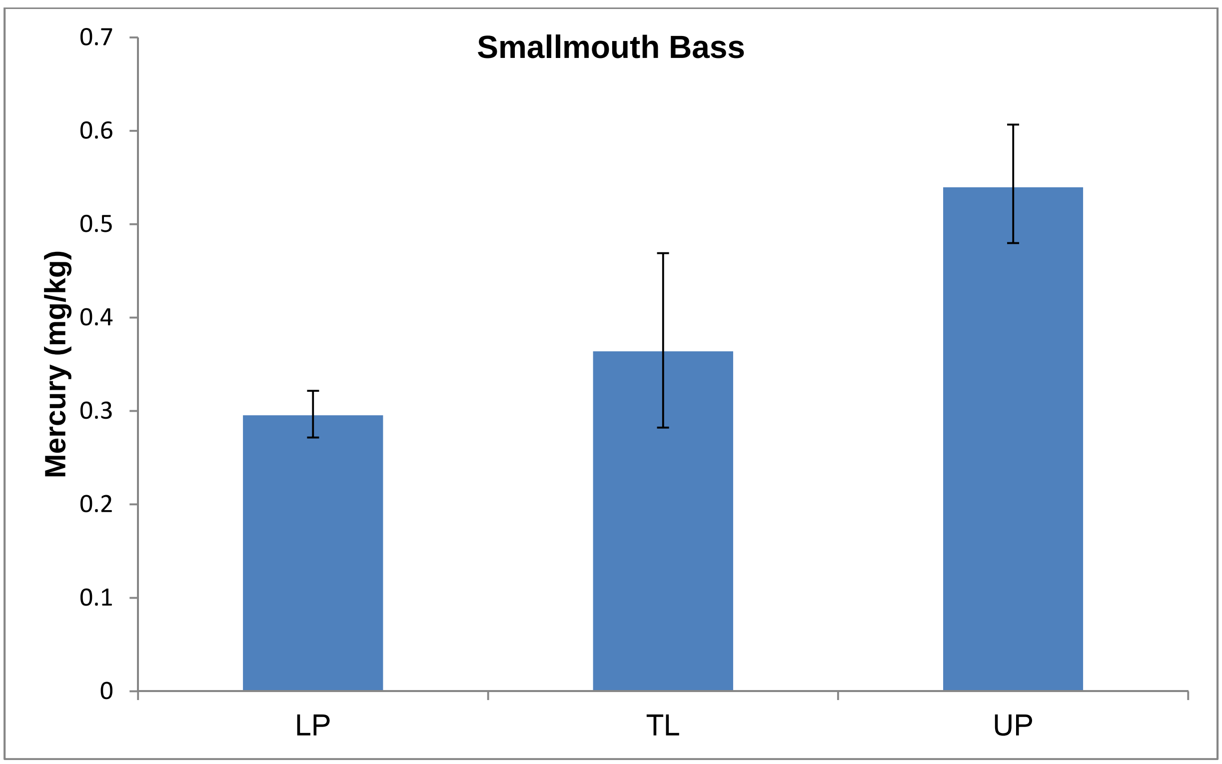

Figure 9. Estimated mean total mercury in smallmouth bass from Lower Peninsula lakes (LP), Torch Lake (TL), and Upper Peninsula lakes (UP). Values are least squares means and confidence limits estimated with the GLM using length as a covariate.

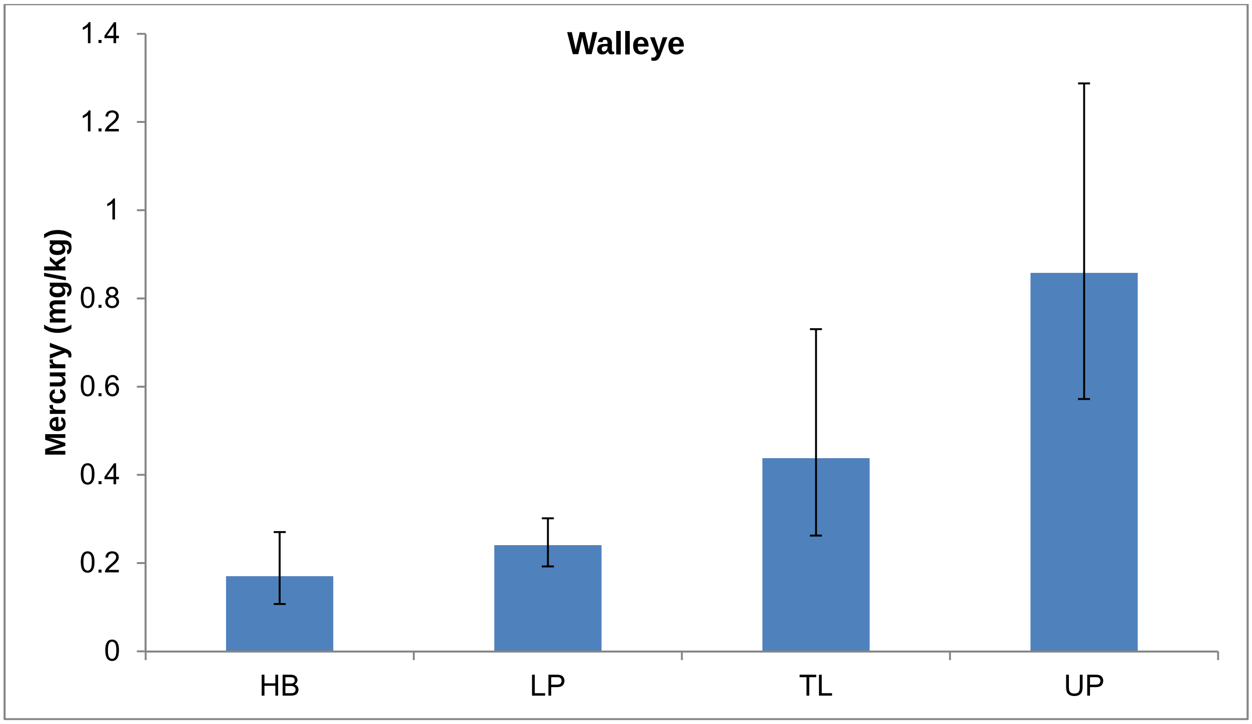

Figure 10. Estimated mean total mercury in walleye from Huron Bay (HB), Lower Peninsula lakes (LP), Torch Lake (TL), and Upper Peninsula lakes (UP). Values are least squares means and confidence limits estimated with the GLM using length as a covariate.

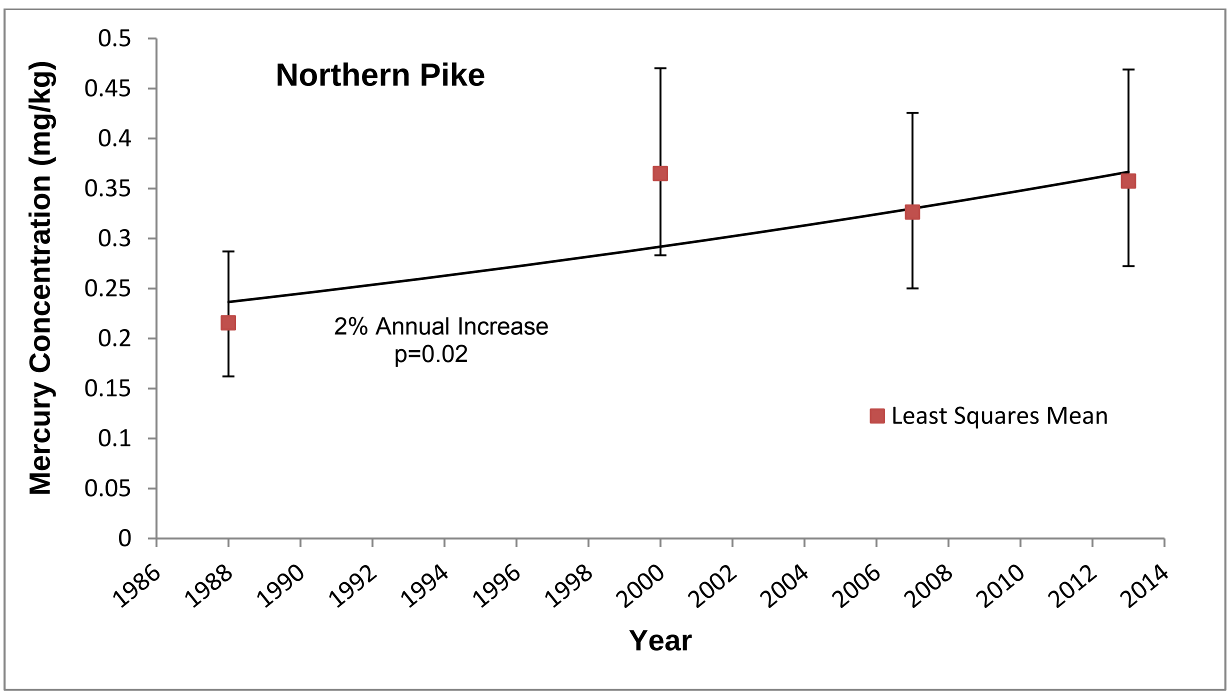

Figure 11. Estimated mean total mercury concentrations in Torch Lake northern pike over time. Least squares means and confidence limits were estimated using GLM with length as a covariate. The trend line was developed using a least squares regression model with length as a factor.

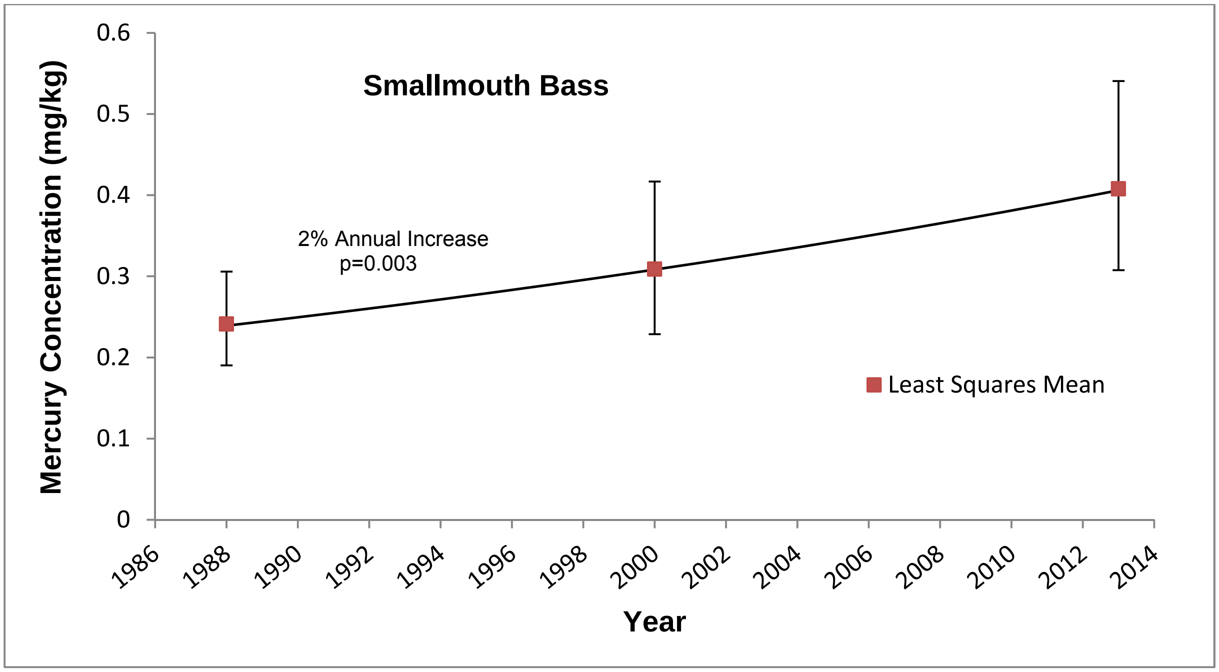

Figure 12. Estimated mean total mercury concentrations in Torch Lake smallmouth bass over time. Least squares means and confidence limits were estimated using GLM with length as a covariate. The trend line was developed using a least squares regression model with length as a factor.

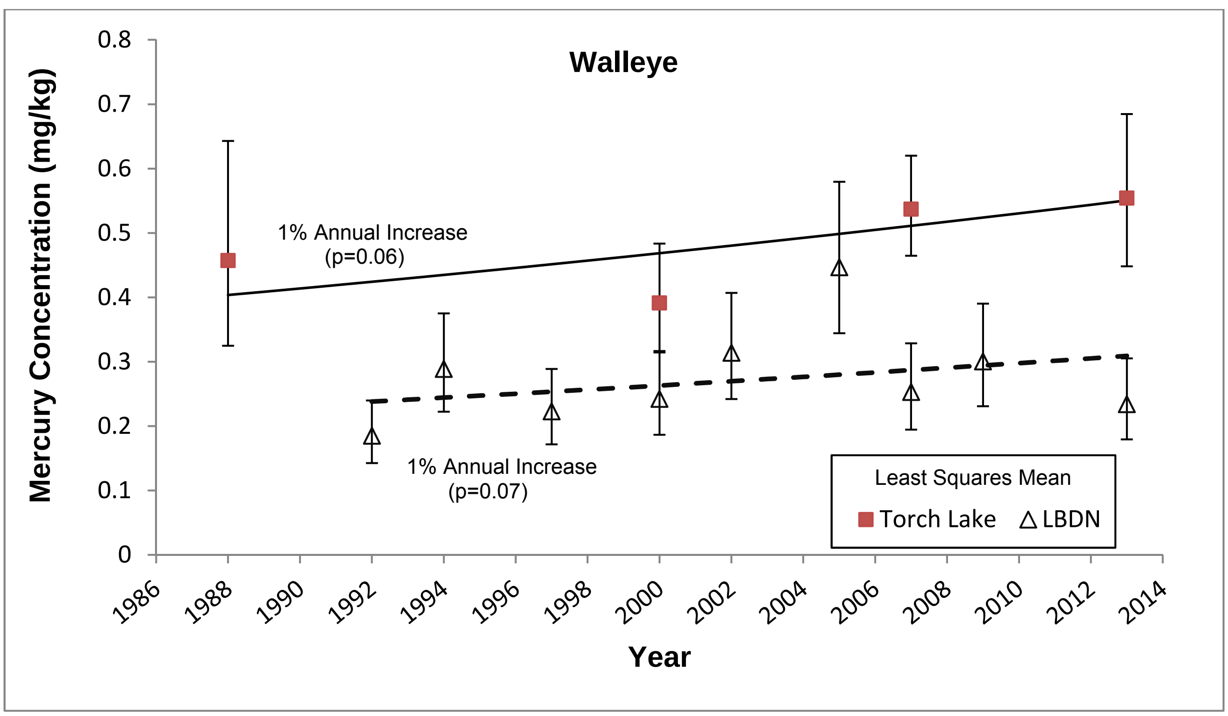

Figure 13. Estimated mean total mercury concentrations in Torch Lake walleye over time. Least squares means and confidence limits were estimated using GLM with length as a covariate. The trend line was developed using a least squares regression model with length as a factor.

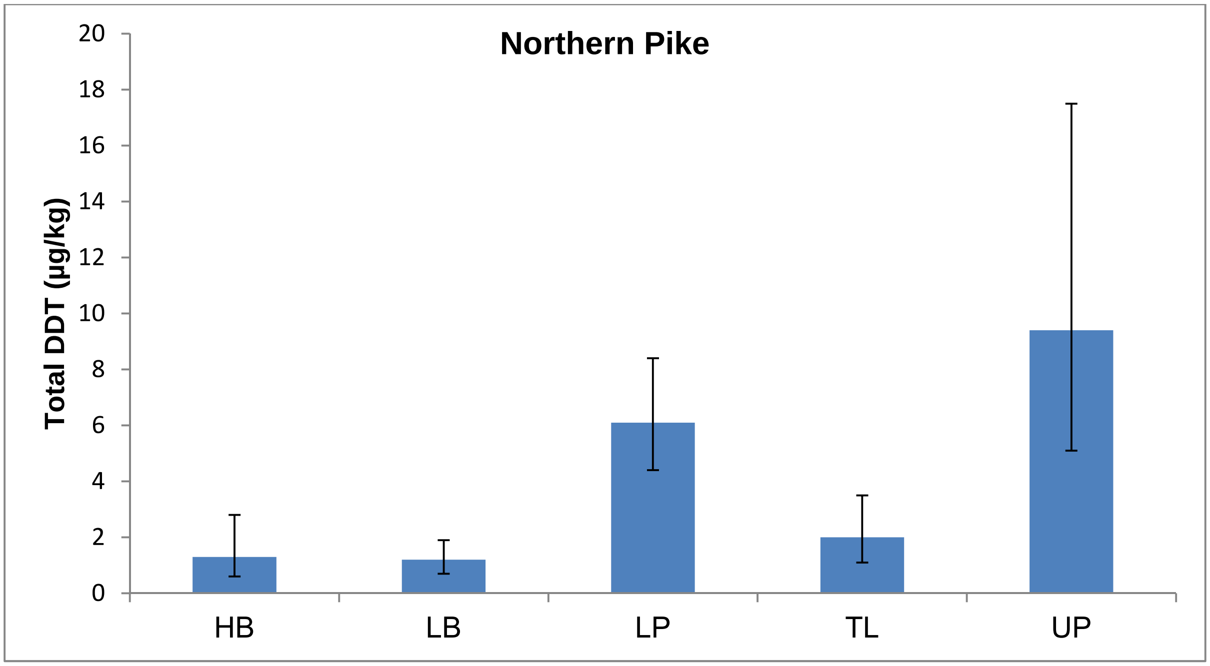

Figure 14. Estimated mean total DDT in northern pike from Huron Bay (HB), L'Anse Bay (LB), Lower Peninsula lakes (LP), Torch Lake (TL), and Upper Peninsula lakes (UP). Values are least squares means and confidence limits estimated with the GLM using lipid content as a covariate (Length was not a significant covariate).

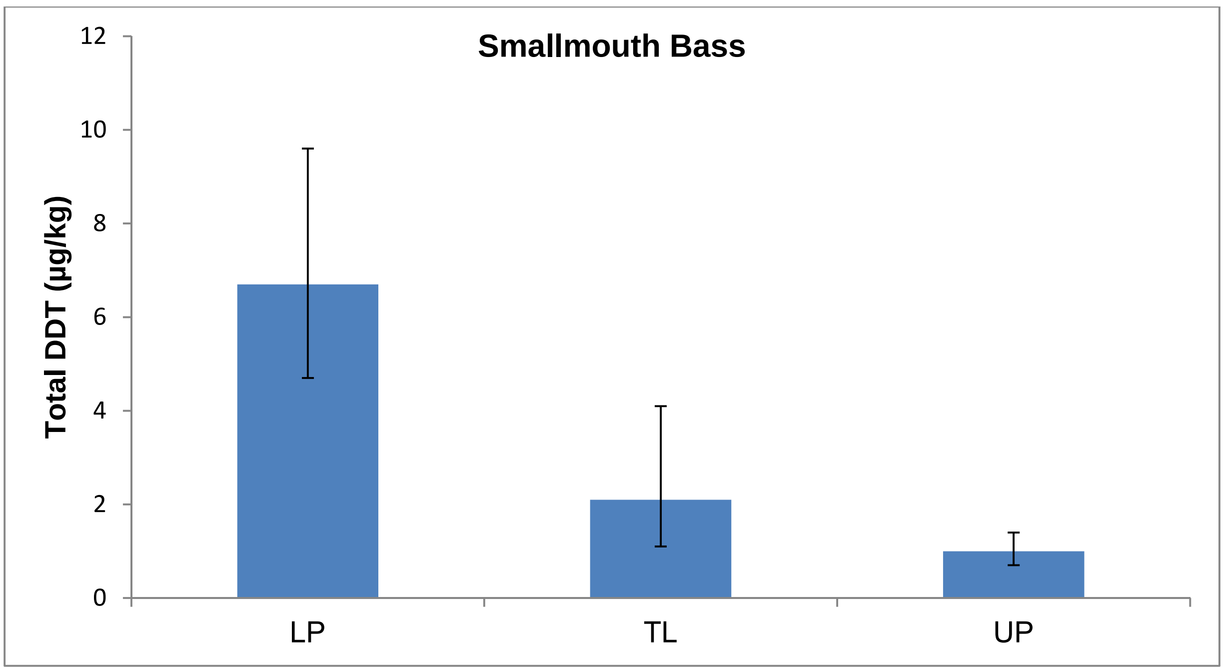

Figure 15. Estimated mean total DDT in smallmouth bass from Lower Peninsula lakes (LP), Torch Lake (TL), and Upper Peninsula lakes (UP). Values are least squares means and confidence limits estimated with the GLM using lipid content as a covariate (Length was not a significant covariate).

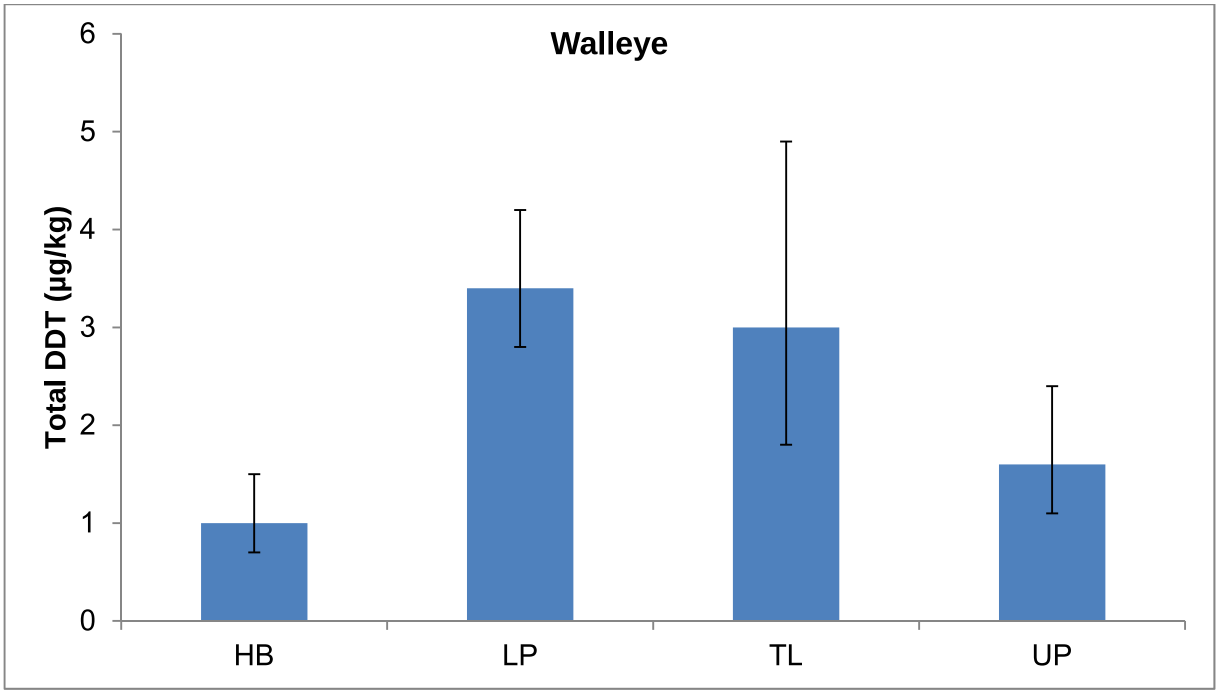

Figure 16. Estimated mean total DDT in walleye from Huron Bay (HB), Lower Peninsula lakes (LP), Torch Lake (TL), and Upper Peninsula lakes (UP). Values are least squares means and confidence limits estimated with the GLM using length and lipid content as covariates.

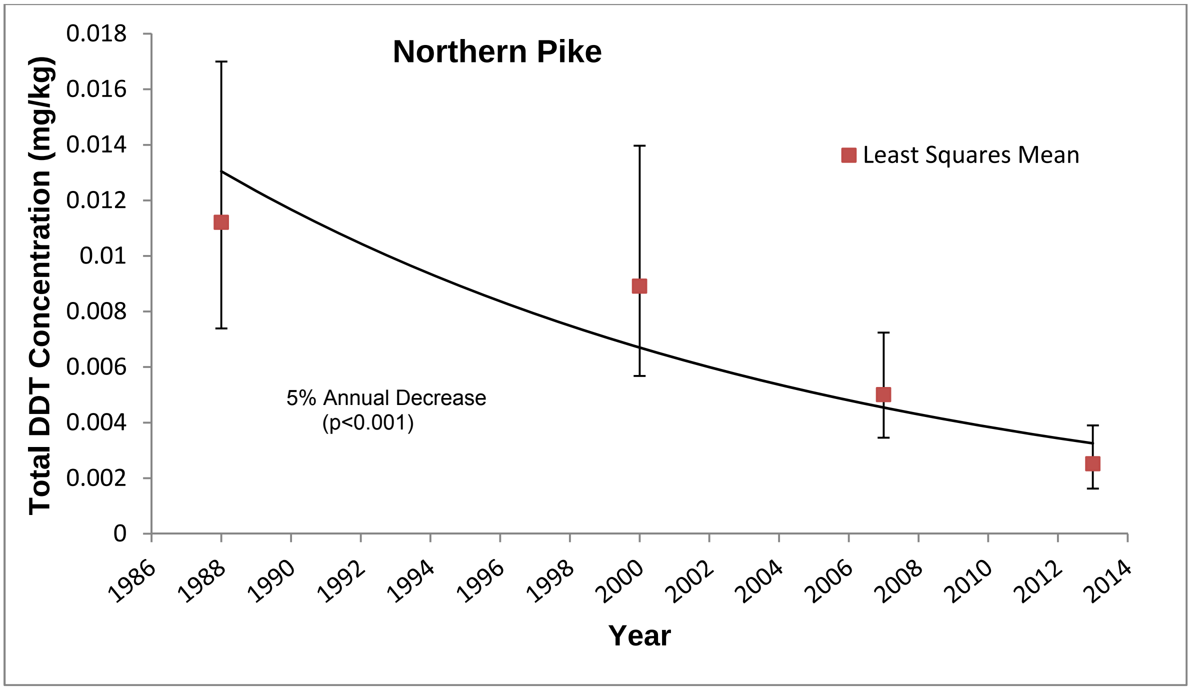

Figure 17. Estimated mean total DDT concentrations in Torch Lake northern pike over time. Least squares means and confidence limits were estimated using GLM with length and lipid content as covariates. The trend line was developed using a least squares regression model with length and covariates as factors.

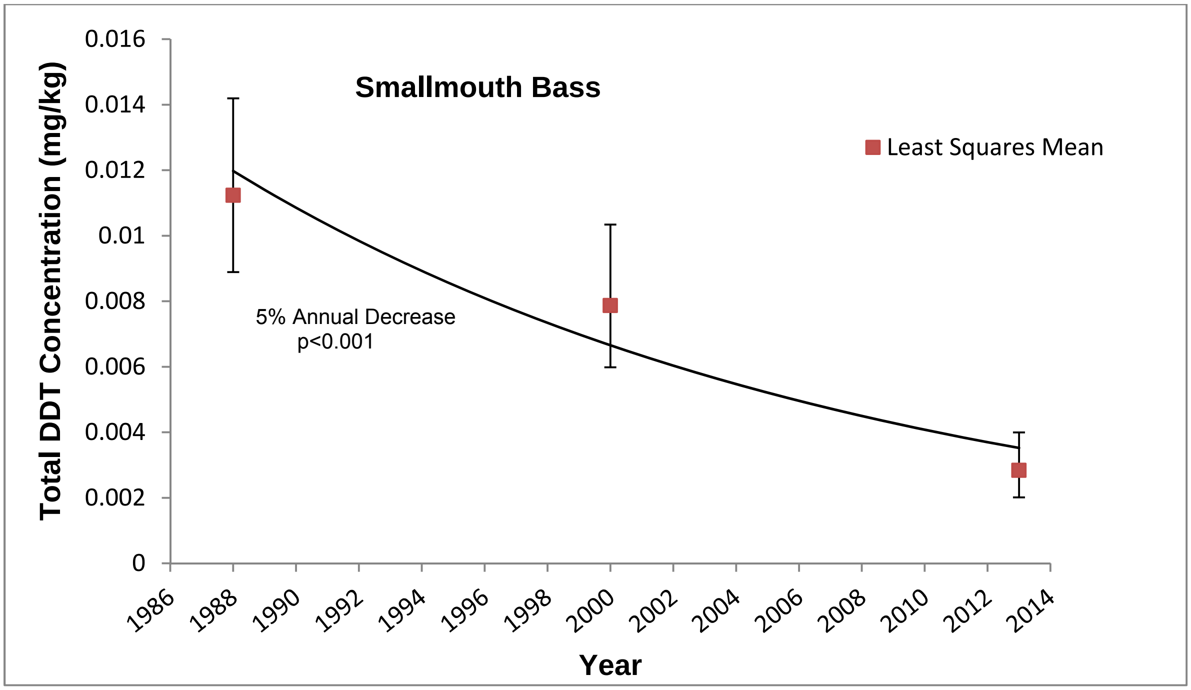

Figure 18. Estimated mean total DDT concentrations in Torch Lake smallmouth bass over time. Least squares means and confidence limits were estimated using GLM with length and lipid content as covariates. The trend line was developed using a least squares regression model with length and covariates as factors.

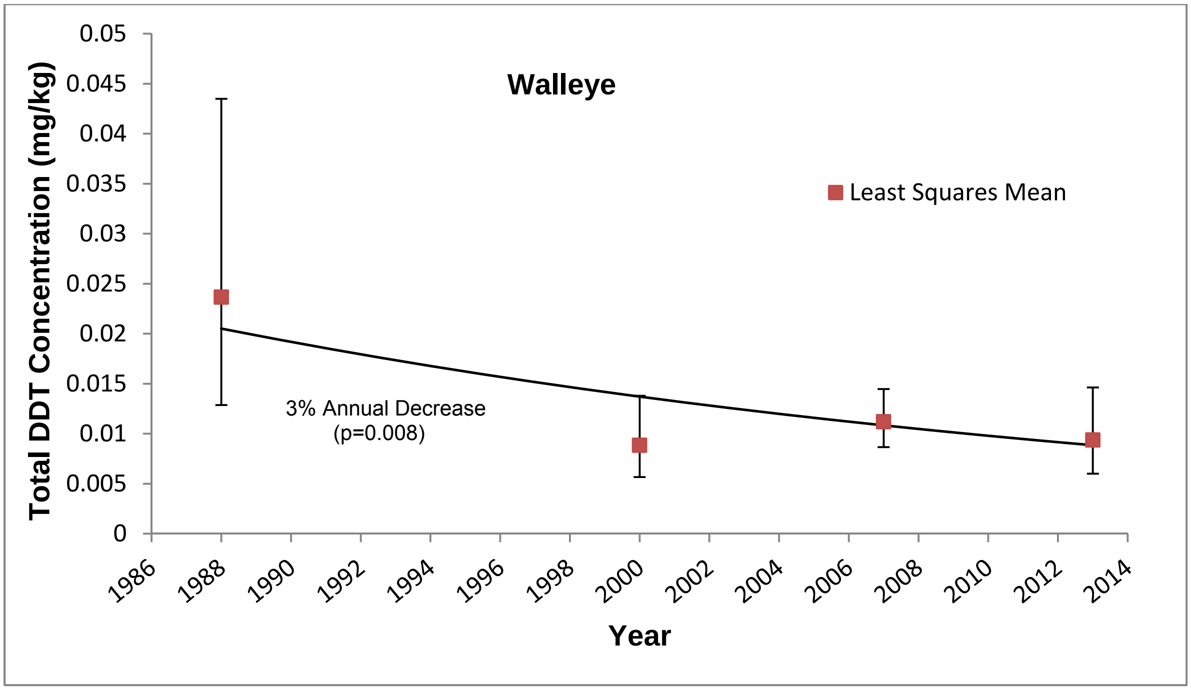

Figure 19. Estimated mean total DDT concentrations in Torch Lake walleye over time. Least squares means and confidence limits were estimated using GLM with length and lipid content as covariates. The trend line was developed using a least squares regression model with length and covariates as factors.

Appendix A1.

Summary statistics for lengths of fish samples collected from Torch Lake (TL), Huron Bay (HB), and L'Anse Bay (LB) in 2013.

Species	Length (Inches)						
	Site	Median	Mean	St Dev	Min	Max	N
Northern Pike	TL	29.0	29.4	2.78	25.2	34.3	10
	HB	32.1	32.1	3.94	27.1	39.2	7
	LB	42.5	28.6	5.86	23.6	42.5	13
Smallmouth Bass	TL	14.9	15.0	1.55	12.9	17.1	10
Walleye	TL	20.8	19.7	2.78	16.0	22.9	10
	HB	20.6	20.7	1.14	19.1	22.9	12

Appendix A2.

Summary statistics for total PCB concentrations fish samples collected from Torch Lake (TL), Huron Bay (HB), and L'Anse Bay (LB) in 2013.

Species	Total PCB Concentration (mg/kg)						
	Site	Median	Mean	St Dev	Min	Max	N
Northern Pike	TL	0.015	0.021	0.02	0.003	0.056	10
	HB	0.001	0.002	0.002	0.001	0.008	7
	LB	0.001	0.002	0.001	0.001	0.004	13
Smallmouth Bass	TL	0.01	0.011	0.01	0.001	0.034	10
Walleye	TL	0.046	0.093	0.132	0.001	0.426	10
	HB	0.003	0.003	0.003	0.001	0.01	12

Appendix A3.

Summary statistics for total mercury concentrations fish samples collected from Torch Lake (TL), Huron Bay (HB), and L'Anse Bay (LB) in 2013.

Species	Total Mercury Concentration (mg/kg)						
	Site	Median	Mean	St Dev	Min	Max	N
Northern Pike	TL	0.45	0.18	0.38	0.24	0.74	10
	HB	0.43	0.10	0.38	0.29	0.55	7
	LB	0.21	0.09	0.18	0.13	0.44	13
Smallmouth Bass	TL	0.42	0.24	0.37	0.18	0.95	10
Walleye	TL	0.64	0.45	0.54	0.22	1.70	10
	HB	0.26	0.09	0.25	0.13	0.48	12

Appendix A4.

Summary statistics for total DDT concentrations fish samples collected from Torch Lake (TL), Huron Bay (HB), and L'Anse Bay (LB) in 2013.

Species	Total DDT Concentration (mg/kg)						
	Site	Median	Mean	St Dev	Min	Max	N
Northern Pike	TL	0.003	0.002	0.002	0.001	0.006	10
	HB	0.001	0.001	0.001	0.001	0.003	7
	LB	0.001	0.0004	0.001	0.001	0.002	13
Smallmouth Bass	TL	0.002	0.001	0.002	0.001	0.004	10
Walleye	TL	0.013	0.021	0.006	0.001	0.069	10
	HB	0.002	0.001	0.002	0.001	0.003	12

MICHIGAN DEPARTMENT OF COMMUNITY HEALTH

SEMI-ANNUAL PROGRESS REPORT

USEPA-Great Lakes Restoration Initiative Projects

Grant or IA Number: GL-00E00869-0
Project Title: Assessing Michigan's Beneficial Use of Sport-Caught Fish
Reporting Period Covered: August 1, 2011 – December 31, 2011
Principal Investigator: Linda D. Dykema

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Summary of Work Accomplished

The following section summarizes the work accomplished on the project, *Assessing Michigan's Beneficial Use of Sport-Caught Fish*, for the reporting period of August 1, 2011 through December 31, 2011.

Restrictions on Fish Consumption Beneficial Use Impairment (BUI) Assessment Activities

Per our USEPA Project Officer, the Michigan Department of Community Health (MDCH) will continue to operate under the existing Quality Assurance Project Plan (QAPP) approved for our existing Great Lakes Restoration Initiative (GLRI) grant, *Enhance State of Michigan Fish Consumption Advisories* [GL-00E00457-2]. Development of project-specific sampling plans for each of the targeted Areas of Concern (AOC) is underway by the Michigan Department of Environmental Quality (MDEQ) in partnership with the public advisory councils in each of the respective AOCs. MDCH will re-submit the existing QAPP, along with the new Sampling Plans to the EPA for approval when completed.

The MDCH project coordinator/health educator and the MDEQ specialist in charge of overseeing the fish sampling program have conducted or scheduled information gathering sessions with each of the MDEQ State Contacts assigned to each of the AOCs. The MDEQ State Contact works closely with each of the AOCs in their jurisdiction. Therefore, they are able to provide valuable information about the operations of the advisory councils in the AOCs and the communities in which they function, identification of potential external stakeholders, and possible anomalies to our traditional sampling plan strategy. This knowledge provides the foundation for the sampling and communication plans integral to this project.

Tainting of Fish Flavor BUI Assessment Activities

The Friends of the Detroit River received a GLRI grant to survey anglers on tainting of flavor of fish from the Detroit River. MDCH and MDEQ are awaiting completion of Friends' analysis to determine if additional studies are needed in order to recommend removal of this BUI from the Detroit River. Friends of the Detroit River anticipate final results of this analysis in April 2012, at which point we can proceed as needed.

Fish Tumor or Other Deformities BUI Assessment Activities

MDEQ looked for tumors in bullhead collected from the Detroit River during 2011 for routine chemical analysis. Results from twenty-one (21) Detroit River bullheads have shown no sign of tumors. The MDCH and MDEQ are in the process of drafting a recommendation letter to the Detroit River AOC advisory council recommending a petition to the EPA for removal of the tumor BUI from the Detroit River.

The Rouge River AOC will also require a novel collection of bullhead in order to fully assess the current status of the BUI. MDEQ is developing a sampling plan to fulfill this need.

The St Marys River AOC sampling plan for fish consumption analysis will also include the collection of 20 bullhead from the St Marys River, as well as 20 bullhead from a suitable referent site, to assess the current tumor-growth status of the fish.

Community Outreach Activities

Key personnel involved in this project were introduced to stakeholders in each of the targeted AOCs. The MDCH project coordinator/health educator presented an overview of the project at a St. Clair River AOC binational public advisory committee meeting in late October 2011. She has also discussed the project via conference call with the Deer Lake Public Advisory Council in early December 2011 and has plans to attend the in-person council meeting scheduled for April 2012. The MDCH project coordinator/health educator also plans to attend the other springtime advisory council meetings in the targeted AOCs to discuss and collect the finalized sampling plans provided to the advisory councils over the winter. She will work to identify key messages important to the advisory council and the community.

The MDCH project coordinator/health educator will use this information to draft Community-based Fish Consumption Advisory plans. MDCH will present these plans to each of the advisory councils prior to the launch of any communication campaign in the targeted AOCs.

The MDCH project coordinator/health educator also attended the October conference, *US Areas of Concern Program Annual Meeting: Celebrating Progress; Confronting Challenges; Moving Forward!* in Detroit. She was an invited speaker for the Beneficial Use Impairment Breakout Session titled, "Tainting of fish and wildlife flavor and restrictions on fish and wildlife consumption." She provided an overview of the MDCH GLRI grant award and objectives to a small group of attendees.

Reporting Activities

Quarterly updates have been posted in the GLAS reporting system as required.

Changes to Object Class Categories

None

Barriers and Corrective Actions

None

Activity Workplan and Current Status (as of 12/31/2011)

Activity	Percentage Completed	
	This Reporting Period	For the Project
Restrictions on Fish Consumption BUI Assessment Activities		
• Submit QAPP for EPA Approval	80%	80%
• Develop AOC Fish Sampling Plans for targeted AOCs	40%	40%
• Fish collection	0	0
• Processing of fish samples	0	0
• Analysis of fish samples	0	0
• Analytical reports completed	0	0
• Data review and analysis	0	0
• Attend AOC advisory council meetings, as necessary	40%	40%
Tainting of Fish Flavor BUI Assessment Activities		
• Evaluate Detroit River data	0	0
• Issue reports and recommendations	0	0
• Attend AOC advisory council meetings, as necessary	0	0
Fish Tumor or Other Deformities BUI Assessment Activities		
• Evaluate Detroit River data	100%	100%
• Develop fish sampling plans, if needed, for St Mary's & Rouge River AOCs	15%	15%
• Fish collection	0	0
• Processing of fish samples	0	0
• Analysis of fish samples	0	0
• Analytical reports completed	0	0
• Data review and analysis	0	0
• Attend AOC advisory council meetings, as necessary	0	0

Community Outreach Activities		
• Develop Community Outreach Plans	15%	15%
• Implement Plans	0	0%
• Attend AOC advisory council meetings, as necessary	15%	15%

Funding Rates

MDCH's current rate of funding use is appropriate for the Workplan. Substantial background work and preparation was required before fish collection, sampling, BUI action recommendations, testing of messages and outreach can begin. This upcoming work will account for the majority of our spending, outside of salary support for the individuals working on this project.

Category	Grant Award	Expend. 10/1/10-9/30/11	% of Award
Salaries	$0	$0	100%
Fringe Benefits	$0	$0	100%
Travel	$0	$0	100%
Supplies	$0	$0	100%
Other (Inc. Contractual)	$491,153.00	$18,506.51	4%
Random Moment	$7,479.00	$0	0%
Subtotal Direct	$498,632.00	$18,506.51	4%
Indirect	$0	$0	100%
Total	$498,632.00	$18,506.51	4%

Drawdown Request & Explanation

As of 12/31/2011, no drawdown has occurred from this grant. This is due to timing and delays in our accounting back office. January's drawdown will reflect the expenditures on the grant since October 2011.

Principal investigator Update

Dr. Linda D. Dykema continues in the principal investigator role for this grant project.

Amendment to Project Period

None

Great Lakes Accountability System Entry Explanation

MDCH reported to GLAS on 01/04/2012.

MICHIGAN DEPARTMENT OF COMMUNITY HEALTH

SEMI-ANNUAL PROGRESS REPORT

USEPA-Great Lakes Restoration Initiative Projects

Grant or IA Number: GL-00E00869-0
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Reporting Period Covered: January 1 – June 30, 2012
Principal Investigator: Linda D. Dykema

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Summary of Work Accomplished

The following section summarizes the work accomplished on the project, *Assessing Michigan's Beneficial Use of Sport-Caught Fish*, for the reporting period of January 1 through June 30, 2012.

Restrictions on Fish Consumption Beneficial Use Impairment (BUI) Assessment Activities

Per the MDEQ's *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, three criteria exist for the removal of Restrictions on Fish Consumption and Wildlife BUI. The BUI is restored when:

- The fish consumption advisories in the Area of Concern (AOC) are the same or less restrictive than the associated Great Lake or appropriate control site.

OR, if the advisory in the AOC is more stringent than the associate Great Lake or control site:

- A comparison study of fish tissue contaminant levels demonstrates that there is no statistically significant difference in fish tissue concentrations of contaminants causing fish consumption advisories in the AOC compared to a control site.

OR, if a comparison study is not feasible because of the lack of a suitable control site:

- Analysis of trend data (if available) for fish with consumption advisories shows similar trends to other appropriate Great Lakes trend sites.

The first step toward assessing this BUI for all sites, regardless of criteria, is fish collection and contaminant analysis. Per our Environmental Protection Agency (EPA) Project Officer, the Michigan Department of Community Health (MDCH) will continue to operate under the existing Quality Assurance Project Plan (QAPP) approved for our existing Great Lakes Restoration Initiative (GLRI) grant, *Enhance State of Michigan Fish Consumption Advisories* [GL-00E00457-2]. MDCH submitted to the EPA for approval on June 19, 2012, the QAPP and the final sampling plans for five targeted sites and two control sites.

Michigan Department of Environmental Quality (MDEQ) in partnership with the MDCH and the public advisory councils (PACs) in each of the respective AOCs developed project-specific sampling plans for most of the targeted AOCs. River Raisin sampling is delayed until Grant Year 3, per request of the EPA.

Status of Assessment Activities for Fish Consumption (as of 6/25/2012):

AOC or Reference Site	Current Status of Fish Assessment		
	Collected	Processed	At Lab
Deer Lake	X	X	X
Menominee River	In Process		
River Raisin	Year 3		
St Clair River	In Process		
St Marys River	X	X	
Les Cheneaux Islands	X	X	
Little Bay de Noc*	X	X	

*Collections will continue in the fall.

Tainting of Fish Flavor BUI Assessment Activities

Per the MDEQ's *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, two criteria exist for the removal of Tainting of Fish and Wildlife Flavor BUIs. This document states that the BUI will be considered restored when:

- No more than three reports of fish tainting have been made to the MDNR or MDEQ for a period of three years.

OR, if there have been reports of tainting

- A one-time analysis of representative fish species in an AOC in accordance with MDEQ Surface Water Assessment Section (SWAS) Procedure #55 for conducting taste and odor studies indicates that there is no tainting of fish flavor.

Detroit River

The Friends of the Detroit River received a GLRI grant to survey anglers on tainting of flavor of fish from the Detroit River. In early June, the Detroit River AOC Public Advisory Council (PAC) delivered their report and request for BUI removal to the MDEQ based upon their survey results.

> "For the ranking of taste and smell of the fish caught and consumed, over ninety-one percent (91.2%) rated the taste of the fish consumed as "excellent/good", while less than one percent (0.7%) rated the taste as "poor". For the ranking of fish smell, over ninety percent (90.4%) of the fishermen surveyed rated the smell of the fish as "excellent/good" with only four percent (4%) rating the fish as smelling "poor".
>
> Of the 27 fishermen who answered "yes" to question five on the survey, "In the last three (3) years have you noticed any objectionable tastes or odors in the fish caught in the Detroit River?", only five directly referenced observing an oily or chemical taste or smell in the fish they caught and consumed. The others made references to having a fishy or strong taste or smell, and references to the fish's texture that might be a factor of how the fish was stored, cleaned or attributable to what the fish might have been eating."
>
> - *An Angler Survey to Assess the Status of the Beneficial Use Impairment: Tainting of Fish and Wildlife Flavor on the U.S. Side of the Detroit River,* **Friends of the Detroit River (2012)**

Their results correlated with those surveys implemented prior to the Detroit study by Ontario on the Detroit River and St Clair River Binational Public Advisory Council (BPAC) – both of which also resulted in the removal of the Tainting of Fish Flavor BUI in their respective AOCs.

The Detroit River AOC PAC's recommendation is currently under review by MDEQ. If accepted, a public comment period will follow, prior to the removal of the Tainting of Fish Flavor BUI from the Detroit River AOC.

Fish Tumor or Other Deformities BUI Assessment Activities

Per the MDEQ's *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, two criteria exist for the removal of Fish Tumor or Other Deformities BUI. The BUI is restored when:

- No reports of fish tumors or deformities due to chemical contaminants which have been verified through observation and analysis by the Michigan Department of Natural Resources (MDNR) or the MDEQ for a period of five years.

Or, in cases where any tumors have been reported:

- A comparison study of resident benthic fish (e.g. brown bullhead) of comparable age and at maturity (3 years), or of fish species that have been historically associated with this BUI, in the AOC and a non-impacted control site indicates that there is no statistically significant difference (with a 95% confidence interval) in the incidence of liver tumors or deformities.

Detroit River AOC
MDEQ looked for tumors in bullhead collected from the Detroit River during 2011 for routine chemical analysis. Results from twenty-one (21) Detroit River bullheads have shown no sign of tumors. At a recent State PAC meeting, a member of the US Fish and Wildlife Service (FWS) notified us of research they were also doing in the Detroit River relative to tumor assessment. MDEQ and MDCH may delay the report to the PAC until we receive the FWS data. The MDEQ Office of the Great Lakes will determine when to finalize and present the report to the PAC.

St Marys River AOC
The St Marys River AOC sampling plan for fish consumption analysis included the collection and examination for tumors in bullhead from the St Marys River. MDEQ examined bullhead during processing. Results from the reference site are pending. However, given that the collection of fish from the AOC had no tumors and there were no confirmed reports of tumors filed in the last five years, it is likely this BUI can be removed in the near future.

Rouge River AOC
The Rouge River AOC may also require a novel collection of bullhead to assess the status of the BUI. However, MDEQ Office of the Great Lakes is currently assessing the necessity of additional sampling, as existing data may provide the statistical evidence needed.

Community Outreach Activities

From January 1 until June 30, the health educator/project coordinator (HE/PC) attended multiple PAC meetings in person and via conference call. The HE/PC presented an overview of the sampling plan and outreach in person at meetings in the St Marys River AOC in February, Detroit River AOC in March, and Deer Lake AOC in April.

The MDCH HE/PC is taking a tiered approach when developing outreach materials for the targeted AOCs. Given the need for data prior to determining if any fish consumption BUIs will be lifted and determining what new fish consumption guidelines may be issued in the AOC, area-specific outreach is predominantly on hold until spring of 2013.

Deer Lake PAC Meeting, April 2012

Communication Outreach (CO) Tier 1
During this downtime, the HE/PC has focused on developing and preparing to distribute general "Eat Safe Fish" materials that promote the Michigan fish consumption guidelines and are applicable statewide in AOCs. The goal of this outreach is to normalize the concept of fish consumption guidelines. The objective is to build awareness of the need to "choose safe fish" throughout the state of Michigan.
The HE/PC proposes that many members of the public are unaware of the terms Area of Concern, Beneficial Use

Impairment and even Michigan Fish Advisory/Eat Safe Fish Guide. With the assumption that fish consumption BUIs will be removed in the near future in many AOCs in Michigan, the HE/PC feels it is important to first saturate the AOC market with information about the fish consumption guidelines and presenting them as a statewide "fact of life," prior to introducing the concept of fish consumption BUIs. The HE/PC hypothesizes that the public will be more accepting of the removal criteria 'no worse than a like body of water' if they understand that fish consumption guidelines exist statewide and that the fish consumption guidelines on their local lake and river are the norm rather than an exception.

CO Tier 2

The HE/PC also feels that as fish consumption BUIs begin to be removed, it is important that the public are introduced to the concepts of AOCs and fish consumption BUIs in a clear, concise manner. It is also important that the public is clear on the distinct differences between a fish consumption BUI and an MDCH fish consumption guideline. It is with this goal in mind that the HE/PC developed, in partnership with the MDEQ AOC Coordinators, the "Eat Safe Fish in Areas of Concern" fact sheet. MDCH and MDEQ will distribute this fact sheet (see attached) to media prior to any fish consumption BUI removal, and to the public during BUI removal public comment sessions and other related events.

The fact sheet, as well as multiple general Eat Safe Fish outreach materials, are being developed and distributed to the targeted AOCs this summer to create familiarity and generate local support of the fish consumption guidelines. MDCH is collaborating with members of the St Marys BPAC to facilitate this project.

CO Tier 3

Once MDCH receives updated fish contaminant data, the HE/PC will work with the PACs to develop area-specific appropriate outreach materials that serve to educate the public about the AOC, the BUI, and the fish consumption guidelines applicable to their area.

Deer Lake
Status: CO Tiers 1-3

Deer Lake is a unique AOC. This location is the only targeted AOC that is using trend data for their BUI removal criteria, rather than a reference site comparison. Given the years of declining mercury levels in fish, and consecutive years of data demonstrating that limited fish consumption is now possible, MDCH will relax the Deer Lake fish consumption guidelines in the 2012-2013 Eat Safe Fish Guide from 'Do Not Eat" for all species to limited consumption of some fish species.

However, despite this relaxed consumption guideline, the Michigan Department of Natural Resources (MDNR) will continue to uphold their "no possession of any fish" rule established on Deer Lake for the remainder of 2012. The MDNR originally implemented this rule to support the MDCH "Do Not Eat" guidelines. Given the relaxation of the fish consumption guidelines, the MDNR will hold a public comment session later this year to discuss their 'no possession' regulation. Based on public and MDNR expert input, the MDNR will either continue to uphold their catch and release only policy to protect the fishery or will amend their policy to allow for other management options.

Given this unique arrangement, MDCH recognizes the need to develop a strategic communication plan that not only celebrates the work being done and the success of continuing work that has resulted in a measurable reduction of mercury in the lake and fish, but also diplomatically acknowledges the MDNR's regulations. MDCH collaborated with the MDEQ, MDNR, and the Deer Lake AOC PAC to start to identify key messages related to these changes.

One strategy implemented by MDCH is the development of an area specific fish consumption brochure that does not just focus on Deer Lake, but also includes other local waterbodies where MDCH has tested fish for contaminants and the MDNR permits legal harvesting. As a companion to this, MDCH is working with MDEQ and MDNR to develop a map of nearby fishing locations and access information that will provide alternatives to fishing in Deer Lake for the time being.

Until updated information is available, MDCH is also partnering with the PAC, local MDNR representatives, the City of Ishpeming, the Marquette County Health Department WIC Program, and other area stakeholders to distribute general awareness Eat Safe Fish materials, as identified in CO Tier 1.

Detroit River AOC
Status: CO Tier 2
Through various other grants, MDCH has worked with a stakeholder group in the Detroit Area for the past several years to educate shore anglers about the importance of choosing less contaminated fish for consumption. However, the focus of this grant in the Detroit Area is the Tainting of Fish Flavor and Tumor and other Deformities BUIs. Given data collected thus far, the HE/PC expects that both of these BUIs will be removed in the coming year.

The HE/PC plans to work with the PAC to determine what outreach will be needed when this occurs. MDCH and the PAC will develop materials that celebrate the efforts that led to the removal of these BUIs, but in order to align people's expectations with reality, the HE/PC feels it may be important to educate the public concurrently about two important facts:

- tumors in fish do not only result from exposure to contamination. Sometimes tumors are a result of viruses or injury and therefore fish may still be caught that have visible deformity, and

- "tainted fish flavor" does not include "fishiness" or other concerns that were raised in the Friends of the Detroit River Fish Flavor survey report.

Expectations that all fish will be "pristine" are unrealistic, regardless of site.

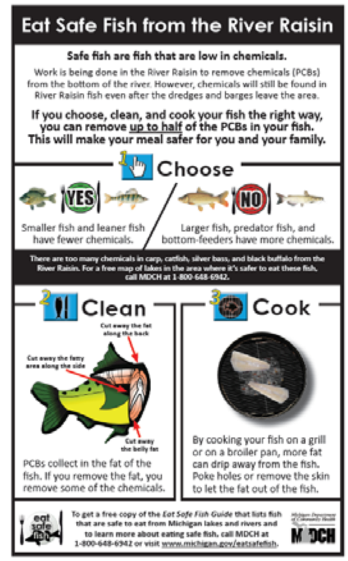
Menominee River AOC
Status: CO Tier 1
Two states, Michigan and Wisconsin, share the Menominee AOC site.

The HE/PC has discussed potential outreach strategies with the Wisconsin DNR and Wisconsin Extension Outreach Coordinator for the site, in order to best coordinate AOC messaging on both sides of the border. In the past, Wisconsin and Michigan consumption advice for the same fish from the river has not aligned. Michigan is in process of updating their methodology for determining fish consumption guidelines and expects that in the future, the state consumption guidelines in Michigan and Wisconsin may be more similar. Wisconsin and Michigan agreed it would be best to delay any area-specific fish consumption guideline communication until these updates have been completed.

Until these updates are completed, MDCH will provide the Menominee River AOC and other local stakeholders with a quantity of general Eat Safe Fish materials to distribute in order to build fish consumption awareness in the area, per the CO Tier 1 strategy.

River Raisin AOC
Status: CO Tier 1

The EPA requested that MDCH delay fish collection and analysis until Year 3 of the current grant period due to site restoration work. The EPA and MDEQ are currently dredging contaminated sediment out of the River Raisin. Indiana-Illinois SeaGrant Liaison to U.S. EPA Great Lakes National Program Office asked MDCH to collaborate with the development of a fact sheet that informs individuals about the dredging process and ways they can choose and prepare safer fish from the AOC area.



MDCH /SeaGrant Factsheet

Indiana-Illinois SeaGrant printed and distributed the factsheet to an area marina affected by the dredging and Sterling State Park.

MDCH is also collaborating with the PAC, local DNR representatives, the City of Monroe Recreation Department, and other area stakeholders to distribute general Eat Safe Fish materials, as identified in CO Tier 1.

Rouge River AOC
CO Tier 1

Per EPA's instruction, MDCH's primary focus for the Rouge River AOC is the Tumor and Other Deformities BUI.

MDEQ is reviewing the veracity of this BUI. The incidence of tumors at the time of listing appears to be statistically lower than one would expect to impose a BUI. The MDEQ is researching the historical context for this listing.

With the recognition that the Rouge River also has a fish consumption BUI, MDCH will continue to partner with the PAC and other area stakeholders to distribute general awareness Eat Safe Fish materials, as identified in CO Tier 1 while awaiting an MDEQ decision.

St Clair River AOC
CO Tier 1

The St Clair River AOC is a binational site operating with a binational PAC (BPAC).

MDCH provided brochures, tattoos, cookbooks and other Eat Safe Fish outreach materials to the St Clair County Health Department for distribution during their River Day event in June.

MDCH is also partnering with the PAC and other area stakeholders to distribute general awareness Eat Safe Fish materials, as identified in CO Tier 1.

St Marys River AOC
Status: CO Tier 1

St Marys is also a binational site. The BPAC has not only binational representation, but also tribal representation.

Per the cursory data report, the HE/PC expects removal of the tumor BUI in the coming year. Similar to the Detroit River AOC outreach plan, MDCH will work with the PAC to develop area-specific materials that celebrate the efforts that led to the removal of this BUI, but in order to align people's expectations with reality, the HE/PC feels it may be important to concurrently educate the public about an important fact:

- tumors in fish do not only result from exposure to contamination. Sometimes tumors are a result of viruses or injury and therefore fish may still be caught that have visible deformity

MDCH is also collaborating with the PAC and other area stakeholders to distribute general awareness Eat Safe Fish materials, as identified in CO Tier 1.

Reporting Activities

MDCH has posted quarterly updates in the GLAS reporting system as required.

Changes to Object Class Categories

MDCH submitted a 424 Short Form to the EPA at the end of May with the request to move $24,999 from *Other* to the *Contractual* category. MDCH had included funding in the Great Lakes Restoration Initiative grant: *Assessing Beneficial Use of Michigan Sport-Caught Fish* to allow the Area of Concern Public Advisory Councils to engage in public outreach activities such as holding public meetings, and development and distribution of outreach products, such as fact sheets and brochures.

Lake Superior State University (LSSU), fiduciary for the St Marys River Area of Concern, has agreed to partner with the MDCH on behalf of all target Areas of Concern, to facilitate the development and distribution of outreach materials in each of the target Areas of Concern, partnering closely with the MDCH, Division of Environmental Health. The scope of this award begins June 1, 2012 and extends to September 30, 2012.

Barriers and Corrective Actions

None

Activity Workplan and Current Status (as of 6/30/2012)

Activity	Percentage Completed	
	This Reporting Period	For the Project
Restrictions on Fish Consumption BUI Assessment Activities		
• Submit QAPP for EPA Approval	100%	90%
• Develop AOC Fish Sampling Plans for targeted AOCs	100%	90%
• Fish collection	50%	50%
• Processing of fish samples	50%	50%
• Analysis of fish samples	0	0
• Analytical reports completed	0	0
• Data review and analysis	0	0
• Attend AOC advisory council meetings, as necessary	100%	50%
Tainting of Fish Flavor BUI Assessment Activities		
• Evaluate Detroit River data	100%	100%
• Issue reports and recommendations	100%	100%
• Attend AOC advisory council meetings, as necessary	100%	100%
Fish Tumor or Other Deformities BUI Assessment Activities		
• Evaluate Detroit River data	100%	100%
• Develop fish sampling plans, if needed, for St. Marys & Rouge River AOCs	50%	50%
• Fish collection	60%	60%
• Processing of fish samples	60%	60%
• Analysis of fish samples	0	0
• Analytical reports completed	0	0

• Data review and analysis	0	0
• Attend AOC advisory council meetings, as necessary	50%	50%
Community Outreach Activities		
• Develop Community Outreach Plans	15%	15%
• Implement Plans	20%	20%
• Attend AOC advisory council meetings, as necessary	100%	50%

Funding Rates

MDCH's current rate of funding use is appropriate for the Workplan. Substantial background work and preparation was required before fish collection, sampling, BUI action recommendations, testing of messages and outreach can begin. This upcoming work will account for the majority of our spending, outside of salary support for the individuals working on this project.

Category	Grant Award	Expend. 10/1/11-6/27/12	% of Award
Salaries	$0	$0	100%
Fringe Benefits	$0	$0	100%
Travel	$0	$0	100%
Supplies	$0	$0	100%
Other (Inc. Contractual)	$491,153.00	$78,139.92	16%
Random Moment	$7,479.00	$0	0%
Subtotal Direct	$498,632.00	$78,139.92	16%
Indirect	$0	$0	100%
Total	$498,632.00	$78,139.92	16%

Drawdown Request & Explanation

The last drawdown occurred on 6/20/2012. MDCH makes a monthly drawdown, generally around the 20th of each month.

Principal investigator Update

Dr. Linda D. Dykema continues in the principal investigator role for this grant project.

Amendment to Project Period

None

Great Lakes Accountability System Entry Explanation

MDCH reported to GLAS on 06/20/2012.

MICHIGAN DEPARTMENT OF COMMUNITY HEALTH

SEMI-ANNUAL PROGRESS REPORT

USEPA-Great Lakes Restoration Initiative Projects

Grant or IA Number: GL-00E00869-0
Project Title: Assessing Michigan's Beneficial Use of Sport-Caught Fish
Reporting Period Covered: July 1 – December 31, 2012
Principal Investigator: Linda D. Dykema

Table of Contents

Summary of Work Accomplished

The following section summarizes the work accomplished on the project, *Assessing Michigan's Beneficial Use of Sport-Caught Fish*, for the reporting period of July 1 – December 31, 2012.

Restrictions on Fish Consumption Beneficial Use Impairment (BUI) Assessment Activities

Per the Michigan Department of Environmental Quality's (MDEQ) *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, three criteria exist for the removal of Restrictions on Fish Consumption and Wildlife BUI. The BUI is considered restored when:

- The fish consumption advisories in the Area of Concern (AOC) are the same or less restrictive than the associated Great Lake or appropriate control site.

OR, if the advisory in the AOC is more stringent than the associate Great Lake or control site:

- A comparison study of fish tissue contaminant levels demonstrates that there is no statistically significant difference in fish tissue concentrations of contaminants causing fish consumption advisories in the AOC compared to a control site.

OR, if a comparison study is not feasible because of the lack of a suitable control site:

- Analysis of trend data (if available) for fish with consumption advisories shows similar trends to other appropriate Great Lakes trend sites.

The first step toward assessing this BUI for all sites, regardless of criteria, is fish collection and contaminant analysis. Per our Environmental Protection Agency (EPA) Project Officer, the Michigan Department of Community Health (MDCH) will continue to operate under the existing Quality Assurance Project Plan (QAPP) approved for our existing Great Lakes Restoration Initiative (GLRI) grant, *Enhance State of Michigan Fish Consumption Advisories* [GL-00E00457-2]. MDCH submitted to the EPA for approval on June 19, 2012, the QAPP and the final sampling plans for five targeted sites and two control sites.

MDEQ in partnership with the MDCH and the public advisory councils (PACs) in each of the respective AOCs developed project-specific sampling plans for most of the targeted AOCs. River Raisin sampling is delayed until Grant Year 3, per request of the EPA.

Status of Assessment Activities for Fish Consumption (as of 12/31/2012):

AOC or Reference Site	Current Status of Fish Assessment		
	Collected	Processed	At Lab
Deer Lake	X	X	X
Menominee River	X	X	X
River Raisin	Year 3		
St Clair River	X	X	
Muskrat Analysis*	X		
St Marys River	X	X	X
Les Cheneaux Islands	X	X	X
Little Bay de Noc	X	X	X

*Collection and analysis not funded by this GLRI grant. Effort supported by MDEQ & MDCH.

In addition to the fish analysis, MDCH and MDEQ are spearheading an effort on behalf of the St Clair River AOC Binational Public Advisory Council (BPAC) to run a chemical analysis on muskrat meat. Although no AOCs in Michigan have wildlife listed as impaired as part of the Restrictions on Fish and Wildlife Consumption BUI, a large number of individuals in the St Clair and southeast Michigan area consume muskrat meat, particularly during the Lenten season. Because of this, the BPAC has repeatedly requested testing of muskrat, turtle, or waterfowl for contaminants. MDEQ agreed to fund the contaminant analysis outside of this grant. MDCH partnered with Environment Canada to arrange the collection of the muskrat, and MDEQ is funding the analysis of three to four composite samples of the muskrat flesh. Based on historical analytical reports provided by Environment Canada, MDCH and MDEQ have surmised that muskrat flesh is unlikely to be contaminated by the legacy chemicals found in the St Clair area. However, the Canadian data are from 1986, and updated data would address the concerns of the BPAC with relation to the eventual removal of the Restrictions on Fish and Wildlife Consumption BUI on both sides of the river. MDCH will provide a Letter Health Consultation to the BPAC based upon the results of the analysis.

Tainting of Fish Flavor BUI Assessment Activities

Per the MDEQ's *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, two criteria exist for the removal of Tainting of Fish and Wildlife Flavor BUIs. This document states that the BUI is considered restored when:

- No more than three reports of fish tainting have been made to the MDNR or MDEQ for a period of three years.

OR, if there have been reports of tainting

- A one-time analysis of representative fish species in an AOC in accordance with MDEQ Surface Water Assessment Section (SWAS) Procedure #55 for conducting taste and odor studies indicates that there is no tainting of fish flavor.

Detroit River

Per the Friends of the Detroit River, during the week of December 3, 2012, they submitted a final letter of support to MDEQ for the removal of this BUI. MDEQ is completing their approval process and is ready to petition EPA for removal of the Tainting of Fish Flavor BUI. (Survey report available upon request.)

The Friends of the Detroit River survey results correlated with those surveys implemented prior to the Detroit study by Ontario on the Detroit River and St Clair River BPAC – both of which also resulted in the removal of the Tainting of Fish Flavor BUI in their respective AOCs.

Fish Tumor or Other Deformities BUI Assessment Activities

Per the MDEQ's *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, two criteria exist for the removal of Fish Tumor or Other Deformities BUI. The BUI is restored when:

- No reports of fish tumors or deformities due to chemical contaminants which have been verified through observation and analysis by the Michigan Department of Natural Resources (MDNR) or the MDEQ for a period of five years.

Or, in cases where any tumors have been reported:

- A comparison study of resident benthic fish (e.g. brown bullhead) of comparable age and at maturity (3 years), or of fish species that have been historically associated with this BUI, in the AOC and a non-impacted control site indicates that there is no statistically significant difference (with a 95% confidence interval) in the incidence of liver tumors or deformities.

Detroit River AOC

MDEQ looked for tumors in bullhead collected from the Detroit River during 2011 for routine chemical analysis. Results from twenty-one (21) Detroit River bullheads have shown no sign of tumors. At a recent State PAC meeting, a member of the US Fish and Wildlife Service (FWS) notified us of research they were also doing in the Detroit River relative to tumor assessment. MDEQ and MDCH may delay the report to the PAC until we receive the FWS data. The MDEQ Office of the Great Lakes will determine when to finalize and present the report to the PAC.

St Marys River AOC

The St Marys River AOC sampling plan for fish consumption analysis included the collection and examination for tumors in bullhead from the St Marys River. MDEQ examined bullhead during processing. Results from the reference site are pending. However, given that the collection of fish from the AOC had no tumors and there were no confirmed reports of tumors filed in the last five years, it is likely this BUI can be removed in the near future. MDCH and MDEQ will prepare and delivery a report on these findings to the St Marys BPAC.

Rouge River AOC

The Rouge River AOC may also require a novel collection of bullhead to assess the status of the BUI. However, MDEQ Office of the Great Lakes is continuing to assess the necessity of additional sampling, as existing data may provide the statistical evidence needed.

Community Outreach Activities

From July 1 to December 31, the health educator/project coordinator (HE/PC) attended multiple PAC meetings in person and via conference call. The HE/PC participated in monthly phone calls and attended a Deer Lake PAC meeting in Ishpeming in August. The HE/PC attended the EPA's AOC Conference in Cleveland, Ohio in September, and co-presented with Elizabeth Murphy during the conference's breakout sessions. Later that month, the HE/PC also presented an update on the fish sampling and the communication strategy for the area to the Menominee River Citizens' Advisory Committee in Marinette, Wisconsin. The HE/PC participated in the State PAC Workshop: Rebranding Your AOC in October. And in November, she presented at the St Clair River BPAC.

The MDCH HE/PC is taking a tiered approach when developing outreach materials for the targeted AOCs. Given the need for data prior to determining if any fish consumption BUIs will be lifted and determining what new fish consumption guidelines may be issued in the AOC, area-specific outreach is predominantly on hold until spring of 2013.

Communication Outreach (CO) Tier 1

During this downtime, the HE/PC has focused on developing and preparing to distribute general "Eat Safe Fish" materials that promote the Michigan fish consumption guidelines and are applicable statewide in AOCs. The goal of this outreach is to normalize the concept of fish consumption guidelines. The objective is to build awareness of the need to "choose safe fish" throughout the state of Michigan.

The HE/PC proposes that many members of the public are unaware of the terms Area of Concern, Beneficial Use Impairment and even Michigan Fish Advisory/Eat Safe Fish Guide. With the assumption that fish consumption BUIs will be removed in the near future in many AOCs in Michigan, the HE/PC feels it is important to first saturate the AOC market with information about the fish consumption guidelines and presenting them as a statewide "fact of life," prior to introducing the concept of fish consumption BUIs. The HE/PC hypothesizes that the public will be more accepting of the removal criteria 'no worse than a like body of water' if they understand that fish consumption guidelines exist statewide and that the fish consumption guidelines on their local lake and river are the norm rather than an exception.

With PAC input, and support from Lake Superior State University, MDCH produced:

- 20,000 Bobbers – "Eat Safe Fish, ❤ Your Watershed"
- 10,000 Tape Measures – "Eat Safe Fish, ❤ Your Watershed"
- 15,000 Temporary Tattoos – "Eat Safe Fish"
- 20,000 Eat Safe Fish in Michigan brochures
- 20,000 Hooked on Fish cookbooks
- 20,000 MDCH/MDEQ co-branded Activity Sheets – Grades K-3rd
- 20,000 MDCH/MDEQ co-branded Activity Sheets – Grades 4-6th
- 20,000 Eat Safe Fish FAQ fact sheets

MDCH arranged printing and the HE/PC is distributing these materials around the state to the targeted AOCs. Organizations that have agreed to act as distributors of the above materials include:

- All local health departments' WIC programs in the targeted AOC areas
- State Park outreach programs in the targeted AOC areas
- MSU Extension Coordinators in the targeted AOC areas
- Michigan Sea Grant in the targeted AOC areas

CO Tier 2

The HE/PC also feels that as fish consumption BUIs begin to be removed, it is important that the public is introduced to the concepts of AOCs and fish consumption BUIs in a clear, concise manner. It is also important that the public is clear on the distinct differences between a fish consumption BUI and an MDCH fish consumption guideline. It is with this goal in mind that the HE/PC developed, in partnership with the MDEQ AOC Coordinators, the "Eat Safe Fish in Areas of Concern" fact sheet.

The HE/PC also developed "Tainting of Fish Flavor in Michigan's Areas of Concern" and "Fish Tumors or Other Deformities in Michigan's Areas of Concern" fact sheets in conjunction with the MDEQ.

MDCH and MDEQ will distribute these fact sheets (see attached) to media prior to any fish consumption, fish tainting or fish tumor BUI removal, and to the public during BUI removal public comment sessions and other related events.

The fact sheet, as well as multiple general Eat Safe Fish outreach materials, are being developed and distributed to the targeted AOCs this summer to create familiarity and generate local support of the fish consumption guidelines. MDCH and MDEQ are also distributing these fact sheets to manage expectations. When the fish tumor or tainting BUIs are removed, there is still a likelihood that individuals will catch fish with tumors or eat fish that have an off taste. It is important that individuals realize that these occurrences can happen anywhere, and that the fact that the BUI was removed does not mean that never again will fish have tumors nor taste strangely from that waterbody.

CO Tier 3

Once MDCH receives updated fish contaminant data, the HE/PC will work with the PACs to develop area-specific appropriate outreach materials that serve to educate the public about the AOC, the BUI, and the fish consumption guidelines applicable to their area.

Deer Lake
Status: CO Tiers 1-3

Deer Lake is a unique AOC. This location is the only targeted AOC that is using trend data for their BUI removal criteria, rather than a reference site comparison. Given the years of declining mercury levels in fish, and consecutive years of data demonstrating that limited fish consumption is now possible, MDCH will relax the Deer Lake fish consumption guidelines in the 2012-2013 Eat Safe Fish Guide from 'Do Not Eat" for all species to limited consumption of some fish species.

However, despite this relaxed consumption guideline, the Michigan Department of Natural Resources (MDNR) will continue to uphold their "no possession of any fish" rule established on Deer Lake for the remainder of 2012. The MDNR originally implemented this rule to support the MDCH "Do Not Eat" guidelines. Originally, the MDNR planned to hold a public comment session later this year to discuss removal of their 'no possession' regulation. However, based on MDNR expert input, they have decided to uphold their catch-and-release only policy to protect the unique fishery that has developed over years.

Related to this, the MDNR is in process of creating a list of Family Friendly Fishing Waters. While not finalized, Deer Lake ranks very highly as one of the flagship locations. The MDCH HE/PC will continue to work closely with the MDNR staff to develop a communication campaign that highlights this positive designation, the high catch rate of the waters, while diplomatically acknowledging the MDNR's regulations, and also the work accomplished by the PAC, EPA, and MDEQ to make Deer Lake a clean and healthy waterbody once again.

MDCH is also continuing the development of an area specific fish consumption brochure that does not just focus on Deer Lake, but also includes other local waterbodies where MDCH has tested fish for contaminants and the MDNR permits legal harvesting. As a companion to this, MDCH is working with MDEQ and MDNR to develop a map of nearby fishing locations and access information that will provide alternatives to fishing in Deer Lake for the time being.

Until updated information is available, MDCH is also partnering with the PAC, local MDNR representatives, the City of Ishpeming, the Marquette County Health Department WIC Program, and other area stakeholders to distribute general awareness Eat Safe Fish materials, as identified in CO Tier 1.

Detroit River AOC
Status: CO Tier 2
Through various other grants, MDCH has worked with a stakeholder group in the Detroit Area for the past several years to educate shore anglers about the importance of choosing less contaminated fish for consumption. However, the focus of this grant in the Detroit Area is the Tainting of Fish Flavor and Tumor and other Deformities BUIs. Given data collected thus far, the HE/PC expects that both of these BUIs will be removed in the coming year.

The HE/PC plans to work with the PAC to determine what outreach will be needed when this occurs. MDCH and the PAC will develop materials that celebrate the efforts that led to the removal of these BUIs, but in order to align people's expectations with reality, the HE/PC feels it may be important to educate the public concurrently about two important facts:

- tumors in fish do not only result from exposure to contamination. Sometimes tumors are a result of viruses or injury and therefore fish may still be caught that have visible deformity, and

- "tainted fish flavor" does not include "fishiness" or other concerns that were raised in the Friends of the Detroit River Fish Flavor survey report.

Expectations that all fish will be "pristine" are unrealistic, regardless of site. The HE/PC has worked with the MDEQ to develop fact sheets that will be distributed to the public and media that explains the BUIs, the requirements for the approval and aligns peoples' expectations with reality.

Menominee River AOC
Status: CO Tier 1
Two states, Michigan and Wisconsin, share the Menominee AOC site.

The HE/PC has discussed potential outreach strategies with the Wisconsin DNR and Wisconsin Extension Outreach Coordinator for the site, in order to best coordinate AOC messaging on both sides of the border. In the past, Wisconsin and Michigan consumption advice for the same fish from the river has not aligned. However, Michigan has recently completed updates to their methodology for determining fish consumption guidelines, and this has resulted in Michigan achieving consensus with Great Lakes Consortium protocols, to which both Michigan and Wisconsin subscribe. MDCH suspects that with these updates, the consumption guidelines for the two states will be more aligned and make it easier for interstate communication pieces to be developed, resulting in a unified outreach strategy.

Until the analysis of the recently collected fish is complete, MDCH will provide the Menominee River AOC and other local stakeholders with a quantity of general Eat Safe Fish materials to distribute in order to build fish consumption awareness in the area, per the CO Tier 1 strategy.

River Raisin AOC
Status: CO Tier 1
The EPA requested that MDCH delay fish collection and analysis until Year 3 of the current grant period due to site restoration work. The EPA and MDEQ are currently dredging contaminated sediment out of the River Raisin. Indiana-Illinois SeaGrant Liaison to U.S. EPA Great Lakes National Program Office asked MDCH to collaborate with the development of a fact sheet that informs individuals about the dredging process and ways they can choose and prepare safer fish from the AOC area.

Indiana-Illinois SeaGrant printed and distributed the factsheet to an area marina affected by the dredging and Sterling State Park.

MDCH is also collaborating with the PAC, local DNR representatives, the City of Monroe Recreation Department, and other area stakeholders to distribute general Eat Safe Fish materials, as identified in CO Tier 1.

Rouge River AOC
CO Tier 1
Per EPA's instruction, MDCH's primary focus for the Rouge River AOC is the Tumor and Other Deformities BUI.

MDEQ is reviewing the veracity of this BUI. The incidence of tumors at the time of listing appears to be statistically lower than one would expect to impose a BUI. The MDEQ continues to research the historical context for this listing.

With the recognition that the Rouge River also has a fish consumption BUI, MDCH will continue to partner with the PAC and other area stakeholders to distribute general awareness Eat Safe Fish materials, as identified in CO Tier 1 while awaiting an MDEQ decision.

St Clair River AOC
CO Tier 1
The St Clair River AOC is a binational site operating with a binational PAC (BPAC).

MDCH provided brochures, tattoos, bobbers, tape measures, cookbooks and other Eat Safe Fish outreach materials to the St Clair County Health Department for distribution at events and to visitors to their office.

MDCH is also partnering with the PAC and other area stakeholders to distribute general awareness Eat Safe Fish materials, as identified in CO Tier 1.

St Marys River AOC
Status: CO Tier 1
St Marys is also a binational site. The BPAC has not only binational representation, but also tribal representation.

Per the cursory data report, the HE/PC expects removal of the tumor BUI in the coming year. Similar to the Detroit River AOC outreach plan, MDCH will work with the PAC to develop area-specific materials that celebrate the efforts that led to the removal of this BUI, but in order to align people's expectations with reality, the HE/PC feels it may be important to concurrently educate the public about tumors in fish. Therefore, MDCH will distribute a quantity of the Fish Tumors or Other Deformities in Michigan's Areas of Concern factsheets to the St Marys AOC stakeholders.

MDCH is also collaborating with the PAC and other area stakeholders to distribute general awareness Eat Safe Fish materials, as identified in CO Tier 1.

Reporting Activities

MDCH has posted quarterly updates in the GLAS reporting system as required.

Changes to Object Class Categories

Per the budget amendment approved by the EPA on 11/15/2012, there have been several changes to our object class categories. There has been no overall increase or decrease to the full grant award amount.

As of November, $156,601 was removed from Other and redistributed to Personnel ($48,249), Fringe Benefits ($34,257), Supplies ($16,295), Contractual ($52,686), and the Indirect ($5,114) line items.

Michigan Department of Community Health (MDCH) included funding in the Great Lakes Restoration Initiative grant, Assessing Beneficial Use of Michigan Sport-Caught Fish, to allow the Area of Concern Public Advisory Councils to engage in public outreach activities such as holding public meetings, and development and distribution of outreach products, such as fact sheets and brochures. Funding for this portion of the project was included under the Other line item.

In order to facilitate the development and distribution of outreach materials in each of the target Areas of Concern, the Great Lakes Commission agreed to partner with us for the second and third years of our grant, which required the shift of funding from Other to Contractual.

Also, due to a recent change of policy, the MDCH Accounting Department now requires MDCH Laboratory services to be broken down into separate accounting line items (e.g. personnel, fringe, and supplies), rather than be presented as a lump sum. For this reason, line items for personnel, fringe, in-direct costs, and supplies are now represented in our budget narrative. Lastly, the MDCH Laboratory has improved capacity; as such MDCH no longer needs to contract dioxin-like chemicals analysis to another facility. Therefore, the funds that were slated to go to a contractual lab have now been moved to MDCH to cover the line items noted above.

These updates account for the remaining changes to the original grant budget narrative.

Barriers and Corrective Actions

None

Activity Workplan and Current Status (as of 12/31/2012)

Activity	Percentage Completed	
	This Reporting Period	For the Project
Restrictions on Fish Consumption BUI Assessment Activities		
• Submit QAPP for EPA Approval	100%	90%
• Develop AOC Fish Sampling Plans for targeted AOCs	100%	90%
• Fish collection	90%	80%
• Processing of fish samples	90%	70%
• Analysis of fish samples	0	0
• Analytical reports completed	0	0
• Data review and analysis	0	0
• Attend AOC advisory council meetings, as necessary	100%	60%
Tainting of Fish Flavor BUI Assessment Activities		
• Evaluate Detroit River data	100%	100%
• Issue reports and recommendations	100%	100%
• Attend AOC advisory council meetings, as necessary	100%	100%
Fish Tumor or Other Deformities BUI Assessment Activities		
• Evaluate Detroit River data	100%	100%
• Develop fish sampling plans, if needed, for St. Marys & Rouge River AOCs	50%	50%
• Fish collection	75%	75%
• Processing of fish samples	75%	75%
• Analysis of fish samples	35%	35%
• Analytical reports completed	0	0
• Data review and analysis	0	0
• Attend AOC advisory council meetings, as necessary	100%	66%
Community Outreach Activities		
• Develop Community Outreach Plans	30%	30%
• Implement Plans	20%	20%
• Attend AOC advisory council meetings, as necessary	100%	66%

Funding Rates

MDCH Accounting has updated the Object Class Categories based on the budget amendment approved by the EPA on 11/15/2012. MDCH's current rate of funding use is appropriate for the Workplan. MDNR and the MDEQ has completed the majority of the fish collection in the targeted AOCs. Lab analysis will occur this winter, which will result in a substantial drawdown. This spring, MDCH will begin testing messages and area-specific outreach can begin. This upcoming work will account for the majority of our spending, outside of salary support for the individuals working on this project.

Category	Grant Award	Expend. 10/1/11-11/30/12	% of Award
Salaries	$48,249	$0	0%
Fringe Benefits	$34,257	$0	0%
Travel	$0	$0	100%
Supplies	$16,295	$36	0%
Other (Inc. Contractual)	$387,238	$149,637	40%
Random Moment	$7,479	$1,579	21%
Subtotal Direct	$486,039	$149,673	31%
Indirect	$5,114	$87	2%
Total	$498,632	$151,339	30%

Drawdown Request & Explanation

The last drawdown occurred on 12/20/2012. MDCH makes a monthly drawdown, generally around the 20th of each month.

Principal investigator Update

Dr. Linda D. Dykema continues in the principal investigator role for this grant project.

Amendment to Project Period

None

Great Lakes Accountability System Entry Explanation

MDCH reported to GLAS on 1/7/2013.

MICHIGAN DEPARTMENT OF COMMUNITY HEALTH

SEMI-ANNUAL PROGRESS REPORT

USEPA-Great Lakes Restoration Initiative Projects

Grant or IA Number: GL-00E00869-0
Project Title: Assessing Michigan's Beneficial Use of Sport-Caught Fish
Reporting Period Covered: January 1 – June 30, 2013
Principal Investigator: Linda D. Dykema

Table of Contents

Summary of Work Accomplished

The following section summarizes the work accomplished on the project, *Assessing Michigan's Beneficial Use of Sport-Caught Fish*, for the reporting period of January 1 – June 30, 2013.

Restrictions on Fish Consumption Beneficial Use Impairment (BUI) Assessment Activities

Per the Michigan Department of Environmental Quality's (MDEQ) *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, three criteria exist for the removal of Restrictions on Fish Consumption and Wildlife BUI. The BUI is considered restored when:

- The fish consumption advisories in the Area of Concern (AOC) are the same or less restrictive than the associated Great Lake or appropriate control site.

OR, if the advisory in the AOC is more stringent than the associate Great Lake or control site:

- A comparison study of fish tissue contaminant levels demonstrates that there is no statistically significant difference in fish tissue concentrations of contaminants causing fish consumption advisories in the AOC compared to a control site.

OR, if a comparison study is not feasible because of the lack of a suitable control site:

- Analysis of trend data (if available) for fish with consumption advisories shows similar trends to other appropriate Great Lakes trend sites.

The first step toward assessing this BUI for all sites, regardless of criteria, is fish collection and contaminant analysis. Per our Environmental Protection Agency (EPA) Project Officer, the Michigan Department of Community Health (MDCH) will continue to operate under the existing Quality Assurance Project Plan (QAPP) approved for our existing Great Lakes Restoration Initiative (GLRI) grant, *Enhance State of Michigan Fish Consumption Advisories* [GL-00E00457-2]. MDCH submitted to the EPA for approval on June 19, 2012, the QAPP and the final sampling plans for five targeted sites and two control sites.

MDEQ determined that a fish collection is required to assess the Rouge River Fish Tumor or Other Deformities BUI. Therefore, this triggered an assessment of the Restrictions on Fish Consumption and Wildlife BUI. The collection in the Rouge will take place this summer with analysis occurring during the fall and winter.

MDEQ in partnership with the MDCH and the public advisory councils (PACs) in each of the respective AOCs developed project-specific sampling plans for most of the targeted AOCs, including the recently added Rouge River. Due to the discovery of dense non-aqueous phase liquid during Great Lakes Legacy Act dredging, collection of River Raisin fish has been further delayed. MDCH requested and received from the EPA a no-cost extension for the collection and analysis of fish from this site. MDCH has delayed River Raisin sampling until the completion of the dredging project or at the latest, the summer of 2014.

Status of Assessment Activities for Fish Consumption (as of 6/30/2013):

AOC or Reference Site	Current Status of Fish Assessment		
	Collected	Processed	At Lab
Deer Lake	X	X	X
Menominee River	IN PROCESS	SOME	SOME
River Raisin	Postponed until 2014		
River Rouge	Scheduled Summer '13		
St Clair River	X	X	X
Muskrat Analysis*	X	X	X
St Marys River	X	X	X
Les Cheneaux Islands	X	X	X
Little Bay de Noc	X	X	X

*Collection and analysis not funded by this GLRI grant. Effort supported by MDEQ & MDCH.

In addition to the fish analysis, MDCH and MDEQ collected and analyzed muskrat meat on behalf of the St Clair River AOC Binational Public Advisory Council (BPAC). Although no AOCs in Michigan have wildlife listed as impaired as part of the Restrictions on Fish and Wildlife Consumption BUI, a large number of individuals in the St Clair and southeast Michigan area consume muskrat meat, particularly during the Lenten season. Because of this, the BPAC has repeatedly requested testing of muskrat, turtle, or waterfowl for contaminants. MDEQ agreed to fund the contaminant analysis outside of this grant. MDCH arranged the collection of muskrat from Walpole Island and Harsen's Island, both within the AOC's river delta. The muskrat from Harsen's Island (Michigan) were collected by a trapper known to the BPAC. MDCH picked up the skinned muskrat in December (2012). The muskrat from Walpole Island (Ontario) were collected by partners of Environment Canada. MDCH picked up the muskrat in Sarnia, Ontario in April (2013) and transported them to Lansing for analysis.

MDEQ is funding the analysis of three to four composite samples of the muskrat flesh. Based on historical analytical reports provided by Environment Canada, MDCH and MDEQ have surmised that muskrat flesh is unlikely to be contaminated by the legacy chemicals found in the St Clair area. However, the Canadian data are from 1986, and updated data would address the concerns of the BPAC with relation to the eventual removal of the Restrictions on Fish and Wildlife Consumption BUI on both sides of the river. MDCH will provide a Letter Health Consultation to the BPAC based upon the results of the analysis, which are still pending.

MDEQ has recently completed a staff report on temporal trends in Deer Lake fish tissue mercury concentrations, which will be used to support the petition for removal of the last remaining BUI on Deer Lake, making the possibility of delisting a reality in the short term.

Tainting of Fish Flavor BUI Assessment Activities

Per the MDEQ's *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, two criteria exist for the removal of Tainting of Fish and Wildlife Flavor BUIs. This document states that the BUI is considered restored when:

- No more than three reports of fish tainting have been made to the MDNR or MDEQ for a period of three years.

OR, if there have been reports of tainting

- A one-time analysis of representative fish species in an AOC in accordance with MDEQ Surface Water Assessment Section (SWAS) Procedure #55 for conducting taste and odor studies indicates that there is no tainting of fish flavor.

Detroit River
The Detroit River PAC's recommendation to remove this BUI has gone through the Four Party process. The MDEQ has subsequently petitioned the EPA for removal of this BUI.

Through various other grants, MDCH has worked with a stakeholder group in the Detroit Area for the past several years to educate shore anglers about the importance of choosing less contaminated fish for consumption. However, the focus of this grant in the Detroit Area is the Tainting of Fish Flavor and Tumor and other Deformities BUIs.

Since the MDEQ has submitted the petition to remove the Tainting of Fish Flavor BUI, the HE/PC anticipates that BUI will be removed soon. MDCH will send the *Tainting of Fish Flavor in Michigan's Areas of Concern* fact sheet to all existing outreach distribution contacts in the area. The HE/PC also volunteered to assist the PAC chair and others with the planning and coordination of a public relations event celebrating the removal of the BUI.

Fish Tumor or Other Deformities BUI Assessment Activities
Per the MDEQ's *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, two criteria exist for the removal of Fish Tumor or Other Deformities BUI. The BUI is restored when:

- No reports of fish tumors or deformities due to chemical contaminants which have been verified through observation and analysis by the Michigan Department of Natural Resources (MDNR) or the MDEQ for a period of five years.

Or, in cases where any tumors have been reported:

- A comparison study of resident benthic fish (e.g. brown bullhead) of comparable age and at maturity (3 years), or of fish species that have been historically associated with this BUI, in the AOC and a non-impacted control site indicates that there is no statistically significant difference (with a 95% confidence interval) in the incidence of liver tumors or deformities.

Detroit River AOC
MDEQ looked for tumors in bullhead collected from the Detroit River during 2011 for routine chemical analysis. Results from twenty-one (21) Detroit River bullheads have shown no sign of tumors. At a 2012 State PAC meeting, a member of the US Fish and Wildlife Service (FWS) announced that they were conducting research in the Detroit River on emerging contaminants. This research included tumor assessment that could be used to assess the current status of the BUI. MDEQ and MDCH decided to delay the finalization of the report until the FWS data is received. The PAC chair, Mary Bohling, MDCH, and MDEQ have put in requests with all agencies working in the Trenton Channel this summer to collect any bullhead incidentally caught during their unrelated actions on the river. At the end of the season, based on the success of the additional collections and the findings of the FWS, MDCH will work with the PAC to determine if a more in-depth collection and analysis is needed or if the data collected is sufficient. The MDEQ Office of the Great Lakes will assist MDCH and the PAC with this decision.

St Marys River AOC
The St Marys River AOC sampling plan for fish consumption analysis included the collection and examination for tumors in bullhead from the St Marys River. MDEQ examined bullhead during processing. Results from the reference site are pending. However, given that the collection of fish from the AOC had no tumors and there were no confirmed reports of tumors filed in the last five years, it is likely this BUI can be removed in the near future. MDCH and MDEQ will prepare and deliver a report on these findings to the St Marys BPAC this summer.

Rouge River AOC
Although the original incidence of tumors appeared to be statistically lower than one would expect to impose a BUI, the MDEQ has decided to move forward with a fish collection and tumor review. Over the summer, at least 100 white suckers will be collected and examined. According to the sampling plan, collections will occur in the Upper Branch and

the Main Branch of the Rouge River, as white sucker from these areas, in particular, had measurable rates of tumor incidence in the 1986 survey. The final sampling plan has been approved by the Rouge River Advisory Council. The plan will be filed with the EPA as an addendum to the grant's existing Quality Assurance Project Plan.

Fish Consumption BUI & Community Outreach Activities

From January 1 to June 30th, the health educator/project coordinator (HE/PC) attended multiple PAC meetings in person and via conference call. Meetings include monthly Deer Lake PAC conference calls, Menominee River CAC in-person meeting, and presentations at the Detroit River PAC in-person meeting, Rouge River Advisory Council in-person meeting, and the St Mary's River BPAC Environmental Summit.

The MDCH HE/PC is taking a tiered approach when developing outreach materials for the targeted AOCs. Given the need for data prior to determining if any fish consumption BUIs will be lifted and determining what new fish consumption guidelines may be issued in the AOC, area-specific outreach is predominantly on hold until spring of 2013.

Communication Outreach (CO) Tier 1

During this downtime, the HE/PC focused on developing and preparing to distribute general "Eat Safe Fish" materials that promote the Michigan fish consumption guidelines and are applicable statewide in AOCs. The goal of this outreach is to normalize the concept of fish consumption guidelines. The objective is to build awareness of the need to "choose safe fish" throughout the state of Michigan.

The HE/PC proposed that many members of the public are unaware of the terms *Area of Concern*, *Beneficial Use Impairment* and even *Michigan Fish Advisory/Eat Safe Fish Guide*. With the assumption that fish consumption BUIs will be removed in the near future in many AOCs in Michigan, the HE/PC feels it is important to first saturate the AOC market with information about the fish consumption guidelines and presenting them as a common statewide issue, prior to introducing the concept of fish consumption BUIs. The HE/PC hypothesized that the public will be more accepting of the removal criteria 'no worse than a like body of water' if they understand that fish consumption guidelines exist statewide and that the fish consumption guidelines on their local lake and/or river are the norm rather than an exception.

With PAC input, and support from Lake Superior State University, MDCH produced:

- 20,000 Bobbers – "Eat Safe Fish, ♥ Your Waters"
- 10,000 Tape Measures – "Eat Safe Fish, ♥ Your Watershed"
- 15,000 Temporary Tattoos – "Eat Safe Fish"
- 20,000 Eat Safe Fish in Michigan brochures
- 20,000 Hooked on Fish cookbooks
- 20,000 MDCH/MDEQ co-branded Activity Sheets – Grades K-3rd
- 20,000 MDCH/MDEQ co-branded Activity Sheets – Grades 4-6th
- 20,000 Eat Safe Fish FAQ fact sheets

The MDCH HE/PC has distributed these materials around the state to the targeted AOCs. Organizations that have agreed to act as distributors of the above materials include:

- All targeted AOCs' local health departments' WIC programs
- MSU Extension Coordinators
- Michigan Sea Grant
- Michigan State Park outreach program coordinators
- Department of Natural Resources' Fisheries Division Creel Clerks
- Department of Natural Resources' Operation Centers
- USGS outreach coordinators

- Municipal parks and recreation departments
- Food Co-Ops and Upper Peninsula Food Exchange
- Local fishing & sportsmen association groups
- Friends of … groups

The MDCH HE/PC or partners distributed items at special events in AOCs around the state, including:

- St Marys River BPAC Environmental Summit (~60 people)
- Rivertown Detroit River Kids' Fishing Fest (~172 people)
- Menominee & Marinette Kids' Fishing Derby (~250 people)
- St Clair River Sturgeon Festival (~300 people)

CO Tier 2

As fish consumption BUIs begin to be removed, it is important that the public is introduced to the concepts of AOCs and fish consumption BUIs in a clear, concise manner. It is also important that the public is clear on the distinct differences between a fish consumption BUI and an MDCH fish consumption guideline. It is with this goal in mind that the HE/PC developed, in partnership with the MDEQ AOC Coordinators, the "Eat Safe Fish in Areas of Concern" fact sheet. MDCH posted this fact sheet online and shared it with PACs in the targeted areas of concern for use as needed.

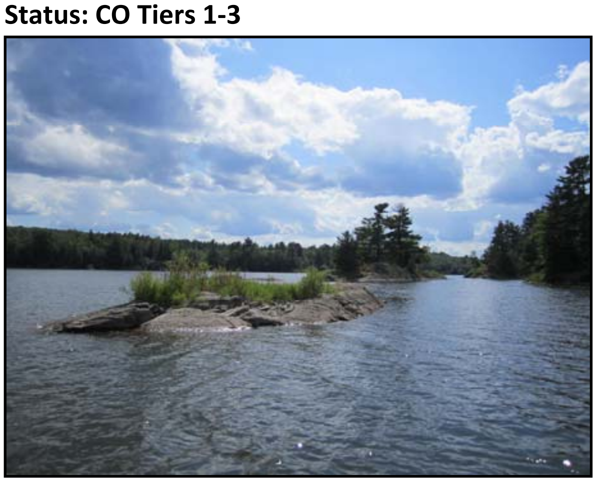
The HE/PC has also distributed the "Tainting of Fish Flavor in Michigan's Areas of Concern" and "Fish Tumors or Other Deformities in Michigan's Areas of Concern" fact sheets in conjunction with the MDEQ in the affected AOCs.

Consistent with the outreach plan, MDCH and MDEQ will distribute these fact sheets to media prior to any fish consumption, fish tainting or fish tumor BUI removal, and to the public during BUI removal public comment sessions and other related events.

CO Tier 3

The HE/PC is waiting for updated fish consumption analysis data to be reviewed by the toxicologists in charge of developing the MDCH safe fish guidelines. Once MDCH receives updated fish contaminant data, the HE/PC will work with the PACs to develop area-specific appropriate outreach materials that serve to educate the public about the AOC, the BUI, and the fish consumption guidelines applicable to their area.

Deer Lake
Status: CO Tiers 1-3



Unlike most other AOCs, Deer Lake is using trend data for their BUI removal criteria rather than a reference site comparison.

Not only have mercury levels in fish have been steadily declining over the last decade, but also the MDCH will relax the Deer Lake fish consumption guidelines in the 2012-2013 Eat Safe Fish Guide from 'Do Not Eat" for all species to limited consumption of some fish species.

However, despite this relaxed consumption guideline, the Michigan Department of Natural Resources (MDNR) will continue to uphold their "no possession of any fish" rule established on Deer Lake for the remainder of 2013. The MDNR originally implemented this rule to support the MDCH "Do Not Eat" guidelines. Originally, the MDNR planned to hold a public comment session later this year to discuss removal of their 'no possession' regulation. However, based on MDNR expert input, they have decided to uphold their catch-and-release only policy to protect the unique fishery that has developed over years.

Over the past several years, the EPA has funded the City of Ishpeming's efforts to divert Partridge Creek from the mines into a storm sewer system. This creek, while running through the mine, was a source of mercury contamination for Deer Lake.

With completion of this project imminent, the MDEQ, the EPA, and the PAC have began gathering data in support of the petition to remove the BUI. MDCH is providing a letter of support to the MDEQ for this removal. Concurrent with the submittal of that petition, MDCH will send the *Eat Safe Fish in Areas of Concern* fact sheet to all existing outreach distribution contacts in the Deer Lake area.

The HE/PC is also continuing the development of a map that highlights fishing locations, access points, and fish consumption guidelines in waterbodies in Marquette County.

In March, the HE/PC conducted a train-the-trainer session with the Menominee County Health Department WIC Coordinator. The Eat Safe Fish outreach materials are now being distributed to all WIC clients who eat locally-caught fish in Menominee County. The HE/PC delivered brochures to the community liaison for the Marquette Food Co-Op and an organizer of the U.P. Food Exchange program. She also met with the head of the Superior Watershed Partnership and Land Trust to discuss collaboration strategies.

Menominee River AOC
Status: CO Tier 1
Michigan and Wisconsin share the Menominee River AOC site.

Angler fishing off the Hattie Street Bridge in Menominee, March 21, 2013.

In March, the HE/PC met with a representative of the Wisconsin Department of Natural Resources (WDNR), as well as the Wisconsin Extension Outreach Coordinator for the site, to brainstorm bi-state outreach methodologies to coordinate AOC messaging on both sides of the border. In the past, Wisconsin and Michigan consumption advice for the same fish from the river has not aligned. However, Michigan has recently completed updates to their methodology for determining fish consumption guidelines, and this has resulted in Michigan achieving consensus with Great Lakes Consortium protocols, to which both Michigan and Wisconsin subscribe. MDCH suspects that with these updates, the consumption guidelines for the two states will be more in consensus and make it easier for interstate communication pieces to be developed, resulting in a unified outreach strategy.

While in Menominee, the HE/PC also conducted a train-the-trainer session with the Public Health of Delta and Menominee Counties WIC Coordinator. She also made contact with the head of the Menominee & Marinette Great Lakes Sports Fishermen Association, which has led to the distribution of fish consumption health outreach at two of the major fishing derbies held in the community this summer.

Until the analysis of the recently collected fish is complete, MDCH will continue to provide the Menominee River AOC and other local stakeholders with a quantity of general Eat Safe Fish materials to distribute in order to build fish consumption awareness in the area, per the CO Tier 1 strategy. The Menominee & Marinette Great Lakes Sports

Fishermen Association and a creel clerk from the MDNR distributed over 200 Eat Safe Fish brochures, bobbers, tape measures, and other outreach materials to children and their families at the Menominee & Marinette Kids' Fishing Derby in early June. MDCH is mailing additional supplies to the Association for distribution during the adults Brown Trout Derby later this summer.

MDEQ has been working with the Wisconsin Department of Natural Resources (WDNR) to orchestrate the collection of fish from the Menominee River. However, traditional electro-shocking collection methods did not yield the number of carp or bass required for analysis. In early June, the HE/PC coordinated with the Menominee & Marinette Great Lakes Sports Fishermen Association to identify volunteers who will attempt to procure the rest through hook and line-style fishing. The fish collected will be fast-tracked into the MDCH Laboratory's analysis queue to get contamination results and new safe fish guidelines issued in early summer.

River Raisin AOC
Status: CO Tier 1
The EPA requested that MDCH delay fish collection and analysis until Year 3 of the current grant period due to site restoration work. However, during the dredging project funded by the Great Lakes Legacy Act, the EPA identified an area of DNAPL, which has delayed the completion of the project.

A child selects an Eat Safe Fish tape measure at the River Raisin Free Fishing Derby on June 8, 2013.

MDCH requested and received a no-cost extension from the EPA to delay the sampling and analysis of the fish until 2014-2015 in order to allow for dredging to be completed.

In January, the HE/PC conducted train-the-trainer sessions with individuals from the City of Monroe Recreation Department and the Monroe County Health Department WIC program. She also continues to partner and distribute outreach materials to the DNR, the PAC, and other area stakeholders to distribute general Eat Safe Fish materials, as identified in CO Tier 1.

Rouge River AOC
CO Tier 1
MDCH and MDEQ are coordinating the assessment the Restrictions on Fish Consumption BUI.

To assess the fish consumption BUI, the MDEQ or a partner will collect up to 20 of at least one benthic species and one resident species of fish residing in the river and one reference site (proposed: Ford Lake). MDCH will analyze the fish for PCBs and MDCH's standard suite of contaminants.

The final sampling plan has been approved by the Rouge River Advisory Council. MDCH will file the plan with the EPA as an addendum to the grant's existing Quality Assurance Project Plan.

In January, the HE/PC conducted a train-the-trainer session with the head of the WIC program at the Public Health Department of Wayne County. She also has distributed materials to the City of Southfield for their yearly fishing derby, as well as to the Friends of the Rouge River for use at a variety of events.

St Clair River AOC
CO Tier 1
The St Clair River AOC is a binational site operating with a binational PAC (BPAC).

MDCH provided brochures, tattoos, bobbers, tape measures, cookbooks and other Eat Safe Fish outreach materials to the St Clair County Health Department for distribution at events and to visitors to their office.

MDCH is also partnering with the PAC and other area stakeholders to distribute general awareness Eat Safe Fish materials, as identified in CO Tier 1.

As part of this grant, MDCH sponsored reusable tote bags for the St Clair River AOC Sturgeon Festival held June 2, 2013. The bags featured facts about sturgeon and their environment; the bags were also stuffed with Eat Safe Fish take-home materials. They were given to the first 200 festival registrants. The HE/PC also attended the St Clair festival. She talked with nearly 150 families (approximately 350 individuals) and distributed Eat Safe Fish outreach materials.

MDCH and the BPAC have begun discussing future outreach needs – including signage and area-specific brochure development – in anticipation of the analytical work being completed soon.

St Marys River AOC
Status: CO Tier 1
St Marys is also a binational site. The BPAC has not only binational representation, but also tribal representation.

Per the cursory data report, the HE/PC expects removal of the tumor BUI in the coming year. Similar to the Detroit River AOC outreach plan, MDCH will work with the PAC to develop area-specific materials that celebrate the efforts that led to the removal of this BUI, as well as distribute a quantity of the *Fish Tumors or Other Deformities in Michigan's Areas of Concern* factsheets to the St Marys AOC stakeholders.

Staff from the Chippewa County Health Department distributed Eat Safe Fish materials at the health fair held at the local Walmart on April 20, 2013.

MDCH is also collaborating with the BPAC and other area stakeholders to distribute general awareness Eat Safe Fish materials, as identified in CO Tier 1. In support of this, the HE/PC spoke to an audience of approximately 40 students, professors, and community members at the BPAC's annual Environmental Summit in March. She also conducted a train-the-trainer session with the WIC coordinators at the Chippewa County Health Department. The Chippewa County Health Department also meets with most of the pregnant women from the Bay Mills Indian Community and will now be distributing our materials to them.

Reporting Activities

MDCH has posted quarterly updates in the GLAS reporting system as required.

Changes to Object Class Categories

There were no changes to Object Class Categories during this term.

Barriers and Corrective Actions

None

Activity Workplan and Current Status (as of 6/30/2013)

Activity	Percentage Completed	
	Current Reporting Period	For the Project
Restrictions on Fish Consumption BUI Assessment Activities		
• Submit QAPP for EPA Approval	100%	90%
• Develop AOC Fish Sampling Plans for targeted AOCs	100%	95%
• Fish collection	90%	90%
• Processing of fish samples	90%	90%
• Analysis of fish samples	60%	30%
• Analytical reports completed	15%	15%
• Data review and analysis	15%	15%
• Attend AOC advisory council meetings, as necessary	100%	70%
Tainting of Fish Flavor BUI Assessment Activities		
• Evaluate Detroit River data	100%	100%
• Issue reports and recommendations	100%	100%
• Attend AOC advisory council meetings, as necessary	100%	100%
Fish Tumor or Other Deformities BUI Assessment Activities		
• Evaluate Detroit River data	100%	100%
• Develop fish sampling plans, if needed, for St. Marys & Rouge River AOCs	100%	100%
• Fish collection	90%	90%
• Processing of fish samples	75%	75%
• Analysis of fish samples	75%	75%
• Analytical reports completed	0	0
• Data review and analysis	0	0
• Attend AOC advisory council meetings, as necessary	100%	66%
Community Outreach Activities		
• Develop Community Outreach Plans	30%	30%
• Implement Plans	20%	20%
• Attend AOC advisory council meetings, as necessary	100%	66%

Funding Rates

MDCH Accounting has updated the Object Class Categories based on the budget amendment approved by the EPA on 11/15/2012. MDCH's current rate of funding use is appropriate for the Workplan. MDNR and the MDEQ have completed the majority of the fish collection in the targeted AOCs. The lab analysis work will result in a substantial drawdown once the payment is processed for work completed. This spring, MDCH will begin testing messages and area-specific outreach can begin. This upcoming work will account for the majority of our spending, outside of salary support for the individuals working on this project.

Category	Grant Award	Expend. 10/1/11-6/30/13	% of Award
Lab Salaries	$ 48,249.00	$ -	0%
Lab Fringe	$ 34,257.00	$ -	0%
Lab Supplies	$ 16,295.00	$ 10,963.57	67%
Lab Maintenance	$ 9,186.00	$ -	0%
Contractual	$ 354,137.00	$ 189,730.57	53%
Novel Fish Collection	$ 16,500.00	$ -	0%
Communication	$ 846.00	$ 502.88	59%
DIT Desktop	$ 6,569.00	$ 2,616.00	40%
Subtotal Direct	$ 486,039.00	$ 203,905.32	42%
Random Moment	$ 7,479.00	$ 1,579.00	21%
Indirect	$ 5,114.00	$ 87.00	2%
Total	**$ 498,632.00**	**$ 205,571.32**	**41%**

Drawdown Request & Explanation

The last drawdown occurred on 6/20/2013. MDCH makes a monthly drawdown, generally around the 20th of each month.

Principal investigator Update

Dr. Linda D. Dykema continues in the principal investigator role for this grant project.

Amendment to Project Period

None

Great Lakes Accountability System Entry Explanation

MDCH reported to GLAS on 7/8/2013.

MICHIGAN DEPARTMENT OF COMMUNITY HEALTH

SEMI-ANNUAL PROGRESS REPORT

USEPA-Great Lakes Restoration Initiative Projects

Grant or IA Number: GL-00E00869-0
Project Title: Assessing Michigan's Beneficial Use of Sport-Caught Fish
Reporting Period Covered: July 1 – December 31, 2013
Principal Investigator: Linda D. Dykema

Table of Contents

Summary of Work Accomplished

The following section summarizes the work accomplished on the project, *Assessing Michigan's Beneficial Use of Sport-Caught Fish*, for the reporting period of July 1 – December 31, 2013.

Restrictions on Fish Consumption Beneficial Use Impairment (BUI) Assessment Activities

Per the Michigan Department of Environmental Quality's (MDEQ) *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, three criteria exist for the removal of Restrictions on Fish Consumption and Wildlife BUI. The BUI is considered restored when:

- The fish consumption advisories in the Area of Concern (AOC) are the same or less restrictive than the associated Great Lake or appropriate control site.

OR, if the advisory in the AOC is more stringent than the associate Great Lake or control site:

- A comparison study of fish tissue contaminant levels demonstrates that there is no statistically significant difference in fish tissue concentrations of contaminants causing fish consumption advisories in the AOC compared to a control site.

OR, if a comparison study is not feasible because of the lack of a suitable control site:

- Analysis of trend data (if available) for fish with consumption advisories shows similar trends to other appropriate Great Lakes trend sites.

The first step toward assessing this BUI for all sites, regardless of criteria, is fish collection and contaminant analysis. Per our Environmental Protection Agency (EPA) Project Officer, the Michigan Department of Community Health (MDCH) will continue to operate under the existing Quality Assurance Project Plan (QAPP) approved for our existing Great Lakes Restoration Initiative (GLRI) grant, *Enhance State of Michigan Fish Consumption Advisories* [GL-00E00457-2]. MDCH submitted to the EPA for approval on June 19, 2012, the QAPP and the final sampling plans for five targeted sites and two control sites. On October 22, 2013, MDCH submitted an addendum that the EPA accepted on December 19, 2013. This addendum included sampling plans for the River Raisin and the Rouge River.

Status of Assessment Activities for Fish Consumption (as of 12/31/2013):

AOC or Reference Site	Current Status of Fish Assessment			
	Collected	Processed	At Lab	Assessment Completed
Deer Lake	X	X	X	X
Menominee River	X (3 carp pending)	X (3 carp pending)	X	
River Raisin	X	X	X	
Rouge River	X	X	X	
St Clair River	X	X	X	X
Muskrat Analysis*	X	X	X	X
St Marys River	X	X	X	X
Les Cheneaux Islands	X	X	X	X
Little Bay de Noc	X	X	X	X

*Collection and analysis not funded by this GLRI grant. Effort supported by MDEQ, MDCH, and Environment Canada.

In addition to the fish analysis, MDCH and MDEQ collected and analyzed muskrat meat on behalf of the St Clair River AOC Binational Public Advisory Council (BPAC). Although no AOCs in Michigan have wildlife listed as impaired as part of the Restrictions on Fish and Wildlife Consumption BUI, a large number of individuals in the St Clair and southeast Michigan area consume muskrat meat, particularly during the Lenten season. Because of this, the BPAC has repeatedly requested testing of muskrat, turtle, or waterfowl for contaminants. MDEQ agreed to fund the contaminant analysis outside of this grant. MDCH arranged the collection of muskrat from Walpole Island (Ontario) and Harsen's Island (Michigan), both within the AOC's river delta.

MDEQ funded the analysis of six samples of the muskrat meat (three composite samples of four muskrat each from Michigan, and three individual muskrats from the Ontario side of the river.) Overall, the majority of the legacy contaminants were undetectable in these samples. However, persistent chemicals were detected in a few of the samples, including mercury, PCBs, DDE, DDT, hexachlorobenzene, and octachlorostyrene. The data are insufficient to derive official consumption guidelines and MDCH does not use composite samples to issue guidelines. However, were MDCH to do so based on these data, the draft recommendation would be to eat no more than sixteen ounces of muskrat meat per month from the St Clair River delta due to elevated levels of PCBs.

MDCH is drafting a Letter Health Consultation for the BPAC. The Letter Health Consultation will be completed and delivered in time for individuals' consideration prior to the Lenten season beginning March 2014. The health educator will work with the stakeholders to develop any necessary outreach materials to educate consumers of St Clair River muskrat. While MDCH will not be issuing any official guidelines, making individuals aware of the potential hazards and ways to mitigate those hazards is important public health.

Fish Consumption BUI & Community Outreach Activities

From July 1 to December 31, 2013, the health educator/project manager (HE/PM) attended multiple public advisory council (PAC) meetings in person and via conference call. Meetings included monthly Deer Lake PAC conference calls and presentations for the Deer Lake PAC, the River Raisin PAC, and the St Clair PAC meeting. The HE/PM presented an overview of the changes to the fish consumption guidelines at the State Public Advisory Council meeting in November, too. The HE/PM also presented the new Eat Safe Fish campaign to the Michigan Department of Natural Resources Creel Clerks. Creel clerks who work within AOCs were given outreach materials to distribute to individuals they encounter while surveying. The HE/PM was also interviewed for a session of the *Greening of the Great Lakes* podcast and radio show.

The MDCH HE/PM continues to take a tiered approach when developing outreach materials for the targeted AOCs.

Communication Outreach (CO) Tier 1

Prior to MDCH/MDEQ's completion of the fish analytical work, the HE/PM focused on developing and preparing to distribute general "Eat Safe Fish" materials that promote the Michigan fish consumption guidelines and are applicable statewide in AOCs. The goal of this outreach is to normalize the concept of fish consumption guidelines. The objective is to build awareness of the need to "choose safe fish" throughout the state of Michigan.

Based on multiple public interactions, the HE/PM determined that many members of the public are unaware of the terms *Area of Concern*, *Beneficial Use Impairment,* and even *Michigan Fish Advisory/Eat Safe Fish Guide*. With the assumption that fish consumption BUIs will be removed in the near future in many AOCs in Michigan, the HE/PM felt it was important to first saturate the AOC market with information about the fish consumption guidelines, prior to introducing the concept of fish consumption BUIs. The HE/PM hypothesized that the public will be more accepting of the removal criteria 'no worse than a like body of water' if they understand that fish consumption guidelines exist statewide and that the fish consumption guidelines on their local lake and/or river are the norm rather than an exception.

With PAC input, and support from Lake Superior State University, MDCH produced:

- 20,000 Bobbers – "Eat Safe Fish, ❤ Your Waters"
- 10,000 Tape Measures – "Eat Safe Fish, ❤ Your Watershed"
- 15,000 Temporary Tattoos – "Eat Safe Fish"
- 20,000 Eat Safe Fish in Michigan brochures
- 20,000 Hooked on Fish cookbooks
- 20,000 MDCH/MDEQ co-branded Activity Sheets – Grades K-3rd
- 20,000 MDCH/MDEQ co-branded Activity Sheets – Grades 4-6th
- 20,000 Eat Safe Fish FAQ fact sheets

The MDCH HE/PM has distributed these materials around the state to the targeted AOCs. Organizations that have agreed to act as distributors of the above materials include:

- All targeted AOCs' local health departments' WIC programs
- MSU Extension Coordinators
- Michigan Sea Grant
- Michigan State Park outreach program coordinators
- Department of Natural Resources' Fisheries Division Creel Clerks
- Department of Natural Resources' Operation Centers
- USGS outreach coordinators
- Municipal parks and recreation departments
- Food Co-Ops and Upper Peninsula Food Exchange
- Local fishing & sportsmen association groups
- Friends of … groups

The MDCH HE/PM or partners distributed items at special events in AOCs around the state, including:

- Rouge River Rouge-A-Palooza
- Monroe Food Day
- Charles Drew Academy in Ecorse, MI
- MDNR Creel Clerk – St Marys River/eastern Upper Peninsula
- Hoist River Basin Kids Fishing Derby – Deer Lake area
- SNAP Education – Wayne Co – Detroit & Rouge River area
- Michigan Alliance for Environmental and Outdoor Education (MAEOE)
- Michigan Earth Science Teachers Association (MESTA)'s Whole Earth: Educating a Global Community Conference

CO Tier 2

As fish consumption BUIs begin to be removed, it is important that the public is introduced to the concepts of AOCs and fish consumption BUIs in a clear, concise manner. It is also important that the public is clear on the distinct differences between a fish consumption BUI and an MDCH fish consumption guideline. It is with this goal in mind that the HE/PM developed, in partnership with the MDEQ AOC Coordinators, the "Eat Safe Fish in Areas of Concern" fact sheet. MDCH posted this fact sheet online and shared it with PACs in the targeted areas of concern for use as needed.

The HE/PM has also distributed the "Tainting of Fish Flavor in Michigan's Areas of Concern" and "Fish Tumors or Other Deformities in Michigan's Areas of Concern" fact sheets in conjunction with the MDEQ in the affected AOCs.

Consistent with the outreach plan, MDCH and MDEQ will distribute these fact sheets to media prior to any fish consumption, fish tainting or fish tumor BUI removal, and to the public during BUI removal public comment sessions and other related events.

CO Tier 3

The MDCH Laboratory has completed much of the fish contaminant analytical work and provided it to the MDEQ. The HE/PM will work with the MDCH toxicologists and MDEQ aquatic biologists to identify and incorporate updated MDCH safe fish guidelines. Once MDCH finalizes the updated fish consumption guidelines, the HE/PM will work with the PACs to develop area-specific appropriate outreach materials to educate the public about the AOC, the BUI, and the fish consumption guidelines applicable to their area.

In the meantime, the HE/PM will continue to work with AOC stakeholders to develop brochures and signs to post at fishing access points – including boat launches and city parks – along the affected waterbodies.

New MDCH sign and brochure templates for Areas of Concern

Deer Lake AOC
Status: CO Tier 3

MDCH Laboratory has completed the analysis of the fish collected from the Deer Lake AOC:

FISH COLLECTION AND ANALYSIS: DEER LAKE				
		Fish Collection Goal	Fish Collected	Lab Analysis Complete
Carp River basin				
	Northern Pike	10	13	13
	White Sucker	10	10	10
	Walleye	--	2	2
	Yellow Perch	--	1	1

Unlike most other AOCs, Deer Lake is using trend data for their BUI removal criteria rather than a reference site comparison.

Not only have mercury levels in fish have been steadily declining over the last decade, but also the MDCH will relax the Deer Lake fish consumption guidelines in the 2012-2013 Eat Safe Fish Guide from 'Do Not Eat" for all species to limited consumption of some fish species.

However, despite this relaxed consumption guideline, the Michigan Department of Natural Resources (MDNR) will uphold their "no possession of any fish" rule established on Deer Lake for the remainder of 2013. The MDNR originally implemented this rule to support the MDCH "Do Not Eat" guidelines. Originally, the MDNR planned to hold a public comment session later this year to discuss removal of their 'no possession' regulation. However, based on MDNR expert input, they have decided to uphold their catch-and-release only policy to protect the unique fishery that has developed over years.

Over the past several years, the EPA has funded the City of Ishpeming's efforts to divert Partridge Creek from the mines into a storm sewer system. While running through the mine, the creek was a source of mercury contamination for Deer Lake.

With completion of this project imminent, the EPA hosted a press conference in early November heralding the work of the community and the public advisory council over many decades, which resulted in the petition for removal of the final BUI, paving the way for Michigan's first AOC delisting. MDCH provided a letter of support to the MDEQ for this removal, and the PAC voted on November 5, 2013 to submit their recommendation for the BUI removal to the MDEQ, as well.

The HE/PM has nearly finalized an area-specific brochure that highlights fishing locations and fish consumption guidelines for MDCH-tested fish from waterbodies in Marquette County. The MDCH will insert the *Eat Safe Fish in Areas of Concern* fact sheet into all the new brochures and will provide the flyers to existing outreach distribution contacts in the Deer Lake area. Interested parties are reviewing signs for Deer Lake before they are finalized for production. MDCH will work with the MDEQ and Cliffs Natural Resources to have them posted around the lake, replacing the existing out-of-date signage.

Menominee River AOC

Status: CO Tier 2-3

Michigan and Wisconsin share the Menominee River AOC site.

MDCH Laboratory has completed analysis for the majority of the fish taken from the Menominee River AOC, although MDEQ still hopes to collect at least four more carp from the Lower Scott Flowage this spring with the cooperation of the Wisconsin Department of Natural Resources.

Fish Collection and Analysis: Menominee River		Fish Collection Goal	Fish Collected	Lab Analysis Complete
River Mouth				
	Carp	10	10	10
	Smallmouth Bass	10	10	8
	Black Crappie	--	10	10
	Bluegill	--	10	10
	Northern Pike	--	9	9
	Redhorse	--	1	
	Rock Bass	--	10	
	Yellow Perch	--	9	8
Lower Scott Flowage				
	Carp	10	6	5
	Smallmouth Bass	10	10	1
	Redhorse Sucker	--	12	5
	Rock Bass	--	14	10
	Yellow perch	--	3	--
	Bluegill	--	3	--

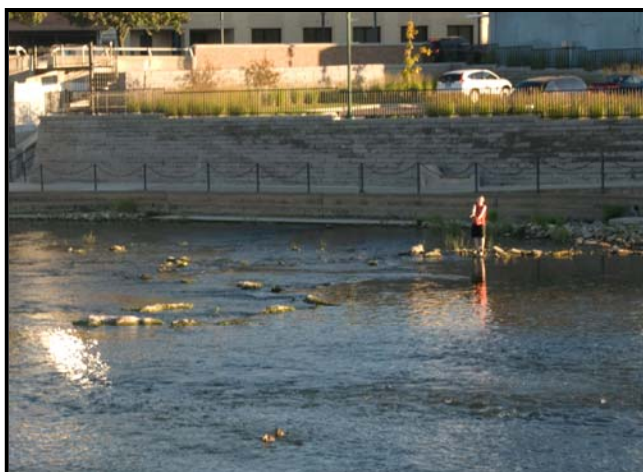
MDCH continues to collaborate with the MDEQ, Wisconsin DNR, and the University of Wisconsin Extension office to determine the best possible outreach strategy for both states.

River Raisin AOC

Status: CO Tier 1

The EPA requested that MDCH delay fish collection and analysis until 2013 due to site restoration work. However, during a dredging project funded by the Great Lakes Legacy Act, the EPA identified an area of dense non-aqueous phase liquid (DNAPL). The DNAPL resulted in substantial delays to the project timeline.

Because of these restoration delays, MDCH requested and received a no-cost extension from the EPA to postpone sampling and analysis of River Raisin fish until 2014-2015 to allow for completion of the dredging project.



Boy fishing in Monroe, MI (September 2013). Many individuals are enjoying the River Raisin in downtown Monroe post-implementation of the GLRI-funded dam removal projects in 2013.

However, since the dredging did not restart in the fall as anticipated, MDEQ took advantage of the delay and collected fish in October. MDEQ's aquatic biologist on the project concedes that the contaminants in the fish may still be superficially elevated due to the prior dredge work; however, it was better to collect the fish prior to further dredging work in order to achieve a more accurate assessment of the BUI.

The MDEQ has completed the collection and processing of fish from the River Raisin AOC:

FISH COLLECTION AND ANALYSIS: RIVER RAISIN		Fish Collection Goal	Fish Collected	Lab Analysis Complete
Monroe				
	Carp	10	10	
	Rock Bass	10	10	
	Smallmouth Bass	10	--	
	Largemouth Bass (collected in place of smallmouth)	--	10	

MDEQ will send the fish to the MDCH Laboratory for analysis over the winter.

The River Raisin PAC has requested signage and brochures, as well. The HE/PM will continue to work with the interested parties in order to provide the desired materials as soon as the contaminant data returns from the MDCH Lab.

Rouge River AOC

CO Tier 1

In the grant narrative, MDCH stated that should the assessment of the Tumor and Deformities BUI necessitate a fish collection, MDCH would also collect fish to assess the Restrictions on Fish Consumption BUI on the Rouge River AOC.

Therefore, per the approved sampling plan, fish were collected in late fall. Over the winter, MDEQ will process the fish, and the MDCH Laboratory will analyze the fish for PCBs and the standard suite of contaminants.

The MDEQ has completed the collection and processing of fish from the Rouge River AOC:

FISH COLLECTION AND ANALYSIS: ROUGE RIVER		Fish Collection Goal	Fish Collected	Lab Analysis Complete
Newburgh Lake				
	Carp	10	10	
	Largemouth Bass	10	10	
	Rock Bass	10	0	
	Bluegill/Pumpkinseed	--	10	
	Black Crappie	--	5	
Main Branch d/s Ford Dam				
	Carp	10	10	
	Largemouth/Smallmouth Bass	10	10	
	Rock Bass	10	10	

MDEQ will send the fish to the MDCH Laboratory for analysis over the winter.

MDCH is distributing outreach materials per the Tier 1 outreach plan. Once the HE/PM receives the updated contaminant data, she will work with the Rouge River PAC to develop area specific outreach materials.

In the meantime, the HE/PM is participating whenever possible in events like the first annual Rouge-A-Palooza and providing outreach materials to local partners.

St Clair River AOC

CO Tier 2 & 3

The St Clair River AOC is operating with a binational PAC (BPAC) representing both United States' and Canadian interests.

MDCH Laboratory has provided MDEQ with the results of the chemical analysis for the fish tested from the St Clair River and the HE/PM has presented the preliminary results to the St Clair BPAC. MDEQ is in the process of finalizing the data report for the BPAC that will assist with their determination of next steps related to BUI assessment.

Fish Collection and Analysis: St Clair River				
		Fish Collection Goal	Fish Collected	Lab Analysis Complete
Algonac				
	Carp	10	10	10
	Smallmouth Bass	10	10	10
	Rock Bass	10	10	10

The St Clair River AOC BPAC has requested signage and area-specific brochures for use in educating individuals about choosing and eating safer fish from the heavily utilized St Clair River fishery. The HE/PM has developed templates for the BPAC that have been presented to and approved by city managers and other stakeholders on the St Clair Watershed Council – representatives of all St Clair River communities (US side) who will benefit from the signage.

St Marys River AOC

Status: CO Tier 2 & 3

St Marys is also a binational site. The BPAC has not only American and Canadian representation, but also tribal representation.

Fish Collection and Analysis: St Marys River				
		Fish Collection Goal	Fish Collected	Lab Analysis Complete
Munuscong Bay				
	Carp	10	10	10
	Northern Pike	10	0	--
	Rock Bass	--	3	--
	Brown Bullhead	--	10	--
	Pumpkinseed	--	10	10
	Redhorse Sucker	--	7	7
	Rock Bass	--	10	10
	Smallmouth Bass (alternate for pike)	--	10	10

Walleye	--	8	8
Yellow Perch	--	10	10

MDCH Laboratory has provided MDEQ with the results of the chemical analysis for the fish tested from the St Marys River. The HE/PM was scheduled to present the preliminary results to the St Marys BPAC, but the meeting was rescheduled due to inclement weather in the Upper Peninsula. The meeting will be rescheduled; in the meantime, MDEQ is in the process of finalizing the data report for the BPAC that will assist with their determination of next steps related to BUI assessment.

MDCH is also collaborating with the BPAC and other area stakeholders to develop area-specific Eat Safe Fish outreach materials, as identified in CO Tier 3.

In summary, MDCH and MDEQ have leveraged the funding provided by the EPA GLRI grant to provide extensive analysis and fish quantities beyond those identified in the award narrative to provide a more robust assessment of the targeted AOC programs' Restrictions on Fish Consumption BUI status.

Tainting of Fish Flavor BUI Assessment Activities

Per the MDEQ's *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, two criteria exist for the removal of Tainting of Fish and Wildlife Flavor BUIs. This document states that the BUI is considered restored when:

- No more than three reports of fish tainting have been made to the MDNR or MDEQ for a period of three years.

OR, if there have been reports of tainting

- A one-time analysis of representative fish species in an AOC in accordance with MDEQ Surface Water Assessment Section (SWAS) Procedure #55 for conducting taste and odor studies indicates that there is no tainting of fish flavor.

Detroit River AOC

The Detroit River PAC's recommendation to remove this BUI has gone through the Four Party process. The MDEQ has subsequently petitioned the EPA for removal of this BUI.

Through various other grants, MDCH has worked with a stakeholder group in the Detroit Area for the past several years to educate shore anglers about the importance of choosing less contaminated fish for consumption. However, the focus of this grant in the Detroit Area is the Tainting of Fish Flavor and Tumor and other Deformities BUIs.

The MDEQ and EPA removed the Tainting of Fish Flavor BUI from the US-side of the river in September 2013. Canada is close behind in the BUI removal process, and MDEQ anticipates that the BUI will be removed in full by the planned celebration scheduled for April 2014. MDCH will send the *Tainting of Fish Flavor in Michigan's Areas of Concern* fact sheet to all existing outreach distribution contacts in the area. The HE/PM also volunteered to assist the PAC chair and others with the planning and coordination of a public relations event celebrating the removal of the BUI.

Fish Tumor or Other Deformities BUI Assessment Activities

Per the MDEQ's *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, two criteria exist for the removal of Fish Tumor or Other Deformities BUI. The BUI is restored when:

- No reports of fish tumors or deformities due to chemical contaminants which have been verified through observation and analysis by the Michigan Department of Natural Resources (MDNR) or the MDEQ for a period of five years.

Or, in cases where any tumors have been reported:

- A comparison study of resident benthic fish (e.g. brown bullhead) of comparable age and at maturity (3 years), or of fish species that have been historically associated with this BUI, in the AOC and a non-impacted control site indicates that there is no statistically significant difference (with a 95% confidence interval) in the incidence of liver tumors or deformities.

Detroit River AOC

MDEQ looked for tumors in bullhead collected from the Detroit River during 2011 for routine chemical analysis. Results from twenty-one (21) Detroit River bullheads have shown no sign of tumors. At a 2012 State PAC meeting, a member of the US Fish and Wildlife Service (FWS) announced that they, in partnership with the United States Geological Services, were conducting research in the Detroit River on emerging contaminants. The federal research plan included examination for tumors, information that can be used to assess the status of the BUI. MDEQ and MDCH decided to delay the finalization of the report until they receive the FWS data. However, despite repeated requests from agencies at all levels, including the EPA, the FWS/USGS has not provided the data.

To supplement the known information, over the summer, the Detroit River PAC chair, Mary Bohling, MDCH, and MDEQ put in requests with all agencies working in the Trenton Channel to collect any bullhead incidentally caught during their unrelated actions on the river. Unfortunately, none were caught – leading to two potential conclusions – bullhead are not choosing to live there or they are there, but are just elusive. MDCH will work with the PAC to determine if a more in-depth collection and analysis is needed or if the data collected is sufficient once the FWS/USGS data is attained. The MDEQ Office of the Great Lakes will assist MDCH and the PAC with this decision.

Rouge River AOC

Although the original incidence of tumors appeared to be statistically lower than one would expect to impose a BUI, the MDEQ moved forward with a fish collection and tumor review. During the collection, MDEQ staff saw only one possible external tumor-like lesion in 41 white sucker collected from the Main Branch Rouge. The MDEQ collection crew were fairly confident that they collected all catchable white sucker from that reach of the river. Given the time of year, these were most likely resident fish.

Out of 147 white sucker (plus 38 hogsucker) collected from the Upper Rouge, the staff did not see any with tumors. A few parasites were identified, as pictured here.

All fish were in good health; there were no signs of malnutrition or stress.

These findings are indicative of an imminent removal of the Tumors or Other Deformities BUI on the Rouge River. If the PAC chooses to move forward and successfully petitions the MDEQ and EPA, this will be the first BUI removed in the Rouge River Area of Concern.

St Marys River AOC

The St Marys River AOC sampling plan for fish consumption analysis included the collection and examination for tumors in bullhead from the St Marys River. MDEQ examined bullhead during processing. However, given that the collection of fish from the AOC had no tumors and there were no confirmed reports of tumors filed in the last five years, it is possible this BUI can be removed in the near future. MDEQ is in the process of preparing a report on the findings and will present it at the St Marys BPAC meeting when it is rescheduled.

Similar to the Detroit River AOC outreach plan, MDCH will work with the PAC to develop area-specific materials that celebrate the efforts that led to the removal of this BUI, as well as distribute a quantity of the *Fish Tumors or Other Deformities in Michigan's Areas of Concern* factsheets to the St Marys AOC stakeholders.

Reporting Activities

MDCH has posted quarterly updates in the GLAS reporting system as required.

Changes to Object Class Categories

There were no changes to Object Class Categories during this term.

Barriers and Corrective Actions

None

Activity Workplan and Current Status (as of 12/31/2013)

Activity	Percentage Completed	
	Current Reporting Period	For the Project
Restrictions on Fish Consumption BUI Assessment Activities		
• Submit QAPP for EPA Approval	100%	100%
• Develop AOC Fish Sampling Plans for targeted AOCs	100%	100%
• Fish collection	100%	98%
• Processing of fish samples	100%	98%
• Analysis of fish samples	100%	98%
• Analytical reports completed	15%	15%
• Data review and analysis	15%	15%
• Attend AOC advisory council meetings, as necessary	100%	80%
Tainting of Fish Flavor BUI Assessment Activities		
• Evaluate Detroit River data	100%	100%
• Issue reports and recommendations	100%	100%
• Attend AOC advisory council meetings, as necessary	100%	80%
Fish Tumor or Other Deformities BUI Assessment Activities		
• Evaluate Detroit River data	100%	100%
• Develop fish sampling plans, if needed, for St. Marys & Rouge River AOCs	100%	100%
• Fish collection	100%	100%
• Processing of fish samples	100%	100%
• Analysis of fish samples	100%	100%
• Analytical reports completed	0%	0%
• Data review and analysis	0%	0%
• Attend AOC advisory council meetings, as necessary	100%	80%
Community Outreach Activities		
• Develop Community Outreach Plans	60%	50%
• Implement Plans	20%	20%
• Attend AOC advisory council meetings, as necessary	100%	80%

Funding Rates

MDCH Accounting has updated the Object Class Categories based on the budget amendment approved by the EPA on 11/15/2012. MDCH's current rate of funding use is appropriate for the Workplan. MDNR and the MDEQ have completed the majority of the fish collection in the targeted AOCs. The lab analysis work will result in a substantial drawdown once the payment is processed for work completed. This spring, MDCH will begin testing messages and area-specific outreach can begin. This upcoming work will account for the majority of our spending, outside of salary support for the individuals working on this project.

Category	Grant Award	Expend. 10/1/11-12/31/13	% of Award
Lab Salaries	*$48,249*	*$22,940*	*48%*
Lab Fringes	*$34,257*	*$17,708*	*52%*
Lab Supplies	*$16,295*	*$11,242*	*69%*
Lab Maintenance	*$9,186*	*$0.00*	*0%*
Contractual	*$354,137*	*$251,971*	*71%*
Novel Fish Collection	*$16,500*	*$1,266*	*8%*
Communication	*$846*	*$642*	*76%*
DIT Desktop	*$6,569*	*$5,200*	*79%*
Subtotal - Direct	$486,039	$310,969	64%
Random Moment	$7,479	$4,667	62%
Indirect	$5,114	$2,689	53%
Total	**$ 498,632**	**$ 318,325**	**64%**

Drawdown Request & Explanation

The last drawdown occurred on 12/20/2013. MDCH makes a monthly drawdown, generally around the 20th of each month.

Principal investigator Update

Dr. Linda D. Dykema continues in the principal investigator role for this grant project.

Amendment to Project Period

None

Great Lakes Accountability System Entry Explanation

MDCH reported to GLAS on 1/7/2014.

MICHIGAN DEPARTMENT OF COMMUNITY HEALTH

SEMI-ANNUAL PROGRESS REPORT

USEPA-Great Lakes Restoration Initiative Projects

Grant or IA Number: GL-00E00869-0
Project Title: Assessing Michigan’s Beneficial Use of Sport-Caught Fish
Reporting Period Covered: January 1 – June 30, 2014
Principal Investigator: Linda D. Dykema

Table of Contents

Summary of Work Accomplished

The following section summarizes the work accomplished on the project, *Assessing Michigan's Beneficial Use of Sport-Caught Fish*, for the reporting period of January 1 through June 30, 2014.

Restrictions on Fish Consumption Beneficial Use Impairment (BUI) Assessment Activities

Per the Michigan Department of Environmental Quality's (MDEQ) *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, three criteria exist for the removal of Restrictions on Fish Consumption and Wildlife BUI. The BUI is considered restored when:

- The fish consumption advisories in the Area of Concern (AOC) are the same or less restrictive than the associated Great Lake or appropriate control site.

OR, if the advisory in the AOC is more stringent than the associate Great Lake or control site:

- A comparison study of fish tissue contaminant levels demonstrates that there is no statistically significant difference in fish tissue concentrations of contaminants causing fish consumption advisories in the AOC compared to a control site.

OR, if a comparison study is not feasible because of the lack of a suitable control site:

- Analysis of trend data (if available) for fish with consumption advisories shows similar trends to other appropriate Great Lakes trend sites.

The first step toward assessing this BUI for all sites, regardless of criteria, is fish collection and contaminant analysis. Per our Environmental Protection Agency (EPA) Project Officer, the Michigan Department of Community Health (MDCH) will continue to operate under the existing Quality Assurance Project Plan (QAPP) approved for our existing Great Lakes Restoration Initiative (GLRI) grant, *Enhance State of Michigan Fish Consumption Advisories* [GL-00E00457-2]. MDCH submitted to the EPA for approval on June 19, 2012, the QAPP and the final sampling plans for five targeted sites and two control sites. On October 22, 2013, MDCH submitted an addendum that the EPA accepted on December 19, 2013. This addendum included sampling plans for the River Raisin and the Rouge River. Once the sampling plans for the two new sites: Clinton River and Saginaw Bay/River are finalized by the respective PACs, another QAPP addendum will be submitted to incorporate the project plans.

Status of Assessment Activities for Fish Consumption (as of 6/30/2014):

AOC or Reference Site	Current Status of Fish Assessment				
	Sampling Plan	Collected	Processed	At Lab	Assessment Completed
Clinton River	X (draft)				
Deer Lake	X	X	X	X	X
Menominee River	X	X (3 carp pending)	X (3 carp pending)	X	
River Raisin	X	X	X	X	
Rouge River	X	X	X	X	
St Clair River	X	X	X	X	X

Muskrat Analysis*	**X**	**X**	**X**	**X**	**X**
St Marys River	**X**	**X**	**X**	**X**	**X**
Saginaw River/Bay	**X** (draft)				
Les Cheneaux Islands		**X**	**X**	**X**	**X**
Little Bay de Noc		**X**	**X**	**X**	**X**

*Collection and analysis not funded by this GLRI grant.
Effort supported by MDEQ, MDCH, and Environment Canada.

Fish Consumption BUI & Community Outreach Activities

From January 1 through June 30, 2014, the health educator/project manager (HE/PM) continued to work with the public advisory councils at the targeted sites. She also attended public meetings, participated in planning sessions and BUI removal events, collaborated with federal and state partners as part of the Great Lakes Consortium for Fish Advisories and at the annual EPA AOC conference, reviewed AOC delisting documents, and participated in myriad conference calls and email conversations regarding AOC issues.

The HE/PM taught basic principles of bioaccumulative and persistent chemicals with regard to fish consumption through a presentation and interactive game for children attending the Rouge River Water Festival. She also spoke with over 200 individuals and families at the Sturgeon Festival, an annual event hosted by the St Clair River AOC. The HE/PM presented to nearly 50 people at the Inland Lakes Conference, educating watershed advocates and lakefront landowners on the new Eat Safe Fish Guides and issues commonly associated with Areas of Concern.

The MDCH HE/PM continues to take a tiered approach when developing outreach materials for the targeted AOCs.

Communication Outreach (CO) Tier 1: All Targeted Sites

Prior to MDCH/MDEQ's completion of the fish analytical work, the HE/PM focused on developing and preparing to distribute general "Eat Safe Fish" materials that promote the Michigan fish consumption guidelines and are applicable statewide in AOCs. The goal of this outreach is to normalize the concept of fish consumption guidelines. The objective is to build awareness of the need to "choose safe fish" throughout the state of Michigan.

Based on multiple public interactions, the HE/PM determined that many members of the public are unaware of the terms *Area of Concern*, *Beneficial Use Impairment,* and even *the Eat Safe Fish Guide*. With the assumption that fish consumption BUIs will be removed in the near future in many AOCs in Michigan, the HE/PM felt it was important to first saturate the AOC market with information about the statewide fish consumption guidelines, prior to introducing the concept of fish consumption BUIs. The HE/PM hypothesized that the public will be more accepting of the removal criteria 'no worse than a like body of water' if they understand that fish consumption guidelines exist statewide and that the fish consumption guidelines on their local lake and/or river are the norm rather than an exception.

From January until June 30, 2014, the HE/PM has distributed or provided to partners:

- 1,500 Bobbers – "Eat Safe Fish, ♥ Your Waters"
- 2,000 Tape Measures – "Eat Safe Fish, ♥ Your Watershed"
- 1,000 Temporary Tattoos – "Eat Safe Fish"
- 8,000 Eat Safe Fish in Michigan brochures
- 1,000 Hooked on Fish cookbooks
- 1,000 MDCH/MDEQ co-branded Activity Sheets – Grades K-3rd
- 1,000 MDCH/MDEQ co-branded Activity Sheets – Grades 4-6th
- 100 Eat Safe Fish FAQ fact sheets
- 1,000 Eat Safe Fish tote bags (Detroit River and St Clair River AOC PAC-branded)

The MDCH HE/PM has distributed these materials to the targeted AOCs around the state. Organizations that have agreed to act as distributors of the above materials include:

- All targeted AOCs' local health departments' WIC programs
- MSU Extension Coordinators
- Michigan Sea Grant
- Michigan State Park outreach program coordinators
- Department of Natural Resources' Fisheries Division Creel Clerks
- Department of Natural Resources' Operation Centers
- United States Geological Services (USGS) outreach coordinators
- Municipal parks and recreation departments
- Food Co-Ops and Upper Peninsula Food Exchange
- Local fishing & sportsmen association groups
- Friends of … groups
- Boat/DNR Fishing License/Live Bait purveyors in Areas of Concern

Many partners have a supply of outreach materials on hand that have been provided previously; however, during this half, the MDCH HE/PM or partners have distributed items at special events in AOCs around the state, including:

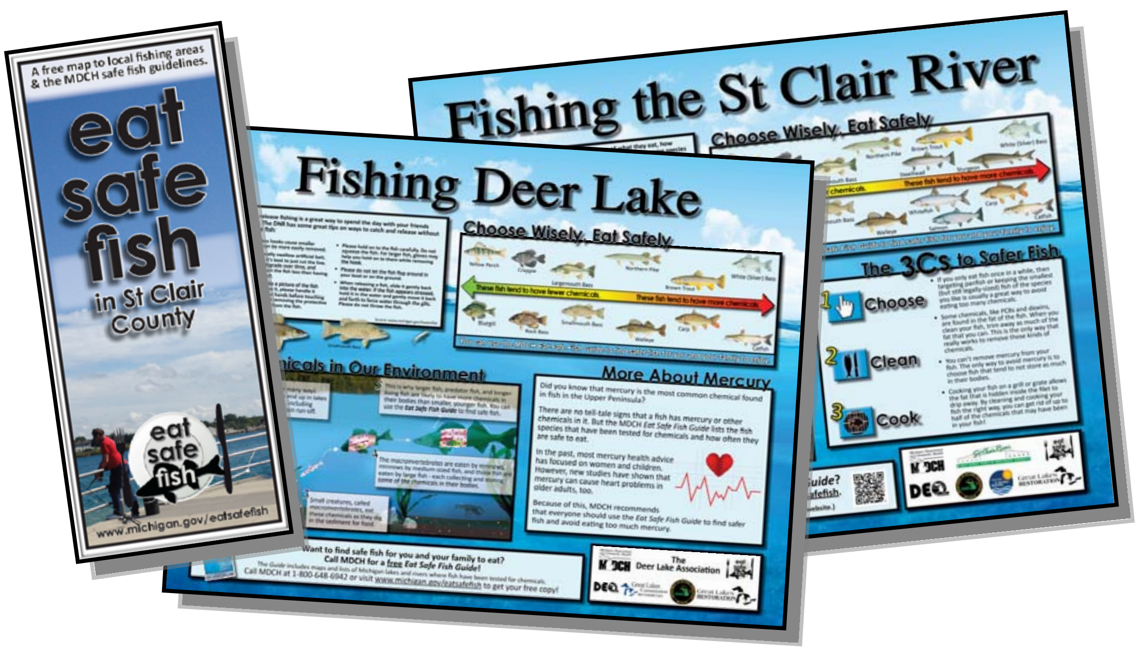
- Great Lakes Legacy Act Trenton Channel Public Meeting (~100 reached)
- St Marys BPAC AOC Kids Day (~50 reached)
- Rouge River Water Festival (~160 reached)
- Inland Lakes Conference (~100 reached)
- Detroit River AOC Fish Tainting Removal Event (~75 reached)
- St Clair River AOC's Sturgeon Festival (~200 reached)
- Deer Lake AOC Delisting Public Meeting (~5 reached)
- Trenton Summer Festival (Detroit AOC) (~200 reached)
- CUPSFA Kids' Fishing Derby (Deer Lake AOC) (~75 reached)
- Menominee Kids' Fishing Derby (Menominee River AOC) (~130 reached)
- Annual WIC Conference (multiple AOCs) (~20 relevant partners reached; ~150 overall)
- Midland County WIC Family Fun Day (~50 reached)

CO Tier 2 Sites: Deer Lake, Muskegon Lake, White Lake
As fish consumption BUIs begin to be removed, it is important that the public is introduced to the concepts of AOCs and fish consumption BUIs in a clear, concise manner. It is also important that the public is clear on the distinct differences between a fish consumption BUI and an MDCH fish consumption guideline. It is with this goal in mind that the HE/PM developed, in partnership with the MDEQ AOC Coordinators, the "Eat Safe Fish in Areas of Concern" fact sheet. MDCH posted this fact sheet online and shared it with PACs in the targeted areas of concern for use as needed. The HE/PM distributed this flyer to participants at the Deer Lake Delisting Public Meeting, and also provided copies to the Muskegon Lake Area of Concern PAC chair for distribution.

The HE/PM distributed the "Tainting of Fish Flavor in Michigan's Areas of Concern" fact sheet to all participants who attended the Fish Tainting BUI Removal event on Fighting Island in May 2014. The flyer was also included along with the Eat Safe Fish brochures and other relevant materials in the press kits. St Marys and Detroit also have access to the "Fish Tumors or Other Deformities in Michigan's Areas of Concern," although the BUI removals at these sites are not imminent.

CO Tier 3: Deer Lake, St Clair River, St Marys River, Muskegon Lake, White Lake
The MDCH Laboratory has completed fully completed the analytical work for the St Marys River and the St Clair River, still pending is the fish analysis work for the Menominee River (3 additional fish were collected this spring and entered into the queue), River Raisin, and Rouge River. The HE/PM will work with the MDCH toxicologists and MDEQ aquatic biologists to identify and incorporate updated MDCH safe fish guidelines into relevant outreach materials. Once MDCH finalizes the updated fish consumption guidelines, the HE/PM will work with the PACs to develop area-specific appropriate outreach materials to educate the public about the AOC, the BUI, and the fish consumption guidelines applicable to their area.

In the meantime, the HE/PM will continue to work with AOC stakeholders to develop brochures and signs to post at fishing access points – including boat launches and city parks – along the affected waterbodies.



Deer Lake AOC
Status: CO Tier 3

MDCH Laboratory has completed the analysis of the fish collected from the Deer Lake AOC:

FISH COLLECTION AND ANALYSIS: DEER LAKE				
		Fish Collection Goal	Fish Collected	Lab Analysis Complete
Carp River basin				
	Northern Pike	10	13	13
	White Sucker	10	10	10
	Walleye	--	2	2
	Yellow Perch	--	1	1

After the EPA and City of Ishpeming completed the last management action – restoring the flow of Partridge Creek from the mines back into its bed, thereby removing the largest source of mercury entering into Deer Lake – the EPA approved MDEQ's request to remove the Beneficial Use Impairment for Restrictions on Fish Consumption in Deer Lake in February 2014.

The MDEQ and Deer Lake PAC have now started the delisting process. The public comment period on the delisting document began June 1, 2014. As a part of this, the MDEQ held a public meeting on June 17, 2014 in Ishpeming, Michigan. The HE/PM, along with representatives from the MDEQ and EPA, were available to discuss fish consumption guidelines and criteria with the attendees.

The HE/PM is finalizing an area-specific brochure that highlights fishing locations and fish consumption guidelines for MDCH-tested fish from waterbodies in Marquette County. The MDCH is also adding the MDNR's family friendly fishing locations onto the map, which will allow individuals to identify areas to go fishing which are easily accessible and have good catch rates.

The MDCH will insert the *Eat Safe Fish in Areas of Concern* fact sheet into all the new brochures and will provide the flyers to existing outreach distribution contacts in the Deer Lake area. The MDCH is conferring with Cliffs Natural Resources with regard to the Consent Agreement and future sign posting. Once the signs are printed, Cliffs will post the signs at both the old and new boat launches, as well as any additional highly utilized shoreline fishing locations around the lake. The HE/PM will work with community members and Cliffs to identify these sites, if any.

Menominee River AOC

Status: CO Tier 2-3

Michigan and Wisconsin share the Menominee River AOC site.

MDCH Laboratory has completed analysis for the majority of the fish taken from the Menominee River AOC, although MDEQ still hopes to collect at least four more carp from the Lower Scott Flowage with the cooperation of the Wisconsin Department of Natural Resources. Recent netting attempts have not proven fruitful, however; and MDEQ is weighing the benefits of getting additional carp versus the continued delay in analyzing the data currently available.

Fish Collection and Analysis: Menominee River		Fish Collection Goal	Fish Collected	Lab Analysis Complete
River Mouth				
	Carp	10	10	10
	Smallmouth Bass	10	10	8
	Black Crappie	--	10	10
	Bluegill	--	10	10
	Northern Pike	--	9	9
	Redhorse	--	1	
	Rock Bass	--	10	
	Yellow Perch	--	9	8
Lower Scott Flowage				
	Carp	10	6	5
	Smallmouth Bass	10	10	1
	Redhorse Sucker	--	12	5
	Rock Bass	--	14	10
	Yellow perch	--	3	--
	Bluegill	--	3	--

MDCH continues to collaborate with the MDEQ, Wisconsin DNR, and the University of Wisconsin Extension office to determine the best possible outreach strategy for both states. MDCH's updates to the fish advisory program bring Michigan's Menominee River fish consumption guidelines more in consensus with Wisconsin's existing guidelines. MDCH has proposed working with the Wisconsin DNR to identify points of compromise so that the consumption guidelines will correspond in both states for this shared waterbody. Should this endeavor prove successful, the HE/PM, Wisconsin Extension office, and Menominee River CAC will be able to more easily correlate outreach materials, mitigating confusion in these closely intertwined bi-state communities and allowing for economy of scale when ordering.

River Raisin AOC
Status: CO Tier 1

The MDEQ has completed the collection and processing of fish from the River Raisin AOC:

Fish Collection and Analysis: River Raisin		Fish Collection Goal	Fish Collected	Lab Analysis Complete
Monroe				
	Carp	10	10	
	Rock Bass	10	10	
	Smallmouth Bass	10	--	
	Largemouth Bass (collected in place of smallmouth)	--	10	

MDEQ and MDCH expects the analytical results to return from the lab in mid-August 2014. At that point, MDCH will work to incorporate the new data into their fish consumption guidelines and MDEQ and MDCH will collaborate to finalize a status report of the BUI for the PAC.

The River Raisin PAC has requested signage and brochures. The HE/PM will continue to work with the interested parties in order to provide the desired materials as soon as the contaminant data returns from the MDCH Lab.

Rouge River AOC
CO Tier 1

In the grant narrative, MDCH stated that should the assessment of the Tumor and Deformities BUI necessitate a fish collection, MDCH would also collect fish to assess the Restrictions on Fish Consumption BUI on the Rouge River AOC.

Therefore, per the approved sampling plan, fish were collected in late fall 2013 and sent to the MDCH Lab for analysis. MDEQ has received some results; however the remaining samples are not expected back until later this month. At that time, MDCH and MDEQ will collaborate to update the fish consumption guidelines and develop a status report for the BUI.

The MDEQ has completed the collection and processing of fish from the Rouge River AOC:

Fish Collection and Analysis: Rouge River		Fish Collection Goal	Fish Collected	Lab Analysis Complete
Newburgh Lake				
	Carp	10	10	10 (Hg)
	Largemouth Bass	10	10	10 (Hg)
	Rock Bass	10	0	--
	Bluegill/Pumpkinseed	--	10	10 (Hg)

	Black Crappie	--	5	(PENDING)
Main Branch d/s Ford Dam				
	Carp	10	10	10 (Hg)
	Largemouth/Smallmouth Bass	10	10	10 (Hg)
	Rock Bass	10	10	10 (Hg) 9 (Org)

The MDCH Laboratory has completed analysis for mercury for all of the samples excluding black crappie. Analysis for the remaining organics is underway.

MDCH is distributing outreach materials per the Tier 1 outreach plan. Once the HE/PM receives the updated contaminant data, she will work with the Rouge River PAC to develop area specific outreach materials.

In the meantime, the HE/PM is participating whenever possible in events and providing outreach materials to local partners.

St Clair River AOC

CO Tier 2 & 3

The St Clair River AOC is operating with a binational PAC (BPAC) representing both United States' and Canadian interests.

MDCH Laboratory has provided MDEQ with the results of the chemical analysis for the fish tested from the St Clair River and the HE/PM has presented the preliminary results to the St Clair BPAC. MDEQ finalized the report in March of 2014, and it was provided to the BPAC for consideration of next steps. **[Attachment A]**

FISH COLLECTION AND ANALYSIS: ST CLAIR RIVER				
		Fish Collection Goal	**Fish Collected**	**Lab Analysis Complete**
Algonac				
	Carp	10	10	10
	Smallmouth Bass	10	10	10
	Rock Bass	10	10	10

The St Clair River AOC BPAC requested signage, which MDCH will deliver in early July to the watershed council. Each of the respective townships will take ownership of the signs and post in locations frequently accessed by shoreline and boat anglers. The St Clair County Health Department will maintain the extra signs and distribute as needed for replacements in the future. The HE/PM is also finalizing the area-specific brochures for use in educating individuals about choosing and eating safer fish from the heavily utilized St Clair River fishery. She is working with the DNR and local stakeholders to identify easily accessible fishing locations to feature on the brochure map.

The MDCH also prepared a Letter Health Consult regarding muskrat consumption. The HE/PM provided this document to the BPAC in January of 2014. **[Attachment B]**

St Marys River AOC
Status: CO Tier 2 & 3
St Marys is also a binational site. The BPAC has not only American and Canadian representation, but also tribal representation.

Fish Collection and Analysis: St Marys River				
		Fish Collection Goal	Fish Collected	Lab Analysis Complete
Munuscong Bay				
	Carp	10	10	10
	Northern Pike	10	0	--
	Rock Bass	--	3	--
	Brown Bullhead	--	10	--
	Pumpkinseed	--	10	10
	Redhorse Sucker	--	7	7
	Rock Bass	--	10	10
	Smallmouth Bass (alternate for pike)	--	10	10
	Walleye	--	8	8
	Yellow Perch	--	10	10

MDCH Laboratory has provided MDEQ with the results of the chemical analysis for the fish tested from the St Marys River. The HE/PM presented the results and the final fish consumption BUI assessment report **[Attachment C]** to the St Marys BPAC in March.

MDCH is also collaborating with the BPAC and other area stakeholders to develop area-specific Eat Safe Fish outreach materials, as identified in CO Tier 3. In May, the HE/PM scouted site locations for signage, as well as distributed brochure, bobbers, and tape measures to all bait and tackle stores and boat repair shops border the AOC, as well as the Michigan Welcome Center in Sault Ste Marie.

In summary, MDCH and MDEQ have leveraged the funding provided by the EPA GLRI grant to provide extensive analysis and fish quantities beyond those identified in the award narrative to provide a more robust assessment of the targeted AOC programs' Restrictions on Fish Consumption BUI status.

Tainting of Fish Flavor BUI Assessment Activities

Per the MDEQ's *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, two criteria exist for the removal of Tainting of Fish and Wildlife Flavor BUIs. This document states that the BUI is considered restored when:

- No more than three reports of fish tainting have been made to the MDNR or MDEQ for a period of three years.

OR, if there have been reports of tainting:

- A one-time analysis of representative fish species in an AOC in accordance with MDEQ Surface Water Assessment Section (SWAS) Procedure #55 for conducting taste and odor studies indicates that there is no tainting of fish flavor.

Detroit River AOC
The EPA, MDEQ and the PAC have successfully removed this BUI from the Detroit River.

The HE/PM sat on the planning committee for the event and provided outreach materials to the event attendees and press, as well as provided tote bags developed specifically for the dignitaries and other attendees at the special event on Fighting Island on May 7, 2014.

MDCH provided the *Tainting of Fish Flavor in Michigan's Areas of Concern* fact sheet to all press and attendees at the meeting.

Fish Tumor or Other Deformities BUI Assessment Activities

Per the MDEQ's *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, two criteria exist for the removal of Fish Tumor or Other Deformities BUI. The BUI is restored when:

- No reports of fish tumors or deformities due to chemical contaminants which have been verified through observation and analysis by the Michigan Department of Natural Resources (MDNR) or the MDEQ for a period of five years.

Or, in cases where any tumors have been reported:

- A comparison study of resident benthic fish (e.g. brown bullhead) of comparable age and at maturity (3 years), or of fish species that have been historically associated with this BUI, in the AOC and a non-impacted control site indicates that there is no statistically significant difference (with a 95% confidence interval) in the incidence of liver tumors or deformities.

Detroit River AOC
MDEQ looked for tumors in bullhead collected from the Detroit River during 2011 for routine chemical analysis. Results from twenty (20) Detroit River bullheads have shown no sign of tumors. USGS provided the final report detailing their tumor survey of fish tumors in the Detroit River and Trenton Channel.

The HE/PM has convened a monthly conference call between representatives from MDEQ, the EPA, the Detroit River AOC PAC, and Environment Canada to assess the data available and identify any data gaps that need to be addressed prior to consideration for removal. As it stands, the data shows that fish taken from the main branch of the river seem to be in good health and free of tumors. However, the USGS assessment of brown bullhead taken from the Trenton Channel show a higher than normal rate of tumor growth. There is also concern on behalf of both the US and Canadian sides of the total population of brown bullhead in the river. Environment Canada had scaled their collection back for concern of population depletion. Both the US and Canada are looking into the feasibility of substituting white sucker for future assessments.

In fact, to supplement the known information, over the summer, the Detroit River PAC chair, Mary Bohling, MDCH, and MDEQ put in requests with all agencies working in the Trenton Channel to collect any bullhead incidentally caught during their unrelated actions on the river. Unfortunately, none were caught – leading to two potential conclusions – bullhead are not choosing to live there or they are there, but are just elusive.

The Great Lakes Legacy Act will be conducting management actions in the Trenton Channel for the next few years. The committee suspects that the BUI removal may be contingent on the completion of this project – as the GLLA project progresses and PAHs are removed from the site, the committee anticipates that tumor levels will decrease in turn.

Rouge River AOC

Although the original incidence of tumors appeared to be statistically lower than one would expect to impose a BUI, the MDEQ moved forward with a fish collection and tumor review. During the collection, MDEQ staff saw only one possible external tumor-like lesion in 41 white sucker collected from the Main Branch Rouge. The MDEQ collection crew were fairly confident that they collected all catchable white sucker from that reach of the river. Given the time of year, these were most likely resident fish.

Out of 147 white sucker (plus 38 hogsucker) collected from the Upper Rouge, the staff did not see any with tumors. A few parasites were identified, as pictured here.

All fish were in good health; there were no signs of malnutrition or stress.

These findings are indicative of an imminent removal of the Tumors or Other Deformities BUI on the Rouge River. If the PAC chooses to move forward and successfully petitions the MDEQ and EPA, this will be the first BUI removed in the Rouge River Area of Concern.

St Marys River AOC

The St Marys River AOC sampling plan for fish consumption analysis included the collection and examination for tumors in bullhead from the St Marys River. MDEQ examined bullhead during processing. However, given that the collection of fish from the AOC had no tumors and there were no confirmed reports of tumors filed in the last five years, it is possible this BUI can be removed in the near future. The HE/PM presented the draft Tumor Assessment report to the BPAC during their monthly meeting March. **[Attachment D]**

Similar to the Detroit River AOC outreach plan, MDCH will work with the PAC to develop area-specific materials that celebrate the efforts that led to the removal of this BUI, as well as distribute a quantity of the *Fish Tumors or Other Deformities in Michigan's Areas of Concern* factsheets to the St Marys AOC stakeholders.

Reporting Activities

MDCH has posted quarterly updates in the GLAS reporting system as required.

Changes to Object Class Categories

There were no changes to Object Class Categories during this term. However, the HE/PM will be submitting updated an 424 to account for the changes in accounting methods for the laboratory work. The scope and processes remain the same; however, MDCH Laboratory has been instructed by the MDCH Accounting Department to itemize the analytical costs based on salary, fringe, supplies, and maintenance rather than simply provide a whole cost, as was the custom previously.

Barriers and Corrective Actions

None

Activity Workplan and Current Status (as of 06/30/2014)

Activity	Percentage Completed	
	Current Reporting Period	For the Project
Restrictions on Fish Consumption BUI Assessment Activities		
• Submit QAPP for EPA Approval	75%	75%
• Develop AOC Fish Sampling Plans for targeted AOCs	100%	100%
• Fish collection	75%	75%
• Processing of fish samples	100%	75%
• Analysis of fish samples	75%	75%
• Analytical reports completed	40%	40%
• Data review and analysis	50%	50%
• Attend AOC advisory council meetings, as necessary	100%	80%
Tainting of Fish Flavor BUI Assessment Activities		
• Evaluate Detroit River data	100%	100%
• Issue reports and recommendations	100%	100%
• Attend AOC advisory council meetings, as necessary	100%	100%
Fish Tumor or Other Deformities BUI Assessment Activities		
• Evaluate Detroit River data	100%	100%
• Develop fish sampling plans, if needed, for St. Marys & Rouge River AOCs	100%	100%
• Fish collection	100%	100%
• Processing of fish samples	100%	100%
• Analysis of fish samples	100%	100%
• Analytical reports completed	50%	50%
• Data review and analysis	50%	50%
• Attend AOC advisory council meetings, as necessary	100%	80%
Community Outreach Activities		
• Develop Community Outreach Plans	60%	50%
• Implement Plans	40%	40%
• Attend AOC advisory council meetings, as necessary	100%	80%

Funding Rates

MDCH Accounting has updated the Object Class Categories based on the budget amendment approved by the EPA on 11/15/2012. MDCH's current rate of funding use is appropriate for the Workplan. MDNR and the MDEQ have completed the majority of the fish collection in the targeted AOCs. The lab analysis work will result in a substantial drawdown once the payment is processed for work completed. This spring, MDCH began testing messages and implementing area-specific outreach. This upcoming work will account for the majority of our spending, outside of salary support for the individuals working on this project.

Category	Grant Award	Expend. 10/1/11-6/30/14	% of Award
Lab Salaries	*$48,249*	*$47,190*	98%
Lab Fringes	*$34,257*	*$35,195*	103%
Lab Supplies	*$29,307*	*$13,701*	47%
Lab Maintenance	*$10,844*	*$0.00*	0%
Contractual	*$387,365*	*$270,481*	70%
Novel Fish Collection	*$33,000*	*$1,266*	4%
Communication	*$846*	*$792*	94%
DIT Desktop	*$6,569*	*$5,200*	79%
Subtotal - Direct	$550,437	$373,845	68%
Random Moment	$8,445	$4,667	55%
Indirect	$5,114	$5,259	103%
Total	$563,996	$383,772	68%

Drawdown Request & Explanation

The last drawdown occurred on 6/20/2014. MDCH makes a monthly drawdown, generally around the 20th of each month.

Principal investigator Update

Dr. Linda D. Dykema continues in the principal investigator role for this grant project.

Amendment to Project Period

None

Great Lakes Accountability System Entry Explanation

MDCH reported to GLAS on 6/20/2014.

MICHIGAN DEPARTMENT OF COMMUNITY HEALTH
SEMI-ANNUAL PROGRESS REPORT
USEPA-Great Lakes Restoration Initiative Projects

Grant or IA Number: GL-00E00869-0
Project Title: Assessing Michigan's Beneficial Use of Sport-Caught Fish
Reporting Period Covered: July 1 – December 31, 2014
Principal Investigator: Kory Groetsch

Table of Contents

Summary of Work Accomplished

The following section summarizes the work accomplished on the project, *Assessing Michigan's Beneficial Use of Sport-Caught Fish*, for the reporting period of July 1 through December 31, 2014.

Restrictions on Fish Consumption Beneficial Use Impairment (BUI) Assessment Activities

Per the Michigan Department of Environmental Quality's (MDEQ) *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, three criteria exist for the removal of Restrictions on Fish Consumption and Wildlife BUI. The BUI is restored when:

- The fish consumption advisories in the Area of Concern (AOC) are the same or less restrictive than the associated Great Lake or appropriate control site.

OR, if the advisory in the AOC is more stringent than the associate Great Lake or control site:

- A comparison study of fish tissue contaminant levels demonstrates that there is no statistically significant difference in fish tissue concentrations of contaminants causing fish consumption advisories in the AOC compared to a control site.

OR, if a comparison study is not feasible because of the lack of a suitable control site:

- Analysis of trend data (if available) for fish with consumption advisories shows similar trends to other appropriate Great Lakes trend sites.

The first step toward assessing this BUI for all sites, regardless of criteria, is fish collection and contaminant analysis. Per our Environmental Protection Agency (EPA) Project Officer, the Michigan Department of Community Health (MDCH) will continue to operate under the existing Quality Assurance Project Plan (QAPP) approved for our existing Great Lakes Restoration Initiative (GLRI) grant, *Enhance State of Michigan Fish Consumption Advisories* [GL-00E00457-2]. MDCH submitted to the EPA for approval on June 19, 2012, the QAPP and the final sampling plans for five targeted sites and two control sites. On October 22, 2013, MDCH submitted an addendum that the EPA accepted on December 19, 2013. This addendum included sampling plans for the River Raisin and the Rouge River. Once the sampling plans for the two new sites: Clinton River and Saginaw Bay/River are finalized by the respective PACs, another QAPP addendum will be submitted to incorporate the project plans.

Status of Assessment Activities for Fish Consumption (as of 12/31/2014):

AOC or Reference Site	Current Status of Fish Assessment				
	Sampling Plan	Collected	Processed	At Lab	Assessment Completed
Deer Lake	X	X	X	X	X
Menominee River	X	X	X	X	
River Raisin	X	X	X	X	
Rouge River	X	X	X	X	X
St Clair River	X	X	X	X	X
Muskrat Analysis*	X	X	X	X	X
St Marys River	X	X	X	X	X

Torch Lake	**X**	**X**	**X**	**X**	**X** **(partial, waiting on Hg analysis)**
Les Cheneaux Islands		**X**	**X**	**X**	**X**
Little Bay de Noc		**X**	**X**	**X**	**X**

*Collection and analysis not funded by this GLRI grant.
Effort supported by MDEQ, MDCH, and Environment Canada.

Fish Consumption BUI & Community Outreach Activities

From July 1 through December 31, 2014, the health educator/project manager (HE/PM) continued to work with the public advisory councils at the targeted sites. She also attended public meetings, participated in planning sessions and BUI removal events, collaborated with federal and state partners as part of the Great Lakes Consortium for Fish Advisories and at the annual EPA Review Team meeting, participated in AOC delisting events, and participated in myriad conference calls and email conversations regarding AOC issues.

The HE/PM taught basic principles of bioaccumulative and persistent chemicals with regard to fish consumption through poster presentations and informational booths at local and national symposiums and summits. She also continued to serve as a liaison between public health and environmental advocates bringing together state, federal, and local stakeholders to address beneficial use impairments in the targeted Areas of Concern.

The MDCH HE/PM continues to take a tiered approach when developing outreach materials for the targeted AOCs.

Communication Outreach (CO) Tier 1: All Targeted Sites

Prior to MDCH/MDEQ's completion of the fish analytical work, the HE/PM focused on developing and preparing to distribute general "Eat Safe Fish" materials that promote the Michigan fish consumption guidelines and are applicable statewide in AOCs. The goal of this outreach is to normalize the concept of fish consumption guidelines. The objective is to build awareness of the need to "choose safe fish" throughout the state of Michigan.

Based on multiple public interactions, the HE/PM determined that many members of the public are unaware of the terms *Area of Concern*, *Beneficial Use Impairment,* and even *the Eat Safe Fish Guide*. With the assumption that fish consumption BUIs will be removed in the near future in many AOCs in Michigan, the HE/PM felt it was important to first saturate the AOC market with information about the statewide fish consumption guidelines, prior to introducing the concept of fish consumption BUIs. The HE/PM hypothesized that the public will be more accepting of the removal criteria 'no worse than a like body of water' if they understand that fish consumption guidelines exist statewide and that the fish consumption guidelines on their local lake and/or river are the norm rather than an exception.

From July 1 until December 31, the HE/PM has distributed or provided to partners:

- 1,500 Bobbers – "Eat Safe Fish, ❤ Your Waters"

- 3,000 Tape Measures – "Eat Safe Fish, ❤ Your Watershed"
- 500 Temporary Tattoos – "Eat Safe Fish"
- 3,000 Eat Safe Fish in Michigan brochures
- 400 Hooked on Fish cookbooks
- 500 MDCH/MDEQ co-branded Activity Sheets – Grades K-3rd
- 500 MDCH/MDEQ co-branded Activity Sheets – Grades 4-6th
- 100 Eat Safe Fish FAQ fact sheets
- 300 Eat Safe Fish tote bags (Detroit River and St Clair River AOC PAC-branded)
- 800 Yes You Can Eat the Fish in White Lake flyers
- 15 Yes You Can Eat the Fish in White Lake posters
- 150 River Raisin Legacy/Eat Safe Fish Ball Caps

The MDCH HE/PM has distributed these materials to partners in the targeted AOCs around the state. Organizations that have agreed to act as distributors of the above materials include:

- All targeted AOCs' local health departments' WIC programs
- MSU Extension Coordinators
- Michigan Sea Grant
- Michigan State Park outreach program coordinators
- Keweenaw Bay Indian Community representatives
- Department of Natural Resources' Fisheries Division Creel Clerks
- Department of Natural Resources' Operation Centers
- United States Geological Services (USGS) outreach coordinators
- Municipal parks and recreation departments
- Conservation Districts
- Local libraries and other community centers
- Food Co-Ops and Upper Peninsula Food Exchange
- Local fishing & sportsmen association groups
- Friends of … groups
- Boat/DNR Fishing License/Live Bait purveyors in Areas of Concern

Many partners have a supply of outreach materials on hand that have been provided previously; however, during this half, the MDCH HE/PM or partners have distributed items at special events in AOCs around the state, including:

- Bay, Saginaw, and Midland County events attended by the local health department liaisons (~500 reached with AOC materials)
- Muskegon Co Boy Scout Fishing Derby (~300 reached)
- MDNR Creel Clerks Surveys (~150 reached)
- Muskegon Co Sportsmen for Youth Day (~1000 reached)
- Rouge-A-Palooza (~100 reached)
- River Raisin Clean Up Day (~75 reached)

CO Tier 2 Sites: River Raisin, Torch Lake, Rouge River, Menominee River

MDCH and MDEQ have collected fish from these sites and the analytical work is underway at the MDCH Analytical Chemistry Laboratory that will result in new edible fish tissue contaminant data. Development of new outreach materials will occur after this new data are generated and assessed. While that work occurred, the HE/PM continued to identify local area partners and stakeholders and distribute statewide materials.

In late August, the HE/PM met with local stakeholders in the River Raisin Area of Concern and scouted locations for Eat Safe Fish signs that will be posted in the spring of 2015. She also delivered 150 baseball caps featuring the River Raisin Legacy logo and the MDCH Eat Safe Fish icon that the PAC distributed at a river clean-up event the weekend of August 23, 2014.

The HE/PM made an inaugural visit to the Torch Lake area in November. On the first day, she hosted a booth at the UP Food Summit, which was co-sponsored by the Western Upper Peninsula Health Department and attended by nearly 70 individuals interested or involved in the local food movement. The HE/PM promoted fish as a local food source, but stressed the importance of using the MDCH *Eat Safe Fish Guide* to identify lesser contaminated fish when fishing from Torch Lake or any of the other surrounding waterbodies, including Lake Superior and the Keweenaw Bay. On the day following, the HE/PM met with 12 stakeholders from the Keweenaw Bay Indian Community. She presented the BUI assessment project and outreach possibilities. She then brainstormed potential outreach strategies that would be effective with the tribal community and identified events and other outreach opportunities that occur throughout the year. The HE/PM left outreach materials with KBIC for distribution at events they planned to attend throughout the winter.

The HE/PM also attended the second annual Rouge-A-Palooza event. This event takes place on the banks of the Rouge River in Wayne, Michigan. Several hundred people attended this event, and over 100 stopped by the Eat Safe Fish booth to learn about choosing and eating safer fish in the Rouge River Area of Concern.

The HE/PM discussed further communications collaboration with the University of Wisconsin Extension Office and the Wisconsin Department of Natural Resources. Currently, MDCH is awaiting final analytical results to determine if Michigan and Wisconsin can come to a consensus with regard to unified fish consumption guidelines for the Menominee River.

CO Tier 3: St Clair River, St Marys River, Muskegon Lake

The MDCH Laboratory has completed the analytical work for the St Marys River and the St Clair River. MDCH toxicologists have calculated the new Eat Safe Fish Guide Guidelines, which are being integrated into newly designed brochures by the HE/PM.

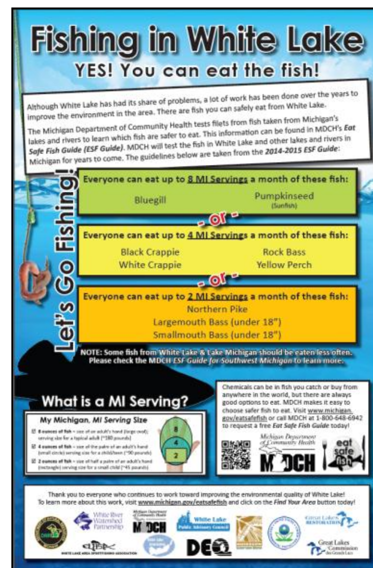
The HE/PM worked with local stakeholders to develop signage for the St Clair River that features basic *Eat Safe Fish* principals. These signs have been posted in communities along the entire forty-one mile stretch of the St Clair River by members of the St Clair County Watershed Council.

The HE/PM is developing a communications plan for the Muskegon Lake AOC based on the priorities identified during the stakeholder focus group held earlier this year. The HE/PM and partners will implement the plan in 2015 with the start of the fishing season.

CO Tier 4: Delisted! White Lake, Deer Lake

Even though these sites were delisted in October, fish consumption guidelines will remain on the waterbodies for the indeterminate future, meaning that outreach on safe fish consumption will need to continue to ensure that human exposure to the remaining contaminants is limited. Although some outreach explaining the difference between fish consumption beneficial use impairments and fish consumption guidelines took place when the fish consumption beneficial use impairments were removed on these sites, the HE/PM is concerned that the press touting the sites as "clean" and "restored" will provide a false sense of security to the public that all is well. However, for these two sites, there are two benefits working in favor of public health.

First, in Deer Lake, the DNR is maintaining regulations to only allow catch and release in order to maintain the unique fishery that has developed over the years when harvest was prohibited due to contamination. MDCH still includes fish consumption guidelines for Deer Lake in the *Eat Safe Fish Guide*; however, harvest is illegal and will continue to be so for the foreseeable future. All outreach materials developed reflect the catch and release status of the lake, while touting the years of clean-up activities and federal, state, and local partnerships.



The White Lake AOC is also unique in that the years of clean-up activities have been very visible and the contamination more tangible than dredges full of sediment – from the removal of pylons to jellied cow carcasses, the citizens in the area are well aware of the lake's troubles. In this case, the HE/PM is working with the local stakeholders to overcome these stigmas and actually promote usage of the beautiful natural resource. The HE/PM developed flyers and posters touting the tagline "Yes, You Can Eat the Fish!" for the White Lake area. The HE/PM worked with the Muskegon Conservation District office to distribute these flyers to organizations and businesses in the area. This spring, the HE/PM will develop and distribute signs and area-specific brochures featuring this message.

Status of Fish Consumption Data Analysis

Deer Lake AOC: Delisted!
Status: CO Tier 4

MDCH Laboratory has completed the analysis of the fish collected from the Deer Lake AOC:

FISH COLLECTION AND ANALYSIS: DEER LAKE				
		Fish Collection Goal	Fish Collected	Lab Analysis Complete
Carp River basin				
	Northern Pike	10	13	13
	White Sucker	10	10	10
	Walleye	--	2	2
	Yellow Perch	--	1	1

After the EPA and City of Ishpeming completed the last management action – restoring the flow of Partridge Creek from the mines back into its bed, thereby removing the largest source of mercury entering into Deer Lake – the EPA approved MDEQ's request to remove the Beneficial Use Impairment for Restrictions on Fish Consumption in Deer Lake in February 2014.

The Deer Lake Area of Concern was delisted on October 30, 2014.

The HE/PM is finalizing an area-specific brochure that highlights fishing locations and fish consumption guidelines for MDCH-tested fish from waterbodies in Marquette County. The MDCH is also adding the MDNR's family friendly fishing locations onto the map, which will allow individuals to identify areas to go fishing which are easily accessible and have good catch rates.

The MDCH is conferring with Cliffs Natural Resources with regard to the Consent Agreement and future sign posting. Once the signs are printed, Cliffs will post the signs at both the old and new boat launches, as well as any additional highly utilized shoreline fishing locations around the lake. The HE/PM will work with community members and Cliffs to identify these sites, if any.

Delisting Event on the shores of beautiful Deer Lake, November 13, 2014

Menominee River AOC
Status: CO Tier 2

Michigan and Wisconsin share the Menominee River AOC site.

MDCH Laboratory has completed analysis for the majority of the fish taken from the Menominee River AOC. However, the additional four carp that were collected from the Lower Scott Flowage later in the season with the cooperation of the Wisconsin Department of Natural Resources are still being analyzed. Results should be available soon.

Fish Collection and Analysis: Menominee River				
		Fish Collection Goal	Fish Collected	Lab Analysis Complete
River Mouth				
	Carp	10	10	10
	Smallmouth Bass	10	10	8
	Black Crappie	--	10	10
	Bluegill	--	10	10
	Northern Pike	--	9	9
	Redhorse	--	1	
	Rock Bass	--	10	
	Yellow Perch	--	9	8
Lower Scott Flowage				
	Carp	10	10	6
	Smallmouth Bass	10	10	1
	Redhorse Sucker	--	12	5
	Rock Bass	--	14	10
	Yellow perch	--	3	--
	Bluegill	--	3	--

MDCH continues to collaborate with the MDEQ, Wisconsin DNR, and the University of Wisconsin Extension office to determine the best possible outreach strategy for both states. MDCH's updates to the fish advisory program bring Michigan's Menominee River fish consumption guidelines more in consensus with Wisconsin's existing guidelines. MDCH has proposed working with the Wisconsin DNR to identify points of latitude so that the consumption guidelines will correspond in both states for this shared waterbody. Should this endeavor prove successful, the HE/PM, Wisconsin Extension office, and Menominee River CAC will be able to more easily correlate outreach materials, mitigating confusion in these closely intertwined bi-state communities and allowing for economy of scale when ordering.

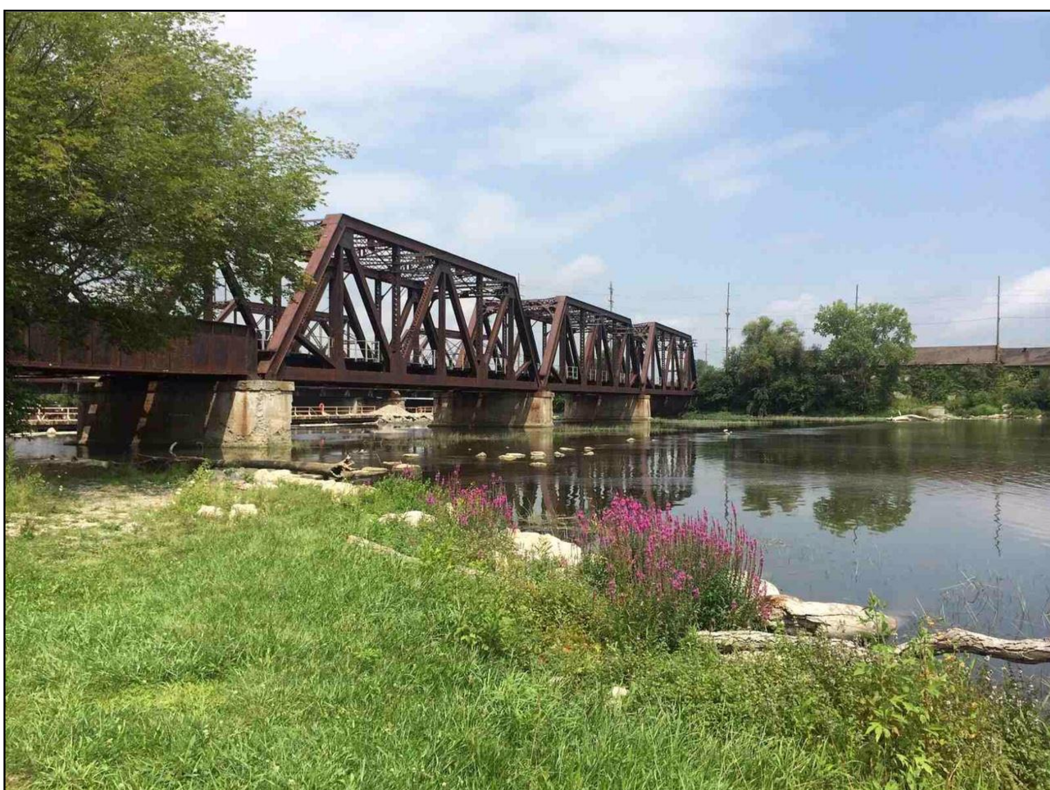
River Raisin AOC
Status: CO Tier 2

The MDEQ has completed the collection and processing of fish from the River Raisin AOC:

Fish Collection and Analysis: River Raisin				
		Fish Collection Goal	**Fish Collected**	**Lab Analysis Complete**
Monroe				
	Carp	10	10	
	Rock Bass	10	10	
	Smallmouth Bass	10	--	
	Largemouth Bass (collected in place of smallmouth)	--	10	

MDEQ and MDCH expects the analytical results to return from the lab in early 2015. At that point, MDCH will work to incorporate the new data into their fish consumption guidelines and MDEQ and MDCH will collaborate to finalize a status report of the BUI for the PAC.

The River Raisin PAC has requested signage and brochures. The HE/PM will continue to work with the interested parties in order to provide the desired materials as soon as the contaminant data returns from the MDCH Lab.



Rouge River AOC

Status: CO Tier 2

In the grant narrative, MDCH stated that should the assessment of the Tumor and Deformities BUI necessitate a fish collection, MDCH would also collect fish to assess the Restrictions on Fish Consumption BUI on the Rouge River AOC.

Therefore, per the approved sampling plan, fish were collected in late fall 2013 and sent to the MDCH Analytical Chemistry Lab for analysis. MDEQ has received some results; however, the lab has not completed analysis on the remaining samples. When finalized, MDCH and MDEQ will collaborate to update the fish consumption guidelines and develop a status report for the BUI.

The MDEQ has completed the collection and processing of fish from the Rouge River AOC:

Fish Collection and Analysis: Rouge River				
		Fish Collection Goal	Fish Collected	Lab Analysis Complete
Newburgh Lake				
	Carp	10	10	10
	Largemouth Bass	10	10	10
	Rock Bass	10	0	--
	Bluegill/Pumpkinseed	--	10	10
Main Branch d/s Ford Dam				
	Carp	10	10	10
	Largemouth/Smallmouth Bass	10	10	10
	Rock Bass	10	10	10

The MDCH Laboratory has completed analysis for mercury for all of the samples. MDCH will be calculating the updated fish consumption guidelines shortly and local communication outreach strategy can be formulated at that time.

As of now, MDCH is distributing outreach materials per the Tier 1 outreach plan. Once the HE/PM receives the updated contaminant data, she will work with the Rouge River PAC to develop area specific outreach materials.

In the meantime, the HE/PM is participating whenever possible in events as highlighted above and providing outreach materials to local partners.

St Clair River AOC

Status: CO Tier 3

The St Clair River AOC is operating with a binational PAC (BPAC) representing both United States' and Canadian interests.

MDCH Laboratory has provided MDEQ with the results of the chemical analysis for the fish tested from the St Clair River and the HE/PM has presented the preliminary results to the St Clair BPAC. MDEQ finalized the report in March of 2014, and it was provided to the BPAC for consideration of next steps.

Fish Collection and Analysis: St Clair River				
		Fish Collection Goal	**Fish Collected**	**Lab Analysis Complete**
Algonac				
	Carp	10	10	10
	Smallmouth Bass	10	10	10
	Rock Bass	10	10	10

The St Clair River AOC BPAC requested signage, which MDCH delivered in early July to the watershed council. Each of the respective townships took ownership of the signs and have started to post them in locations frequently accessed by shoreline and boat anglers. The St Clair County Health Department will maintain the extra signs and distribute as needed for replacements in the future. The HE/PM is also finalizing the area-specific brochures for use in educating individuals about choosing and eating safer fish from the heavily utilized St Clair River fishery. She is working with the DNR and local stakeholders to identify easily accessible fishing locations to feature on the brochure map.

The HE/PC will also consult with the BPAC and local health department to determine if outreach is desired for muskrat consumption around the Lenten season, the time of year in which most muskrat is consumed.

St Marys River AOC

Status: CO Tier 3

St Marys is also a binational site. The BPAC has not only American and Canadian representation, but also tribal representation.

Fish Collection and Analysis: St Marys River		Fish Collection Goal	Fish Collected	Lab Analysis Complete
Munuscong Bay				
	Carp	10	10	10
	Northern Pike	10	0	--
	Rock Bass	--	3	--
	Brown Bullhead	--	10	--
	Pumpkinseed	--	10	10
	Redhorse Sucker	--	7	7
	Rock Bass	--	10	10
	Smallmouth Bass (alternate for pike)	--	10	10
	Walleye	--	8	8
	Yellow Perch	--	10	10

MDCH Laboratory has provided MDEQ and the BPAC with the results of the chemical analysis for the fish tested from the St Marys River and the new Eat Safe Fish Guidelines.

MDCH is also collaborating with the BPAC and other area stakeholders to develop area-specific Eat Safe Fish outreach materials, as identified in CO Tier 3. Earlier this year, HE/PM scouted site locations for signage, as well as distributed brochure, bobbers, and tape measures to all bait and tackle stores and boat repair shops border the AOC, as well as the Michigan Welcome Center in Sault Ste Marie.

In summary, MDCH and MDEQ have leveraged the funding provided by the EPA GLRI grant to provide extensive analysis and fish quantities beyond those identified in the award narrative to provide a more robust assessment of the targeted AOC programs' Restrictions on Fish Consumption BUI status.

Torch Lake AOC

Status: CO Tier 2

Torch Lake is located in Michigan's Upper Peninsula, in the Keweenaw Peninsula.

FISH COLLECTION AND ANALYSIS: TORCH LAKE				
		Fish Collection Goal	Fish Collected	Lab Analysis Complete
Torch Lake & Portage Lake				
	Walleye	10	10	10 (PCB)
	Northern Pike	10	10	10 (PCB)
	Smallmouth Bass	10	10	10 (PCB)
Huron Bay				
	Walleye	10	12	12 (PCB)
	Northern Pike	10	7	7 (PCB)
	Smallmouth Bass	10	0	0
L'Anse Bay				
	Northern Pike	10	13	13 (PCB)

The MDCH Laboratory has completed the mercury analysis on Torch Lake fish, and data show a very slight decline in mercury trends in the lake. However, MDCH and MDEQ are still awaiting the results from the PCB and other organics analysis.

Tainting of Fish Flavor BUI Assessment Activities

Per the MDEQ's *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, two criteria exist for the removal of Tainting of Fish and Wildlife Flavor BUIs. This document states that the BUI is considered restored when:

- No more than three reports of fish tainting have been made to the MDNR or MDEQ for a period of three years.

OR, if there have been reports of tainting:

- A one-time analysis of representative fish species in an AOC in accordance with MDEQ Surface Water Assessment Section (SWAS) Procedure #55 for conducting taste and odor studies indicates that there is no tainting of fish flavor.

Detroit River AOC

The EPA, MDEQ and the PAC have successfully removed this BUI from the Detroit River.

Fish Tumor or Other Deformities BUI Assessment Activities

Per the MDEQ's *Guidance for Delisting Michigan's Great Lakes Areas of Concern*, two criteria exist for the removal of Fish Tumor or Other Deformities BUI. The BUI is restored when:

- No reports of fish tumors or deformities due to chemical contaminants which have been verified through observation and analysis by the Michigan Department of Natural Resources (MDNR) or the MDEQ for a period of five years.

Or, in cases where any tumors have been reported:

- A comparison study of resident benthic fish (e.g. brown bullhead) of comparable age and at maturity (3 years), or of fish species that have been historically associated with this BUI, in the AOC and a non-impacted control site indicates that there is no statistically significant difference (with a 95% confidence interval) in the incidence of liver tumors or deformities.

Detroit River AOC

MDEQ looked for tumors in bullhead collected from the Detroit River during 2011 for routine chemical analysis. Results from twenty (20) Detroit River bullheads have shown no sign of tumors. USGS provided the final report detailing their tumor survey of fish tumors in the Detroit River and Trenton Channel.

The HE/PM has convened a monthly conference call between representatives from MDEQ, the EPA, the Detroit River AOC PAC, and Environment Canada to assess the data available and identify any data gaps that need to be addressed prior to consideration for removal. As it stands, the data show that fish taken from the main branch of the river seem to be in good health and free of tumors. However, the USGS assessment of brown bullhead taken from the Trenton Channel shows a higher than normal rate of tumor growth. There is also concern on behalf of both the US and Canadian sides of the total population of brown bullhead in the river. Environment Canada had scaled their collection back for concern of population depletion. Both the US and Canada are looking into the feasibility of substituting white sucker for future assessments.

In fact, to supplement the known information, over the summer, the Detroit River PAC chair, Mary Bohling, MDCH, and MDEQ put in requests with all agencies working in the Trenton Channel to collect any bullhead incidentally caught during their unrelated actions on the river. Unfortunately, none were caught – leading to two potential conclusions – bullhead are not choosing to live there or they are there, but are just elusive.

The Great Lakes Legacy Act will be conducting management actions in the Trenton Channel for the next few years. The committee suspects that the BUI removal may be contingent on the completion of this project – as the GLLA project progresses and PAHs are removed from the site, the committee anticipates that tumor levels will decrease in turn.

Rouge River AOC

Although the original incidence of tumors appeared to be statistically lower than one would expect to impose a BUI, the MDEQ moved forward with a fish collection and tumor review. During the collection, MDEQ staff saw only one possible external tumor-like lesion in 41 white sucker collected from the Main Branch Rouge. The MDEQ collection crew were fairly confident that they collected
a robust representative sample of white sucker

from that reach of the river. Given the time of year, these were most likely resident fish.

Out of 147 white sucker (plus 38 hogsucker) collected from the Upper Rouge, the staff did not see any with tumors. A few parasites were identified, as pictured here.

All fish were in good health; there were no signs of malnutrition or stress.

Although these findings are indicative of an imminent removal of the Tumors or Other Deformities BUI on the Rouge River, as of December, the MDEQ AOC Coordinator for the Rouge River stated it is unlikely the Tumor and Deformities BUI will be removed until the sediment cleanups are completed. MDEQ and EPA data confirm hot spots remaining in the main channel, and there are a number limiting factors in the original analysis, leading to a lack of confidence that no tumors actually are present in the fish population. The AOC Coordinator is investigating whether there are any feasible actions to undertake at this point to more thoroughly assess this BUI, including the possibility of a histological survey, since the sediment work will not be completed for a number of years.

St Marys River AOC

The St Marys River AOC sampling plan for fish consumption analysis included the collection and examination for tumors in bullhead from the St Marys River. MDEQ examined bullhead during processing. However, given that the collection of fish from the AOC had no tumors and there were no confirmed reports of tumors filed in the last five years, it is possible this BUI can be removed in the near future. The HE/PM presented the Tumor Assessment report to the BPAC during their monthly meeting March.

Similar to the Detroit River AOC outreach plan, MDCH will work with the PAC to develop area-specific materials that celebrate the efforts that led to the removal of this BUI, as well as distribute a quantity of the *Fish Tumors or Other Deformities in Michigan's Areas of Concern* factsheets to the St Marys AOC stakeholders.

Reporting Activities

MDCH has posted quarterly updates in the GLAS reporting system as required.

Changes to Object Class Categories

There were no changes to Object Class Categories during this term.

Barriers and Corrective Actions

None

Activity Workplan and Current Status (as of 12/31/2014)

Activity	Percentage Completed	
	Current Reporting Period	For the Project
Restrictions on Fish Consumption BUI Assessment Activities		
• Submit QAPP for EPA Approval	90%	90%
• Develop AOC Fish Sampling Plans for targeted AOCs	100%	100%
• Fish collection	100%	100%
• Processing of fish samples	100%	100%
• Analysis of fish samples	75%	75%
• Analytical reports completed	40%	40%
• Data review and analysis	50%	50%
• Attend AOC advisory council meetings, as necessary	100%	90%
Tainting of Fish Flavor BUI Assessment Activities		
• Evaluate Detroit River data	100%	100%
• Issue reports and recommendations	100%	100%
• Attend AOC advisory council meetings, as necessary	100%	100%
Fish Tumor or Other Deformities BUI Assessment Activities		
• Evaluate Detroit River data	100%	100%
• Develop fish sampling plans, if needed, for St. Marys & Rouge River AOCs	100%	100%
• Fish collection	100%	100%
• Processing of fish samples	100%	100%
• Analysis of fish samples	100%	100%
• Analytical reports completed	100%	100%
• Data review and analysis	100%	100%
• Attend AOC advisory council meetings, as necessary	100%	90%
Community Outreach Activities		
• Develop Community Outreach Plans	60%	50%
• Implement Plans	60%	60%
• Attend AOC advisory council meetings, as necessary	100%	90%

Funding Rates

MDCH Accounting has updated the Object Class Categories based on the budget amendment approved by the EPA on 11/15/2012. MDCH's current rate of funding use is appropriate for the Workplan. MDNR and the MDEQ have completed the majority of the fish collection in the targeted AOCs. The communications outreach work will result in a substantial drawdown once the final analysis is in for all fish and outreach materials are printed for the targeted Areas of Concern. MDCH has started testing messages and implementing area-specific outreach in areas where analysis is complete. This upcoming work will account for the majority of our spending here forth.

Category	Grant Award	Expend. 10/1/11-12/31/14	% of Award
Lab Salaries	*$48,249*	*$53,026.60*	110%
Lab Fringes	*$34,257*	*$39,383.77*	115%
Lab Supplies	*$29,307*	*$18,660.29*	64%
Lab Maintenance	*$10,844*	-	0%
Contractual	*$387,365*	*$246,215.75*	64%
Novel Fish Collection	*$33,000*	*$7,562.59*	23%
Communication	*$846*	*$702.82*	83%
DIT Desktop	*$6,569*	*$5,243.00*	80%
Subtotal - Direct	$550,437	$365,607.50	66%
Random Moment	$8,445	$6,102.00	72%
Indirect	$5,114	$5,947.82	116%
Total	**$563,996**	**$377,657.32**	**67%**

Drawdown Request & Explanation

The last drawdown occurred on 12/20/2014. MDCH makes a monthly drawdown, generally around the 20th of each month.

Principal investigator Update

Kory Groetsch has replaced Dr. Linda Dykema as the principal investigator for this grant project as of November 2014.

Amendment to Project Period

None

Great Lakes Accountability System Entry Explanation

MDCH reported to GLAS on 12/17/2014.

Deer Lake

BUI: Fish Consumption – Removed

AOC: Delisted

The signs around Deer Lake have been posted, and the permissions process is underway with the townships, counties, and municipalities which maintain the property around Carp Creek and Carp River for additional sign posting.

Detroit River

BUI: Tainting - Removed

The Tainting of Fish Flavor fact sheet continues to be available on an as needed/requested basis.

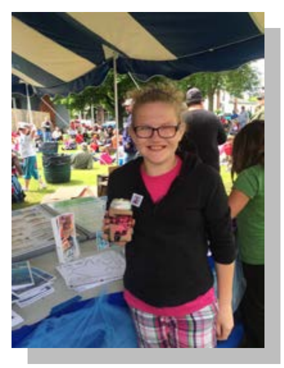
BUI: Tumors - Pending

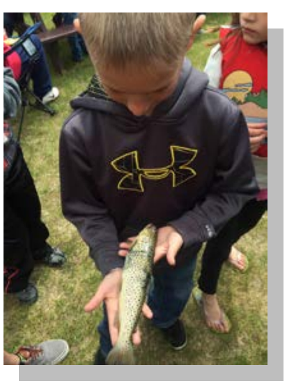
I participated in recent EPA conference call hosted by John Perrecone which presented new scientific viewpoints on the causes of fish tumors. I shared my notes and the speakers' presentations with the Tumor subcommittee. We're awaiting release of the published paper this fall and the NOAA GLC dredging project to take place prior to making any further decisions on action items pertaining to the BUI.

Menominee River

BUI: Fish Consumption - Pending

The draft version of the DEQ Staff Report has been completed and is attached. The data point to an imminent removal of the Fish Consumption BUI in the Menominee River if the impact of Green Bay migratory fish is removed from consideration.





Customized signage has been finalized and approved by partners in both Wisconsin and Michigan. The order will be processed shortly, and the signs posted in multiple locations along the river and the portion of Lake Michigan included in the Area of Concern.

I also attended the Kids' Fishing Derby and the Brown Trout Derby in Menominee this summer. Over 800 people – many of whom were frequent fish consumers - were provided outreach materials that focused on safe fish consumption.

River Raisin

BUI: Fish Consumption - Pending

Fish have been collected and analysis of fish is underway. A final report will be provided this fall.

Customized signage has been finalized and approved by partners in the Monroe, MI area. The order will be processed shortly, and the signs posted in multiple locations along the river and the portion of Lake Erie included in the Area of Concern. The area-specific Eat Safe Fish brochure has been approved by the PAC and will be printed shortly.

Rouge River

BUI: Fish Consumption - Pending

Fish have been collected, processed, and are undergoing analysis at the MDHHS Laboratory. Once all fish data have been received by MDEQ, a final report will be drafted providing updated guidelines and BUI recommendations for the PAC.

Customized signage has been finalized and approved by partners in the Rouge River area. Locations frequented by shoreline anglers and boaters are being identified for potential postings.

BUI: Tumors - Pending

In early October 2013, MDEQ biologists surveyed the river collecting 147 white sucker and 38 hogsucker from the Upper Rouge. None of those fish had visible tumors and only 3 had what is being classified as likely parasite wounds. Forty-one white sucker were also collected from the Main Branch of the Rouge River. None of those fish had visible tumors; however, several fish had what the researchers believe to be parasite wounds. Despite this data, the MDEQ and AOC Coordinator feel it's prudent to gather data from locations in the Lower Rouge as well prior to making any final BUI removal determinations.

In light of the recent EPA conference call hosted by John Perrecone which presented new scientific viewpoints on the causes of fish tumors, the Tumor BUI may be reassessed after the paper is published this fall.

St Clair River

BUI: Fish Consumption - Pending

In addition to the signs that have already been posted, a new Eat Safe Fish in the St Clair River brochure has been distributed to partners in municipalities along the St Clair River. This new brochure highlights not only the new fish consumption guidelines for the St Clair River and surrounding waterbodies, but also features some of the habitat work underway that is supported by GLRI funding.

St Marys River

BUI: Fish Consumption – Pending

Customized signage has been finalized and approved by binational partners along the St Marys River AOC. The order will be processed shortly, and the signs posted in multiple locations along the river.

BUI: Tumors - Pending

Per the MDEQ's BUI removal criteria of no confirmed reports and/or no observed tumors, the tumor BUI could be removed; however the BPAC is currently hesitant to move forward given ongoing Canadian tumor studies. Additional assessment may be required.

The MDEQ AOC Coordinator for the St Marys also participated in recent EPA conference call hosted by John Perrecone which presented new scientific viewpoints on the causes of fish tumors. After release of the published paper this fall, the Tumor BUI may be reassessed.

Torch Lake

BUI: Fish Consumption – Pending

The draft report was originally provided to stakeholders, including Torch Lake PAC members, the MDEQ, and US EPA in 2014. MDEQ is awaiting additional data from MDHH's laboratory prior to releasing the final report.

I have been working closely with the Keweenaw Bay Indian Community to develop a brochure that is sensitive to the Native American's cultural heritage surrounding fishing, while also providing the consumption guidelines that will protect their health. This should be completed shortly.

Customized signs are also being developed to post around Torch Lake. The MDEQ Regional Coordinator has concern over the generalized beliefs of many in the area that assume that since the EPA has ceased clean-up in the area, that the lake is once again pristine. Torch Lake will get not only generalized custom signs, but also signs that list the consumption guidelines in an easy to use format for people who will be heading out to fish to consider.

I also attended the KBIC Earth Day event and the KBIC Kid's Fishing Derby, educating over 600 families about safe fish consumption at both events.

Saginaw Bay/River

BUI: Fish Consumption – Pending

Sampling has been completed and fish have been processed and sent to the MDHHS Laboratory.

Clinton River

BUI: Fish Consumption – Pending

Sampling has been completed and fish have been processed and sent to the MDHHS Laboratory.

White Lake

BUI: Fish Consumption – Removed

AOC: Delisted.

A flyer and posters featuring "White Lake: Yes! You can eat the fish!" have been distributed to partnering fishing-focused and lake-centric organizations in the area. Customized signage has been developed and will be posted in areas frequented by shoreline anglers, and also at marinas and boat launches.

Muskegon Lake

BUI: Fish Consumption – Removed

Signage has been finalized and will be posted shortly. The area-specific Eat Safe Fish brochure is being reviewed by the PAC. I also hosted a booth on the Children's Lane at the Lakeshore Art Festival over the 4th of July weekend, providing outreach to over 1200 people who eat

locally-caught fish.

Reach of Messaging

In all, over 48,000 Eat Safe Fish outreach items were distributed at special events and to local partners this quarter, reaching an approximated 12,000 people in Areas of Concern throughout Michigan.

DEQ	WATER RESOURCES DIVISION SURFACE WATER ASSESSMENT SECTION POLICY AND PROCEDURE		DEPARTMENT OF ENVIRONMENTAL QUALITY
Original Effective Date: June 21, 1990 Revised Date: Reformatted Date: May 21, 2014	Subject: Fish Taste and Odor Studies Program Name: Surface Water Quality Program		Category: ☒ Internal/Administrative ☐ External/Non-Interpretive ☐ External/Interpretive
	Number: WRD-SWAS-006	Page: 1 of 4	Type: ☒ Policy ☐ Procedure ☐ Policy and Procedure

A Department of Environmental Quality (DEQ) Policy and Procedure cannot establish regulatory requirements for parties outside of the DEQ. This document provides direction to DEQ staff regarding the implementation of rules and laws administered by the DEQ. It is merely explanatory; does not affect the rights of, or procedures and practices available to, the public; and does not have the force and effect of law.

INTRODUCTION:

The following procedure is to be used by Surface Water Assessment Section (SWAS) staff when evaluating compliance with Rule 55 of the Michigan Water Quality Standards. Rule 55 states that "the waters of the state shall contain no taste-producing or **odor-producing substances in concentrations which impair or may impair** their use for a public, industrial or agricultural water supply source or which impair the palatability of fish as measured by test procedures approved by the Commission."

Fish taste and odor studies may be conducted by SWAS staff or required of a National Pollutant Discharge Elimination System (NPDES) permit applicant when it has been established that complaints of poor tasting fish from a particular water body are occurring with some regularity.

There are three parts to a fish taste and odor study: 1) exposure of the fish to the suspected taint producing water; 2) taste tests where a panel tastes and rates the exposed fish; and 3) statistical interpretation of the results of the panel taste test. The ASTM method "Standard Practice for Evaluating an Effluent for Flavor Impairment to Fish Flesh," D 3696-89 (Attachment I) will be followed during all phases of testing.

1. Exposure

There are three possible ways to complete the exposure phase of a fish taste and odor study: native fish study, laboratory study, and caged fish study. Each is described below, including the advantages and disadvantages of each.

A. Native fish studies: Using this method, native fish, preferably the same species for which complaints have been received, are collected from the area of reported tainting and a background station. A suitable background station for a stream would be upstream and separated from the tainted area by a dam or other structure, which would impede the upstream movement of fish. For an inland lake, a suitable background station would be a nearby inland lake with similar watershed characteristics. On the Great Lakes, a suitable background station would be of sufficient distance away to be reasonably certain of not collecting tainted fish.

The relative advantages of native fish collections are:

1. Fish can usually be sampled immediately since additional **exposure time is not necessary, such as with caged fish** or laboratory studies.
2. They are generally less labor intensive than caged fish or laboratory studies.
3. The fish species that prompted the complaints can usually be collected rather than using a surrogate test species.

The relative disadvantages of native fish collections are:

1. Tainted fish might be missed in the collections.
2. A suitable background station may not be available.
3. The variability in native fish due to food sources or waters previously resided in may lead to misinterpretation of the results of the taste test.
4. Due to the mobility of fish, it is generally difficult to attribute any tainting detected in the collected fish to a single source.

Native fish studies are often used as a screening tool to detect the general presence of tainting in a water body, then followed by a caged fish or laboratory study to more specifically identify the source of a taint. Native fish studies would most often be conducted by SWAS staff.

B. Laboratory study: The selected test fish, preferably the same species as the reported tainted fish, are exposed to varying concentrations of the suspected tainting source (i.e., a point source effluent) and receiving water in a laboratory setting following Section 10.2 of the ASTM method. The exposure period generally lasts for ten days. Ordinarily, exposure concentrations will be equal to:

1. The Instream Waste Concentration (IWC) = effluent design flow/ (100% of the receiving water 95% exceedance flow + effluent design flow),
2. 100% receiving water, and generally
3. An additional concentration to simulate conditions within the **mixing zone.**

This study would be used in situations where a taint source has tentatively been identified, either through a native fish study, a caged fish study, or knowledge of the discharge characteristics. It would likely be required of a permittee as an NPDES permit condition.

The relative advantages of laboratory exposure studies are:

1. All test fish would be from a common source (e.g., a hatchery), thereby eliminating potential taste variability due to different food sources or water characteristics.
2. Any taste impairment resulting from this test can be **attributed to a single source.**

The relative disadvantages of laboratory exposure studies are:

1. They are likely more costly and time consuming than native fish or caged fish studies.
2. Depending on the availability of hatchery fish, the species for which taint complaints were reported may not be available at the time of testing.

C. Caged fish studies: Caged fish studies involve the placement of cages containing fish from a common source (e.g., a hatchery) at various locations in a water body, usually downstream from suspected source or sources of tainting and at a background location for a period of ten days, following Section 10.1 of the ASTM method. This study would be used most often when a fish tainting problem has tentatively been identified through complaints but the DEQ is not yet ready to require a laboratory study by a permittee; or the suspected source of the taint is a nonpoint source. This test would most often be conducted by SWAS staff.

The relative advantages of caged fish studies are:

1. All test fish would be from a common source (e.g., a hatchery), thereby eliminating potential taste variability due to different food sources or water body characteristics.
2. The fish would be held to a single location (vs. native fish studies) with the result of being able to better attribute any tainting to a specific source. Where multiple discharges or nonpoint sources exist, this method would serve to identify whether tainting exists relative to a background station.
3. A barrier to fish movement would not be necessary between background and downstream locations as is required with the native fish study.

The relative disadvantages of caged fish studies are:

1. They are generally more labor intensive than native fish studies.
2. If a taint is produced, it may be difficult to attribute the **taint to a single point source or nonpoint source if several exist.**
3. Depending on the availability of hatchery fish, the species for which taint complaints were reported may not be available at the time of testing.
4. The cages are susceptible to vandalism.

2. Taste Test

After the collection or exposure phases of the fish taste and odor study, the fish are prepared and evaluated by a flavor impairment panel as described in the ASTM method Sections 10.4 through 10.7.

The DEQ currently has a contract with the Department of Public Health (DPH) where the DPH will conduct Sections 10.5 through 10.7 of the ASTM method, covering the preparation and presentation of test fish to taste panel members. Fish collected by SWAS staff will be initially prepared by SWAS as described in Section 10.4 and provided to the DPH within 24 hours of the taste test.

3. Statistical Interpretation of the Results

The data will be analyzed according to Section 11 of the ASTM method.

If the results show that exposed fish taste worse than control fish at a level of significance of p = 0.05, then a meeting shall be held with **SWAS management to discuss the results and determine future actions.**

SECTION CHIEF APPROVAL:

Diana Klemans

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Diana Klemans, Chief
Surface Water Assessment Section

ATTACHMENT I

Designation: D 3696 – 89

Standard Practice for Evaluating an Effluent for Flavor Impairment to Fish Flesh[1]

This standard is issued under the fixed designation D 3696; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the potential of an effluent to cause flavor impairment of fish flesh. Caged fish can be exposed either in the effluent, at various sites relative to the discharge, or to dilutions of the effluent in a laboratory. Depending upon the uptake rate of the chemicals into the flesh from the discharge, from 1 day to several weeks may be required for a detectable off flavor. However, an exposure of 10 days is usually adequate. This practice is applicable to respective fish in fresh or salt water.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Specific hazard statements are given in Section 8.

2. Referenced Documents

2.1 *ASTM Standards:*

- D 1125 Test Methods for Electrical Conductivity and Resistivity of Water[2]
- D 1126 Test Methods for Hardness in Water[2]
- D 1129 Definitions of Terms Relating to Water[2]
- D 1192 Specification for Equipment for Sampling Water and Steam[2]
- D 1252 Test Method for Chemical Oxygen Demand (Dichromate Oxygen Demand) of Water[2]
- D 1293 Test Methods for pH of Water[2]
- D 1888 Test Methods for Particulate and Dissolved Matter in Water[2]
- D 2579 Test Methods for Total and Organic Carbon in Water[3]
- D 3250 Test Method for Total Oxygen Demand in Water[3]
- D 3370 Practices for Sampling Water[2]
- E 729 Guide for Conducting Acute Toxicity Tests With Fishes, Macroinvertebrates, and Amphibians[4]

3. Summary of Practice

3.1 Fish are exposed to an effluent or dilutions of an effluent either in the field or in the laboratory. After an exposure sufficient to allow tainting, fish are removed, cleaned and eviscerated, double-wrapped in metal foil, and refrigerated. Each fish sample including control fish, is encoded for identification. Fish are baked at 190°C for 20 to 30 min, then tasted by the testing panel. Flavor results are evaluated statistically to detect flavor impairment.

4. Significance and Use

4.1 This procedure, although subjective, may detect qualitative contamination of a fishery resource. Enforcement agencies usually recognize as a water quality standard that no substance shall be discharged into water that imparts an undesirable flavor to fish.

4.2 This practice does not eliminate all bias.

5. Terminology

5.1 *Definitions:*

5.1.1 For definitions of terms used in this practice, refer to Definitions D 1129.

5.2 *Description of Terms Specific to This Standard:*

5.2.1 *flavor impairment*—a detectable flavor deterioration between a test and control sample. Flavor tainting, off flavor, and undesirable flavor are considered synonyms.

6. Apparatus

6.1 *Field Study:*

6.1.1 *Cages*—Cages should be large enough to allow free swimming of the fish. The wire mesh or holes used to provide water circulation into and out of the cage should be small enough to retain small minnows, yet large enough to allow free passage of stream drift organisms. A 5-mm screen has proven satisfactory. See Fig. 1 for a typical fish exposure cage.

6.1.2 *Nets*—Nets should be pocketed to retain fish. Use soft nets to prevent abrasion of the test fish during handling. Thoroughly wash new nets to remove any textile finish present.

6.1.3 *Chest Waders or Hip Boots.*

6.1.4 *Boat*—Depending upon the nature of the study, especially when large rivers or lakes are being investigated, a boat is a necessary piece of equipment. The type of boat necessary must be matched to the type and size of the water body.

6.1.5 *Life Preservers*—There shall be one for each person.

6.1.6 *Holding Cages or Tankage*—Fish should be held for at least 10 days prior to testing.

6.2 *Laboratory Study:*

6.2.1 *Flow-Through System*—Many metering systems can

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[1] This practice is under the jurisdiction of ASTM Committee E-47 on Biological Effects and Environmental Fate and is the direct responsibility of Subcommittee E47.01 on Aquatic Toxicology.

Current edition approved April 28, 1989. Published June 1989. Originally published as D 3696 – 78. Last previous edition D 3696 – 78 (1984)$^{\epsilon 1}$.

[2] *Annual Book of ASTM Standards*, Vol 11.01.

[3] *Annual Book of ASTM Standards*, Vol 11.02.

[4] *Annual Book of ASTM Standards*, Vol 11.04.

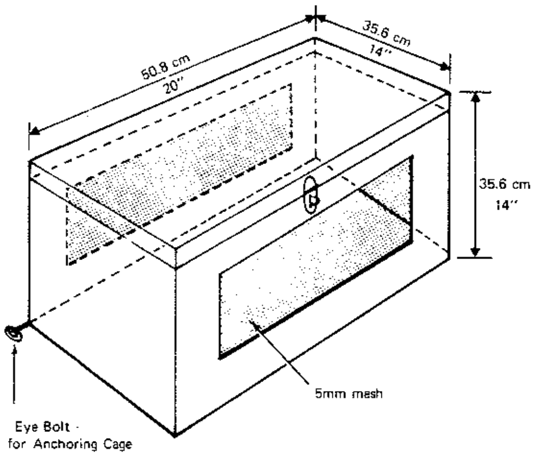


FIG. 1 Fish Cage

be used. Reference (**1, 2**)[5] and Practice E 729 describe suitable systems that are or can be modified for effluents.

6.2.2 *Compressed Air* (oil free).

6.2.3 *Aquaria*—Aquaria should be large enough to provide an adequate volume of water and sufficient room for the fish, such as 35 by 35 by 50 cm or larger.

NOTE 1: **Caution**—Testing apparatus that comes in contact with the water in which the fish are exposed should not contain any substance that could be leached out. Glass, No. 316 stainless steel, and perfluorocarbon plastics should be used whenever possible. Other plastics that contain no leachable plasticizers may also be used. However, substances that are known to absorb organics should be avoided. Rubber, copper, brass, zinc, and lead should not come in contact with the water or effluents to which the fish are exposed.

6.3 *Equipment Required for Taste Evaluation*:

6.3.1 *Oven*, capable of 190 ± 5°C (electric or gas).

6.3.2 *Plates, glasses*, and *disposal cups*.

6.3.3 *Metal Foil*.

6.3.4 *Cookie Sheets*.

7. Dilution Water

7.1 The minimal water quality criteria for any flavor impairment testing are that the fish will survive in it and remain healthy for the acclimation period and during the tainting tests. The more general acceptable criteria are that first instar (newly hatched) daphnids will survive in the dilution water for 48 h without food (see Guide E 729). The water must be free of taint producing materials. Also sample water for chemical analysis in accordance with Specification D 1192 and Practices D 3370. Some suggested chemical analyses are designations Methods D 2579, Method D 1252, Method D 3250, Method D 1293, Methods D 1126, Methods D 1125, and Methods D 1888.

7.2 *Fresh or Frozen Unsweetened Lemon Juice*, 1+32 dilution or weaker.

8. Safety Hazards

8.1 Do not wash fish that are being cleaned in the field with effluent or the dilution water (river, lake, etc.). Use paper towels to wipe the fish clean. Do not taste fish that are dead in the exposure tank or show any signs of toxic effects, as they may be toxic to the taster or possible tissue deterioration may influence the test results.

8.2 Minimize personal contact with the effluent or dilutions of the effluent as it is always possible that some hazardous material, bacterial, or viral pathogen may be present. Thoroughly clean hands, clothing, and equipment after contact.

8.3 Follow local water safety laws and practices in field studies. Check with local enforcement agencies, since these laws vary from one area to another. When wading in water, wear boots or chest high waders. Wear a life vest or preserver when wading in deep water or in a boat.

8.4 A current food handler's certificate may be required by local law for the cleaning, handling, and preparation of fish samples.

9. Test Specimen (Fish)

9.1 Any edible fish available in sufficient numbers is an acceptable test species. Cultured fish, such as rainbow trout, *Salmo gairdneri* Richardson, and bluegill, *Lepomis macrochirus* Rafinesque, are two freshwater species that have commonly been used. Fish should be large enough to provide a fair-sized fillet. Trout 200 to 300 mm or bluegill 150 to 200 mm are of sufficient size.

9.2 Prior to testing, hold fish in a flow-through water system of similar water quality to that of the experimental exposure for at least 10 days. Maintain a sufficient flow in and out of the holding tankage to provide dissolved oxygen of at least 60 % saturation and to flush out fish excretory products. Holding temperature should be ± 2°C of the exposure temperature.

9.3 Feed the stock fish and those being exposed, if practical, but it *must* be recognized that materials may be bioaccumulated from the food and also cause flavor impairment.

9.4 Conducting fish taste tainting studies may require a permit of some type; therefore, notify the local conservation department or enforcement agency.

10. Procedure

10.1 *Field Studies—Using Caged Fish:*

10.1.1 A common field technique of evaluating fish flesh tainting can be accomplished by placing fish in cages at various locations relative to the outfall. If trout are exposed in small wire mesh cages, include minnows as food. In a river or stream, place cages upstream of the effluent, at the outfall, and at sites downstream. The number of cages placed above and below an effluent and the distances of sites from the river effluent vary depending upon the hydrology of the river. In a lake or large river, the wind velocity and direction and other factors may also affect the effluent concentration to which the fish are exposed. Placement of the cages as to area of study and depth is at the discretion of the investigator. An exposure of 10 days is accepted as adequate.

10.1.2 Place at least one cage of fish as a control in the water upstream from the outfall or away from influence of the effluent.

10.1.3 The number of fish per cage is dependent upon the size of the test species and the number of taste panel

[5] The boldface numbers in parentheses refer to the references appended to this standard.

members. Plan on at least a 10-g fish portion per taster per exposure concentration.

10.2 *Laboratory Studies:*

10.2.1 Pump a representative sample (Practices D 3370) of effluent from the discharge or storage containers through a flow-through system capable of providing a series of effluent dilutions. Include a dilution water control in the test series. Place fish in each dilution and control. See 10.1.3 for suggested number of fish per concentration. Feed the fish once a day throughout the exposure.

10.2.2 Allow sufficient flow through the test aquaria to maintain a dissolved oxygen concentration of at least 60 % saturation. Do not aerate aquaria because the flavor test material may be volatilized from the test water.

10.2.3 Maintain the test temperature of the aquaria at ± 2°C of the average receiving water temperature outside the effluent mixing zone. If a test temperature other than that of the receiving water is used, report the reason and temperature.

10.3 The uptake of materials by fish from water varies from one material to another. Because of this variation, there is not one exposure period that will cover all situations. However, it is recommended the exposure period be 10 days.

10.4 After exposure, remove, kill, fillet, wrap, and refrigerate the fish. If the flavor impairment evaluation is performed within 2 days (48 h), it is desirable to keep the fish refrigerated (or iced) rather than freezing. Freezing is believed by some to alter the texture and taste of the fillet. However, if the flavor evaluation is delayed for more than 2 days, freezing the fish samples is the best method of preservation.

NOTE 2—Take special care to avoid contamination of the fish fillet with oil, gasoline, detergent, etc., because these materials impart flavor.

10.5 On the day of the flavor evaluation, cut fish fillets (if frozen, thaw first) into several portions (at least 10 g) and double wrap in metal foil with the same side out (shiny or dull). This may affect the cooking time. Randomly code each packet of fish to identify each individual fish, area of fish from which the fillet was taken, and the dilution or cage to which the fish was exposed. Provide enough packets of control fish for known and unknown controls, plus a few extra.

10.6 Place the encoded foil packets on a flat cookie sheet and bake at 190°C for 20 to 30 min. Small portions of fish may require less cooking time; therefore, include a few extra packets of control fish to pull at earlier time intervals to check if the fish are properly baked. Overcooking dries out the flesh, seriously damaging the taste quality.

10.6.1 An alternative method for cooking the portions is to wrap each portion in a suitable polyethylene or poly(vinyl chloride) film or bag and then cook in a microwave oven for 5 min. Since various microwave ovens may vary in cooking efficiency, several extra portions should be available to check cooking times.

10.7 *Flavor Impairment Panel:*

10.7.1 A flavor panel can be selected from associates at work, a university, or another testing group to taste the fish fillets. The panel may be comprised of experienced or inexperienced fish tasters, but not a mixture of both. Inexperienced tasters would more likely represent the typical consumer. The smallest detectable concentration will probably vary depending upon whether experienced or inexperienced tasters are used. The normal flavor test panel should have at least 10 members. Flavor panels with fewer than 10 members are likely to produce results with no significant difference between the exposed fish and hidden control fish. Members of the flavor panel should be free from head colds or chest colds, and be free from allergic reactions to hayfever, etc., in order to perform satisfactorily as members of the flavor panel. Any physical disturbance that could affect the flavor panel at the time of taste testing should be cause for preventing a member from active participation at the time of testing.

10.7.2 After the flavor panel members or consulting groups have been selected, inform them of the basic nature and purpose of the test. It may be advisable to initiate an "Informed Consent Agreement" between the flavor panel members and the sponsoring organization.

10.7.3 Record the following information on the rating sheet (see Fig. X1.1 of the Appendix):

1	Name of tester
2	Date
3	Species of fish tested
4	Sample number of code
5	Rating
6	Area for comments

10.7.4 After baking, rate the coded fillet samples by comparing each sample with the known control:

0	Same as or better than known control
1	Slight flavor impairment
2	Moderate flavor impairment
3	Strong flavor impairment
4	Extreme flavor impairment

Before any portion is tasted and between fish samples, rinse the mouth with dilute unsweetened lemon juice (1+32). This helps to prevent carry over of flavor from one sample to another.

10.7.5 Prepare the panel to start as soon as the fish are baked. The taste evaluation is best accomplished with as little distraction as possible. Isolate panel members whenever possible while tasting. Prior to the evaluation, review the tasting and rating procedure with the panel.

10.7.6 Always identify at least one control fillet.

10.7.7 Before tasting begins, note the odor of the fish. If any odor is detected, taste samples in an order of increasing odor.

10.7.8 Taste the known control first. Chew and spit out the cooked fish. Rate each fish before proceeding to the next sample. The panel member may refer back to the control as necessary.

10.7.9 For more detailed information on the principle of sensory evaluation and testing methods, consult two ASTM manuals **(3)** **(4)**.

11. Calculation or Interpretation of Results

11.1 Tabulate the results of the flavor evaluation panel, similar to that shown in the appendix. Once the data are tabulated, it can be easily seen if flavor impairment is detected. If the flavor impairment data are treated statistically, the method of analysis used should reflect the fact that data are often very consistent at high concentrations and for the hidden control, and less consistent in between (nonnormal, unequal variance). Another restriction in choosing a statistical procedure is that the ratings from each concentration are not independent because the same tasters evaluate each concentration. With these restrictions, a simple method of statistical analysis that may be used is Wilcoxon's modification of Friedman's nonparametric analysis of variance for matched samples **(5)**. This test minimizes the inherent approximation in Wilcoxon's matched-pairs signranked test if a large number of ties are present, and requires only simple hand calculations. An example of some sample data is provided in the appendix (see Tables X1.1 to X1.4).

12. Report

12.1 A suggested listing of the data to be included in the report may be found in the appendix.

APPENDIX

(Nonmandatory Information)

X1. EXAMPLE OF WILCOXON'S MODIFIED NONPARAMETRIC ANOVA

X1.1 Rank data within each taster, assigning average rank for ties.

X1.2 Calculate the absolute differences between the rank sum for the control and the rank sum of the other concentrations.

X1.3 Compare the calculated results with Tables X1.1 and X1.2 where: p = the number of effluent concentrations and n = the number of tasters.

X1.4 If the calculated result is equal to or greater than the tabled (critical difference) result, then a significant difference exists.

TABLE X1.1 Critical Differences for Two-Way Classification: Comparing Several Treatments with a Control

$n = 3(1)25$ and $p = 3(1)10$
$P = 0.01$ (one-sided)

n	$p = 3$	$p = 4$	$p = 5$	$p = 6$	$p = 7$	$p = 8$	$p = 9$	$p = 10$
3	6	8	11	13	15	18	20	22
4	7	10	12	15	18	20	23	26
5	8	11	14	17	20	23	26	29
6	9	12	15	18	22	25	28	31
7	10	13	16	20	23	27	30	34
8	10	14	18	21	25	29	33	36
9	11	15	19	23	26	30	35	39
10	11	15	20	24	28	32	36	41
11	12	16	21	25	29	34	38	43
12	13	17	21	26	31	35	40	44
13	13	18	22	27	32	37	41	46
14	14	18	23	28	33	38	43	48
15	14	19	24	29	34	39	45	50
16	14	20	25	30	35	41	46	51
17	15	20	26	31	36	42	47	53
18	15	21	26	32	37	43	49	54
19	16	21	27	33	38	44	50	56
20	16	22	28	34	39	45	51	57
21	17	22	28	34	40	47	53	59
22	17	23	29	35	41	48	54	60
23	17	23	30	36	42	49	55	62
24	18	24	30	37	43	50	56	63
25	18	24	31	38	44	51	58	64

TABLE X1.2 Critical Differences for Two-Way Classification: Comparing Several Treatments with a Control

$n = 3(1)25$ and $p = 3(1)10$
$P = 0.05$ (one-sided)

n	$p = 3$	$p = 4$	$p = 5$	$p = 6$	$p = 7$	$p = 8$	$p = 9$	$p = 10$
3	5	7	8	10	12	14	16	18
4	5	8	10	12	14	16	18	21
5	6	8	11	13	16	18	21	23
6	7	9	12	14	17	20	23	25
7	7	10	13	16	19	21	24	27
8	8	11	14	17	20	23	26	29
9	8	11	14	18	21	24	28	31
10	9	12	15	19	22	26	29	33
11	9	12	16	20	23	27	31	34
12	9	13	17	20	24	28	32	36
13	10	14	17	21	25	29	33	37
14	10	14	18	22	26	30	34	39
15	11	15	19	23	27	31	36	40
16	11	15	19	24	28	32	37	41
17	11	16	20	24	29	33	38	43
18	12	16	20	25	30	34	39	44
19	12	16	21	26	30	35	40	45
20	12	17	22	26	31	36	41	46
21	12	17	22	27	32	37	42	47
22	13	18	23	28	33	38	43	49
23	13	18	23	28	34	39	44	50
24	13	18	24	29	34	40	45	51
25	14	19	24	30	35	41	46	52

TABLE X1.3 Modified from Wastewater Exposure, (7 Days Using Rainbow Trout 01-16-76)[A]

Taster	Percent Effluent					
	0	12.5	25	33	50	100
Fish Tainting Data:						
A	0	0	0	1	0	4
B	0	0	0	0	1	3
C	1	2	0	3	1	4
D	0	0	1	1	1	3
E	0	3	3	3	3	3
F	0	0	1	2	2	1
G	0	0	2	2	3	3
H	1	0	0	1	3	4
Ranked Data:						
A	2.5	2.5	2.5	5.0	2.5	6.0
B	2.5	2.5	2.5	2.5	5.0	6.0
C	2.5	4.0	1.0	5.0	2.5	6.0
D	1.5	1.5	4.0	4.0	4.0	6.0
E	1.0	4.0	4.0	4.0	4.0	4.0
F	1.5	1.5	3.5	5.5	5.5	3.5
G	1.5	1.5	3.5	3.5	5.5	5.5
H	3.5	1.5	1.5	3.5	5.0	6.0
	16.5	19.0	22.5	33.0	34.0	43.0
Δ From Control		2.5	6.0	16.5	17.0	26.5

[A] There are six concentrations and eight tasters. For $p = 6$ and $n = 8$, the critical difference is 17 (5 % level) or 21 (1 % level). Therefore, the 50 and 100 % concentrations are different at $p \leq 0.05$ and the 100% concentration different at $p \leq 0.01$. The other concentrations are not different at $p \leq 0.05$.

TABLE X1.4 Summary of Data to be Included in the Final Report

Principal investigator
Laboratory
Dates of samples, exposure, and taste evaluation
Chemical or physical properties of dilution water
Characteristics of stream, river, lake or effluent plus dilution water:
(*a*) pH
(*b*) Total oxygen demand
(*c*) Chemical oxygen demand
(*d*) Total dissolved solids
(*e*) Suspended solids
(*f*) Dissolved oxygen
(*g*) Total organic carbon
(*h*) Conductivity
Species name, weight, length, number of fish exposed to each concentration, source.
Description of exposure system and length of exposure
Effects on fish
Flavor Evaluation.
(*a*) number of panel members
(*b*) relative experience level of each panel member, for example:
frequent tasting experience
some tasting experience
no previous tasting experience
(*c*) summary of raw data
Statistical method used to evaluate data.

FIG. X1.1 Sample Flavor Impairment Rating Sheet

Name ______________________

Date ______________________

Species of fish ______________________

Rating Code

0 Same or better than known control
1 Slight flavor impairment
2 Definite impairment
3 Bad
4 Repulsive

Sample	Rating	Comments
Known Control		

REFERENCES

(1) Shumway, D. L. and Palensky, J. R., "Impairment of the Flavor of Fish by Water Pollutants," Ecological Research Series No. EPA-R3-73-010. U.S. Environmental Protection Agency, Washington, D.C. 1973, p. 80.

(2) Mount, D. I. and Brungs, W. A., "A Simplified Dosing Apparatus for Fish Toxicological Studies," Water Res. Vol 1, 1967, pp. 21–29.

(3) *Basic Principles of Sensory Evaluation, ASTM STP 433*, ASTM 1968.

(4) *Manual on Sensory Testing Methods, ASTM STP 434*, ASTM 1968.

(5) Wilcoxon, F. and Wilcox, R. A., "Some Rapid Approximate Statistical Procedures," Lederle Laboratories, Pearle River, N.Y., 1964.

REFERENCES

(1) Shumway, D. L. and Palensky, J. R., "Impairment of the Flavor of Fish by Water Pollutants," Ecological Research Series No. EPA-R3-73-010. U.S. Environmental Protection Agency, Washington, D.C. 1973, p. 80.

(2) Mount, D. I. and Brungs, W. A., "A Simplified Dosing Apparatus for Fish Toxicological Studies," Water Res. Vol 1, 1967, pp. 21–29.

(3) *Basic Principles of Sensory Evaluation, ASTM STP 433*, ASTM 1968.

(4) *Manual on Sensory Testing Methods, ASTM STP 434*, ASTM 1968.

(5) Wilcoxon, F. and Wilcox, R. A., "Some Rapid Approximate Statistical Procedures," Lederle Laboratories, Pearle River, N.Y., 1964.

Tainting of Fish Flavor in Michigan's Areas of Concern

Areas of Concern (AOCs)

In the 1980s, the United States and Canadian governments identified 43 places in the Great Lakes region that had severe, long-term environmental problems. These places are called *Areas of Concern*.

People in federal, state, and provincial government environmental remediation programs are working to address the problems in these areas. Funding and expert guidance are provided to AOCs to help local groups, known as Public Advisory Councils (PACs), work on these environmental problems, as well.

Michigan's AOCs in 2012

Beneficial Use Impairments (BUIs)

These environmental problems are called *beneficial use impairments.* There are 14 categories of BUIs, originally named in the U.S.-Canadian Great Lakes Water Quality Agreement. However, a place does not have to have all 14 problems to be called an AOC.

Each BUI has goals that need to be met in order to be removed from the AOC's list of problems. Once all BUIs are removed from the list, the AOC is considered to be no longer impaired and can be *delisted,* or removed from the list of AOCs.

The 14 BUIs that an AOC can have are:

- Restrictions on Fish and Wildlife Consumption
- Tainting of Fish and Wildlife Flavor
- Degraded Fish and Wildlife Populations
- Fish Tumors or Other Deformities
- Loss of Fish and Wildlife Habitat
- Degradation of Benthos
- Degradation of Aesthetics
- Beach Closings
- Added Costs to Agriculture or Industry
- Restrictions on Dredging Activities
- Eutrophication or Undesirable Algae
- Restrictions on Drinking Water Consumption or Taste and Odor Problems
- Bird or Animal Deformities or Reproductive Problems
- Degradation of Phytoplankton and Zooplankton Populations

Over the years, several BUIs have been removed from Michigan's AOCs, as citizens, industries, and government joined together to improve our state's environmental health. In fact, after decades of hard work, some Michigan AOCs only have one or two BUIs remaining and are getting closer to being delisted.

Tainting of Fish Flavor BUI

If an AOC has a ***Tainting of Fish Flavor BUI***, it means that the fish from the affected lake or river once had a flavor not normal for fish. Many different chemicals can cause these strange flavors, but they are often caused by oils in the water.

The Detroit River was the last AOC to still have this problem. As some of the problem areas in the Detroit River have been cleaned up, the fish flavor got better. In fact, the State has not received any reports of strange fish flavors in several years.

To be sure the fish tainting problem really is better, the Friends of the Detroit River surveyed nearly 300 people who ate Detroit River fish in 2011 and 2012. Of those who had eaten Detroit River fish, 91% said the taste of the fish from the river was now “good” to “excellent.”

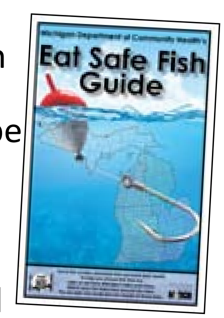
It is important to note that:

- **Strong “fishy” flavors are not considered to be part of the *Tainting of Fish Flavor BUI*.**
- **Fish with meat that is softer than normal is not considered to be part of the *Tainting of Fish Flavor BUI*.**
- **Sores or tumors on the fish are not part of the *Tainting of Fish Flavor BUI*.**
- **The *Tainting of Fish Flavor BUI* is not the same as the *Restrictions on Fish Consumption BUI*.**

If you are concerned about a fish that you caught that seems sick or is deformed, or if you see a large number of dead fish, you can report it to your local Michigan Department of Natural Resources (MDNR) office. The number for the MDNR office nearest Detroit is (248) 359-9040.

You can’t taste <u>all</u> chemicals. Use the *Eat Safe Fish Guide*.

- You can’t always taste the chemicals in fish that can cause health problems in people. In fact, the chemicals that cause the Michigan Department of Community Health’s (MDCH) fish eating guidelines and the ***Restrictions on Fish Consumption BUI*** to be issued can’t be tasted at all.
- The ***MDCH Eat Safe Fish Guide*** can help you choose safer fish to eat from many of Michigan’s lakes and rivers, not just the ones in the AOCs. MDCH tests filets of fish for chemicals from locations all around the state.



Even when the ***Tainting of Fish Flavor BUI*** is removed from an AOC’s list of problems, fish from the area will still be tested and listed in the *MDCH Eat Safe Fish Guide* for some time after. This is because different chemicals cause different problems. None of the chemicals listed in the *MDCH Eat Safe Fish Guide* will ever change the taste or the look of the fish.

Michigan lakes and rivers are improving thanks to federal and state environmental rules, and the hard work of the US Environmental Protection Agency, the MDEQ, and the PACs. However, it will take many years for these chemicals to leave the ecosystem and the fish.

To learn more about AOCs & BUIs:

MDEQ - Office of the Great Lakes

517-335-3168

<u>http://www.michigan.gov/deqaocprogram</u>

To learn more about eating safe fish:

MDCH - Division of Environmental Health

1-800-648-6942

<u>http://www.michigan.gov/eatsafefish</u>

Detroit River Area of Concern

Status of the Fish Tumor and Other Deformities Beneficial Use Impairment

Sampling Plan

Background

The Detroit River is a 32-mile international connecting channel linking Lake St. Clair to Lake Erie and is a binational Area of Concern. The Detroit River Area of Concern (DR AOC) is listed for 11 beneficial use impairments, including “Fish Tumors or Other Deformities”. Several studies have associated internal and external tumors in fish with carcinogens in sediment and water at several locations in North America, and they were summarized by Baumann et al. (1996). Specifically, epidermal and liver tumors in brown bullhead and white sucker are strongly correlated with the presence of polynuclear aromatic hydrocarbons (PAH). It has been recommended that one or both species should be used to monitor tumor prevalence (Baumann 2002).

A study of 5 species of fish collected in Michigan waters of the Detroit River in 1986 and 1987 found a 10.2% rate of dermal or oral neoplasms in bullhead (Kreis et al. 1987). The prevalence of external lesions in brown bullhead from 3 relatively pristine areas ranges from 2.5% to 15.0% (Baumann et al., 1996) with an overall average of 5.5%. The elevated incidence of lesions in fish from the Detroit River led to the determination that the Fish Tumor beneficial use is impaired.

The US Fish & Wildlife Service (USFWS), in partnership with USGS and USEPA, is analyzing a series of chemical and physical indicators in fish samples from several areas of the Great Lakes, including the Detroit River. One factor being analyzed is the incidence of dermal and liver lesions. The sample collection and analysis is ongoing.

Recommendations

A fish collection and analysis effort is needed to determine current conditions. While the USFWS effort mentioned above promises to be rigorous and informative, results may not be available for several months. Examination of fish samples collected as part of other ongoing monitoring activities will be helpful in determining the status of the Fish Tumor BUI. Bullhead collected at relatively pristine Great Lakes sites (e.g. St. Marys River, Little Bay De Noc) should be kept and examined; the tumor prevalence at these sites can be considered a background rate.

Sampling Plan

The MDNR Fisheries Division collected samples of fish from several areas of the Detroit River in 2010 and 2011. Samples of both brown and black bullhead were kept and examined for external and gross internal lesions.

A total of 21 bullhead were collected during fisheries survey work in the Detroit River. In addition, bullhead will be collected as encountered during survey work at other sites around the state. The latter samples will be used to determine the background rate of lesion incidence.

Fish samples will be inspected for internal and external lesions (tumors). The prevalence of lesions observed in the Detroit River samples will be compared statistically to lesion rates observed in literature and, if collected, in reference site samples.

Joseph Bohr
Water Resources Division
Michigan department of Environmental Quality

References

Baumann, P. C. 2002. *Fish tumor BUI Criteria: Determining numbers for the delisting process*. Downloaded from www.glc.org/spac/proceedings/pdf/15Baumann.pdf on 4/2/2012.

Baumann, P.C., I.R. Smith, and C.D. Metcalfe. 1996. *Linkages between chemical contaminants and tumors in benthic Great Lakes fish.* J. Great lakes Res. 22(2):131-152.

Kreis, R. G. Jr., J. E. Rathbun, A. E. Maccubbin, R. A. Hites, V. E. Smith, M. J. Mac, J. C. Filkins, F. A. Rudolph, M. D. Mullin, K. A. Vargo, and K. P. McGunagle. 1989. An investigation of neoplasia in Detroit River fish and its relationship to sediment contamination. USEPA, Office of Research and Development, ERL-Duluth, MN, and LLRS-Grosse Ile, MI. 110 pp.

Status of the Fish Tumor Beneficial Use Impairment In the Rouge River Area of Concern

Background

The Rouge River Area of Concern (RR AOC) includes the entire main branch as well as the lower, middle, and upper branches of the river. The RR AOC is listed for 14 beneficial use impairments, including fish tumors or other deformities. Several studies have associated internal and external tumors in fish with carcinogens in sediment and water at several locations in North America, and they were summarized by Baumann et al. (1996). Specifically, epidermal and liver tumors in brown bullhead and white sucker are strongly correlated with the presence of polynuclear aromatic hydrocarbons (PAH). It has been recommended that one or both species should be used to monitor tumor prevalence (Baumann 2002).

A fish community survey of the Rouge River watershed was conducted in 1986 by the Michigan Department of Natural Resources (SEMCOG, 1989). During that study the incidence of external lesions on the fish was recorded. Three species of bullhead (brown, black, and yellow) were collected during the survey but only 12 bullhead were collected overall, and none of the bullhead had external tumors. White sucker were much more numerous with 579 collected, 23 of which (4%) had external lesions. A spatial trend in the distribution of those fish with lesions was apparent: white suckers in the Upper Branch of the Rouge River had an occurrence rate of 6.5%, and white suckers in the Main Branch (between Troy at the upstream end and Detroit downstream) had an occurrence rate of 6.3%. No lesions were observed on white suckers collected in the Middle and Lower Branches. It is important to note that age data are not available for these fish; tumors are more likely to occur in older fish (Bauman 2002).

The prevalence of external lesions in white suckers from 3 relatively pristine areas ranges from 3.4% to 8.6% (Baumann et al., 1996) with an overall average of 5.2%.

Recommendations

Although the incidence of external lesions in fish from the RR AOC may be low we should conduct a follow-up study to verify the 1986 results.

Few bullhead of any species were collected during the relatively intense survey of the Rouge River conducted in 1986, and there is no reason to suspect that collections would be any more successful now. White sucker are likely to be more numerous and should be the target species. Any bullhead collected, regardless of species, should also be kept for examination.

At a minimum, collections should be attempted in the Upper Branch and the Main Branch of the Rouge River, as white sucker from these areas had measurable rates of tumor incidence in the 1986 survey. Collection of white sucker from a reference site should also be considered. Sufficient data are available in the literature for brown bullhead but similar data may not be available for white sucker.

Dr. Baumann (2002) has recommended an external tumor rate of 12% as a criterion for an Area of Recovery. A minimum of 100 white suckers should be collected from both

the Upper Branch and Main Branch of the Rouge River in order to be sufficiently confident that the rate of tumor incidence in the RR AOC is no greater than the background rate at a reference site or sites.

Age of the fish should be determined in order to help in the interpretation of results. This can be done by collecting scale samples from the white sucker and otoliths (inner-ear structures) from bullhead.

Sampling Plan Summary

A. Fish Collection Sites:
1. Upper Branch Rouge River between Farmington Hills and Wayne
2. Main Branch Rouge River between Troy and Detroit
3. Reference Area - need for site to be determined; possibilities would include the Huron River (Washtenaw, Wayne, and Monroe Counties)

B. Number of Samples: Up to 100 white suckers will be collected from both the Upper and Main Branches of the Rouge River. Bullhead collected incidentally to the white sucker collection will also be kept for analysis.

C. Sample Processing: Fish samples will be inspected for external lesions (tumors). Lesions will be described as to location on the body and photographed. Twenty white sucker will be randomly selected from each river reach; scale samples will be collected from those fish and total length will be recorded.

D. Data Analysis: The proportion and 95% confidence limits on the proportion of the incidence of external lesions will be calculated for each river reach. The Rouge River proportions will be compared to each other and to literature values. Fish age & length data will be reported.

Joseph Bohr
10/14/2013

References

Baumann, P. C. 2002. *Fish tumor BUI Criteria: Determining numbers for the delisting process*. Downloaded from www.glc.org/spac/proceedings/pdf/15Baumann.pdf on 4/2/2012.

Baumann, P.C., I.R. Smith, and C.D. Metcalfe. 1996. *Linkages between chemical contaminants and tumors in benthic Great Lakes fish.* J. Great lakes Res. 22(2):131-152.

Southeast Michigan Council of Governments and Michigan Department of Natural Resources. 1989. Remedial action plan for the Rouge River Basin.

Status of the Fish Tumor Beneficial Use Impairment
In the Rouge River Area of Concern

Background

The Rouge River Area of Concern (RR AOC) includes the entire main branch as well as the lower, middle, and upper branches of the river. The RR AOC is listed for 14 beneficial use impairments, including fish tumors or other deformities. Several studies have associated internal and external tumors in fish with carcinogens in sediment and water at several locations in North America, and they were summarized by Baumann et al. (1996). Specifically, epidermal and liver tumors in brown bullhead and white sucker are strongly correlated with the presence of polynuclear aromatic hydrocarbons (PAH). It has been recommended that one or both species should be used to monitor tumor prevalence (Baumann 2002).

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Joseph Bohr
10/14/2013

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Baumann, P.C., I.R. Smith, and C.D. Metcalfe. 1996. *Linkages between chemical contaminants and tumors in benthic Great Lakes fish.* J. Great lakes Res. 22(2):131-152.

Southeast Michigan Council of Governments and Michigan Department of Natural Resources. 1989. Remedial action plan for the Rouge River Basin.

AGENDA

Conference Call to Discuss Detroit Tumor BUI

June 23, 2014 @ 3pm

Call number: 877/873-8018

Access Code: 8282547

1. Introductions
2. Overview of Canadian Studies – Sandra Kok
3. Overview of MDEQ Study – Joe Bohr
4. Update of FWS/USGS Study – Michelle for Jeremy Moore
5. Future Data Needs – Rose, Melanie, & Mary
    a. Identify timeline – post-dredging? How long?
    b. Potential Funding Sources
6. Anything else?
7. Action Items/Next Steps
8. Adjourn

MINUTES

Detroit Tumor BUI

June 23, 2014 @ 3pm

On the call:

- **Sandra Kok – Environment Canada**
- **Rose Ellison – US EPA**
- **Mary Bohling – Detroit PAC / MSUE Sea Grant**
- **Melanie Foose – MDEQ**
- **Joe Bohr – MDEQ**
- **Michelle Bruneau - MDCH**

1. Introductions began a little after 3pm

2. Overview of Canadian Studies – Sandra Kok
   a. Canada sampled several brown bullhead from Peche Island and Grosse Ile (Note: Sandra followed up after the meeting and the Gross Ile – labelled samples are not from Gross Ile but around Boblo Island and Crystal Island on the Canadian side. Will provide exact UTM locations when she gets them from EC scientist.)
   b. Had difficulty collection 100, concerned about depleting the brown bullhead population in the Detroit River
   c. Did complete histological surveys on 59 samples and found only 1 liver tumor
   d. Future plans for additional studies are currently unknown. If additional study were to occur, white suckers may be considered as an alternative species to avoid further depletion of the population.

3. Overview of MDEQ Study – Joe Bohr
   a. MDEQ completed a study of 20 brown bullhead from the Detroit River.
   b. No histological work done.
   c. No gross internal or external tumors identified.

4. Update of FWS/USGS Study – Michelle for Jeremy Moore
   a. Not aware of future studies; Vicki Blazer is retiring; USGS Leetown Science Center – where she is based – may have more information with regard to future study plans

5. Future Data Needs – Rose, Melanie, & Mary
   a. Combine USGS and Environment Canada Datasets
   b. Identify minimum age of suckers/bullhead & tumor susceptibility

   c. Identify management actions that may need to take place before further testing is needed

6. Potential Funding Sources
   a. MDEQ has monitoring funds that may be available for additional sampling.
   b. Rose believes that additional funding from the EPA may be available, if needed.

7. Action Items/Next Steps
   a. Rose – Check to see if Rachel is comfortable merging USGS/EC datasets; if not, we'll need to identify someone who has time to do so
   b. Rose – Check to see if Rachel is comfortable conducting a literature search with regard to tumors – start with Baumann study references?
   c. Joe - Identify minimum age of suckers/bullhead & tumor susceptibility
   d. Sandra – Will see if she can get fish tumors on the DR Canadian RAP Science and Monitoring Work Group meeting agenda in September
   e. Michelle – send out Doodle poll for a second meeting at the end of July

8. Adjourn @ 3:58pm

AGENDA

Conference Call to Discuss Detroit Tumor BUI

August 6, 2014 @ 10am

Call number: 877/873-8018
Access Code: 8282547

1. Introductions
2. Overview of Canadian Modeling Study – Sandra Kok/Claire Sanders
3. Synthesis of Detroit PAC Meeting (US) Discussion – All
4. Old Business – Action Item Follow-Up
    a. Rose – Check to see if Rachel is comfortable merging USGS/EC datasets; if not, we'll need to identify someone who has time to do so
    b. Rose – Check to see if Rachel is comfortable conducting a literature search with regard to tumors – start with Baumann study references?
    c. Joe - Identify minimum age of suckers/bullhead & tumor susceptibility
    d. Sandra – Will see if she can get fish tumors on the DR Canadian RAP Science and Monitoring Work Group meeting agenda in September
5. Updates on GLLA Project - Rose
6. Anything else?
7. Action Items/Next Steps
8. Adjourn

From:	Braunscheidel, Jeffrey (DNR)
To:	Bruneau, Michelle (DCH); Kok,Sandra [Burlington]
Cc:	Bohr, Joseph (DEQ)
Subject:	RE: Tumors in the Detroit River Conference Call - Tuesday 7/29 @ 2pm
Date:	Monday, September 08, 2014 10:31:43 AM

Actually, it was the Fish & Wildlife Service that made that comment about collecting bullhead (Justin).

Jeffrey Braunscheidel
Senior Fisheries Biologist
Lake Erie Management Unit
MDNR Fisheries Division
(248) 666-7445
Email: Braunscheidelj@michigan.gov

From: Bruneau, Michelle (DCH)
Sent: Monday, September 08, 2014 9:47 AM
To: Kok,Sandra [Burlington]
Cc: Bohr, Joseph (DEQ); Braunscheidel, Jeffrey (DNR)
Subject: RE: Tumors in the Detroit River Conference Call - Tuesday 7/29 @ 2pm

Hi Sandra –

I have not, but a quick overview:

It was a very quick call.
The DNR thinks we should be able to get bullhead without a problem using a different sampling method. They had pulled up 20 bullhead from Humbug Marsh in just a couple hours using gill nets when they were out there sampling before.
If we wait until the dredging is done, we'll probably want to wait a minimum of 2 or 3 years before we sample again, and we'll be targeting about 7-8 inch fish at that time (age/size correlation).

No one is in a hurry to have another call any time soon…We'll just touch base every so often, and I'll schedule one if something comes up. ☺

I'll draft up formal minutes soon, but I'm cc'ing Joe and Jeff, so they can correct me if I'm misinterpreting anything. Which could very well be likely. ☺

><{{{'> www.michigan.gov/eatsafefish <'}}}><

Michelle Bruneau, MA
Michigan Department of Community Health
Project Manager & Health Educator
(517) 335-8984
bruneaum@michigan.gov

From: Kok,Sandra [Burlington] [mailto:Sandra.Kok@ec.gc.ca]
Sent: Friday, September 05, 2014 3:45 PM
To: Bruneau, Michelle (DCH)
Subject: RE: Tumors in the Detroit River Conference Call - Tuesday 7/29 @ 2pm

Hi Michelle:

Has there been any minutes prepared /sent out from this meeting. I just have to help Rose with an update of the fish tumor issue for our Four Agency Management Committee (need info mid week).. just notes /points will do if u've not done up formal minutes. Thanks!

From: Bruneau, Michelle (DCH) [mailto:BruneauM@michigan.gov]
Sent: July 29, 2014 8:56 AM
To: Ellison, Rosanne; Rachael Miksys (r_miksys2009@yahoo.com); Foose, Melanie (DEQ); Bohling, Mary (bohling@anr.msu.edu); Kok,Sandra [Burlington]; Ted.Briggs@ontario.ca; Bohr, Joseph (DEQ); Claire Sanders (sanders@detroitriver.ca) (sanders@detroitriver.ca) (sanders@detroitriver.ca); jeremy_n_moore@fws.gov
Subject: RE: Tumors in the Detroit River Conference Call - Tuesday 7/29 @ 2pm

Just a reminder for today's call at 2pm. Hope everyone who could make it can still make it! Talk to you soon!

><{{{'> www.michigan.gov/eatsafefish <'}}}><

Michelle Bruneau, MA
Michigan Department of Community Health
Project Manager & Health Educator
(517) 335-8984
bruneaum@michigan.gov

From: Bruneau, Michelle (DCH)
Sent: Friday, July 25, 2014 12:48 PM
To: 'Ellison, Rosanne'; 'Rachael Miksys (r_miksys2009@yahoo.com)'; Foose, Melanie (DEQ); Bohling, Mary (bohling@anr.msu.edu); Kok,Sandra [Burlington] (Sandra.Kok@ec.gc.ca) (Sandra.Kok@ec.gc.ca); 'Ted.Briggs@ontario.ca'; Bohr, Joseph (DEQ); Claire Sanders (sanders@detroitriver.ca) (sanders@detroitriver.ca) (sanders@detroitriver.ca); jeremy_n_moore@fws.gov
Subject: Tumors in the Detroit River Conference Call - Tuesday 7/29 @ 2pm

Hello all:

Attached is the agenda and call-in info for those of you who can make it next week. If you have any additions or changes to the agenda, we can cover them when we get started on the call. Just remind me in case I forget to ask, please! ☺

Rose – I know you're unable to make this call, but if you could either fill me or Melanie in on any of your updates/status of action items to report on the call, I'd appreciate it!

- M

><{{{'> www.michigan.gov/eatsafefish <'}}}><

Michelle Bruneau, MA

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MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION
MAY 2014

STAFF REPORT

ROUGE RIVER AREA OF CONCERN
FISH TUMOR OR OTHER DEFORMITY INVESTIGATION
2013

INTRODUCTION

The Rouge River Area of Concern includes the entire Rouge River watershed of approximately 466 square miles in southeastern Michigan. The Rouge River Area of Concern is listed for 14 beneficial use impairments (BUI), including "Fish Tumors or Other Deformities". Several studies have associated internal and external tumors in fish with carcinogens in sediment and water at several locations in North America, and they were summarized by Baumann et al. (1996). Specifically, epidermal and liver tumors in bullhead (*Ameiurus* spp.) and white sucker (*Catostomus commersonii*) are strongly correlated with the presence of polynuclear aromatic hydrocarbons (PAH).

A fish community survey of the Rouge River watershed was conducted in July and August 1986 by the Michigan Department of Natural Resources (SEMCOG, 1989). During that study the incidence of external lesions on the fish was recorded. Brown, black, and yellow bullhead (*A. nebulosus, A. melas,* and *A. natalis*) were collected during the survey but only 12 bullhead were collected overall, and none of the bullhead had external neoplasms (tumors). White sucker were much more numerous with 579 collected, 23 of which (4%) had external lesions; it was noted that these lesions were probably caused by anchorworms (a parasitic copepod).

A spatial trend in the distribution of those fish with lesions was apparent in the 1986 survey. White sucker in the Upper Branch of the Rouge River had an occurrence rate of 6.5%, and white sucker in the Main Branch (between Troy at the upstream end and Detroit downstream) had an occurrence rate of 6.3%. No lesions were observed on white sucker collected in the Middle and Lower Branches. It is important to note that tumors are more likely to occur in older fish (Baumann 2002) however age data are not available for the fish collected in 1986. The prevalence of external lesions in white sucker from 3 relatively pristine areas ranges from 3.4% to 8.6% (Baumann et al., 1996) with an overall average of 5.2%.

The Michigan Department of Environmental Quality, Water Resources Division, conducted a survey of the Rouge River Area of Concern in October 2013 with a goal of determining dermal lesion rates in white sucker in the Main Branch Rouge River and in the Upper Branch Rouge River.

SUMMARY

1. White sucker were collected from one reach of the Main Branch Rouge River downstream of the Ford Dam and from two reaches of the Upper Branch Rouge River.

2. The fish were examined for dermal lesions, neoplasms, and other external anomalies.
3. Dermal lesions attributable to anchorworms were observed on 24% of the white sucker collected from the Main Branch and on 2% of the white sucker collected from the Upper Branch Rouge River.
4. A dermal neoplasm was observed on one white sucker collected from the Main Branch Rouge River. This translates to an upper 95% confidence interval estimate of 12.8% of the population in the survey reach having similar dermal neoplasms. No dermal neoplasms were observed on white sucker collected from the Upper Branch Rouge River.
5. The estimated proportion of white sucker from the Main Branch Rouge River with dermal neoplasms was not statistically different than the estimated proportion in the Upper Branch Rouge River population, however statistical power was low.

METHODS

Standard electrofishing gear was used to collect white sucker from the Main Branch Rouge River downstream of the Ford Dam and from two reaches of the Upper Branch Rouge River (Figure 1). Other fish species encountered while electrofishing were also collected and held for inspection. All fish were held in a live well until the end of each electrofishing run and were then examined for gross external lesions or other dermal anomalies. Digital photographs were taken of examples of fish with lesions or other anomalies. Total length was measured and scale samples collected from a subsample of 20 white suckers at each sampling site. All fish were released after examination.

White sucker scales were aged by Great Lakes Environmental Center (Traverse City, Michigan) using techniques outlined by Nielsen and Johnson (1989). Scales were cleaned, compressed between two glass microscope slides, and examined using low-power magnification.

Confidence intervals about the estimated percent occurrence of dermal neoplasms were calculated based on a binomial distribution (Sprent and Smeeton, 2001). A comparison of the rate of occurrence of neoplasms between Upper Branch and Main Branch Rouge River samples was made using Fisher's exact test for independence. A one proportion test was used to compare the Main Branch rate estimate with the presumed background rate of 5% (based on Baumann et al., 1996). Confidence interval estimates and statistical comparisons were made using the Minitab 15 software package.

RESULTS AND DISCUSSION

A total of 41 and 147 white sucker were collected from the Main Branch and Upper Branch Rouge River, respectively, in 2013 (Table 1). A high percentage of the white sucker collected from the Main Branch Rouge River had dermal lesions which most likely were caused by anchorworms (*Lernaea* spp.), a common freshwater copepod with a parasitic life stage. Figures 2 through 9 show typical lesions observed during the survey. Figure 10 shows an unusually large dermal lesion that may not have been caused by anchor worms. Both Figures 11 and 12 are photos of the same white sucker with an anchorworm attached and showing the associated lesion.

In addition to the white sucker, one channel catfish (*Ictaluras punctatus*) and eight northern pike (*Esox lucius*) were collected from the Main Branch Rouge River. No external anomalies were observed in the catfish or pike. One yellow bullhead and 38 northern hogsucker (*Hypentelium nigricans*) were collected from the Upper Branch Rouge River in addition to the white sucker. Again, no external anomalies were observed in the non-target species.

One white sucker was observed with a dermal neoplasm (Figures 13 and 14). The fish was collected from the Main Branch Rouge River and represents 2.4% of the total catch from that reach (Table 1). No dermal neoplasms were observed on the white sucker collected from the Upper Branch Rouge River reaches. There was no statistically significant difference in the percentage of dermal neoplasms observed in the Main Branch compared to the Upper Branch Rouge River (Fisher's exact test P-value = 0.22); however, with only 41 samples from the Main Branch the power to detect a difference was low. More specifically, with the given sample sizes we only have sufficient power to detect a difference in proportions of about 20%. If the sample size were 100 from both the Upper and Main Branches we would be able to detect a difference of about 10%.

The white sucker collected from the Main Branch tended to be both larger and older than those collected from the Upper Branch stations (Table 2). This could explain the observed difference in neoplasm proportion between the two populations; older fish are more likely to develop neoplasms having been exposed to potential tumor causing agents (i.e. toxins, parasites, or pathogens) for a longer period of time.

The one white sucker with a dermal neoplasm represents 0.5% of the 188 white sucker collected from all three Rouge River reaches sampled in the 2013 survey. The 95% confidence interval on the overall estimated percent of white sucker with dermal neoplasms ranged from 0.01% to 2.9%. Taken as a whole, the proportion of dermal neoplasms observed in this survey is statistically significantly less ($p = 0.001$) than the average background proportion of 5% suggested by Baumann et al. (1996).

The results of this survey indicate that the proportion of white sucker in the Rouge River with dermal neoplasms is low; if the "Fish Tumors or Other Deformities" BUI is based solely on external lesions and neoplasms then that BUI could be removed. Baumann (2010) strongly recommends evaluating the incidence of neoplastic liver tumors as evidence of exposure to contaminants, arguing that external lesions can be caused by a combination of many factors, including toxins, parasites, and bacterial or viral pathogens. An evaluation of the incidence of liver tumors would require an intensive survey but would provide a definitive answer. However, if in general there is a correlation between external neoplasms and liver tumors, the results of the 2013 study would indicate that liver tumors in white sucker are likely to be relatively rare.

Field Work By: Kevin Goodwin, Aquatic Biologist
Sam Noffke, Aquatic Biologist
Surface Water Assessment Section
Water Resources Division

Report By: Joseph Bohr, Aquatic Biologist
Seth Wright, Aquatic Biologist (map)
Surface Water Assessment Section
Water Resources Division

LITERATURE CITED

Baumann, P. C. 2002. *Fish tumor BUI Criteria: Determining numbers for the delisting process*. Downloaded from www.glc.org/spac/proceedings/pdf/15Baumann.pdf on 4/2/2012.

Baumann, P. C. 2010. Data analysis and fish tumor BUI assessment for Lake Superior and the St. Clair River AOCs.

Baumann, P.C., I.R. Smith, and C.D. Metcalfe. 1996. *Linkages between chemical contaminants and tumors in benthic Great Lakes fish.* J. Great lakes Res. 22(2):131-152.

Nielsen, L. A., and D. L. Johnson. 1989. Fisheries Techniques. Chapter 16: Age Determination. American Fisheries Society. Bethesda, Maryland.

Southeast Michigan Council of Governments and Michigan Department of Natural Resources. 1989. Remedial action plan for the Rouge River Basin.

Sprent, P., and N. C. Smeeton. 2001. Applied nonparametric statistical methods. Chapman & Hall/CRC Press. 461 pp.

Table 1. Sample sizes and estimated percent dermal neoplasm in white sucker collected from the Main and Upper Branches of the Rouge River in 2013 and 1986.

	2013 Survey		1986 Survey	
	Main Rouge River	Upper Rouge River	Main Rouge River	Upper Rouge River
Total Number Collected	41	147	270	92
Number w/Dermal Lesion(s)	10	3	17	6
% w/Dermal Lesion(s)	24.4	2.0	6.3	6.5
Number w/Dermal Neoplasm	1	0	na	na
% w/Dermal Neoplasm	2.4	0	na	na
95% Confidence Limit on Estimated Percent w/Neoplasm	0.1 - 12.8%	0 - 2.0%	na	na

Table 2. Age structure of white sucker collected from the Rouge River in 2013.

	Percent at Age	
Fish Age	Upper Branch	Main Branch
2	25	10
3	45	35
4	30	30
5		20
6		5
Total	100	100

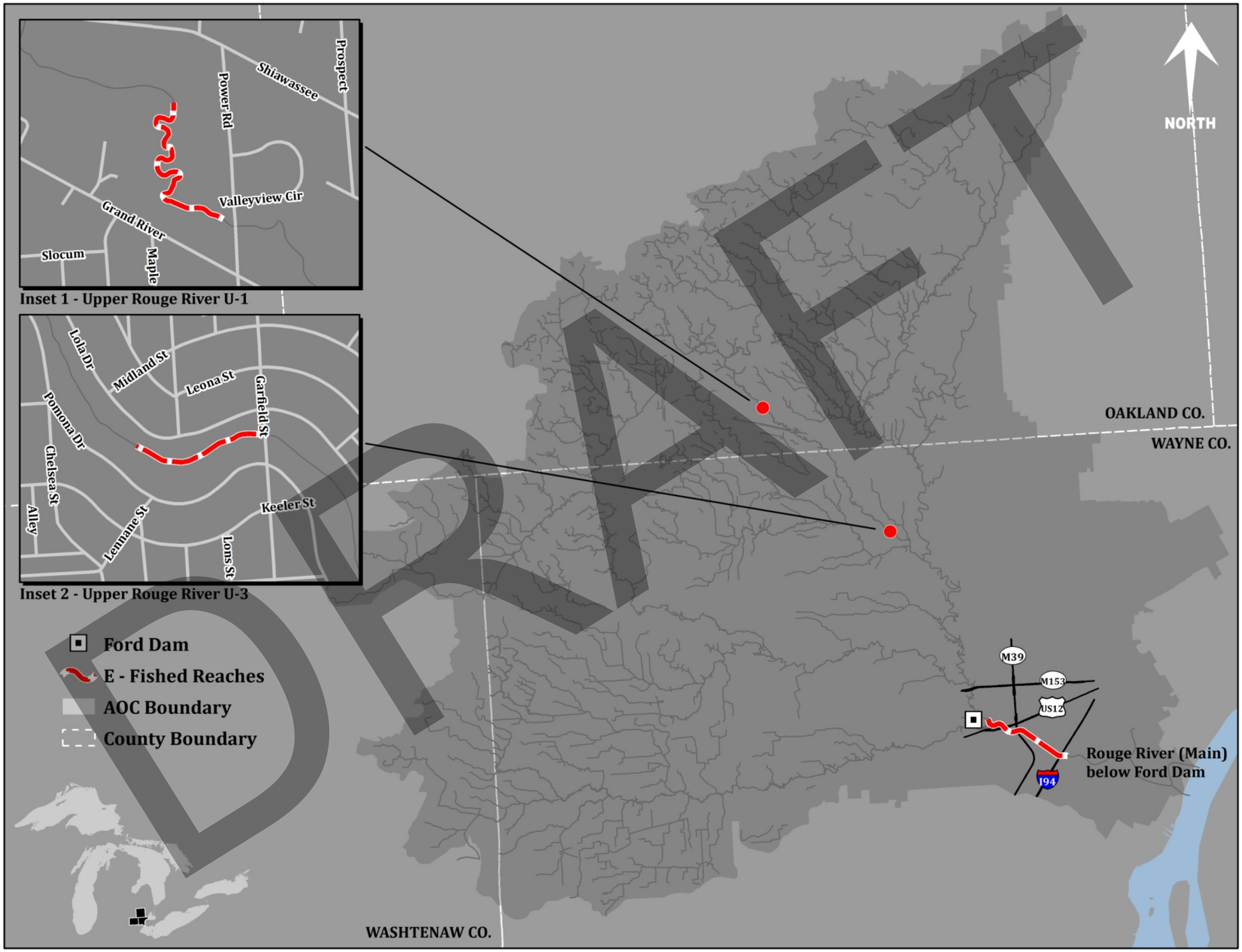


Figure 1. Map of River Rouge Area of Concern showing 2013 fish tumor survey sampling sites.

Figure 2.

Figure 3.

Figure 4.

Figure 5.

Figure 6.

Figure 7.

Figure 8.

Figure 9.

Figure 10.

Figure 11.

Figure 12.

Figure 13


Figure 14.

St. Marys River Area of Concern
Fish Tumor or Other Deformity Investigation
2012

Background

The St. Marys River is a 70-mile international connecting channel linking Lake Superior to Lake Huron and is a bi-national Area of Concern. The St. Marys River Area of Concern (SMR) is listed for 10 beneficial use impairments (BUI). The "Fish Tumor or Other Deformities" BUI was listed for the SMR-AOC in part due to results of an investigation conducted by the U. S. Fish and Wildlife Service. The study indicated an elevated incidence of liver tumors in brown bullheads from Munuscong Bay (St. Marys River Remedial Action Plan, Stage 1, 1992). The survey also found 4% of walleye from Munuscong Bay with grossly observable liver tumors (Great Lakes Water Quality Board, 1987).

Several studies have associated internal and external tumors in fish with carcinogens in sediment and water at several locations in North America, and they were summarized by Baumann et al. (1996). Specifically, epidermal and liver (hepatic) tumors in brown bullhead and white sucker are strongly correlated with the presence of polynuclear aromatic hydrocarbons (PAH). Bauman (2013) conducted an intensive study of the prevalence of hepatic tumors in white sucker (*Catostomus commersoni*) collected in 2009 from Ontario waters of the St. Marys River near Sault Ste. Marie, Ontario. After histological examination of the livers it was determined that white sucker from the SMR had higher rates of hepatic tumors than white sucker from two reference locations.

2012 Reconnaissance Survey

The Michigan Department of Environmental Quality conducted a small survey in 2012 screening for obvious tumors in fish collected from the SMR as part of an evaluation of the status of contaminant levels in fish. A total of 10 brown bullhead and 67 fish of 7 other species were collected from the St. Marys River (Munuscong Lake) in 2012 (Table 1). In addition, a reference collection of 10 brown bullhead and 57 fish of 5 other species were taken from the Les Cheneaux Islands (LCI) area of northern Lake Huron (near Cedarville, Michigan). White sucker were not found at either area during the sampling effort.

Table 1. Number of fish collected from the St. Marys River (SMR) and Les Cheneaux Islands (LCI) in 2012.

Species		Number Collected SMR	Number Collected LCI
Brown Bullhead	*Ameiurus nebulosus*	10	10
Common Carp	*Cyprinus carpio*	10	10
Pumpkinseed	*Lepomis gibbosus*	10	10
Redhorse Sucker	*Moxostoma sp.*	7	0
Rock Bass	*Ambloplites rupestris*	12	17
Smallmouth Bass	*Micropterus dolomieu*	10	10
Walleye	*Sander vitreum*	8	0
Yellow Perch	*Perca flavescens*	10	10

All of the fish were examined for gross external lesions. The redhorse sucker and brown bullhead were examined for gross internal lesions. Histological examinations were not conducted. No gross external or hepatic lesions were observed in any of the fish examined from SMR or LCI.

Based on this survey we could say that 0% of the SMR brown bullhead have gross internal or external lesions; however given the very small sample size that conclusion is not justified. The presence/absence of gross lesions follows a binomial distribution and a confidence interval can be calculated based on that distribution (Sprent and Smeeton, 2001). The formula is:

$$(1 - p_u)^n = 0.05$$

where p_u is the upper limit on the estimated percentage occurrence of gross lesions when none were observed, and n is the sample size. The number 0.05 is the α value associated with a 95% confidence interval.

With the given sample size of 10 fish we can be 95% confident that *p* is between 0% and 16% (for comparison, if we had examined 100 brown bullhead and found no lesions we could be 95% confident that *p* is between 0% and 3%).

This survey in itself does not have sufficient power to show a low incidence of lesions, however it does provide anecdotal evidence backing up a lack of reported incidence of gross tumors.

Joseph Bohr
Water Resources Division
Michigan Department of Environmental Quality

12/6/2013

<u>References</u>

Baumann, P. C. 2002. *Fish tumor BUI Criteria: Determining numbers for the delisting process*. Downloaded from www.glc.org/spac/proceedings/pdf/15Baumann.pdf on 4/2/2012.

Baumann, P. C. 2013. *Liver tumor prevalence in St. Marys River white sucker: A discussion of possible causes*. Report to Environment Canada.

Baumann, P.C., I.R. Smith, and C.D. Metcalfe. 1996. *Linkages between chemical contaminants and tumors in benthic Great Lakes fish.* J. Great lakes Res. 22(2):131-152.

Great Lakes Water Quality Board. 1987. *1987 Report on Great lakes Water Quality, Appendix A.* 208 pp.

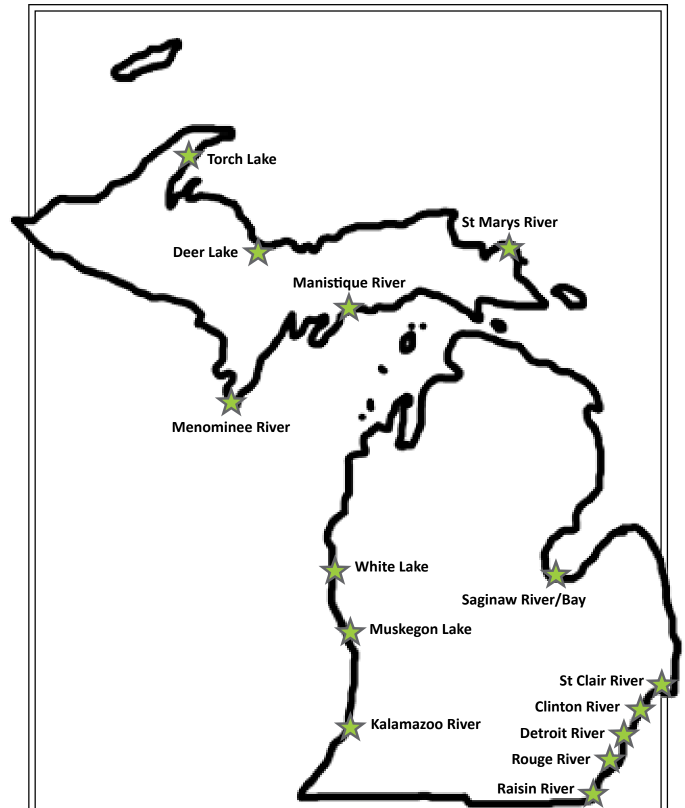
Sprent, P. and N. C. Smeeton. 2001. *Applied nonparametric statistical methods, 3rd Edition.* Chapman and Hall / CRC Press. 461 pp.

Fish Tumors or Other Deformities in Michigan's Areas of Concern

Areas of Concern (AOCs)

In the 1980s, the United States and Canadian governments identified 43 places in the Great Lakes region that had severe, long-term environmental problems. These places are called *Areas of Concern*.

People in federal, state, and provincial government environmental remediation programs are working to address the problems in these areas. Funding and expert guidance are provided to AOCs to help local groups, known as Public Advisory Councils (PACs), work on these environmental problems, as well.



Michigan's AOCs in 2012

Beneficial Use Impairments (BUIs)

These environmental problems are called *beneficial use impairments.* There are 14 categories of BUIs, originally named in the U.S.-Canadian Great Lakes Water Quality Agreement. However, a place does not have to have all 14 problems to be called an AOC.

Each BUI has goals that need to be met in order to be removed from the AOC's list of problems. Once all BUIs are removed from the list, the AOC is considered to be no longer impaired and can be *delisted,* or removed from the list of AOCs.

The 14 BUIs that an AOC can have are:

- Restrictions on Fish and Wildlife Consumption
- Tainting of Fish and Wildlife Flavor
- Degraded Fish and Wildlife Populations
- Fish Tumors or Other Deformities
- Loss of Fish and Wildlife Habitat
- Degradation of Benthos
- Degradation of Aesthetics
- Beach Closings
- Added Costs to Agriculture or Industry
- Restrictions on Dredging Activities
- Eutrophication or Undesirable Algae
- Restrictions on Drinking Water Consumption or Taste and Odor Problems
- Bird or Animal Deformities or Reproductive Problems
- Degradation of Phytoplankton and Zooplankton Populations

Over the years, several BUIs have been removed from Michigan's AOCs, as citizens, industries, and government joined together to improve our state's environmental health. In fact, after decades of hard work, some Michigan AOCs only have one or two BUIs remaining and are getting closer to being delisted.

Fish Tumors or Other Deformities BUI

If an AOC has a ***Fish Tumors or Other Deformities BUI***, it means that the fish from the affected lake or river once had a higher rate of tumors, possibly caused by chemicals.

Fish tumors aren't only caused by chemicals, however. There are diseases that can cause tumors in fish, just like in humans. For this reason, even after the *Fish Tumors or Other Deformities BUI* has been removed from an AOC, there still might be fish with tumors in the river.

There are two ways to remove the *Fish Tumors or Other Deformities BUI.* The first is by reviewing MDEQ and Michigan Department of Natural Resources (MDNR) records for confirmed reports of fish tumors in the past five years. If there are none, the BUI may be removed. If tumors have been reported, then a number of fish that typically have more tumors, like bullheads or suckers, are collected from the river. These fish are then examined by scientists at the MDEQ for tumors or lesions. The same types of fish are also collected from an area outside of the AOC, called a reference site. These fish are also examined for tumors or lesions. The two groups are then compared. If the group of fish from the AOC shows the same number or fewer tumors or lesions than the fish from the reference site, the BUI can be removed.

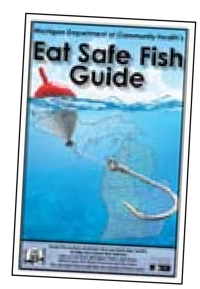
It is important to note that:

- **Tumors can occur naturally in fish. Catching a fish with a tumor is not always a sign that there are problems with the water or fish population.**
- **Spots and other lesions on fish can be caused by viruses, lampreys, or even scrapes during the fight on your fishing line.**
- **People can't get sick from most fish diseases (except tapeworms), but it's good practice to wash your hands after handling a fish and to cook your freshwater fish filets completely.**

If you are concerned about a fish that you caught that seems sick or is deformed, or if you see a large number of dead fish, you can report it to your local Michigan Department of Natural Resources (MDNR) office: **Rouge River area / Detroit area - (248) 359-9040 • St Marys River area - (906) 293-5131.**

You can't see chemicals in fish. Use the *Eat Safe Fish Guide*.

- You can't always see the chemicals in fish that can cause health problems in people. In fact, the chemicals that cause the Michigan Department of Community Health's (MDCH) fish eating guidelines and the ***Fish Tumors or Other Deformities BUI*** to be issued can't be seen at all.
- The ***MDCH Eat Safe Fish Guide*** can help you choose safer fish to eat from many of Michigan's lakes and rivers, not just the ones in the AOCs. MDCH tests filets of fish for chemicals from locations all around the state.



Even when the ***Fish Tumors or Other Deformities BUI*** is removed from an AOC's list of problems, fish from the lake or river will still be tested and listed in the *MDCH Eat Safe Fish Guide* for some time after. This is because different chemicals cause different problems. None of the chemicals listed in the *MDCH Eat Safe Fish Guide* will ever change the taste or the look of the fish.

Michigan lakes and rivers are improving thanks to federal and state environmental rules, and the hard work of the US Environmental Protection Agency, the MDEQ, and the PACs. However, it will take many years for these chemicals to leave the ecosystem and the fish.

To learn more about AOCs & BUIs:

MDEQ - Office of the Great Lakes

517-335-3168

http://www.michigan.gov/deqaocprogram

To learn more about eating safe fish:

Michigan Department of Community Health

MDCH - Division of Environmental Health

1-800-648-6942

http://www.michigan.gov/eatsafefish

Eat Safe Fish from Michigan's Areas of Concern

Areas of Concern (AOCs)

In the 1980s, the United States and Canadian governments identified 43 places in the Great Lakes region that had severe, long-term environmental problems. These places are called *Areas of Concern*.

People in federal, state, and provincial government environmental remediation programs are working to address the problems in these areas. Funding and expert guidance are provided to AOCs to help local groups, known as Public Advisory Councils (PACs), work on these environmental problems, as well.

Michigan's AOCs

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These environmental problems are called *beneficial use impairments.* There are 14 categories of BUIs, originally named in the U.S.-Canadian Great Lakes Water Quality Agreement. However, a place does not have to have all 14 problems to be called an AOC.

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Over the years, several BUIs have been removed from Michigan's AOCs, as citizens, industries, and government joined together to improve our state's environmental health. In fact, after decades of hard work, some Michigan AOCs only have one or two BUIs remaining and are getting closer to being delisted.

Restrictions on Fish Consumption BUI

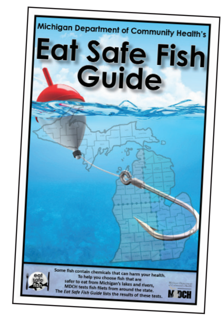
If an AOC has a ***Restrictions on Fish Consumption BUI***, it means that the fish from the affected lake or river at one time had higher levels of chemicals than fish in similar lakes or rivers in the Great Lakes region.

In most cases, the process to remove the Fish Consumption BUI is fairly direct. Chemical levels in fish from the AOC are compared to levels in fish from outside of the AOC. The BUI can be removed from the AOC's list of problems when:

- the levels of chemicals found in fish from the AOC are the same or less than fish from a similar location that is not an AOC, or
- the levels of chemicals in fish from the same lake or river have decreased over time. This process is used if there isn't a similar enough location outside of the AOC to use as a comparison.

Each AOC has their own process for BUI removal in place. The final decision to remove the BUI depends on the process that the PAC and the Michigan Department of Environmental Quality agree upon.

Michigan Department of Community Health *Eat Safe Fish Guide*



The ***Eat Safe Fish Guide*** is put out by the Michigan Department of Community Health (MDCH). This guide lists all of the fish species that have been tested from lakes and rivers throughout Michigan. MDCH tests only the filet of the fish for chemicals like PCBs, dioxins, and mercury. They use this information to develop the safe fish eating guidelines printed in the *Eat Safe Fish Guide*.

Fish with chemicals in their bodies are not just found in AOCs, but also in the other thousands of lakes and rivers throughout Michigan. If you eat a lot of Michigan fish, are young, and/or have health problems, you can use the *Eat Safe Fish Guide* to find fish that are lower in chemicals and safer for you to eat. You can get a free copy of the *Eat Safe Fish Guide* from MDCH by calling 1-800-648-6942 or visiting www.michigan.gov/eatsafefish.

BUIs and Eat Safe Fish Guidelines are NOT the same.

- ***Fish Consumption BUIs*** compare chemical levels in fish from the AOC to chemical levels in fish that are not in an AOC. When these levels are similar - meaning the amount of chemicals in fish from the AOC are little different than those from other lakes and rivers in the state that are not in an AOC - then the BUI can be removed.
- The ***MDCH Eat Safe Fish Guide*** helps you find safer fish to eat from Michigan lakes and rivers. MDCH tests filets of fish for chemicals from locations all around the state. The *Eat Safe Fish Guide* can help you find safer fish to eat in lakes and rivers throughout Michigan, not just in the AOC.

When the Fish Consumption BUI is removed from an AOC's list of problems, fish from the lake or river will still be tested and listed in the ***MDCH Eat Safe Fish Guide*** for some time after.

Michigan lakes and rivers are improving thanks to federal and state environmental rules and the hard work of the US Environmental Protection Agency, the MDEQ, and the PACs, but it will take many years for these chemicals to leave the ecosystem and the fish.

To learn more about AOCs & BUIs:

MDEQ - Office of the Great Lakes

517-335-3168

http://www.michigan.gov/deqaocprogram

To learn more about eating safe fish:

MDCH - Division of Environmental Health

1-800-648-6942

http://www.michigan.gov/eatsafefish

APPENDIX L - LIST OF EVENTS

Date	AOC	Event	Participation	Estimated # of Interactions
3/16/2013	St Marys River AOC	Environmental Summit	Eat Safe Fish Booth	50
3/26/2013	ALL	WIC Conference	Eat Safe Fish Booth	200
6/2/2013	St Clair River AOC	Sturgeon Fest	Eat Safe Fish Booth	300
6/9/2013	Menominee River AOC	Fishing Derby	HE/PM provided outreach materials, couldn't attend	100
10/12/2013	Rouge River AOC	Rouge Rescue	Eat Safe Fish Booth	50
10/20/2013	River Raisin AOC	Monroe Food Day	Eat Safe Fish Booth	50
1/15/2014	Detroit River AOC	Trenton Channel Legacy Act Public Meeting	Eat Safe Fish Booth	100
2/1/2014	Detroit River AOC	Shiver on the River	Eat Safe Fish Booth	250
4/12/2014	St Marys River AOC	Environmental Summit	Presentation and Eat Safe Fish Booth	80
5/1/2014	Rouge River AOC	Rouge River Water Festival	Classroom Presentations	120
5/7/2014	Detroit River AOC	Fish Tainting Removal Event	Eat Safe Fish Booth	50
5/31/2014	St Clair River AOC	Sturgeon Fest	Eat Safe Fish Booth	1,000
6/17/2014	Deer Lake AOC	Public Meeting	Eat Safe Fish Booth	10
9/6/2014	Muskegon Lake AOC	Sportsmen for Youth Day	Eat Safe Fish Booth	2,300
9/18/2014	St Clair River AOC	St Clair Symposium	Poster Display	100
10/11/2014	Rouge River AOC	Rouge-A-Palooza	Eat Safe Fish Booth	150
10/23/2014	Clinton River AOC	Clinton River Water Trails Summit	Eat Safe Fish Booth	50
11/4/2014	St Marys River AOC	UP Food Summit - EUP	Eat Safe Fish Booth	70
11/5/2014	Deer Lake AOC	UP Food Summit - Central	Eat Safe Fish Booth	150
11/6/2014	Torch Lake AOC	UP Food Summit - WUP	Eat Safe Fish Booth	60
11/13/2014	Deer Lake AOC	Deer Lake Delisting Event	Eat Safe Fish Booth	13
2/7/2015	Detroit River AOC	Shiver on the River	Eat Safe Fish Booth	70
2/26/2015	Saginaw Bay AOC	Saginaw Bay Resource, Conservation & Development Celebration of Success	Eat Safe Fish Booth	100
4/22/2015	Torch Lake AOC	KBIC Environmental Fair	Eat Safe Fish Booth	300
4/29/2015	White Lake AOC	Public Meeting	Presentation and Eat Safe Fish Booth	40
5/30/2015	St Clair River AOC	Sturgeon Fest	Eat Safe Fish Booth	850
6/13/2015	Menominee River AOC	Kids Fishing Derby	Eat Safe Fish Booth	1,200
6/27/2015	Torch Lake AOC	KBIC Kids Fishing Derby	Eat Safe Fish Booth	460
7/3/2015	Muskegon Lake AOC	Muskegon Art Festival	Eat Safe Fish Booth	400
7/4/2015	Muskegon Lake AOC	Muskegon Art Festival	Eat Safe Fish Booth	800
7/25/2015	Menominee River AOC	Menominee Brown Trout Derby	Eat Safe Fish Booth	250
9/2/2015	Rouge River AOC	Southfield Safety Conference	Eat Safe Fish Booth	300
9/12/2015	Muskegon Lake AOC	Sportsmen for Youth Day	Eat Safe Fish Booth	2,500
9/16/2015	Rouge River AOC	Rouge River Water Festival	Classroom Presentations	90
10/10/2015	Rouge River AOC	Bloomfield Twp Open House	HE/PM provided outreach materials, couldn't attend	50
10/10/2015	Rouge River AOC	Rouge-A-Palooza	HE/PM provided outreach materials, couldn't attend	100
2/6/2016	Detroit River AOC	Shiver on the River	Eat Safe Fish Booth	200
			TOTAL:	**12,963**

Order Date	AOC	Item	Quantity	Cost	Balance
1/1/2000	GLRI GRANT YR 01				**$ 24,000.00**
7/13/2012	Many	ESF Tape Measures	10,000	$ (5,250.93)	*$ 18,749.07*
7/17/2012	Many	ESF Tattoos	15,000	$ (624.00)	*$ 18,125.07*
7/30/2012	Many	ESF Bobbers	20,000	$ (5,600.00)	*$ 12,525.07*
7/30/2012	Many	Lake Superior State Admir	1	$ (1,797.67)	*$ 10,727.40*
7/31/2012	Many	Eat Safe Fish in Michigan b	20,000	$ (1,355.00)	*$ 9,372.40*
7/31/2012	Many	Hooked on Fish Cookbook	20,000	$ (7,132.00)	*$ 2,240.40*
7/31/2012	Many	3 Documents (2 activity sh	60,000	$ (1,490.40)	*$ 750.00*
7/31/2012	Many	Shipping to Lansing for the	1	$ (350.00)	*$ 400.00*
10/1/2012	**GLRI GRANT YR 02**			**$ 24,000.00**	***$ 24,400.00***
4/25/2013	St Clair & Detroit + PACs	Tote Bags	1,000.00	$ (1,330.00)	*$ 23,070.00*
6/5/2013	St Clair	Tote Bags	200.00	$ (531.26)	*$ 22,538.74*
1/1/2014	White Lake	Flyers and Posters	1,015.00	$ (184.10)	*$ 22,354.64*
1/1/2014	N/A	Grant Admin		$ (800.00)	*$ 21,554.64*
1/1/2014	River Raisin	Hats	150.00	$ (1,613.50)	*$ 19,941.14*
1/1/2014	St Clair	Signs	30.00	$ (1,380.00)	*$ 18,561.14*
3/10/2014	All	Tape Measures	15,000.00	$ (6,750.00)	*$ 11,811.14*
9/1/2014	**Torch Lake/White Lake/Muskegon Grant**			**$ 16,000.00**	*$ 27,811.14*
9/1/2014	**GLRI GRANT YR 03**			**$ 25,000.00**	*$ 52,811.14*
12/10/2014	Many	Lanyards	1,500.00	$ (1,474.12)	*$ 51,337.02*
12/19/2014	All	Tattoos	10,000.00	$ (377.00)	*$ 50,960.02*
1/1/2015	Saginaw Bay/River	ESF Guides - Teacher Copie	100.00	$ (195.00)	*$ 50,765.02*
2/13/2015	Saginaw Bay/River	Tote Bags	150.00	$ (593.26)	*$ 50,171.76*
4/8/2015	Deer Lake	Signs	34.00	$ (2,000.00)	*$ 48,171.76*
4/9/2015	All	Tape Measures	15,000.00	$ (6,998.13)	*$ 41,173.63*
4/16/2015	All	Can Koozies	15,000.00	$ (9,251.82)	*$ 31,921.81*
4/27/2015	St Clair River	Brochures - ESF in St Clair	5,000.00	$ (2,259.00)	*$ 29,662.81*
4/27/2015	White Lake	Tote Bags	500.00	$ (1,375.13)	*$ 28,287.68*
5/27/2015	St Clair River	Brochures - ESF in St Clair I	2,500.00	$ (493.00)	*$ 27,794.68*
5/27/2015	St Clair River	ESF Brochures Insertion	2,400.00	$ (456.00)	*$ 27,338.68*
9/10/2015	Southwest Michigan	ESF Guides - compilation	648.00	$ (252.72)	*$ 27,085.96*
10/19/2015	Many	Signs	165.00	$ (6,600.00)	*$ 20,485.96*
12/4/2015	Many	Brochures	4,500.00	$ (2,282.02)	*$ 18,203.94*
12/4/2015	Torch Lake	Brochures - Recipes	500.00	$ (111.00)	*$ 18,092.94*
12/7/2015	Many	Brochures with pocket	2,000.00	$ (2,317.00)	*$ 15,775.94*
12/10/2015	Many	Banners	2.00	$ (206.00)	*$ 15,569.94*
12/10/2015	Many	Koozies	30,000.00	$ (13,454.87)	*$ 2,115.07*
12/31/2015	GLC	Admin Costs - FINAL		$ (2,115.07)	*$ (0.00)*
FINAL					*$ (0.00)*