Final Report

Great Lakes Health Collaboration to Reduce Toxics Exposures
Assistance ID GL-00E01283

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Project Summary and Results

The Minnesota Department of Health (MDH) partnered with: the Human Dimensions Research Unit (HDRU), in the Department of Natural Resources at Cornell University (Cornell); Minnesota-based healthcare systems HealthPartners Institute (HP) and Essentia Health (EH); the Lake County Health and Human Services Women, Infants, and Children program (LCHHS WIC); the MDH WIC program; and the Great Lakes Consortium for Fish Consumption Advisories to protect human health through safer fish consumption.

This collaboration of state and local public health together with health care providers supported increased protection for Great Lakes fish consumers from toxic substances, such as mercury and PCBs by:

> (1) protecting human health through safer fish consumption with sound and sensible advice provided through enhanced and expanded state and tribal fish advisory programs, health care providers, and WIC; and
>
> (2) working closely with the Great Lakes medical and health communities to educate the general public regarding the benefits and risks of Great Lakes fish consumption and to integrate fish benefits and risks information into regular nutritional education.

MDH and sub-grantees obtained necessary Internal Review Board (IRB) approval from their organizations and approval was granted by the US EPA Human Subjects Research Review Official.

Mercury in fish is a major cause of fish consumption advisories for lakes in the Great Lakes Basin. Reductions in mercury exposure in women of childbearing age (WCBA) was the main focus of this project; however, reductions in exposure to other toxic substances in fish are expected to follow. Relative to other life stages, the developing fetus is more sensitive to neurodevelopmental effects from exposure to mercury. Because the fetus is exposed through the mother, WCBA represent a sensitive subpopulation for reducing mercury toxicity. Health care providers are a trusted source of information in this sensitive population (Gliori, 2006; McCann, 2007; Teisl, 2011). A MDH study (Mercury in Newborns in the Lake Superior Basin; *Mercury in Newborns*) reported that eight percent of newborns tested from the US side of the Lake Superior Basin had mercury levels above the Environmental Protection Agency's (EPA) reference dose (RfD) for methyl mercury (McCann, 2011). Results from *Mercury in Newborns* underscore the need to improve outreach with WCBA.

Great Lakes Consortium for Fish Consumption Advisories

The Consortium includes the eight Great Lakes states' health, environmental, and natural resource agencies and was formed in the 1980s to develop science-based protocols for fish consumption advice in the Great Lakes (Anderson et al. 1993, McCann et al. 2007). The Consortium has since worked together on data sharing, communication tools, and protocol enhancements.

Results from this project as well as other GLRI funded fish advisory related projects are shared among members of the Consortium through conference call and face-to-face meetings. These meetings facilitate use of project results by Consortium states to enhance their programs to communicate the risks and benefits of fish consumption.

MDH hosted two face-to-face meetings with the Consortium during the period of this project. The first meeting in September 2014, was funded through the MDH FY2010 GLRI grant and is not reported on here. A summary of the March 2016 Consortium meeting is in Appendix A.

Monthly or as needed conference calls were held with the Consortium during the project period. Calls ranged from presentations by experts outside the Consortium, presentations of Consortium member work, and open discussions. A listing of calls held during the project period and corresponding presentation files are in Appendix A.

Objective 1: Develop evidence-based public health education for fish consumption that reduces exposure to toxic substances in women of childbearing age.

The Consortium was funded in 2010 by EPA to work together to enhance state programs which communicate fish consumption advice. A focus of the 2010 Consortium project was more effective ways to communicate information to the public, thereby increasing public knowledge about the risks and benefits of fish consumption and reducing exposure of the public to toxic substances from consumption of contaminated fish. This work was the foundation for the development of evidence-based education designed to reduce exposure to toxic substances from Great Lakes fish. This new project builds on past research to improve fish consumption advisories targeting WCBA.

Cornell lead the development of brochures designed to encourage women to eat enough fish to get the health benefits of fish consumption without exceeding recommended limits. The brochures were used in a diary study. Cornell has worked since 2011 with the Consortium to study fish consumption and fish advisories in the Great Lakes region. Key messages in the brochures include: (1) qualitative messages about fish consumption; and (2) specific, quantified fish consumption guidelines. The design and content, for the brochure was informed by:

- findings of past Cornell research for the Consortium funded by GLRI,
- the broader risk communication literature,
- existing language used in fish consumption advisories across Great Lakes states,
- the Consortium's input and expertise,
- review by MDH WIC staff,
- message testing by HealthPartners Institute, and
- focus groups conducted by Essentia Health.

The effects of these brochures on fish consumption were quantified in the diary study to assess the degree to which particular types of messages lead to desired fish consumption behavior and, in turn, reduce exposure to toxic substances.

Print brochures for the intervention used in the diary study are available for incorporation into Consortium state programs and public health agency programs. More background on the brochure development process and copies of these brochures are in Appendix B and B1.

Objective 2: Evaluate effects of public health education on actual behavior using a diary study

A two-year diary study was undertaken in 2014-2015 to assess: (a) how much and what types of fish are eaten by women of childbearing age and urban anglers; and (b) how receiving a fish consumption guidelines brochure influences the amount and types of fish eaten. See *Reducing Toxic Exposure from Fish Consumption in Women of Childbearing Age and Urban Anglers: Results of a Two-Year Diary Study* in Appendix C. The report details consumption by WCBA in the Great Lakes region and how consumption was influenced by the brochures. Results for urban anglers are also included in the report. Funding for the urban anglers portion was through a grant to Cornell University, Reducing Exposure to Toxics in Urban Anglers project (#GL00E1281-0).

Objective 3: Expand use of MDH FY2012 GLRI Project Outputs

Mercury Screening Project

The Lake County Mercury Screening Project (MSP) was a collaborative effort by LCHHS WIC and MDH. The project focused on reducing mercury exposure in women who are or may become pregnant and, therefore, in future babies by raising awareness about risks and benefits of eating fish. MSP is an extension of the Fish are Important for Superior Health (FISH) Project conducted in Cook County, Minnesota and funded by EPA Grant # 00E01161. Both North Shore projects are in response to the 2011 study (*Mercury in Newborns*) that showed that 10% of Minnesota babies tested from the North Shore area had mercury in their blood above the level considered safe. The protocol followed in MSP was developed based on the FISH Project. MSP participants answered the same 3 screening questions as FISH participants and provided a blood sample that was tested for mercury. WIC does a finger stick to test hemoglobin. Blood was also collected, using a finger stick and a collection tube without additional invasive procedures for participants, to test for total mercury. LCHHS WIC staff reported their experiences with the project to inform other WIC programs that may be interested in performing screening for mercury exposure. Participants received the results of their blood tests; informational materials on fish risks and benefits; an incentive payment; and appropriate counseling, if their levels were above the EPA RfD.

Most people's exposure to mercury comes from eating fish. All 121 women who participated, reported eating fish in the last 2-3 months. In general, women who ate more fish meals had higher levels of mercury. However, the mercury results for most participants were below the level considered safe for women of childbearing age and a growing fetus.

The project protocol, report to the community, local media coverage of project completion, and a summary of LCHHS WIC staff comments about MSP are in Appendix D.

Risk Benefit Training for Health Care Providers

The risks and benefits training for health care providers developed as part of the FISH Project was presented to providers participating in the GLRI funded Wisconsin Department of Human Services' project on the southern shore of Lake Superior and MDH WIC staff. It is also considered as part of MDH Medical Toxicologist Fellows Rotations and MDH Public Health Rotation for Primary Care Residents. The goals of the rotations are to: (1) give fellows insight into the role and function of environmental health toxicology and public health at the state level; (2) improve the primary care residents' knowledge of their public health role and tools used by MDH staff to identify and prevent illnesses of public health importance; and (3) connect MDH staff to fellows to enhance greater understanding of current clinical practices. MDH also offered this training as a continuing medical education course for hospital staff and medical residents through the Minnesota Medical Association. The training PowerPoint is found in Appendix E.

Health Care Provider Collaboration

MDH worked with the Consortium and health care providers to integrate project results into public health systems, e.g. WIC. WIC's Special Supplemental Nutrition Program for Women, Infants and Children is designed to influence lifetime nutrition and health behaviors in a targeted, high-risk population. Numerous studies prove the efficacy of WIC programs in improving outcomes for pregnant women and their babies. Partnering with HP and EH in this project lead to better integration of advice for reducing intake of contaminants from Great Lakes and other fish into clinical practice, including close collaboration on education materials incorporating refined key messages. HP's programs promote healthy eating and healthy food choices during pregnancy; HP places a strong emphasis on health promotion among all its clients. Partnerships with these organizations helped MDH integrate fish choice information into their nutritional education and outreach and improved the understanding of all partners regarding successful strategies for dietary change.

A series of focus groups were conducted with HealthPartners members to understand barriers and facilitators to safe fish consumption as well as where and how women want to receive this information. A literature search was conducted prior to the focus groups to help frame the focus group discussions as well as support the findings. HealthPartners patient education experts incorporated literacy considerations into the focus group design; an important element of communicating effectively was to use appropriate language for the audience. Results from the HP focus groups were used to develop and strengthen existing key messages about eating fish for women of childbearing age. See Appendix F for the literature review and focus groups report.

Outputs and Outcomes

This project resulted in reduced chemical exposure to at-risk Great Lakes fish consumers by: (1) utilizing successful public health system practices and resources, and (2) partnering with health care and public health professionals, in accordance with the GLRI Action Plan to: "Protect Human Health through Safer Fish Consumption." Achievements for specific outputs and outcomes from this project are listed in Tables 1 and 2 below.

Table 1: Outputs

Proposed Outputs	Achieved Outputs
Develop sound and sensible advice, informed by the results of this and previous research and by the experience and insights of health professionals and staff members of state health departments and environmental agencies in the region, to protect Great Lakes fish consumers from harmful chemicals such as mercury and PCBs:	
• Tested and refined message elements incorporated into a brochure and other education products containing benefits and risks of fish consumption and safe-eating information.	• Tested and refined message elements were incorporated into brochures containing benefits and risks of fish consumption and safe-eating information (see Appendix B, Brochure Development).
• Education product or template for use Great Lakes Basin-wide.	• Print brochures for the intervention used in the diary study are available for incorporation into Consortium state programs (see Appendix B1, State Brochures).
Reductions in contaminant exposure resulting from Great Lakes fish consumption among women of childbearing age. This will be achieved through the following work products and activities:	
• GLRI 2012 (FISH) risks and benefits training for healthcare providers will be made available to providers in the at-risk NE Minnesota area associated with HP, EH, and WIC.	• Risks and benefits training for healthcare providers developed as part of the FISH Project was offered to hospitals and residents through the Minnesota Medical Association. Ttraining was presented to providers participating in the GLRI funded Wisconsin Department of Human Services' project on the southern shore of Lake Superior and MDH WIC staff. It is also part of MDH Medical Toxicologist Fellows Rotations and MDH Public Health Rotation for Primary Care Residents.
• Minnesota women associated with HP and EH will participate in message testing over a nine month period.	• Minnesota women associated with HP and EH participated in message testing (see Appendix B, Brochure Development).
• 150 WIC clients will be screened and tested for mercury using the protocol developed for the FISH Project, providing more information on ability of mercury screening questions to predict mercury exposure.	• 121 women screened and tested for mercury in MSP using the protocol developed for the FISH Project (see Appendix D, MSP Reports).
• 1,475 Great Lakes WCBA will complete detailed fish consumption diaries for 4-month periods in each of two successive years.	• 1,135 women completed fish consumption diaries throughout the 4-month periods in both years of the diary study (see Appendix C, Cornell Final Report).
• Based on these data, we will estimate: (1) the number of WCBA eating fish in excess of recommendations (an indicator of exposure to toxic substances from Great Lakes fish consumption); and (2) number of WCBA eating less fish than is recommended to receive health benefits.	• The number of WCBA eating fish in excess of recommendations and the number of WCBA eating less fish than is recommended to receive health benefits was estimated. Three to five percent of WCBA exceeded federal recommendations for total fish consumption, 0% exceeded federal recommendations for canned "white" tuna, and 4% consumed one or more meals of federal "do not eat" species. Rates of exceedance of state fish consumption guidelines, which include sport-caught fish, were much higher. One-quarter of WCBA exceeded the state guidelines, with rates as high as 41% exceeding the guidelines in Michigan and Minnesota. A total of 84-87% of WCBA ate less fish than was recommended by the USDA and (current and proposed) EPA/FDA guidelines to receive health benefits (see Appendix C, Cornell Final Report).
• We will obtain results on behavior changes after intervention for up to 1,000 participants.	• The 1,135 women who completed fish consumption diaries throughout the 4-month periods in both years of the project were included in the experiment to test the impacts of an advisory brochure on fish consumption. Approximately two-thirds of women received one of four versions of the brochure, and the remaining one-third served as a control group. The brochure increased the amount of fish that women ate without increasing the number exceeding advisory recommendations. Therefore, it increased the number of women getting benefits from fish consumption without increasing the number at risk from fish consumption. Women who ate the least fish (< 0.7 meals/week at baseline) stood to benefit most from increasing their fish consumption. Women who ate < 0.7 meals/week of fish and received fish consumption guidelines with messages about the importance of eating fish ate more fish the next year. However, this benefit only occurred if they received messages in a "narrative" format; other forms of the guidelines did not influence fish consumption. These women increased their fish consumption largely by eating more low-mercury, purchased fish. These women did not increase their consumption of more contaminated fish. Women who ate too much fish (>2.8 meals/week at baseline) were also influenced by the narrative form of the brochure. They ate fewer meals after receiving the brochure but did not decrease their consumption sufficiently to be within advisory recommendations (see Appendix C, Cornell Final Report).
• We will report the effect of intervention via risks and benefits messages and safe-eating guidance; and make recommendations about messages and guidelines that will reduce the exposure of WCBA to toxic substances from Great Lakes fish consumption.	• See above.
• We will provide WCBA screening/intake protocols and brochures to other clinics, who will adopt protocols and distribute brochures.	• FISH Project protocols were shared with Consortium and used as the basis for MSP and the WI DHS project on the southern shore of Lake Superior.

Table 2: Outcomes

Proposed Outcomes	Achieved Outcomes
Utilizing public health agency programs in conjunction with health care professionals to reduce human exposure to toxic substances from Great Lakes fish consumption.	
· Increasing collaboration among MDH, healthcare professionals, and public health systems to promote risks and benefits information and to incorporate it into general nutritional and pre-natal counseling.	· MDH worked with the Consortium and health care providers to integrate project results into public health systems, e.g. WIC. Partnering with HP and EH in this project lead to better integration of advice for reducing intake of contaminants from Great Lakes and other fish into clinical practice, including close collaboration on education materials incorporating refined key messages. Partnerships with these organizations helped MDH integrate fish choice information into their nutritional education and outreach and improved the understanding of all partners regarding successful strategies for dietary change.
· Extending FISH Project impact through broader access to intake/screening protocols and provider training.	· FISH Project protocols were shared with the Consortium and HP.
· Increasing the number of women and healthcare professionals able to identify, understand, and take action to reduce mercury and other toxic exposures from fish.	· Key messages promoting identification, understanding, and action to reduce mercury and other toxic exposures from fish were improved through key message testing and incorporated into education materials (see Appendix B, Brochure Development and Appendix C, Cornell Final Report). · The risks and benefits training for health care providers developed as part of the FISH Project was presented to providers participating in the WI DHS project on the southern shore of Lake Superior and MDH WIC staff. It is considered part of MDH Medical Toxicologist Fellows Rotations and MDH Public Health Rotation for Primary Care Residents. MDH also offered this training as a continuing medical education course for hospital staff and medical residents through the Minnesota Medical Association.
· Establishing groundwork for future collaborations with project partners.	· Collaborations in this project lead to continued improvement of evidence based education materials. Future and ongoing projects (EPA grant #'s GL00E01161 and GL00E02047) will continue to work closely with the Great Lakes medical and health communities to educate the general public regarding the benefits and risks of Great Lakes fish consumption and to integrate fish benefits and risks information into regular nutritional education.
Prevent and/or reduce accumulation of toxic substances in the bodies of Great Lakes residents, particularly in women of childbearing age and their babies.	
· WCBA will increase consumption of low mercury fish and decrease consumption of high mercury fish.	· See outputs (above) and Appendix C, Cornell Final Report.
· Levels of mercury in babies will be reduced by providing evidence-based information to WCBA (10% of babies tested from the Minnesota portion of the Lake Superior Basin had mercury levels greater than the level equivalent to the US EPA RfD).	· Evidence-based information was provided to women through the diary study, MSP, HP survey, EH focus groups, and HP focus groups.
· Changes in exposures to WCBA will be documented through two-year diary results.	· We documented how healthy fish consumption and ingestion of toxic substances through fish consumption changed over the two-year course of this project in response to the advisory brochure (as described above). (see Appendix C, Cornell Final Report)
· Exposures in WCBA will be reduced throughout Great Lakes Basin by use of project materials and interventions in Consortium states. Investment of the Consortium in this project is a good indicator that these states plan to use the results of the project to inform their advisory programs.	· Based on these findings, we estimate for every 10,000 narrative brochures distributed, 2797-3330 women of childbearing age would eat more fish, totaling 14,544-17,316 more fish meals each year. This increase in fish consumption would not result in any more women exceeding fish consumption guidelines. Furthermore, we estimate for every 10,000 narrative brochures distributed, 76-90 women of childbearing age who were currently exceeding fish consumption guidelines would eat fewer fish, totaling 1011-1197 fewer fish meals each year. These estimates are based on the fish consumption messages and methods of distributing the brochures used in this study. The distribution methods (and possibly the messages) used in advisory programs would differ. (see Appendix C, Cornell Final Report)
· The principal outcome of this work will be a reduction in the number of WCBA who eat Great Lakes fish in excess of recommended consumption guidelines and, therefore, accumulate toxic substances in their bodies. Currently, no good estimates of the number of women in the Great Lakes region who exceed these recommended guidelines exist. However, based on a diary study of Lake Ontario anglers, Connelly et al. (1996) found that 53% of female anglers exceeded the recommended consumption limits for WCBA for Lake Ontario sport-caught fish. Therefore, as an approximate upper bound, our work could lead to a reduction of exposure to toxic substances among 53% of women living in the Great Lakes region. However, the actual percentage of women in whom exposure to toxic substances will be reduced is somewhat less than this percentage because of two factors: 1) Not every woman who receives messages and eating guidelines related to fish consumption will reduce her consumption (if it is in excess of those guidelines). Our work will allow us to estimate the percentage of women who will reduce their consumption sufficiently to meet these guidelines. 2) While we anticipate enrolling 2,500 women in our diary study (two-thirds of whom will receive fish consumption messages and eating guidelines), the ultimate number of women who are affected by this project depends on the number of women to whom the Great Lakes states distribute these or similar messages and guidelines in the future. While this number cannot be predicted with accuracy, the investment of the Great Lakes Consortium for Fish Consumption Advisories in this project is a good indicator that these states plan to use the results of this project to inform their advisory programs.	· The principal outcome of this work was intended to be a reduction in the number of WCBA who eat Great Lakes fish in excess of recommended consumption guidelines and, therefore, accumulate toxic substances in their bodies. Our intervention did not lead to a reduction in the number of women eating purchased or sport-caught fish in excess of guidelines. It did, however, lead to an increase in fish consumption by WCBA without a corresponding increase in the number of WCBA exceeding the guidelines. Consequently, it increased the benefits women are getting from fish consumption without increasing the risks. Furthermore, a few women who were exceeding the recommended guideline of 2 meals per week decreased their consumption somewhat. (see Appendix C, Cornell Final Report)

Conclusions and Recommendations

Collaborations that continued development of evidence-based education and delivery of that education through health care systems resulted in reductions in mercury exposure in women who are or may become pregnant through promotion of safer fish consumption.

Diary study key findings

Fish Consumption

- Two-thirds of the women (all of childbearing age and anglers - who are more likely than other women to eat fish) reported eating less than 1 meal of fish each week. Only 10-12% reported eating within the federally-recommended range of 8 to 12 oz. of fish per week, with 84-87% eating less than the recommended amount.
- From the fish consumption diaries, purchased fish meals averaged 4.7 to 5.2 ounces of cooked fish. Locally-caught fish meals average 5.5 to 5.8 ounces. (Participants indicated portion size in reference to a picture of a portion of salmon and were told it was 6 oz. cooked [8 oz. pre-cooked]. Participants selected if the meal they ate was larger, smaller, or the same size as the picture. Fish consumption portion size was calculated as 6 oz. for meals reported as being the same size as the picture and 8 oz. if larger than the picture. For meals reported as being smaller than the picture, a sensitivity analysis was used to compare two options for calculating portion size: 3 oz. and 4 oz.)
- Most of the fish women reported eating is low in mercury. Purchased fish accounted for more than 80% of the fish meals women reported eating in the diary study. Two-thirds of these purchased fish consumed are classified as low-mercury fish by the EPA/FDA. Only 3-5% of women of childbearing age exceeded federal consumption guidelines for purchased fish.
- Nevertheless, one-quarter of women exceeded state and federal guidelines that include both purchased and locally-caught fish. The number of women exceeding these guidelines varied considerably from state to state. In Ohio, Illinois, and Wisconsin, 12-19% of women exceeded these guidelines. In New York and Indiana, 25-29% of women exceeded these guidelines. In Pennsylvania, Minnesota, and Michigan, 35-42% of women exceeded these guidelines.

Impacts of Communication

- Communicating fish consumption guidelines in a narrative format, which included a story about how a hypothetical woman learned about which fish she could eat safely, increased consumption among women who were eating the least amount of fish. Using a narrative format as part of a fish consumption guidelines brochure can lead women to eat more low-mercury fish, which could be beneficial to their health. Women who ate the least fish (< 0.7 meals/week at baseline) stood to benefit the most from increasing their fish consumption. In our study, women who ate < 0.7 meals/week of fish and received fish consumption messages in a "narrative" format increased their fish consumption largely by eating more low-mercury, purchased fish. These women did not increase their consumption of more contaminated fish.
- Women who ate too much fish (>2.8 meals/week at baseline) were also influenced by the narrative form of the brochure. They ate fewer meals after receiving the brochure but did not decrease their consumption sufficiently to be within advisory recommendations.
- Based on these results, estimated projections show that for every 10,000 narrative brochures distributed, 2797-3330 women of childbearing age would eat more fish, totaling 14,544-17,316

more fish meals each year. This increase in fish consumption would not result in any more women exceeding fish consumption guidelines. Furthermore, for every 10,000 narrative brochures distributed, 76-90 women of childbearing age who are currently exceeding fish consumption guidelines would eat fewer fish, totaling 1011-1197 fewer fish meals each year.

Evidence-based education and integration into health care practice

Key findings from the HP focus groups on behaviors and preferences when buying and consuming fish include:

- Taste and flavor were the most important factors when women chose which fish to buy
- Preparation was frequently described as a barrier to eating fish in focus group discussions
- A major perceived risk of eating fish was mercury and other contaminants
- Regarding type of information, women want to know about both the risks and the benefits of fish consumption
- Women overwhelmingly requested fish recipes, and many requested pictures as well, mentioning Pinterest as an example

Focus groups also revealed mode preferences for communication of these messages in a health care setting, such as posters in clinic waiting rooms, exam rooms, and links in health care plan websites.

Collaboration with HP lead to continued improvement of evidence-based education materials. Future and ongoing projects (EPA grant #'s GL00E01161 and GL00E02047) will continue to work closely with the Great Lakes medical and health communities to educate the general public regarding the benefits and risks of Great Lakes fish consumption and to integrate fish benefits and risks information into regular nutritional education.

References

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Appendices

Appendix A: Consortium Collaboration

Appendix B: Brochure Development
- B1: State Brochures
- B2: Summary of Potential High Impact Communication Strategies
- B3: Key Message Testing
- B4: Focus Groups

Appendix C: Cornell Final Report *Reducing Toxic Exposure from Fish Consumption in Women of Childbearing Age and Urban Anglers: Results of a Two-Year Diary Study*

Appendix D: Mercury Screening Project (MSP) Reports

Appendix E: Fish are Important for Superior Health (FISH) Project Risks and Benefits Training

Appendix F: Testing the Dissemination of Fish Consumption Information

Appendix A:
Consortium Collaboration

Face-to-Face Meeting Report

Great Lakes Consortium for Fish Advisories Meeting Summary
March 1-3, 2016

Thirty-four people attended the Great Lakes Consortium for Fish Advisories meeting March 1-3, 2016. All states were represented at the meeting except Pennsylvania. Staff from Pennsylvania were unable to obtain approval from their management for travel. The meeting took place at the EPA building in Chicago. The meeting agenda is attached.

During the first day of the meeting Consortium members discussed the goals, vision, benefits as well as challenges of the group. Notes from the discussion were taken on flip charts; those notes are attached.

The meeting agenda also included updates by states, a presentation on mercury isotopes, fish monitoring results, and presentations of work with healthcare providers on outreach/education. The Cornell team presented results from the two-year diary study. The Consortium provided more ideas for data analysis. Cornell will follow-up with these analyses and report back to the group prior to completing their final report. Some of the ideas for further data analysis are not within the scope of current funding for Cornell. For example, the Consortium is interested in estimating mercury exposure based on reported fish consumption and an analysis of the effects of brochure based on the estimated exposure.

The group began working together in the 1980s. Over the years there have been staff changes and State management priority changes. Now seems like a good time to revisit expectations. The group has overall interest in sharing data, research, and methods. Value is also placed on peer review. Consistency is our vision however differences in policy, risk assessment and risk management exist present challenges to reaching that vision.

Moving forward we need to agree on a process for revising and/or developing new protocols. Based on discussions at the meeting it seems clear that PFOS is the next chemical the group could consider for a new protocol. We can use PFOS as test case for determining a process.

The purpose and format of conference calls and face-to-face meetings will also be assessed. Shared agenda setting and facilitating will be explored. Logistics including location and lead-time needed by states for travel approval will also be considered.

Future committees of interest to the group include:

- Work with health care providers
- PFOS risk assessment
- Risks and benefits
- Purchased fish

State attendees were asked to complete and a meeting evaluation. Results are attached from the 18 of the 21 non-MDH state attendees who completed the evaluation. Expectations for the meeting were reported to be either met or exceeded by all. Responses are included below.

Great Lakes Consortium for Fish Advisories Meeting
March 1-3, 2016
Lake Michigan Room, 12th Floor EPA Building 77 West Jackson Blvd, Chicago Illinois

__**Tuesday, March 1**__

9:00 **Introductions and Logistics**

9:15 **Fish Contaminant Monitoring**

- MI – PFCs in fish (15 min) - Jennifer
- WI – PFCs, PBDEs and FAs in fish (30 min) – Candy/Meghan
- NY – legacy contaminants (10 min) - Wayne
- EPA – GLHHFTS (15 min) - Beth

10:30 **Break**

10:45 **Consortium Protocols – group discussion**

- Overview
- Fish Contaminant Data Sharing
- Fish Contaminant Data Analysis for Advisory Determinations
- Risk Assessments – Past
- Meal Advice categories
- Risk Assessments – Future?

12:00 **Lunch**

1:00 **Consortium Protocols – group discussion (continued - topics listed above)**

3:00 **Break**

3:15 **NY 2016 FCA update** – Agnes

3:30 **EPA Headquarters FCA Program**

- Storet database

3:45 **Fish samples for Clarkson**

4:15 **Mercury Isotopes** – Dave Krabbenhoft and Jim Hurley

5:00 **Adjourn**

Wednesday, March 2

9:00 **Diary Study, Part 1 – Cornell Team**

11:00 **Break**

11:15 **NY Fish Advisory Communications Update - Faith**

11:30 **Work with Health Care Providers – MI**

12:00 **Lunch**

1:00 **Work with Health Care Providers - MN and Mary Turyk**

2:00 **Work with Health Care Providers – WI**

2:15 **Work with Health Care Providers – Susan Buchanan**

2:45 **Break**

3:00 **Work with Health Care Providers – Group Discussion**

3:30 **Diary Study, Part 2 – Cornell Team**

5:00 **Adjourn**

Thursday, March 3

8:30 **Diary Study, Part 3 – Cornell Team**

10:00 **Break**

10:15 **Consortium Next Steps**

- Revisit outcomes of discussions on Tuesday & Wednesday
- EPA GLRI Funding
- Future face-to-face meetings
- Conference call topics and format ideas

12:30 **Adjourn**

Great Lakes Consortium for Fish Advisories
March 1-3, 2016 Meeting, Chicago

Action Items:

- PFOS – interested members will review EPA (numbers and basis) as a group when released. MI (Jennifer Gary) will share her on-going review.
- HABs – OH (Gary Klase) will keep Consortium updated on status of lab analysis methods
- MDH will provide Google analytics data on GLRI webpages from MDH site
- Schedule and facilitate conference calls - see below (Beth will coordinate Adobe Connect)
- Begin/continue collaboration with other states who share lakes to work towards consistent messaging (data sharing, compare current state advice for same waters, etc.); report progress in 6 months
    - Lake Superior – WI, MN, MI (WI lead)
    - Lake Michigan – WI, MI, IL, IN (WI lead)
    - Lake Huron – MI, Ontario (lead ?)
    - Lake Erie – MI, OH, NY, PA (MI lead)
    - Lake Ontario – NY, Ontario (lead ?)
    - SharePoint site - Jackie –
- List of Consortium 101 questions to address – Magan and Laura
- Cornell Team send presentations to group
- Invite Satyendra to be part of Consortium – Pat

Conference call ideas:

- Risks and benefits – Pat/WI
    - call with Gary Ginsberg – April
    - follow-up call with group
- Follow-up call on goals, expectations, roles, products and process - Pat
- Consortium 101 before the old timers retire – May (call facilitator TBD)
- Definition of sensitive population
    - age (Magan)
    - health status (TBD)

- APPs demonstrations
- Health care provider workgroup call (Pat/WI)
- Cornell – results from additional data analysis (Cornell Team)
- GLFMSP – August (Beth)
- Lake-by-lake updates (status of data sharing and advice) - September
- Clarkson – January (Beth)
- Arsenic – (Jennifer)
- Using composites for mercury based fish consumption advisories and trends - Satyendra
- Microplastics – Beth
- Methylmercury vs total mercury in fish – Jim Stahl
- PCB trends in Carp in relation to cleanup at a superfund site – Jim Stahl

Great Lakes Consortium for Fish Advisories
March 1-3, 2016 Meeting, Chicago

Flip Chart Notes

Goals/Purpose

- Consistent basis for advice - Shared protocols
- Consistent advice (especially for shared waters)
    - Was charge from Great Lakes governors
    - Difference in administrative goals
- Data sharing
- Consistency is a "Vision"
- Speak with one voice
- Incorporate benefits of fish consumption into advice (example: fatty acids)
- Risk/benefits quantitative framework

Value/Benefit

- Helps states when working within state to get new guidelines adopted if can say Consortium supports change
- Good example of cooperative work – EPA backs Consortium – helps with public
- Standardizing lab protocols
- Continuing Ed – sharing info; review info
- Increased ability to identify trends in data
- Size of group is good – can focus; common interest
- Composition & diversity of group
- Finding common ground – science, standards
- Staying on top of new science
- Other states benefit from work of Consortium
- More robust data to base guidance on – pooling data, corroborates each other's conclusions (check one another's work)
- Having group speak with one voice is important to public and federal agencies

Opportunities

- Put all contaminant data from each state on website
    - Water quality exchange network? (could share data on this website)
- Proactively and consistently share data
- Exploring seasonality & other issues together – emerging issues
- Share institutional knowledge
- How to deal with declining contaminant levels
- Discuss again choice of age at 15
- Other revisions to current protocols

Challenges

- Frequency of testing has decreased
- Resources have decreased

- Differences in following protocols (admin diff?)
- Accessible data – data exchange difficult; IT issues
- Data validation (differences)
- Border data (info)/sharing/species
- Analysis
- Incorporating benefits of fish consumption into advice
- How much data needed to deviate from group?
- How to deal with multiple contaminants?
- How to deal with declines in one area of a waterbody before another

Future?

- Toxaphene – agree not a driver for advice even in Lake Superior so WI paper completes our efforts
- PFOS – interested members will review EPA (numbers and basis) as a group when released. MI (Jennifer Gary) will share her on-going review.
- HABs – OH (Gary Klase) will keep group updated on lab analysis status
    - Fish tissue storage bank? – storage protocol?
- Dioxins – revisit after receive EPA GLHHFTS data ~2017
- Risks and Benefits – continue work with Gary Ginsberg. WI is interested in working on methods to incorporate PCBs into analysis.
- Membership – invite Ontario
- Definition of sensitive population - Issue of adolescents in SP – age of SP
- Process for revising protocols

Data Sharing Poll

State	share data?	with who?	when?	use shared data for FCA determinations?
NY	Yes	Ontario, plans to start sharing again with OH	upon request	Yes - Ontario
PA				
OH	No		upon request	No - maybe could
IN	Yes	WI, IL, MI, available to anyone	every 5 years, annually (WI)	Yes - WI, IL
MI	Yes	WI, IL, IN, OH, Ontario	annually	No - needs lab validation
IL	Yes	WI, IN, MI	annually	Yes
WI	Yes	MI, MN, IL, IN	annually	Yes
MN	Yes	WI	annually	Yes

PCB Protocol Poll

State	Follow PCB Protocol?	Comments
NY	Yes - Lake Erie SenPop No - other waters, GenPop, general advice	
PA		
OH	Yes	
IN	Yes	"bump up", 50% vs. 70% vs 30% reduction factor
MI	No	sampling prep = yes; screening levels = no; trimming and cooking reduction = no, analysis = no (arochlor vs congeners vs TEQs); "limited" meal category of 1-2 per year
IL	Yes	
WI	Yes	PCB vs Hg for Gen Pop?
MN	Yes	

Mercury Protocol Poll

State	Follow Hg Protocol for SP?	Comments
NY	N/A	all populations fall under general advisory; no specific Hg advice for their Great Lakes waters
PA		
OH	Yes	same advice for all pops
IN	Yes	"Bump up", uses RfD=0.3 for GenPop
MI	Yes	same advice for all pops, "limited" meal category of 1-2 per year
IL	Yes	no 2 meals/wk category, uses RfD= 0.3 for GenPop
WI	Yes	RfD=0.3 used for GebPop; if both PCBs & Hg are equal will use ??? (except for L. Superior), no 2/wk category, disclaimer for statewide advice
MN	Yes	uses RfD= 0.3 for GenPop

State	Q1: how well did the meeting meet your expectations?	Q2: If your expectations were not met, please provide comments	Q3: What presentations or discussions did you find most helpful during the meeting?	Q4: What topics should be addressed or types of work should the Consortium do together?	Q5: Other comments
MI	Met all		I thought the discussion of what each state was doing or had adopted from the protocols was very helpful.	I enjoy the continuing education opportunities & updates on other states' activities regarding emerging issues.	Thank you for organizing the meeting! Good range of topics.
MI	Met all		Found it really helpful to learn more about goals & mission of the Consortium. Discussion of differences & new ideas were great to consider.	A broad range of topics is good. Communications is most directly helpful to my role, but it was extremely enlightening to discuss technical aspects, too.	Great meeting! Thank you for all your organizing. Liked going out for lunch & dinners together.
IL	Exceeded		All presentations/discussions were helpful. The Cornell Diary Study & the Hg isotope study were highlights of the meeting as was the discussion about emerging chemicals of concern.	As a fish manager, I am most interested in contaminants & advisories for angler-caught fish & would prefer that to be the focus of the group. That said, I realize & understand the need for a broader focus for DH & EPA professionals.	Very interesting & informative meeting, especially for a first time attendee. Keeping public advisories & messages as simple as possible should remain an important goal of the group.
IL	Exceeded		As a first-time participant, I found all of the presentations & discussions very informative & interesting. Faith's presentation was great - good slides & info. All of the Cornell information was especially interesting.	Consistent messaging on commercial fish consumption?	Both discussed the possibility of involving Ontario in future meetings, which I think is a good idea. Hotel arrangements were very good & great hotel & good location. Also I appreciated "staying on track" on the agenda & times.
IL	Exceeded		Diary studies, brochure discussion	HABs (?), risk/benefit issues, age for sensitive population	
IN	Met all		Being a contaminants ecologist, I was interested in the presentations and discussions on contaminants and what others are looking for, levels, trends, etc. I was especially interested in the Mercury Isotope research of Dr. Krabbenhoft. I enjoyed the opportunity for some one-on-one conversation with him on his research and on my work. For issues of messaging and risk communication, I sat more in the back seat letting my colleague from our State health agency take the lead in representing our State, which she engaged very well. This is why it is good that states can bring multiple talents to the table, because there are numerous aspects and expertise's needed for the work we do.	The various major subject areas that we always make time for should continue. It is always good to know what each of our programs is up to, where we are challenged, and where we would like to go. We should always discuss new and emerging contaminants and the latest work in the field. Risk communication on the science of understanding contaminants, their fate, toxicology, epidemiology should always be a priority topic. Continuing to develop unified risk messaging I believe continues to be our primary charge stemming from the original Sport Fish Advisory Workgroup and the charge from the Council of Great Lakes Governors. Development of common interest research, such as has been pursued for understanding omega-3 F.A.s in GL fish should continue. Interfacing with higher level researchers should also be a part of our pursued work.	In my opinion having regular Consortium meetings keeps us on the cutting edge. We have a reputation for being the leaders in the science and development in State, Federal, and Tribal fish consumption advisories, risk assessment and communication of. I understand that it is probably not possible for annual meetings, but at biennial meetings should be pursued. I enjoy interfacing with the high level professionals that are a part of the consortium. Our continuous history now expands back to at least four decades of unbroken work in the pursuit of good science, and clear and honest health information.
OH	Met all		Coming from a non-health background, the Hg presentation & discussion provided some valuable information. The Cornell discussions & presentations opened my eyes to very valuable aspects of information dissemination.	It is important for states to keep up to date with emerging contaminant work that the others are doing. Data sharing for shared lakes & rivers should be a priority.	Learning about the public health & information dissemination that other states are doing was very helpful coming from an ecology background.
WI	Met all		Hg isotopes, diary study results from Cornell, health care provider work	Determine where standardization of advice is possible/pragmatic and where it is not; risk benefit analysis incorporating lipophilic contaminants.	I always find these meetings to be a great way to share ideas and opinions with other state and federal employees. I think these are an invaluable resource for fish contaminant monitoring and consumption advisory formulation.
WI	Met all	I wanted to hear more from EPA national on Storet Database & guidance - but I guess I missed getting those items on the agenda.	Cornell's findings - could have reduced details on methods a bit	Agenda items should be more detailed with assigned presenters & typically with a "panel" e.g. a PRO & CON presentation so that participants think - prepare about an issue before the meeting. I am at fault for this!	
WI	Exceeded		The work by Cornell and their update was most helpful. The sharing of ideas and priority setting exercise was very useful.	Unless more funds become available, we need to focus on teleconferences and webinar topics. We could ask each state to pick a topic they would like to present that features their state.	
NY	Met all		Cornell's presentations	I like that it is a mix of fish advisory and communication approaches and think it should continue as such. I always learn more when I listen to both and think it serves as a good model for the Consortium as a group.	I would have liked to hear more about what other states are doing for communication and outreach but understand there are "newbies".
OH	Met all		The more technical presentations were much more helpful for me—in particular, the mercury isotope presentation was excellent. The 2nd day was much less helpful for the role that I play in the fish advisories, although I understand that it was appropriate for others. Given that the 2nd day was entirely outreach, it may have been appropriate to have a half-day breakout session for the technical folks to discuss something more pertinent to our roles. While I found some of the outreach info to be helpful, I think we began to re-tread the same ground again and again—a full day on the topic was underwhelming, to say the least, and held little value for me.	I find the most value in discussions of contaminant monitoring, program updates, and revisiting old assumptions. Basically, what are other states doing that could help me update my own program.	I recognize the need to maximize our limited time together, but there's a tipping point at which more presentations and more sitting still during the course of 8 hours becomes counter-productive. I think we passed that tipping point a few times, but I don't have a solution to the problem. Alternating between large-group to small-group formats is one way to break up the day, and to let individuals self-select themselves into the most pertinent discussions.
NY	Met all		Dave Krabbenhoft, discussions on PFCs, data sharing		
WI	Met all		Discussion of public health research studies and results was the most helpful for me in my current program role. Discussions of opportunities for collaborations was also helpful to identify potential members to reach out to in the future.	It seemed like many programs had a shared interest in health care provider messaging, as well as risk-benefit analyses which seem to affect all states.	It was very nice to meet everyone face to face, and great that outside researchers were able to participate in topics of expertise or interest.
IN	Met all		I found it very interesting to find out through discussions how other states programs are organized. It seems like some states have toxicologists assigned to the program, or some states had other agencies collecting the data for them and then dealt primarily with the data only. It was interesting to learn how few resources Indiana actually has designated for this program! I am fairly new to the program and learning that 84% (Cornell Study I think) of the fish eaten are commercial fish when our whole world surrounds the native fish we collect makes me think that more emphasis should be put on promoting commercial fish consumption. I think a Sharepoint site and the documentation of the Consortiums history would be very helpful for newbies and the next generation. The mercury isotopes presentation was interesting. Hearing what other states are working on (ex. OH with the algal toxins in tissue) was nice to bring back to our agency.	Discuss the age cut off for the sensitive population (15 vs 18). I think that's already on the agenda. Working together for more uniform advisories along shared waters. I think this is being addressed somewhat.	
NY	Exceeded	n/a	All the presentations were very helpful. I learned something from every presentation/discussion. I enjoyed the technical presentations the most because I was able to learn new information that directly relates to my program duties. If more time were available, smaller group breakout sessions that allow for informal discussions amongst technical staff would be ideal. That being said, I also found the Cornell sessions to be very informative because the results of the diary study will be used to help better inform our individual programs. The results were really exciting, and it almost felt like there was not enough time to really understand and discuss them.	Everything that we are working on so far as a consortium is helpful i.e., the sharing of data, and sharing of new information (including but not limited to the monthly phone calls). The only think I can think of at the moment would be including an extra group discussion session on the challenges that we face as FCA programs. Some of these challenges are universal to all states, and some are unique to each state. Discussions about these challenges and strategies utilized to resolve/overcome these challenges may be useful to some states, especially to those with staff who are relatively newer to the program. Maybe some kind of discussion about how to retain the institutional knowledge of staff who are retiring. With Henry Anderson, Tom Hornshaw, and Jim Stahl retiring this year, I cannot help but wonder if there is a way to archive all that institutional knowledge.	It would be splendid if we were funded for more fact to face meetings. If we are, here is my two cents worth of thoughts and ideas moving forward: · Take a group photo at the beginning of each meeting. This is great for historical documentation. · Maybe delegating meeting tasks to members, so that the burden of running the meeting does not fall on Pat/ MN group. This will help ensure that even those that are running the meeting do not miss out on discussions that may be of value to them. For example, if Pat is facilitating the technical discussions, other technical members of the group can sign up to take the notes for a particular discussion/presentation (whatever topic they are most comfortable with). And likewise with the outreach and education discussions. · This hotel was really fantastic. The availability of a fridge and microwave meant that I was able to carry food with me that would last for days, and was able to heat it up as and when needed. The breakfast provided meant that I could also have some eggs to go with my gluten-free, everything free bagels, and have various tea options. What more can an upstate NYer ask for? J · The seven day metro pass was a good idea. I used mine every day. As always, Minnesota did an excellent job planning, facilitating, and organizing the Consortium meeting. All of your hard work and efforts in making it all come together were noted and appreciated. I am very happy to be a part of the Consortium, and I look forward to continued participation with the group, and helping out in any way I can at future meetings. Thank you!
WI	Met all		updates on work with fish-consuming populations in various states	harmonization of advisories; unified risk assessments; share resources such as translated advisory materials	
IN	Met all		I think all of them were important, so much great material packed into 2 1/2 days.	Review the protocols again regarding age & the benefits of fish consumption messaging.	In-person meetings are always valuable. Understand the structure & resources of every consortium is different.

Consortium Calls Summary

Call Date	Topics	Presenter	Presentation Title
12/8/14	Google Analytics, Group discussion on BRFSS fish questions	Meghan Williams, WI DNR	Using Google Analytics to Asses Web-Based Outreach Efforts (ppt)
1/20/15	Emerging contaminants	GLFMSP Clarkson University	Great Lakes Fish Monitoring and Surveillance Program (GLFMSP) Emerging Chemical Discovery (ppt)
1/26/15	Discussion of revised Diary Study brochure	Cornell University	None
3/16/15	Ontario's Fish Contaminant Monitoring	Satyendra Bhavsar, Ontario Ministry of the Environment and Climate Change, Fish Contaminant Monitoring Program	All you wanted to know about Ontario's Fish Contaminant Monitoring (ppt)
4/13/15	Chemicals of Mutual Concern Nomination Process	Ted Smith, EPA	Overview of Annex 3 – Chemicals of Mutual Concern/Nominating Chemicals for Evaluation (ppt)
5/18/15	Cardiovascular Disease and Risks/Benefits of Fish Consumption	Gary Ginsberg, Toxicologist	Updated Risk/Benefit Analysis of Fish Consumption for Cardiovascular Endpoints (ppt)
6/30/15	EPA Fish Consumption BUI delisting criteria	Beth Murphy and Jackie Fisher, EPA	Federal Review of Fish Consumption BUI Removal Recommendations (ppt)
7/28/15	Discussion of Toxaphene Fish Tissue data from MI lab, evaluated by WI toxicologists	Krista Christensen and Michelle Raymond, Wisconsin Department of Health Services	Toxaphene (ppt)
8/24/15	GLFMSP update	Beth Murphy, EPA	Great Lake Fish Monitoring and Surveillance Program - Background, Enhancements, and Data (pdf)
9/25/15	Discussion of Simon and Manning 2006 paper - Revised Risk Assessment for Toxaphene, including basis for uncertainty factors	Ted Simon, Ph.D., DABT	A New Look at Toxicity Factors for Toxaphene related to Fish Consumption in the Great Lakes (pdf)
10/19/15	Mercury Isotopes "101"	Dave Krabbenhoft, USGS and Jim Hurley, University of Wisconsin - Madison	Mercury Isotope Applications Toward Linking Environmental Mercury Sources and Human Exposure (ppt)

11/12/15	Lead	Magan Meade, ISDH	Lead Poisoning in Indiana: A Collaborative Effort to Prevent Lead Exposures in a Burmese Community (ppt)
1/11/16	Discussion of future Consortium call topics Results of WI Study on Older Male Anglers Understanding Fish Consumption Guidelines	Krista Christensen, Michelle Raymond, Brooke Thompson – WI Dept of Health Services	Comprehension of Fish Consumption Guidelines Among Older Male Anglers in Wisconsin (ppt)
2/22/16	Annual Update from Clarkson University	Bernie Crimmins, Clarkson University	Great Lakes Fish Monitoring and Surveillance Program: Emerging Chemical Update (ppt)
3/1-3/3/16	Consortium face-to-face meeting in Chicago		
4/26/16	Recap of face-to-face March Consortium meeting in Chicago, Consortium funding proposal, Consortium 101 questions, update on Gary Ginsberg risk & benefit work	Group discussions	None
6/9/16	Consortium 101 Questions/Discussion, PFOS-update on schedule for MDH review of EPA risk assessment	Laura Gossiaux, MDHHS and Pat McCann, MDH	Consortium 101 Questions/Discussion (ppt)
7/25/16	GLRI funding proposal updates, Data analysis related to Consortium 101 questions, mobile friendly apps	Group discussions, Satyendra Bhavsar from the Ontario Fish Contaminant Monitoring Program was unable to present – his presentation was shared with the group	Update from 2 recent studies: 1. Compositing fish samples for Hg monitoring and advisories; 2. Effects of cooking on PFAS levels in fish (pdf)
8/18/16	GLFMSP update	Beth Murphy, EPA	GLFMSP Update (ppt)
10/4/16	Updates on sharing monitoring data, face-to-face meeting discussion	Group discussions	None

Consortium Call Presentations

Using Google Analytics to Assess Web-Based Outreach Efforts

Meghan Williams

8 December 2014

1. Introduction to Google Analytics
    - How does the program work?

2. Navigating the Google Analytics interface

3. How WDNR uses GA to assess outreach efforts and track website usage
    - “Eating Your Catch” materials
    - Query tool

Introduction to GA

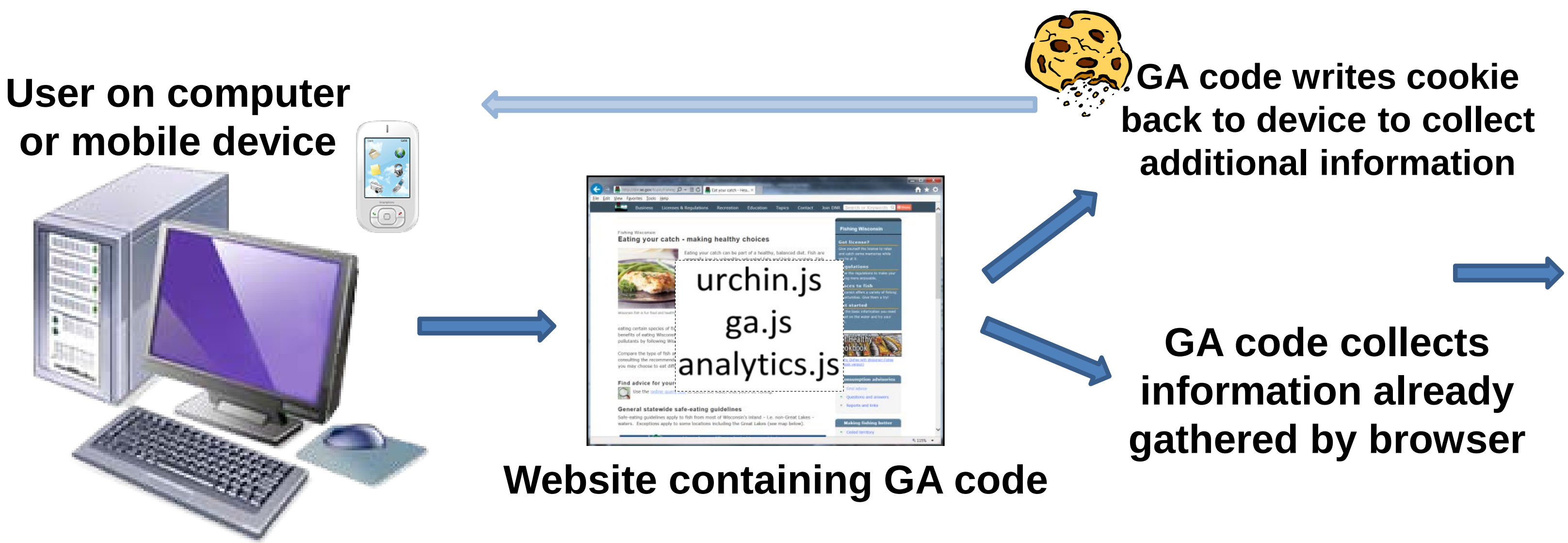
- A free tool that measures web traffic data
- Reports generated by GA can allow you to determine…
  - Number of visitors to each page
  - Visitors' location (city, country)
  - How visitors reached your pages
  - How long visitors stayed on each page
  - Etc…

How does Google Analytics work?

1. A user directs a browser to a website that contains Google Analytics tracking code.

2. Tracking code collects information already being gathered by the browser (search keyword, type of browser, location of IP address, etc.) but ALSO writes a cookie back to the device that collects additional information that the browser cannot provide (as time-on-site, page-views, etc.).

Graphic and caption modified from Jones et al. 2014; doi: 10.3897/BDJ.2.e1558

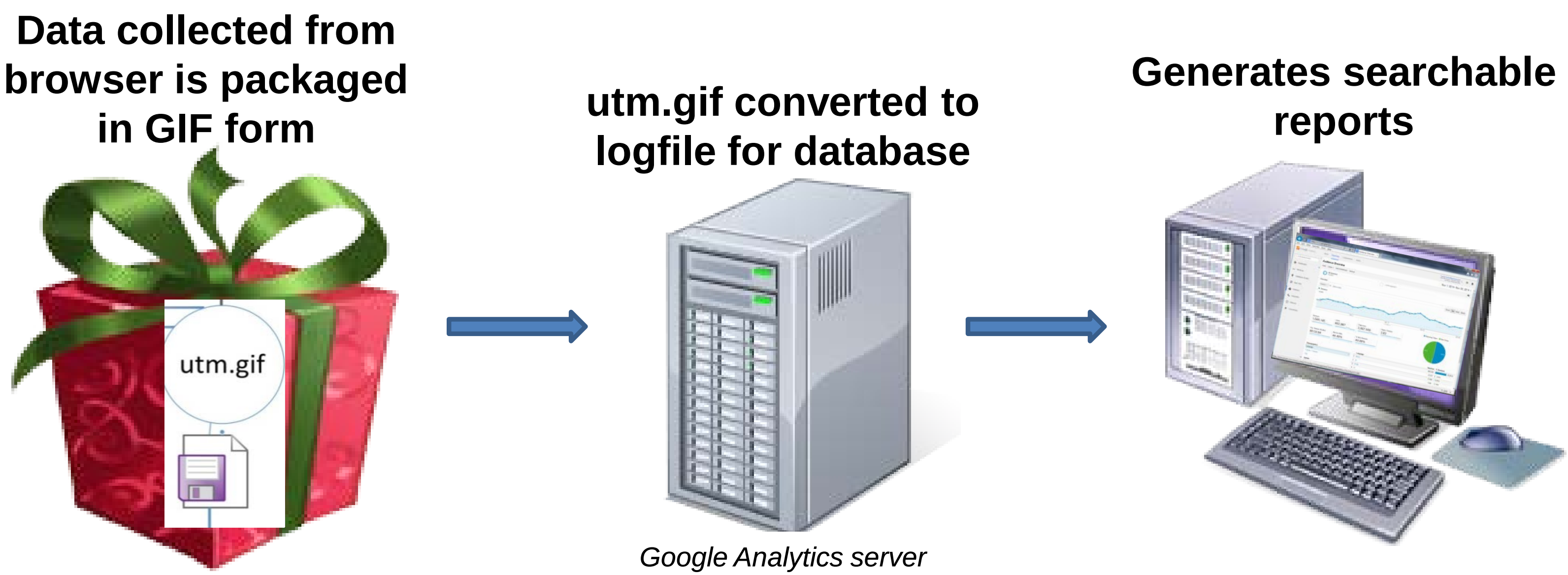


How does Google Analytics work? (continued)

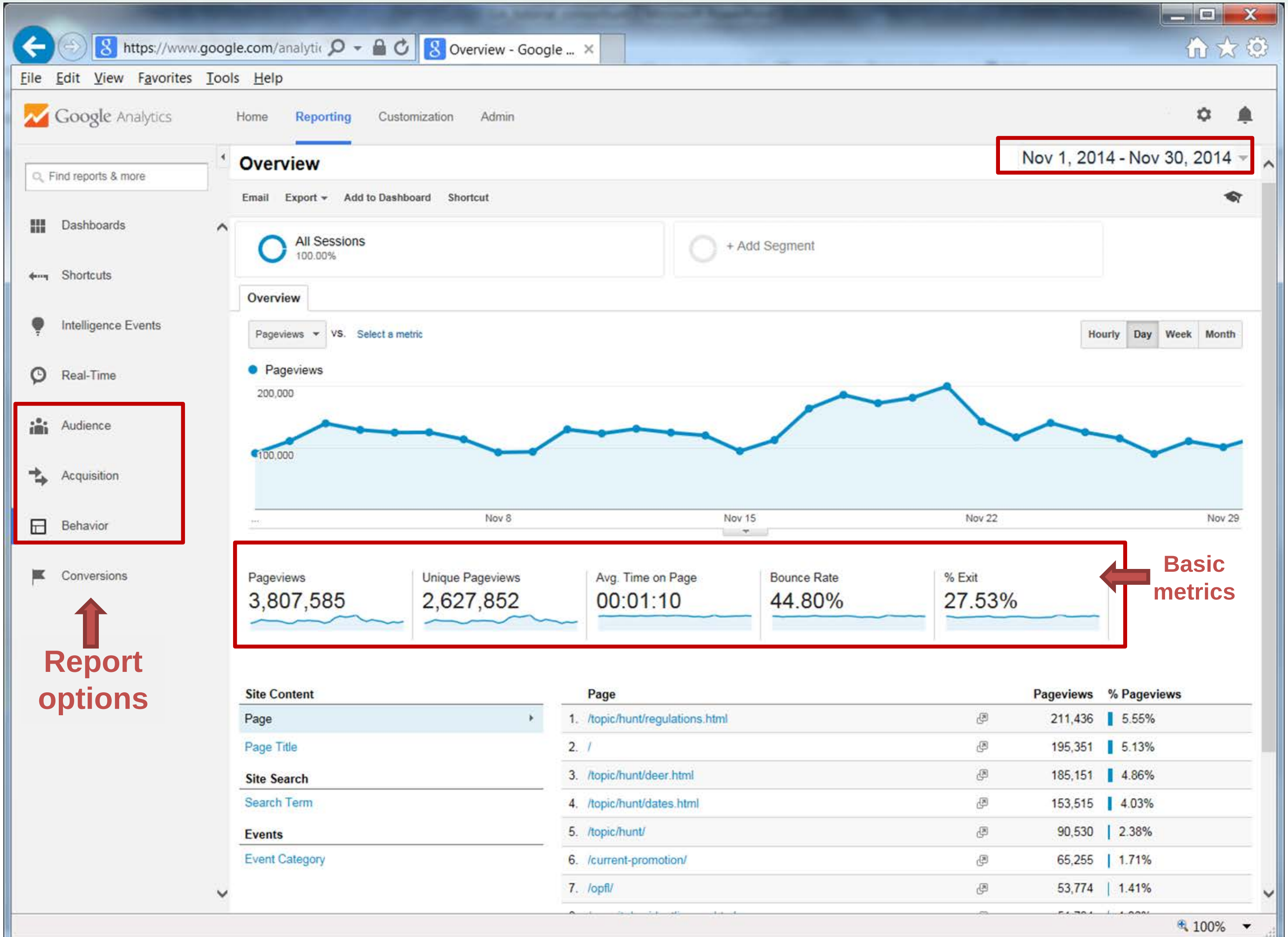
3. This packaged set of data is then sent back to a Google server in the form of a GIF file.

4. The GIF file is interpreted and incorporated into reports, which are then available to view and search.

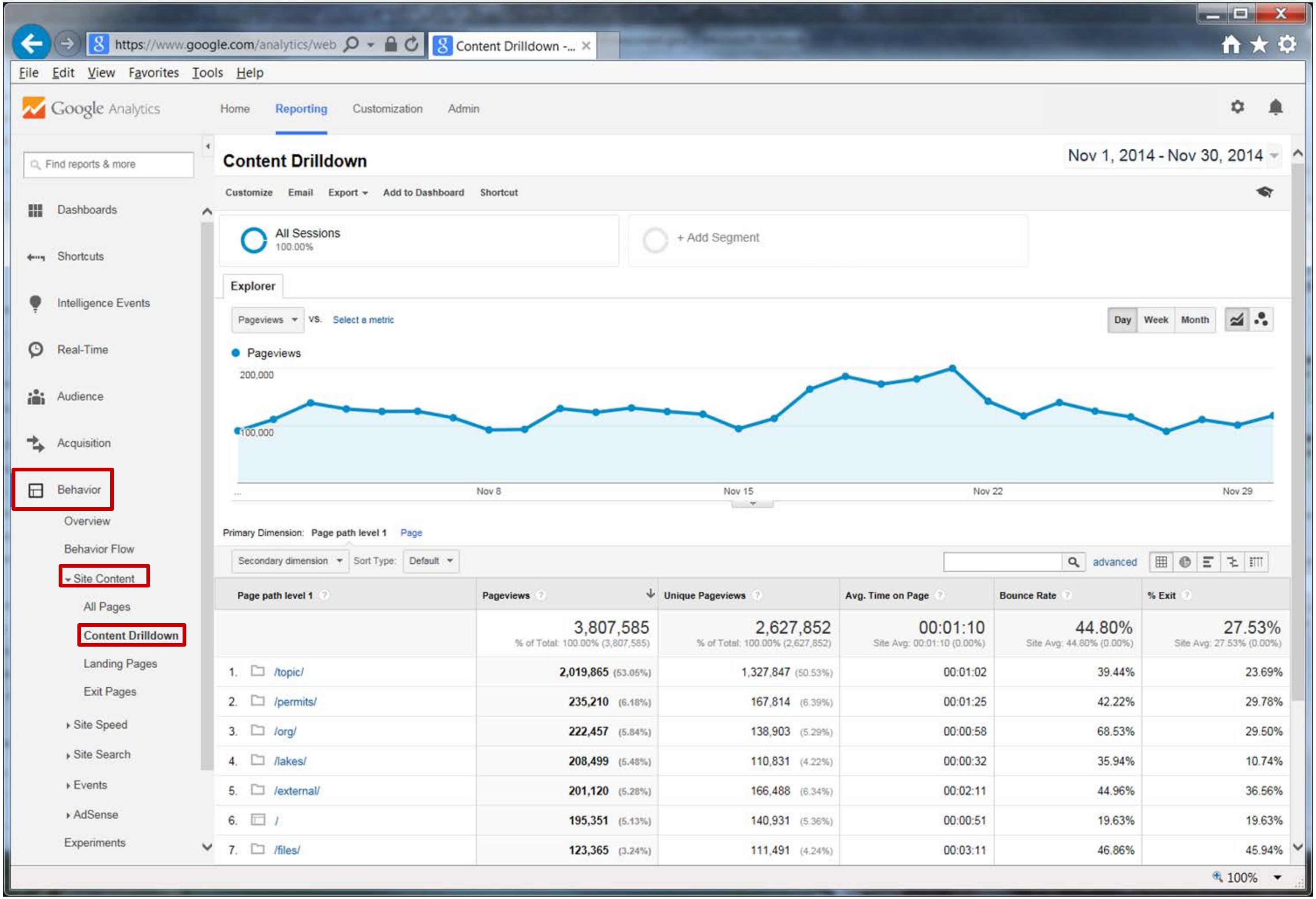
Graphic and caption modified from Jones et al. 2014; doi: 10.3897/BDJ.2.e1558



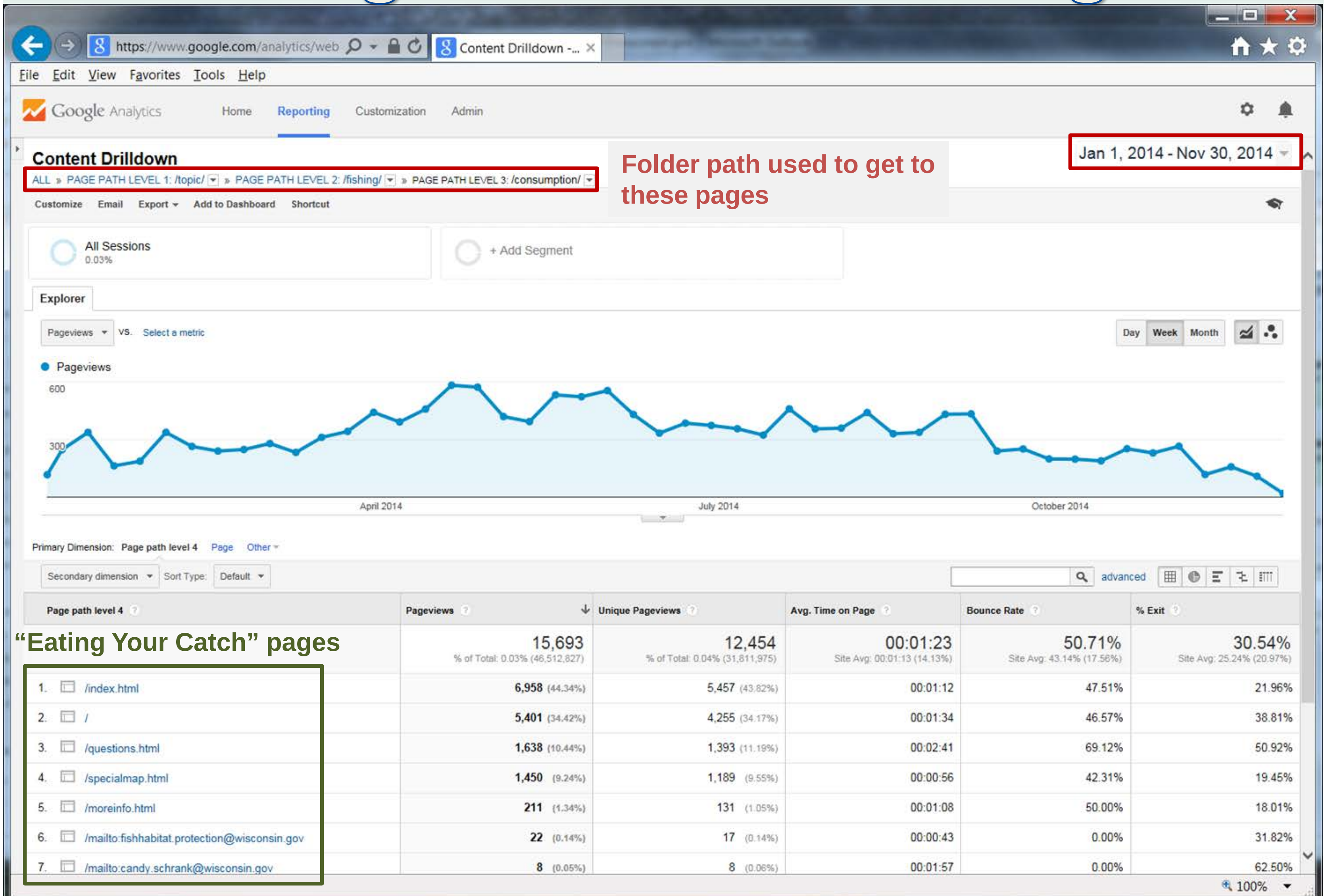
Exploring the GA Interface: Reports & Basic Metrics



Finding your web pages: Content Drilldown

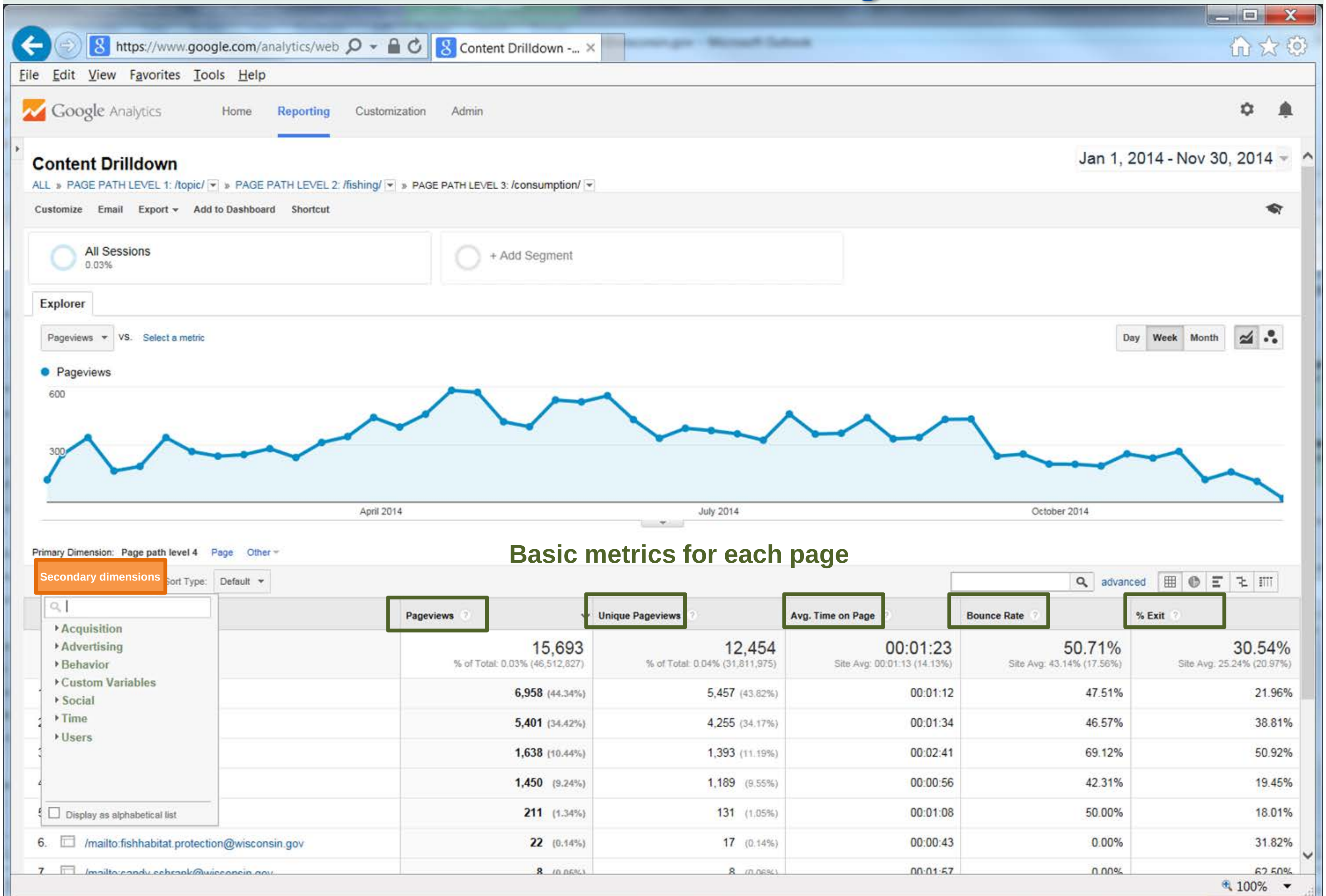


Finding Individual Web Pages



	Page path level 4	Pageviews	Unique Pageviews	Avg. Time on Page	Bounce Rate	% Exit
		15,693 % of Total: 0.03% (46,512,827)	12,454 % of Total: 0.04% (31,811,975)	00:01:23 Site Avg: 00:01:13 (14.13%)	50.71% Site Avg: 43.14% (17.56%)	30.54% Site Avg: 25.24% (20.97%)
1.	/index.html	6,958 (44.34%)	5,457 (43.82%)	00:01:12	47.51%	21.96%
2.	/	5,401 (34.42%)	4,255 (34.17%)	00:01:34	46.57%	38.81%
3.	/questions.html	1,638 (10.44%)	1,393 (11.19%)	00:02:41	69.12%	50.92%
4.	/specialmap.html	1,450 (9.24%)	1,189 (9.55%)	00:00:56	42.31%	19.45%
5.	/moreinfo.html	211 (1.34%)	131 (1.05%)	00:01:08	50.00%	18.01%
6.	/mailto:fishhabitat.protection@wisconsin.gov	22 (0.14%)	17 (0.14%)	00:00:43	0.00%	31.82%
7.	/mailto:candy.schrank@wisconsin.gov	8 (0.05%)	8 (0.06%)	00:01:57	0.00%	62.50%

Basic Metrics & Secondary Dimensions



More about Secondary Dimensions

- Secondary dimensions menu
  - Acquisition:
    - Did visitors reach pages using a search engine? Were they referred to your pages from another site?
  - Advertising:
    - Did visitors reach your page via a keyword or campaign (like a QR code)?
  - Behavior:
    - How long did visitors stay on each page? On which page did they enter and exit? How many pages did they view?
  - Social:
    - Did users find or interact with pages via social media?
  - Time:
    - What time (minute/hour) of the day/week/year did visitors reach your pages?
  - Users
    - What location(s) are visitors from? What operating system or browser are they using? Are they using mobile platforms?

Utilizing Secondary Dimensions

- Examples of questions the WDNR uses GA to answer:
  – Through which websites or keywords do people find our “Eating Your Catch” site?
  – For which waters do visitors search most often for consumption advice using the query tool?
  – Does outreach event attendance or presence influence website visits?

Through which websites do visitors find our pages?

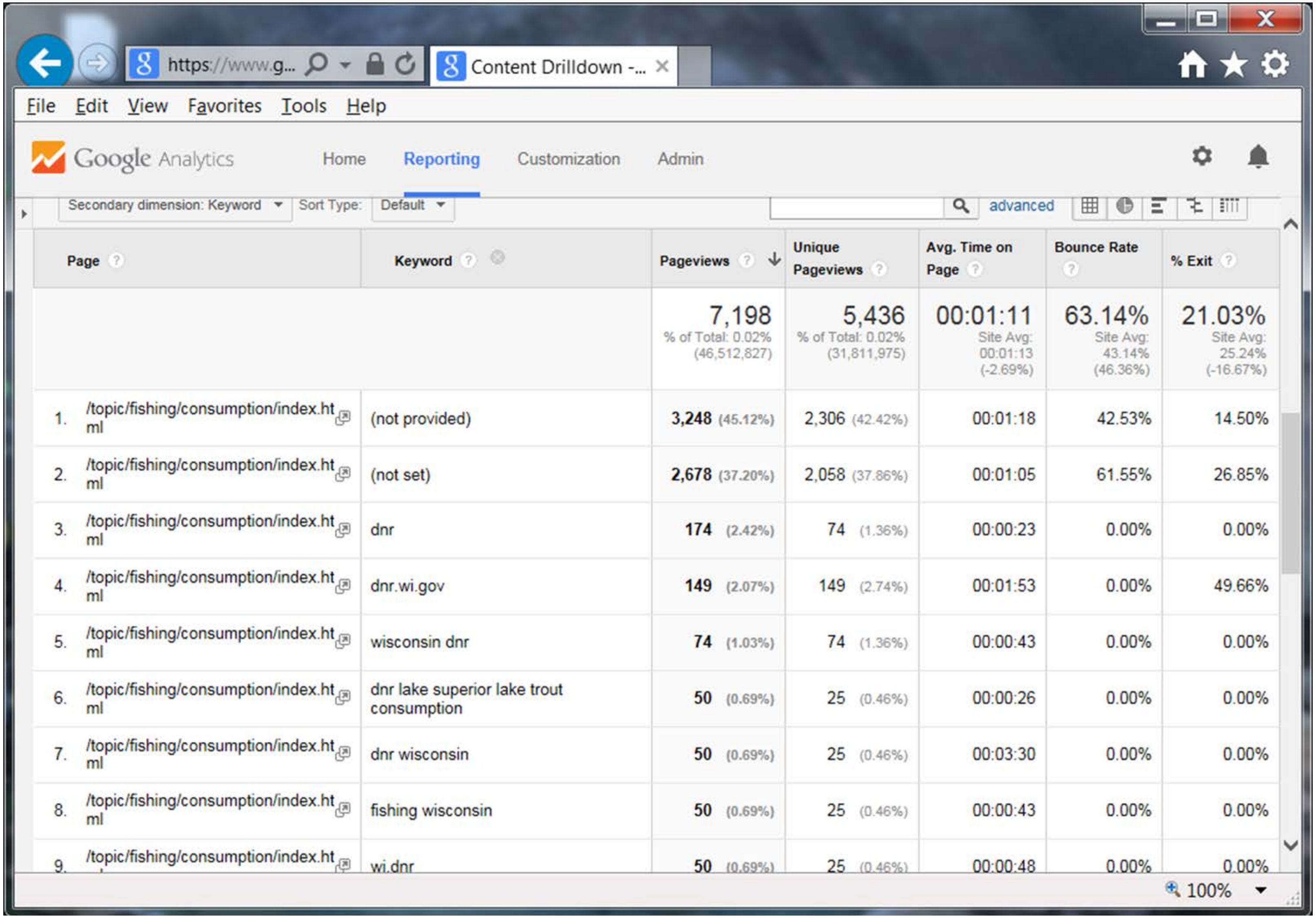
Google Analytics — Home | Reporting | Customization | Admin

Secondary dimension: Source / Medium | Sort Type: Default | advanced

~74% of visitors reach pages directly or via search engines

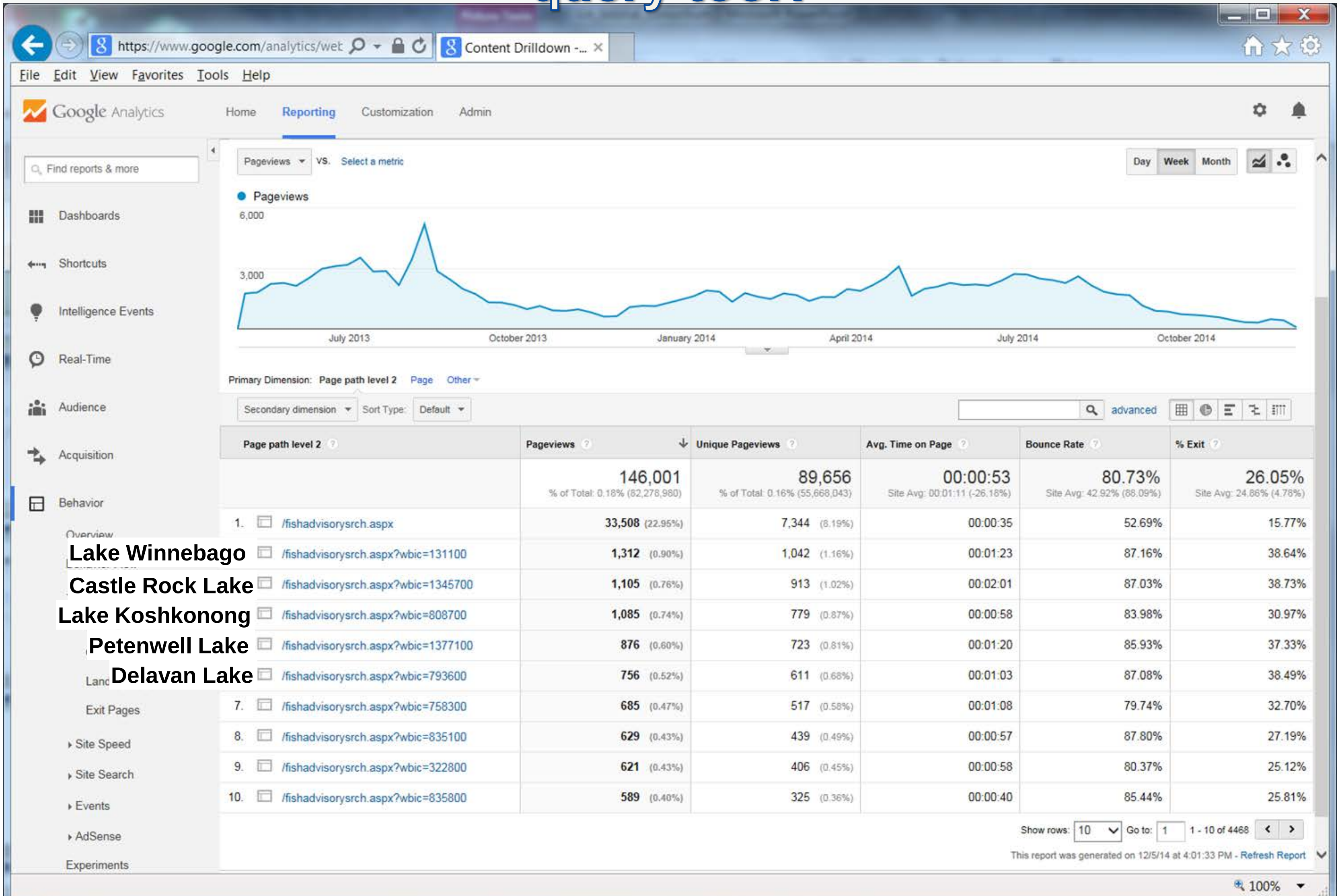
	Page path level 4	Source / Medium	Pageviews	Unique Pageviews	Avg. Time on Page	Bounce Rate	% Exit
			16,152 % of Total: 0.03% (46,512,827)	12,509 % of Total: 0.04% (31,811,975)	00:01:18 Site Avg: 00:01:13 (6.74%)	57.64% Site Avg: 43.14% (33.63%)	31.04% Site Avg: 25.24% (22.96%)
1.	/	google / organic	3,893 (24.10%)	2,951 (23.59%)	00:01:35	47.62%	42.67%
2.	/index.html	google / organic	3,595 (22.26%)	2,554 (20.42%)	00:01:18	42.53%	14.49%
3.	/questions.html	google / organic	1,463 (9.06%)	1,190 (9.51%)	00:02:34	53.60%	40.67%
4.	/index.html	(direct) / (none)	1,066 (6.60%)	868 (6.94%)	00:01:15	85.63%	27.95%
5.	/specialmap.html	google / organic	843 (5.22%)	744 (5.95%)	00:00:55	50.00%	14.71%
6.	/index.html	bing / organic	595 (3.68%)	496 (3.97%)	00:00:50	100.00%	33.28%
7.	/	(direct) / (none)	471 (2.92%)	397 (3.17%)	00:00:33	79.84%	47.35%
8.	/index.html	dhs.wisconsin.gov / referral	372 (2.30%)	273 (2.18%)	00:00:54	45.42%	33.33%
9.	/index.html	yahoo / organic	248 (1.54%)	248 (1.98%)	00:00:43	100.00%	29.84%
10.	/	manitowocpublicschools.com / referral	149 (0.92%)	50 (0.40%)	00:00:43	0.00%	16.78%
11.	/specialmap.html	(direct) / (none)	149 (0.92%)	149 (1.19%)	00:00:21	100.00%	33.56%
12.	/	great-lakes.net / referral	124 (0.77%)	74 (0.59%)	00:00:43	0.00%	0.00%
13.	/index.html	intranet.dnr.state.wi.us / referral	124 (0.77%)	50 (0.40%)	00:00:19	0.00%	0.00%
14.	/index.html	QRcode / General Use	124 (0.77%)	99 (0.79%)	00:00:27	74.75%	79.84%
15.	/questions.html	search.dnr.wi.gov / referral	124 (0.77%)	99 (0.79%)	00:06:00	100.00%	59.68%
16.	/	fn.cfs.purdue.edu / referral	99 (0.61%)	99 (0.79%)	00:00:00	100.00%	100.00%
17.	/index.html	great-lakes.net / referral	99 (0.61%)	50 (0.40%)	00:01:09	0.00%	0.00%
18.	/questions.html	(direct) / (none)	99 (0.61%)	99 (0.79%)	00:00:00	100.00%	100.00%
19.	/questions.html	bing / organic	99 (0.61%)	74 (0.59%)	00:01:51	100.00%	50.51%
20.	/	bing / organic	74 (0.46%)	50 (0.40%)	00:00:07	100.00%	33.78%

Through which keywords do visitors find our pages?



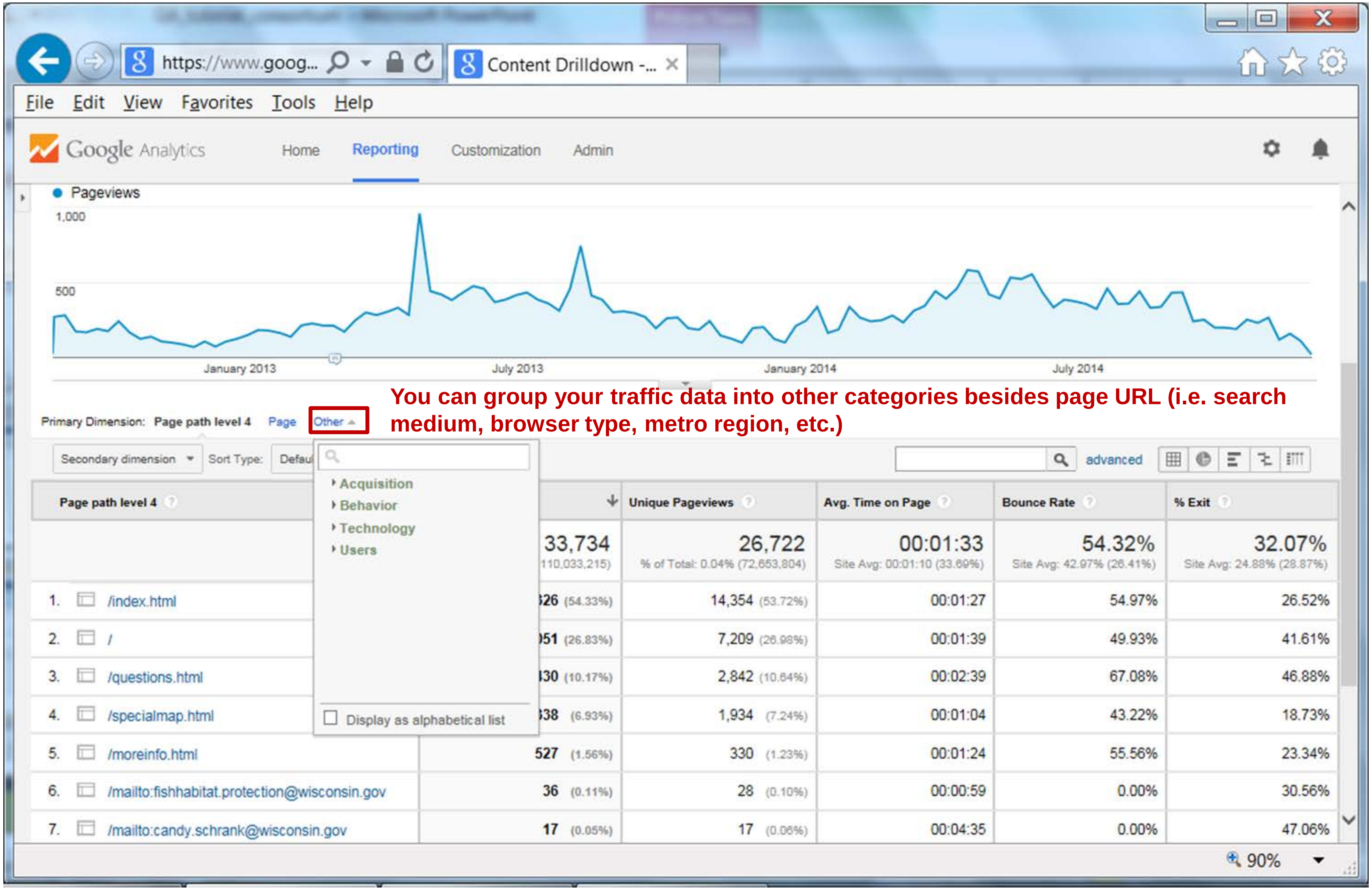
	Page	Keyword	Pageviews	Unique Pageviews	Avg. Time on Page	Bounce Rate	% Exit
			7,198 % of Total: 0.02% (46,512,827)	5,436 % of Total: 0.02% (31,811,975)	00:01:11 Site Avg: 00:01:13 (-2.69%)	63.14% Site Avg: 43.14% (46.36%)	21.03% Site Avg: 25.24% (-16.67%)
1.	/topic/fishing/consumption/index.html	(not provided)	3,248 (45.12%)	2,306 (42.42%)	00:01:18	42.53%	14.50%
2.	/topic/fishing/consumption/index.html	(not set)	2,678 (37.20%)	2,058 (37.86%)	00:01:05	61.55%	26.85%
3.	/topic/fishing/consumption/index.html	dnr	174 (2.42%)	74 (1.36%)	00:00:23	0.00%	0.00%
4.	/topic/fishing/consumption/index.html	dnr.wi.gov	149 (2.07%)	149 (2.74%)	00:01:53	0.00%	49.66%
5.	/topic/fishing/consumption/index.html	wisconsin dnr	74 (1.03%)	74 (1.36%)	00:00:43	0.00%	0.00%
6.	/topic/fishing/consumption/index.html	dnr lake superior lake trout consumption	50 (0.69%)	25 (0.46%)	00:00:26	0.00%	0.00%
7.	/topic/fishing/consumption/index.html	dnr wisconsin	50 (0.69%)	25 (0.46%)	00:03:30	0.00%	0.00%
8.	/topic/fishing/consumption/index.html	fishing wisconsin	50 (0.69%)	25 (0.46%)	00:00:43	0.00%	0.00%
9.	/topic/fishing/consumption/index.ht	wi.dnr	50 (0.69%)	25 (0.46%)	00:00:48	0.00%	0.00%

For which waters do users search for advice via the query tool?

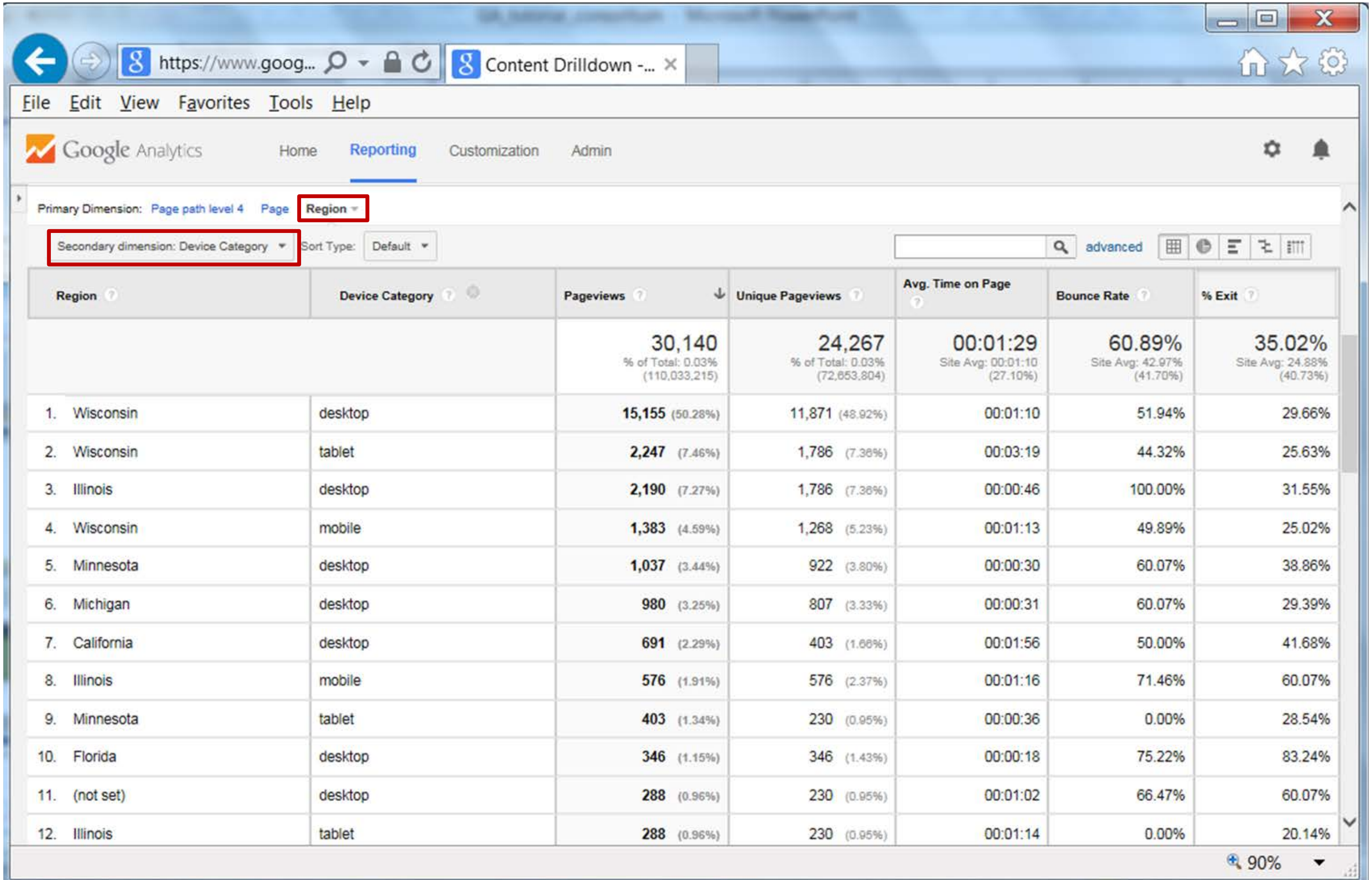


	Page path level 2	Pageviews	Unique Pageviews	Avg. Time on Page	Bounce Rate	% Exit
		146,001 % of Total: 0.18% (82,278,980)	89,656 % of Total: 0.16% (55,668,043)	00:00:53 Site Avg: 00:01:11 (-26.18%)	80.73% Site Avg: 42.92% (88.09%)	26.05% Site Avg: 24.86% (4.78%)
1.	/fishadvisorysrch.aspx	33,508 (22.95%)	7,344 (8.19%)	00:00:35	52.69%	15.77%
Lake Winnebago	/fishadvisorysrch.aspx?wbic=131100	1,312 (0.90%)	1,042 (1.16%)	00:01:23	87.16%	38.64%
Castle Rock Lake	/fishadvisorysrch.aspx?wbic=1345700	1,105 (0.76%)	913 (1.02%)	00:02:01	87.03%	38.73%
Lake Koshkonong	/fishadvisorysrch.aspx?wbic=808700	1,085 (0.74%)	779 (0.87%)	00:00:58	83.98%	30.97%
Petenwell Lake	/fishadvisorysrch.aspx?wbic=1377100	876 (0.60%)	723 (0.81%)	00:01:20	85.93%	37.33%
Delavan Lake	/fishadvisorysrch.aspx?wbic=793600	756 (0.52%)	611 (0.68%)	00:01:03	87.08%	38.49%
7.	/fishadvisorysrch.aspx?wbic=758300	685 (0.47%)	517 (0.58%)	00:01:08	79.74%	32.70%
8.	/fishadvisorysrch.aspx?wbic=835100	629 (0.43%)	439 (0.49%)	00:00:57	87.80%	27.19%
9.	/fishadvisorysrch.aspx?wbic=322800	621 (0.43%)	406 (0.45%)	00:00:58	80.37%	25.12%
10.	/fishadvisorysrch.aspx?wbic=835800	589 (0.40%)	325 (0.36%)	00:00:40	85.44%	25.81%

Additional primary dimension options

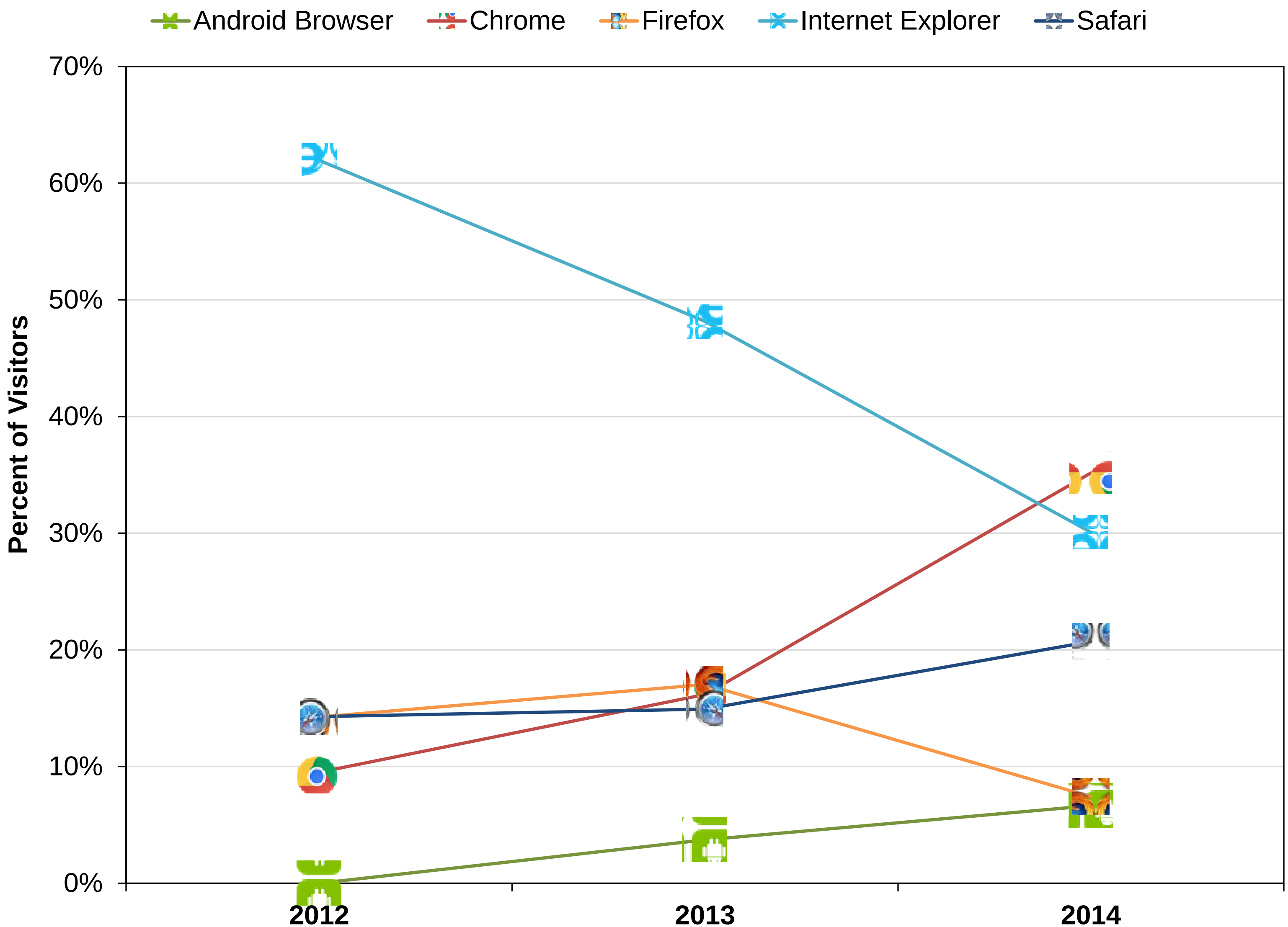


You can group your traffic data into other categories besides page URL (i.e. search medium, browser type, metro region, etc.)

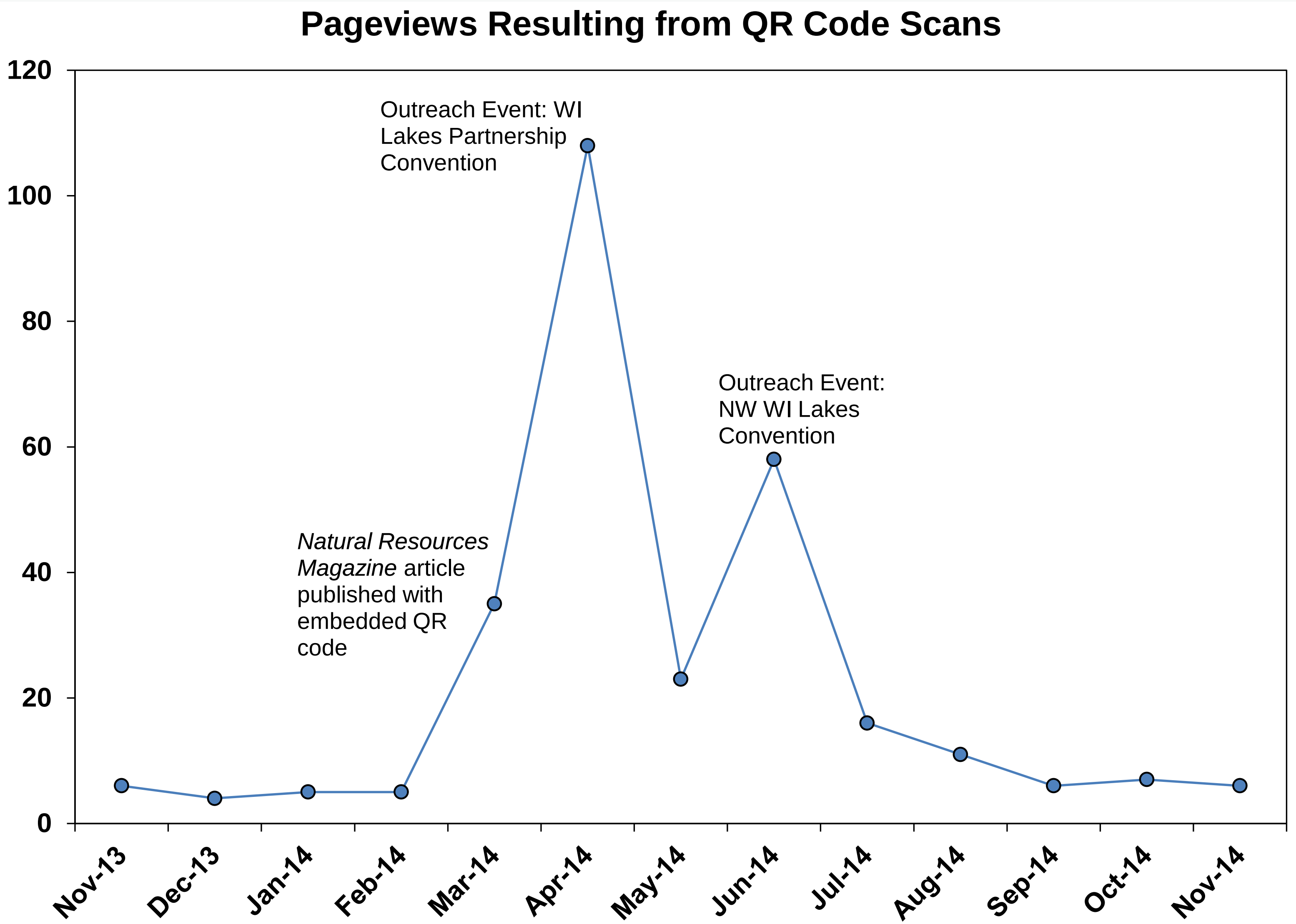


Region	Device Category	Pageviews	Unique Pageviews	Avg. Time on Page	Bounce Rate	% Exit
		30,140 % of Total: 0.03% (110,033,215)	24,267 % of Total: 0.03% (72,653,804)	00:01:29 Site Avg: 00:01:10 (27.10%)	60.89% Site Avg: 42.97% (41.70%)	35.02% Site Avg: 24.88% (40.73%)
1. Wisconsin	desktop	15,155 (50.28%)	11,871 (48.92%)	00:01:10	51.94%	29.66%
2. Wisconsin	tablet	2,247 (7.46%)	1,786 (7.36%)	00:03:19	44.32%	25.63%
3. Illinois	desktop	2,190 (7.27%)	1,786 (7.36%)	00:00:46	100.00%	31.55%
4. Wisconsin	mobile	1,383 (4.59%)	1,268 (5.23%)	00:01:13	49.89%	25.02%
5. Minnesota	desktop	1,037 (3.44%)	922 (3.80%)	00:00:30	60.07%	38.86%
6. Michigan	desktop	980 (3.25%)	807 (3.33%)	00:00:31	60.07%	29.39%
7. California	desktop	691 (2.29%)	403 (1.66%)	00:01:56	50.00%	41.68%
8. Illinois	mobile	576 (1.91%)	576 (2.37%)	00:01:16	71.46%	60.07%
9. Minnesota	tablet	403 (1.34%)	230 (0.95%)	00:00:36	0.00%	28.54%
10. Florida	desktop	346 (1.15%)	346 (1.43%)	00:00:18	75.22%	83.24%
11. (not set)	desktop	288 (0.96%)	230 (0.95%)	00:01:02	66.47%	60.07%
12. Illinois	tablet	288 (0.96%)	230 (0.95%)	00:01:14	0.00%	20.14%

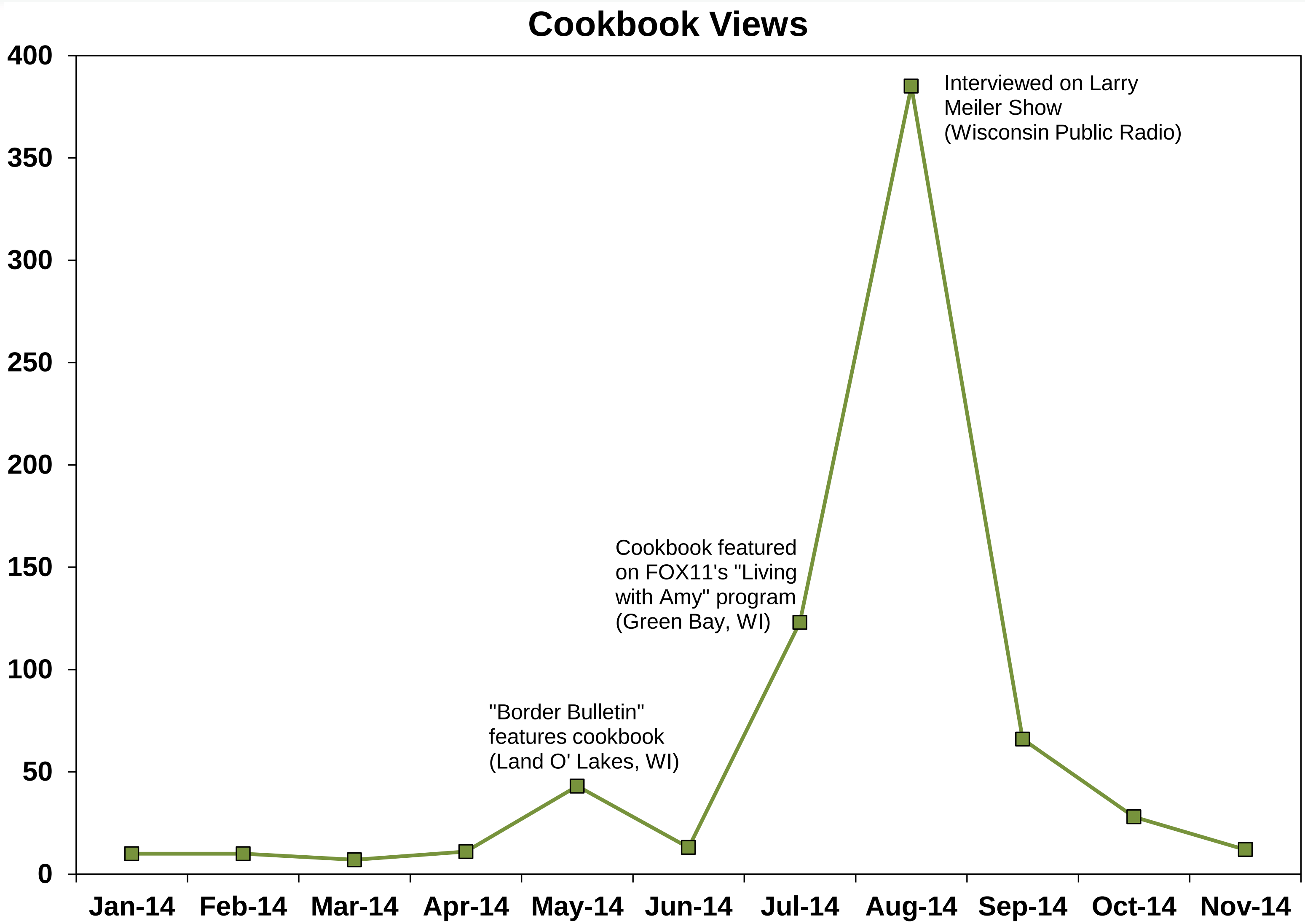
Visitors' browser preferences over time

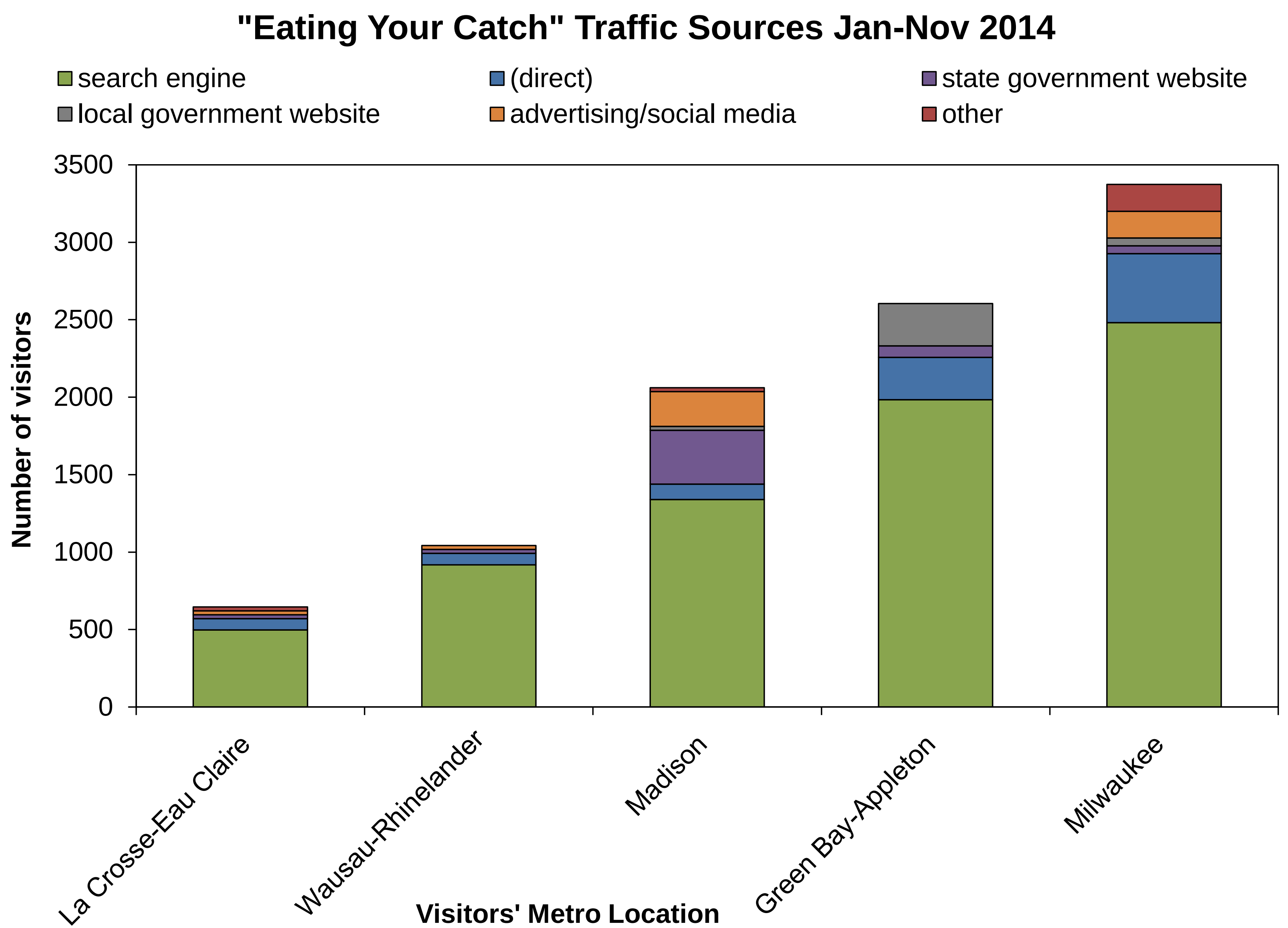


Visitor traffic reflects outreach events & publications



Visitor traffic reflects outreach events & publications




"Eating Your Catch" Traffic Sources Jan-Nov 2014
search engine
(direct)
state government website
local government website
advertising/social media
other
Number of visitors
3500
3000
2500
2000
1500
1000
500
0
La Crosse-Eau Claire
Wausau-Rhinelander
Madison
Green Bay-Appleton
Milwaukee
Visitors' Metro Location

In summary…

- DNR has tracked web page traffic for “Eating Your Catch” since 08/2012 and the query tool since 05/2013

- Google Analytics allows us to determine…
  - Numbers of visitors we reach
  - When and how visitors find our pages
  - How visitors behave once they get to the pages
  - How our outreach activities influence website traffic

Additional Resources

- Google Analytics Academy (free!)
  - Set up web tracking code

- GA Training through Lynda.com

- More info about metrics and dimensions

Great Lakes Fish Monitoring and Surveillance Program (GLFMSP) Emerging Chemical Discovery

Thomas Holsen, Bernard Crimmins, Philip Hopke, ***Clarkson University, Potsdam, NY***
James Pagano, ***SUNY Oswego, Oswego, NY***
Michael Milligan, ***SUNY Fredonia, Fredonia, NY***

Elizabeth Murphy, **Great Lakes National Program Office (GLNPO), Chicago, IL**

Great Lakes Fish Monitoring and Surveillance Program

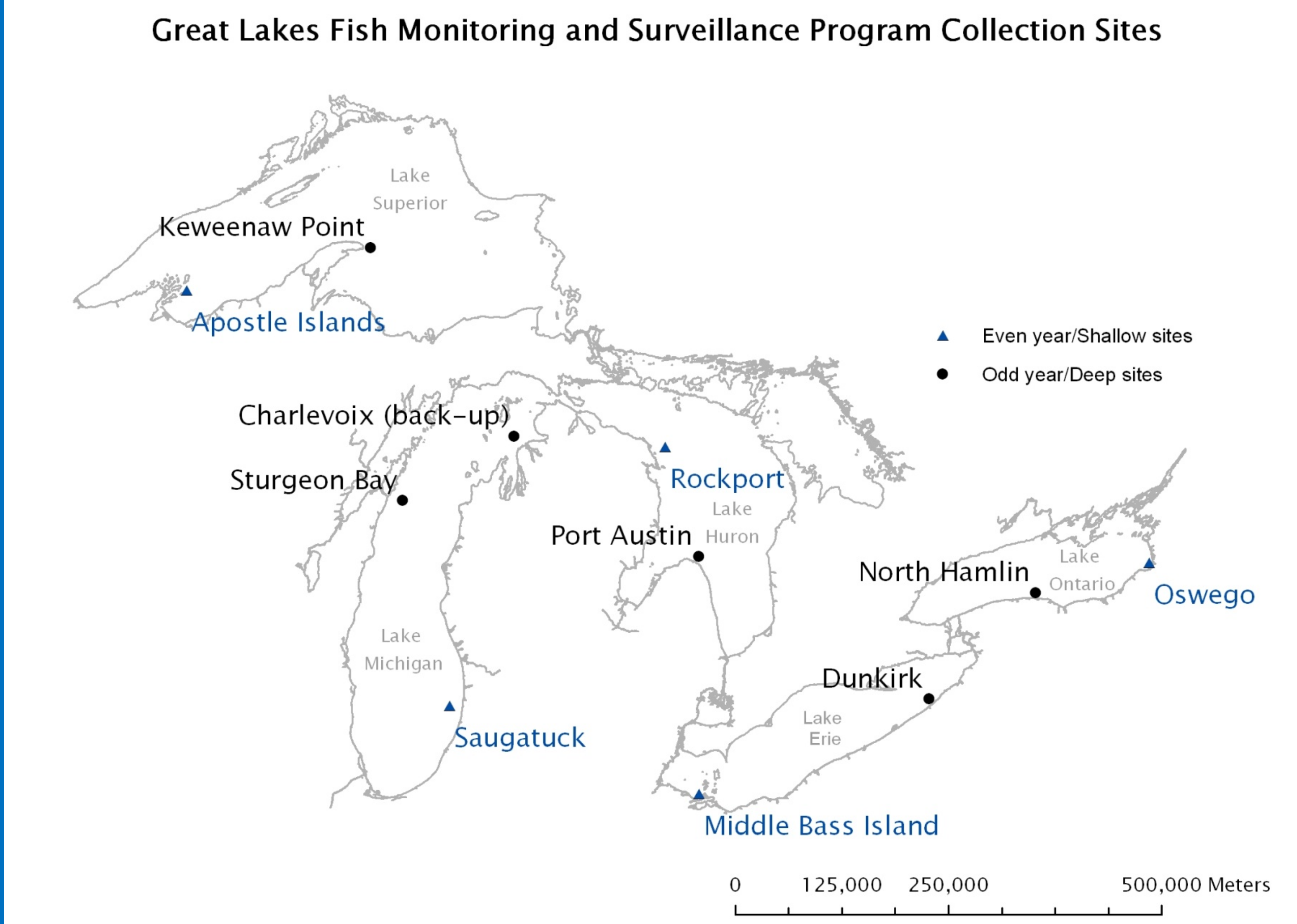
Open Lake Trends Monitoring – legacy

- Monitor contaminant trends in the open waters of the Great Lakes using whole fish (trout and walleye)
- 50 size-selected fish collected from each lake
- Alternate between near and offshore sites every year
- 10 composites containing 5 fish each.
- Yearly Mega-composites created after 2008 integrating all 50 fish collected for each lake

Lake of the Year – Contemporary bioaccumulation and food web structure for each lake

Emerging Chemicals of Concern – Discovery of new PBTs

Monitoring Stations



Lake of the Year

Top to bottom lake snapshot

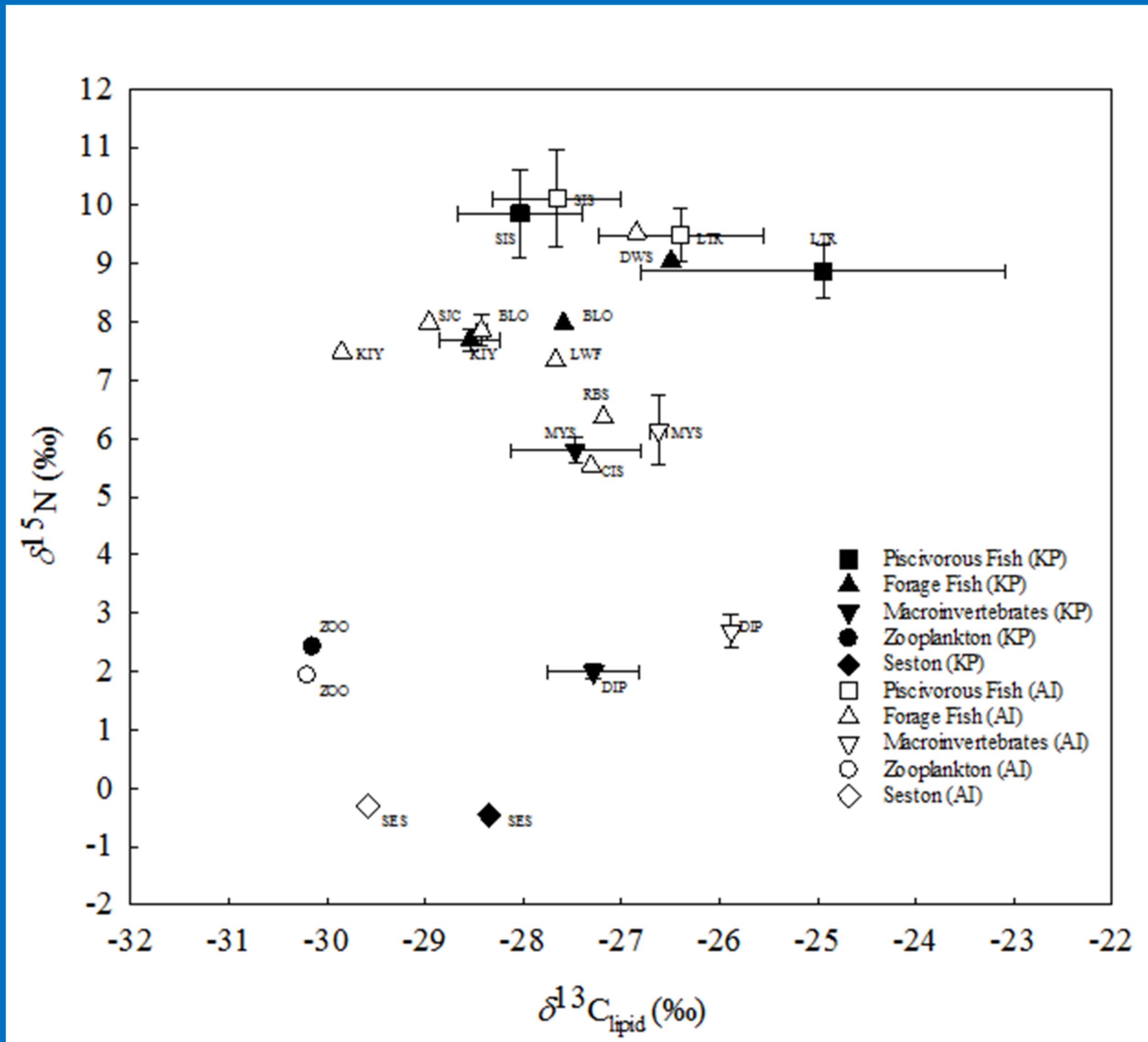
Perform a detailed bioaccumulation study

- Water (dissolved and particulate)
- Phytoplankton
- Zooplankton
- Mussels
- Benthic macro invertebrates
- Forage fish
- Lake trout

Lake Superior in 2011
Lake Huron in 2012
Lake Ontario in 2013
Lake Erie in 2014
Lake Michigan 2015

Pushing the Science

Lake Superior Food Web Isotopes

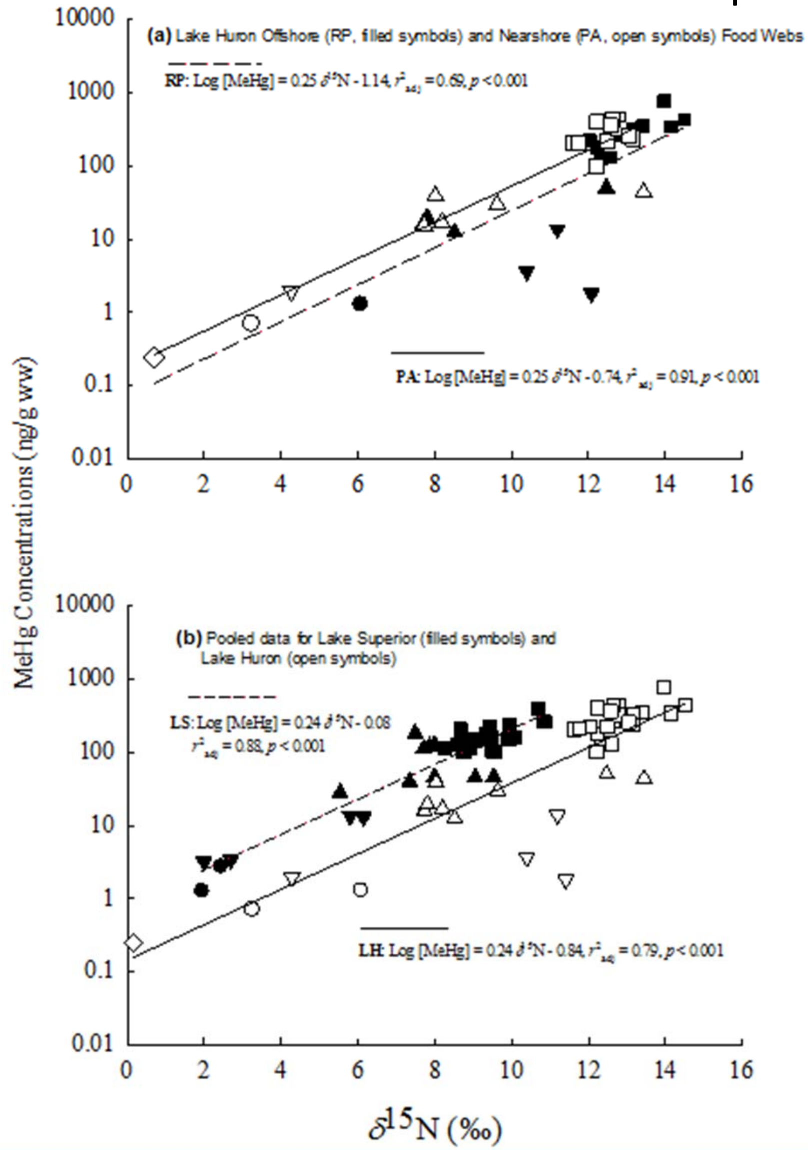


Bioaccumulation of Hg in Lakes Huron (top) and Superior (bottom).

Similar slopes between sites and lakes

Similar bioaccumulation rates

Omara et al 2015 in accepted



Emerging Chemicals of Concern

Discovery of new (?) Persistent and Bioaccumulative Toxics (PBTs)

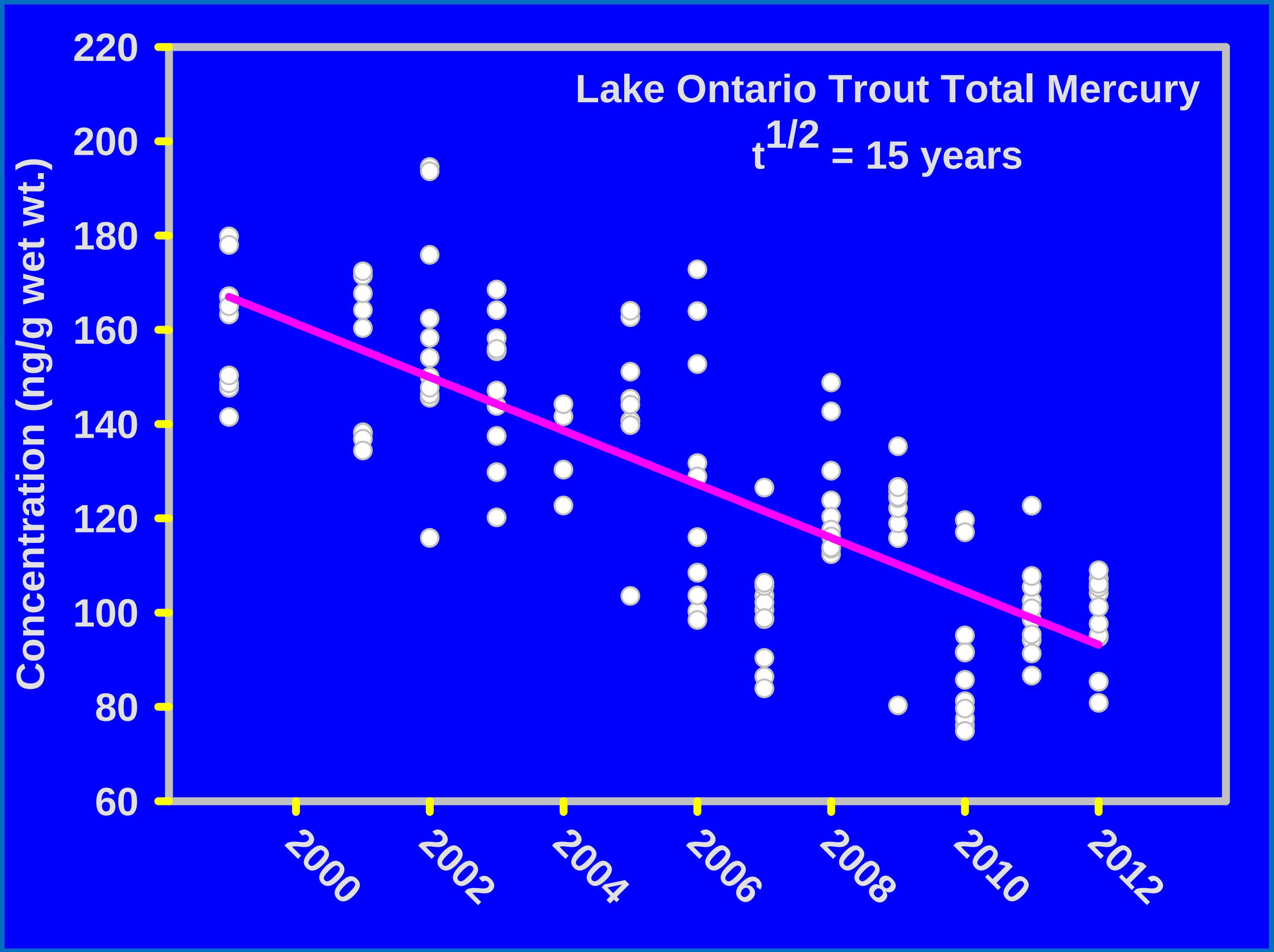
Evaluate the presence PBTs not currently monitored in the Great Lakes

- **Flame retardants** – PBDE replacements (bromophthalates, bromobenzenes, organophosphorous, chlorinated "legacy" flame retardants)
- **Perfluorochemicals** – Perfluoroalkyl carboxylic (PFOA) and sulfonic acids (PFOS)
- **Synthetic Musks –** Prevalent use and sparse data
- **Polychlorinated Dioxins/Furans and Co-planar PCBs** – legacy, yet contemporary data is currently limited
- **Polychlorinated naphthalenes** – Legacy, dioxin-like, limited data
- **Howard Muir, 2010** - High Production Volume, *in silico* candidates

Full screens of mega-composites for chemicals with PBT properties

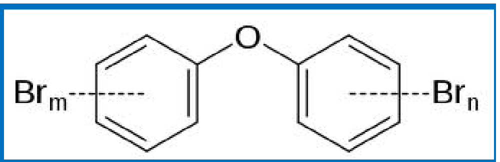
- **GCxGC-ToF** – Multiple dimensional chromatographic separation of non-polar species paired with library search spectral matching
- **HRMS** – High resolution mass spectrometry for molecular formula confirmation of species not found in commercial libraries
- **UPLC-QToF –** Ultra High Performance liquid chromatography coupled with a high resolution mass spectrometer for identification and confirmation of PBTs containing polar functional groups

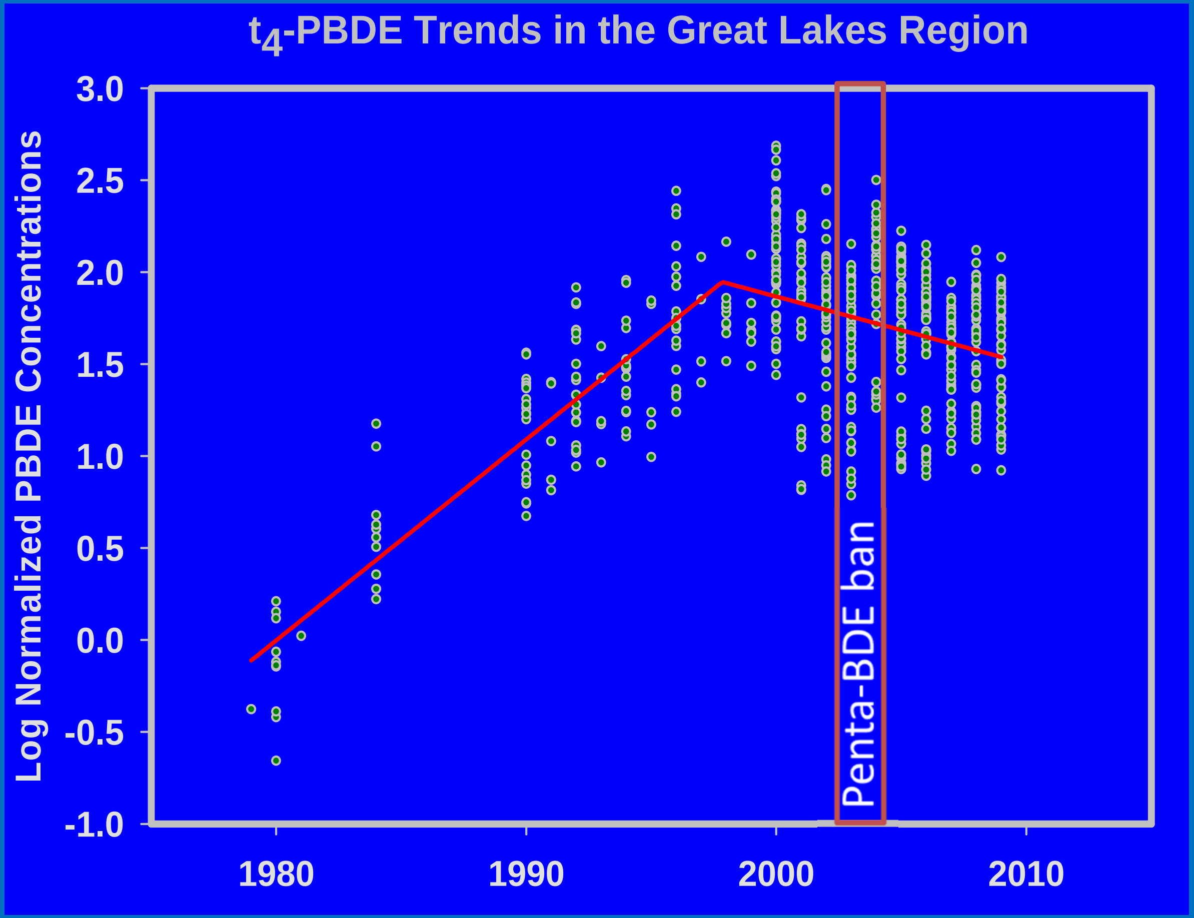
Mercury – Legacy, emerged or emerging?



Expected trend for legacy chemicals

Emerged Chemical of Concern
Polybrominated Diphenyl Ethers





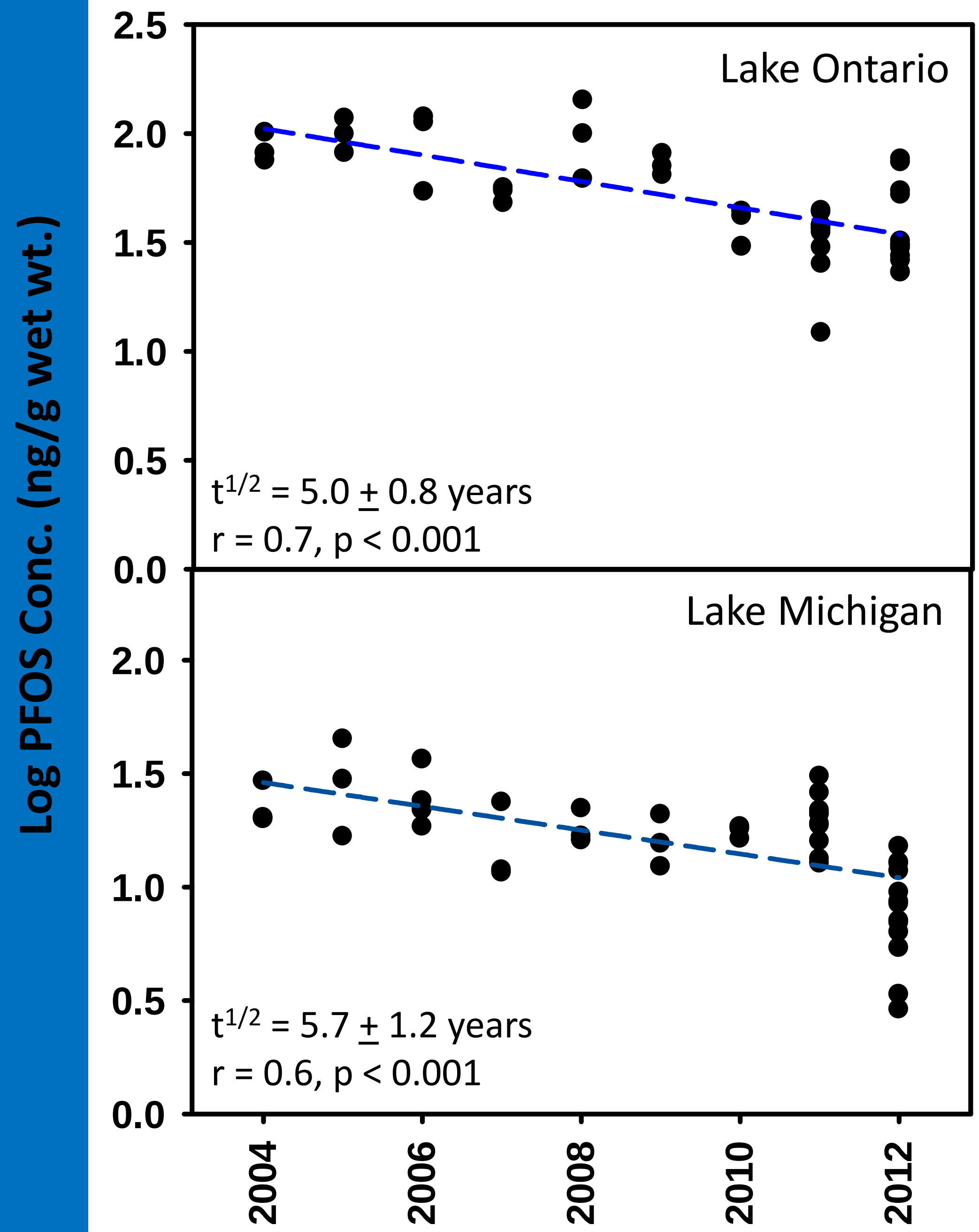
Region wide 1998 – 2010

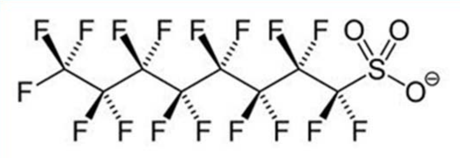
$t^{1/2} = 8.2 \pm 1.7$ yrs, $p<0.001$

Perfluoroalkyl Sulfonic Acids (PFAAs)

Lakes Ontario and Michigan PFOS Concentrations decreasing from 2004 - 2012

2002 Voluntary phase out of PFOS Chemistries in North America

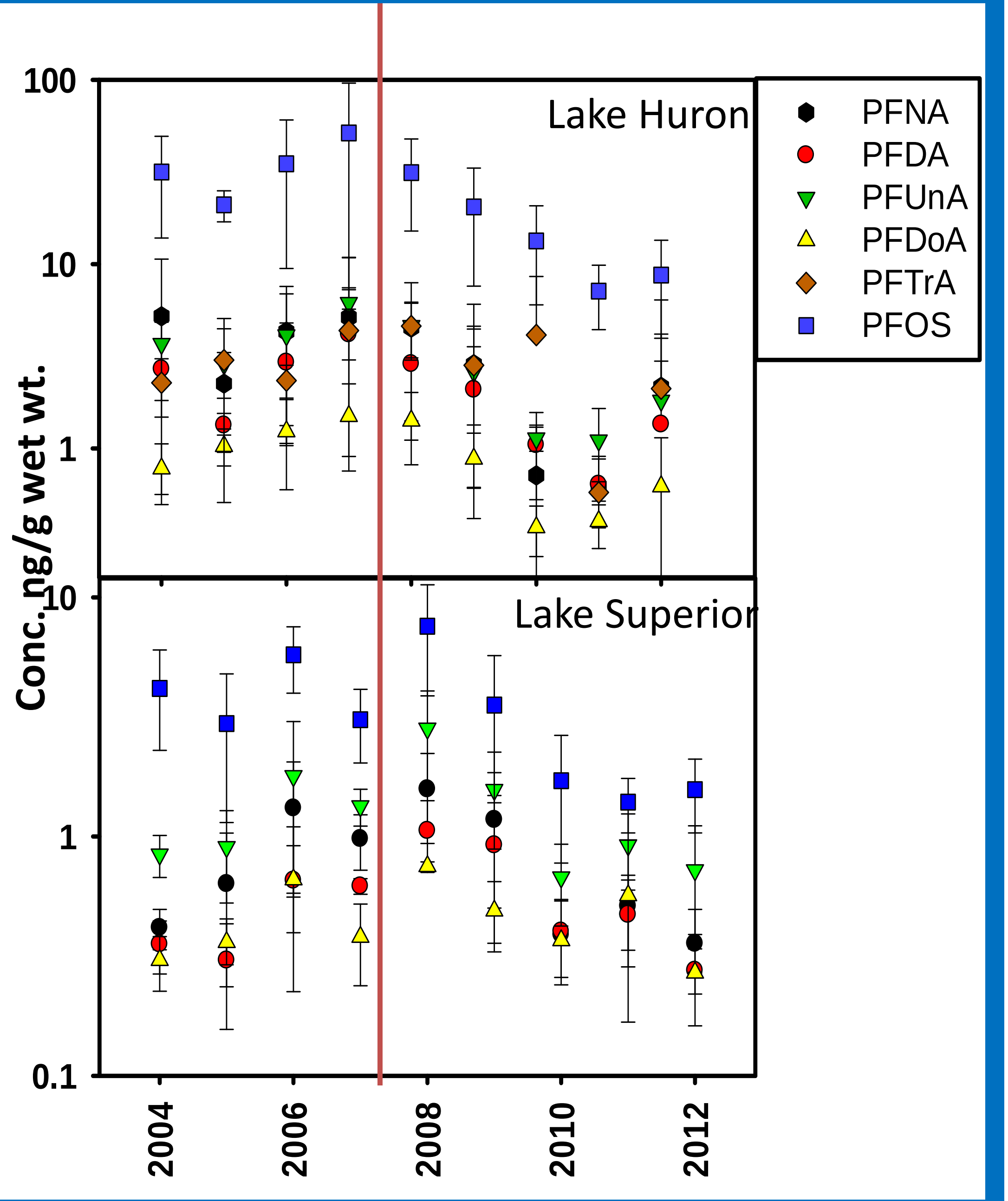




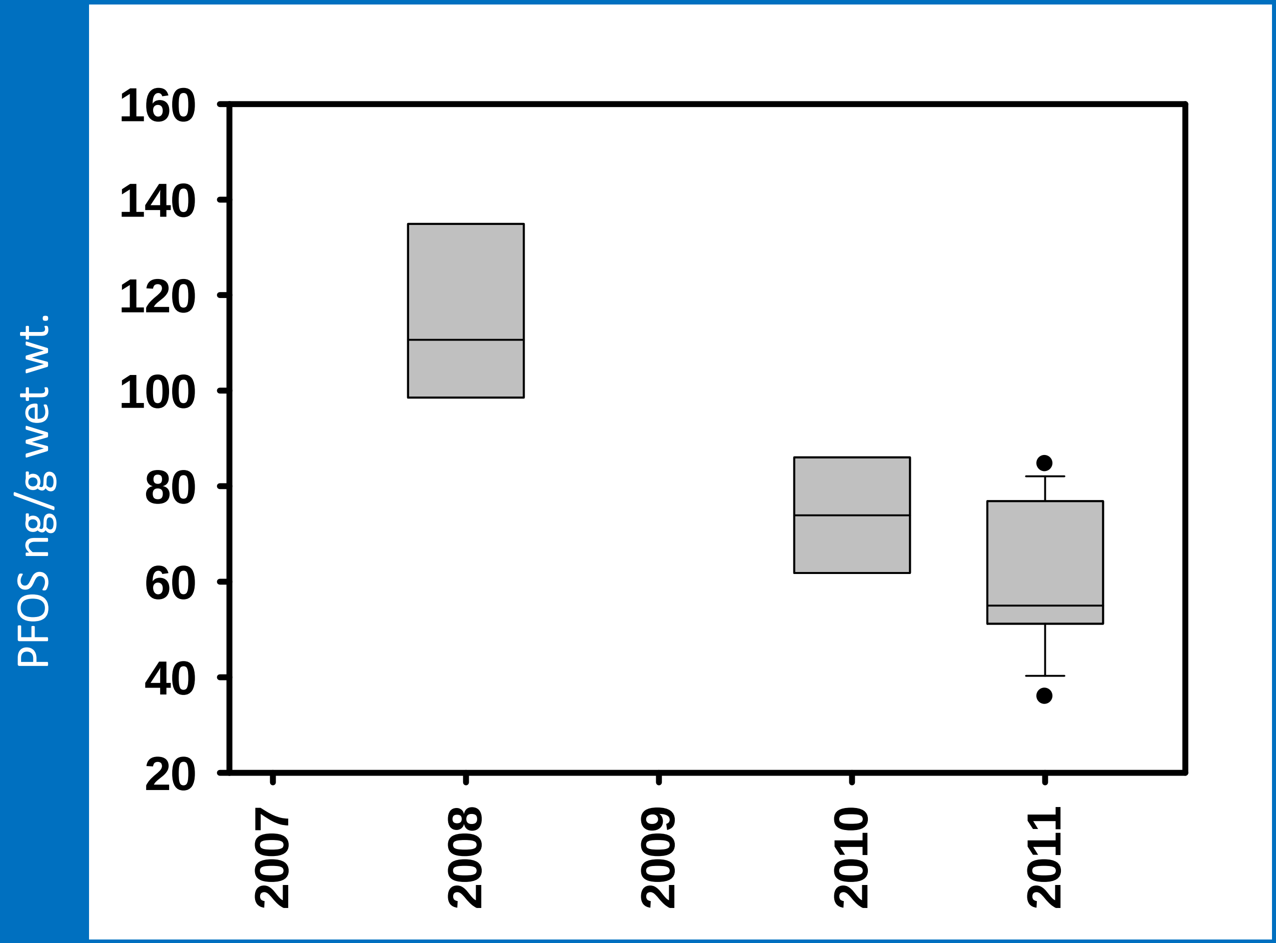
Perfluoroalkyl Carboxylic Acids (PFCAs)

Lakes Huron and Superior appear to be decreasing after 2007 for selected long chain PFAAs.

2010/2015 Stewardship Program Agreement 2006

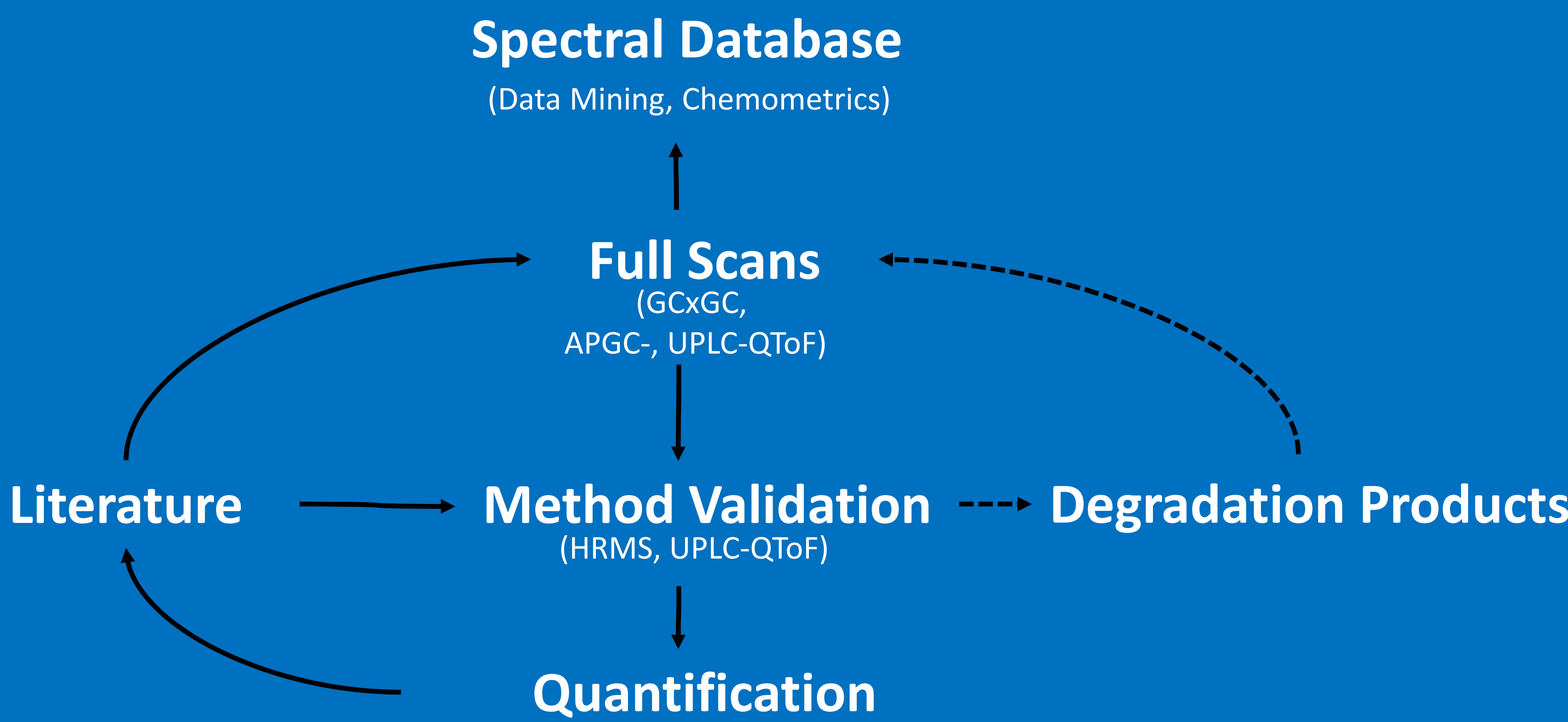


Lake Erie Lake Trout PFOS
Western Basin

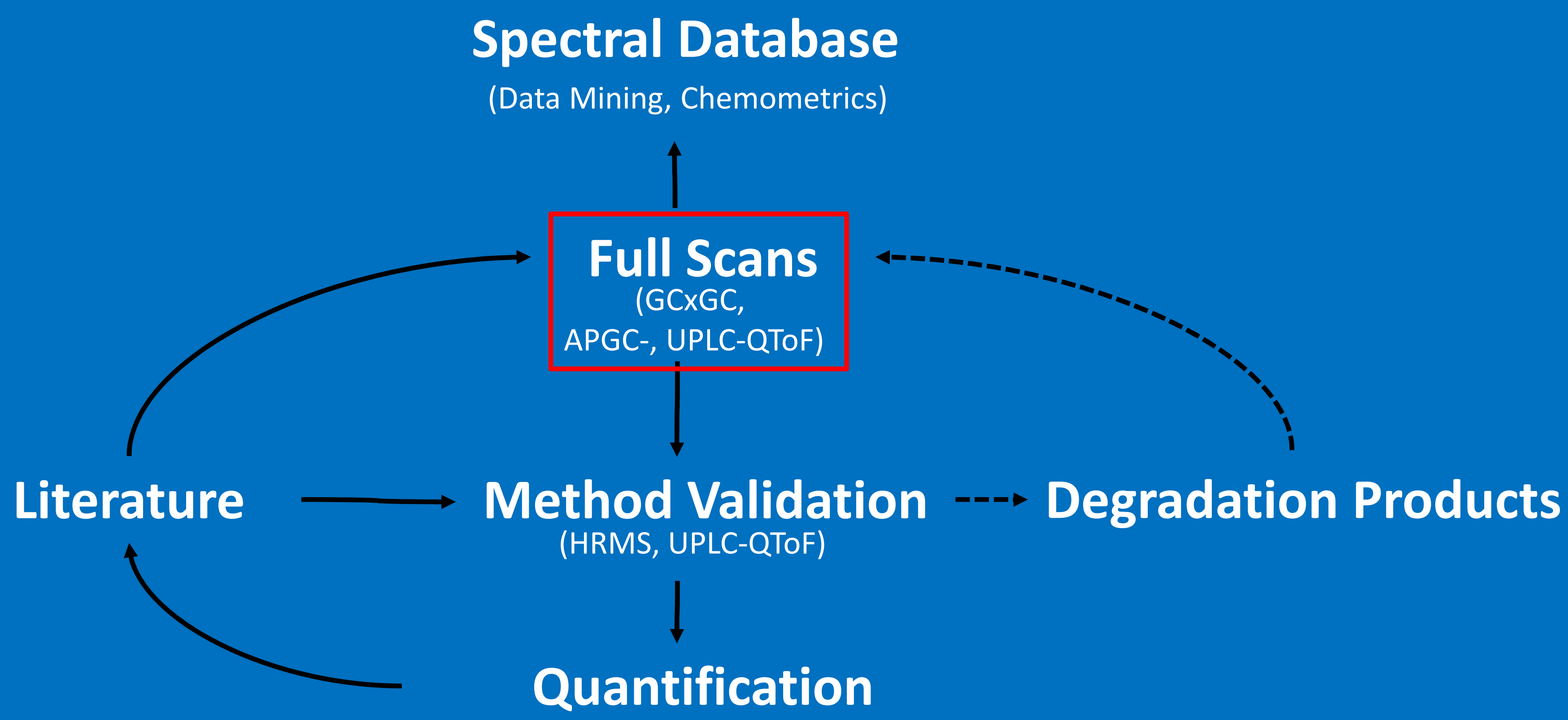


~ 16% /year decrease

Emerging Contaminant Discovery



Emerging Contaminant Discovery



Approach for Identifying Emerging Contaminants
Pegasus GCxGC-ToF

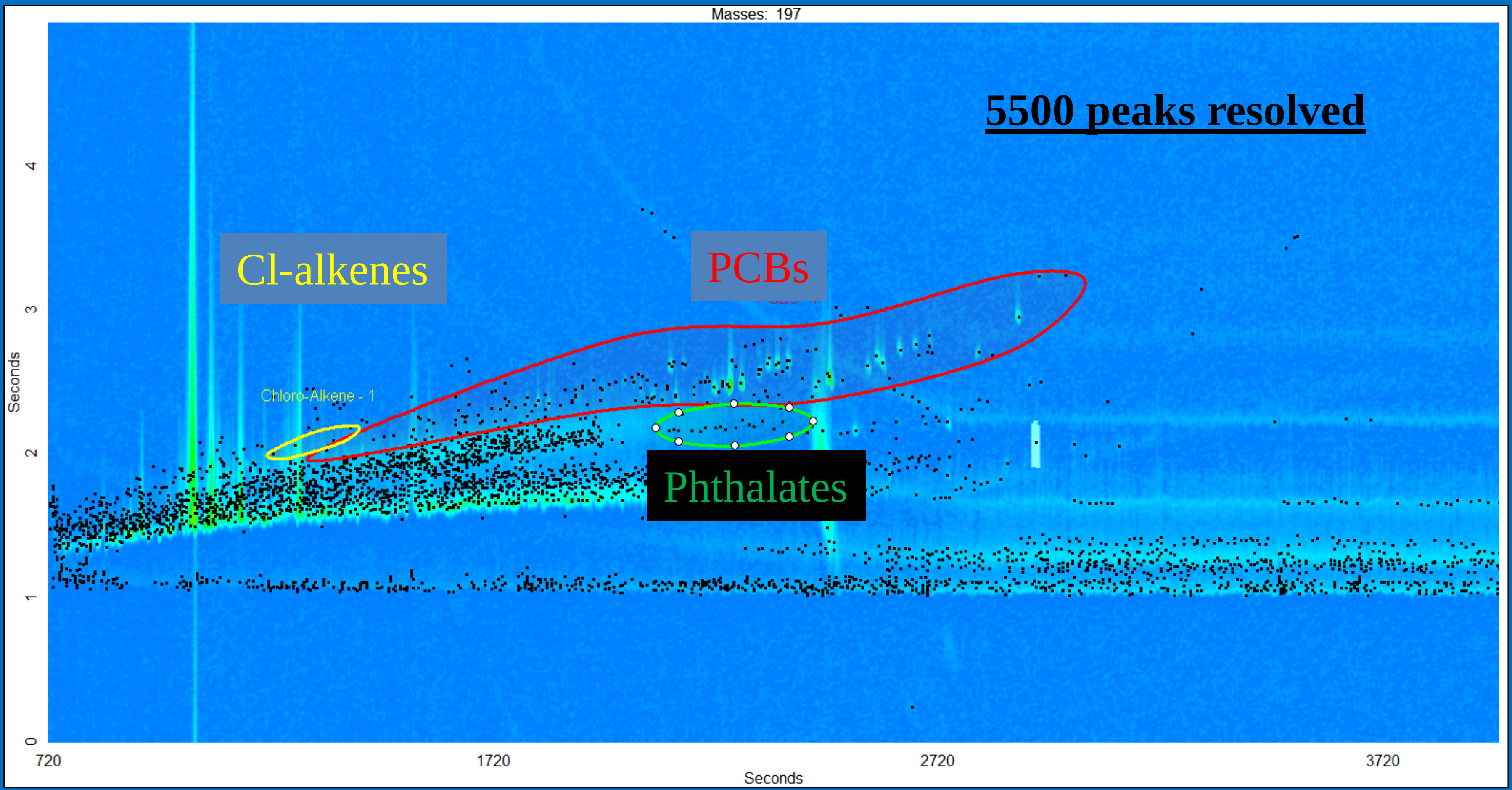
- Howard-Muir List of persistent and bioaccumulative in-use organic chemicals in commerce (2010)
    - 610 potential compounds, including a top 50 list

- Purchase neat compounds listed by Howard-Muir, prepare standards
    - Process GCxGC-TOF data files – confirm hits based on MS and retention time

- Reverse MS library search for Howard-Muir List compounds where standards not available
    - NIST Mass Spectral Database: 213,000 chemicals

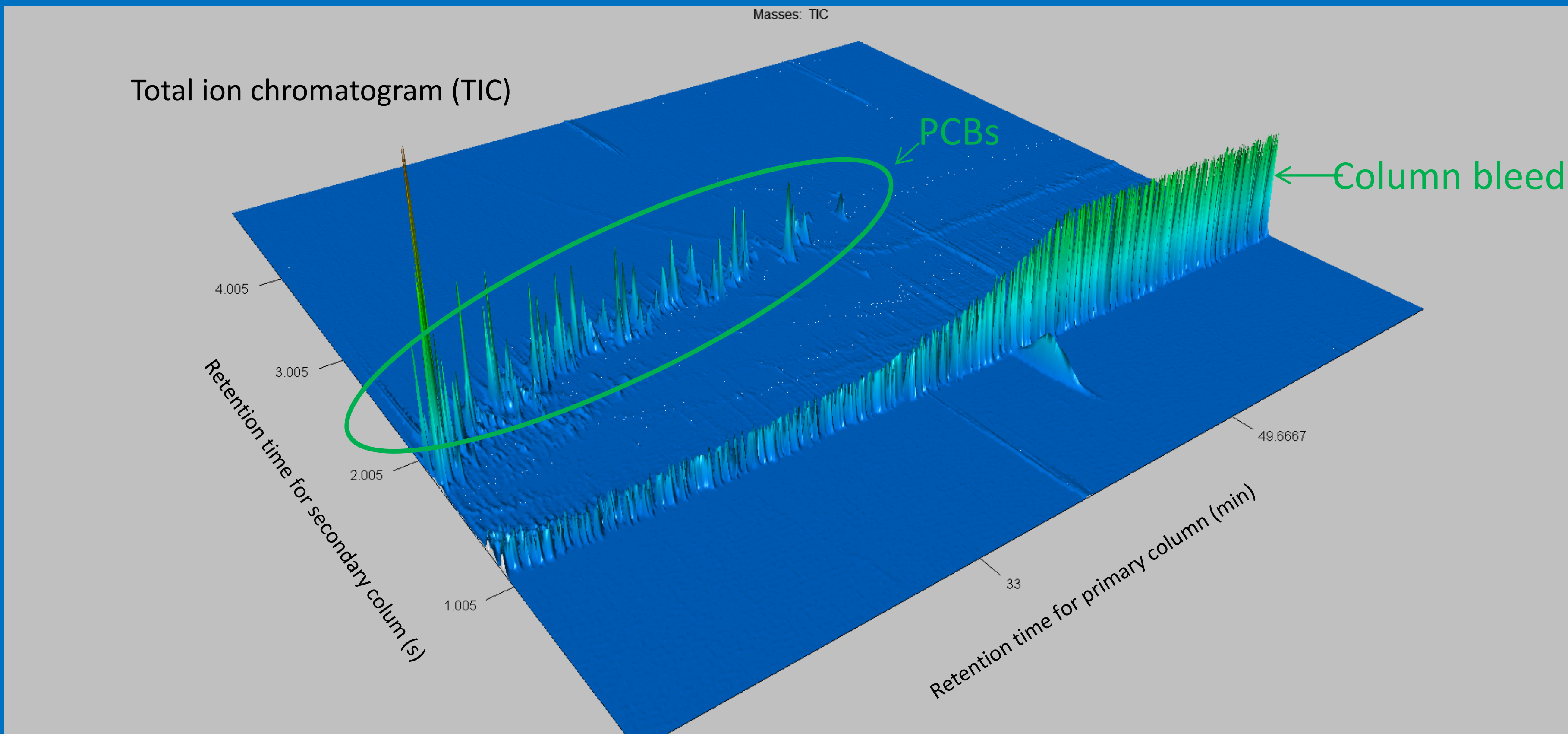
- Non-targeted approach for identifying emerging contaminants
    - Sort through mass spectra from peak table in processed datafile, and investigate interesting matches

Pegasus GC x GC - ToF



1. 1000's of compounds can be indentified using associated mass spectra (fingerprint).
2. Search for unknown compounds with similar structural components to known chemicals of concern (most flame retardants are halogenated).

GCxGC-TOF analysis of an Aroclor mixture



Howard-Muir (2010) PBTs in Commerce and PBT Suspects Observed: NIST Library Results

Halobenzenes
Hexachlorocyclopentadiene – *acute toxicity*
Octachlorocyclopentene - *tetragen*
Tetrachlorobenzene – *kidney, liver injury*
Pentachlorobenzene
Hexachlorobenzene
Pentachlorobenzenethiol – *produces anisole*
Pentachloro-5,6-dimethoxy-benzene
1,4-dichloro-2-dichloromethyl-5-
Trichloromethylbenzene
Hexachloromethylxylene
Nonachloromesitylene

Cl-Nitrobenzenes – *Dyes, pesticides, rubber*
Chlorodinitrobenzene – *possible carcinogen*
Dichloronitrobenzene

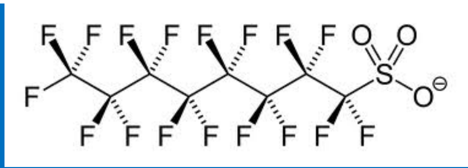
Brominated
Tribromophenol –*fungicide, metabolite*
Tetrabromobiphenyls
Bromonaphthalenes (several isomers)
Bromomethoxybenzenes (several isomers)

OP Flame Retardants – *carcinogenic, neurotoxic*
Triphenyl phosphate
Tris (2-chloroethyl) phosphate
Tris (1,3-dichloroisopropyl) phosphate
Tris (3-chlorophenyl) phosphine
Di (2-methoxypropyl) ester

Misc
Tetrabromobisphenol S – *not regulated BPA analogue*
Mitotane - *DDD isomer, antineoplastic medication*)
p-bis[trichlorovinyl] Benzene
Triclosan - *antibacterial*
Triphenyborane –*oxidizable, ng/mL toxicity for inverts*
2[p-chloro-anilino]-4,6-bis[trchloromethyl]-S-triazine (& isomers)

Fluorinated
5,5-difluorohexanechloro-1,3-pentadiene
Dichlorobenzotrifluoride – raw material, *mutagen*

UPLC-QToF Full Scans



Not all Chemicals of Emerging Concern are GC Amenable
Example: PFOS

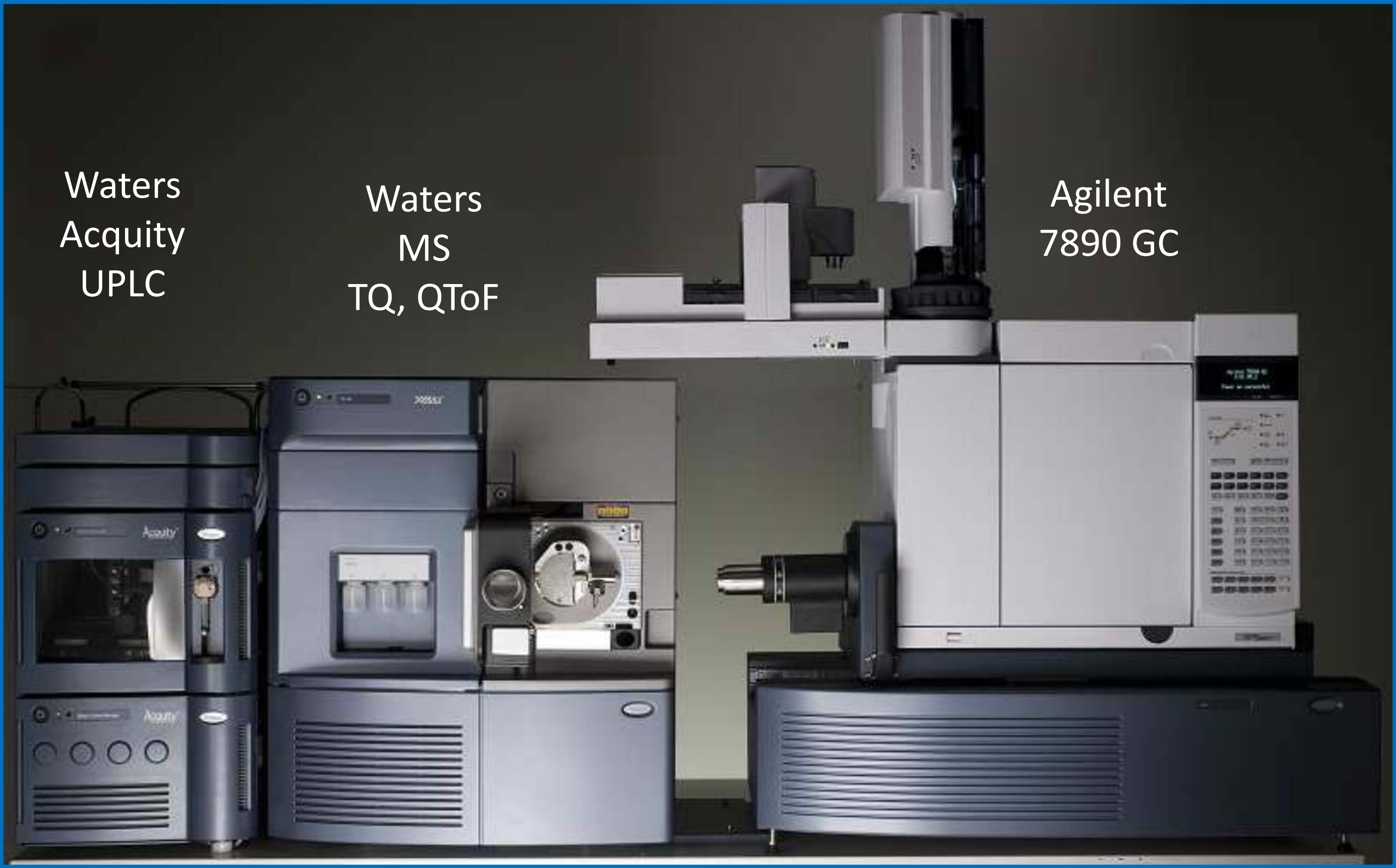
A targeted/non-targeted screening method for perfluoroalkyl carboxylic acids and sulfonates in whole fish using quadrupole time of flight mass spectrometry and Ms^e; Crimmins et al., 2014 *Analytical and Bioanalytical Chemistry* (2014) 406:1471-1480.

Utilize multiple ionization energy channels (conformation) and high resolution mass spectrometry (molecular formula).

Currently using plotting techniques to identify e-chemical candidates based on accurate mass measurements

Data files from the targeted analysis for PFCAs and PFSAs in lake trout serve as input data

Emerging Contaminant Screening Using Atmospheric Pressure Gas Chromatography – Quadrupole Time of Flight Mass Spectrometry (APGC-QToF)



Waters (Milford, MA)

Screening for Emerging Chemicals (APGC-QToF)

Advantages

1. Softer Ionization (increased M+ presence)
2. Atmospheric Pressure (no venting)
3. Tuning (multiple lock mass configurations)
4. Addition of compound specific modifiers (wet vs. dry)
5. Continuous data independent MS/MS (Low/high energy channels)

Disadvantages

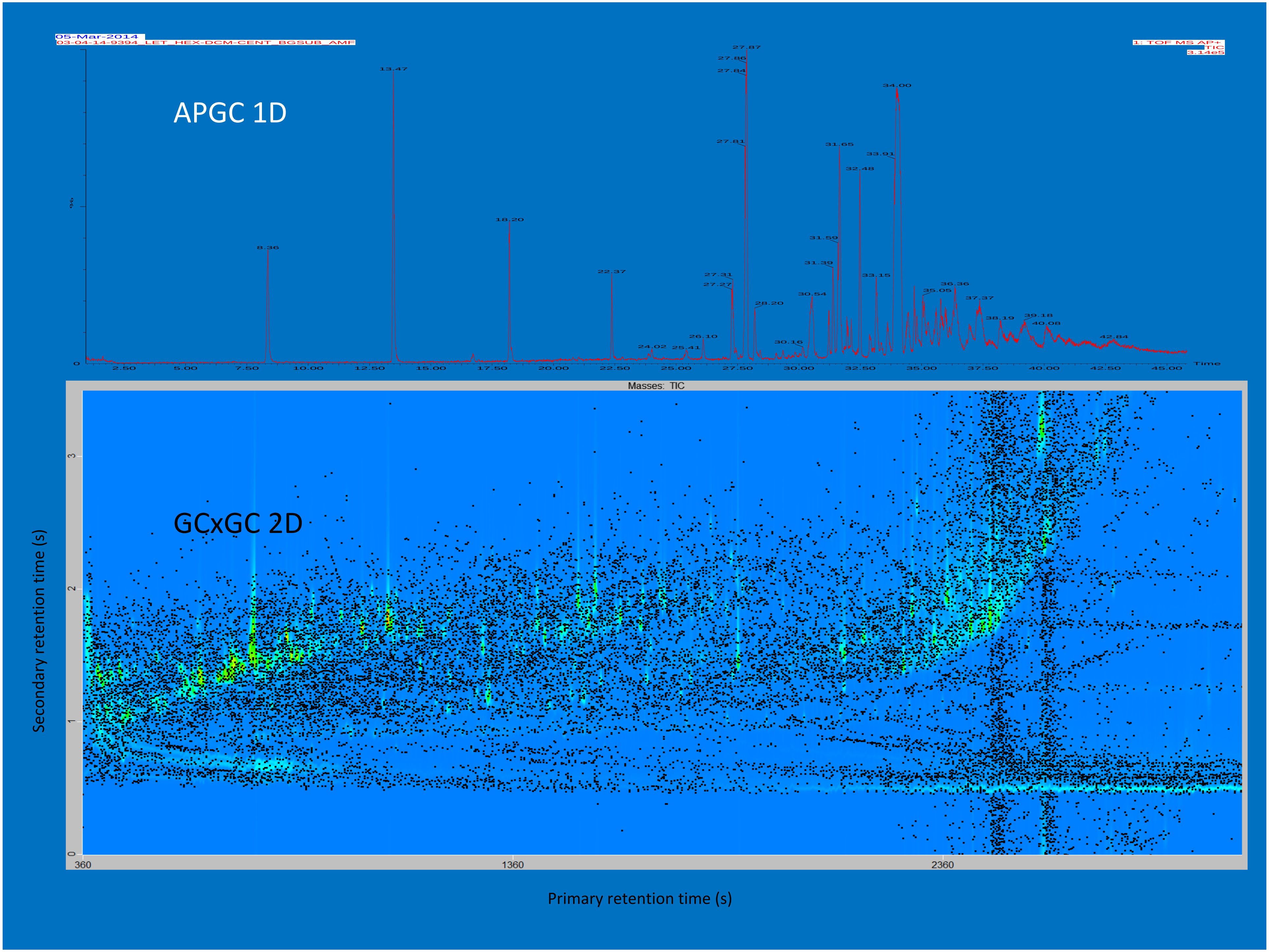
1. Softer ionization (no library)
2. Atmospheric pressure (potential matrix affects)
3. Matrix induced ionization differences (wet vs. dry)

QToF- full spectra acquisitions for low and high energies, >10,000 res

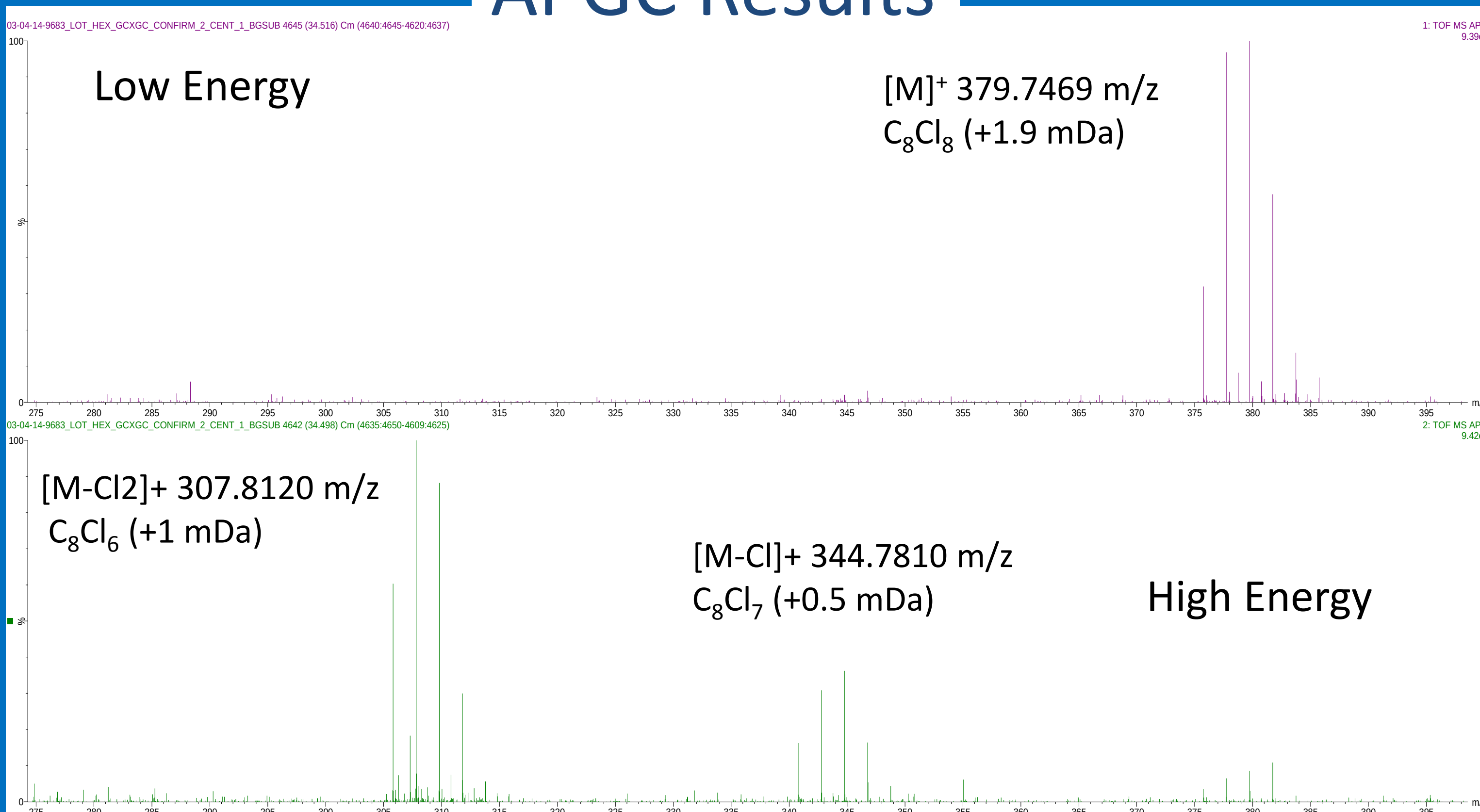
Screening for Emerging Chemicals

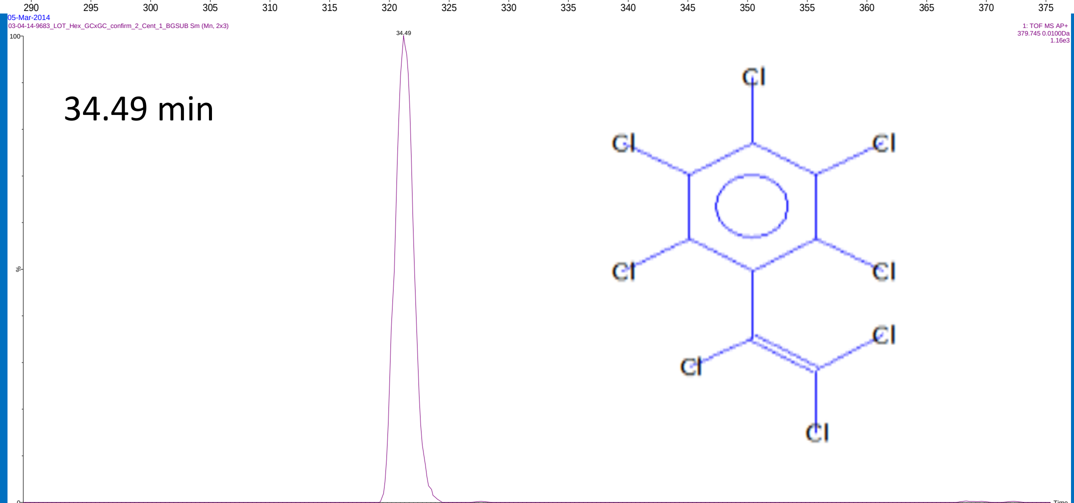
1.Confirmation of GCxGC-TOF results (Molecular ion)
- Similar instrument configuration
- Utilize the mass resolution
- Multiple energy channels

2.Data reduction of full scans
- Background Subtraction
- Mass defect filtering
- Data independent MS/MS – Low and high energy channels for each scan


APGC 1D
GCxGC 2D
Masses: TIC
Secondary retention time (s)
Primary retention time (s)

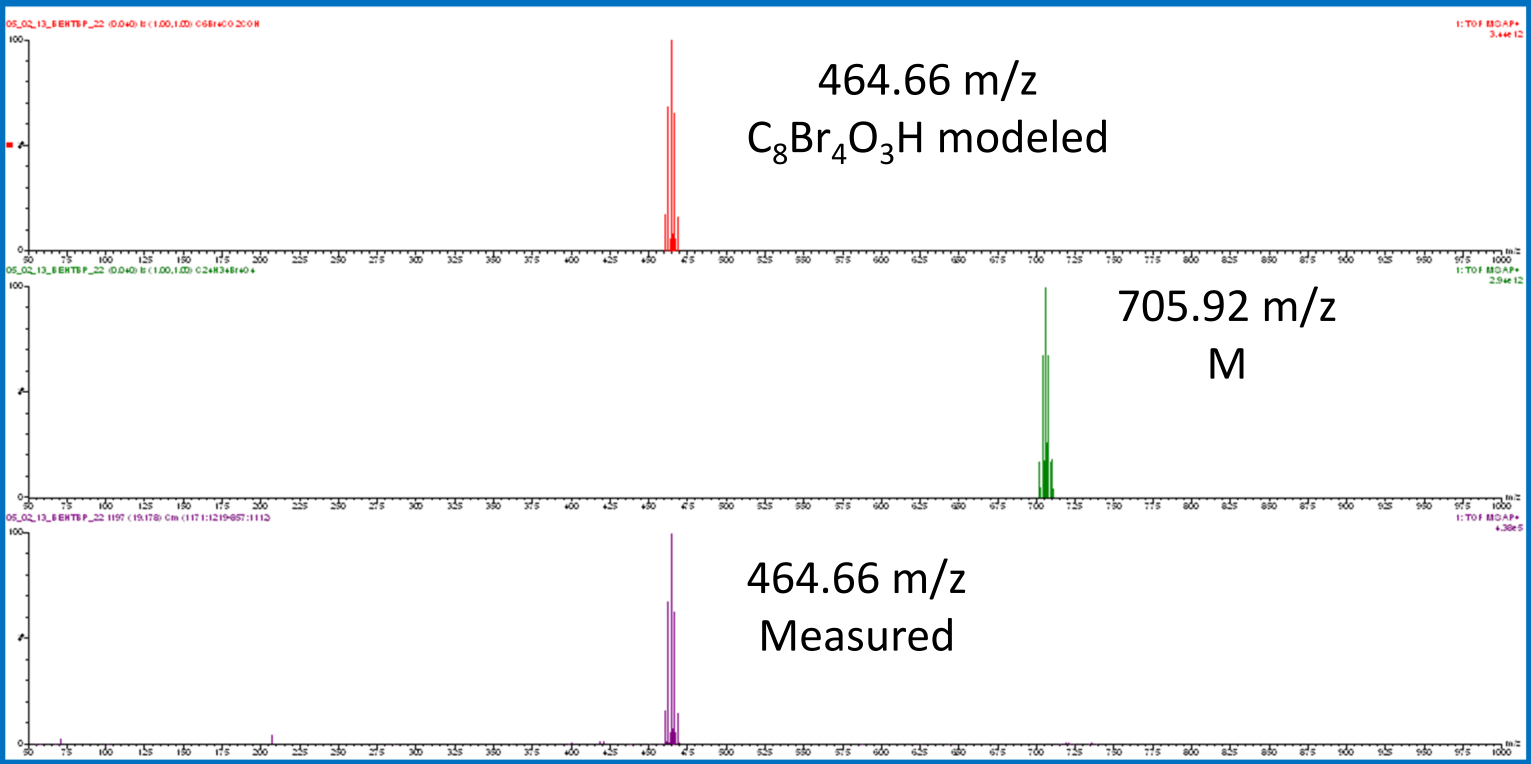
APGC Results



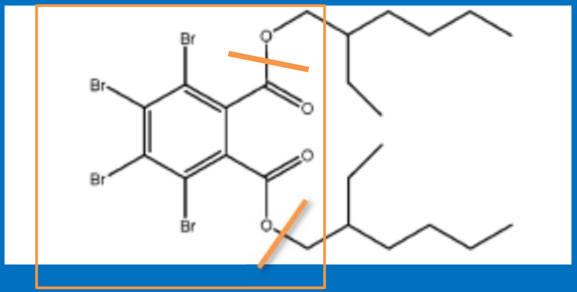


Octachlorostyrene
C_8Cl_8

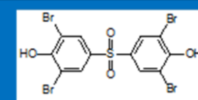
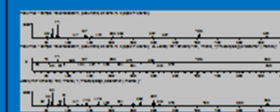
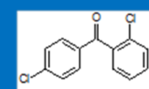
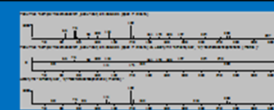
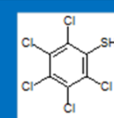
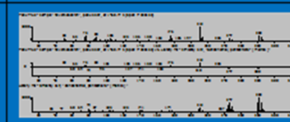
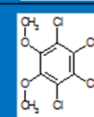
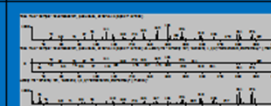
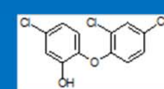
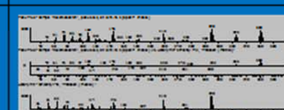
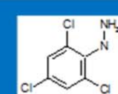
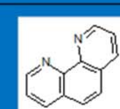
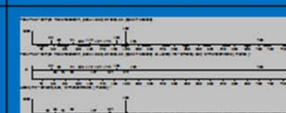
Bis(ethylhexyl) tetrabromophthalate (BEHTBP)



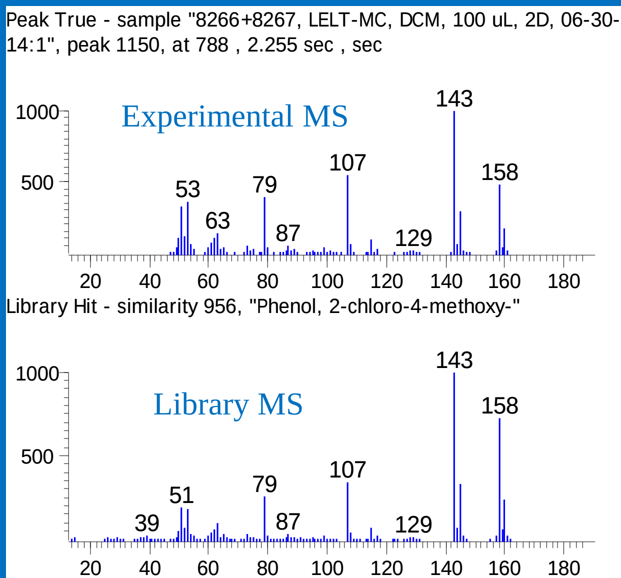
Molecular ions not observed

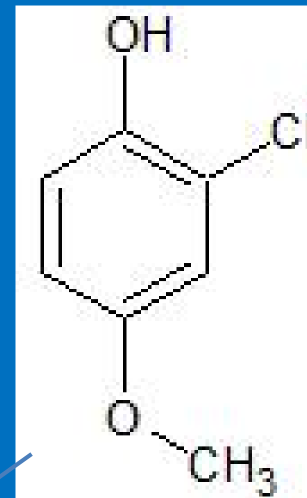


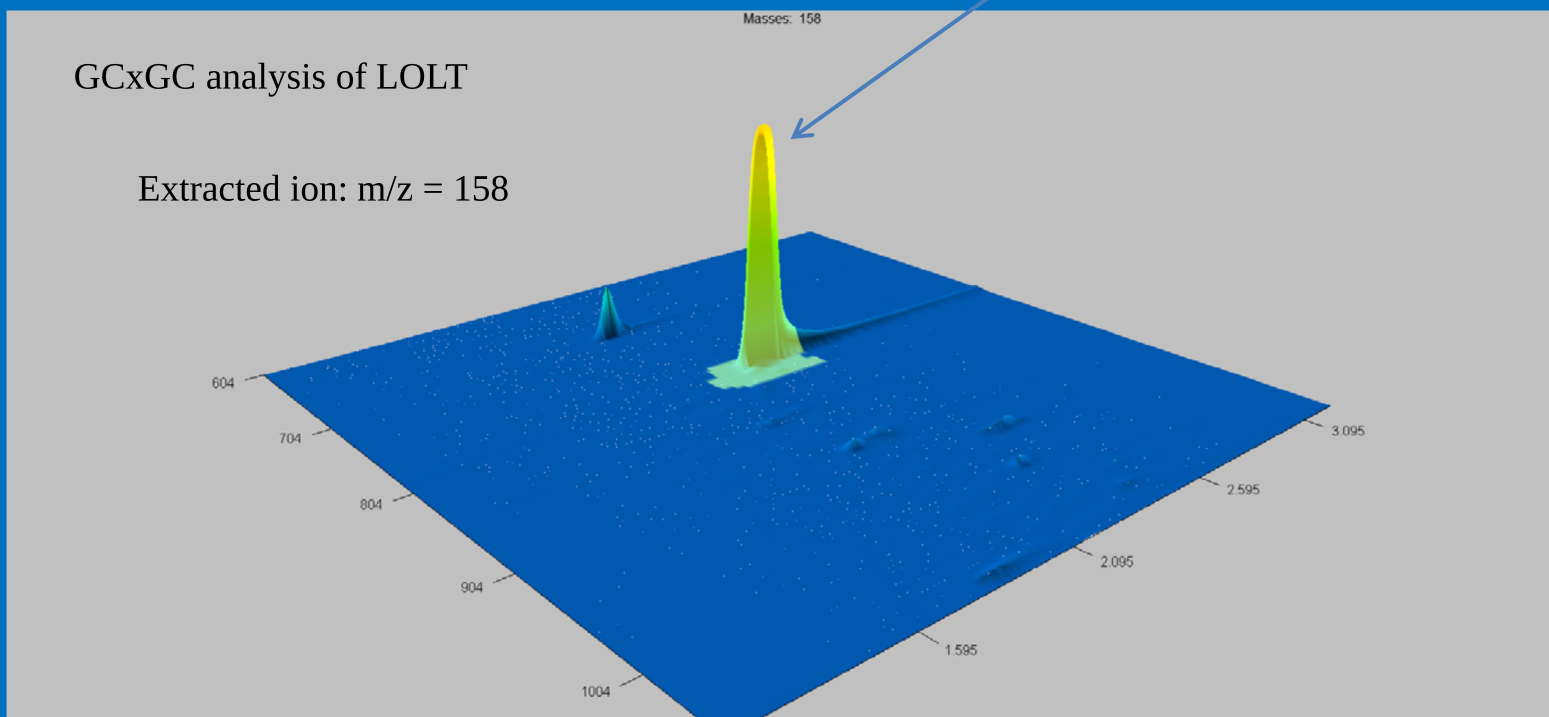
Muir Howard Database

File Name	Peak #	Area	Name	Formula	CAS#	Structure	MS
Targeted Howard-Muir List Compounds							
2010 LELT Combined, 50/50, 2D, 02-07-13	9048	53010	Phenol, 4,4'-sulfonylbis[2,6-dibromo-	C12H6Br4O4S	039635-79-5		
2010 LELT Combined, 50/50, 2D, 02-07-13	4669	9250.8	2,4'-Dichlorobenzophenone	C13H8Cl2O	000085-29-0		
2010 LELT Combined, 50/50, 2D, 02-07-13	5557	966637	Benzenethiol, pentachloro-	C6HCl5S	000133-49-3		
2010 LELT Combined, 50/50, 2D, 02-07-13	2656	14472	Benzene, 1,2,3,4-tetrachloro-5,6-dimethoxy-	C8H6Cl4O2	000944-61-6		
2010 LELT Combined, 50/50, 2D, 02-07-13	4179	58969	Triclosan	C12H7Cl3O2	003380-34-5		
2010 LELT Combined, 50/50, 2D, 02-07-13	515	21217	trichlorophenyl)-	C6H5Cl3N2	005329-12-4		
2010 LELT Combined, 50/50, 2D, 02-07-13	2784	76332	Phenanthroline	C12H8N2	000066-71-7		

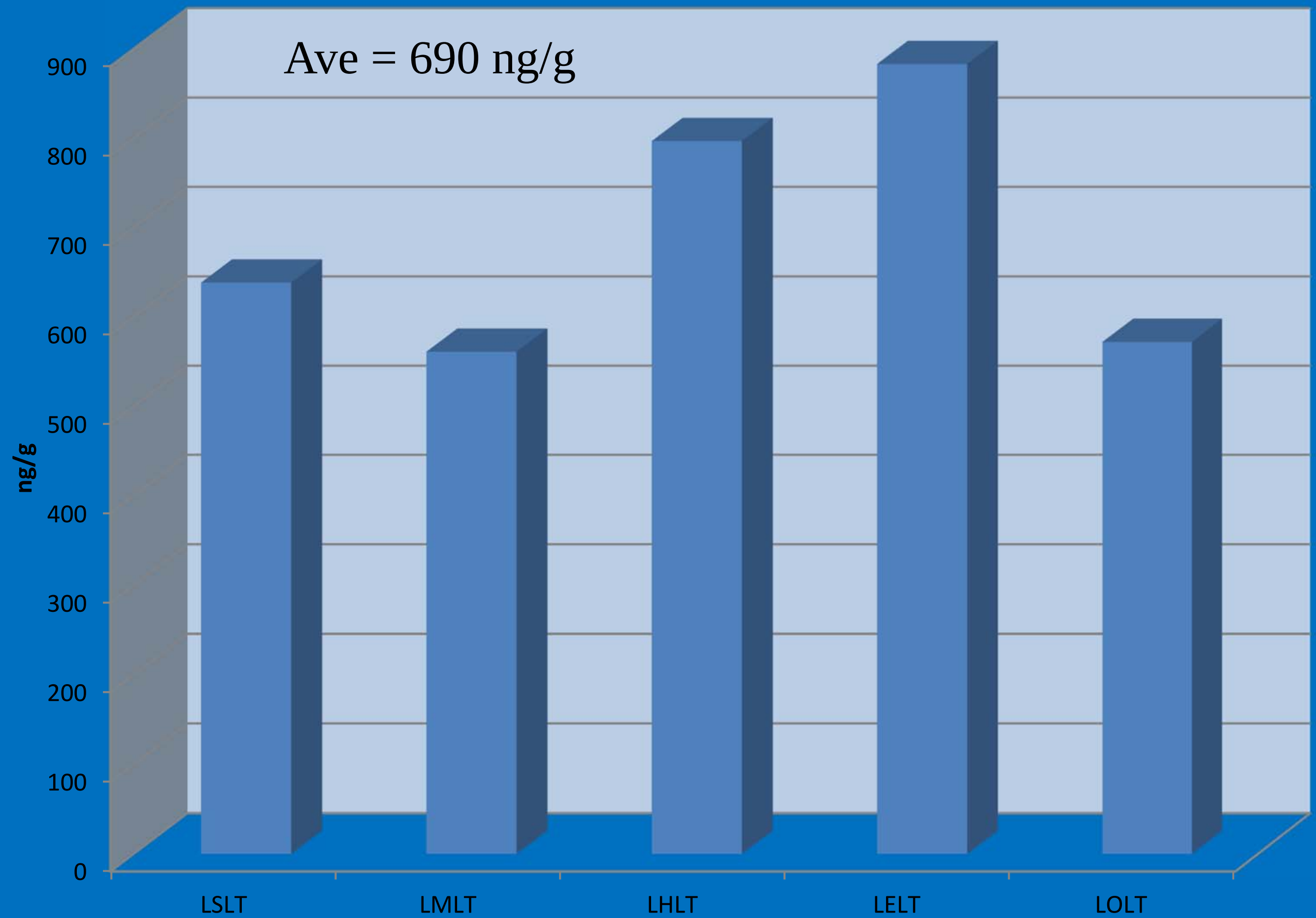
2-Chloro, 4-methoxy phenol: isomer confirmed with standard

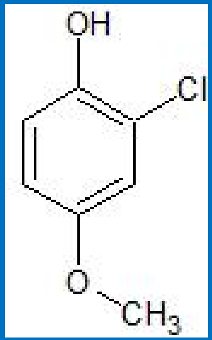






Concentrations (ng/g, or ppb) of 2-Chloro, 4-methoxy phenol in 2010 Great Lakes Lake Trout megacomposites





• Concentrations of this single isomer very similar to total concentrations of PCBs

GLFMSP E-chemical 2015 Summary

1. Currently building contemporary food web/contaminant relationships, perfluoroalkyl acids, fatty acids, stable isotopes.

2. New chemicals are out there, and we are slowly combing through the thousands of compounds – PFOS decreasing, PFAA transition period 2006-2008 consistent with legislative action.

3. The *in silico* work based on physical chemical properties has yielded detectable chemicals of concern in Great Lakes biota (Howard and Muir, 2010) and continuing to compile, catalogue and confirm new chemicals,

4. We are not at a point to provide concentration data or an all-inclusive list of emerging chemicals in the various Great Lakes (standard availability, data quantity) – working on a tabulated list of new chemicals,

5. Employing new techniques to speed up compound identification (scripts, APGC-QToF).

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All you wanted to know about Ontario's Fish Contaminant Monitoring

Satyendra Bhavsar
Research Scientist, Fish Contaminant Monitoring Program
Ontario Ministry of the Environment and Climate Change

Province of Ontario

Great Lakes Region

1 Canadian Province

8 U.S. States

Great Lakes Region

	Area (km^2)	Water (km^2)	% Water	Population	GDP millions USD
Ontario	1,076,395	158,654	14.7	12,851,821	584,129
Illinois	149,998	5,985	4.0	12,880,580	633,938
Indiana	94,321	1,415	1.5	6,596,855	253,575
Michigan	250,493	103,955	41.5	9,909,877	380,363
Minnesota	225,181	18,915	8.4	5,457,173	262,631
New York	141,300	19,076	13.5	19,746,227	1,141,088
Ohio	116,096	10,100	8.7	11,594,163	470,925
Pennsylvania	119,283	3,221	2.7	12,787,209	552,432
Wisconsin	169,639	28,839	17.0	5,757,564	239,991
Great Lake States	1,266,311	191,505	15.1	84,729,648	3,934,943
Gr Lk States/Ontario	**1.2**	**1.2**	**1.0**	**6.6**	**6.7**

All values from Wikipedia; GDP values for 2008

Ontario

Province of Ontario

- 2nd largest Canadian Province
- 4th when the Northwest Territories and Nunavut are included
- Canada's most populous province by a large margin, accounting for nearly 40% of all Canadians

Ontario

Province of Ontario

Northern Ontario

87% of the area

- First Nations, Mining
- Climate Change, Hydropower
- Fishing etc

Southern Ontario

94% of the population

(38% of Canada's popn)

Ontario

Province of Ontario

- contains about 250,000 freshwater lakes
- more than 400,000 lakes, rivers and streams

ONTARIO'S FISH CONTAMINANT MONITORING

HOW DID IT START?

Ontario

English-Wabigoon Mercury Contamination

- **Dryden Chemicals Ltd**
- **Used mercury cells** to make caustic soda and chlorine for bleaching paper
- **Released 10 tonnes of mercury into the English-Wabigoon River between 1962 and 1970**
- The river served as a source of a food and drinking water, and tourism and commercial fishery

Ontario

English-Wabigoon Mercury Contamination

- High levels of mercury in fish were reported
- Fish is a prime food item for First Nation residents
- **The Government of Ontario advised the First Nations to stop eating fish, and closed commercial fishery in 1970**

Ontario

MERCURY USES IN CANADA AND THEIR POSSIBLE HAZARDS AS SOURCES OF MERCURY CONTAMINATION

1970

NORVALD FIMREITE

Department of Zoology, University of Western Ontario, London, Canada

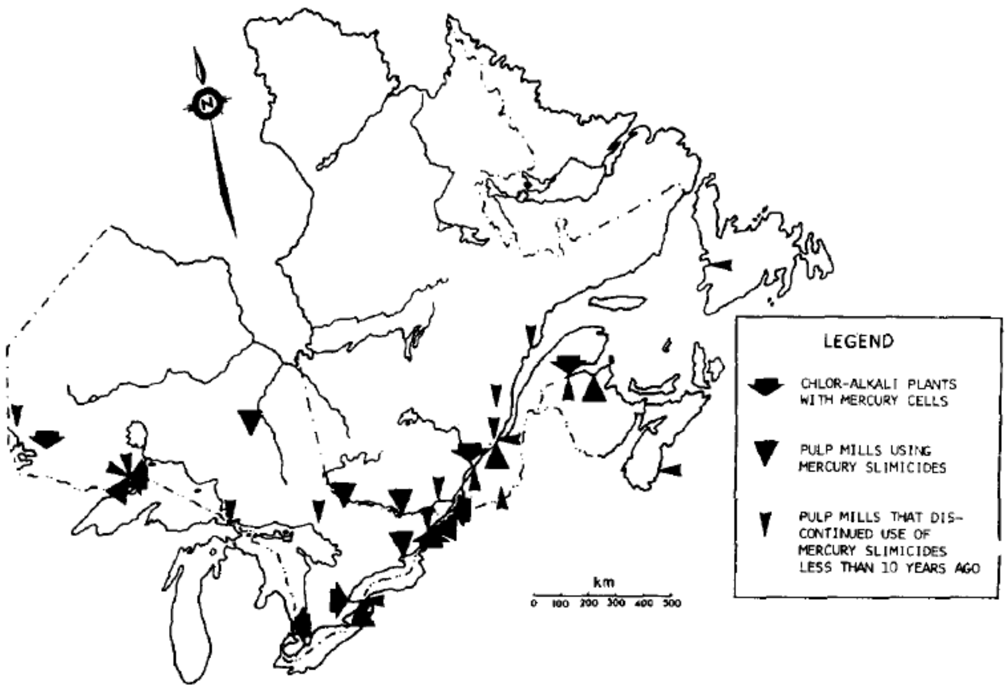


Fig. 2. Distribution of important sources of mercury contamination of water in Canada's eastern provinces.

Ontario

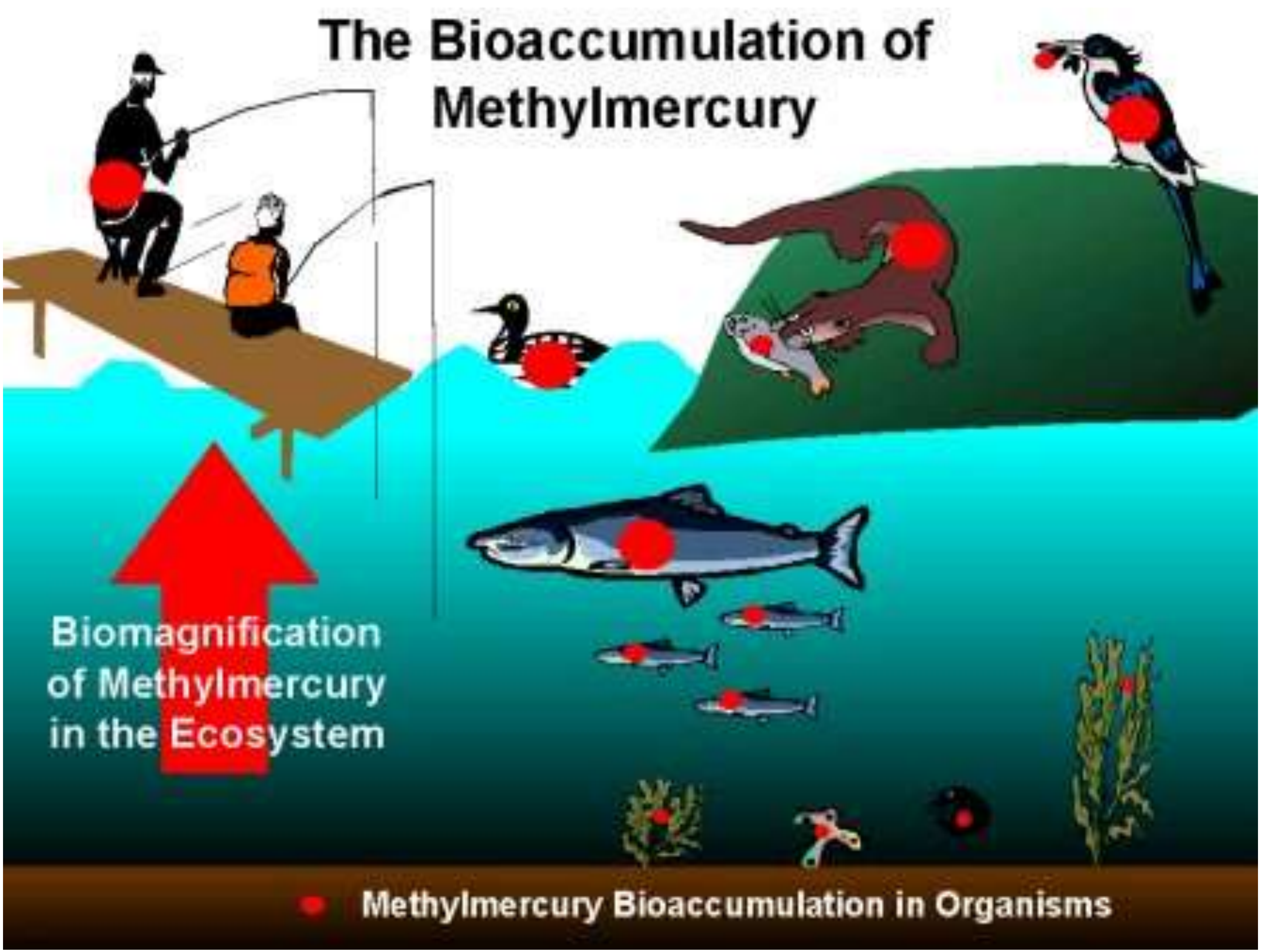
Government of Ontario started monitoring contaminants in fish during the late 1960s

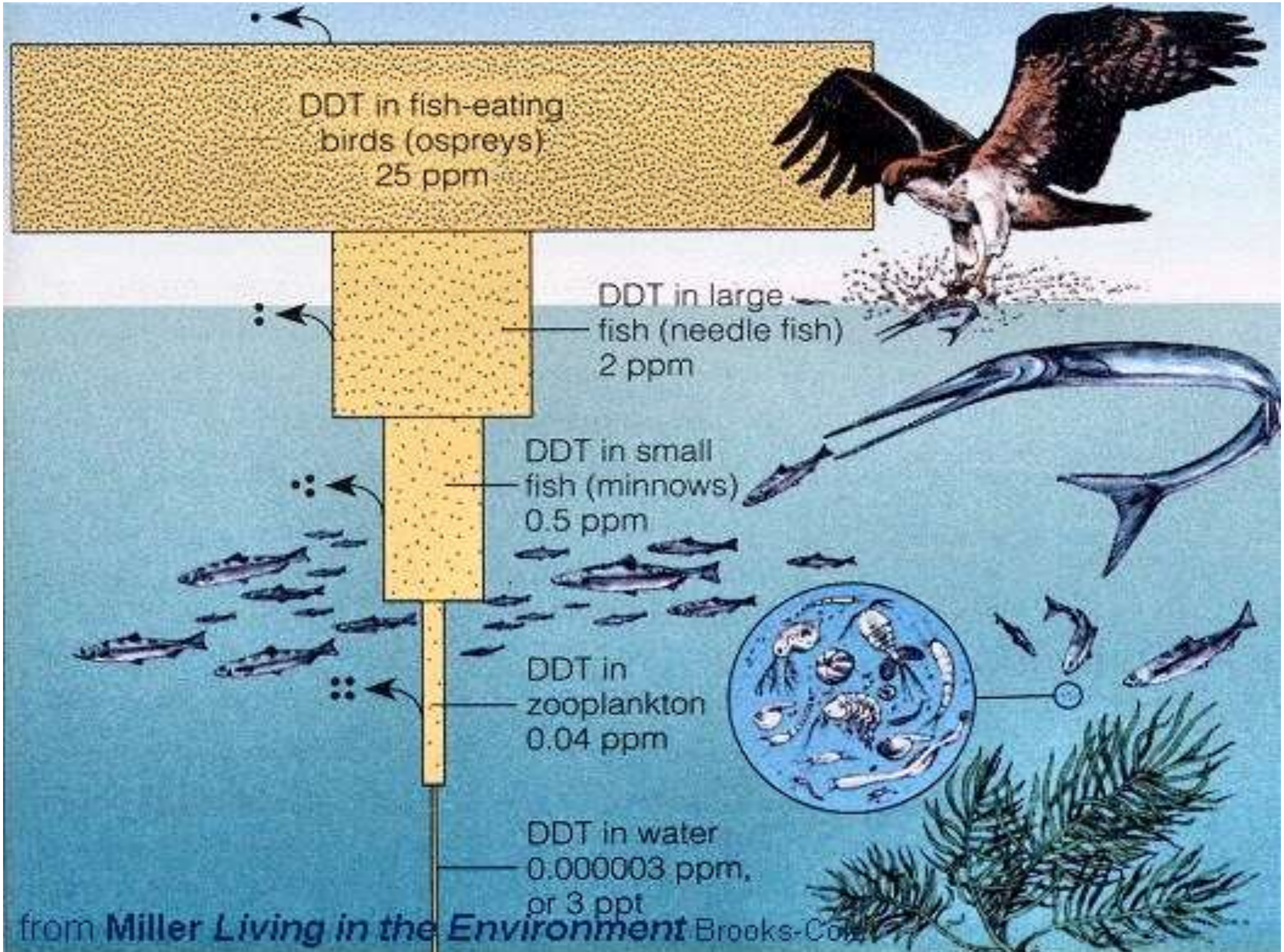
The Fish Contaminant Monitoring Program was initiated in 1976 to provide advice on safe consumption of Ontario's fish and track contaminant levels in the fish

Why Fish Contaminant Monitoring

- Fish are a **valuable bioindicator** of ecosystem health
- Fish **integrate temporal and spatial variability** over the area they travel
- Fish are the **primary link for transfer** of many contaminants from an aquatic system **to humans** and wildlife
- **Long-term biomonitoring programs**, such as fish contaminant monitoring, have been recognized as **a valuable tool**

Ontario


The Bioaccumulation of Methylmercury
Biomagnification of Methylmercury in the Ecosystem
Methylmercury Bioaccumulation in Organisms


DDT in fish-eating birds (ospreys): 25 ppm
DDT in large fish (needle fish) 2 ppm
DDT in small fish (minnows) 0.5 ppm
DDT in zooplankton 0.04 ppm
DDT in water 0.000003 ppm, or 3 ppt
from Miller *Living in the Environment* Brooks-Cole

Components of the Program

1. Field sampling

MNR Partners

Program staff

Program students

2. Sample prep

Program staff

Program students

MNR Partners

3. Laboratory analyses

MOE staff

MOE students

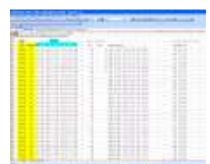
External labs

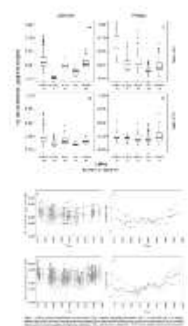
4. Data storage and archiving

Program Staff

MOE staff

5. Data analyses





Program staff

Program students

Academic partners

Others…

6. Reporting and publication

Program staff

Program students

MOE staff

Academic partners, Others…

Ontario

1. SAMPLING

Selecting locations for testing

New locations are added each year. A location may be selected if

- it is a popular angling area
- there is a known or suspected source of pollution nearby
- it is a major source of food for local inhabitants (usually lakes in the vicinity of First Nations' communities)
- it is being developed for recreation or industrial purposes
- it is part of a monitoring program for long-term studies of contaminants in fish

The selection of testing sites is an ongoing process and public input is welcomed through

www.ontario.ca/fishguide

fishguide@ontario.ca

Ontario

Retesting of a location

Retested locations are divided into three general groups:

1. Areas where contaminant levels are either unusually elevated or change substantially: **retested every 1-3 years**, depending on their popularity or whether they are a major food source for local communities
2. Areas that show no signs of substantial changes in contaminant levels but are very popular fishing areas: **retested approximately every 5 years**
3. All other areas – usually relatively remote locations with no major sources of pollution nearby and no indication of changing contaminant levels in fish: **retested approximately every 10-40 years**

Ontario

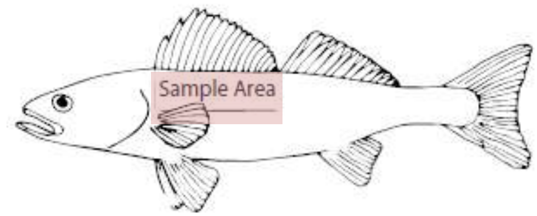
Sample collection

- In partnership with Ontario Ministry of Natural Resources and Forestry and others
- Using various methods
  - Gill nets
  - Trap nets
  - Electrofishing
  - Angling

Ontario

Sample selection

- If possible, 10 or more fish of each species with representative of the size range
- The length, weight and sex of each fish are recorded
- Generally, a skinless, boneless fillet of dorsal muscle flesh is retained
- Samples are frozen and shipped to the Program office



Ontario

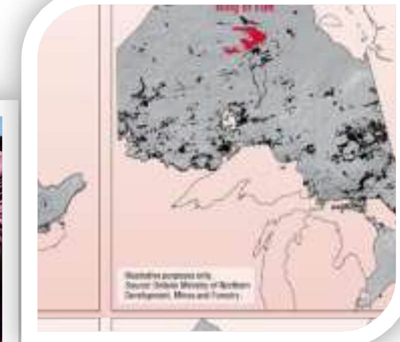
We monitor
for more than advisories
and more than sport fish!




Issue related sample collection: Partnership

<u>Ring of Fire</u>

- MNR
- Laurentian University



<u>First Nations</u>

- First Nations
- MNR
- Laurentian University

<u>Hydropower</u>

- Proponents & Consultants

Ontario

2. SAMPLE PREP

Ontario

Homogenizing fish samples

Ontario

Specimen Bank

- Established a specimen bank in 2010 to archive samples of indicator species from selected locations
- The samples are cryo-preserved at -80 C
- Allows a retrospective analysis

3. SAMPLE ANALYSIS

Analysis for Contaminants

- Conducted at the Ontario Ministry of the Environment and Climate Change laboratories in Toronto
- Accredited, world class facility

Ontario

Start and End of Monitoring of Major Contaminants

1967 – Mercury

1970 – DDT

1975 – PCB, some organochlorines, metals

1982 – Dioxins

1983 – Toxaphene

1985 – Chlorinated phenols, benzene (stopped: 2002)

1987 – PAHs (stopped: 2006)

2005 – PBDEs, PCNs

2008 – PFASs

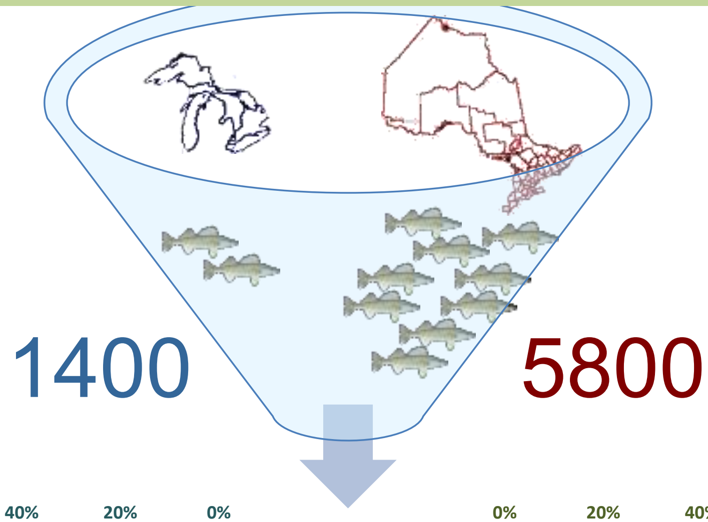
Ontario

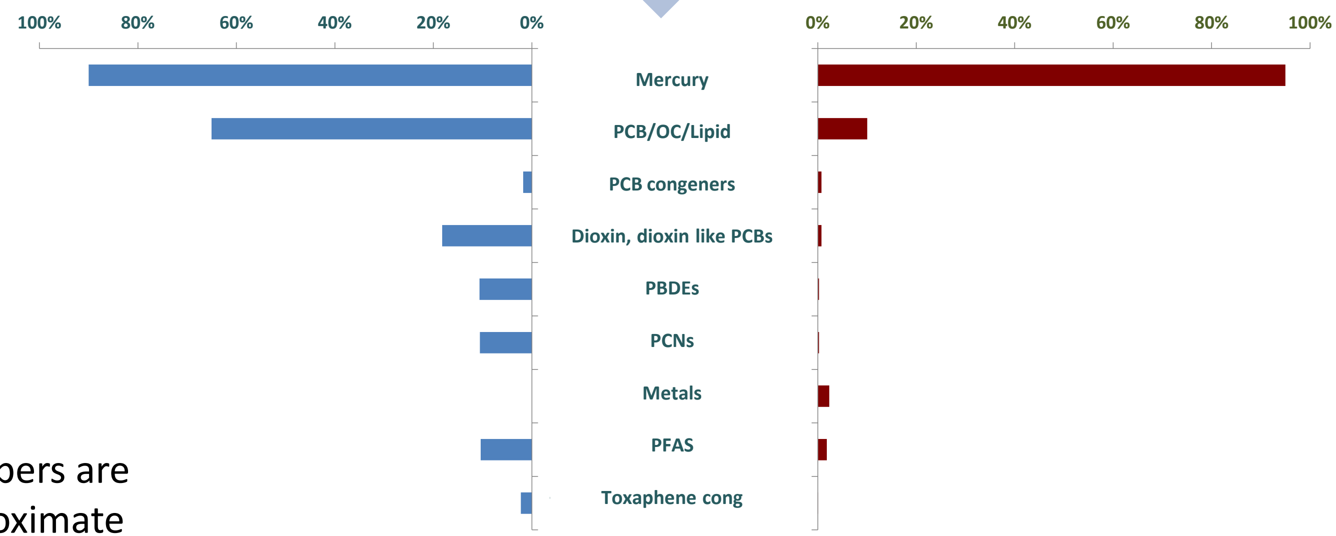
Selecting species for testing

- Not all species from a location accumulate a particular contaminant at the same rate
- For mercury, we start with top predators, as they likely indicate the highest mercury levels. If low levels of mercury are found, the testing of other species may not be necessary.
- For organic contaminants such as PCBs and mirex, species with high fat, such as Salmon, Trout, Carp and Catfish, are initially selected. Again, if these species do not contain excessive levels, then species with less fat from the same location may not have to be tested.

Ontario

Yearly sample collection & analyses





Numbers are approximate

Managing Laboratory Analysis Requirements

- Adopted a surveillance approach for PCBs and other organic contaminants
  - Resulted in saving of about 3500 PCB/Lipid/OC analysis in last 10 years
- Developed an empirical relationship to estimate dioxin-like PCBs using total-PCB
  - Would require equivalent analysis of $1M per year

Moving forward: Revise Monitoring Needs

1967 – Mercury

1970 – DDT

1975 – PCB, some organochlorines, metals

1982 – Dioxins

1983 – Toxaphene

1985 – Chlorinated phenols, benzene (stopped: 2002)

1987 – PAHs (stopped: 2006)

2005 – PBDEs, PCNs

2008 – PFASs

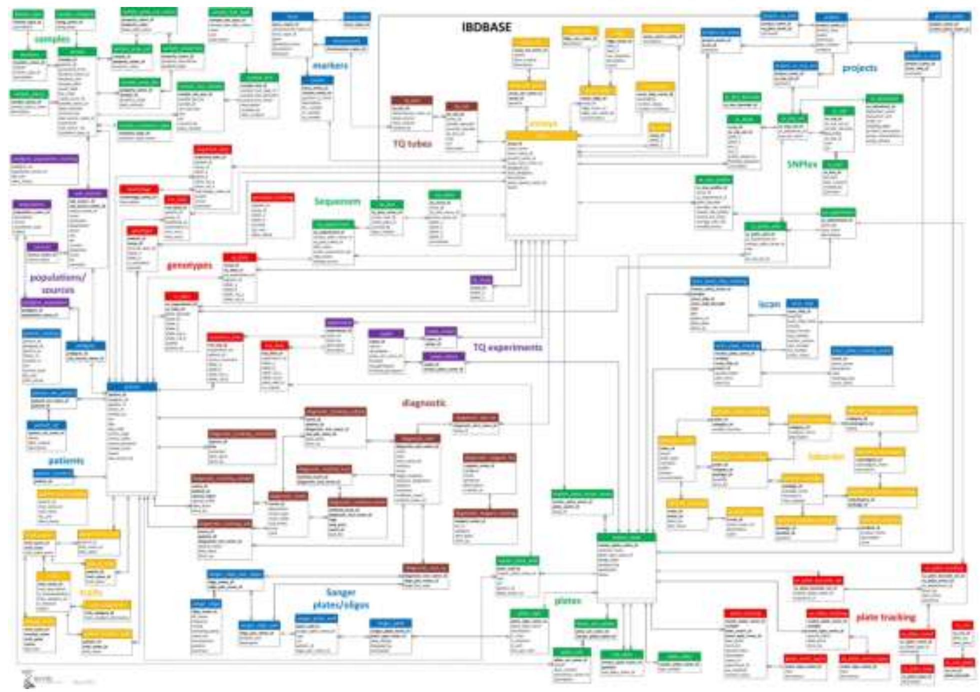
Ontario

4. DATA STORAGE

Data Storage

<u>LIMS</u>: Laboratory Information Management System

<u>FISHBASE</u>: Fish Contaminant Monitoring Program Database



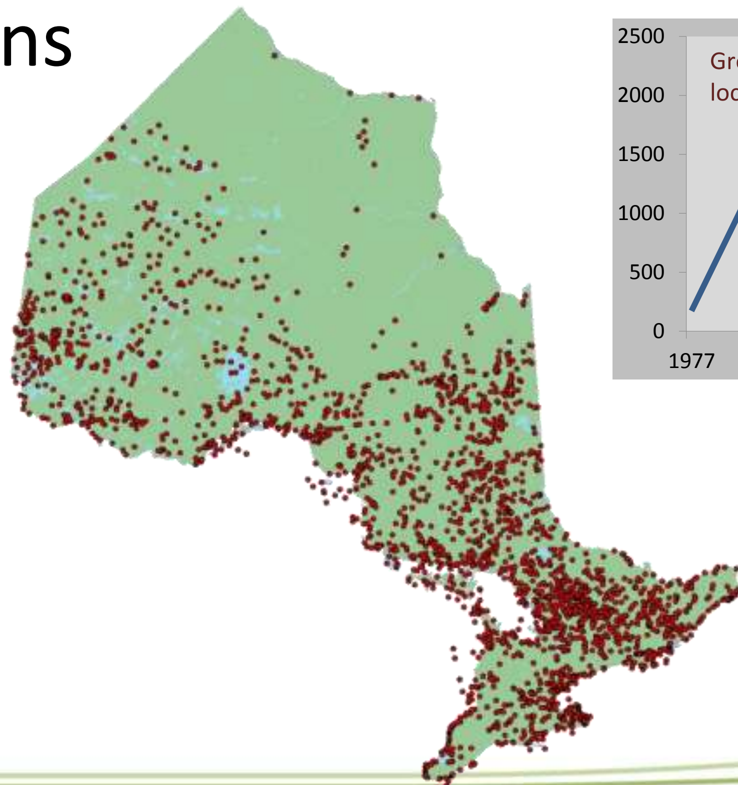
Ontario

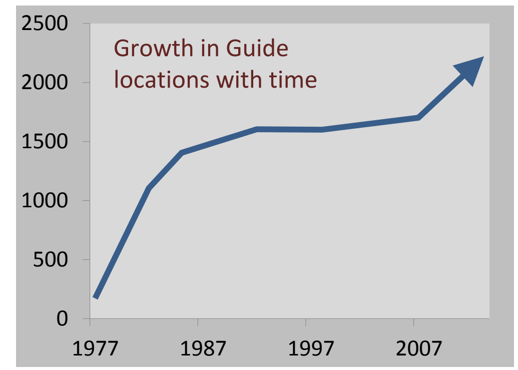
5. FISH CONSUMPTION ADVISORIES

Ontario

Advisory locations: Province-wide Coverage

>2300 locations





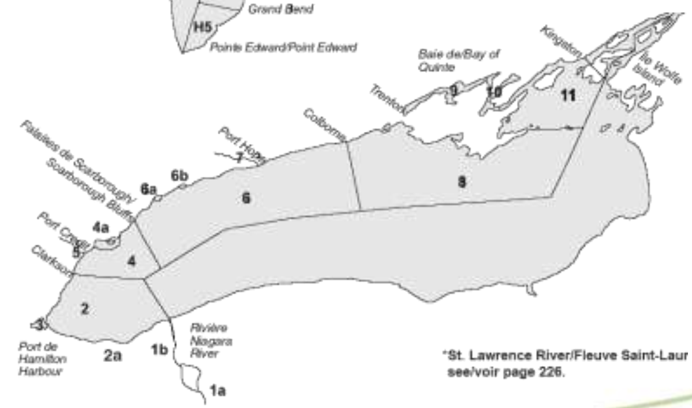
Ontario

Great Lakes Blocks (for advisories)

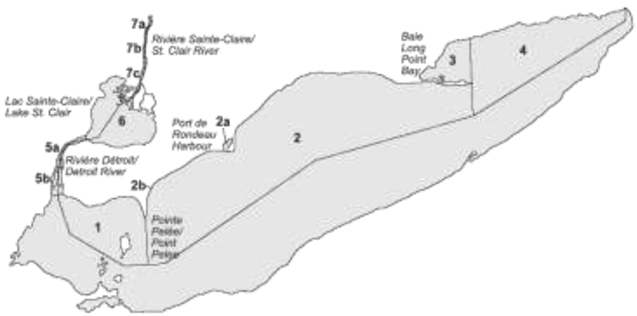
Superior

Huron

Ontario

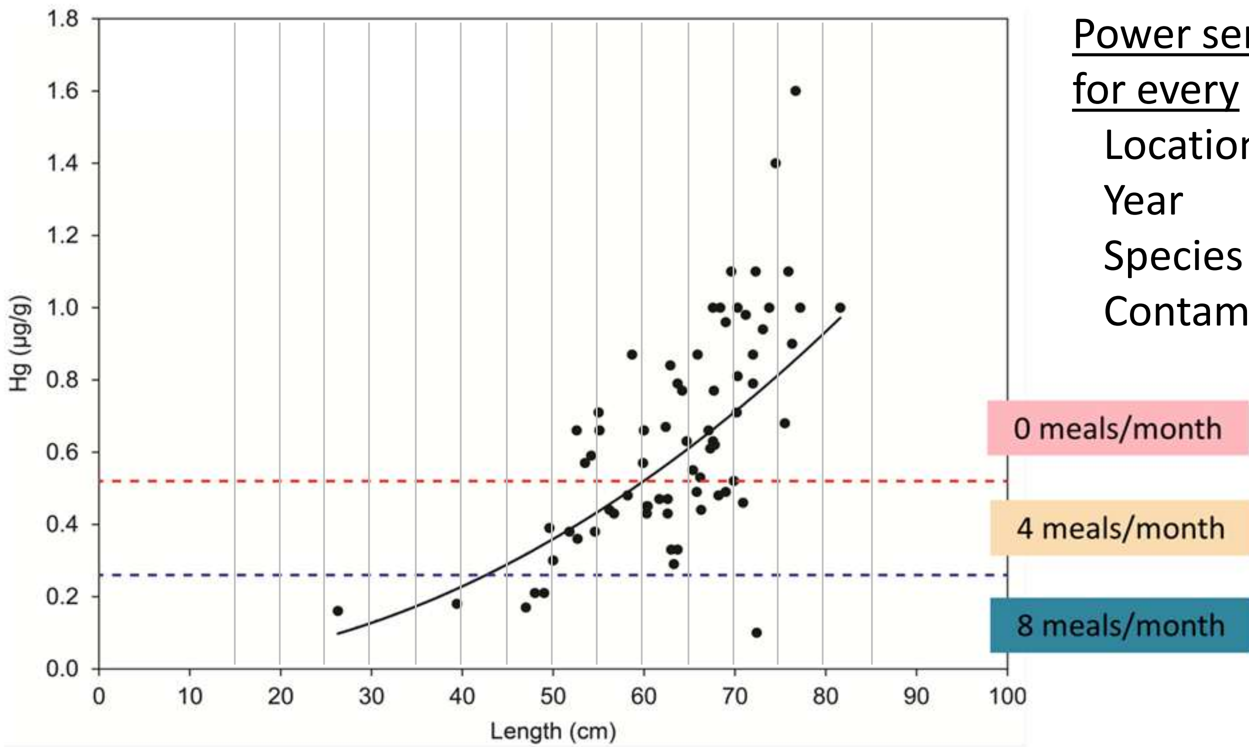


Erie



Total: >60 blocks
AOCs are separate blocks

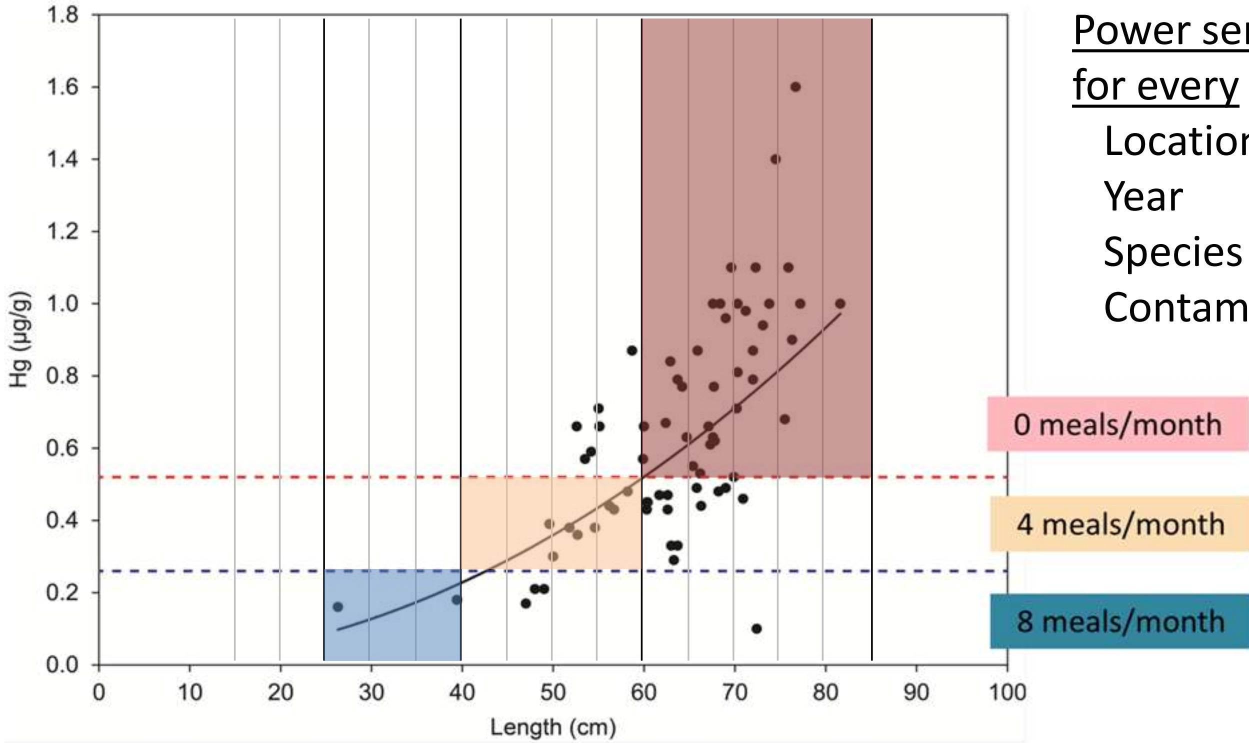
Calculation of advisories



<u>Power series regression for every</u>

- Location
- Year
- Species
- Contaminant

Calculation of advisories



Power series regression for every

- Location
- Year
- Species
- Contaminant

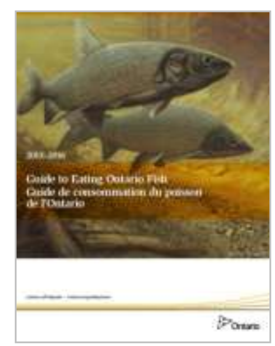
Ontario

Calculation of advisories

- Advisory benchmarks are generally based on tolerable daily intake from Health Canada
- Separate benchmarks for Hg for the general and sensitive populations
- Advisories calculated for 5 cm size categories for each contaminant
- Most restrictive advisory for a 5 cm size category is generally selected

Ontario

Guide to Eating Ontario Fish



Released annually: 1977-1992
Biennially: 1992-Present

2005 onwards - Separate advise for Children and Women of child-bearing age

<table>
<tr><th>Length/</th><th>15</th><th>20</th><th>25</th><th>30</th><th>35</th><th>40</th><th>45</th><th>50</th><th>55</th><th>60</th><th>65</th><th>70</th><th>75</th><th>>75 cm</th></tr>
<tr><th>Longueur</th><th>6"</th><th>8"</th><th>10"</th><th>12"</th><th>14"</th><th>16"</th><th>18"</th><th>20"</th><th>22"</th><th>24"</th><th>26"</th><th>28"</th><th>30"</th><th>>30"</th></tr>
<tr><td colspan="15">Bentley Lake / Lac Bentley
Faraday Twp./Canton de Faraday, Hastings Co./Cté de Hastings 4502/7755</td></tr>
<tr><td>Largemouth Bass[6]</td><td colspan="6">8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Achigan à grande bouche[6]</td><td>8</td><td colspan="5">4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Smallmouth Bass[6]</td><td colspan="5">8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Achigan à petite bouche[6]</td><td colspan="2">8</td><td colspan="3">4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Yellow Perch[6]</td><td colspan="3">8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Crapet de roche[6]</td><td colspan="2">8</td><td>4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Pumpkinseed[6]</td><td colspan="2">8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Crapet-soleil[6]</td><td colspan="2">8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Brown Bullhead[6]</td><td></td><td colspan="3">8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Barbotte brune[6]</td><td></td><td colspan="3">8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>White Sucker[6]</td><td></td><td colspan="5">8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Meunier noir[6]</td><td></td><td colspan="5">8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

☐ General population/population générale
☐ Sensitive population/population sensible – *Women of child-bearing age and children under 15/Les femmes en âge de procréer et les enfants de moins de 15 ans*

Starting this year – Extended advisories Up to 32 meals per month

Length • Longueur	15 6"	20 8"	25 10"	30 12"	35 14"	40 16"	45 18"	50 20"	55 22"	60 24"	65 26"	70 28"	75+cm 30+"
Lake Erie 1 - Western Basin • Lac Érié 1 - Bassin ouest													
from the Detroit River mouth to Point Pelee • entre l'embouchure de la rivière Détroit et Pointe Pelée													
Channel Catfish[2]		4		2	1						0		
Barbue de rivière[2]		4		0									
Coho Salmon[2]		2							1				
Saumon coho[2]		0											
Common Carp[2,3]			16	8	4			2	0				
Carpe[2,3]			16	8	4			0					
Freshwater Drum[1,2]	16	8	2										
Malachigan[1,2]	8		0										
Gizzard Shad[2]						2	1						
Alose à gésieree[2]						0							
Lake Whitefish[2,3]					4	2		1					
Grand corégone[2,3]					4	0							
Largemouth Bass[2]				1		0							
Achigan à grande bouche[2]				0									
Rainbow Smelt[1,2]	0												
Éperlan arc-en-ciel[1,2]	0												
Rainbow Trout[2]		1										0	
Truite arc-en-ciel[2]		0											
Sauger[2]			8										
Doré Noir[2]			8										
Smallmouth Bass[1,2]		8	4	2									
Achigan à petite bouche[1,2]		8	4	0									
Walleye[1,2]				16	12	8			4				
Doré[1,2]				12		8		4				0	
White Bass[2]		2				1							
Bar blanc[2]		0											
White Perch[2]	2		1										
Bar-perche[2]	0												
White Sucker[2]		12			8		4						
Meunier noir[2]		12			8		4						
Yellow Perch[1,2]	32	16		8									
Perchaude[1,2]	32	16	12	4									

☐ General population • population générale

☐ Sensitive population • population sensible – *Women of child-bearing age and children under 15 • Les femmes en âge de procréer et les enfants de moins de 15 ans.*

Maximum of 8 meals per month was based on our angler surveys showing that most anglers do not eat wild fish more often

Recent addition of higher meals per month categories was to address the needs of more frequent consumers (e.g., subsistence fishers).

Conversion Table: Meals to fillets

Conversion table

The following table can be used to convert one meal of 227 grams (8 oz) into approximate equivalent number of fish fillets (note: one fish contains 2 fillets). If more than one meal is safe to eat, multiply the number in the table by the meals advised. Remember, the recommendations in the advisory tables are in meals per month; as such, converting it to fillet equivalent would result in fillets per month.

For example, two meals of 227 grams (8 oz) of 30 cm Brook Trout are equivalent to approximately 6 fillets.

Tableau de conversion

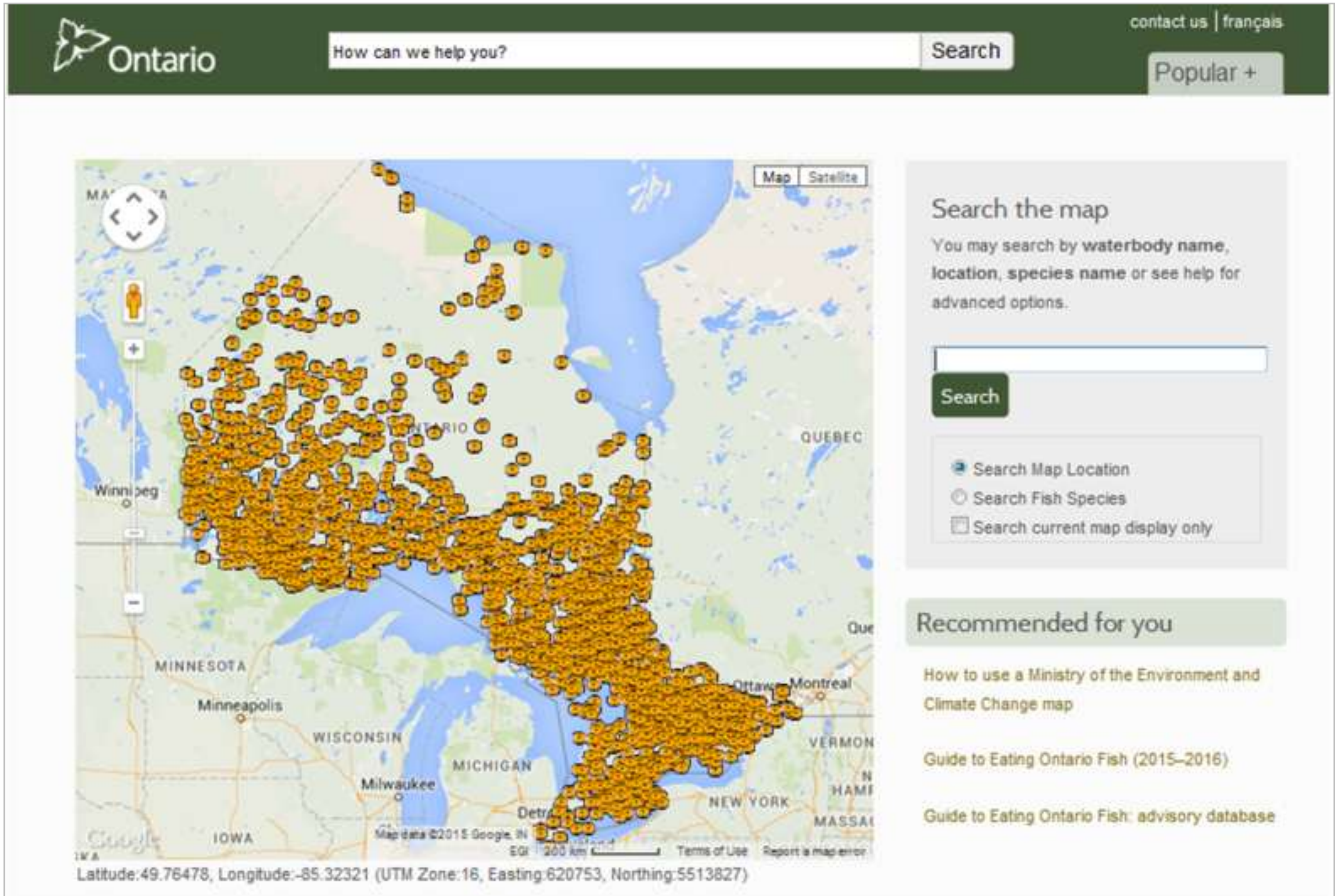
Le tableau suivant vous permet de convertir un repas de 227 grammes (8 onces) en nombre approximatif de filets (remarque : un poisson comporte deux filets). S'il est sécuritaire de prendre plus d'un repas, multipliez le nombre indiqué dans le tableau par le nombre de repas conseillé. N'oubliez pas que le nombre de repas recommandé dans le tableau s'applique à un mois entier; la conversion en filets signifie donc le nombre de filets par mois.

Par exemple, deux repas de 227 grammes (8 onces) de truites de ruisseau de 30 cm équivalent à environ 6 filets.

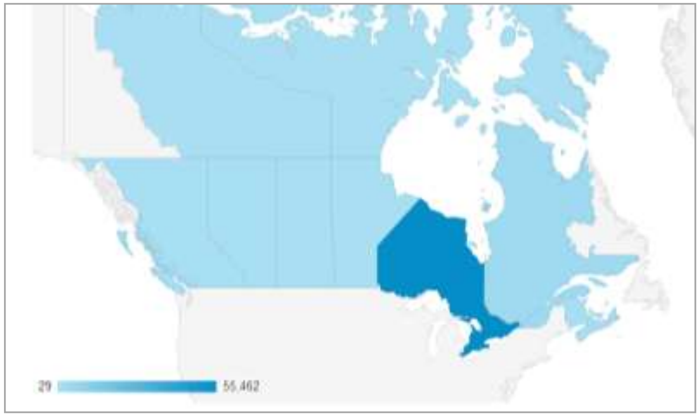
Fish species	15	20	25	30	35	40	45	50	55	60	65	70	75cm	Espèce de poisson
Length	6"	8"	10"	12"	14"	16"	18"	20"	22"	24"	26"	28"	30"	Longueur
Atlantic Salmon								0.5	0.4	0.3	0.2	0.2	0.1	Saumon de l'Atlantique
Bigmouth Buffalo					1.8	1.2	0.8	0.6	0.4	0.3	0.2			Buffalo à grande bouche
Black Crappie	34	14	7	4	2.7									Marigane noire
Bluegill	19	7												Crapet arlequin
Brook Trout	25	10	5	3	1.9	1.3	0.9	0.6	0.5					Omble de fontaine
Brown Bullhead	33	14	7	4	2.5	1.7								Barbotte brune
Brown Trout	22	9	4	2	1.4	0.9	0.6	0.5	0.3	0.3	0.2	0.2	0.1	Truite brune
Channel Catfish	40	16	7	4	2.5	1.6	1.1	0.8	0.6	0.4	0.3	0.3	0.2	Barbue de rivière
Chinook Salmon		9	5	3	1.7	1.1	0.8	0.6	0.4	0.3	0.2	0.2	0.2	Saumon quinnat
Cisco (Lake Herring)	38	15	7	4	2.4	1.5	1	0.7	0.5					Cisco (cisco de lac)
Coho Salmon			4	3	1.6	1.1	0.7	0.5	0.4	0.3	0.2	0.2	0.2	Saumon coho
Common Carp	27	11	6	3	2.1	1.4	1	0.7	0.5	0.4	0.3	0.3	0.2	Carpe
Freshwater Drum	47	19	9	5	3	1.9	1.3	0.9	0.7	0.5	0.4	0.3	0.3	Malachigan
Gizzard Shad	33	14	7	4	2.4	1.5	1.1							Alose à gésier
Goldeye		22	10	5	2.8	1.7								Laquaiche aux yeux d'or
Goldfish		6	4	2	1.7									Poisson doré
Lake Trout		12	6	3	2.1	1.3	0.9	0.7	0.5	0.4	0.3	0.2	0.2	Truite de lac
Lake Whitefish	29	12	6	3	2	1.3	0.9	0.6	0.5	0.4	0.3	0.2		Grand corégone
Largemouth Bass	24	10	5	3	1.7	1.1	0.8	0.6						Achigan à grande bouche
Ling (Burbot)		32	16	9	5.9	4	2.8	2	1.5	1.2	0.9	0.7	0.6	Lotte (barbot)
Longnose Sucker		14	7	4	2.6	1.8	1.3	0.9	0.7	0.5				Meunier rouge
Mooneye		11	6	4	2.4	1.7	1.2	0.9	0.7					Laquaiche argentée
Northern Pike			17	10	6	4	2.8	2	1.5	1.2	0.9	0.7	0.6	Brochet
Pink Salmon				3	2	1.3	0.9	0.6	0.5					Saumon rose
Pumpkinseed	16	7	3											Crapet-soleil
Quillback Carpsucker	11	6	3	2	1.6	1.2	0.9	0.7	0.6					Couette
Rainbow Smelt	33	14	8											Éperlan arc-en-ciel
Rainbow Trout		8	4	3	1.7	1.1	0.8	0.6	0.4	0.3	0.3	0.2	0.2	Truite arc-en-ciel
Redhorse Sucker	30	12	6	3	2.1	1.4	1	0.7	0.5	0.4	0.3	0.2		Suceur rouge
Rock Bass	25	11	6	4										Crapet de roche
Round Whitefish		18	9	5	2.8	1.8	1.2	0.8	0.6					Ménomini rond
Sauger	39	16	8	5	2.9	1.9	1.3	1	0.7	0.5				Doré noir
Siscowet				4	2.3	1.4	1	0.7	0.5	0.3	0.3	0.2	0.2	Siscowet
Smallmouth Bass	35	14	7	4	2.4	1.6	1.1	0.8	0.6					Achigan à petite bouche
Splake	27	10	5	3	1.7	1.1	0.7	0.5	0.4	0.3	0.2	0.2		Truite moulac
Walleye	37	15	7	4	2.6	1.7	1.2	0.8	0.6	0.5	0.4	0.3	0.2	Doré
White Bass	41	17	8	5	3	2								Bar blanc
White Crappie	37	16	9	5	3.4									Marigane blanche
White Perch	37	15	7	4	2.4									Baret
White Sucker	35	14	7	4	2.6	1.7	1.2	0.9	0.6	0.5				Meunier noir
Yellow Perch	25	10	5	3	1.8									Perchaude

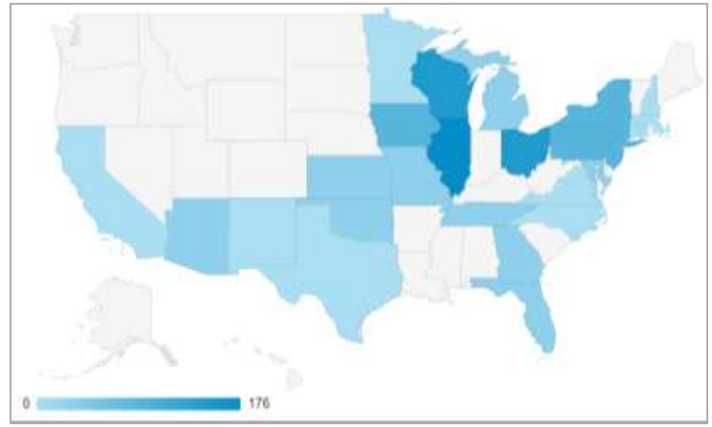
- Added in the 2015-2016 edition of the Guide

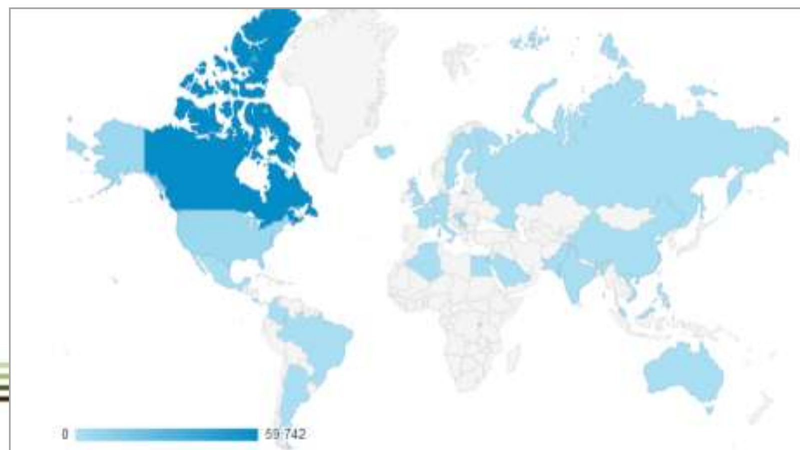
Interactive Advisory Map (since 2011)
www.ontario.ca/fishguide



Google analytics: visits of Program webpage







Last 3 years

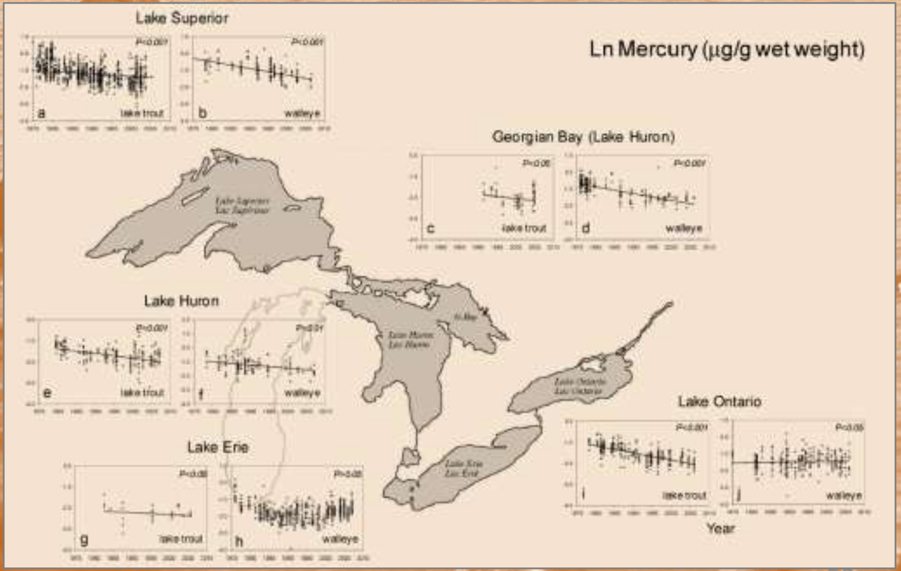
OTHER USES OF MONITORING DATA

Ontario

Program Monitoring data are used in…

Assessing environmental conditions, eg,

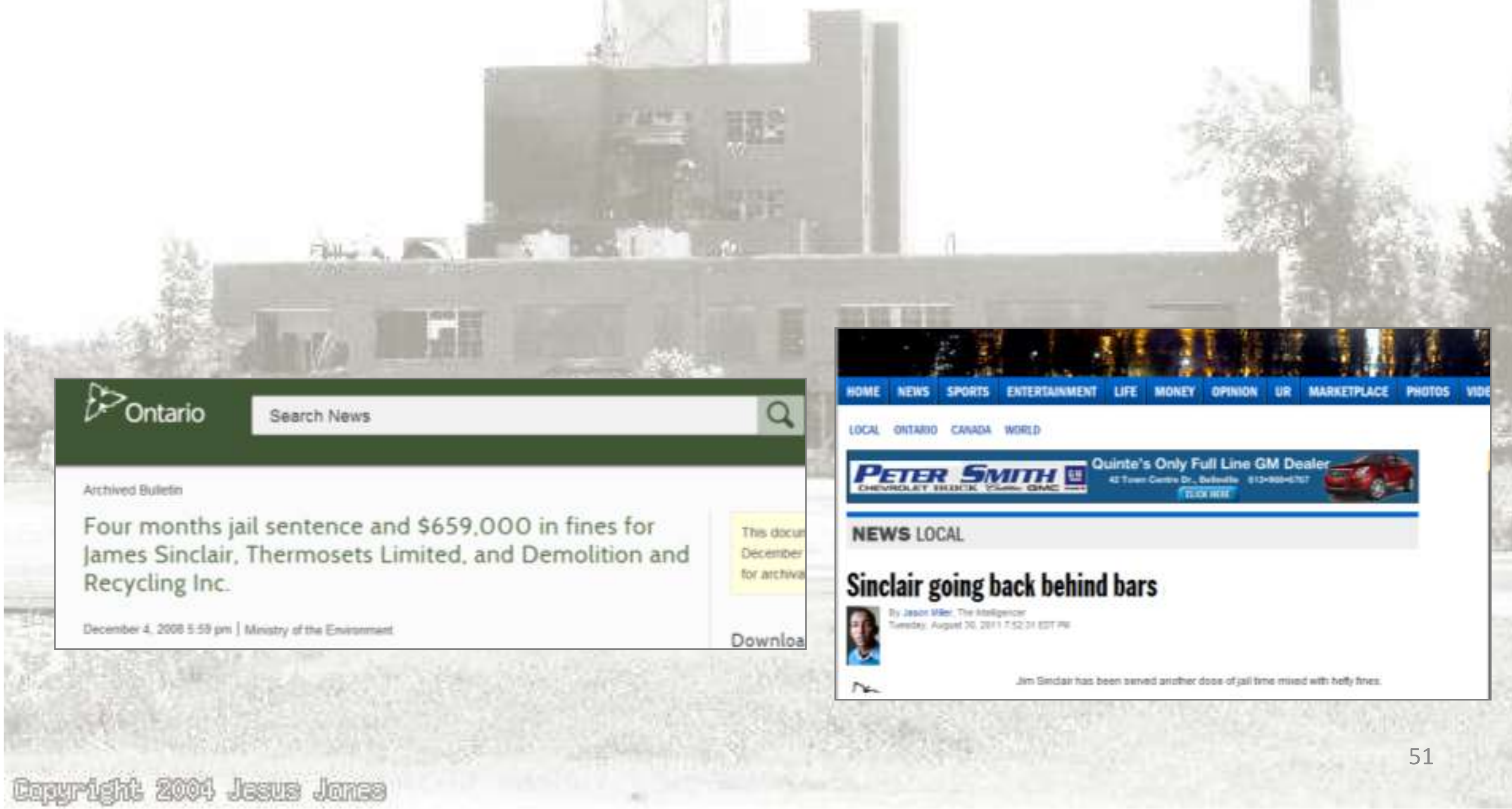
- Long-term improvement/changes in the Great Lakes
- Impact of climate change on fish contaminants



Program Monitoring data are used in…

Tracking down a contaminant source, eg,

– Bakelite Case in Belleville



Ontario

Search News

Archived Bulletin

Four months jail sentence and $659,000 in fines for James Sinclair, Thermosets Limited, and Demolition and Recycling Inc.

December 4, 2008 5:59 pm | Ministry of the Environment

HOME NEWS SPORTS ENTERTAINMENT LIFE MONEY OPINION UR MARKETPLACE PHOTOS

LOCAL ONTARIO CANADA WORLD

NEWS LOCAL

Sinclair going back behind bars

Jim Sinclair has been served another dose of jail time mixed with hefty fines.

Program Monitoring data are used in…

Tracking down a contaminant source, eg,

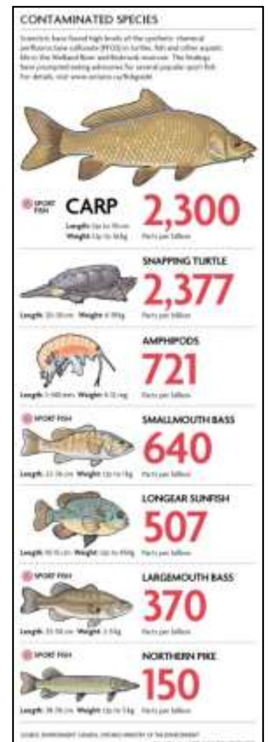
– PFOS at Hamilton Airport

City waits on province to review plan for contaminated land

Hamilton waiting on answers, activist says

By Samantha Craggs , CBC News Posted: Jun 28, 2013 7:27 AM ET | Last Updated: Jun 28, 2013 7:26 AM ET

The province is still reviewing a remediation plan to clean up PFOS-contaminated lands at the airport. Local activist Joe Minor says the public should know more. (Joe Minor)



Program Monitoring data are used in…

Evaluating AOC status, eg,

- Fish Consumption Beneficial Use Impairment (BUI)
- Fish body burden - contaminants

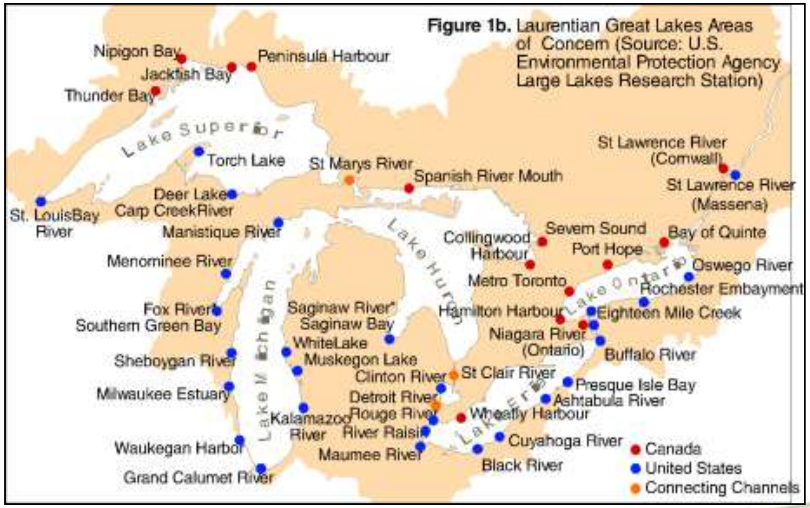


Figure 1b. Laurentian Great Lakes Areas of Concern (Source: U.S. Environmental Protection Agency Large Lakes Research Station)

Ontario

Program Monitoring data are used in…

First Nations Issues, eg,

- Grassy Narrows mercury contamination

2013

thestar.com

ONTARIO

News / Ontario

Dalton McGuinty says he'll study report on Grassy Narrows mercury poisoning

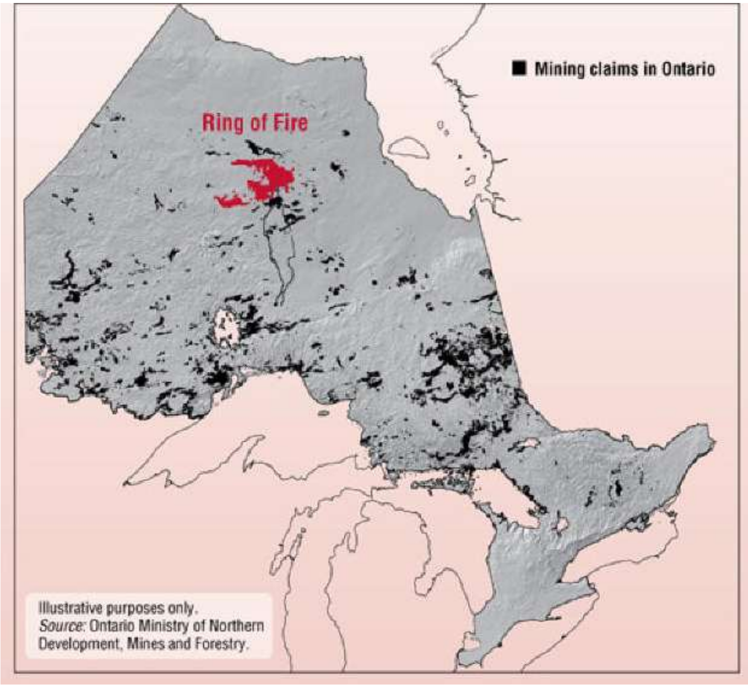
Premier Dalton McGuinty says he will wait to see a report on the effects of mercury poisoning on an Ontario First Nations reserve.

Ontario

Program Monitoring data are used in…

Cumulative Impact Assessment, eg,

- Ring of Fire
- Impact of Hydro Power development



Program Monitoring data are used in…

Making sound management decisions, policy development, eg,

- Is Mercury a major contaminant of concern for the Great Lakes?

Ecotoxicology (2011) 20:1588–1598
DOI 10.1007/s10646-011-0731-0

Great Lakes fish consumption advisories: is mercury a concern?

Satyendra P. Bhavsar · Emily Awad ·
Chris G. Mahon · Steve Petro

Environmental Science & Technology
Article
pubs.acs.org/est

Fish Mercury Levels Appear to Be Increasing Lately: A Report from 40 Years of Monitoring in the Province of Ontario, Canada

Nilima Gandhi,[†] Rex W. K. Tang,[‡] Satyendra P. Bhavsar,[*,†,‡,§] and George B. Arhonditsis[†,‡]

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ELSEVIER

ENVIRONMENT INTERNATIONAL

Environment International 34 (2008) 913–921

Converting Toxic Equivalents (TEQ) of dioxins and dioxin-like compounds in fish from one Toxic Equivalency Factor (TEF) scheme to another

Satyendra P. Bhavsar [a,*], Eric J. Reiner [b], Alan Hayton [a], Rachael Fletcher [a], Karen MacPherson [b]

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Received 28 November 2007; accepted 7 February 2008
Available online 14 March 2008

Environ. Sci. Technol. 2010, 44, 760–766

Identification and Screening Analysis of Halogenated Norbornene Flame Retardants in the Laurentian Great Lakes: Dechloranes 602, 603, and 604

LI SHEN, ERIC J. REINER, KAREN A. MACPHERSON, TERRY M. KOLIC, ED SVERKO, PAUL A. HELM, SATYENDRA P. BHAVSAR, IAN D. BRINDLE, AND CHRIS H. MARVIN

Department of Chemistry, Brock University, 500 Glenridge

bioaccumulation in biota, and persistence in sediment. Flame retardants that are persistent, bioaccumulative, and toxic such as polybrominated diphenyl ethers (PBDEs) have been restricted and regulated. Recently, tetra-, penta-, hexa-, and hepta-BDEs were added to Annex A (elimination of production and use of all intentionally produced POPs) at the fourth Meeting of the Parties to the Stockholm Convention on Persistent Organic Pollutants (POPs) (May 4–8, 2009) (1).

Mirex ($C_{10}Cl_{12}$), made by the cyclodimerization of hexachlorocyclopentadiene (HCCPD), is a legacy organochlorine pesticide. It was also used extensively, under the trade name Dechlorane from Hooker Chemicals and Plastics Corp., as a flame retardant additive in the 1960s in plastics, rubber, paint, paper, and electrical goods. Mirex was banned in the late 1970s because of its toxicity (2). Nonagricultural mirex was replaced partially by other dechloranes (Figure 1) such as Dechlorane 602 (Dec 602, ...), Dechlorane 603 (Dec 603, ...), Dechlorane 604 (Dec 604, ...

SETAC PRESS

Environmental Toxicology and Chemistry, Vol. 26, No. 8, pp. 1622–1628, 2007
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0730-7268/07 $12.00 + .00

ESTIMATING DIOXIN-LIKE POLYCHLORINATED BIPHENYL TOXIC EQUIVALENTS FROM TOTAL POLYCHLORINATED BIPHENYL MEASUREMENTS IN FISH

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Environ. Sci. Technol. 2007, 41, 3096–3102

Composition of Dioxin-like PCBs in Fish: An Application for Risk Assessment

SATYENDRA P. BHAVSAR, RACHAEL FLETCHER, ALAN HAYTON, ERIC J. REINER, AND DONALD A. JACKSON

Department of Ecology and Evolutionary Biology, University of Toronto, Toronto, Ontario M5S 3G5, Canada, and Environmental Monitoring and Reporting Branch and Laboratory Services Branch, Ontario Ministry of the Environment, 125 Resources Road, Toronto, Ontario M9P 3V6, Canada

It is widely accepted that a congener-specific analysis of

the trade name Aroclor in North America. PCB mixtures have been used for a variety of applications largely based on their chemical stability and physical properties. Their stability is also responsible for their continued presence in the environment even decades after extensive regulatory actions and an effective ban on their production in the 1970s (1). Although the levels of PCBs in various environmental matrices have decreased dramatically since peaking in the 1970s (1–3), their current levels in fish are a major cause of fish consumption advisories in North America (4, 5).

Environmental levels of PCBs are traditionally measured as total PCB based on Aroclor equivalent analysis, as opposed to congener-specific concentrations, due to analytical limitations and/or cost differentials (6). Many studies have shown that physical, chemical, and biological processes alter the distribution of PCB congeners in Aroclor after release into the environment (7–9). In addition, it is well-recognized that the potential for adverse effects varies considerably among PCB congeners (10). For these reasons, congener-specific PCB analysis is recommended for risk assessment purposes

Science of the Total Environment 443 (2013) 218–225

Contents lists available at SciVerse ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

ELSEVIER

Effects of skin removal on contaminant levels in salmon and trout filets

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Integrated Environmental Assessment and Management — Volume 6, Number 4—pp. 641–652
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Estimating Sediment Quality Thresholds To Prevent Restrictions on Fish Consumption: Application to Polychlorinated Biphenyls and Dioxins–Furans in the Canadian Great Lakes

Satyendra P Bhavsar,†,‡ Sarah B Gewurtz,†,‡ Paul A Helm,† Tanya L Labencki,† Christopher H Marvin,§ Rachael Fletcher,† Alan Hayton,† Eric J Reiner,† and Duncan Boyd†*

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§Environment Canada, 867 Lakeshore Road, PO Box 5050, Burlington, Ontario L7R 4A6, Canada

Ontario

Program has trained about 35 undergraduates, graduates and post-docs and research associates in the last 5 years

OUTREACH

Outreach at Outdoor Shows

Minister releasing the Guide

Minister releasing the Guide

Pamphlets for Sensitive Population

Multi-language brochure

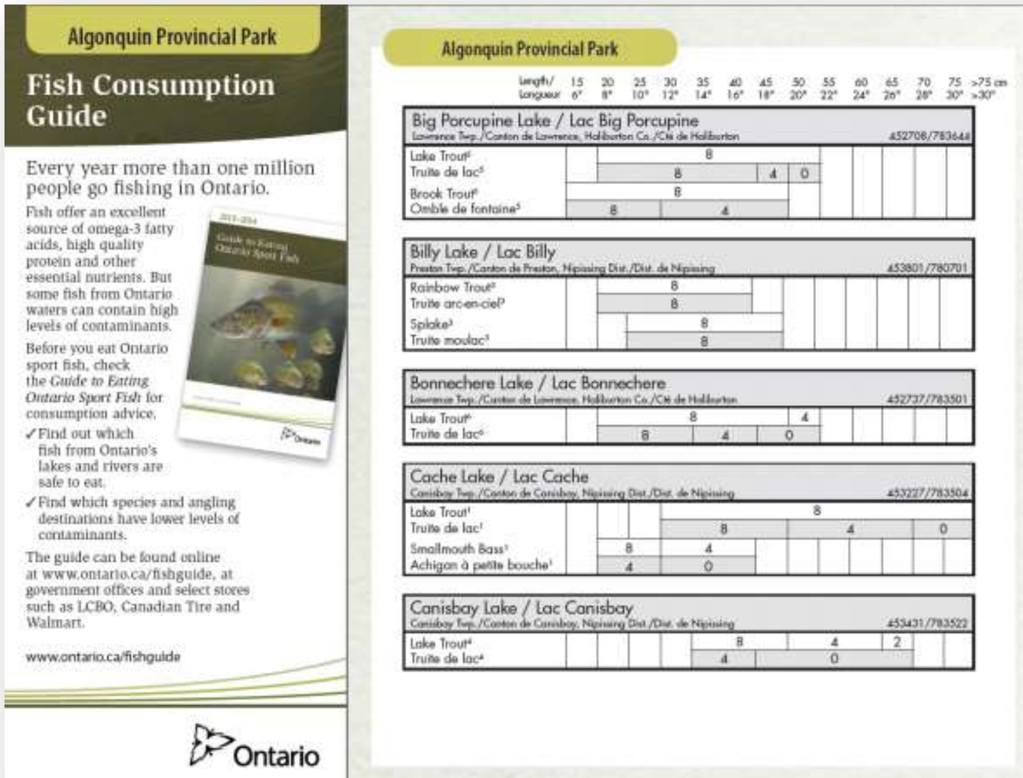
Ontario


Guide to Eating Sport Fish from Hamilton Harbour
2005-2006
Check Before You Eat
1. Identify your fish species.
2. Measure the total length of the fish.
3. Refer to length and species in the charts below for consumption advice. For fish outside size ranges, see page 9 of the Guide.
4. If you intend to eat fish from other than this location, please consult the Guide.
Carp
Freshwater Drum
White Perch
Yellow Perch
Channel Catfish
Brown Bullhead
Chinook Salmon
Largemouth Bass
Ontario

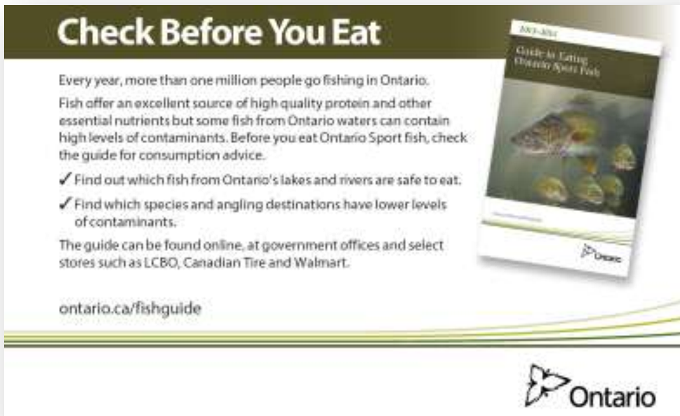
Wallet size cards

Ontario

Provincial park pamphlets

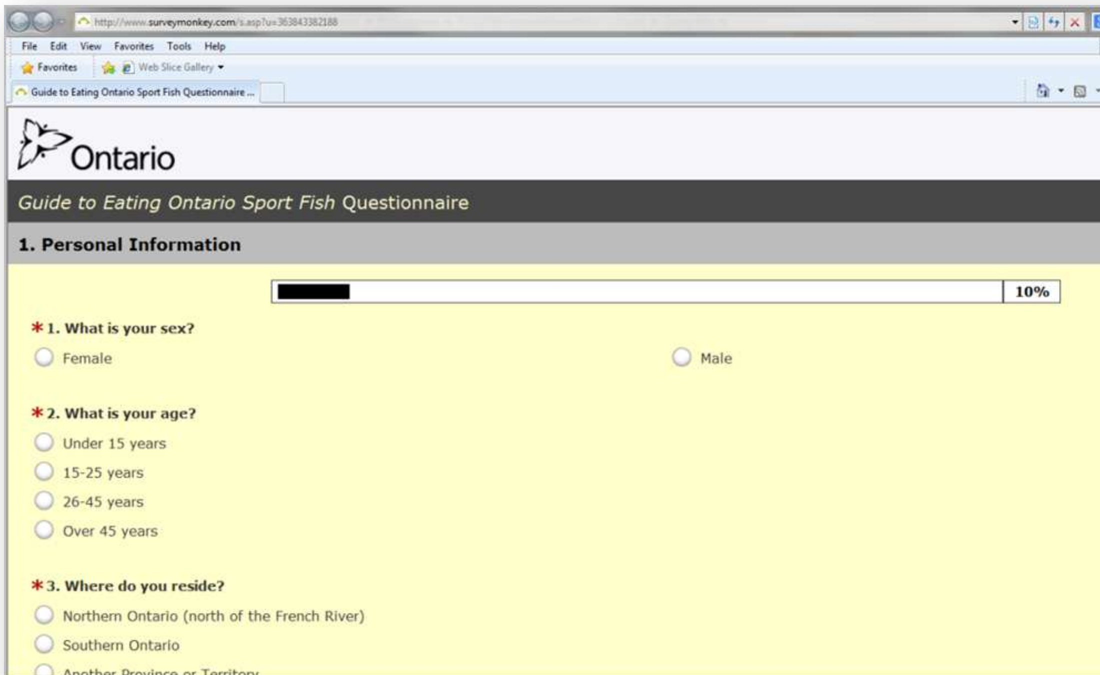


Adverts in Fishing Regulations, Ontario Parks Newsletters & Guide



FEEDBACK - SURVEYS

Ongoing Angler Survey



Ontario


"GUIDE TO EATING ONTARIO SPORT FISH" QUESTIONNAIRE
MAY 1986
A COMPARISON OF THE RESULTS FROM THE "GUIDE TO EATING ONTARIO SPORT FISH" QUESTIONNAIRES
February, 1987
THE RESULTS OF THE 1989 "GUIDE TO EATING ONTARIO SPORT FISH" QUESTIONNAIRE
JUNE 1990
THE RESULTS OF THE 19 "GUIDE TO EATING ONTA SPORT FISH" QUESTION
NOVEMBER 1993
Ontario
THE RESULTS OF "GUIDE TO EATIN QUESTIONNAIRE
AUGUST 1996
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The Results of the 1999 "Guide to Eating Ontar Questionnaire
May 2002
The Results of the 2003 Guide to Eating Ontario Sport Fish Questionnaire
Ontario
"Guide to Eating Ontario Sport Fish" 2007 Questionnaire
Ontario
Ontario

Ontario

Fisheries and Oceans Canada | Pêches et Océans Canada

2010 SURVEY OF RECREATIONAL FISHING IN CANADA

PROVINCE OF ONTARIO

Ontario — Fisheries and Oceans Canada / Pêches et Océans Canada

2010 SURVEY OF RECREATIONAL FISHING IN CANADA

PROVINCE OF ONTARIO

Le présent questionnaire est également disponible en français

QUESTIONS? → 1-800-667-1940 or by email at mnr.nric.mnr@ontario.ca

The Ministry of Natural Resources appreciates you taking the time to provide information about your fishing activities in Ontario in 2010.

MNR will hold a random draw for prizes in Peterborough on May 12th, 2011 from all the questionnaires that have been completed and returned. Gifts from a Canadian Sporting Goods retailer will be awarded, with the first ten (10) receiving $50 gift certificates; the next ten (10), $100 gift certificates; the next two (2), $500 gift certificates; and, one (1) will receive a $1,000 certificate.

May MNR contact you by telephone if you are a winner? Yes O

THANK YOU IN ADVANCE FOR YOUR COOPERATION AND ASSISTANCE

The questionnaire is to be answered only by the person to whom it is addressed.

YOUR LICENCE INFORMATION

1. Which of the following Ontario fishing licences did you personally hold in 2010? For 8-day and 1-day licences please indicate how many you purchased for yourself.

Sport fishing (annual) O — Conservation fishing (annual) O

1-day fishing O → number purchased ___

8-day sport (non-resident only) O → number purchased ___

8-day conservation (non-resident only) O → number purchased ___

YOUR PERSONAL RECREATIONAL FISHING ACTIVITIES

2a) Did you fish in Ontario in 2010? Yes O No O → go to question 19

b) How many days in total did you spend fishing in Ontario in 2010? ___ days fished (A "day" is all or any part of a day fished)

3. Of the above days, how many were spent ice-fishing in Ontario in 2010? None O or ___ days fished

4. On average, how many hours per day did you fish and during what times of the day did you most frequently fish (check all time periods that apply)?

a) During the open water season: ___ hours per day

before 10am O 10am - 2pm O 2pm - 6pm O 6pm – dark O after dark O

b) During the winter (ice-fishing): ___ hours per day

before 10am O 10am - 2pm O 2pm – dark O after dark O

DFO / PPP-045-04215 — Canada

CONSUMPTION OF FISH CAUGHT IN ONTARIO WATERS

The Ministry of the Environment's Sport Fish Contaminant Monitoring Program would appreciate your co-operation in completing the questions below in order to improve the Guide to Eating Ontario Sport Fish.

29. Do you eat any fish from Ontario waters that is caught by angling?

Yes O → please continue No O → End of the survey, thank you.

30. What are the top three species of fish caught by angling from Ontario waters that you eat?

1st ___ 2nd ___ 3rd ___

31a) How often do you usually eat fish caught by angling in Ontario waters?

daily O	3 to 5 times a week O	twice a week O	once a week O
2 to 3 times a month O	once a month O	rarely O	

b) About how much does the average portion you eat at a single meal weigh? (e.g., a fillet of plate size = approx. 8 oz)

Less than 4 oz / 115 g O	4 oz / 115 g O	6 oz / 170 g O	8 oz / 230 g O	12 oz / 340 g O	More O

c) What parts of the fish do you eat (check all that apply)?

skinless fillet O skin-on fillet O steak with fat O steak fat trimmed O whole fish O eggs/organs O

d) Which methods do you use for cooking fish caught by angling (check all that apply)?

none O baking/broiling O frying O grilling O steaming O smoking O other O ___

32a) Did you obtain a copy of the Guide to Eating Ontario Sport Fish for 2009-2010?

Yes O → please continue to question 32b	Unaware of Guide O → End of the survey, thank you.
No O → If you used an old version of the Guide, please go to question 32b	

b) Where did you obtain the copy of the Guide you used?

Internet O	Government office O	Tourism office O	Friend/Relative O
Liquor store O	Beer Store O	Walmart O	Canadian Tire O
Park O	Trade show O	Other (specify) ___ O	

33a) Do you check the consumption advice in the Guide prior to eating the fish you catch in Ontario?

Yes O → please continue to question 33b No O → End of the survey, thank you.

b) Do you follow the consumption advice in the Guide?

Always O Usually O Sometimes O Never O

c) If not always, why not? ___

34a) Has the information in the Guide led to a change in your fishing and/or fish consumption habits?

Yes O No O

b) If yes, in what way(s)? ___

THANK YOU FOR YOUR ASSISTANCE.

If you have any questions regarding fishing in Ontario, please call 1-800-667-1940 TOLL FREE.

12000 responses

Can be statistically extrapolated to 1.4M anglers

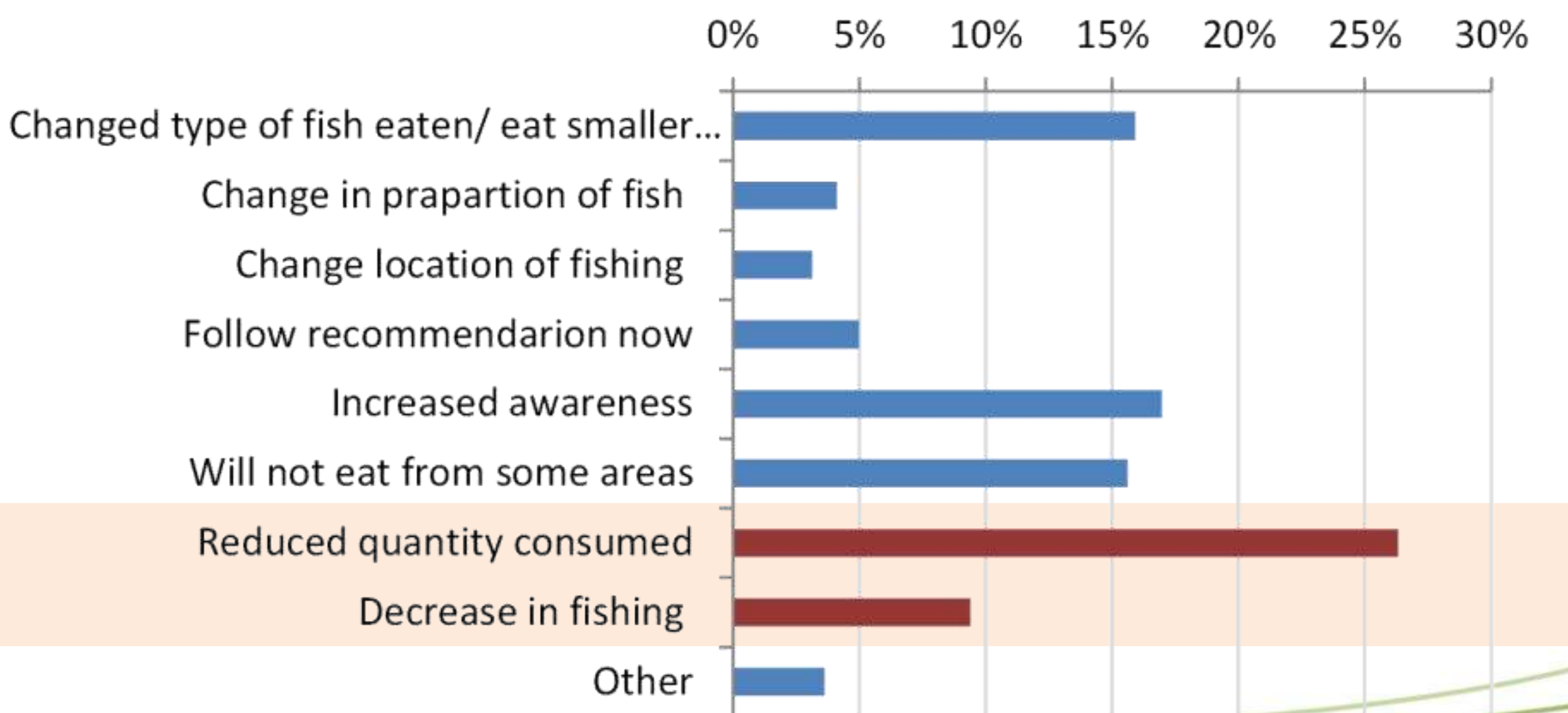
Stakeholder Survey

- Soon a stakeholder survey will be conducted on the program services
- You may be on the list of people who will be contacted!
- If interested in receiving this survey invitation, please email me at satyendra.bhavsar@ontario.ca

Ontario

Ontario's sport fish consumption survey

Has information in the Guide change your fish consumption habits?



Ontario

RISK BENEFIT ANALYSIS

Eating fish is healthy

CTV.ca Mobile Canada AM Autos Entertainment

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Health - Thursday Feb. 4, 2010

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Home : Health : Omega-3s protect heart by slowing cellular aging: study

Omega-3s protect heart by slowing cellular aging: study

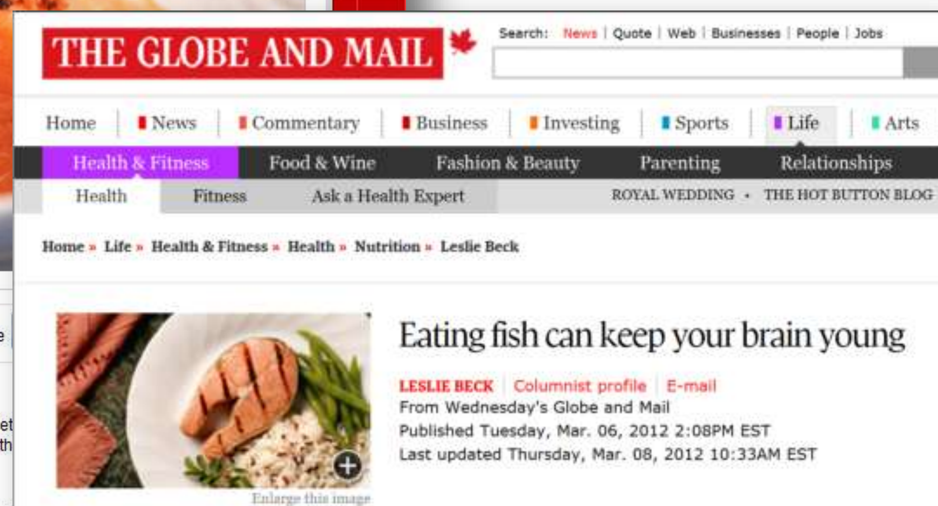
Font-size: A A Share

CTV.ca News Staff
Date: Wednesday Jan. 20, 2010 10:46 AM ET

Heart patients have long been told to eat a diet
omega-3 fatty acids. Now, researchers think th
beneficial.

A number of studies have shown that fish oil a
heart attacks or heart disease. What has not been clear is why. So scientists decided to find out by looking deep into the blood cells of heart disease patients, focusing on their telomeres

Contest



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Eating fish can keep your brain young

LESLIE BECK | Columnist profile | E-mail
From Wednesday's Globe and Mail
Published Tuesday, Mar. 06, 2012 2:08PM EST
Last updated Thursday, Mar. 08, 2012 10:33AM EST

Eating fish is healthy

- Excellent source of protein, vitamins and minerals
- Contain Omega-3 fatty acids (eg, EPA and DHA) essential for optimal brain and cardiovascular development
  - Not made in our body, need to get them from our diet
- Sport fishing contributes to a healthy life style
- For subsistence fishers (eg, First Nations), fish consumption is a part of their culture

Various health agencies including WHO, American Heart Association, and Health Canada recommend that adults eat fish (particularly fatty fish) at least two times a week

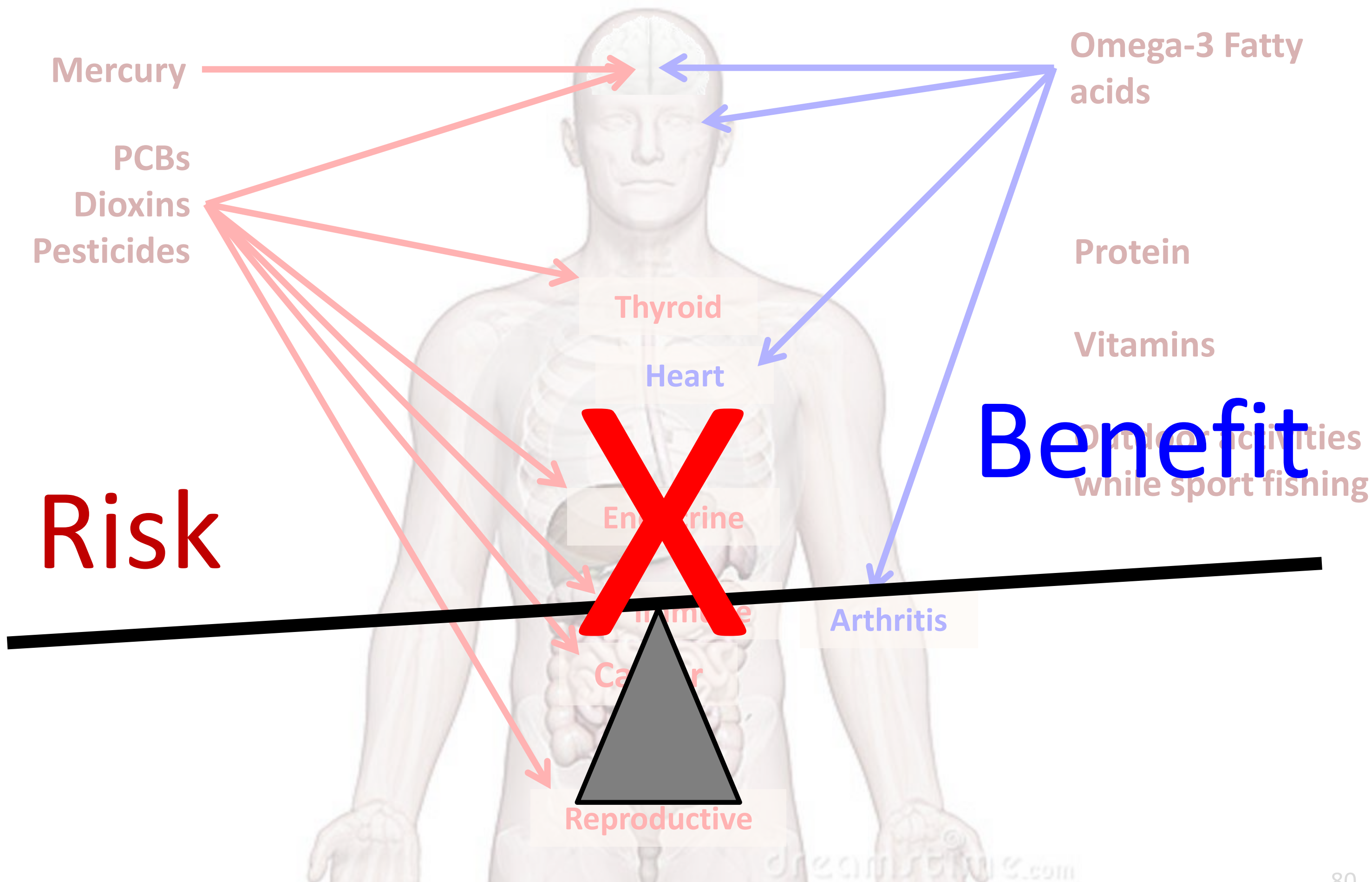
Ontario


KEEP
RIGHT


Benefits
Risks

Risk vs Benefit: Different end points

example



Simplified Approach

Limitation: Omega-3 data availability

Risks and Benefits of Consumption of Great Lakes Fish

Mary E. Turyk,[1] Satyendra P. Bhavsar,[2] William Bowerman,[3] Eric Boysen,[4] Milton Clark,[5] Miriam Diamond,[6] Donna Mergler,[7] Peter Pantazopoulos,[8] Susan Schantz,[9] and David O. Carpenter[10]

CONCLUSIONS: Our knowledge of Great Lakes fish has critical gaps, particularly regarding the benefits of consumption. A risk–benefit analysis requires more information than is currently available on the concentration of omega-3 fatty acids in Great Lakes fish and their absorption by fish eaters in addition to more information on the social, cultural, and health consequences of changes in the amount of fish consumed.

Environmental Health Perspectives • VOLUME 120 | NUMBER 1 | January 2012

Ontario

Efforts underway to fill the data gap

Journal of Great Lakes Research 39 (2013) 120–127

Contents lists available at SciVerse ScienceDirect

Journal of Great Lakes Research

journal homepage: www.elsevier.com/locate/jglr

Fatty acids in Great Lakes lake trout and whitefish

Peter Pantazopoulos [a], Jennifer M. Sawyer [b], Mary E. Turyk [c], Miriam Diamond [b], Satyendra P. Bhavsar [d], Donna Mergler [e], Susan Schantz [f], Nimal Ratnayake [g], David O. Carpenter [h,*]

Contents lists available at ScienceDirect

Journal of Great Lakes Research

journal homepage: www.elsevier.com/locate/jglr

Fatty acids in thirteen Wisconsin sport fish species

Meghan C.W. Williams [a,*], Candy Schrank [a,1], Henry A. Anderson [b,2]

[a] Wisconsin Department of Natural Resources, 101 S. Webster Street, Madison, WI 53703, USA
[b] Wisconsin Department of Health Services, 1 W. Wilson Street, Madison, WI 53703, USA

Environmental Research 134 (2014) 57–65

Contents lists available at ScienceDirect

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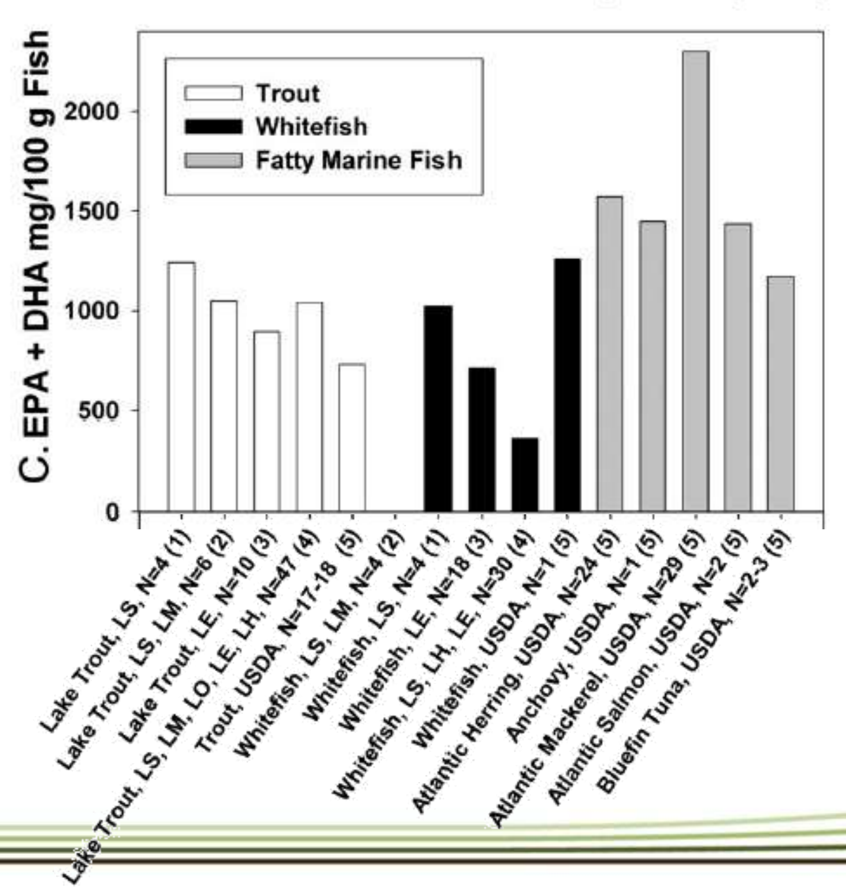
Risk-benefit of consuming Lake Erie fish

Margaret R. Neff [a], Satyendra P. Bhavsar [a,b,c,*], Felicity J. Ni [d], David O. Carpenter [e], Ken Drouillard [c], Aaron T. Fisk [c], Michael T. Arts [c,f]

Ontario

Great Lakes Fish ~ Marine Fish



Ontario

RISK BENEFIT FOR LAKE ERIE FISH

Why Lake Erie?

- Fresh water commercial fishery in Lake Erie is the largest in the Great Lakes and Canada
- Lake Erie is the most popular Great Lake amongst U.S. anglers for recreational fishing

Ontario

Data collection: FAs & Contaminants

- 15 species sampled
- Total of 146 samples

Species	Total N	Length (cm)	Weight (g)	Total Lipid (%)	Sample Sizes											
					Sex			Season				Location				
					NS	F	M	Spring	Summer	Fall	NS	LE1	LE2	LE2a	LE3	LE4
Black Crappie	5	22.1 (2.1)	197.4 (64.0)	4.3 (0.4)		4	1			5				5		
Bluegill	5	17.0 (2.0)	109.0 (49.0)	4.1 (0.4)		2	3		1	4						5
Channel Catfish	13	49.5 (10.0)	1546.5 (1132.7)	21.7 (10.3)		8	5	4	2	7		5	5	3		
Coho Salmon	2	66.6 (6.4)	3933.5 (1287.6)	21.7 (7.4)		1	1		1	1					2	
Lake Trout	10	52.7 (19.5)	2617.7 (2422.6)	22.3 (9.6)		2	8		10						10	
Lake Whitefish	18	50.7 (4.7)	1334.4 (415.0)	30.7 (11.6)	1	7	10	10		8		7	6		5	
Largemouth Bass	10	31.9 (7.8)	578.1 (464.6)	3.7 (0.7)		1	9		2	8						10
Northern Pike	10	57.5 (8.9)	1025.5 (430.5)	3.3 (0.6)		8	2		1	9						10
Pumpkinseed	5	15.8 (1.1)	95.8 (18.8)	4.7 (0.1)		3	2	5						5		
Rainbow Trout	6	60.0 (15.8)	2733.7 (1493.9)	28 (12.5)	1	3	2			6			6			
Smallmouth Bass	13	36.6 (3.0)	833.0 (215.9)	6.9 (3.4)	1	7	5		13					13		
Walleye	21	54.8 (9.9)	1829.0 (969.8)	10.8 (9)	3	14	4	19		2		7	7		7	
White Bass	16	31.1 (5.1)	458.5 (241.2)	13.6 (8.1)	2	8	6	2	4	10		5	5		6	
White Perch	13	25.3 (2.9)	277.9 (85.4)	17.2 (5.9)		8	5	2	7	2	2	4	3	3	3	
Yellow Perch	5	19.8 (4.6)	106.2 (77.8)	3.6 (0.6)		4	1		2	3						5

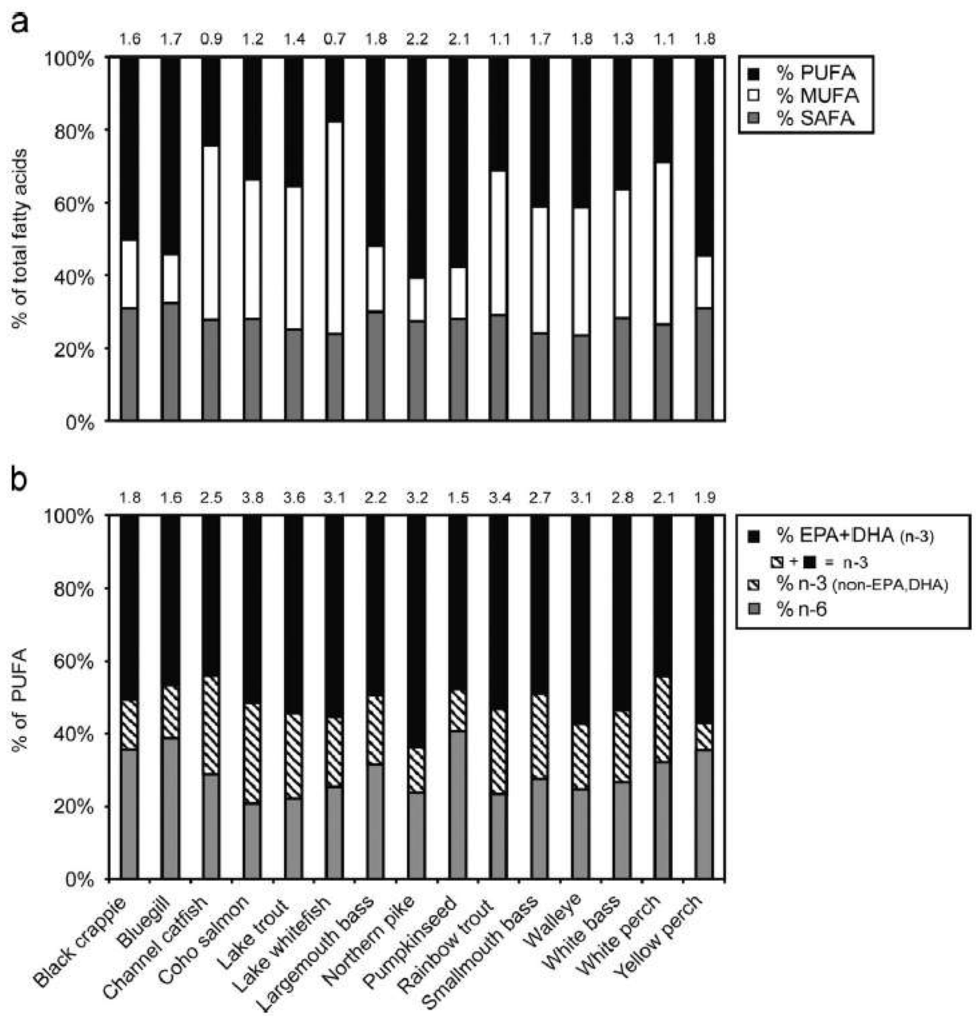
Ontario

FA results

Mean fatty acid content (mg/100 g ww) ± standard deviation in Lake Erie fish species.

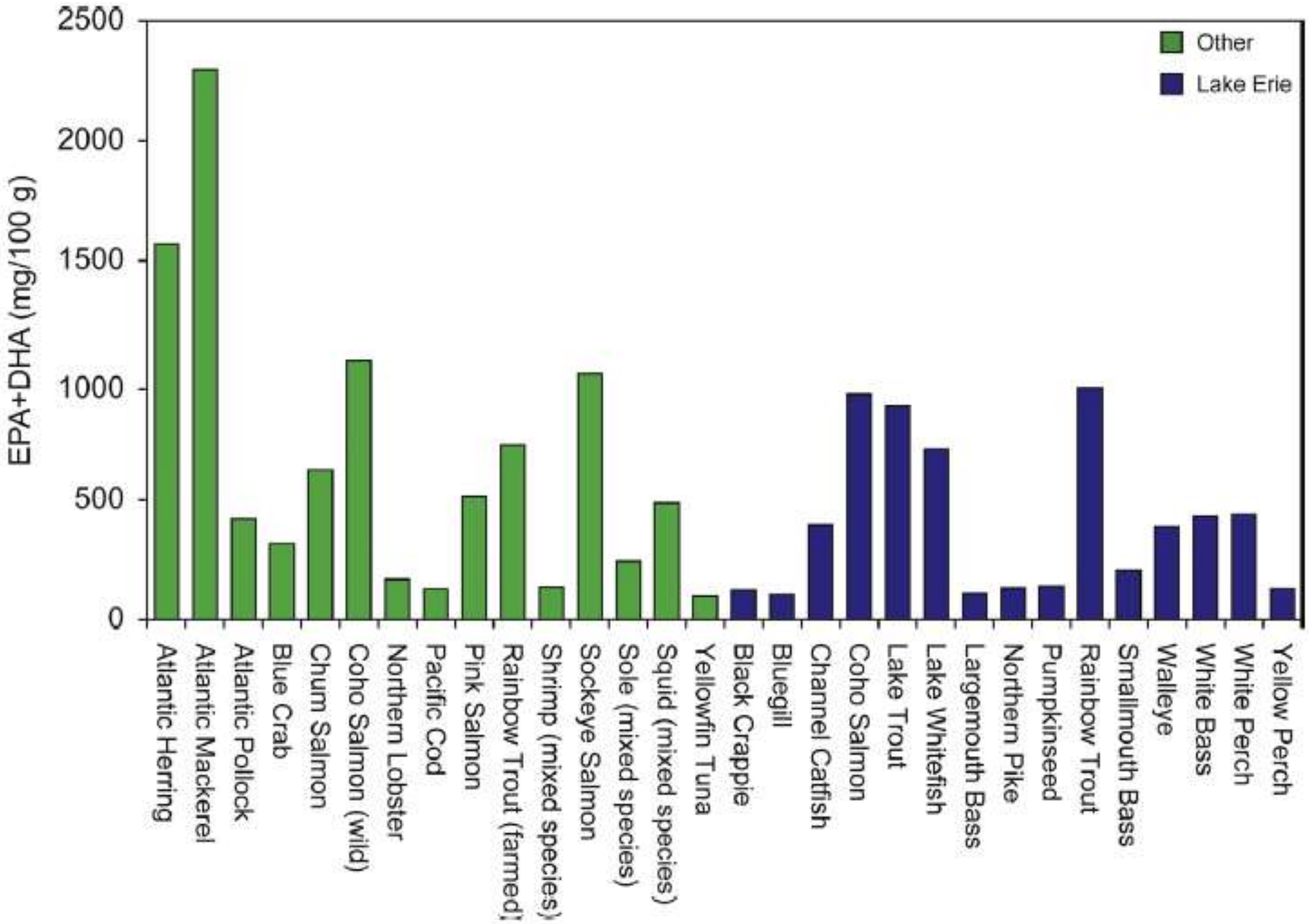
Species	LIN	ALA	EPA	DHA	EPA+DHA	n-3	n-6	n-3:n-6	SAFA	MUFA	PUFA	PUFA:SAFA	FA	Lipid
Black crappie	16 ± 4	7 ± 2	15 ± 4	111 ± 4	126 ± 5	161 ± 11	89 ± 7	1.8 ± 0.2	156 ± 17	98 ± 24	252 ± 12	1.6 ± 0.2	505 ± 48	888 ± 89
Bluegill	29 ± 11	12 ± 5	17 ± 3	89 ± 12	106 ± 13	139 ± 20	87 ± 10	1.6 ± 0.2	138 ± 17	58 ± 10	231 ± 29	1.7 ± 0.1	427 ± 52	746 ± 75
Channel catfish	89 ± 56	92 ± 58	161 ± 75	162 ± 65	398 ± 214	660 ± 377	275 ± 161	2.5 ± 0.3	1159 ± 764	2121 ± 1624	950 ± 544	0.9 ± 0.1	4230 ± 2905	5543 ± 3128
Coho salmon	10 ± 4	0	275 ± 92	669 ± 201	944 ± 293	1459 ± 478	392 ± 170	3.8 ± 0.4	1570 ± 677	2188 ± 1074	1851 ± 648	1.2 ± 0.1	5608 ± 2399	6675 ± 2597
Lake trout	8 ± 4	0.4 ± 1	256 ± 145	639 ± 292	896 ± 435	1323 ± 703	381 ± 226	3.6 ± 0.4	1213 ± 668	2084 ± 1396	1706 ± 924	1.4 ± 0.1	5003 ± 2976	6145 ± 3341
Lake whitefish	122 ± 93	51 ± 45	373 ± 217	341 ± 119	714 ± 330	961 ± 432	323 ± 136	3.1 ± 0.8	1828 ± 861	4679 ± 2602	1302 ± 563	0.7 ± 0.1	7809 ± 4009	9502 ± 4761
Largemouth bass	9 ± 9	4 ± 0	13 ± 9	98 ± 31	111 ± 36	153 ± 47	71 ± 25	2.2 ± 0.5	128 ± 37	78 ± 29	225 ± 70	1.8 ± 0.3	431 ± 127	755 ± 145
Northern pike	5 ± 6	3 ± 5	21 ± 7	113 ± 32	134 ± 38	160 ± 47	50 ± 14	3.2 ± 0.5	93 ± 17	42 ± 9	211 ± 60	2.2 ± 0.3	350 ± 83	658 ± 130
Pumpkinseed	21 ± 5	5 ± 0.5	27 ± 4	115 ± 24	142 ± 26	176 ± 28	119 ± 8	1.5 ± 0.3	145 ± 6	75 ± 10	299 ± 21	2.1 ± 0.2	519 ± 19	985 ± 66
Rainbow trout	210 ± 106	189 ± 103	357 ± 177	613 ± 267	967 ± 440	1395 ± 625	435 ± 218	3.4 ± 0.6	1875 ± 1025	2618 ± 1671	1928 ± 900	1.1 ± 0.2	6422 ± 3483	8587 ± 4392
Smallmouth bass	20 ± 32	12 ± 22	36 ± 25	172 ± 78	208 ± 102	313 ± 166	123 ± 77	2.7 ± 0.4	246 ± 126	437 ± 365	438 ± 243	1.7 ± 0.2	1121 ± 728	1584 ± 855
Walleye	52 ± 119	49 ± 114	141 ± 185	250 ± 171	391 ± 351	532 ± 518	190 ± 236	3.1 ± 0.4	406 ± 401	734 ± 982	725 ± 756	1.8 ± 0.2	1864 ± 2135	2627 ± 2786
White bass	47 ± 43	55 ± 54	169 ± 124	264 ± 204	434 ± 322	607 ± 487	225 ± 188	2.8 ± 0.3	688 ± 581	949 ± 1016	862 ± 678	1.3 ± 0.2	2499 ± 2267	3268 ± 2632
White perch	6 ± 3	0.4 ± 0.5	215 ± 80	225 ± 100	440 ± 164	685 ± 278	322 ± 133	2.1 ± 0.3	932 ± 375	1614 ± 715	1008 ± 406	1.1 ± 0.2	3554 ± 1474	4117 ± 1696
Yellow perch	9 ± 5	4 ± 3	22 ± 4	109 ± 20	131 ± 24	148 ± 67	81 ± 16	1.9 ± 0.6	131 ± 27	64 ± 26	230 ± 32	1.8 ± 0.1	425 ± 84	725 ± 100

FA results



Ontario

FA: Erie vs marine & freshwater seafood



Simulated fish consumption advisories

- Advisory calculated for each individual fish sample
- Max number of fish meals/month (up to 32) that can be safely consumed based on contaminant conc
- Meal size: 227 g (8 oz)
- Used OMOE advisory benchmarks; similar to US Gr Lk States
- Separate benchmarks for the general & sensitive population (i.e., women of child-bearing age and children under the age of 15).

Ontario

Compared to suggested EPA+DHA Intake

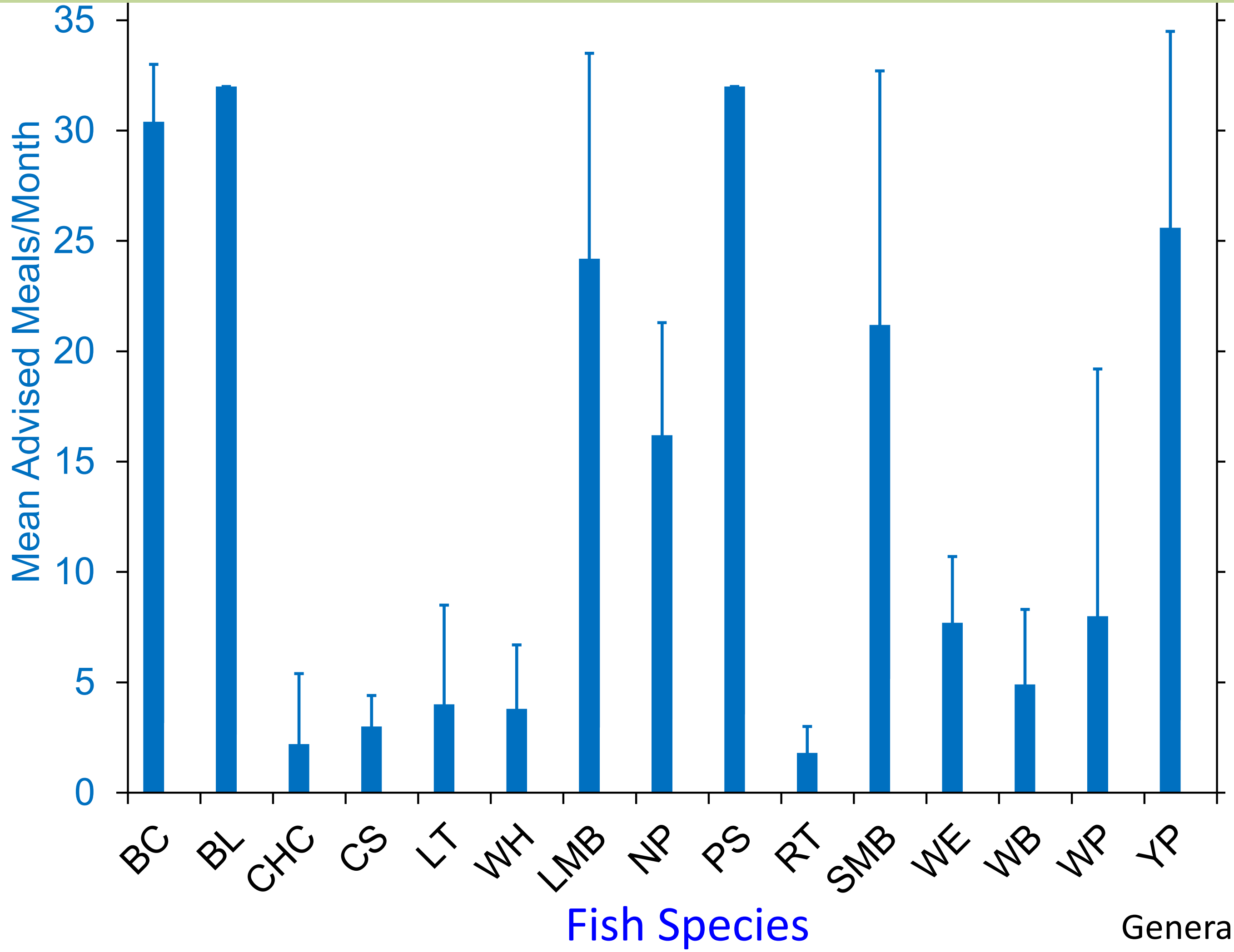
- Calculated FA intake if advisories followed and compared with the following recommendations

Source	Recommendation	EPA+DHA mg/month
American Dietetic Association/Dietitians of Canada	500 mg/day EPA+DHA	15000
AFSSA[a], CNERNA[b] & CNRS[c]	500 mg/day EPA+DHA	15000
Superior Health Council of Belgium	667 mg/day EPA+DHA	20010
International Society for the Study of Fatty Acids and Lipids	500 mg/day EPA+DHA	15000
United Kingdom Scientific Advisory Committee on Nutrition	450 mg/day EPA+DHA	13500
World Health Organization	1-2 servings/week of 200-500 mg EPA+DHA	1600-4000

[a] Agence française de sécurité sanitaire des aliment
[b] Centre national d'études et de recommandations sur la nutrition et l'alimentation
[c] Centre national de la recherche scientifique

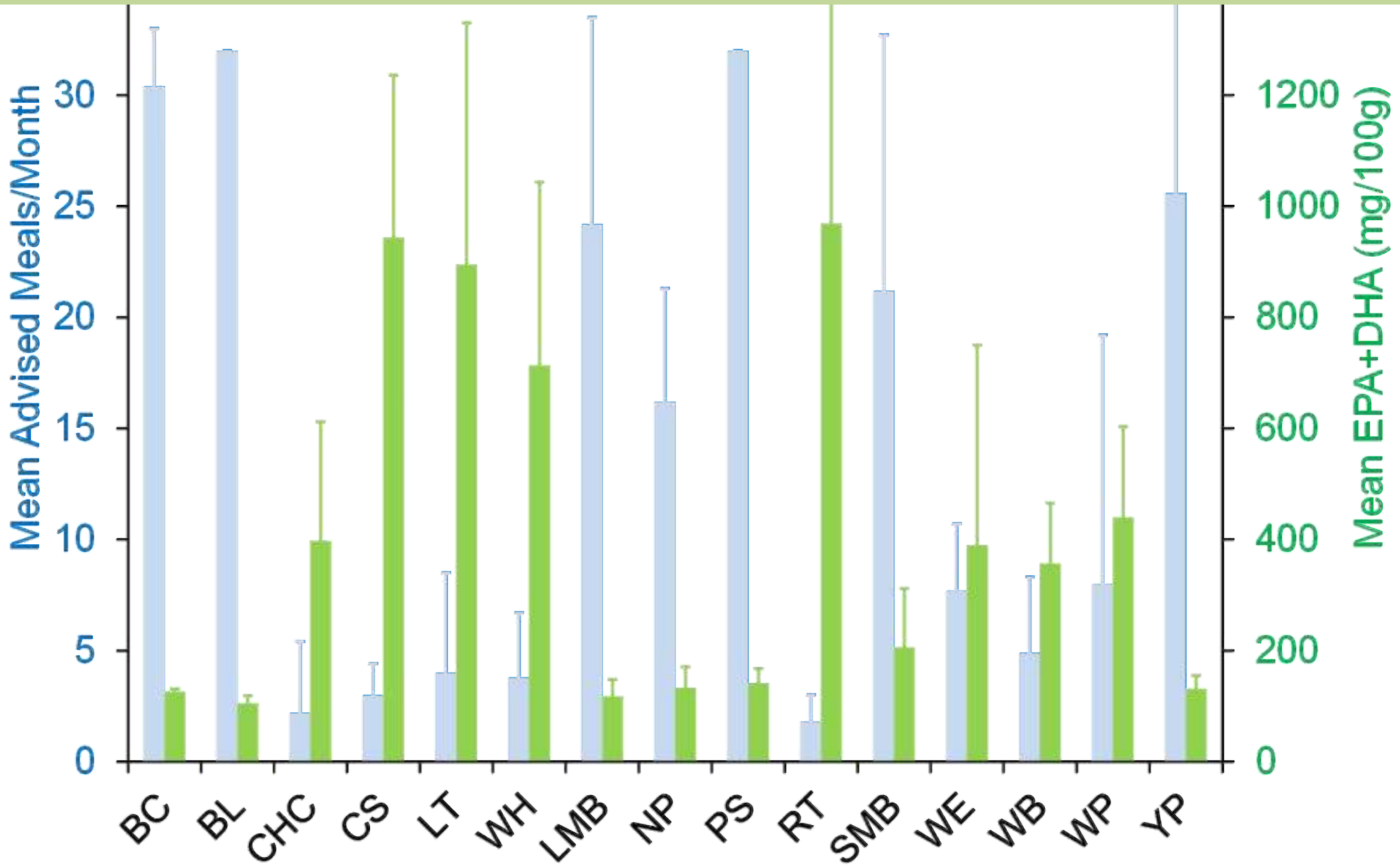
Ontario

Simulated advisories for Erie samples



General Popn

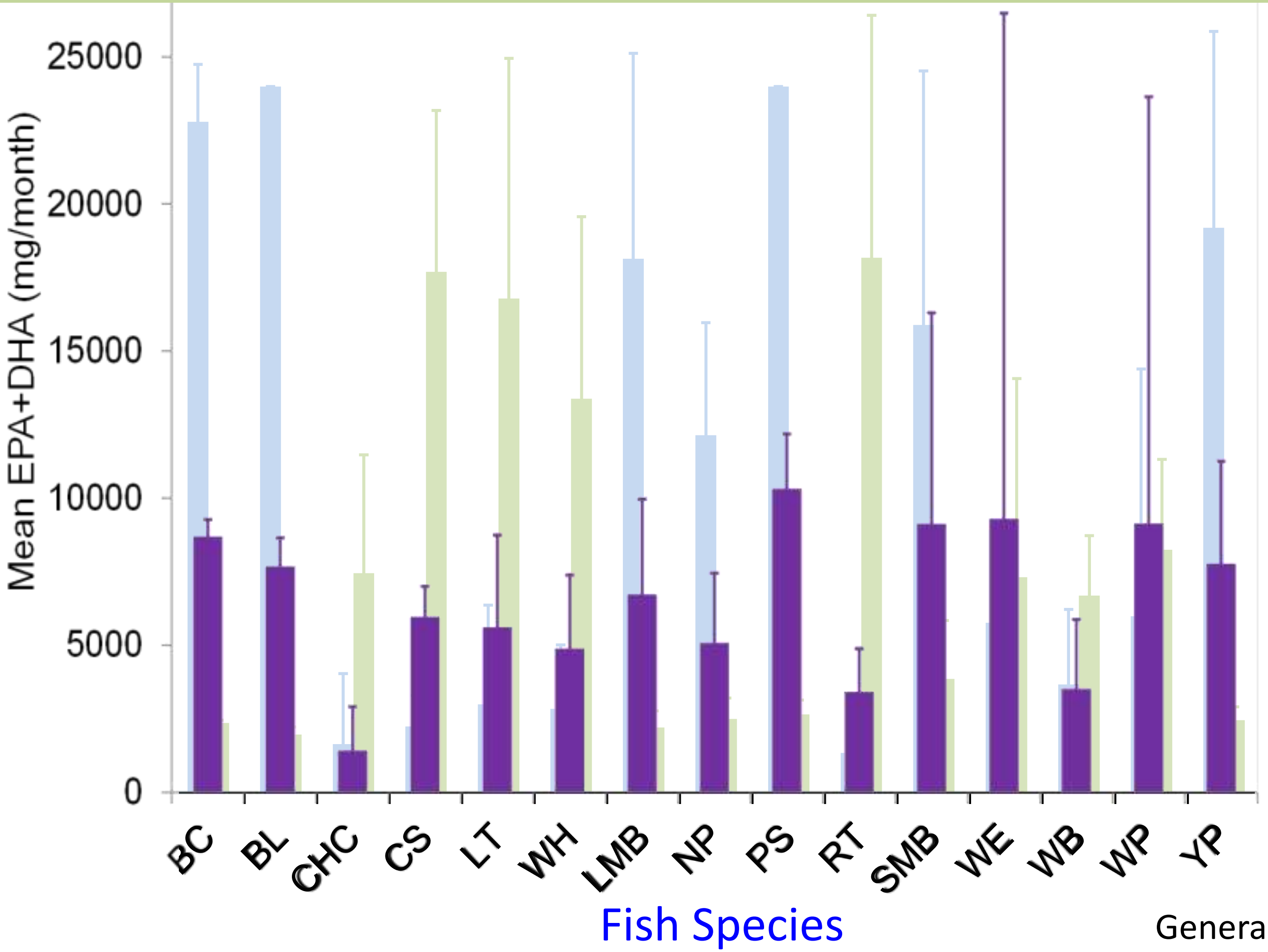
Advisory & EPA+DHA content for Lake Erie Fish



Fish Species

General Popn

EPA+DHA intake for Lake Erie Fish



General Popn

Findings of the study

- All 15 species had nutritionally desirable PUFA:SAFA (>0.4) and n3:n6 (>1).
- Large, fatty species had the highest EPA+DHA content, but had the most restrictive consumption advisories due to high PCB concentrations.
- To minimize contaminant exposure while maximizing EPA+DHA intake, consumers should consider small lake whitefish and lake trout, small panfish species, and/or walleye.
- However, very few species had an EPA+DHA sufficient to safely meet highest dietary guidelines while following advisories.
- Consumption of certain Lake Erie fish within the limits of our simulated fish consumption advisories, can be a good supplemental source of beneficial n-3 long chain PUFA.

Ontario

Published paper: Envi Res 134(2014):57-65

Environmental Research 134 (2014) 57–65

Contents lists available at ScienceDirect

Environmental Research

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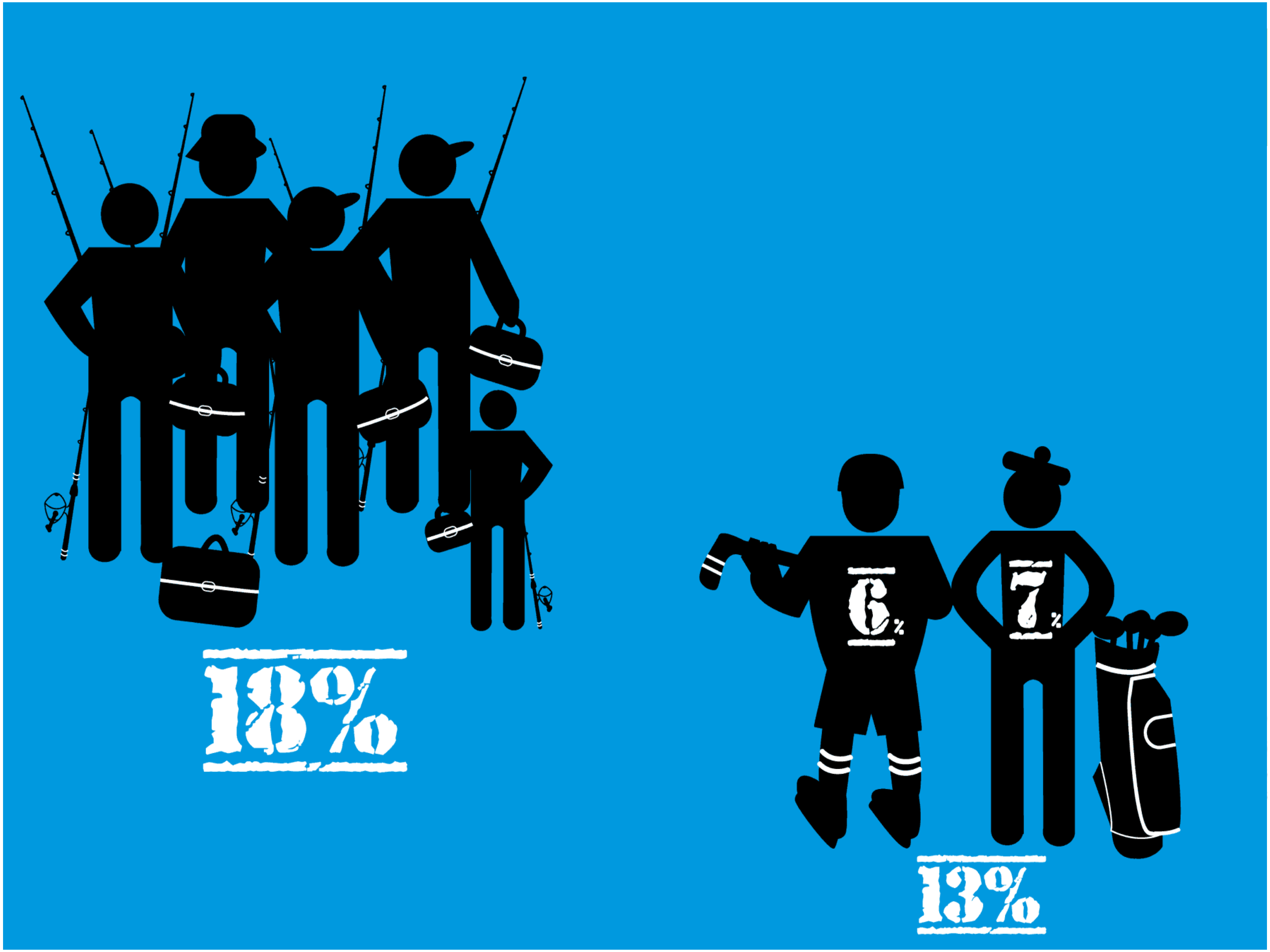
Risk-benefit of consuming Lake Erie fish

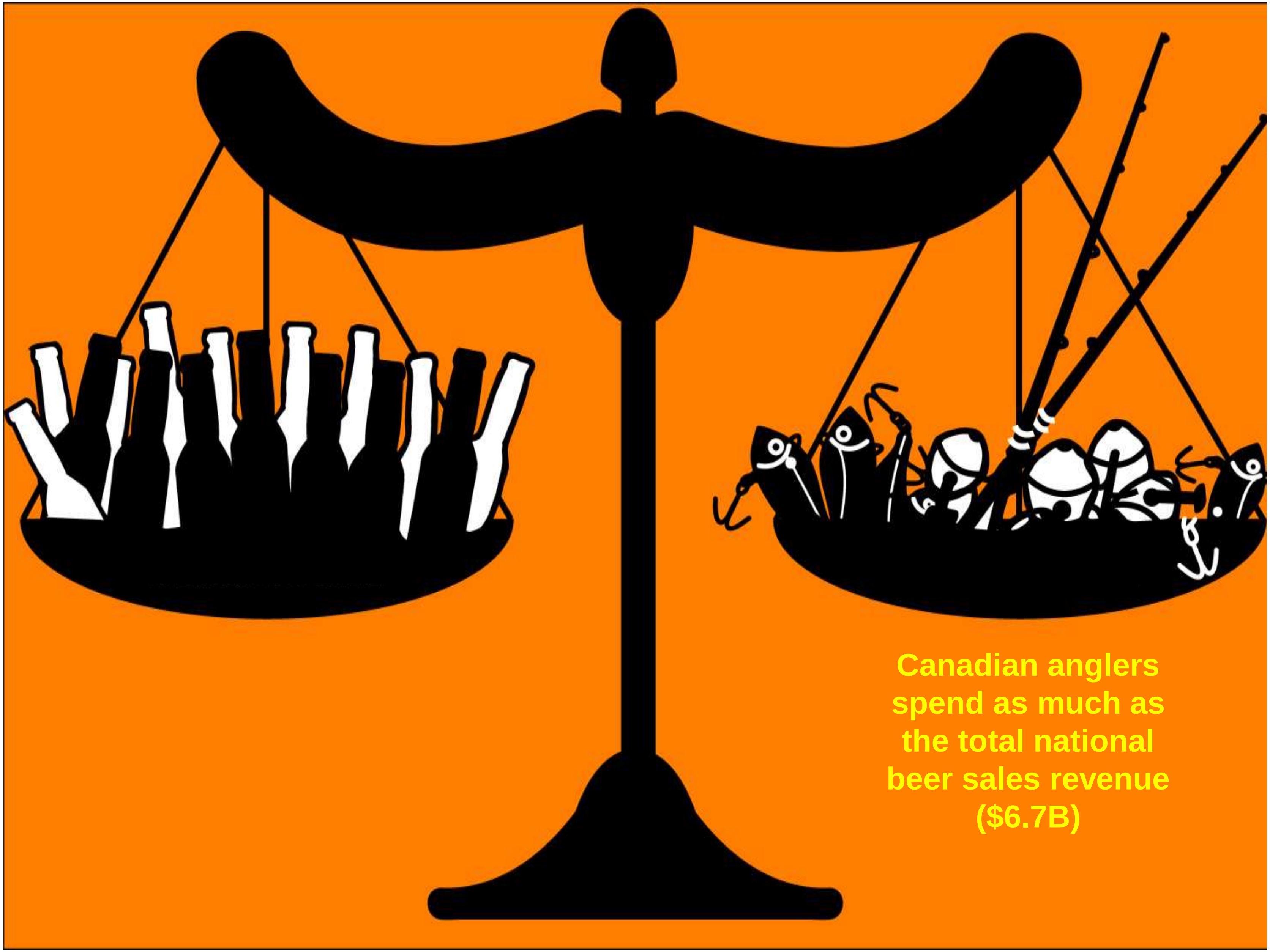
Margaret R. Neff[a], Satyendra P. Bhavsar[a,b,c,*], Felicity J. Ni[d], David O. Carpenter[e], Ken Drouillard[c], Aaron T. Fisk[c], Michael T. Arts[c,f]

[a] Ontario Ministry of the Environment, Sport Fish Contaminant Monitoring Program, Environmental Monitoring and Reporting Branch, 125 Resources Road, Toronto, ON, Canada M9P 3V6

HOW IMPORTANT FISHING IS IN CANADA?

Ontario


18%
6%
7%
13%

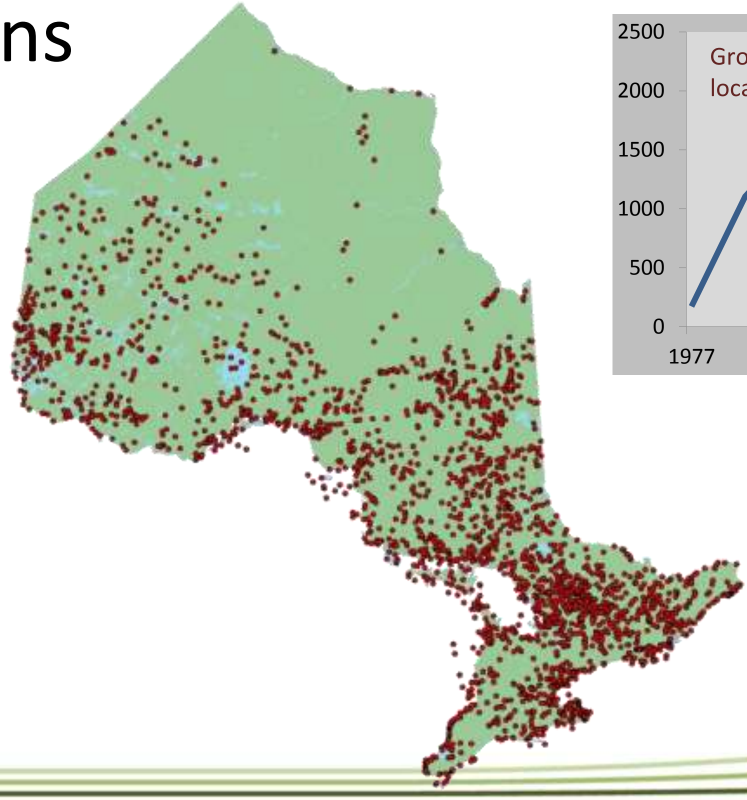

Canadian anglers
spend as much as
the total national
beer sales revenue
($6.7B)

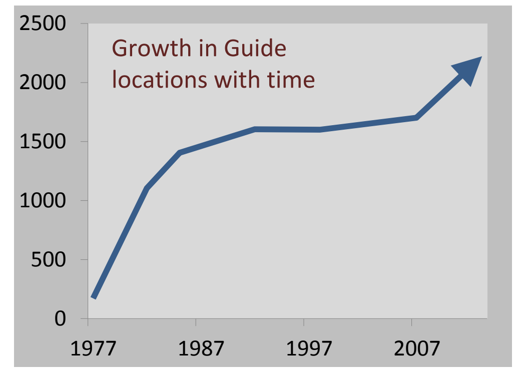
Ontario

What we have done so far?

Advisory locations: Province-wide Coverage

>2300 locations



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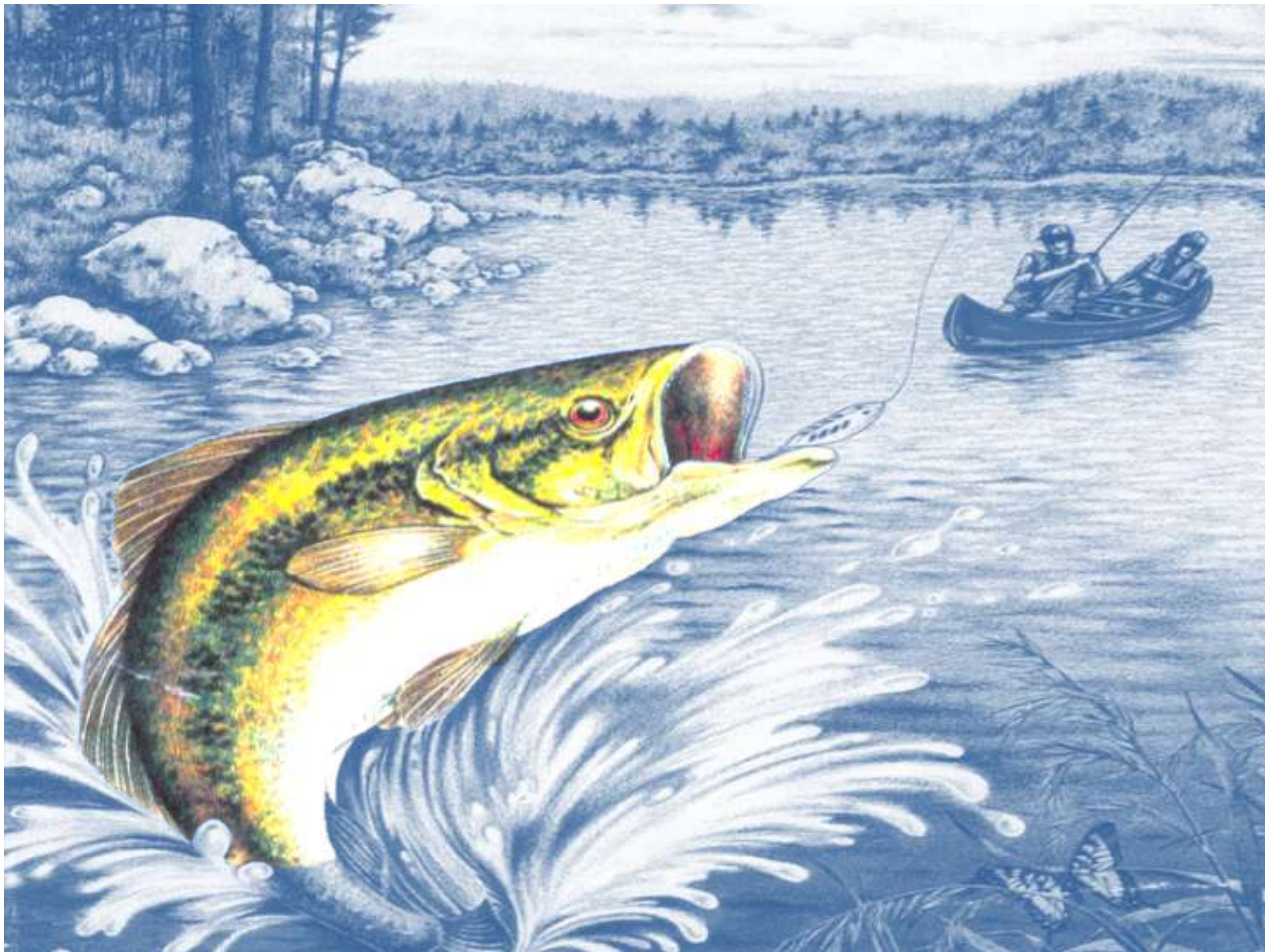
Ontario

How do we manage all these?

Satyendra Bhavsar

Ontario Ministry of the Environment and Climate Change

satyendra.bhavsar@ontario.ca



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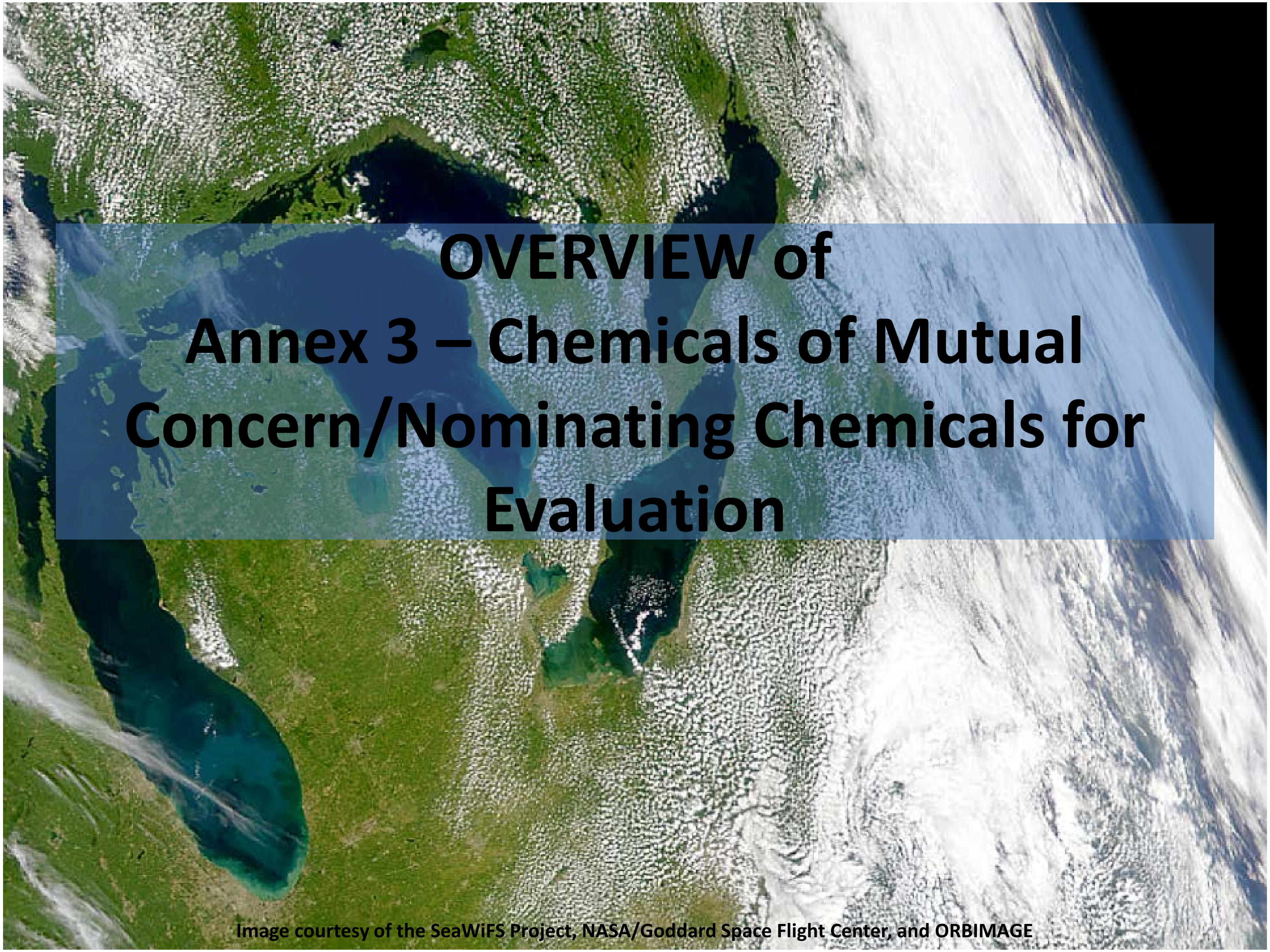

OVERVIEW of
Annex 3 – Chemicals of Mutual Concern/Nominating Chemicals for Evaluation
Image courtesy of the SeaWiFS Project, NASA/Goddard Space Flight Center, and ORBIMAGE

Annex 3 – Purpose

- To contribute to the achievement of the General and Specific Objectives of the GLWQA by protecting human health and the environment through cooperative and coordinated measures **to reduce the anthropogenic release of chemicals of mutual concern (CMCs) into the waters of the Great Lakes**; recognizing:

Annex 3 – Principles

- That CMCs released into the air, water, land, sediment and biota should not result in impairment to the quality of the waters of the Great Lakes;
- The need to manage CMCs including, as appropriate, by implementing measures to achieve virtual elimination and zero discharge of these chemicals;
- That knowledge and information concerning the use, creation and release of CMCs, and combinations thereof, are fundamental to the sound management of chemicals in the Great Lakes Basin Ecosystem;
- That CMCs may be managed at the federal, state, provincial, tribal and local levels through a combination of regulatory and non-regulatory programs;

Annex 3 – Specific Commitments

a. Establish and implement a process by which the Great Lakes Executive Committee (GLEC) may recommend chemicals of mutual concern, herein after referred to as CMCs, to the Parties. The recommendation shall include a review of available scientific information supporting the recommendation;

b. Prepare binational strategies for CMCs, which may include research, monitoring and surveillance and pollution prevention and control provisions;

c. Report on progress toward implementation of the Annex every three years through the progress report of the Parties, which shall include:

   I. An identification of CMCs; and

   II. The status of initiatives to develop binational strategies to address issues involving CMCs and the status of implementing binational strategies for CMCs;

Annex 3 – Specific Commitments

d. Coordinate the development and application of domestic water quality standards, objectives, criteria and guidelines among the Parties and other governmental entities, subject to relevant domestic laws and regulations by:

   i. Maintaining, periodically reviewing and making publically available current water quality standards, objectives, criteria and guidelines for CMCs;

   ii. Aligning, where approriate, domestic water quality standards, objectives, criteria and guidelines applicable to CMCs;

   iii. Developing, where warranted, new domestic water quality standards, objectives, criteria and guidelines for CMCs; and

   iv. Reviewing and addressing any exceedances of or non-compliance with domestic water quality standards, objectives, criteria and guidelines for CMCs;

Annex 3 - Specific Commitments (cont'd)

e. Exchange, on a regular basis, information on monitoring, surveillance, research, technology and measures for managing CMCs;

f. Coordinate on science priorities, research and surveillance and monitoring activities associated with CMC's, as appropriate;

   i. Identify and assess the occurrence, sources, transport and impact of CMCs, including spatial and temporal trends in the atmosphere, aquatic biota, wildlife water and sediments;
   ii. Identify and assess loadings of CMCs into the waters of the Great Lakes from all sources, including point sources, non-point sources, tributaries and the atmosphere;
   iii. Evaluate the effects of CMCs, and combinations thereof, on human health and the ecosystem, including the development and use of reproductive, physiological and biochemical measures in wildlife, fish and humans as health effects indicators;
   iv. Review and prioritize research, monitoring and surveillance needs on an annual basis, taking into account progress made in implementing this agreement, new developments in science and other factors;
   v. Explore research, monitoring and surveillance opportunities related to management at source and treatment technologies, under the respective jurisdictional authorities, to address CMCs in wastewater effluent and residuals; and
   vi. Coordinate research, monitoring and surveillance activities as a means to provide early warning for chemicals that could become CMCs;

Nominating Potential CMCs

- Under Annex 3 – Chemicals of Mutual Concern (CMC), it is the responsibility of the Parties to nominate substances for review and evaluation for potential designation as a CMC. Following outlines the basic criteria which may be used in the US by federal, state and tribal governments for this purpose.

First Round of Chemical Evaluation

- Mercury
- PCBs
- BFRs
- PFCs
- NP/NPE
- BPA
- CP

CONTENTS OF A PROPOSAL

Chemical proposals should be accompanied by a supporting rationale that outlines the justification for the proposal. This supporting rationale should be based on currently available data or other information including, but not necessarily be limited to, the following…

Criteria for Nominating CMCs

- Data and/or information indicating presence in the Great Lakes;
- Data and/or information indicating a potential ecological or human health threat in the Great Lakes;
- Information regarding the present and historical uses and releases in the Great Lakes;
- Government and/or non-government assessments, reports, reviews and/or other regulatory conclusions;
- Existing water and other environmental quality standards, criteria or guidelines;
- Past and present government and non-government risk management activities; and
- Any other relevant information with regards to the proposed chemical.

TIMELINES

- Governmental chemical proposals will be periodically reviewed through regularly scheduled Federal/State and federal/tribal meetings.

SUBMISSION OF PROPOSALS

Governmental chemical proposals should be submitted electronically to the Annex 3 US Co-lead at the following e-mail addresses:

- GLWQA@glnpo.net

Annex 3 Governance – Chemicals of Mutual Concern Bi-national Co-Leads

CANADA

Vincenza Galatone

Environment Canada

UNITED STATES

Louise Wise

U.S. Environmental Protection Agency

The collective role of the Annex 3 Co-Leads is to coordinate and lead on the delivery of the Annex specific commitments on behalf of the Parties.


Discussion
Image courtesy of the Image Science & Analysis Laboratory, NASA Johnson Space Center

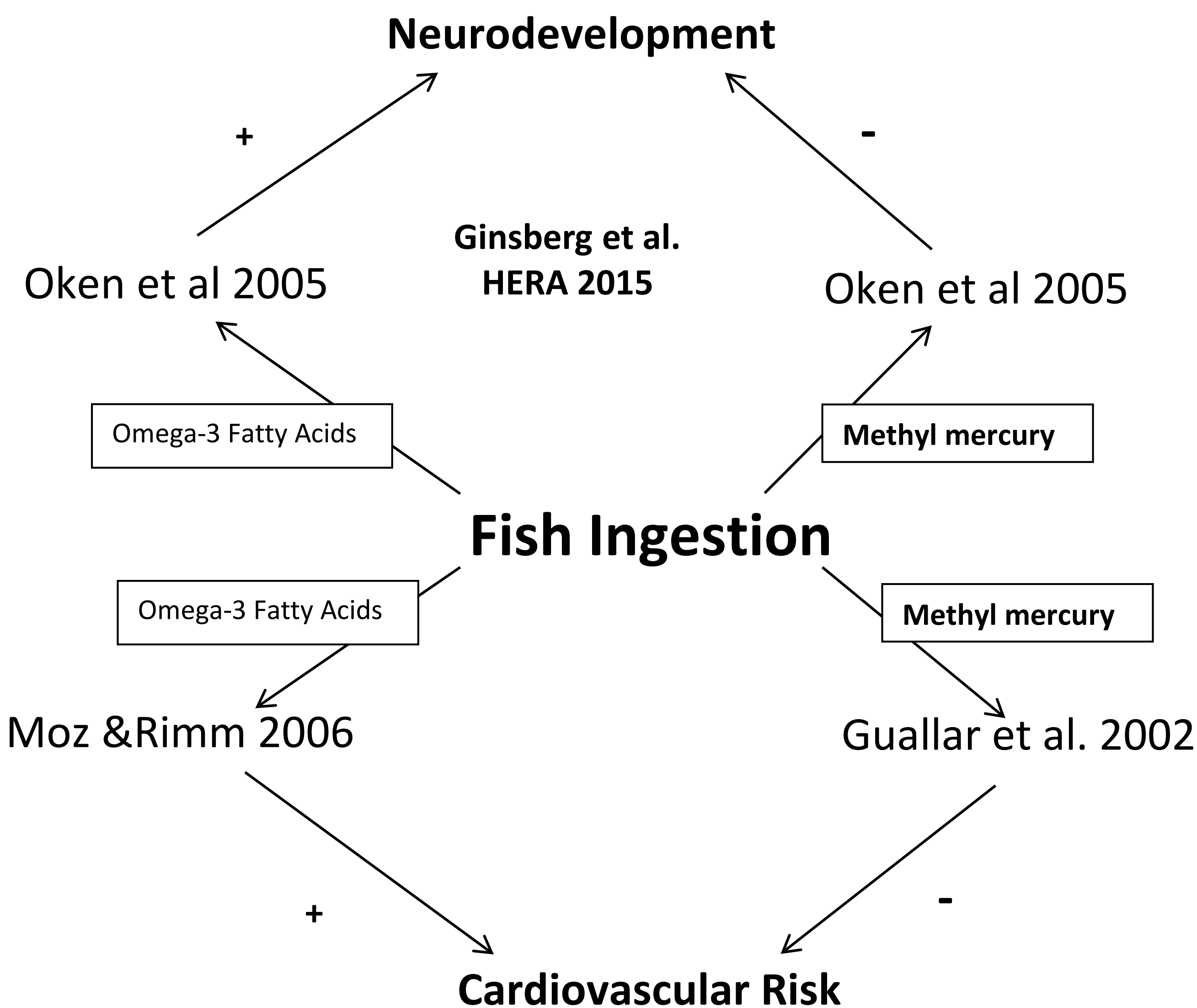
Updated Risk/Benefit Analysis of Fish Consumption for Cardiovascular Endpoints

Gary Ginsberg

May 18, 2015

Great Lakes Consortium

Ginsberg & Toal 2009 Risk/Benefit Modeling



Risk Benefit for CVD Endpoints: Major Uncertainties

- Mercury Risk
  - epidemiology mixed
    - Mozzafarian et al. 2011, Bergdahl et al. 2013
    - The higher the Hg in hair the lower the risk
  - upstream markers and mechanism supportive

- O-3 Benefit
  - Uncertain if fish benefit due to O-3 FA content
    - Supplementation studies mixed results

Direct and Supporting Evidence for meHg Effect on CVD

Mechanism (Animals and Cells)

Vascular Endothelial Reactivity and Damage:

Oxidative stress, loss of protein sulfhydryls, activation of MAPK

(Aguado et al. 2013; Rizzetti et al. 2013; Joshi et al. 2014)

Blood lipids:

PON1 oxidation (Cole TB 2002), increased lipid hydroperoxides (Sharma et al. 2005)

Human Disease Biomarker

Vascular: IMT Increased

(Salonen et al. 2000; Skoczyńska et al. 2009; Choi et al. 2009)

Blood Lipids: PON1 Decreased

(Ayotte et al. 2011; Drescher et al. 2014; Pollack et al 2014; Ginsberg et al. 2014)

Human Disease Outcome

Myocardial Infarction and Hypertension

(Guallar et al. 2002; Salonen et al. 1995 ; Wennberg et al. 2012; Kim et al. 2014)

Ginsberg et al. 2014: Hg Inhibition of PON1 and Risk of CVD

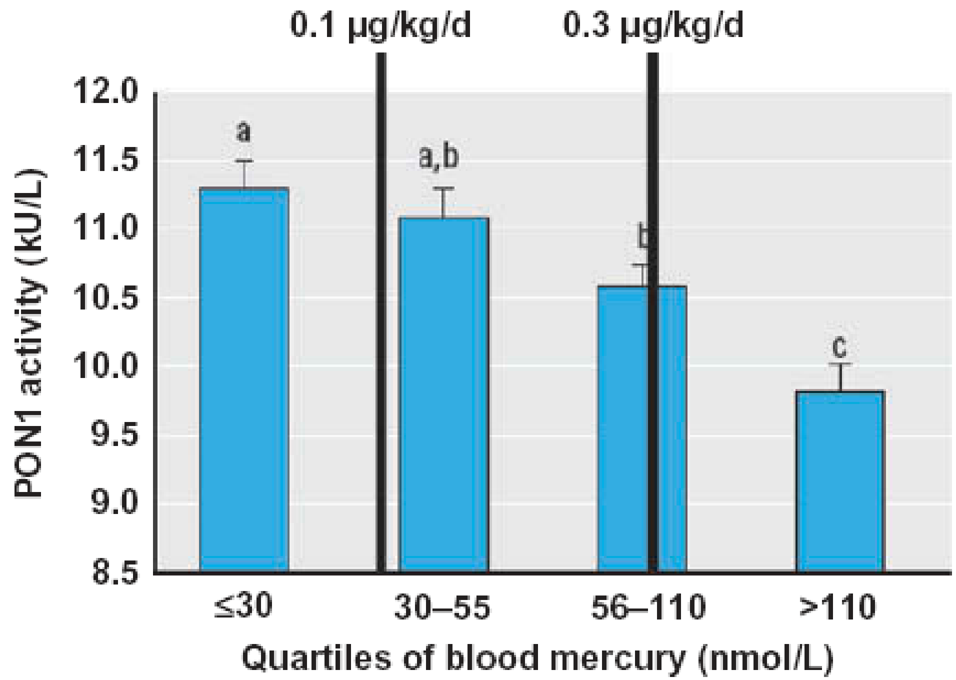


FIGURE 4. Relationship between blood mercury and PON1 in a Canadian Inuit population relative to estimated intake dose (adapted from Ayotte et al. 2011). Intake dose estimated from blood levels based upon a one compartment pharmacokinetic model as described in text. Different letters above the bars indicate mean values that are significantly different from one another, $p < .05$.

Ginsberg et al. 2014 Estimates of CVD Risk fromMeHg Exposure Based upon MeHg Inhibition of PON1

TABLE 2. Methylmercury Cardiovascular Risk Based Upon Its Effects on PON1

	0.1 μg/kg/d methylmercury	0.3 μg/kg/d methylmercury
Hair concentration (ppm)	1.1	3.3
Percent change in PON1	(−1.09)	(−6.11)
Extra risk		
From total distribution	1.76%	9.68%
From QQ192 distribution	3.74%	34.6%

Roman et al. 2011

- USEPA convened workplace on whether evidence for Hg effects on CVD is sufficient
- “***Conclusions: We recommend the development of a dose–response function relating MeHg exposures with MIs for use in regulatory benefits analyses of future rules targeting Hg air emissions.”***

Table 1. Summary of Epidemiology Studies Relating Mercury Exposure to Cardiovascular Outcomes

Study	Subjects	Mercury Source	Exposure & Outcome Measures	Results
Guallar et al. 2002	684 men with initial MI were cases compared to 724 controls spanning 8 European countries plus Israel	Fish, amalgam possibly others	Exposure: toenail Hg, adipose tissue DHA Outcome: MI	Cases had higher Hg, quintile analysis showed MI odds ratio of 2.16 for highest to lowest Hg quintiles; regression showed **23% increase in odds ratio per ppm hair** Hg after conversion of toenail to hair Hg
Salonen et al. 1995	1833 men from Eastern Finland 42-60 years of age and free of CVD at baseline, studied prospectively, 2 to 7 yr followup	Primarily local fish, low in fish oils	Exposure: hair Hg; diet survey of fish intake Outcome: MI	Highest hair Hg tertile had 2.0 odds ratio for MI
Virtanen et al. 2005	1871 men from Eastern Finland, same cohort as Salonen et al. 1995, avg follow up 13.9 yrs	Primarily local fish, low in fish oils	Exp: hair Hg, dietary survey of fish oils; Outcome: Acute coronary event, CVD	Higher hair Hg tertile (> 2 ug/g) had 1.6 fold risk of acute events
Virtanen et al. 2012	1857 men from Eastern Finland, same cohort as Salonen, 1995 but now with 20 year followup	Primarily local fish, low in fish oil	Exp: Hair Hg, serum O-3s Outcome: Sudden cardiac death (SCD)	A beneficial effect seen for DHA on SCD when controlling for hair Hg; fish oil benefit of 29% ↓ in SCD reversed at high hair Hg
Kim et al. 2014	Korean NHANES IV, N=3800 men and women, cross-sectional design	Fish, alcohol, tea, vegetables, etc.	Exp: blood Hg; Outcome: angina, MI, hypertension	Quartile analysis shows blood Hg dose response with MI; highest quartile 3 fold increase in MI risk

Dose Response for Mercury Association with CVD Outcomes in the 4th Korean NHANES, Kim et al. 2014, N= 3800

Table 4. Odds ratio (95% CIs) for cardiovascular diseases associated with blood mercury levels

Cardiovascular disease	Blood mercury level quartile	Unadjusted[1)]	Adjusted for fish consumption[2)]	Adjusted for all characteristics and fish consumption[3)]
Hypertension	Q1	1	1	1
	Q2	0.800 (0.580~1.103)	0.867 (0.616~1.219)	0.853 (0.583~1.248)
	Q3	1.027 (0.777~1.356)	1.245 (0.917~1.690)	1.184 (0.830~1.689)
	Q4	1.450 (1.106~1.901)	1.550 (1.131~2.123)	1.221 (0.845~1.764)
Stroke	Q1	1	1	1
	Q2	0.716 (0.322~1.596)	0.644 (0.285~1.457)	0.708 (0.302~1.662)
	Q3	0.380 (0.149~0.974)	0.393 (0.141~1.095)	0.418 (0.150~1.165)
	Q4	1.023 (0.515~2.036)	1.030 (0.504~2.105)	0.986 (0.468~2.079)
Myocardial infarction or angina	Q1	1	1	1
	Q2	1.048 (0.388~2.829)	1.158 (0.393~3.408)	1.083 (0.370~3.171)
	Q3	2.138 (0.883~5.172)	2.585 (1.005~6.650)	2.265 (0.896~5.727)
	Q4	2.293 (0.961~5.469)	3.334 (1.338~8.308)	2.740 (0.978~7.675)

[1)]Not adjusted.
[2)]Adjusted for fish (i.e., mackerel, tuna, yellow fish, pollack, anchovy, squid, and clam) consumption frequency.
[3)]Adjusted for age, education level (less than high school diploma, high school diploma, and some college education), BMI ($<$18.5 kg/m^2, 18.5~24.9 kg/m^2, and $\geq$25 kg/m^2), alcohol consumption frequency (none, moderate, and heavy), smoking status (never, former, and current), and waist circumference (male: $<$90 cm and $\geq$90 cm, female: $<$80 cm and $\geq$80 cm).

Table 1. Mercury CVD Epidemiology (continued)

Study	Subjects	Mercury Source	Exposure & Outcome Measures	Results
Ahlqvist et al. 1999	**1462 Swedish women studied prospectively over several decades**	**Primarily amalgam, no estimation of fish ingestion**	**Exp: Serum Hg Outcome: MI, Stroke**	**No association between Hg and CV outcomes**
Hallgren et al. 2001	78 MI cases, Northern Sweden, cross-sectional against 156 controls	Fish ingestion but not quantitated	Exp: RBC Hg, plasma O-3 Outcome: first MI	RBC Hg and plasma O-3 associated with lower risk of MI
Mozzafarian et al. 2011	3427 subjects from 2 US cohorts, 2/3 women, avg age 57 studied prospectively avg followup 11 yrs	Fish ingestion dietary recall	Exp: toenail mercury, fish diet recall Outcome: review of medical records for MI and CVD	Hg exposure correlated to 20% lower CVD risk in model uncorrected for fish benefit
Bergdahl et al. 2013	1391 Swedish women aged 38-60 at baseline followed 32 yrs	Fish consumption, dental amalgams	Exp: Serum Hg at baseline, fish ingestion diet recall Outcome: MI and stroke hospital records	Highest serum Hg quartile had lower MI by 44% in model not corrected for fish intake; serum concs relatively low compared to other studies; dental health more impt risk factor than fish ingestion

Table 2. Alternative CVD Risk Slopes for Mercury Exposure

Study	Subjects	Mercury Source	Slope	Comments
Ginsberg and Toal 2009, based upon Guallar et al. 2002	684 men from 8 European countries + Israel with initial MI; 724 controls	Dietary, mixture of fish	**23% increase relative risk of a 2nd MI per ppm hair Hg after correction for DHA biomarker**	Convert toenail Hg to hair Hg as per slope in Ohno et al. 2007 and Hammitt et al. 2012; Apparent threshold at approx. 0.51 ppm hair
Rice et al. 2010 based upon Salonen et al. 1995	1833 men from Eastern Finland	Diet high in nonfatty fish, high in Hg	**6.6% increased relative risk for MI per ppm hair Hg; no correction needed for O-3 since diet low in O-3**	Same slope used in risk/benefit analysis of Rheinberger and Hammitt 2012
Wennberg et al. 2012	211 male MI cases from Eastern Finland + 361 male MI cases from Sweden	Eastern Finland: Nonfatty fish high in Hg; Sweden: low Hg fish	**Pooled exponential function, adjusted for serum O-3s, slope range 4-10% increase MI RR per ppm hair Hg**	Combining data across 2 studies required conversion of erythrocyte Hg to hair Hg; RRs calculated against reference group having hair Hg of 1 ppm
Kim et al. 2014	3800 male/female subjects from the Korean NHANES	Hg in fish, tea, alcohol, other foods	Categorical analysis shows dose response for Hg increase in MI	**Approx 300% increased risk when increasing hair Hg 1.5 ppm (0.5 to 2 ppm) corresponding to approx. 200% increase per ppm**

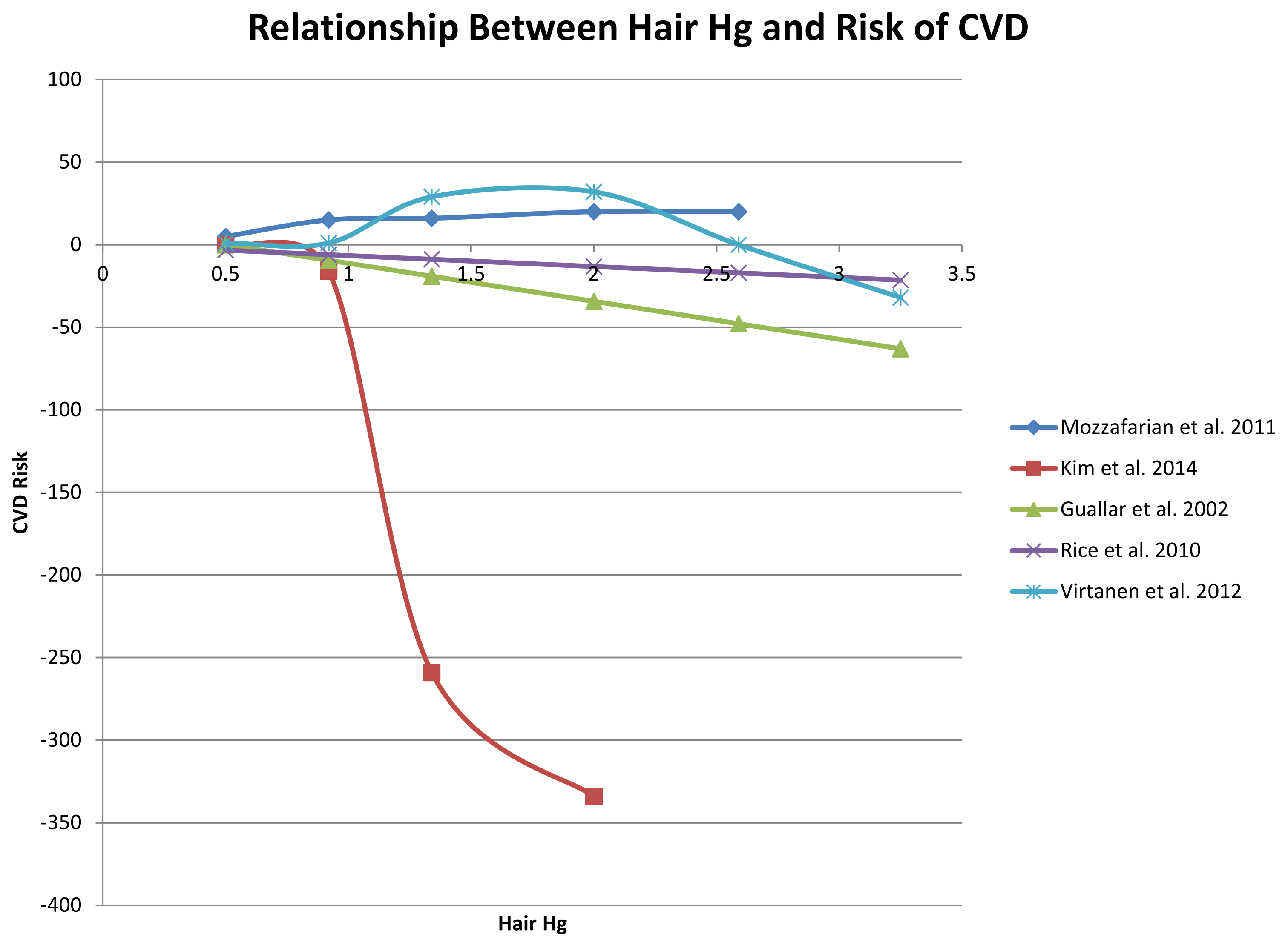

Relationship Between Hair Hg and Risk of CVD
100
50
0
-50
-100
-150
-200
-250
-300
-350
-400
0
0.5
1
1.5
2
2.5
3
3.5
CVD Risk
Hair Hg
Mozzafarian et al. 2011
Kim et al. 2014
Guallar et al. 2002
Rice et al. 2010
Virtanen et al. 2012

Table 3. Summary of Epidemiology Studies Relating Omega-3 FA Intake to CVD

Study	Subjects	Omega-3 Source	Exposure & Outcome Measures	Results
Mozaffarian and Rimm 2006	20 studies reviewed which evaluated O-3 FA intake vs coronary heart disease (CHD) in prospective or clinical intervention designs	Fish in some studies, supplements in others	Exp: daily O-3 intake Outcome: various cardiovascular outcomes studied but main one was CHD	Nearly all studies showed significant improvement of CHD risk with greater intake of O-3 FAs although benefit seemed to dissipate beyond 250 mg/day; data synthesis: 14.6% ↓ in CHD risk per 100mg/d EPA+DHA intake
Wang et al. 2006	15 clinical intervention studies plus 25 prospective cohorts, most fish oil supplementation	Fish intake recall or known administered amount in trial	Exp: daily intake of O-3 FA from diet or supplement	Majority of studies showed benefit of fish or fish oil on cardiac outcomes; quantitative relationship not examined
Rizos et al. 2012	Meta-analysis of 20 prospective studies	Supplementation	Exp: O-3 FA in daily supplements Outcome: MI, others	O-3 supplementation not associated with CVD benefit
Kwak et al. 2012	Meta-analysis of 14 clinical intervention studies involving 20485 patients with history of CVD	Supplementation	Exp: O-3 FA in supplements Outcome: MI, sudden cardiac death	No effect of supplementation on cardiac events seen in this pop of those with pre-existing CVD

Study	Subjects	Omega-3 Source	Exposure & Outcome Measures	Results
Musa-Veloso et al. 2011	Meta-analysis of 8 prospective fish consumption studies, 214,000 subjects without pre-existing CVD	Fish Consumption	Exp: dietary recall with conversion to O-3 FA ingestion Outcomes: CHD, acute coronary event	**Consumption of > 250 mg/d of O-3 FA from fish lowered coronary risks 7-35% compared to < 250 mg/d** depending upon the endpoint
Zheng et al. 2012	Meta-analysis of 17 prospective fish consumption studies, 316,000 subjects, avg followup 16 years	Fish consumption	Exp: dietary recall of fish ingestion; no attempt to quantitate O-3 intake Outcomes: MI, coronary heart disease mortality	Dose response benefit of fish consumption: **1 meal/wk OR = 0.84; 2-4 meals/wk OR = 0.79;** apparent saturation of benefit at 50 g fish/day (approx. 2 meals/wk or 260 mg/d O-3 FA)
Nestel et al. 2015	Systematic literature review 2007-2013 for O-3 FA influence on CV risk	Fish consumption or supplements	Exp: O-3 intake rates Outcome: CHD and other CV endpoints	Fish ingestion associated with lower heart disease, MI and stroke. O-3 FA intake only associated with lower serum triglycerides

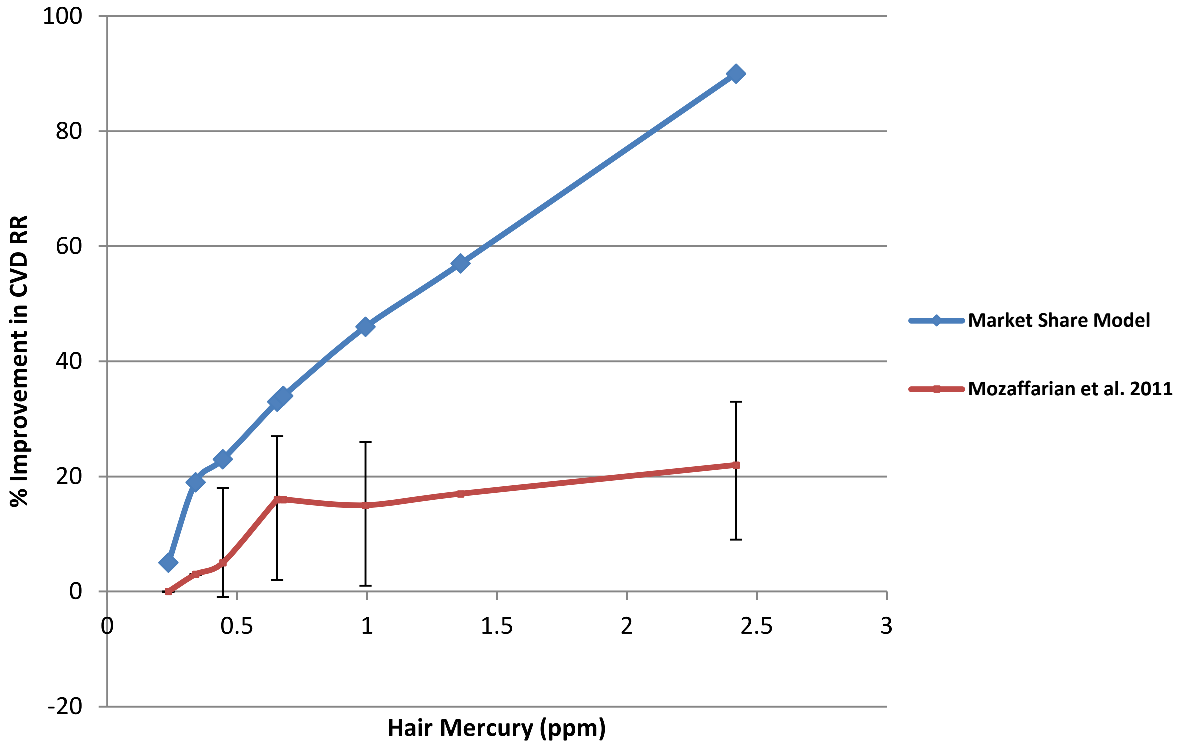
Issues in Hg-CVD Risk Benefit Modeling

- Calibration Data to test and adjust model
  - Marketshare composite fish ingestion model
- Which Hg slope?
  - Eastern Finland (Salonen, 1995;Wennberg et al. 2012; Rice et al. 2010) – N=1833
  - 8 Countries – Europe and Israel (Guallar et al. 2002, N=684)
    - Threshold or not?
  - Korea (Kim et al. 2014, N=3800)
- O-3 FA benefit
  - Surrogate for other components in fish?
  - Saturation of benefit > 250 mg/d

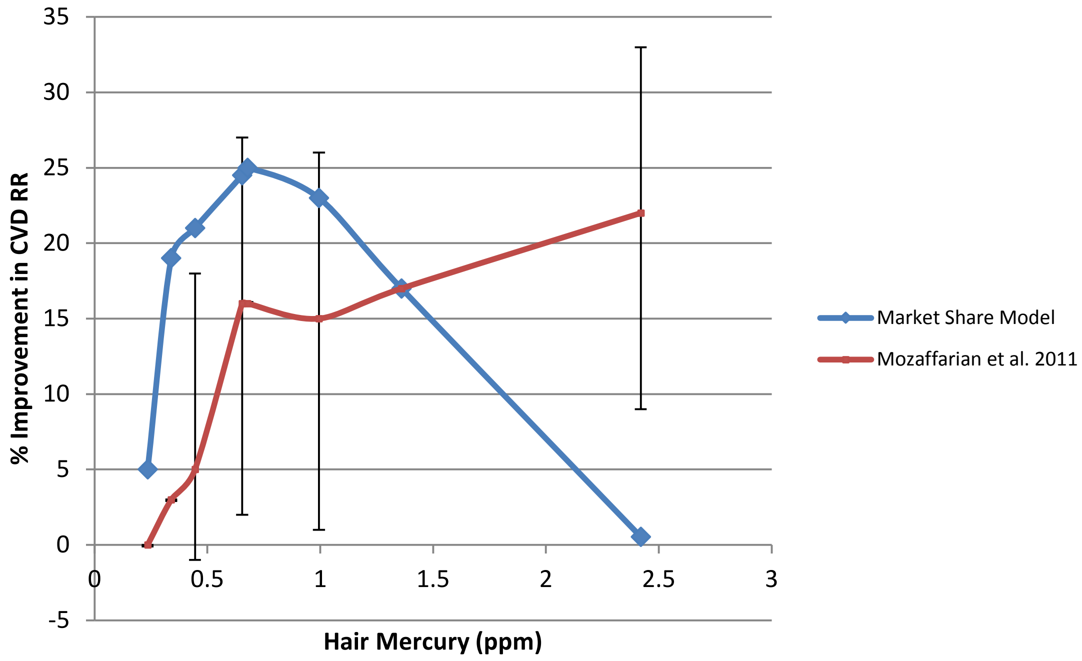
Table 2. Basic Features of Composite Marketshare Fish Diet

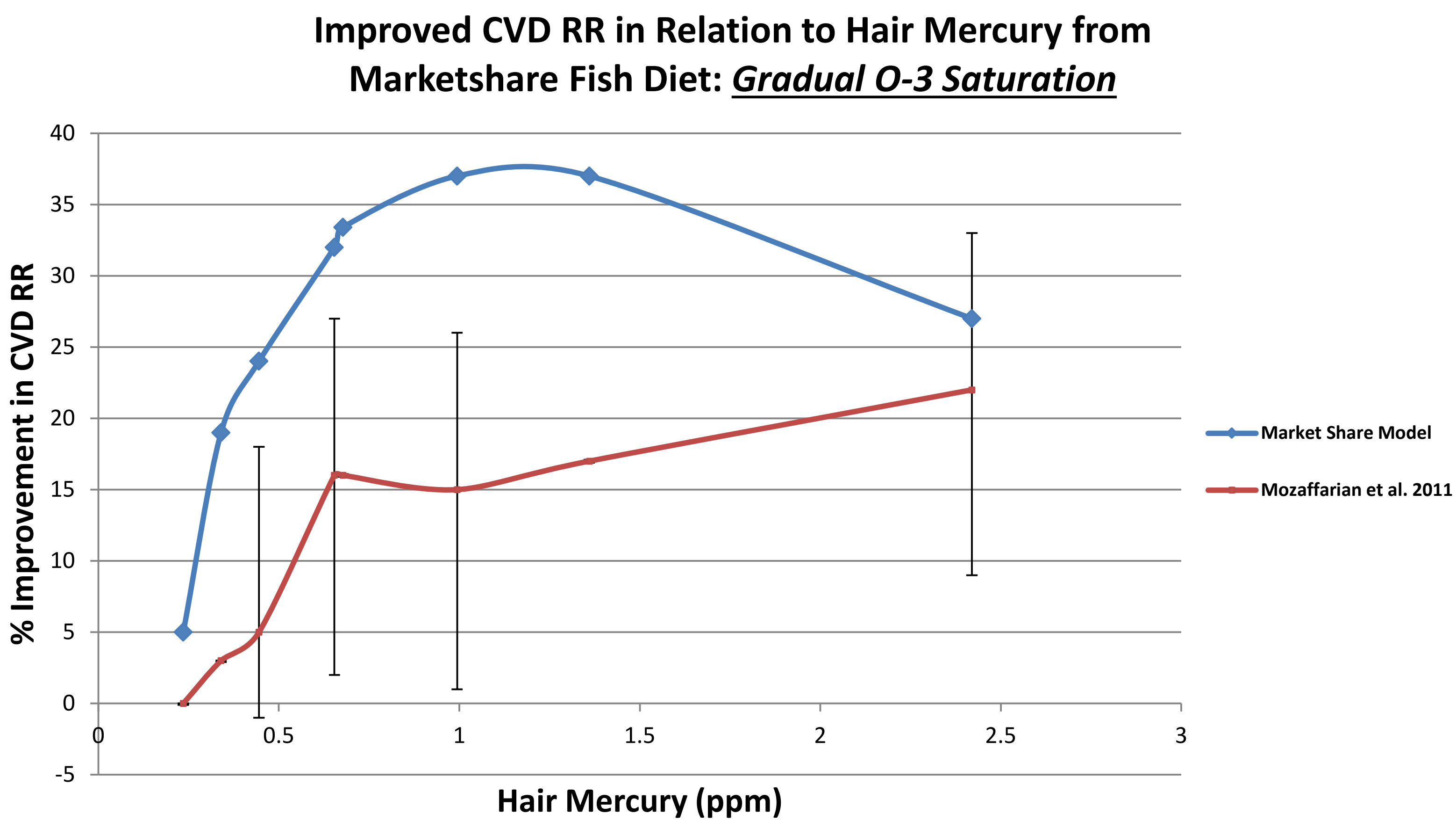
	Fish Content	Dietary Exposure (2 meals/week)	Recommended Value
EPA+DHA	912 mg/6 oz	261 mg/d	500 -1000 mg/d
meHg	0.085 ug/g	0.069 ug/kg/d	0.1 ug/kg/d
Omega-3/ Hg ratio	63 mg / ug	---	None available

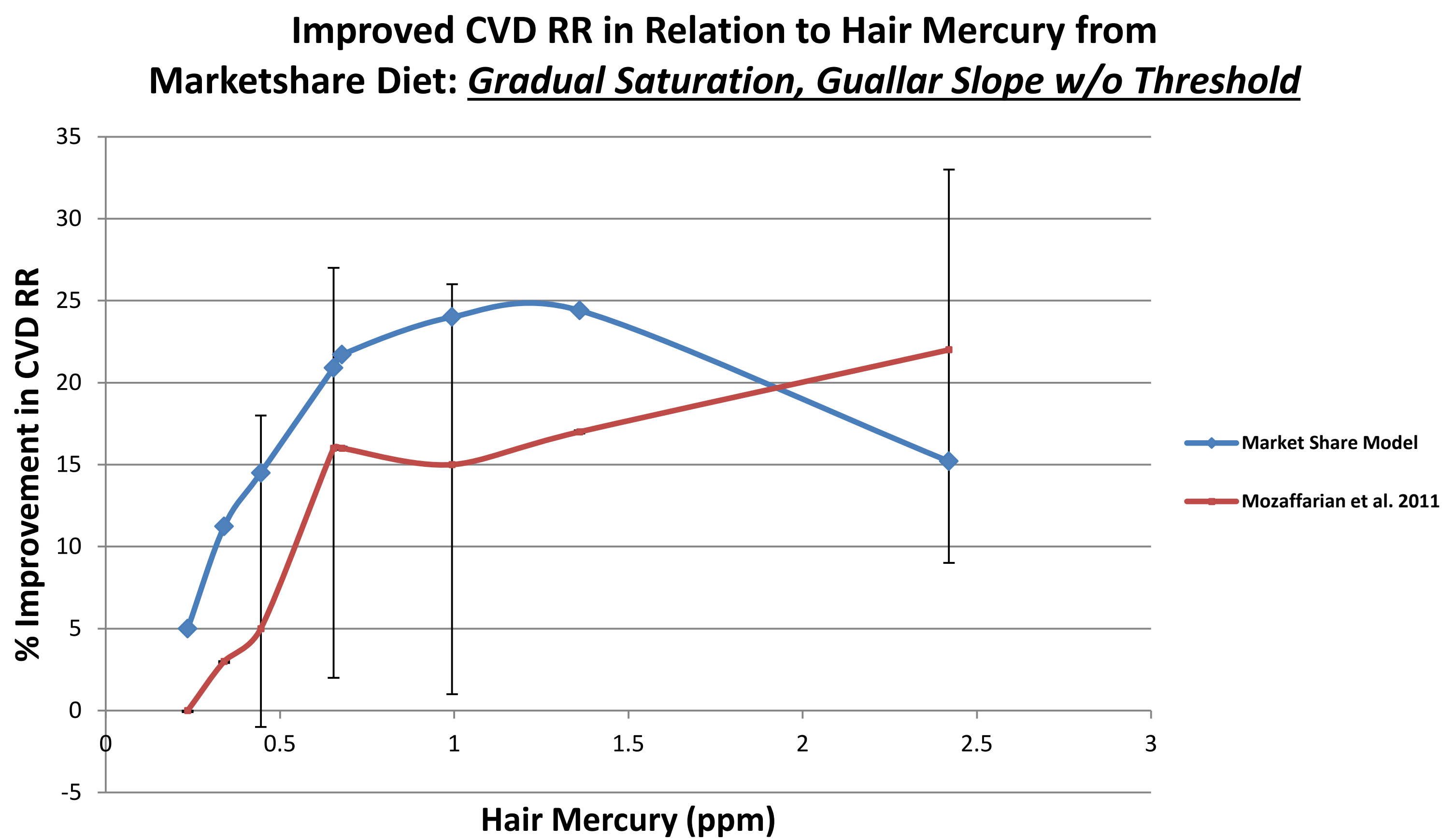
Improved CVD Relative Risk in Relation to Hair Mercury Obtained from Marketshare Fish Diet: ***No O-3 Saturation***

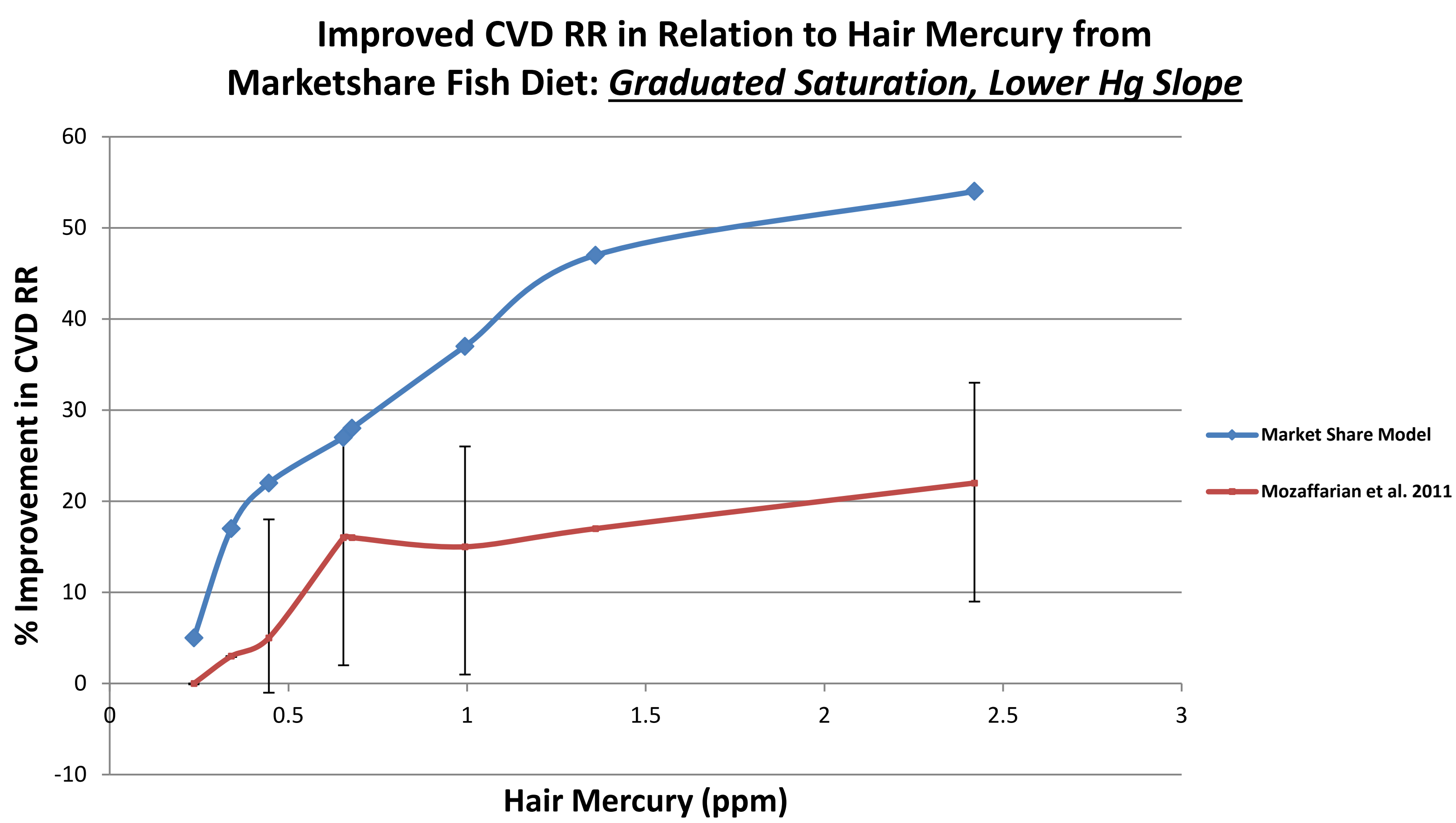


Improved CVD Relative Risk in Relation to Hair Mercury from Marketshare Fish Diet: ***Sharp O-3 Saturation***




Improved CVD RR in Relation to Hair Mercury from
Marketshare Fish Diet: Gradual O-3 Saturation
40
35
30
25
20
15
10
5
0
-5
% Improvement in CVD RR
0
0.5
1
1.5
2
2.5
3
Hair Mercury (ppm)
Market Share Model
Mozaffarian et al. 2011


Improved CVD RR in Relation to Hair Mercury from
Marketshare Diet: Gradual Saturation, Guallar Slope w/o Threshold
% Improvement in CVD RR
Hair Mercury (ppm)
35
30
25
20
15
10
5
0
-5
0
0.5
1
1.5
2
2.5
3
Market Share Model
Mozaffarian et al. 2011



Improved CVD RR in Relation to Hair Mercury from
Marketshare Fish Diet: Graduated Saturation, Lower Hg Slope
% Improvement in CVD RR
60
50
40
30
20
10
0
-10
0
0.5
1
1.5
2
2.5
3
Hair Mercury (ppm)
Market Share Model
Mozaffarian et al. 2011

Improved CVD RR in Relation to Hair Mercury from Marketshare Fish Diet: Saturable O-3, No Hg Risk

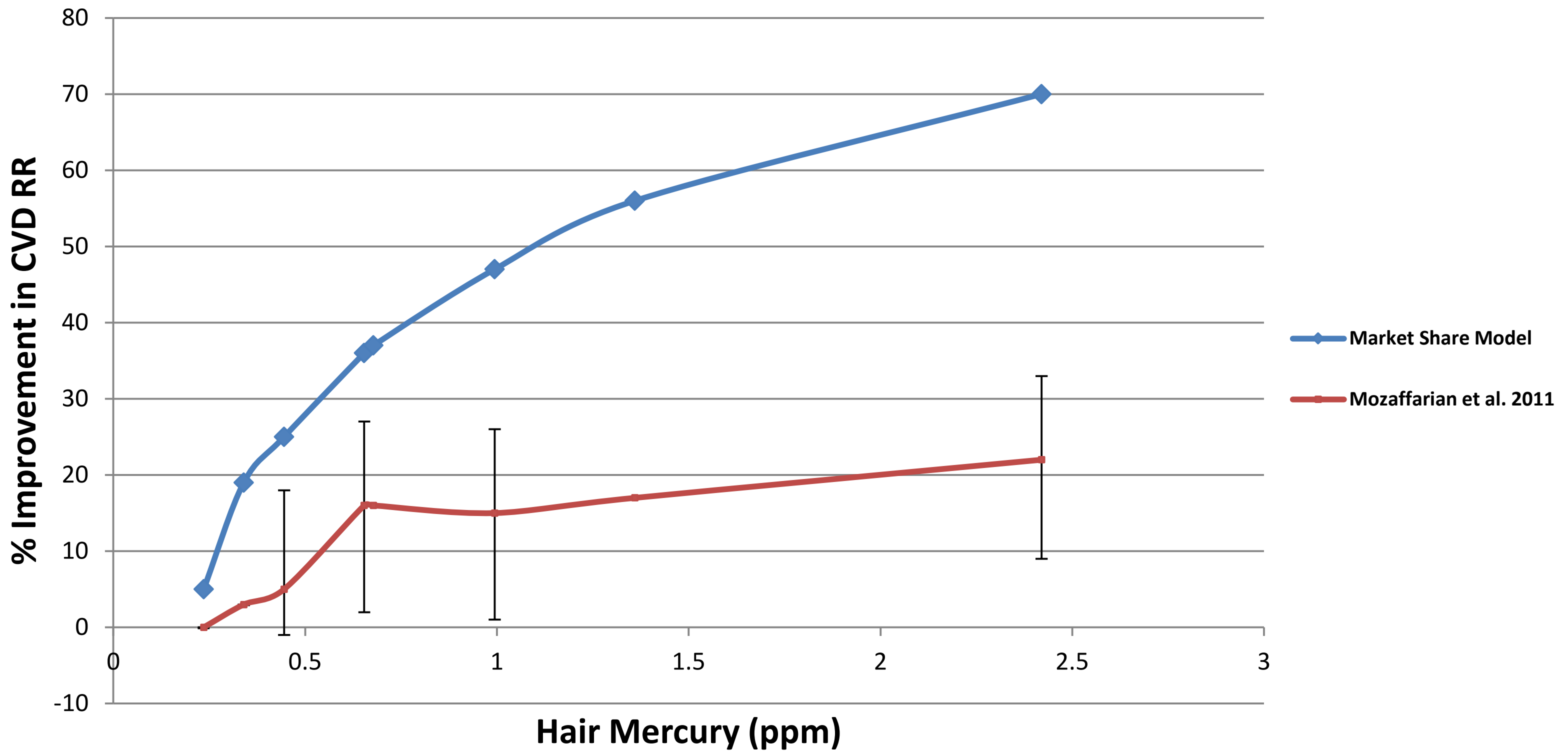
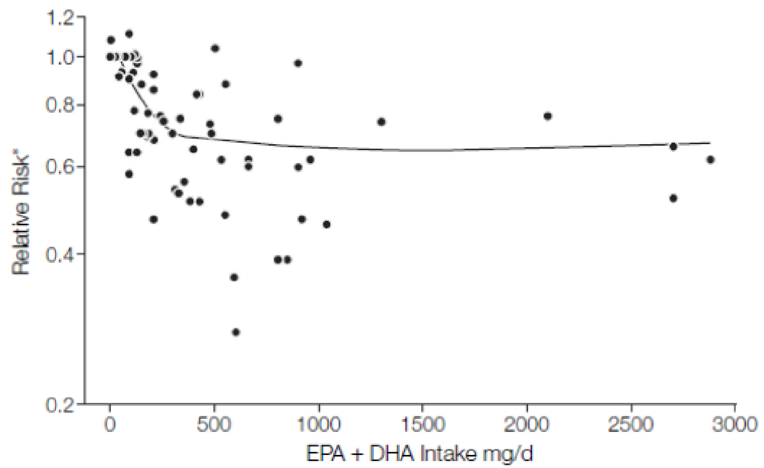
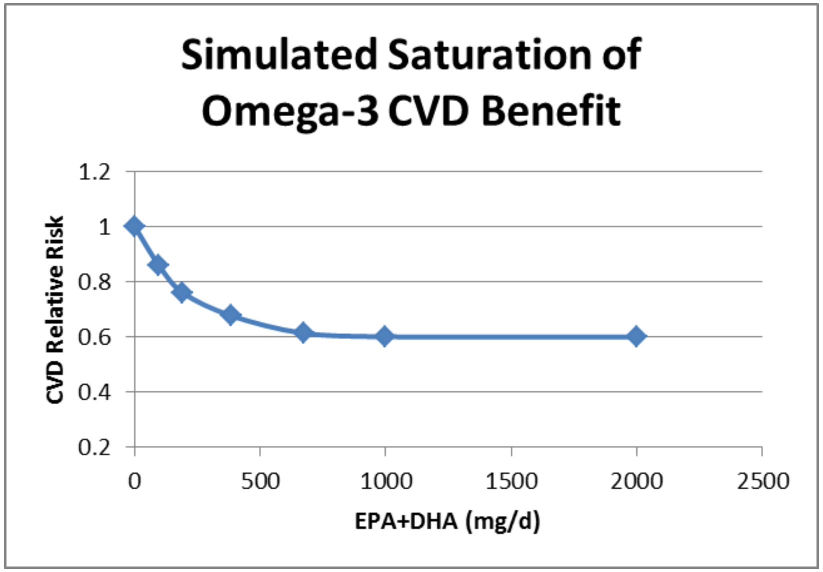


Figure 2. Relationship Between Intake of Fish or Fish Oil and Relative Risks of CHD Death in Prospective Cohort Studies and Randomized Clinical Trials





Zheng et al. 2012 Meta Analysis of 17 Studies Involving Fish Consumption and CHD

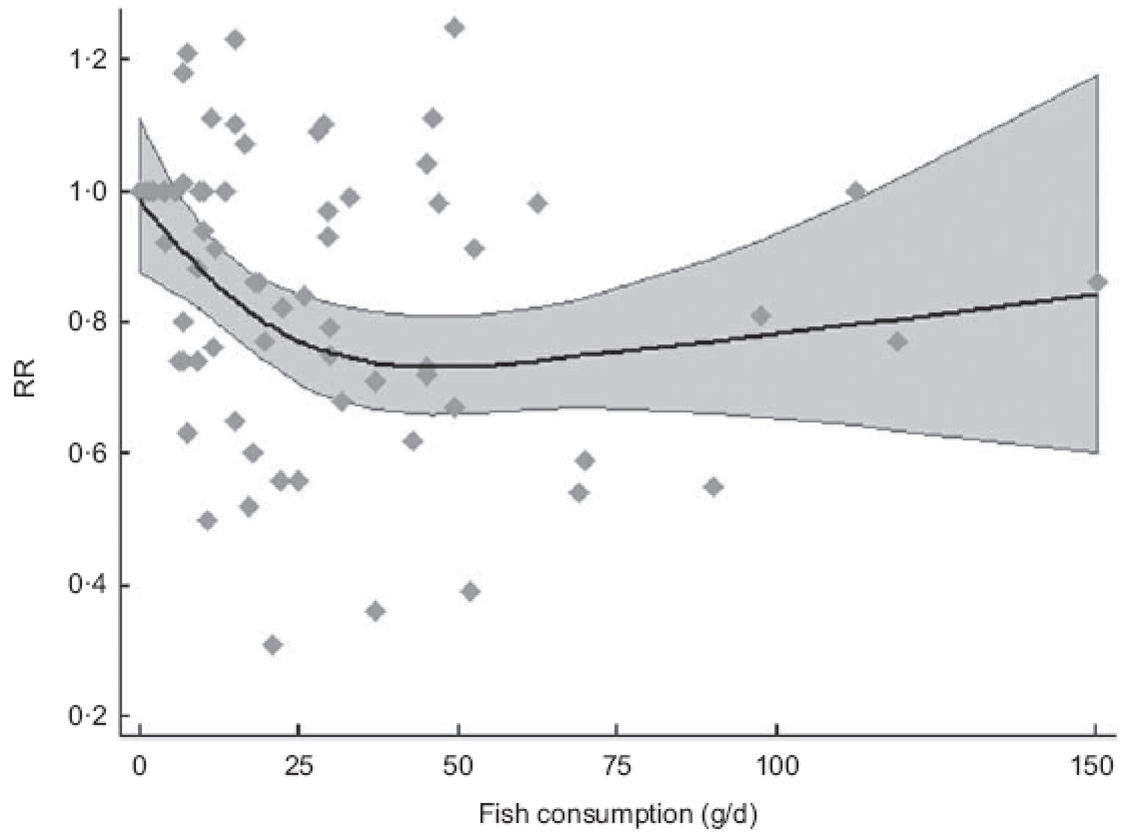
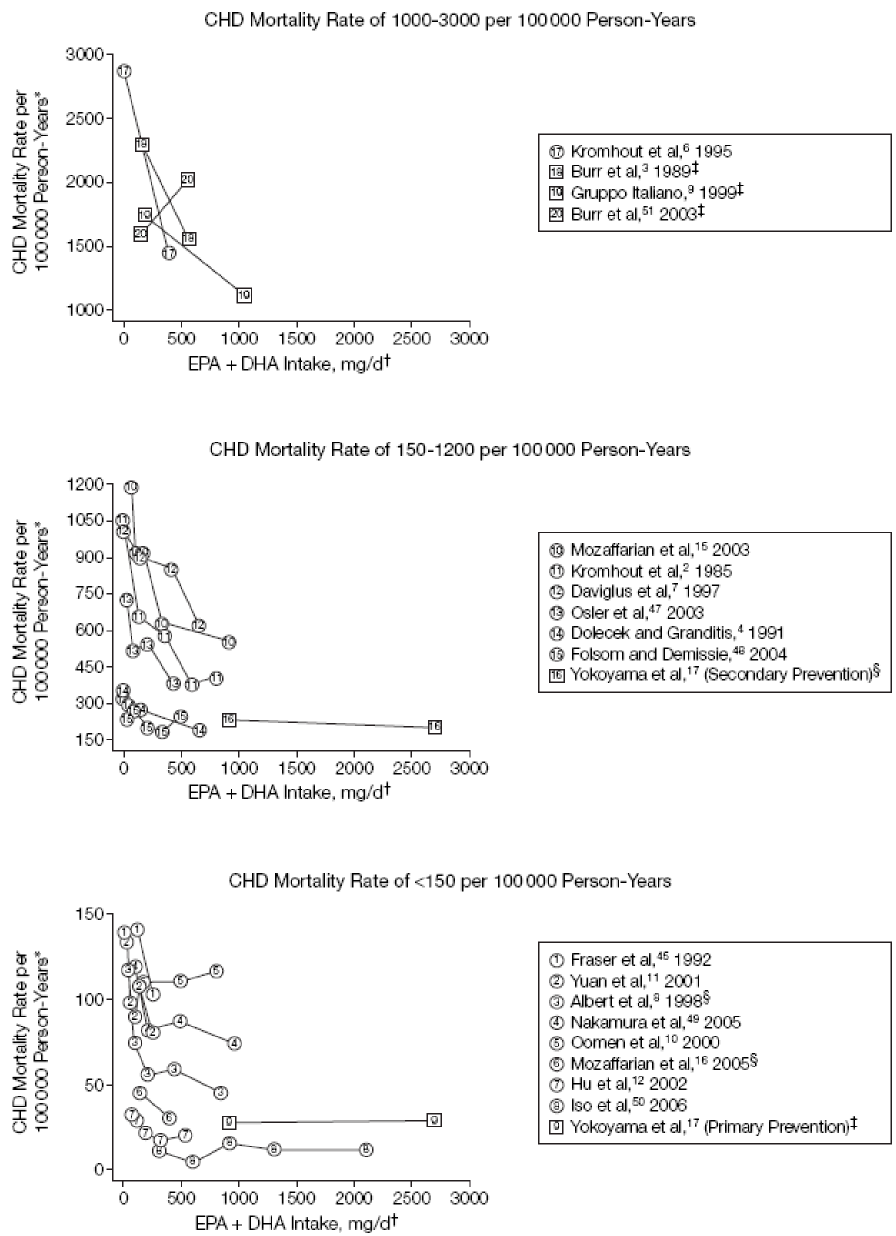
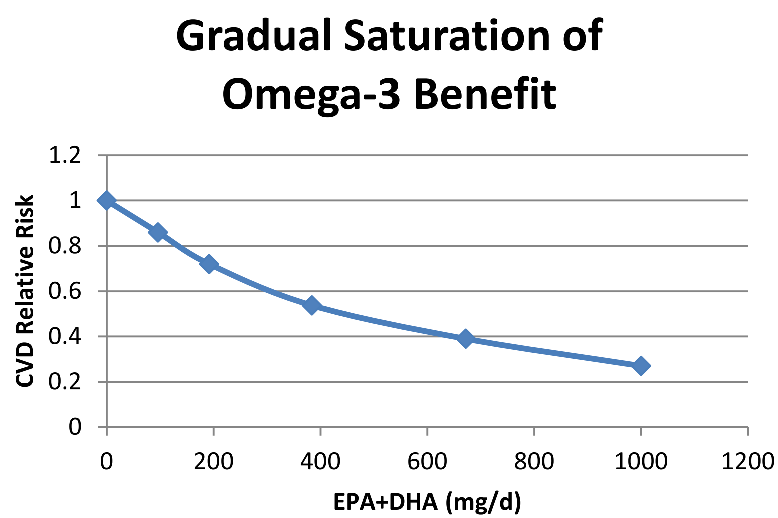


Fig. 6 Dose–response relationship between fish consumption (g/d) and CHD mortality with a restricted cubic spline model. The grey shaded area represents the 95 % confidence limits for the fitted curve (RR, relative risk)

Saturation of Benefit at 50 g/d, 2 meals/wk or approx 260 mg O-3 FA if ingesting marketshare composite fish meal

Figure 1 from Mozzafarian and Rimm 2006 showing continued benefit beyond 250 mg O-3 FA/day in some studies

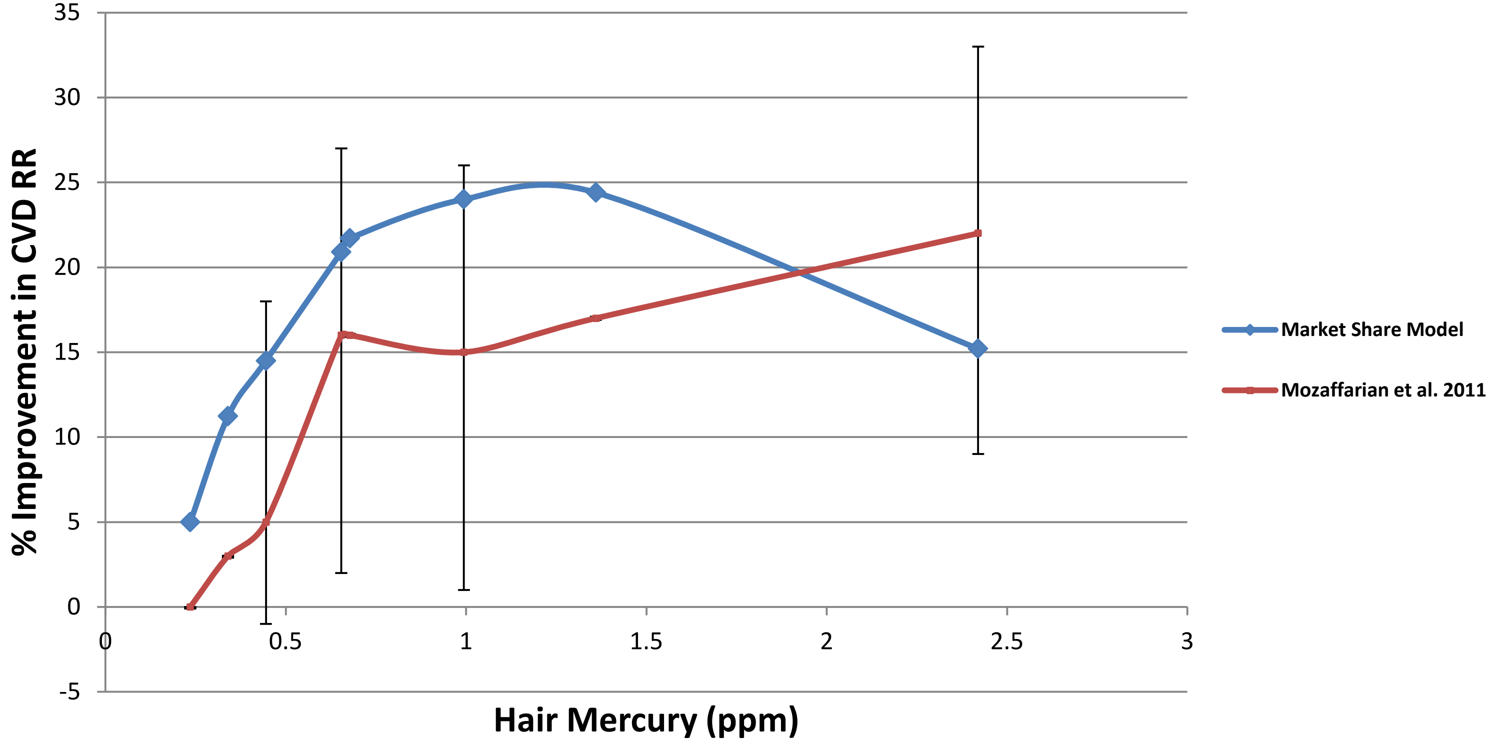


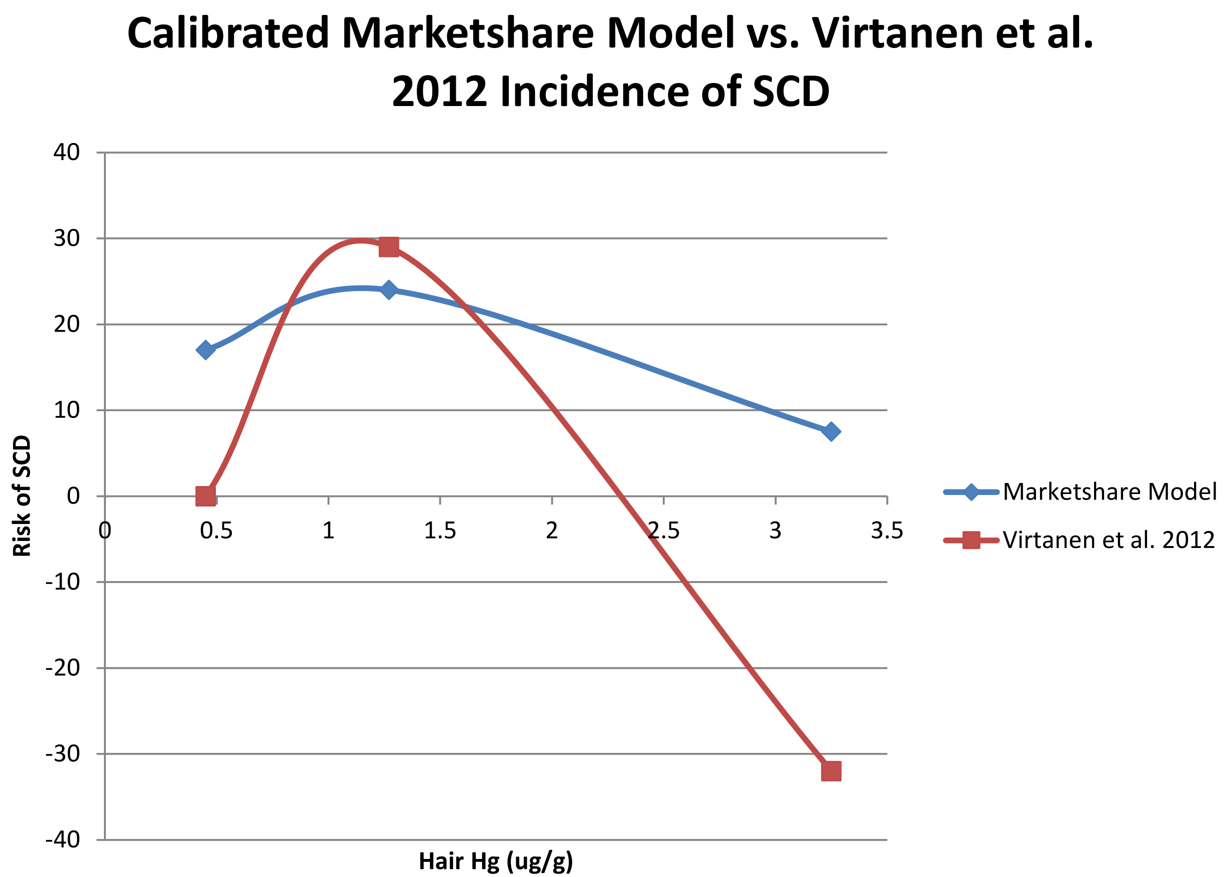


$$\textbf{Benefit} = (\text{O-3 FA}_{250mg/d} * 0.14) + (\text{O-3 FA}_{500\text{-}250mg/d} * 0.073) + (\text{O-3 FA}_{1000\text{-}500mg/d} * 0.0365)$$

- Musa-Veloso et al. 2011 showed 7-35% additional CHD benefit in those consuming >250 mg/day O-3 FA from fish compared to <250 mg/d over 8 prospective studies and 214,000 subjects
- Mozzafarian and Rimm 2006 showed numerous studies with continued O-3 FA benefit beyond 250 mg/d

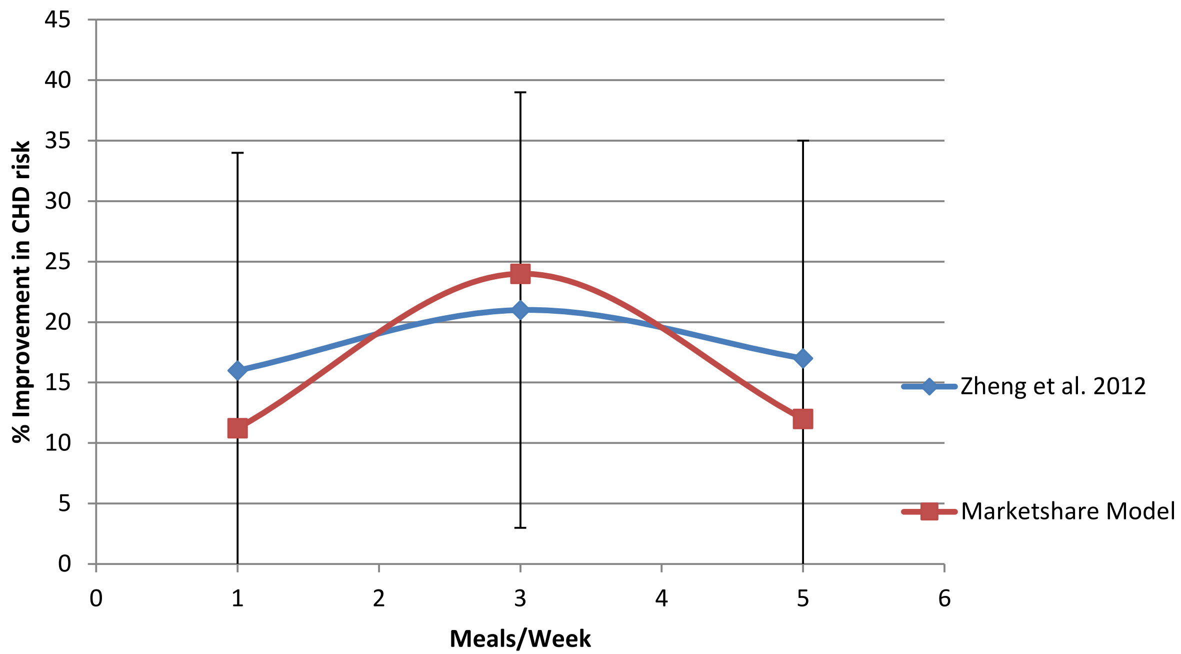
Improved CVD RR in Relation to Hair Mercury from Marketshare Fish Diet: Saturable Benefit, Guallar Slope

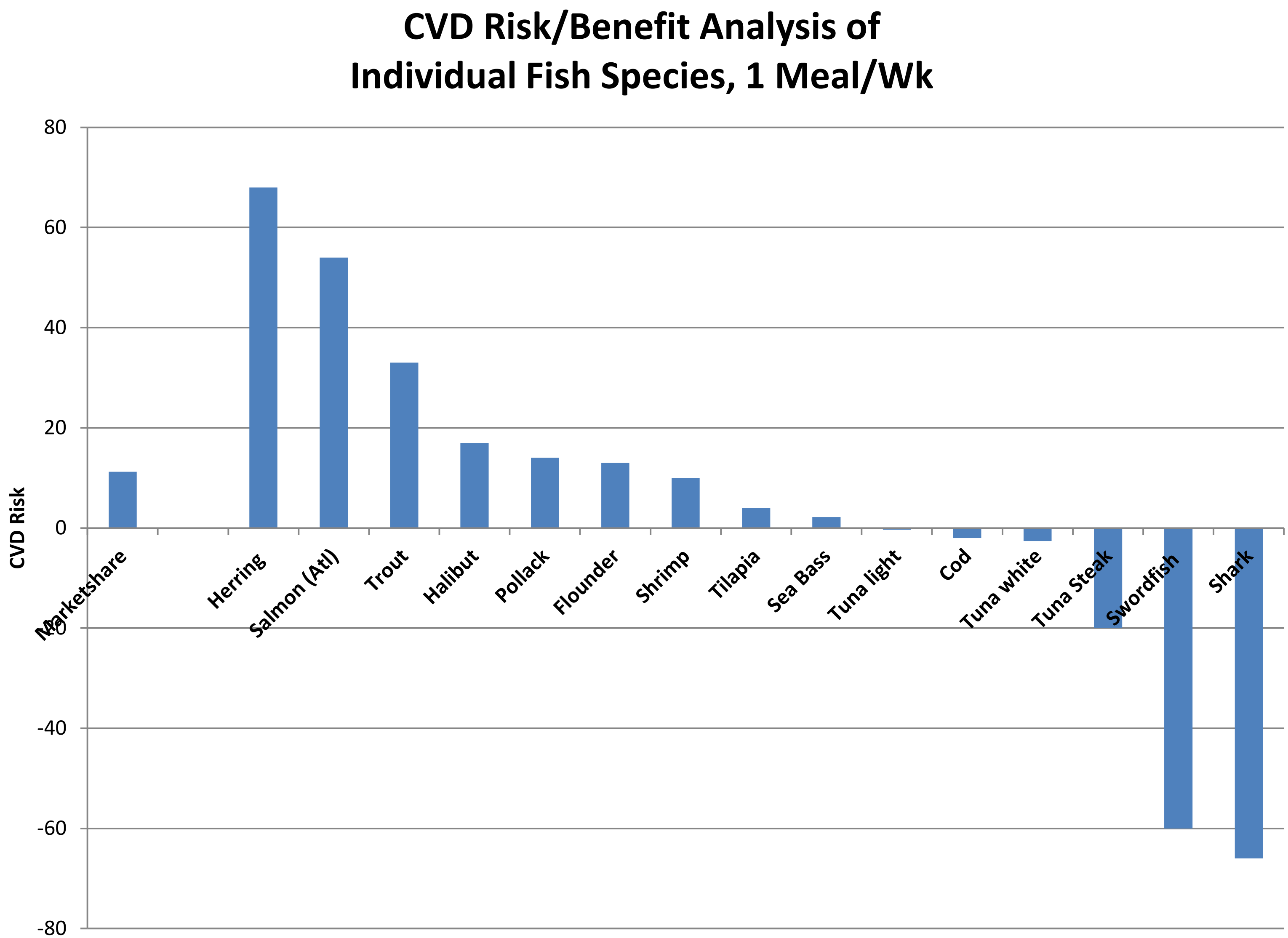




Calibrated Marketshare Model vs. Virtanen et al. 2012 Incidence of SCD
40
30
20
10
0
-10
-20
-30
-40
Risk of SCD
0
0.5
1
1.5
2
2.5
3
3.5
Hair Hg (ug/g)
Marketshare Model
Virtanen et al. 2012

Zheng et al. 2012 Estimates of Fish Meal CHD Benefit (17 Studies) vs Calibrated Marketshare Model





CVD Risk/Benefit Analysis of
Individual Fish Species, 1 Meal/Wk
80
60
40
20
0
-20
-40
-60
-80
CVD Risk
Marketshare
Herring
Salmon (Atl)
Trout
Halibut
Pollack
Flounder
Shrimp
Tilapia
Sea Bass
Tuna light
Cod
Tuna white
Tuna Steak
Swordfish
Shark

CVD Risk Benefit as a Function of O-3 FA and Hg Content of Fish, 1 Meal/Wk

Fish	CVD Risk/Benefit	O-3/Hg (mg/ug)	Hg Dose
Marketshare	+ 11.23	63	0.029
Salmon	+ 53	1534	0.005
Tuna steak	- 20	8.6	0.11
Swordfish	- 60	8.4	0.34

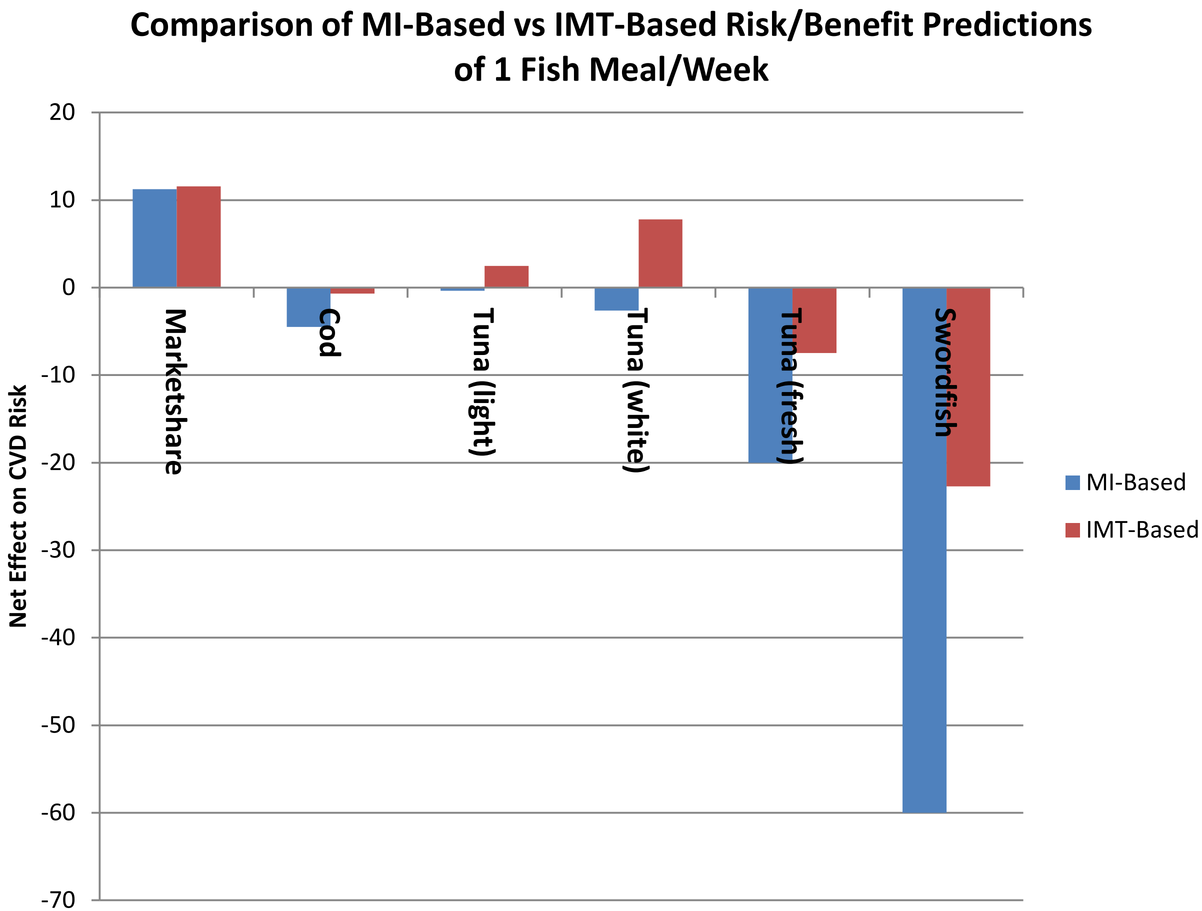
- **CVD concern for species with O-3/Hg <10; limit to RfD consumption**
- **CVD benefit for species with O-3/Hg > 30**
- **Encourage consumption of species with high O-3/Hg (>30)**

Mercury Relationship to Intima-Media Thickness

Population	Exposure	Study Design	IMT Relationship	Reference
1014 men from eastern Finland avg age 52 yrs	Not described but likely dietary/fish	CVD prospective risk factors study; IMT measured at baseline and then 4 years later; correction for various CVD risk factors but not for fish benefits	Hair Hg among the strongest predictors of IMT increase; Regression slope = 0.008 mm IMT ↑/ ppm hair Hg; Quintile analysis: only top quintile (Hair Hg > 2.81 ppm) ↑ed; IMT increase 0.034 mm	Salonen et al 2000
42 male Faroese Whalers avg age 55	Whale and other fish consumption	Regression of IMT on various Hg biomarkers corrected for number of fish meals and various CVD risk factors	Hair Hg regression slope = 0.0055 mm IMT ↑/ ppm hair Hg	Choi et al. 2009
154 Polish factory workers, 81% men, avg age 48 yrs	Occupational exposure to inorganic Hg in chlorine factory	Correlation analysis of urinary Hg with IMT	Statistical correlation found but coefficients not presented and not adjustment for confounders	Skoczynska et al. 2009

Fish Oil Relationship to Intima-Media Thickness

Population	O-3 FA Intake	Study Design	IMT Relationship	Reference
608 Japanese and US men, 40-49 yrs old; no clinical CV disease	Not described but likely dietary/fish, fish consumption survey performed	Cross-sectional analysis of O-3FA serum levels vs IMT; cannot be used for O-3FA slope because intake of fish or FAs not reported	IMT higher in US compared to Japanese men; fish ingestion and serum O-3FAs also higher in Japanese; Serum DHA but not EPA associated with lower IMT in Japanese but not US men	Sekikawa et al. 2011
56 hypertensive Italian patients, 48% men, 64 yr old, taking anti-hypertensive medications	3 farmed fish meals per wk delivering 2.4 g O-3 FAs per 100 gram fish meal	Fish intervention prospective study of hypertensive patients to see if ingestion of high O-3 FA fish for 1 year can modulate the increase in IMT	Increased RBC PUFA content assoc with lower IMT but the fish intervention didn't increase RBC PUFA in all cases; 1 gm/d O-3 FAs assoc with 20% drop in IMT in those whose RBC PUFA ↑ed by intervention	Colussi et al. 2014
592 healthy Florida subjects, 48 yr old, 75% were male, 100 on statins at start	Fish ingestion from back-ground diet, assessed in 3 day intake survey	Cross-sectional design assessing how 51 risk factors correspond to IMT	Correlation found for only a few of the 51 factors: age, systolic BP, BMI ↑ed IMT, ingestion of fish, magnesium, zinc and fiber ↓ed IMT; IMT ↓ed 0.008 mm/fish meal per week in adjusted model	Masley et al. 2015
961 Italians, 37% male, 48 yr old, 37% male without CV disease, 10-20% on antihypertensives	Fish ingestion, assessed in food intake survey	Cross-sectional design assessing whether fish meal frequency is correlated to IMT	Carotid plaques and IMT>0.9 mm were ↑ed in those consuming < 1 meal/wk and ↓ed in those ingesting more than 2 meals/wk; OR for atherosclerosis = 0.52 in >2 meals/wk group	Buscemi et al. 2014
1902 Japanese, 41% male, 63 yr old from farming village without CV disease; drug use not reported	Fish ingestion and type of fish recorded in 1 year recall survey	Cross-sectional analysis of O-3 FA intake on IMT	O-3 FA intake inverse assoc with IMT: 0.02 mm IMT improvement per gram O-3 FA/day	Hino et al. 2004



- Mercury Slope on IMT (Salonen et al. 2000) = 0.08 mm increase/ppm hair Hg
- O-3 slope on IMT: 0.08 mm decrease per 100 mg/day over 1 year (Colussi et al. 2014
- IMT-based risk for CHD: 15% increase per 0.1 mm ↑ in IMT

Conclusions

- Most commercial species have either positive or little impact on CVD
- Baseline marketshare diet - + effect
- meHg from fish ingestion likely has (-) effect
- Periodic consumption of high mercury fish may be a risk to CVD health
  - O-3/Hg ratio < 10, eat less than Hg RfD
- Advice for gen pop, not just pregnant women
- Encourage consumption of high O-3 fish

Acknowledgements

- Pat McCann
- Great Lakes Consortium
- Brian Toal

Federal Review of Fish Consumption BUI Removal Recommendations

BETH MURPHY, US EPA
JACKIE FISHER, US EPA

What will we cover?

BUI REVIEW CONTACTS
STEPS FOR BUI REMOVAL
FISH CONSUMPTION ADVISORY BUI BY AOC
BUI REMOVAL TARGETS
SITE EVALUATION & MONITORING
DEVELOPMENT OF TECHNICAL REPORT
EPA REVIEW OF TECHNICAL REPORT

BUI Removal Contacts

- State/Provincial Leads (Environmental Agency)
- EPA Task Force Lead
- Restrictions of Fish and Wildlife Consumption BUI Reviewers
  - Jacqueline Fisher
    - Fisher.Jacqueline@epa.gov
    - 312-353-1481
  - Elizabeth Murphy
    - Murphy.Elizabeth@epa.gov
    - 312-353-2447

AOCs with Fish Consumption BUI

IL, Waukegan Harbor	MI, Clinton River	MI, Deer Lake
MI, Detroit River	MI, Kalamazoo River	MI, Manistique River
MI, Muskegon Lake	MI, ON St.Clair River	MI, ON, St. Mary's River
MI, River Raisin	MI, Rouge River	MI, Saginaw River
MI, Torch Lake	MI, White Lake	MI, WI Lower Menominee River
NY, Buffalo River	NY, Eighteenmile Creek	NY, ON Niagara River
NY, ON St. Lawrence River	NY, Oswego River	NY, Rochester Embayment
OH, Ashtabula River	OH, Black River	OH, Cuyahoga River
OH, Maumee River	WI, Fox River Lower Green Bay	WI, Milwaukee Estuary
WI, MN, St. Louis River	WI, Sheboygan River	

BUI Removed

BUI in review

AOCs with Fish Consumption BUI

- Recommendation:
  - Familiarize yourself with the your State and Federal contacts so that you are not brought in at the end of the process.

See Spreadsheet

Fish Consumption BUI Spreadsheet

AOC	State	Contacts	Link to BUI Removal Criteria
ALL AOCs	Federal Topic Expert Leads	AOC Coordination: EPA: Ted Smith (smith.edwin@epa.gov) 312-353-6571 EPA: John Perrecone (perrecone.john@epa.gov) 312-353-1149 Fish Consumption: EPA: Beth Murphy (murphy.elizabeth@epa.gov) 312-353-4227 EPA: Jackie Fisher (fisher.jacqueline@epa.gov) 312-353-1481	http://www.ijc.org/rel/boards/annex2/buis.htm
Waukegan Harbor	Illinois	U.S. EPA: Scott Cieniawski (cieniawkski.scott@epa.gov) 312-353-9184 IDNR: Diane Tecic (diane.tecic@illinois.gov) 312-814-0665	http://waukeganharborcag.com/ReportsandStudies/Waukegan%20Fish%20Sampling_Summary%20Report%2002%2001%2013.pdf
Grand Calumet River	Indiana	U.S. EPA: Mark Loomis (loomis.mark@epa.gov) 312-886-0406 IDEM: Ashley Snyder (ASnyder@idem.IN.gov) 219-464-0437 IDEM: Hala Kuss (hkuss@idem.in.gov) 219-464-0491	http://www.in.gov/idem/files/grancal_rap_stage_2_update.pdf
Clinton River	Michigan	U.S. EPA: Sue Virgilio (virgilio.susan@epa.gov) 312-886-4244 MEDQ: Jennifer Tewkesbury (tewkesburyj@michigan.gov) 586-753-3863	http://www.michigan.gov/documents/deq/wb-aoc-delistguide_247421_7.pdf
Deer Lake	Michigan BUI REMOVED	U.S. EPA: Mark Loomis (loomis.mark@epa.gov) 312-886-0406 MDEQ: Stephanie Swart (swarts@michigan.gov) 517-284-5046	http://www.michigan.gov/documents/deq/DL_BUI_Removal_Fish_Consumption_448709_7.pdf http://www.michigan.gov/documents/deq/deq-ogl-Deer_-Lake-Final-_Delisting-_Rpt_456955_7.pdf

Steps to for BUI Removal

- **Step 1** • Utilize the Fish and Wildlife BUI removal target
- **Step 2** • Collect and Compare all of the relevant data to removal targets and determine feasibility of BUI removal.
- **Step 3** • Draft a technical report with stakeholder input that clearly substantiates the removal recommendation
- **Step 4** • Submit the draft technical report to EPA for review.
- **Step 5** • Obtain EPA concurrence for BUI removal.

Removal Criteria Targets

- State-wide or AOC Specific
- Basis
  - Source Controlled
  - Population Based
  - Some remedial action must be completed
  - Tissue contaminant levels must meet some standard
  - Fish tissue compare favorably to a reference population
  - Declining contaminant levels in fish tissue
  - Advisories with in AOC must be at or lower than the Great Lake or control site
  - No advisories/ Not 303(d) listed

Removal Criteria Targets

- Recommendation:
  - Learn the criteria for the AOCs in your state and assess them to see if they are achievable.

See Spreadsheet

Steps to for BUI Removal

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Step 2
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Step 5
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Site Evaluation & Monitoring

- Involve ALL experts early and often in planning (EPA Reviewers Included)
  - Review QAPP
  - Sample Plan
  - Liaison between Health Agency and DNR
- Ensure State Health Agency has reviewed and approved species selection and sampling plan prior to field work
  - Avoid duplication
  - Ensure smoother review of final package
- Consider evaluation criteria in developing sampling plan
- Know your Criteria and be ready to work with the discuss revisions, if necessary

Steps to for BUI Removal

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Development of Technical Report

- Prepare
  - Stand-Alone Document
  - Well organized and easy to follow
  - Criteria Defined
  - Data (Tables, Maps, Figures, etc.)
  - Assumptions and Limitations identified and discussed
  - Provide Other Supporting documentation (Links, appendices)
- Internal Review
  - Have all stakeholders (including the Health Departments) review the document for completeness.

Development of Technical Report

- Recommendation:
  - Consider utilizing EPA Submission Checklist when preparing the BUI removal document.

See Submission Checklist

Submission Check List

Restrictions to Fish and Wildlife Consumption BUI Package Submission Checklist

Please consider these questions in creating you removal recommendation package. Items in the below checklist may be included in the removal recommendation document or as an attachment.

Y = Yes NA = Not Applicable N = No	Y	N	NA	Comments

Document Preparation				
Is the document considered draft by all stakeholders?				
Does the document include page numbers?				
Are attachments clearly labeled?				
Is analytical data included?				
Are all hyperlinks live?				
Are all memos, documents, and/or data referenced in the document provided as attachments or referenced in the appendix?				
Are maps, tables, and figures properly labeled?				
Is there a clear connection between the removal recommendation text and the supporting technical information?				
Removal Criteria				
Is the removal criteria clearly labeled in the document?				
Are all pieces of the removal criteria addressed / justified in the removal recommendation				
a. Concentrations compared to reference				
b. Advice compared to reference				

Steps to for BUI Removal

Step 1
- Utilize the Fish and Wildlife BUI removal target

Step 2
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Step 5
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EPA Review of Technical Report

1. Receive draft package from State for initial review and comment.
2. Evaluate draft for content and science based recommendations using individual expertise and established removal criteria identified in AOC documentation.
3. Provide written comments to State.
4. Review of intermediate draft documents.
5. Written memo of support for removal of BUI.

EPA Review of Technical Report

- Review
  - Background information is provided
  - Well organized and easy to follow
  - Criteria Clearly Defined
  - Data supports Recommendations (Tables, Maps, Figures, etc.)
  - Assumptions and Limitations identified and discussed
  - Provide Other Supporting documentation (Links, appendices)

EPA Review of Technical Report

- Recommendation:
  - Choose the most appropriate data .
    - Include additional data in supporting documentation
    - Justify sample size
    - Consider power of data and / or error bars
  - Pay Attention to all parts of Removal criteria.
  - Explain / Rationalize choice for reference location, if appropriate.
  - Be consistent in language and interpretation of data over time, for species, chemicals, etc.
  - Consider using removal recommendation to add specificity to broadly defined criteria.
  - Don’t be surprised if we have a lot of questions; its not easy to prepare a technical document of this nature if you haven’t done so before.

See Submission Checklist

Steps to for BUI Removal

- **Step 1** — Utilize the Fish and Wildlife BUI removal target
- **Step 2** — Collect and Compare all of the relevant data to removal targets and determine feasibility of BUI removal.
- **Step 3** — Draft a technical report with stakeholder input that clearly substantiates the removal recommendation
- **Step 4** — Submit the draft technical report to EPA for review.
- **Step 5** — Obtain EPA concurrence for BUI removal.

Federal Package Approval

1. As this Report will be scrutinized by the public the IJC, the report has to be thorough, logical and complete.
2. Be Prepared to Revisit the Removal Criteria, Collect additional Data and Submit more than one Draft of the Report.
3. We are the Federal Government and We are here to help...No, Seriously!!

Thank you

QUESTIONS

Toxaphene

Krista Christensen and Michelle Raymond

Great Lakes Consortium Call

28 July 2015

Wisconsin Department of Health Services

Background

- Michigan
  - 2007 – Resident concerned that current fish consumption advisories not protective for toxaphene
  - 2009 – Health consultation with ATSDR to evaluate recent literature on health effects of toxaphene, and develop an oral reference dose (RfD)
- Wisconsin
  - Request from the Great Lakes consortium to evaluate risk of adverse health effects from toxaphene exposure using recent sampling data from Lakes Superior and Michigan
  - Conducted as part of the EPA Great Lakes Restoration Initiative (GLRI) grant

Toxaphene

- Pesticide; synthesized by chlorinating camphene; mixture of 670 different compounds ('parlars')

- Mixture changes over time due to weathering/degradation (decreased number of compounds, decreased chlorination)

- Banned in 1990 in the USA, but still manufactured for export abroad

Toxaphene

- Primarily used in the southern US, but persistence in the atmosphere → aerial transport and deposition into water bodies including the Great Lakes
- Exposure sources for Great Lakes residents
  - 80-90% consumption of Great Lakes fish
  - ~10% contaminated drinking and surface water
- Health Effects
  - Toxicology studies → liver, kidney, spleen, adrenal, thyroid, immune and central nervous system effects
  - IARC group 2B carcinogen (possibly carcinogenic to humans)

Methods

Exposure Assessment

- Fish tissue samples from Lakes Superior and Michigan (including some tributaries)
- Samples taken 2010-2012, for multiple species

Species	Water body	Average concentration (ppt)	Average concentration (mg/kg fish fillet)
Lake Trout	Lake Michigan	5558.72	0.006
Walleye		970.90	0.001
Chinook	Lake Superior	18606.00	0.019
Cisco		10877.92	0.011
Coho		3704.11	0.004
Lake Trout		69557.45	0.070
Lake Whitefish		52504.30	0.053
Pink Salmon		3510.04	0.004
Siscowett Lake Trout		163183.61	**0.163**
Total toxaphene is the sum of: Hex-Sed, Hep-Sed, P26, P41, P40, P44, P50, P62			

Exposure Assessment

- Estimate human exposure and compare to the RfD

$$\text{Chronic toxaphene dose (mg / kg-day)} = \frac{\text{(toxaphene in fish, mg / kg x 0.5)} \\ \text{x (fish consumption, kg / day)}}{\text{(bodyweight, kg)}}$$

- Consumption frequency categories
  - Unrestricted (>140 g/day fish fillet)
  - One meal per week (32 g/day)
  - One meal per month (7.4 g/day)
  - One meal every two months (i.e., six meals per year, 3.73 g/day)
  - No consumption (<3.7 g/day)
- Assume:
  - Bodyweight →70 kg
  - 50% reduction in toxaphene content due to preparation/cooking

Risk Assessment

- Hazard quotient (HQ)
  - Ratio of (potential) exposure, to a specified reference value
  - i.e., (chronic toxaphene dose) / (RfD)
  - Interpretation
    - HQ is <1 → no adverse health effects expected to occur
    - HQ ≥1 → possibility that adverse health effects may occur

Risk Assessment

- Currently no formal EPA RfD; similar values derived in the literature
  - Health Canada TDI = 2×10^{-4} mg/kg-day
  - CalEPA RfD = 3.5×10^{-4} mg/kg-day
  - Michigan/ATSDR evaluated two toxicology studies and developed potential RfD values:
    - 1×10^{-6} mg/kg-day
    - 3.33×10^{-5} mg/kg-day
    - 1-2 orders of magnitude lower than reference values from other agencies

Selection of an RfD for Toxaphene

Critical Study 1

- Besselink et al. 2000 / Simon and Manning 2006
  - Female Sprague-Dawley rats
  - Sub-chronic exposure (20 weeks) to weathered toxaphene administered sub-cutaneously in corn oil vehicle
    - Doses ranged from 0.46 to 12.5 mg/week
    - Dose may be converted to represent sum of the three parlars thought to be responsible for toxic effects (∑3PC)
  - Critical effect: altered hepatic foci (AHF) expressing placental glutathione-S-transferase (GSTp-AHF) → indicators of tumor promotion
  - No Observed Adverse Effect Level (NOAEL) = 4.17 mg/kg-week toxaphene, or 0.0021 mg/kg-day ∑3PC

Critical Study 1, *cont'd.*

- Uncertainty Factors → Total UF = 1000
  - Interspecies (10-fold)
  - Intraspecies (10-fold)
  - Michigan/ATSDR recommend subchronic-to-chronic (10-fold)

- RfD = 0.0021 ÷ 1000 = **2.1×10^{-6} mg/kg-day**

Critical Study 2

- Tryphonas et al. 2001
- Cynomolgus monkeys
- Subchronic exposure (75 weeks) to technical toxaphene, administered orally in glycerol/corn oil
  - Doses ranged from 0.1 to 0.8 mg/kg-day
- Critical Effect: Antibody titres for sheep red blood cells (humoral immunity)
- NOAEL = 0.1 mg/kg-day

Critical Study 2, *cont'd.*

- Uncertainty Factors → Total UF = 3000
    - Interspecies (10-fold)
    - Intraspecies (10-fold)
    - Subchronic-to-chronic (10-fold)
    - Database (3-fold)

- RfD = 0.1 ÷ 3000 = **3.3×10^{-5} mg/kg-day**

Final Selection

- Comparing the critical studies → Tryphonas et al. (2001) preferred
  - Oral administration of toxaphene (as opposed to injection) mirrors human exposure route of interest;
  - Monkeys may be a better model for human exposure than rat models;
  - Longer exposure duration (75 v. 20 weeks);
  - Immune system effects represent a sensitive endpoint
- Final RfD: **3.3×10^{-5} mg/kg-day**

Risk Assessment Results

Results – Fish Tissues Concentrations

Consumption Category	Concentration in edible tissue after preparation (mg/kg)	Concentration in fish before preparation (mg/kg)	Advice
Unrestricted	<0.0165	<0.033	Lake Michigan lake trout, walleye; Lake Superior cisco, coho salmon, chinook salmon, and pink salmon.
1 meal/week	0.0165 to 0.072	0.033 to 0.146	Lake Superior, lake trout and lake whitefish
1 meal/month	0.072 to 0.312	0.146 to 0.630	Lake Superior siscowett lake trout
6 meals/year	0.312 to 0.624	0.630 to 1.26	--
Do Not Eat	>0.624	>1.26	--

Results – Estimated Daily Intake

Species	Unrestricted		1 meal/week		1 meal/month		6 meals/year		No consumption	
	Chronic Dose	HQ	Chronic Dose	HQ	Chronic Dose	HQ	Chronic Dose	HQ	Chronic Dose	HQ
	Lake Michigan									
Lake trout	5.56E-06	0.17	1.27E-06	0.038	2.94E-07	0.009	1.48E-07	0.004	1.47E-07	0.004
Walleye	9.71E-07	0.03	2.22E-07	0.007	5.13E-08	0.0015	2.59E-08	0.001	2.57E-08	0.001
	Lake Superior									
Coho	3.70E-06	0.11	8.47E-07	0.025	1.96E-07	0.01	9.87E-08	0.003	9.79E-08	0.003
Chinook	1.86E-05	0.6	4.25E-06	0.13	9.83E-07	0.03	4.96E-07	0.015	4.92E-07	0.015
Cisco	1.10E-05	0.33	2.51E-06	0.076	5.81E-07	0.0175	2.93E-07	0.009	2.91E-07	0.009
Lake Trout	**6.96E-05**	**2.1**	1.59E-05	0.48	3.68E-06	0.11	1.85E-06	0.06	1.84E-06	0.06
Lake Whitefish	**5.25E-05**	**1.6**	1.20E-05	0.36	2.78E-06	0.08	1.40E-06	0.042	1.39E-06	0.042
Pink Salmon	3.51E-06	0.11	8.02E-07	0.024	1.86E-07	0.006	9.35E-08	0.003	9.28E-08	0.003
Siscowett Lake Trout	**1.63E-04**	**4.9**	**3.73E-05**	**1.1**	8.63E-06	0.26	4.35E-06	0.13	4.31E-06	0.13

Shading indicates exposure level exceeding the calculated chronic RfD for toxaphene.

Conclusions

- Calculated RfD of 3.3 x 10-5 mg/kg-day for toxaphene
  - Tryphonas et al. 2001 chosen as base study; maximum UF applied

- Evaluated risk at different levels of fish consumption using toxaphene concentration data from Great Lakes
  - Adverse health effects are not expected if consuming 1 meal per month or less for any species or water body combination
  - Exposures may exceed RfD at higher consumption levels for certain species from Lake Superior

Cautions and Considerations

- May reach different conclusions if using a different RfD/critical study (e.g., 10-fold lower RfD from Besselink et al. 2000)
- HQ above one indicates that the RfD has been exceeded, but does not imply that adverse health effects will necessarily occur
- Consumption advisories must also consider other contaminants (e.g., mercury and PCBs)
  - Risks posed by these contaminants will frequently overshadow the risk conferred by toxaphene

Questions?

Great Lakes Fish Monitoring and Surveillance Program

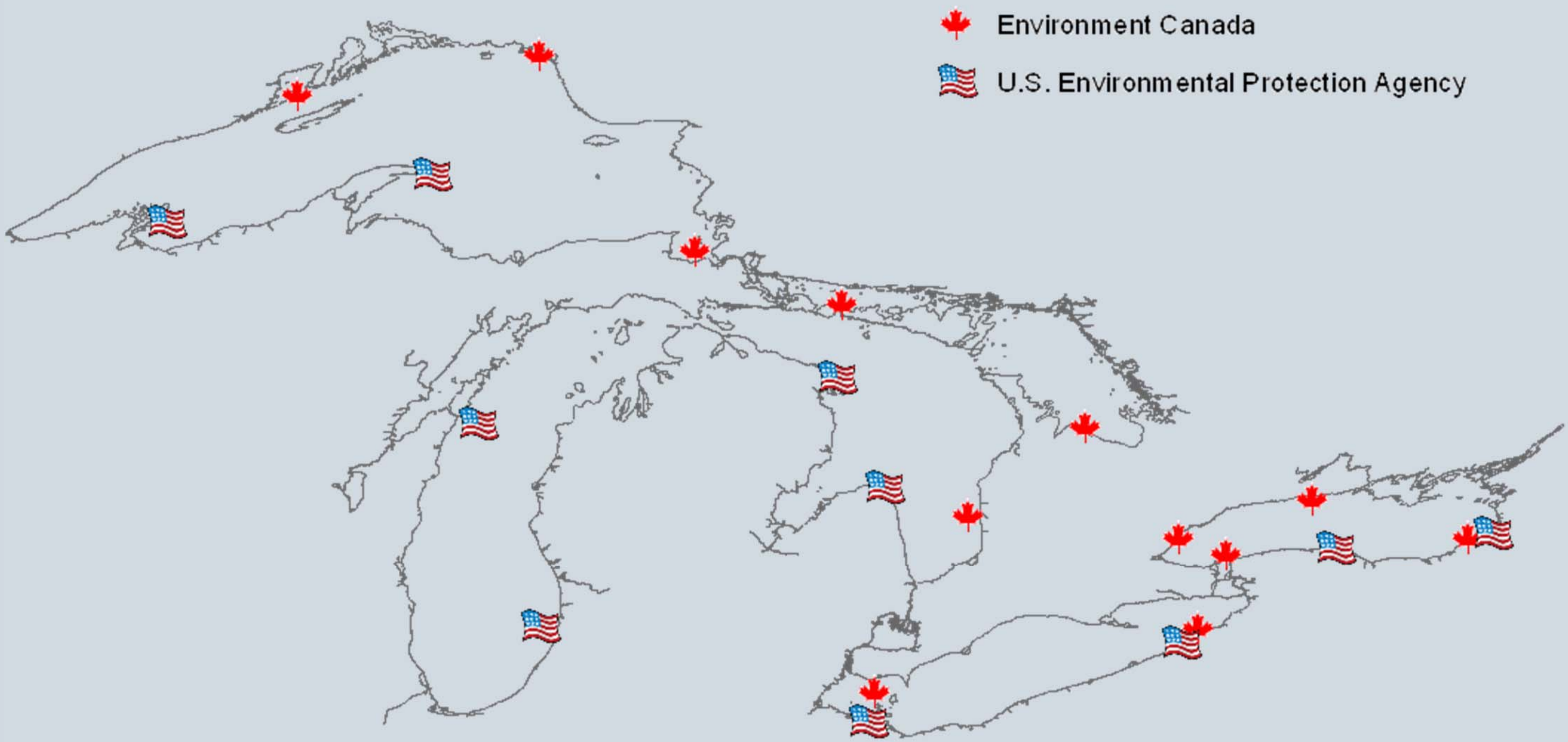
BACKGROUND, ENHANCEMENTS, AND DATA

Background, History and Partners

YOU HAVE SEEN THIS BEFORE, THIS WILL BE A QUICK REVIEW

Great Lakes Fish Monitoring and Surveillance Program Collection Sites

http://www.epa.gov/grtlakes/monitoring/fish/index.html



http://www.epa.gov/grtlakes/monitoring/fish/index.html

GLFMSP Program Elements

Open Lakes Trend Monitoring Program
- Top Predator Fish (Lake Trout and Walleye)
- 1972 – present
- Long term archive
- Focus on Legacy Contaminants

Emerging Contaminant Surveillance Program
- ID new chemicals
- Early warning system
- Created in 2008, renamed program GLFMSP

Sport Fish Fillet Monitoring Program
- 1980 - 2008
- Long term archive
- Eliminated via Peer Review Recommendation and approval of State / Tribal Programs in 2008

http://www.epa.gov/grtlakes/monitoring/fish/index.html

GLFMSP Program Logistics

Samples collected in fall of every year

Samples collected by size

Alternating location by lake

Rely upon partners for sample collection

Program issued as 5 year cooperative agreement
- Current PI Clarkson University

Routine Peer Review of program and publications

Complimentary program at Environment Canada

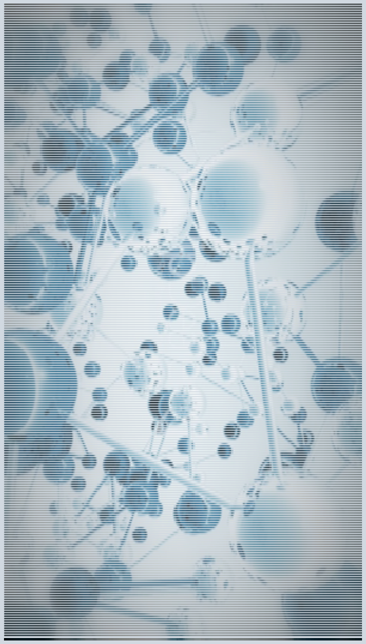
Routine reporting

http://www.epa.gov/grtlakes/monitoring/fish/index.html

Legacy Contaminant List examples
Open Lake Trend Monitoring

- PCB congeners
- PCB co-planers
- Hexachlorobenzene
- Octachlorostyrene
- Lindane
- Alpha BHC
- Dieldrin
- Heptachlor epoxide-b
- PBDEs
- PFAAs
- Mercury

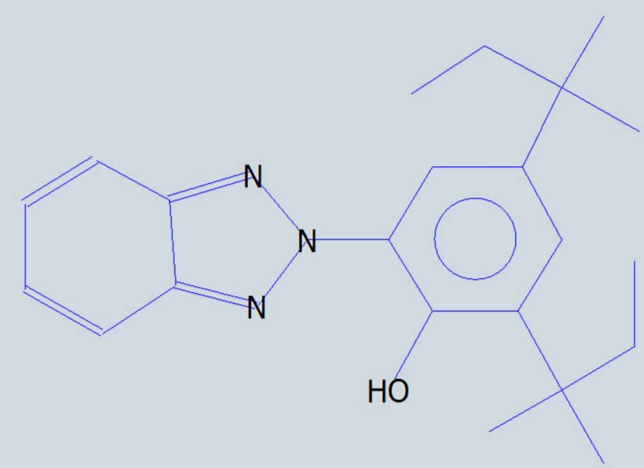
- Cis-chlordane
- Trans- chlordane
- Oxychlordane
- Cis-nonachlor
- Trans- nonachlor
- pp,-DDT
- pp,-DDE
- pp,-DDD
- Endrin
- Mirex (Lake Ontario Only)
- Toxaphene & homologs
- Dioxins and Furans



http://www.epa.gov/grtlakes/monitoring/fish/index.html

Emerging Chemicals List examples
Emerging Contaminant Surveillance

- Current use/produced
- Literature
- Replacement and Breakdown products
- Annex 3 GLWQA
- Health Concerns
- Collaborative work with other programs



Phenol, 2-(2H-benzotriazol-2-yl)-
4,6-bis(1,1-dimethylpropyl)-
- Top 50 H-M list

http://www.epa.gov/grtlakes/monitoring/fish/index.html

GLHHFFTS

Collection & processing to occur 2015

Analysis to occur 2016 & 2017
- PCBs (209 congeners)
- Hg
- Omega 3 & Omega 6
- Dioxin

Results & Reporting to occur 2018 & 2019

2010 NCCA report to be released SOON - http://water.epa.gov/type/oceb/assessmonitor/nccr/

Great Lakes Fish Monitoring and Surveillance Program

IT'S NEW AND IMPROVED…

Clarkson University 2015 – 2020

Element 1 – legacy chemical monitoring
- add HBCD to standard list
- Jointly monitor Dunkirk Lake Erie and Oswego Lake Ontario with Environment Canada

Element 1a – Emerging chemical Surveillance
- Additional compounds driven by Annex 3, State Requests, CEC network
- E chemical database development

Special Studies
- CSMI / LOY – food web assessment
- Heavy Metals
- Liver toxicity
- Passive water sampling
- Fillet analysis to support States
- Egg analysis
- Lake Champlain & Cayuga Lake – Reference development
- Omics

E Chemical Database

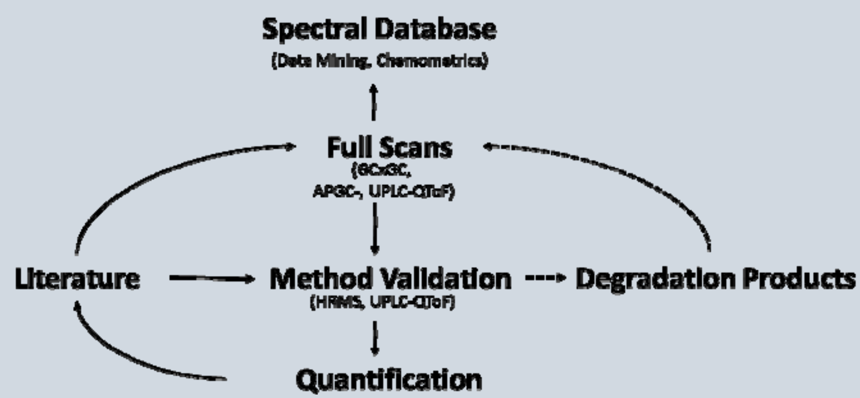
Identified a need for a central repository of emerging chemical data beyond the peer-reviewed literature

Propose to develop a virtual database containing emerging chemical identification aids

Virtual reference storage facility to include identified and unidentified emerging chemical spectra

- Mass spectra
- Relative chromatographic retention times

Available to groups approved by PIs and EPA



Heavy Metals analysis

Clarkson to run heavy metal analysis on yearly “megacomposites” to supplement Hg

- including Cd, As, Pb, Cu, Zn, Ni, Se, Tl, Sn, Sb
- Platinum group elements

Fillet Analysis

Clarkson University Consortium to analyze fillet samples from Consortium

- Limited in number
- Emerging Chemicals
- Can be added to State databases
- Links to human health
- Logistics to be worked out

Mercury Sources and Bioaccumulation in the Great Lakes

Overall objective: Improve our understanding of sources and cycling of mercury across all five Great Lakes

Collaborative effort through US EPA Great Lakes Restoration Initiative and the Great Lakes Fish Surveillance Program.

Water, sediment and benthos sampling started in 2010; first comprehensive Hg data set for all five Great Lakes

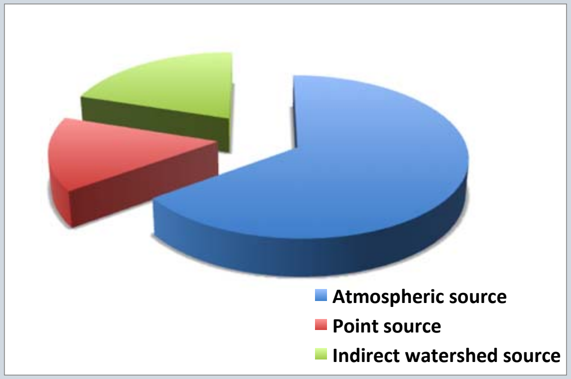
- Annual sampling in April and August (stratified) sampling using standard oceanographic methods (trace-metal free rosette in deep water sites)
- Fish derived from the USEPA Fish Surveillance Program.

Trends and new ways to look at data…

COLLABORATIONS, LEGACY TRENDS, RANKING, BIOLOGICAL EFFECTS

High-Resolution Mercury Isotope Measurement used to Define Mercury Source Attribution

A New Capability of the USGS Mercury Research Lab



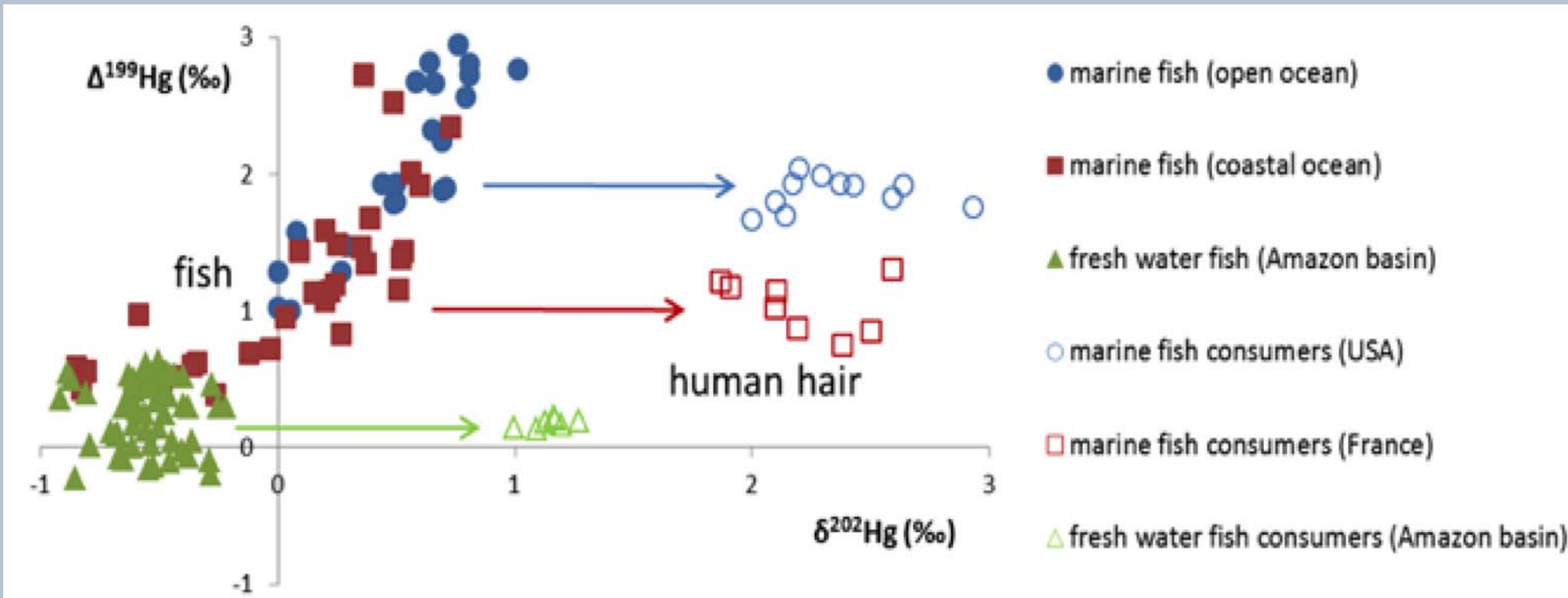
Field sampling

Neptune Plus: Dedicated MC ICPMS for Mercury Research

$\delta^{202}Hg$, $\Delta^{199}Hg$, and $\Delta^{200}Hg$

High resolution measurements of Hg isotopes used for source attribution

USGS, Krabbenhoft et al



Example of mercury isotopes as tracers to human exposure:

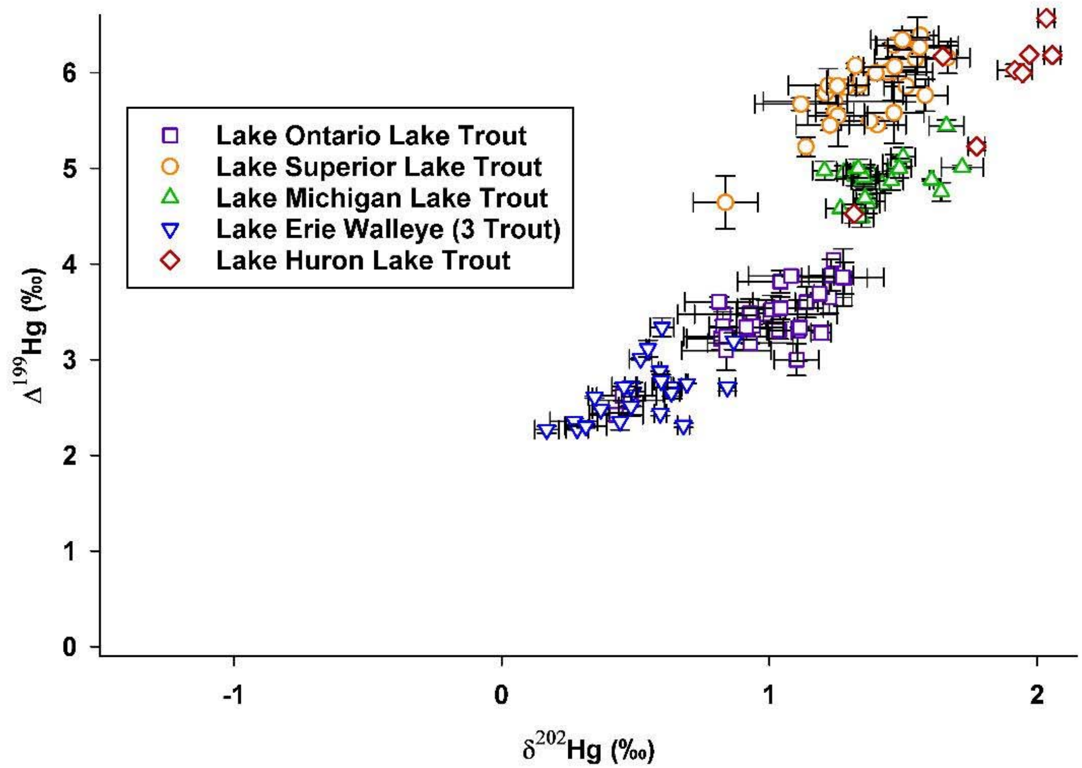
A French study showing link between Hg isotopic composition of human hair and the fish they eat regionally.

Mercury stable isotope results GLFMSP

Delta 202Hg is integrated Hg source indicator

Delta 199Hg indicator of clarity of water derived from methylmercury

Water clarity is related to mercury



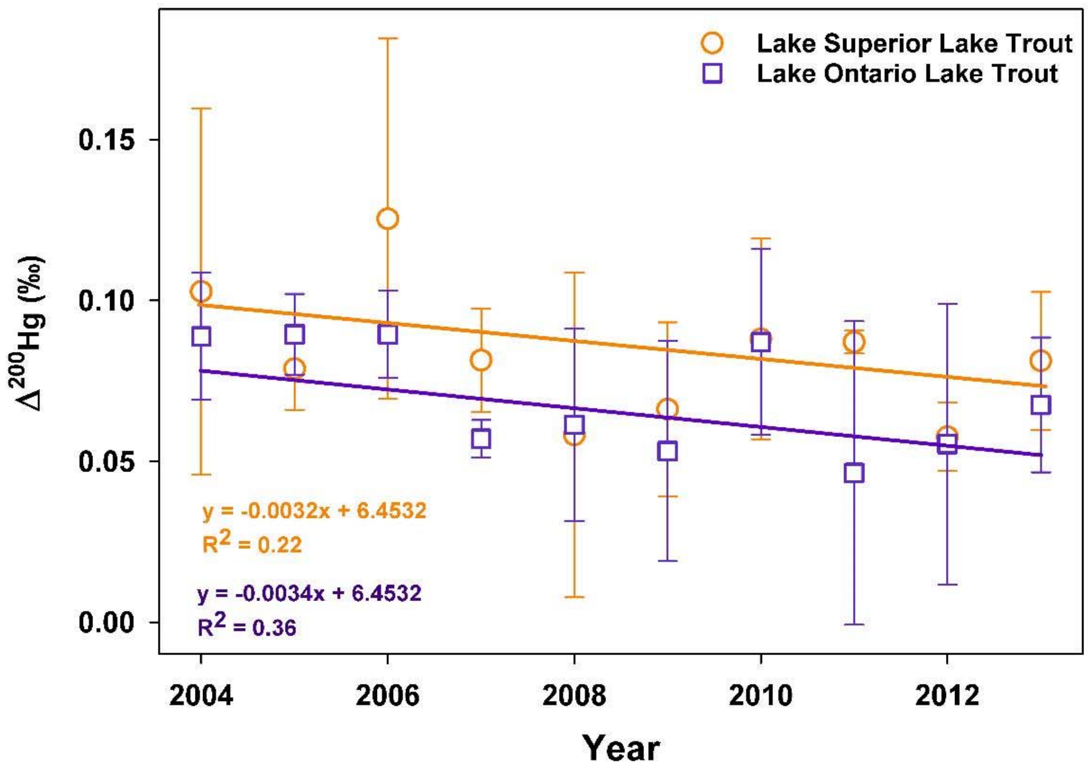
USGS, Krabbenhoft et al

Atmospheric Mercury in GLFMSP samples

Delta 200Hg is an indicator of atmospheric mercury.

Steady decline in both Superior and Huron

Less atmospheric mercury into lakes between 2004 and 2014



USGS, Krabbenhoft et al

Summary of analysis of total mercury levels in top-level predator fish in the Great Lakes between 1999 and 2012

Overall, mercury is on the decline. An updated trends paper is in production.

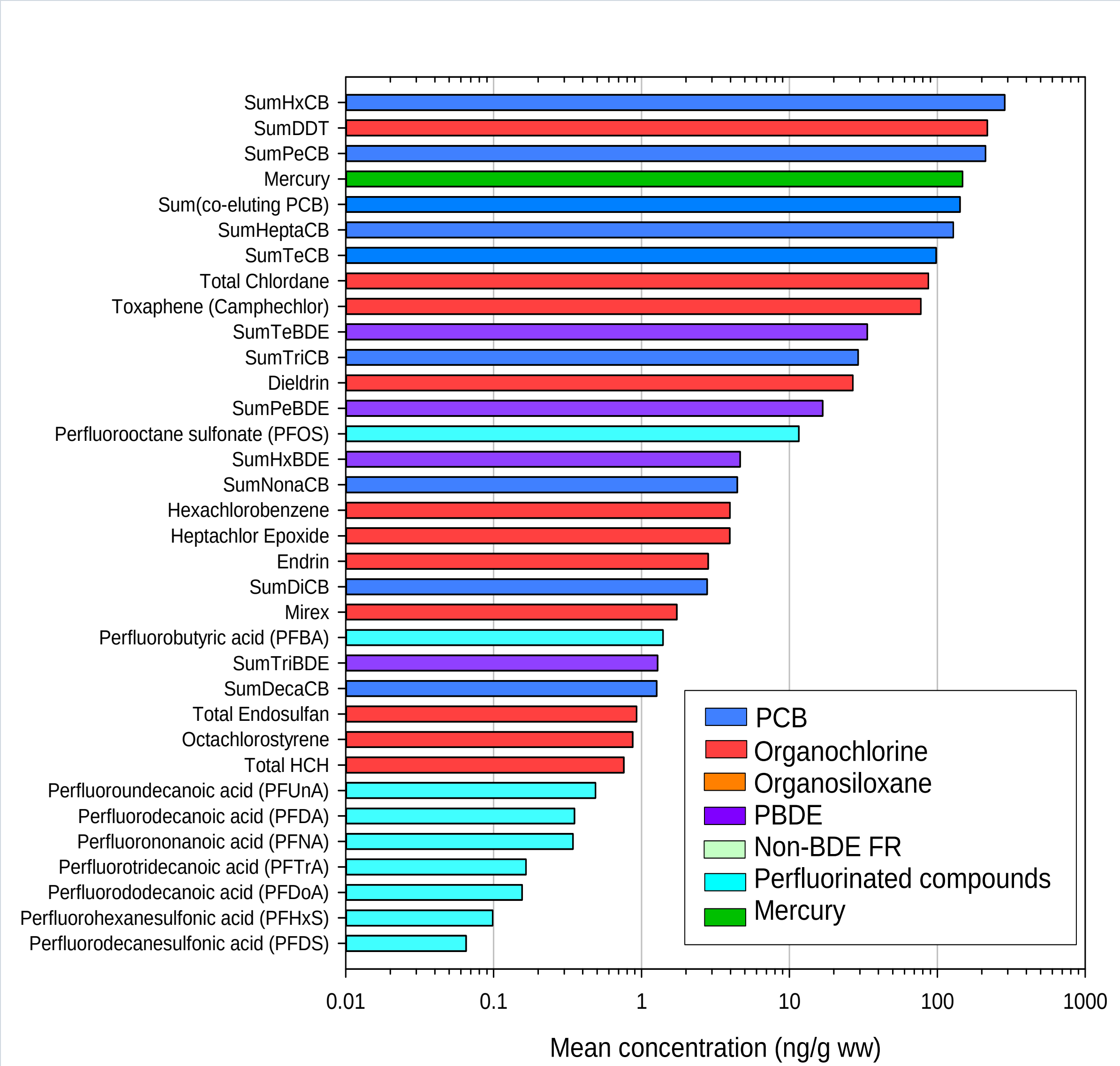
Lake	Regression		
	Quadratic	**2 Segment piecewise**	Linear
Erie (Walleye)	NS*	Increase then decrease (break at 2008)	NS*
Ontario	Increase then decrease	Steady then decrease (break at 2008)	$T^{1/2}$= 11.5 $\pm$ 2.76 years
Huron (Shallow)	Increase then decrease	Increase then decrease (break at 2006)	NS*
Huron (Deep)	Increase then faster increase	Increase then faster increase (break at 2003)	T^{2}=13.4 $\pm$ 2.62 years
Michigan (Shallow)	Decrease then increase	Decrease then increase (break at 2008)	NS*
Michigan (Deep)	Increase then decrease	Increase then decrease (break at 2007)	$T^{1/2}$=10.77 $\pm$ 3.0 years
Superior (Deep)	Increase then decrease	Increase then decrease (break at 2005)	NS*
Superior (Shallow)	NS*	NS*	$T^{1/2}$=16.78 $\pm$ 8.32 years

Clarkson University et. Al.

Lake Michigan – Top 36

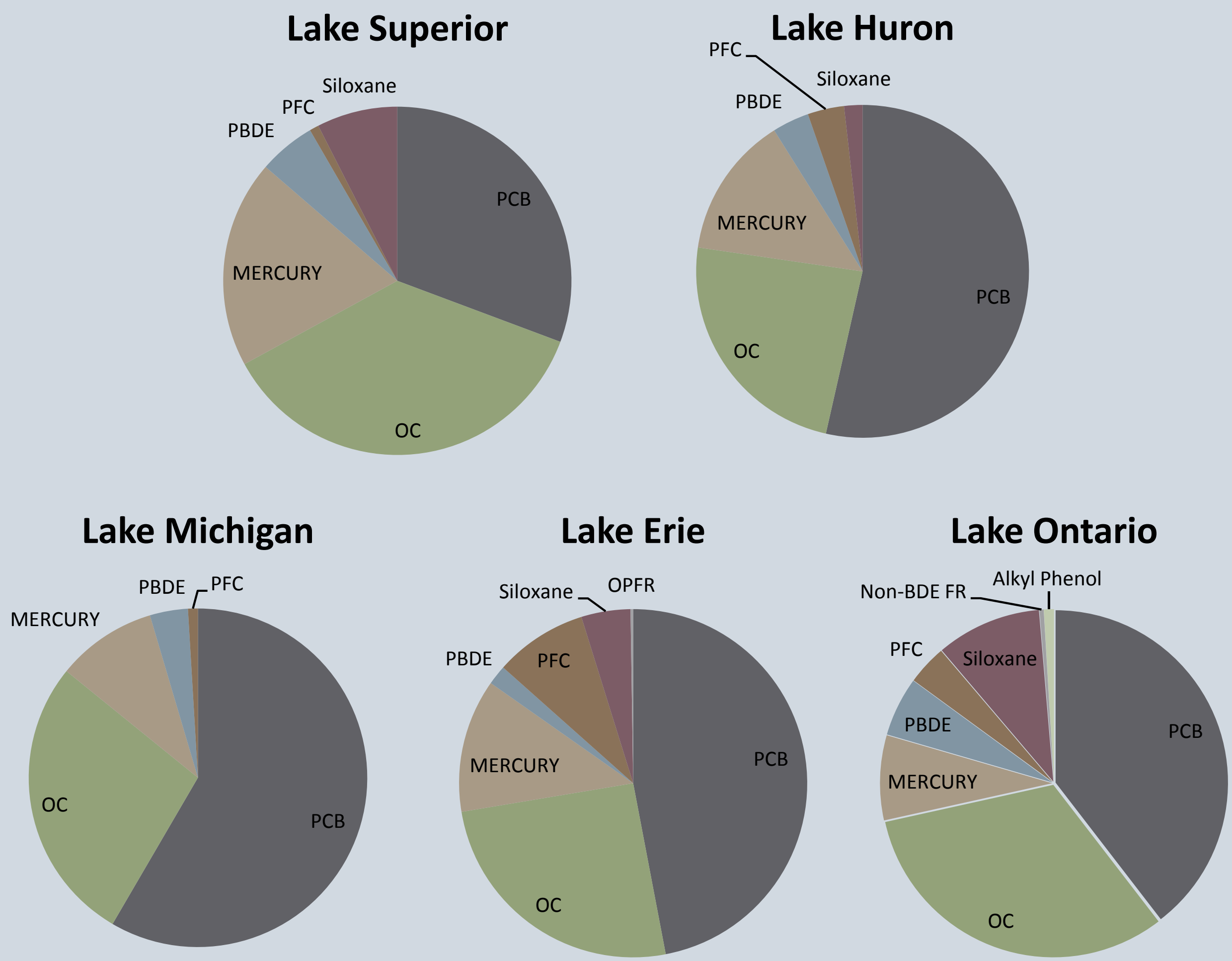
1. HexaCB
2. DDT & metabolites
3. PentaCB
4. Mercury
5. Co-eluting PCBs
6. HeptaCB
7. TetraCB
8. Chlordanes
9. Toxaphene
10. TetraBDE

EC & USEPA



Basin-wide summary

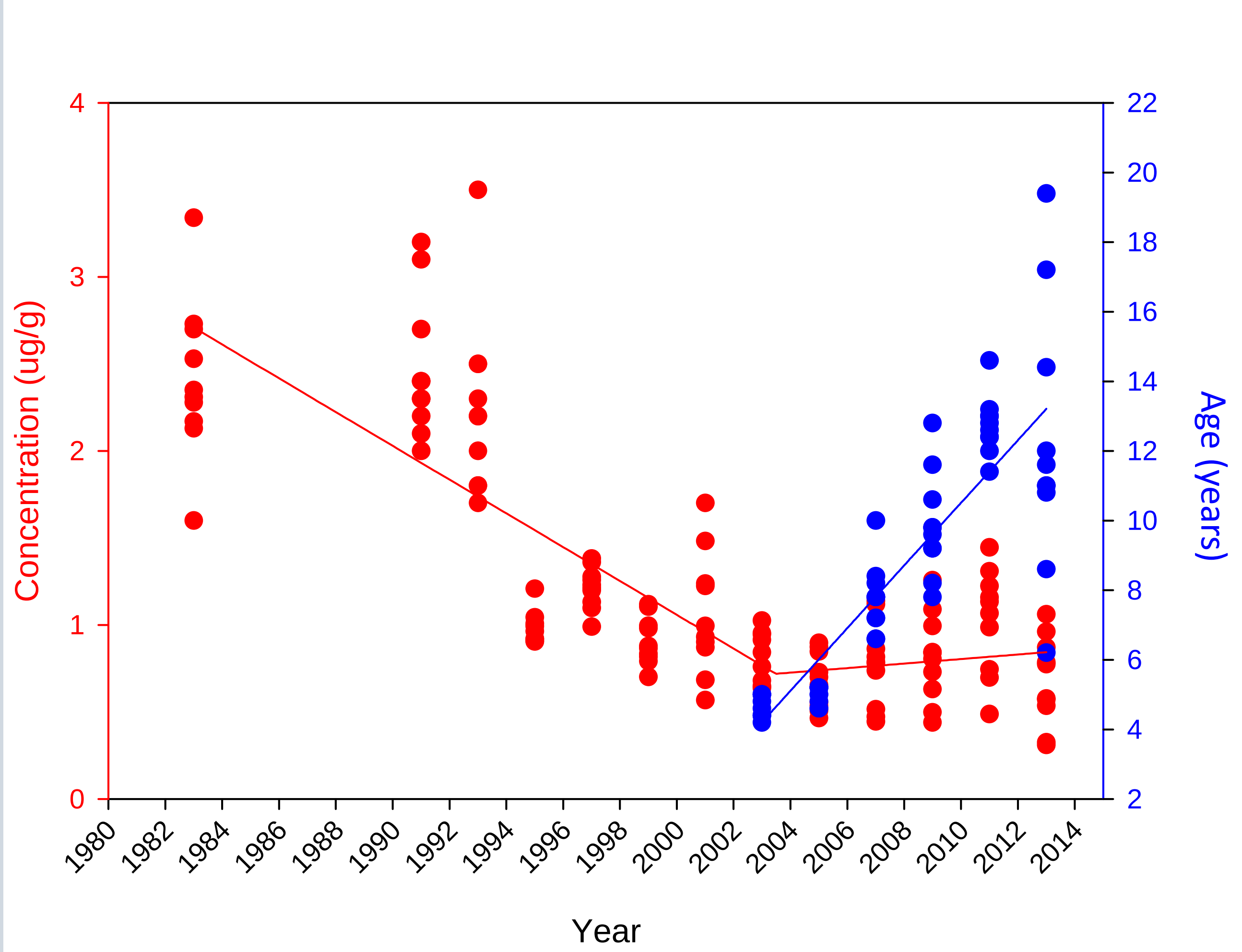
On a mass basis - “Legacy” compounds dominate body burdens of fish in the GLB



EC & USEPA

Total PCBs Port Austin, Lake Huron

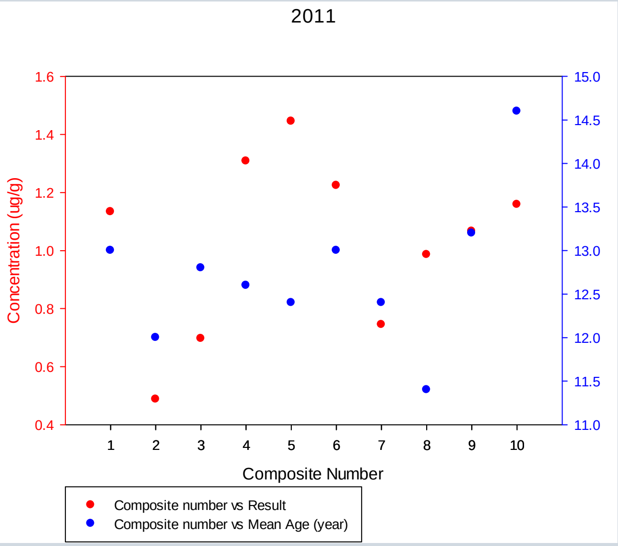
Perceived increase of PCB concentration can be explained by increase in age of fish.



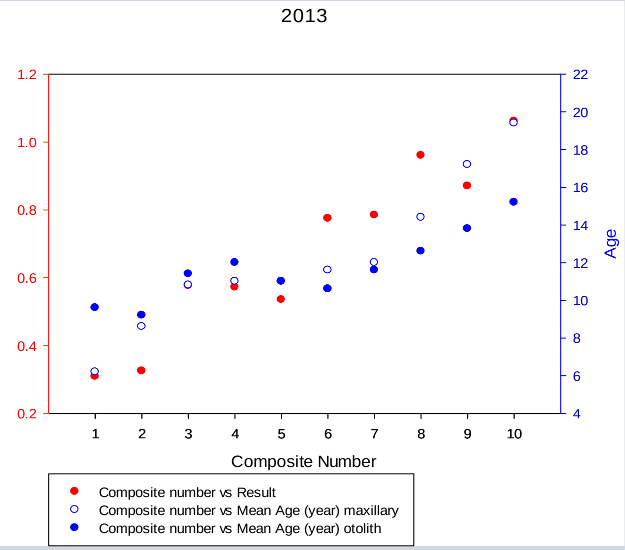
New Compositing Scheme

Testing Maxillary and Otolith Aging

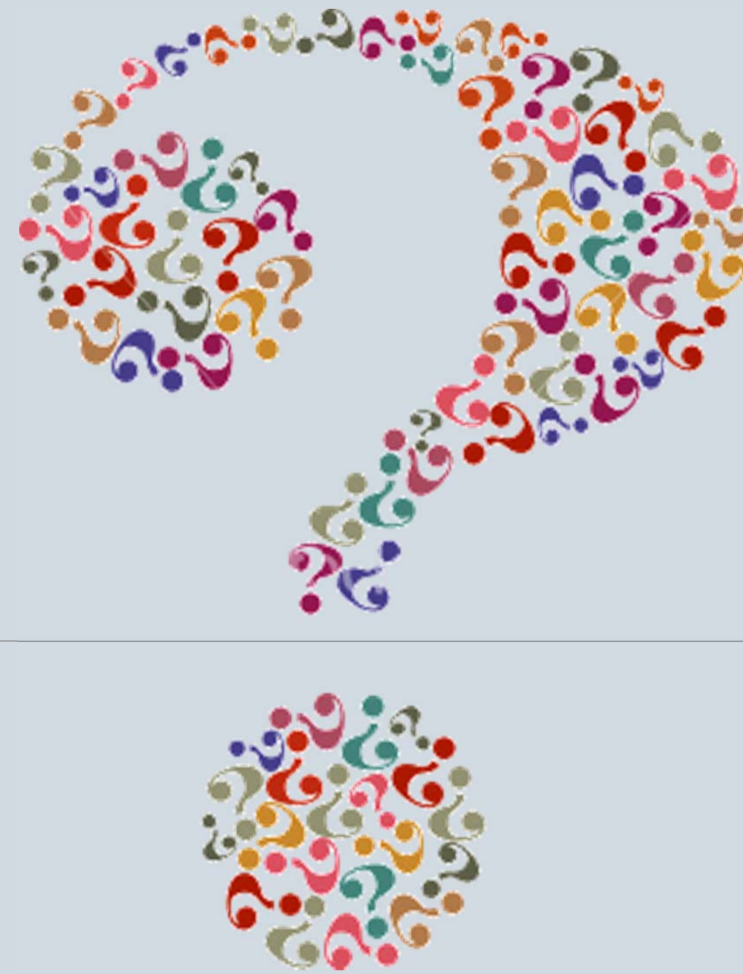
Composite by Size



Composite by Age



Questions




A New Look at Toxicity Factors for Toxaphene related to Fish Consumption in the Great Lakes
Ted W. Simon, Ph.D., DABT
Ted Simon LLC
Sept. 25, 2015
Discussion for
The Great Lakes Consortium of Fish Advisories

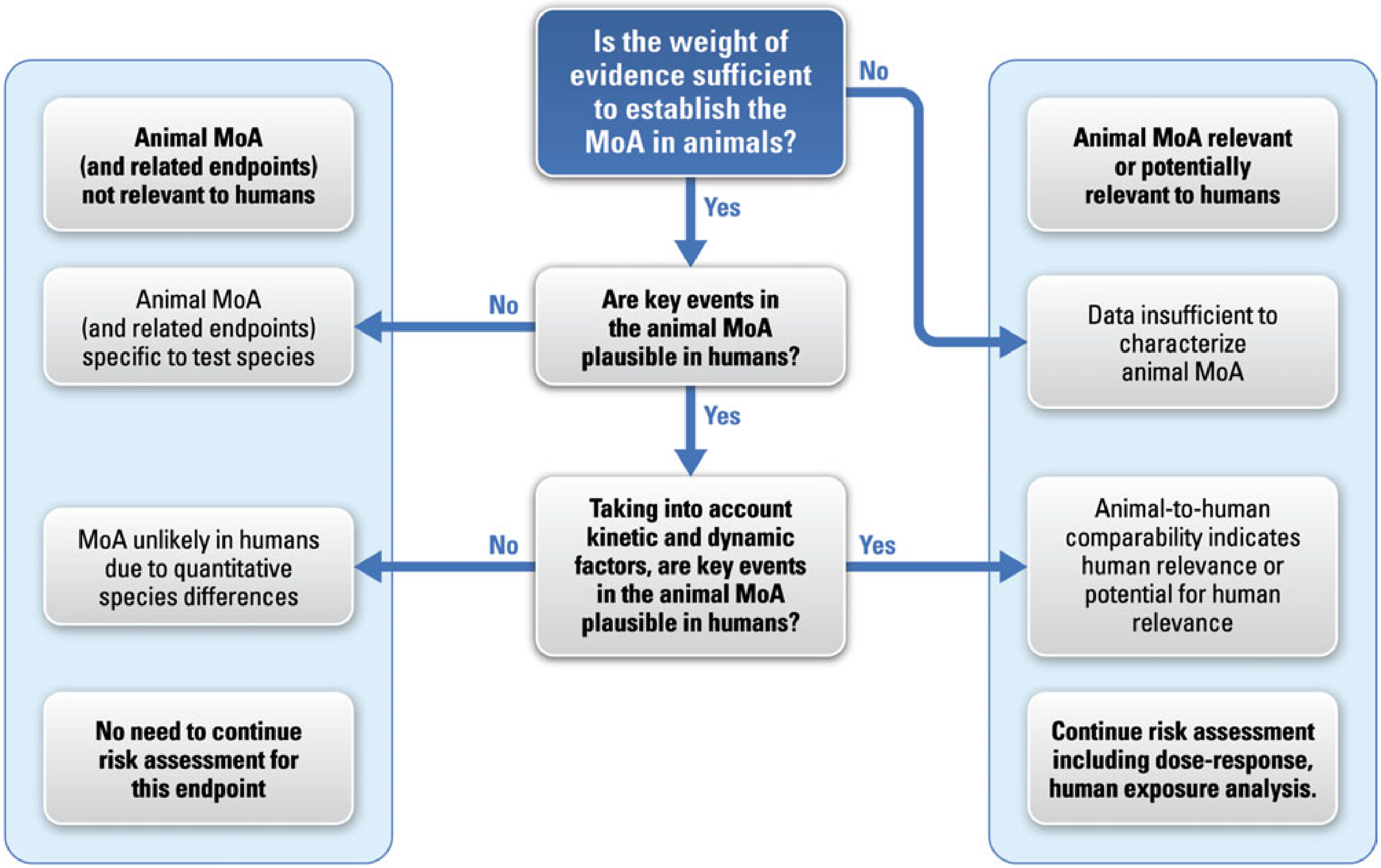
Presentation Outline

- The importance of mode of action (MOA)
- Cancer slope factors ignore MOA
- Carcinogenic Mode of Action of Toxaphene
  - Relevance to humans
- Brief history of Toxaphene Toxicity Criteria
- The National Academy's View of Reference Doses applied to Toxaphene

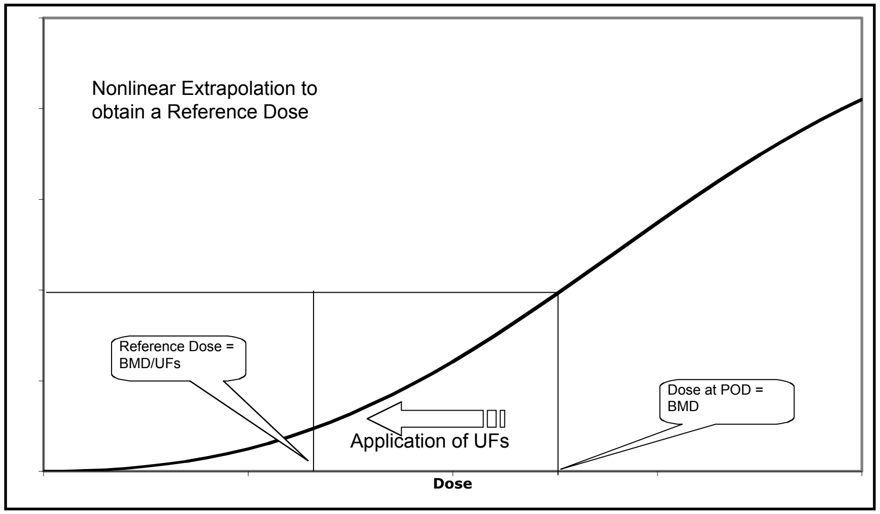
Mode of Action

- Definition in EPA's 2005 Cancer Guidelines
  - The term "mode of action" is defined as a sequence of key events and processes, starting with interaction of an agent with a cell, proceeding through operational and anatomical changes, and resulting in cancer formation. A "key event" is an empirically observable precursor step that is itself a necessary element of the mode of action or is a biologically based marker for such an element.

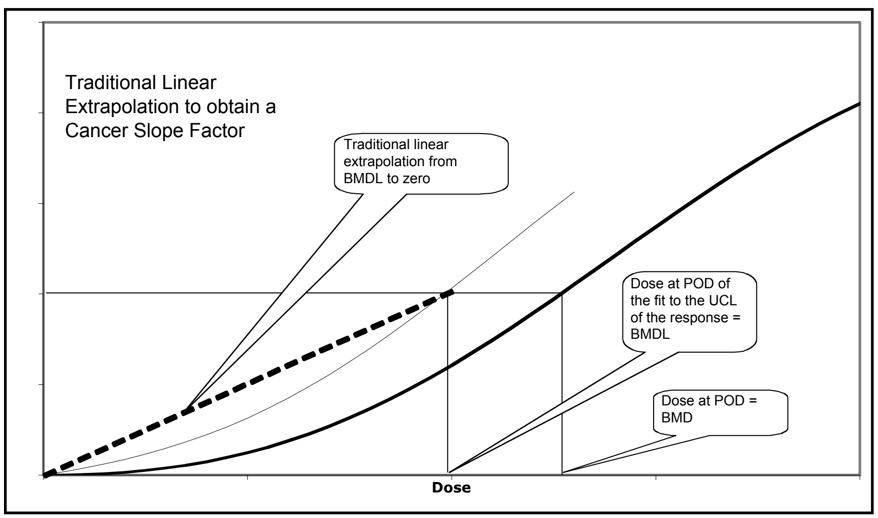
Human Relevance Framework for Use of MOA Information



Linear Extrapolation-then and now



Uncertainty Factors for noncarcinogens



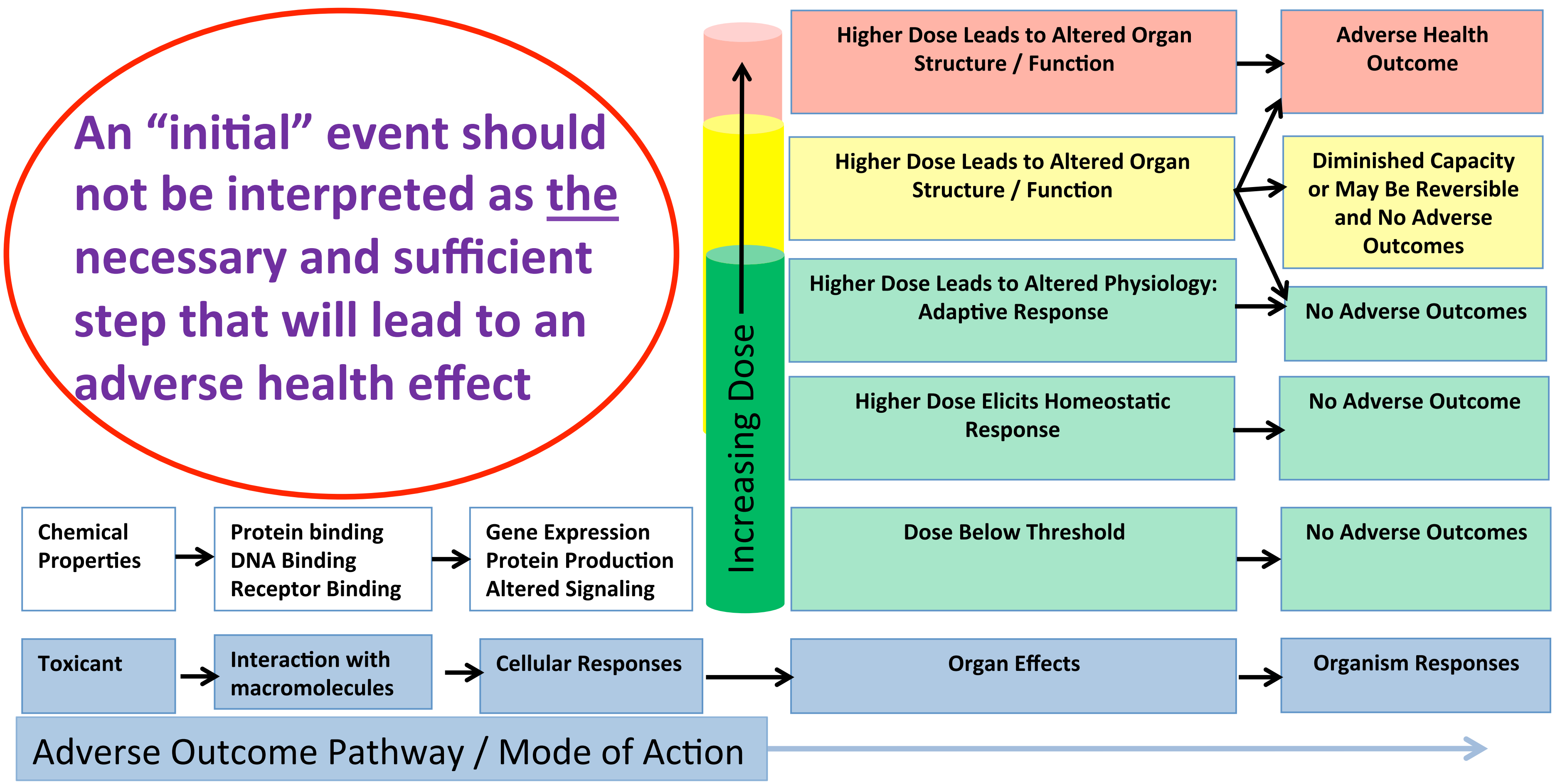
Linear extrapolation for carcinogens

Herman Muller and Linearity

- "Priority Complex" – would not credit others for their ideas
- Published results in Science in 1927 of high dose experiments without any data
- 1932 attempted suicide
- Politically unsavvy, did not understand distinction of science and policy
- Nov. 1946-read manuscript from Stern that showed a threshold for radiation
- Nobel speech, Dec. 1946 "no escape from the conclusion that there is no threshold"
- 1977 NAS SDWA committee picked linearity for chemical carcinogens – why the linear hypothesis has been used since then.

Mode of Action Implies a Discontinuum at which the threshold of adversity occurs

Response is Dependent on Dose and Time: Not All Exposures Will Produce Adverse Effects



Mode of Action of Toxaphene and Other CAR Activators

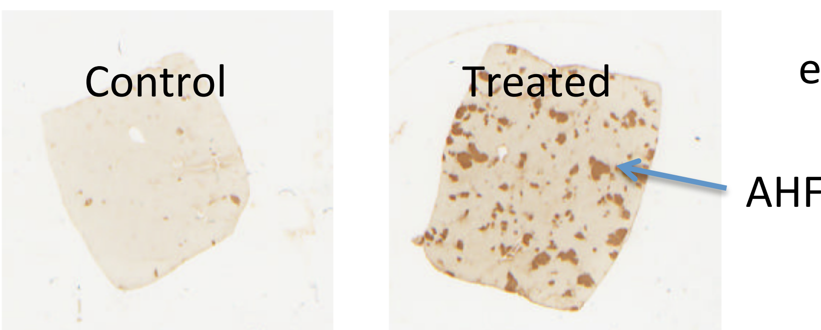
CAR-Activators e.g. Phenobarbital, Toxaphene, Cyproconazole → KE #1: CAR Activation → KE #2: Altered Gene Expression → KE #3: Changes in Apoptosis and Proliferation, → Liver Tumors

Increased DNA Synthesis

Altered Hepatic Foci

CAR = Constitutive Androstane Receptor

Enzymes induced by CAR: CYP2B10, CYP3A11, epoxide hydrolase, UGTs



Considered evidence of preneoplastic lesions

This MOA is likely not relevant to humans

Human Relevance of the MOA

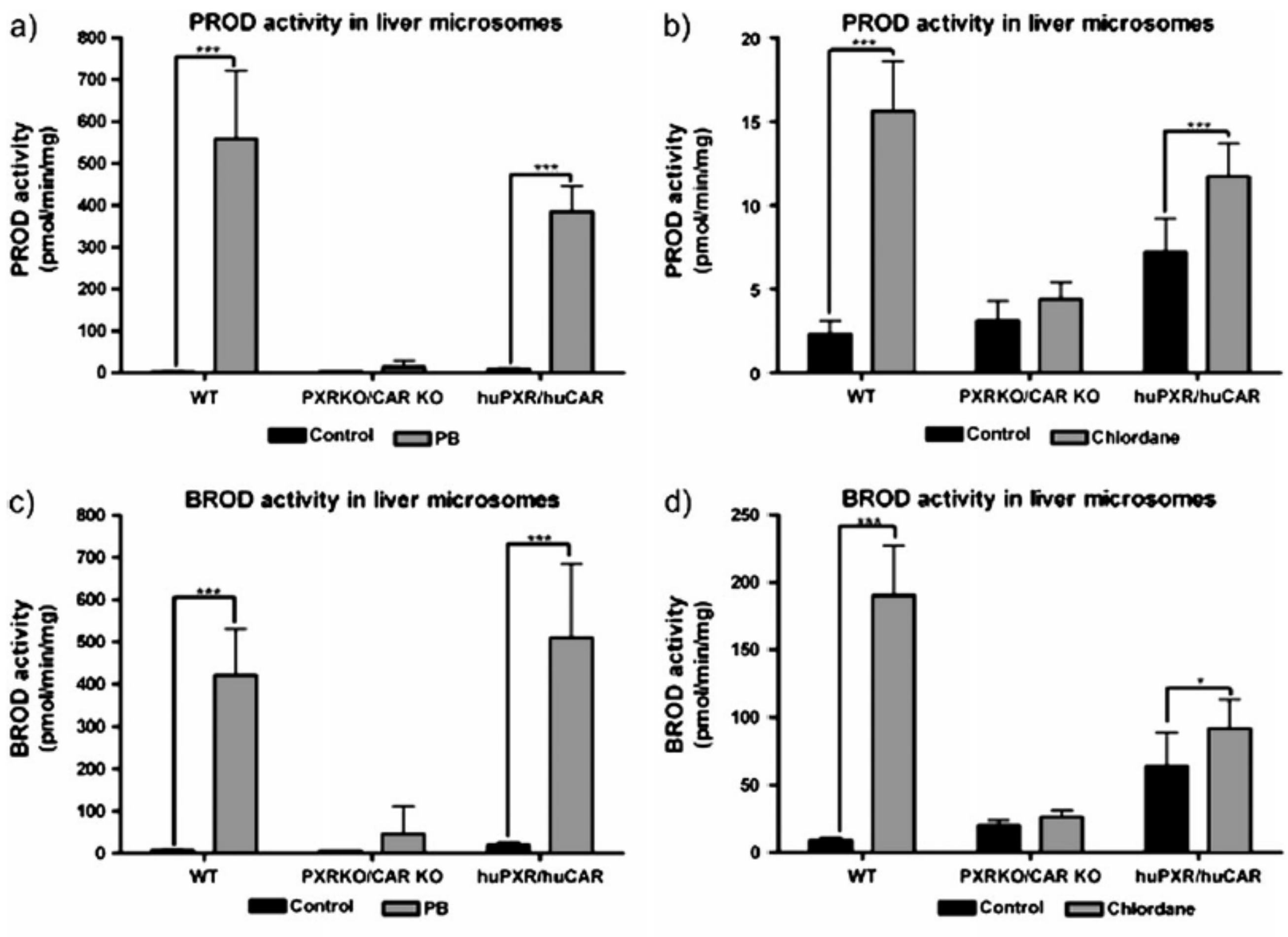
- CAR activation and enzyme induction in humans and rodents
- No replicative DNA synthesis in humans
- No apoptosis of inhibition in humans

MOA likely not qualitatively plausible in humans

Chemicals with a similar MOA for Liver Tumors in Mice

- Cyproconazole – fungicide
- Metofluthrin – pyrethroid insecticide
- Propioconazole – fungicide
- Sulfoxaflor – insecticide
- Phenobarbital – human sleep aid
- Gingko biloba – dietary supplement

Human CAR is no more sensitive to activation than mouse CAR



Phenobarbital

Chlordane

Chlordane and phenobarbital are both CAR activators measured by CYP2B induction.

WT mice on left, KO mice in center and humanized mice on right

These same type of data exist for toxaphene but are not yet published

Uncertainty Factors

- UFA = 3 based on TK uncertainty only
  - UF-A-TD = 1 based on CAR activation
- UFH = 10 default value
- UFS = 1
  - Historical reasons, consistency with earlier values
  - Initiation/promotion studies are consistent with chronic studies because an initiator is used

Toxaphene RfDs - MATT Report 2000

- Used three types of toxaphene:
  - Technical toxaphene
  - UV-treated toxaphene
  - Cod liver extract from fish administered toxaphene
- Administed to rats by subcutaneous injection
  - CLE doses were 0.07, 0.2, 0.6 and 1.8 mg/kg/d
- 0.69 mg/kg/d = NOAEL; UF = 100
- TDI / RfD = 0.007 mg/kg/d

Toxaphene RfDs – Simon & Manning

- Used CLE data from MATT report
- Based RfD on conc. of 3 persistent congeners in CLE
- No detectable toxaphene in liver and the number of AHF and focal area decreased at the highest dose
- NOAEL = 0.002 mg/kg/d Σ3PC or 0.6 mg/kg/d CLE
- RfD = 2E-05 mg/kg/d Σ3PC or 0.006 mg/kg/d total toxaphene

Toxaphene RfDs – Lamb et al. 2008

- POD was ED10 for liver tumors from the Litton Bionetics bioassay used by EPA for the CSF derived in Goodman et al. (2000)
- ED10 = 6.44 mg/kg/d
- UF = 100
- RfD = 0.06 mg/kg/d

New Methods for RfDs in NRC (2014)

- NRC (2014) *Review of EPA's Integrated Risk Information System (IRIS) Process*
- Advocates Bayesian methods for RfD development
- Here we will look at a range of RfDs
- Method in brief
  - UFA = 3: 3 for TK component and 1 for TD component based on CAR activation between humans and rodents
  - Assume uncertainty in POD and in UFs can be represented by a lognormal distribution.
  - Hence, subtraction of the log(UF) is used rather than division

Bayesian Methodology (NRC, 2014)

- UFs are best represented as distributions
- The default UF values occur at the 95th %ile
- Lognormal distributions are tractable so

  $(Z_{0.95} * \sigma) = \ln(10)$ for a default

  $Z_{0.95} = 1.645$ and $\sigma = 1.4$

  $\mathrm{Exp}(1.645 * 1.4) = 10.004$

$$\ln(POD) - Z * \sqrt{\sigma^2_{POD} + \sigma^2_{UFA} + \sigma^2_{UFH}}$$

Bayesian Methodology (NRC, 2014)

$$\ln(POD) - Z * \sqrt{\sigma_{POD}^2 + \sigma_{UFA}^2 + \sigma_{UFH}^2}$$

$$\sigma_{POD} = \frac{\ln(BMD) - \ln(BMDL)}{1.645}$$

Cell proliferation from Wang et al. (2015) 14 dose-finding study, doses are 0, 0.3, 1.2, 2.5, 5, 10.2 mg/kg/d

(ln(1.057) - ln(0.725)) / 1.645 = 0.2292

Ln(1.057) – 1.645 * sqrt($0.2292^2 + 0.668^2 + 1.4^2$) = -2.52
RfD = 0.08 mg/kg/d

Variance Weighting of PODs

$$\sigma_{POD} = \frac{\ln(BMD) - \ln(BMDL)}{1.645}$$

Variance = σ^2

$$Wt.of\ POD_i = \frac{\text{var}_i}{\sum_{i=1}^{n} \text{var}_i}$$

Overall POD = Wt_1 * POD_1 + Wt_2 * POD_2 + Wt_3 * POD_3

$$\text{Overall standard deviation} = \sqrt{\sigma_1^2 + \sigma_2^2 + \sigma_3^2}$$

Compilation of RfD Values

Source	Critical Effect	POD value (mg/kg/d	Pod type	UF	RfD (mg/kg/d)	Refined UF (MOA)	Refined RfD (mg/kg/d)
MATT (2000)	AHF	0.69	NOAEL	100	0.007	30	0.05
Simon & Manning	AHF	0.6	NOAEL	100	0.006	30	0.05
Lamb et al. (2008)	Liver tumors (female mice)	6.44/5.05	ED10/LED10	100	0.06	30	0.5
NEW RfD values derived for this presentation using BMD modeling and, in some cases, variance weighting of PODs based on the Bayesian methods from NRC (2014)							
Besselink et al. (2008) (Variance-weighted POD)		2.62/ 0.425	BMD-1SD/ BMDL-1SD	NC	NC	30	0.11 ~ 0.1
Liver tumors (male mice)		3.32/2.52	ED10/LED10	100	0.03	30	0.255 ~ 0.3
Cell Proliferation (from Wang et al., 2015) (Variance-weighted POD)		1.355/ 0.480	BMD-1SD/ BMD-1SD	100	0.005	30	0.09 ~ 0.1

Recommended RfD value for fish consumption:
Geometric mean = 0.1 mg/kg/d

Risk-Based Levels in Fish based on 0.194 g/kg/d consumption from Simon and Manning

• MATT	35 mg/kg fish
• Simon and Manning	0.45 – 2.2 mg/kg
• Lamb	300 mg/kg
• RfD = 0.1 mg/kg/d here	500 mg/kg

- Chan and Yeboah (2000) ~0.25 mg/kg wet weight highest conc. observed in the Yukon

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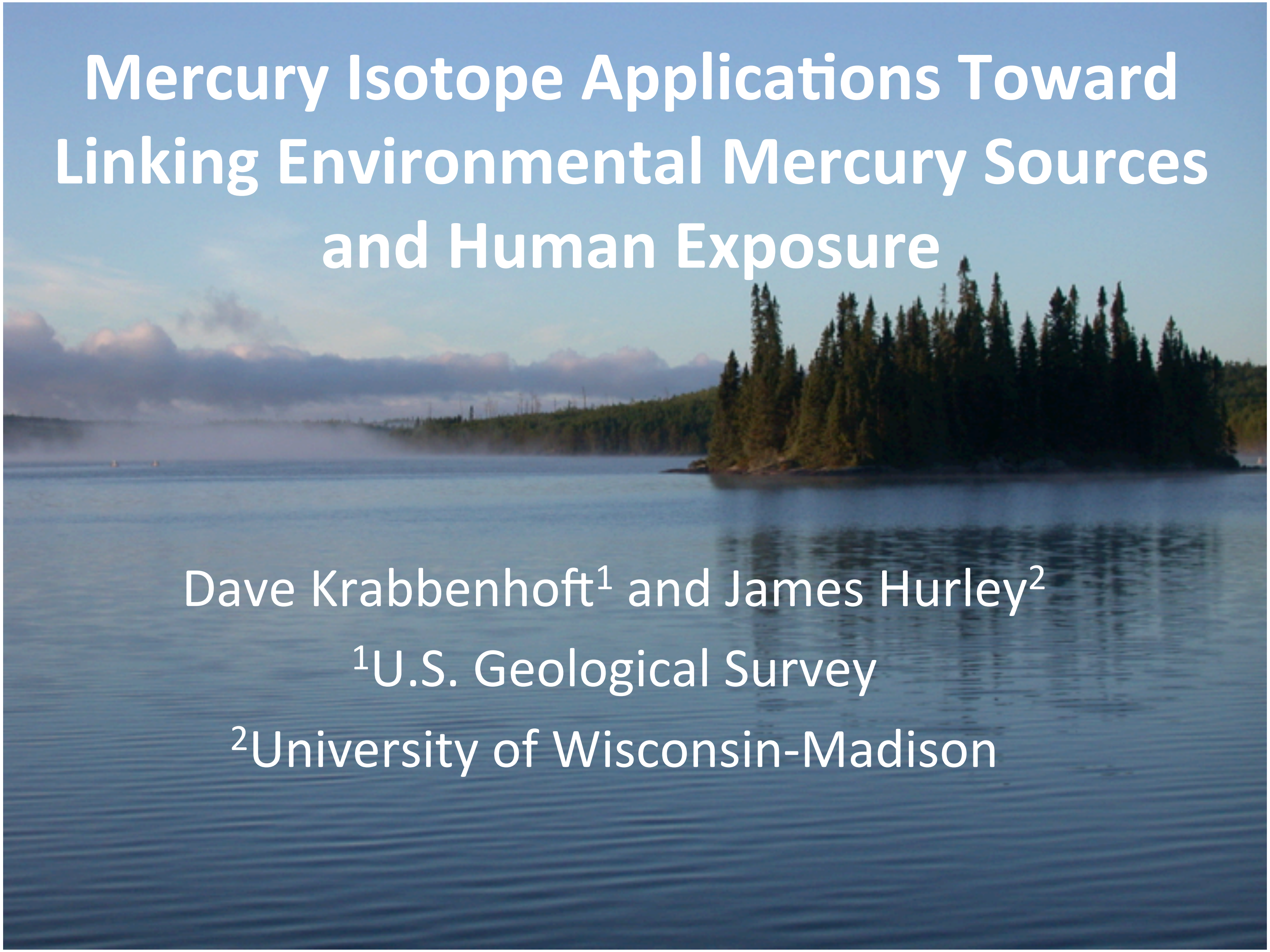
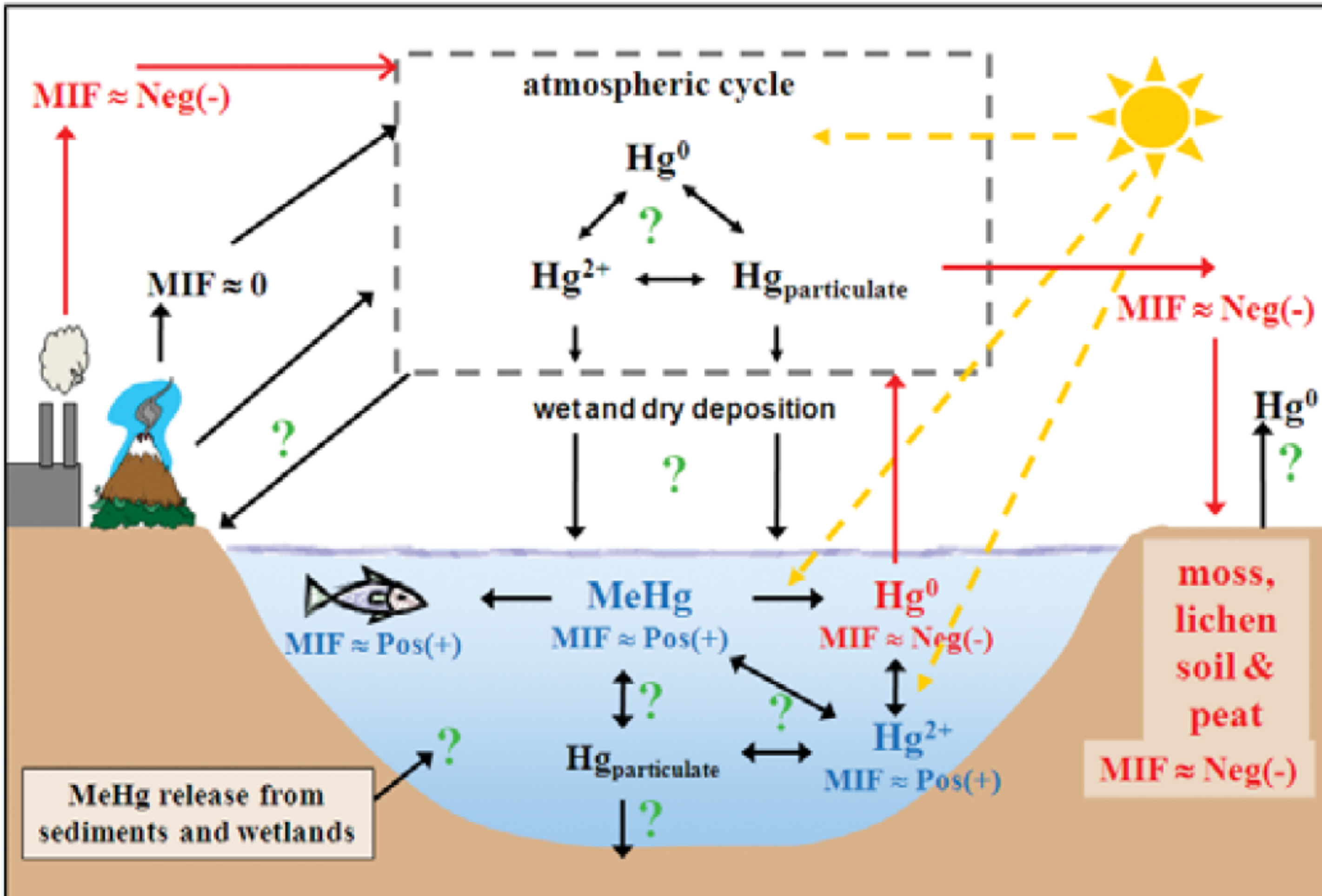
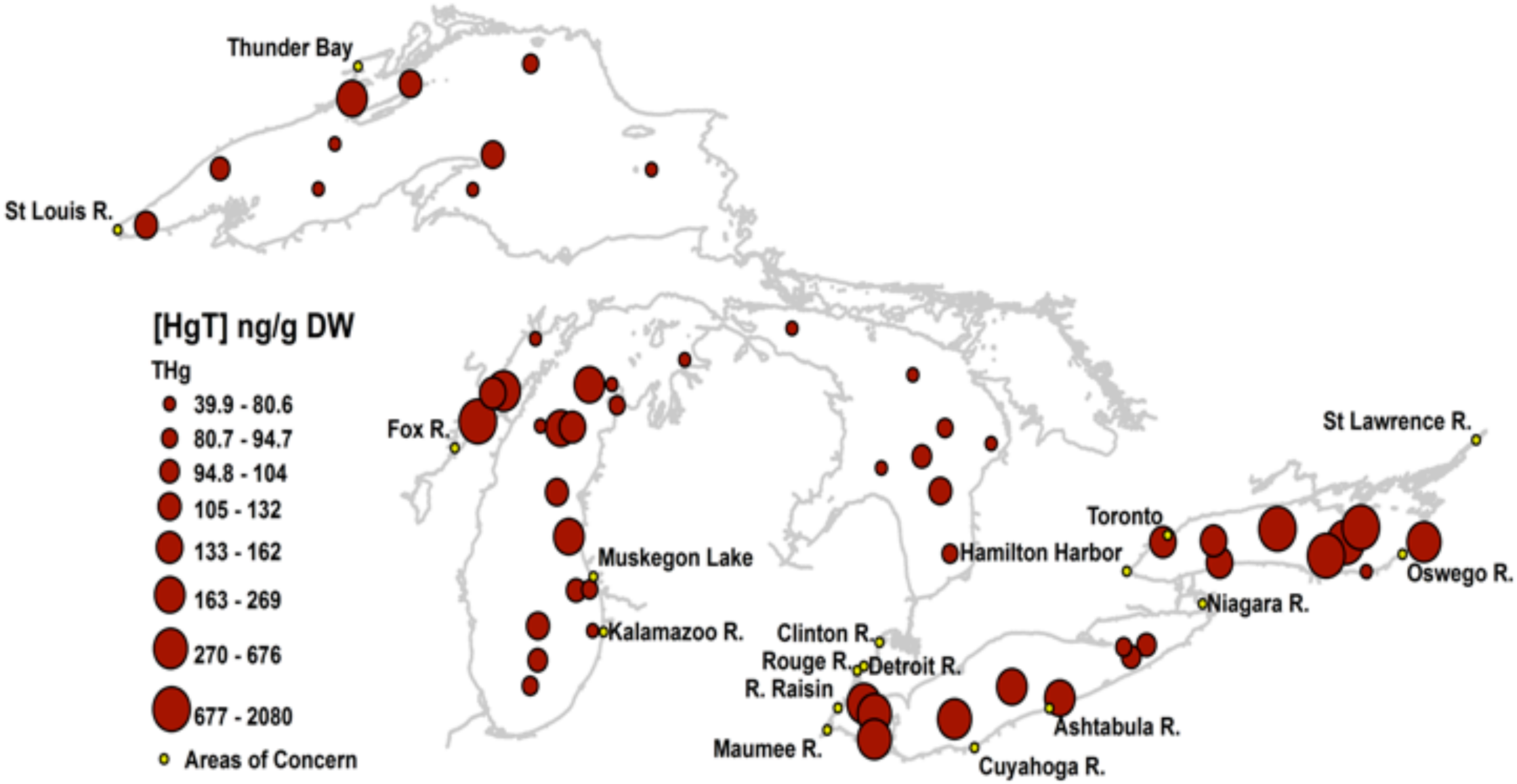

Mercury Isotope Applications Toward Linking Environmental Mercury Sources and Human Exposure
Dave Krabbenhoft[1] and James Hurley[2]
[1]U.S. Geological Survey
[2]University of Wisconsin-Madison

The Mercury Cycle and Mercury Stable Isotopes: New Insights with Source/Process Tracers



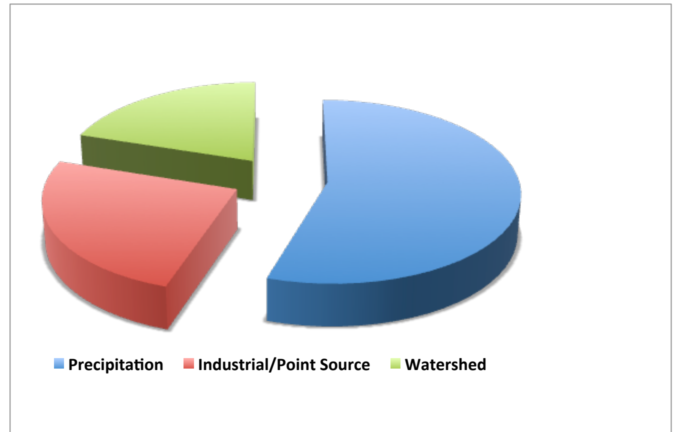
Bergquist and Blum, ELEMENTS, 2009, VOL. 5, PP. 353–357

Mercury Isotope Application to Help Resolve Spatial Concentration Patterns and Sources across the Great Lakes

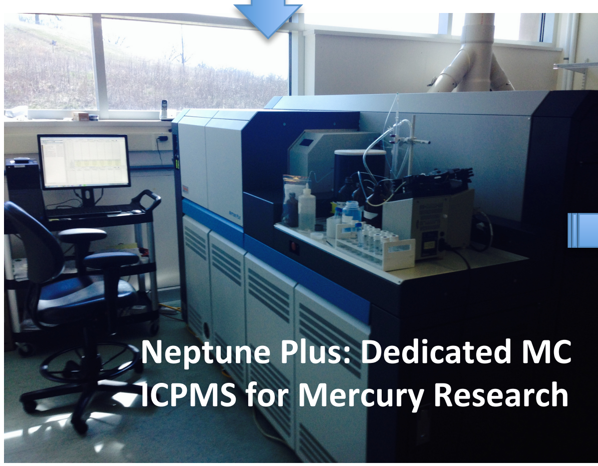


From Lepak et al., 2015, submitted to Nature Geosciences

High-Resolution Mercury Isotope Measurement : A New Capability of the USGS Mercury Research Lab



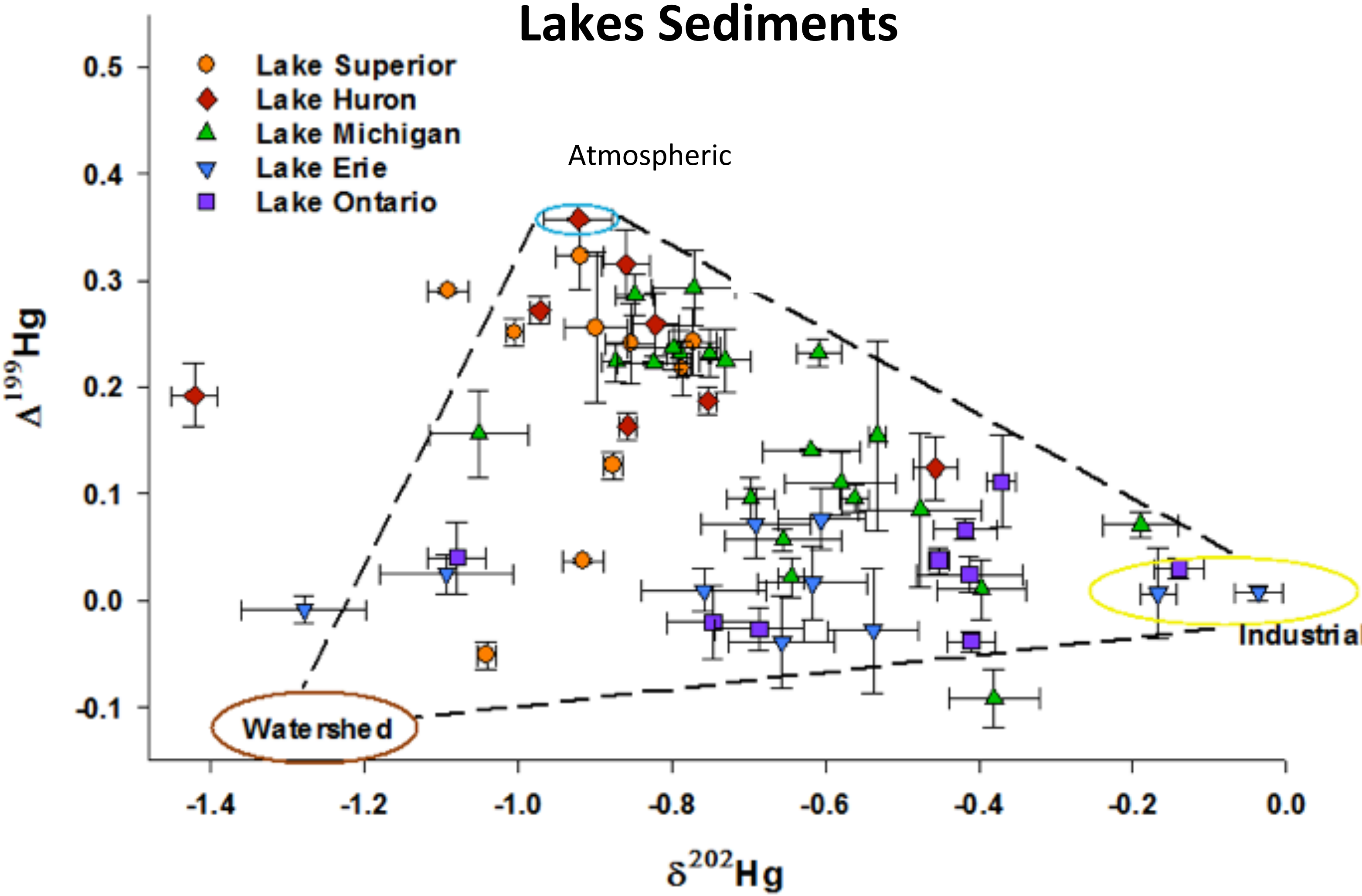
Mercury Source Attribution



δ^{202}Hg, Δ^{199}Hg, and Δ^{200}Hg

High resolution measurements of Hg isotopes used for source attribution

A Tri-Linear Mixing Model of Mercury Sources to Great Lakes Sediments



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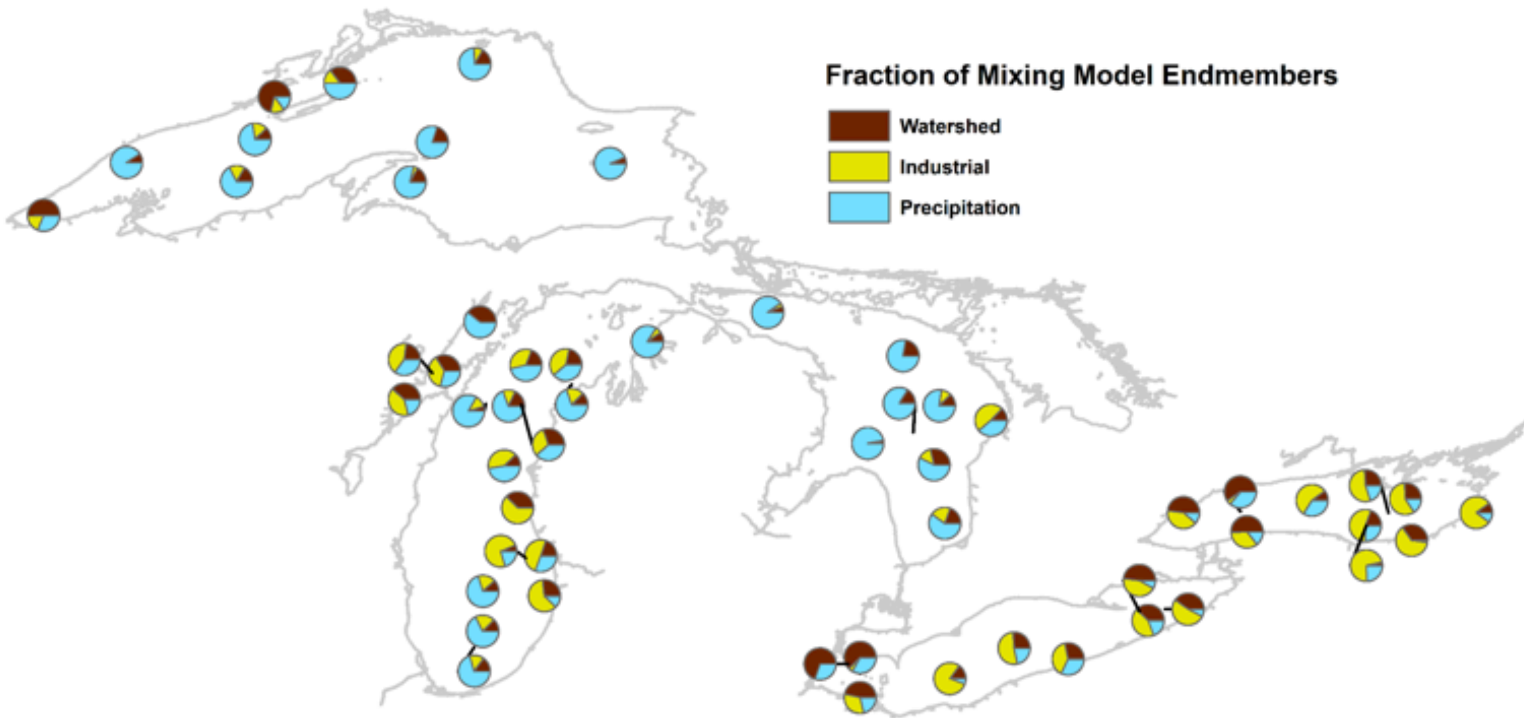

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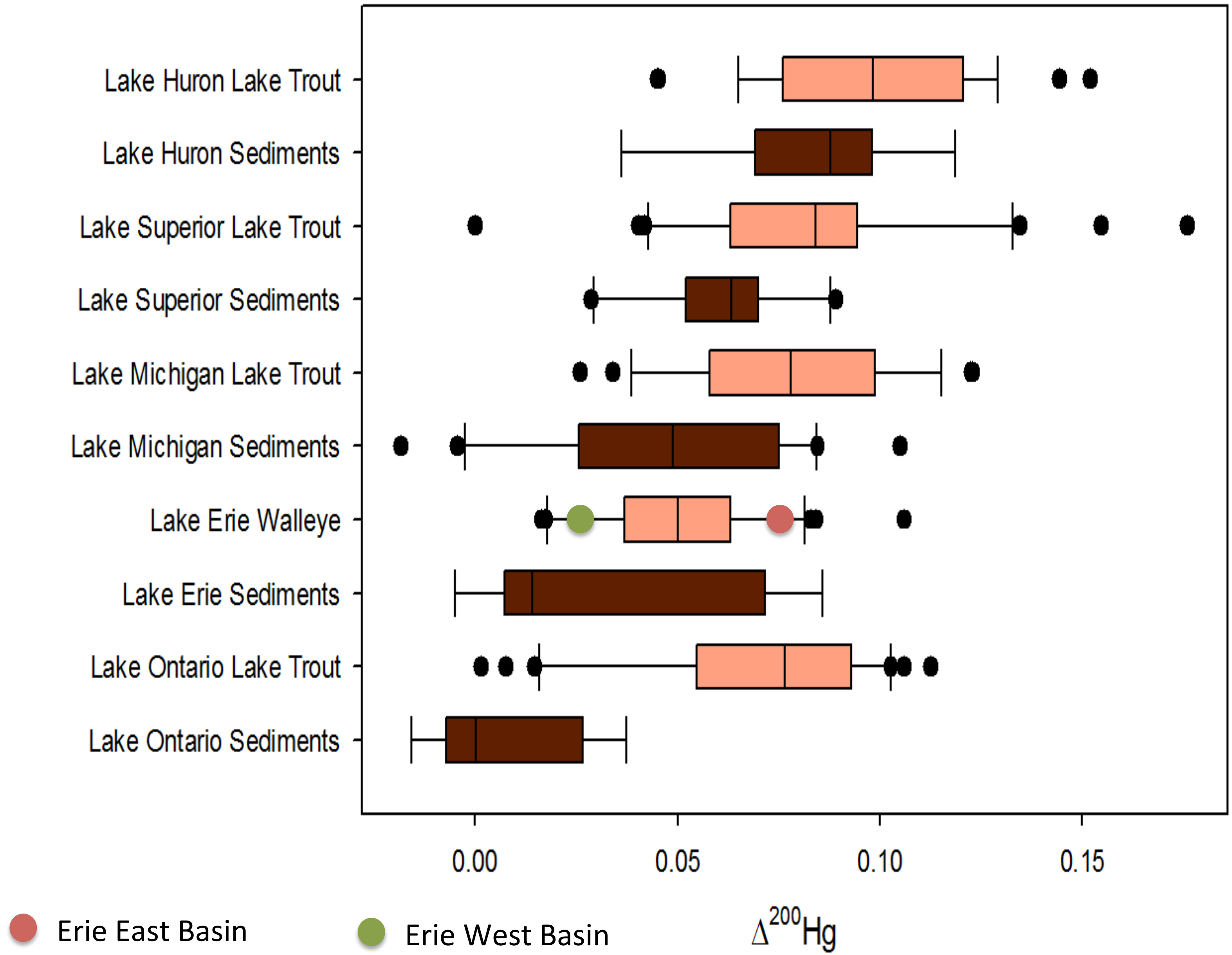
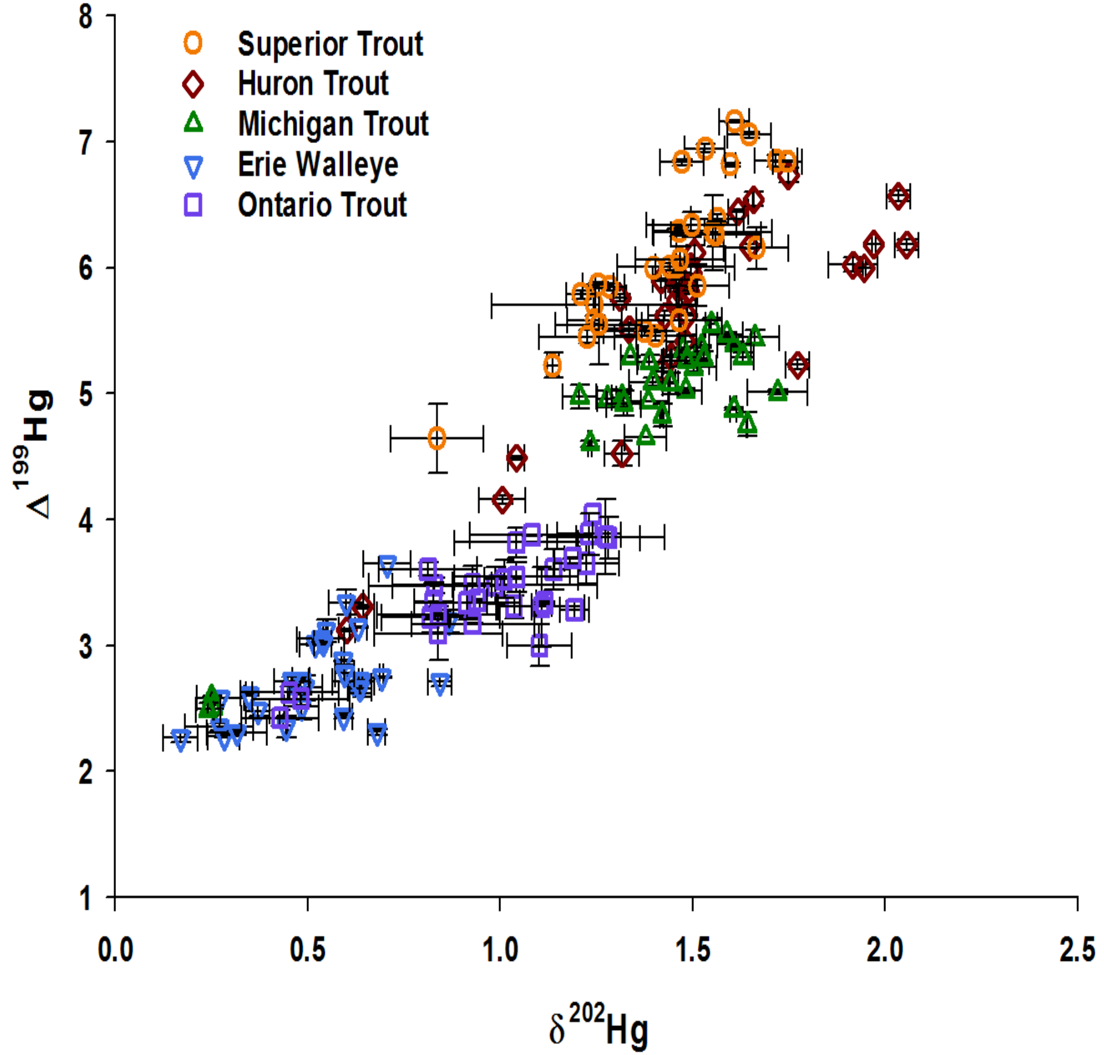


Lake Huron Lake Trout
Lake Huron Sediments
Lake Superior Lake Trout
Lake Superior Sediments
Lake Michigan Lake Trout
Lake Michigan Sediments
Lake Erie Walleye
Lake Erie Sediments
Lake Ontario Lake Trout
Lake Ontario Sediments
0.00
0.05
0.10
0.15
Erie East Basin
Erie West Basin
Δ200Hg

Distinguishing among Commercial/Sport Fish from the Great Lakes



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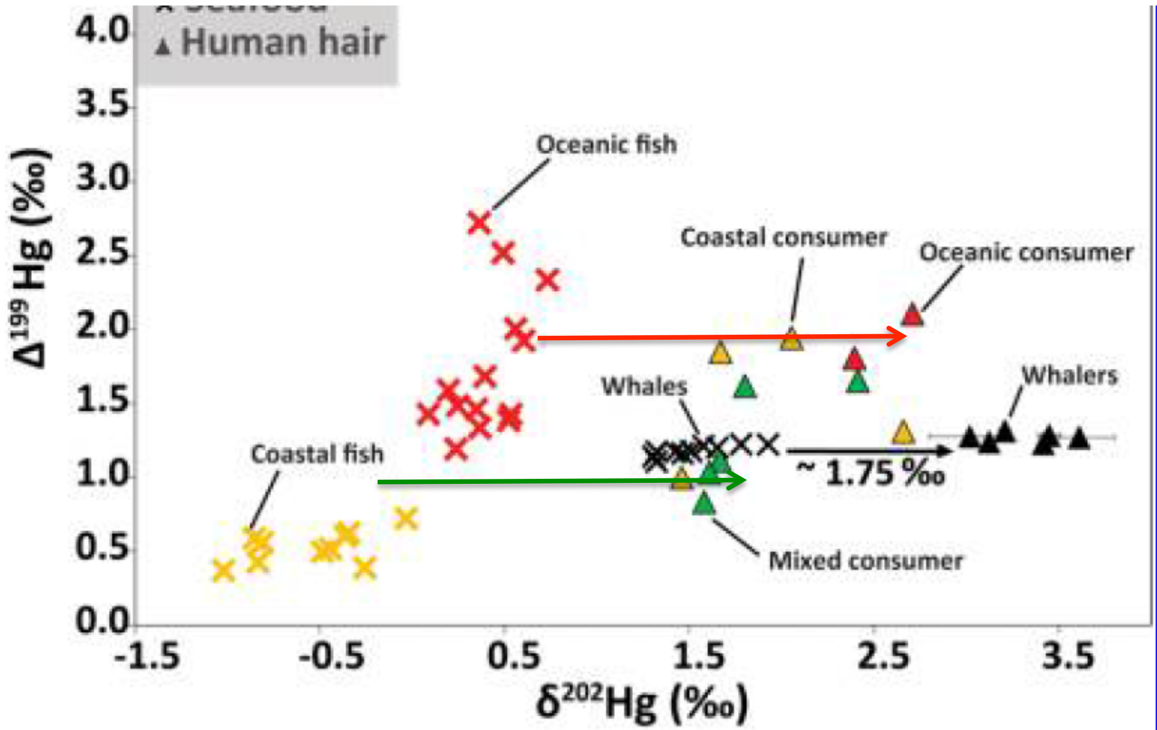
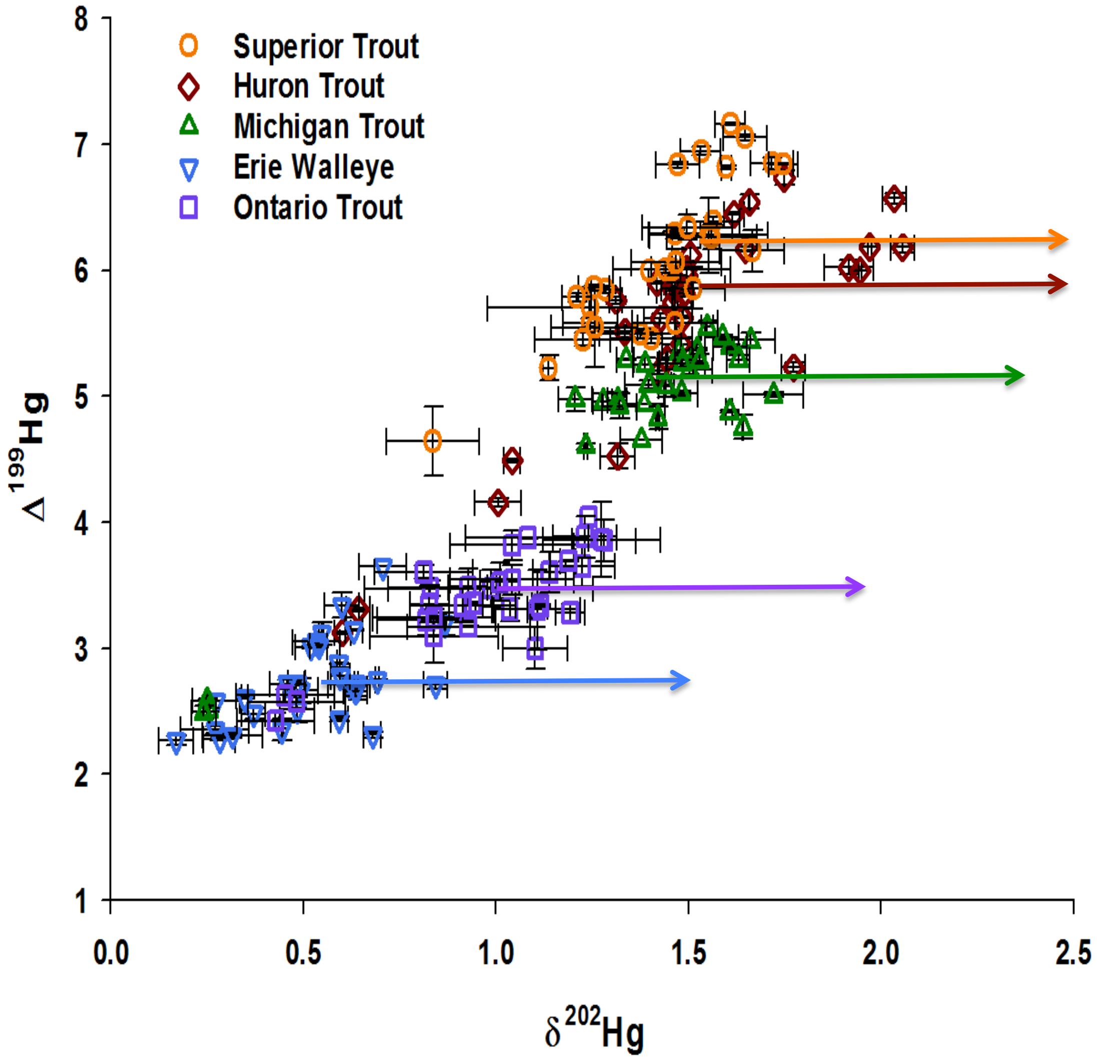
Assessing Sources of Human Methylmercury Exposure Using Stable Mercury Isotopes

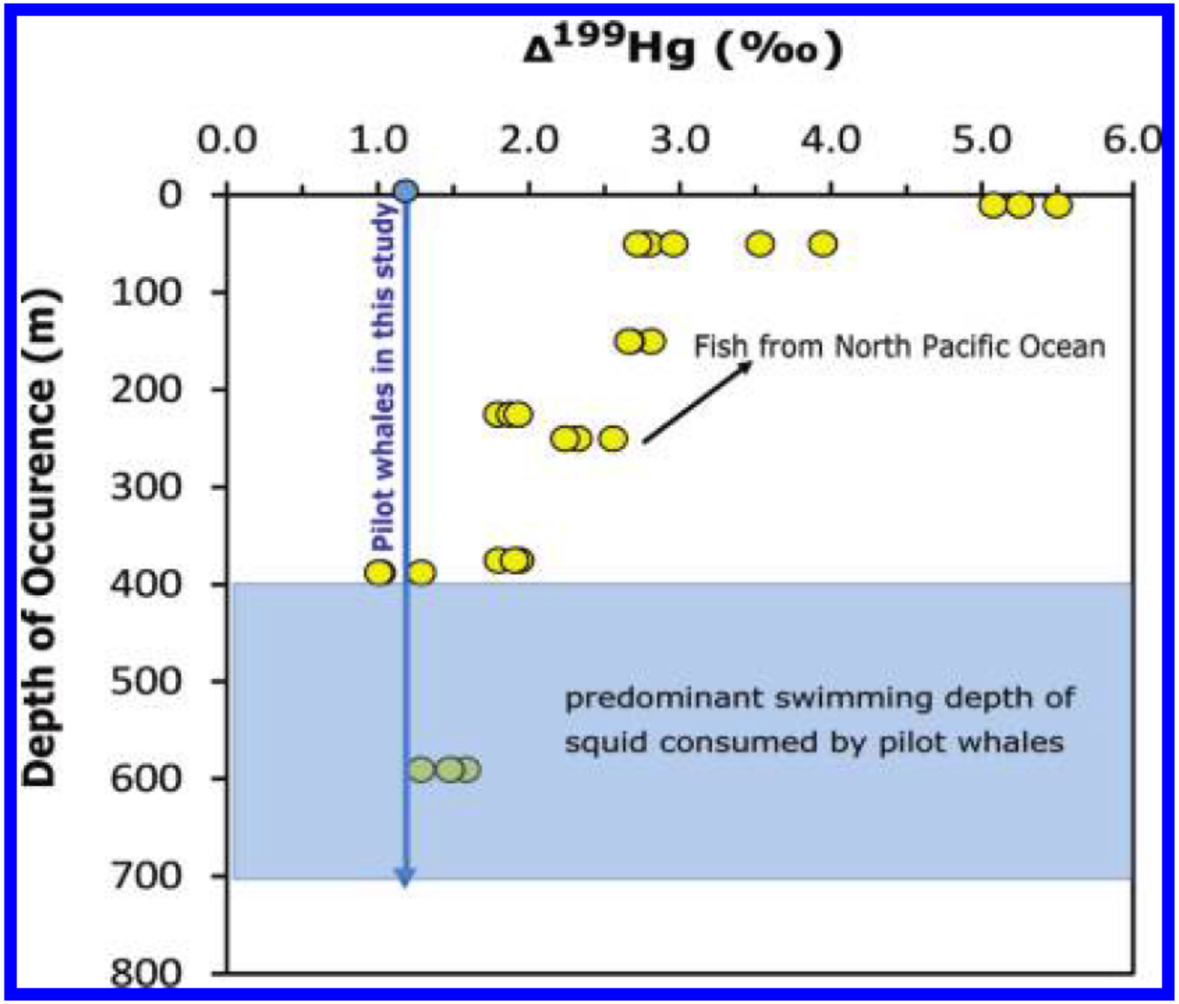
Miling Li,*[,†] Laura S. Sherman,[‡] Joel D. Blum,[‡] Philippe Grandjean,[†,§] Bjarni Mikkelsen,[∥] Pál Weihe,[⊥] Elsie M. Sunderland,[†,#] and James P. Shine[†]



Distinguishing among Commercial/Sport Fish from the Great Lakes



Where does the $\Delta^{199}Hg$ fractionation come from?

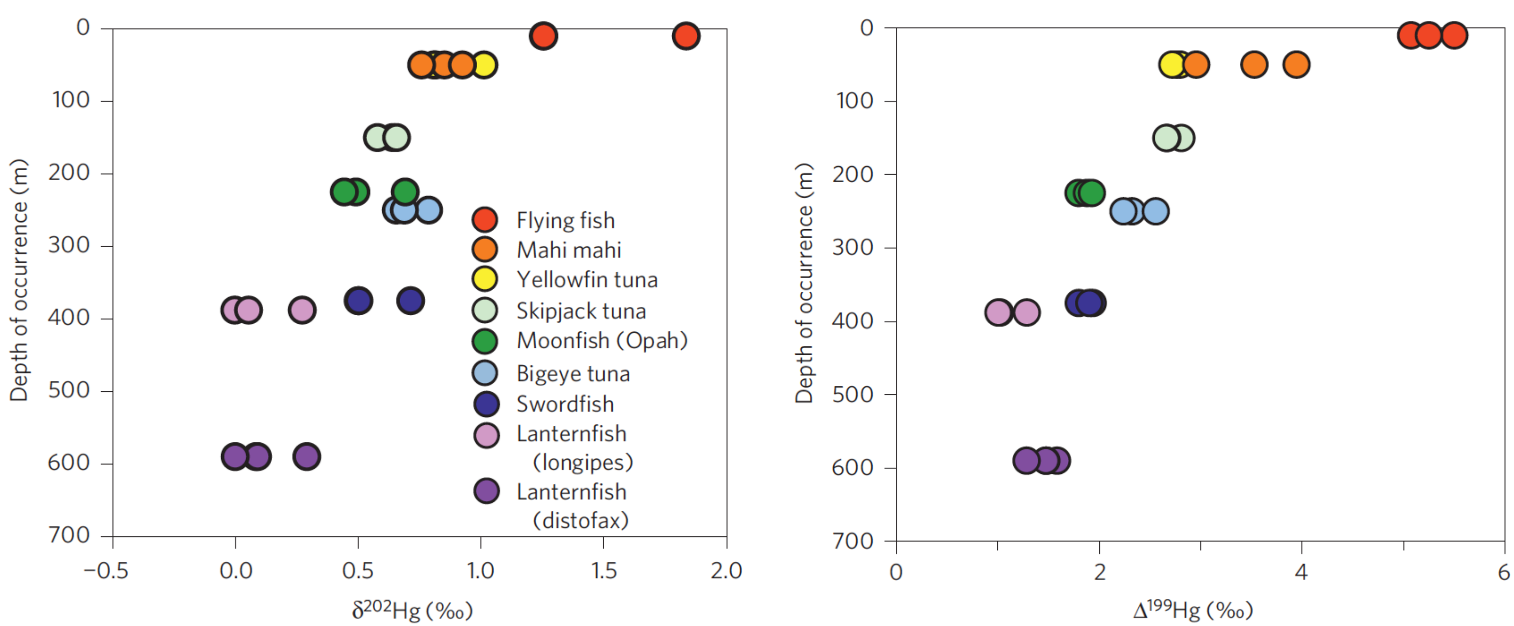


From Li et al., 2014

nature geoscience | ARTICLES
PUBLISHED ONLINE: 25 AUGUST 2013 | DOI: 10.1038/NGEO1918

Methylmercury production below the mixed layer in the North Pacific Ocean

Joel D. Blum[1]*, Brian N. Popp[2], Jeffrey C. Drazen[3], C. Anela Choy[3] and Marcus W. Johnson[1]



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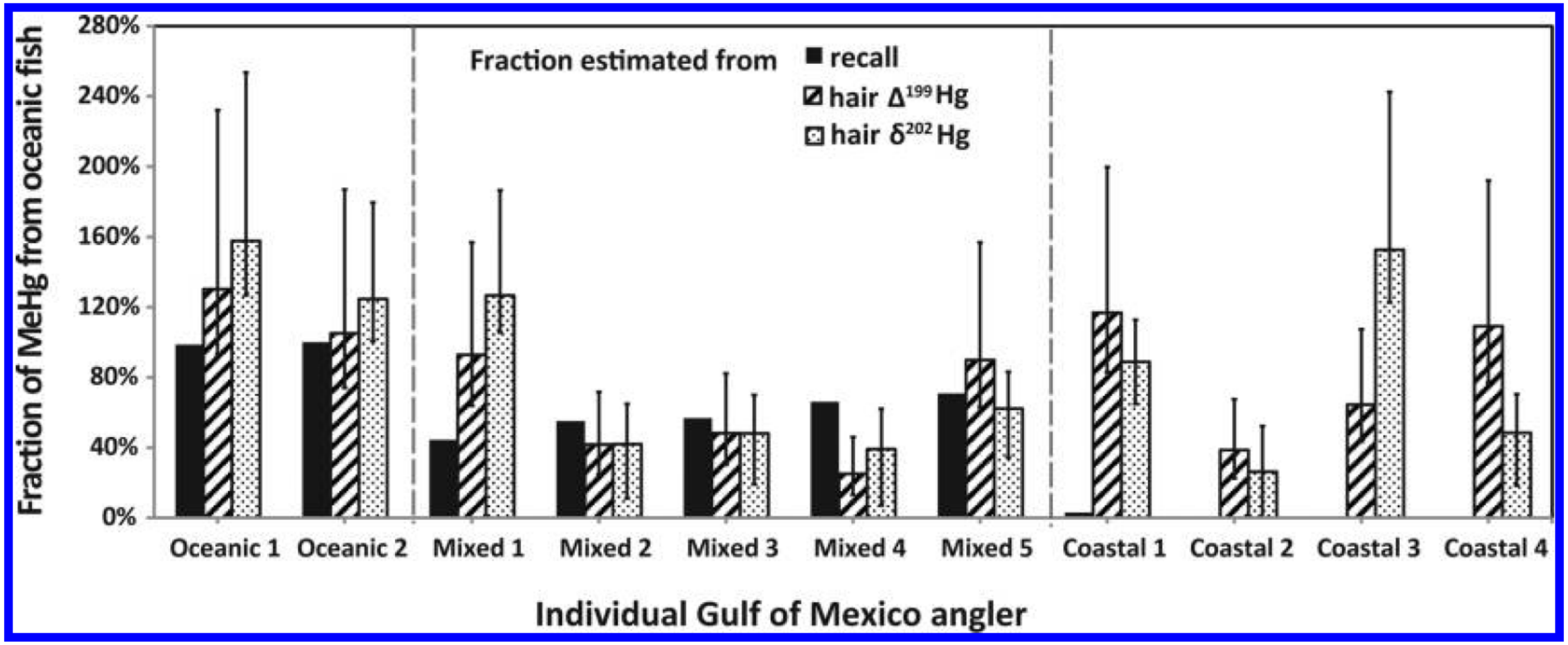

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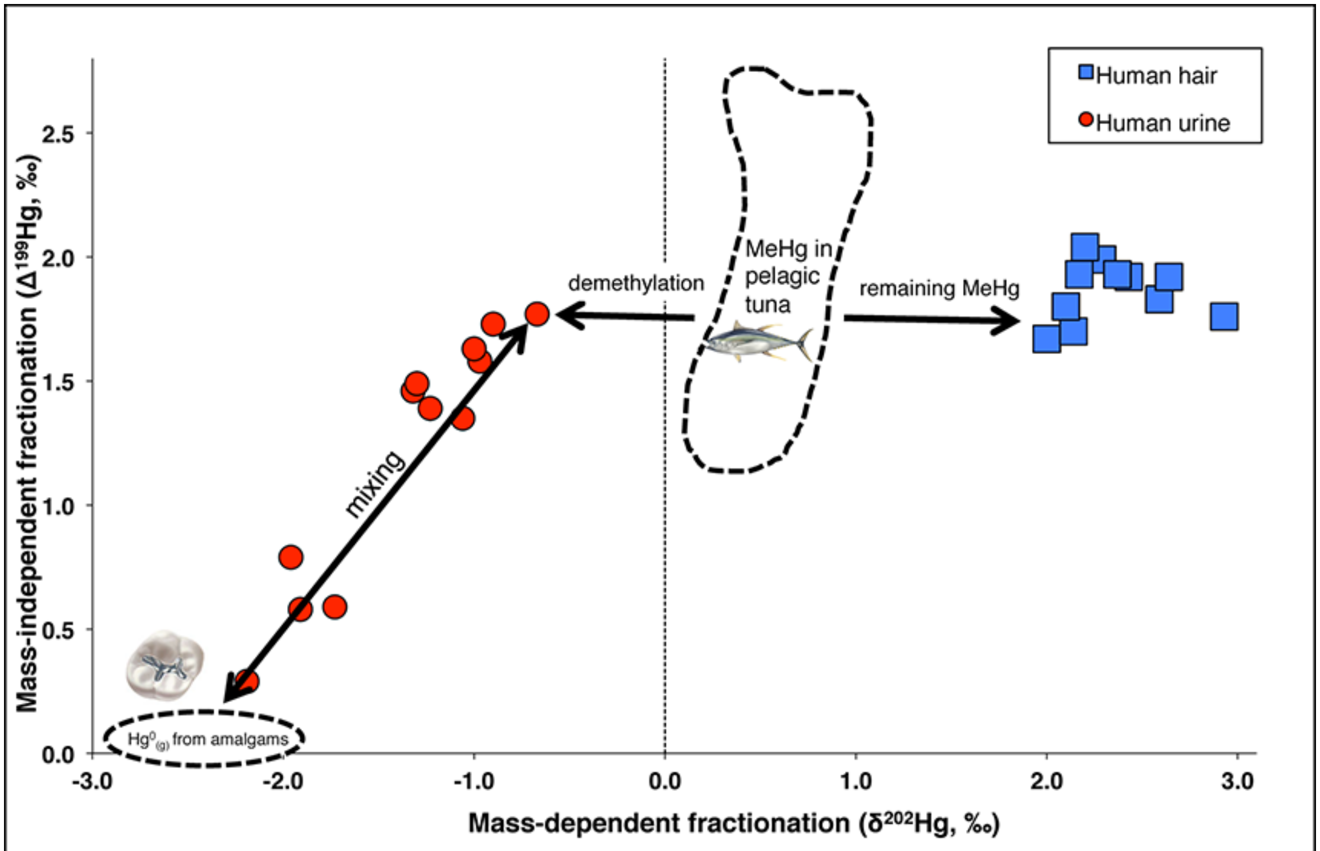
New Insight into Biomarkers of Human Mercury Exposure Using Naturally Occurring Mercury Stable Isotopes

Laura S. Sherman,[†,*] Joel D. Blum,[†] Alfred Franzblau,[‡] and Niladri Basu[‡]



Next Steps (what's needed):

- **<u>Much</u>** larger N values. The co-operated (USGS, UW-Madison and WSLOH) MC-ICPMS is the only mercury-exclusive instrument in the world → Machine time unlimited!
  - Our research team has focused heavily on methods development in our first 18 months of operation, increasing sample throughput by ~20X

- To date, **<u>very few attempts</u>** to measure the Hg isotopes on mercury specific species (it has mostly been inferred).
  - Our research group is planning for a focused method development phase to enable Hg isotope measurements on methylated versus inorganic Hg fractions in environmental and human samples - hair, urine, blood (?)

- Presently funded (USEPA GLRI) to work with Dr. Henry Anderson on recently collected and analyzed samples (THg) to examine the potential for providing greater understanding and applicability of mercury stable isotopes on epidemiological studies

- Other human-related studies (underway) includes the use of tissue samples (hair, liver, kidney, heart, skeletal muscle, and brain) from "fresh" cadavers

Lead Poisoning in Indiana: A Collaborative Effort to Prevent Lead Exposures in a Burmese Community

Magan Meade, MPA, MPH, Environmental Epidemiologist, Environmental Public Health Division, ISDH

Laurie Kidwell, Rapid Response Team Food Protection Program, ISDH

Josh Blauvelt, Environmental Health Specialist, Allen County Health Department

Saw Ridgeway, Translator for Allen County Health Department, Clinics

Indiana State Department of Health

Overview of Presentation

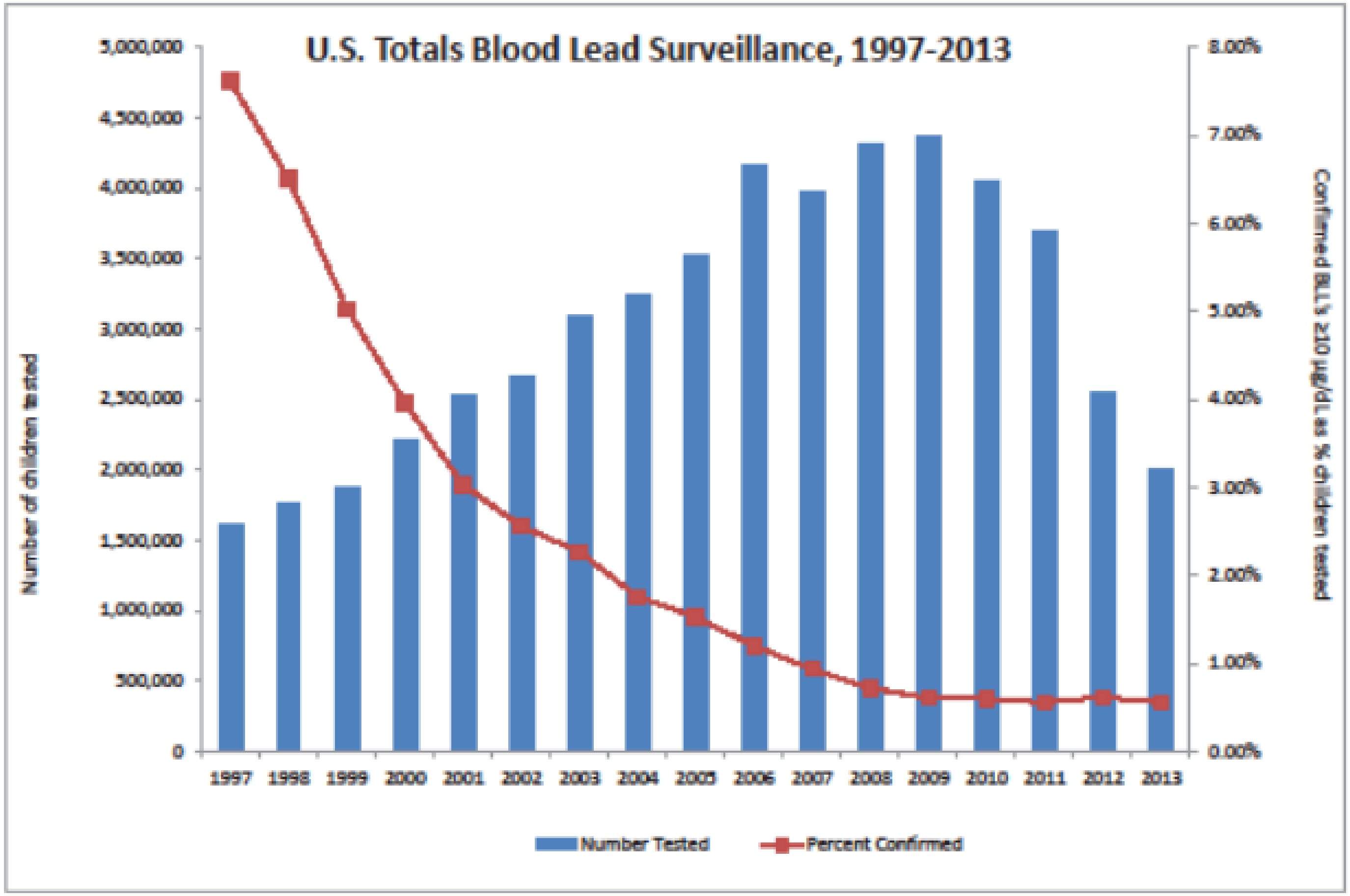
Section One: Lead Poisoning and Statistics
Section Two: Background Information
1. Cultural Background
2. Allen County
Section Three: State Investigation
Section Four: Follow-up and Post-Investigation

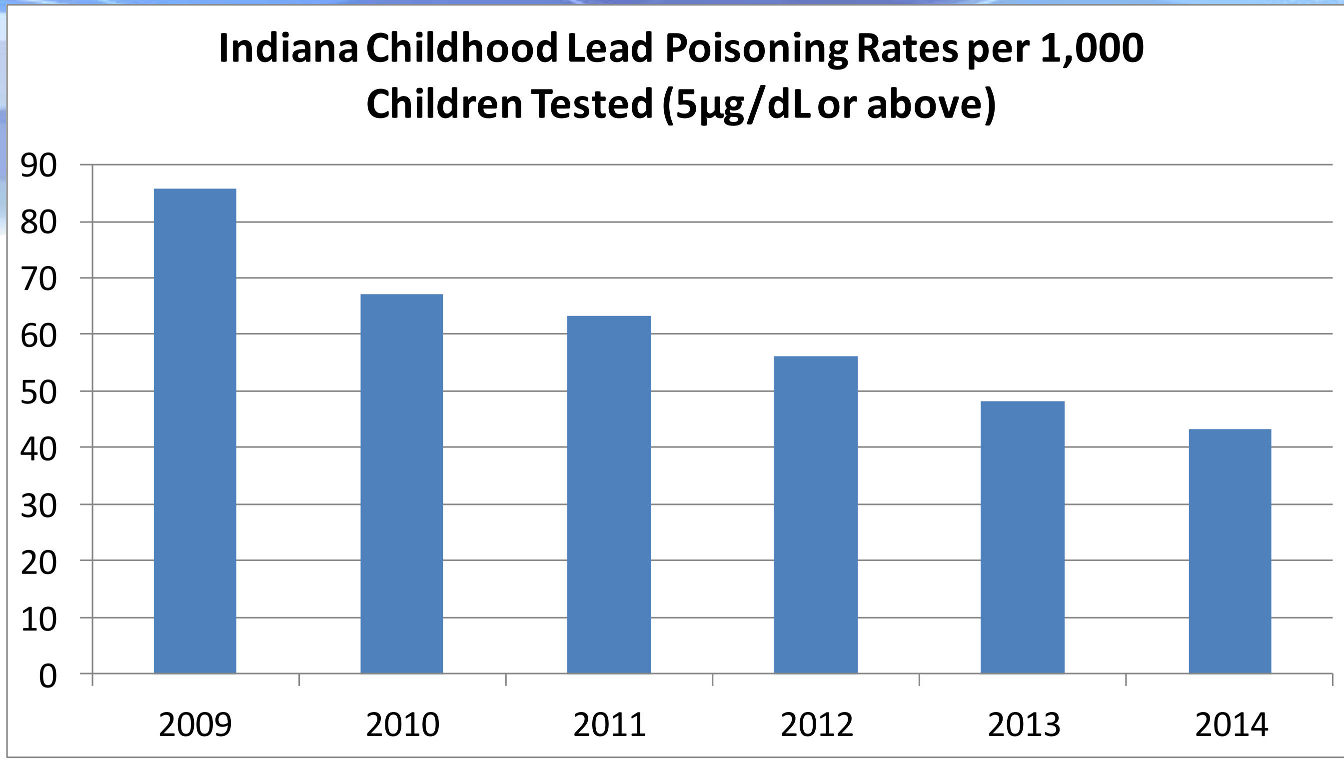
Lead Poisoning and Statistics

Lead Poisoning: Healthcare providers are still saying that lead poisoning is not an issue.

Why Lead?

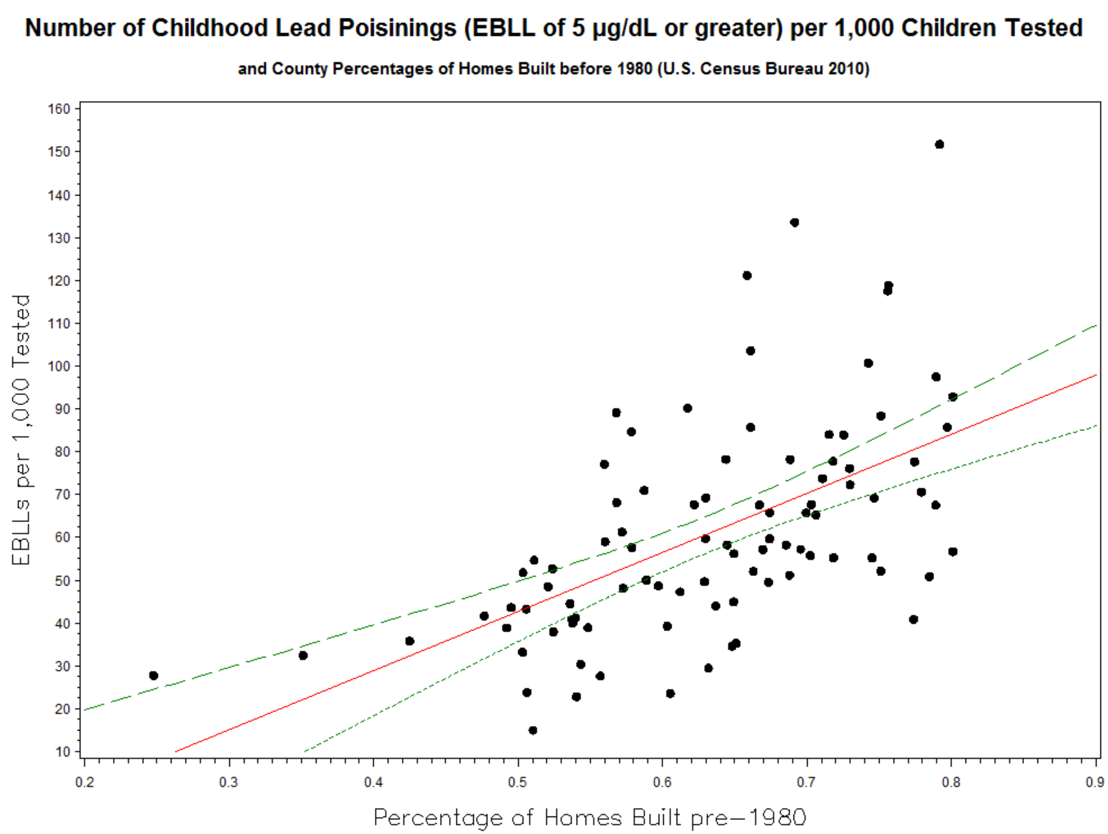
- Effects to the central nervous system
- Effects to a developing baby
- Effects to major organs
- Effects to the blood and immune systems
- Effects to the sensory system
- Deposits in bone
- Decreases IQ scores, cognitive and learning skills, behavioral impacts
- Long term effects later in life, elderly
- Increase in crime and teen pregnancies
- Economic Impacts


U.S. Totals Blood Lead Surveillance, 1997-2013
Number of children tested
Confirmed BLLs ≥10 µg/dL as % children tested
5,000,000
4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
8.00%
7.00%
6.00%
5.00%
4.00%
3.00%
2.00%
1.00%
0.00%
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Number Tested
Percent Confirmed



Indiana Childhood Lead Poisoning Rates per 1,000 Children Tested (5µg/dL or above)
90
80
70
60
50
40
30
20
10
0
2009
2010
2011
2012
2013
2014

What does lead poisoning look like in Indiana?



Regression Equation:
EBLL_Rate = -26.17064 + 137.7257*Homes_Pre1980

P < 0.0001

Lead Rates in Allen County

	Burmese Population (2014)	Asian Children Tested (2014)
Indiana	17,551	35,377
Marion County	11,708	764
Allen County	5,750	186

Source: Baci-indy.org

Demographic	EBLL ≥5 (2013)	Screened (2013)	EBLL ≥ 5 (2014)	Screened (2014)	Lead Rate per 100 (2013)	Lead Rate Per 100 (2014)
Asian Pacific	24	211	19	187	11	10
White	51	1146	64	1262	5	4
Black	41	496	30	529	8	6

Allen County

The Burmese Population

Why is this population susceptible to lead poisoning?

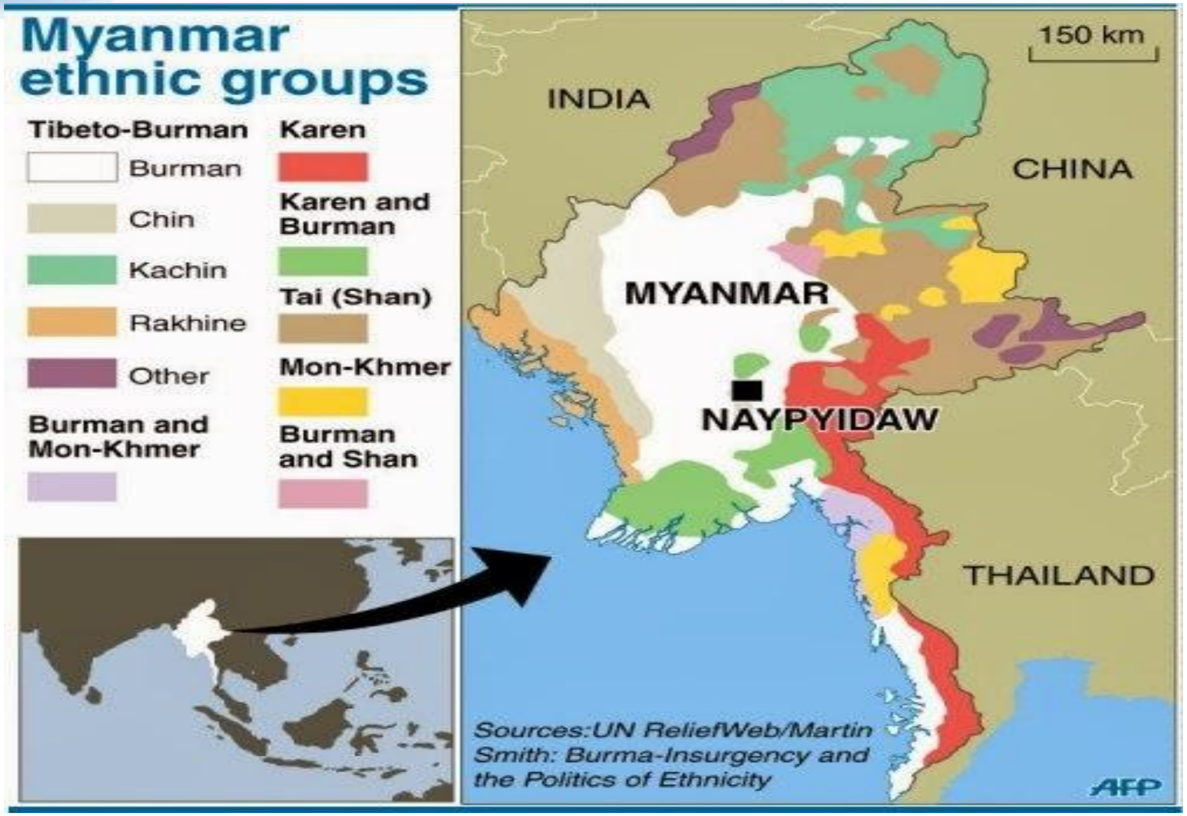
Indiana Map


LaPorte
Porter
Elkhart
LaGrange
Steuben
Marshall
Kosciusko
Whitley
Fulton
Jasper
Newton
Benton
Warren
Tippecanoe
Clinton
Tipton
Montgomery
Boone
Delaware
Randolph
Henry
Wayne
Fayette
Union
Franklin
Decatur
Jennings
Jackson
Lawrence
Washington
Orange
Clark
Floyd
Crawford
Dubois
Pike
Warrick
Daviess
Martin
Sullivan
Owen
Vigo
Parke
Putnam
Morgan
Johnson
Shelby
Rush
Hancock
Hamilton
Madison
Grant
Wabash
Cass
White
Carroll
Howard
Wells
Adams
Jay
Switzerland
Jefferson
Scott
Harrison
Perry
Gibson
Posey

Saw's Presentation.mp4

Burma: A Quick Glance

A Diverse Country



Civil Unrest

- Violence between Burmese and Karen has been going on since 1949.
- Fighting between the military regime and pro-democracy supporters and ethnic groups escalated in the 1990's.
- Led to major refugee influx in neighboring Thailand

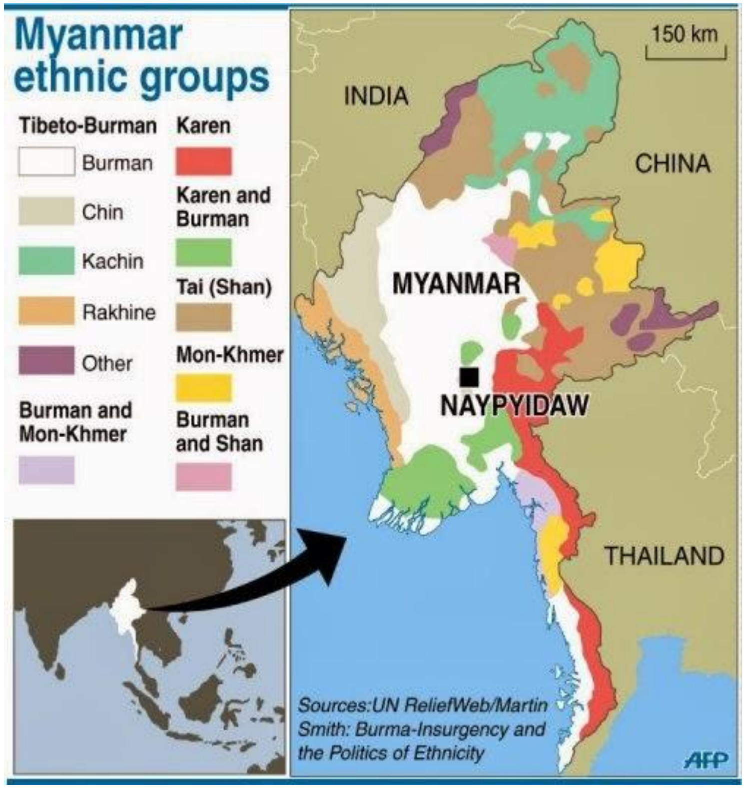
Refugee Camp In Thailand

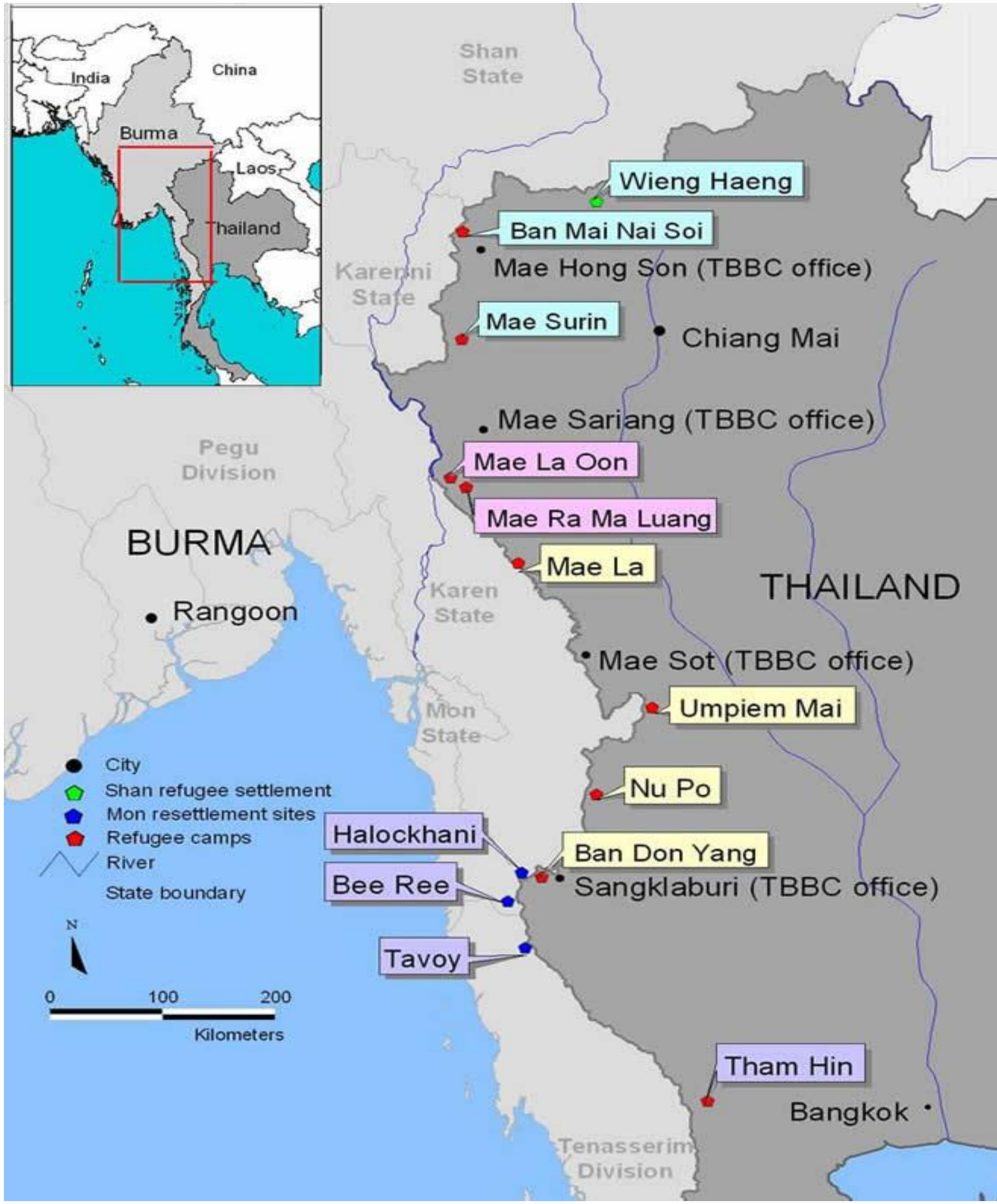
Allen County Refugee Pop.

- 2001 – July 2015 – 3,091 Burmese refugee arrivals
- 2007 – August 2015 - 1,881 Secondary arrivals in Allen County
- Restrictions on primary resettlement were put into place from 2009 – 2012

Ethnicities in Allen County

- From 2001 – 2009 most of the refugees were from the Karen state (UN camps in Thailand)
- From 2012 – Present refugees are coming from the Rakhine State (UN camps set up just into Bangledesh)





Location of Refugee Camps in Thailand

Dietary Habits

- Commonly Consumed Foods:
  - Rice
  - Fish, Chicken, pork and beef in a curry (Meat is often times a luxury food)
  - Fish Paste and Fish powder is a staple added to almost every meal
  - A variety of vegetables: cauliflower, cabbage, potatoes, cucumber, eggplant, squash, okra, and bamboo sprouts
  - Common spices include: ground red pepper, ginger, garlic and turmeric powder

Herbal Remedies

- Cost of a Dr.'s visit
- Language and reading barrier
- Herbal remedies have been a traditional medicine passed down through generations

2009 Lead Investigation

- Two digestive aides for children
- Daw Tway – 970 ppm Lead
  7,100 ppm Arsenic
- Daw Kyin – 23,000 ppm Arsenic

State Investigation

How did this investigation develop and what are the action steps?

Investigation Trigger

- Higher than average blood lead level rates prompted a CDC led investigation in 2009.
  - Investigated Daw Tway and Thanaka. Daw Tway ranged between 480-560ppm.
  - Identified that although they likely contributed, these products may not have been the sole factor. Other environmental factors were not investigated.
- Continued elevated rates and use of Thanaka prompted another investigation in 2014.
  - Results did not indicate that Thanaka was the sole source of the elevated blood lead levels.

Thanaka

Daw Tway

The Team

- Allen County Health Department
  - Joshua Blauvelt
  - Saw Ridgeway*
- Indiana State Department of Health
  - Food Protection: Laurie Kidwell, Misty Harvey, Eric Eldridge
  - Env Public Health: Magan Meade, Jim King, Rachel Pitto
  - Laboratory: Pradip Patel, Aaron Bolner, Marsha Rinehart, and Mary Hagerman.
- Indiana Department of Environmental Management
  - Jim Stahl – Indiana Fish Surveillance

Investigation Actions

- Gathered blood lead statistics for the target population.
- Gathered research on cultural, dietary, medicinal, cosmetic, environmental, and health information.
- Conduct product sampling of commonly used products (Based on recommendations by Saw/Store Clerks).
- Collected 48 individual products, totaling 77 samples.

Surveillance Sampling Plan

- Dried, salted, smoked, pickled, fermented, processed imported fish/seafood products.
- Dried imported spices
- Any variation of Burmese rice products
- Traditional Burmese cosmetics
- Traditional herbal remedies and Pharmaceutical products
- Added Candy

Laboratory Analyses

- Lead
- Arsenic
- Cadmium
- Mercury - Seafood
- PCB – Seafood

FDA Action Levels

• Candy:	0.1ppm Recommended 0.5ppm for Enforcement
• Fish:	1.5ppm (Crustaceans) 1.7ppm (Shellfish)
• Cosmetics:	3ppm
• Food/Juice:	Enforcement case by case, 0.05ppm Recommended

Description of Fish in the Stores

Surveillance Sample Results

By Source Product (Product Comparison)

Source	Sample Quantity	Notable Pb Quantities (ppm)				[redacted]	Notable As Quantities (ppm)				
		0.1 to 1	1 to 3	3 to 5	>15		0.1 to 1	1 to 3	3 to 5	5 to 10	>10
Candy	**2**	0	0	0	0		0	0	0	0	0
Cosmetic	**13**	10	1	1	0		*4	0	0	0	0
Fish/ Seafood	**18**	10	1	2	1		6	4	3	2	0
Food (misc. selections)	**3**	0	0	0	0		0	0	0	0	0
Pharmaceutical	**30**	11	7	1	6		**17	2	0	2	2
Rice	**3**	0	0	0	0		2	0	0	0	0
Spice	**8**	6	2	0	0		6	0	0	0	0
Total Samples	**77**	37	11	4	7		35	6	3	4	2

Note: Of the 77 Samples, 50 (65%) contained some level of lead.
High: >15, Medium: 1-5, Low: 0.1-1

Lead levels in products are not linked to human cases.

Surveillance Sample Results

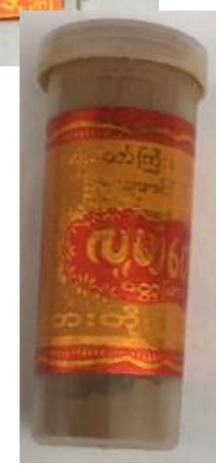
By Lead Level (Product Comparison)

Lead Levels Ranked	Quantity of Samples	% of Total Samples	Cosmetic		Fish/Seafood		Pharmaceutical		Spice		Candy	Food (misc.)	Rice	Arsenic Levels < 0.1	Arsenic Levels 0.1 to 1	Arsenic Levels 1-5	Arsenic Levels 5 +
High	**7**	**9.09%**			**1**	**14.3%**	**6**	**85.7%**							**1**	**1**	**4**
Medium	15	19.5%	2	13.3%	3	20.0%	8	53.3%	2	13.3%					9	4	1
Low	37	48.1%	10	27.0%	10	27.0%	11	30.0%	6	16.2%				5	23	3	1
Absent	18	23.3%	1		4		3				2	3	5	12	2	2	
Total Samples	**77**																

*****High: >15, Medium: 1-5, Low: 0.1-1*****
****Notable Pb Quantities in ppm, Notable As Quantities in ppm****
10 Samples had no As data

Lead levels in products are not linked to human cases.

High Level Products <15ppm



Medium Level Products 1-5ppm

Low Level Products 0.1 – 1ppm

Fish Tissue Analysis

Weight (Kg)	3.5 ug/kg body wt. day^{-1}	0.8 ug/kg body wt. day^{-1}	0.172 ug/kg body wt. day^{-1}	0.375 ug/kg body wt. day^{-1}*
70	2100 ug/kg (ppb)	479 ug/kg (ppb)	103 ug/kg (ppb)	225 ug/kg (ppb)
60	1800 ug/kg (ppb)	410 ug/kg (ppb)	88.0 ug/kg (ppb)	192 ug/kg (ppb)
16	1273 ug/kg (ppb)	291 ug/kg (ppb)	62.5 ug/kg (ppb)	136 ug/kg (ppb)

Indiana Fish

- Decided to revisit the local Indiana fish, to determine if this was a source of lead for this population.

Considering Lead Exposure from Consumption of Indiana Wild Caught Fish

- Burmese population often buys fish from the stores but we wanted to determine lead concentrations in IN fish as a possible contribution to population blood lead levels. We do not know what their locally caught wild fish consumption habits are.
- Summary statistics were calculated for lead in each species and for sample preparation method for samples dating from 2000 through 2013 across Indiana. Most samples were from rivers and streams. (63 species)
- Identified four potential benchmarks for different populations based on four different dose rate scenarios.
- Determined the proportion of samples for each species and each preparation that exceeded a calculated benchmark that was based on a consumption rate of 117 grams per day.
- Proportions of samples exceeding the most conservative benchmarks for each of four dose rate scenarios (see derivation of benchmarks slide) were determined to gain an insight into risks from the contribution of fish consumption to the population.
- The keyed-on population was a 16 kg child consuming a meal size 3/8 x 117 grams.

Considering Lead Exposure from Consumption of Indiana Wild Caught Fish

- Estimated Adult Consumption Rate 117 grams/day
- Estimated consumption rate for children 44 grams/day (based on 3/8 x 117 grams considering 8oz adult meal and 3oz meal for child)
- Calculate maximum daily ingestion rates based on four dose rate scenarios:
  1. 3.5 ug/kg body weight/day
  2. 0.8 ug/kg body weight/day
     - Derived from the IN drinking water maximum contaminant level of 0.0004mg/L
  3. 0.172 ug/kg body weight/day
     - Based on back calculation from a 0.086 ppm benchmark for Group 2 (one meal per week) (per comm. Rob Tewes, ORSANCO)
  4. 0.375 ug/kg body weight/day
     - Acceptable Daily Intake for fish (OHEPA)

Calculations

Calculation of the daily maximum Ingestion of lead for a 70 kg adult, A 60 kg adult, and a 16 kg Child.

Maximum daily ingestion of lead base on different dose rate scenarios.

Weight (Kg)	3.5 ug/kg body wt. day^{-1}	0.8 ug/kg body wt. day^{-1}	0.172 ug/kg body wt. day^{-1}	0.375 ug/kg body wt. day^{-1}
70	245 ug Pb/day	56 ug Pb/day	12.0 ug Pb/day	26.3 ug Pb/day
60	210 ug Pb/day	48 ug Pb/day	10.3 ug Pb/day	22.5 ug Pb/day
16	56 ug Pb/day	12.8 ug Pb/day	2.75 ug Pb/day	6.0 ug Pb/day

Calculation of a fish tissue benchmark not to be exceeded for each reference dose" based on 117 g/day for adults, and 44 g/day for the 16 kg child.

Fish Tissue concentration benchmark so that "reference dose is NOT exceeded.

Weight (Kg)	3.5 ug/kg body wt. day^{-1}	0.8 ug/kg body wt. day^{-1}	0.172 ug/kg body wt. day^{-1}	0.375 ug/kg body wt. day^{-1}
70	2100 ug/kg (ppb)	479 ug/kg (ppb)	103 ug/kg (ppb)	225 ug/kg (ppb)
60	1800 ug/kg (ppb)	410 ug/kg (ppb)	88.0 ug/kg (ppb)	192 ug/kg (ppb)
16	1273 ug/kg (ppb)	291 ug/kg (ppb)	62.5 ug/kg (ppb)	136 ug/kg (ppb)

Percentage of Indiana fish tissue samples exceeding the benchmark for limited consumption based on the dose rate scenario and a 16 Kilogram adolescent consuming 44 grams fish per meal.

Species	Median Average Length (mm)	Median Lead Concentration (ug/kg ww)	3.5 ug/kg body wt. day-1	0.8 ug/kg body wt. day-1	0.172 ug/kg body wt. day-1	0.375 ug/kg body wt. day-1
Channel Catfish	476	33.02	0.3	2.8	12.9	2.5
Common Carp	532	35.00	1	3.9	7.2	4.3
Bluegill	162	31.53	0	1.4	12.6	5.2
Largemouth Bass	335	27.20	0	3.5	11	1
Smallmouth Bass	309	27.5	0	1	15.9	1
Smallmouth Buffalo	504	31.82	0	8.8	6.6	8.8
White Bass	340	33.33	0	6.6	13.3	6.6

Preparation Type	Median Average Length (mm)	Median Lead Concentration (ug/kg ww)	3.5 ug/kg body wt. day-1	0.8 ug/kg body wt. day-1	0.172 ug/kg body wt. day-1	0.375 ug/kg body wt. day-1
Skin-Off Fillets	375	33.18	0.2	2.0	17.7	4.2
Skin-On Fillets	261	33.02	0.5	3.7	21.7	7.6
Whole Fish	114	65.60	4.1	15.2	51.4	26.7

Enforcement and Education

How will the state and county proceed with the results from the investigation?

Product Advisories

Consumer Product Advisory

Product Name: Golden Hinthar

Elevated Lead Products: DO NOT USE

The following products have been sampled by the Indiana State Department of Health and have been found to contain high levels of lead. These products tested above 15 parts per million for lead and were found to contain elevated levels of arsenic as well. There is no safe level of lead in products that will be consumed. The products are used for cooking or natural remedies.

Please contact Allen County Health Department for questions.

Golen Hinthar is a fish powder product used as a sauce on rice dishes. Regular consumption of this product can cause harmful irreversible effects, especially to children and pregnant women.

Lu Pyan Pa Da Myar is used as an herbal remedy for daily health or for treating headaches or digestive disorders.

These products contain high levels of lead. Please use products that have no lead or are regulated.

Product Name: Lu Pyan Pa Da Myar

Translate to Burmese

Fish Consumption Advisory

- Presenting sampling results and investigation to the Great Lakes Consortium on Fish Consumption in November for feedback and to raise awareness.
- Add additional materials for subpopulations who consume more than the national average in fish.

Future Sampling Plans

- Integrated imported pharmaceutical and herbal remedies into the ISDH FPP surveillance sampling plan.
- Allen County Lead Program will continue to test food, cosmetic, and traditional pharmaceutical products as part of their investigations.
- Marion County ramping up to conduct sampling in their stores.

Recommend to Sample this Nut

Lessons Learned

- Tested and utilized partnerships between different agencies and disciplines.
- Uncovered the need for improvements to product sample collection.
  - Documentation of the label, manufacturer, address/country of origin, where it was collected, and where it was purchased.
  - Taking pictures and matching pictures with sample numbers.
  - Provide impromptu training to lead programs as needed.
- Exposed the need for greater access to interpreters.
  - Educating and gathering information
  - Translate product labels
- Laboratory Insurance of tissue analysis

Applications to Other Populations

- Observed Hispanic products in the Burmese stores.
- Fish consumption among the Hispanics are assumed to be high.
- Lead poisoning rates are a concern among this population as well.

Overall Message

- We worked backward- identified a potential source of lead, looked at the statistics, confirmed and identified a problem, and conducted environmental sampling. Investigate the data and talk to people!
- Minority groups are growing, cultural practices are mixing, and there is an impact of globalization. There are huge economic and societal impacts from these groups. Prevent chronic conditions that can drain a population.
- There is a focus on infectious disease, when chronic disease conditions are as important within these communities- mental health & environmental exposures.

Questions?

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Laurie Kidwell, (317) 233-3213, lkidwell@isdh.in.gov

Josh Blauvelt, (260) 449-7825,
Joshua.Blauvelt@co.allen.in.us

References

Ritchey, M.D., et al. (2011). Lead poisoning among Burmese Refugee children—Indiana, 2009. *Clinical Pediatrics*. 50(7), 648-656.

Comprehension of Fish Consumption Guidelines Among Older Male Anglers in Wisconsin

Krista Christensen, Michelle Raymond, and Brooke Thompson

Great Lakes Consortium Call

January 11, 2016

Wisconsin Department of Health Services

Introduction: Study Overview

Background:

- Fish consumption advisories and outreach materials are available for sensitive populations.
  - Women of childbearing age
  - **Older adults**
- Research among older males points to adverse health effects from exposures to mercury, polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), etc.
- Previous studies indicate that advisory awareness does not necessarily translate to comprehension and behavior change.

Wisconsin Department of Health Services

Introduction: Study Overview

- Study purpose
  - Evaluate reach and impact of Wisconsin's advisory program on a subpopulation not previously targeted.
- Institutional Review Board
  - Study reviewed by the University of Wisconsin Human Subjects Review Board and determined to be exempt.

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Study Objectives

- Describe fish consumption behaviors of older male anglers in Wisconsin.
- Assess behavior changes and factors related to change.
- **Determine level of advisory awareness, knowledge, and comprehension, and assess determinants of advisory comprehension.**

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Introduction: Study Methods

- Open online survey
  - October 27, 2011, through August 1, 2013
- Survey topics:
  - Location of catch and species of fish caught and eaten in the last 12 months
  - Awareness and source of information for local and statewide consumption advisories
  - Consumption of locally caught and commercially purchased fish in the last 12 months
  - Health status and demographics

Wisconsin Department of Health Services

Introduction: Study Methods

- Target population:
  - Men age 50 and older who live and fish in Wisconsin
- Recruitment:
  - Press releases (newspaper and radio)
  - Twitter©
  - Notices in state agency and other fishing and lake organization publications targeted at fishermen
  - Distribution of flyer notices at various fishing expos and other related venues

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Results

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Demographic Characteristics

Table 1. Demographic characteristics of survey respondents (n=3,740)	
Age - Mean (Standard Deviation)	62.2 (6.9)
	Percent* (n)
Years living and fishing in Wisconsin	
Lived <10 years in the state	2.9 (103)
Fished WI waters <10 years (not including Great Lakes)	3.7 (137)
Never fished in any of the Great Lakes	17.3 (646)
Residence	
Lives in a county bordering lakes Superior or Michigan	24.3 (910)
Race and Ethnicity	
(Missing)	(122)
Identification as Hispanic or Latino	0.8 (28)
Identification as White (alone or in combination)	98.0 (3545)
Educational Attainment	
High school or less	17.4 (629)
Some college or Associate's or two-year degree	37.5 (1351)
College degree or greater	45.1 (1628)
Employment Status	
Working (full time, part time, or self-employed)	50.4 (1822)
Retired	44.9 (1622)
Other	4.7 (171)
Marital Status	
Married or marriage-like relationship	88.6 (3202)
Other	11.4 (414)

Fish and Shellfish Consumption

- Relatively high levels of fish consumption
  - This study population
    - Median annual meals (25th, 75th percentiles): 55 (32, 88)
  - Demographically similar population from 2011-2012 National Health and Nutrition Examination Survey:
    - Median annual meals (25th, 75th percentiles): 32.4 (15.6, 63.6)
  - Great Lakes states licensed anglers:
    - Median annual meals : 20.5

References: CDC, 2014; Connelly et al., 2012

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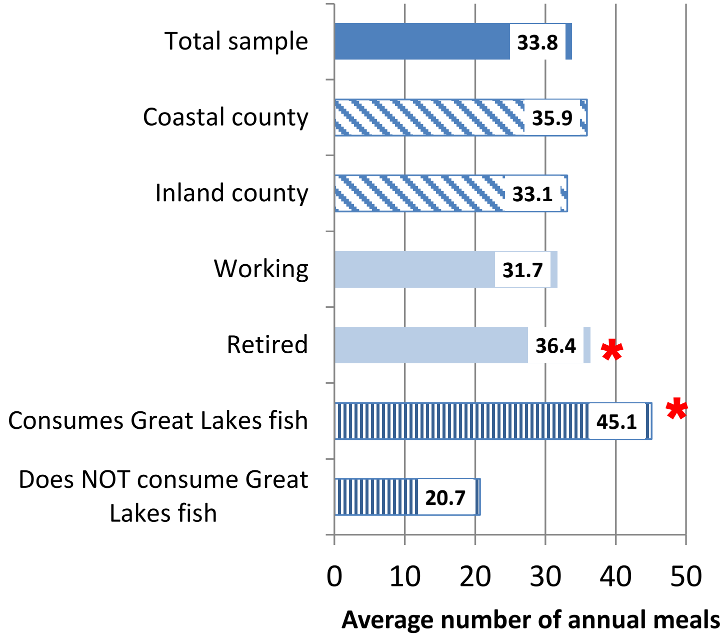
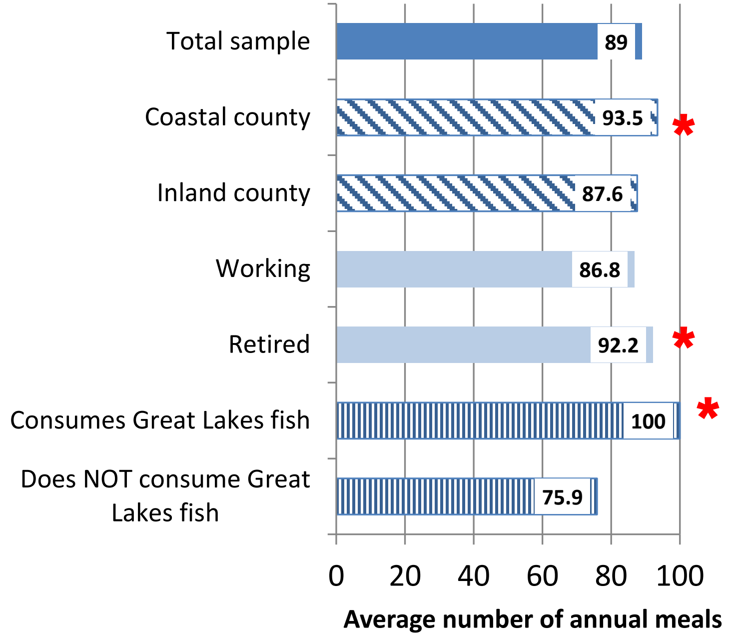
Fish and Shellfish Consumption

Locally Caught Fish Meals by Demographic Characteristics



Total Fish and Shellfish Meals by Demographic Characteristics



* Significantly different mean values ($p<0.05$) as calculated using a t-test with Cochran adjustment for unequal variance between groups.

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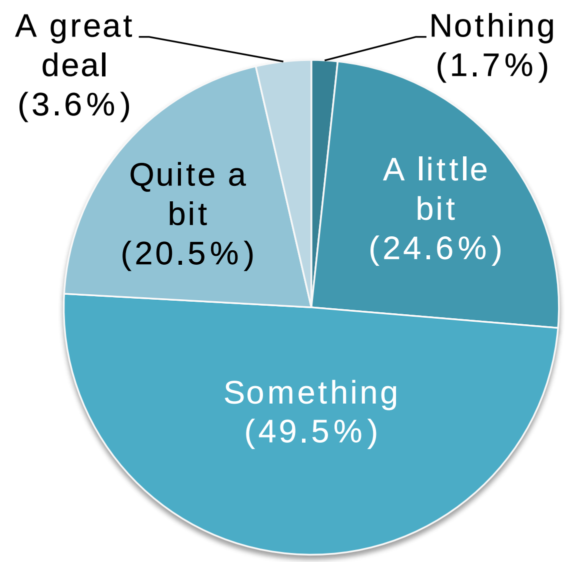
Advisory Awareness: Mercury

- Overall, 95% had ever heard of Wisconsin's fish consumption advisory for mercury (generally aware).
- Those who were generally aware were asked to self-rate their knowledge.

Self-rated advisory knowledge among those generally aware



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Advisory Comprehension: Mercury

Answers to mercury advisory comprehension questions, by self-reported knowledge level

Question, percentage correct (n)	Total	A little bit	Some	Quite a bit	A great deal
False: By trimming the fat and skin off of fish, I can minimize the amount of mercury I may consume when eating fish.	18.89 (663)	21.96 (193)	16.47 (291)	18.14 (133)	35.38 (46)
False: I can minimize my mercury intake by: Eating only walleye or Northern pike.	87.18 (3,059)	83.82 (732)	87.55 (1,547)	89.63 (657)	94.62 (123)
True: I can minimize my mercury intake by: Eating mostly panfish.	67.08 (2,354)	60.30 (530)	66.72 (1,179)	73.94 (542)	79.23 (103)
True: I can minimize my mercury intake by: Eating small gamefish.	74.98 (2,631)	66.33 (583)	75.61 (1,336)	81.45 (597)	88.46 (115)

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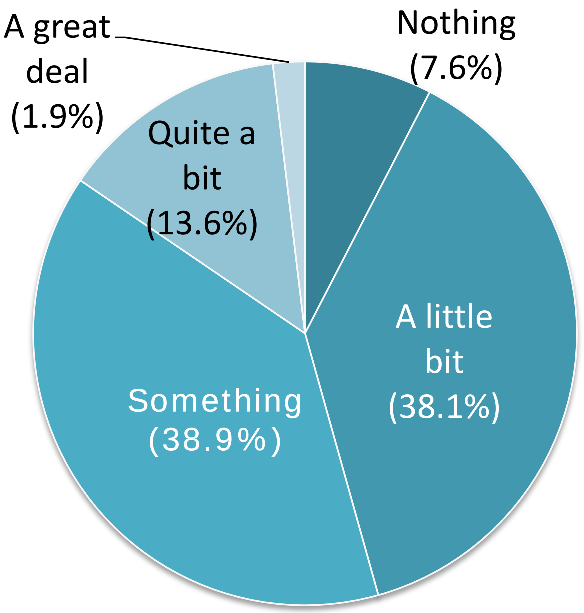
Advisory Awareness: PCBs

- Overall, 77% had ever heard of Wisconsin's fish consumption advisory for PCBs ('generally aware').
- Those who were generally aware were asked to self-rate their knowledge.

Self-rated advisory knowledge among those generally aware



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Advisory Comprehension: PCBs

Answers to PCB advisory comprehension questions, by self-reported knowledge level

Question, percentage correct (n)	Total	A little bit	Some	Quite a bit	A great deal
True: By trimming fat and cooking so that the fat drains away, I can reduce the amount of PCBs I consume.	77.29 (2051)	71.51 (783)	79.12 (883)	85.35 (332)	98.11 (52)
False: The following species tend to have higher concentrations of PCBs: panfish (such as bluegill or crappie).	94.31 (2504)	93.97 (1029)	93.73 (1046)	96.66 (376)	96.23 (51)
False: The following species tend to have higher concentrations of PCBs: predator species (such as walleye or northern pike).	48.83 (1297)	54.43 (596)	46.77 (522)	40.62 (158)	37.74 (20)
True: The following species tend to have higher concentrations of PCBs: bottom fish (such as carp or catfish).	89.30 (2370)	87.21 (955)	90.05 (1005)	92.03 (358)	96.23 (51)
True: The following species tend to have higher concentrations of PCBs: fatty fish (such as lake trout).	90.05 (2390)	87.85 (962)	90.68 (1012)	93.06 (362)	100.0 (53)
True: Fish from the following locations tend to have higher concentrations of PCBs: Sheboygan River, Cedar Creek, and Pine/Jordan Creeks.	80.71 (2142)	76.16 (834)	82.71 (923)	86.89 (338)	86.79 (46)

Advisory Comprehension: Knowledge Gaps

- Two questions with <50% correct response rate
  - Mercury exposure and fish preparation method
    - Question: By trimming the fat and skin off of fish, I can minimize the amount of mercury I may consume when eating fish.
    - **18.9% correctly answered False.**
  - PCB exposure and fish species
    - Question: The following species of Wisconsin sport-caught fish tend to have higher concentrations of PCBs: predator species (such as walleye or northern pike).
    - **48.8% correctly answered False.**

Issues with PCB question phrasing?

- *Examples of predator species may not be applicable to all lakes.*
- *Predator species only mentioned in mercury guidelines pamphlet.*

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Advisory Comprehension: Predictors of Knowledge Gaps

- We used adjusted logistic regression models to identify effect of advisory information source.
- Mercury knowledge gap:
  - Wisconsin Department of Natural Resources fishing regulations booklet was the only source associated with correct response.
  - "Other" sources of information associated with incorrect responses.
  - Older age and the education category of "some college or two-year degree" (compared with ≤high school) associated with incorrect response.

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Advisory Comprehension: Predictors of Knowledge Gaps

- PCB knowledge gap
  - Correct response associated with these sources:
    - DHS materials
    - Fishing regulations booklet
    - Warnings posted on waters fished
  - Higher education (≥bachelor's degree) associated with lower odds of answering correctly

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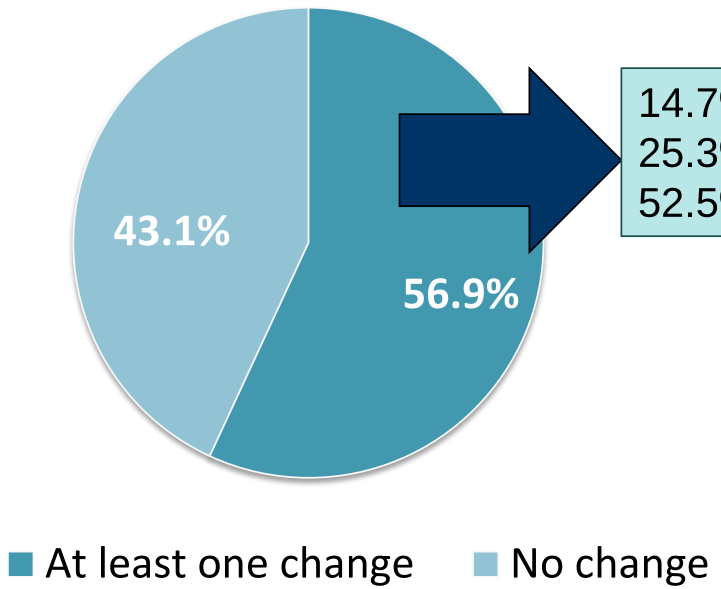
Behavior Changes

Participants were asked if they had ever tried to eat fewer fish meals, to eat different types of fish meals, or to avoid eating fish from certain locations due to contamination concerns.



14.7% tried to eat **fewer** meals.
25.3% tried to eat **different types** of meals.
52.5% **avoided** eating fish from some **locations**.

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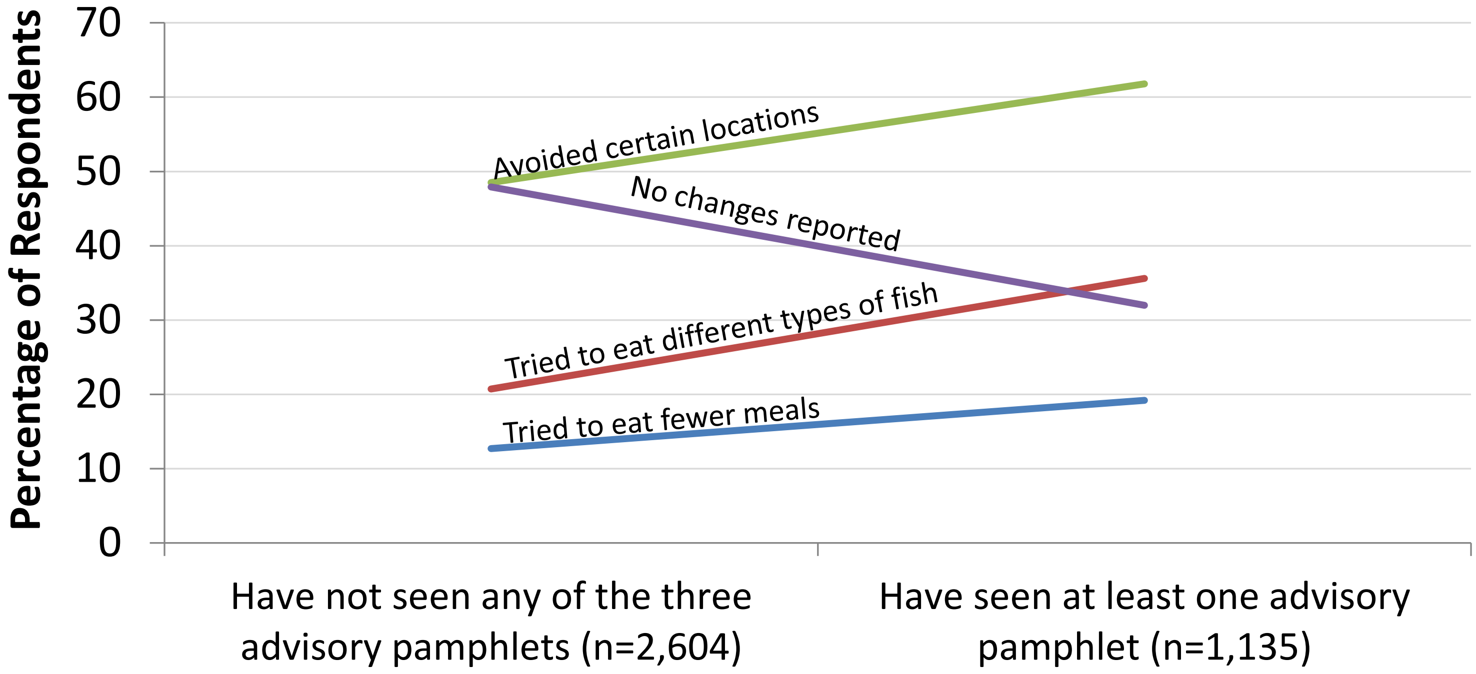
Behavior Changes and Advisory Pamphlets

Participants who reported having seen advisory pamphlets were more likely to report behavior changes.



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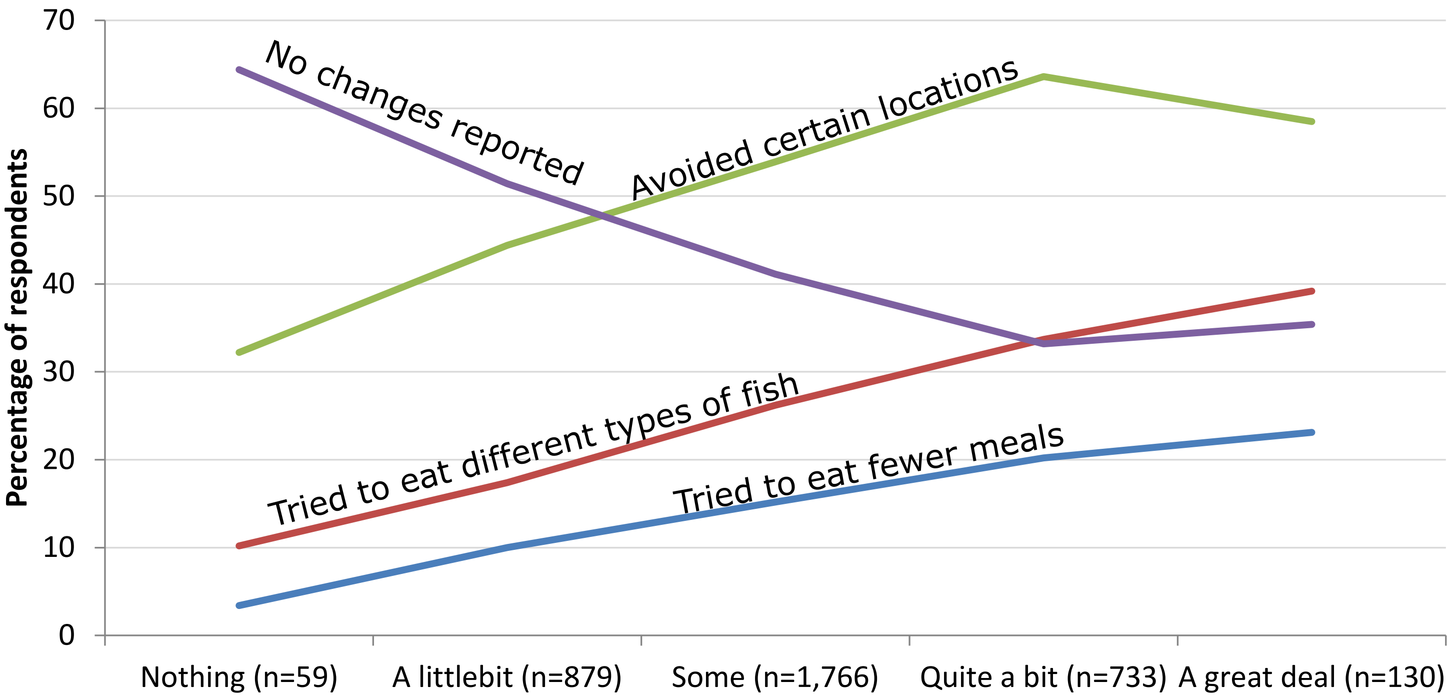
Behavior Changes and Advisory Knowledge: Mercury

Participants with greater self-reported knowledge of mercury advisories were more likely to report behavior changes.



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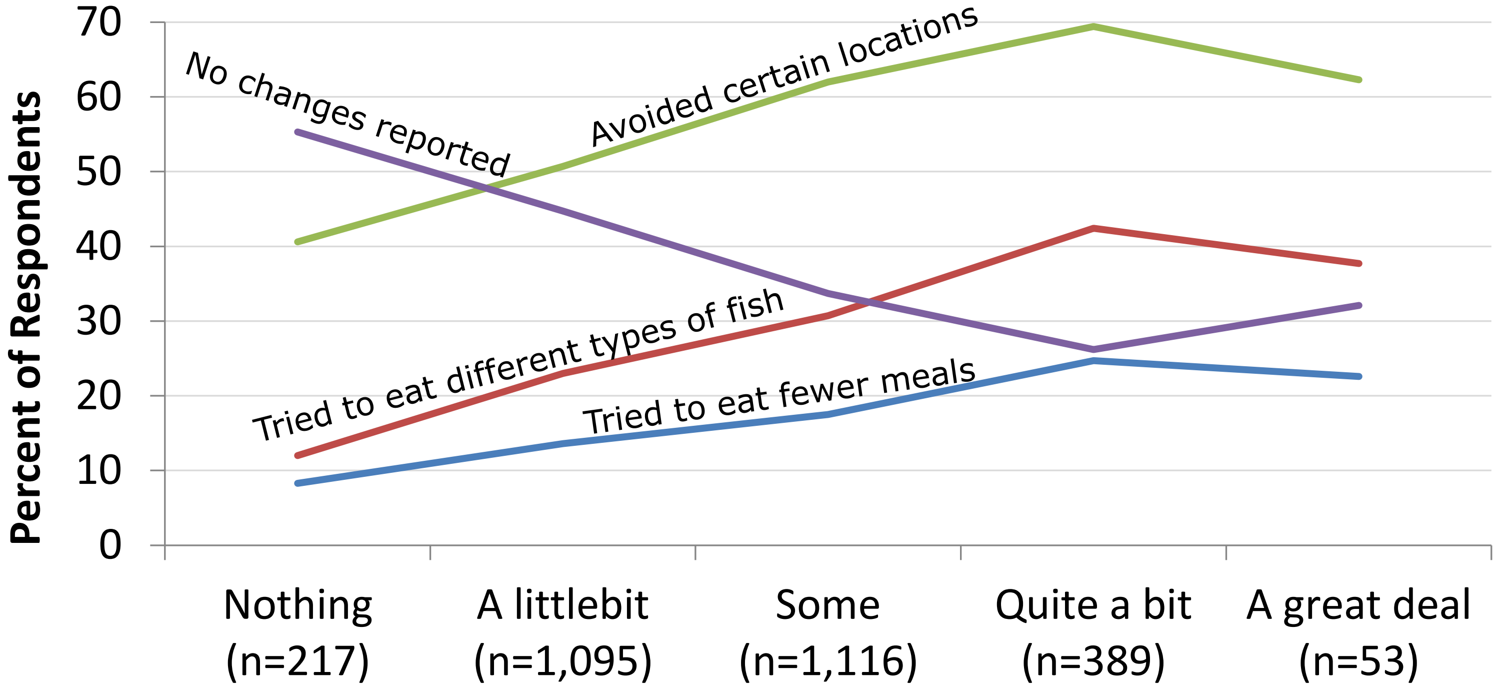
Behavior Changes and Advisory Knowledge: PCBs

Participants with greater self-reported knowledge of PCBs advisories were more likely to report behavior changes



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Discussion

- Survey methodology
  - Older male anglers may be comfortable with electronic media
    - Over 40% of participants heard about study survey via email
    - DNR webpage was one of the most commonly reported information sources for fish consumption guidelines
- Fish consumption
  - High consumption overall, and high proportion from locally caught fish
  - Higher consumption compared with both NHANES general population data and other angler cohorts

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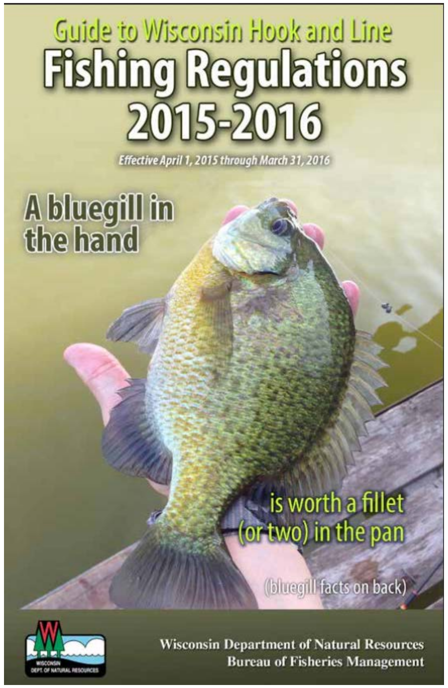
Discussion

- Behavior changes
  - The most common behavioral changes were modifying the species eaten or the water body source of their meals, not eating fewer fish meals.
  - Behavior changes were more likely among anglers who:
    - Consumed Great Lakes fish.
    - Resided in coastal counties.
    - Reported higher levels of guideline knowledge.

Wisconsin Department of Health Services

Discussion

- Information sources and knowledge gaps
  - The fishing regulations booklet is a widely used and effective source of guideline information.
  - ‘Other’ sources of information were associated with the mercury guideline knowledge gap.



Wisconsin Department of Health Services

Conclusions

- Measures to educate older male anglers about the risks and benefits of fish consumption are generally effective.
- Further efforts may be needed to clarify certain aspects of both the mercury and PCB guidelines.
- This population of frequent fish consumers could greatly benefit from enhanced guideline awareness and knowledge.
- Findings will aid DNR and DHS in crafting appropriate, targeted consumption advice and outreach and education strategies to reach older males in Wisconsin.

Wisconsin Department of Health Services

Acknowledgements

- A thank you to all those who are on Wisconsin's Fish Team:
  - Krista Christensen; Scott Hetzel (ICTR); Pamela Imm, Henry Nehls-Lowe, Michelle Raymond, Candy Schrank, Brooke Thompson; Mark Werner; Meghan Williams, Emelia Wollenburg and the UW-Madison Survey Center
- This work was funded by U.S. Environmental Protection Agency (EPA), Great Lakes Restoration Initiative Grant.
- The content is solely the responsibility of the authors and does not necessarily represent the official views of the EPA.

Wisconsin Department of Health Services

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- Connelly NA, Lauber TB, Niederdeppe J, Knuth BA. Factors Affecting Fish Consumption Among Licensed Anglers Living in the Great Lakes Region. HDRU Publication Number 12-3. Department of Natural Resources, NYS College of Agricultural And Life Sciences, Cornell University, Ithaca, NY. Available at http://www2.dnr.cornell.edu/hdru/pubs/fishpubs.html#risk. 2012.

Wisconsin Department of Health Services

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  - Krista Christensen – krista.christensen@wi.gov
  - Michelle Raymond – michelle.raymond@wi.gov
  - Brooke Thompson – brooke.thompson@wi.gov
- For further information on this study, see:
  - http://www.ncbi.nlm.nih.gov/pubmed/26306781
  - http://www.ncbi.nlm.nih.gov/pubmed/23894808

Wisconsin Department of Health Services

Great Lakes Fish Monitoring and Surveillance Program: Emerging Chemical Update

Bernie Crimmins
Clarkson University, Potsdam, NY

Emerging Chemical Update Webinar
February 22, 2016

Co-Authors
Thomas Holsen, Philip Hopke, Sujan Fernando, *Clarkson University, Potsdam, NY*
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Michael Milligan, *SUNY Fredonia, Fredonia, NY*

Elizabeth Murphy, US EPA GLNPO

Great Lakes Fish Monitoring and Surveillance Program Post 2010 - present

Open Lake Trends Monitoring – legacy

- Monitor contaminant trends in the open waters of the Great Lakes using whole fish (trout and walleye)
- 50 size-selected fish collected from each lake
- Alternate between near and offshore sites every year
- 10 composites containing 5 fish each.
- Yearly Mega-composites created after 2008 integrating all 50 fish collected for each lake

Lake of the Year – Bioaccumulation and food web structure for each lake

Emerging Chemicals of Concern – Discovery of new PBTs

2015: Proteomics component added (Costel Darie, Clarkson University)

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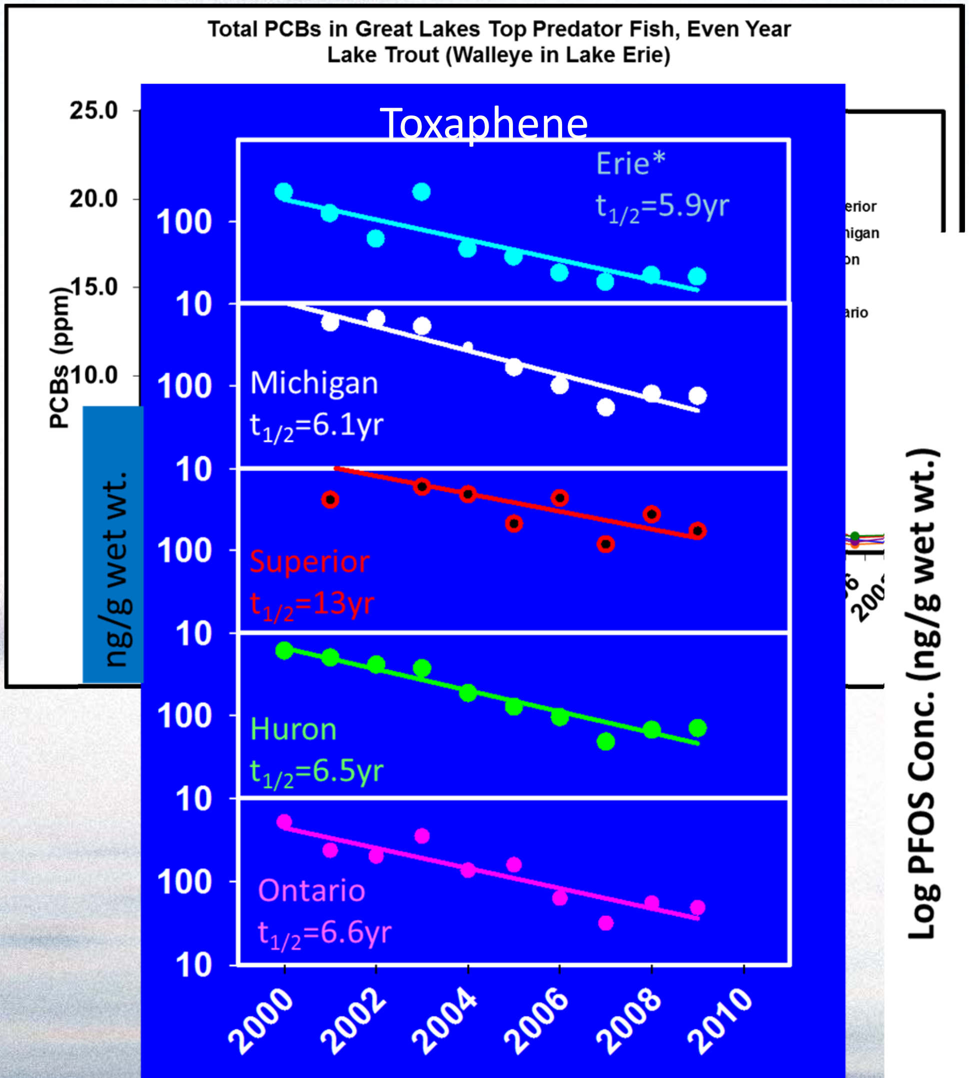
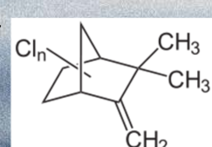
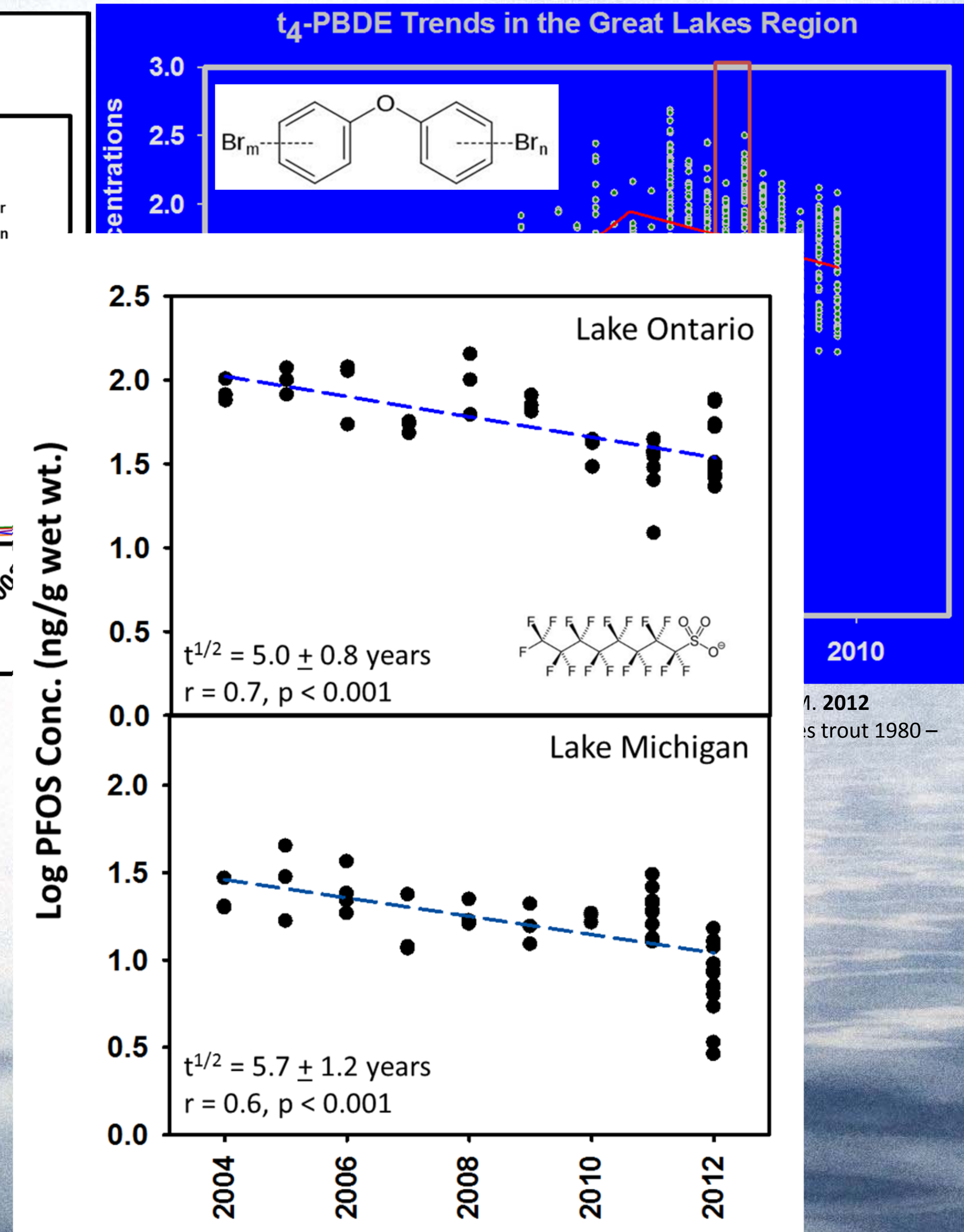
Contaminant Trends



Xia, X., Hopke, P.K., Crimmins, B.S., Pagano, J.J., Milligan, M.S., Holsen, T.M., **2012**. Toxaphene trends in the Great Lakes fish. *Journal of Great Lakes Research*, 38:31-38.





M. **2012**

s trout 1980 –

Emerging Concerns of Legacy Contaminants (ECLCTs)

Open Lake Trends Monitoring – legacy

- Monitor contaminant trends in the open waters of the Great Lakes using whole fish (trout and walleye)
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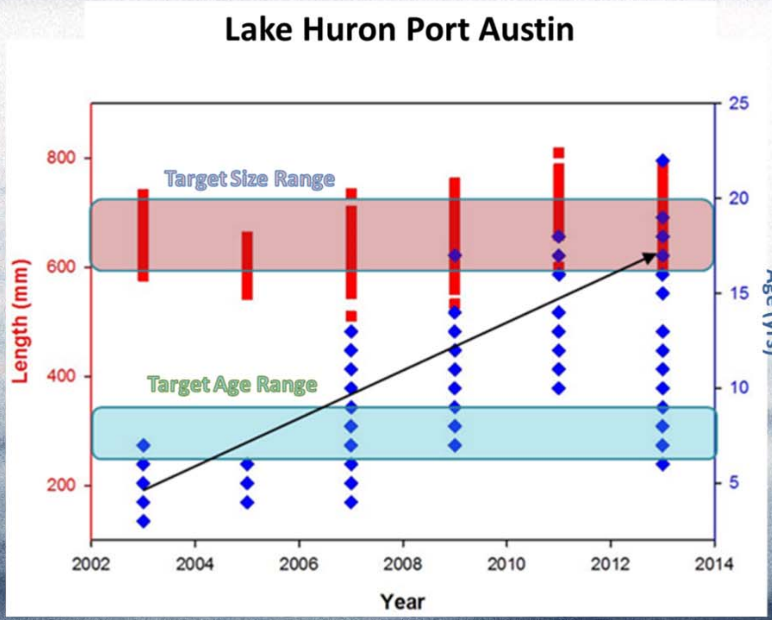
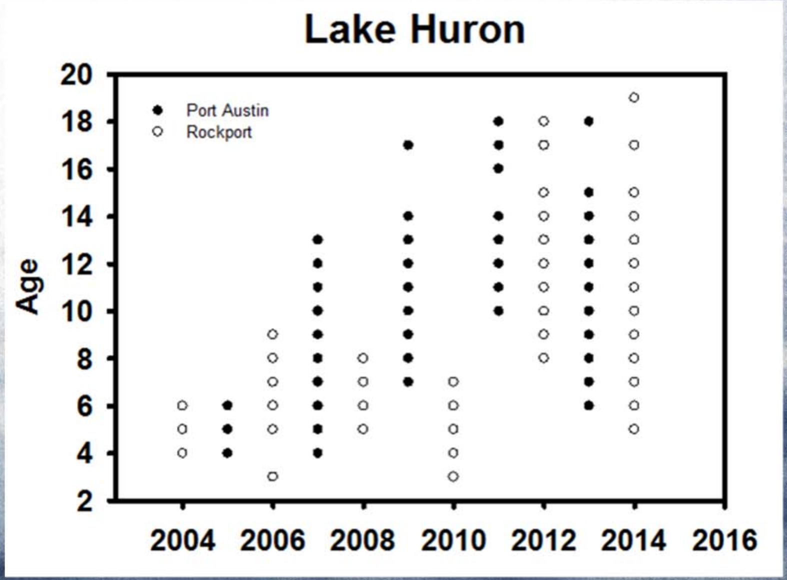
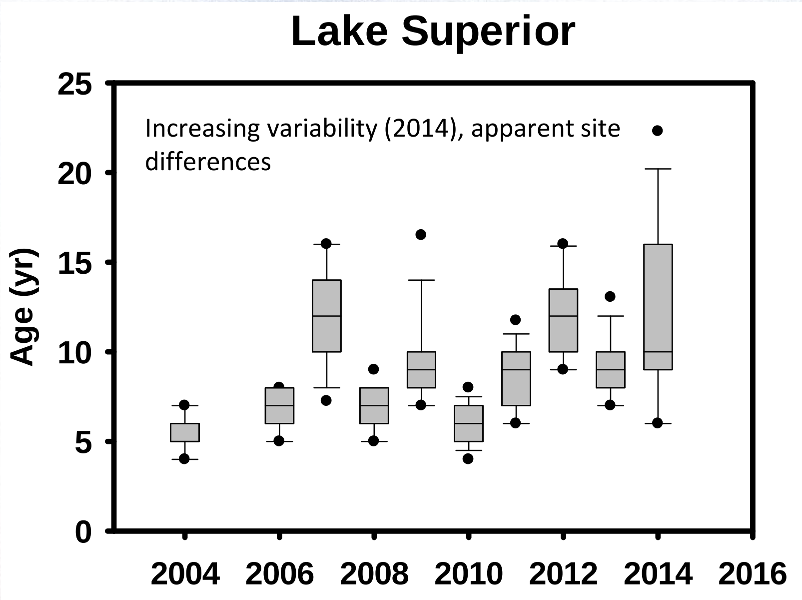
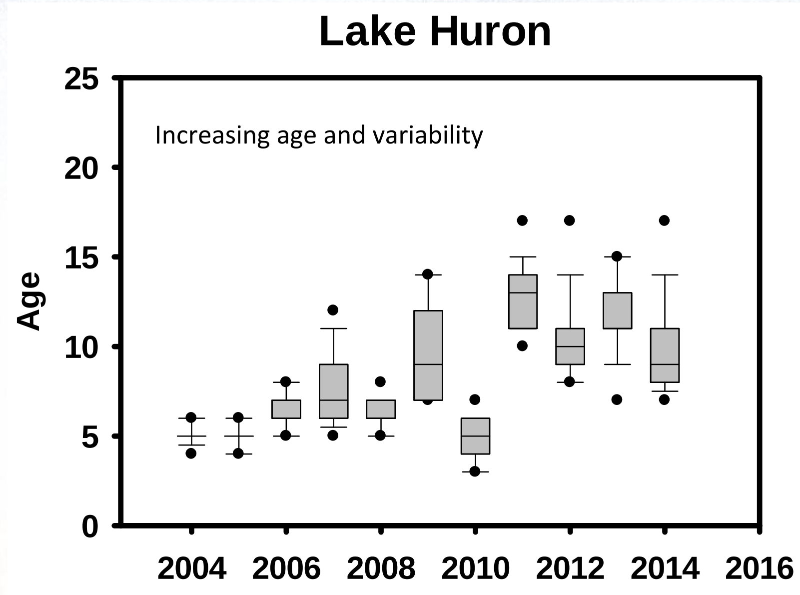
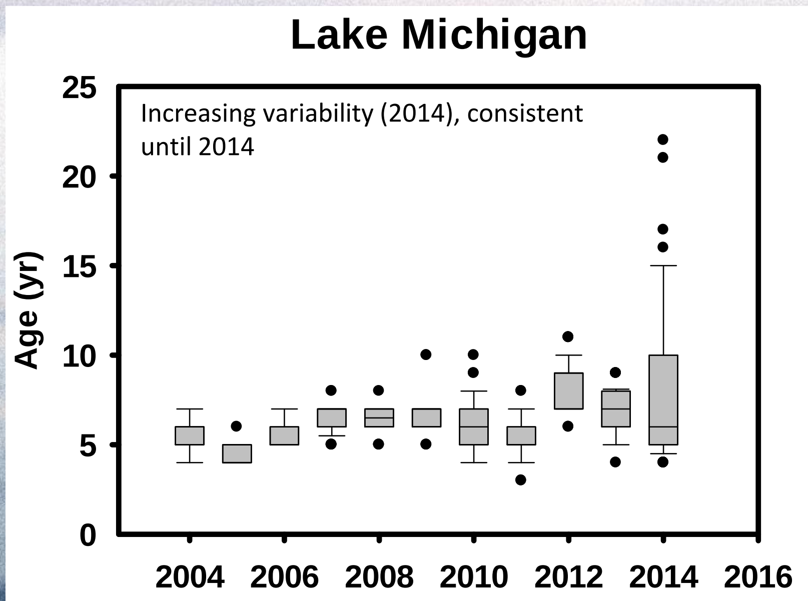


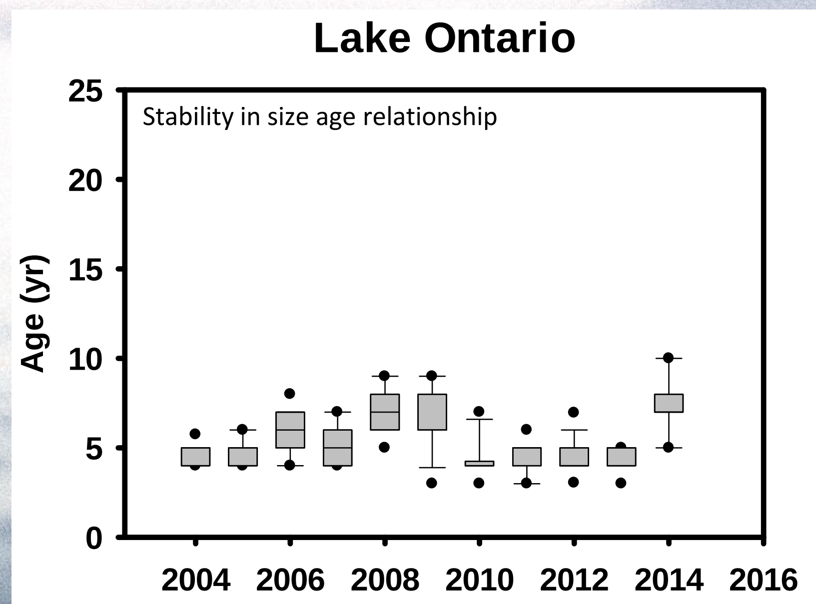


Trout Size/Age Variability



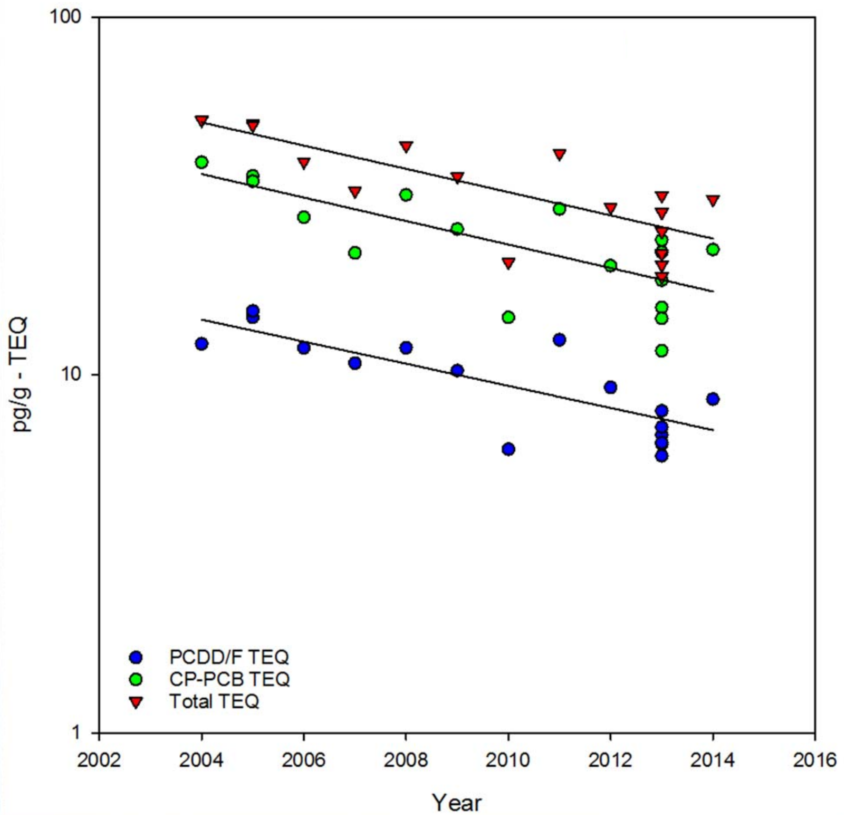


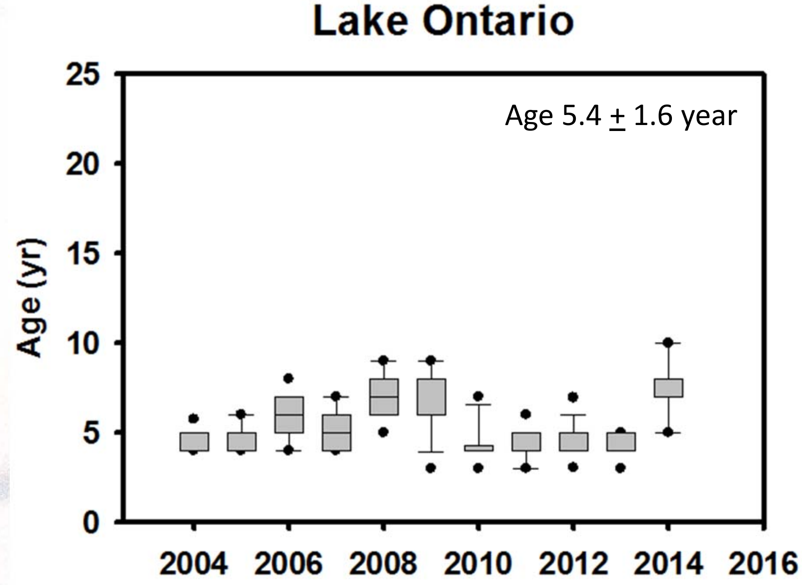




Concentration trends valid when temporal age structure is conserved (apples to apples)

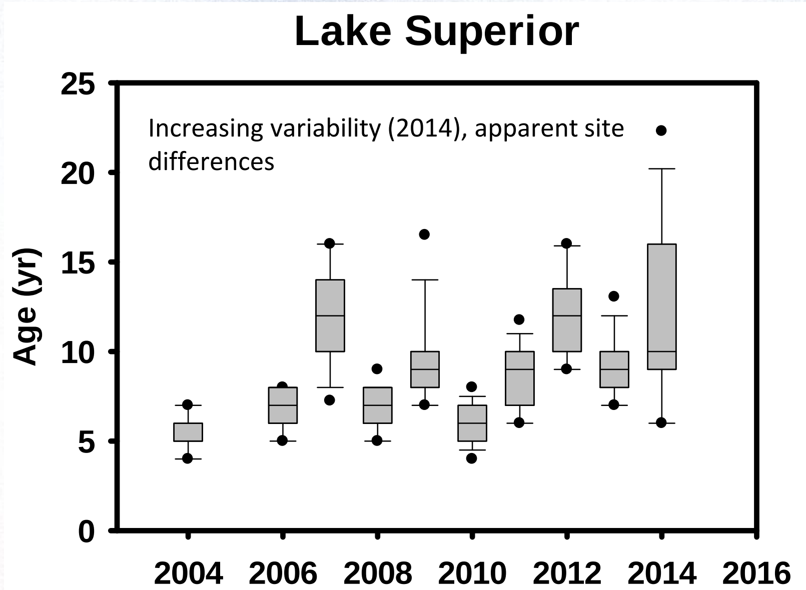
Trout PCDD/F and Co-PCBs

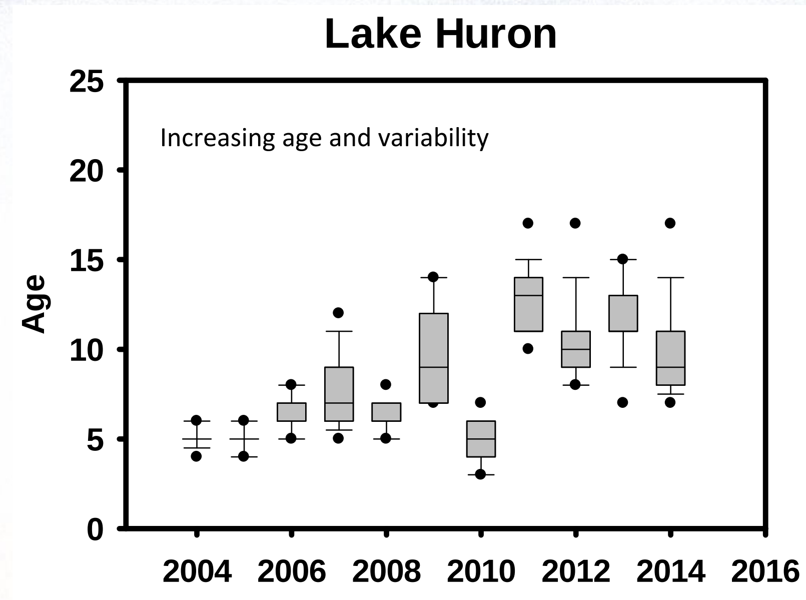




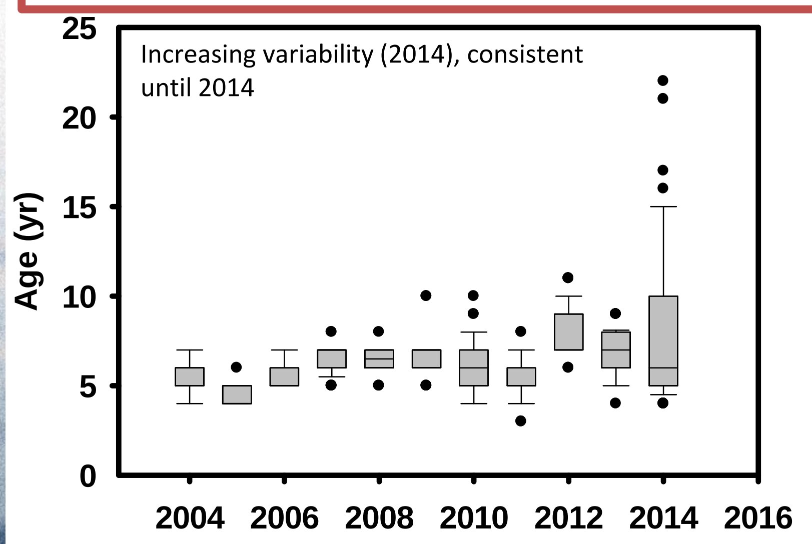
Declining PCDD/F and Co-planar PCBs concentrations in Lake Ontario

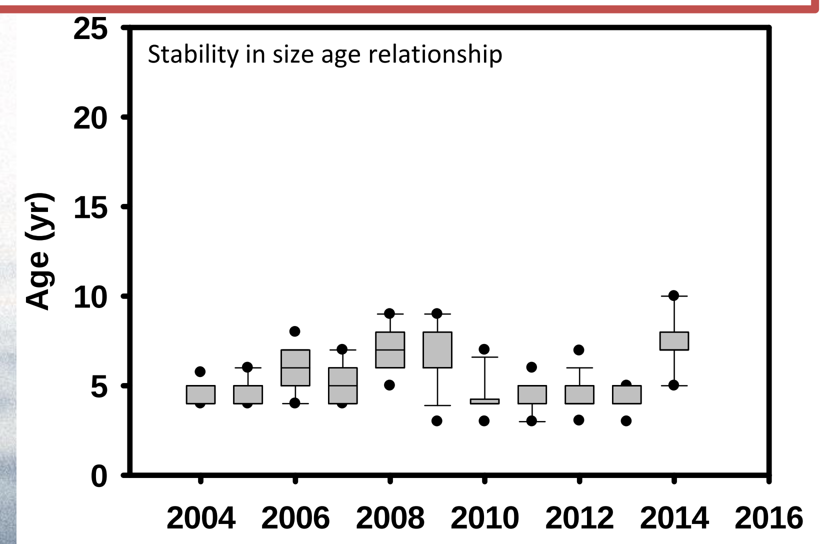
Trout Size/Age Variability





What if the age/size relationship is not stable?





Age Adjusted Concentrations

Develop yearly concentration/age regressions

Conditions:

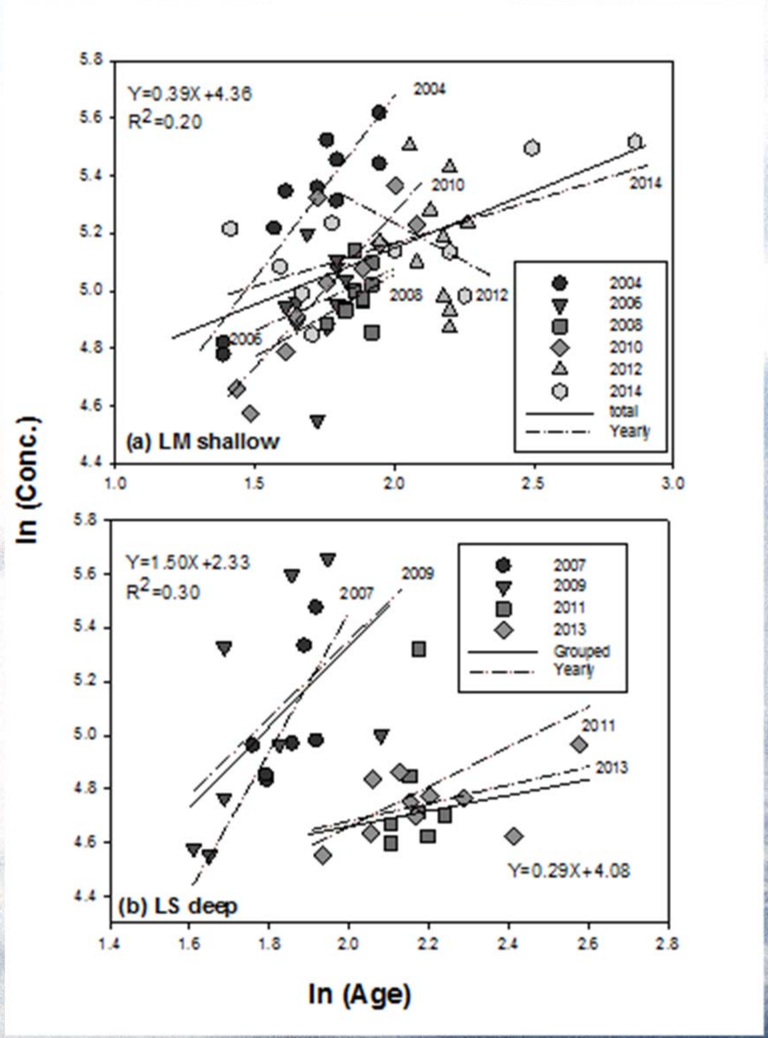
A) Scatter, no year specific relationship between dependence

B) Clustering, year specific conc/age relationships

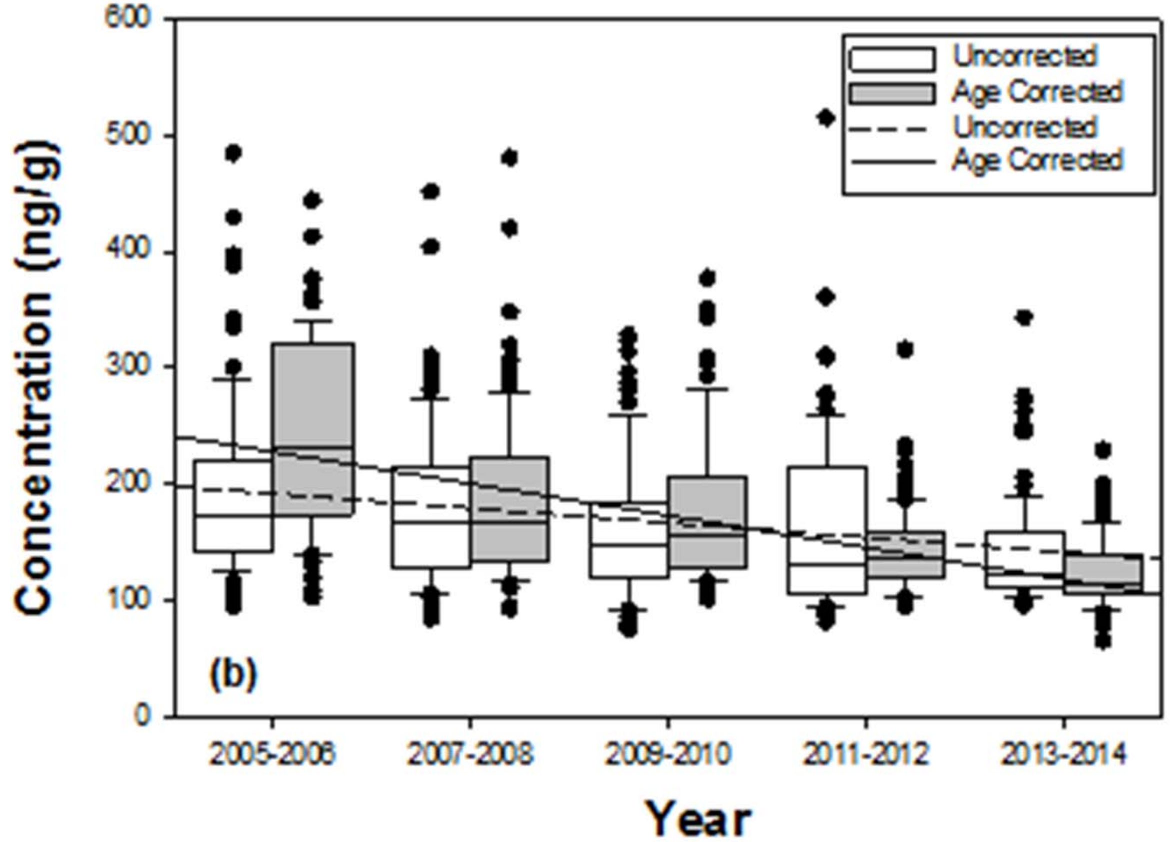
Adjustment:

Using regression results adjust measured concentrations to represent a 6.9 year old fish ($C_{6.9yr}$)

Hg Trends



Age Adjusted Concentrations indicate greater declines in Hg concentrations in Lake trout (apples to apples)



Great Lakes Fish Monitoring and Surveillance Program
Post 2010 - present

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Lake of the Year – Bioaccumulation and food web structure for each lake

Emerging Chemicals of Concern – Discovery of new PBTs

2015: Proteomics component added (Costel Darie, Clarkson University)

Lake of the Year Sampling

Lake of the Year

Top to bottom lake snapshot

Perform a detailed bioaccumulation study

- Water (dissolved and particulate)
- Phytoplankton
- Zooplankton
- Mussels
- Benthic macro invertebrates
- Forage fish
- Lake trout - Individuals

Lake Superior in 2011
Lake Huron in 2012
Lake Ontario in 2013
Lake Erie in 2014
Lake Michigan 2015

Pushing the Science

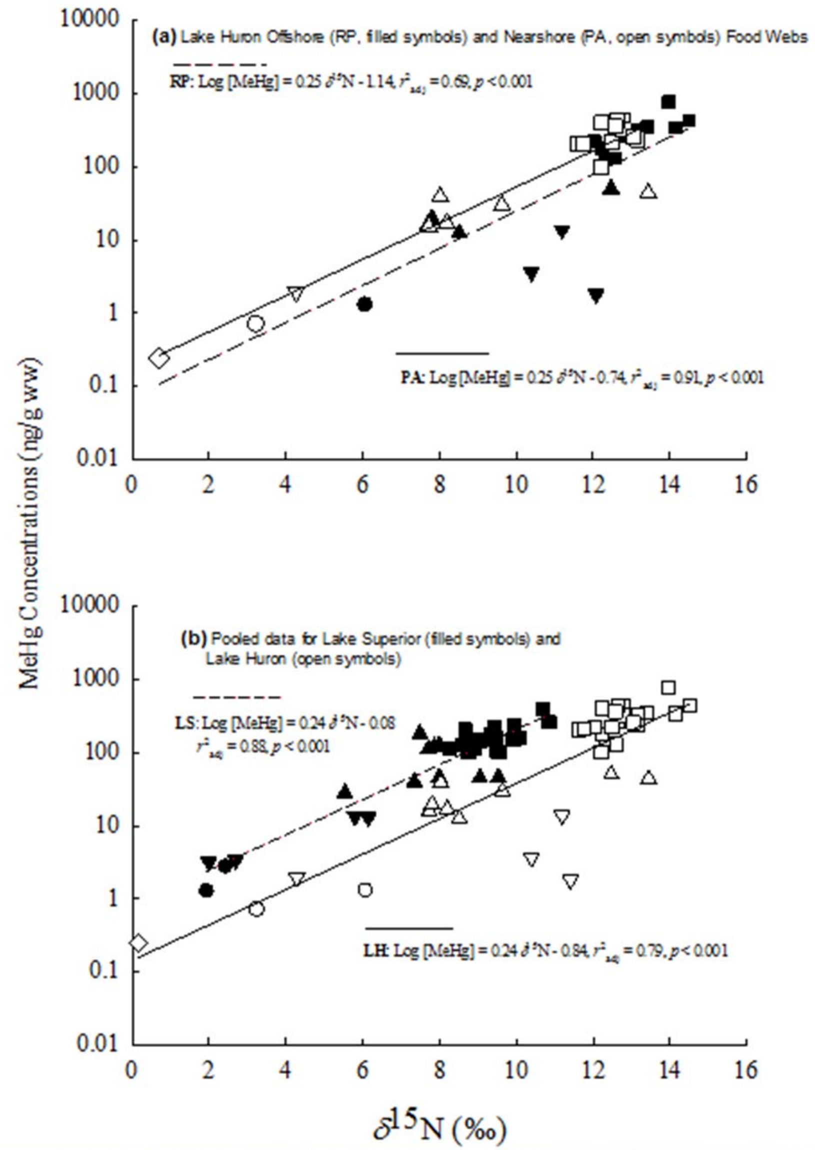
Bioaccumulation of Hg in Lakes Huron (top) and Superior (bottom).

Omara et al 2015 JGLR

Similar bioaccumulation rates

Pending food web manuscripts

- ❖ Fatty acids, Isotopes
- ❖ PFAS Bioaccumulation

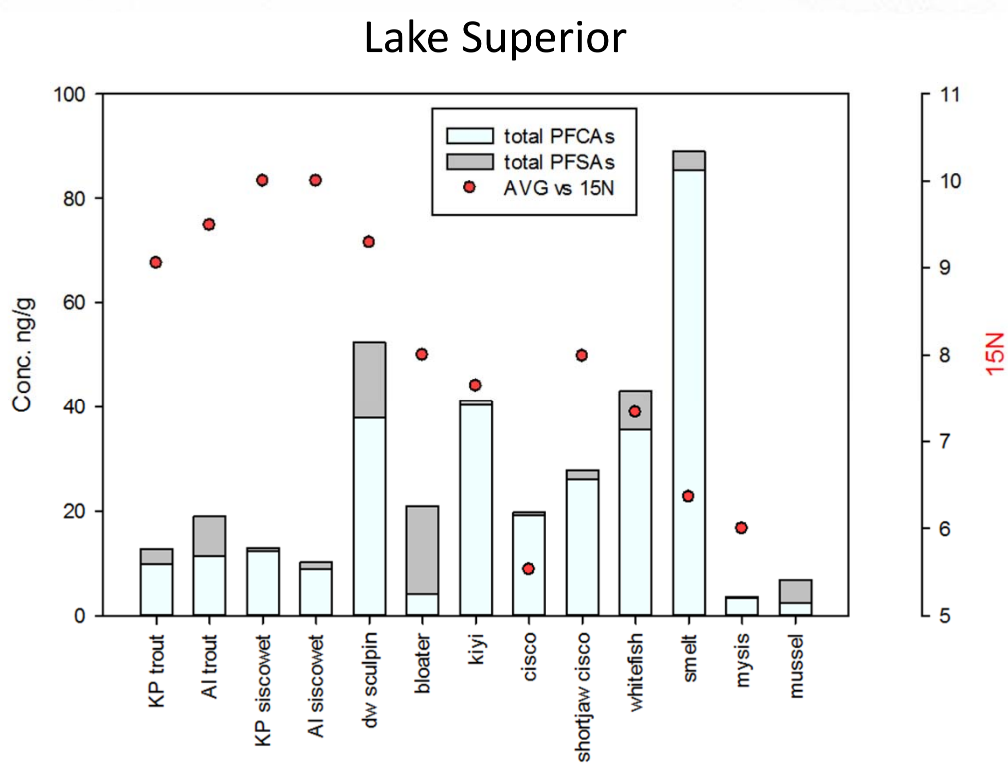


Bioaccumulation of Hg in Lakes Huron (top) and Superior (bottom).

Similar bioaccumulation rates

Pending food web manuscripts

- ❖ Fatty acids, Isotopes
- ❖ PFAA Bioaccumulation
    - ❖ Not as straight forward



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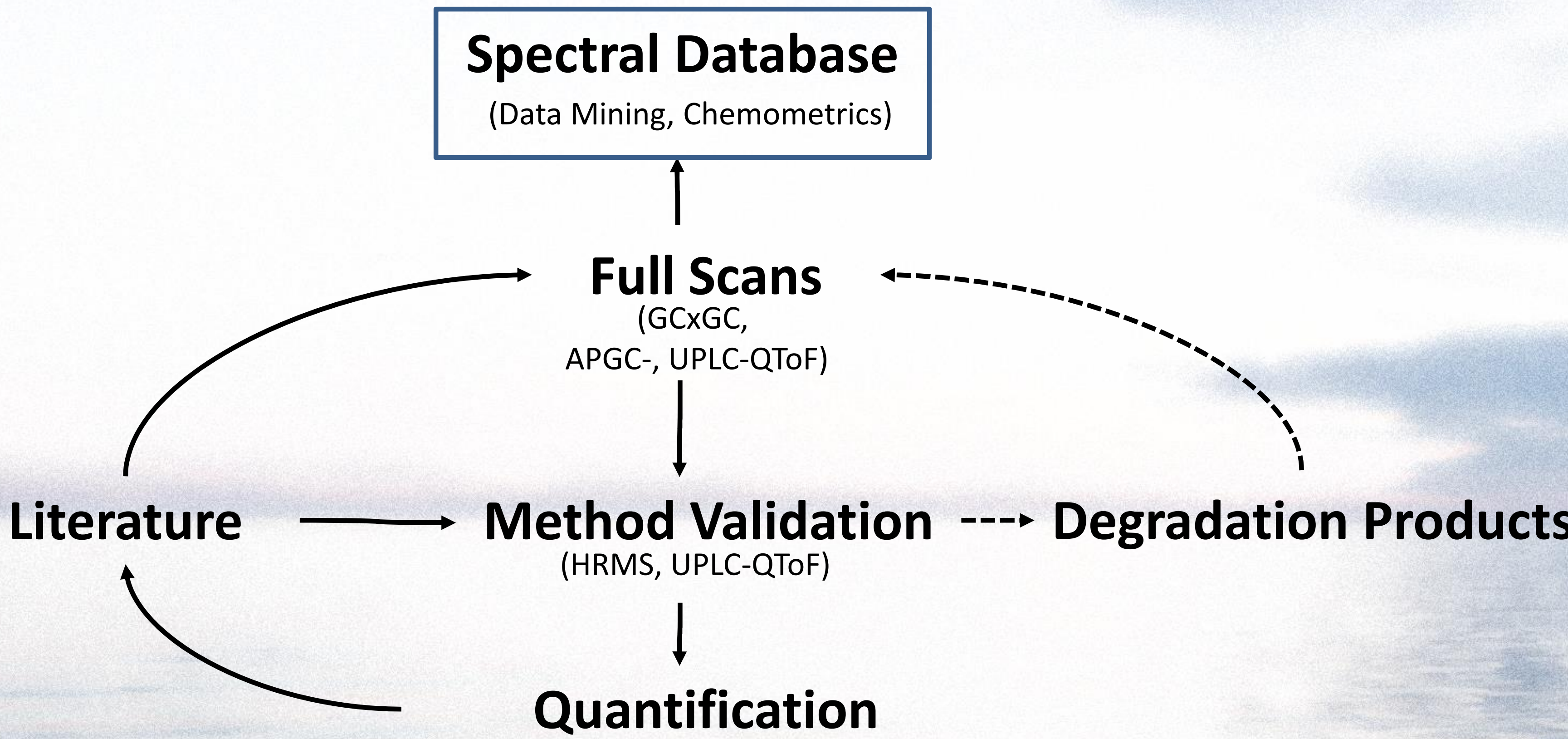
Lake of the Year – Contemporary bioaccumulation and food web structure for each lake

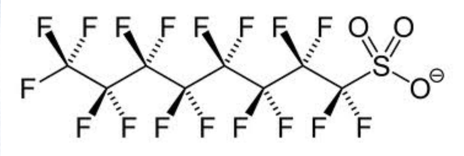
Emerging Chemicals of Concern – Discovery via GCxGC-MS, HRMS data

2015: Proteomics component added (Costel Darie, Clarkson University)

Emerging Contaminant Discovery



Targeted Analysis



A targeted/non-targeted screening method for perfluoroalkyl carboxylic acids and sulfonates in whole fish using quadrupole time of flight mass spectrometry and Ms^{e}; Crimmins et al., 2014 *Analytical and Bioanalytical Chemistry* (2014) 406:1471-1480.

Quantitative method for PFAAs using an UPLC – QToF

- Reversed phase chromatographic separation
- Suite of labeled ^{13}C standards added to each sample
- High sensitivity
- Exact mass (<5ppm error)
- Full scan data (100-1000 m/z)
- Low and high energy channels (indiscriminant precursor/product spectra)

Perfect for identification and qualification of unknown species

And… Lets Automate the Screening!

Screening Lake Michigan Lake Trout for Perfluorinated and Polyfluorinated Compounds Using UPLC-QToF in MS^{e} Mode with a Search Algorithm. *Fakouri Baygi, et al, ES&T, in revision*

Candidate list – $C_cO_oF_fCl_{cl}H_hS_s$ (c 4-10, o 2-3, saturated, no rings, n=3750)

Generate theoretical spectra for the candidates (Yergey et al., 1983)

MassWolf used to convert data files to Matlab readable format
mzXML (Tasman et al., 2009)

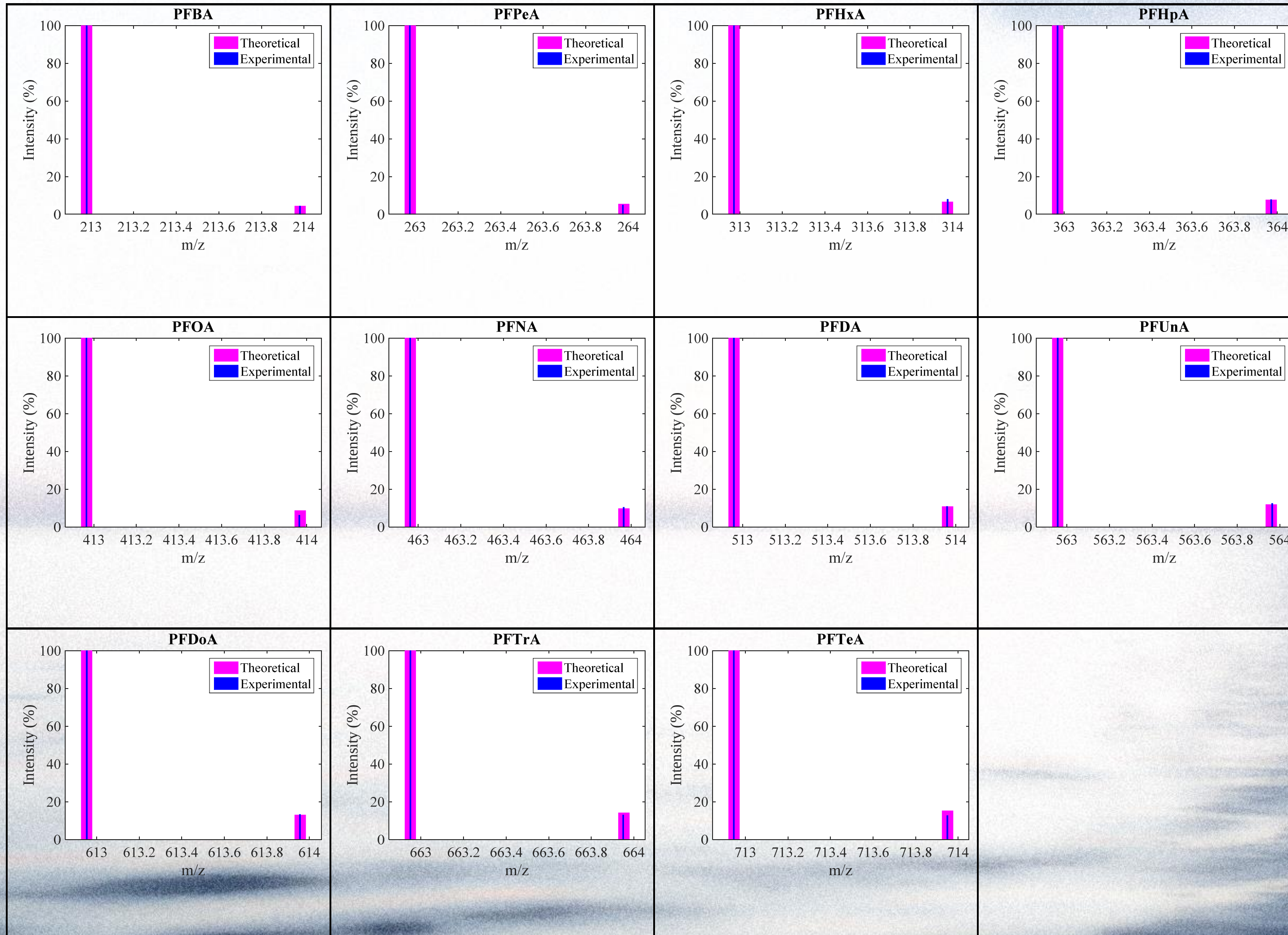
Identify m/z clusters consistent with the candidate list (< 5ppm and 5% intensity error)

Candidate Qualification

- Δ Extraction and injection replicate reproducibility (0.1 min)
- Δ Supporting fragments (i.e. PFAA fragments $[M\text{-}CO_2]^-$)
- Δ RT vs. log K_{ow} of proposed structure (SMILES).

Tasman, N.; Philosof, R. S.; Tchekhovskoi, D. *MassWolf*, 4. 3. 1; 2009
Yergey, J. A., A general approach to calculating isotopic distributions for mass spectrometry. *International Journal of Mass Spectrometry and Ion Physics* **1983,** *52* (2–3), 337-349

Calibrating the Model



PFCA Standard Solution

Novel F-Alkyl Compound Molecular Formulas Observed in Lake Trout

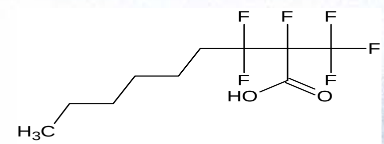
Processing

1. 2008 Lake Michigan, whole lake trout homogenate
2. ACN:MeOH, 0.1% NaOH extraction
3. Activated carbon clean-up
4. UPLC-QToF analysis

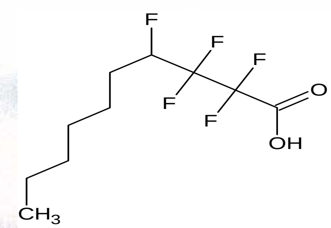
Molecular Formulas Observed

Formula	**n**
$\mathbf{C_nFH_{2n-1}O_2}$	**5-10**
$\mathbf{C_nF_3H_{2n-3}O_2}$	**4 -10**
$\mathbf{C_nF_4H_{2n-4}O_2}$	**9,10**
$\mathbf{C_nF_5H_{2n-5}O_2}$	**10**
$\mathbf{C_nF_6H_{2n-6}O_2}$	**9,10**
$\mathbf{C_nFH_{2n-1}O_3}$	**5-10**
$\mathbf{C_nF_3H_{2n-3}O_3}$	**6 -10**
$\mathbf{C_6F_2H_{11}SO_3}$	
$\mathbf{C_8F_8H_9SO_3}$	

Conformation Estimation

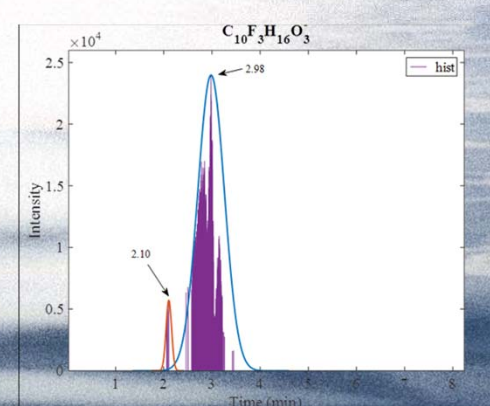


or



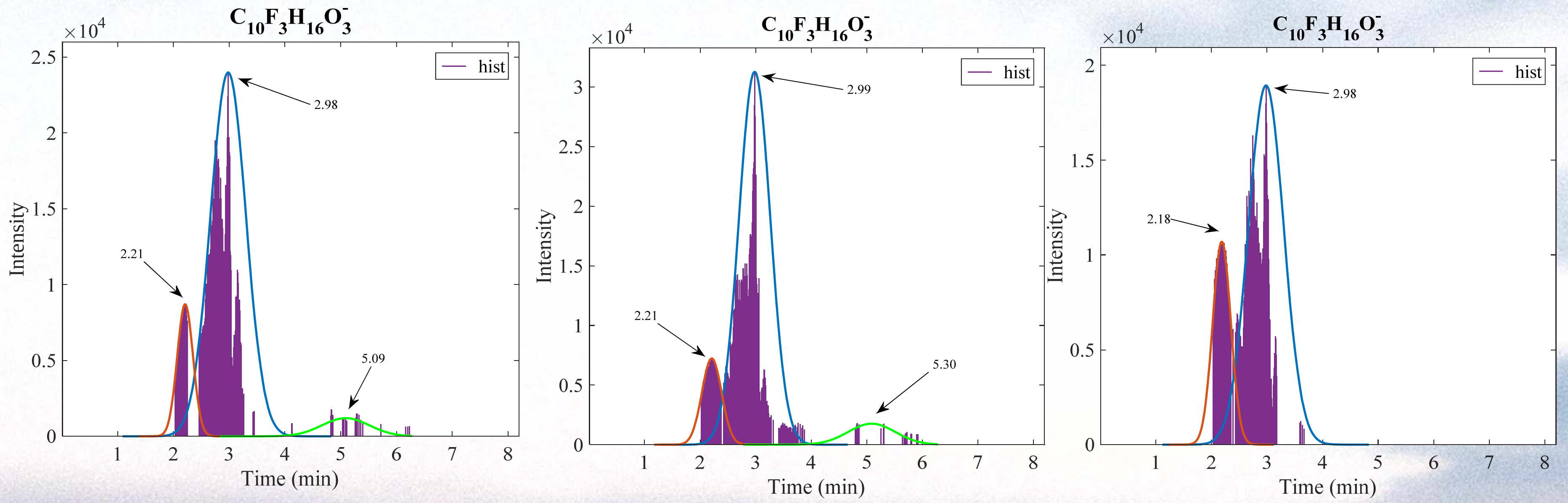
Selection Criteria

1. < 5ppm mass error
2. <5% relative intensity profile error
3. RT diff among triplicate extraction and triplicate injection <0.1min
4. For homologous series a positive relationship between K_{ow} and RT
5. [CO2] fragment for majority of carboxylic acids

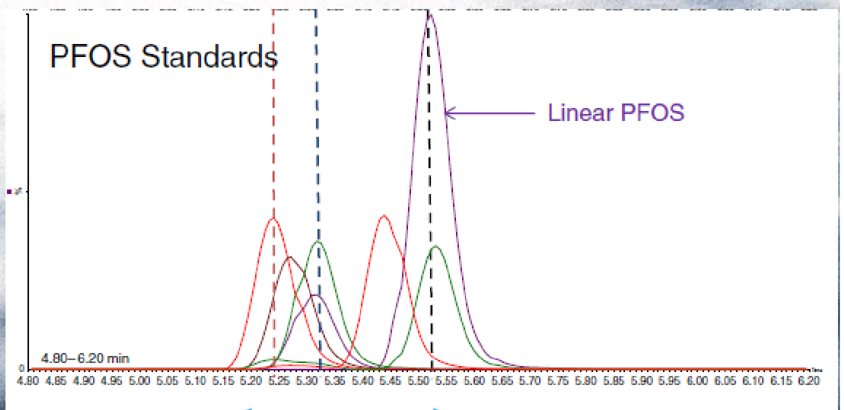


Reconstructed chromatogram

Reproducible RT and Profiles

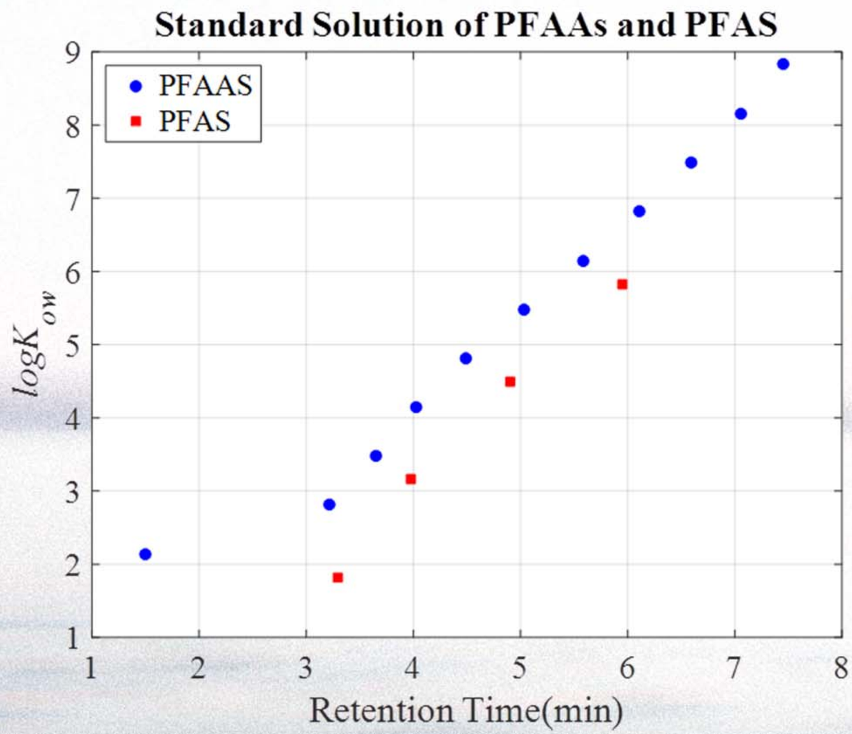


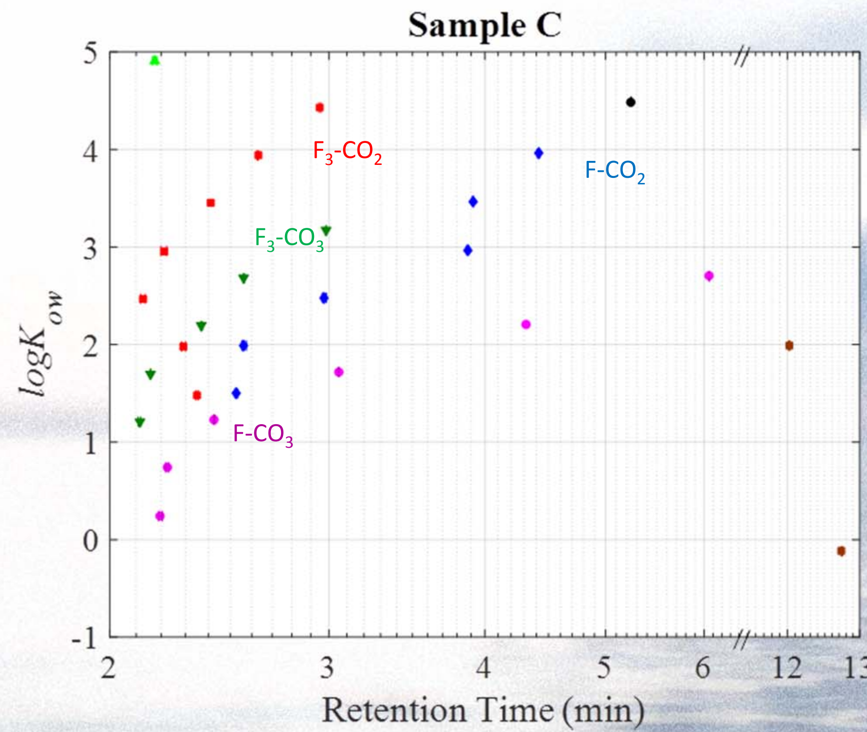
- Present in triplicate extractions (not spurious spectral peaks)
- Profile conserved
- Relative intensity profile may represent branched (2.21 min) and linear (2.98 min) isomers



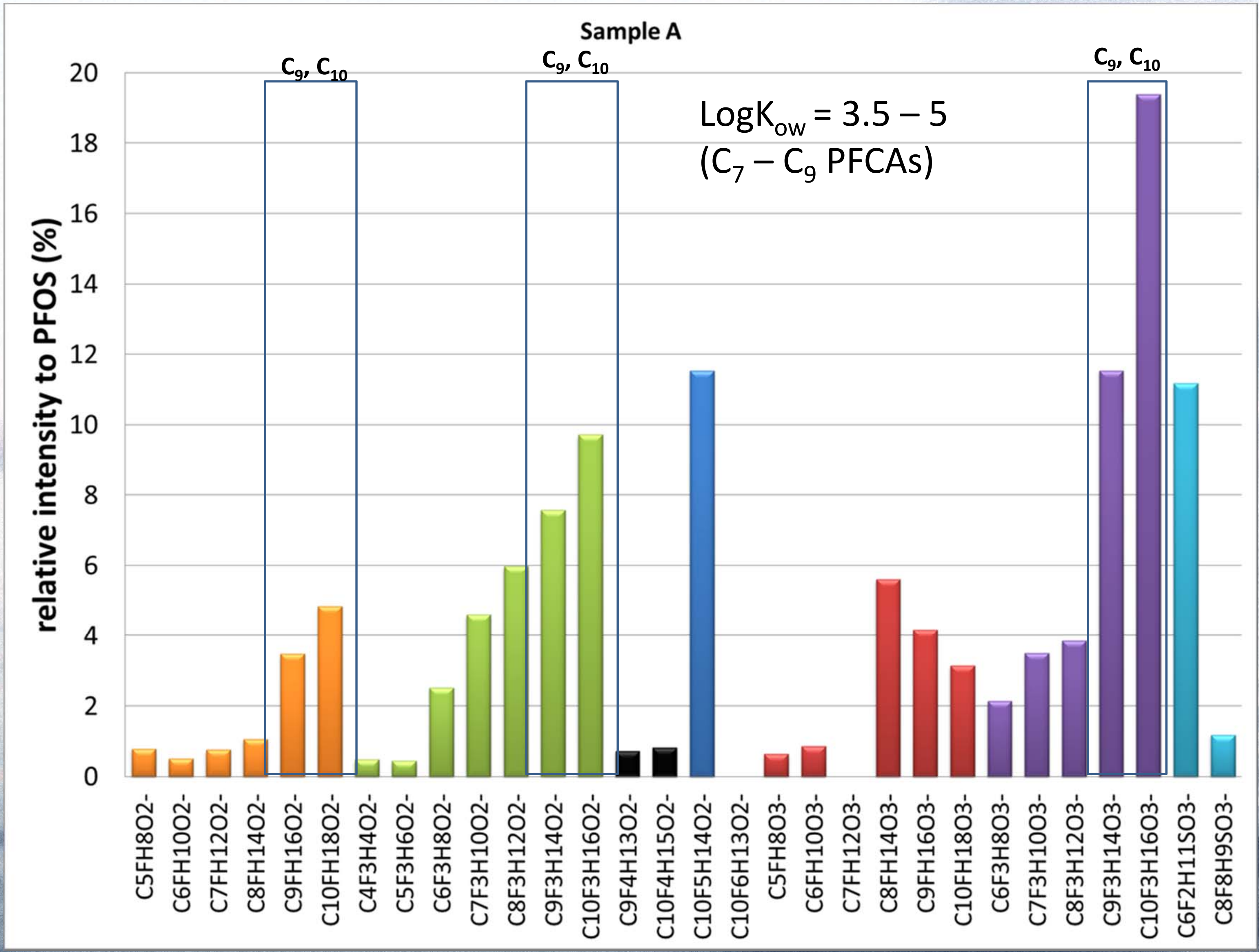
Crimmins et al 2014

Positive Log K_{ow}, RT Relationship Within Classes





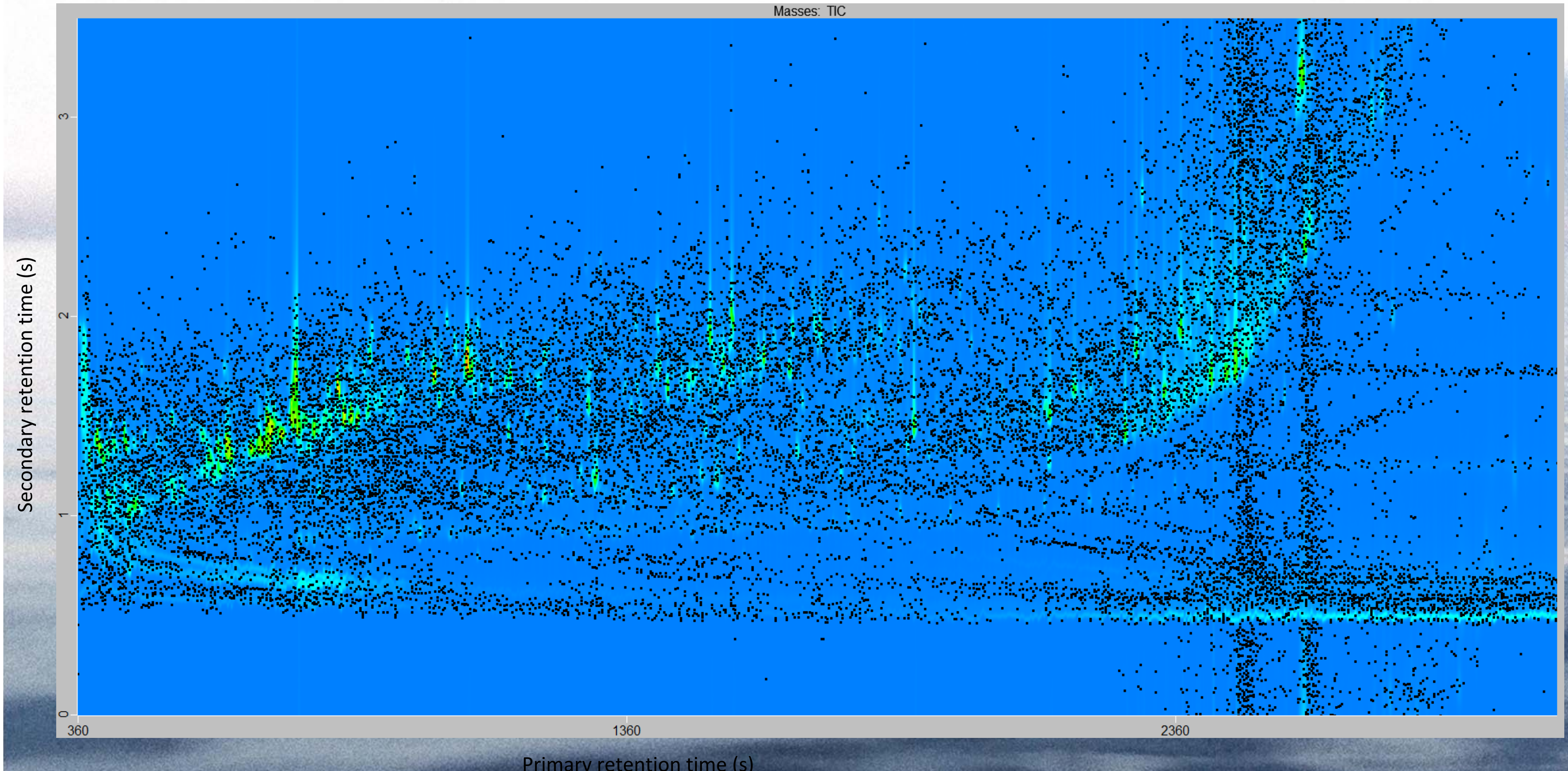
Abundance Relative to PFOS



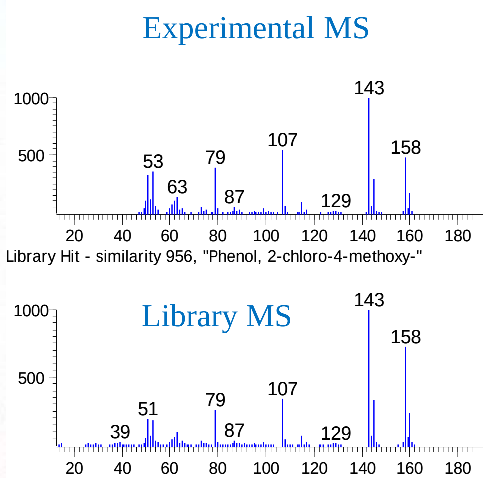
Script Applications

- High Resolution Data
- MATLAB
- Vendor Specific Converter (ms-utils.com)
- Modify candidate matrix (include fragments)
- Adapt modules to search for different classes of compounds
- Any chromatographic interface (GC, LC)
- Able to identify candidates quickly (3750 compounds searched in minutes)

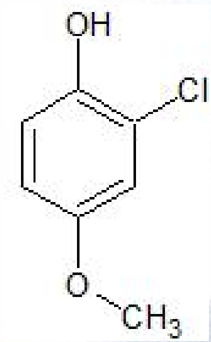
- GCxGC-TOF (LECO Pegasus 4D) scan analysis
  - Comprehensive 2-D chromatography: enhanced chromatographic resolution
  - Time-of-flight (TOF) MS: high scan rate (200 s^{-1})/mass spectral deconvolution algorithm – very effective in separating mass spectra of overlapping peaks

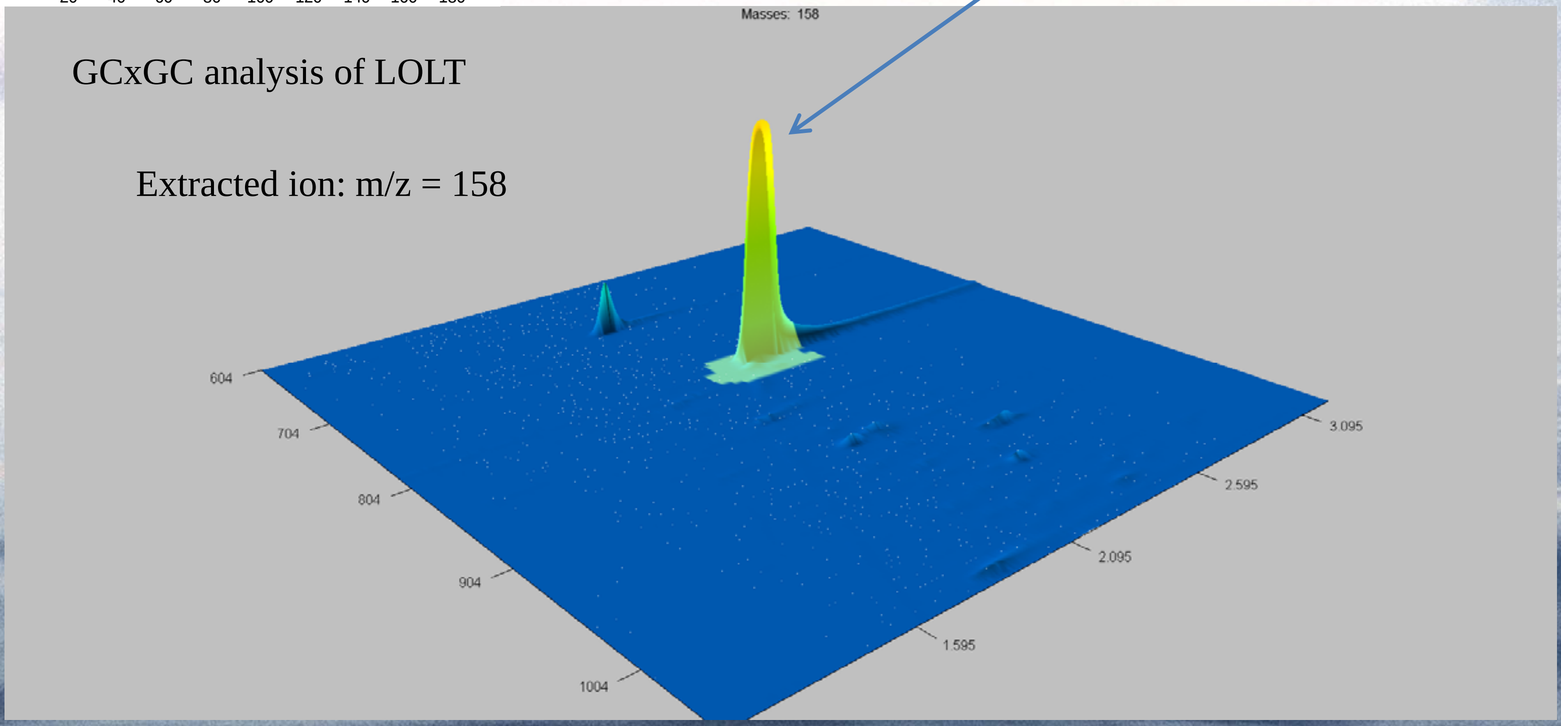


Novel Emerging Chemical Found in Trout



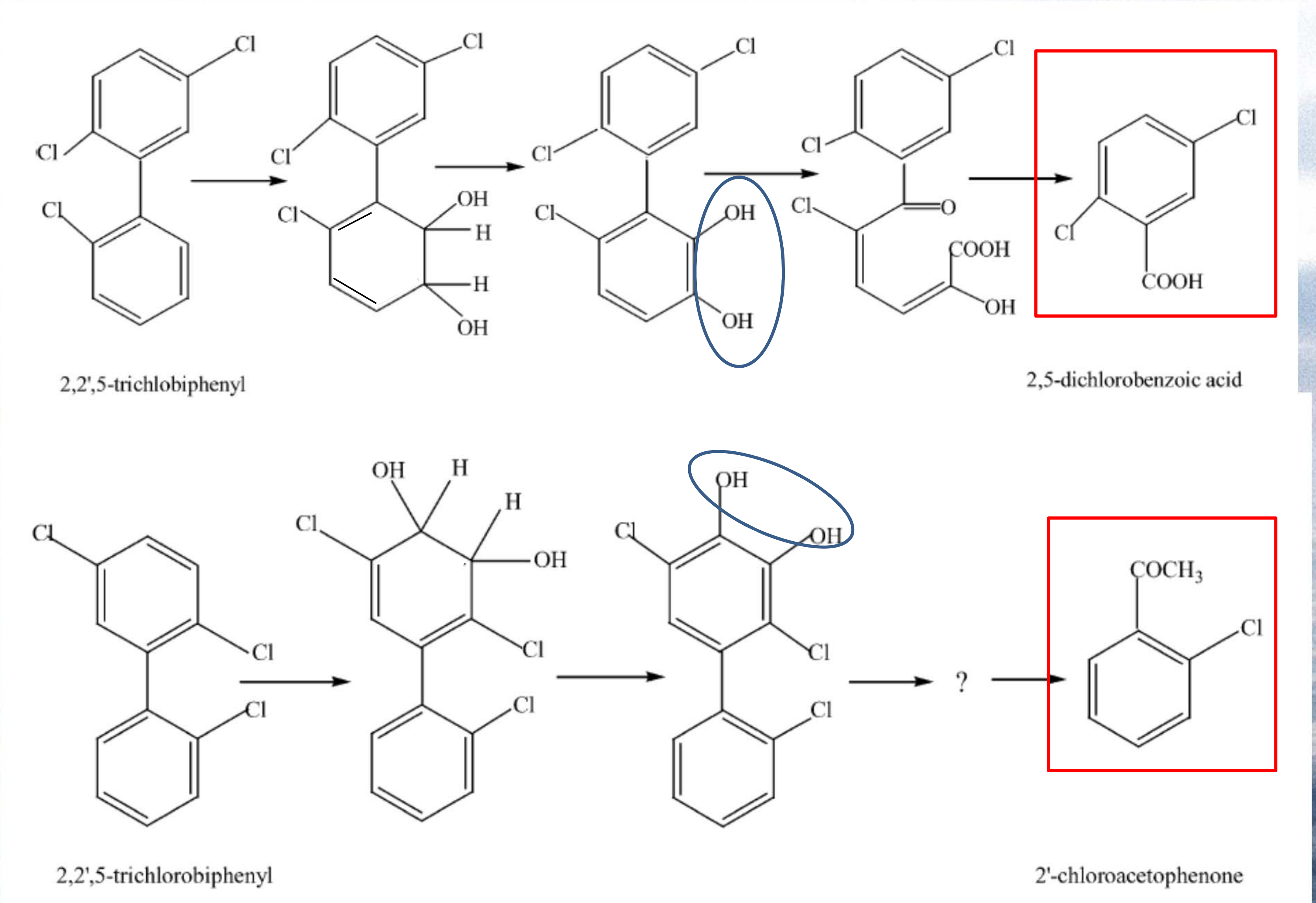
2-Chloro, 4-methoxy phenol: isomer confirmed with standard





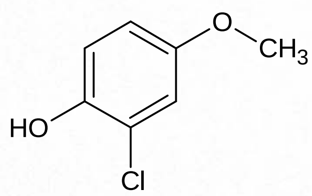
Proposed biodegradation pathways for PCBs

(Komancova et al., 2003)

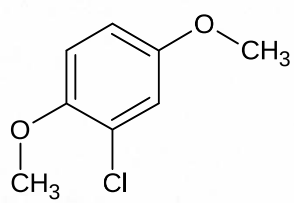


Chlorinated and Brominated Phenol Derivatives Observed in Trout

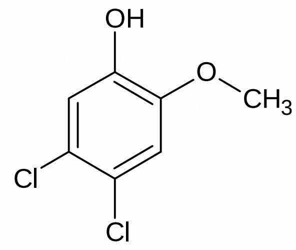
Chlorinated



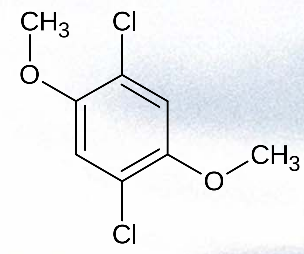
Chloromethoxyphenol



Chlorodimethoxybenzene

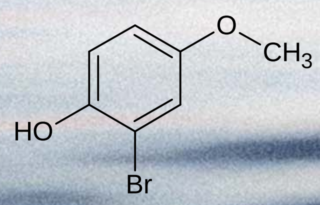


Dichloromethoxyphenol

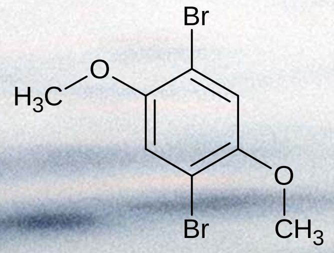


Dichlorodimethoxybenzene

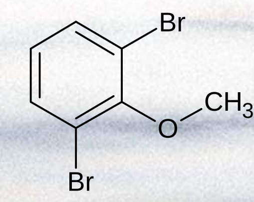
Brominated



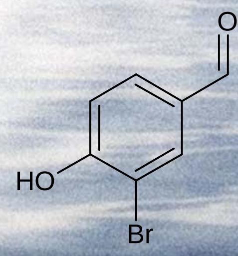
Bromomethoxyphenol



Dibromodimethoxybenzene



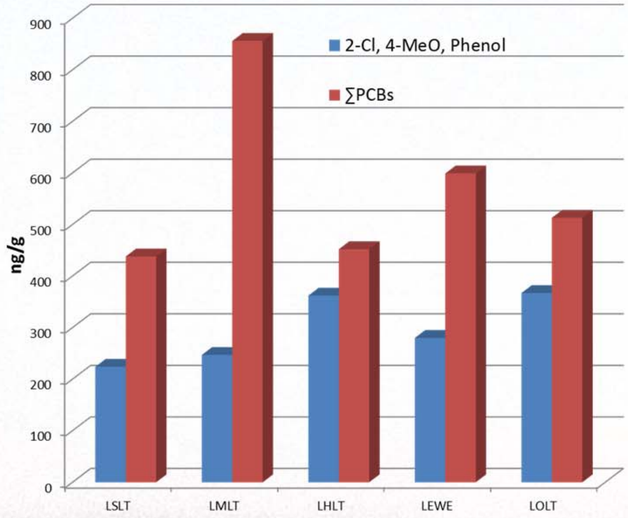
Dibromomethoxybenzene



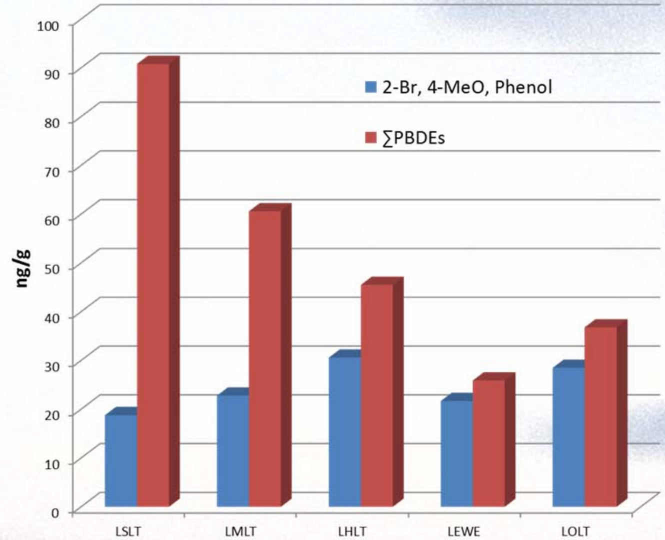
Bromohydroxybenzaldehyde

Spatial Distribution in the Great Lakes Region

Cl Derivative PCB Comparison

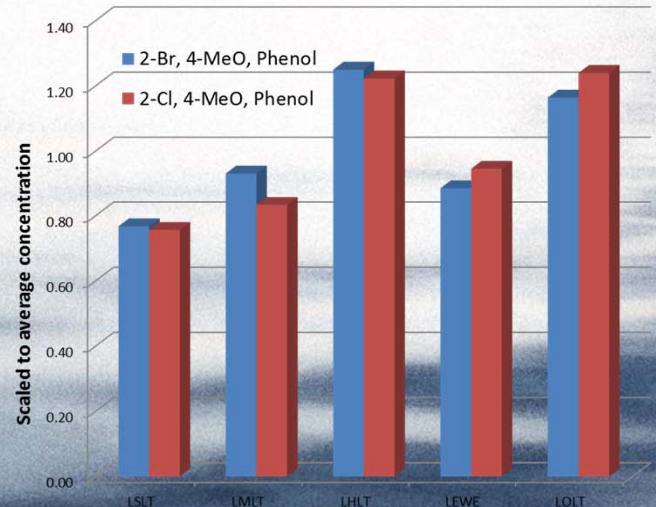


Br Derivative PBDE Comparison



- Cl and Br Derivatives same range as PCBs and PBDEs
- No observable trend with PCBs and PBDEs
- Derivatives similar levels within a lake

Cl and Br Derivative Comparison



Photochemical byproduct of TBBPA ?

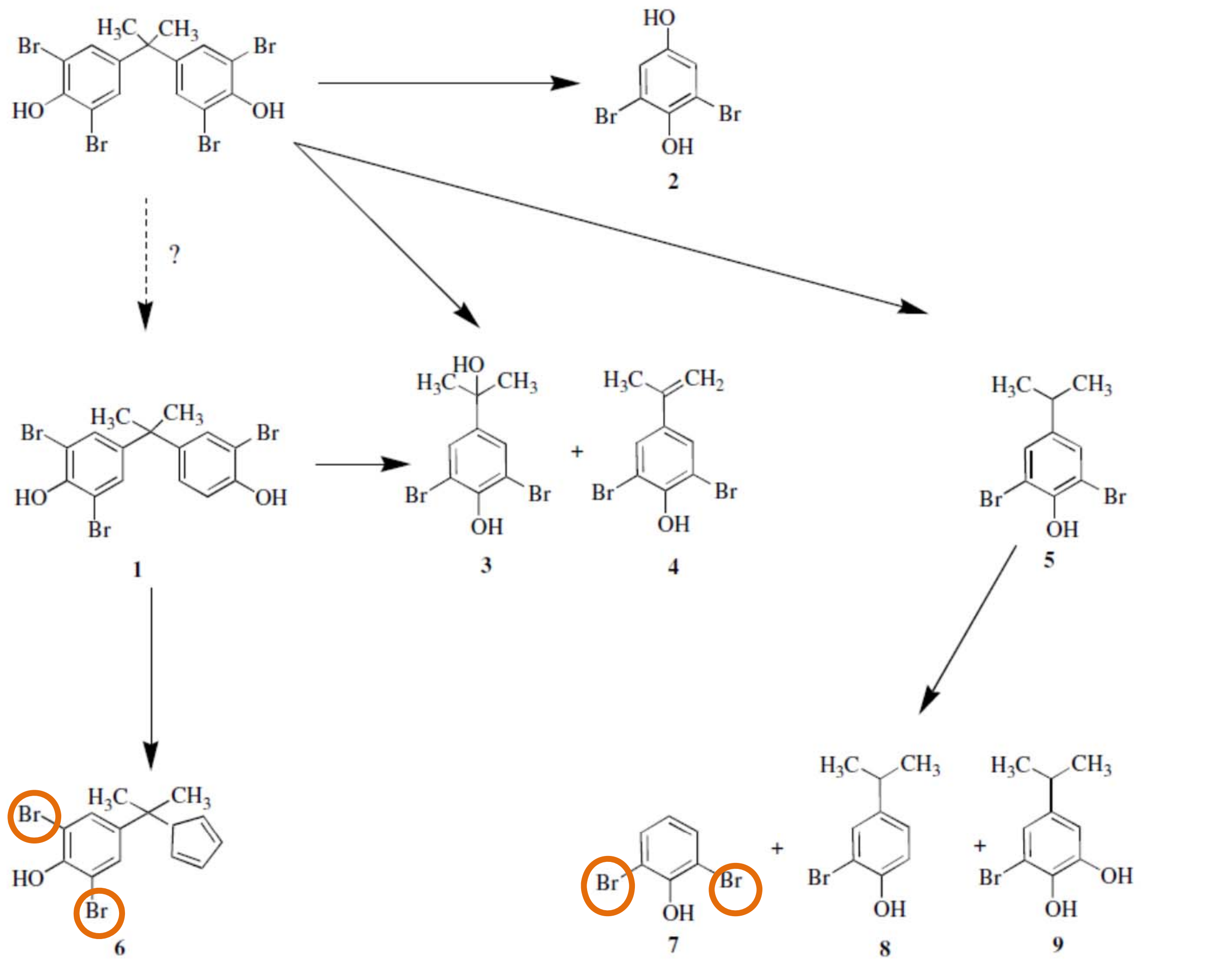


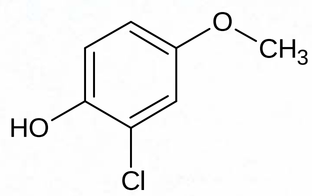
Fig. 5. Proposed degradation path for TBBPA.

Dibromomethoxybenzene

Eriksson et al., 2004 Photochemical transformations of tetrabromobisphenol A and related phenols in Water *Chemosphere*, 54, 117

Relative Abundances

2,4-chloromethoxy phenol



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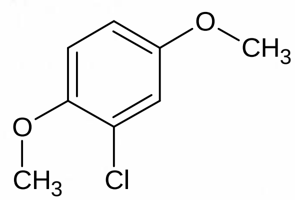
chlorodimethoxy phenol



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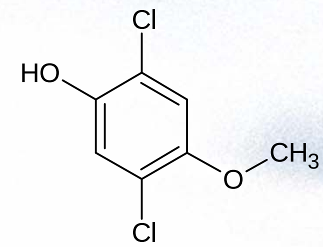
dichlorodimethoxy phenol



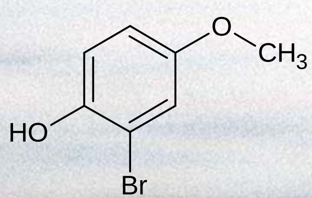
Relative pe
areas

Same Conformation, Source?

7

1

2,4-bromomethoxy phenol

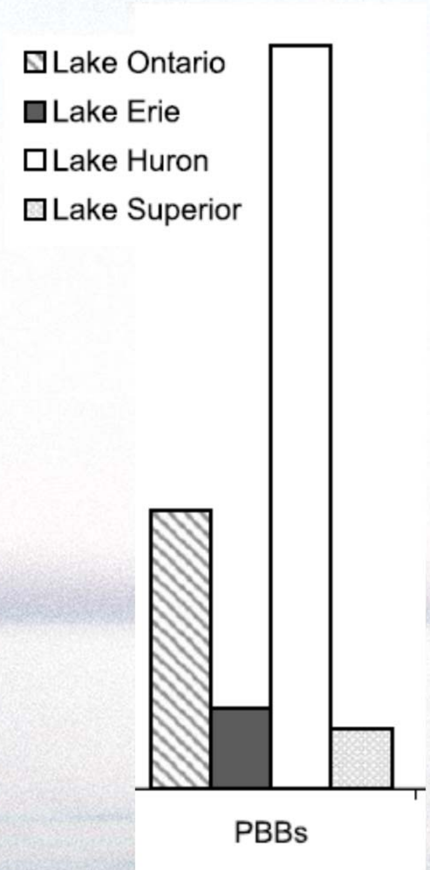


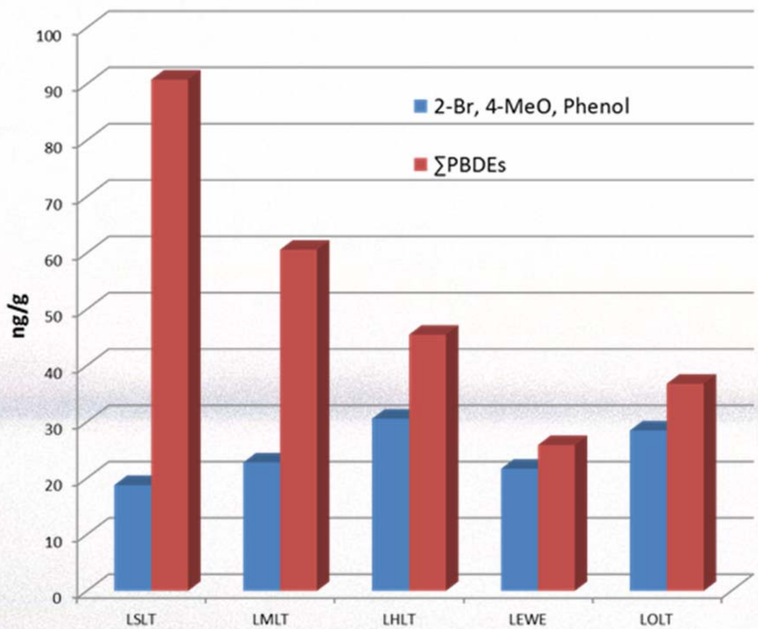
4

>>

Other suspected brominated degradation products

2,4-Bromomethoxy phenol a product of non-BDE brominated biphenyl?

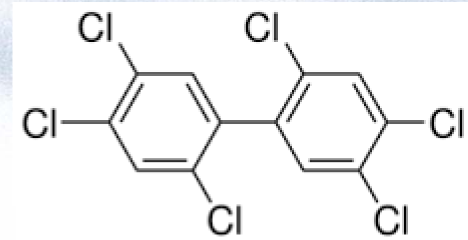




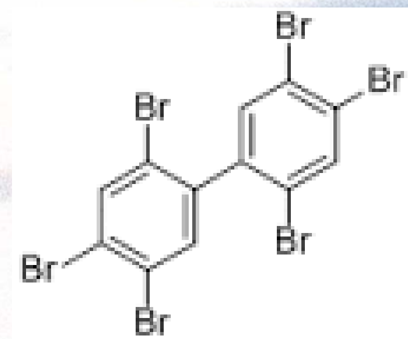
2001 Lake trout PBBs

J.M. Luross et al. / Chemosphere 46 (2002) 665–672

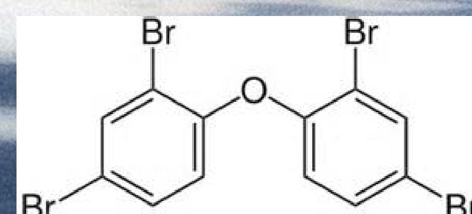
PCB 153



PBB 153



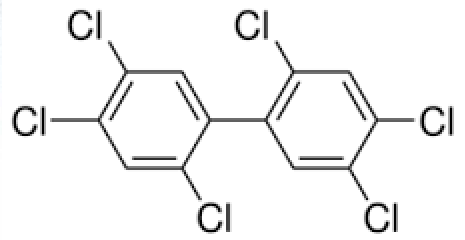
BDE 47



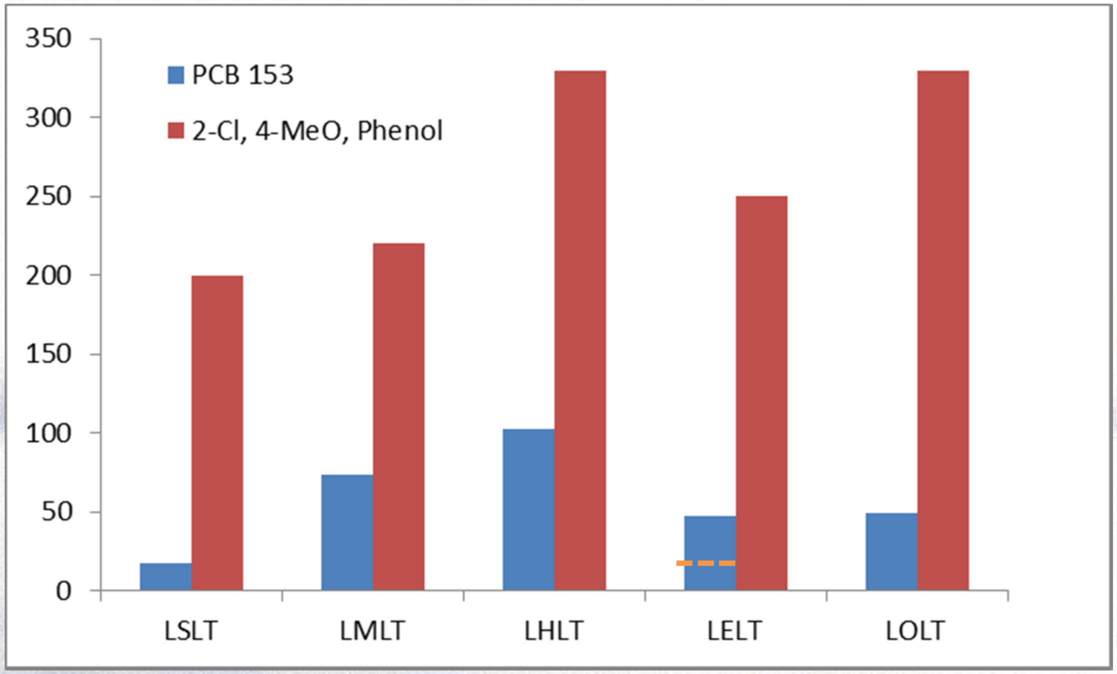
Historical PBB distribution better match (LH>LO>LE>LS)

Contemporary PBB data coming to confirm relationship

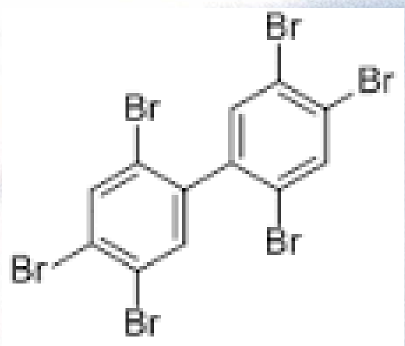
PCB 153



PCB 153 Spatial profile also a better match to Cl derivative

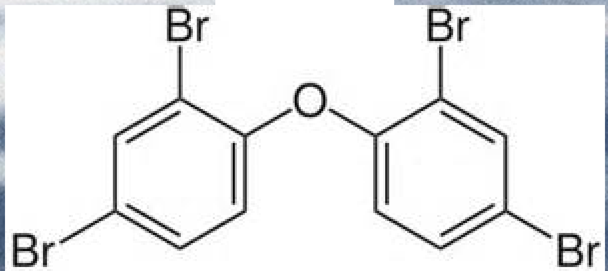


PBB 153

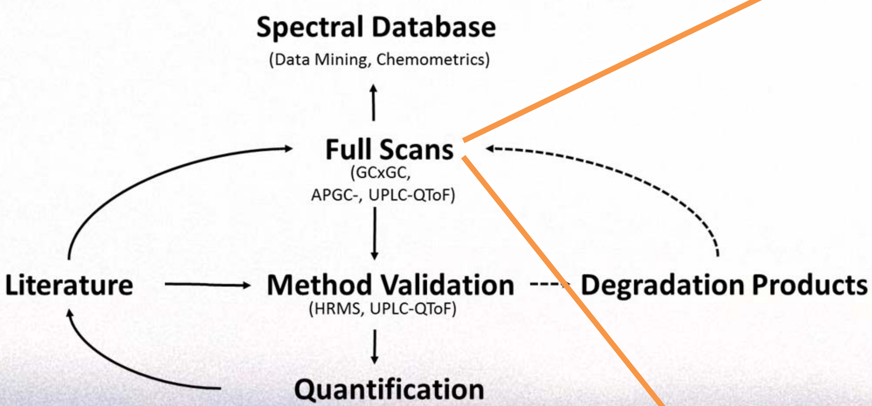


PCB LELT PCB compared to LEWE – PCB number biased high (typically 2x) ---

BDE 47



Improved Capabilities and Potential Services



New GCxGC-HRT

- GCxGC high resolution mass measurements
- Full scans performed with state-of-the-art instrumentation
- Set aside funds to perform fillet scans
  - GCxGC-HRT or UPLC-QToF
- Screening methodology being optimized
  - Sample prep
  - Column combinations
  - Search algorithms

Great Lakes Fish Monitoring and Surveillance Program: Emerging Chemical Update

Legacy chemicals still posing challenges as lake systems continue to change

- Homogeneous data sets for trend analysis
- Accurate age/size relationship (apples to apples)
- Accurate aging prior to homogenization (Maxillary)

Targeted/non-targeted hybrid methods proving productive for emerging chemicals

- Script searching archived data files (chemical fingerprint database)
- Universal application to HRMS data
- Comprehensive e-chemical screening

GCxGC finds prove significant in Great Lakes (ΣPCB levels)

GCxGC-HRT coming online to enhance surveillance and discovery of ECs

Questions?

Consortium 101 Questions/Discussion

June 9, 2016 Conference Call

- **Goals, purpose, process**
- Benefits
- Data analysis

Is this still seen as the goal of the protocols/addendum?

Mercury Addendum, Introduction, document page 5:

The Protocol was developed to promote consistency in the methods used by the Great Lakes States in issuing fish consumption advice. Consistency promotes public comprehension, acceptance and adherence to fish consumption advice.

March 2016 Consortium Meeting Notes

- **Goals/Purpose**
  - Consistent basis for advice - Shared protocols
  - Consistent advice (especially for shared waters)
    - Was charge from Great Lakes governors
    - Difference in administrative goals
  - Data sharing
  - Consistency is a "Vision"
  - Speak with one voice
  - Incorporate benefits of fish consumption into advice (example: fatty acids)
  - Risk/benefits quantitative framework

What fishing habits would be considered to merit ***differences*** *in protocol?*
What merits differences?

Mercury Addendum, Introduction, page 6

Fish consumption advisory program staff from state agencies in the Great Lakes basin developed this addendum. Prior to beginning development it was important to systematically characterize current advisory practices. The eight states adjoining the Great Lakes were surveyed to determine differences in current protocols to develop advice as of September 2004. Each of the eight Great Lakes States currently provides both site-specific and statewide consumption advice based on fish mercury content. Statewide advice in some states is based on other chemicals as well. Most of the Great Lakes states provide separate advice for the general and sensitive populations. Other protocol components vary between states such as meal advice categories used, significant figures, listing of site-specific versus statewide advice, and how fish tissue concentration data are analyzed. [1] While differences in protocols to develop advice exist, differences in species occurrence and mercury accumulation, and fishing habits and regulations may be valid reasons for fish consumption advice to vary between states. Results from the survey are reported in Appendix B.

Why was there a decision to make categorical divisions rather than more of a "sliding scale" approach?
Why these, why not more?

PCB Protocol, page 13

- Unrestricted Consumption
- One Meal a Week (52 meals/year)
- One Meal a Month (12 meals/year)
- One Meal every 2 Months (6 meals/year)
- No Consumption (Do Not Eat)

How was this decided?

PCB Protocol, page 57:

Uniform Tissue Sample

A raw, skin-on, fillet will be the primary sample to be analyzed for contaminants. The fish should be scaled, then filleted so as to include all flesh from the back of the head to the tail and from the top of the back down to and including the belly flap area of the fish. Remove all fins, the tail, head, viscera, and major bones (backbone and ribs). The only exceptions to this sample type would be as follows: the skin will be removed from black bullhead, brown bullhead, yellow bullhead, channel catfish, flathead catfish and burbot, but still remain untrimmed. Sturgeon would be analyzed as a skin-off cross section (steak). Smelt should be gutted and the head removed. Whole fish samples should never be used for the purpose of issuing consumption advisories.

What was/is the process for refining and updating this document?

PCB Protocol, page 49

This document remains a "working paper" and may well undergo further refinement. However, the Task Force felt the HPV and advisory protocol which is based upon the HPV was sufficiently complete to forward to the Council of Great Lakes Governors for further consideration.

What was the response of the Council of Great Lakes Governors? Does anyone have these records?

Why was an expert committee approach chosen?

PCB Protocol, page 28

The Task Force did not develop and utilize a quantitative method to assign "weights" to specific studies which could then be combined to derive the HPV. The Task Force process represented an expert committee approach. The Task force did not make judgements or weight decisions on individual studies. Thus, as one of the Peer Reviewers pointed out, it is difficult for non-task force members to fully understand how each study affected the final HPV.

PCB Protocol, page 2

The advisory utilizes a weight-of-evidence derived individual health protection value (HPV) of 0.05 ug/kg/day for PCBs residue ingested from fish tissue. The HPV is intended to encompass acceptable cancer and reproductive/developmental risk. To assist in the process, the Task Force sent the final draft protocol out for peer review. The reviewers were a spectrum of scientists who had no association with the development of the HPV or protocol. The reviewer comments were helpful to the Task Force.

Is there/was there a process in place to continue to revise and update model tables and specific advice?

PCB Protocol, page 3

Please note that the model tables and specific advice for each of the Great Lakes are preliminary in nature and will be revised and updated to reflect the most current data prior to final advisory issuance.

Process for Mercury Addendum

- Risk assessment
  - Review of current EPA RfD
  - Acceptance as HPV
- Tiered advice
  - Agreement to focus on sensitive population
  - Some states use tiered approach with 1985 EPA IRIS RfD as basis for general population advice (MN, WI, IN, IL)
- No reduction factor for cooking and cleaning
- Interest in revising other components of the Protocol?
  - Benefits
  - Data analysis
  - Meal advice categories

How do we update benefits?

Was it seen as important to use this statement verbatim? Or to include a statement on the benefits of fish? Seems inconsistent with other guidance due to lack of serving size.

PCB Protocol, page 6 and Mercury Addendum, page 8

1. A general statement about contaminants, benefits and hazards

Summary

The Task Force agreed on the use of a general hazard statement. This component is intended to provide a general overview of contaminants in fish, to give reasons as to why the public should be aware of the risks, and to serve as an introduction to the advisory. The Task Force agreed to the use of the following statement:

"Fish are good for you and good to eat. But some fish may take in contaminants from the water they live in and the food they eat. Some of these contaminants build up in the fish - and you - over time. These contaminants could harm the people who eat them, so it is important to keep your exposure to these contaminants as low as possible. This advisory helps you plan what fish to keep as well as how often and how much sport fish to eat. This advisory is not intended to discourage you from eating fish, but should be used as a guide to eating fish low in contaminants."

3. Statement includes benefits of fish consumption

Summary

In order for consumers to make an informed choice about fish consumption, the Task Force agreed that a statement regarding the health benefits from eating fish should be included. Based upon a review of the literature,[72,74,76,77,96] the Task Force agreed to the use of the following statement:

"When properly prepared, fish provide a diet high in protein and low in saturated fats. Many doctors suggest that eating a half-pound of fish each week is helpful in preventing heart disease. Almost any kind of fish may have real health benefits when it replaces a high-fat source of protein in the diet. You can get the health benefits of fish and reduce unwanted contaminants by following this advisory."

IV. Statement on benefits of fish consumption

There are eight points that should be included in a benefit statement for fish consumption. These points are:

1) Fish are a good source of protein (Gebhardt, 2002).
2) Fish are typically low in saturated fat (Gebhardt, 2002).
3) Fish are the main dietary source of long-chain omega-3 fatty acids (Kris-Etherton, 2002).
4) Fish are a good source of many vitamins and minerals (Gebhardt, 2002).
5) Nutrients from fish are believed to help prevent cardiovascular disease (Kris-Etherton, 2002).
6) Nutrients from fish are important for healthy fetuses (Holman, 1991).
7) The majority of benefits is achieved with modest fish consumption (one or two 4-6 oz servings per week) and may outweigh the risks to adults especially when high contaminant fish are avoided (Mozaffarian, 2006).
8) American Heart Association recommends at least two fish meals per week (AHA, 2005).

It seems like there is a lot of variation in the ensuing techniques. At the time of creating this addendum, were protocols seen as a way to gather information and discuss methodology more so than to standardize advisories?

Mercury Addendum, page 15

VIII. Evaluation of Edible Portion Fish Contaminant Data for Determining Meal Frequency Consumption Advice

The development of site-specific sport fish consumption advisories and general advisories for a state or region can be accomplished using a variety of methods depending on the quantity and characteristics of the data and site specific or regional considerations. This section includes some methods that could be used to develop site specific or general mercury advisories. However, none of these suggestions are meant to be prescriptive. Lastly, the resulting advice would ideally be reviewed by local biologists who manage the waters and be examined in the context of applicable fishing regulations, catch rates, consumption information, and other factors.

A. Site-Specific Advisories

Different approaches to examine fish contaminant data may be appropriate when developing site- and species- specific consumption advisories. In many cases, the different approaches will result in the same determination of appropriate advice. Mercury concentrations in fish tend to be variable and dependent on the species and length (or age) of the fish as well as the waterbody. In addition, sample sizes and sampling protocol may vary between sites. For example, individual samples are collected at most sites but composite samples are collected in some instances. Wide distributions of lengths are targeted but not always available and sample sizes may vary depending on the availability of a particular species of interest. Also, the history of the site may dictate the sampling protocol and may influence final decisions regarding the development or modification of sport fish consumption advisories.

[1] The following techniques could be considered and use of more than one approach may be advantageous in some cases:

- Length vs Concentration and Regression Models
- Mean or median concentrations
- Frequency Distribution within Meal Categories

Is the 1985 RfD and current RfD still used to set guidelines for these populations?
Which states use a two-tiered?

Mercury Addendum, page 11

VI. Meal Frequency Advisory Groups

Many states separate advice for eating mercury-contaminated fish into two tiers, one for the sensitive population and one for the general population. The sensitive population is generally defined by states as women of childbearing age and children. The age of children included in the sensitive population is not consistent. [1]For states that use this tiered approach, the 1985 U.S. EPA RfD is generally used to derive advice for the general population and advice for the sensitive population is developed using the current 2001 U.S. EPA RfD. This tiered approach is used by states in an effort to not restrict women beyond childbearing age and men to the levels of consumption recommended to women of childbearing age and children, because there are [2]many reported benefits to fish consumption and data may not support the more restrictive advice for men. Future assessments of adverse effects in adults, cardiovascular effects in particular, may result in changes to this approach. [3]However, to date an adequate dose-response evaluation for cardiovascular effects has not yet been conducted.

State	Follow Hg Protocol for SP?	Comments
NY	N/A	all populations fall under general advisory; no specific Hg advice for their Great Lakes waters
PA		
OH	Yes	same advice for all pops
IN	Yes	"Bump up", uses RfD=0.3 for GenPop
MI	Yes	same advice for all pops, "limited" meal category of 1-2 per year
IL	Yes	no 2 meals/wk category, uses RfD= 0.3 for GenPop
WI	Yes	RfD=0.3 used for GebPop; if both PCBs & Hg are equal will use ??? (except for L. Superior), no 2/wk category, disclaimer for statewide advice
MN	Yes	uses RfD= 0.3 for GenPop

Chlordane

- HPV Proposal by primary reviewer
- Review by Consortium
- White paper – no revision of other sections of the Protocol

PFOS

- Risk Assessment
  - Review of EPA Health Advisory RfD
    - Process?
    - Primary reviewers?
  - Appropriate for FCA?
  - Tiered advice - Appropriate for all pops or tiered approach
- Cooking and Cleaning reduction factor?
  - Data presented on July call

Update from 2 recent studies:
1. Compositing fish samples for Hg monitoring and advisories
2. Effects of cooking on PFAS levels in fish

Satyendra Bhavsar, Ph.D., P.Eng.
Research Scientist, Fish Contaminant Monitoring Program
Ontario Ministry of the Environment and Climate Change

1. Compositing fish for Hg monitoring/advisories

Environment International: 2016: 80-85

Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

Is it appropriate to composite fish samples for mercury trend monitoring and consumption advisories?

Nilima Gandhi [a], Satyendra P. Bhavsar [a,b,c,*], Sarah B. Gewurtz [c], Ken G. Drouillard [c], George B. Arhonditsis [a], Steve Petro [b]

[a] University of Toronto, Toronto, ON M1C 1A4, Canada
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[c] University of Windsor, 401 Sunset Avenue, Windsor, ON N9B 3P4, Canada

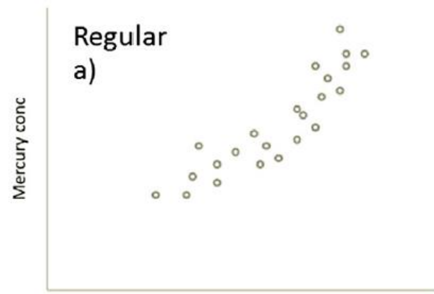
Ontario

Approach

- Formulate a variety of methods to composite samples
- Utilize a large, comprehensive monitoring dataset
- Apply the compositing methods to the dataset assuming a composite of individual samples would have resulted in a mercury measurement equal to an average of the individual measurements
- Using individual and corresponding composite mercury values, compare/evaluate
  - Fish consumption advisories
  - temporal trends
- Recommend a suitable compositing method based on
  - Performance to reproduce advisories and trends
  - Savings in number of samples and analytical costs

Ontario

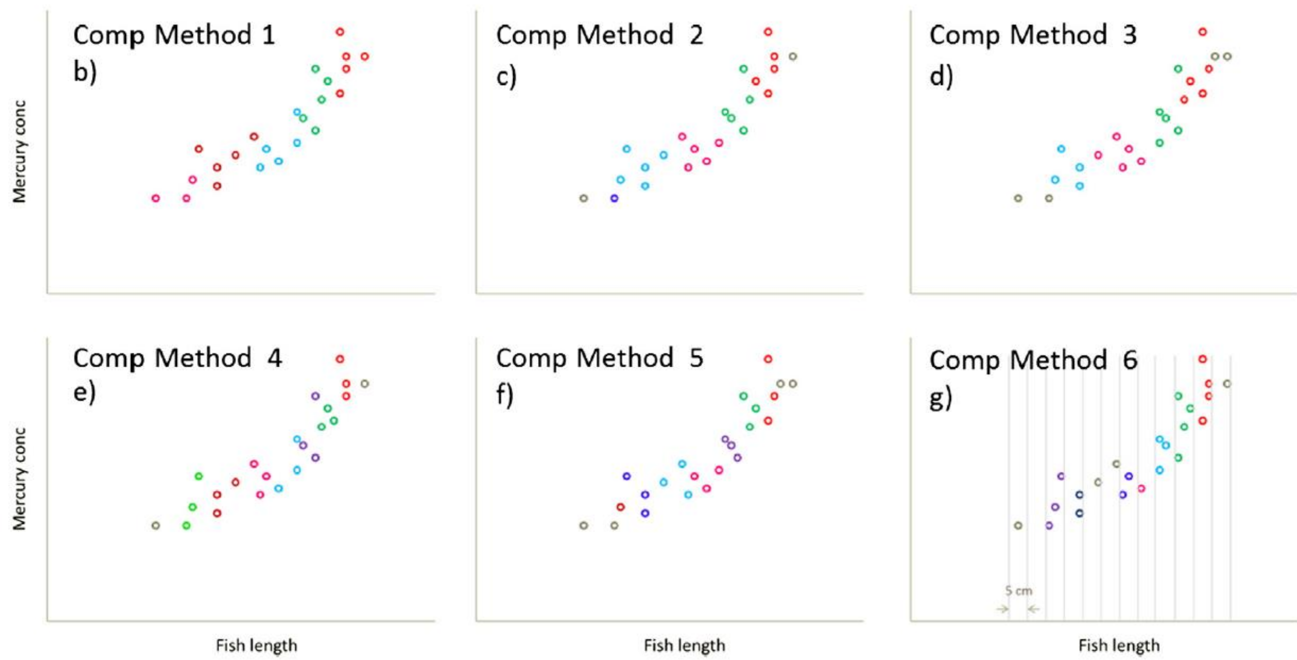
Compositing methods considered



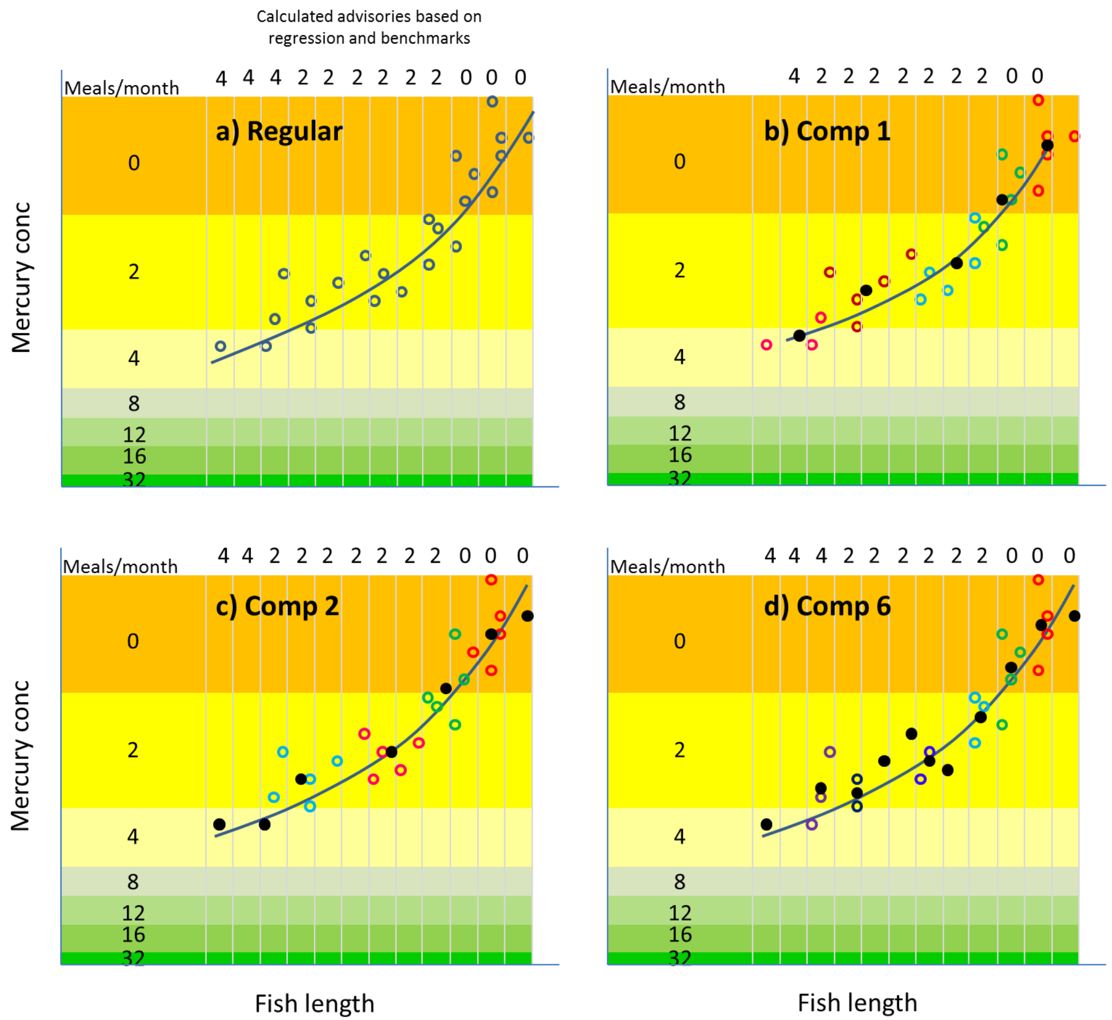
Individual measurements are shown in grey
Same coloured individuals belong to the same composite

For this example sampling event

Method →	Reg	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Comp 6
Initial samples	23	23	23	23	23	23	23
Final samples	23	5	7	8	9	11	11
Reduction	0%	78%	70%	65%	61%	52%	52%



Advisory calculation example



Composite value – Avg of individuals

Power series regression performed on comp values

Same coloured individuals belong to the same composite
Grey colour for individuals

Advisory comparison example

- For every sampling event (location/year/species)

Size (cm) →	15	20	25	30	35	40	45	50	55	60	65	70	75+
Regular		**4**	**4**	**4**	**2**	**2**	**2**	**2**	**2**	**2**	**0**	**0**	**0**
Comp 1			4	2	2	2	2	2	2	2	0	0	
Comp 2		4	4	2	2	2	2	2	2	2	0	0	0
Comp 3		4	4	2	2	2	2	2	2	2	0	0	0
Comp 4		4	4	4	4	2	2	2	2	2	0	0	0
Comp 5		4	4	2	2	2	2	2	2	2	0	0	0
Comp 6		4	4	4	2	2	2	2	2	2	2	0	0

Ontario

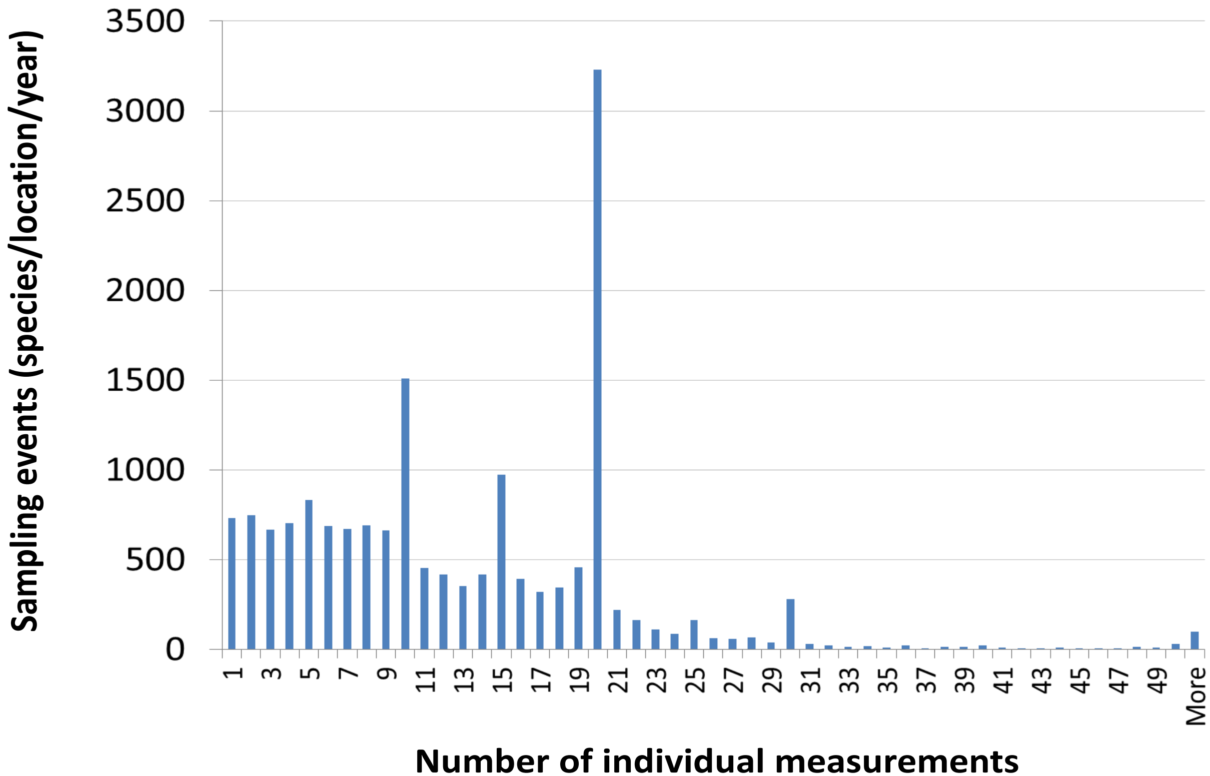
Trend evaluation example

For Species A, from Location B

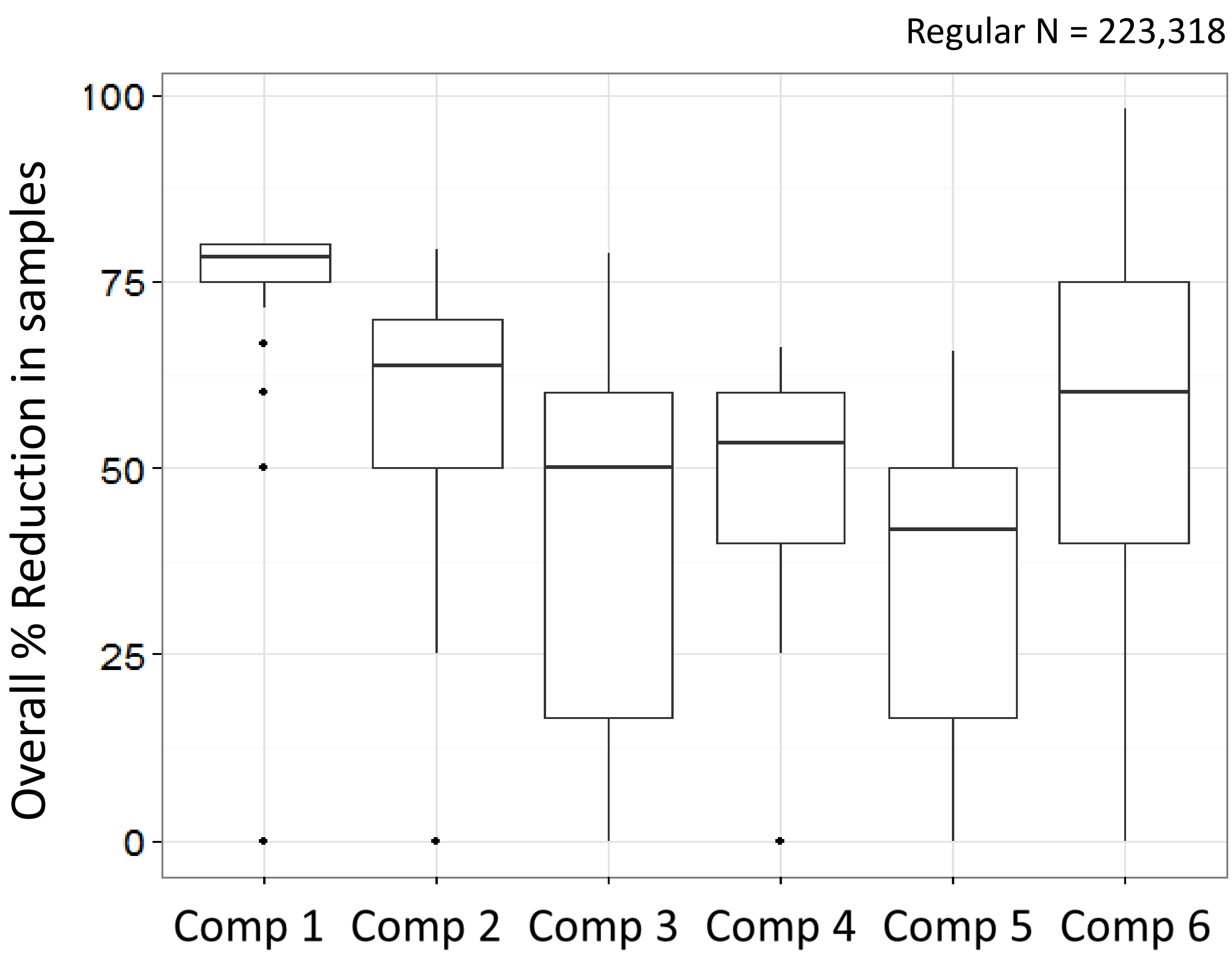
	1981	1983	1988	1994	1995	2001	2007	2011
1981								
1983	*2, 2*							
1988	*7, 3*	*5, 2*						
1994	*13, 4*	*11, 3*	*6, 2*					
1995	*14, 5*	*12, 4*	*7, 3*	*1, 2*				
2001	*20, 6*	*18, 5*	*13, 4*	*7, 3*	*6, 2*			
2007	*26, 7*	*24, 6*	*19, 5*	*13, 4*	*12, 3*	*6, 2*		
2011	*30, 8*	*28, 7*	*23, 6*	*17, 5*	*16, 4*	*10, 3*	*4, 2*	

Illustration of number of temporal trends conducted for a species at a location where sampling was conducted 8 times between 1981 and 2011. A rate of change in fish mercury level was calculated for each grey coloured cell. The number combination (e.g., *13, 4*) represents the time period (13 years) with (4) sampling years during the period. In this example, 28 rates of changes were calculated for each of the regular and six composite methods (total 196).

Number of measurements

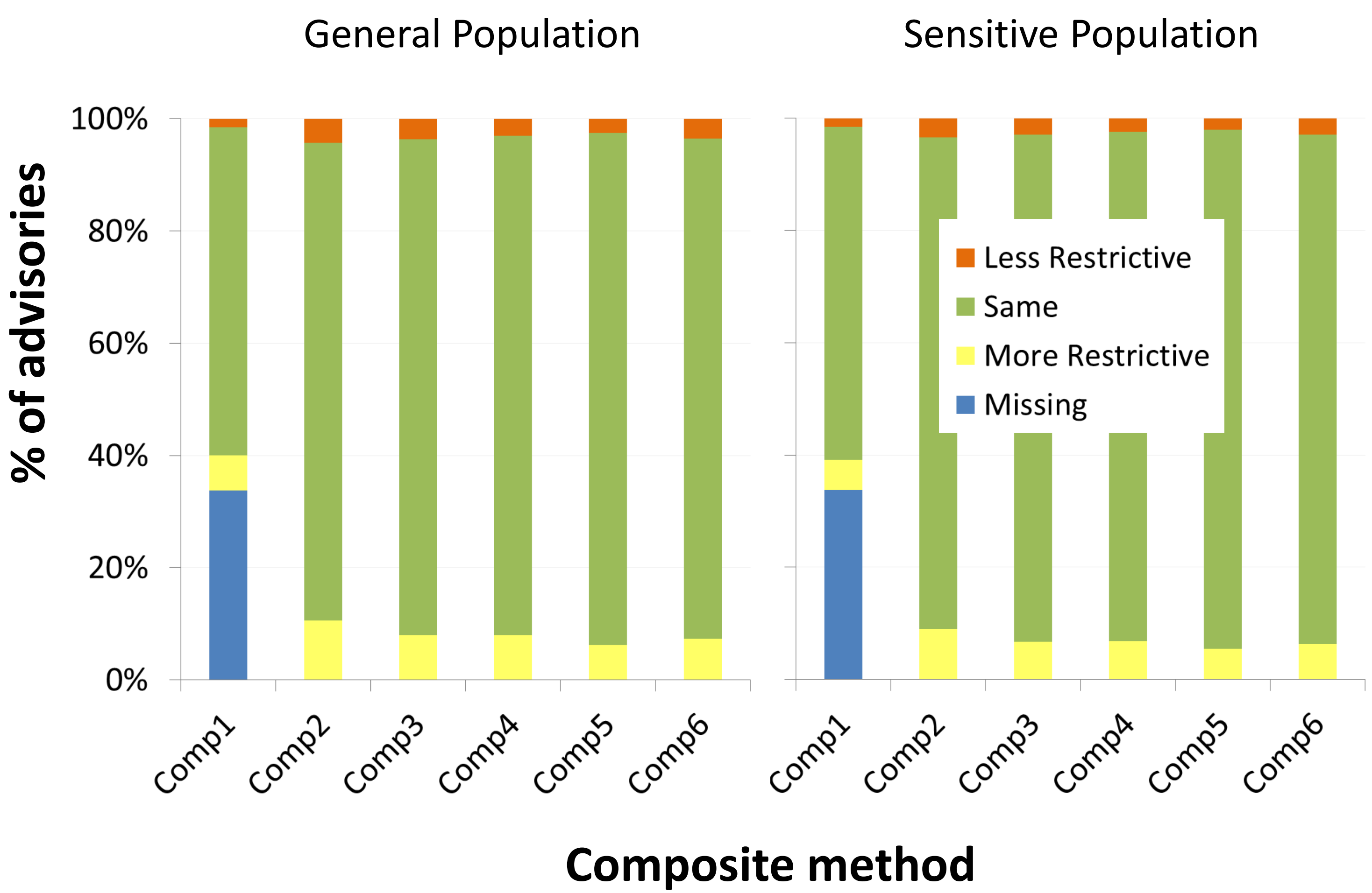


Reduction in samples



Advisories

Most advisories are Same or 1 category more restrictive



Advisories

- For every composite method and population (general & sensitive)

	Meals/month	0	2	4	8	12	16	32	Total
Comp1	0	**44%**	5%	0%	0%	0%	0%	0%	1%
	2	1%	**43%**	3%	0%	0%	0%	0%	3%
	4	0%	1%	**58%**	8%	0%	0%	0%	12%
	8	0%	0%	1%	**57%**	13%	0%	0%	11%
	12	0%	0%	0%	1%	**52%**	6%	0%	8%
	16	0%	0%	0%	0%	2%	**59%**	5%	16%
	32	0%	0%	0%	0%	0%	1%	**57%**	12%
	Missing	55%	51%	39%	33%	33%	34%	38%	37%
	Total	100%	100%	100%	100%	100%	100%	100%	100%
Comp2	0	**92%**	10%	0%	0%	0%	0%	0%	3%
	2	8%	**80%**	5%	0%	0%	0%	0%	5%
	4	0%	10%	**89%**	14%	0%	0%	0%	20%
	8	0%	0%	5%	**80%**	21%	0%	0%	16%
	12	0%	0%	0%	6%	**70%**	10%	0%	12%
	16	0%	0%	0%	0%	9%	**87%**	9%	24%
	32	0%	0%	0%	0%	0%	3%	**91%**	20%
	Total	100%	100%	100%	100%	100%	100%	100%	100%

Most advisories
Same or 1 category more restrictive

Most less restrictive advisories are only 1 category less restrictive

General Popn

Sensitive Popn

	Meals/month	0	4	8	12	16	32	Total
Comp1	0	**59%**	5%	0%	0%	0%	0%	21%
	4	0%	**61%**	10%	0%	0%	0%	19%
	8	0%	1%	**54%**	14%	0%	0%	10%
	12	0%	0%	1%	**48%**	8%	0%	5%
	16	0%	0%	0%	2%	**54%**	8%	6%
	32	0%	0%	0%	0%	1%	**49%**	2%
	Missing	41%	33%	34%	36%	37%	43%	37%
	Total	100%	100%	100%	100%	100%	100%	100%
Comp2	0	**97%**	9%	0%	0%	0%	0%	35%
	4	3%	**88%**	15%	0%	0%	0%	28%
	8	0%	3%	**80%**	25%	1%	0%	15%
	12	0%	0%	5%	**68%**	14%	0%	7%
	16	0%	0%	0%	7%	**83%**	15%	10%
	32	0%	0%	0%	0%	2%	**85%**	4%
	Total	100%	100%	100%	100%	100%	100%	100%

Advisories: sample size effect

No major effect

Comp method 2 advisories compared to Regular							
N	EQUAL	Less Res	More Res	Total	EQUAL	Less Res	More Res
1	590			590	100.0%	0.0%	0.0%
2	1710	1		1711	99.94%	0.1%	0.0%
3	1994			1994	100.00%	0.0%	0.0%
4	2195	84	167	2446	89.70%	3.4%	6.8%
5	2625	165	281	3071	85.48%	5.4%	9.2%
6	2397	151	346	2894	82.83%	5.2%	12.0%
7	2363	176	362	2901	81.45%	6.1%	12.5%
8	2711	186	328	3225	84.06%	5.8%	10.2%
9	2600	183	300	3083	84.33%	5.9%	9.7%
10	5750	350	803	6903	83.30%	5.1%	11.6%
11	1842	133	274	2249	81.90%	5.9%	12.2%
12	1834	107	259	2200	83.36%	4.9%	11.8%
13	1622	124	261	2007	80.82%	6.2%	13.0%
14	2025	119	251	2395	84.55%	5.0%	10.5%
15	4653	253	638	5544	83.93%	4.6%	11.5%
16	1940	115	292	2347	82.66%	4.9%	12.4%
17	1605	68	228	1901	84.43%	3.6%	12.0%
18	1791	81	235	2107	85.00%	3.8%	11.2%
19	2215	109	312	2636	84.03%	4.1%	11.8%
20	15056	736	1965	17757	84.79%	4.1%	11.1%
21	1129	43	177	1349	83.69%	3.2%	13.1%
22	916	43	122	1081	84.74%	4.0%	11.3%
23	579	31	83	693	83.55%	4.5%	12.0%
24	489	15	76	580	84.31%	2.6%	13.1%
25	880	39	99	1018	86.44%	3.8%	9.7%
26	359	10	52	421	85.27%	2.4%	12.4%
27	323	23	36	382	84.55%	6.0%	9.4%
28	354	14	40	408	86.76%	3.4%	9.8%
29	246	5	32	283	86.93%	1.8%	11.3%
30	1491	47	215	1753	85.05%	2.7%	12.3%
31	152	7	18	177	85.88%	4.0%	10.2%
32	89	8	22	119	74.79%	6.7%	18.5%
33	74		13	87	85.06%	0.0%	14.9%
34	91	6	30	127	71.65%	4.7%	23.6%
35	58	1	5	64	90.63%	1.6%	7.8%
36	87	8	16	111	78.38%	7.2%	14.4%
37	38	3	3	44	86.36%	6.8%	6.8%
38	88	1	10	99	88.89%	1.0%	10.1%
39	74	4	9	87	85.06%	4.6%	10.3%
40	113		13	126	89.68%	0.0%	10.3%

Comp method 6 advisories compared to Regular							
N	EQUAL	Less Res	More Res	Total	EQUAL	Less Res	More Res
1	590			590	100.0%	0.0%	0.0%
2	1627	80	2	1709	95.2%	4.7%	0.1%
3	1889	53	43	1985	95.2%	2.7%	2.2%
4	2300	64	79	2443	94.1%	2.6%	3.2%
5	2789	110	150	3049	91.5%	3.6%	4.9%
6	2624	100	157	2881	91.1%	3.5%	5.4%
7	2633	97	154	2884	91.3%	3.4%	5.3%
8	2947	105	164	3216	91.6%	3.3%	5.1%
9	2762	120	195	3077	89.8%	3.9%	6.3%
10	6172	278	421	6871	89.8%	4.0%	6.1%
11	1991	85	165	2241	88.8%	3.8%	7.4%
12	1994	57	140	2191	91.0%	2.6%	6.4%
13	1771	68	164	2003	88.4%	3.4%	8.2%
14	2123	94	168	2385	89.0%	3.9%	7.0%
15	4934	166	427	5527	89.3%	3.0%	7.7%
16	2023	80	230	2333	86.7%	3.4%	9.9%
17	1655	72	166	1893	87.4%	3.8%	8.8%
18	1847	67	185	2099	88.0%	3.2%	8.8%
19	2300	99	228	2627	87.6%	3.8%	8.7%
20	15450	639	1560	17649	87.5%	3.6%	8.8%
21	1178	41	125	1344	87.6%	3.1%	9.3%
22	938	42	96	1076	87.2%	3.9%	8.9%
23	602	20	69	691	87.1%	2.9%	10.0%
24	501	19	59	579	86.5%	3.3%	10.2%
25	862	54	100	1016	84.8%	5.3%	9.8%
26	366	12	38	416	88.0%	2.9%	9.1%
27	325	16	37	378	86.0%	4.2%	9.8%
28	362	14	30	406	89.2%	3.4%	7.4%
29	248	10	23	281	88.3%	3.6%	8.2%
30	1466	53	225	1744	84.1%	3.0%	12.9%
31	155	6	16	177	87.6%	3.4%	9.0%
32	91	7	21	119	76.5%	5.9%	17.6%
33	74	1	12	87	85.1%	1.1%	13.8%
34	102	3	21	126	81.0%	2.4%	16.7%
35	54		10	64	84.4%	0.0%	15.6%
36	92	7	11	110	83.6%	6.4%	10.0%
37	40		4	44	90.9%	0.0%	9.1%
38	88		10	98	89.8%	0.0%	10.2%
39	77	3	7	87	88.5%	3.4%	8.0%
40	108	2	16	126	85.7%	1.6%	12.7%

Advisories: species effect

No major effect

Comp method 2 advisories compared to Regular							
Species	EQUAL	Less Res	More Res	Total	EQUAL	Less Res	More Res
Alewife	10			10	100.0%	0.0%	0.0%
American Eel	104	15	15	134	77.6%	11.2%	11.2%
Atlantic Salmon	12	2		14	85.7%	14.3%	0.0%
Bigmouth Buffalo	6			6	100.0%	0.0%	0.0%
Black Crappie	526	18	55	599	87.8%	3.0%	9.2%
Blackfin Cisco	4			4	100.0%	0.0%	0.0%
Bloater	74	3	5	82	90.2%	3.7%	6.1%
Bluegill	206	10	28	244	84.4%	4.1%	11.5%
Bowfin	50	9	11	70	71.4%	12.9%	15.7%
Brook Trout	776	39	93	908	85.5%	4.3%	10.2%
Brown Bullhead	1177	37	83	1297	90.7%	2.9%	6.4%
Brown Trout	749	27	58	834	89.8%	3.2%	7.0%
Catfish species (not I. punctatus)	2			2	100.0%	0.0%	0.0%
Channel Catfish	886	44	189	1119	79.2%	3.9%	16.9%
Chinook Salmon	969	26	38	1033	93.8%	2.5%	3.7%
Chub (not C. artedii)	39			39	100.0%	0.0%	0.0%
Cisco(Lake Herring)	709	42	44	795	89.2%	5.3%	5.5%
Coho Salmon	613	17	21	651	94.2%	2.6%	3.2%
Common Carp	2445	182	217	2844	86.0%	6.4%	7.6%
Creek Chub	4			4	100.0%	0.0%	0.0%
Freshwater Drum	545	66	112	723	75.4%	9.1%	15.5%
Gizzard Shad	70	1		71	98.6%	1.4%	0.0%
Golden Redhorse Sucker	7			7	100.0%	0.0%	0.0%
Goldeye	21	4	3	28	75.0%	14.3%	10.7%
Goldfish	12			12	100.0%	0.0%	0.0%
Greater Redhorse	8	1		9	88.9%	11.1%	0.0%
Humper Lake Trout	14		3	17	82.4%	0.0%	17.6%
Lake Chub	4			4	100.0%	0.0%	0.0%
Lake Trout	7336	346	1063	8745	83.9%	4.0%	12.2%
Lake Whitefish	2949	106	235	3290	89.6%	3.2%	7.1%
Largemouth Bass	1906	59	290	2255	84.5%	2.6%	12.9%
Ling (Burbot)	828	89	68	985	84.1%	9.0%	6.9%
Longnose Gar	4			4	100.0%	0.0%	0.0%
Longnose Sucker	318	19	34	371	85.7%	5.1%	9.2%
Mooneye	54	3	7	64	84.4%	4.7%	10.9%
Muskellunge	92	3	17	112	82.1%	2.7%	15.2%
Northern Hog Sucker	2			2	100.0%	0.0%	0.0%
Northern Pike	13920	935	1601	16456	84.6%	5.7%	9.7%
Pink Salmon	106		1	107	99.1%	0.0%	0.9%
Pumpkinseed	281	13	49	343	81.9%	3.8%	14.3%
Quillback Carpsucker	30	1	5	36	83.3%	2.8%	13.9%
Rainbow Smelt	23	2	2	27	85.2%	7.4%	7.4%
Rainbow Trout	1508	57	104	1669	90.4%	3.4%	6.2%
Redhorse Sucker	271	22	30	323	83.9%	6.8%	9.3%
River Redhorse	2			2	100.0%	0.0%	0.0%
Rock Bass	655	49	105	809	81.0%	6.1%	13.0%
Round Whitefish	128	1	6	135	94.8%	0.7%	4.4%
Salmon Hybrid	2	1		3	66.7%	33.3%	0.0%
Sauger	363	26	33	422	86.0%	6.2%	7.8%
Shorthead Redhorse	62	4	7	73	84.9%	5.5%	9.6%
Silver Redhorse	30		1	31	96.8%	0.0%	3.2%
Siscowet	31	3	3	37	83.8%	8.1%	8.1%
Smallmouth Bass	5478	177	847	6502	84.3%	2.7%	13.0%
Splake	158	4	6	168	94.0%	2.4%	3.6%
Spotted Sucker	5			5	100.0%	0.0%	0.0%
Sturgeon	120	16	7	143	83.9%	11.2%	4.9%
Sucker Family	1		1	2	50.0%	0.0%	50.0%
Walleye	15671	682	2407	18760	83.5%	3.6%	12.8%
White Bass	523	31	61	615	85.0%	5.0%	9.9%
White Crappie	61	7	3	71	85.9%	9.9%	4.2%
White Perch	252	15	25	292	86.3%	5.1%	8.6%
White Sucker	3197	128	271	3596	88.9%	3.6%	7.5%
Whitefish hybrid	8			8	100.0%	0.0%	0.0%
Yellow Bullhead	4			4	100.0%	0.0%	0.0%
Yellow Perch	1933	123	247	2303	83.9%	5.3%	10.7%
Grand Total	68354	3465	8511	80330	85.1%	4.3%	10.6%

Comp method 6 advisories compared to Regular							
Species	EQUAL	Less Res	More Res	Total	EQUAL	Less Res	More Res
Alewife	10			10	100.0%	0.0%	0.0%
American Eel	114	7	13	134	85.1%	5.2%	9.7%
Atlantic Salmon	13	1		14	92.9%	7.1%	0.0%
Bigmouth Buffalo	6			6	100.0%	0.0%	0.0%
Black Crappie	524	21	42	587	89.3%	3.6%	7.2%
Blackfin Cisco	4			4	100.0%	0.0%	0.0%
Bloater	71	6	3	80	88.8%	7.5%	3.8%
Bluegill	195	21	24	240	81.3%	8.8%	10.0%
Bowfin	55	7	8	70	78.6%	10.0%	11.4%
Brook Trout	793	32	80	905	87.6%	3.5%	8.8%
Brown Bullhead	1154	48	82	1284	89.9%	3.7%	6.4%
Brown Trout	777	21	34	832	93.4%	2.5%	4.1%
Catfish species (not I. punctatus)	2			2	100.0%	0.0%	0.0%
Channel Catfish	928	49	140	1117	83.1%	4.4%	12.5%
Chinook Salmon	983	19	30	1032	95.3%	1.8%	2.9%
Chub (not C. artedii)	38			38	100.0%	0.0%	0.0%
Cisco(Lake Herring)	693	48	45	786	88.2%	6.1%	5.7%
Coho Salmon	624	9	14	647	96.4%	1.4%	2.2%
Common Carp	2578	127	132	2837	90.9%	4.5%	4.7%
Creek Chub	2	2		4	50.0%	50.0%	0.0%
Freshwater Drum	602	44	71	717	84.0%	6.1%	9.9%
Gizzard Shad	70	1		71	98.6%	1.4%	0.0%
Golden Redhorse Sucker	7			7	100.0%	0.0%	0.0%
Goldeye	22	3	3	28	78.6%	10.7%	10.7%
Goldfish	11			11	100.0%	0.0%	0.0%
Greater Redhorse	7	2		9	77.8%	22.2%	0.0%
Humper Lake Trout	14		3	17	82.4%	0.0%	17.6%
Lake Chub	4			4	100.0%	0.0%	0.0%
Lake Trout	7796	263	663	8722	89.4%	3.0%	7.6%
Lake Whitefish	2977	109	190	3276	90.9%	3.3%	5.8%
Largemouth Bass	2015	57	176	2248	89.6%	2.5%	7.8%
Ling (Burbot)	880	54	50	984	89.4%	5.5%	5.1%
Longnose Gar	3	1		4	75.0%	25.0%	0.0%
Longnose Sucker	328	13	27	368	89.1%	3.5%	7.3%
Mooneye	55	3	5	63	87.3%	4.8%	7.9%
Muskellunge	101	5	6	112	90.2%	4.5%	5.4%
Northern Hog Sucker	2			2	100.0%	0.0%	0.0%
Northern Pike	14848	552	1018	16418	90.4%	3.4%	6.2%
Pink Salmon	106		1	107	99.1%	0.0%	0.9%
Pumpkinseed	253	31	44	328	77.1%	9.5%	13.4%
Quillback Carpsucker	29	4	3	36	80.6%	11.1%	8.3%
Rainbow Smelt	22	3	2	27	81.5%	11.1%	7.4%
Rainbow Trout	1547	45	73	1665	92.9%	2.7%	4.4%
Redhorse Sucker	250	40	33	323	77.4%	12.4%	10.2%
River Redhorse	2			2	100.0%	0.0%	0.0%
Rock Bass	639	60	106	805	79.4%	7.5%	13.2%
Round Whitefish	127	1	5	133	95.5%	0.8%	3.8%
Salmon Hybrid	3			3	100.0%	0.0%	0.0%
Sauger	367	27	26	420	87.4%	6.4%	6.2%
Shorthead Redhorse	65	2	5	72	90.3%	2.8%	6.9%
Silver Redhorse	29	1		30	96.7%	3.3%	0.0%
Siscowet	34		3	37	91.9%	0.0%	8.1%
Smallmouth Bass	5769	170	534	6473	89.1%	2.6%	8.2%
Splake	160	3	4	167	95.8%	1.8%	2.4%
Spotted Sucker	4	1		5	80.0%	20.0%	0.0%
Sturgeon	112	18	13	143	78.3%	12.6%	9.1%
Sucker Family	1		1	2	50.0%	0.0%	50.0%
Walleye	16550	542	1599	18691	88.5%	2.9%	8.6%
White Bass	494	30	75	599	82.5%	5.0%	12.5%
White Crappie	60	8	2	70	85.7%	11.4%	2.9%
White Perch	235	16	34	285	82.5%	5.6%	11.9%
White Sucker	3225	133	221	3579	90.1%	3.7%	6.2%
Whitefish hybrid	8			8	100.0%	0.0%	0.0%
Yellow Bullhead	4			4	100.0%	0.0%	0.0%
Yellow Perch	1891	131	250	2272	83.2%	5.8%	11.0%
Grand Total	71292	2791	5893	79976	89.1%	3.5%	7.4%

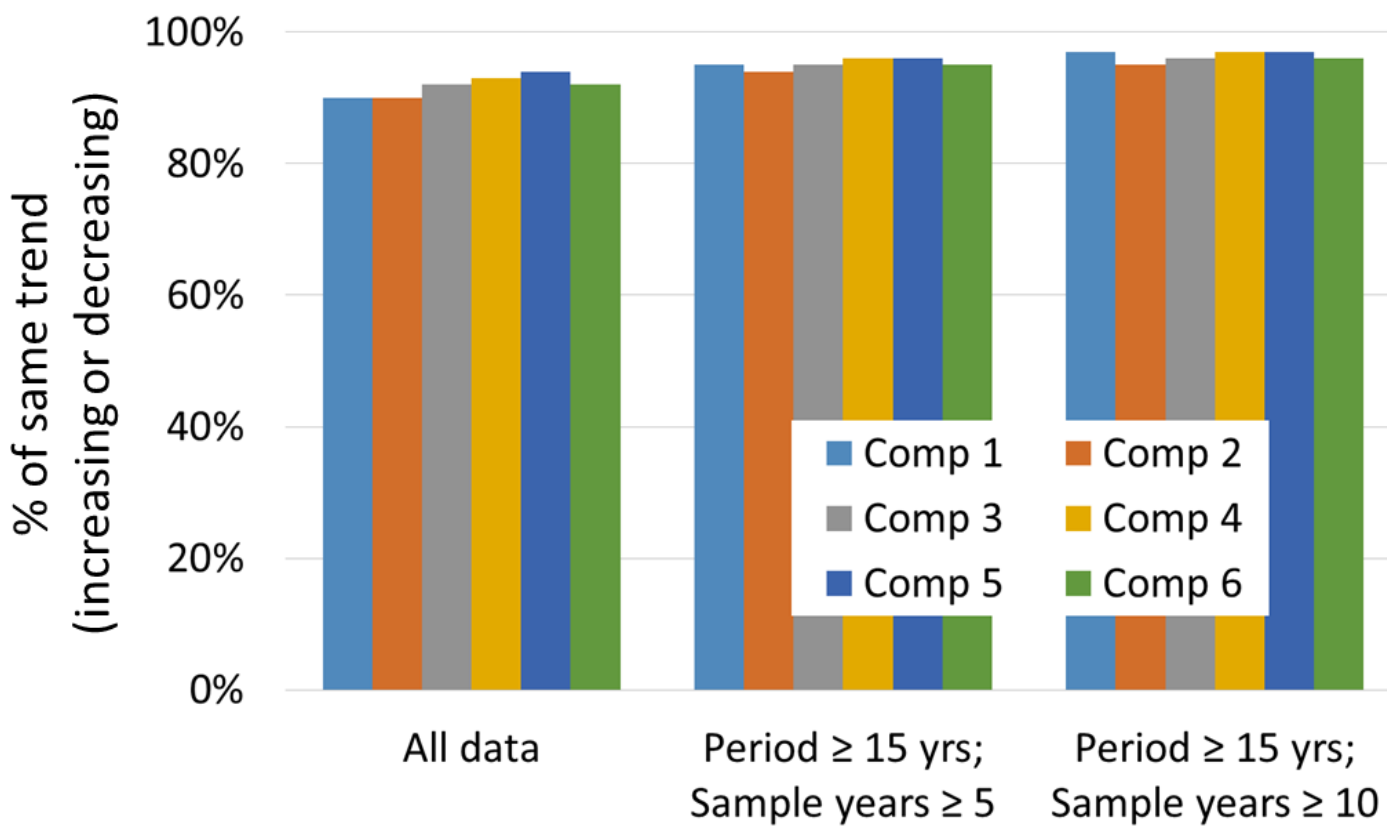
Advisories: fish size effect

No major effect

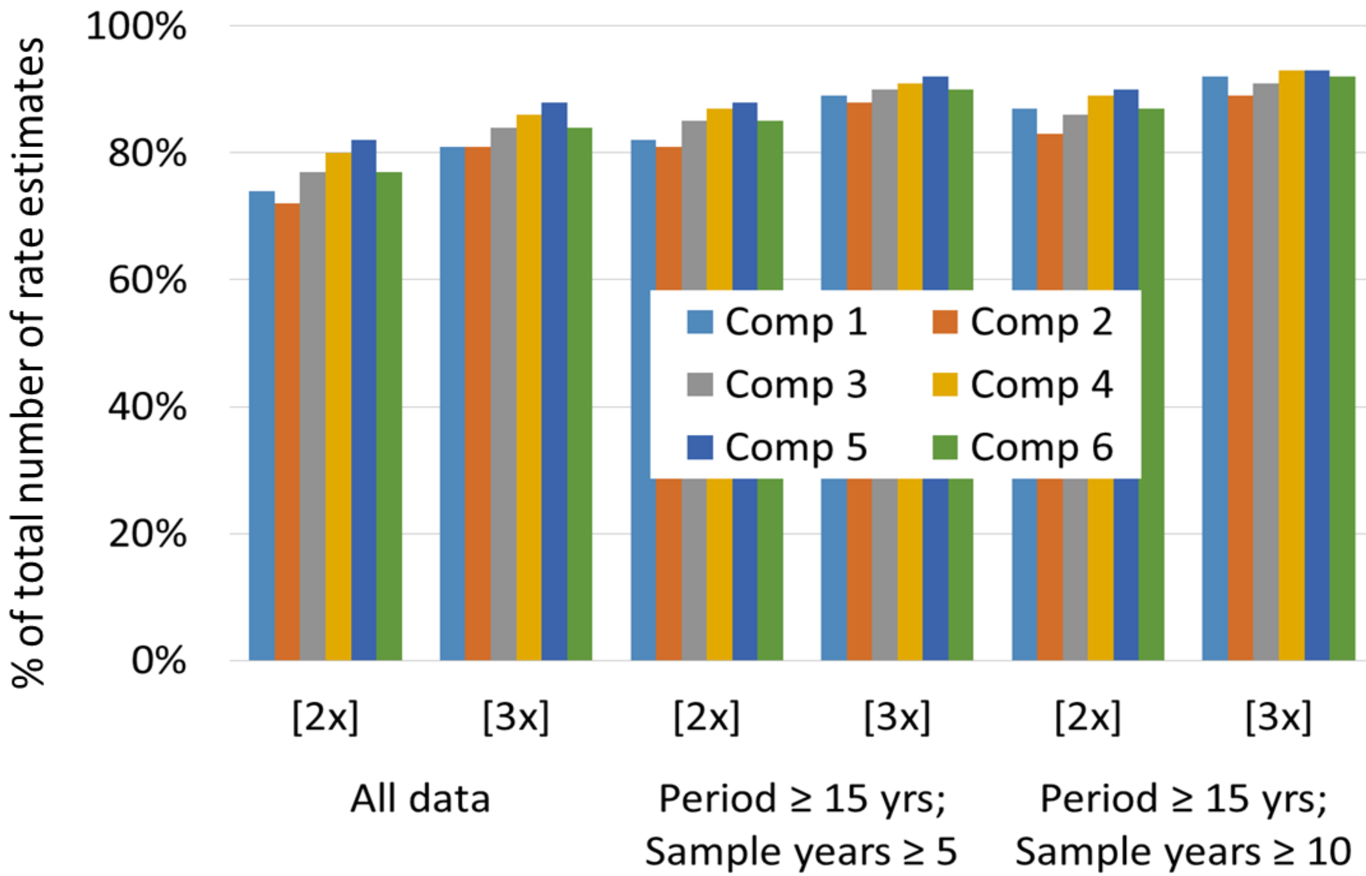
Comp method 2 advisories compared to Regular							
Size class	EQUAL	Less Res	More Res	Total	EQUAL	Less Res	More Res
15-20cm	2789	73	232	3094	90.1%	2.4%	7.5%
20-25cm	4477	140	496	5113	87.6%	2.7%	9.7%
25-30cm	5691	185	626	6502	87.5%	2.8%	9.6%
30-35cm	6677	225	826	7728	86.4%	2.9%	10.7%
35-40cm	7371	303	958	8632	85.4%	3.5%	11.1%
40-45cm	7756	336	1000	9092	85.3%	3.7%	11.0%
45-50cm	7483	407	983	8873	84.3%	4.6%	11.1%
50-55cm	6681	385	855	7921	84.3%	4.9%	10.8%
55-60cm	5843	363	752	6958	84.0%	5.2%	10.8%
60-65cm	4907	303	624	5834	84.1%	5.2%	10.7%
65-70cm	3841	285	503	4629	83.0%	6.2%	10.9%
70-75cm	2831	221	372	3424	82.7%	6.5%	10.9%
>75cm	2007	239	284	2530	79.3%	9.4%	11.2%
Total	68354	3465	8511	80330	85.1%	4.3%	10.6%

Comp method 6 advisories compared to Regular							
Size class	EQUAL	Less Res	More Res	Total	EQUAL	Less Res	More Res
15-20cm	2715	120	192	3027	89.7%	4.0%	6.3%
20-25cm	4494	162	394	5050	89.0%	3.2%	7.8%
25-30cm	5762	203	497	6462	89.2%	3.1%	7.7%
30-35cm	6889	230	572	7691	89.6%	3.0%	7.4%
35-40cm	7709	249	634	8592	89.7%	2.9%	7.4%
40-45cm	8109	271	694	9074	89.4%	3.0%	7.6%
45-50cm	7864	313	676	8853	88.8%	3.5%	7.6%
50-55cm	7026	278	596	7900	88.9%	3.5%	7.5%
55-60cm	6245	250	457	6952	89.8%	3.6%	6.6%
60-65cm	5206	205	415	5826	89.4%	3.5%	7.1%
65-70cm	4108	182	333	4623	88.9%	3.9%	7.2%
70-75cm	3011	164	244	3419	88.1%	4.8%	7.1%
>75cm	2154	164	189	2507	85.9%	6.5%	7.5%
Total	71292	2791	5893	79976	89.1%	3.5%	7.4%

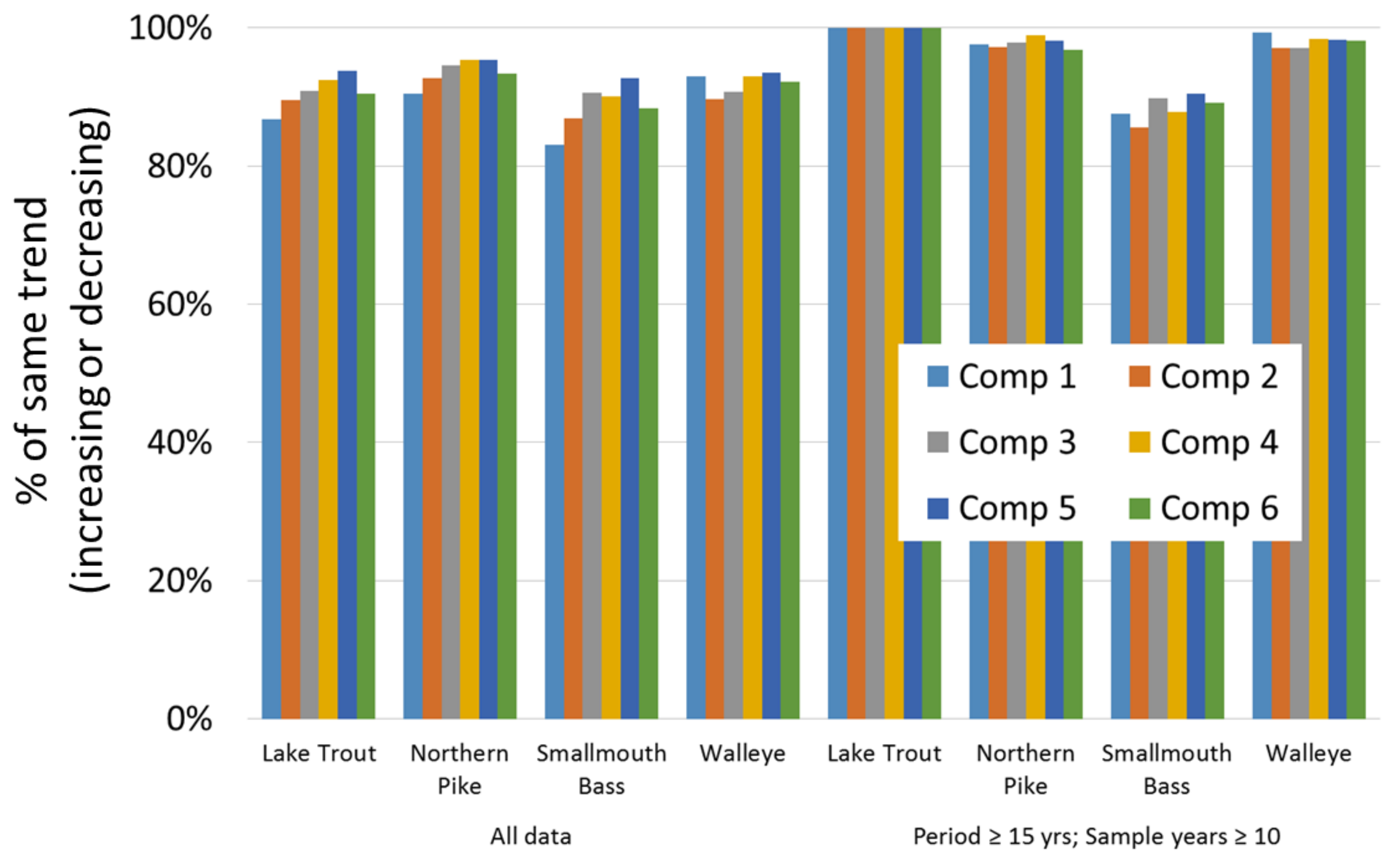
Temporal trend evaluation



Temporal trend evaluation



Temporal trend evaluation



Summary

- Six sample compositing method for fish mercury monitoring and consumption advisories were evaluated
- Reduction in number of sample vary by the method
- Overall, all methods (except Method-1) produced mostly similar or 1 category more restrictive advisories
  - Differences among the methods were minor
- Fish type and sample size had minimal effect on performance
- Generally, compositing resulted in a little less restrictive advisories for large sized fish of some species
- In >90% of the cases, the direction of trends were same from all methods
- All methods performed very well for temporal trend in Lake Trout, Northern Pike And Walleye; smallmouth bass should be avoided

Ontario

2. Effects of cooking on PFAS in fish

Environment International: 2014: 107-114

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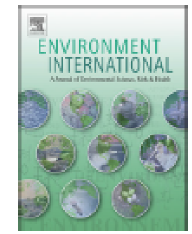

Cooking fish is not effective in reducing exposure to perfluoroalkyl and polyfluoroalkyl substances

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Ontario

Fish samples and analysis

Fish species

- Chinook salmon
- common carp
- lake trout
- Walleye

Sampling location: four rivers in Ontario

Sample type: skin-off fillets

PFAS analysed

- Perfluoroalkyl carboxylic acids (PFCAs)
- Perfluoroalkane sulfonic acids (PFSAs)
- Perfluoroalkyl phosphonic acids (PFPAs),
- Perfluoroalkyl phosphinic acids (PFPIAs)
- Polyfluoroalkyl phosphoric acid diesters (diPAPs)

Ontario

Cooking methods

Frying

- An electric frying pan was set to 175 °C and given 10 min to reach test temperature. The aluminum dishes were placed in the frying pan and cooked uncovered. After 5min, the fish fillets were carefully flipped with a plastic spatula and cooked for an additional 5 min.

Baking

- A small toaster oven was preheated to 200 °C (measured using an oven thermometer). The aluminum dishes were placed in the oven and cooked uncovered for 15 min.

Broiling

- The toaster oven was set to broil. The broiling temperature (measured using an oven thermometer) was set at 300 °C. The aluminum dishes were placed in the oven and cooked uncovered for 10 min.

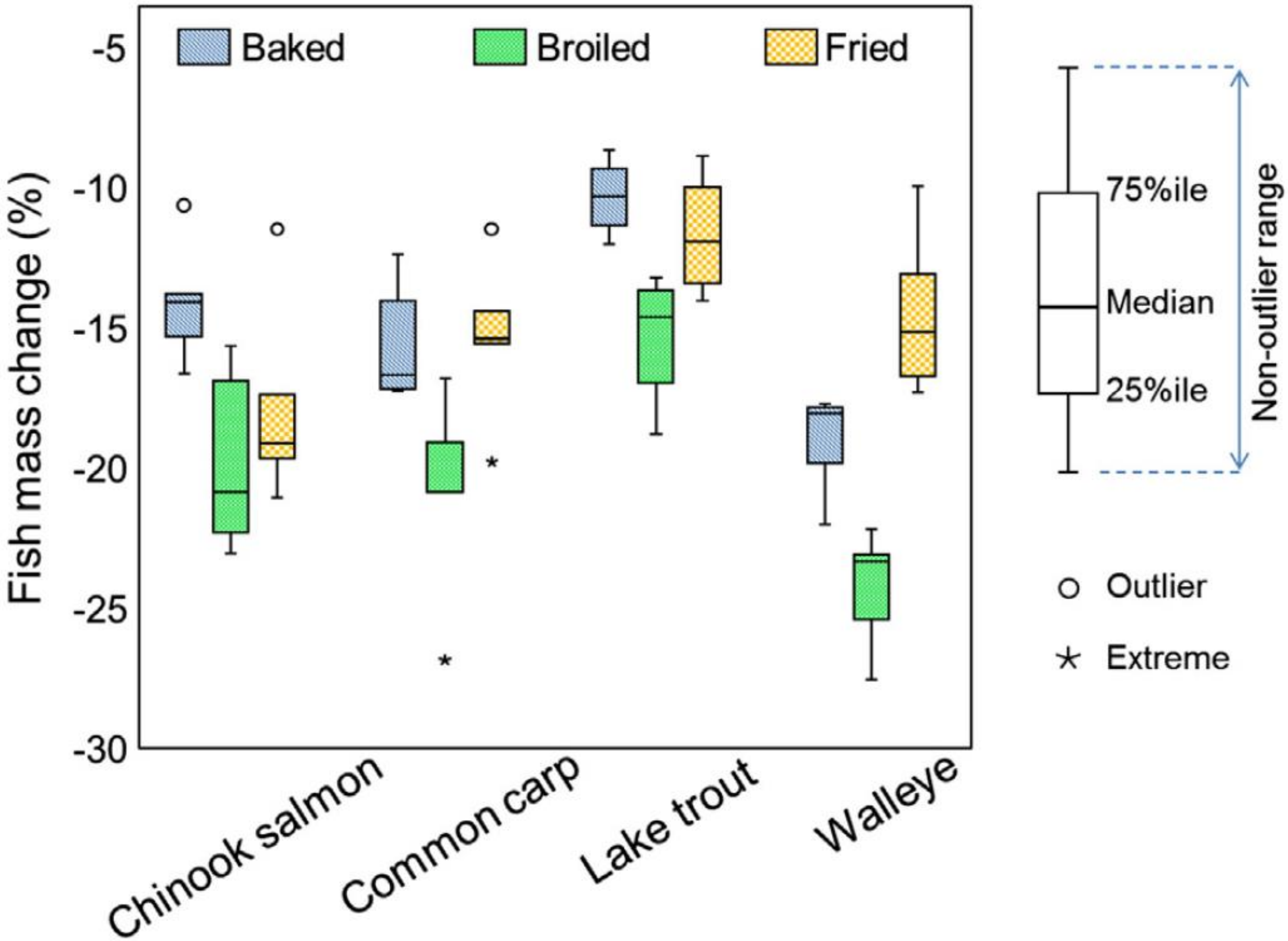
Ontario

Post-cooking

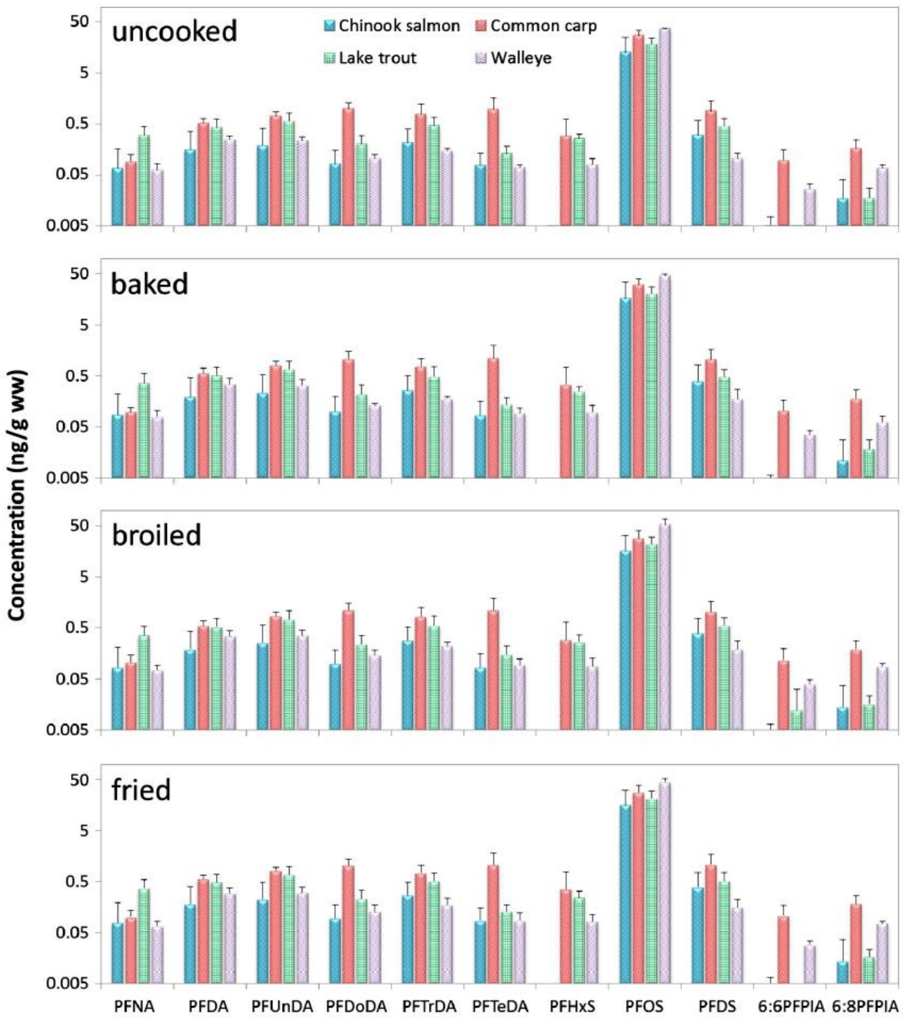
- The samples were removed from heat and the internal temperature of the fish was immediately measured with a digital probe.
- The fish were allowed to cool before the total weight (dish + oil + fish) was measured.
- The fish was removed from its weighing dish, wrapped in aluminum foil, replaced in its labeled bag and frozen to −20 °C for later analysis.
- The final weight of the dish with cooking juices and leftover canola oil was also measured. The weights of the cooking juices generated were calculated by subtracting pre-cooking weight of dish with oil from the final weight of the dish with juices and oil.
- Cooking juices and leftover canola oil were transferred to a polypropylene sample bottle and frozen for later analysis.

Ontario

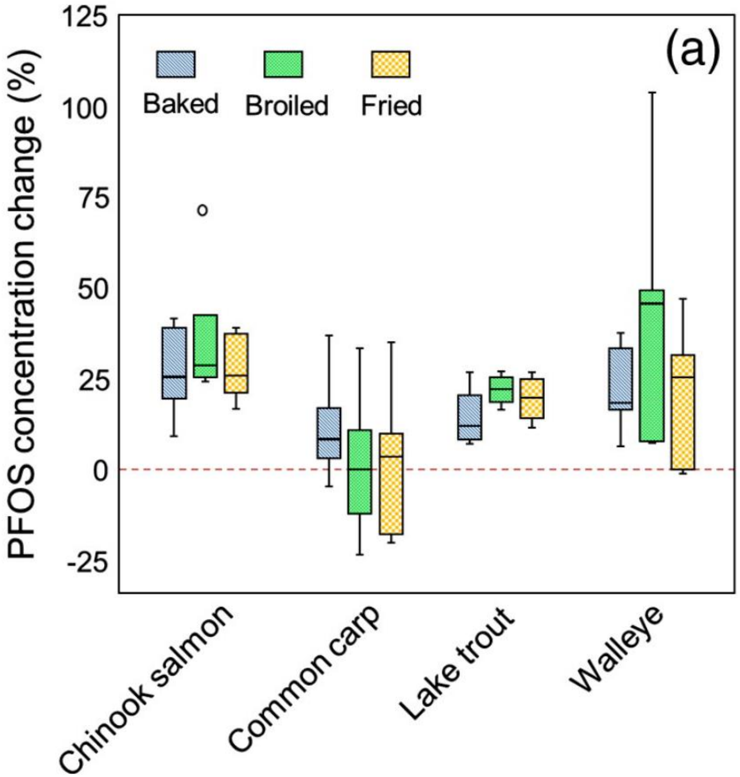
Change in fish mass

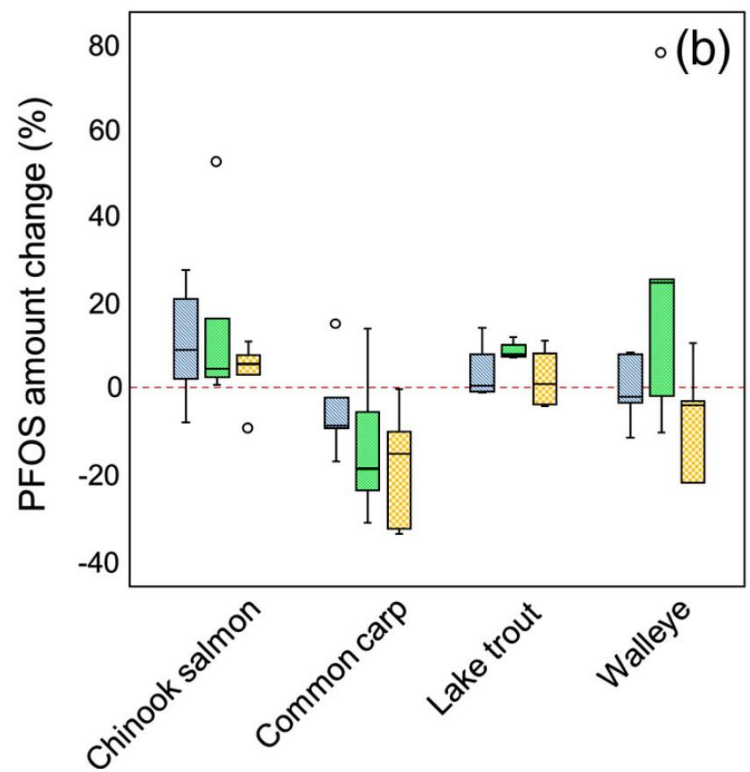


PFAS Concentrations



Change in PFOS





Ontario

Summary

- Examined the effectiveness of baking, broiling, and frying on reducing PFAS in four fish species.
- PFOS was the dominant PFAS
  - Concentrations more than an order of magnitude higher than those for fish from grocery stores in Canada, Spain and China
- Although concentrations of PFOS in fish fillets generally increase after cooking, amounts of PFOS largely remain unchanged.
- Relatively minor differences in changes in the fish PFAS amounts after cooking depended on fish species and cooking method used.

Cooking fish is generally not an effective approach to reduce dietary exposure to PFASs, especially PFOS

Ontario

GLFMSP UPDATE

8/18/2016

Forth coming Publications

- Mercury Trends Paper (In Prep for September Submission)
- Dioxin Trends Paper 2004 – 2015 Data (In prep for September submission)
- Legacy Contaminants Paper (in Draft, planned December 2016 submission)
- CEC Scripting Paper – Published at ES&T, see next slide
- Fatty Acids & Stable Isotopes
- CSMI results for Lakes Ontario, Michigan, and Erie (follow up to previous publication)
- 2017 IAGLR Special Issue articles
  - Aging techniques

pubsdm_prod | ACSJCA | JCA10.0.1465/W Unicode | research.3f (R3.6.i11:4432 | 2.0 alpha 39) 2015/07/15 14:30:00 | PROD-JCAVA | rq_6809385 | 8/11/2016 11:23:05 | 9 | JCA-DEFAULT

Environmental Science & Technology

Article

pubs.acs.org/est

Comprehensive Emerging Chemical Discovery: Novel Polyfluorinated Compounds in Lake Michigan Trout

Sadjad Fakouri Baygi,[†] Bernard S. Crimmins,*[,‡,§] Philip K. Hopke,[†,∥] and Thomas M. Holsen[‡]

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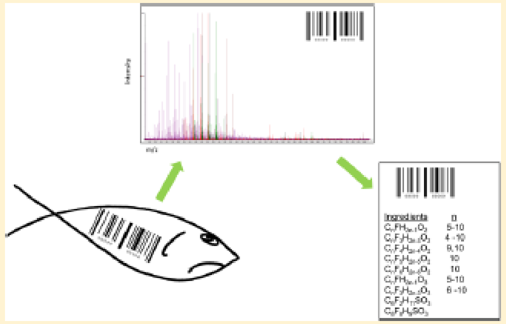
[§]AEACS, LLC, Alliance, Ohio 44601, United States

Supporting Information

ABSTRACT: A versatile screening algorithm capable of efficiently searching liquid chromatographic/mass spectrometric data for unknown compounds has been developed using a combination of open source and generic computing software packages. The script was used to search for select novel polyfluorinated contaminants in Great Lakes fish. However, the framework is applicable whenever full-scan, high-resolution mass spectral and chromatographic data are collected. Target compound classes are defined and a matrix of candidates is generated that includes monoisotopic mass spectral profiles and likely fragmentation pathways. The initial calibration was performed using a standard solution of known linear perfluoroalkyl acids. Once validated, Lake Michigan trout data files were analyzed for polyfluoroalkyl acids using the algorithm referencing 3570 possible compounds including C_4–C_{10} perfluoro- and polyfluoroalkyl, polyfluorochloroalkyl acids and sulfonates, and potential ether forms. The results suggest the presence of 30 polyfluorinated chemical formulas which have not been previously reported in the literature. The identified candidates included mono- to hexafluoroalkyl carboxylic acids, mono- and trifluoroalkyl carboxylic acid ethers, and novel polyfluoroalkyl sulfonates. Candidate species identified in lake trout were qualified using theoretical isotopic profile matching, characteristic fragmentation patterns based on known linear perfluoroalkyl acid (PFAA) fragmentation, and retention time reproducibility among replicate extractions and injections. In addition, the relative retention times of multiple species within a compound class were compared based on theoretical octanol–water partition coefficients.



Data Received

- 2015 Data starting to be submitted to EPA
  - PCBs
  - Hg
  - PBDE
  - OC Pest
  - Fatty Acid
  - PCDD/F
- Implementing a submission mechanism for CEC identification and status
- HBCD added to routine analyte list as part of GLWQA Annex 3 process

Collaborations

- USGS
  - Mercury Isotopes – David Krabbenhoft
  - Food Web – Bo Bunell
  - Legacy Contaminants – Chuck Madenjanin
- Bioeffects Working Group
  - 8 Federal Agencies & 2 Universities
  - Effects of CECs by land use with focus on mixtures
- EPA Office of Science and Technology
  - See following presentation from 2016 IAGLR

Great Lakes Fish Monitoring and Surveillance Program Collaboration on Mercury Science with USGS

Specific activities:

Great Lakes Fish Archive:

- Fish archive samples dating back nearly 40 years were secured and are presently being analyzed for their mercury, methylmercury, mercury isotopes, and C/N isotopes.
- Mercury and methylmercury results will be used to verify trends and optimize the Hg-isotope determinations
- Mercury isotope ratios can be used to infer changes in mercury sources (atmospheric versus industrial versus watershed), and pathways from sources to fish
- C/N isotopes determine trophic position and trends over time

Mercury Isotopes on Recent FMSP fish

- USGS is also contracted to analyze recently collected fish from the FMSP for mercury isotopes.

PROBABILITY-BASED ASSESSMENT OF CONTAMINANTS IN GREAT LAKES FISH FILLETS

MURPHY, E.W.[1], STAHL, L.[2], WATHEN, J.[2], SNYDER, B.[3] and McCARTY, H.[4], **[1]U.S. Environmental Protection Agency, Great Lakes National Program Office, 77 W Jackson Blvd., Chicago, IL, 60604**, USA; [2]U.S. Environmental Protection Agency, Office of Science and Technology, William Jefferson Clinton Building 1200 Pennsylvania Avenue, N. W., Washington, DC, 20460, USA; [3]Tetra Tech, 10711 Red Run Blvd., Suite 105, Owings Mills, MD, 21117, USA;[4]CSC Government Solutions LLC, 6361 Walker Lane, Suite 300, Alexandria, VA, 22310, USA.

DISCLAIMER: *THE VIEWS EXPRESSED IN THIS PRESENTATION ARE THOSE OF THE AUTHOR(S) AND DO NOT NECESSARILY REPRESENT THE VIEWS OR POLICIES OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY.*

Background

EPA's Office of Science and Technology within the Office of Water, the Great Lakes National Program Office, and the Office of Research and Development have combined resources and expertise to conduct the **first statistically based assessments** of a variety of chemicals in Great Lakes fish for human health applications.

The **Great Lakes Human Health Fish Tissue Studies** are being conducted under EPA's National Coastal Condition Assessment, one in a series of probability-based surveys designed to assess the condition of U.S. waters.

Collaborators

OW/Office of Science and Technology

- Project management
- Fish collection and tissue preparation
- Laboratory solicitation and tissue analysis oversight
- Data validation and reporting

Great Lakes National Program Office

- Technical and financial support for fish sample collection and fillet tissue analysis

ORD/National Health and Environmental Effects Laboratory

- Study design development
- Sample tracking
- Statistical analysis of tissue data

Study Design

Sampling Locations
- At least 150 randomly selected sites (about 30 per lake) in the nearshore region (depths up to 30 m or distance up to 5 km from shore)

Sample Collection
- Collected one fish composite sample from each site (optimally, 5 similarly sized adult fish of the same species that are consumed by humans)

Sample Preparation
- Shipped whole frozen fish for storage and lab prepared fillet composite samples for analysis

2010 GL HH Fish Tissue Study Design

2010 Great Lake Human Health Fish Tissue Study
157 Sampling Locations

Sample Collection: 2010

Fish Samples: 157

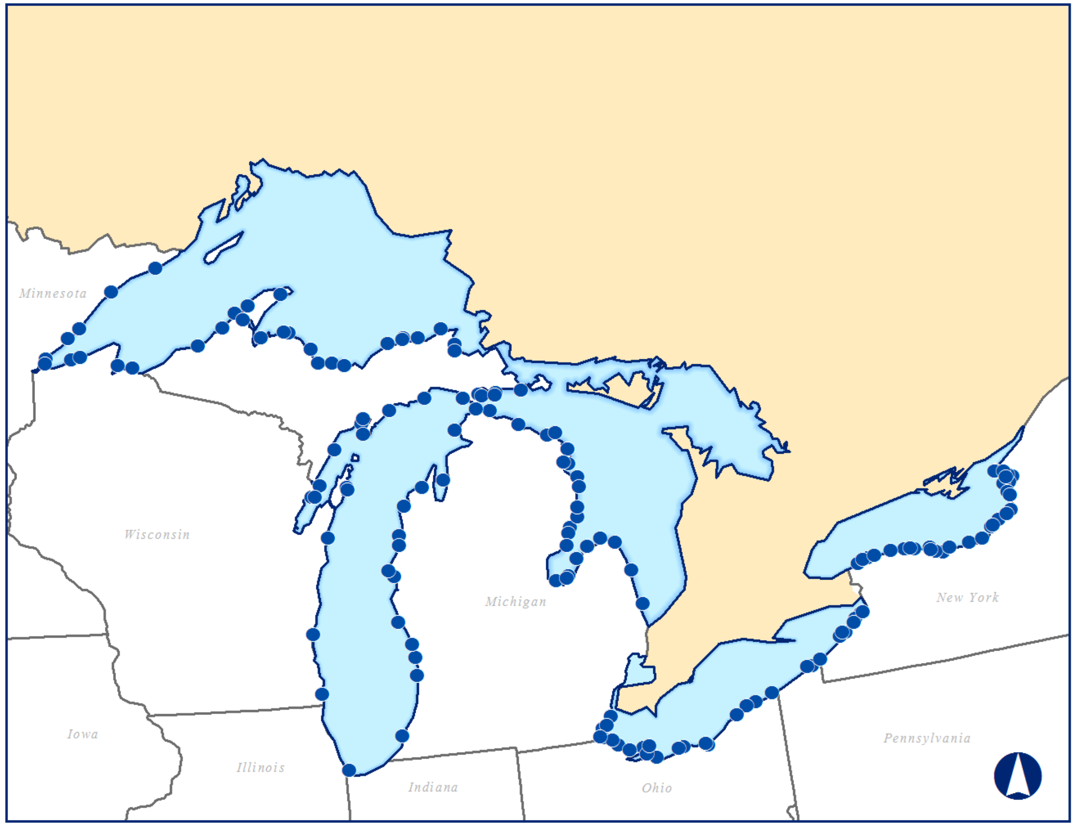
Tissue Analysis: Fillets

Target Chemicals:

- Mercury (total)
- PCBs (all 209 congeners)
- PBDEs (52 congeners)
- Other flame retardants (2)
- PFCs (13)
- Omega-3 Fatty Acids (5)

2015 GLHHFFTS Design

2015 Great Lakes Human Health Fish Fillet Tissue Study
153 Sampling Locations



Sample Collection: 2015 & 2016

Fish Samples: 153

Tissue Analysis: Fillets

Target Chemicals:

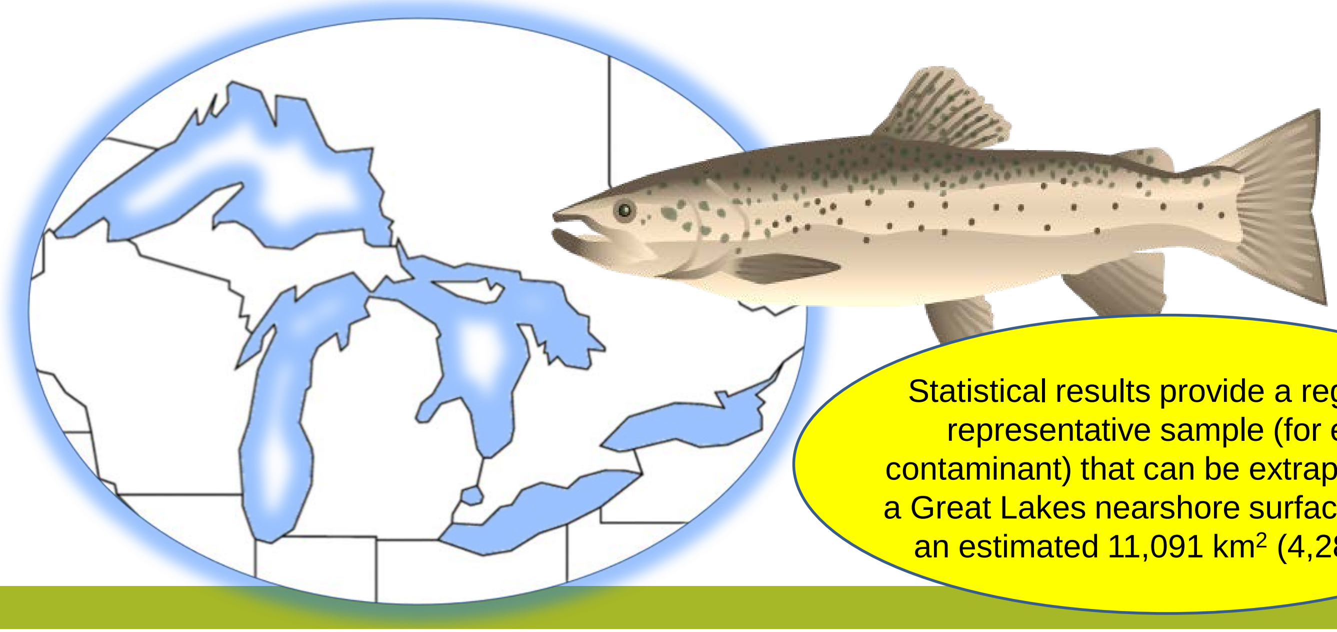
- Mercury (total)
- PCBs (all 209 congeners)
- PFCs (13)
- PCDD/Fs (17 congeners)
- Other CECs (TBD / fingerprinting)
- Omega-3 and -6 Fatty Acids

Carcass shared for microplastic assessment

Statistical Analysis

The statistical analysis process incorporates elements of the probabilistic survey design and includes:

- survey design (sample) weights adjustment based on site status
- target population estimation (i.e., number of sites that met the study definition of a nearshore Great Lakes location)
- estimation of the number and proportion of sites in the sampled population
- estimation of percentiles and cumulative distribution of tissue concentrations by chemical for the sampled population of Great Lakes locations



Statistical results provide a regionally representative sample (for each contaminant) that can be extrapolated to a Great Lakes nearshore surface area of an estimated 11,091 km^2 (4,282 mi^2)

RESULTS OF 2010 GLHHFTS

Human Health Screening Values

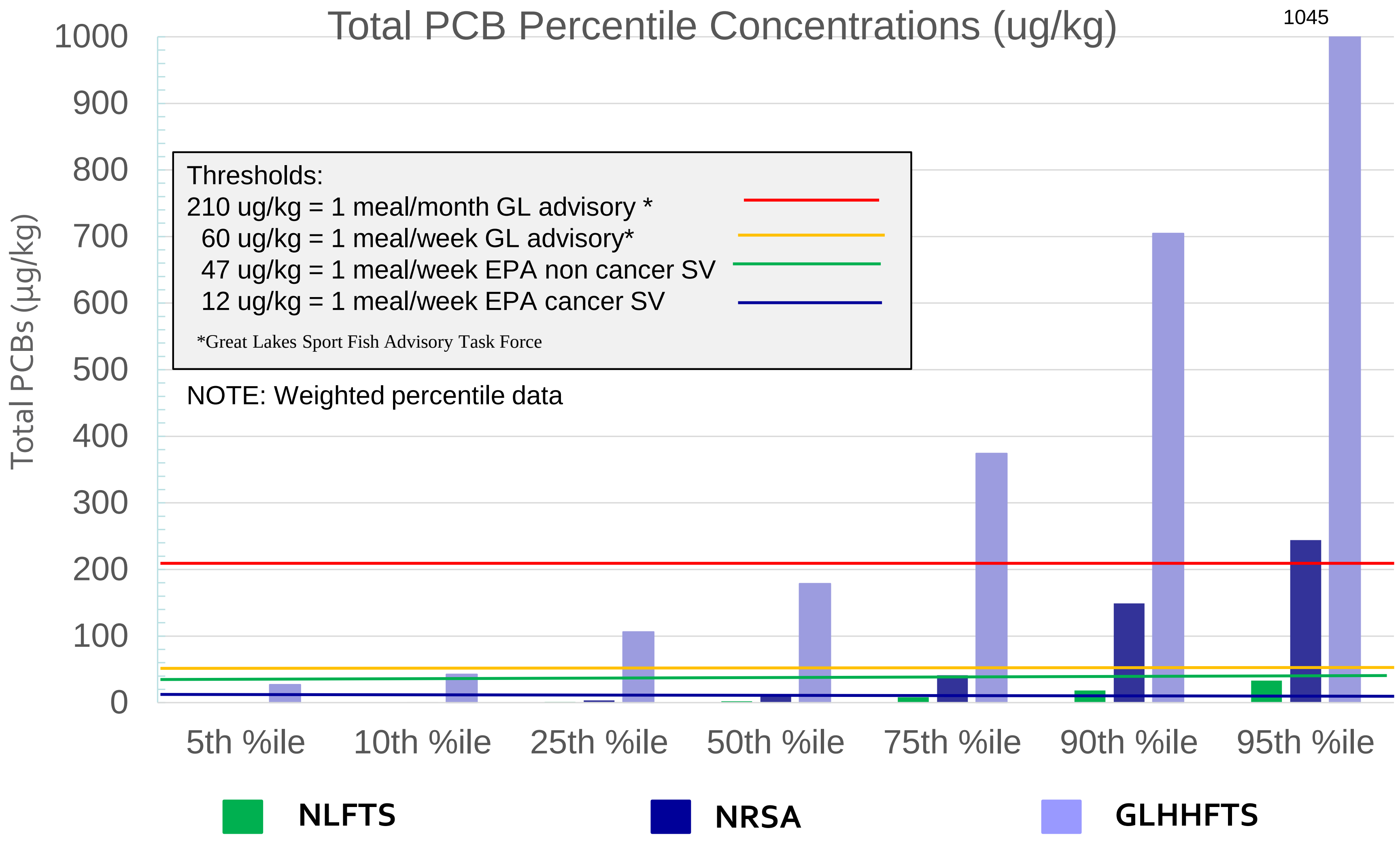
Consumption	Mercury (ppb)		PCBs (ppb)		PFOS (ppb)	PBDEs (ppb)
	Great Lakes Sport Fish Advisory Task Force[1]	EPA Water Quality Criterion[2]	Great Lakes Sport Fish Advisory Task Force[1]	EPA Fish Advisory Guidance Document[2]	Minnesota Department of Health[2]	California Environmental Protection Agency[2]
Unrestricted	0 ≤ 50	--	0 – 59	--	≤ 40	--
3 meals / week	--	--	--	--	--	≤ 100
2 meals / week	> 50≤ 110	--	--	--	--	>100 – 210
1 meal / week	> 110 ≤ 220	--	60 – 220	12	> 40 - 200	> 210 - 630
2 meals / month	--	300	--	--	--	--
1 meal / month	> 220 ≤ 950	--	221 – 1000	--	>200 - 800	--
6 meals / year	--	--	1001 – 1900	--	--	--
Do not eat	> 950	--	> 1900	--	>800	>630

[1] Sensitive populations (women of 000childbearing age and children under 15) [2] General population

Hg and PCB Results Summary

Chemical	MDL (ppb)	Detections (n)	Weighted Median (ppb)	Maximum Concentration (ppb)
Mercury	0.2	157	139.0	956.0
Total PCBs		157	178.7	2378.6

- 100% detection in samples.
- **10.9%** of the sampled population exceeded US EPA **300 ppb** fish tissue-based water quality criterion for methylmercury.
- **98.7%** of the sampled population exceeded the **12 ppb** US EPA human health screening value for PCBs (the one meal per month cancer health endpoint).


Total PCB Percentile Concentrations (ug/kg)
1045
Total PCBs (µg/kg)
1000
900
800
700
600
500
400
300
200
100
0
Thresholds:
210 ug/kg = 1 meal/month GL advisory *
60 ug/kg = 1 meal/week GL advisory*
47 ug/kg = 1 meal/week EPA non cancer SV
12 ug/kg = 1 meal/week EPA cancer SV
*Great Lakes Sport Fish Advisory Task Force
NOTE: Weighted percentile data
5th %ile
10th %ile
25th %ile
50th %ile
75th %ile
90th %ile
95th %ile
NLFTS
NRSA
GLHHFTS

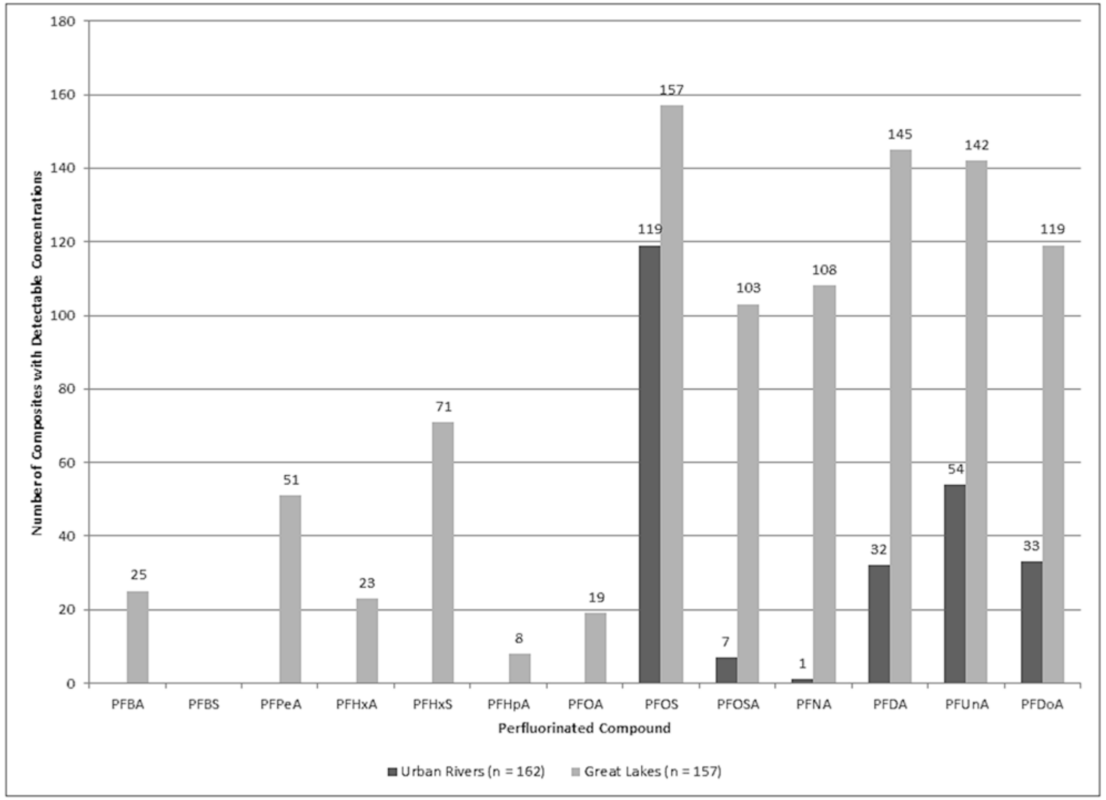
Results for 6 Most Dominant PFCs

Perfluorinated Compound	Abbreviation	MDL (ppb)	Detections (n)	Weighted Median (ppb)	Maximum Concentration (ppb)
Perfluorooctane sulfonate	PFOS	0.13	157	15.2	80.0
Perfluorooctanesulfonamide	PFOSA	0.08	103	0.15	4.20
Perfluorononanoic acid	PFNA	0.08	108	0.32	9.70
Perfluorodecanoic acid	PFDA	0.06	145	0.68	13.0
Perfluoroundecanoic acid	PFUnA	0.11	142	0.99	18.0
Perfluorododecanoic acid	PFDoA	0.12	119	0.32	3.10

- 100% of the Great Lakes samples contained some detectable PFCs.
- PFOS was the most frequently detected chemical (in 100% of samples).
- **9%** of the sampled population had PFOS tissue concentrations that exceeded the MDH **40 ppb** SV (no more than one meal per week).

PFCs in Great Lakes Fish compared to Urban Rivers

Stahl, L.L., B.D. Snyder, A.R. Olsen, T.M. Kincaid, J.B. Wathen, and H.B. McCarty. 2014. Perfluorinated compounds in fish from U.S. urban rivers and the Great Lakes. Science of the Total Environment 499:185-195.



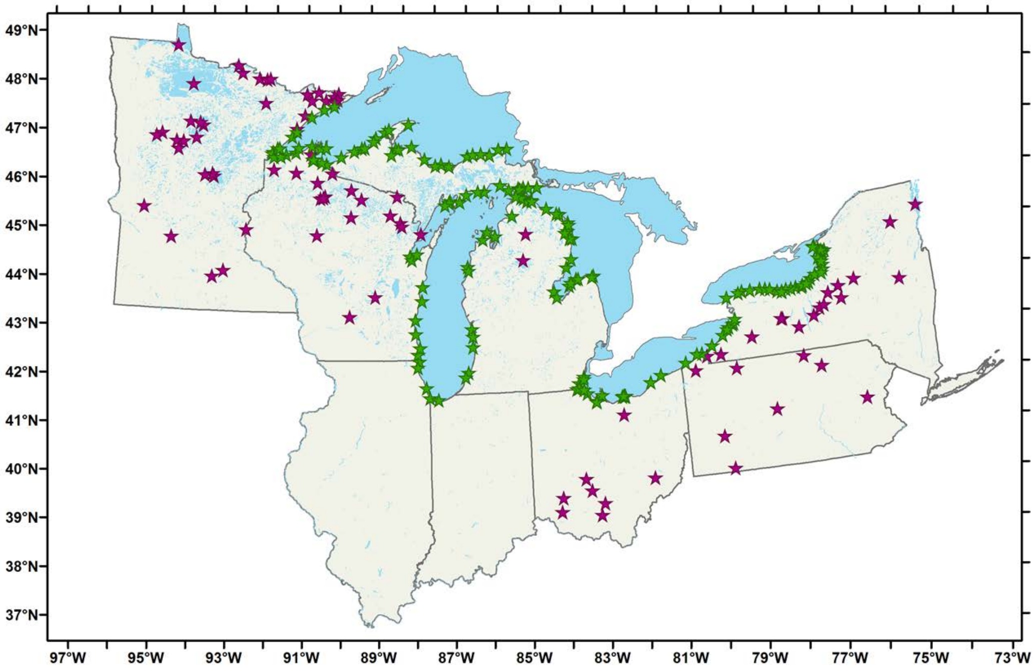
Number of fish composite samples with detectable concentrations of PFCs from urban rivers (N= 152) and the Great Lakes (N=157) (lower chain detection differences may be attributable to lower MDLs in the analytical method applied for the NCCA/GL study

PBDE Results

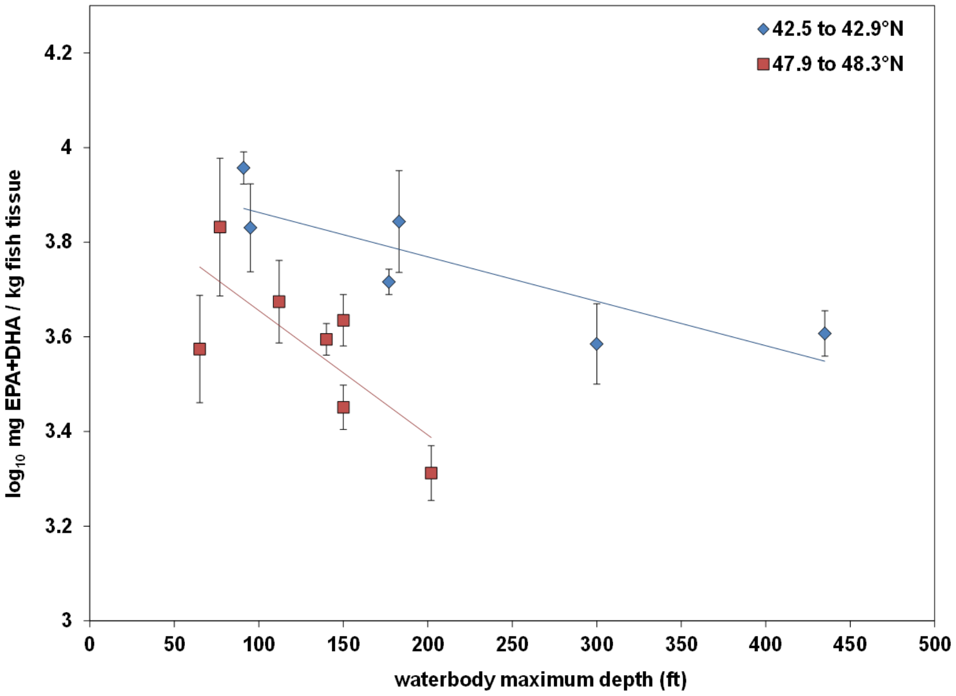
Polybrominated Diphenyl Ether Congener	MDL (ppb)	Detections (n)	Weighted Median (ppb)	Maximum Concentration (ppb)
BDE-47	.00096	157	5.42	111
BDE-49	.00029	157	0.47	10.0
BDE-99	.00300	*153*	1.88	50.2
BDE-100	.00066	157	1.84	31.1
BDE-153	.00039	157	0.45	8.4
BDE-154	.00001	157	0.90	17.7
Sum of 52 Analyzed Congeners		157	12.6	227

- 100% of the Great Lakes samples contained PBDEs.
- BDE-47, BDE-49, BDE-100, BDE-153, and BDE-154 were the most frequently detected congeners (in 100% of samples).
- **<1% of the sampled population exceeded the 210 ppb Cal EPA screening value.**

Omega-3 Fatty Acids Results



Locations from which fish were sampled for fatty acid analysis. Green stars indicate Great Lakes sampling locations; purple stars indicate inland sampling locations.



Actual EPA+DHA in lake trout sampled from lakes at various latitudes; diamonds represent lakes sampled from 42.5 – 42.9°N and squares represent lakes sampled from 47.9 – 48.3°N. At both latitude ranges there was a decrease in lake trout EPA+DHA with increasing waterbody depth.

Williams, M.C.W., Murphy, E.W., McCarty, H.B., Snyder, B.D., Schrank, C.S., McCann, P., Crimmins, B.S. *in review*. Omega-3 fatty acids EPA and DHA in fish from the Great Lakes and Great Lakes Region. Journal of Great Lakes Research.

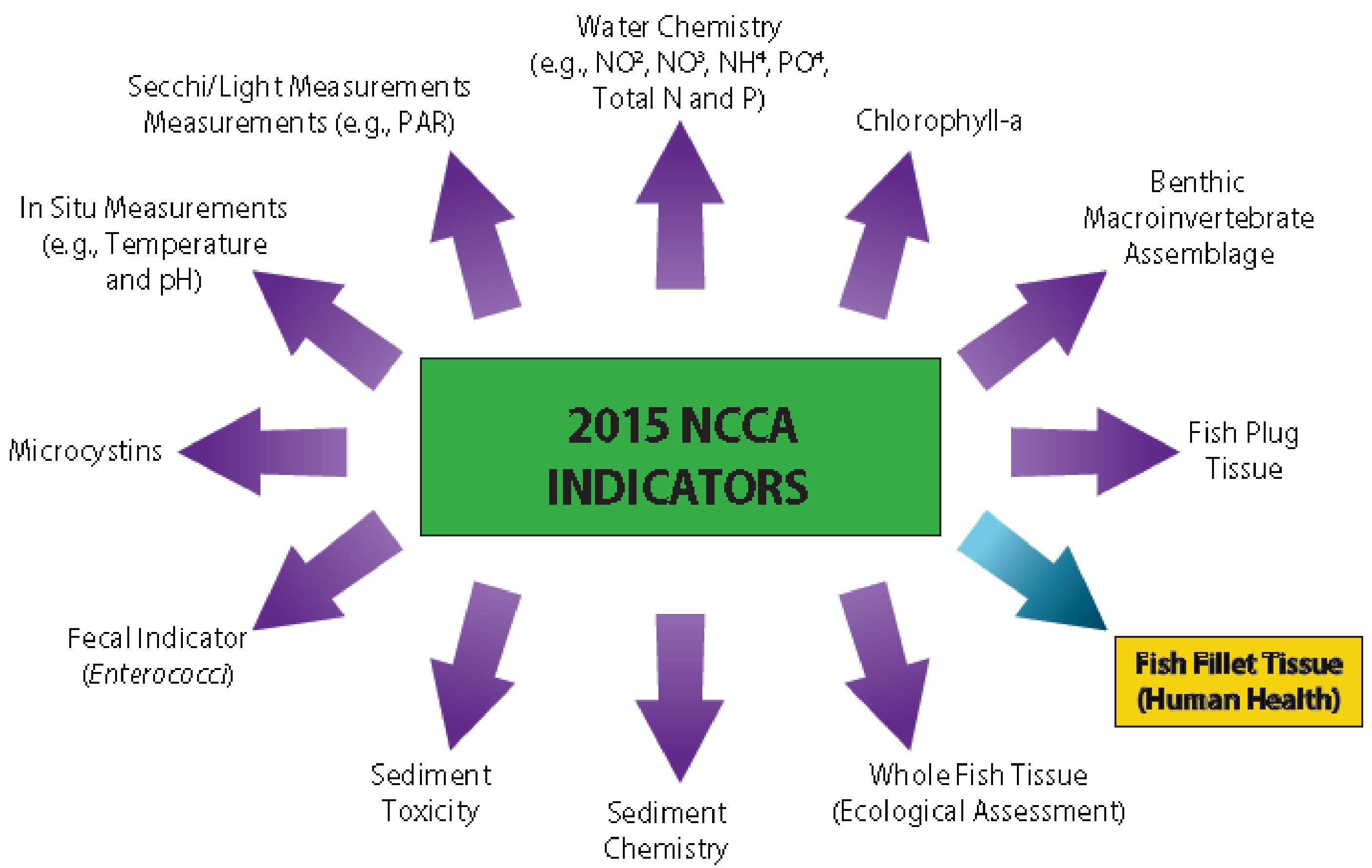
Data Reporting

Fish Tissue Data Reporting

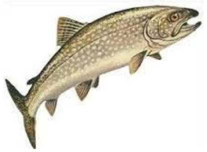
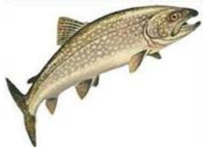
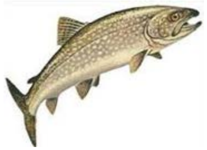
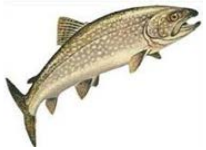
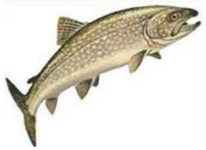
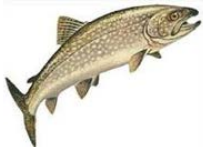
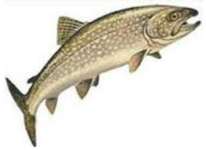
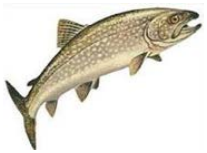
- **PFCs**
  - Stahl, L.L., B.D. Snyder, A.R. Olsen, T.M. Kincaid, J.B. Wathen, and H.B. McCarty. 2014. Perfluorinated compounds in fish from U.S. urban rivers and the Great Lakes. Science of the Total Environment 499:185-195.
- **Other contaminants**
  - Stahl, L.L., Snyder, B.D., Murphy, E.W., Olsen, A.R., Kincaid, T.M., McCarty, H.B., Wathen, J.B. In preparation. A Probability-Based Assessment of Contaminants in Great Lakes Fish. Journal of Great Lakes Research.
- **Omega-3 Fatty Acids**
  - Williams, M.C.W., Murphy, E.W., McCarty, H.B., Snyder, B.D., Schrank, C.S., McCann, P., Crimmins, B.S. *in review*. Omega-3 fatty acids EPA and DHA in fish from the Great Lakes and Great Lakes Region. Journal of Great Lakes Research.

2015 GLHHFFTS

2015 NCCA Indicators



Current Status

	Fish Sample Collection	Fish Tissue Sample Preparation	Fish Tissue Sample Analysis	Statistical Data Analysis	Reporting	Anticipated Completion
2008-09 NRSA						2016
2010 GLHHFTS						2017
2013-14 NRSA						2018
2015 GLHHFFTS						2019

National Fish Tissue Data Repository

What is it?

Comprehensive dataset and database of both EPA and state fish tissue contaminant data for use in human health assessments.

What will it contain?

- **EPA fish tissue data**
  - **National Lake Fish Tissue Study**: fillet and whole body tissue concentrations for 314 chemicals
  - **2008–09 National Rivers and Streams Assessment**: fillet tissue concentrations for 66 chemicals
  - **2010 Great Lakes Human Health Fish Tissue Study**: fillet concentrations for 232 chemicals
  - **2013 – 14 National Rivers and Streams Assessment** fillet tissue concentrations for 173 chemicals
  - **More than 361,000 fish tissue results**

Where is it?

https://www.epa.gov/fish-tech/studies-fish-contamination

Acknowledge Authors

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  - Wathen.John@epa.gov
- Elizabeth Murphy – EPA GLNPO
  - Murphy.Elizabeth@epa.gov
- Blaine Snyder – Tetra Tech
- Harry McCarty – CSGov

&

Questions

Appendix B:
Brochure Development

Brochure Development

Four versions of the brochure were developed for each state for the Diary Study. Versions included common core messages to allow all versions to be effective interventions. Core messages were chosen to encourage women of childbearing age to eat fish and to follow fish consumption guidelines. Two experimental contrasts were also incorporated into the brochures. Potentially high-impact strategies found to be effective in other contexts were considered for incorporation into some versions to test whether these strategies increase the persuasiveness of fish consumption messages. A description of six strategies (including reviews of the communication, risk, health, and natural resource literatures to offer guidance on fish advisory messages development) is in Appendix B2, Summary of Potential High Impact Communication Strategies.

The two experimental contrasts chosen for the Diary Study brochure experiment were: (a) narrative versus non-narrative format, and (b) certainty versus uncertainty language for fish consumption advisory recommendations. For example, brochures using language about “safe” fish consumption (indicating more certainty) were contrasted with brochures using language about “healthier choices” and “reduced risk” (indicating more uncertainty).

The first step in the development of the brochures was to identify which messages about safe fish consumption resonated most with the target audience. Messages were pretested to refine the wording and content. Several variants of the messages were developed. Health Partners Institute (HP) then surveyed women of childbearing age to test the receptivity to different statements about fish consumption. Women completed the survey via the internet or by phone. Respondents evaluated two types of statements: reasons for eating fish and reasons for following fish consumption guidelines. Respondents also evaluated sources of information (e.g. physicians, scientists, experts). See Appendix B3, Key Message Testing.

After testing by HP lead to tentative selection of a final set of messages, Essentia Health conducted focus groups to assess response to these messages by women living in northern Minnesota. Women living in this region may have different characteristics than women living elsewhere in Minnesota, and these focus groups helped assess whether the language used in the messages is accessible to a wide range of women. The focus groups: (a) further explored the response of women of childbearing age to the messages tested in the HP survey; and (b) tested response to draft narratives to refine and improve those narratives. See Appendix B4, Focus Groups.

Women of child-bearing age in each of the eight Great Lakes states were randomly assigned to treatment (receiving one of the four versions of the brochure, varying two key characteristics) and control groups (receiving no brochure):

- **Narratives vs. Non-narrative Information.** Half the versions of the brochure communicated key information in the form of a narrative (story) about an individual in the target audience. The other half of the brochures communicated the same information in a non-narrative format. For this non-narrative format, a question-and-answer format, “Frequently Asked Questions about Eating Fish”, was adopted.
- **High Uncertainty vs. Low Uncertainty.** Half the versions of the brochure communicated more uncertainty about the health effects of eating fish and the other half communicated less uncertainty. The amount of uncertainty was varied in two ways: (1) the “high uncertainty”

brochures included 2 additional statements (communicating uncertainty) as part of the core messages that appeared on the back cover; and (2) individual words and phrases were varied throughout the core messages, narratives, and frequently asked questions to reflect more or less uncertainty.

Four variations of the brochure were designed for use in each state: (1) narratives and high uncertainty; (2) narratives and low uncertainty; (3) non-narratives and high uncertainty; and (4) non-narratives and low uncertainty. See brochures below.

Appendix B1:
State Brochures

Your guide to eating FISH & SHELLFISH

Fish is an important part of a healthy diet for all women. It is even more important for women who are pregnant, breastfeeding, or might become pregnant.

Frequently Asked Questions
about Eating Fish

I heard that eating fish has risks for women who might become pregnant – is this true?

Certain fish are actually a great source of omega-3s. Omega-3s are important for a baby's development and are not found in many other foods. Fish are also a very nutritious food for children to eat as they grow.

But aren't there harmful chemicals in fish, too?

Some types of fish contain higher levels of chemicals like mercury or PCBs, but many fish are healthy for women and children to eat.

Where can I find out which fish are healthy to eat and which I should avoid?

New York State's "Health Advice for Eating Fish You Catch" can help you to choose which fish are healthiest to eat and which you should avoid. These guidelines can be found in this brochure!

New York Health Advice for Eating Fish you Catch for Women Under 50 and Children Under 15: Great Lakes Waters

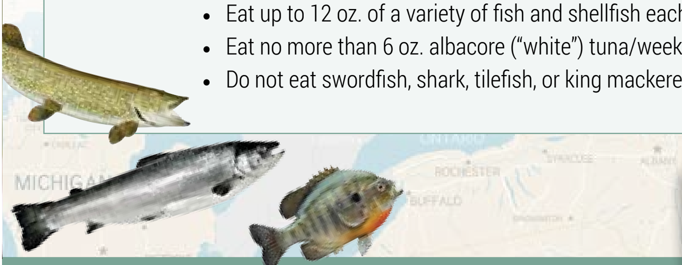
WATERBODY[1] (COUNTY)	FISH	WOMEN UNDER 50 & CHILDREN UNDER 15
All waters NOT listed (Great Lakes and nearby waters)	All fish	Up to 4 meals/month
Lake Erie (Chautauqua, Erie)	Rock bass, Yellow perch, Burbot	Up to 4 meals/month
	Carp, Channel catfish	DON'T EAT
	All other fish	Up to 1 meal/month
Lake Ontario[2] including Irondequoit Bay (Niagara, Oswego, Monroe, Jefferson, Orleans, Cayuga, Wayne)	All fish	DON'T EAT
Niagara River, downstream of Niagara Falls (Niagara)	All fish	DON'T EAT
Niagara River upstream of Niagara Falls (Niagara, Erie)	Carp, Channel catfish	DON'T EAT
	Rock bass, Yellow perch, Burbot	Up to 4 meals/month
	All other fish	Up to 1 meal/month
St. Lawrence River (Franklin, Jefferson, St. Lawrence)	All fish	DON'T EAT

[1]The specific advice for waters also applies to tributaries and connected waters if there are no dams, falls or barriers to stop the fish from moving upstream. For complete fish advice for New York State, go to http://www.health.ny.gov/publications/2800.pdf.
[2]Harvest/possession of American eel is prohibited per NYS DEC regulations. See www.dec.ny.gov/outdoor/fishing.html for fishing regulations.

PURCHASED FISH GUIDELINES

(from the U.S. Environmental Protection Agency and Food and Drug Administration)

- Eat up to 12 oz. of a variety of fish and shellfish each week.
- Eat no more than 6 oz. albacore ("white") tuna/week.
- Do not eat swordfish, shark, tilefish, or king mackerel.



WHAT IS A MEAL?
A half-pound of fish

THE FACTS ON FISH

Fish is an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish lowers the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant helps brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who do better developmentally.

Most fish are a healthy food, but eating some types of fish raises health risks over time.

- Some types of fish from some lakes and streams contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals build up in your body. Eventually, they can cause health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthy for you and your family to eat.

- See the guidelines in this brochure from the New York State Department of Health, the EPA, and the FDA.
- These guidelines tell which fish are the healthiest to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines will keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

http://www.health.ny.gov/publications/2800.pdf

Form 4

Produced by Cornell University in cooperation with the New York State Department of Health

Your guide to eating
FISH & SHELLFISH

Fish is an important part of a healthy diet for all women. It is even more important for women who are pregnant, breastfeeding, or might become pregnant.

Do you think eating fish has risks for women who might become pregnant?

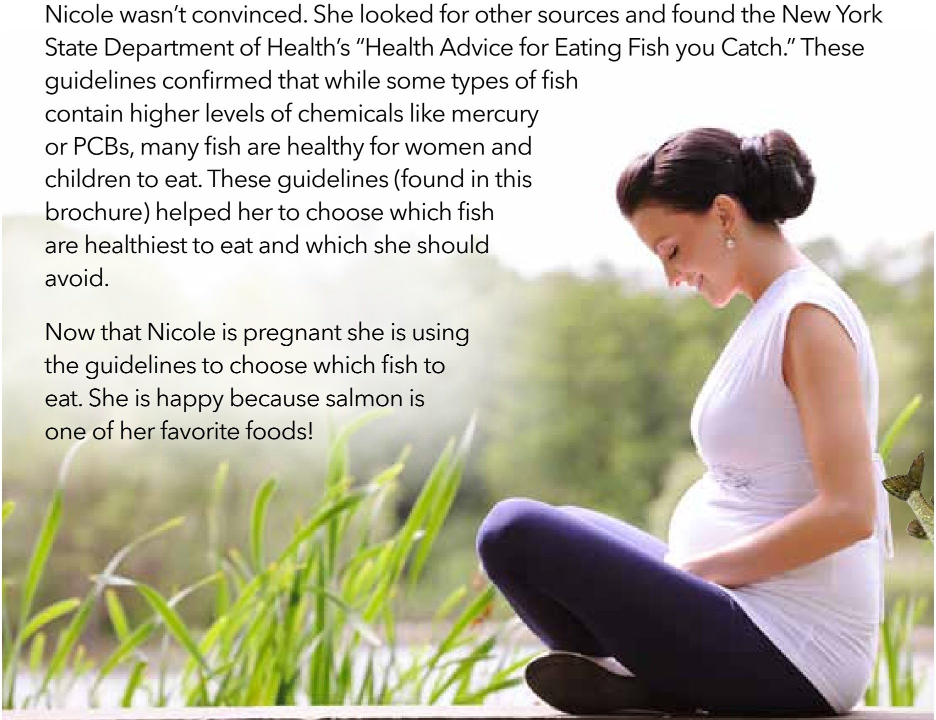
Like Nicole, you might be surprised to learn that fish is an important part of a healthy diet.

After being away for several years, Nicole and Chris recently moved back to their hometown of Buffalo, New York. They decided it was time to try to have a baby. A baby is a big change, so Nicole began doing her homework on exercise and nutrition that would help her have a healthy baby.

Nicole found a website with guidelines about eating fish for women of childbearing age. The website explained that, although many women don't eat fish before and during pregnancy, certain fish are actually a great source of omega-3s. Omega-3s are important for a baby's development and are not found in many other foods. Fish are also a very nutritious food for children to eat as they grow.

Nicole wasn't convinced. She looked for other sources and found the New York State Department of Health's "Health Advice for Eating Fish you Catch." These guidelines confirmed that while some types of fish contain higher levels of chemicals like mercury or PCBs, many fish are healthy for women and children to eat. These guidelines (found in this brochure) helped her to choose which fish are healthiest to eat and which she should avoid.

Now that Nicole is pregnant she is using the guidelines to choose which fish to eat. She is happy because salmon is one of her favorite foods!



New York Health Advice for Eating Fish you Catch for Women Under 50 and Children Under 15: Great Lakes Waters

WATERBODY[1] (COUNTY)	FISH	WOMEN UNDER 50 & CHILDREN UNDER 15
All waters NOT listed (Great Lakes and nearby waters)	All fish	Up to 4 meals/month
Lake Erie (Chautauqua, Erie)	Rock bass, Yellow perch, Burbot	Up to 4 meals/month
	Carp, Channel catfish	DON'T EAT
	All other fish	Up to 1 meal/month
Lake Ontario[2] including Irondequoit Bay (Niagara, Oswego, Monroe, Jefferson, Orleans, Cayuga, Wayne)	All fish	DON'T EAT
Niagara River, downstream of Niagara Falls (Niagara)	All fish	DON'T EAT
Niagara River upstream of Niagara Falls (Niagara, Erie)	Carp, Channel catfish	DON'T EAT
	Rock bass, Yellow perch, Burbot	Up to 4 meals/month
	All other fish	Up to 1 meal/month
St. Lawrence River (Franklin, Jefferson, St. Lawrence)	All fish	DON'T EAT

[1]The specific advice for waters also applies to tributaries and connected waters if there are no dams, falls or barriers to stop the fish from moving upstream. For complete fish advice for New York State, go to http://www.health.ny.gov/publications/2800.pdf.
[2]Harvest/possession of American eel is prohibited per NYS DEC regulations. See www.dec.ny.gov/outdoor/fishing.html for fishing regulations.

PURCHASED FISH GUIDELINES

(from the U.S. Environmental Protection Agency and Food and Drug Administration)

- Eat up to 12 oz. of a variety of fish and shellfish each week.
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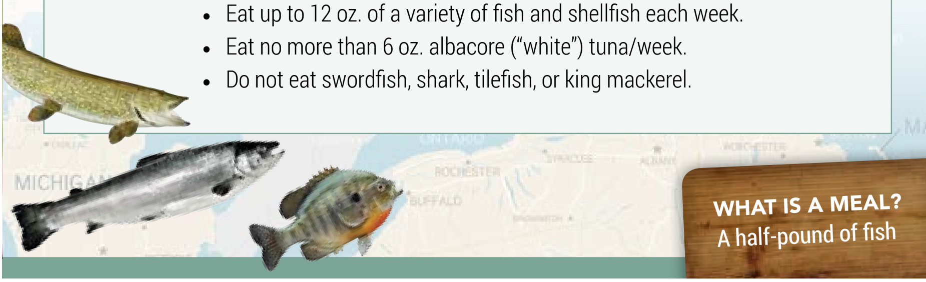
- Do not eat swordfish, shark, tilefish, or king mackerel.



THE FACTS ON FISH

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- Eating fish with omega-3s while pregnant helps brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who do better developmentally.

Most fish are a healthy food, but eating some types of fish raises health risks over time.

- Some types of fish from some lakes and streams contain harmful chemicals such as PCBs and mercury.
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- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthy for you and your family to eat.

- See the guidelines in this brochure from the New York State Department of Health, the EPA, and the FDA.
- These guidelines tell which fish are the healthiest to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines will keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

http://www.health.ny.gov/publications/2800.pdf

Form 2

Produced by Cornell University in cooperation with the New York State Department of Health

Your guide to eating
FISH & SHELLFISH

Fish can be an important part of a healthy diet for all women. It may be even more important for women who are pregnant, breastfeeding, or might become pregnant.

Frequently Asked Questions
about Eating Fish

I heard that eating fish may have risks for women who might become pregnant – is this true?

Certain fish are actually a great source of omega-3s. Omega-3s may be important for a baby's development and are not found in many other foods. Fish can also be a very nutritious food for children to eat as they grow.

But aren't there harmful chemicals in fish, too?

Some types of fish contain higher levels of chemicals like mercury or PCBs, but many fish can be healthy for women and children to eat.

Where can I find out which fish are healthier to eat and which I should avoid?

New York State's "Health Advice for Eating Fish you Catch" can help you to choose which fish are healthier to eat and which you should try to avoid. These guidelines can be found in this brochure!

New York Health Advice for Eating Fish you Catch for Women Under 50 and Children Under 15: Great Lakes Waters

WATERBODY[1] (COUNTY)	FISH	WOMEN UNDER 50 & CHILDREN UNDER 15
All waters NOT listed (Great Lakes and nearby waters)	All fish	Up to 4 meals/month
Lake Erie (Chautauqua, Erie)	Rock bass, Yellow perch, Burbot	Up to 4 meals/month
	Carp, Channel catfish	DON'T EAT
	All other fish	Up to 1 meal/month
Lake Ontario[2] including Irondequoit Bay (Niagara, Oswego, Monroe, Jefferson, Orleans, Cayuga, Wayne)	All fish	DON'T EAT
Niagara River, downstream of Niagara Falls (Niagara)	All fish	DON'T EAT
Niagara River upstream of Niagara Falls (Niagara, Erie)	Carp, Channel catfish	DON'T EAT
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	All other fish	Up to 1 meal/month
St. Lawrence River (Franklin, Jefferson, St. Lawrence)	All fish	DON'T EAT

[1]The specific advice for waters also applies to tributaries and connected waters if there are no dams, falls or barriers to stop the fish from moving upstream. For complete fish advice for New York State, go to http://www.health.ny.gov/publications/2800.pdf.
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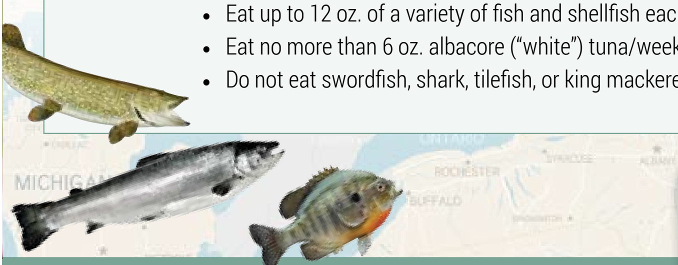

WHAT IS A MEAL?
A half-pound of fish

THE FACTS ON FISH

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- Eating fish with omega-3s while pregnant may help brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who may do better developmentally.

Most fish are a healthy food, but eating some types of fish may raise health risks over time.

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- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthier for you and your family to eat.

- See the guidelines in this brochure from the New York State Department of Health, the EPA, and the FDA.
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FOR MORE INFORMATION VISIT:

http://www.health.ny.gov/publications/2800.pdf

Form 3

Produced by Cornell University in cooperation with the New York State Department of Health



Your guide to eating FISH & SHELLFISH

Fish can be an important part of a healthy diet for all women. It may be even more important for women who are pregnant, breastfeeding, or might become pregnant.

Do you think eating fish may have risks for women who might become pregnant?

Like Nicole, you might be surprised to learn that fish can be an important part of a healthy diet.

After being away for several years, Nicole and Chris recently moved back to their hometown of Buffalo, New York. They decided it was time to try to have a baby. A baby is a big change, so Nicole began doing her homework on exercise and nutrition that would help her have a healthy baby.

Nicole found a website with guidelines about eating fish for women of childbearing age. The website explained that, although many women don't eat fish before and during pregnancy, certain fish are actually a great source of omega-3s. Omega-3s may be important for a baby's development and are not found in many other foods. Fish can also be a very nutritious food for children to eat as they grow.

Nicole wasn't convinced. She looked for other sources and found the New York State Department of Health's "Health Advice for Eating Fish You Catch." These guidelines confirmed that while some types of fish contain higher levels of chemicals like mercury or PCBs, many fish can be healthy for women and children to eat. These guidelines (found in this brochure) helped her to choose which fish are healthier to eat and which she should try to avoid.

Now that Nicole is pregnant she is using the guidelines to choose which fish to eat. She is happy because salmon is one of her favorite foods!

New York Health Advice for Eating Fish you Catch for Women Under 50 and Children Under 15: Great Lakes Waters

WATERBODY[1] (COUNTY)	FISH	WOMEN UNDER 50 & CHILDREN UNDER 15
All waters NOT listed (Great Lakes and nearby waters)	All fish	Up to 4 meals/month
Lake Erie (Chautauqua, Erie)	Rock bass, Yellow perch, Burbot	Up to 4 meals/month
	Carp, Channel catfish	DON'T EAT
	All other fish	Up to 1 meal/month
Lake Ontario[2] including Irondequoit Bay (Niagara, Oswego, Monroe, Jefferson, Orleans, Cayuga, Wayne)	All fish	DON'T EAT
Niagara River, downstream of Niagara Falls (Niagara)	All fish	DON'T EAT
Niagara River upstream of Niagara Falls (Niagara, Erie)	Carp, Channel catfish	DON'T EAT
	Rock bass, Yellow perch, Burbot	Up to 4 meals/month
	All other fish	Up to 1 meal/month
St. Lawrence River (Franklin, Jefferson, St. Lawrence)	All fish	DON'T EAT

[1]The specific advice for waters also applies to tributaries and connected waters if there are no dams, falls or barriers to stop the fish from moving upstream. For complete fish advice for New York State, go to http://www.health.ny.gov/publications/2800.pdf.
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PURCHASED FISH GUIDELINES

(from the U.S. Environmental Protection Agency and Food and Drug Administration)

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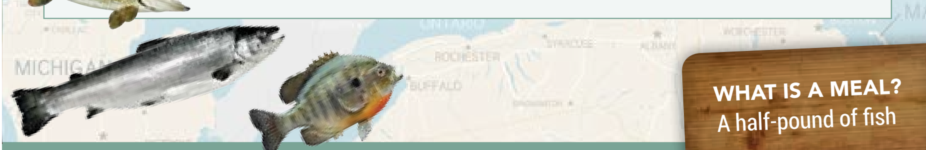

THE FACTS ON FISH

Fish can be an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish may lower the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant may help brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who may do better developmentally.

Most fish are a healthy food, but eating some types of fish may raise health risks over time.

- Some types of fish from some lakes and streams may contain harmful chemicals such as PCBs and mercury.
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Health experts can help you know which fish are healthier for you and your family to eat.

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- These guidelines tell which fish are healthier to eat.
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FOR MORE INFORMATION VISIT:

http://www.health.ny.gov/publications/2800.pdf

Form 1

Produced by Cornell University in cooperation with the New York State Department of Health



Your guide to eating
FISH & SHELLFISH

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Frequently Asked Questions
about Eating Fish

I heard that eating fish has risks for women who might become pregnant – is this true?

Certain fish are actually a great source of omega-3s. Omega-3s are important for a baby's development and are not found in many other foods. Fish are also a very nutritious food for children to eat as they grow.

But aren't there harmful chemicals in fish, too?

Some types of fish contain higher levels of chemicals like mercury or PCBs, but many fish are healthy for women and children to eat.

Where can I find out which fish are healthy to eat and which I should avoid?

Pennsylvania's Fish Consumption Advice can help you to choose which fish are healthiest to eat and which you should avoid. These guidelines can be found in this brochure!

Pennsylvania Fish Consumption Advice

STATEWIDE GUIDELINES FOR FISH YOU CATCH

KIND OF FISH	HOW OFTEN?
All fish	1 meal/week

For complete fish consumption advice for Pennsylvania, go to
http://www.portal.state.pa.us/portal/server.pt?open=514&objID=554001&mode=2

LAKE ERIE GUIDELINES

KIND OF FISH	HOW OFTEN?
Walleye, Coho salmon, Steelhead (Rainbow trout), Brown trout, Smallmouth bass, White perch, White bass, Lake whitefish, Carp (<20"), Freshwater drum, Lake trout (<30"), Channel catfish	1 meal/month
Carp (>20"), Lake trout (>30")	Do Not Eat

The advice for Lake Erie also applies to tributary streams.

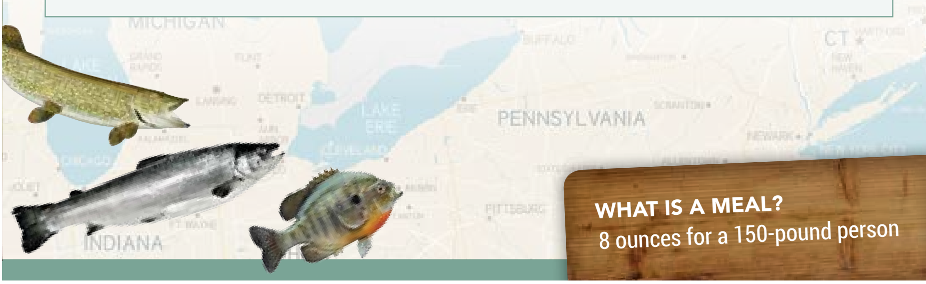
PRESQUE ISLE BAY GUIDELINES

KIND OF FISH	HOW OFTEN?
Smallmouth bass, Northern pike, White perch, Freshwater drum, Bowfin, Carp, Coho salmon, Steelhead (Rainbow trout), Brown trout	1 meal/month

PURCHASED FISH GUIDELINES

(from the U.S. Environmental Protection Agency and Food and Drug Administration)

- Eat up to 12 oz. of a variety of fish and shellfish each week.
- Eat no more than 6 oz. albacore ("white") tuna/week.
- Do not eat swordfish, shark, tilefish, or king mackerel.



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- Eating fish with omega-3s while pregnant helps brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who do better developmentally.

Most fish are a healthy food, but eating some types of fish raises health risks over time.

- Some types of fish from some lakes and streams contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals build up in your body. Eventually, they can cause health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthy for you and your family to eat.

- See the guidelines in this brochure from the Pennsylvania Department of Environmental Protection, the EPA, and the FDA.
- These guidelines tell which fish are the healthiest to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines will keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.portal.state.pa.us/portal/server.pt?open=514&objID=554001&mode=2

Form 8

Produced by Cornell University in cooperation with the Pennsylvania Department of Environmental Protection

  

Your guide to eating
FISH & SHELLFISH

Fish is an important part of a healthy diet for all women. It is even more important for women who are pregnant, breastfeeding, or might become pregnant.

Do you think eating fish has risks for women who might become pregnant?

Like Megan, you might be surprised to learn that fish is an important part of a healthy diet.

After being away for several years, Megan and Dan recently moved back to their hometown of Erie, Pennsylvania. They decided it was time to try to have a baby. A baby is a big change, so Megan began doing her homework on exercise and nutrition that would help her have a healthy baby.

Megan found a website with guidelines about eating fish for women of childbearing age. The website explained that, although many women don't eat fish before and during pregnancy, certain fish are actually a great source of omega-3s. Omega-3s are important for a baby's development and are not found in many other foods. Fish are also a very nutritious food for children to eat as they grow.

Megan wasn't convinced. She looked for other sources and found the Pennsylvania Department of Environmental Protection's Fish Consumption Advice. These guidelines confirmed that while some types of fish contain higher levels of chemicals like mercury or PCBs, many fish are healthy for women and children to eat. These guidelines (found in this brochure) helped her to choose which fish are healthiest to eat and which she should avoid.

Now that Megan is pregnant she is using the guidelines to choose which fish to eat. She is happy because salmon is one of her favorite foods!

Pennsylvania Fish Consumption Advice

STATEWIDE GUIDELINES FOR FISH YOU CATCH

KIND OF FISH	HOW OFTEN?
All fish	1 meal/week

For complete fish consumption advice for Pennsylvania, go to
http://www.portal.state.pa.us/portal/server.pt?open=514&objID=554001&mode=2

LAKE ERIE GUIDELINES

KIND OF FISH	HOW OFTEN?
Walleye, Coho salmon, Steelhead (Rainbow trout), Brown trout, Smallmouth bass, White perch, White bass, Lake whitefish, Carp (<20"), Freshwater drum, Lake trout (<30"), Channel catfish	1 meal/month
Carp (>20"), Lake trout (>30")	Do Not Eat

The advice for Lake Erie also applies to tributary streams.

PRESQUE ISLE BAY GUIDELINES

KIND OF FISH	HOW OFTEN?
Smallmouth bass, Northern pike, White perch, Freshwater drum, Bowfin, Carp, Coho salmon, Steelhead (Rainbow trout), Brown trout	1 meal/month

PURCHASED FISH GUIDELINES

(from the U.S. Environmental Protection Agency and Food and Drug Administration)

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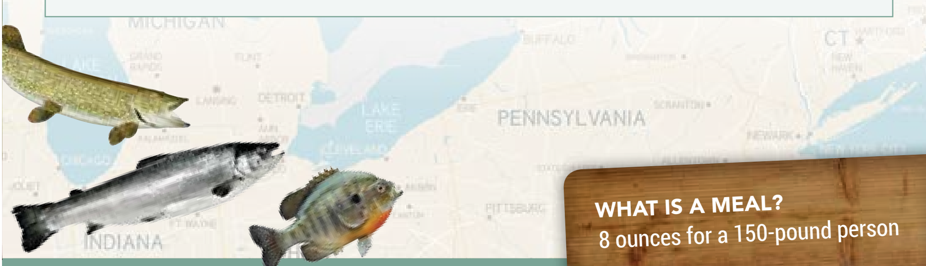

WHAT IS A MEAL?
8 ounces for a 150-pound person

THE FACTS ON FISH

Fish is an important part of a healthy diet for all women.

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FOR MORE INFORMATION VISIT:

www.portal.state.pa.us/portal/server.pt?open=514&objID=554001&mode=2

Form 6

Produced by Cornell University in cooperation with the Pennsylvania Department of Environmental Protection

Your guide to eating
FISH & SHELLFISH

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Frequently Asked Questions
about Eating Fish

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Pennsylvania Fish Consumption Advice

STATEWIDE GUIDELINES FOR FISH YOU CATCH

KIND OF FISH	HOW OFTEN?
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LAKE ERIE GUIDELINES

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Carp (>20"), Lake trout (>30")	Do Not Eat

The advice for Lake Erie also applies to tributary streams.

PRESQUE ISLE BAY GUIDELINES

KIND OF FISH	HOW OFTEN?
Smallmouth bass, Northern pike, White perch, Freshwater drum, Bowfin, Carp, Coho salmon, Steelhead (Rainbow trout), Brown trout	1 meal/month

PURCHASED FISH GUIDELINES

(from the U.S. Environmental Protection Agency and Food and Drug Administration)

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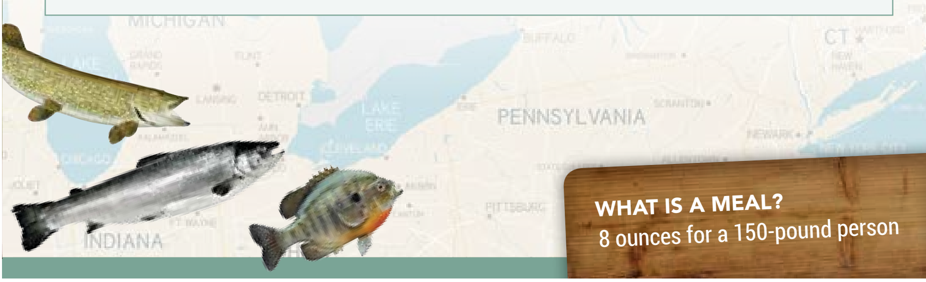

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FOR MORE INFORMATION VISIT:

www.portal.state.pa.us/portal/server.pt?open=514&objID=554001&mode=2

Form 7

Produced by Cornell University in cooperation with the Pennsylvania Department of Environmental Protection

Your guide to eating FISH & SHELLFISH

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Do you think eating fish may have risks for women who might become pregnant?

Like Megan, you might be surprised to learn that fish can be an important part of a healthy diet.

After being away for several years, Megan and Dan recently moved back to their hometown of Erie, Pennsylvania. They decided it was time to try to have a baby. A baby is a big change, so Megan began doing her homework on exercise and nutrition that would help her have a healthy baby.

Megan found a website with guidelines about eating fish for women of childbearing age. The website explained that, although many women don't eat fish before and during pregnancy, certain fish are actually a great source of omega-3s. Omega-3s may be important for a baby's development and are not found in many other foods. Fish can also be a very nutritious food for children to eat as they grow.

Megan wasn't convinced. She looked for other sources and found the Pennsylvania Department of Environmental Protection's Fish Consumption Advice. These guidelines confirmed that while some types of fish contain higher levels of chemicals like mercury or PCBs, many fish can be healthy for women and children to eat. These guidelines (found in this brochure) helped her to choose which fish are healthier to eat and which she should try to avoid.

Now that Megan is pregnant she is using the guidelines to choose which fish to eat. She is happy because salmon is one of her favorite foods!

Pennsylvania Fish Consumption Advice

STATEWIDE GUIDELINES FOR FISH YOU CATCH

KIND OF FISH	HOW OFTEN?
All fish	1 meal/week

For complete fish consumption advice for Pennsylvania, go to
http://www.portal.state.pa.us/portal/server.pt?open=514&objID=554001&mode=2

LAKE ERIE GUIDELINES

KIND OF FISH	HOW OFTEN?
Walleye, Coho salmon, Steelhead (Rainbow trout), Brown trout, Smallmouth bass, White perch, White bass, Lake whitefish, Carp (<20"), Freshwater drum, Lake trout (<30"), Channel catfish	1 meal/month
Carp (>20"), Lake trout (>30")	Do Not Eat

The advice for Lake Erie also applies to tributary streams.

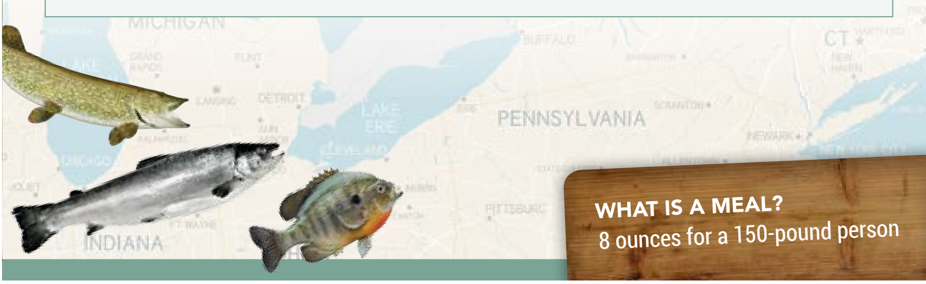
PRESQUE ISLE BAY GUIDELINES

KIND OF FISH	HOW OFTEN?
Smallmouth bass, Northern pike, White perch, Freshwater drum, Bowfin, Carp, Coho salmon, Steelhead (Rainbow trout), Brown trout	1 meal/month

PURCHASED FISH GUIDELINES

(from the U.S. Environmental Protection Agency and Food and Drug Administration)

- Eat up to 12 oz. of a variety of fish and shellfish each week.
- Eat no more than 6 oz. albacore ("white") tuna/week.
- Do not eat swordfish, shark, tilefish, or king mackerel.



THE FACTS ON FISH

Fish can be an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish may lower the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant may help brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who may do better developmentally.

Most fish are a healthy food, but eating some types of fish may raise health risks over time.

- Some types of fish from some lakes and streams may contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals can build up in your body. Eventually, they may cause health problems.
- It is difficult to know who might have health problems from chemicals in fish. Some people can be fine after years of eating fish with these chemicals in them, while others can have health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthier for you and your family to eat.

- See the guidelines in this brochure from the Pennsylvania Department of Environmental Protection, the EPA, and the FDA.
- These guidelines tell which fish are healthier to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines can keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.portal.state.pa.us/portal/server.pt?open=514&objID=554001&mode=2

Form 5

Produced by Cornell University in cooperation with the Pennsylvania Department of Environmental Protection

Your guide to eating FISH & SHELLFISH

Fish is an important part of a healthy diet for all women. It is even more important for women who are pregnant, breastfeeding, or might become pregnant.

Frequently Asked Questions
about Eating Fish

I heard that eating fish has risks for women who might become pregnant – is this true?

Certain fish are actually a great source of omega-3s. Omega-3s are important for a baby's development and are not found in many other foods. Fish are also a very nutritious food for children to eat as they grow.

But aren't there harmful chemicals in fish, too?

Some types of fish contain higher levels of chemicals like mercury or PCBs, but many fish are healthy for women and children to eat.

Where can I find out which fish are healthy to eat and which I should avoid?

Ohio's Fish Consumption Advice can help you to choose which fish are healthiest to eat and which you should avoid. These guidelines can be found in this brochure!

Ohio Fish Consumption Advice

STATEWIDE GUIDELINES

KIND OF FISH	HOW OFTEN?
Flathead catfish(>23"), northern pike (>23")	1 meal/month
All fish not specified in this table	1 meal/week
Yellow perch, sunfish (e.g., bluegill, green, longear, redear)	2 meals/week

LAKE ERIE GUIDELINES

KIND OF FISH	HOW OFTEN?
Steelhead trout, channel catfish, common carp (<27"), freshwater drum, lake trout, smallmouth bass, white bass, whitefish (>19"), white perch, brown bullhead	1 meal/month
Common carp (>27")	1 meal/2 months

LAKE ERIE TRIBUTARIES GUIDELINES

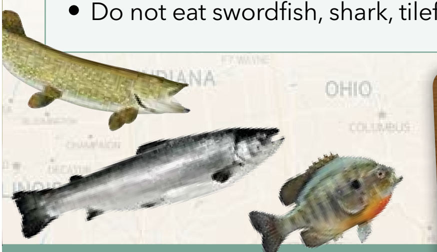
KIND OF FISH	HOW OFTEN?
Steelhead trout	1 meal/month

Also see specific advice for each Lake Erie tributary in Ohio's Sport Fish Consumption Advisory booklet (found at http://www.epa.state.oh.us/dsw/fishadvisory/index.aspx).

PURCHASED FISH GUIDELINES

(from the U.S. Environmental Protection Agency and Food and Drug Administration)

- Eat up to 12 oz. of a variety of fish and shellfish each week.
- Eat no more than 6 oz. albacore ("white") tuna/week.
- Do not eat swordfish, shark, tilefish, or king mackerel.



WHAT IS A MEAL?

- For an adult, the serving size is eight ounces uncooked or six ounces cooked.
- For children under age six, the serving size is three ounces uncooked or two ounces cooked.

THE FACTS ON FISH

Fish is an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish lowers the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant helps brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who do better developmentally.

Most fish are a healthy food, but eating some types of fish raises health risks over time.

- Some types of fish from some lakes and streams contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals build up in your body. Eventually, they can cause health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthy for you and your family to eat.

- See the guidelines in this brochure from the Ohio Environmental Protection Agency, the U.S. EPA, and the FDA.
- These guidelines tell which fish are the healthiest to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines will keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.epa.state.oh.us/dsw/fishadvisory/index.aspx

Form 12

OhioEPA

Produced by Cornell University in cooperation with the Ohio Environmental Protection Agency

Your guide to eating FISH & SHELLFISH

Fish is an important part of a healthy diet for all women. It is even more important for women who are pregnant, breastfeeding, or might become pregnant.

Do you think eating fish has risks for women who might become pregnant?

Like Sarah, you might be surprised to learn that fish is an important part of a healthy diet.

After being away for several years, Sarah and David recently moved back to their hometown of Cleveland, Ohio. They decided it was time to try to have a baby. A baby is a big change, so Sarah began doing her homework on exercise and nutrition that would help her have a healthy baby.

Sarah found a website with guidelines about eating fish for women of childbearing age. The website explained that, although many women don't eat fish before and during pregnancy, certain fish are actually a great source of omega-3s. Omega-3s are important for a baby's development and are not found in many other foods. Fish are also a very nutritious food for children to eat as they grow.

Sarah wasn't convinced. She looked for other sources and found the Ohio Environmental Protection Agency's Fish Consumption Advice. These guidelines confirmed that while some types of fish contain higher levels of chemicals like mercury or PCBs, many fish are healthy for women and children to eat. These guidelines (found in this brochure) helped her to choose which fish are healthiest to eat and which she should avoid.

Now that Sarah is pregnant she is using the guidelines to choose which fish to eat. She is happy because salmon is one of her favorite foods!

Ohio Fish Consumption Advice

STATEWIDE GUIDELINES

KIND OF FISH	HOW OFTEN?
Flathead catfish(>23”), northern pike (>23”)	1 meal/month
All fish not specified in this table	1 meal/week
Yellow perch, sunfish (e.g., bluegill, green, longear, redear)	2 meals/week

LAKE ERIE GUIDELINES

KIND OF FISH	HOW OFTEN?
Steelhead trout, channel catfish, common carp (<27”), freshwater drum, lake trout, smallmouth bass, white bass, whitefish (>19”), white perch, brown bullhead	1 meal/month
Common carp (>27”)	1 meal/2 months

LAKE ERIE TRIBUTARIES GUIDELINES

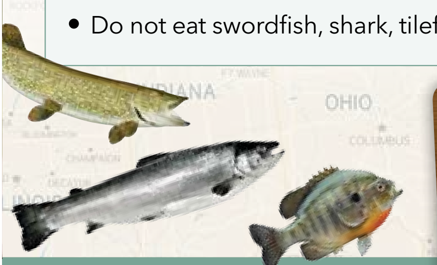
KIND OF FISH	HOW OFTEN?
Steelhead trout	1 meal/month

Also see specific advice for each Lake Erie tributary in Ohio’s Sport Fish Consumption Advisory booklet (found at http://www.epa.state.oh.us/dsw/fishadvisory/index.aspx).

PURCHASED FISH GUIDELINES

(from the U.S. Environmental Protection Agency and Food and Drug Administration)

- Eat up to 12 oz. of a variety of fish and shellfish each week.
- Eat no more than 6 oz. albacore (“white”) tuna/week.
- Do not eat swordfish, shark, tilefish, or king mackerel.



WHAT IS A MEAL?

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- For children under age six, the serving size is three ounces uncooked or two ounces cooked.

THE FACTS ON FISH

Fish is an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish lowers the risk of heart disease and other health problems.
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- These guidelines tell which fish are the healthiest to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines will keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.epa.state.oh.us/dsw/fishadvisory/index.aspx

Form 10

Produced by Cornell University in cooperation with the Ohio Environmental Protection Agency



Your guide to eating FISH & SHELLFISH

Fish can be an important part of a healthy diet for all women. It may be even more important for women who are pregnant, breastfeeding, or might become pregnant.

Frequently Asked Questions
about Eating Fish

I heard that eating fish may have risks for women who might become pregnant – is this true?

Certain fish are actually a great source of omega-3s. Omega-3s may be important for a baby's development and are not found in many other foods. Fish can also be a very nutritious food for children to eat as they grow.

But aren't there harmful chemicals in fish, too?

Some types of fish contain higher levels of chemicals like mercury or PCBs, but many fish can be healthy for women and children to eat.

Where can I find out which fish are healthier to eat and which I should avoid?

Ohio's Fish Consumption Advice can help you to choose which fish are healthier to eat and which you should try to avoid. These guidelines can be found in this brochure!

Ohio Fish Consumption Advice

STATEWIDE GUIDELINES

KIND OF FISH	HOW OFTEN?
Flathead catfish(>23"), northern pike (>23")	1 meal/month
All fish not specified in this table	1 meal/week
Yellow perch, sunfish (e.g., bluegill, green, longear, redear)	2 meals/week

LAKE ERIE GUIDELINES

KIND OF FISH	HOW OFTEN?
Steelhead trout, channel catfish, common carp (<27"), freshwater drum, lake trout, smallmouth bass, white bass, whitefish (>19"), white perch, brown bullhead	1 meal/month
Common carp (>27")	1 meal/2 months

LAKE ERIE TRIBUTARIES GUIDELINES

KIND OF FISH	HOW OFTEN?
Steelhead trout	1 meal/month

Also see specific advice for each Lake Erie tributary in Ohio's Sport Fish Consumption Advisory booklet (found at http://www.epa.state.oh.us/dsw/fishadvisory/index.aspx).

PURCHASED FISH GUIDELINES

(from the U.S. Environmental Protection Agency and Food and Drug Administration)

- Eat up to 12 oz. of a variety of fish and shellfish each week.
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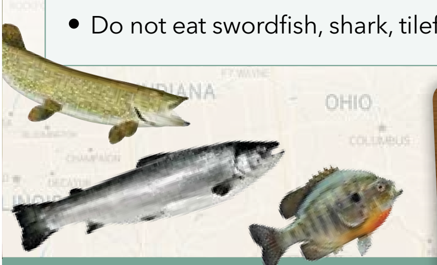
- Do not eat swordfish, shark, tilefish, or king mackerel.



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Fish can be an important part of a healthy diet for all women.

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- Eating fish with omega-3s while pregnant may help brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who may do better developmentally.

Most fish are a healthy food, but eating some types of fish may raise health risks over time.

- Some types of fish from some lakes and streams may contain harmful chemicals such as PCBs and mercury.
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Health experts can help you know which fish are healthier for you and your family to eat.

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- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines can keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.epa.state.oh.us/dsw/fishadvisory/index.aspx

Form 11

Produced by Cornell University in cooperation with the Ohio Environmental Protection Agency

Your guide to eating FISH & SHELLFISH

Fish can be an important part of a healthy diet for all women. It may be even more important for women who are pregnant, breastfeeding, or might become pregnant.

Do you think eating fish may have risks for women who might become pregnant?

Like Sarah, you might be surprised to learn that fish can be an important part of a healthy diet.

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Now that Sarah is pregnant she is using the guidelines to choose which fish to eat. She is happy because salmon is one of her favorite foods!

Ohio Fish Consumption Advice

STATEWIDE GUIDELINES

KIND OF FISH	HOW OFTEN?
Flathead catfish(>23”), northern pike (>23”)	1 meal/month
All fish not specified in this table	1 meal/week
Yellow perch, sunfish (e.g., bluegill, green, longear, redear)	2 meals/week

LAKE ERIE GUIDELINES

KIND OF FISH	HOW OFTEN?
Steelhead trout, channel catfish, common carp (<27”), freshwater drum, lake trout, smallmouth bass, white bass, whitefish (>19”), white perch, brown bullhead	1 meal/month
Common carp (>27”)	1 meal/2 months

LAKE ERIE TRIBUTARIES GUIDELINES

KIND OF FISH	HOW OFTEN?
Steelhead trout	1 meal/month

Also see specific advice for each Lake Erie tributary in Ohio’s Sport Fish Consumption Advisory booklet (found at http://www.epa.state.oh.us/dsw/fishadvisory/index.aspx).

PURCHASED FISH GUIDELINES

(from the U.S. Environmental Protection Agency and Food and Drug Administration)

- Eat up to 12 oz. of a variety of fish and shellfish each week.
- Eat no more than 6 oz. albacore (“white”) tuna/week.
- Do not eat swordfish, shark, tilefish, or king mackerel.

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- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthier for you and your family to eat.

- See the guidelines in this brochure from the Ohio Environmental Protection Agency, the U.S. EPA, and the FDA.
- These guidelines tell which fish are healthier to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines can keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.epa.state.oh.us/dsw/fishadvisory/index.aspx

Form 9

Produced by Cornell University in cooperation with the Ohio Environmental Protection Agency



Your guide to eating FISH & SHELLFISH

Fish is an important part of a healthy diet for all women. It is even more important for women who are pregnant, breastfeeding, or might become pregnant.

Frequently Asked Questions
about Eating Fish

I heard that eating fish has risks for women who might become pregnant – is this true?

Certain fish are actually a great source of omega-3s. Omega-3s are important for a baby's development and are not found in many other foods. Fish are also a very nutritious food for children to eat as they grow.

But aren't there harmful chemicals in fish, too?

Some types of fish contain higher levels of chemicals like mercury or PCBs, but many fish are healthy for women and children to eat.

Where can I find out which fish are healthy to eat and which I should avoid?

Michigan's Fish Consumption Guidelines can help you to choose which fish are healthiest to eat and which you should avoid. These guidelines can be found in this brochure!

Michigan Fish Consumption Guidelines:

PURCHASED FISH GUIDELINES

(Eat up to 8 points/month)

KIND OF FISH	POINTS/ MI SERVING
Anchovies, Catfish (farm-raised), Crab, Crawfish, Flatfish (flounder, sole), Herring, Mullet, Oysters, Perch (ocean or freshwater), Pollock, Salmon (canned, frozen, fresh), Sardines, Scallops, Shrimp, Squid, Tilapia, Trout (freshwater), Whitefish	1
Cod, Freshwater Drum (aka Sheephead), Jack Smelt, Mahi Mahi, Snapper, Tuna (canned light)	2
Bass (sea, striped, rockfish), Bluefish, Halibut, Lobster, Sablefish, Scorpion Fish, Tuna (Albacore, canned white), Tuna (fresh, frozen), Weakfish (sea trout)	4
Grouper, Mackerel, Marlin, Orange Roughy	8
Shark, Swordfish, Tilefish, King Mackerel	Do Not Eat*

If you are eating fish listed above which were caught in Michigan waters, please refer instead to “Eating Fish from Michigan’s Lakes & Rivers” (insert).

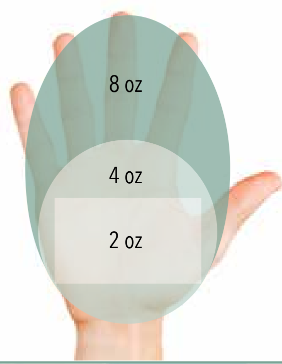
MY MICHIGAN, MI SERVING SIZE

What is a MI Serving?

8 ounces of fish = size of an adult’s hand (large oval)

4 ounces of fish = size of the palm of an adult’s hand (small circle)

2 ounces of fish = size of half a palm of an adult’s hand (rectangle)



***DO NOT EAT:** These fish are very high in chemicals and should not be eaten by anyone.

THE FACTS ON FISH

Fish is an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish lowers the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant helps brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who do better developmentally.

Most fish are a healthy food, but eating some types of fish raises health risks over time.

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- When you eat fish that contain these chemicals, the chemicals build up in your body. Eventually, they can cause health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthy for you and your family to eat.

- See the guidelines in this brochure from the Michigan Department of Community Health.
- These guidelines tell which fish are the healthiest to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines will keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

http://www.michigan.gov/documents/FishAdvisory03_67354_7.pdf

Form 24

Produced by Cornell University in cooperation with the Michigan Department of Community Health

Eating Fish from Michigan's Lakes & Rivers

Find the lake or river where the fish was caught in the list below. If the lake or river isn't on the list, use the "statewide guidelines" at the bottom of the last page.

LAKE ERIE GUIDELINES

(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Yellow Perch	2/month
Lake Whitefish (under 16"), Walleye	6/year
Carp (under 28"), Catfish, Chinook Salmon, Coho Salmon, Freshwater Drum, Lake Whitefish (over 16"), Rainbow Trout, White (Silver) Bass, White Perch	Limited*
Carp (over 28")	Do Not Eat*

NORTH MAUMEE BAY GUIDELINES

KIND OF FISH	MI SERVINGS
Largemouth Bass, Smallmouth Bass	Limited*

Use Lake Erie Guidelines for any fish species not listed in this table.

LAKE HURON GUIDELINES

(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Smelt	4/month
Suckers, Yellow Perch	2/month
Freshwater Drum, Lake Trout (under 20"), Northern Pike	1/month
Brown Trout, Chinook Salmon, Coho Salmon, Lake Trout (20-24"), Lake Whitefish, Rainbow Trout, Walleye, White Perch	6/year
Carp, Catfish, Lake Trout (over 24"), White (Silver) Bass	Limited*

***LIMITED:** These fish are higher in chemicals, but healthy adults who are not pregnant or planning on having children in the near future can eat these fish 1-2 times per year.

***DO NOT EAT:** These fish are very high in chemicals and should not be eaten by anyone.

SAGINAW BAY GUIDELINES
(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Yellow Perch	2/month
Freshwater Drum	1/month
Walleye, All Other Species Not Listed Here	6/year
Carp, Catfish, White (Silver) Bass	Do Not Eat*

LAKE MICHIGAN GUIDELINES
(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Yellow Perch	4/month
Rainbow Trout (under 20"), Smelt, Walleye (under 18")	2/month
Burbot, Coho Salmon	1/month
Chinook Salmon, Lake Trout (under 24"), Rainbow Trout (over 20"), Suckers	6/year
Brown Trout, Lake Trout (over 24"), Lake Whitefish, Walleye (over 18")	Limited*
Carp	Do Not Eat*

GREEN BAY & LITTLE BAY DE NOC GUIDELINES
(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Rock Bass	8/month
Largemouth Bass (under 16"), Smallmouth Bass (under 16")	2/month
Largemouth Bass (over 16"), Northern Pike, Smallmouth Bass (over 16")	1/month
Suckers	6/year
Carp	Do Not Eat*

Use Lake Michgan Guidelines for any fish species not listed in this table.

LAKE SUPERIOR GUIDELINES
(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Lake Herring	8/month
Coho Salmon	4/month
Lake Trout (under 24"), Lake Whitefish, Rainbow Trout, Suckers, Walleye, Yellow Perch	2/month
Brown Trout, Lake Trout (24-28")	1/month
Chinook Salmon, Lake Trout (over 28")	6/year
Burbot, Siscowet	Limited*

LAKE ST. CLAIR GUIDELINES

KIND OF FISH	MI SERVINGS
Bluegill, Black Crappie (under 9"), Sunfish, White Crappie (under 9")	8/month
Black Crappie (over 9"), White Crappie (over 9"), Yellow Perch	4/month
Freshwater Drum, Largemouth Bass (under 20"), Northern Pike, Smallmouth Bass (under 20")	2/month
Largemouth Bass (over 20"), Rock Bass, Smallmouth Bass (over 20")	1/month
Walleye	6/year
Carp, Catfish, Sturgeon, White (Silver) Bass	Limited*
Muskellunge	Do Not Eat*

LAKE ST. CLAIR GUIDELINES: SPECIAL NOTICE

(Use when fishing within 2 miles of the Lange-Revere Canals. This area is between Lakefront Park & Verteran's Memorial Park & out into open water.)

KIND OF FISH	MI SERVINGS
Yellow Perch	2/month
Largemouth Bass, Smallmouth Bass	1/month
Bluegill, Sunfish, Walleye	6/year
All Other Species Not Listed Here	Limited*
Muskellunge	Do Not Eat*

Do not eat any fish from the Lange-Revere Canals!

DETROIT RIVER GUIDELINES

KIND OF FISH	MI SERVINGS
Rock Bass, Yellow Perch	4/month
Bullhead, Sucker (under 14")	2/month
Northern Pike	1/month
Sucker (14-18"), Walleye	6/year
Carp, Catfish, Freshwater Drum, Largemouth Bass, Smallmouth Bass, Sucker (over 18"), White (Silver) Bass	Limited*

***LIMITED:** These fish are higher in chemicals, but healthy adults who are not pregnant or planning on having children in the near future can eat these fish 1-2 times per year.

***DO NOT EAT:** These fish are very high in chemicals and should not be eaten by anyone.

ST. CLAIR RIVER GUIDELINES

KIND OF FISH	MI SERVINGS
Yellow Perch	8/month
Rock Bass	4/month
Freshwater Drum, Largemouth Bass (under 18"), Smallmouth Bass (under 18")	2/month
Largemouth Bass (over 18"), Smallmouth Bass (over 18")	1/month
Walleye	6/year
Carp, Sturgeon, White Bass	Limited*

ST. MARY'S RIVER GUIDELINES

KIND OF FISH	MI SERVINGS
Bluegill, Sunfish	12/month
Sucker, Rock Bass (under 8"), Yellow Perch	4/month
Largemouth Bass (under 18"), Northern Pike (under 30"), Rock Bass (over 8"), Smallmouth Bass (under 18"), Walleye (under 22")	2/month
Largemouth Bass (over 18"), Northern Pike (over 30"), Smallmouth Bass (over 18"), Walleye (over 22")	1/month
Carp	Limited*

STOP

YOU SHOULD USE THE STATEWIDE GUIDELINES BELOW ONLY IF YOUR KIND OF FISH AND/OR FISHING LOCATION ARE NOT LISTED ABOVE.

STATEWIDE GUIDELINES

KIND OF FISH	MI SERVINGS
Bluegill, Suckers, Sunfish	8/month
Black Crappie, Catfish, Rock Bass, White Crappie, Yellow Perch	4/month
Carp, Largemouth Bass (under 18"), Northern Pike (under 30"), Smallmouth Bass (under 18"), Walleye (under 20")	2/month
Largemouth Bass (over 18"), Muskellunge, Northern Pike (over 30"), Smallmouth Bass (over 18"), Walleye (over 20")	1/month

FOR COMPLETE FISH CONSUMPTION ADVICE FOR MICHIGAN,
go to http://www.michigan.gov/documents/FishAdvisory03_67354_7.pdf

***LIMITED:** These fish are higher in chemicals, but healthy adults who are not pregnant or planning on having children in the near future can eat these fish 1-2 times per year.

***DO NOT EAT:** These fish are very high in chemicals and should not be eaten by anyone.



Your guide to eating FISH & SHELLFISH

Fish is an important part of a healthy diet for all women. It is even more important for women who are pregnant, breastfeeding, or might become pregnant.

Do you think eating fish has risks for women who might become pregnant?

Like Jessica, you might be surprised to learn that fish is an important part of a healthy diet.

After being away for several years, Jessica and Ryan recently moved back to their hometown of Muskegon, Michigan. They decided it was time to try to have a baby. A baby is a big change, so Jessica began doing her homework on exercise and nutrition that would help her have a healthy baby.

Jessica found a website with guidelines about eating fish for women of childbearing age. The website explained that, although many women don't eat fish before and during pregnancy, certain fish are actually a great source of omega-3s. Omega-3s are important for a baby's development and are not found in many other foods. Fish are also a very nutritious food for children to eat as they grow.

Jessica wasn't convinced. She looked for other sources and found the Michigan Department of Community Health's Fish Consumption Guidelines. These guidelines confirmed that while some types of fish contain higher levels of chemicals like mercury or PCBs, many fish are healthy for women and children to eat. These guidelines (found in this brochure) helped her to choose which fish are healthiest to eat and which she should avoid.

Now that Jessica is pregnant she is using the guidelines to choose which fish to eat. She is happy because salmon is one of her favorite foods!

Michigan Fish Consumption Guidelines:

PURCHASED FISH GUIDELINES

(Eat up to 8 points/month)

KIND OF FISH	POINTS/ MI SERVING
Anchovies, Catfish (farm-raised), Crab, Crawfish, Flatfish (flounder, sole), Herring, Mullet, Oysters, Perch (ocean or freshwater), Pollock, Salmon (canned, frozen, fresh), Sardines, Scallops, Shrimp, Squid, Tilapia, Trout (freshwater), Whitefish	1
Cod, Freshwater Drum (aka Sheephead), Jack Smelt, Mahi Mahi, Snapper, Tuna (canned light)	2
Bass (sea, striped, rockfish), Bluefish, Halibut, Lobster, Sablefish, Scorpion Fish, Tuna (Albacore, canned white), Tuna (fresh, frozen), Weakfish (sea trout)	4
Grouper, Mackerel, Marlin, Orange Roughy	8
Shark, Swordfish, Tilefish, King Mackerel	Do Not Eat*

If you are eating fish listed above which were caught in Michigan waters, please refer instead to “Eating Fish from Michigan’s Lakes & Rivers” (insert).

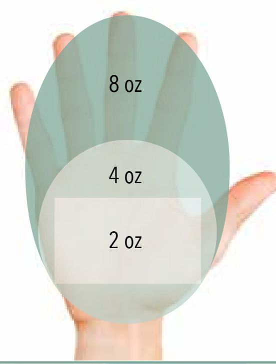
MY MICHIGAN, MI SERVING SIZE

What is a MI Serving?

8 ounces of fish = size of an adult’s hand (large oval)

4 ounces of fish = size of the palm of an adult’s hand (small circle)

2 ounces of fish = size of half a palm of an adult’s hand (rectangle)



***DO NOT EAT:** These fish are very high in chemicals and should not be eaten by anyone.

THE FACTS ON FISH

Fish is an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish lowers the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant helps brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who do better developmentally.

Most fish are a healthy food, but eating some types of fish raises health risks over time.

- Some types of fish from some lakes and streams contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals build up in your body. Eventually, they can cause health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthy for you and your family to eat.

- See the guidelines in this brochure from the Michigan Department of Community Health.
- These guidelines tell which fish are the healthiest to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines will keep these chemicals from building up to harmful levels in their bodies.



FOR MORE INFORMATION VISIT:

http://www.michigan.gov/documents/FishAdvisory03_67354_7.pdf

Form 22

Produced by Cornell University in cooperation with the Michigan Department of Community Health

Eating Fish from Michigan's Lakes & Rivers

Find the lake or river where the fish was caught in the list below. If the lake or river isn't on the list, use the "statewide guidelines" at the bottom of the last page.

LAKE ERIE GUIDELINES

(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Yellow Perch	2/month
Lake Whitefish (under 16"), Walleye	6/year
Carp (under 28"), Catfish, Chinook Salmon, Coho Salmon, Freshwater Drum, Lake Whitefish (over 16"), Rainbow Trout, White (Silver) Bass, White Perch	Limited*
Carp (over 28")	Do Not Eat*

NORTH MAUMEE BAY GUIDELINES

KIND OF FISH	MI SERVINGS
Largemouth Bass, Smallmouth Bass	Limited*

Use Lake Erie Guidelines for any fish species not listed in this table.

LAKE HURON GUIDELINES

(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Smelt	4/month
Suckers, Yellow Perch	2/month
Freshwater Drum, Lake Trout (under 20"), Northern Pike	1/month
Brown Trout, Chinook Salmon, Coho Salmon, Lake Trout (20-24"), Lake Whitefish, Rainbow Trout, Walleye, White Perch	6/year
Carp, Catfish, Lake Trout (over 24"), White (Silver) Bass	Limited*

***LIMITED:** These fish are higher in chemicals, but healthy adults who are not pregnant or planning on having children in the near future can eat these fish 1-2 times per year.

***DO NOT EAT:** These fish are very high in chemicals and should not be eaten by anyone.

SAGINAW BAY GUIDELINES
(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Yellow Perch	2/month
Freshwater Drum	1/month
Walleye, All Other Species Not Listed Here	6/year
Carp, Catfish, White (Silver) Bass	Do Not Eat*

LAKE MICHIGAN GUIDELINES
(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Yellow Perch	4/month
Rainbow Trout (under 20"), Smelt, Walleye (under 18")	2/month
Burbot, Coho Salmon	1/month
Chinook Salmon, Lake Trout (under 24"), Rainbow Trout (over 20"), Suckers	6/year
Brown Trout, Lake Trout (over 24"), Lake Whitefish, Walleye (over 18")	Limited*
Carp	Do Not Eat*

GREEN BAY & LITTLE BAY DE NOC GUIDELINES
(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Rock Bass	8/month
Largemouth Bass (under 16"), Smallmouth Bass (under 16")	2/month
Largemouth Bass (over 16"), Northern Pike, Smallmouth Bass (over 16")	1/month
Suckers	6/year
Carp	Do Not Eat*

Use Lake Michgan Guidelines for any fish species not listed in this table.

LAKE SUPERIOR GUIDELINES
(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Lake Herring	8/month
Coho Salmon	4/month
Lake Trout (under 24"), Lake Whitefish, Rainbow Trout, Suckers, Walleye, Yellow Perch	2/month
Brown Trout, Lake Trout (24-28")	1/month
Chinook Salmon, Lake Trout (over 28")	6/year
Burbot, Siscowet	Limited*

LAKE ST. CLAIR GUIDELINES

KIND OF FISH	MI SERVINGS
Bluegill, Black Crappie (under 9”), Sunfish, White Crappie (under 9”)	8/month
Black Crappie (over 9”), White Crappie (over 9”), Yellow Perch	4/month
Freshwater Drum, Largemouth Bass (under 20”), Northern Pike, Smallmouth Bass (under 20”)	2/month
Largemouth Bass (over 20”), Rock Bass, Smallmouth Bass (over 20”)	1/month
Walleye	6/year
Carp, Catfish, Sturgeon, White (Silver) Bass	Limited*
Muskellunge	Do Not Eat*

LAKE ST. CLAIR GUIDELINES: SPECIAL NOTICE

(Use when fishing within 2 miles of the Lange-Revere Canals. This area is between Lakefront Park & Verteran’s Memorial Park & out into open water.)

KIND OF FISH	MI SERVINGS
Yellow Perch	2/month
Largemouth Bass, Smallmouth Bass	1/month
Bluegill, Sunfish, Walleye	6/year
All Other Species Not Listed Here	Limited*
Muskellunge	Do Not Eat*

Do not eat any fish from the Lange-Revere Canals!

DETROIT RIVER GUIDELINES

KIND OF FISH	MI SERVINGS
Rock Bass, Yellow Perch	4/month
Bullhead, Sucker (under 14”)	2/month
Northern Pike	1/month
Sucker (14-18”), Walleye	6/year
Carp, Catfish, Freshwater Drum, Largemouth Bass, Smallmouth Bass, Sucker (over 18”), White (Silver) Bass	Limited*

***LIMITED:** These fish are higher in chemicals, but healthy adults who are not pregnant or planning on having children in the near future can eat these fish 1-2 times per year.

***DO NOT EAT:** These fish are very high in chemicals and should not be eaten by anyone.

ST. CLAIR RIVER GUIDELINES

KIND OF FISH	MI SERVINGS
Yellow Perch	8/month
Rock Bass	4/month
Freshwater Drum, Largemouth Bass (under 18”), Smallmouth Bass (under 18”)	2/month
Largemouth Bass (over 18”), Smallmouth Bass (over 18”)	1/month
Walleye	6/year
Carp, Sturgeon, White Bass	Limited*

ST. MARY’S RIVER GUIDELINES

KIND OF FISH	MI SERVINGS
Bluegill, Sunfish	12/month
Sucker, Rock Bass (under 8”), Yellow Perch	4/month
Largemouth Bass (under 18”), Northern Pike (under 30”), Rock Bass (over 8”), Smallmouth Bass (under 18”), Walleye (under 22”)	2/month
Largemouth Bass (over 18”), Northern Pike (over 30”), Smallmouth Bass (over 18”), Walleye (over 22”)	1/month
Carp	Limited*

STOP

YOU SHOULD USE THE STATEWIDE GUIDELINES BELOW ONLY IF YOUR KIND OF FISH AND/OR FISHING LOCATION ARE NOT LISTED ABOVE.

STATEWIDE GUIDELINES

KIND OF FISH	MI SERVINGS
Bluegill, Suckers, Sunfish	8/month
Black Crappie, Catfish, Rock Bass, White Crappie, Yellow Perch	4/month
Carp, Largemouth Bass (under 18”), Northern Pike (under 30”), Smallmouth Bass (under 18”), Walleye (under 20”)	2/month
Largemouth Bass (over 18”), Muskellunge, Northern Pike (over 30”), Smallmouth Bass (over 18”), Walleye (over 20”)	1/month

FOR COMPLETE FISH CONSUMPTION ADVICE FOR MICHIGAN,
go to http://www.michigan.gov/documents/FishAdvisory03_67354_7.pdf

***LIMITED:** These fish are higher in chemicals, but healthy adults who are not pregnant or planning on having children in the near future can eat these fish 1-2 times per year.

***DO NOT EAT:** These fish are very high in chemicals and should not be eaten by anyone.

Your guide to eating

FISH & SHELLFISH

Fish can be an important part of a healthy diet for all women. It may be even more important for women who are pregnant, breastfeeding, or might become pregnant.

Frequently Asked Questions
about Eating Fish

I heard that eating fish may have risks for women who might become pregnant – is this true?

Certain fish are actually a great source of omega-3s. Omega-3s may be important for a baby's development and are not found in many other foods. Fish can also be a very nutritious food for children to eat as they grow.

But aren't there harmful chemicals in fish, too?

Some types of fish contain higher levels of chemicals like mercury or PCBs, but many fish can be healthy for women and children to eat.

Where can I find out which fish are healthier to eat and which I should avoid?

Michigan's Fish Consumption Guidelines can help you to choose which fish are healthier to eat and which you should try to avoid. These guidelines can be found in this brochure!

Michigan Fish Consumption Guidelines:

PURCHASED FISH GUIDELINES

(Eat up to 8 points/month)

KIND OF FISH	POINTS/ MI SERVING
Anchovies, Catfish (farm-raised), Crab, Crawfish, Flatfish (flounder, sole), Herring, Mullet, Oysters, Perch (ocean or freshwater), Pollock, Salmon (canned, frozen, fresh), Sardines, Scallops, Shrimp, Squid, Tilapia, Trout (freshwater), Whitefish	1
Cod, Freshwater Drum (aka Sheephead), Jack Smelt, Mahi Mahi, Snapper, Tuna (canned light)	2
Bass (sea, striped, rockfish), Bluefish, Halibut, Lobster, Sablefish, Scorpion Fish, Tuna (Albacore, canned white), Tuna (fresh, frozen), Weakfish (sea trout)	4
Grouper, Mackerel, Marlin, Orange Roughy	8
Shark, Swordfish, Tilefish, King Mackerel	Do Not Eat*

If you are eating fish listed above which were caught in Michigan waters, please refer instead to "Eating Fish from Michigan's Lakes & Rivers" (insert).

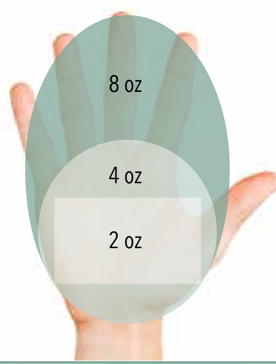
MY MICHIGAN, MI SERVING SIZE

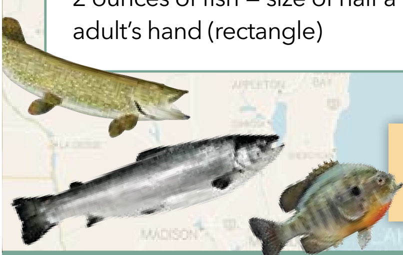
What is a MI Serving?

8 ounces of fish = size of an adult's hand (large oval)

4 ounces of fish = size of the palm of an adult's hand (small circle)

2 ounces of fish = size of half a palm of an adult's hand (rectangle)





***DO NOT EAT:** These fish are very high in chemicals and should not be eaten by anyone.

THE FACTS ON FISH

Fish can be an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish may lower the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant may help brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who may do better developmentally.

Most fish are a healthy food, but eating some types of fish may raise health risks over time.

- Some types of fish from some lakes and streams may contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals can build up in your body. Eventually, they may cause health problems.
- It is difficult to know who might have health problems from chemicals in fish. Some people can be fine after years of eating fish with these chemicals in them, while others can have health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthier for you and your family to eat.

- See the guidelines in this brochure from the Michigan Department of Community Health.
- These guidelines tell which fish are healthier to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines can keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

http://www.michigan.gov/documents/FishAdvisory03_67354_7.pdf

Form 23

Produced by Cornell University in cooperation with the Michigan Department of Community Health

Eating Fish from Michigan's Lakes & Rivers

Find the lake or river where the fish was caught in the list below. If the lake or river isn't on the list, use the "statewide guidelines" at the bottom of the last page.

LAKE ERIE GUIDELINES

(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Yellow Perch	2/month
Lake Whitefish (under 16"), Walleye	6/year
Carp (under 28"), Catfish, Chinook Salmon, Coho Salmon, Freshwater Drum, Lake Whitefish (over 16"), Rainbow Trout, White (Silver) Bass, White Perch	Limited*
Carp (over 28")	Do Not Eat*

NORTH MAUMEE BAY GUIDELINES

KIND OF FISH	MI SERVINGS
Largemouth Bass, Smallmouth Bass	Limited*

Use Lake Erie Guidelines for any fish species not listed in this table.

LAKE HURON GUIDELINES

(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Smelt	4/month
Suckers, Yellow Perch	2/month
Freshwater Drum, Lake Trout (under 20"), Northern Pike	1/month
Brown Trout, Chinook Salmon, Coho Salmon, Lake Trout (20-24"), Lake Whitefish, Rainbow Trout, Walleye, White Perch	6/year
Carp, Catfish, Lake Trout (over 24"), White (Silver) Bass	Limited*

***LIMITED:** These fish are higher in chemicals, but healthy adults who are not pregnant or planning on having children in the near future can eat these fish 1-2 times per year.

***DO NOT EAT:** These fish are very high in chemicals and should not be eaten by anyone.

SAGINAW BAY GUIDELINES
(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Yellow Perch	2/month
Freshwater Drum	1/month
Walleye, All Other Species Not Listed Here	6/year
Carp, Catfish, White (Silver) Bass	Do Not Eat*

LAKE MICHIGAN GUIDELINES
(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Yellow Perch	4/month
Rainbow Trout (under 20”), Smelt, Walleye (under 18”)	2/month
Burbot, Coho Salmon	1/month
Chinook Salmon, Lake Trout (under 24”), Rainbow Trout (over 20”), Suckers	6/year
Brown Trout, Lake Trout (over 24”), Lake Whitefish, Walleye (over 18”)	Limited*
Carp	Do Not Eat*

GREEN BAY & LITTLE BAY DE NOC GUIDELINES
(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Rock Bass	8/month
Largemouth Bass (under 16”), Smallmouth Bass (under 16”)	2/month
Largemouth Bass (over 16”), Northern Pike, Smallmouth Bass (over 16”)	1/month
Suckers	6/year
Carp	Do Not Eat*

Use Lake Michgan Guidelines for any fish species not listed in this table.

LAKE SUPERIOR GUIDELINES
(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Lake Herring	8/month
Coho Salmon	4/month
Lake Trout (under 24”), Lake Whitefish, Rainbow Trout, Suckers, Walleye, Yellow Perch	2/month
Brown Trout, Lake Trout (24-28”)	1/month
Chinook Salmon, Lake Trout (over 28”)	6/year
Burbot, Siscowet	Limited*

LAKE ST. CLAIR GUIDELINES

KIND OF FISH	MI SERVINGS
Bluegill, Black Crappie (under 9”), Sunfish, White Crappie (under 9”)	8/month
Black Crappie (over 9”), White Crappie (over 9”), Yellow Perch	4/month
Freshwater Drum, Largemouth Bass (under 20”), Northern Pike, Smallmouth Bass (under 20”)	2/month
Largemouth Bass (over 20”), Rock Bass, Smallmouth Bass (over 20”)	1/month
Walleye	6/year
Carp, Catfish, Sturgeon, White (Silver) Bass	Limited*
Muskellunge	Do Not Eat*

LAKE ST. CLAIR GUIDELINES: SPECIAL NOTICE

(Use when fishing within 2 miles of the Lange-Revere Canals. This area is between Lakefront Park & Verteran’s Memorial Park & out into open water.)

KIND OF FISH	MI SERVINGS
Yellow Perch	2/month
Largemouth Bass, Smallmouth Bass	1/month
Bluegill, Sunfish, Walleye	6/year
All Other Species Not Listed Here	Limited*
Muskellunge	Do Not Eat*

Do not eat any fish from the Lange-Revere Canals!

DETROIT RIVER GUIDELINES

KIND OF FISH	MI SERVINGS
Rock Bass, Yellow Perch	4/month
Bullhead, Sucker (under 14”)	2/month
Northern Pike	1/month
Sucker (14-18”), Walleye	6/year
Carp, Catfish, Freshwater Drum, Largemouth Bass, Smallmouth Bass, Sucker (over 18”), White (Silver) Bass	Limited*

***LIMITED:** These fish are higher in chemicals, but healthy adults who are not pregnant or planning on having children in the near future can eat these fish 1-2 times per year.

***DO NOT EAT:** These fish are very high in chemicals and should not be eaten by anyone.

ST. CLAIR RIVER GUIDELINES

KIND OF FISH	MI SERVINGS
Yellow Perch	8/month
Rock Bass	4/month
Freshwater Drum, Largemouth Bass (under 18”), Smallmouth Bass (under 18”)	2/month
Largemouth Bass (over 18”), Smallmouth Bass (over 18”)	1/month
Walleye	6/year
Carp, Sturgeon, White Bass	Limited*

ST. MARY’S RIVER GUIDELINES

KIND OF FISH	MI SERVINGS
Bluegill, Sunfish	12/month
Sucker, Rock Bass (under 8”), Yellow Perch	4/month
Largemouth Bass (under 18”), Northern Pike (under 30”), Rock Bass (over 8”), Smallmouth Bass (under 18”), Walleye (under 22”)	2/month
Largemouth Bass (over 18”), Northern Pike (over 30”), Smallmouth Bass (over 18”), Walleye (over 22”)	1/month
Carp	Limited*

STOP

YOU SHOULD USE THE STATEWIDE GUIDELINES BELOW ONLY IF YOUR KIND OF FISH AND/OR FISHING LOCATION ARE NOT LISTED ABOVE.

STATEWIDE GUIDELINES

KIND OF FISH	MI SERVINGS
Bluegill, Suckers, Sunfish	8/month
Black Crappie, Catfish, Rock Bass, White Crappie, Yellow Perch	4/month
Carp, Largemouth Bass (under 18”), Northern Pike (under 30”), Smallmouth Bass (under 18”), Walleye (under 20”)	2/month
Largemouth Bass (over 18”), Muskellunge, Northern Pike (over 30”), Smallmouth Bass (over 18”), Walleye (over 20”)	1/month

FOR COMPLETE FISH CONSUMPTION ADVICE FOR MICHIGAN,
go to http://www.michigan.gov/documents/FishAdvisory03_67354_7.pdf

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Your guide to eating

FISH & SHELLFISH

Fish can be an important part of a healthy diet for all women. It may be even more important for women who are pregnant, breastfeeding, or might become pregnant.

Do you think eating fish may have risks for women who might become pregnant?

Like Jessica, you might be surprised to learn that fish can be an important part of a healthy diet.

After being away for several years, Jessica and Ryan recently moved back to their hometown of Muskegon, Michigan. They decided it was time to try to have a baby. A baby is a big change, so Jessica began doing her homework on exercise and nutrition that would help her have a healthy baby.

Jessica found a website with guidelines about eating fish for women of childbearing age. The website explained that, although many women don't eat fish before and during pregnancy, certain fish are actually a great source of omega-3s. Omega-3s may be important for a baby's development and are not found in many other foods. Fish can also be a very nutritious food for children to eat as they grow.

Jessica wasn't convinced. She looked for other sources and found the Michigan Department of Community Health's Fish Consumption Guidelines. These guidelines confirmed that while some types of fish contain higher levels of chemicals like mercury or PCBs, many fish can be healthy for women and children to eat. These guidelines (found in this brochure) helped her to choose which fish are healthier to eat and which she should try to avoid.

Now that Jessica is pregnant she is using the guidelines to choose which fish to eat. She is happy because salmon is one of her favorite foods!

Michigan Fish Consumption Guidelines:

PURCHASED FISH GUIDELINES

(Eat up to 8 points/month)

KIND OF FISH	POINTS/ MI SERVING
Anchovies, Catfish (farm-raised), Crab, Crawfish, Flatfish (flounder, sole), Herring, Mullet, Oysters, Perch (ocean or freshwater), Pollock, Salmon (canned, frozen, fresh), Sardines, Scallops, Shrimp, Squid, Tilapia, Trout (freshwater), Whitefish	1
Cod, Freshwater Drum (aka Sheephead), Jack Smelt, Mahi Mahi, Snapper, Tuna (canned light)	2
Bass (sea, striped, rockfish), Bluefish, Halibut, Lobster, Sablefish, Scorpion Fish, Tuna (Albacore, canned white), Tuna (fresh, frozen), Weakfish (sea trout)	4
Grouper, Mackerel, Marlin, Orange Roughy	8
Shark, Swordfish, Tilefish, King Mackerel	Do Not Eat*

If you are eating fish listed above which were caught in Michigan waters, please refer instead to “Eating Fish from Michigan’s Lakes & Rivers” (insert).

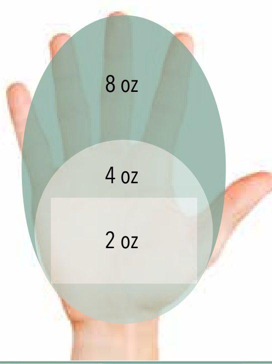
MY MICHIGAN, MI SERVING SIZE

What is a MI Serving?

8 ounces of fish = size of an adult’s hand (large oval)

4 ounces of fish = size of the palm of an adult’s hand (small circle)

2 ounces of fish = size of half a palm of an adult’s hand (rectangle)



***DO NOT EAT:** These fish are very high in chemicals and should not be eaten by anyone.

THE FACTS ON FISH

Fish can be an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish may lower the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant may help brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who may do better developmentally.

Most fish are a healthy food, but eating some types of fish may raise health risks over time.

- Some types of fish from some lakes and streams may contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals can build up in your body. Eventually, they may cause health problems.
- It is difficult to know who might have health problems from chemicals in fish. Some people can be fine after years of eating fish with these chemicals in them, while others can have health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthier for you and your family to eat.

- See the guidelines in this brochure from the Michigan Department of Community Health.
- These guidelines tell which fish are healthier to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines can keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

http://www.michigan.gov/documents/FishAdvisory03_67354_7.pdf

Form 21

Produced by Cornell University in cooperation with the Michigan Department of Community Health

Eating Fish from Michigan's Lakes & Rivers

Find the lake or river where the fish was caught in the list below. If the lake or river isn't on the list, use the "statewide guidelines" at the bottom of the last page.

LAKE ERIE GUIDELINES

(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Yellow Perch	2/month
Lake Whitefish (under 16"), Walleye	6/year
Carp (under 28"), Catfish, Chinook Salmon, Coho Salmon, Freshwater Drum, Lake Whitefish (over 16"), Rainbow Trout, White (Silver) Bass, White Perch	Limited*
Carp (over 28")	Do Not Eat*

NORTH MAUMEE BAY GUIDELINES

KIND OF FISH	MI SERVINGS
Largemouth Bass, Smallmouth Bass	Limited*

Use Lake Erie Guidelines for any fish species not listed in this table.

LAKE HURON GUIDELINES

(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Smelt	4/month
Suckers, Yellow Perch	2/month
Freshwater Drum, Lake Trout (under 20"), Northern Pike	1/month
Brown Trout, Chinook Salmon, Coho Salmon, Lake Trout (20-24"), Lake Whitefish, Rainbow Trout, Walleye, White Perch	6/year
Carp, Catfish, Lake Trout (over 24"), White (Silver) Bass	Limited*

***LIMITED:** These fish are higher in chemicals, but healthy adults who are not pregnant or planning on having children in the near future can eat these fish 1-2 times per year.

***DO NOT EAT:** These fish are very high in chemicals and should not be eaten by anyone.

SAGINAW BAY GUIDELINES
(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Yellow Perch	2/month
Freshwater Drum	1/month
Walleye, All Other Species Not Listed Here	6/year
Carp, Catfish, White (Silver) Bass	Do Not Eat*

LAKE MICHIGAN GUIDELINES
(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Yellow Perch	4/month
Rainbow Trout (under 20"), Smelt, Walleye (under 18")	2/month
Burbot, Coho Salmon	1/month
Chinook Salmon, Lake Trout (under 24"), Rainbow Trout (over 20"), Suckers	6/year
Brown Trout, Lake Trout (over 24"), Lake Whitefish, Walleye (over 18")	Limited*
Carp	Do Not Eat*

GREEN BAY & LITTLE BAY DE NOC GUIDELINES
(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Rock Bass	8/month
Largemouth Bass (under 16"), Smallmouth Bass (under 16")	2/month
Largemouth Bass (over 16"), Northern Pike, Smallmouth Bass (over 16")	1/month
Suckers	6/year
Carp	Do Not Eat*

Use Lake Michgan Guidelines for any fish species not listed in this table.

LAKE SUPERIOR GUIDELINES
(and tributaries up to the first dam)

KIND OF FISH	MI SERVINGS
Lake Herring	8/month
Coho Salmon	4/month
Lake Trout (under 24"), Lake Whitefish, Rainbow Trout, Suckers, Walleye, Yellow Perch	2/month
Brown Trout, Lake Trout (24-28")	1/month
Chinook Salmon, Lake Trout (over 28")	6/year
Burbot, Siscowet	Limited*

LAKE ST. CLAIR GUIDELINES

KIND OF FISH	MI SERVINGS
Bluegill, Black Crappie (under 9"), Sunfish, White Crappie (under 9")	8/month
Black Crappie (over 9"), White Crappie (over 9"), Yellow Perch	4/month
Freshwater Drum, Largemouth Bass (under 20"), Northern Pike, Smallmouth Bass (under 20")	2/month
Largemouth Bass (over 20"), Rock Bass, Smallmouth Bass (over 20")	1/month
Walleye	6/year
Carp, Catfish, Sturgeon, White (Silver) Bass	Limited*
Muskellunge	Do Not Eat*

LAKE ST. CLAIR GUIDELINES: SPECIAL NOTICE

(Use when fishing within 2 miles of the Lange-Revere Canals. This area is between Lakefront Park & Verteran's Memorial Park & out into open water.)

KIND OF FISH	MI SERVINGS
Yellow Perch	2/month
Largemouth Bass, Smallmouth Bass	1/month
Bluegill, Sunfish, Walleye	6/year
All Other Species Not Listed Here	Limited*
Muskellunge	Do Not Eat*

Do not eat any fish from the Lange-Revere Canals!

DETROIT RIVER GUIDELINES

KIND OF FISH	MI SERVINGS
Rock Bass, Yellow Perch	4/month
Bullhead, Sucker (under 14")	2/month
Northern Pike	1/month
Sucker (14-18"), Walleye	6/year
Carp, Catfish, Freshwater Drum, Largemouth Bass, Smallmouth Bass, Sucker (over 18"), White (Silver) Bass	Limited*

***LIMITED:** These fish are higher in chemicals, but healthy adults who are not pregnant or planning on having children in the near future can eat these fish 1-2 times per year.

***DO NOT EAT:** These fish are very high in chemicals and should not be eaten by anyone.

ST. CLAIR RIVER GUIDELINES

KIND OF FISH	MI SERVINGS
Yellow Perch	8/month
Rock Bass	4/month
Freshwater Drum, Largemouth Bass (under 18"), Smallmouth Bass (under 18")	2/month
Largemouth Bass (over 18"), Smallmouth Bass (over 18")	1/month
Walleye	6/year
Carp, Sturgeon, White Bass	Limited*

ST. MARY'S RIVER GUIDELINES

KIND OF FISH	MI SERVINGS
Bluegill, Sunfish	12/month
Sucker, Rock Bass (under 8"), Yellow Perch	4/month
Largemouth Bass (under 18"), Northern Pike (under 30"), Rock Bass (over 8"), Smallmouth Bass (under 18"), Walleye (under 22")	2/month
Largemouth Bass (over 18"), Northern Pike (over 30"), Smallmouth Bass (over 18"), Walleye (over 22")	1/month
Carp	Limited*

STOP

YOU SHOULD USE THE STATEWIDE GUIDELINES BELOW ONLY IF YOUR KIND OF FISH AND/OR FISHING LOCATION ARE NOT LISTED ABOVE.

STATEWIDE GUIDELINES

KIND OF FISH	MI SERVINGS
Bluegill, Suckers, Sunfish	8/month
Black Crappie, Catfish, Rock Bass, White Crappie, Yellow Perch	4/month
Carp, Largemouth Bass (under 18"), Northern Pike (under 30"), Smallmouth Bass (under 18"), Walleye (under 20")	2/month
Largemouth Bass (over 18"), Muskellunge, Northern Pike (over 30"), Smallmouth Bass (over 18"), Walleye (over 20")	1/month

FOR COMPLETE FISH CONSUMPTION ADVICE FOR MICHIGAN,
go to http://www.michigan.gov/documents/FishAdvisory03_67354_7.pdf

***LIMITED:** These fish are higher in chemicals, but healthy adults who are not pregnant or planning on having children in the near future can eat these fish 1-2 times per year.

***DO NOT EAT:** These fish are very high in chemicals and should not be eaten by anyone.



Your guide to eating
FISH & SHELLFISH

Fish is an important part of a healthy diet for all women. It is even more important for women who are pregnant, breastfeeding, or might become pregnant.

Frequently Asked Questions
about Eating Fish

I heard that eating fish has risks for women who might become pregnant – is this true?

Certain fish are actually a great source of omega-3s. Omega-3s are important for a baby's development and are not found in many other foods. Fish are also a very nutritious food for children to eat as they grow.

But aren't there harmful chemicals in fish, too?

Some types of fish contain higher levels of chemicals like mercury or PCBs, but many fish are healthy for women and children to eat.

Where can I find out which fish are healthy to eat and which I should avoid?

Indiana's Fish Consumption Guidelines can help you to choose which fish are healthiest to eat and which you should avoid. These guidelines can be found in this brochure!

Indiana Fish Consumption Guidelines:

For Women up to Age 50

STATEWIDE GUIDELINES FOR FISH YOU CATCH

KIND OF FISH	HOW OFTEN?
Buffalo (<19"), Channel catfish (<23"), Crappie, Flathead catfish (<18"), Freshwater drum (<14"), Largemouth bass (<13"), Northern pike (<20"), Redhorse (<22"), Rock bass (<8"), Smallmouth bass (<12"), Spotted bass (<10"), Sauger (<12"), Sunfish, Walleye (<19"), White, striped, or hybrid striped bass (<18")	1 meal/week
Buffalo (>19"), Channel catfish (>23"), Flathead catfish (>18"), Freshwater drum (>14"), Largemouth bass (>13"), Northern pike (>20"), Redhorse (>22"), Rock bass (>8"), Sauger (>12"), Smallmouth bass (>12"), Spotted bass (>10"), Walleye (19-26"), White, striped, or hybrid striped bass (>18")	1 meal/month
Walleye (>26"), Carp (in rivers and streams) (>15")	Do Not Eat!

For complete fish consumption advice for Indiana, go to http://www.in.gov/isdh/23650.htm.

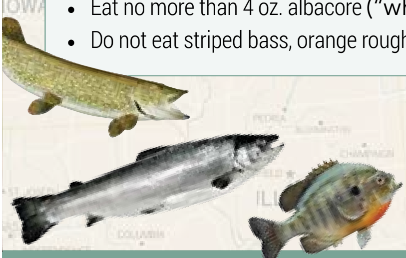
LAKE MICHIGAN GUIDELINES

(and all tributaries)

KIND OF FISH	HOW OFTEN?
Black crappie (<7"), Bluegill (<8"), Quillback (<20"), Longnose sucker (<20"), Rainbow trout (aka Steelhead) (<22"), Rock bass (<9"), Smallmouth Bass (<16"), Smelt, Walleye (<17"), White sucker (<15"), Yellow perch	1 meal/month
Black crappie (>7"), Bloater, Bluegill (>8"), Brook trout, Brown trout, Channel catfish, Chinook salmon, Coho salmon, Common carp, Freshwater drum, Lake trout, Lake whitefish, Largemouth bass, Longnose sucker (>20"), Northern pike, Pink salmon, Quillback (>20"), Rainbow trout (aka Steelhead) (>22"), Rock bass (>9"), Silver redhorse, Smallmouth bass (>16"), Walleye (>17"), White sucker (>15")	Do Not Eat!

PURCHASED FISH GUIDELINES

- Eat up to 8 to12 oz. of a variety of fish and shellfish including salmon, sardine, whitefish, clam, crab, herring, pollock, scallop, shrimp, tilapia, and farm-raised catfish and trout each week.
- Eat no more than 4 oz. albacore ("white") tuna/week.
- Do not eat striped bass, orange roughy, shark, swordfish, or king mackerel.



A MEAL IS 8 OUNCES OF FISH (BEFORE COOKING).

THE FACTS ON FISH

Fish is an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish lowers the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant helps brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who do better developmentally.

Most fish are a healthy food, but eating some types of fish raises health risks over time.

- Some types of fish from some lakes and streams contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals build up in your body. Eventually, they can cause health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthy for you and your family to eat.

- See the guidelines in this brochure from the Indiana State Department of Health.
- These guidelines tell which fish are the healthiest to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines will keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.in.gov/isdh/23650.htm

Form 16

Indiana State Department of Health

Produced by Cornell University in cooperation with the Indiana State Department of Health



Your guide to eating FISH & SHELLFISH

Fish is an important part of a healthy diet for all women. It is even more important for women who are pregnant, breastfeeding, or might become pregnant.

Do you think eating fish has risks for women who might become pregnant?

Like Ashley, you might be surprised to learn that fish is an important part of a healthy diet.

After being away for several years, Ashley and Josh recently moved back to their hometown of Michigan City, Indiana. They decided it was time to try to have a baby. A baby is a big change, so Ashley began doing her homework on exercise and nutrition that would help her have a healthy baby.

Ashley found a website with guidelines about eating fish for women of childbearing age. The website explained that, although many women don't eat fish before and during pregnancy, certain fish are actually a great source of omega-3s. Omega-3s are important for a baby's development and are not found in many other foods. Fish are also a very nutritious food for children to eat as they grow.

Ashley wasn't convinced. She looked for other sources and found the Indiana State Department of Health's Fish Consumption Guidelines. These guidelines confirmed that while some types of fish contain higher levels of chemicals like mercury or PCBs, many fish are healthy for women and children to eat. These guidelines (found in this brochure) helped her to choose which fish are healthiest to eat and which she should avoid.

Now that Ashley is pregnant she is using the guidelines to choose which fish to eat. She is happy because salmon is one of her favorite foods!

Indiana Fish Consumption Guidelines:

For Women up to Age 50

STATEWIDE GUIDELINES FOR FISH YOU CATCH

KIND OF FISH	HOW OFTEN?
Buffalo (<19”), Channel catfish (<23”), Crappie, Flathead catfish (<18”), Freshwater drum (<14”), Largemouth bass (<13”), Northern pike (<20”), Redhorse (<22”), Rock bass (<8”), Smallmouth bass (<12”), Spotted bass (<10”), Sauger (<12”), Sunfish, Walleye (<19”), White, striped, or hybrid striped bass (<18”)	1 meal/week
Buffalo (>19”), Channel catfish (>23”), Flathead catfish (>18”), Freshwater drum (>14”), Largemouth bass (>13”), Northern pike (>20”), Redhorse (>22”), Rock bass (>8”), Sauger (>12”), Smallmouth bass (>12”), Spotted bass (>10”), Walleye (19-26”), White, striped, or hybrid striped bass (>18”)	1 meal/month
Walleye (>26”), Carp (in rivers and streams) (>15”)	Do Not Eat!

For complete fish consumption advice for Indiana, go to http://www.in.gov/isdh/23650.htm.

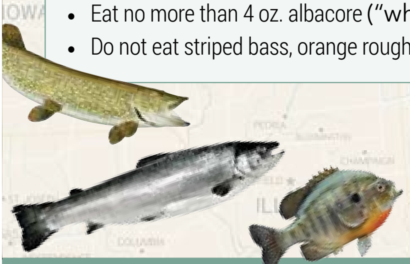
LAKE MICHIGAN GUIDELINES

(and all tributaries)

KIND OF FISH	HOW OFTEN?
Black crappie (<7”), Bluegill (<8”), Quillback (<20”), Longnose sucker (<20”), Rainbow trout (aka Steelhead) (<22”), Rock bass (<9”), Smallmouth Bass (<16”), Smelt, Walleye (<17”), White sucker (<15”), Yellow perch	1 meal/month
Black crappie (>7”), Bloater, Bluegill (>8”), Brook trout, Brown trout, Channel catfish, Chinook salmon, Coho salmon, Common carp, Freshwater drum, Lake trout, Lake whitefish, Largemouth bass, Longnose sucker (>20”), Northern pike, Pink salmon, Quillback (>20”), Rainbow trout (aka Steelhead) (>22”), Rock bass (>9”), Silver redhorse, Smallmouth bass (>16”), Walleye (>17”), White sucker (>15”)	Do Not Eat!

PURCHASED FISH GUIDELINES

- Eat up to 8 to12 oz. of a variety of fish and shellfish including salmon, sardine, whitefish, clam, crab, herring, pollock, scallop, shrimp, tilapia, and farm-raised catfish and trout each week.
- Eat no more than 4 oz. albacore (“white”) tuna/week.
- Do not eat striped bass, orange roughy, shark, swordfish, or king mackerel.



A MEAL IS 8 OUNCES OF FISH (BEFORE COOKING).

THE FACTS ON FISH

Fish is an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish lowers the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant helps brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who do better developmentally.

Most fish are a healthy food, but eating some types of fish raises health risks over time.

- Some types of fish from some lakes and streams contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals build up in your body. Eventually, they can cause health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthy for you and your family to eat.

- See the guidelines in this brochure from the Indiana State Department of Health.
- These guidelines tell which fish are the healthiest to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines will keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.in.gov/isdh/23650.htm

Form 14

Indiana State Department of Health

Produced by Cornell University in cooperation with the Indiana State Department of Health



Your guide to eating FISH & SHELLFISH

Fish can be an important part of a healthy diet for all women. It may be even more important for women who are pregnant, breastfeeding, or might become pregnant.

Frequently Asked Questions
about Eating Fish

I heard that eating fish may have risks for women who might become pregnant – is this true?

Certain fish are actually a great source of omega-3s. Omega-3s may be important for a baby's development and are not found in many other foods. Fish can also be a very nutritious food for children to eat as they grow.

But aren't there harmful chemicals in fish, too?

Some types of fish contain higher levels of chemicals like mercury or PCBs, but many fish can be healthy for women and children to eat.

Where can I find out which fish are healthier to eat and which I should avoid?

Indiana's Fish Consumption Guidelines can help you to choose which fish are healthier to eat and which you should try to avoid. These guidelines can be found in this brochure!

Indiana Fish Consumption Guidelines:

For Women up to Age 50

STATEWIDE GUIDELINES FOR FISH YOU CATCH

KIND OF FISH	HOW OFTEN?
Buffalo (<19”), Channel catfish (<23”), Crappie, Flathead catfish (<18”), Freshwater drum (<14”), Largemouth bass (<13”), Northern pike (<20”), Redhorse (<22”), Rock bass (<8”), Smallmouth bass (<12”), Spotted bass (<10”), Sauger (<12”), Sunfish, Walleye (<19”), White, striped, or hybrid striped bass (<18”)	1 meal/week
Buffalo (>19”), Channel catfish (>23”), Flathead catfish (>18”), Freshwater drum (>14”), Largemouth bass (>13”), Northern pike (>20”), Redhorse (>22”), Rock bass (>8”), Sauger (>12”), Smallmouth bass (>12”), Spotted bass (>10”), Walleye (19-26”), White, striped, or hybrid striped bass (>18”)	1 meal/month
Walleye (>26”), Carp (in rivers and streams) (>15”)	Do Not Eat!

For complete fish consumption advice for Indiana, go to http://www.in.gov/isdh/23650.htm.

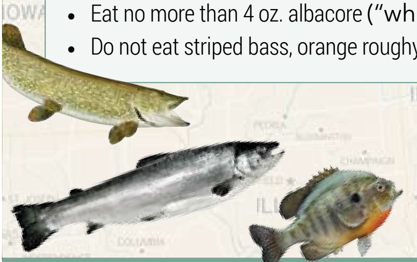
LAKE MICHIGAN GUIDELINES

(and all tributaries)

KIND OF FISH	HOW OFTEN?
Black crappie (<7”), Bluegill (<8”), Quillback (<20”), Longnose sucker (<20”), Rainbow trout (aka Steelhead) (<22”), Rock bass (<9”), Smallmouth Bass (<16”), Smelt, Walleye (<17”), White sucker (<15”), Yellow perch	1 meal/month
Black crappie (>7”), Bloater, Bluegill (>8”), Brook trout, Brown trout, Channel catfish, Chinook salmon, Coho salmon, Common carp, Freshwater drum, Lake trout, Lake whitefish, Largemouth bass, Longnose sucker (>20”), Northern pike, Pink salmon, Quillback (>20”), Rainbow trout (aka Steelhead) (>22”), Rock bass (>9”), Silver redhorse, Smallmouth bass (>16”), Walleye (>17”), White sucker (>15”)	Do Not Eat!

PURCHASED FISH GUIDELINES

- Eat up to 8 to12 oz. of a variety of fish and shellfish including salmon, sardine, whitefish, clam, crab, herring, pollock, scallop, shrimp, tilapia, and farm-raised catfish and trout each week.
- Eat no more than 4 oz. albacore (“white”) tuna/week.
- Do not eat striped bass, orange roughy, shark, swordfish, or king mackerel.



A MEAL IS 8 OUNCES OF FISH (BEFORE COOKING).

THE FACTS ON FISH

Fish can be an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish may lower the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant may help brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who may do better developmentally.

Most fish are a healthy food, but eating some types of fish may raise health risks over time.

- Some types of fish from some lakes and streams may contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals can build up in your body. Eventually, they may cause health problems.
- It is difficult to know who might have health problems from chemicals in fish. Some people can be fine after years of eating fish with these chemicals in them, while others can have health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthier for you and your family to eat.

- See the guidelines in this brochure from the Indiana State Department of Health.
- These guidelines tell which fish are healthier to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines can keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.in.gov/isdh/23650.htm

Form 15

Produced by Cornell University in cooperation with the Indiana State Department of Health



Your guide to eating
FISH & SHELLFISH

Fish can be an important part of a healthy diet for all women. It may be even more important for women who are pregnant, breastfeeding, or might become pregnant.

Do you think eating fish may have risks for women who might become pregnant?

Like Ashley, you might be surprised to learn that fish can be an important part of a healthy diet.

After being away for several years, Ashley and Josh recently moved back to their hometown of Michigan City, Indiana. They decided it was time to try to have a baby. A baby is a big change, so Ashley began doing her homework on exercise and nutrition that would help her have a healthy baby.

Ashley found a website with guidelines about eating fish for women of childbearing age. The website explained that, although many women don't eat fish before and during pregnancy, certain fish are actually a great source of omega-3s. Omega-3s may be important for a baby's development and are not found in many other foods. Fish can also be a very nutritious food for children to eat as they grow.

Ashley wasn't convinced. She looked for other sources and found the Indiana State Department of Health's Fish Consumption Guidelines. These guidelines confirmed that while some types of fish contain higher levels of chemicals like mercury or PCBs, many fish can be healthy for women and children to eat. These guidelines (found in this brochure) helped her to choose which fish are healthier to eat and which she should try to avoid.

Now that Ashley is pregnant she is using the guidelines to choose which fish to eat. She is happy because salmon is one of her favorite foods!

Indiana Fish Consumption Guidelines:

For Women up to Age 50

STATEWIDE GUIDELINES FOR FISH YOU CATCH

KIND OF FISH	HOW OFTEN?
Buffalo (<19"), Channel catfish (<23"), Crappie, Flathead catfish (<18"), Freshwater drum (<14"), Largemouth bass (<13"), Northern pike (<20"), Redhorse (<22"), Rock bass (<8"), Smallmouth bass (<12"), Spotted bass (<10"), Sauger (<12"), Sunfish, Walleye (<19"), White, striped, or hybrid striped bass (<18")	1 meal/week
Buffalo (>19"), Channel catfish (>23"), Flathead catfish (>18"), Freshwater drum (>14"), Largemouth bass (>13"), Northern pike (>20"), Redhorse (>22"), Rock bass (>8"), Sauger (>12"), Smallmouth bass (>12"), Spotted bass (>10"), Walleye (19-26"), White, striped, or hybrid striped bass (>18")	1 meal/month
Walleye (>26"), Carp (in rivers and streams) (>15")	Do Not Eat!

For complete fish consumption advice for Indiana, go to http://www.in.gov/isdh/23650.htm.

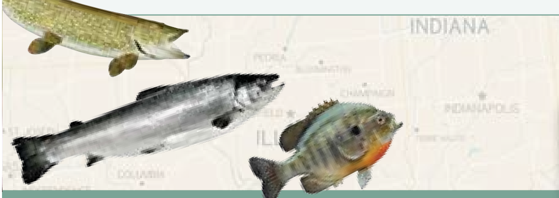
LAKE MICHIGAN GUIDELINES

(and all tributaries)

KIND OF FISH	HOW OFTEN?
Black crappie (<7"), Bluegill (<8"), Quillback (<20"), Longnose sucker (<20"), Rainbow trout (aka Steelhead) (<22"), Rock bass (<9"), Smallmouth Bass (<16"), Smelt, Walleye (<17"), White sucker (<15"), Yellow perch	1 meal/month
Black crappie (>7"), Bloater, Bluegill (>8"), Brook trout, Brown trout, Channel catfish, Chinook salmon, Coho salmon, Common carp, Freshwater drum, Lake trout, Lake whitefish, Largemouth bass, Longnose sucker (>20"), Northern pike, Pink salmon, Quillback (>20"), Rainbow trout (aka Steelhead) (>22"), Rock bass (>9"), Silver redhorse, Smallmouth bass (>16"), Walleye (>17"), White sucker (>15")	Do Not Eat!

PURCHASED FISH GUIDELINES

- Eat up to 8 to12 oz. of a variety of fish and shellfish including salmon, sardine, whitefish, clam, crab, herring, pollock, scallop, shrimp, tilapia, and farm-raised catfish and trout each week.
- Eat no more than 4 oz. albacore ("white") tuna/week.
- Do not eat striped bass, orange roughy, shark, swordfish, or king mackerel.



A MEAL IS 8 OUNCES OF FISH (BEFORE COOKING).

THE FACTS ON FISH

Fish can be an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish may lower the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant may help brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who may do better developmentally.

Most fish are a healthy food, but eating some types of fish may raise health risks over time.

- Some types of fish from some lakes and streams may contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals can build up in your body. Eventually, they may cause health problems.
- It is difficult to know who might have health problems from chemicals in fish. Some people can be fine after years of eating fish with these chemicals in them, while others can have health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthier for you and your family to eat.

- See the guidelines in this brochure from the Indiana State Department of Health.
- These guidelines tell which fish are healthier to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines can keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.in.gov/isdh/23650.htm

Form 13

Indiana State Department of Health

Produced by Cornell University in cooperation with the Indiana State Department of Health

Your guide to eating FISH & SHELLFISH

Fish is an important part of a healthy diet for all women. It is even more important for women who are pregnant, breastfeeding, or might become pregnant.

Frequently Asked Questions
about Eating Fish

I heard that eating fish has risks for women who might become pregnant – is this true?

Certain fish are actually a great source of omega-3s. Omega-3s are important for a baby's development and are not found in many other foods. Fish are also a very nutritious food for children to eat as they grow.

But aren't there harmful chemicals in fish, too?

Some types of fish contain higher levels of chemicals like mercury or PCBs, but many fish are healthy for women and children to eat.

Where can I find out which fish are healthy to eat and which I should avoid?

Illinois's Fish Consumption Guidelines can help you to choose which fish are healthiest to eat and which you should avoid. These guidelines can be found in this brochure!

Illinois Fish Consumption Guidelines:

STATEWIDE GUIDELINES

For pregnant or nursing women, women of childbearing age, and children less than 15 years of age.

KIND OF FISH	HOW OFTEN?
Flathead catfish, Hybrid striped bass, Largemouth bass, Muskellunge, Northern pike, Sauger, Saugeye, Smallmouth bass, Spotted bass, Striped bass, Walleye, White bass	1 meal/week

For complete fish consumption advice for Illinois, go to
http://www.idph.state.il.us/envhealth/fishadvisory/illinois_fish_advisory.pdf

LAKE MICHIGAN GUIDELINES

For all children and adults.

KIND OF FISH	HOW OFTEN?
Rainbow trout (<22”), Smelt, Yellow perch (<11”)	1 meal/week
Brown trout, Chinook salmon, Coho salmon, Lake whitefish, Lake trout (<27”), Rainbow trout (>22”), Yellow perch (>11”)	1 meal/month
Carp, Channel catfish, Lake trout (>27”)	Do Not Eat!

ADDITIONAL GUIDELINES FOR WAUKEGAN NORTH HARBOR

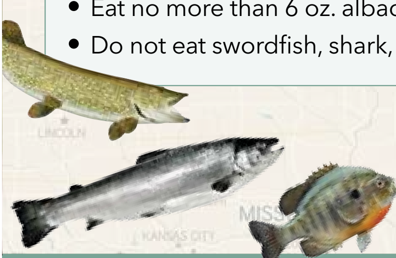
For all children and adults.

KIND OF FISH	HOW OFTEN?
Rock bass, sunfish, white sucker	1 meal/month
Black bullhead	6 meals/year

PURCHASED FISH GUIDELINES

(from the U.S. Environmental Protection Agency and Food and Drug Administration)

- Eat up to 12 oz. of a variety of fish and shellfish each week.
- Eat no more than 6 oz. albacore (“white”) tuna/week.
- Do not eat swordfish, shark, tilefish, or king mackerel.



WHAT IS A MEAL?
8 ounces for a 150-pound person

THE FACTS ON FISH

Fish is an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish lowers the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant helps brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who do better developmentally.

Most fish are a healthy food, but eating some types of fish raises health risks over time.

- Some types of fish from some lakes and streams contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals build up in your body. Eventually, they can cause health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthy for you and your family to eat.

- See the guidelines in this brochure from the Illinois Department of Public Health, the EPA, and the FDA.
- These guidelines tell which fish are the healthiest to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines will keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.idph.state.us/envhealth/fishadvisory/illinois_fish_advisory.pdf

Form 20

PUBLIC HEALTH

Produced by Cornell University in cooperation with the Illinois Department of Public Health

Your guide to eating FISH & SHELLFISH

Fish is an important part of a healthy diet for all women. It is even more important for women who are pregnant, breastfeeding, or might become pregnant.

Do you think eating fish has risks for women who might become pregnant?

Like Jennifer, you might be surprised to learn that fish is an important part of a healthy diet.

After being away for several years, Jennifer and Mike recently moved back to their hometown of Chicago, Illinois. They decided it was time to try to have a baby. A baby is a big change, so Jennifer began doing her homework on exercise and nutrition that would help her have a healthy baby.

Jennifer found a website with guidelines about eating fish for women of childbearing age. The website explained that, although many women don't eat fish before and during pregnancy, certain fish are actually a great source of omega-3s. Omega-3s are important for a baby's development and are not found in many other foods. Fish are also a very nutritious food for children to eat as they grow.

Jennifer wasn't convinced. She looked for other sources and found the Illinois Department of Public Health's Fish Consumption Guidelines. These guidelines confirmed that while some types of fish contain higher levels of chemicals like mercury or PCBs, many fish are healthy for women and children to eat. These guidelines (found in this brochure) helped her to choose which fish are healthiest to eat and which she should avoid.

Now that Jennifer is pregnant she is using the guidelines to choose which fish to eat. She is happy because salmon is one of her favorite foods!

Illinois Fish Consumption Guidelines:

STATEWIDE GUIDELINES

For pregnant or nursing women, women of childbearing age, and children less than 15 years of age.

KIND OF FISH	HOW OFTEN?
Flathead catfish, Hybrid striped bass, Largemouth bass, Muskellunge, Northern pike, Sauger, Saugeye, Smallmouth bass, Spotted bass, Striped bass, Walleye, White bass	1 meal/week

For complete fish consumption advice for Illinois, go to
http://www.idph.state.il.us/envhealth/fishadvisory/illinois_fish_advisory.pdf

LAKE MICHIGAN GUIDELINES

For all children and adults.

KIND OF FISH	HOW OFTEN?
Rainbow trout (<22"), Smelt, Yellow perch (<11")	1 meal/week
Brown trout, Chinook salmon, Coho salmon, Lake whitefish, Lake trout (<27"), Rainbow trout (>22"), Yellow perch (>11")	1 meal/month
Carp, Channel catfish, Lake trout (>27")	Do Not Eat!

ADDITIONAL GUIDELINES FOR WAUKEGAN NORTH HARBOR

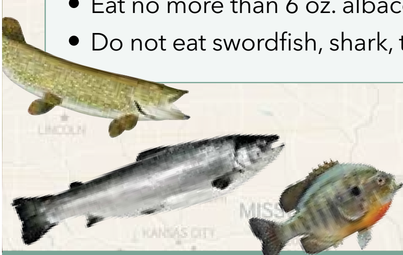
For all children and adults.

KIND OF FISH	HOW OFTEN?
Rock bass, sunfish, white sucker	1 meal/month
Black bullhead	6 meals/year

PURCHASED FISH GUIDELINES

(from the U.S. Environmental Protection Agency and Food and Drug Administration)

- Eat up to 12 oz. of a variety of fish and shellfish each week.
- Eat no more than 6 oz. albacore ("white") tuna/week.
- Do not eat swordfish, shark, tilefish, or king mackerel.



WHAT IS A MEAL?
8 ounces for a 150-pound person

THE FACTS ON FISH

Fish is an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish lowers the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant helps brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who do better developmentally.

Most fish are a healthy food, but eating some types of fish raises health risks over time.

- Some types of fish from some lakes and streams contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals build up in your body. Eventually, they can cause health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthy for you and your family to eat.

- See the guidelines in this brochure from the Illinois Department of Public Health, the EPA, and the FDA.
- These guidelines tell which fish are the healthiest to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines will keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.idph.state.us/envhealth/fishadvisory/illinois_fish_advisory.pdf

Form 18

Produced by Cornell University in cooperation with the Illinois Department of Public Health

Your guide to eating FISH & SHELLFISH

Fish can be an important part of a healthy diet for all women. It may be even more important for women who are pregnant, breastfeeding, or might become pregnant.

Frequently Asked Questions
about Eating Fish

I heard that eating fish may have risks for women who might become pregnant – is this true?

Certain fish are actually a great source of omega-3s. Omega-3s may be important for a baby's development and are not found in many other foods. Fish can also be a very nutritious food for children to eat as they grow.

But aren't there harmful chemicals in fish, too?

Some types of fish contain higher levels of chemicals like mercury or PCBs, but many fish can be healthy for women and children to eat.

Where can I find out which fish are healthier to eat and which I should avoid?

Illinois's Fish Consumption Guidelines can help you to choose which fish are healthier to eat and which you should try to avoid. These guidelines can be found in this brochure!

Illinois Fish Consumption Guidelines:

STATEWIDE GUIDELINES

For pregnant or nursing women, women of childbearing age, and children less than 15 years of age.

KIND OF FISH	HOW OFTEN?
Flathead catfish, Hybrid striped bass, Largemouth bass, Muskellunge, Northern pike, Sauger, Saugeye, Smallmouth bass, Spotted bass, Striped bass, Walleye, White bass	1 meal/week

For complete fish consumption advice for Illinois, go to
http://www.idph.state.il.us/envhealth/fishadvisory/illinois_fish_advisory.pdf

LAKE MICHIGAN GUIDELINES

For all children and adults.

KIND OF FISH	HOW OFTEN?
Rainbow trout (<22"), Smelt, Yellow perch (<11")	1 meal/week
Brown trout, Chinook salmon, Coho salmon, Lake whitefish, Lake trout (<27"), Rainbow trout (>22"), Yellow perch (>11")	1 meal/month
Carp, Channel catfish, Lake trout (>27")	Do Not Eat!

ADDITIONAL GUIDELINES FOR WAUKEGAN NORTH HARBOR

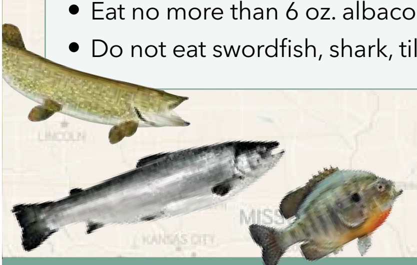
For all children and adults.

KIND OF FISH	HOW OFTEN?
Rock bass, sunfish, white sucker	1 meal/month
Black bullhead	6 meals/year

PURCHASED FISH GUIDELINES

(from the U.S. Environmental Protection Agency and Food and Drug Administration)

- Eat up to 12 oz. of a variety of fish and shellfish each week.
- Eat no more than 6 oz. albacore ("white") tuna/week.
- Do not eat swordfish, shark, tilefish, or king mackerel.



WHAT IS A MEAL?
8 ounces for a 150-pound person

THE FACTS ON FISH

Fish can be an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish may lower the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant may help brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who may do better developmentally.

Most fish are a healthy food, but eating some types of fish may raise health risks over time.

- Some types of fish from some lakes and streams may contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals can build up in your body. Eventually, they may cause health problems.
- It is difficult to know who might have health problems from chemicals in fish. Some people can be fine after years of eating fish with these chemicals in them, while others can have health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthier for you and your family to eat.

- See the guidelines in this brochure from the Illinois Department of Public Health, the EPA, and the FDA.
- These guidelines tell which fish are healthier to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines can keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.idph.state.us/envhealth/fishadvisory/illinois_fish_advisory.pdf

Form 19

Produced by Cornell University in cooperation with the Illinois Department of Public Health



Your guide to eating FISH & SHELLFISH

Fish can be an important part of a healthy diet for all women. It may be even more important for women who are pregnant, breastfeeding, or might become pregnant.

Do you think eating fish may have risks for women who might become pregnant?

Like Jennifer, you might be surprised to learn that fish can be an important part of a healthy diet.

After being away for several years, Jennifer and Mike recently moved back to their hometown of Chicago, Illinois. They decided it was time to try to have a baby. A baby is a big change, so Jennifer began doing her homework on exercise and nutrition that would help her have a healthy baby.

Jennifer found a website with guidelines about eating fish for women of childbearing age. The website explained that, although many women don't eat fish before and during pregnancy, certain fish are actually a great source of omega-3s. Omega-3s may be important for a baby's development and are not found in many other foods. Fish can also be a very nutritious food for children to eat as they grow.

Jennifer wasn't convinced. She looked for other sources and found the Illinois Department of Public Health's Fish Consumption Guidelines. These guidelines confirmed that while some types of fish contain higher levels of chemicals like mercury or PCBs, many fish can be healthy for women and children to eat. These guidelines (found in this brochure) helped her to choose which fish are healthier to eat and which she should try to avoid.

Now that Jennifer is pregnant she is using the guidelines to choose which fish to eat. She is happy because salmon is one of her favorite foods!

Illinois Fish Consumption Guidelines:

STATEWIDE GUIDELINES

For pregnant or nursing women, women of childbearing age, and children less than 15 years of age.

KIND OF FISH	HOW OFTEN?
Flathead catfish, Hybrid striped bass, Largemouth bass, Muskellunge, Northern pike, Sauger, Saugeye, Smallmouth bass, Spotted bass, Striped bass, Walleye, White bass	1 meal/week

For complete fish consumption advice for Illinois, go to http://www.idph.state.il.us/envhealth/fishadvisory/illinois_fish_advisory.pdf

LAKE MICHIGAN GUIDELINES

For all children and adults.

KIND OF FISH	HOW OFTEN?
Rainbow trout (<22"), Smelt, Yellow perch (<11")	1 meal/week
Brown trout, Chinook salmon, Coho salmon, Lake whitefish, Lake trout (<27"), Rainbow trout (>22"), Yellow perch (>11")	1 meal/month
Carp, Channel catfish, Lake trout (>27")	Do Not Eat!

ADDITIONAL GUIDELINES FOR WAUKEGAN NORTH HARBOR

For all children and adults.

KIND OF FISH	HOW OFTEN?
Rock bass, sunfish, white sucker	1 meal/month
Black bullhead	6 meals/year

PURCHASED FISH GUIDELINES

(from the U.S. Environmental Protection Agency and Food and Drug Administration)

- Eat up to 12 oz. of a variety of fish and shellfish each week.
- Eat no more than 6 oz. albacore ("white") tuna/week.
- Do not eat swordfish, shark, tilefish, or king mackerel.

WHAT IS A MEAL?
8 ounces for a 150-pound person

THE FACTS ON FISH

Fish can be an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish may lower the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant may help brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who may do better developmentally.

Most fish are a healthy food, but eating some types of fish may raise health risks over time.

- Some types of fish from some lakes and streams may contain harmful chemicals such as PCBs and mercury.
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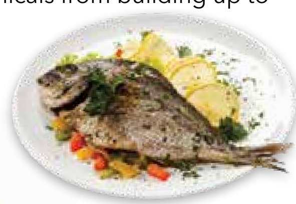


FOR MORE INFORMATION VISIT:

www.idph.state.us/envhealth/fishadvisory/illinois_fish_advisory.pdf

Form 17

Produced by Cornell University in cooperation with the Illinois Department of Public Health

Your guide to eating FISH & SHELLFISH

Fish is an important part of a healthy diet for all women. It is even more important for women who are pregnant, breastfeeding, or might become pregnant.

Frequently Asked Questions
about Eating Fish

I heard that eating fish has risks for women who might become pregnant – is this true?

Certain fish are actually a great source of omega-3s. Omega-3s are important for a baby's development and are not found in many other foods. Fish are also a very nutritious food for children to eat as they grow.

But aren't there harmful chemicals in fish, too?

Some types of fish contain higher levels of chemicals like mercury or PCBs, but many fish are healthy for women and children to eat.

Where can I find out which fish are healthy to eat and which I should avoid?

Wisconsin's Safe-Eating Guidelines for fish can help you to choose which fish are healthiest to eat and which you should avoid. These guidelines can be found in this brochure!

Wisconsin Safe-Eating Guidelines for Fish:

For Women Up to Age 50 and Children Under Age 15

STATEWIDE* GUIDELINES FOR FISH YOU CATCH

MAY EAT 1 MEAL PER WEEK OF: Bluegill, crappies, yellow perch, sunfish, bullheads, or inland trout

AND

MAY EAT 1 MEAL PER MONTH OF: Walleye, pike, bass, catfish, or all other species

DO NOT EAT: Muskies

*For exceptions to this advice and to find advice for waters not listed here, visit wi.dnr.gov and search "Eating Your Catch."

PURCHASED FISH GUIDELINES

MAY EAT 2 MEALS PER WEEK OF: Atlantic or Pacific Salmon (not Great Lakes), farm-raised catfish, shrimp, pollock, or other purchased fish low in mercury

OR

MAY EAT 1 MEAL PER WEEK OF: Canned "light" tuna

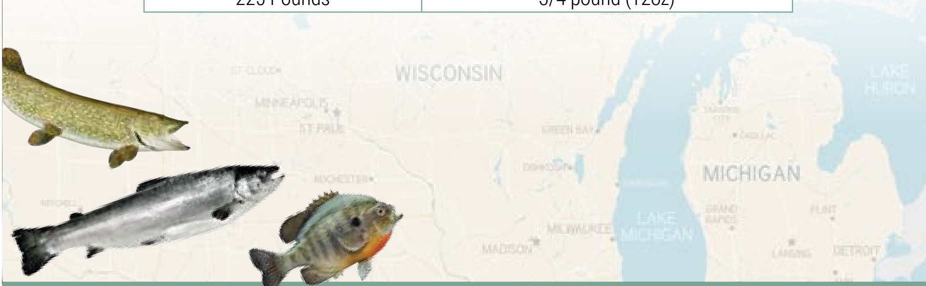
AND

MAY EAT 1 MEAL PER MONTH OF: Canned white tuna, tuna steaks, or halibut

DO NOT EAT: Shark, swordfish, king mackerel, or tilefish

WHAT IS A MEAL?

YOUR BODY WEIGHT	FILLET WEIGHT BEFORE COOKING
75 Pounds	1/4 pound (4oz)
150 Pounds	1/2 pound (8oz)
225 Pounds	3/4 pound (12oz)



THE FACTS ON FISH

Fish is an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish lowers the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant helps brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who do better developmentally.

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- Some types of fish from some lakes and streams contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals build up in your body. Eventually, they can cause health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthy for you and your family to eat.

- See the guidelines in this brochure from the Wisconsin Department of Natural Resources.
- These guidelines tell which fish are the healthiest to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines will keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.dnr.wi.gov/topic/fishing/consumption/

Form 28

Produced by Cornell University in cooperation with the Wisconsin Department of Natural Resources and Department of Health Services

Great Lakes Guidelines

For exceptions to this advice and to find advice for waters not listed here, visit wi.dnr.gov and search "Eating Your Catch."

LAKE SUPERIOR GUIDELINES

(and tributaries up to the first impassable barrier)

MAY EAT 1 MEAL PER WEEK OF: Brown trout, burbot, chinook salmon (<32"), chubs, coho salmon, lake herring, lake trout (<22"), lake whitefish, rainbow trout, or yellow perch

MAY EAT 1 MEAL PER MONTH OF: Chinook salmon (>32"), lake sturgeon (>50"), lake trout (22-37"), siscowet (<29"), or walleye

MAY EAT 6 MEALS PER YEAR (1 MEAL EVERY 2 MONTHS) OF: Lake trout (>37") or siscowet (29-36")

DO NOT EAT: Siscowet (>36")

LAKE MICHIGAN GUIDELINES

(and tributaries up to the first dam)

MAY EAT 1 MEAL PER WEEK OF: Rainbow trout (<22"), smelt, or yellow perch (<11")

MAY EAT 1 MEAL PER MONTH OF: Brown trout, chinook salmon, chubs, coho salmon, lake trout (<27"), lake whitefish, rainbow trout (>22"), or yellow perch (>11")

DO NOT EAT: Lake trout (>27")

GREEN BAY GUIDELINES

(and tributaries up to the first dam – see also more stringent advice for the lower Fox River)

MAY EAT 1 MEAL PER WEEK OF: Burbot, northern pike (<27"), smallmouth bass (<13"), white sucker, or yellow perch

MAY EAT 1 MEAL PER MONTH OF: Brown trout (<28"), chinook salmon, lake whitefish, northern pike (>27"), rainbow trout, sheepshead, smallmouth bass (>13"), or walleye

MAY EAT 6 MEALS PER YEAR (1 MEAL EVERY 2 MONTHS) OF: Channel catfish, musky (>50"), white bass, or white perch

DO NOT EAT: Brown trout (>28"), carp, or sturgeon

Your guide to eating
FISH & SHELLFISH

Fish is an important part of a healthy diet for all women. It is even more important for women who are pregnant, breastfeeding, or might become pregnant.

Do you think eating fish has risks for women who might become pregnant?

Like Amanda, you might be surprised to learn that fish is an important part of a healthy diet.

After being away for several years, Amanda and Andy recently moved back to their hometown of Milwaukee, Wisconsin. They decided it was time to try to have a baby. A baby is a big change, so Amanda began doing her homework on exercise and nutrition that would help her have a healthy baby.

Amanda found a website with guidelines about eating fish for women of childbearing age. The website explained that, although many women don't eat fish before and during pregnancy, certain fish are actually a great source of omega-3s. Omega-3s are important for a baby's development and are not found in many other foods. Fish are also a very nutritious food for children to eat as they grow.

Amanda wasn't convinced. She looked for other sources and found the Wisconsin Department of Natural Resources' Safe-Eating Gudelines for fish. These guidelines confirmed that while some types of fish contain higher levels of chemicals like mercury or PCBs, many fish are healthy for women and children to eat. These guidelines (found in this brochure) helped her to choose which fish are healthiest to eat and which she should avoid.

Now that Amanda is pregnant she is using the guidelines to choose which fish to eat. She is happy because salmon is one of her favorite foods!

Wisconsin Safe-Eating Guidelines for Fish:

For Women Up to Age 50 and Children Under Age 15

STATEWIDE* GUIDELINES FOR FISH YOU CATCH

MAY EAT 1 MEAL PER WEEK OF: Bluegill, crappies, yellow perch, sunfish, bullheads, or inland trout

AND

MAY EAT 1 MEAL PER MONTH OF: Walleye, pike, bass, catfish, or all other species

DO NOT EAT: Muskies

*For exceptions to this advice and to find advice for waters not listed here, visit wi.dnr.gov and search "Eating Your Catch."

PURCHASED FISH GUIDELINES

MAY EAT 2 MEALS PER WEEK OF: Atlantic or Pacific Salmon (not Great Lakes), farm-raised catfish, shrimp, pollock, or other purchased fish low in mercury

OR

MAY EAT 1 MEAL PER WEEK OF: Canned "light" tuna

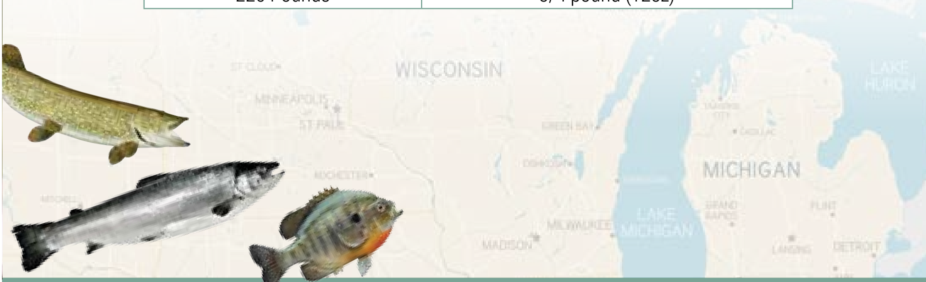
AND

MAY EAT 1 MEAL PER MONTH OF: Canned white tuna, tuna steaks, or halibut

DO NOT EAT: Shark, swordfish, king mackerel, or tilefish

WHAT IS A MEAL?

YOUR BODY WEIGHT	FILLET WEIGHT BEFORE COOKING
75 Pounds	1/4 pound (4oz)
150 Pounds	1/2 pound (8oz)
225 Pounds	3/4 pound (12oz)



THE FACTS ON FISH

Fish is an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish lowers the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant helps brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who do better developmentally.

Most fish are a healthy food, but eating some types of fish raises health risks over time.

- Some types of fish from some lakes and streams contain harmful chemicals such as PCBs and mercury.
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FOR MORE INFORMATION VISIT:

www.dnr.wi.gov/topic/fishing/consumption/

Form 26

Produced by Cornell University in cooperation with the Wisconsin Department of Natural Resources and Department of Health Services

Great Lakes Guidelines

For exceptions to this advice and to find advice for waters not listed here, visit wi.dnr.gov and search "Eating Your Catch."

LAKE SUPERIOR GUIDELINES

(and tributaries up to the first impassable barrier)

MAY EAT 1 MEAL PER WEEK OF: Brown trout, burbot, chinook salmon (<32"), chubs, coho salmon, lake herring, lake trout (<22"), lake whitefish, rainbow trout, or yellow perch

MAY EAT 1 MEAL PER MONTH OF: Chinook salmon (>32"), lake sturgeon (>50"), lake trout (22-37"), siscowet (<29"), or walleye

MAY EAT 6 MEALS PER YEAR (1 MEAL EVERY 2 MONTHS) OF: Lake trout (>37") or siscowet (29-36")

DO NOT EAT: Siscowet (>36")

LAKE MICHIGAN GUIDELINES

(and tributaries up to the first dam)

MAY EAT 1 MEAL PER WEEK OF: Rainbow trout (<22"), smelt, or yellow perch (<11")

MAY EAT 1 MEAL PER MONTH OF: Brown trout, chinook salmon, chubs, coho salmon, lake trout (<27"), lake whitefish, rainbow trout (>22"), or yellow perch (>11")

DO NOT EAT: Lake trout (>27")

GREEN BAY GUIDELINES

(and tributaries up to the first dam – see also more stringent advice for the lower Fox River)

MAY EAT 1 MEAL PER WEEK OF: Burbot, northern pike (<27"), smallmouth bass (<13"), white sucker, or yellow perch

MAY EAT 1 MEAL PER MONTH OF: Brown trout (<28"), chinook salmon, lake whitefish, northern pike (>27"), rainbow trout, sheepshead, smallmouth bass (>13"), or walleye

MAY EAT 6 MEALS PER YEAR (1 MEAL EVERY 2 MONTHS) OF: Channel catfish, musky (>50"), white bass, or white perch

DO NOT EAT: Brown trout (>28"), carp, or sturgeon

WISCONSIN

Your guide to eating
FISH & SHELLFISH

Fish can be an important part of a healthy diet for all women.
It may be even more important for women who are pregnant,
breastfeeding, or might become pregnant.

Frequently Asked Questions
about Eating Fish

I heard that eating fish may have risks for women who might become pregnant – is this true?

Certain fish are actually a great source of omega-3s. Omega-3s may be important for a baby's development and are not found in many other foods. Fish can also be a very nutritious food for children to eat as they grow.

But aren't there harmful chemicals in fish, too?

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Where can I find out which fish are healthier to eat and which I should avoid?

Wisconsin's Safe-Eating Guidelines for fish can help you to choose which fish are healthier to eat and which you should try to avoid. These guidelines can be found in this brochure!

Wisconsin Safe-Eating Guidelines for Fish:

For Women Up to Age 50 and Children Under Age 15

STATEWIDE* GUIDELINES FOR FISH YOU CATCH

MAY EAT 1 MEAL PER WEEK OF: Bluegill, crappies, yellow perch, sunfish, bullheads, or inland trout

AND

MAY EAT 1 MEAL PER MONTH OF: Walleye, pike, bass, catfish, or all other species

DO NOT EAT: Muskies

*For exceptions to this advice and to find advice for waters not listed here, visit wi.dnr.gov and search "Eating Your Catch."

PURCHASED FISH GUIDELINES

MAY EAT 2 MEALS PER WEEK OF: Atlantic or Pacific Salmon (not Great Lakes), farm-raised catfish, shrimp, pollock, or other purchased fish low in mercury

OR

MAY EAT 1 MEAL PER WEEK OF: Canned "light" tuna

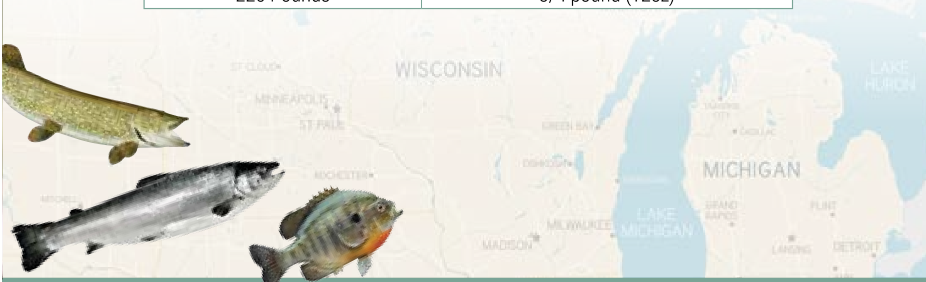
AND

MAY EAT 1 MEAL PER MONTH OF: Canned white tuna, tuna steaks, or halibut

DO NOT EAT: Shark, swordfish, king mackerel, or tilefish

WHAT IS A MEAL?

YOUR BODY WEIGHT	FILLET WEIGHT BEFORE COOKING
75 Pounds	1/4 pound (4oz)
150 Pounds	1/2 pound (8oz)
225 Pounds	3/4 pound (12oz)



THE FACTS ON FISH

Fish can be an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish may lower the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant may help brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who may do better developmentally.

Most fish are a healthy food, but eating some types of fish may raise health risks over time.

- Some types of fish from some lakes and streams may contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals can build up in your body. Eventually, they may cause health problems.
- It is difficult to know who might have health problems from chemicals in fish. Some people can be fine after years of eating fish with these chemicals in them, while others can have health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthier for you and your family to eat.

- See the guidelines in this brochure from the Wisconsin Department of Natural Resources.
- These guidelines tell which fish are healthier to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines can keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.dnr.wi.gov/topic/fishing/consumption/

Form 27

Produced by Cornell University in cooperation with the Wisconsin Department of Natural Resources and Department of Health Services

Great Lakes Guidelines

For exceptions to this advice and to find advice for waters not listed here, visit wi.dnr.gov and search “Eating Your Catch.”

LAKE SUPERIOR GUIDELINES

(and tributaries up to the first impassable barrier)

MAY EAT 1 MEAL PER WEEK OF: Brown trout, burbot, chinook salmon (<32”), chubs, coho salmon, lake herring, lake trout (<22”), lake whitefish, rainbow trout, or yellow perch

MAY EAT 1 MEAL PER MONTH OF: Chinook salmon (>32”), lake sturgeon (>50”), lake trout (22-37”), siscowet (<29”), or walleye

MAY EAT 6 MEALS PER YEAR (1 MEAL EVERY 2 MONTHS) OF: Lake trout (>37”) or siscowet (29-36”)

DO NOT EAT: Siscowet (>36”)

LAKE MICHIGAN GUIDELINES

(and tributaries up to the first dam)

MAY EAT 1 MEAL PER WEEK OF: Rainbow trout (<22”), smelt, or yellow perch (<11”)

MAY EAT 1 MEAL PER MONTH OF: Brown trout, chinook salmon, chubs, coho salmon, lake trout (<27”), lake whitefish, rainbow trout (>22”), or yellow perch (>11”)

DO NOT EAT: Lake trout (>27”)

GREEN BAY GUIDELINES

(and tributaries up to the first dam – see also more stringent advice for the lower Fox River)

MAY EAT 1 MEAL PER WEEK OF: Burbot, northern pike (<27”), smallmouth bass (<13”), white sucker, or yellow perch

MAY EAT 1 MEAL PER MONTH OF: Brown trout (<28”), chinook salmon, lake whitefish, northern pike (>27”), rainbow trout, sheepshead, smallmouth bass (>13”), or walleye

MAY EAT 6 MEALS PER YEAR (1 MEAL EVERY 2 MONTHS) OF: Channel catfish, musky (>50”), white bass, or white perch

DO NOT EAT: Brown trout (>28”), carp, or sturgeon



Your guide to eating FISH & SHELLFISH

Fish can be an important part of a healthy diet for all women. It may be even more important for women who are pregnant, breastfeeding, or might become pregnant.

Do you think eating fish may have risks for women who might become pregnant?

Like Amanda, you might be surprised to learn that fish can be an important part of a healthy diet.

After being away for several years, Amanda and Andy recently moved back to their hometown of Milwaukee, Wisconsin. They decided it was time to try to have a baby. A baby is a big change, so Amanda began doing her homework on exercise and nutrition that would help her have a healthy baby.

Amanda found a website with guidelines about eating fish for women of childbearing age. The website explained that, although many women don't eat fish before and during pregnancy, certain fish are actually a great source of omega-3s. Omega-3s may be important for a baby's development and are not found in many other foods. Fish can also be a very nutritious food for children to eat as they grow.

Amanda wasn't convinced. She looked for other sources and found the Wisconsin Department of Natural Resources' Safe-Eating Guidelines for fish. These guidelines confirmed that while some types of fish contain higher levels of chemicals like mercury or PCBs, many fish can be healthy for women and children to eat. These guidelines (found in this brochure) helped her to choose which fish are healthier to eat and which she should try to avoid.

Now that Amanda is pregnant she is using the guidelines to choose which fish to eat. She is happy because salmon is one of her favorite foods!

Wisconsin Safe-Eating Guidelines for Fish:

For Women Up to Age 50 and Children Under Age 15

STATEWIDE* GUIDELINES FOR FISH YOU CATCH

MAY EAT 1 MEAL PER WEEK OF: Bluegill, crappies, yellow perch, sunfish, bullheads, or inland trout

AND

MAY EAT 1 MEAL PER MONTH OF: Walleye, pike, bass, catfish, or all other species

DO NOT EAT: Muskies

*For exceptions to this advice and to find advice for waters not listed here, visit wi.dnr.gov and search "Eating Your Catch."

PURCHASED FISH GUIDELINES

MAY EAT 2 MEALS PER WEEK OF: Atlantic or Pacific Salmon (not Great Lakes), farm-raised catfish, shrimp, pollock, or other purchased fish low in mercury

OR

MAY EAT 1 MEAL PER WEEK OF: Canned "light" tuna

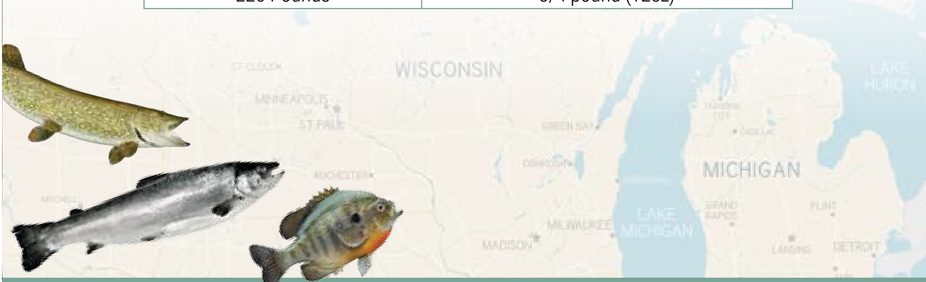
AND

MAY EAT 1 MEAL PER MONTH OF: Canned white tuna, tuna steaks, or halibut

DO NOT EAT: Shark, swordfish, king mackerel, or tilefish

WHAT IS A MEAL?

YOUR BODY WEIGHT	FILLET WEIGHT BEFORE COOKING
75 Pounds	1/4 pound (4oz)
150 Pounds	1/2 pound (8oz)
225 Pounds	3/4 pound (12oz)



THE FACTS ON FISH

Fish can be an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish may lower the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant may help brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who may do better developmentally.

Most fish are a healthy food, but eating some types of fish may raise health risks over time.

- Some types of fish from some lakes and streams may contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals can build up in your body. Eventually, they may cause health problems.
- It is difficult to know who might have health problems from chemicals in fish. Some people can be fine after years of eating fish with these chemicals in them, while others can have health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthier for you and your family to eat.

- See the guidelines in this brochure from the Wisconsin Department of Natural Resources.
- These guidelines tell which fish are healthier to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines can keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.dnr.wi.gov/topic/fishing/consumption/

Form 25

Produced by Cornell University in cooperation with the Wisconsin Department of Natural Resources and Department of Health Services

Great Lakes Guidelines

For exceptions to this advice and to find advice for waters not listed here, visit wi.dnr.gov and search "Eating Your Catch."

LAKE SUPERIOR GUIDELINES

(and tributaries up to the first impassable barrier)

MAY EAT 1 MEAL PER WEEK OF: Brown trout, burbot, chinook salmon (<32"), chubs, coho salmon, lake herring, lake trout (<22"), lake whitefish, rainbow trout, or yellow perch

MAY EAT 1 MEAL PER MONTH OF: Chinook salmon (>32"), lake sturgeon (>50"), lake trout (22-37"), siscowet (<29"), or walleye

MAY EAT 6 MEALS PER YEAR (1 MEAL EVERY 2 MONTHS) OF: Lake trout (>37") or siscowet (29-36")

DO NOT EAT: Siscowet (>36")

LAKE MICHIGAN GUIDELINES

(and tributaries up to the first dam)

MAY EAT 1 MEAL PER WEEK OF: Rainbow trout (<22"), smelt, or yellow perch (<11")

MAY EAT 1 MEAL PER MONTH OF: Brown trout, chinook salmon, chubs, coho salmon, lake trout (<27"), lake whitefish, rainbow trout (>22"), or yellow perch (>11")

DO NOT EAT: Lake trout (>27")

GREEN BAY GUIDELINES

(and tributaries up to the first dam – see also more stringent advice for the lower Fox River)

MAY EAT 1 MEAL PER WEEK OF: Burbot, northern pike (<27"), smallmouth bass (<13"), white sucker, or yellow perch

MAY EAT 1 MEAL PER MONTH OF: Brown trout (<28"), chinook salmon, lake whitefish, northern pike (>27"), rainbow trout, sheepshead, smallmouth bass (>13"), or walleye

MAY EAT 6 MEALS PER YEAR (1 MEAL EVERY 2 MONTHS) OF: Channel catfish, musky (>50"), white bass, or white perch

DO NOT EAT: Brown trout (>28"), carp, or sturgeon

Your guide to eating FISH & SHELLFISH

Fish is an important part of a healthy diet for all women. It is even more important for women who are pregnant, breastfeeding, or might become pregnant.

Frequently Asked Questions
about Eating Fish

I heard that eating fish has risks for women who might become pregnant – is this true?

Certain fish are actually a great source of omega-3s. Omega-3s are important for a baby's development and are not found in many other foods. Fish are also a very nutritious food for children to eat as they grow.

But aren't there harmful chemicals in fish, too?

Some types of fish contain higher levels of chemicals like mercury or PCBs, but many fish are healthy for women and children to eat.

Where can I find out which fish are healthy to eat and which I should avoid?

Minnesota's Fish Consumption Guidelines can help you to choose which fish are healthiest to eat and which you should avoid. These guidelines can be found in this brochure!

Minnesota Guidelines for Eating Fish:

For Pregnant Women, Women Who Could Become Pregnant, and Children under Age 15:

Every week eat some of these fish!

2 SERVINGS OF ANY OF THESE FISH:

LAKE SUPERIOR FISH:
- Herring (Cisco)
- Coho Salmon
- Rainbow Trout/Steelhead
- Smelt

INLAND FISH:
- Rainbow Trout

PURCHASED FISH:
- Cod
- Crab
- Salmon (Atlantic or Pacific; not Great Lakes)
- Sardines
- Scallops
- Shrimp
- Tilapia

OR

1 SERVING OF ANY OF THESE FISH:

LAKE SUPERIOR FISH:
- Lake Whitefish
- Menominee
- Brown Trout
- Lake Trout <22"
- Chinook Salmon < 32"

INLAND FISH:
- Herring (Cisco)
- Lake Whitefish
- Splake
- Sunfish and Crappie
- Yellow Perch

PURCHASED FISH:
- Canned "light" tuna

Once a month it's also OK to eat 1 serving of these fish:

1 SERVING EACH MONTH OF ANY OF THESE FISH:

LAKE SUPERIOR FISH:
- Lake Trout 22"-37"
- Chinook Salmon 32"+
- Walleye

INLAND FISH:
- Northern Pike
- Walleye
- Trout - Lake, Brown, Brook

PURCHASED FISH:
- Canned "white" (albacore) tuna
- Tuna (steak, fillet, sushi)
- Halibut

Avoid eating these fish:

Shark and Swordfish

WHAT COUNTS AS A SERVING?

A serving is 8 oz un-cooked fish for a 150lb person

THE FACTS ON FISH

Fish is an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish lowers the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant helps brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who do better developmentally.

Most fish are a healthy food, but eating some types of fish raises health risks over time.

- Some types of fish from some lakes and streams contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals build up in your body. Eventually, they can cause health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthy for you and your family to eat.

- See the guidelines in this brochure from the Minnesota Department of Health.
- These guidelines tell which fish are the healthiest to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines will keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.health.state.mn.us/fish

Form 32

Produced by Cornell University in cooperation with the Minnesota Department of Health

Your guide to eating FISH & SHELLFISH

Fish is an important part of a healthy diet for all women. It is even more important for women who are pregnant, breastfeeding, or might become pregnant.

Do you think eating fish has risks for women who might become pregnant?

Like Laura, you might be surprised to learn that fish is an important part of a healthy diet.

After being away for several years, Laura and Matt recently moved back to their hometown of Virginia, Minnesota. They decided it was time to try to have a baby. A baby is a big change, so Laura began doing her homework on exercise and nutrition that would help her have a healthy baby.

Laura found a website with guidelines about eating fish for women of childbearing age. The website explained that, although many women don't eat fish before and during pregnancy, certain fish are actually a great source of omega-3s. Omega-3s are important for a baby's development and are not found in many other foods. Fish are also a very nutritious food for children to eat as they grow.

Laura wasn't convinced. She looked for other sources and found the Minnesota Department of Health's Fish Consumption Guidelines. These guidelines confirmed that while some types of fish contain higher levels of chemicals like mercury or PCBs, many fish are healthy for women and children to eat. These guidelines (found in this brochure) helped her to choose which fish are healthiest to eat and which she should avoid.

Now that Laura is pregnant she is using the guidelines to choose which fish to eat. She is happy because salmon is one of her favorite foods!

Minnesota Guidelines for Eating Fish:

For Pregnant Women, Women Who Could Become Pregnant, and Children under Age 15:

Every week eat some of these fish!

2 SERVINGS OF ANY OF THESE FISH:

LAKE SUPERIOR FISH:
- Herring (Cisco)
- Coho Salmon
- Rainbow Trout/Steelhead
- Smelt

INLAND FISH:
- Rainbow Trout

PURCHASED FISH:
- Cod
- Crab
- Salmon (Atlantic or Pacific; not Great Lakes)
- Sardines
- Scallops
- Shrimp
- Tilapia

OR

1 SERVING OF ANY OF THESE FISH:

LAKE SUPERIOR FISH:
- Lake Whitefish
- Menominee
- Brown Trout
- Lake Trout <22"
- Chinook Salmon < 32"

INLAND FISH:
- Herring (Cisco)
- Lake Whitefish
- Splake
- Sunfish and Crappie
- Yellow Perch

PURCHASED FISH:
- Canned "light" tuna

Once a month it's also OK to eat 1 serving of these fish:

1 SERVING EACH MONTH OF ANY OF THESE FISH:

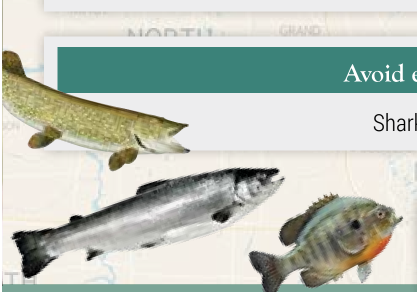
LAKE SUPERIOR FISH:
- Lake Trout 22"-37"
- Chinook Salmon 32"+
- Walleye

INLAND FISH:
- Northern Pike
- Walleye
- Trout - Lake, Brown, Brook

PURCHASED FISH:
- Canned "white" (albacore) tuna
- Tuna (steak, fillet, sushi)
- Halibut

Avoid eating these fish:

Shark and Swordfish



WHAT COUNTS AS A SERVING?
A serving is 8 oz un-cooked fish for a 150lb person

THE FACTS ON FISH

Fish is an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish lowers the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant helps brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who do better developmentally.

Most fish are a healthy food, but eating some types of fish raises health risks over time.

- Some types of fish from some lakes and streams contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals build up in your body. Eventually, they can cause health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthy for you and your family to eat.

- See the guidelines in this brochure from the Minnesota Department of Health.
- These guidelines tell which fish are the healthiest to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines will keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.health.state.mn.us/fish

Form 30

Produced by Cornell University in cooperation with the Minnesota Department of Health

Your guide to eating
FISH & SHELLFISH

Fish can be an important part of a healthy diet for all women. It may be even more important for women who are pregnant, breastfeeding, or might become pregnant.

Frequently Asked Questions
about Eating Fish

I heard that eating fish may have risks for women who might become pregnant – is this true?

Certain fish are actually a great source of omega-3s. Omega-3s may be important for a baby's development and are not found in many other foods. Fish can also be a very nutritious food for children to eat as they grow.

But aren't there harmful chemicals in fish, too?

Some types of fish contain higher levels of chemicals like mercury or PCBs, but many fish can be healthy for women and children to eat.

Where can I find out which fish are healthier to eat and which I should avoid?

Minnesota's Fish Consumption Guidelines can help you to choose which fish are healthier to eat and which you should try to avoid. These guidelines can be found in this brochure!

Minnesota Guidelines for Eating Fish:

For Pregnant Women, Women Who Could Become Pregnant, and Children under Age 15:

Every week eat some of these fish!

2 SERVINGS OF ANY OF THESE FISH:

LAKE SUPERIOR FISH:
- Herring (Cisco)
- Coho Salmon
- Rainbow Trout/Steelhead
- Smelt

INLAND FISH:
- Rainbow Trout

PURCHASED FISH:
- Cod
- Crab
- Salmon (Atlantic or Pacific; not Great Lakes)
- Sardines
- Scallops
- Shrimp
- Tilapia

OR

1 SERVING OF ANY OF THESE FISH:

LAKE SUPERIOR FISH:
- Lake Whitefish
- Menominee
- Brown Trout
- Lake Trout <22"
- Chinook Salmon < 32"

INLAND FISH:
- Herring (Cisco)
- Lake Whitefish
- Splake
- Sunfish and Crappie
- Yellow Perch

PURCHASED FISH:
- Canned "light" tuna

Once a month it's also OK to eat 1 serving of these fish:

1 SERVING EACH MONTH OF ANY OF THESE FISH:

LAKE SUPERIOR FISH:
- Lake Trout 22"-37"
- Chinook Salmon 32"+
- Walleye

INLAND FISH:
- Northern Pike
- Walleye
- Trout - Lake, Brown, Brook

PURCHASED FISH:
- Canned "white" (albacore) tuna
- Tuna (steak, fillet, sushi)
- Halibut

Avoid eating these fish:

Shark and Swordfish

WHAT COUNTS AS A SERVING?

A serving is 8 oz un-cooked fish for a 150lb person

THE FACTS ON FISH

Fish can be an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish may lower the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant may help brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who may do better developmentally.

Most fish are a healthy food, but eating some types of fish may raise health risks over time.

- Some types of fish from some lakes and streams may contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals can build up in your body. Eventually, they may cause health problems.
- It is difficult to know who might have health problems from chemicals in fish. Some people can be fine after years of eating fish with these chemicals in them, while others can have health problems.
- Benefits outweigh risks if you eat fish low in mercury and other contaminants.

Health experts can help you know which fish are healthier for you and your family to eat.

- See the guidelines in this brochure from the Minnesota Department of Health.
- These guidelines tell which fish are healthier to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines can keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.health.state.mn.us/fish
Form 31

Produced by Cornell University in cooperation with the Minnesota Department of Health



Your guide to eating FISH & SHELLFISH

Fish can be an important part of a healthy diet for all women. It may be even more important for women who are pregnant, breastfeeding, or might become pregnant.

Do you think eating fish may have risks for women who might become pregnant?

Like Laura, you might be surprised to learn that fish can be an important part of a healthy diet.

After being away for several years, Laura and Matt recently moved back to their hometown of Virginia, Minnesota. They decided it was time to try to have a baby. A baby is a big change, so Laura began doing her homework on exercise and nutrition that would help her have a healthy baby.

Laura found a website with guidelines about eating fish for women of childbearing age. The website explained that, although many women don't eat fish before and during pregnancy, certain fish are actually a great source of omega-3s. Omega-3s may be important for a baby's development and are not found in many other foods. Fish can also be a very nutritious food for children to eat as they grow.

Laura wasn't convinced. She looked for other sources and found the Minnesota Department of Health's Fish Consumption Guidelines. These guidelines confirmed that while some types of fish contain higher levels of chemicals like mercury or PCBs, many fish can be healthy for women and children to eat. These guidelines (found in this brochure) helped her to choose which fish are healthier to eat and which she should try to avoid.

Now that Laura is pregnant she is using the guidelines to choose which fish to eat. She is happy because salmon is one of her favorite foods!

Minnesota Guidelines for Eating Fish:

For Pregnant Women, Women Who Could Become Pregnant, and Children under Age 15:

Every week eat some of these fish!

2 SERVINGS OF ANY OF THESE FISH:

LAKE SUPERIOR FISH:
- Herring (Cisco)
- Coho Salmon
- Rainbow Trout/Steelhead
- Smelt

INLAND FISH:
- Rainbow Trout

PURCHASED FISH:
- Cod
- Crab
- Salmon (Atlantic or Pacific; not Great Lakes)
- Sardines
- Scallops
- Shrimp
- Tilapia

OR

1 SERVING OF ANY OF THESE FISH:

LAKE SUPERIOR FISH:
- Lake Whitefish
- Menominee
- Brown Trout
- Lake Trout <22"
- Chinook Salmon < 32"

INLAND FISH:
- Herring (Cisco)
- Lake Whitefish
- Splake
- Sunfish and Crappie
- Yellow Perch

PURCHASED FISH:
- Canned "light" tuna

Once a month it's also OK to eat 1 serving of these fish:

1 SERVING EACH MONTH OF ANY OF THESE FISH:

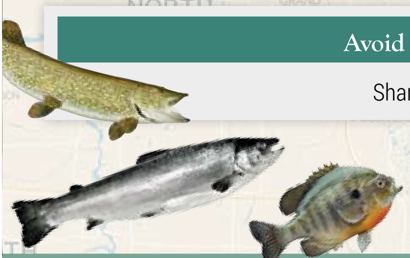
LAKE SUPERIOR FISH:
- Lake Trout 22"-37"
- Chinook Salmon 32"+
- Walleye

INLAND FISH:
- Northern Pike
- Walleye
- Trout - Lake, Brown, Brook

PURCHASED FISH:
- Canned "white" (albacore) tuna
- Tuna (steak, fillet, sushi)
- Halibut

Avoid eating these fish:

Shark and Swordfish



WHAT COUNTS AS A SERVING?
A serving is 8 oz un-cooked fish for a 150lb person

THE FACTS ON FISH

Fish can be an important part of a healthy diet for all women.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish may lower the risk of heart disease and other health problems.
- Eating fish with omega-3s while pregnant may help brain and eye development in a woman's fetus.
- Women who eat low mercury fish every week when they are pregnant have children who may do better developmentally.

Most fish are a healthy food, but eating some types of fish may raise health risks over time.

- Some types of fish from some lakes and streams may contain harmful chemicals such as PCBs and mercury.
- When you eat fish that contain these chemicals, the chemicals can build up in your body. Eventually, they may cause health problems.
- It is difficult to know who might have health problems from chemicals in fish. Some people can be fine after years of eating fish with these chemicals in them, while others can have health problems.
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Health experts can help you know which fish are healthier for you and your family to eat.

- See the guidelines in this brochure from the Minnesota Department of Health.
- These guidelines tell which fish are healthier to eat.
- Our bodies eliminate chemicals from fish over time. Women who follow the guidelines can keep these chemicals from building up to harmful levels in their bodies.

FOR MORE INFORMATION VISIT:

www.health.state.mn.us/fish

Form 29

Produced by Cornell University in cooperation with the Minnesota Department of Health

Appendix B2: Summary of Potential High Impact Communication Strategies

Summary of Potential High Impact Communication Strategies

This document describes potentially high-impact strategies to promote healthy fish consumption behavior, particularly among populations at risk for unhealthy consumption patterns including urban anglers and women of childbearing age. This document reviews the communication, risk, health, and natural resource literatures to offer guidance on fish advisory messages development. Strategies listed below that are of interest to the Consortium could be incorporated into some versions of the brochures Cornell develops for this project to test whether these strategies increase the persuasiveness of fish consumption messages.

NARRATIVES (PERSONAL STORIES)

- **Summary**: Narrative is one of the most basic and universal modes of expression. Research suggests a thoughtfully crafted narrative, or message in the form of a story, can immerse the reader in the plot line so that they are less likely to counter-argue a message, and more likely to experience the emotion a character is experiencing.
- **Evidence**: Narrative messages have been found to be persuasive in a variety of behavioral contexts, including skin cancer prevention and smoking cessation.
- **Message design considerations**: Use of narrative involves communication of a message in the form of a story. For example, a narrative message might describe the situation of a particular woman of childbearing age and incorporate direct quotations from her describing how her state's fish consumption guidelines reassured her that eating fish was good for her baby. Successful approaches to narrative research typically draw on authentic stories from real people, with only minor edits to improve comprehension.

ACKNOWLEDGING UNCERTAINTY

- **Summary**: Risk information is often uncertain. Medical decision-making research has found providing individuals in the patient/doctor context with information about the uncertainty of the effects of treatment options can induce anxiety in these individuals. Research suggests attempting to overcome this anxiety by providing individuals with full information about the variety of treatment options available (including levels of uncertainty associated with each option) to create trust and increase the likelihood of persuasive outcomes.
- **Evidence**: No systematic reviews available.
- **Message design considerations**: A large portion of fish advisory information is based on measurements of harmful chemicals in samples of fish from specific waterbodies, leading to recommendations about which fish to eat and which to avoid. With the uncertain nature of this information, one fruitful avenue for message design is to explore effects of disclosing uncertainty about fish advisory guidelines versus *not* disclosing the uncertain nature of guidelines. There are many examples of such disclosures in existing advisories. Examples include:

- “Sometimes we discover new problem sites, though. These sites are different because they are so new; we sometimes just don't know what is exactly wrong. We have data that show the fish are contaminated, but until we find out the source of the chemicals or how far the problem reaches, we often recommend that no one eat the fish until we have more information.” – Michigan Department of Community Health
- “The waters that have been tested are not necessarily more contaminated than those not tested. Waters are selected for sampling where angling is popular, where there is a known or suspected pollution source, or where fish contaminant trends are being tracked. Mercury is found in most fish tested from Minnesota lakes. PCBs are found mainly in Lake Superior and major rivers such as the Mississippi River. Perfluorochemicals (PFCs) have been found in some fish in Minnesota. MPCA is investigating the sources of PFCs in fish. These guidelines are based on the contaminant level measured in fillets.” – Minnesota Department of Health
- “Not all waters in Minnesota have been tested for contaminants in fish.” – Minnesota Department of Health
- “Wisconsin’s fish collection and testing program is frequently adjusted to meet changing needs. New sites are tested each year, along with some previously tested waters to determine trends in contaminant levels.” – Wisconsin Department of Natural Resources
- In New York State, these advisories are primarily based on information that NYS DEC gathers on contaminant levels in fish and game. NYS DEC collects fish samples each year from different water bodies. In recent years, NYS DEC has annually collected approximately 2,000 fish from more than 50 locations/waters and analyzed these fish for various contaminants. Sampling focuses on water bodies with known or suspected contamination, water bodies susceptible to mercury contamination, popular fishing waters and waters where trends in fish contamination are being monitored. Also, testing focuses on those species that are most likely to be caught and eaten by sport anglers. NYS DEC also tests some game species (e.g., waterfowl, snapping turtles) that accumulate chemical contaminants.” NY State Department of Health

NUMBERS & STATISTICS

- **Summary**: Information about risk can be provided qualitatively with verbal statements or quantitatively with numbers or statistics.
- **Evidence (systematic reviews):** Risk information is often provided in terms of statistics, odds, or numbers. A broad distinction can be made between quantitative information that is probabilistic, like “1% of women will develop breast cancer,” or represented as a natural frequency, like “1 in 100 women will develop breast cancer.” Probabilities can be in absolute terms (applying to an entire target audience), like the percent of all women susceptible to breast cancer (1% of women will develop breast cancer), or relative terms, comparing that risk group to another population (e.g., women are thirty times more likely to die from breast cancer than men). Research suggests the use of relative probabilities should be avoided, as readers often draw incorrect conclusions when presented with information in this type. Research on information in the form of numbers or

statistics typically compares the same general information in quantitative form (numbers or statistics) with qualitative forms (such as “very much”). Of all quantitative forms, natural frequencies describing absolute risks (5 out of 100 people…) have been found to elicit the most accurate perceptions about risk. That said, there is also some evidence that qualitative representations (many; most; some; a few) can also effectively convey risk information.

- **Message design considerations**: Messages must be drafted with the target population’s level of numeracy (e.g., comfort in engaging with quantitative or numerical information) in mind. For some populations, qualitative statements may be more appropriate. An appropriate message comparison for the fish consumption advisory brochure may be to test persuasive outcomes from a version that uses qualitative information (“very high” or “more than”) with quantitative information (absolute risk probabilities or natural frequencies).

INCLUDING PICTURES OR FIGURES

- **Summary**: Charts and pictures are an easy way to visually depict risk information. Statistical graphs can convey quantitative information clearly and visually, while pictorial information (like traffic lights or speedometers) often uses colors to convey risk information (red = do not eat, yellow = eat with some restrictions, green = eat without restriction), and can represent relationships clearly and simply.
- **Evidence**: Meta-analysis of research on different statistical chart formats has found graphs are a preferred way to receive information over text and statistical information alone. In fact, graphs are also more persuasive (with the exception of pie charts). Material in the form of pictures or video are also more persuasive than text alone, and evidence suggests pictures plus text can enhance comprehension and memory. Finally, research suggests circular items that are familiar to individuals improve comprehension, such as a traffic light or speedometer.
- **Message design considerations**: Use of pictures, such as traffic lights or speedometers, may be a useful strategy for effective fish advisory brochures. For example, mercury levels in high-risk fish could be displayed with a red light whereas low mercury fish could have a ‘green’ light. In addition, information that lends itself to a graph may also be effective, although pie charts should be avoided.

EMPHASIZING DIFFERENT CONSEQUENCES

- **Summary**: An emphasis on different types of consequences in persuasive messages can yield different outcomes. For instance, messages could emphasize individual consequences (harm to oneself) and collective consequences (harms to one’s child, family, or friends).
- **Evidence:** One meta-analysis concluded that messages attributing responsibility for imposing addiction upon industry (or the consequences of secondhand smoke for a smoker’s loved ones) to be more efficacious at encouraging people to quit smoking than messages about the individual consequences of smoking. At the same time, many studies have found individual consequences messages to be effective as well.

- **Message design considerations**: Message strategies might build on this evidence to compare messages focused on consequences to oneself (mother's health, angler's health) versus consequences to others (child's health, angler's family's health) consequences.

QUOTING EXPERTS OR AUTHORITIES FOR SUPPORT

- **Summary**: Experts are a key source of information, particularly when issues of risk arise. Persuasion research often explores and compares how various characteristics of expert or authority figures (credibility, attractiveness, and power) influence message effectiveness.
- **Evidence:** The greatest effect in source manipulation studies has been observed in comparing messages from experts and non-experts. One systematic review points to the importance of trust of experts. Another systematic review points to significant persuasive effects of source expertise, but points to the need for more work exploring potential interactions among these variables.
- **Message design considerations**: Evidence suggests expert or authority figures may enhance the persuasiveness of messages. However, they but must be trustworthy. The fish consumption brochure could make use of experts by referencing "physicians" or "experts" or other trusted sources for particular types of information in articulating guidelines.

Appendix B3:
Key Message Testing

Message Testing Results

From April to June 2014, HealthPartners Institute for Education and Research conducted a survey of women of child-bearing age in which they assessed responses to a series of messages about fish consumption and the trustworthiness of various sources of information about fish consumption. Out of an initial sample of 2,000 English-speaking female HealthPartners patients between the ages of 18-50, 601 women completed the survey. This document provides a summary of the results.

Women were presented with several sets of statements: 1) six reasons to eat fish, 2) three additional reasons to eat fish concerned with EPA and DHA, and 3) six reasons to follow consumption guidelines. The statements are provided below for your reference (along with abbreviated versions used in the tables). Women were asked two questions about each statement. The first question assesses novelty (whether or not the information is new), and the second assesses importance. These two factors are the primary drivers of persuasiveness of messages. Questions for each statement were worded as follows: a) have you heard this reason for eating fish before (yes or no)? and b) how important is this reason to you (on a scale of 1 to 7)?

1) Reasons to Eat Fish

- Eating fish is the best way to get healthy omega-3 fats. ("get healthy omega-3s")
- Eating fish that has omega-3 fats while pregnant may help during fetal brain and eye development. ("help fetal brain and eye development")
- Eating fish that has omega-3 fats may lower the risk of heart disease in adults. ("lower the risk of heart disease")
- Fish are generally low in saturated fats. ("low in saturated fats")
- Benefits outweigh risks if women eat fish low in mercury and other contaminants. ("benefits outweigh risks")
- Children of women who eat lower mercury fish every week when they are pregnant have been found to do better developmentally. ("children do better developmentally")

2) Reasons to eat fish concerned with EPA and DHA:

- Our bodies can't make EPA and DHA and they are generally not found in other foods**.** ("bodies can't make EPA and DHA")
- DHA is a building block of the brain and eyes. ("DHA builds brain and eyes")
- Pregnant moms and breastfeeding moms can eat fish to give DHA to their babies. ("eat fish to give DHA to babies")

3) Reasons to follow consumption guidelines:

- Women who follow the guidelines get the health benefits of fish with very little risk to themselves or their children. ("health benefits with few risks: self or children")
- Women who follow the guidelines are less exposed to contaminants found in some fish. ("less exposed to contaminants")
- Women who follow the guidelines avoid eating fish high in contaminants. ("avoid eating fish high in contaminants")
- Women who follow the guidelines know which fish are low in contaminants. ("know which fish are low in contaminants")
- Women who follow the guidelines get the health benefits of fish with few risks. ("health benefits with few risks: self")

- Our bodies eliminate mercury over time. Women who follow the guidelines will keep mercury in fish from building up to harmful levels in their bodies. (“keep mercury from building up”)

Women were asked two questions about each statement:

- Have you heard this reason for eating fish before? (Yes or No)
- How important is this reason to you? (Answered on a scale of 1 to 7.)

The first question assesses novelty (whether or not the information is new), and the second assesses importance. These two factors are the primary drivers of persuasiveness of messages.

Table 1A presents the results for the initial set of 6 statements. In this table, importance is measured on a dichotomous scale because it is more comparable to the measure of novelty. Table 1B presents the importance results using the full 7-point scale.

Two general conclusions emerge from these results. The majority of women consider all 6 reasons important reasons for eating fish. However, not all reasons are equally novel. The most novel reasons are those statements about the benefits that children gain when women eat fish when they are pregnant.

Table 1A: Statements about Reasons to Eat Fish (Question Set 1)

Dichotomous Version of Importance Variable

		Seen Before?				**Important? (5-7 on scale)**			
		No		*Yes*		*Low*		*High*	
	N	N	%	N	%	N	%	N	%
Eating fish that has omega-3 fats may lower the risk of heart disease in adults. **(sq1_3b_fsh)**	601	117	(19.5%)	484	(80.5%)	167	(28.0%)	430	(72.0%)
Eating fish that has omega-3 fats while pregnant may help during fetal brain and eye development. **(sq1_2b_fsh)**	599	307	(51.3%)	292	(48.7%)	191	(31.9%)	407	(68.1%)
Eating fish is the best way to get healthy omega-3 fats. **(sq1_1b_fsh)**	598	157	(26.3%)	441	(73.7%)	213	(35.7%)	384	(64.3%)
Fish are generally low in saturated fats. **(sq1_4b_fsh)**	599	141	(23.5%)	458	(76.5%)	217	(36.3%)	380	(63.7%)
Children of women who eat lower mercury fish every week when they are pregnant have been found to do better developmentally. **(sq1_6b_fsh)**	602	432	(71.8%)	170	(28.2%)	244	(40.8%)	354	(59.2%)
Benefits outweigh risks if women eat fish low in mercury and other contaminants. **(sq1_5b_fsh)**	600	239	(39.8%)	361	(60.2%)	236	(39.2%)	366	(60.8%)

Table 1B: Statements about Reasons to Eat Fish (Question Set 1)

Continuous Version of Importance Variable

	Importance			
			95% CI	
	N	*Mean*	Lower	Upper
Eating fish that has omega-3 fats may lower the risk of heart disease in adults. **(sq1_3b_fsh)**	597	5.35	5.21	5.49
Eating fish that has omega-3 fats while pregnant may help during fetal brain and eye development. **(sq1_2b_fsh)**	598	5.07	4.91	5.23
Eating fish is the best way to get healthy omega-3 fats. **(sq1_1b_fsh)**	597	4.97	4.83	5.12
Fish are generally low in saturated fats. **(sq1_4b_fsh)**	597	4.96	4.82	5.10
Children of women who eat lower mercury fish every week when they are pregnant have been found to do better developmentally. **(sq1_6b_fsh)**	598	4.86	4.69	5.02
Benefits outweigh risks if women eat fish low in mercury and other contaminants. **(sq1_5b_fsh)**	602	4.84	4.68	5.00

Table 2A and 2B present the results for the second set of 3 statements about EPA and DHA. The majority of women consider all 3 reasons important reasons for eating fish. The majority also consider all 3 statements novel.

Table 2A: Statements about DHA (Question Set 2)

Dichotomous Version of Importance Variable

		Seen Before?				Important? (5-7 on scale)			
		No		*Yes*		*Low*		*High*	
	N	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
DHA is a building block of the brain and eyes. **(sq2_2b_fsh)**	600	326	(54.3%)	274	(45.7%)	185	(30.9%)	414	(69.1%)
Pregnant moms and breastfeeding moms can eat fish to give DHA to their babies. **(sq2_3b_fsh)**	595	430	(72.3%)	165	(27.7%)	232	(38.7%)	368	(61.3%)
Our bodies can't make EPA and DHA and they are generally not found in other foods**. (sq2_1b_fsh)**	601	487	(81.0%)	114	(19.0%)	263	(44.0%)	335	(56.0%)

Table 2B: Statements about DHA (Question Set 2)

Continuous Version of Importance Variable

	Importance			
			95% CI	
	N	*Mean*	*Lower*	*Upper*
DHA is a building block of the brain and eyes. **(sq2_2b_fsh)**	599	5.16	5.01	5.31
Pregnant moms and breastfeeding moms can eat fish to give DHA to their babies. **(sq2_3b_fsh)**	600	4.83	4.67	5.00
Our bodies can't make EPA and DHA and they are generally not found in other foods. **(sq2_1b_fsh)**	598	4.67	4.52	4.82

Reasons to Follow Guidelines

Women were presented with 6 statements describing reasons to follow fish consumption guidelines:

- Women who follow the guidelines get the health benefits of fish with very little risk to themselves or their children.
- Women who follow the guidelines avoid eating fish high in contaminants.
- Our bodies eliminate mercury over time. Women who follow the guidelines will keep mercury in fish from building up to harmful levels in their bodies.
- Women who follow the guidelines get the health benefits of fish with few risks.
- Women who follow the guidelines are less exposed to contaminants found in some fish.
- Women who follow the guidelines know which fish are low in contaminants.

They were asked questions about each statement that paralleled those for the statements describing reasons to eat fish:

- Have you heard this reason for following the guidelines before? (Yes or No)
- How important is this reason to you? (Answered on a scale of 1 to 7.)

Tables 3A and 3B present the results for these statements.

All 6 statements were considered important reasons for eating fish; little difference existed in the importance ratings. The most novel statement was the statement about our bodies eliminating mercury over time.

Table 3A: Statements about the Value of Following Guidelines (Question Set 3)

Dichotomous Version of Importance Variable

		Seen Before?				**Important? (5-7 on scale)**			
		No		*Yes*		*Low*		*High*	
	N	N	%	N	%	N	%	N	%
Women who follow the guidelines get the health benefits of fish with very little risk to themselves or their children. **(sq3_1b_fsh)**	597	311	(52.1%)	286	(47.9%)	173	(28.9%)	425	(71.1%)
Women who follow the guidelines avoid eating fish high in contaminants. **(sq3_3b_fsh)**	597	286	(47.9%)	311	(52.1%)	176	(29.8%)	415	(70.2%)
Our bodies eliminate mercury over time. Women who follow the guidelines will keep mercury in fish from building up to harmful levels in their bodies. **(sq3_6b_fsh)**	595	436	(73.3%)	159	(26.7%)	174	(29.3%)	419	(70.7%)
Women who follow the guidelines get the health benefits of fish with few risks. **(sq3_5b_fsh)**	598	312	(52.2%)	286	(47.8%)	174	(29.1%)	424	(70.9%)
Women who follow the guidelines are less exposed to contaminants found in some fish. **(sq3_2b_fsh)**	600	302	(50.3%)	298	(49.7%)	190	(31.9%)	405	(68.1%)
Women who follow the guidelines know which fish are low in contaminants. **(sq3_4b_fsh)**	598	338	(56.5%)	260	(43.5%)	193	(32.4%)	403	(67.6%)

Table 3B: Statements about the Value of Following Advisories (Question Set 3)

Continuous Version of Importance Variable

	Importance			
			95% CI	
	N	*Mean*	*Lower*	*Upper*
Women who follow the guidelines get the health benefits of fish with very little risk to themselves or their children. **(sq3_1b_fsh)**	597	5.25	5.10	5.40
Women who follow the guidelines avoid eating fish high in contaminants. **(sq3_3b_fsh)**	598	5.23	5.08	5.38
Our bodies eliminate mercury over time. Women who follow the guidelines will keep mercury in fish from building up to harmful levels in their bodies. **(sq3_6b_fsh)**	595	5.22	5.07	5.37
Women who follow the guidelines get the health benefits of fish with few risks. **(sq3_5b_fsh)**	597	5.17	5.02	5.32
Women who follow the guidelines are less exposed to contaminants found in some fish. **(sq3_2b_fsh)**	600	5.15	5.00	5.30
Women who follow the guidelines know which fish are low in contaminants. **(sq3_4b_fsh)**	598	5.1	4.95	5.25

Novelty and Importance

For all messages (both reasons for eating fish and reasons for following consumption guidelines) women who had heard a particular reason before considered it more important than women who had not heard that reason before (Table 4).

Table 4: Level of Importance with Data Stratified by Novelty (Seen Before)

	Seen Before?			
	No	**Yes**		
Question Set 1	**Mean**	**Mean**	**F**	**p**
Benefits outweigh risks if women eat fish low in mercury and other contaminants. **(sq1_5b_fsh)**	4.1	5.3	21.2	0.000
Children of women who eat lower mercury fish every week when they are pregnant have been found to do better developmentally. **(sq1_6b_fsh)**	4.5	5.7	18.6	0.000
Eating fish is the best way to get healthy omega-3 fats. **(sq1_1b_fsh)**	4.2	5.3	17.3	0.000
Eating fish that has omega-3 fats may lower the risk of heart disease in adults. **(sq1_3b_fsh)**	4.6	5.5	44.8	0.000
Eating fish that has omega-3 fats while pregnant may help during fetal brain and eye development**. (sq1_2b_fsh)**	4.6	5.6	18.8	0.000
Fish are generally low in saturated fats. **(sq1_4b_fsh)**	4.2	5.2	2.6	0.107
Question Set 2				
DHA is a building block of the brain and eyes. **(sq2_2b_fsh)**	4.6	5.8	46.3	0.000
Our bodies can't make EPA and DHA and they are generally not found in other foods. **(sq2_1b_fsh)**	4.4	5.7	10.2	0.002
Pregnant moms and breastfeeding moms can eat fish to give DHA to their babies. **(sq2_3b_fsh)**	4.6	5.5	9.2	0.002
Question Set 3				
Women who follow the guidelines are less exposed to contaminants found in some fish. **(sq3_2a_fsh and sq3_2b_fsh)**	4.7	5.7	40.8	0.000
Women who follow the guidelines get the health benefits of fish with very little risk to themselves or their children. **(sq3_1b_fsh)**	4.8	5.8	33.5	0.000
Women who follow the guidelines get the health benefits of fish with few risks. **(sq3_5b_fsh)**	4.7	5.7	30.2	0.000
Women who follow the guidelines avoid eating fish high in contaminants. **(sq3_3b_fsh)**	4.8	5.6	28.1	0.000
Women who follow the guidelines know which fish are low in contaminants. **(sq3_4b_fsh)**	4.7	5.7	23.3	0.000
Our bodies eliminate mercury over time. Women who follow the guidelines will keep mercury in fish from building up to harmful levels in their bodies. **(sq3_6b_fsh)**	5.0	5.8	21.7	0.000

Trustworthiness of Information Sources

Women were asked to rate the trustworthiness of 7 sources of information about eating fish (Table 5). Ratings were made on a scale of 1 (“not at all trustworthy”) to 7 (“very trustworthy”). The Minnesota Department of Health was rated as most trustworthy with the Minnesota Department of Natural Resources and health professionals (obstetricians and physicians) also receiving high ratings.

Table 5: Trustworthy Sources of Information (Question Set 4)

			95% Confidence Interval	
	N	**Mean**	**Lower**	**Upper**
The Minnesota Department of Health **(sq4_6_fsh)**	588	6.03	5.92	6.13
Obstetricians **(sq4_5_fsh)**	588	5.74	5.63	5.85
The Minnesota Department of Natural Resources **(sq4_7_fsh)**	590	5.69	5.58	5.80
Physicians **(sq4_4_fsh)**	590	5.66	5.55	5.77
Scientists **(sq4_2_fsh)**	589	5.46	5.34	5.58
Researchers **(sq4_1_fsh)**	587	5.30	5.18	5.42
Experts **(sq4_3_fsh)**	591	5.23	5.10	5.37

Respondents were also given the opportunity to write in additional trustworthy (Table 6) and untrustworthy (Table 7) sources of information. The Mayo Clinic and the FDA were listed by the most additional people as trustworthy sources. The internet and industry were listed by many women as untrustworthy.

Table 6: Other Trustworthy Sources of Information

Responses in First Answer Bank to Additional Sources		
Theme	**Specific Response**	**Count**
Government Bodies	CDC	3
	Department of Natural Resources	4
	FDA	5
	NIH	2
	USDA	1
Medical Experts	Mayo Clinic	6
	Nutritionists	2
	Nurse	1
	Research	2
Additional Groups	WIC	4
	Monterey Bay Seafood Watch	1
	University of Maryland Epidemiology	1

Table 7: Other Untrustworthy Sources of Information

Responses in Second Answer Bank to Additional Sources		
Theme	**Specific Response**	**Count**
Internet	Internet – general	57
	Blogs	2
Experts	General experts	5
Government	FDA	4
	EPA	1
	Government – general	3
Social Ties	Friend	8
Industry	Industry, general or fish-related	26
News & Marketing	News – magazine	7
	News – newspapers	9
	Television commercial	6

Demographic Information

Demographic characteristics of women in the sample are provided in Table 8.

Table 8: Demographic Information

Item	**N**	**%**	**Mean (SD)**
Age **(sq6_dob_fsh)**	588		35.7 (8.9)
Fish Servings **(sq5_fsh)**			
Never (1)	60	10.1%	
Only a few times a year (2)	115	19.4%	
About once a month (3)	176	29.7%	
About once a week (4)	173	29.2%	
More than once a week (5)	68	11.5%	
Children under 18 **(sq7_chld_fsh)**			
0	269	47.0%	
1	116	20.3%	
2	136	23.8%	
3 or more	51	8.9%	
Likelihood of Children in Future **(sq8_fkid_fsh)**			
Not at all likely (1)	293	49.5%	
Somewhat likely (2)	113	19.1%	
Very Likely (3)	186	31.4%	

Message Testing Supplementary Analysis Results

Tables below present the results of tests comparing responses along several key demographic factors: age, whether or not respondent has any children, and whether respondent intends to have additional children. Age was split to separate women below the age of 43 (based on the age distribution of the sample to make sure there were sufficient numbers of women in each age group), and women age 43 or higher. Secondly, a four-level variable was created by crossing children and intention to have additional children such that values represented: no child/no intention, no child/intention, child/no intention, and child/intention.

Two general conclusions emerge from these results:

- The age of women had little effect on whether they had heard reasons for eating fish or following advisories before and on whether they considered these reasons important.
- For a number of reasons, women were more likely to have heard the reason and to consider it important if they had children and if they intended to have more children. Women who had children AND who intended to have more children were consistently the group most likely to have heard the reasons provided for eating fish before, as well as to consider them important. Several of these reasons were explicit statements of the benefits of fish consumption for children.

Table 1A: Novelty and Importance of Reasons to Eat Fish by Age (< 43, versus ≥43)

	NOVELTY					IMPORTANCE				
	< 43		*≥ 43*			*< 43*		*≥ 43*		
REASONS TO EAT FISH	NOT SEEN	SEEN	NOT SEEN	SEEN	P-Value	LOW	HIGH	LOW	HIGH	P-Value
Get healthy omega-3s	24%	75%	30%	70%	0.105	37%	63%	31%	69%	0.091
Help fetal brain and eye development	49%	50%	54%	46%	0.197	33%	67%	29%	71%	0.268
Lower the risk of heart disease	21%	79%	12 %	89%	0.004	29%	71%	23%	77%	0.124
Low in saturated fats	24%	76%	21%	79%	0.256	38%	61%	32%	68%	0.090
Benefits outweigh risks	42%	57%	31%	69%	0.007	41%	59%	33%	70%	0.054
Children do better developmentally	71%	29%	73%	27%	0.413	42%	59%	38%	62%	0.259

[ ] Yellow highlighting indicates significant difference at the .05 level or below.

Summary

Older women are more likely than younger women to have heard of two of the reasons to eat fish:

- Eating fish that has omega-3 fats may lower the risk of heart disease in adults.
- Benefits outweigh risks if women eat fish low in mercury and other contaminants.

The first of these reasons is concerned with a health risk that is particularly relevant to older women.

Table 1B: Novelty and Importance of Reasons to Eat Fish by Child X Intention

	NOVELTY								
	No Child, No Intention		*No Child, Intention*		*Child, No Intention*		*Child, Intention*		
REASONS TO EAT FISH	NOT SEEN	SEEN	NOT SEEN	SEEN	NOT SEEN	SEEN	NOT SEEN	SEEN	P-Value
Get healthy omega-3s	29%	71%	18%	82%	32%	68%	27%	73%	0.020
Help fetal brain and eye development	62%	39%	63%	37%	49%	51%	30%	69%	0.000
Lower the risk of heart disease	20%	80%	17%	83%	17%	84%	27%	73%	0.090
Low in saturated fats	24%	76%	12%	88%	24%	76%	25%	75%	0.960
Benefits outweigh risks	46%	54%	50%	50%	31%	69%	35%	65%	0.001
Children do better developmentally	80%	20%	77%	23%	71%	29%	58%	42%	0.001

	IMPORTANCE								
	No Child, No Intention		*No Child, Intention*		*Child, No Intention*		*Child, Intention*		
REASONS TO EAT FISH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	P-Value
Get healthy omega-3s	29%	71%	37%	61%	42%	58%	31%	69%	0.089
Help fetal brain and eye development	43%	57%	36%	64%	33%	67%	15%	85%	0.000
Lower the risk of heart disease	25%	75%	27%	73%	29%	71%	32%	68%	0.712
Low in saturated fats	30%	70%	39%	61%	40%	60%	33%	67%	0.250
Benefits outweigh risks	42%	58%	45%	55%	38%	62%	31%	69%	0.080
Children do better developmentally	51%	49%	44%	56%	38%	62%	33%	68%	0.023

[ ] Yellow highlighting indicates significance at the .05 level or below.

Summary

Women with children were more likely than women without children to have heard 3 of the 6 reasons for eating fish:

- Eating fish that has omega-3 fats while pregnant may help during fetal brain and eye development.
- Benefits outweigh risks if women eat fish low in mercury and other contaminants.
- Children of women who eat lower mercury fish every week when they are pregnant have been found to do better developmentally.

The latter 2 reasons are the reasons that explicitly describe the benefits of a mother's fish consumption for her children. For these two reasons: women with children who intended to have more children were particularly likely to have heard the reasons before; women with children were more likely to consider the reasons important than women without children; and women who intended to have more children were more likely to consider the reasons important than women who did not intend to have more children.

Table 2A: Novelty and Importance of Reasons to Eat Fish (concerned w/ EPA and DHA) by Age (< 43, versus ≥43)

	NOVELTY					IMPORTANCE				
	< 43		*≥ 43*			*< 43*		*≥ 43*		
REASONS TO EAT FISH (EPA AND DHA)	NOT SEEN	SEEN	NOT SEEN	SEEN	P-Value	LOW	HIGH	LOW	HIGH	P-Value
Bodies can't make EPA and DHA	81%	19 %	81%	19%	0.530	44%	56%	44%	56%	0.491
DHA builds brain and eyes	53%	47%	59%	41%	0.119	33%	76%	27%	73%	0.109
Eat fish to give DHA to babies	71%	30%	75%	25%	0.159	39%	76%	39%	62%	0.507

[ ] Yellow highlighting indicates significance at the .05 level or below.

Summary

There were no significant differences between younger and older women with regard to their response to reasons for eating fish that were concerned with EPA and DHA.

Table 2B: Novelty and Importance of Reasons to Eat Fish (concerned w/ EPA and DHA) by Child X Intention

	NOVELTY								
	No Child, No Intention		*No Child, Intention*		*Child, No Intention*		*Child, Intention*		
REASONS TO EAT FISH (EPA AND DHA)	NOT SEEN	SEEN	NOT SEEN	SEEN	NOT SEEN	SEEN	NOT SEEN	SEEN	P-Value
Bodies can't make EPA and DHA	85%	14%	80%	20%	81%	19%	78%	21%	0.612
DHA builds brain and eyes	65%	14%	59%	41%	50%	50%	44%	56%	0.004
Eat fish to give DHA to babies	81%	19%	79%	21%	71%	29 %	58%	42%	0.000

	IMPORTANCE								
	No Child, No Intention		*No Child, Intention*		*Child, No Intention*		*Child, Intention*		
REASONS TO EAT FISH (EPA AND DHA)	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	P-Value
Bodies can't make EPA and DHA	46%	54%	44%	56%	44%	55%	41%	59%	0.858
DHA builds brain and eyes	32%	68%	35%	66%	31%	69%	24%	75%	0.300
Eat fish to give DHA to babies	51%	49%	43%	57%	38%	62%	23%	77%	0.000

[ ] Yellow highlighting indicates significance at the .05 level or below.

Summary

Women with children were more likely to have heard two of the statements about DHA before:

- DHA is a building block of the brain and eyes.
- Pregnant moms and breastfeeding moms can eat fish to give DHA to their babies.

Women who intended to have more children were also more likely in most cases to have heard these reasons before. The second of these statements was more likely to be important to women with children and women who intended to have more children. These two statements tie DHA to specific benefits for children and tie a mother's fish consumption to providing these benefits.

Table 3A: Novelty and Importance of Reasons to Follow Advisories by Age (< 43, versus ≥43)

	NOVELTY					IMPORTANCE				
	< 43		*≥ 43*			*< 43*		*≥ 43*		
REASONS TO FOLLOW ADVISORIES	NOT SEEN	SEEN	NOT SEEN	SEEN	P-Value	LOW	HIGH	LOW	HIGH	P-Value
Health benefits with few risks: self or children	51%	49%	54%	46%	0.315	29%	71%	27%	73%	0.319
Less exposed to contaminants	51%	49%	48%	52%	0.297	33%	67%	29%	71%	0.219
Avoid eating fish high in contaminants	46%	54%	50%	50%	0.227	31%	69%	26%	74%	0.113
Know which fish are low in contaminants	56%	44%	55%	44 %	0.491	34%	66%	28%	72%	0.113
Health benefits with few risks: self	51%	48%	53%	47%	0.448	29%	71%	27%	73%	0.252
Keep mercury from building up	73%	27%	73%	27%	0.515	29%	71%	30%	70%	0.514

[ ] Yellow highlighting indicates significance at the .05 level or below.

Summary

There were no significant differences between younger and older women with regard to their response to reasons for following the advisories.

Table 3B: Novelty and Importance of Reasons to Follow Advisories Child X Intention

	NOVELTY								
	No Child, No Intention		*No Child, Intention*		*Child, No Intention*		*Child, Intention*		
REASONS TO FOLLOW ADVISORIES	NOT SEEN	SEEN	NOT SEEN	SEEN	NOT SEEN	SEEN	NOT SEEN	SEEN	P-Value
Health benefits with few risks: self or children	67%	33%	57%	43%	48%	52%	39%	61%	0.000
Less exposed to contaminants	58%	49%	57%	43%	46%	54%	41%	59%	0.008
Avoid eating fish high in contaminants	60%	40%	56%	44%	42%	58%	35%	65%	0.000
Know which fish are low in contaminants	70%	30%	62%	38%	51%	49%	45%	55%	0.000
Health benefits with few risks: self	65%	35%	58%	42%	45%	55%	44%	56%	0.001
Keep mercury from building up	79%	21%	74%	26%	75%	25%	66%	34%	0.140

	IMPORTANCE								
	No Child, No Intention		*No Child, Intention*		*Child, No Intention*		*Child, Intention*		
REASONS TO FOLLOW ADVISORIES	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	P-Value
Health benefits with few risks: self or children	35%	65%	29%	71%	31%	69%	20%	80%	0.062
Less exposed to contaminants	39%	61%	33%	66%	34%	66%	22%	78%	0.037
Avoid eating fish high in contaminants	30%	70%	33%	67%	31%	69%	23%	77%	0.230
Know which fish are low in contaminants	37%	62%	33%	66%	33%	67%	26%	74%	0.264
Health benefits with few risks: self	31%	69%	32%	68%	31%	69%	19%	81%	0.049
Keep mercury from building up	34%	66%	29%	71%	32%	68%	22%	78%	0.140

[ ] Yellow highlighting indicates significance at the .05 level or below.

Summary

For almost all of the reasons for following the advisories, women who had children were more likely to have heard the reasons than women without children. It also tended to be true that women who intended to have more children were more likely to have heard these reasons than women who did not intend to have more children, although this difference was less pronounced and consistent.

Women who had children and intended to have more children were most likely to consider two of these reasons important:

- Women who follow the guidelines are less exposed to contaminants found in some fish.
- Women who follow the guidelines get the health benefits of fish with few risks.

Appendix B4:
Focus Groups

Preferences for Statements and Narratives about Fish Consumption among Women of Childbearing Age:

Minnesota Focus Group Results

Rebecca Robbins
Bruce Lauber
Jeff Niederdeppe
Cornell University

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Introduction

Five focus groups were conducted in Minnesota in September 2014 with women between the ages of 18 and 50 who ate fish at least occasionally. The purpose of the focus groups was to determine how women of childbearing age in northern Minnesota respond to fish consumption materials. The groups were conducted in Duluth (residents within city limits), Duluth-Rural (residents of area surrounding city), Ely, Hibbing, and Two Harbors. The number of women participating in each group ranged between 4 and 11.

The focus groups had two primary components:

(1) Women were presented with a list of 18 statements (organized into 4 groups) describing either reasons to eat fish or reasons to follow Minnesota's fish consumption guidelines. They were asked to organize each group of statements from those that they thought were most likely to encourage them to eat fish or follow the guidelines to those that they thought were least likely to encourage them to eat fish or follow the guidelines. Each participant was asked to explain the reasons for her most preferred statement and her least preferred statement; although participants may have had positive or negative reactions to multiple statements, only the most and least preferred were discussed.

The specific questions used to elicit responses in the focus groups were:

- Which statements would make it most likely for you to continue to eat fish/follow the guidelines? What is it about the statements that would make it more likely for you to continue to eat fish/follow the guidelines?
- Which statements would make it least likely for you to continue to eat fish/follow the guidelines? What is it about the statements that would make it less likely for you to continue to eat fish/follow the guidelines?

(3) Focus group leaders distributed three narratives (stories about individuals designed to communicate fish consumption advice) to the participants and asked them a series of questions to understand their positive and negative reactions to each story. The specific questions asked were:

- What came to your mind as you read this story?
- What do you think about the main character in this story?
- Does this story sound familiar to you? Why or why not? OR
- Have you ever had feelings or thoughts similar to those described in the story? Tell me about that.

Discussions were recorded and transcribed.

The focus group data in the transcripts were separated by question. Next, responses from each question were joined across all five focus groups in a single worksheet to be coded.

The coding procedure took place in three stages. In the first stage, the transcripts were simply read in entirety. In the second stage, initial "codes" were assigned to the comments women made to explain their reactions to statements or narratives. Each code reflected the reasons women provided for either liking statements or narratives, or disliking statements or narratives. The final stage of coding involved refining the coding system by clarifying the codes and ensuring that all excerpts assigned the same code were conceptually related. The final product of the coding procedure was a set of cohesive codes, which was used to categorize all relevant data from the focus groups.

Results

The results of the analysis of statement preferences is presented first. The analysis of narrative preferences follows.

Statement preferences. The results of the statement preference analysis are organized according to each of the four sets of statements about which women were asked. The two most preferred statements and two least preferred statements are presented for each set of statements about which women were asked. In the statement sets that contained only 3 statements (statements 7 – 9 and statements 16 – 18), only the single most and least preferred statements and associated justifications are offered.

Narrative analysis. Reactions to the narratives are analyzed and reported in 3 sections corresponding to the 3 narratives.We discuss both favorable and unfavorable reactions to narratives. We discuss the primary reasons for these reactions and present representative focus group excerpts to illustrate them.

Statement Preferences

Statements were presented to focus group participants in four sets:

Statement Set #1:

- Statement 1: Eating fish is the best way to get healthy omega-3 fats.
- Statement 2: Eating fish that has omega-3 fats while pregnant may help during fetal brain and eye development.
- Statement 3: Eating fish that has omega-3 fats may lower the risk of heart disease in adults.
- Statement 4: Fish are generally low in saturated fats.
- Statement 5: Benefits outweigh risks if women eat fish low in mercury and other contaminants.
- Statement 6: Children of women who eat lower mercury fish every week when they are pregnant have been found to do better developmentally.

Statement Set #2

- Statement 7: Our bodies can't make EPA and DHA and they are generally not found in other foods.
- Statement 8: DHA is a building block of the brain and eyes.
- Statement 9: Pregnant moms and breastfeeding moms can eat fish to give DHA to their babies.

Statement Set #3

- Statement 10: Women who follow the guidelines get the health benefits of fish with very little risk to themselves or their children.
- Statement 11: Women who follow the guidelines get the health benefits of fish with few risks.

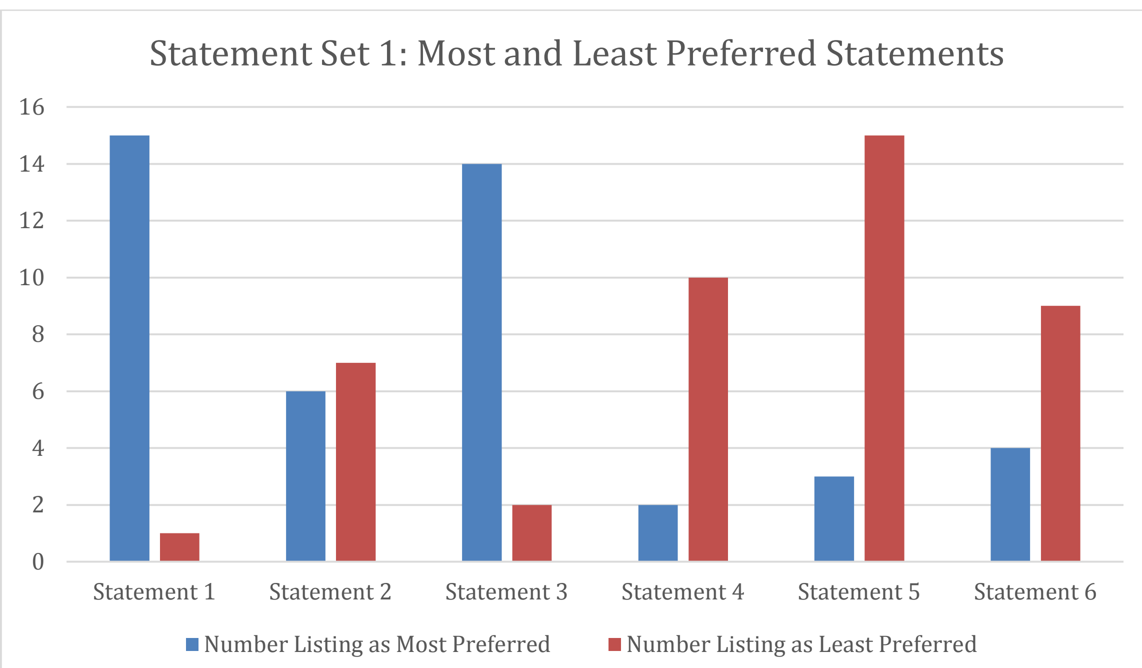
- Statement 12: Women who follow the guidelines are less exposed to contaminants found in some fish.
- Statement 13: Women who follow the guidelines avoid eating fish high in contaminants.
- Statement 14: Women who follow the guidelines know which fish are low in contaminants.
- Statement 15: Our bodies eliminate mercury over time. Women who follow the guidelines will keep mercury in fish from building up to harmful levels in their bodies.

Statement Set #4

- Statement 16: Women who follow the guidelines reduce their risk of being exposed to contaminants found in some fish.
- Statement 17: Women who follow the guidelines know how to make healthier choices about which fish to eat.
- Statement 18: Women who follow the guidelines are able to eat fish safely.

Preferences for Statements in Set 1

Statements 1 through 6 offered reasons for eating fish. The two most preferred statements were 1 and 3, while the least preferred statements were 5 and 4.



Most Preferred Statements

<u>Statement 1</u>: Eating fish is the best way to get healthy omega-3 fats.

The code most commonly used to classify the reasons women offered justifying their selection of this statement as most preferred was "information on health/nutrients."

- ***Information on health/nutrients***: This code was assigned in the majority of cases to explain preference for statement 1. This code was assigned when women explained their interest in receiving information about either ways fish consumption could enhance their health or important nutrients like omega-3s that are found in fish. Representative comments include:
    - *"Well, I guess that would be most important for me right now. I'm not pregnant either, so it's what is healthiest for me at this point in my life." – A woman from Hibbing, MN*
    - *"I know that eating fish is the best way to get healthy omegas, but I do take a liquid fish oil supplement every day, too. CuzI don't eat a whole lot of fish and so I know that's important." – A woman from Duluth, MN*

<u>Statement 3</u>: Eating fish that has omega-3 fats may lower the risk of heart disease in adults.

The vast majority of women who selected statement 3 as their most preferred explained their selection was in large measure due to personal experience with heart disease. We used the code "information on avoiding chronic health conditions" to classify these reasons.

- ***Information on avoiding chronic health conditions***: This code was applied to statements that linked important nutrients found in fish with lower risk of health conditions. In many cases, women referred to personal experience with heart conditions.
    - *"#3 because my dad died of a heart attack so there's some heart disease in my family. And just women in general tend to have a higher risk of heart disease so that's important to me." – A woman from Duluth, MN – Rural*

- *"I have heart disease in the family so that one resonates. And like she said, it's very specific and that jumped out at me the most." – A woman from Ely, MN*

Least Preferred Statements

<u>Statement 5</u>: Benefits outweigh risks if women eat fish low in mercury and other contaminants.

Codes used to classify comments from women justifying their selection of this statement as least preferred included "information about contaminants" and "vague or confusing message."

- ***Information about contaminants***: In this category of responses, women explained that they simply were not concerned about contaminants, or the risks from consuming contaminants were not large enough to warrant concern.
  - *"Mercury poisoning… it's a low risk. If you're eating fish only a couple times a week, it's not a big deal. Probably eat more teflon than you do mercury, you know? You know how it is on the bottom of your pan there." – A woman from Two Harbors, MN*
  - *"I'm not as concerned with contaminants, I guess. I feel like it's more hype, a lot of hype, I guess." – A woman from Hibbing, MN*
- ***Vague or confusing message***: In this case, women explained they were confused by the message content or wording.
  - *"And #5 I put last just because it seemed kind of vague, like didn't really have any effect on whether or not I'm going to eat fish." – A woman from Duluth, MN*

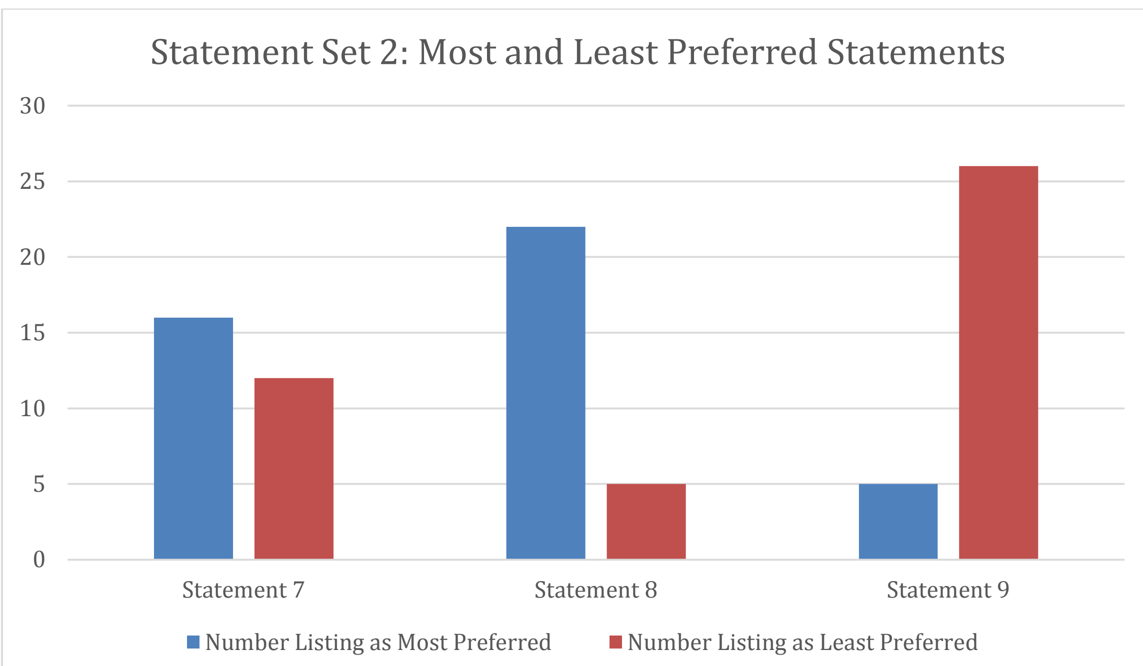
<u>Statement 4</u>: Fish are generally low in saturated fats.

Most participant explanations for their low ranking of this statement were classified with "information about saturated fats."

- ***Information about saturated fats***: Women explained that they did not have to worry about saturated fats or that their diet was healthy and saturated fats were not a concern for them.
    - *"Then #4 is fish are generally low in saturated fats. That's really not that important to me." – A woman from Duluth, MN – Rural*
    - *"And #4 because I don't usually have fried fish. I usually do baked. I just try to cook it in a healthier way." – A woman from Duluth, MN*

Preferences for Statements in Set 2

Statements 7 through 9 also described reasons for eating fish. This series of statements had to do with specific nutrients found in fish, like EPA and DHA. With only three statements in this set, only the single most preferred and the least preferred statements are reported. The most preferred statement was 8, while the least preferred statement was 9.



Most Preferred Statement

<u>Statement 8</u>: DHA is a building block of the brain and eyes.

The codes most commonly used to classify the reasons women offered to justify their selection of this statement as their most preferred in the question set included "Information on brain and eye benefits" and "Information on health/nutrients."

- ***Information on brain and eye benefits***: This type of rationale was most common, cited the majority of the time by those who preferred statement 8. This code was assigned when women mentioned their appreciation of the information on brain and eye benefits in the message. Interestingly, the message was interpreted by some women as describing the benefits possible for their baby during pregnancy or early childhood development, while other women interpreted the message as describing brain and eye development benefits that the women themselves stand to receive.
    - *"#8 most important cuz it is a very good promoter for brain and eye development which are important." – Woman from Duluth, MN – Rural*
    - *"#8 being the first one. I put it up there because I know DHA is important for your brain, specifically." – Woman from Hibbing, MN*
- ***Information on health/nutrients***: In several cases, this code was assigned when women explained their preference for receiving information about ways fish consumption could enhance their health more generally:
    - *"Those amino acids are important for keeping our health of our eyes and our brain and they actually help with depression and things like that, supposedly, too. There's a whole bunch to that." – Woman from Two Harbors, MN*

Least Preferred Statement

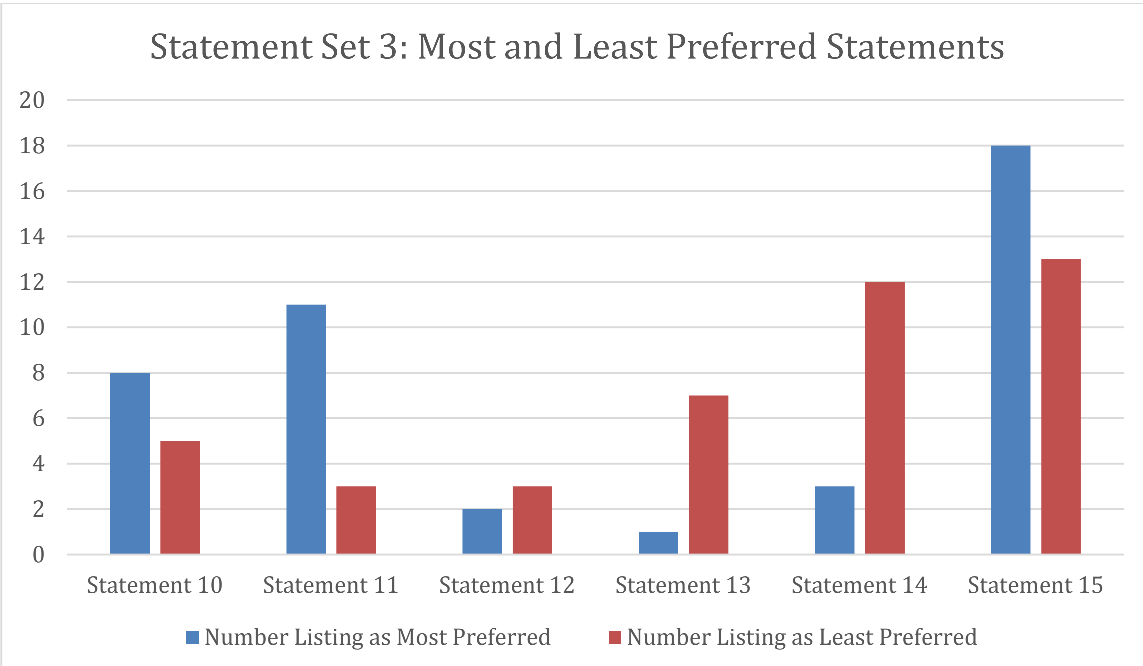
<u>Statement 9</u>: Pregnant moms and breastfeeding moms can eat fish to give DHA to their babies.

The codes that were most commonly during the analysis to explain women's selection of this statement as least preferred included "Lacked relevance," and "Lacked evidence for claims."

- ***Lacked relevance***: This code was assigned when women argued that the information in the statement was less relevant to them for one reason or another. This type of justification was observed approximately 20 times in the focus group data.
  - *"I picked #9 last because when I was pregnant and breastfeeding, I didn't change the amount of fish that I ate. I just kinda ate the same amount as I do normally which wasn't very much. So then, I just took a DHA supplement anyways… guess it wasn't too relevant cuz being pregnant or not doesn't change the amount of fish I eat." –Woman from Duluth, MN*
  - *"Again, it doesn't affect me personally or a whole lot of people I know, if I'm looking at overall health for myself and my family, it's just not really relevant." –Woman from Ely, MN*
- ***Lacked evidence for claims***: This code was assigned when women supported their selection of a statement as least preferred with the lack of evidence for the facts stated in the message.
  - *"I feel like it's chronological so if you said, you know, great I can give DHA to my baby, why does that matter? Like I feel like you need this information first before you could draw that conclusion. If you have the eight and seven first, then it makes nine important, but nine without that other information is kind of irrelevant. Not irrelevant, that's not a good word, but it doesn't – it's not as important." – Woman from Duluth, MN*

Preferences for Statements in Set 3

Unlike statements 1 through 9, which described reasons for eating fish, statements 10 through 15 described reasons for following fish consumption guidelines. This set of statements mentions outcomes of following the guidelines. Interestingly, statement 15 was the most preferred choice but also the least preferred choice. The two most preferred statements were 15 and 11, while the two least preferred were 15 and 14.



Most Preferred Statements

<u>Statement 15</u>: Our bodies eliminate mercury over time. Women who follow the guidelines will keep mercury in fish from building up to harmful levels in their bodies.

There were two general explanations women gave as to why they chose this statement, including "Information on body removing contaminants" and "Clear/straightforward information."

- ***Information on body removing contaminants***: This was the most common response from women who selected statement 15 first. In their justification, women explained their interest in the information about the body's ability to remove contaminants. Sample quotes are offered below:
    - *"#15 because, yeah, it was clear and said that even if you get the mercury, it's going to leave your body if you don't get too much." – Woman from Ely, MN*

- *"Um, it's good that our bodies eliminate it over time… It's good that it can – you can eliminate it from your body." – Two Harbors, MN*

- ***Clear, straightforward information***: Comments that were assigned this code explained the selection of first choice for statement 15 due to the clear, straightforward nature of the information. A sample quote is offered below:
  - *"It was the easiest for me to understand. All of 'em kinda got confusing." – A woman from Ely, MN*

<u>Statement 11</u>: Women who follow the guidelines get the health benefits of fish with few risks.

This statement explains that women who follow the guidelines will receive benefits with low risks. Among the explanations women offered for their preference for this statement, women explained interest in such factors as "Information about benefits of fish," "Information on following guidelines," and 3"A positive message."

- ***Information about benefits of fish***: This type of response was the most common from women who selected statement 11 first. Quotes were assigned to this category when women explained their preference for information that emphasized what they stood to receive from fish consumption versus what they stood to lose. Sample quotes are offered below:
  - *"My thought was similar. They're all kinda one and the same. I put #11 first because… I love the taste of fish but most of the reason I eat it is because of the health benefits. So I want those benefits with few risks." – Duluth, MN*
  - "*And #11 just because it gets the health benefits with the few risks." – Woman from Duluth, MN-Rural*
- ***Information on following the guidelines***: This code was applied when participants mentioned liking the connection made in the statement between following the guidelines, and their likelihood of receiving benefits or avoiding risks.

- *"#11 just kind of seems like a natural choice for me. I can't really say specifically, but it's just like if you're following the guidelines and you know the health benefits of fish and you're educated, you're going to have fewer risks." – A woman from Duluth, MN*

- ***Positive message***: This code was assigned in two cases where women mentioned liking the positive emphasis in statement
    - *"I chose #11 – cuz #11-14 all sounded pretty similar but #11 seemed the most positive out of those five." – A woman from Duluth, MN-Rural*

Least Preferred Statements

Statement 15: Our bodies eliminate mercury over time. Women who follow the guidelines will keep mercury in fish from building up to harmful levels in their bodies.

The comments explaining dislike for this statement were assigned the codes "Information on body removing contaminants" or "Information about contaminants."

- ***Information on body removing contaminants***: This code was assigned to the majority of comments from women in focus groups about their reason for selecting this statement last. Women expressed skepticism about the body's efficacy in removing contaminants, or general distrust of the message. Sample quotes are offered below:
    - *"And then #15, I don't think that – I thought that mercury didn't really go – get out of your body over time. I'm not really sure about that, but I thought not, so I'm kind of skeptical of that statement." – Woman from Hibbing, MN*
    - *"And then for the least one, I didn't like #15 because I don't think that's true. I don't think our body does eliminate mercury over time. I think it's one of those that stays with you. Where if it does, it's over a long period of time from what I've read and where I've caught fish." – A woman from Duluth, MN*

- ***Information about contaminants***: In this category of responses, women explained that they simply were not concerned about contaminants, or the risks from consuming contaminants were not large enough to warrant concern. A sample quote is offered below:
    - *“And then I picked #15. I just don't like to hear about mercury, I don't know, it just sounds – I don't know, the fact that your body is trying to eliminate it all the time, it just sounds like I'd rather not think about it, I guess.” – A woman from Duluth, MN-Rural*

<u>Statement 14</u>: Women who follow the guidelines know which fish are low in contaminants.

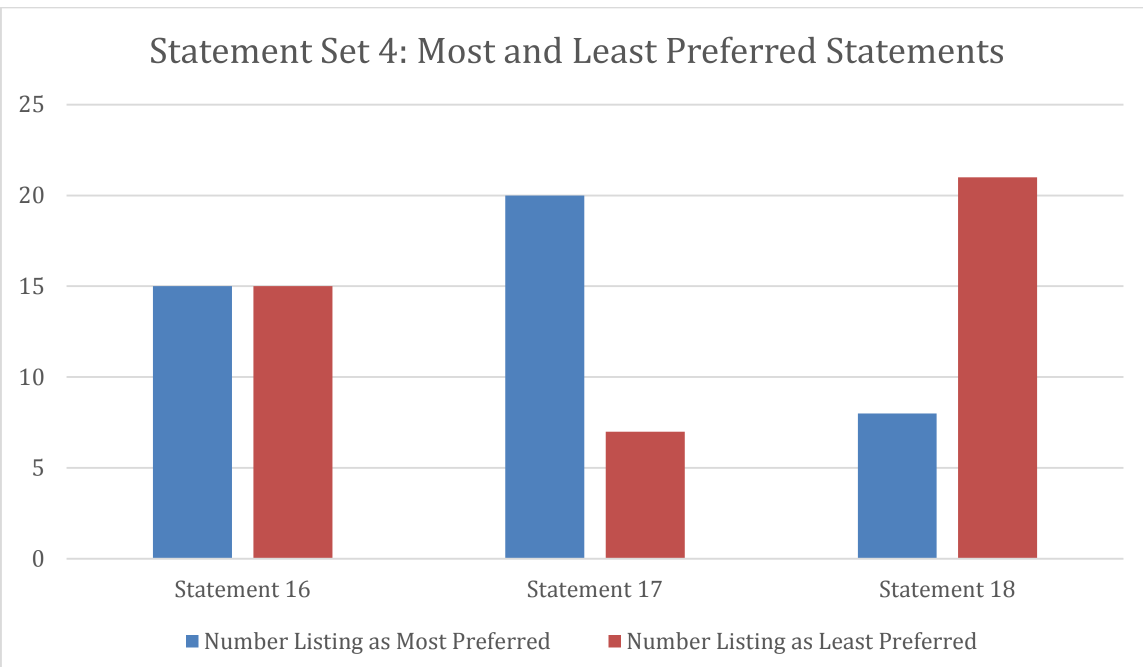
Two categories of justification for selecting this statement were classified as “Information on following the guidelines” and “Information about contaminants.”

- ***Information on following the guidelines***: This code was applied where participants mentioned the uncertainty about what the guidelines were. This was the most commonly observed code in the justifications for statement 14 being least preferred.
    - *“And then the rest are really similar but again, I think the guidelines are so nebulous that I don't know whose guidelines? What guidelines? That manufacturers guidelines? Or the government guidelines? Like guidelines don't mean, I don't trust any guidelines. I just do what I feel I am more educated to do, based on what I read because I don't trust anybody's guidelines but my own for my own family so guidelines don't mean anything to me, personally, on anything.” – A woman from Duluth, MN*
    - *“#14 was my least and, um, basically just that guidelines thing, really, I don't know anything about the guidelines so it didn't – it wouldn't stick out to me, I wouldn't care about any of those other statements cuz it doesn't tell me anything.” – A woman from Ely, MN*
- ***Information about contaminants***: In this category of responses, women explained that they simply were not confident in information about contaminants.

- *"# 14, I wasn't real sure. Still not really knowing which fish, exactly, are high in mercury, how do we know for sure?" – A woman from Duluth, MN-Rural*

Preferences for Statements in Set 4

Statements 16 through 18 also described reasons for following fish consumption guidelines. This set of statements included text that mentions the importance of following guidelines to either avoid risk, or to obtain a certain benefit. Women often noted the similarity in of these statements and described the difficulty of choosing among the options due to the similarity. With only three statements in this set, only the most and least preferred are reported. The most preferred was statement 17 while the least preferred was statement 16.



Most Preferred Statement

<u>Statement 17</u>: Women who follow the guidelines know how to make healthier choices about which fish to eat.

The comments from women justifying their choice of statement 17 as most preferred were categorized as showing interest in "Information on healthy choices" and "Information on following the guidelines."

- ***Information on health/nutrients***: This code was assigned in the majority of cases to explain preference for statement 17. This code was assigned when women explained their preference for receiving information about ways fish consumption could be most healthy.
    - *"I chose #17 first because I think if I knew the healthier choices, personally, that would make me want to eat fish more and I guess I never really think about it, you know. I just eat what I want to eat." – A woman from Two Harbors, MN*
    - *"I chose #17 because the reason I eat fish is for the benefit, so I want to know how to make those healthier choices." – A woman from Duluth, MN*

Least Preferred Statement

<u>Statement 16</u>: Women who follow the guidelines reduce their risk of being exposed to contaminants found in some fish.

Two primary types of justifications for selecting this statement last were identified: "Information about contaminants" and "Information about following guidelines."

- ***Information about contaminants***: In this category of responses, women explained that they simply were not particularly concerned about contaminants. This type of comment was observed most frequently among responses to selecting statement 16 last. Sample quotes are offered below:
    - *"#16 I put last. I guess I'm not as worried about the risks, and it was worded a little bit ambiguously… 'being exposed to contaminants found in some fish.' So are the contaminants only in some fish? Or you'd only know how to reduce risk with certain types of fish? I don't know." – A woman from Duluth, MN*
    - *And #16 because, honestly, that's exposed to contaminants thing is really getting annoying." – A woman from Two Harbors, MN*
- ***Information about following the guidelines***: This code was applied in instances where women mentioned confusion about the guidelines, which guidelines the message was referencing, and what they

suggested as far as fish consumption. This was observed among several women explaining their low preference for this statement. Several sample quotes are offered below:

- *"And then #16, 'women who follow the guidelines reduce their risk of being exposed to contaminants found in some fish.' It goes back to my guidelines; I don't know whose guidelines. I don't believe that's true or not true. It depends on what guidelines you follow. I think a lot of the manufacturer guidelines you would not be reducing your risk to contamination found in fish so this just gets hung up on the guidelines." – A woman from Duluth, MN*

Summary of Responses to Statements

Given that messages were presented to focus group participants in sets, we are unable to evaluate which of the 18 statements were most and least preferred overall. However, certain types of rationales for liking or disliking particularly messages emerged repeatedly and are worth noting:

- Women often responded favorably to more positive messages that emphasized particular benefits.
- Responses to messages were influence by personal experience and the perceived relevancy of messages. For example, women who had family histories of heart disease were more likely to respond favorably to messages about heart disease. Women who did not perceive fats or contaminants as a concern to them, were less likely to respond favorably to messages about fats or contaminants.
- Messages that were perceived as more clear and straightforward were more favorably perceived.
- Some women responded favorably to information that was new and novel to them. However, others distrusted new and novel information specifically because it was inconsistent with what they already believed.

Narrative Analysis

Narrative 1:

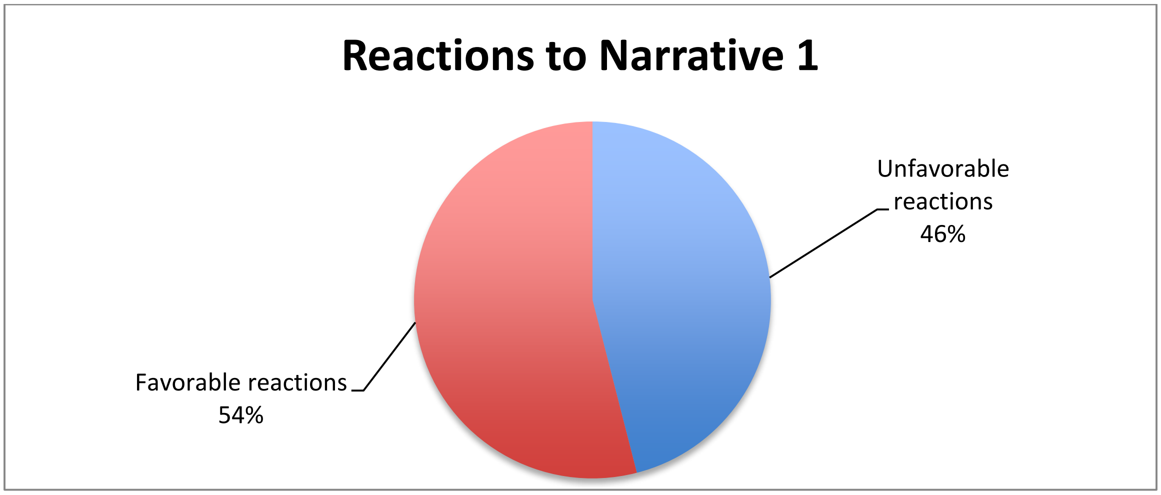
Melanie, from Duluth, Minnesota, was very excited to become pregnant with their first child. Since she and her husband John had been trying to get pregnant, she had made a strong effort to cook healthy meals for her family. While she and John have always loved fishing, Melanie stopped eating any fish when she became pregnant because she had heard that mercury and other fish contaminants can hurt a baby's development.

One Saturday early in her pregnancy, Melanie ran into her neighbor Julie, who was visibly pregnant with her second child. Julie mentioned that she was cooking walleye for her family that evening. Melanie was surprised – she loved walleye but had stopped eating it since she became pregnant. Julie responded that she had done some research and learned that fish are a great source of omega-3 fatty acids, which are very important for a baby's development. She said that while some types of fish do contain contaminants like mercury, Minnesota's Safe Eating Guidelines provided information about which fish to eat and how often.

Melanie went home and checked it out herself - she and John were excited to learn that they could eat many of the fish that they loved and offer benefits to the baby! Eight months later, Melanie gave birth to a healthy baby girl, and while it seems like almost everything in their life has changed, they can continue to enjoy eating fish together.

Analysis

This story descries a woman's hesitation to eat fish during her pregnancy until she encounters her neighbor who tells her about the evidence that fish is healthy for pregnant women. Among the women in the focus groups, slightly more than half made favorable remarks about the narrative (54%), with the remainder unfavorable comments (46%).



Favorable Reactions to the Story

There were several different types of favorable reactions from focus group participants. Favorable reactions received three primary codes, including 1) agreement with the story, 2) admirable character qualities, and 3) personally relevant storyline. Codes and supplementary quotes are offered below:

- ***Agreement/liking***: This code was assigned to participants who indicated agreement with the plot of the story or character actions, or simply restated events in the story to explain why they liked the story. Sample quotes are offered below:
  - *"I feel like it shows that the more educated, in this case Melanie, but the more educated we are, the healthier choices we can make for ourselves and our family" – A woman from Duluth, MN (Rural)*
  - *"She was given information that fish aren't healthy for her and then she was provided with the real information so she probably looked it up on-line and got misinformation" – A woman from Two Harbors, MN*
- ***Admirable character qualities***: This code was assigned to comments that described likeable qualities in the character. Some of the adjectives used by participants included "smart" and "cautious." Another

reason comments were coded in this manner was if the participant mentioned appreciating that the character was focused on protecting her family. Sample quotes are offered below:

    - *"Well, it's smart enough to do your own research instead of just taking somebody else's word for it" – a woman from Hibbing, MN*
    - *"Well, Melanie, you know, had heard one story and that's what she was sticking with until she learned something from somebody else and went and researched it herself and found she didn't have to be as worried as she was. So that was good for her and her family" – A woman from Duluth, MN (Rural)*

- ***Personally relevant storyline***: This code was assigned when women explained the story was somehow familiar to them, or they explained added meaning from the story due to their personal experience. Sample quotes are offered below:
    - *"Yeah, I hear it, you know, with friends and everything else, too. I mean the story is very familiar because that's what people do that happened a lot and even working in clinics where people come in because they heard this or they heard that so it's a very familiar story" – A woman from Duluth, MN*
    - *"I feel like I kind of relate to Melanie. I've had two kids. The first one was in Nebraska and the doctor there was more on don't eat fish while you're pregnant. We didn't have a lot of local cod, great fish there" – A woman from Duluth, MN (Rural)*

Unfavorable Reactions to the Story

Most unfavorable reactions were coded as either 1) relying on word of mouth/failure to do research or 2) unrealistic characters actions. Codes and supplementary quotes are offered below:

- ***Character relied on word of mouth***: This code was assigned when focus group participants voiced dislike for how the character relied on the word of mouth from her neighbor as to how to behave, and also the failure to do research and be prepared before her child arrived. Sample quotes are offered below:

- *"I would definitely do some research then, but I'm not going to just stop eating it altogether based on what somebody else has to say. I guess, I don't know, if I was to do the research and, you know, it pretty much clearly explained why it was bad or why you shouldn't eat it, then I might reconsider like, oh, ok, instead of having it once a week, maybe once a month or once every two months while I'm pregnant. But I wouldn't just stop eating it altogether" – A woman from Ely, MN*
- *"It just seemed odd she made this healthy effort to cook healthy meals but didn't do this research and got it from her neighbor and then did some research. Kind of conflicting" – A woman from Duluth, MN*

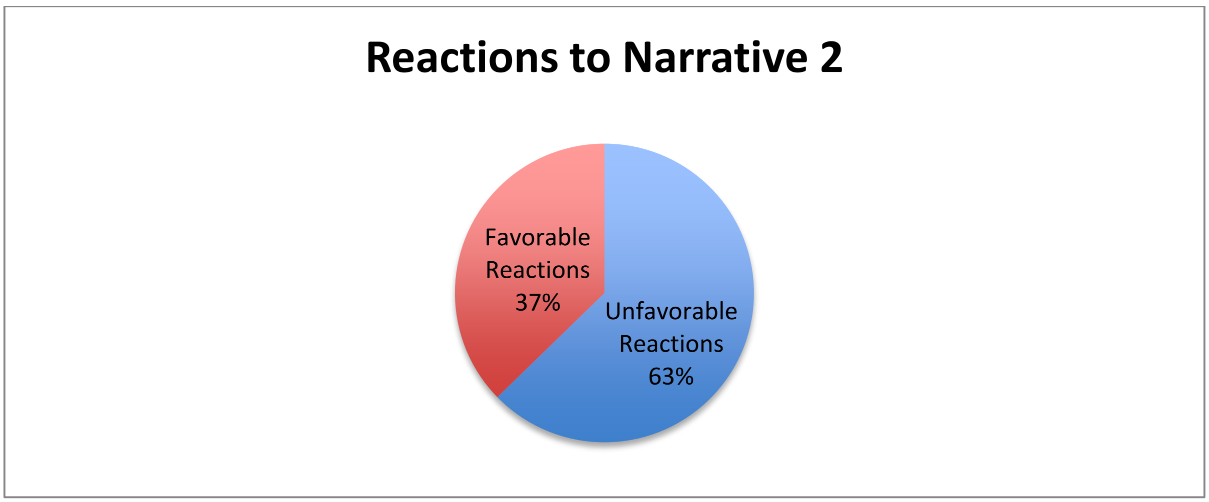
- ***Unrealistic character actions***: This code was assigned when participants indicated that actions were unrealistic, and specifically, in response to this narrative, represented irrational fear about fish consumption. A sample quotes is offered below:
  - *"In moderation. If you're eating some type of fish like every meal of every day, then you might have a problem just in general. Um, yeah, and I think that Melanie is a little paranoid" – A woman from Duluth, MN*

Narrative 2:

Sarah and her husband Nick got married four years ago and live in Two Harbors, Minnesota. Recently they decided that they wanted to start a family, and after a few months Sarah learned she was pregnant! Nick works flexible hours and loves to cook fish he catches, but he stopped bringing fish home after Sarah got pregnant because he was concerned about mercury and the baby's health. One night, when Sarah and Nick were watching the news, they saw a story about guidelines for healthy fish consumption among women of childbearing age, issued by the Minnesota Department of Health. The story described the health benefits of including fish as part of a balanced diet during pregnancy. Nick was relieved that he could cook their favorite fish like perch. Eight months *later, after a safe, and relatively easy pregnancy, Nick and Sara are so glad they have a healthy, happy baby and grateful that they heard the fish consumption guidelines when they did.*

Analysis

This story descries a husband, responsible for preparing meals for his pregnant wife, learns fish is not healthy for women, then stops bringing back fish he catches like he once did. The couple refrains from eating fish until they learn of the healthiness of fish for pregnant women on the television. Among the women in the focus groups, slightly more than one third made favorable remarks about the narrative (37%), with the remainder two thirds unfavorable comments (63%).



Favorable Reactions to the Story

There were two codes that were observed most commonly, including 1) admirable character qualities, and 2) personally relevant information. Codes and supplementary quotes are offered below:

- ***Admirable character qualities***: This code was assigned to comments that described likeable qualities in the character. Some of the adjectives used by participants included "smart" and "cautious." Another reason comments were coded in this manner was if the participant mentioned appreciating that the character was focused on protecting her family. Sample quotes are offered below:

- *"I think that it was cute that Nick got concerned for Sarah and the baby's health and stopped bringing fish home. It was kind of his fatherly instincts, you know" – A woman from Hibbing, MN*
- *"They are conscientious. I mean, they want what's best for their kids" – A woman from Duluth, MN (Rural)*

- ***Personally relevant storyline***: This code was assigned to nearly two thirds of the positive comments. This code was assigned when women explained the story was somehow familiar to them, or they explained added meaning from the story due to their personal experience. Sample quotes are offered below:
  - *"I guess that was me when I was younger but not like so much recently. I guess when I was younger" – A woman from Two Harbors, MN*
  - *"Yeah, absolutely, I think it's just part of having children is that you do want to do what's best for them and research everything and if you find one anecdotal thing, it kind of tends to be magnified sometimes in your brain because of hormonal changes in your body and then it might spin out of control sometimes for people and they think, oh, I can't do this. I can't safely do this or I can't safely do that" – A woman from Duluth, MN (Rural)*

Unfavorable Reactions to the Story

There were three primary unfavorable reactions from participants. The most commonly observed unfavorable reaction to the narratives were coded as 1) unrealistic character actions, 2) content that was not personally relevant, and 3) unclear cause and effect. Codes and supplementary quotes are offered below:

- ***Unrealistic character actions***: This code was assigned when participants indicated that actions were unrealistic. A number of comments coded as unrealistic in response to Narrative 2 centered on the role of the husband in this story. Sample quotes are offered below:
  - *"All the men in our family, in my family, wouldn't really care. They wouldn't really know enough, they'd leave it up to the woman of the house to make all the health and diet decisions so for me, it didn't like hit home or anything because my husband is kind of clueless when it comes to – during*

the whole pregnancy and whatever. He wasn't one of those worriers" – A woman from Two Harbors, MN

- *"And I think the thing that stuck out for me was like they weren't necessarily on the same page. Like neither of them had really done some research – like he had heard that it wasn't good but neither of them really looked into it or talked to their OB about it. Like you just cut out this, you know, this out of your diet without even really understanding. And, yeah, the research says different things, but you need to figure out what's best for you and what you're comfortable with instead of just like stopping, not really knowing all the facts" – A woman from Duluth, MN*

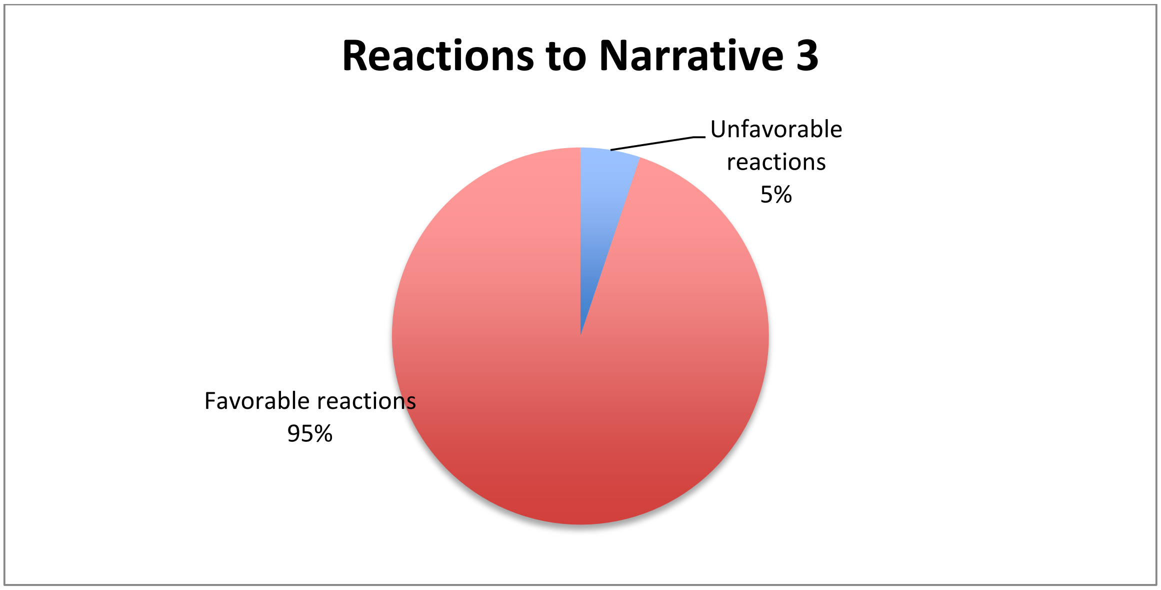
- ***Content was not personally relevant***: This code was assigned when focus group participants explained the story was not something they had personally experienced or events that might be relevant to their personal experience. Sample quotes are offered below.
  - *"It seems it has a lot to do with being pregnant. That's kind of the whole thing. For me, I've never been pregnant, so –" – A woman from Duluth, MN (Rural)*
  - *"I just know where I'm getting my food, I guess, so like, I feel like that's not an issue because I'm not getting my food from – shipped from who knows where – where they dump sewage in the oceans and stuff like that. I don't have to worry about that, but I guess I never have researched the levels of mercury in Minnesota lakes either" – A woman from Hibbing, MN*
- ***Unclear cause and effect***: This code was assigned when women indicated the story jumped to conclusions about fish consumption being important during pregnancy yet failed to provide sufficient causal evidence. Sample quotes are offered below:
  - *"I don't get the cause and effect either. I mean, your baby could be healthy if you ate fish everyday, I don't know. Did it have anything to do with it?" – A woman from Duluth, MN*
  - *"It just makes me think, what if they didn't have a healthy baby? Would they have thought maybe the fish wasn't healthy to eat?" – A woman from Duluth, MN (Rural)*

Narrative 3:

Kristy and her husband Nathan recently moved back to their hometown of Virginia, Minnesota. Now married for several years, the couple was excited to try to have a baby. A baby is a big change, so Kristy began doing her homework on healthy exercise and nutrition for women hoping to conceive. Kristy came across an article on the internet about fish consumption guidelines for women of childbearing age. The article explained that, although many women avoid fish during pregnancy, there is strong evidence that eating fish during pregnancy is important for her baby's development. Skeptical, Kristy explored several fish consumption guidelines, like the Minnesota Department of Health and found this report to be well supported. In truth, Kristy was relieved; crappie is one of her favorite foods! The next month, Kristy discovered she was pregnant. Kristy and Nathan decided they would try to eat a variety of low-mercury fish during her pregnancy. The couple was grateful, and happy to have found the helpful guidelines.

Analysis

This story descries a woman and her husband who carefully plan to have a baby, and incorporate fish into their diet after doing their research on healthy fish consumption during pregnancy. There were overwhelmingly favorable reactions to this narrative, with nearly all comments being coded as favorable (95%), while only several negative (5%).



Favorable Reactions to the Story

There were two primary codes observed among the data, including 1) proactive character, and 2) personally relevant story. Codes and supplementary quotes are offered below:

- ***Admirable character qualities – Proactive character***: This code was assigned to nearly two thirds of favorable comments. The code was assigned to comments that described likeable qualities in the character. The specific quality that came up again and again in response to this story was that focus group participants appreciated that the character did her research and was prepared for her pregnancy, as opposed to having to receive information about fish consumption from a neighbor. Sample quotes are offered below:
    - *"She seemed much more smart about it. She researched it on her own, she didn't just, you know, she might have heard one thing but she did her own research on it and went to a lot of different sources." – A woman from Duluth, MN (Rural)*
    - *"Um, I liked this one probably the most so far. Yeah, I liked that she does research, it's kind of my thing, too, and I like that they decided they would – well, I like that she learned that there's*

obviously a variety of lower mercury fish out there so she learned that and --" – A woman from Hibbing, MN

- ***Personally relevant storyline***: This code was assigned to approximately one third of the positive reactions to Narrative 3. This code was assigned when women explained the story was somehow familiar to them, or they explained added meaning from the story due to their personal experience. Sample quotes are offered below:
    - *"When I was pregnant, that's kind of what – when I was handed that brochure at my doctor's office, I kind of looked at it, looked at the guidelines, and realized that I would never eat that much fish to push me over, you know, say you could have two tuna sandwiches a day and if I ate three I wasn't gonna freak out, you know, I mean I just knew I was never gonna get that much fish but I did, you know, get the information, I looked at it, did my own research and realized then the rest of the time I didn't really worry about what I was eating cuz I knew I wasn't gonna eat fish every meal, every day to get to the point where I would have to be worried about anything if there were ever any worries" – A woman from Duluth, MN*
    - *"I guess it kinda seems like how like my husband and I would probably work together, I'd say like, oh, my gosh, I heard this and we would probably, you know, be like little, you know, Google and something like that and figure out, oh, you saw this but I saw this that said this and I don't know, it just seems like I could probably relate to this story cuz that's probably how I would go about it more likely than the first two" – A woman from Duluth, MN (Rural)*

Unfavorable Reactions to the Story

There were two comments coded as unfavorable and "unrealistic." Sample quotes are outlined below:

- ***Unrealistic story***: Both unfavorable codes were assigned this category, for citing that the events seemed unrealistic. The two quotes are outlined below:

- *"I just, I mean, I kinda feel like, you know, they do mention the Minnesota Department of Health Guidelines in here, and I almost feel like, to me, I almost feel like they're creating an unnecessary worry and stress for pregnant women when they're already worried and stressed. So for women to have to be worried about where they eat their fish, where it was caught, where it, you know, I just, I don't know, to me, um, you know, the clinic I worked at, we ended up just – we stopped handing out those brochures because it was creating too much. We were getting phone calls about, oh, my gosh, like I said, I had three tuna sandwiches this week and I was only supposed to eat two, am I gonna be ok? It's like, I don't know, I just feel that these guidelines are just kinda putting false fear into people" – A woman from Duluth, MN*
- *"I just can't imagine the majority of the people eating this much fish. I mean, I think all of us being highly intelligent women and being familiar with fish and eating fish, we're gonna think about it more than like the average people so I guess in my mind I think about our younger generation and the amount of processed foods they eat, thinking that it's ok to drink Monster drinks and, you know, Red Bull when you're pregnant" – A woman from Duluth, MN*

Summary of Narrative Analysis

Although all three narratives elicited some positive and negative reactions, the response to narrative 3 was overwhelmingly positive. The responses to the other two narratives were mixed with narrative 1 perceived more favorably than narrative 2.

Appendix C: Cornell Final Report

Reducing Toxic Exposure from Fish Consumption in Women of Childbearing Age and Urban Anglers: Results of a Two-Year Diary Study

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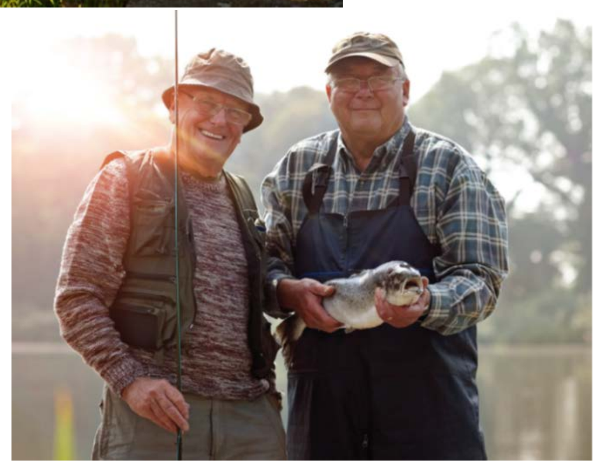
Reducing Toxic Exposure from Fish Consumption in Women of Childbearing Age and Urban Anglers: Results of a Two-Year Diary Study



FINAL REPORT TO THE USEPA
October 2016

Prepared by:
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*This document is labeled "draft" because it contains manuscripts that are under review but have not yet been published. A citable document with summary results can be found at: https://ecommons.cornell.edu/bitstream/handle/1813/44706/HDRU%20Report%2016-3%20Version%201.pdf?sequence=2&isAllowed=y
As manuscripts are published and we receive permission from the publishers, the document online will be updated to include the full manuscripts.

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We thank the members of the Great Lakes Consortium for Fish Consumption Advisories for their help with study design, providing access to survey samples, and reviewing results.

We thank Human Dimensions Research Unit (HDRU) staff member, Karlene Smith, who assisted with sample selection, initial recruitment and brochure mailings. We thank Rebecca Robbins for research assistance on analysis of formative research results and development of the brochures, and Shannon Hovencamp for assisting with table preparation. The Survey Research Institute at Cornell University conducted the telephone recruitment and hosted the online diary.

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INTRODUCTION AND SUMMARY

The ultimate goal of this project was to find ways to reduce exposure to toxic substances from Great Lakes fish consumption among women of child-bearing age (WCBA) and urban anglers. The Great Lakes Restoration Initiative Action Plan II identifies these two groups as being at particular risk from exposure to toxic substances from fish consumption. While consuming fish provides important health benefits to women, developing fetuses and children, consuming too much contaminated fish can lead to a variety of problems in children, including birth defects and learning difficulties. In addition, urban waters in industrialized areas may be polluted, and some types of fish in those waters accumulate high levels of industrial contaminants. Urban anglers are considered more likely than other anglers to fish at urban sites and, if they eat the fish they catch, more likely to be exposed to the contaminants in these fish. Consequently, state health departments in the Great Lakes states have made ongoing, long-term efforts to encourage urban anglers and WCBA to continue to eat fish, but within recommended limits.

Part of this effort has included research on how best to communicate messages about risks and benefits of fish consumption to prompt desired behavioral responses. The research has been fruitful in identifying the types of messages and materials that WCBA and urban anglers think would be most likely to encourage them to eat fish within recommended limits. These messages and materials had not yet been tested, however, to determine if they actually influence behavior as intended. This type of testing is important because the process through which communication leads to behavior change is complex; it involves a person receiving messages, correctly understanding them, considering them credible, incorporating relevant information, intending to follow their recommendations, and engaging consistently in the particular behavior (in this case, healthy fish consumption). A message or material may be perceived very positively by representatives of a target audience, but not actually influence behavior as expected. Consequently, we designed a study that would evaluate the impacts of communication of fish consumption guidelines and messages on healthy fish consumption behavior.

To assess behavioral impacts, we conducted a randomized experiment in which we determined the degree to which fish consumption guidelines and materials (developed on the basis of practitioners' insights and past research) reduced the consumption of fish high in toxic substances by WCBA and urban anglers, while still encouraging consumption of fish for the health benefits they provide. We selected a sample of WCBA and urban anglers from the Great Lakes region, gathered detailed information about their fish consumption patterns (including the degree to which these patterns conform to their states' health departments' recommendations), distributed fish consumption messages and guidelines to a randomly selected subset of this sample as an intervention, and gathered detailed information about how these messages and guidelines influenced fish consumption patterns. We hope these results will be used by the Great Lakes states to further enhance their programs to communicate the risks and benefits of fish consumption.

We have organized this report into six sections. Each section describes an important component of the study. The sections are written so that they can be submitted to peer-reviewed journals. Therefore, each section can be read independently and will give the reader an understanding of one component of the study. The sections are:

- Section 1: Using a Web-based Diary Method to Estimate Risks and Benefits from Fish Consumption
- Section 2: Fish Consumption among Women Anglers of Childbearing Age in the Great Lakes Region
- Section 3: Are Women Anglers of Childbearing Age in the Great Lakes Region Following Fish Consumption Guidelines?
- Section 4: Effects of Narrative Messages to Promote Healthy Fish Consumption Among Women of Childbearing Age
- Section 5: Urban Anglers' Adherence to Fish Consumption Advisories in the Great Lakes Region
- Section 6: Effects of an Advisory Brochure on Fish Consumption of Urban Anglers in the Great Lakes Region

Each section includes footnotes that provide the reader with related information and sometimes references appendices with more detailed analyses that were beyond the scope of the journal manuscripts. (This information is primarily intended to answer questions raised at the Great Lakes Consortium for Fish Consumption Advisories meeting held in Chicago in March, 2016.) We provide a summary of each section below. We follow these six summaries with a description of the outputs and outcomes of this project.

Summary of Section 1: Using a Web-based Diary Method to Estimate Risks and Benefits from Fish Consumption

Objective: Accurate estimates of the amount and type of fish people eat are necessary to determine the health benefits and risks people face from consuming fish and to assess compliance with fish consumption guidelines. We examine the strengths and weaknesses of using a diary method for collecting such fish consumption information.
Design: We developed a web-based (and mobile phone-enabled) diary methodology to collect detailed fish consumption information for two 16-week periods in the summers of 2014 and 2015.
Participants: We recruited study participants from two populations of licensed anglers living in the Great Lakes region – women of childbearing age (WCBA) and urban residents.
Results: At the end of the first year of data collection, 81% of WCBA and 79% of urban anglers provided at least some fish consumption information. In total, 58% of WCBA and 52% of urban anglers provided complete data across both data collection periods. Among those who provided information at the beginning of Year 2, 97% of both audiences provided information throughout the entire 16-week period. Those who participated throughout the two-year period were older on average (1.9-2.5 years) than other members of our original samples.
Conclusions: Using diaries with web and smartphone technology, combined with incentives and persistent communication, has great potential for assessing fish consumption for situations where the potential risks associated with fish consumption are substantial and the cost can be justified. The primary limitation of this method is the large cost associated with recruitment and incentive payments.

Summary of Section 2: Fish Consumption among Women Anglers of Childbearing Age in the Great Lakes Region

Objective: Fish consumption advisories are issued by the federal government for women of childbearing age (WCBA). These advisories make recommendations about the amount and types of fish that should be consumed to provide the greatest health benefits to women and their children while avoiding risks from chemical contaminants. Our objective was to describe the fish consumption habits of WCBA anglers and compare their consumption levels with the USDA and (current and proposed) EPA/FDA recommendations.
Design: We used diary methods to study fish consumption patterns for a 4-month period during the summer of 2014.
Participants: We obtained consumption data from 1,395 WCBA in the Great Lakes coastal region who purchased fishing licenses, a group which has significant opportunity to eat larger quantities of fish.
Results: Very few members of this group reported exceeding the federal recommendations for total fish consumption (between 3% and 5% depending on assumptions about portion sizes), consumption of canned "white" tuna (0%), or consumption of "do not eat" purchased fish species (4%). WCBA did report eating more fish on average than recent national study estimates, but they did not report consuming as much fish as is recommended to obtain the greatest health benefits of fish consumption. Only 10–12% of study participants reported eating within the recommended range of 8–12oz. of fish per week, with 84–87% eating less than the recommended amount.
Conclusions: Additional efforts are likely needed to encourage WCBA to eat more low-risk fish, even among this group of higher-than-average fish consumers.

Summary of Section 3: Are Women Anglers of Childbearing Age in the Great Lakes Region Following Fish Consumption Guidelines?

Objective: States in the Great Lakes region of the United States issue fish consumption guidelines for women of childbearing age (WCBA) to help them minimize the health risks to themselves and their potential offspring from eating fish contaminated with chemicals. Our objective was to examine the fish consumption patterns of WCBA and determine if WCBA were aware of the guidelines and following them.
Design: We used diary methods to study fish consumption patterns for a 4-month period during the summer of 2014, and a survey to assess awareness of the guidelines.
Participants: We obtained consumption data from 1,395 WCBA in the Great Lakes coastal region who purchased fishing licenses.
Results: We found that two-thirds of WCBA reported at least minimal awareness of the fish consumption guidelines issued by the states and federal government, and those that reported awareness were more likely to hold beliefs consistent with the messages emphasized in the guidelines. WCBA reported eating less than one meal/week of fish with most of this fish purchased at a store or restaurant. On average, they consumed just 2.4 sport-caught fish meals over the 16-week study period. The average portion size for sport-caught fish meals eaten by WCBA was similar to that assumed by states when determining the guidelines. One-quarter of WCBA in our study exceeded the state guidelines for sport-caught and purchased fish, with rates as high as 41% exceeding these guidelines in Michigan and Minnesota.

Conclusions: Additional outreach efforts may be needed to increase compliance with fish consumption guidelines, particularly among subpopulations that exceed the guidelines more frequently.

Summary of Section 4: Effects of Narrative Messages to Promote Healthy Fish Consumption among Women of Childbearing Age

Objective: To test the impact of brochures designed to promote healthy fish consumption among licensed female anglers of childbearing age.
Design: We conducted a randomized, two-wave longitudinal experiment between May 18th, 2014 and September 5th, 2015. Participants reported their fish consumption in summer 2014 via an online diary. We then randomly assigned women to either be sent one of four brochures in spring 2015 using a two (including a short personal narrative or not) by two (using certain or uncertain language) factorial design, or to a fifth, no-exposure control arm. All participants completed a fish consumption diary again in summer 2015. We used ordinary least squares regression to test the effect of the brochures on fish consumption.
Participants: 1,135 women of childbearing age (18 to 48 years of age at baseline) drawn from a sample of licensed anglers who completed an online diary of their fish consumption in both years of the study.
Results: There were no overall effects of randomized condition on fish consumption, driven by low levels of confirmed exposure to the brochure among treatment groups. Among those confirmed to have seen it, however, exposure to brochure versions that included a short personal narrative helped to move women whose levels of fish consumption at baseline were furthest from federally recommended levels closer to these guidelines.
Conclusions: Narratives hold promise as a strategy to effectively convey information about the risks and benefits of fish consumption among women of childbearing age, but more research is needed to identify strategies to maximize exposure to these messages.

Summary of Section 5: Urban Anglers' Adherence to Fish Consumption Advisories in the Great Lakes Region

Objective: Previous research suggests that urban anglers are a group at high risk of being exposed to contaminants from fish consumption. Past studies of urban anglers' fish consumption, however, have had significant limitations making it difficult to generalize their findings broadly and to assess the degree to which urban anglers are complying with advisory recommendations. In three cities in the Great Lakes region, we assessed how much fish urban anglers consumed, whether they complied with fish consumption advisories, and how fish consumption and advisory compliance varied for different demographic groups and in different locations.
Design: We used a diary method to collect detailed information on fish consumption for a 4-month period during the summer of 2014.
Participants: We collected fish consumption data from a representative sample of 1,363 licensed anglers in the three counties containing Rochester, NY, Erie, PA, and Kalamazoo, MI.
Results: We estimated a mean of 1.12 meals/week of fish and 25.1-26.8 grams/day of fish, and the amount of fish consumed varied by no more than 25% from one site to another. Advisory exceedance was more variable, however, ranging from 7-10% to 27-40% in our three study sites. Fish consumption increased with age, education, and income, and was higher for nonwhites than

for whites. Advisory exceedance was higher for women, nonwhites, and older anglers. At each site, the types of fish that contributed the most to advisory exceedance varied.
Conclusions: Community-specific (and resource-intensive) fish consumption guidelines are likely to benefit populations of urban anglers.

Summary of Section 6: Effects of an Advisory Brochure on Fish Consumption of Urban Anglers in the Great Lakes Region

Objective: Past research suggests that urban anglers are a group at high risk of being exposed to contaminants from fish consumption. Fish consumption advisories have been used in many regions to encourage healthy fish-eating behaviors, but few studies have been designed to assess whether these advisories actually influence behavior as intended. We conducted a large-scale, randomized experiment to test the influence of an advisory brochure on urban anglers' fish consumption.
Design: We collected detailed information on urban anglers' fish consumption in the summers of 2014 and 2015. We provided a treatment group with fish consumption guidelines in an advisory brochure before the summer of 2015 and compared their change in fish consumption to a control group.
Participants: We collected fish consumption data from a representative sample of 1,041 licensed anglers in the three counties containing Rochester, NY, Erie, PA, and Kalamazoo, MI.
Results: The brochure led to a reduction in fish consumption for anglers who ate the most fish; these anglers reduced their consumption of high-contaminant purchased fish and both high- and low-contaminant sport-caught fish. The brochure also reduced sport-caught fish consumption among those anglers who exceeded the advisories in 2014. In addition, the brochure led to small increases in fish consumption in urban anglers who ate very little fish.
Conclusions: Fish consumption guidelines brochures can have effects on target audiences. Future research that could improve our understanding of the effects of such interventions might assess the effects of brochure interventions on contaminant ingestion, explore the effectiveness of different delivery methods for brochures, or explore the effectiveness and cost-effectiveness of different types of interventions.

Milestones

Work on both the urban anglers project and the women of childbearing age project were conducted in parallel and progressed through the same series of milestones:

- Recruitment of participants for the study (April 2014)
- Development of diary instrument for collecting fish consumption data and pre-intervention survey instrument (April 2014)
- Completion of first year's collection of fish consumption data and pre-intervention survey (September 2014)
- Development of 44 versions of fish consumption guidelines brochure (4 versions for each study subpopulation) for use as intervention in study (February 2015)
- Distribution of fish consumption guidelines brochure to randomly selected participants (May 2015)
- Development of post-intervention survey instrument (May 2015)

- Completion of second year's collection of fish consumption data and post-intervention survey (September 2015)
- Preliminary data analysis and presentation of study results to Great Lakes Consortium for Fish Consumption Advisories (March 2016)
- Final data analysis and final written research reports (September 2016)

Data

The data collected for the women of childbearing age and urban anglers were one of the outputs of the project:

- We collected detailed diary-based fish consumption information from women of childbearing age in the Great Lakes region over 4-month periods in the summers of 2014 and 2015. In 2014, 1,395 provided information on their fish consumption for the entire 4-month period. In 2015, 1,173 provided information for the entire period. Combining data from the two years, 1,135 WCBA provided information on their fish consumption for the entire 4-month period in both years.
- We collected detailed diary-based fish consumption information from urban anglers living in three sites in the Great Lakes region over 4-month periods in the summers of 2014 and 2015. In 2014, 1,363 provided information on their fish consumption for the entire 4-month period. In 2015, 1,081 provided information for the entire period. Combining data from the two years, 1,041 urban anglers provided information on their fish consumption for the entire 4-month period in both years.

Data summaries are reported in the Outputs and Outcomes section below and in the manuscripts in Sections 2-4 for women of childbearing age and in the manuscripts in Sections 5-6 for urban anglers.

Outputs and Outcomes

This project produced a number of outputs that will contribute to longer-term outcomes. These outputs and outcomes are summarized here for both women of childbearing age and urban anglers.

Women of Childbearing Age (WCBA)

The principal outputs of the WCBA portion of the project were:

- We developed a set of print brochures intended to encourage women to eat fish, but to follow healthy fish-eating guidelines. These print brochures were informed by the results of past research, by a survey and a set of focus groups conducted as part of this project, and by the experience and insights of health professionals and staff members of state health departments and environmental agencies in the region. The 32 versions of the brochure developed for WCBA are included in a zipped file serving as an addendum to this report.

- We estimated the number of WCBA eating fish in excess of recommendations and the number of WCBA eating less fish than is recommended to receive health benefits. Three to five percent of WCBA exceeded federal recommendations for total fish consumption, 0% exceeded federal recommendations for canned “white” tuna, and 4% consumed one or more meals of federal “do not eat” species. Rates of exceedance of state fish consumption guidelines, which include sport-caught fish, were much higher. One-quarter of WCBA exceeded the state guidelines, with rates as high as 41% exceeding the guidelines in Michigan and Minnesota. A total of 84-87% of WCBA ate less fish than was recommended by the USDA and (current and proposed) EPA/FDA guidelines to receive health benefits.

- The 1,135 women who completed fish consumption diaries throughout the 4-month periods in both years of the project were included in the experiment in which we tested the impacts of an advisory brochure on fish consumption. Approximately two-thirds of the women received one of four versions of the brochure, and the remaining one-third served as a control group. The brochure increased the amount of fish that women ate without increasing the number exceeding advisory recommendations. Therefore, it increased the number of women getting benefits from fish consumption without increasing the number at risk from fish consumption. Women who ate the least fish (< 0.7 meals/week at baseline) stood to benefit the most from increasing their fish consumption. In our study, women who ate < 0.7 meals/week of fish and received fish consumption guidelines with messages about the importance of eating fish ate more fish the next year. However, this benefit only occurred if they received messages in a “narrative” format (messages communicated as part of a story about a hypothetical woman of childbearing age); other forms of the guidelines did not influence fish consumption. These women increased their fish consumption largely by eating more low-mercury, purchased fish. These women did not increase their consumption of more contaminated fish.

- Women who ate too much fish (>2.8 meals/week at baseline) were also influenced by the narrative form of the brochure. They ate fewer meals after receiving the brochure, but did not decrease their consumption sufficiently to be within advisory recommendations.

The principal outcomes of this portion of the project were:

- We documented how healthy fish consumption and ingestion of toxic substances through fish consumption changed over the two-year course of this project in response to the advisory brochure (as described above).

- The principal outcome of this work was intended to be a reduction in the number of WCBA who eat Great Lakes fish in excess of recommended consumption guidelines and, therefore, accumulate toxic substances in their bodies. Our intervention did not lead to a reduction in the number of women eating purchased or sport-caught fish in excess of guidelines. It did, however, lead to an increase in fish consumption by WCBA without a corresponding increase in the number of WCBA exceeding the guidelines. Consequently, it increased the benefits women are getting from fish consumption without increasing the risks. Furthermore, a few women who were exceeding the recommended guideline of 2 meals per week decreased their consumption somewhat.

- Based on these findings, we estimate for every 10,000 narrative brochures distributed, 2,797-3,330 women of childbearing age would eat more fish, totaling 14,544-17,316 more fish meals each year. This increase in fish consumption would not result in any more women exceeding fish consumption guidelines. Furthermore, we estimate for every 10,000 narrative brochures distributed, 76-90 women of childbearing age who were currently exceeding fish consumption guidelines would eat fewer fish, totaling 1,011-1,197 fewer fish meals each year. These estimate are based on the fish consumption messages and methods of distributing the brochures used in this study. The distribution methods (and possibly the messages) used in advisory programs would differ.

Urban Anglers

The principal outputs of the urban angler portion of the project were:

- We developed a set of print brochures intended to encourage urban anglers to follow fish consumption guidelines. These print brochures were informed by the results of past research and by the experience and insights of health professionals and staff members of state health departments and environmental agencies in the region. The 12 versions of the brochure developed for urban anglers are included in a zipped file serving as an addendum to this report.

- We estimated the number of urban anglers eating fish in excess of advisory guidelines. Advisory exceedance ranged from 7-10% to 27-40% in our three study sites (with the range reflecting different assumptions). Advisory exceedance was higher for women, nonwhites, and older anglers.

- The 1,041 urban anglers who completed fish consumption diaries throughout the 4-month periods in both years of the project were included in the experiment in which we tested the impacts of an advisory brochure on fish consumption. Approximately two-thirds of the sample received one of four versions of the brochure, and the remaining one-third served as a control group.

- The brochure led to a reduction in fish consumption for anglers who ate the most fish; these anglers reduced their consumption of purchased fish, sport-caught fish, high-contaminant purchased fish and both high- and low-contaminant sport-caught fish. (We defined “high-contaminant fish” as those for which guidelines recommend fewer than one meal/week.) The version of the brochure did not matter.

- The brochure also led to a reduction in sport-caught fish consumption by those anglers who exceeded advisory recommendations in 2014. These anglers reduced their consumption of sport-caught fish compared to the control group by nearly 2 fish over the course of the summer.

- The brochure led to small increases in fish consumption in urban anglers who ate very little fish. These anglers increased their consumption of sport-caught fish and high-contaminant purchased and sport-caught fish. These increases in fish consumption came without increasing the number of anglers who were exceeding advisory recommendations.

The principal outcomes of this portion of the project were:

- The principal outcome of this work was intended to be a reduction in the number of urban anglers who eat Great Lakes fish in excess of recommended consumption guidelines and, therefore, accumulate toxic substances in their bodies. Our intervention led to a reduction in consumption of high-contaminant fish (fish for which guidelines recommend fewer than one meal/week) among anglers who ate the most fish.

- Based on these findings, we estimate for every 10,000 brochures distributed, the 1,948-2,452 anglers eating the most fish would reduce their consumption of high-contaminant fish by 6,457-8,127 meals each year. Similarly, the 2,504-3,048 anglers eating the most purchased fish would reduce their consumption of high-contaminant purchased fish by 4,780-5,818 meals each year, and the 1,120-1,532 anglers eating the most sport-caught fish would reduce their consumption of high-contaminant sport-caught fish by 3,381-4,625 meals each year. At the same time, high-consuming anglers would also reduce their consumption of low-contaminant sport-caught fish. The 2,133-2,651 anglers eating the most sport-caught fish would reduce their consumption of low-contaminant sport-caught fish by 5,629-6,996 meals each year. These estimates are based on the fish consumption messages and methods of distributing the brochures used in this study. The distribution methods (and possibly messages) used in advisory programs would differ.

- Although high-consuming anglers would reduce their consumption of fish, anglers who ate very little fish would increase their consumption of high-contaminant fish. The 668-1,004 anglers who ate the least purchased fish would increase their consumption of high-contaminant purchased fish by 786-1,181 meals each year. The 3,661-4,255 anglers who ate the least sport-caught fish would increase their consumption of high-contaminant sport-caught fish by 4,023-4,675 meals each year. Because these anglers ate almost no fish initially, increasing their consumption of high-contaminant fish by these small amounts would pose very little risk to them. Thus, communication of fish consumption guidelines would allow anglers who were at low risk to take additional advantage of their opportunities to eat fish.

SECTION 1: USING A WEB-BASED DIARY METHOD TO ESTIMATE RISKS AND BENEFITS FROM FISH CONSUMPTION

ABSTRACT: Accurate estimates of the amount and type of fish people eat are necessary to determine the health benefits and risks people face from consuming fish, and to assess compliance with fish consumption guidelines issued for fish affected by chemical contaminants. We developed a web-based (and mobile phone-enabled) diary methodology to collect detailed fish consumption information for two 16-week periods in the summers of 2014 and 2015. We recruited study participants from two populations living in the Great Lakes region – women of childbearing age (WCBA) and urban residents who had purchased fishing licenses. This paper offers our findings on the benefits and limitations of the diary method for collecting fish consumption information. At the end of the first year of data collection, 81% of WCBA and 79% of urban anglers provided at least some fish consumption information. In total, 58% of WCBA and 52% of urban anglers provided complete data across both data collection periods. Among those who provided information at the beginning of Year 2, 97% of both audiences provided information throughout the entire 16-week period. Those who participated throughout the two-year period were older on average (1.9-2.5 years) than other members of our original samples. The primary limitation of this method is the large cost associated with recruitment and incentive payments. Nevertheless, using diaries with web and smartphone technology, combined with incentives and persistent communication, has great potential for assessing fish consumption in other areas of the country or for situations where the potential risks associated with fish consumption are substantial and the cost can be justified.

KEYWORDS: diary method, fish consumption, Great Lakes, web-based

1. Introduction

A large body of research has shown that some fish contain chemical contaminants, such as mercury and polychlorinated biphenyls (PCBs), that can be harmful to humans if consumed in too great quantities, especially among women of childbearing age (WCBA) (e.g., Turyk et al., 2012: Papadopoulou et al., 2014). Research has also shown that there are benefits to consuming fish, as they are the primary dietary source of omega-3 fatty acids which are important for adult health (Domingo, 2014), as well as the development of eyes, brains, and nervous systems in a fetus (Innis, 2008). Federal, state, and tribal agencies provide guidelines for fish consumers on the safest amounts and types of fish to eat based on analyses of contaminants in fish from different waters.

It is important to know the species, the amounts, and the frequency with which people are eating fish in order to know if people are following the guidelines. If many people are exceeding the recommendations, these agencies need to know how they can improve their outreach efforts so more people follow their guidelines. Reliable data about fish consumption are also needed for regulatory programs to use in their risk assessment processes.

Fish consumption has been measured using different methods which vary in terms of the amount and type of information collected, the timeframe over which data are collected, the period of recall for the respondent, respondent burden, and cost. They also vary in how well they address concerns about accuracy and representativeness. The methods used in the vast majority of studies can be grouped into two general types. First, the use of a Food Frequency Questionnaire (FFQ) (e.g., How frequently do you eat tuna? Once a week, once a month, etc.). The FFQ method is easy to administer and generally low cost (Stephen, 2007: Shim et al., 2014). Nonetheless, it is an approximation and relies on a respondent's good memory of dietary behavior and therefore raises concerns about recall bias and accuracy. It also may not collect information at the level of detail (e.g., waterbody origin or sub-species of the fish, like albacore versus light tuna) needed in certain situations.

The second general method is the use of a diet diary. This method asks respondents to record all food consumed, usually for three to seven days. It is used frequently because it provides more detail than FFQs. The "gold standard" diet diary method for measuring food consumption involves a researcher checking these diaries every day (Friedman et al., 2016). This places a heavy burden on both the respondent and the researcher, however, making it very costly to implement and therefore less feasible for widespread use. Such short-term diet diaries are also limited because they provide only a snapshot of a person's diet (Stephen, 2007); as a result, these short-term diary methods may not capture consumption of infrequently consumed items like sport-caught (and potentially contaminated) fish. To overcome these limitations, researchers have used various combinations of these two methods, asking people to keep detailed short-term food diaries for 3, 4 or 7 days while also filling out a FFQ to cover a longer period of time (Moya et al., 2008; EPA, 2013). These combination studies address some of the pitfalls of each method, but still rely on recall (and its potential bias) for infrequently consumed foods, and do not provide precise estimates of consumption of these foods.

Connelly and Brown (1996) sought to address the need for detailed estimates of infrequently consumed fish meals by developing a longer-term diary method. They asked participants to record fishing trips and fish consumption over the course of a year in a paper diary. They contacted participants every three months by telephone to retrieve information recorded in the diary and encourage participation. This method allowed for the collection of information about fish rarely eaten and thus sought to reduce concerns about recall bias. Nevertheless, it raised concerns about representativeness of the data, with a limited number of people willing to participate in the long-term.

For these longer-term studies, researchers, such as Adamson and Chojenta (2014), have written about the importance of developing and maintaining relationships with participants to encourage response, lower attrition rates and maintain a representative sample. Laurie and Lynn (2009) further concluded that the use of incentives was an important element in minimizing attrition in longer term studies. They acknowledge, however, limited available evidence about optimum incentive strategies.

Advances in technology now allow for web-based and mobile phone-enabled data collection. These methods may reduce research costs and perhaps respondent burden, but what impact do they have on accuracy and the representativeness of the sample? Kissinger et al. (2010) developed a computer-assisted personal interview software system for collecting tribal fish consumption data which allows a person to interview a respondent using a computer to record the information during the interview. The authors thought using the computer was better than paper and pen methods because it allowed for complex branching, no data entry errors (which are found in transcribing data from paper to computer), and no printing or mailing costs. Sharp et al. (2014), in a review article that focused on the use of mobile phones to assess dietary intake, found no difference in validity or reliability between the use of mobile phones and conventional methods (i.e., pen and paper), with participants in the studies they reviewed reporting higher satisfaction and a greater preference for the mobile phone method. Similarly, Hutchesson et al. (2015) found that among a small sample of young women aged 18 to 30 there was no difference in the accuracy of reported food consumption between diary methods administered by paper versus online or smartphone, but the women preferred the online or smartphone methods.

Taking all of this past research into consideration, we endeavored to develop a method to measure fish consumption accurately over time that included consumption of both purchased fish and frequently and infrequently eaten sport-caught fish from a variety of waters. Our approach was designed to minimize recall bias, keep respondent burden to a minimum, make use of web-based and mobile phone-enabled technology, and reduce attrition by the use of incentives. In this paper, we describe our methods in the form of a case study, offer evidence of participation rates and measures of representativeness of our sample over time, and reflect on the potential value of such a method for future collection of fish consumption data to inform consumption advisory efforts.

2. Methods

2.1. Study Context

The overall objectives of the study to which we applied our methods were to: 1) quantify fish consumption (species and amounts), 2) assess adherence to fish consumption guidelines, and 3) measure the effects of a fish consumption advisory brochure on fish consumption behavior. We chose two audiences to study. One audience was WCBA who had fishing licenses; because of their potential to bear children, this group may have both higher risks and higher benefits from fish consumption than other groups (Mozaffarian and Rimm, 2006). The second audience was urban anglers, who have long been thought to be at greater risk from fish consumption because they are more likely to fish urban waters that are heavily polluted and may contain fish that have accumulated industrial contaminants (Lauber et al., In review). We conducted our research in the Great Lakes region where the Great Lakes Consortium for Fish Consumption Advisories has long-standing efforts to improve communication of fish consumption guidelines. We used a web-based (and mobile phone-enabled) diary method to collect fish consumption information for two 16-week periods in the summers of 2014 and 2015. Data collected during the first summer provided information for our first two objectives. Between the first and second summer we developed brochures containing different risk communication messages, which we sent to a subset of participants. We compared fish consumption data collected in the second summer to data collected in the first summer to assess the effectiveness of the risk communication messages (Objective 3). We monitored participation rates and the representativeness of our samples over time. In this paper, we evaluate the data-collection method but do not report results on the three main research questions which the method was designed to address.

2.2. Sample Selection and Diary Recruitment

We used fishing license records to obtain the samples for both survey audiences. We drew a sample of 15,000 fishing licenses sold to women aged 18 to 48 (who would reach a maximum age of 50 [considered the end of the childbearing years] at the end of our two-year study) who lived in counties in the eight states bordering the Great Lakes (i.e., Great Lakes coastal region). We drew the sample by state in proportion to the number of licenses sold in each state to WCBA who lived in the Great Lakes coastal region.

We selected three urban areas in the Great Lakes region for the urban angler portion of our study – Kalamazoo, MI; Erie, PA; and Rochester, NY (Fig. 1). We drew a sample of 15,000 fishing licenses sold to anglers living in the counties containing the urban areas. We sampled an equal number of licenses (n=5,000) from each urban area.

We set recruitment quotas for each state or urban area based on the number of participants we estimated we needed at the end of the two-year study for sufficient power in our statistical analysis. The recruitment quotas were in the same proportions as the sample selection.

We sent invitation letters to each member of the sample in February 2014. The letter described the study and what would be required of participants and provided a link to a sign-up page on the Internet. We offered a financial incentive up to $20 for participation in the first year of the project, and up to $25 for participation in the second year. We provided a postage-paid return postcard for people to opt out of the study because they did not eat fish, did not have regular internet access, or were not interested in participating. We sent a follow-up letter to all invitees a week later encouraging participation.

We made telephone calls to those who did not sign-up or return a postcard to encourage participation and allow sign-up directly over the telephone. Calling ceased in a particular area when the quota of participants had been reached for that area. During the study sign-up process we obtained email addresses and then checked them by sending out a verification email. We then used email for all communication with study participants.

Fig. 1. Great Lakes study area. (Stars indicate location of urban angler study sites.)

Before the start of data collection in Year 2 we sent out an email to all participants who had provided data in Year 1. We asked them to verify their mailing address so we could determine if they still resided in the study area. Those who had moved out of the area were sent an email thanking them for their participation in Year 1, and indicating they were no longer eligible to participate in the study.

2.3. Diary Data Collection
We collected fish consumption information for 16 weeks from May 18 through September 6, 2014 and again from May 17 through September 5, 2015. Participants recorded data in two-week blocks. Participants could record information as many times as they wished during the two-week period[1]. Every two weeks we sent an email invitation to participants with a direct link to their diary to signal the start of the next two-week period and remind them that the previous two week-period was ending. We also included occasional "tips," as recommended by Connelly and Brown (1996), for filling out the diary that addressed potential recording errors identified in preliminary data analysis. When a two-week period ended, we sent up to three reminders to participants who had not completed entering data for the period to finish recording their information for the period. Participants earned financial incentives for each period completed and received a bonus at the end if they completed reporting for every period.

We gave each participant a link unique to them to access their personal fish consumption diary on the Web. On the initial page, participants saw information for the eight two-week periods of the study, showing completed periods and incentives earned. On the next page we asked participants to record for each day in the current two-week period whether or not they ate fish, with a click on a "yes" or "no" radio button. For each day they indicated they ate fish, another page opened asking the number of fish meals they ate on that day. For each meal reported, participants recorded whether the fish was purchased (at a store or restaurant) or sport-caught (i.e., fish caught by you or someone else), the species eaten, the portion size, and (for sport-caught fish) where the fish was caught, using radio buttons. We provided a list of fish species via a drop down menu, including the most commonly consumed purchased fish and specific purchased fish with consumption guideline recommendations, along with a text box to record other purchased-fish species not on the list. For sport-caught species, we listed only those with consumption guideline recommendations and provided an "other" option for species not on the list. Participants indicated portion size in reference to a picture of a 6 oz. cooked portion of salmon; we asked participants if the meal they ate was larger, smaller, or the same size as the picture.

2.4. Data Analysis
We analyzed data from the diary using SPSS (IBM SPSS Statistics 24). We obtained data on participant age and gender from fishing license records. We compared diary recruits and participants with those not recruited or participating using chi-square and t-tests to identify statistically significant differences at the $P < 0.05$ level.

3. Results

3.1. Initial Recruitment
As noted earlier, we sent initial recruitment letters to 15,000 WCBA and 15,000 urban anglers. We made contact in some form (via direct web signup, postcard return, or telephone interview) with 4,185 WCBA and 5,384 urban anglers (Table 1). Of those with whom we had contact, 48% of WCBA and 39% of urban anglers agreed to participate in the study. Fewer than 15% in each

[1] Appendix A provides information on how often participants recorded fish consumption information within a two-week interval.

group were ineligible to participate because they did not consume fish. Fewer than 10% in each group were ineligible because they did not have an email account or internet access. Over one-third of those we had contact with in each group declined to participate in the study.

Those who agreed to participate were slightly older than others in the original sample pool for both WCBA and urban anglers (WCBA - 35.5 years old vs. 33.7 years old, $p<0.001$, Urban anglers - 47.6 years old vs. 45.5 years old, $p<0.001$). There were no gender differences between urban anglers who agreed to participate and the remainder of the original sample pool (83.0% vs. 83.1% male, respectively). There were some differences between those who agreed to participate and those who were ineligible based on our criteria (Table 2). WCBA who did not eat fish were younger than those who agreed to participate in the study. Urban anglers who did not have internet access were much older on average than those who agreed to participate. Urban anglers who refused to participate were also older on average than those who were recruited.

Table 1
Results of recruitment efforts for WCBA and urban anglers.

	WCBA		Urban anglers	
	n	%	n	%
Communicated with via web sign-up, return postcard, or phone interview	4,185	100.0	5,384	100.0
Recruited	2,014	48.1	2,099	39.0
Ineligible – Do not eat fish	565	13.5	490	9.1
Ineligible – No email or web access	86	2.1	405	7.5
Refused to participate	1,520	36.3	2,390	44.4

Table 2
Comparison of those recruited with others in the sample by age and gender.

	WCBA	Urban anglers	
	Mean age	Mean age	% male
Recruited	35.6	47.6	83.0
Ineligible – Do not eat fish	34.0*	49.1	80.5
Ineligible – No email or web access	36.2	63.2*	84.5
Refused to participate	35.4	52.0*	85.6*

*Significantly different (at $P<0.05$) from group recruited.

A total of 2,014 WCBA and 2,099 urban anglers consented to participate in the study. The number recruited in each stratum was similar to or exceeded the recruitment quota in 8 of the 11 strata (Table 3). Michigan (WCBA and urban anglers) and Ohio WCBA proved more difficult to recruit from than the other states. The number recruited was 5-10% less than the recruitment quotas in Michigan and 17% less in Ohio.

3.2. Participation in Year 1

We sent up to three reminder emails at the end of each two-week period to encourage participants to complete data entry for that period and qualify for the financial incentive offered for that period. The effectiveness of the reminder emails peaked in each period on the day the reminder email was sent (Fig. 2); the number of participants responding to each reminder declined over time.

Table 3
Initial sample size, recruitment quota, and number recruited by study strata.

	Initial sample size	Recruitment quota	Number recruited
WCBA			
New York	2,178	290	360
Pennsylvania	228	30	34
Ohio	1,806	241	199
Indiana	556	74	73
Illinois	1,101	147	157
Michigan	4,860	648	608
Wisconsin	3,620	483	482
Minnesota	651	87	101
Urban anglers			
Kalamazoo, MI	5,000	667	610
Erie, PA	5,000	667	705
Rochester, NY	5,000	667	784

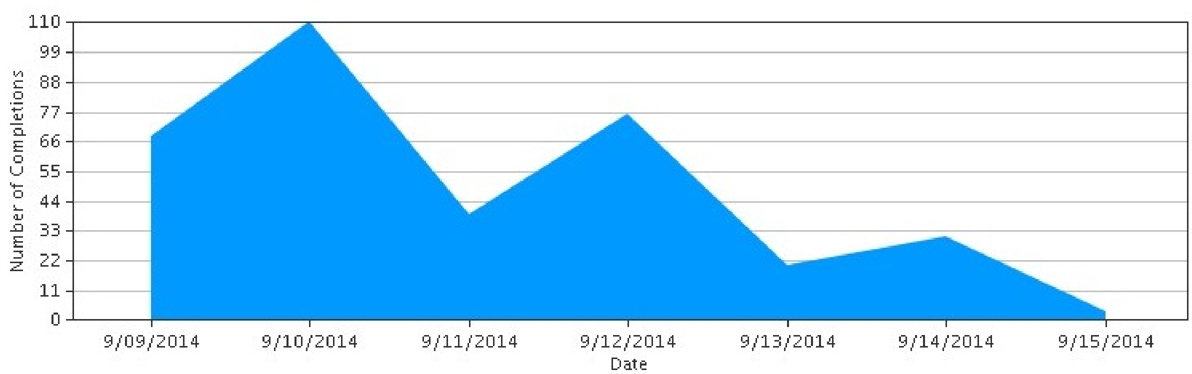

Fig. 2. Illustration of response peaks due to email reminders on 9/10, 9/12, and 9/14 (WCBA, eighth period, 2014).

Participation was highest in the first two-week period for both WCBA and urban anglers (Fig. 3). Participation declined after the first period but remained steady over the remaining periods. Participation among urban anglers was consistently slightly 1ower than among WCBA.

Participation rates (i.e., number providing information each period) were similar across strata, with slightly higher average rates among WCBA compared to urban anglers (Table 4). About 80% of WCBA and 76% of urban anglers participated in the first two-week period. The proportion decreased slightly over time, with between 65% and 75% of each stratum participating in the last two-week period of the first summer. At the end of the first year of data collection, among those who agreed to participate at the outset, 81% of WCBA and 79% of urban anglers provided some information, and 70% of WCBA and 66% of urban anglers provided information throughout the 16-week study period. A few participants (24 WCBA and 15 urban anglers) did not eat any fish during the 16-week study period. We did not include them in the analysis performed using Year 1 data but retained them as potential Year 2 participants because they indicated previously that they ate fish.

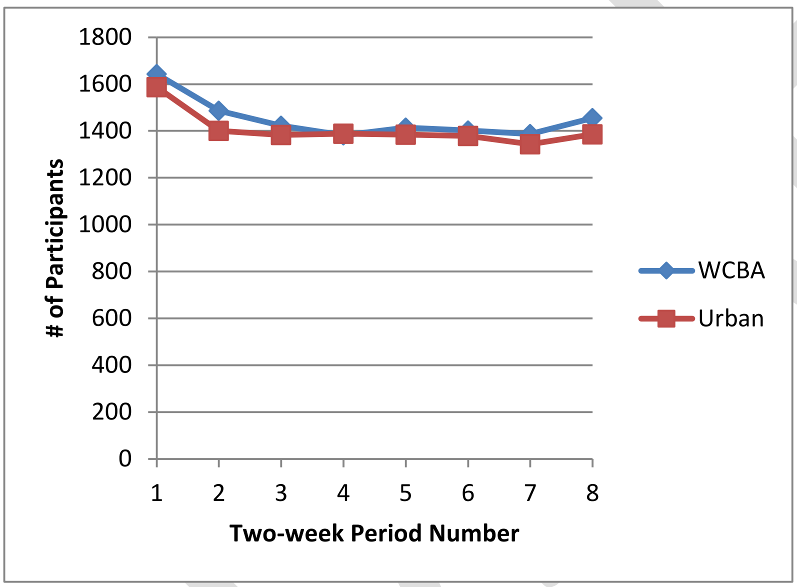

Fig. 3. Number of participants providing information in each two-week period of Year 1.

Using participants that ate at least one fish meal during the Year 1 study period, we compared those who participated in all periods (88% of WCBA and 85% of urban anglers) with those who participated in fewer (one to seven) periods. We found that WCBA who participated in all periods were slightly younger than those who participated in fewer periods (WCBA - 35.7 years old vs. 36.9 years old, p=0.042) and urban anglers who participated in all periods were slightly older than those who participated in fewer periods (Urban anglers – 49.0 years old vs. 46.1 years old, p=0.005). There were no gender differences between urban anglers who participated in all periods versus those who participated in fewer periods. For both target audiences, we found no differences in fish consumption between those who participated fully and those who participated during only part of the study period for the periods when the two groups overlapped.

Table 4
Participation rates in diary by study strata.

	Percent		
	Participated in first two-week period	Participated in last two-week period	Participated in all periods
WCBA	80.5	71.3	69.6
New York	78.9	68.1	67.2
Pennsylvania	82.4	73.5	67.6
Ohio	81.4	73.4	73.4
Indiana	78.1	68.5	67.1
Illinois	79.0	70.1	70.0
Michigan	80.3	71.5	70.7
Wisconsin	82.8	73.4	72.6
Minnesota	83.2	73.3	68.3
Urban anglers	75.6	66.0	65.6
Kalamazoo, MI	78.5	68.9	68.7
Erie, PA	74.2	64.8	64.5
Rochester, NY	74.6	64.9	64.3

3.3. Participation in Year 2

Before the start of data collection in Year 2 we contacted all participants who provided data in Year 1 and found that very few WCBA (2%) and urban anglers (1%) had moved from the stratum area in which they had originally been selected. We excluded these participants from Year 2 data collection.

Among all participants who provided data in Year 1 (and had not moved out of the study area or emailed us to say they did not want to participate in Year 2 [<1%]), 75% of WCBA and 69% of urban anglers participated in the first two-week period of Year 2. Of those who participated in the first two-week period, 97% of both WCBA and urban anglers participated in all remaining periods in Year 2.

Those who provided complete data in Year 1, regardless of study audience, were far more likely to provide complete data in Year 2 (Table 5). Over 80% of WCBA and over 75% of urban anglers who provided complete data in Year 1 did so again in Year 2. Three-quarters of those in both audiences who provided partial data in Year 1 did not provide any data in Year 2.

From among those who originally agreed to participate in the study, 58% of WCBA and 52% of urban anglers provided complete data throughout both Year 1 and Year 2. Those who participated fully in both years were slightly older than others in the original sample pool for both WCBA and urban anglers (WCBA - 35.7 years old vs. 33.8 years old, p<0.001, Urban anglers – 48.2 years old vs. 45.6 years old, p<0.001). There were no gender differences between urban anglers who participated fully in both years and the remainder of the original sample pool (81.2% vs. 83.3% male, respectively).

Table 5
Participation in Year 2 by WCBA and urban anglers who provided complete or partial data in Year 1.

	WCBA		Urban anglers	
	Provided complete data in Year 1	Provided partial data in Year 1	Provided complete data in Year 1	Provided partial data in Year 1
sample n	1,387	233	1,357	266
% providing complete data in Year 2	82.9%	16.3%	77.8%	14.3%
% providing partial data in Year 2	4.3%	8.1%	3.5%	9.8%
% not providing any data in Year 2	12.8%	75.6%	18.7%	75.9%

4. Discussion

4.1. Benefits of the Web-based Diary Method

We recruited over 2,000 people in each target audience to participate in a two-year study where they had to record their fish consumption online for 16-weeks each summer. We offered a modest financial incentive as suggested by others (Laurie and Lynn, 2009) and made efforts to reduce respondent burden by giving participants a direct link to their personal diary, using radio buttons and drop down menus to reduce recording time, and using mobile phone-enabled technology as preferred by participants in other studies (Hutchesson et al., 2015: Sharp et al., 2014). The nature of the data we sought to collect (bi-weekly reports of fish consumption over two 16-week periods), however, reflects a substantial respondent burden. Nonetheless, over half of the people we recruited initially participated fully throughout the two-year period (58% of WCBA and 52% of urban anglers), suggesting that this method was not too burdensome to a large subset of those who initially agreed to participate. This rate of full participation exceeds the 43% rate reported by Connelly and Brown (1996) in their one-year study of fish consumption using a paper diary method.

The final, full-participation sample was not a perfect snapshot of the broader populations, but differences we could detect were relatively modest. In both audiences, those who participated throughout the two-year period were older on average (1.9-2.5 years) than other members of our original sample. However these differences, while significant due to the large sample size, were small in a practical sense. Also, we found no gender differences in the urban sample. Therefore, based on the measures we had available, we believe that the final group of participants we used in our analysis may be a reasonable representation of WCBA who have fishing licenses in the Great Lakes coastal region and urban anglers in the three communities studied. Based on findings from other studies (Bray and Schramm, 2001; Lusk and Brooks, 2011), it is likely that participants in our study had higher education and income levels and were less racially diverse than the populations they came from, but we have no way to test the degree to which this might be occurring in our sample because we do not have any comparable population data.

Over three-quarters of those who participated fully in Year 1 (78-83%) participated fully in Year 2. An astonishing 97% of participants who provided information at the beginning of the second summer provided information throughout the entire summer. The level of commitment of participants in our study was clearly high. We attribute this commitment in part to the incentive, but also to the persistent communication with an email every two-weeks and up to three reminders at the end of each two-week period encouraging participation. Our results seem to confirm the recommendation of Adamson and Chojenta (2014) regarding the importance of establishing a relationship with participants.

This longer term diary method (16-weeks) implemented during late spring through summer when the most sport-caught fish are typically consumed (Connelly et al., 1996) is likely to provide more precise measurement of the number of sport-caught fish consumed, the species, and the location where they were caught than other methods (like FFQs) which rely on estimates such as "one per month." The type of detailed fish consumption information we collected, which has been viewed as a major challenge to researchers (Silver et al., 2007), allows direct comparison with fish consumption guidelines and identification of individuals exceeding the guidelines. For example, we found that 7% to 40% of urban anglers exceeded their state's fish consumption guidelines (Lauber et al., In review), exposing them to risks from consumption of chemical contaminants. We also found that only 10 to 12% of WCBA reported eating within the federally recommended range of 8 to 12 oz. of fish per week, with 84-87% eating less than the recommended amount, suggesting they are not eating enough fish to maximize the potential for health benefits (Connelly et al., 2016).

Few people moved out of our study areas between Year 1 and Year 2. This suggests that concern about loss of sample due to changing residences need not be a major concern when estimating initial sample size requirements in a multi-year survey.

4.2. Limitations of the Method

The most substantial limitations of this method are the costs of implementation and the technical capability required to program the website for respondent use. An experienced web programmer was needed to develop each page of the diary, and time was required to test and retest all elements of data collection. While the costs associated with the administration of the diary were not high because much of the administration was automated through the website programming, the costs (in descending order of magnitude) of recruiting participants via mail and telephone, the completion-incentive payments, and the development of the website were significant. One of the purposes of the study, to measure actual behavior change as a result of risk communication messages provided experimentally via brochure, was deemed by the research team to be important enough to justify the costs. However, these methods may not be worth the time, effort, and money for research goals that do not require precise measurement of the number, species, and source of fish meals.

Internet access is generally available to most Americans; 84% have access in a 2015 Pew Research Poll (Perrin and Duggan, 2015). It was a limitation to only a few of our potential participants (2% of WCBA, 8% of urban anglers), but precluded participation by some older anglers, especially in the urban angler sample. Nevertheless, the final group of participants were older than other members of the original sample. The tendency of older people to be more likely to respond to survey requests (Lusk et al., 2007; Gigliotti and Dietsch, 2014) seems to have outweighed the tendency of web-based surveys to attract younger respondents (Kaplowitz et al., 2004; Sexton et al., 2011).

4.3. Conclusions

The web-based and mobile phone-enabled diary method allowed us to gather detailed measures of fish consumption over a sustained period of time. This method provided us with often difficult to obtain information about specific species, amounts, frequency and locations caught of fish consumed necessary to accurately assess adherence to fish consumption guidelines. Those who participated fully over the two year period were demographically similar to those who comprised the original sample (based on available measures). The primary limitations of this method are the large cost associated with recruitment and incentive payments, and the technological skill required for programming the web-based diary. Nevertheless, the use of web and smartphone technology combined with incentives and persistent communication, appears to have great potential for use to assess fish consumption in other areas of the country or for situations where the potential risks associated with fish consumption may be substantial and the cost of a detailed diary approach can be justified.

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SECTION 2: FISH CONSUMPTION AMONG WOMEN ANGLERS OF CHILDBEARING AGE IN THE GREAT LAKES REGION*

ABSTRACT: Fish consumption advisories are issued by the federal government for women of childbearing age (WCBA). These advisories make recommendations about the amount and types of fish that should be consumed to provide the greatest health benefits to women and their children while avoiding risks from chemical contaminants. We used diary methods to study fish consumption patterns of 1,395 WCBA in the Great Lakes coastal region who purchased fishing licenses, a group which has significant opportunity to eat larger quantities of fish. Very few members of this group reported exceeding the federal recommendations for total fish consumption (between 3% and 5% depending on assumptions about portion sizes), consumption of canned "white" tuna (0%), or consumption of "do not eat" species (4%). They did report eating more fish on average than recent national study estimates, but they did not report consuming as much fish as is recommended to obtain the greatest health benefits of fish consumption. Only 10 to 12% of study participants reported eating within the recommended range of 8 to 12 oz. of fish per week, with 84-87% eating less than the recommended amount. Additional efforts are likely needed to encourage WCBA to eat more low-risk fish, even among this group of higher-than-average fish consumers.

KEYWORDS: fish consumption; fish consumption guidelines; anglers; risk communication; women of childbearing age

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1. Introduction

Fish consumption advisories are issued by state, federal, and tribal agencies in part because of the potential health risks to women and their children from a variety of chemical contaminants (Turyk et al., 2012: Papadopoulou et al., 2014). These advisories recommend that women of childbearing age (WCBA) limit their consumption of certain fish. At the same time, many of these agencies recommend that women consume more low-risk fish, especially during and after pregnancy, emphasizing fish with lower concentrations of chemical contaminants, particularly mercury. Fish are the primary dietary source of omega-3 fatty acids, which are important for adult health (Domingo, 2014) as well as the development of eyes, brains, and nervous systems in the fetus (Innis, 2008).

Several agencies within the federal government offer advice to women. The United States Department of Agriculture (USDA) advises that "women who are pregnant or breastfeeding consume at least 8 and up to 12 ounces of a variety of seafood per week, from choices lower in methyl mercury" (USDA, 2010, p. 39). Current Environmental Protection Agency/Food and Drug Administration (EPA/FDA) advice suggests that WCBA "eat up to 12 ounces (2 average meals) a week of a variety of fish and shellfish that are lower in mercury" (USEPA, 2004, p.1). However, EPA/FDA are in the process of revising their recommendations to more closely follow the USDA advice. The draft advice proposed by the EPA/FDA suggests that WCBA "eat 8 to 12 ounces of a variety of fish each week" from choices that are lower in mercury (USFDA, 2014, p. 1). The key difference is a change from suggesting it is permissible for WCBA to eat *up to* 12 ounces to suggesting women *should* eat 8 to 12 ounces. This change encourages consumption.

Advice from all federal agencies suggests that WCBA limit their consumption of certain fish that are higher in mercury. The recommendation is to limit canned "white" tuna consumption to 6 oz. per week, and avoid consumption of four species of fish (swordfish, shark, tilefish, and king mackerel).

While all states offer advice about consumption of fish caught by anglers within state waters, some states also offer advice regarding purchased fish. This advice generally follows the federal recommendations but offers more details and suggestions about specific species to consume (e.g., MDHHS, n.d.). Some states provide more conservative advice than the federal government, particularly for the consumption of canned "white" tuna. For example, Minnesota and Wisconsin suggest one serving per month (MDH, n.d.; WDHS, 2008) compared to the federal advice of 6 oz. per week.

Several studies have found that most WCBA avoid consumption of the most contaminated fish (Lando et al., 2012; Silver et al., 2007), however they do not seem to be following the advice encouraging consumption of low-risk fish and therefore may be missing out on the benefits of fish consumption for themselves and their offspring. Connelly et al. (2014) found that almost all new mothers consume less fish during pregnancy than was recommended by USDA. Similarly, Lando et al. (2012) found in a national survey that on average, all major demographic groups of women, but especially pregnant women, ate less fish than was recommended. Among women who ate fish, the median intake was 1.8 oz/week for pregnant women, 2.5 oz/week for postpartum women, and 3.0 oz/week for WCBA who were not pregnant or postpartum. Each of these medians is far below the recommended 8 to 12 oz/week. Mahaffey et al. (2009) used National Health and Nutrition Examination Survey (NHANES) data from 1999-2004 to examine fish consumption patterns of WCBA (and their association with blood mercury levels). They found that WCBA in the Great Lakes coastal region ate less than 1 meal/week of fish on average, far below the recommended 2 meals/week. Based on more recent NHANES data (2009-2010), among those who ate fish nationwide, 60% ate less than 0.75 meals/week and 40% ate 0.75+ meals/week (EPA, 2013). A survey of Great Lakes states' residents found that among the 83% of women who ate fish, 6% consumed more than 2 meals per week, 14% consumed 1 to 2 meals/week, and the remaining 80% consumed less than 1 meal/week (Imm et al., 2005). None of these studies specifically examined the fish consumption patterns of women who fish, however. Women anglers likely have additional opportunities to consume fish, including potential exposure to additional chemical contaminants found in the fish they catch. Their consumption rates are likely to be higher than women who do not fish. Knobeloch et al. (2005) found that women who lived in a household where someone had a fishing license did eat more meals of sport-caught fish. Therefore, they may be more likely to get the benefits as well as be exposed to the risks of fish consumption.

We studied WCBA in the Great Lakes coastal region who purchased fishing licenses (and therefore have the opportunity to fish legally). Specifically, we recruited WCBA anglers who indicated that they consumed fish at least occasionally to participate in a diary study in which they reported their fish consumption behaviors. Because our objective was to describe the fish consumption habits of WCBA anglers living in this region, we did not include WCBA who did not eat fish. Among fish-consuming WCBA, this angler WCBA group may be likely to have higher levels of fish consumption than typical WCBA. Specifically, we examined how much and what types of fish they reported consuming and compared these levels with the USDA and (current and proposed) EPA/FDA recommendations.

2. Materials and methods

2.1 Sample selection and diary recruitment

We drew a sample of 15,000 fishing licenses sold to women aged 18 to 48 (who would reach a maximum age of 50 [considered the end of the childbearing years] at the end of our two-year study[2]) who lived in counties bordering the Great Lakes (i.e., Great Lakes coastal region). We drew the sample by state in proportion to the number of licenses sold in each state to WCBA who lived in the Great Lakes coastal region[3].

We sent invitation letters to each member of the sample in February 2014. The letter described the study and what would be required of participants. It also offered a financial incentive up to $20 for participation in the project, and provided a link to a sign-up page on the Internet. We provided a postage-paid return postcard for people to opt out of the study because they did not eat fish, did not have regular Internet access, or were not interested in participating. We sent a follow-up letter to all invitees a week later encouraging participation.

[2] We report only data from the first year of the study in this paper.

[3] Appendix B provides information on results from a special sample of Minnesota WCBA who were recruited as part of another research project and not included in the results of the main body of this report.

We made telephone calls to those who did not sign-up or return a postcard to encourage participation and allow sign-up directly over the telephone. Calling ceased in a particular state when the quota of participants had been reached for that state. During the study sign-up process we obtained email addresses and then checked them by sending out a study participation verification email. Email was then used for all communication with study participants.

2.2 Diary data collection

We collected fish consumption information for 16 weeks from May 18 through September 6, 2014. Participants recorded data in two-week blocks. Participants could record information as many times as they wished during the two-week period. Every two weeks we sent an email invitation to participants to signal the start of the next two-week period and remind them that the previous two week-period was ending. When a two-week period ended, we sent up to three reminders to participants who had not completed entering data for the period to finish recording their information for the period. Participants earned financial incentives for each period completed and received a bonus at the end if they completed reporting for every period.

We gave each participant a link unique to them to access their personal fish consumption diary on the Internet. On the initial page, participants saw information for the eight two-week periods of the study, showing completed periods and incentives earned. On the next page we asked participants to record whether or not they ate fish on each day in the current two-week period. For each day they indicated they ate fish, another page opened asking the number of fish meals they had eaten on that day. For each meal reported, participants recorded whether the fish was purchased (at a store or restaurant) or sport-caught (i.e., fish caught by you or someone else), the species eaten, the portion size, and (for sport-caught fish) where the fish was caught. We provided a list of fish species, including the most commonly consumed purchased fish and those with consumption guideline recommendations, along with a text box to record species not on the list. For sport-caught species, we listed only those with consumption guideline recommendations and provided an "other" option. Participants indicated portion size in reference to a picture of a 6 oz. cooked (170 grams) portion of salmon (Fig. 1); we asked participants if the meal they ate was larger, smaller, or the same size as the picture.

We obtained data on participant age from fishing license records. We gathered data on other socio-demographic characteristics, such as education and race, using an online survey conducted during the last 2-week period of diary data collection[4].

2.3 Data analysis

Several previous studies have estimated the size of fish portions that people consume using pictures similar to those used in our study (Connelly et al., 1996; West et al., 1989) or plastic models (Silver et al., 2007). Since we provided a picture of a 6 oz. cooked salmon meal, we assumed those indicating an equivalent portion to the photo ate a 6 oz. portion (170 grams). For 14% of meals, the participants indicated their portion size was larger than the picture; we assumed they ate 8 oz. (227 grams). For meals reported as being smaller than the picture (47% of meals), we used a sensitivity analysis to compare two options for calculating portion size. For one option, we estimated the smaller portion size to be 3 oz. (85 grams) and for the other we

[4] We did not ask if they fished during the study period.

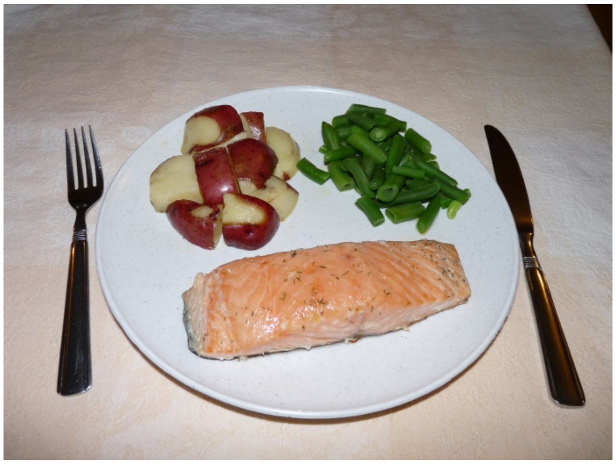

Fig. 1. Picture shows a 6 oz. piece of cooked salmon (8 oz. pre-cooked).

assumed the size to be 4 oz. (113 grams). We used these estimates to convert from the number and size of meals to an estimate of ounces and grams consumed per week or per day.

We analyzed data from the diary using SPSS (IBM SPSS Statistics 20). We used chi-square tests to identify statistically significant differences between states at the $P < 0.05$ level. Any differences described in the narrative text are statistically significant at this level. We used Scheffe's test to identify differences in portion sizes based on species of fish consumed. We used linear regression to explain differences in fish consumption based on available demographic data.

We report state-specific data unweighted so these values reflect the number of WCBA who participated from that state. We weighted all other reported data in proportion to the number of fishing licenses sold to WCBA in the Great Lakes coastal region of each state. Weighting factors ranged from 0.85 to 1.17.

3. Results

3.1 Diary recruitment and participation rates

We recruited 2,014 WCBA to participate in the study. Women who agreed to participate were slightly older (35.5) than other women in the sample pool (33.7, $p<0.001$). Participation in the first two-week period was 80%. The number who participated throughout the 16-week study period was 1,419 (70%). WCBA were selected to participate in this study because they indicated that they ate fish at least occasionally. However, a few participants (n=24) reported that they did not consume any fish during the 16-week study period and were thus excluded from the analysis. We found no differences in fish consumption between those who participated fully and those who participated during only part of the study period for the periods when the two groups overlapped. Women of childbearing age who participated the entire 16 weeks were slightly younger than those who did not (35.7 vs. 36.9, $p=0.042$). Since these differences were substantively small, we considered WCBA who participated throughout the 16-week period as similar to all women who participated in the study and report results for the 16-week group only (n=1,395).

By design, women in our study ranged in age from 18 to 48. The average participant was 36 years old. Most were white (95%) and half (52%) reported they had a college degree. The median household income was in the $50,000 to $75,000 range. Eleven percent reported earning less than $25,000 per year, and 7% reported earning more than $150,000. Half of the participants (51%) reported having children 15 years of age or younger living in their household.[5]

3.2 Fish consumption

3.2.1 Types of fish eaten

Participants consumed over 20,000 meals during the 16-week study period, of which the vast majority (82%) were purchased fish (i.e., fish purchased at a store or restaurant). The proportion of meals from sport-caught fish (i.e., caught by the WCBA angler or someone they know) varied by state, with the lowest proportion of sport-caught meals consumed in Illinois and the highest proportion consumed in Minnesota (Fig. 2).

WCBA consumed a variety of purchased fish and shellfish (Table 1)[6]. Most of the more frequently eaten species, such as shellfish and salmon, are considered to have low mercury levels. (We defined "low mercury level" as <0.05ppm, which is equivalent to the unrestricted category in the Great Lakes protocol [McCann et al., 2007]. Mercury concentrations in fish were taken from the FDA list of commercial fish and shellfish [FDA, 2014]). Species low in mercury, highlighted in bold type in Table 1, comprise roughly two-thirds of meals consumed. Shellfish (e.g., shrimp, crab, scallops, and clams) alone comprise about one-third of purchased meals consumed. Shellfish consumption was particularly common among New York and Ohio WCBA (35% of meals) but less so among Minnesota WCBA (26%). Salmon, canned "light" tuna, canned "white" tuna, and cod were among the other most frequently consumed fish. Canned tuna, both varieties, was particularly common in Minnesota ("light" 18% and "white" 11% of meals). Canned "white" tuna was also somewhat common in Indiana (11%), but less so in Ohio (5%). Cod made-up a greater proportion of meals in Wisconsin (15%) than in the other states. Haddock, while not commonly eaten in most states, was most frequently eaten in New York (12% of purchased meals consumed).

The average portion size varied considerably by type of fish (Table 1). Canned tuna, both varieties, were the smallest in average portion size. Fish sticks/fast food sandwiches, shellfish, and tuna (not canned) portions were slightly larger. Salmon, the most commonly consumed single species, was intermediate among the types of fish examined, but average portion size was still smaller than the 6 oz. picture shown to participants. Women reported eating sport-caught fish and purchased haddock, perch, and catfish in significantly larger portions, averaging close in portion size to the picture shown.

[5] At the end of the study, we asked about pregnancy and breastfeeding status during the study period. Only 53 of the 913 respondents to the question indicated they were pregnant or breastfeeding during the period. We concluded the sample size was too small to assess how pregnancy and breastfeeding influenced fish consumption.

[6] Appendix C characterizes the number of types of purchased fish that individuals consume.

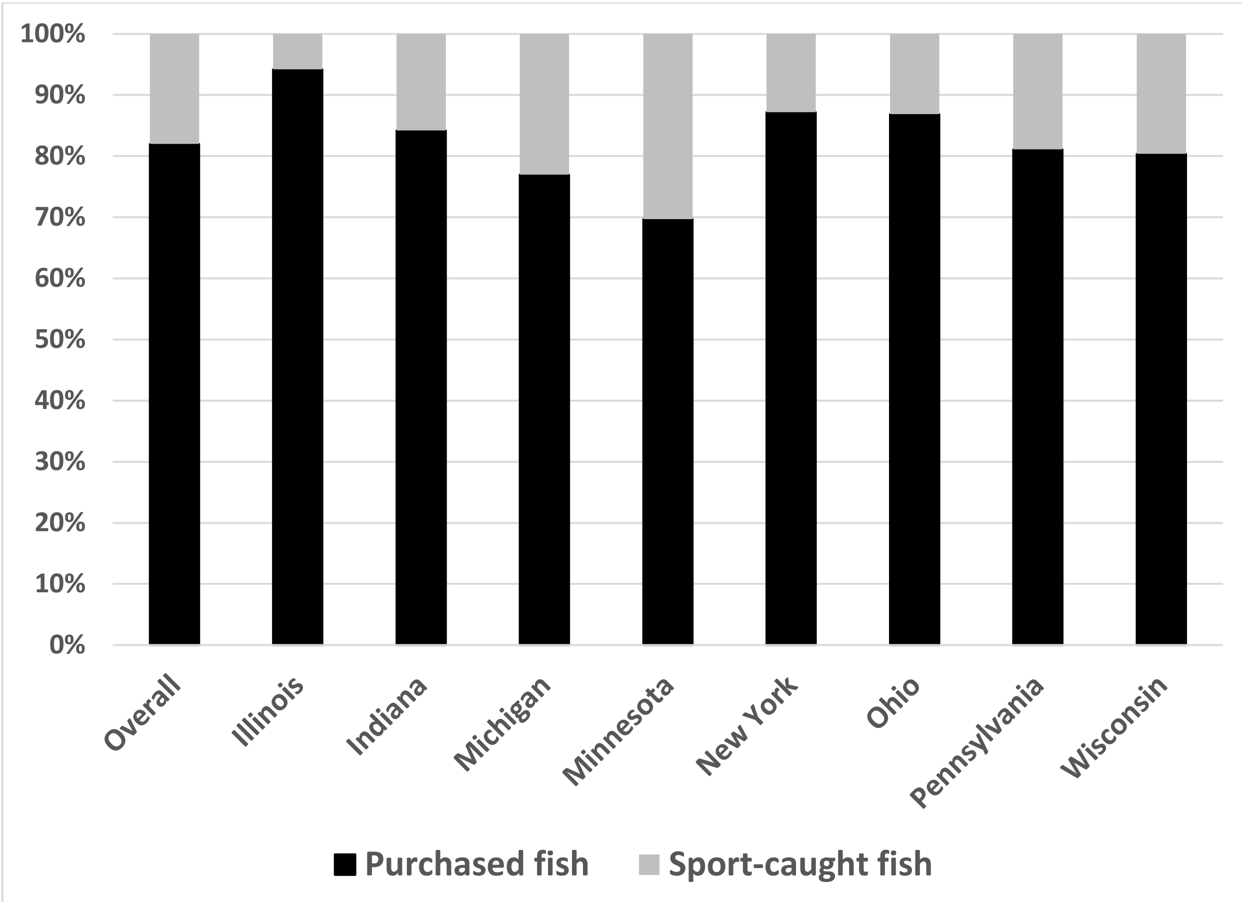

Fig. 2. Percentage of meals that were purchased versus sport-caught, overall and by state (Statistically significant difference between states at $p \leq 0.05$ using chi-square test).

3.2.2 Amount of fish eaten

The number of meals reported eaten during the 16-week period ranged from 1 to 92. The median was 12 meals or 0.75 meals/week. The average was 0.93 meals/week and did not differ by state of residence. A regression model using available demographic data showed that consumption increased as age and education level increased (adj. $R^2 = 0.041$, Table 2). Consumption was also higher among non-white WCBA and those without children age 15 or younger living in the household. Using the model coefficients to predict levels of consumption among the demographic groups reporting the highest fish consumption, the model predicts that older, highly educated, non-white women without children living at home averaged 1.5 fish meals/week.

Table 1
Percent of purchased meals and portion sizes for all meals by type of fish eaten (bolded species are considered low in mercury).

Type of Fish Eaten	% of purchased meals	Portion Size (Grams) based on* 3, 6, 8 oz. (85,170,227 grams)	4, 6, 8 oz. (113,170,227 grams)
Shellfish	30.4	131[c,d,e]	146[c,d]
Salmon	13.6	138[d,e,f]	150[d,e]
Canned "light" tuna	9.7	103[a]	125[a]
Cod	7.8	155[g,h,i]	156[f,g,h]
Canned "white" tuna	7.6	109[a,b]	129[a,b]
Tilapia	5.5	144[e,f,g]	154[d,e,f]
Fish sticks/fast food sandwiches	3.9	121[b,c]	138[b,c]
Haddock	3.1	163[i]	171[h]
Tuna (not canned)	2.7	130[c,d]	144[c,d]
Catfish (farm-raised)	1.4	161[i]	169[h]
Perch (purchased)	1.0	160[i]	168[h]
Other types of purchased fish	13.3	145[f,g,h]	163[e,f,g]
Sport-caught	N/A	157[h,i]	166[g,h]

* Used two options for calculating portion size if the participant indicated the meal was smaller than the 6 oz. portion pictured. Assumed 8 oz. if they indicated the meal size was larger.
[a-h] Values without a letter in common are significantly different from each other at p = 0.05 using Scheffe's test.

When portion size was factored in, WCBA anglers in the Great Lakes region reported consuming on average between 18.3 (using a more conservative assumption) and 20.1 (using a more liberal assumption) grams per day (g/day). As with the number of meals, the average grams per day consumed did not differ by state of residence. However, individual daily fish consumption varied considerably, with half of the WCBA eating 15.2 to 17.2 g/day or less (Table 3). Ten percent of WCBA consumed more than 35.4-38.4 g/day, almost double the average daily consumption; 1% consumed more than 67.8-73.3 g/day.

Table 2
Demographic predictors of fish consumption (meals/week).

Variable	Coefficient	*p*-value
Intercept	0.81	<0.001
Race[a]	- 0.29	<0.001
Age	0.01	<0.001
Child age 15 or younger in household[b]	- 0.21	<0.001
Education[c]	0.03	0.026

[a]Dummy variable (1=white, 0=non-white).
[b]Dummy variable (1=child age 15 or younger living in the household, 0= no child age 15 or younger in household)
[c]Education level was measured on a 6-point scale from 1=less than high school to 6=graduate degree. Income was also a significant predictor, but dramatically reduced the sample size if included in the model. It was highly correlated with education (0.31).

Table 3
Individual average daily fish consumption for WCBA who were at each consumption percentile.

Percentile of Women of Childbearing Age (WCBA)	Grams per day based on portion sizes of*	
	3, 6, 8 oz. (85,170,227 grams)	4, 6, 8 oz. (113,170,227 grams)
25%	8.9	10.1
50%	15.2	17.2
75%	24.0	26.3
80%	27.1	29.9
90%	35.4	38.4
95%	42.3	46.0
99%	67.8	73.3

* Used two options for calculating portion size if the participant indicated the meal was smaller than the 6 oz. portion pictured. Assumed 8 oz. if they indicated the meal size was larger.

Fish consumption patterns of those eating the most fish differed little from those eating fewer meals. Those eating the most fish (top 10%) did not eat more fish that the federal government recommends against eating than those who ate fewer fish meals. They consumed slightly more meals from species low in mercury than those who ate fewer fish meals (56% versus 50% of fish meals), and somewhat fewer sport-caught fish (16% versus 19% of fish meals)[7].

3.2.3 Adherence to federal guidelines

EPA/FDA guidelines recommend that WCBA eat up to 12oz. of a variety of fish and shellfish each week. Assuming 6 oz. is a standard meal size, this recommendation is for up to two meals per week. Few women in our study reported consumption levels exceeding the recommendation by any of the metrics we used (Table 4). Five percent reported consumption levels exceeding the recommendation based on the number of meals consumed. Three to four percent exceeded the recommendation based on portion size.

The federal guidelines also recommend that WCBA eat no more than 6 oz. of canned "white" tuna per week. Although 29% of women in our study ate canned "white" tuna during the study period, none reported consuming more than the recommended amount. Consumption varied somewhat by state of residence, with Minnesota women who ate canned "white" tuna consuming twice as much per week as New York women (1.7 versus 0.7 oz. per week).

Table 4

Percent of WCBA in each meal category using three measures of fish consumption.

	Measures of fish consumption		
Meals (oz.)/week	# of meals	3, 6, 8 oz portion size	4, 6, 8 oz portion size
0.5 (3oz.) or less	29.3	38.9	33.6
0.51 (>3oz.) to 1.0 (6oz.)	36.6	36.5	38.0
1.01 (>6 oz.) to 1.5 (9oz.)	18.9	15.5	17.0
1.51 (>9oz.) to 2.0 (12oz.)	10.0	6.0	7.7
2.01 (>12oz.) to 2.5 (15oz.)	2.4	1.8	1.9
2.51 (>15oz.) or more	2.8	1.3	1.8

Very few WCBA in our study (4%) ate fish that the federal government recommends against (i.e., swordfish, shark, tilefish, king mackerel). Swordfish was the most commonly consumed "do not eat" fish, followed by shark. Only one participant reported eating tilefish, and none reported consuming king mackerel. Among women who ate these fish, 78% reported eating only one meal of the "do not eat" fish during the 16-week study period.

Federal and state advisories also discuss the benefits of fish consumption. Current EPA/FDA guidelines suggest women eat up to two meals of fish lower in mercury per week to receive the benefits. While at least two-thirds of the fish consumed are species considered low in mercury, Table 4 shows that most WCBA did not consume the recommended amount of fish (i.e., 2 meals per week). The vast majority of women ate less than 1.5 meals per week (85%), and most ate less than 1 meal per week (66%). Only 12% reported eating in the range of 2 meals per week (1.5-2.5

[7] Appendix D profiles the top 10% of fish consumers in more detail.

meals). The USDA and the proposed EPA/FDA guidelines suggest that WCBA consume between 8 to 12 oz. of fish per week. Only 10-12% of our study participants reported eating fish within that range.

4. Discussion and Conclusions

Our findings suggest several implications for communicating with WCBA about fish consumption to gain desirable health benefits while guarding against health risks from chemical contaminants in fish. Messages about the healthiest fish to consume should be tailored to locally popular fish, whether sport-caught or purchased. Species of purchased fish consumed by WCBA varied significantly, even within the eight-state region of the Great Lakes. Species like canned tuna made up a greater proportions of the meals consumed by women in Minnesota, whereas shellfish and haddock were more frequently consumed in New York.

Messages in fish consumption advisories should emphasize the health benefits and importance of fish consumption, encouraging consumption of low-contaminant species. Even though there was variation in species consumed within the Great Lakes region, the total amount of fish consumed did not vary. Average consumption was consistent at 0.93 meals/week across the region, much lower than federal advice for desired consumption. Some demographic sub-groups (older, more educated, non-White WCBA without children age 15 or younger living in the household) reported consuming more fish, patterns consistent with findings from previous research (e.g., EPA, 2013; Knobeloch et al., 2005; Lando et al., 2012; Traynor et al., 2013). Even among these sub-groups, however, our model estimated an average of 1.5 meals/week, a rate of fish consumption which is still lower than federal advice.

Although state fish consumption guidelines are often focused strongly on sport-caught fish from within-state, recommendations should be included regarding purchased fish, focusing on the health benefits of eating fish while affirming advice about species to avoid or limit. Among WCBA in our study, most of the fish consumed were purchased fish, not sport-caught fish. Several states do currently offer advice for purchased fish, and in some cases the advice is more detailed than the federal advice, including recommendations for fish with moderate mercury levels (e.g., MDH, n.d.).

Very few members of this audience exceeded the federal recommendations for consumption of canned "white" tuna (0%), or consumption of "do not eat" species (4%), similar to the findings of Lando et al. (2012) in a national study, and Silver et al. (2007) in a study of low income WCBA in the California Sacramento-San Joaquin Delta. We also found very few WCBA exceeding the recommended limit for total fish consumption (3-5%), similar to Lando et al. (2012). These findings suggest that at the broad population level there does not appear to be a need for greater attention to risk messages beyond reinforcing the guidance that already exists.

Messages about purchased and sport-caught fish should focus on eating a certain amount of fish to obtain the benefits from fish consumption for WCBA and their potential offspring. Very few women (10-12%) in our study were eating the recommended amount of fish averaged over the 16-week study period, with 84-87% eating less than the recommended amount. Mahaffey et al. (2009) came to a similar conclusion studying WCBA who lived in the same geographic area as our sample, but who did not necessarily fish. They found using data from the NHANES study that WCBA ate on average less than 1 meal/week of fish. Using more recent NHANES data (2009-2010), the EPA (2013) reported that among those who ate fish, 60% of WCBA nationally ate less than 0.75 meals/week.

WCBA living in the Great Lakes region who were anglers were consuming more fish on average than national estimates for WCBA in the summer months when sport-caught fish consumption would be expected to be highest due to favorable conditions for fishing and increased recreational opportunities. The EPA (2013) reported average consumption for those who ate fish was 12.8 g/day, calculated from 2009-2010 data presented in the report, compared with our estimate of 18-20 g/day. However, this was still not enough fish for women to obtain all the health benefits for themselves and their potential offspring.

Enhanced outreach efforts appear to be necessary to focus on encouraging more WCBA to eat more low-risk fish. Other researchers have suggested this as well (Bloomingdale et al., 2010; Lando et al., 2012; MDH, 2012; Teisl et al., 2011). We recommend focusing future research on measuring actual behavior change among women of childbearing age exposed to different messages that encourage consumption of low-risk fish. WCBA are not eating enough fish to maximize the potential for health benefits, even among this group of anglers who may have the greatest opportunity and inclination to eat larger quantities of fish.

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SECTION 3: ARE WOMEN ANGLERS OF CHILDBEARING AGE IN THE GREAT LAKES REGION FOLLOWING FISH CONSUMPTION GUIDELINES?

ABSTRACT: States in the Great Lakes region of the United States issue fish consumption guidelines for women of childbearing age (WCBA) to help them minimize the health risks to themselves and their potential offspring from eating fish contaminated with chemicals. We used diary methods to study 1,395 WCBA who purchased fishing licenses in the Great Lakes coastal region to determine if they were aware of the guidelines and following them. We found that two-thirds of WCBA reported at least minimal awareness of the fish consumption guidelines, and those that reported awareness were more likely to hold beliefs consistent with the messages emphasized in the guidelines. WCBA reported eating less than one meal/week of fish with most of this fish purchased at a store or restaurant. On average, they consumed just 2.4 sport-caught fish meals over the 16-week study period. The average portion size for sport-caught fish meals eaten by WCBA was similar to that assumed by states when determining the guidelines. However, one-quarter of WCBA in the overall sample exceeded the guidelines, with rates as high as 41% exceeding the guidelines in Michigan and Minnesota. Additional outreach efforts may be needed to increase compliance with fish consumption guidelines, particularly among subpopulations that exceed the guidelines more frequently.

KEYWORDS: anglers; fish consumption; fish consumption guidelines; Great Lakes; risk communication; women of childbearing age.

1. Introduction

Eating fish contaminated with chemicals like mercury and polychlorinated biphenyls (PCBs), poses health risks to women and their potential offspring (Jacobson and Woodson, 1993; Lonky et al., 1996). These risks may include carcinogenesis and developmental, reproductive, behavioral, metabolic, or neurological impairment (e.g., Counter and Buchanan, 2004; Davidson et al., 2004; Humphrey, 1988; Kreiss, 1985). Some of the chemicals of greatest concern in the Great Lakes region include methylmercury, PCBs, dioxin, and mirex. For example, a study in the late 1990s found that women who ate salmonines from Lake Ontario had higher concentrations of mirex in their breast milk than women who ate Lake Ontario panfish or did not eat Lake Ontario fish at all (Madden and Makarewicz, 1996).

As a result of these concerns about chemical contaminants, U.S. states have issued fish consumption guidelines for several decades. Most states target women of childbearing age (WCBA) and children 15 or younger with the most restrictive guidelines because of the concerns described above. Guidelines for WCBA in the Great Lakes region range from do-not-eat recommendations for species such as large carp or lake trout (Pennsylvania Department of Environmental Protection, 2016) to very liberal guidelines (one or two times per week) for species such as sunfish or yellow perch, which are low in contaminants and can provide health benefits if consumed (Minnesota Department of Health, n.d.).

Past research has shown that most anglers are generally aware of the fish consumption guidelines in their state (Connelly et al., 1993; Imm et al, 2005; Katner et al., 2011; Kearney and Cole, 2003). For example, Connelly et al. (2012) found that over 90% of anglers living in the Great Lakes region were aware of sport-caught fish advisories. However, certain segments of the angler community (e.g., younger, non-white) were less likely to be aware (Katner et al. 2011).

Awareness of the advice for sport-caught and purchased fish among WCBA may be more variable, and in some cases lower, than awareness among anglers in general. Imm et al. (2005) found that while 65% of male Great Lakes anglers were aware of the advice for fish caught in the Great Lakes, only 30% of women were aware. Gliori et al. (2006) conducted a study of Wisconsin women who recently gave birth and found that 65% of those who ate sport-caught fish had some awareness of the Wisconsin advisory. However, only 3% said they knew a lot about the advisory. Connelly et al. (2014) found that two-thirds of new mothers surveyed in Minnesota, Wisconsin, and Pennsylvania who fished or had a household member that fished reported receiving information about the types of fish and how much fish to eat. Specifically for mercury, Lando et al. (2012) found that 73% of pregnant and 74% of postpartum women aware that mercury was a problem, while Knobeloch et al. (2005) said few (20%) WCBA were aware that states issue guidelines about mercury consumption.

Several studies show that most anglers believe they are following the guidelines of their state (Imm et al., 2005; Kearney and Cole, 2003). However, other studies show that they may be mistaken. In a 1992 survey of Lake Ontario anglers, 36% consumed fish in excess of the fish consumption limits recommended for Lake Ontario, and of that group, 90% said they believed their consumption was within the recommended limit (Connelly et al., 1996); this study focused on anglers in general, not WCBA specifically. Very little is known about the adherence of

WCBA to the sport-fish guidelines specific to them. Silver et al. (2007) suggest that this may be because local advisories vary a great deal, and consequently, determining if they are being followed is a major challenge to researchers.

To address this gap, we conducted a study of women anglers of childbearing age living near the Great Lakes to determine if they were aware of fish consumption guidelines, where they reported getting their information, and if they followed the guidelines. We also explored whether notable socio-demographic groups within WCBA were more or less likely to exceed the guidelines.

2. Methods

We used a web-based diary method, described in detail in Connelly et al. (2016), to gather fish consumption data from WCBA who had fishing licenses and lived in U.S. counties bordering the Great Lakes. We collected fish consumption information for 16 weeks from May 18 through September 6, 2014. Participants recorded data in two-week blocks. For each meal reported, participants recorded whether the fish was purchased (at a store or restaurant) or sport-caught (i.e., fish caught by you or someone else), the species eaten, the portion size, and (for sport-caught fish) where the fish was caught. We provided a list of fish species, including the most commonly consumed purchased fish and those with consumption guideline recommendations, along with a text box to record purchased fish species not on the list. For sport-caught species, we listed only those with consumption guideline recommendations and provided an “other” option. Participants indicated portion size in reference to a picture of an 8 oz. uncooked (6 oz. cooked) portion of salmon (Fig. 1); we asked participants if the meal they ate was larger, smaller, or the same size as the picture.

We obtained data on participant age from fishing license records. We gathered data on awareness of fish consumption guidelines, sources of information, beliefs about fish consumption, pregnancy and breastfeeding status during the study period, and other socio-demographic characteristics, such as education, income and race, using online surveys conducted at the end of diary data collection.

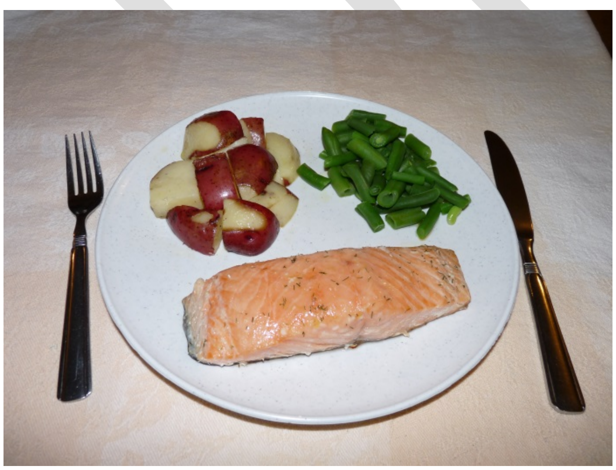

Fig. 1. Picture shows an 8 oz. uncooked (6 oz. cooked) portion of salmon.

We analyzed data from the diary using SPSS (IBM SPSS Statistics 24). We used chi-square tests to identify statistically significant differences between subgroups at the $P < 0.05$ level. Any differences described in the narrative text are statistically significant at this level.

We compared the meals eaten by each participant to the guidelines of the state where they lived. We characterized participants as adhering to the guidelines if they kept their total consumption for the 4-month study period within the recommendations for that time period. For example, if the recommendation was to consume no more than one serving of coho salmon per month from Lake Michigan, and a person consumed five servings of coho salmon during the 4-month study period, we concluded that she had exceeded the guidelines. We measured fish consumption against the guidelines for the Great Lakes (including bays, tributaries, and connecting waters as defined by each state), the statewide guidelines for all other sport-caught fish, and the state guidelines (or federal guidelines if no state guidelines existed) for purchased fish. If an individual exceeded any of these guidelines, we concluded that she exceeded the guidelines.

We present some results as ranges (based on liberal and conservative assumptions) because some advice is based on the length of the fish caught; if consumers did not know the length of the fish they ate, we estimated their adherence to the guidelines assuming both the most and least restrictive consumption recommendations for that species. Similarly, a few consumers did not know the species of fish they were eating, or more commonly, reported eating multiple species at one meal. In these cases, we estimated their adherence to the guidelines assuming both the most and least restrictive consumption recommendations for the water where the fish was caught.

We report state-specific data unweighted; we weighted all other reported data (aggregated across states) in proportion to the number of fishing licenses sold to WCBA in the counties bordering the Great Lakes in each state. Weighting factors ranged from 0.85 to 1.17.

3. Results and Discussion

3.1 Diary recruitment and participation rates

We recruited 2,014 WCBA licensed anglers to participate in the study. Women who agreed to participate were slightly older (35.5) than other women in the sample pool (33.7, $p<0.001$). Eighty percent of WCBA participated in the first two-week period, while 1,419 (70%) participated throughout the 16-week study period. WCBA who indicated in the recruitment process that they never ate fish were ineligible for the study; however, a few eligible participants (n=24) reported that they did not consume any fish during the 16-week study period and were thus excluded from the analysis. There were no differences in fish consumption between those who participated fully and those who participated during only part of the study period for the periods when the two groups overlapped. WCBA who participated the entire 16 weeks were slightly younger than those who did not (35.7 vs. 36.9, $p=0.042$). Since there was no difference in fish consumption and the difference in age was small, we considered WCBA who participated throughout the 16-week period as similar to all women who participated in the study and report results for the 16-week group only (final analytic sample n=1,395)[8].

By design, women in our study ranged in age from 18 to 48. The average participant was 36 years old. Most were white (95%) and half (52%) reported they had a college degree. The median household income was in the $50,000 to $75,000 range. Eleven percent reported earning less than $25,000 per year, and 7% reported earning more than $150,000. Half of the participants (51%) reported having children 15 years of age or younger living in their household. Only 6% reported being pregnant or breastfeeding during the 16-week study period.

3.2 Awareness of fish consumption guidelines

Two-thirds of WCBA (66%) indicated they had heard about government agencies providing guidelines recommending how much of certain kinds of fish you should or should not eat. Older WCBA were more likely to have heard of these guidelines (70% of those aged 30+ vs. 55% of those aged 29 or less) as were those without children 15 or younger living with them (69% vs. 62% with children). WCBA were more likely to be aware of the guidelines for sport-caught fish compared with purchased fish (54% vs. 36%). Nevertheless, very few women reported they were aware of the *specific* guidelines for either sport-caught (8%) or purchased fish (2%). These findings regarding the level of awareness among all WCBA and older WCBA are similar to other studies of WCBA over more than a decade (Anderson et al., 2004; Connelly et al., 2014; Gliori et al., 2006).

WCBA reported the fishing regulations guide most frequently as a source of fish consumption guideline information (Table 1). It was considered very useful by almost half (45%) of its readers. No other source was used by more than 20% of WCBA. One-third of WCBA who accessed posted warnings, healthcare providers, websites, and sportsman's shows/outdoor expos considered them very useful. Sixteen percent of women used health information brochures (often available in healthcare settings) as a source of information, 28% of whom found them to be very useful.

WCBA who were aware of the guidelines were more likely to hold several beliefs that are often emphasized in guideline communication (Table 2). For example, state guidelines often emphasize that the benefits of fish consumption outweigh the risks if women eat fish low in mercury and other contaminants. WCBA who were aware of the guidelines were more likely to agree with this statement than those not aware. Similarly, WCBA who were aware of the guidelines were more likely than those who were unaware to: (a) agree that children and unborn babies' health can be harmed more from chemical contaminants in fish than an adult's health, and (b) disagree that health problems related to eating contaminated fish are largely short-term. Exposure to the guidelines thus appears to be associated with a variety of beliefs that accurately reflect facts and key messages about fish consumption.

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[8] Appendix E provides detailed information by state or state groupings for all questions asked of WCBA in the surveys conducted at the end of Year 1 and Year 2. These include questions about socio-demographic characteristics, awareness of fish consumption guidelines, sources of information, beliefs about fish consumption, perceived changes in fish consumption behavior between Year 1 and Year 2, and awareness of the brochure sent between study years.

Table 1
Information sources where WCBA saw fish consumption guidelines and their perceived usefulness.

	Percent	
Information sources	Seen	Source rated as very useful
Fishing regulations guide	31.0	45.4
Friends or family	19.9	26.5
Websites	19.8	34.9
Health information brochures	15.9	27.7
Newspaper articles	14.7	19.5
TV or radio	14.0	21.4
Posted warnings at fishing locations	13.3	55.4
Healthcare providers	10.8	36.2
Sportsman's shows or outdoor expos	3.8	31.5
iPhone/Smartphone apps	2.9	17.3

Table 2
Percent agreeing (or disagreeing) with beliefs emphasized in guidelines by awareness of the government guidelines.

	Percent agreeing	
Beliefs	Aware of government guidelines	Not aware of government guidelines
Benefits outweigh risks if women eat fish low in mercury and other contaminants*	50.3	40.8
Children's health can be harmed more than adults' health by chemical contaminants in fish*	64.1	47.4
An unborn baby's health can be harmed more than its mother's health by chemical contaminants in the fish that the mother eats*	71.3	55.1
	Percent disagreeing	
Any health problems from eating fish contaminated with chemicals are mainly short-term*	62.5	42.6

*Statistically significant difference between those aware and not aware at p = 0.05 using chi-square test.

3.3 Fish consumption

Participants consumed an average of 14.7 fish meals over the 16-week study period (just less than 1 meal/week)[9], which is more than the average for all WCBA including non-anglers living in the area (Mahaffey et al., 2009). The majority of fish meals were purchased at a store or restaurant (mean of 12.3 meals over 16 weeks). Almost half of study participants (47%), all of whom had purchased a fishing license and lived near the Great Lakes, did not eat any sport-caught fish (i.e., fish caught by the WCBA angler or someone they know) during the study period. The average WCBA in the sample consumed 2.4 sport-caught meals over the 16-week period.

Almost half (45%) of sport-caught fish meals eaten were similar in size to the picture shown in the diary (Fig. 1). The picture represents an 8 oz. uncooked (6 oz. cooked) portion which reflects a common size assumption used by the Great Lakes states when determining recommendations for fish consumption, that a 150 lb. person eats an 8 oz. fish meal. Almost one-third of meals (31%) eaten by WCBA were smaller than the picture, suggesting that WCBA who ate this size meal may have been exposed to less contaminants than assumed in the guidelines, depending on WCBA body size. However, 24% of meals were larger than the assumed size, suggesting increased potential for exposure, depending on WCBA body size. With the average meal size reported consumed by WCBA approximately equal to the assumed meal size used by states to calculate exposure levels, this study provides state agencies with some confirmation of the validity of their assumption, recognizing some WCBA eat above and some below this average.

Fish consumption guidelines are provided by states for most species eaten by WCBA. The species mentioned in fish consumption guidelines accounted for 86% of fish meals.

3.4 Adherence to state guidelines

We chose the time of year for our study when the most sport-caught fish are eaten, based on past research (Connelly et al., 1996; Murkin et al., 2003). Therefore, the percent exceeding the guidelines is likely greatest during this period, so our results may provide a measure of the maximum percent likely exceeding the guidelines throughout the year.

We found 25-28%[10] of women anglers of childbearing age living near the Great Lakes exceeded their state's guidelines in the summer of 2014[11]. The percent of WCBA exceeding the guidelines varied considerably by state (Table 3)[12]. Michigan and Minnesota had the greatest percentages exceeding the guidelines (34-41%); Illinois and Ohio the least (12-13%). These rates are similar to those found in a 1992 survey of Lake Ontario anglers (mostly men), which reported 36% of

[9] Most WCBA (76%) ate their fish meals distributed over the 16-week study period, with no single period comprising 25% or more of their total consumption. Twenty-four percent ate 25% or more of their meals within a two-week period. These WCBA might represent a group who ate most of their fish while on vacation, thus concentrating their exposure to potential contaminants within a short period of time.
[10] The range in the percentage exceeding the guidelines is due to the assumptions (liberal versus conservative) made about meals when it was not clear what guidelines should be followed because of lack of specific information regarding fish size or species (discussed in detail in the Methods section).
[11] Appendix D profiles WCBA who exceeded the guidelines.
[12] Appendix F identifies the types of fish most likely to cause exceedance.

anglers consumed fish in excess of the fish consumption recommendations (Connelly et al., 1996). It appears fish consumption in excess of recommended guidelines continues to occur.

Older WCBA and those without children 15 or younger living in their household were more likely to exceed their state's guidelines (Table 4), even though these same subpopulations were more likely to be aware of consumption guidelines. Although few women indicated they were pregnant or breastfeeding during the summer of 2014, the women who were pregnant or breastfeeding were less likely to exceed their state's guidelines than women who were not. Pregnant and breastfeeding women are considered to be the potentially most at-risk group within WCBA due risk of exposure for the fetus or infant, so greater compliance with state guidelines among this group is particularly noteworthy. Race (white, non-white), education level, and income were not significantly related to adherence to the guidelines.

Of particular interest to us was the subpopulation of women anglers of childbearing age who were exceeding the guidelines associated with Great Lakes fish, as these women lived close to the Great Lakes and were therefore most likely to report consuming Great Lakes fish. We found 12-14% of WCBA exceeded the guidelines associated with Great Lakes fish. The range was from 0% to 26%, depending on the state (Table 5).

Table 3
Percent of women anglers of childbearing age who exceed their state fish consumption guidelines*, by state and region.

	Percent	
State	Exceed state guidelines (liberal assumptions)**	Exceed state guidelines (conservative assumptions)**
Illinois	13.2	13.2
Indiana	24.5	28.6
Michigan	34.4	41.5
Minnesota	34.8	40.6
New York	29.2	29.2
Ohio	12.0	12.7
Pennsylvania	34.8	34.8
Wisconsin	18.4	19.0
Great Lakes Region	**25.3**	**28.2**

*When the species or length of fish caught was unknown, adherence to the guidelines was calculated assuming both the most and least restrictive consumption recommendations.
**Statistically significant difference between states at p = 0.05 using chi-square test.

Table 4
Percent of women anglers of childbearing age who exceed their state fish consumption guidelines* by significant socio-demographic characteristics.

	Percent	
Socio-demographic characteristics	Exceed state guidelines (liberal assumptions)	Exceed state guidelines (conservative assumptions)
Age		
18-29	20.6**	24.0
30-39	28.3	31.1
40-49	26.0	28.7
Children aged 15 or younger living in the household		
No	29.1**	32.4**
Yes	22.6	25.4
Pregnant or breastfeeding during study period		
No	26.2**	29.0**
Yes	11.5	13.5

*When the species or length of fish caught was unknown, adherence to the guidelines was calculated assuming both the most and least restrictive consumption recommendations.
**Statistically significant difference between socio-demographic subgroups at p = 0.05 using chi-square test.

Table 5
Percent of women anglers of childbearing age who exceed their state's Great Lakes fish consumption guidelines*, by state and region.

	Percent	
State	Exceed Great Lakes guidelines (liberal assumptions)**	Exceed Great Lakes guidelines (conservative assumptions)**
Illinois	2.8	2.8
Indiana	16.3	20.4
Michigan	21.9	25.7
Minnesota	0.0	1.4
New York	21.2	21.2
Ohio	1.4	1.4
Pennsylvania	21.7	21.7
Wisconsin	3.8	4.7
Great Lakes Region	**12.5**	**14.1**

*When the species or length of fish caught was unknown, adherence to the guidelines was calculated assuming both the most and least restrictive consumption recommendations.
**Statistically significant difference between states at p = 0.05 using chi-square test.

4. Conclusions and Recommendations

Many WCBA report at least some awareness of the fish consumption guidelines, but most indicate they are not aware of the specifics. Those that are aware are more likely to hold beliefs consistent with the messages emphasized in the guidelines. Past work has also reported little awareness of guideline specifics among WCBA (Gliori et al., 2006). However, the proportion of women anglers of childbearing age living in the Great Lakes region that exceed fish consumption guidelines was not previously known. We found that substantial proportions of WCBA are exceeding the guidelines, with an average of 25-28%, but as high as 41% in some states surrounding the Great Lakes.

The extent of non-compliance suggests that more needs to be done to communicate fish consumption guidelines to WCBA licensed anglers. One approach would be to increase efforts to promote the sources of information most commonly accessed and found to be most useful by this audience. WCBA licensed anglers most frequently reported the fishing regulations guide as a valuable information source. Similar findings have been reported for angler audiences in general (Connelly and Knuth, 1993; Connelly et al., 2012). Other sources considered very useful by some licensed female anglers are currently used less frequently, but they may be able to reach some of the women that the fishing regulations guides are not reaching. These include (a) posted warnings, (b) healthcare providers, (c) websites, and (d) sportsman's shows/outdoor expos. Additional research may be needed to learn how to increase access to and use of these sources.

Another recommendation would be for more states to consider providing guidelines for consumption of purchased fish, as we found most of the fish consumed were purchased fish even among this group of anglers. This would enable WCBA who fish to be able to consult just one source for integrated advice about both sport-caught and purchased fish.

Fish consumption guidelines should also consider the type of women who exceed the guidelines. We found that WCBA who exceeded the guidelines were more likely to be older and not have children living at home. These two subpopulations were also more likely to be aware of the guidelines. Perhaps these women are interpreting the guidelines as more important to follow for "women of childbearing intent" and for "children." Since they are older and do not currently have children at home, they may feel the guidelines do not apply to them, so they are more likely to exceed them. If our interpretation of why these women are more likely to exceed the guidelines is correct, then messages about the guidelines may need to be revised so they are more relevant to these groups. Perhaps these women are not following the guidelines to the letter, but they are protecting their health well because they will not have any more children. Do the more restrictive guidelines really need to be applied to these women?

When identifying ways to better communicate fish consumption advice to WCBA, it is also important to consider that fish also provide important health benefits for WCBA. A recent study by Connelly et al. (2016) found that WCBA in the Great Lakes coastal region generally did not consume enough fish to obtain the maximum health benefits for themselves and their potential offspring. This finding suggests that fish consumption guidelines must encourage consumption of "safer" fish to obtain the health benefits while also reducing consumption of "riskier" fish to minimize the negative impacts of chemical contaminants.

Fish consumption guidelines, if followed, hold significant potential to reduce exposure to harmful chemical contaminants found in some fish. Our estimate of the number of WCBA licensed anglers exceeding those guidelines suggests that a substantial number of women are potentially exposed to harmful levels of chemicals from fish in the Great Lakes region. This estimate does not, however, indicate the actual contaminant loads of WCBA. Future research could more precisely estimate contaminant loads in WCBA by linking data on the types of fish meals eaten (location caught, species eaten, and meal size) with estimates of the amount of contaminants in each type of meal from fish sampling data. Such an analysis could be used to compare the actual contaminant loads with the guideline recommendations.

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SECTION 4: EFFECTS OF NARRATIVE MESSAGES TO PROMOTE HEALTHY FISH CONSUMPTION AMONG WOMEN OF CHILDBEARING AGE

ABSTRACT:
Objective: To test the impact of brochures designed to promote healthy fish consumption among licensed female anglers of childbearing age.
Design: We conducted a randomized, two-wave longitudinal experiment between May 18th, 2014 and September 5th, 2015. Participants reported their fish consumption in summer 2014 via an online diary. We then randomly assigned women to either be sent one of four brochures in spring 2015 using a two (including a short personal narrative or not) by two (using certain or uncertain language) factorial design, or to a fifth, no-exposure control arm. All participants completed a fish consumption diary again in summer 2015. We used ordinary least squares regression to test the effect of the brochures on fish consumption.
Setting: The Great Lakes coastal region of the US.
Participants: 1,135 women of childbearing age (18 to 48 years of age at baseline) drawn from a sample of licensed anglers.
Results: There were no overall effects of randomized condition on fish consumption, driven by low levels of confirmed exposure to the brochure among treatment groups. Among those confirmed to have seen it, however, exposure to brochure versions that included a short personal narrative helped to move women whose levels of fish consumption at baseline were furthest from federally recommended levels closer to these guidelines.
Conclusions: Narratives hold promise as a strategy to effectively convey information about the risks and benefits of fish consumption among women of childbearing age, but more research is needed to identify strategies to maximize exposure to these messages.

KEYWORDS: fish consumption, omega-3s, health communication, narrative, uncertainty

1. Introduction

Fish and other seafood are a good source of lean protein and a primary source of omega-3 fatty acids (omega-3s).[1] Omega-3s are particularly important for pregnant women and women who may become pregnant because they offer significant health benefits to both adults and the physical and cognitive development of a fetus.[2,3] The US Department of Agriculture (USDA) advises that "women who are pregnant or breastfeeding consume at least 8 and up to 12 ounces of a variety of seafood per week from choices lower in methylmercury."[4] This corresponds to 1-2 fish meals per week. The US Environmental Protection Agency (USEPA) and US Food and Drug Administration (USFDA) also recommend that pregnant women, those who may become pregnant, breastfeeding mothers, and young children eat "up to 12 ounces (two average meals) a week of a variety of fish and shellfish that are lower in mercury."[5] Many states offer similar guidelines that encourage regular consumption of fish low in mercury.[6]

Despite these recommendations, most women of childbearing age (WCBA), and pregnant women in particular, eat less fish than is recommended by federal agencies.[7-11] A recent national survey, for example, found that the typical WCBA consumed only 3.0oz/week of fish; the median level of consumption for women who were pregnant was 1.8oz/week.[11] Both estimates, far below national guidelines, suggest missed opportunities for obtaining the health benefits of omega-3s and other nutrients found in fish.

Many WCBA and pregnant women avoid fish out of concerns about mercury exposure.[11-16] Fish consumption declined rapidly after a 2001 federal advisory emphasized harms of mercury exposure from eating fish on fetal development.[12] Messages emphasizing potential harms of mercury exposure far outnumber messages about the health benefits of fish consumption in the news media,[13] and many WCBA and pregnant women cite concerns about mercury exposure as a primary reason for limiting or avoiding eating fish altogether.[11,14-16] WCBA and pregnant women can attain health benefits of eating fish while minimizing risks by eating fish that are low in mercury (like salmon, tilapia, and shellfish) and following fish consumption advisories by state and federal agencies for sport-caught and purchased fish.[4-6] Efforts to warn WCBA and pregnant women about the health risks of mercury exposure, however, appear to have overshadowed information about the health benefits of fish consumption.[11]

In response, researchers have developed and evaluated interventions to increase healthy fish consumption. Two of these intervention studies focused exclusively on pregnant women. Oken and colleagues reported increased fish consumption and intake of omega-3s among US pregnant women, but no differences in mercury intake or biomarkers of mercury exposure, in response to a 12-week print brochure and email intervention promoting healthy fish consumption.[17] Bosaeus and colleagues reported increased fish consumption and intake of omega-3s among US pregnant women in response to a 4-month dietary counselling intervention involving three in-person sessions and five follow-up phone calls.[18]

Other interventions have promoted fish consumption among WCBA or adults in general, as many pregnancies are unplanned and fish consumption offers health benefits to adults and their potential offspring.[5] One trial tested the effect of a 12-week intervention (involving 9 contacts with women in Canada) to increase compliance with a Mediterranean diet (in which increased fish consumption was a significant component). Trial evaluators reported increased fish consumption and reduced cholesterol and body mass index (BMI) among intervention participants.[19] A month-long community intervention in Australia used various media (TV, radio) to promote fish consumption and reported significant increases in fish sales within a month of the intervention.[20] Another Australian study reported increased consumption of fatty fish among adult participants at 3-months (but not at later time points) in response to a 12-month dietary counselling intervention involving six 1-hour in-person sessions and six 30-minute follow-up sessions.[21]

Collectively, these interventions show the potential for effective communication to promote healthy fish consumption among WCBA without increasing mercury exposure. However, each was resource intensive and thus may not be scalable given the typically limited resources available to government agencies tasked with providing fish consumption guidelines in the US. In addition, several of these studies occurred outside of the US, contexts where the public information environment about the relative risks and benefits of eating fish may differ. Furthermore, existing evidence does not provide guidance for public health officials on how best to convey information to maximize the effectiveness of efforts to promote healthy fish consumption.

The current study tested the impact of a short brochure designed to promote healthy fish consumption among licensed WCBA anglers in the Great Lakes coastal region of the US. We tested the impact of two features that state and federal agencies may consider in the design of such messages: the use of (a) a short, personal narrative to supplement traditional risk/benefit information about fish consumption, and (b) certain versus uncertain language in describing the risks/benefits of consuming fish. Narratives describe the experiences of one or more characters and, in doing so, can convey information about a health issue.[22] Narratives often outperform non-narrative messages in shaping attitudes and behavior because they are easy to understand, create emotional connections with story characters, and reduce counterarguing of message content.[23-27] Evidence on the impact of certain versus uncertain language in describing risk and benefit information is less clear,[28-30] with federal agencies noting the need for research on how to best communicate information laden with various forms of uncertainty, including deficits in the evidence base and the probabilistic nature of causality in epidemiological studies.[30]

Based on prior research, we hypothesized that exposure to a brochure that included the narrative message would increase healthy fish consumption relative to a no-exposure control group (H1). In light of limited evidence on the topic, we tested whether the use of certain or uncertain language in sections of the brochure describing risks and benefits of fish consumption would influence healthy fish consumption relative to a no-exposure control group (RQ1).

2. Method

2.1 Study Design Overview

We conducted a randomized, two-wave longitudinal experiment, involving 1,135 WCBA drawn from a sample of licensed anglers, between May 18th, 2014 and September 5th, 2015. Participants reported their fish consumption in summer 2014 by completing an online diary for relevant meals, receiving a reminder every two weeks. We then randomly assigned women to either be sent one of four brochures in spring 2015 using a 2 (included a short personal narrative or not) by 2 (certain or uncertain language) factorial design, or to a fifth, no-exposure control arm. All WCBA participants completed a fish consumption diary again in summer 2015.

2.2 Sampling Strategy

We drew a sample of 15,000 fishing licenses sold to women ages 18 to 48 that lived in counties bordering one of the Great Lakes in the US. We drew the sample by state, in proportion to the number of licenses sold in each state to women who lived in counties bordering the Great Lakes.

We sent invitation letters to each member of the sample in February 2014, offering up to $45 for participation in the project and providing a link to a sign-up page on the Internet. We provided a postage-paid return postcard for people to opt out of the study because they did not eat fish, did not have regular Internet access, or were not interested in participating. We sent a follow-up letter to all invitees a week later encouraging participation.

We made telephone calls to encourage sign-up directly over the telephone among those who did not sign-up or return a postcard. Calling ceased in a state when we reached the quota of state participants. During the study sign-up period we obtained email addresses and checked them by sending out a verification email. We then used email for all communication with study participants.

Initially, 2,014 WCBA agreed to participate. Of these, 1,395 participated throughout the 16-week study period in Year 1 (69% of those who consented). A total of 1,173 participated throughout the 16-week study period in Year 2 (58% of those who originally consented). There were no differences in demographic characteristics or fish consumption between those who participated fully and those who participated during only part of the study period for the periods when the two groups overlapped. Thus we report results for only those participants who provided complete data in Year 1 and Year 2 (n=1,135; 56% of those who originally consented).

2.3 Dependent Variables: Fish Consumption Reported Via Online Diaries

We collected fish consumption information for 16 weeks from mid-May through mid-September 2014 and again over the same four-month period in 2015. We gave each participant a link unique to them to access their personal fish consumption diary on the Internet. We encouraged and incentivized them to complete the diary at least every two weeks. The diary first asked women to report on any meals in which they consumed fish. For each meal reported, participants recorded whether the fish was purchased (at a store or restaurant) or sport-caught (i.e., fish caught by you or someone else) and the species eaten. We obtained data on participant age from fishing license records. We gathered data other socio-demographic characteristics in an online baseline survey at the end of Year 1 (N = 1,081) and data on recall of the experimental brochure and perceptions of changes in fish consumption in a follow-up survey at the end of Year 2 (N = 946).

We calculated several dependent variables based on fish consumption diary reports. First, we calculated the total number of fish meals consumed in summers 2014 (m = 14.6, SD = 10.0) and

2015 ($m = 13.5$, $SD = 9.6$). Second, we calculated the total number of purchased (p) and sport-caught (sc) fish meals consumed in summers 2014 ($m_p = 12.0$, $SD_p = 9.6$; $m_{sc} = 2.6$, $SD_{sc} = 4.2$) and 2015 ($m_p = 11.4$, $SD_p = 9.3$; $m_{sc} = 2.1$, $SD_{sc} = 3.7$). Most fish meals consumed were of purchased fish (82% in summer 2014; 85% in 2015). Third, we calculated the number of lower-mercury purchased (lmp) fish-meals (including all purchased shellfish, salmon, cod, tilapia, fish sticks/fast food sandwiches, haddock, and farm-raised catfish) and all other purchased/all sport-caught (opsc) fish meals consumed in summers 2014 ($m_{lmp} = 7.5$, $SD_{lmp} = 7.1$; $m_{opsc} = 7.1$, $SD_{opsc} = 6.4$) and 2015 ($m_{lmp} = 7.2$, $SD_{lmp} = 7.1$; $m_{opsc} = 6.3$, $SD_{opsc} = 5.8$).

2.4 Independent Variables: Versions of the Fish Consumption Guidelines Brochure

We developed four versions of a fish consumption guideline brochure based on a review of existing literature, formative message testing via pilot surveys of the target population (drawn from a different sampling frame than the main study), and a series of focus groups. We worked closely with public health, pollution control and natural resource agency representatives from the eight Great Lakes States to develop brochure content (a) consistent with state-specific advice and (b) that had potential to be incorporated into existing fish consumption guideline communication practices.

All of the brochures were professionally designed and followed the same general orientation and flow. The front page, entitled, "Your guide to eating fish and shellfish," featured a series of photographs and a short message emphasizing the benefits of fish consumption using either certain or more uncertain terms ("Fish [is/can be] an important part of a healthy diet for all women. It [is/may be] even more important for women who are pregnant, breastfeeding, or might become pregnant"). The second page featured either a short personal narrative or a series of responses to frequently asked questions. The third page (and in some cases on an additional two-sided page if the state had extensive fish consumption guidelines) featured state-specific fish consumption guidelines that matched Great Lakes and state-wide guidelines for sport-caught and, in states where they are offered, purchased fish. For states that do not offer purchased fish advice, we used the current federal guidelines from the USEPA and USFDA.[5] The final page featured a series of facts on fish, first emphasizing the benefits of fish consumption ("Fish is low in calories, has plenty of protein, and is a great way to get omega-3s. Eating fish [lowers/may lower] the risk of heart disease and other health problems") but also offering advice on ways to maximize health benefits while minimizing risks ("most fish are a healthy food, but eating some types of fish [raises/may raise] health risks over time").

2.4.1 Narrative versus FAQ

The narrative version featured a short, personal story about a young woman who was trying to become pregnant and was surprised to learn that fish can be an important part of a healthy diet for women in general but also before, during, and after pregnancy. The narrative conveyed three central messages – that (1) fish are a great source of omega-3s, (2) some types of fish have more chemical contaminants than others, and (3) fish consumption guidelines can help her to choose which fish are healthier to eat and which to try to avoid. The FAQ version conveyed the same messages using identical language to the extent possible (see Figs. 1 and 2). The FAQ section was (on average, depending on state-specific details) 140 words, while the narrative section was longer (averaging 220 words) due to the need to include details about the character, setting, and storyline. The overall brochure ranged from 731 to 1,704 words (depending on the extent of advice given by a particular state), so the narrative and FAQ sections represent a relatively small part of the brochure's overall content.

Fig. 1. Narrative Version of the Brochure

2.4.2 Certain versus Uncertain Language

The certain language version differed from the uncertain language version in the degree to which we described relationships between fish consumption and health benefits and risks as definitive ["causes, is, will"] or hedged ["may cause, can be, might"]. We manipulated this language throughout the first (title), second (narrative or FAQ), and final (facts on fish) pages of the brochure in every instance where we described potential health benefits and/or risks of fish consumption. In addition, the uncertain language version included an extra statement on the final page, among the other facts on fish, calling attention to the probabilistic nature of health causation: “It is difficult to know who might have health problems from chemicals in fish. Some people can be fine after years of eating fish with these chemicals in them, while others can have health problems.”

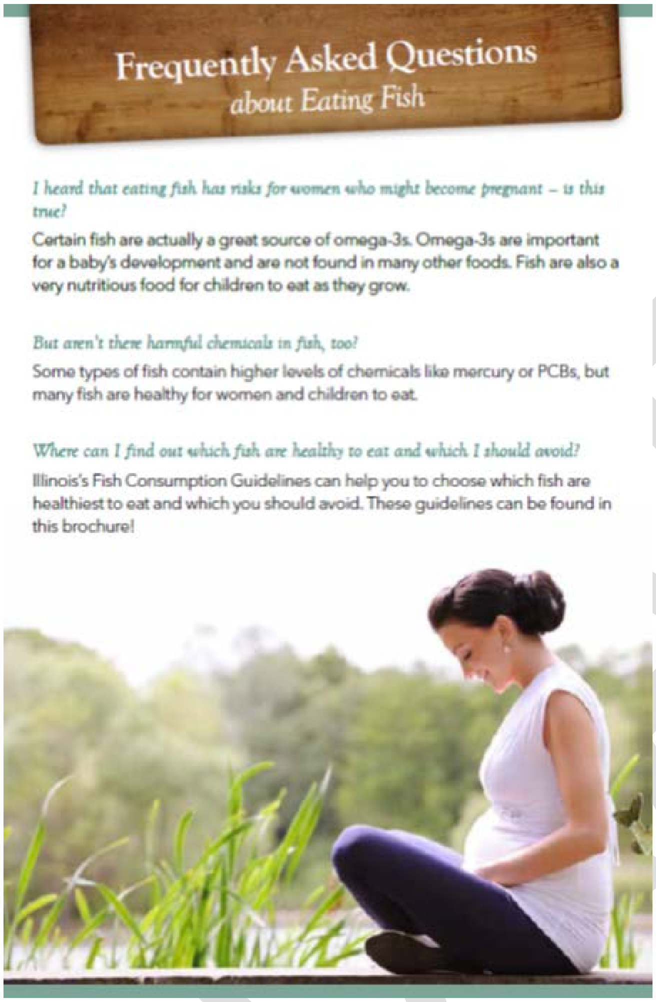

Fig. 2. Frequently Asked Questions (FAQ) Version of the Brochure

As noted above, we randomly assigned all participants who provided diary information in Year 1 to one of five groups – control (no brochure) and each possible combination of the 2 (narrative versus FAQ) by 2 (certain or uncertain language) design. We mailed brochures to study participants randomly assigned to one of the four (non-control) experimental groups approximately one week before data collection began in Year 2. We also provided a link to the brochure at the top of the first page of the fish consumption diary. We used web tracking software to record a date time stamp each time a participant clicked on the link to the brochure.

2.5 Statistical Analysis

We analyzed data between September 15th, 2015 and July 31st, 2016 using IBM SPSS Statistics v24. We used chi-square and t-tests to assess whether random assignment produced balanced groups on measured variables (using $P < 0.05$ as the statistical criterion throughout the paper). We used paired-sample t-tests to compare the number of fish meals consumed in summer 2015 (follow-up) to summer 2014 (baseline). We used ordinary least squares (OLS) regression to test whether changes in fish consumption from baseline to follow-up were conditional on baseline consumption.

We also used OLS regression to test whether assignment to a brochure featuring a narrative (H1) or using uncertain language (RQ1) influenced changes in fish consumption. These models included four variables: a continuous variable indicating the number of fish meals consumed in summer 2014, an indicator for the narrative condition, an indicator for the uncertain language condition, and an indicator for the FAQ*certain condition (in order to make the "reference" group for each dummy variable the no-exposure control group). The coefficients from the indicator variables in these models can thus be interpreted as the magnitude of difference in fish consumption from 2014 to 2015 between a particular version of the brochure (including a narrative; using uncertain language) and the no-exposure control group.

We ran preliminary models in which we controlled for respondent demographics and state of residence; the inclusion of these controls did not influence the magnitude or significance of our tests of study hypotheses, so we do not include them in the models presented in text or tables. We also ran models in which we interacted indicators for whether or not respondents were assigned to the narrative versus FAQ and whether they were assigned to view certain versus uncertain language; none of these interactions were statistically significant (all Ps > .05) so we do not report on them in the text or tables.

Finally, we ran models in which we interacted baseline levels of fish consumption with indicators for narrative versus FAQ and exposure to certain versus uncertain language; several of these findings were statistically significant ($P < .05$) so we report these results in the text and tables. We probed these interactions using the Johnson-Neyman technique to identify levels of the moderator (baseline fish consumption) at which effects of the dependent variable (e.g., brochures with a narrative vs. FAQ) were statistically significant.[(31)] We repeated these models by replacing the FAQ*certain variable with an indicator for the control condition to test whether the effect of the narrative or uncertain language versions differed from the FAQ or certain language versions.

2.5.1 Confirmed Exposure to the Brochure and Subgroup Analyses

There was limited evidence of brochure exposure among WCBA in groups we sent it to. Among those who completed the end of year survey (N = 946 total) and were randomly assigned to be sent the brochure (N = 628), only 63% (N = 397) recalled receiving it in the mail. Far fewer (17%; N = 104) recalled looking at it online. A total of 472 respondents (75%) recalled viewing the brochure in either the mail or online. Among these, the majority (60%) reported looking at it just once, when they first received it. Most of the rest (37%) reported looking at it only "a few times." Web tracking data confirmed these reports of low exposure – only 20% of those randomly assigned to view it clicked on the brochure, and the vast majority of these respondents (81%) clicked on it only once. Combining all of these confirmed types of exposure, we calculate that 67% (N = 525) of respondents randomly assigned to receive the brochure had at least one indicator (recall or web tracking) of confirmed exposure.

We used this information to create a "confirmed exposure plus control" (CEC) subgroup comprised of these 525 respondents (considered to have confirmed exposed to the brochure in all analyses using this subsample) and the 365 respondents from the control group who provided complete data in Years 1 and 2 (considered unexposed to the brochure in this subsample). We repeated all multivariable regression analyses with two different samples: one involving all study respondents (overall N = 1,135) and the other involving the CEC subgroup (N = 890).

3. Results

3.1 Participant Demographics, Randomization Checks, and Manipulation Checks

The average participant was 36 years old in Year 1 (Table 1). Most were white (95%), half (54%) reported that they had a college degree, and nearly half (45%) reported a household income between $50,000 and $99,999 before taxes in 2014. Only 85 women were pregnant or breastfeeding during the study period; we were thus unable to analyze this group separately. Among those randomly assigned to be sent the brochure, respondent demographics were similar between those with or without confirmed exposure, with one exception: those with confirmed exposure were more educated than those without confirmed exposure ($P < .05$)[13].

There were no statistically significant differences in demographic composition (on measured variables) or baseline fish consumption between the five randomized groups in either the overall sample or the CEC subgroup (all Ps > .05), suggesting that we can still interpret any differences in response to the various brochure conditions as a causal influence of exposure to those stimuli (because brochure was not confounded with demographic characteristics)[14].

We included one item on the end of study survey designed to serve as a manipulation check for whether or not respondents noticed the certain versus uncertain language (there was no manipulation check for the narrative versus FAQ version). Specifically, we gauged agreement with the statement, "Some people will have health problems from eating fish contaminated with chemicals, while others won't," a statement which was included in only those versions of the brochure that utilized uncertain language. Respondents assigned to the uncertain language brochure were more likely than those assigned to the certain language brochure to agree with this

[13] There were also no differences in beliefs about fish consumption, as measured in the end-of-study survey, between those with or without confirmed exposure.

[14] We calculated the odds of a person who received one brochure knowing a person who received a different brochure, based on the size of the population of WCBA fishing licenses holders in each state from which the sample was drawn. The draw of the sample was random. The best odds of knowing someone were 1 in 142 in New York, making it very unlikely in our opinion that someone could be influenced by a different brochure than the one they were assigned to receive.

statement (standardized B = .08, P = .023), providing evidence that the manipulation was successful.

Table 1
Sample Characteristics of the Overall Sample and Those Randomly Assigned to be sent the Brochure, with and without Confirmed Exposure.

Demographic Characteristics	**Overall Sample**	**Randomly Assigned to be Sent the Brochure, with Confirmed Exposure**	**Randomly Assigned to be Sent the Brochure, without Confirmed Exposure**	***X^2* or t, *p*-value[a]**
Age (mean)	36.2	36.2	36.3	T(1)=0.18, P =.86
Non-white (%)	4.9	5.3	7.3	X^2(1)=0.99, P=.32
Education (%)				X^2(2)=7.22, P=.03
High school or less	7.9	8.0	11.3	
Some college or technical school	38.0	35.0	42.6	
College grad or more	54.1	57.0	46.1	
Household income before taxes in 2014				X^2(2)=1.13, P=.57
Less than $50,000	29.8	29.1	33.1	
$50,000 to $99,999	45.4	47.0	46.8	
$100,000 or more	24.8	23.9	20.2	

Note: [a] Statistical tests compare those randomly assigned to brochure exposure groups (a) who were confirmed to have clicked on the brochure or who recalled receiving the experimental brochure, versus (b) those who did not click and did not recall receiving it.

3.2 Comparing the Number of Fish Meals Consumed in summer 2014 and summer 2015

Overall, WCBA in the sample consumed fewer fish meals in summer 2015 (M = 13.5, SD = 9.6; 0.84 meals/week) than in summer 2014 (M = 14.6, SD = 9.9; 0.91 meals/week; t-score for mean difference from zero = -5.4, P < .001). These patterns were similar for the CEC subgroup (mean difference = -.9, t-score for difference from zero = -3.7, P < .001). These changes were dependent, however, on baseline levels of fish consumption. The number of fish meals consumed in summer 2014 was a significant ($p<.001$) predictor of change (in both the overall and CEC samples) in fish meals from baseline to follow-up. We used this model to predict the direction and magnitude of change at various levels of baseline fish consumption. For WCBA with no baseline fish consumption in summer 2014, the overall model estimates an increase of 2.75 fish meals from baseline to follow-up. The model further estimates that each 1-unit change in fish meals at baseline reduced the predicted change in consumption by 0.26 fish meals. Combining these coefficients, the model estimates that WCBA who ate up to 10 fish meals in summer 2014 tended to increase their fish consumption in summer 2015. In contrast, the model estimates that WCBA who ate 11 or more meals in summer 2014 tended to reduce their fish consumption the next summer. The size of this reduction became larger as baseline levels of fish consumption increased. We observed a similar pattern of change for purchased meals, lower mercury fish meals, and sport-caught fish meals.

3.3 Predicting the Average Number of Fish Meals Consumed by Exposure to the Brochure

We first ran a series of OLS regression models predicting changes in overall, purchased, sport-caught, lower-mercury purchased and other (other purchased plus all sport-caught) fish consumption as a function of brochure condition (narrative, uncertain language, and the FAQ w/certain language) relative to the no-exposure control group. None of these analyses showed any statistically significant differences in any kind of fish consumption, in either the overall sample or CEC subgroup, between those sent any variety of the brochure and the no-exposure control group (all $Ps > .05$; see Table 2)[15]. Thus, we offer no overall evidence in support of H1 or suggestive of differences by certain language as in RQ1.

There was a consistent pattern of statistically significant interactions, however, between baseline fish consumption and the narrative brochure version in predicting overall, purchased, sport-caught, and lower-mercury purchased fish consumption in two of three models with the overall sample ($Ps < .05$; see Table 3) and the CEC subgroup (all $Ps < .01$; see Table 4). The models found statistically significant differences relative to both the control group (as shown in all tables) and those exposed to the FAQ brochure version (results not shown but available upon request).

We probed interactions within the CEC subgroup (where effects were clearest) to identify levels of baseline consumption at which effects of the narrative brochure were statistically significant. The narrative brochure significantly ($P<.05$) <u>increased</u> overall fish consumption, relative to the control or FAQ brochures, for WCBA who ate 11 or fewer fish at baseline (0.7 meals per week, a level below federal recommendations consumed by 44% of the sample). The magnitude of these effects ranged from an increase of 1 fish meal for women who ate 11 fish meals at baseline to 2.4 total fish meals among women who ate no fish at baseline. The narrative brochure also <u>reduced</u> overall fish consumption for WCBA who ate 46 or more fish meals at baseline (2.8 per week, a level above federal recommendations but consumed by only 1% of the sample). The

[15] Awareness by WCBA (prior to participating in the study) that states issued guidelines for fish consumption was not a significant variable in any of the models we tested, nor was intention to have children in the next five years.

effect was estimated to reflect a reduction of 3.0 total fish meals for women who ate 46 fish meals at baseline (Fig. 3).

Table 2
OLS Regression Models Predicting Overall, Purchased, Sport-Caught, Lower-Mercury, and Other Sport-Caught or Purchased Fish Meals Consumed in Summer 2015 by Version of the Brochure, Overall Sample (N = 1,135).

	Overall	Purchased	Sport Caught	Lower Mercury	Other Sport or Purchased
No-exposure control	Ref.	Ref.	Ref.	Ref.	Ref.
# of fish meals, summer 2014	0.74***	0.75***	0.70***	0.75***	0.72***
Narrative	0.18	0.33	−0.17	−0.16	0.26
Uncertain language	−0.11	−0.08	−0.02	0.16	−0.23
FAQ w/certain language	−0.87	−0.71	−0.16	−0.29	−0.56
Constant	2.86***	2.47***	0.38***	1.70***	1.92***
Model r-squared	0.58	0.59	0.65	0.56	0.47

Notes: OLS, ordinary least squares. CEC, confirmed exposure + control subgroup. Ref, referent category in linear regression model. FAQ, frequently asked questions. * P<.05; **P<.01; ***P<.001.

Table 3
OLS Regression Models Predicting Overall, Purchased, and Lower-Mercury Fish Meals Consumed in Summer 2015 including Interaction Terms between Narrative Version of the Brochure and Baseline Fish Consumption, Overall Sample (N = 1,135).

	Overall	Purchased	Sport-Caught	Lower Mercury
No-Exposure Control	Ref.	Ref.	Ref.	Ref.
# of fish meals, summer 2014	0.76***	0.78***	0.73***	0.77***
Narrative	1.01	0.44*	0.10	0.49
# of fish meals in 2014*narrative	−0.06	−0.08*	−0.12**	−0.09*
Uncertain language	−0.09	−0.06	−0.02	0.17
FAQ w/certain language	−0.87	−0.70	−0.16	−0.28
Constant	2.58***	2.12***	0.30**	1.48***
Model R-Squared	0.58	0.59	0.65	0.56

Notes: OLS, ordinary least squares. Ref, referent category in linear regression model. FAQ, frequently asked questions. * P<.05; **P<.01; ***P<.001.

Table 4
OLS Regression Models Predicting Overall, Purchased, and Lower-Mercury Fish Meals Consumed in Summer 2015 including Interaction Terms between Narrative Version of the Brochure and Baseline Fish Consumption, CEC Subgroup Sample (N = 890).

	Overall	Purchased	Sport-Caught	Lower Mercury
No-Exposure Control	Ref.	Ref.	Ref.	Ref.
# of fish meals, summer 2014	0.77***	0.80***	0.73***	0.81***
Narrative	2.39**	2.60***	0.20	1.27*
# of fish meals in 2014*narrative	−0.12*	−0.15***	−0.14**	−0.15**
Uncertain language	0.22	0.29	−0.03	−0.57
FAQ w/certain language	−0.32	−0.31	−0.03	0.21
Constant	3.34***	1.87***	0.28*	1.21***
Model R-Squared	0.57	0.59	0.63	0.56

Notes: OLS, ordinary least squares. CEC, confirmed exposure + control subgroup. Ref, referent category in linear regression model. FAQ, frequently asked questions. * P<.05; **P<.01; ***P<.001.

Patterns were similar for purchased and lower mercury fish meals. The narrative brochure significantly increased purchased fish consumption (relative to the control or FAQ brochures) among women with 11 or fewer baseline purchased fish meals (56% of the sample) and reduced purchased fish consumption among women with 29 or more baseline purchased fish meals (6% of the sample). The narrative brochure also significantly increased lower mercury fish consumption (relative to the control or FAQ brochures) among women with 2.5 or fewer baseline lower mercury fish meals (24% of the sample) and reduced lower mercury fish consumption among women with 14.5 or more lower mercury fish meals at baseline (12% of the sample). The pattern was somewhat different for sport-caught fish meals. The narrative brochure significantly decreased sport-caught fish consumption among WCBA with 3.4 or more purchased fish meals (24% of the sample) by a magnitude ranging from a decrease of 0.3 fish meals (at 3.5 sport-caught fish meals at baseline) to 0.7 sport-caught fish meals (at 7 sport-caught fish meals at baseline, the 90th percentile).

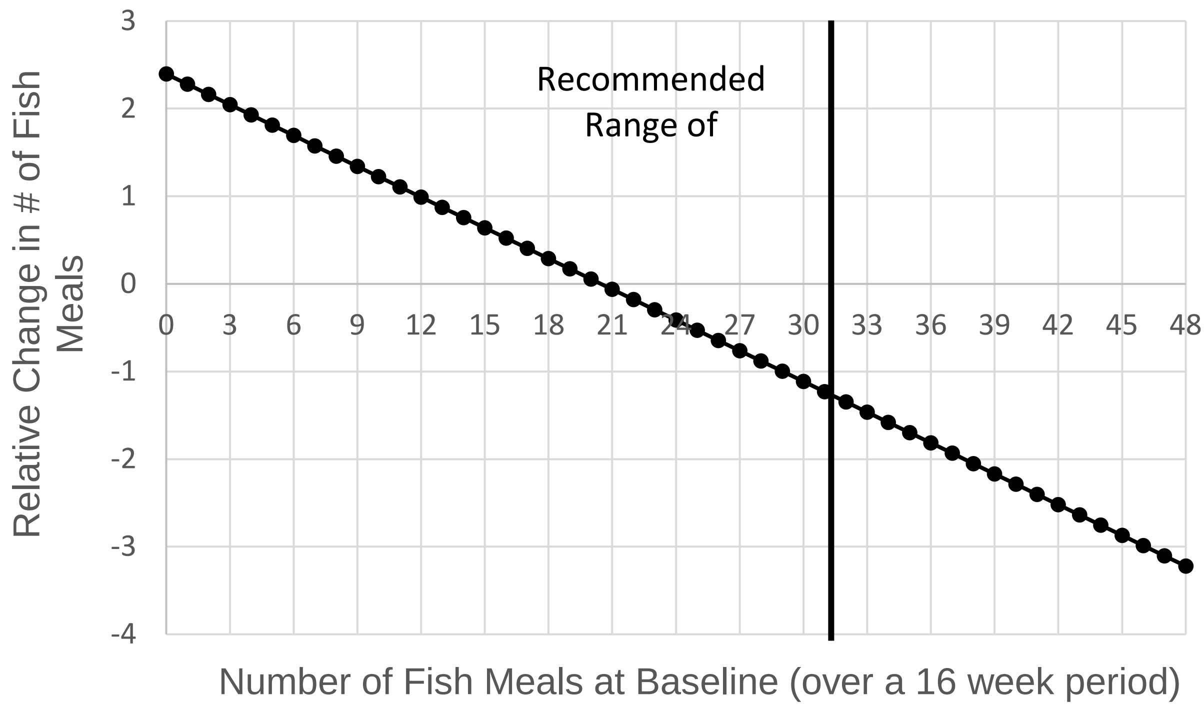

Fig. 3. Model Predicted Change in Fish Consumption, Narrative Version versus Control Group, CEC Subgroup Sample (N = 890).

4. Discussion

This study provides evidence that WCBA who were (a) furthest from federal recommendations for levels of fish consumption at baseline, and (b) confirmed to have seen a brochure featuring a short personal story about the benefits of eating fish, were more likely to move toward recommended levels of fish consumption at follow-up than WCBA randomized to either the no-exposure control group or FAQ brochure versions. Among WCBA with low baseline fish consumption (≤11 fish meals over the 16-week baseline period), those with confirmed exposure to the narrative version of the brochure increased their fish consumption by 1-2 fish meals more than women exposed to FAQ versions of the brochure or randomized to the control condition. In contrast, among WCBA with high baseline levels of fish consumption (≥46 fish meals over the 16-week baseline period), those with confirmed exposure to the narrative brochure version decreased their fish consumption by 3-5 fish meals more than women exposed to non-narrative versions of the brochure or women randomized to the control condition. Changes in consumption of purchased fish appeared to drive these changes. The narrative brochure also reduced sport-caught fish consumption among periodic to regular consumers of these meals.

At the same time, while a majority of WCBA randomly assigned to be sent the brochure reported looking at it, most women who saw it looked at it only one time. This contributed to the fact that we were unable to detect differences in fish consumption behavior, regardless of whether or not a woman was randomly assigned to see the brochure, in the overall study sample. The use of certain versus uncertain language in the brochures had no effect on fish consumption in any study sample.

Our findings offer limited evidence that narratives hold promise as a strategy to effectively convey information about the benefits of modest fish consumption and the risks of fish overconsumption among WCBA to women who are the least inclined to eat at levels consistent with federal recommendations. While the magnitude of message effects was modest (ranging from 1 to 5 fish meals over an entire summer), these findings are nevertheless noteworthy in light of the (a) small-scale of the overall intervention (a single brochure largely seen only once), (b) length of the narrative (comprising only a quarter of the broader brochure), and yet (c) consistency in patterns of effects (for three different outcome measures, suggesting that these findings are unlikely a product of chance alone). We thus argue that these findings offer meaningful opportunities for government agencies responsible for communicating the benefits and risks of fish consumption. Adding a short, personal narrative to existing fish consumption advice would appear to be a cost-effective way to increase the potential impact of advice on fish consumption among WCBA.

4.1 Limitations

First, as described above, the mode of dissemination (mailing brochures and making them available online) did not generate high levels of confirmed exposure. Those seeking to promote fish consumption among WCBA may require different channels of distribution or more frequent points of contact to promote larger increases in healthy fish consumption[17-21] The intervention was not intended to be a test of the most effective mode of fish consumption guideline delivery. As such, it is not equivalent to the ways that states typically disseminate guideline information and should not be compared to those broader efforts. Second, it is possible that regression to the mean is partially responsible for the observed increases in fish consumption among those with lower levels of consumption at baseline, as well as observed declines among those with higher levels. Regression to the mean would not, however, explain why confirmed exposure to the narrative version of the brochure produced greater changes than in other conditions. Third, the study's sample was not intended to reflect the broader population of WCBA. All WCBA in the study indicated that they eat fish at least sometimes and were licensed anglers in the Great Lakes coastal region, so these findings may not apply to the broader population of WCBA in general. Finally, the sample included very few WCBA who were pregnant or breastfeeding; we cannot speak to these populations.

5. Conclusions

Narratives may hold promise as a strategy to effectively convey information about the benefits of healthy fish consumption and risks of overconsumption among WCBA, but substantial levels of message exposure may be necessary to offset widely available and pervasive messages emphasizing potential risks of fish consumption in the broader information environment.

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SECTION 5: URBAN ANGLERS' ADHERENCE TO FISH CONSUMPTION ADVISORIES IN THE GREAT LAKES REGION

ABSTRACT: Urban anglers are considered a group at high risk of being exposed to contaminants from fish consumption. Past studies of urban anglers' fish consumption, however, have had significant limitations making it difficult to generalize their findings broadly and to assess the degree to which urban anglers are complying with advisory recommendations. We used a diary method to collect detailed information on fish consumption in three cities in the Great Lakes region for a 4-month period during the summer of 2014. We assessed how much fish anglers were consuming, whether they were complying with fish consumption advisories, and how fish consumption and advisory compliance varied for different demographic groups and in different locations. We estimated a mean of 1.12 meals/week of fish and 25.1-26.8 grams/day of fish, and the amount of fish consumed varied by no more than 25% from one site to another. Advisory exceedance was more variable, however, ranging from 7-10% to 27-40% in our three study sites. Fish consumption increased with age, education, and income, and was higher for nonwhites than for whites. Advisory exceedance was higher for women, nonwhites, and older anglers. At each site, the types of fish that contributed the most to advisory exceedance varied, which points to the benefits of community-specific (and resource-intensive) fish consumption guidelines. Our findings could help fish consumption advisory programs tailor their advice to vulnerable populations and particular locations.

KEYWORDS: fish consumption, advisories, urban anglers.

1. Introduction

The Great Lakes Restoration Initiative Action Plan II identifies urban anglers as a group at high risk of being exposed to contaminants through fish consumption (Great Lakes Interagency Task Force, 2014). Urban waters in industrialized areas may be polluted, and some types of fish in those waters accumulate high levels of industrial contaminants (2). Therefore, fish consumption advisories for urban waters are sometimes more restrictive than advisories for other waters. Urban anglers are considered more likely than other anglers to fish at urban sites and, if they eat the fish they catch, more likely to be exposed to the contaminants in these fish.

Past work on urban anglers has explored the demographic characteristics of urban anglers (Burger et al., 1999; Lauber et al., in review), fish consumption by demographic groups that are more prevalent in urban areas, such as low income individuals, racial minorities, and immigrant groups (Burger et al., 1999; Silver et al., 2007; West et al., 1993), and how urban anglers make decisions about fish consumption and use fish advisories (Beehler et al., 2003, 2001; Burger et al., 1993; Lauber et al., in review; Pflugh et al., 1999). Relatively little work, however, has investigated the fish consumption patterns and adherence to advisories of urban anglers themselves. The limited work that has been done on this topic provides some insight into how much fish urban anglers are eating and which types of people are eating more. Overall, this work finds considerable variation in the volume of sport-caught and purchased fish consumption as well as the potential for exposure to contaminants through excessive consumption beyond that which health authorities advise.

Some of this work has explored fish consumption by urban ethnic populations that were expected to eat a lot of fish. Hutchison and Kraft (Hutchison and Kraft, 1994) studied sportfish consumption in the Hmong community of Green Bay, Wisconsin, in 1989 and 1990. They interviewed 125 Hmong households to collect information on the types of fish people reported catching and how frequently they ate fish they caught over the course of a year. They reported that 61% ate sportfish once a month or less and only 9% ate sportfish at least once a week. They calculated an average of 30 sportfish meals for each household over the course of a year, which was considerably higher than the rate of fish consumption among Wisconsin anglers overall. Their conclusion was that some members of the Hmong community were likely eating sportfish in excess of fish advisory recommendations, but they did not quantify advisory adherence.

Murkin et al. (2003) documented patterns of fish consumption among frequent fish consumers in five Ontario Great Lakes Areas of Concern (sites with significant impairment of beneficial uses) between 1995 and 1997. They targeted two groups of people they considered at risk of eating too much contaminated fish: Asian-born anglers (identified through key informants, social and religious community organizations, newspapers, and health fairs) and anglers observed to be fishing at selected shore fishing sites (a group that has been a common focus in urban angler studies). Through home visits with 91 participants, they collected data on quantity and type of fish consumed during each season over the previous twelve months. They reported means of 33 meals of Great Lakes fish over the summer, 99 sportfish meals each year, and 157 total fish meals each year. Asian-born anglers consumed more fish than European- Canadian- or United States-born anglers. Considerable variation existed in the types and parts of fish that were eaten.

Burger (2002) reported fish consumption patterns of anglers fishing in the urban Newark Bay complex of New York and New Jersey. She interviewed 267 people fishing on site between May and September 1999. She reported 4.06 meals (1410 g) of fish/month for anglers who only fished and 3.56 meals (1630 g) of fish/month for anglers who both fished and crabbed. Consumption increased with age, and nonwhites were more likely to eat their catch.

Sheaffer and O'Leary (2005) collected data on fish consumption through an onsite survey of 946 anglers who were fishing in metropolitan areas of Indiana in the spring and summer and compared it with similar data collected for 1,743 licensed Indiana anglers collected through a statewide mail survey. The data were collected in 1997 and 1998. The mail survey asked anglers to report their consumption over the past three months, and it was administered to different samples of anglers at three different times of the year to obtain better estimates of annual fish consumption. They found slightly higher consumption of sportfish in the metropolitan anglers compared to the statewide sample (22.9 vs. 19.8 g/day) with 18% of the metropolitan anglers eating in excess of advisory limits compared to 16% of the statewide sample. Nonwhite anglers in the metropolitan areas consumed more fish than white anglers.

Kearney and Cole (2003) reported on fish consumption of 232 licensed anglers in two Ontario cities in 1992. The sample was selected to represent anglers who ate a lot of Great Lakes fish. Anglers were asked to recall the numbers and species of Great Lakes fish consumed over a 12-month period, reporting the results by season whenever that was possible. The authors found differences in the amount and species of fish eaten in the two communities, with reported fish consumption ranging from 10.9-34.2 meals/year and 12.3-19.9 g/day. Sportfish consumption was not related to age or income. In one of the communities, anglers with the lowest levels of education ate more fish.

Lauber et al. (in review) characterized the fish consumption of anglers who self-identified as being from urban areas in a mail survey of licensed anglers from the Great Lakes region of the United States. They reported means of 5.4 sportfish meals/year (with 63% eating at least some sportfish) and 12.5 purchased fish meals/year (with 70% eating at least some purchased fish). Fish consumption increased with income. Their study was the only one of this set that selected a representative sample of anglers living in urban areas. The others all selected samples of anglers that were expected to consume a lot of fish because of their ethnicity, fishing locations, or the results of a screening process.

These studies have some significant limitations. The narrow definition of study populations as well as the approach to sampling in some studies would make it difficult to generalize to larger populations. Most sample sizes were relatively small, making it difficult to compare subpopulations within groups. Many of the studies only considered sportfish consumption, although consumption of purchased fish can also contribute to risk. Most of these studies report on data collected in the 1990s or earlier and do not report whether or not levels or species of fish consumption complied with advisory recommendations. Finally, participants in the studies were asked to report fish consumption by recalling either how much fish they typically ate or based on their recall of a specific 3- to 12-month period; these methods of reporting are likely to be less accurate than more proximal recollections (e.g., in the past few weeks).

This study seeks to address these limitations by reporting on urban anglers' fish consumption and compliance with fish advisories based on data collected from 1,200 anglers in 3 metropolitan areas in the Great Lakes region of the United States in the summer of 2014. We selected a representative sample of licensed urban anglers to explore how vulnerable subpopulations are similar to or different from the larger population of anglers living in cities. We used a diary method, in which anglers reported fish consumed on at least a biweekly basis, to assess the amounts and types (species, lengths, and location caught) of fish consumed over a 4-month period. We report on anglers' adherence to fish consumption advisories in each area and how fish consumption and advisory compliance varied with demographic characteristics.

2. Methods

2.1 Study Sites

We selected three urban counties in the Great Lakes region as our study sites: the counties containing Kalamazoo, MI, Erie, PA, and Rochester, NY. Each of these cities had populations of at least 75,000 people. All 3 sites had statewide sportfish advisories as well as advisories for local bodies of water (with advice for particular species and lengths of fish), but the complexity of these guidelines varied. In Rochester and Erie, only one to three local bodies of water had special advisories, but 11 local bodies of water had special advisories in Kalamazoo. Michigan is also the only state of the three that publishes guidelines for the consumption of purchased fish.

2.2 Sample Selection and Diary Recruitment

We drew a sample of 15,000 fishing licenses sold to licensed anglers who lived in one of three study sites; we drew 5,000 licenses for each site. We sent invitation letters to each member of the sample in February 2014. The letter described the study and what would be required of participants. It also offered a financial incentive of up to $20 for participation in the project and provided a link to a sign-up page on the Internet. We provided a postage-paid return postcard for people to opt out of the study because they did not eat fish, did not have regular Internet access, or were not interested in participating. We sent a follow-up letter to all invitees a week later encouraging participation.

We called those who did not sign-up or return a postcard to encourage participation and allow them to sign up over the telephone. Calling ceased when at least 2,000 total participants and at least 600 participants in each city had been reached. During the study sign-up process, we obtained email addresses and then checked them by sending out a study participation verification email. We then used email for all communication with study participants.

2.3 Diary Data Collection

We collected fish consumption information for 16 weeks from May 18 through September 6, 2014. Participants recorded data in two-week blocks. Participants could record information as many times as they wished during the two-week period. Every two weeks we sent an email invitation to participants to signal the start of the next two-week period and remind them that the previous two week-period was ending. When a two-week period ended, we sent up to three reminders to participants who had not completed entering data for the period to finish recording their information for the period. Participants earned financial incentives for each period completed and received a bonus at the end if they completed reporting for every period.

We gave each participant a link unique to them to access their personal fish consumption diary on the Internet. On the initial page, participants saw information for the eight two-week periods of the study, showing completed periods and incentives earned. On the next page we asked participants to record whether or not they ate fish on each day in the current two-week period. For each day they indicated they ate fish, another page opened asking the number of fish meals they had eaten on that day. For each meal reported, participants recorded whether the fish was purchased (at a store or restaurant) or sport-caught (i.e., fish caught by you or someone else), the species eaten, the portion size, and (for sport-caught fish) where the fish was caught. We provided a list of water bodies in each urban area that had special advisories for the fish caught there. We provided a list of fish species, including the most commonly consumed purchased fish and those with consumption guideline recommendations, along with a text box to record species not on the list. For sport-caught species, we listed only those with consumption guideline recommendations and provided an “other” option. Participants indicated portion size in reference to a picture of a 6 oz. cooked (170 grams) portion of salmon (Fig. 1); we asked participants if the meal they ate was larger, smaller, or the same size as the picture.

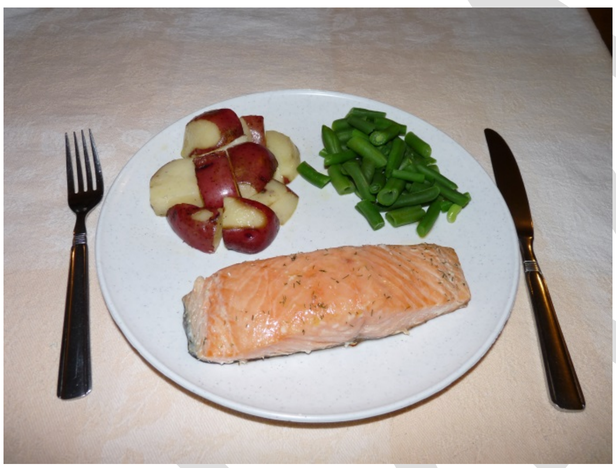

Fig. 1. Picture shows a 6 oz. piece of cooked salmon (8 oz. pre-cooked).

We obtained data on participant age from fishing license records. We gathered data on other socio-demographic characteristics, such as education and race, using an online survey conducted during the last 2-week period of diary data collection.

2.4 Data Analysis

Several previous studies have estimated the size of fish portions that people eat using pictures similar to those used in our study (Connelly et al., 1996; West et al., 1993) or plastic models (Silver et al., 2007). Since we provided a picture of a 6 oz. cooked salmon meal, we assumed those indicating an equivalent portion to the photo ate a 6 oz. portion (170 grams). For 41% of meals, the participants indicated their portion size was smaller than the picture; we assumed that meant 4 oz. (113 grams). For meals reported as being larger than the picture (19% of meals), we used a sensitivity analysis to compare two options for calculating portion size. For one option, we estimated the larger portion size to be 8 oz. (227 grams) and for the other we assumed the size to be 10 oz. (283 grams). We used these estimates to convert from the number and size of meals to an estimate of ounces and grams consumed per week or per day.

We analyzed data from the diary using IBM SPSS Statistics 20. We used chi-square tests to identify statistically significant differences between cities at the $P < 0.05$ level. Any differences described in the narrative text are statistically significant at this level. We used Scheffe's test to identify differences in portion sizes based on species of fish consumed. We used ANOVAs and chi-square tests to explain differences in fish consumption based on available demographic data.

We compared the meals eaten by each participant to the guidelines of the state where they lived. We characterized participants as adhering to the guidelines if they kept their total consumption for the 4-month study period within the recommendations for that time period. For example, if the recommendation was to consume no more than one serving of coho salmon per month from Lake Michigan, and a person consumed five servings of coho salmon during the 4-month study period, we concluded that he or she had exceeded the guidelines. We measured fish consumption against the guidelines for local bodies of water, the statewide guidelines for all other sportfish, and the state guidelines (or federal guidelines if no state guidelines existed) for purchased fish. If an individual exceeded any of these guidelines, we concluded that he or she exceeded the guidelines.

We present some results as ranges (based on liberal and conservative assumptions) because some respondents did not know the length and/or species of the fish they ate. Some consumption advice is based on the length of the fish caught; if consumers did not know the length of the fish they ate, we estimated their adherence to the guidelines assuming both the most and least restrictive consumption recommendations for that species. Similarly, a few consumers did not know the species of fish they were eating, or more commonly, reported eating multiple species at one meal. In these cases, we estimated their adherence to the guidelines assuming both the most and least restrictive consumption recommendations for the water where the fish was caught.

We estimated the degree to which advisory exceedance was affected by the consumption of particular species of fish, consumption of fish from particular water bodies, and the consumption of too much low mercury purchased fish. To estimate the contribution of particular species of fish to advisory exceedance, we eliminated the consumption data from each species of fish in turn, recalculated advisory exceedance, and calculated the percentage reduction in advisory exceedance. For example, to get an estimate of how much walleye consumption contributed to advisory exceedance, we calculated advisory exceedance without any data on walleye consumption. We used a similar approach to estimate the degree to which consumption of fish from particular local water bodies contributed to advisory exceedance. For some individuals, advisory exceedance was not caused by the consumption of particular contaminated fish, but by consumption of too much purchased fish with the lowest levels of contaminants. To estimate the degree to which consumption of too much purchased fish contributed to advisory exceedance, for all species of purchased fish which had recommended consumption limits of one/week or two/week, we assumed that no one exceeded these particular limits and recalculated advisory exceedance.

3. Results

3.1 Diary Recruitment and Participation Rates

We recruited 2,099 study-eligible licensed urban anglers to participate in the study. Anglers who agreed to participate were slightly older (47.6) than other anglers in the sample pool (45.5, $p<0.001$). Seventy-six percent of urban anglers (n=1,587) participated in the first two-week period, while a smaller subset of 1,378 (66%) participated throughout the 16-week study period. Urban anglers who indicated in the screening interview that they never ate fish were ineligible for the study; however, a few eligible participants (n=15) reported that they did not consume any fish during the 16-week study period and were thus excluded from the analysis. There were no differences in fish consumption between those who participated fully and those who participated during only part of the study period for the periods when the two groups overlapped. Anglers who participated the entire 16 weeks were slightly older than those who did not (49.0 vs. 46.1, $p=0.005$), but their gender did not differ. Since there was no difference in fish consumption or gender and the difference in age was small, for simplicity we considered anglers who participated throughout the 16-week period as similar to all urban anglers who participated in the study and report results for the 16-week group only (final analytic sample n=1,363).

3.2 Angler Characteristics

Between 400 and 500 anglers in each of the study sites completed the diaries throughout the summer of 2014[16]. The characteristics of the participants were fairly similar in all three sites (Table 1). They were predominantly white (92-95%) and male (82-84%). The mean age ranged between 45 and 52 years with Erie anglers significantly younger. The median household income level was in the $75,000-$99,999 range at all three sites. The most substantial difference between sites was in level of education. Sixty-two percent of participants in Kalamazoo had a college degree while only 46% of those in Erie did; Rochester anglers were in the middle at 53%. Nonwhite anglers included Black or African American (42%), Asian or Pacific Islander (23%), Native American or Indian (11%), and Other (25%). Because of the small sample size for every racial category except White, we compared white and nonwhite anglers in our analyses.

[16] Appendix G provides detailed information by study site for all questions asked in the surveys conducted at the end of Year 1 and Year 2. These include questions about socio-demographic characteristics, awareness of fish consumption guidelines, sources of information, beliefs about fish consumption, perceived changes in fish consumption behavior between Year 1 and Year 2, and awareness of the brochure sent between study years.

Table 1
Characteristics of diary participants.

	Kalamazoo, MI	Erie, PA	Rochester, NY
Sample Size	414	449	500
Age (mean)	51.8	45.9	49.4
Gender – % male	82	84	82
Annual Household Income (median)	$75,000-$99,999	$75,000-$99,999	$75,000-$99,999
Education – % w/ college degree	62	46	53
Race – % white	95	95	92

3.3 Amount of Fish Consumed

The number of fish meals eaten over the 16-week period ranged from 1 to 73 with 51% of participants eating less than 1 fish meal/week[17]. The mean number of fish meals/week was 1.12 and the mean grams of fish consumed per day was 25.1-26.8 (depending on the assumptions made about portion size). Anglers in Erie ate less fish than anglers at the other two study sites (Table 2). Older anglers, better educated anglers, and higher income anglers all ate more fish. Nonwhite anglers did not eat more fish meals/week than white anglers, but they did eat more grams/day. The amount of fish consumed by male and female anglers did not differ.

3.4 Types of Fish Consumed

A large majority (81%) of the 17.9 fish meals (mean) consumed over the 16-week study period were purchased as opposed to sport-caught fish. The proportion of sport-caught fish varied in the study sites from a low of 10% in Rochester to more than one-quarter of meals in Erie (Table 3)[18]. Some demographic groups consumed a greater proportion of sport-caught fish than others. Men ate a greater proportion of sport-caught fish than did women. The oldest group of anglers (60 years or older) consumed a lower proportion of sport-caught fish. The relative proportion of sport-caught fish consumption decreased with education and income. Nonwhite anglers consumed a greater proportion of sport-caught fish than white anglers did.

[17]Almost all urban anglers (91%) ate their fish meals distributed over the 16-week study period, with no single period comprising 25% or more of their total consumption. Nine percent ate 25% or more of their meals within a two-week period. These urban anglers might represent a group who ate most of their fish while on vacation, thus concentrating their exposure to potential contaminants within a short period of time.

[18] Appendix H describes the amount of fish eaten for each type of fish identified in the guidelines for each study site.

Table 2
Amount of fish consumed by study participants.

	Fish Meals/Week[1]	Grams/Day[1,2]
Study Site		
Kalamazoo, MI	1.15[a]	25.8-27.4[a]
Erie, PA	0.98[b]	22.5-24.2[b]
Rochester, NY	1.22[a]	27.0-28.6[a]
Age		
Under 35	0.85[a]	19.4-20.8[a]
35 to 49	1.01[a]	23.2-25.1[b]
50 to 59	1.17[b]	26.2-27.9[b]
60 or over	1.39[c]	30.5-32.2[c]
Education		
High school or less	0.88[a]	20.2-21.9[a]
Some college	1.09[b]	24.7-26.5[b]
College degree or more	1.23[b]	27.3-28.9[b]
Annual Household Income		
Less than $50,000	1.03[a]	23.0-24.6[a]
$50,000-$99,999	1.06[a]	23.7-25.3[a]
$100,000 or more	1.31[b]	29.4-31.2[b]
Race		
Nonwhite	1.30[a]	30.4-33.1[a]
White	1.13[a]	25.2-26.9[b]
Total	1.12	25.1-26.8

[1]Within each category, figures with different superscripts differ significantly ($p<0.05$).
[2]The range reflects different assumptions about portion size (as described in Methods).

Table 3
Percentage of sport-caught fish within total fish meals.

	Percentage of Sport-Caught Fish Meals[1]
Study Site	
Kalamazoo, MI	23[a]
Erie, PA	26[b]
Rochester, NY	10[c]
Gender	
Male	20[a]
Female	15[b]
Age	
Under 35	20[a]
35 to 49	21[a]
50 to 59	20[a]
60 or over	16[b]
Education	
High school or less	29[a]
Some college	23[b]
College degree or more	15[c]
Annual Household Income	
Less than $50,000	26[a]
$50,000-$99,999	21[b]
$100,000 or more	15[c]
Race	
Nonwhite	24[a]
White	19[b]
Total	19

[1]Within each category, figures with different superscripts differ significantly ($p<0.05$).

Urban anglers ate a variety of species of purchased fish, but more than 70% of fish meals were of one of six types of fish: shellfish (28%), salmon (15%), canned "white" tuna (9%), canned "light" tuna (8%), haddock (7%), and tilapia (5%)[19].

3.5 Advisory Exceedance

Because urban anglers did not always know the length and occasionally the species of fish they had eaten, we estimated advisory exceedance using both liberal and conservative assumptions. Overall, 17-22% of anglers exceeded advisory limits, but the proportion varied considerably from one study site to another: from 27-40% of anglers in Kalamazoo to 7-10% in Rochester (Table 4). Female anglers were more likely to exceed conservative advisory guidelines than

[19] Appendix C characterizes the number of types of purchased fish that individuals consume.

men[20]. Exceedance of advisories was greater for older anglers and for nonwhite anglers. Advisory exceedance was not correlated with education or income.

Table 4
Percentage of study participants exceeding advisory guidelines.

	Liberal Assumptions[1]	Conservative Assumptions[1]
Study Site		
Kalamazoo, MI	27[a]	40[a]
Erie, PA	17[b]	20[b]
Rochester, NY	7[c]	10[c]
Gender		
Male	16	21[a]
Female	21	28[b]
Age		
Under 35	13[a]	17[a]
35 to 49	14[a]	21[a]
50 to 59	16[a,b]	22[a,b]
60 or over	22[b]	28[b]
Race		
Nonwhite	28[a]	39[a]
White	17[b]	22[b]
Total	17	22

[1]Within each category, figures with different superscripts differ significantly ($p<0.05$).

We selected just those individuals who exceeded the advisory guidelines based on conservative assumptions in Kalamazoo (40% of participants), Erie (20%), and Rochester (10%) and calculated the relative contributions of different types of fish consumption to advisory exceedance (Table 5). The types of fish that contributed most to advisory exceedance varied from site to site. In Kalamazoo, which is the only site relying on state (rather than federal) guidelines for purchased fish consumption, the consumption of too much low-mercury purchased fish made the greatest contribution to advisory exceedance. In Erie, consumption of walleye and white perch made the greatest contributions; if the consumption of walleye alone was eliminated in Erie, it would reduce the number of people exceeding the guidelines by nearly 50%. In Rochester, the consumption of sport-caught lake trout (lake trout > 25” have stricter consumption limits), the consumption of any fish from Lake Ontario by women of childbearing age, and the consumption of too much low-mercury purchased fish all made similar contributions to advisory exceedance.

[20] Appendix I: Profiles urban anglers who are exceeding the guidelines.

Table 5
Percentage reduction in advisory exceedance from eliminating certain types of fish consumption from data set.

	Kalamazoo, MI	Erie, PA	Rochester, NY
Purchased fish			
Shark	0	2	0
Swordfish	5	1	2
Too much low-mercury purchased fish[1]	38	0	6
Sport-caught fish			
Lake trout	0	8	14
Walleye	2	48	0
White perch	0	35	0
Fish from specific water bodies			
Kalamazoo River (Morrow to Allegan Dams)	5	-	-
Lake Ontario (women of childbearing age only)	-	-	12

[1]Purchased fish with recommended limits of one/week or two/week.

4. Discussion

Our characterization of fish consumption by urban anglers complements past research on this population. Nearly all past research on urban anglers has focused on subgroups of anglers that were expected to eat a lot of fish. This work has helped to characterize fish consumption among individuals that are most likely to be exposed to contaminants in fish. In some cases, however, the sampling strategies used to select heavy fish consumers prevent generalization of the results to a larger population. Even when the results can be generalized to a larger population, these studies as a set do not provide a comprehensive picture of urban anglers and how vulnerable subpopulations are similar to or different from the larger population of anglers living in cities. The more comprehensive characterization of urban anglers that we generated in this study can inform fish consumption advisory programs because it can reveal the degree to which these subgroups may benefit from a tailored approach to communicating advisory information.

Our estimate of fish consumption by urban anglers was lower than the estimates of most past studies. We found that the average angler consumed 1.12 meals/week of fish (with about one-fifth of those being sportfish meals) and 25.1-26.8 grams/day in three Great Lakes cities during summer 2014. This estimate is equivalent to 58 total fish meals/year. Kearney and Cole (2003) estimated 10.9-34.2 meals of Great Lakes fish/year, and the lower end of this range (because it includes Great Lakes fish only) overlaps with our estimate of sportfish consumption. Studies by Hutchison and Kraft (1994), Sheaffer and O'Leary (2005), Burger (2002), and particularly Murkin et al. (2003) all produced estimates of fish consumption that were considerably higher than ours, with Murkin et al. reporting 99 sportfish meals/year and 157 total fish meals/year.

In contrast, Lauber et al. (in review) reported much lower estimates of fish consumption by urban anglers: a mean of 17.9 fish meals/year, which is about one-third of our figure. Their findings were based on a survey of a representative sample of anglers throughout the Great Lakes region, with their analysis focused on a subset of respondents who self-identified as being from urban areas. Their approach to sampling included a much broader range of types of cites than ours. They also included all anglers in their sample, whether or not they actually ate fish, while we included only people who ate at least some fish.

Because almost all of the studies of urban anglers summarized above selected for individuals expected to consume large amounts of fish, we would not expect their estimates of fish consumption to be similar to ours. Studies of representative samples of licensed anglers and sportfish consumers are more comparable to ours, even though they do not focus specifically on *urban* anglers. Cole et al. (2004) estimated sport fish and total fish consumption among likely sport fish consumers in several Canadian communities. They reported a range of 11 to 29 sportfish meals per year and 26 to 82 total fish meals per year depending on the community and demographic group. Imm et al. (2005) surveyed Great Lakes states' residents in 2001 and 2002 and reported a mean of 53 fish meals per year among those residents who consumed sportfish from the Great Lakes. Turyk et al. (2012) estimated total fish consumption and Great Lakes fish consumption among Great Lakes fish consumers based on a number of other studies. They reported a mean of 7 to 77 Great Lakes fish meals per year and 42 to 111 total fish meals per year. West et al. (1993) studied fish consumption of licensed Michigan anglers, asking them to report their fish consumption over only the last seven days, but staggering their data collection over a full year to produce annual estimates; they estimated that total fish consumption was 24.4 grams/day and sport fish consumption was 14.5 grams/day.

Although these findings are broadly consistent with ours, the estimates of fish consumption are quite varied, ranging from 26 to 111 total fish meals/year. Some of this variation could be attributable to methodology. With very few exceptions, the studies cited above relied on surveys or interviews and asked people either how much fish they typically ate or to recall how much fish they ate in the last three to 12 months. These studies could be expected to generate less reliable estimates than the diary method that we used. Our estimates of total fish consumption and grams/day of fish were fairly consistent across our three study sites, varying by no more than 25%.

The only published study of anglers using a diary method that we found was Connelly et al.'s study of 1992 Lake Ontario anglers (Connelly et al., 1996). The authors had participants keep diaries over a full year, and used the results to estimate fish consumption and compliance with fish advisories. They reported averages of 17.9 grams of fish/day and 30.3 total fish meals per year (both lower than our estimates) with 28% of those meals being sport-caught fish (similar to our estimate).

Our findings focused not just on how much fish was being consumed but the types of people consuming the most fish. We found that fish consumption increased with age, education, and income and was higher for nonwhites than for whites. These findings are consistent with the literature, although no study that we could find documented all of these patterns. Burger (2002) found that fish consumption increased with age. Imm et al. (2005) reported that more educated individuals ate more fish. Lauber et al. (in review) and Imm et al. (2005) reported fish consumption increased with income.

The findings on racial differences in fish consumption are more complicated. Although we found higher fish consumption among nonwhites, we were unable to distinguish different nonwhite racial groups because of our sample size. Most studies of racial patterns in fish consumption in urban anglers have focused on Asian ethnic groups and may not directly compare these individuals to other ethnic groups. Hutchison and Kraft (1994) reported high levels of consumptions for a Hmong community, but did not collect data on whites. Murkin et al. (2003) compared Asian-born fish consumers with European-, Canadian-, and U.S.-born, and found that Asian-born ate more fish. Although these findings are compatible with ours, anglers of Asian or Pacific Islander descent made up only 23% of our nonwhite sample (n=19), limiting our ability to characterize racial differences in detail.

In addition to our analysis of fish consumption, we also estimated advisory exceedance. The only other study we found that produced similar estimates of advisory exceedance was Connelly et al.'s study of Lake Ontario anglers (Connelly et al., 1996), which reported 36% of anglers exceeding advisory limits; this was somewhat higher than our estimate of 17-22% across all three study sites. In our study, exceedance was higher for older anglers, women, and nonwhites, but it did not differ significantly with education and income despite the fact that better educated and higher income anglers tended to consume more fish. The finding that women and nonwhites are more likely to exceed advisories has rarely been documented elsewhere, but is often expected because advisories are more stringent for women of childbearing age and some nonwhite angler populations have been shown to consume more fish (see above). The higher rate of advisory exceedance in older anglers is not as widely recognized, however, and suggests the potential benefits of directing special attention to older anglers in advisory programs.

We also found that advisory exceedance varied a great deal geographically, ranging from 7-10% in Rochester, NY, to 27-40% in Kalamazoo, MI, despite similar levels of fish consumption at the three sites. There are several reasons for these differences. To begin with, advisory programs at the three sites have adopted different approaches. In particular, Kalamazoo, with the highest rates of exceedance, also has the most detailed advisory for purchased fish consumption. The purchased fish advice in Kalamazoo was developed by the State of Michigan and includes all consumers, whereas for the other two sites, we used the simpler federal purchased fish advice which applies only to women of childbearing age (who make-up a small portion of the angler population) in evaluating compliance with advisories. Indeed, purchased fish consumption contributes substantially to advisory exceedance in Kalamazoo.

In addition to the differences in the advisories, the types of fish that are most likely to expose anglers to contaminants varies from site to site because the species that are available to catch, and their contaminant loads, vary from city to city. In Erie, consumption of walleye and white perch have a considerable influence on advisory exceedance, and these are sportfish that many anglers catch in Lake Erie. These species have little to no effect on advisory exceedance at the other two sites.

These findings have practical value for advisory programs. To begin with, they demonstrate or confirm that certain audiences, namely women, older anglers, and nonwhites, are more likely to exceed the advisories. Indeed, many fish advisory programs direct special attention to women and nonwhite anglers, in particular. We also reported novel findings regarding the types of fish that contribute to advisory exceedance, demonstrating considerable variation in these types of fish from site to site. Although advisory programs understandably attempt to provide comprehensive consumption advice for fish for particular locations, there is the potential for anglers to be overwhelmed by the amount of information they receive in these advisories. Recognizing that certain species are most likely to contribute to exceedance suggests that highlighting the importance of monitoring the consumption of particular species could play an important role in protecting the public health, but such a community-specific approach to advisories would be resource-intensive.

The limitations of our study relate to the audience on which we focused. We studied only *licensed* anglers and not unlicensed anglers, who might consume more fish and be at greater risk. We restricted the anglers in our sample to those who ate at least some fish and focused on their fish consumption over the summer, when they were likely eating the most. Therefore, we may very well over represent annual fish consumption by licensed urban anglers. By collecting data on consumption during the period when licensed anglers are likely to eat the most fish, however, we ensure that our estimates reflect the periods when health risks are greatest.

Finally, although we relied on advisory exceedance as an indication of health risk, this measure of risk is relatively crude. Anglers who exceed advisory guidelines may do so by a lot or a little. Clearly, the public health implications differ depending on how much anglers exceed advisory limits. Future work could focus on developing estimates of contaminant loads from fish consumption rather than a simple dichotomous measure of advisory exceedance.

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SECTION 6: EFFECTS OF AN ADVISORY BROCHURE ON FISH CONSUMPTION OF URBAN ANGLERS IN THE GREAT LAKES REGION

ABSTRACT: Past research has suggested that urban anglers are a group at high risk of being exposed to contaminants from fish consumption. Fish consumption advisories have been used in many regions to encourage healthy fish-eating behaviors, but few studies have been designed to assess whether these advisories actually influence behavior as intended. We conducted a large-scale, randomized experiment to test the influence of an advisory brochure on urban anglers' fish consumption. We collected detailed information on urban anglers' fish consumption in three cities in the Great Lakes region in the summers of 2014 and 2015. We provided a treatment group with fish consumption guidelines in an advisory brochure before the summer of 2015 and compared their change in fish consumption to a control group. The brochure led to a reduction in fish consumption for anglers who ate the most fish; these anglers reduced their consumption of high-contaminant purchased fish and both high- and low-contaminant sport-caught fish. The brochure also reduced sport-caught fish consumption among those anglers who exceeded the advisories in 2014. In addition, the brochure led to small increases in fish consumption in urban anglers who ate very little fish.

KEYWORDS: fish consumption; advisories; urban anglers.

1. Introduction

The Great Lakes Restoration Initiative Action Plan II identifies urban anglers as a group at high risk of being exposed to contaminants through fish consumption (Great Lakes Interagency Task Force 2014). Urban waters are often heavily polluted, and fish in those waters may be more likely than fish in other waters to accumulate contaminants. Fish consumption advisories for urban waters are often more restrictive than advisories for other waters. Urban anglers are considered more likely than other anglers to fish at urban sites and, if they eat the fish they catch, more likely to be exposed to the contaminants in these fish.

A number of studies of urban anglers or urban residents who eat fish have reported relatively high levels of fish consumption compared to the population at large. Most of these studies, however, have focused on particular subpopulations who were expected to consume a lot of fish because of their ethnicity (Hutchison and Kraft 1994, Murkin et al. 2003), fishing site selection (Sheaffer and O'Leary 2005), or the results of a screening process (Kearney and Cole 2003). Lauber et al. (in review) studied fish consumption in a representative sample of urban anglers in three Great Lakes cities using a diary method in which participants recorded data on all of their fish meals over a four-month period. They reported a mean of 1.12 meals/week across the three urban sites, with evidence of excessive consumption by some anglers. The percentage of anglers exceeding fish consumption advisory recommendations ranged from a low of 7-10% at one site to a high of 27-40% at another. Women, older anglers, and nonwhites were more likely to exceed advisory recommendations.

Fish consumption advisories are used throughout the Great Lakes region and elsewhere to encourage safe fish consumption. Most studies of the effectiveness of these advisories are limited, using indirect evidence to infer whether or not advisories lead to safe fish-eating behaviors. A number of studies have reported rates of compliance with advisories (Lauber et al. in review a, Silver et al. 2007, Burger 2002, Connelly et al. 1996), but do not assess whether the advisories are contributing to that compliance. Other studies have explored the prevalence of various antecedents to advisory compliance. For example, Beehler et al. (Beehler et al. 2001,2003) and Burger et al. (1999) documented urban anglers' awareness of advisories. Some authors have studied whether fish eaters believe or correctly understand key advisory messages (Pflugh et al. 1999, McDermott et al. 2003, Burger and Waishwell 2001). Chess et al. (2005) and Burger et al. (2003) assessed which approaches to communicating advisory messages are most effective at encouraging correct beliefs. Studies have also explored the advisory formats and messages that are preferred by urban anglers (Lauber et al. in review b) or anglers in general (Connelly and Knuth 1998). This body of work is valuable, as urban anglers must be aware of advisories, find them accessible, and correctly understand their messages before the advisories can influence fish consumption.

None of these studies, however, provides evidence that advisories actually influence behavior. Only a few studies have attempted to answer this question, and none of them have specifically targeted urban anglers. The most common approach to assessing the influence of advisories on behavior has been to explore whether awareness or receipt of advisories is associated with safe fish consumption patterns. For example, Silver et al. (2007) reported that fish consumption was lower for women who were aware of advisories. Teisl et al. (2011) surveyed women to find out whether they had received a fish advisory brochure and compared the fish consumption of those who did and did not receive the brochure before, during, and after pregnancy. Although studies like these show a connection between advisory awareness and fish consumption behavior, they are correlational and so cannot establish causation. The people who are aware of or remember receiving advisories may be those who pay more attention to fish consumption and who would be eating different amounts of fish regardless of whether or not they received the advisory.

Shimshack et al. (2007) took a different approach and studied how consumer purchases of fish changed after the issuance of the FDA/EPA advisory for mercury in fish. To do this, they took advantage of the Bureau of Labor Statistic's CEX, an annual survey that collects data on all household expenditures. They looked at how purchases of canned fish changed after the advisory was first issued. They found that some targeted groups reduced canned fish purchases as a result of the advisory and concluded that issuing the advisory could influence behavior, but they did not focus on urban anglers or other high-risk groups of anglers.

Roosen et al. (2009) and Verger et al. (2007) took an experimental approach to establish the effects of advisories. They tracked fish consumption in a sample of individuals for three months (in two separate periods) in France. A treatment group received a message about mercury in fish and recommendations for fish consumption during an in-person visit. Both studies found small decreases in fish consumption in the treatment group compared to a control group. Both also found, however, that consumption of the most contaminated fish did not decrease, and neither study examined urban anglers.

Given that experimental evidence of the effectiveness of fish consumption advisories is limited, and no such evidence is available for urban anglers, we conducted a large-scale, randomized experiment to test the influence of an advisory brochure on urban anglers' fish consumption. We collected detailed information on urban anglers' fish consumption in three cities in the Great Lakes region in the summers of 2014 and 2015. We provided a treatment group with fish consumption guidelines in an advisory brochure before the summer of 2015 and compared their change in fish consumption to the change in fish consumption of a control group that did not receive the experimental brochure.

2. Methods

2.1 Sample selection and diary recruitment

We drew a sample of 15,000 fishing licenses sold to licensed anglers who lived in one of three urban counties in the Great Lakes region: the counties containing Kalamazoo, MI, Erie, PA, and Rochester, NY. Each of these cities had populations of at least 75,000 people. We drew 5,000 licenses from each county.

We sent invitation letters to each member of the sample in February 2014. The letter described the study and what would be required of participants. It also offered a financial incentive of up to $45 for participation in the project and provided a link to a sign-up page on the Internet. We provided a postage-paid return postcard for people to opt out of the study because they did not eat fish, did not have regular Internet access, or were not interested in participating. We sent a follow-up letter to all invitees a week later encouraging participation.

We called those who did not sign-up or return a postcard to encourage participation and allow them to sign up over the telephone. Calling ceased in each city when the quota of participants had been reached for that city. During the study sign-up process we obtained email addresses and then checked them by sending out a study participation verification email. Email was then used for all communication with study participants.

2.2 Diary data collection

We collected fish consumption information for 16 weeks in the summer of 2014 (May 18-September 6, 2014) and 16 weeks in the summer of 2015 (May 17- September 5, 2015). Participants recorded data in two-week blocks. Participants could record information as many times as they wished during the two-week period. Every two weeks we sent an email invitation to participants to signal the start of the next two-week period and remind them that the previous two week-period was ending. When a two-week period ended, we sent up to three reminders to participants who had not completed entering data for the period to finish recording their information for the period. Participants earned a $2 financial incentive for each period completed and received a $5 bonus at the end of the first year and $9 at the end of the second year if they completed reporting for every period.

We gave each participant a link unique to them to access their personal fish consumption diary on the Internet. On the initial page, participants saw information for the eight two-week periods of the study, showing completed periods and incentives earned. On the next page we asked participants to record whether or not they ate fish on each day in the current two-week period. For each day they indicated they ate fish, another page opened asking the number of fish meals they had eaten on that day. For each meal reported, participants recorded whether the fish was purchased (at a store or restaurant) or sport-caught (i.e., fish caught by you or someone else), the species eaten, the portion size, and (for sport-caught fish) where the fish was caught. We provided a list of water bodies in each urban area that had special advisories for the fish caught there. We provided a list of fish species, including the most commonly consumed purchased fish and those with consumption guideline recommendations, along with a text box to record species not on the list. For sport-caught species, we listed only those with consumption guideline recommendations and provided an “other” option. Participants indicated portion size in reference to a picture of a 6 oz. cooked (170 grams) portion of salmon (Fig. 1); we asked participants if the meal they ate was larger, smaller, or the same size as the picture.

We obtained data on participant age from fishing license records. We gathered data on other socio-demographic characteristics, such as education and race, using an online survey conducted during the last 2-week period of diary data collection.

2.3 Intervention

We developed a single-page, bifold fish consumption guidelines brochure to serve as the intervention in this study. We worked collaboratively with the Great Lakes Consortium for Fish

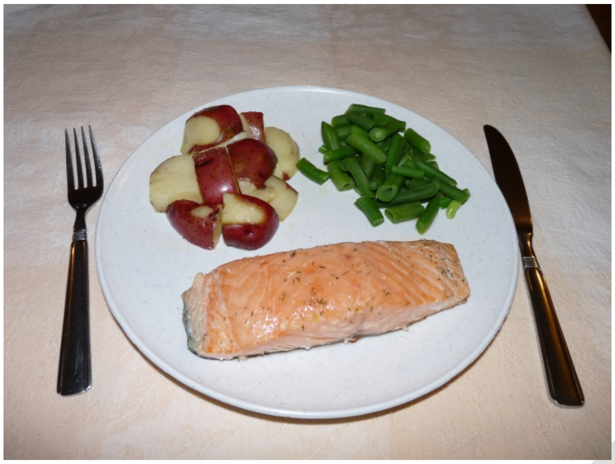

Fig. 1. Picture shows a 6 oz. piece of cooked salmon (8 oz. pre-cooked).

Consumption Advisories to develop this brochure. Different versions of the brochure were designed for each of our three study sites, listing the fish consumption guidelines for those sites, including guidelines for local bodies of water with special advisories. The fish consumption messages were the same for each site, however. These messages were based on past research on effective messaging sponsored by the Consortium, Consortium members' insights into effective messaging based on their experience, and dialogue among members of the Consortium and the authors of this paper. The key messages were designed to encourage recipients to follow the fish consumption guidelines for their city (Table 1).

The sample was randomly assigned either to receive the brochure intervention (two-thirds of the sample) or to be part of a control group (one-third of sample), which did not receive the brochure. For those receiving the brochure, two elements of the brochure content were varied in a 2x2 experimental design leading to 4 versions of the brochure. Members of the treatment group were randomly assigned to four equal groups, each of which received a different version of the brochure.[21] The two elements of the brochure which varied were:

- On the second page of the brochure, key messages about fish consumption were presented in two different versions: a frequently asked questions (FAQ) format, in which the messages were presented as answers to three questions about fish consumption; and a narrative format in which the same messages were incorporated into the form of a story about a hypothetical urban angler.
- Language was varied throughout the brochure to reflect more certainty about fish consumption recommendations in one version and less certainty about recommendations in other versions. For example, the "certain" version included the text "Fish is an

[21] We calculated the odds of a person who received one brochure knowing a person who received a different brochure, based on the size of the population of urban anglers in each county from which the sample was drawn. The draw of the sample was random. The best odds of knowing someone were 1 in 42 in Erie, PA and 1 in 65 in Rochester, NY, making it unlikely in our opinion that someone could be influenced by a different brochure than the one they were assigned to receive.

important part of a healthy diet" on the first page. The "uncertain" version included the text "Fish can be an important part of a healthy diet." In addition, the last page of the uncertain version contained an additional bullet point conveying uncertainty: "It is difficult to know who might have health problems from chemicals in fish. Some people can be fine after years of eating fish with these chemicals in them, while others can have health problems."

These variations allowed us to test the relative effects of different variations of the brochures on encouraging anglers to follow the advisories.

For those individuals in one of the treatment groups, hard copies of the brochure were sent to them by mail on May 11, 2015, shortly before data collection for the second year began. The brochure was also available to them electronically on the website on which they entered their fish consumption records.

Table 1
Key messages about fish consumption in advisory brochure.

Fish is an important part of a healthy diet.

- Fish is low in calories, has plenty of protein, and is a great way to get omega-3s.
- These nutrients help your brain and body work well.
- Eating fish lowers your risk of heart disease and other health problems.

Some types of fish from some lakes and streams contain harmful chemicals such as PCBs and mercury.

- You can't see, smell, or taste these chemicals when you eat fish.
- When you eat fish that contain these harmful chemicals, the chemicals build up in your body. Eventually, they can cause health problems.
- Sometimes these health problems are hard to notice. Other times they can cause major problems such as cancer.
- You should eat less of these kinds of fish and choose fish that are healthy to eat.

Health experts can help you know which fish are healthy for you and your family to eat.

- See the guidelines in this brochure from the [relevant state or federal agencies].
- These guidelines tell which fish are the healthiest fish to eat. They also tell which lakes, streams, and rivers have fish that are less healthy to eat.
- People who follow these guidelines can enjoy fish and keep the chemicals from building up to harmful levels in their bodies.

2.4 Data Analysis

Several previous studies have estimated the size of fish portions that people eat using pictures similar to those used in our study (Connelly et al. 1996, West et al. 1993) or plastic models (Silver et al. 2007). Since we provided a picture of a 6 oz. cooked salmon meal, we assumed those indicating an equivalent portion to the photo ate a 6 oz. portion (170 grams). For 41% of meals, the participants indicated their portion size was smaller than the picture; we assumed that corresponded to 4 oz. (113 grams). For meals reported as being larger than the picture (19% of meals), we used a sensitivity analysis to compare two options for calculating portion size. For one option, we estimated the larger portion size to be 8 oz. (227 grams) and for the other we assumed the size to be 10 oz. (283 grams). We used these estimates to convert from the number and size of meals to an estimate of ounces and grams consumed per week or per day.

We compared the meals eaten by each participant to the guidelines of the state where they lived. We characterized participants as adhering to the guidelines if they kept their total consumption for the 4-month study period within the recommendations for that time period. For example, if the recommendation was to consume no more than one serving of coho salmon per month from Lake Michigan, and a person consumed five servings of coho salmon during the 4-month study period, we concluded that he or she had exceeded the guidelines. We measured fish consumption against the guidelines for local bodies of water, the statewide guidelines for all other sport-caught fish, and the state guidelines (or federal guidelines if no state guidelines existed) for purchased fish. If an individual exceeded any of these guidelines, we concluded that he or she exceeded the guidelines.

We present some results as ranges (based on liberal and conservative assumptions) because some advice is based on the length of the fish caught; if consumers did not know the length of the fish they ate, we estimated their adherence to the guidelines assuming both the most and least restrictive consumption recommendations for that species. Similarly, a few consumers did not know the species of fish they were eating, or more commonly, reported eating multiple species at one meal. In these cases, we estimated their adherence to the guidelines assuming both the most and least restrictive consumption recommendations for the water where the fish was caught.

We analyzed data from the diary using SPSS (IBM SPSS Statistics 20). We used chi-square tests to identify statistically significant differences between cities at the $P < 0.05$ level. Any differences described in the narrative text are statistically significant at this level. We used Scheffe's test to identify differences in portion sizes based on species of fish consumed. We used linear regression to explain differences in fish consumption based on available demographic data.

We developed logistic regression models to predict adherence to the advisories in year 2, while controlling for advisory exceedance in year 1. We developed OLS regression models to estimate the number of total, purchased, and sport fish meals consumed in year 2, while controlling for meals consumed in year 1. We tested for the main effects of: (a) being in the experimental group (receiving a version of the brochure) vs. control; (b) the narrative version of the brochure vs. the FAQ version vs. control; and (c) the certain version of the brochure vs. the uncertain vs. the control. We tested for interactions between the narrative-FAQ variation and the certain-uncertain variation. We included demographic variables as covariates. In some variations of these regressions, we predicted consumption of only low-contaminant fish (fish for which recommended consumption limits were once/week or more) or high-contaminant fish (fish for which recommended consumption limits were less than once/week). We probed interactions in the regressions using the Johnson-Neyman technique to identify levels of the moderator (fish meals consumed in year 1) at which effects of the dependent variable (brochures) were statistically significant (Hayes 2013).

3. Results

3.1 Diary Recruitment and Participation Rates

We recruited 2,099 study-eligible licensed urban anglers to participate in the study. Anglers who agreed to participate were slightly older (47.6) than other anglers in the sample pool (45.5, $p<0.001$). Seventy-six percent of urban anglers (N = 1,587) participated in the first two-week period in 2014, 1,378 (66%) participated throughout the 16-week study period in 2014, and 1,041 (50%) completed the diaries in both 2014 and 2015 and are included in the analyses in this manuscript.

We first compared respondents who participated fully in both 2014 and 2015 to those who participated fully in 2015 but not 2014. Anglers who participated fully in both 2014 and 2015 were somewhat older than those who participated fully in 2015, but not 2014 (48.6 vs. 42.1, $p=0.01$). Their household income, education level, race, and gender did not differ.

3.2 Angler Characteristics by Study Site

Between 300 and 400 anglers in each of the study sites completed the diaries throughout both 2014 and 2015. The characteristics of the participants were fairly similar in all three sites (Table 2). They were predominantly white (93-97%) and male (80-83%). The mean age ranged between 45 and 51 years with Erie anglers significantly younger. The median household income level was in the $75,000-$99,999 range at all three sites. The most substantial difference between sites was in level of education. Sixty-four percent of participants in Kalamazoo had a college degree while only 49% of those in Erie did; Rochester anglers were in the middle at 57%.

Nonwhite anglers included Black or African American (38%, n=18), Asian or Pacific Islander (30%, n=14), Native American or Indian (15%, n=7), and Other (23%, n=11). Because of the small sample size for every racial category except White, we compared white and nonwhite anglers in our analyses.

3.3 Fish Consumption and Advisory Exceedance at Baseline (2014)

The number of meals of fish consumed over the 4-month study period in 2014 ranged from 15.32 meals in Erie to 19.43 meals in Rochester (Table 3). Most of the meals were purchased fish meals, although the percentage varied from site to site with a low of 73% in Erie to a high of 90% in Rochester. Anglers in Erie ate fewer total fish meals and purchased fish meals than anglers at the other two sites. Anglers in Rochester ate fewer sport-caught fish meals and more purchased fish meals. The number of fish meals (purchased, sport-caught, and total) decreased in 2015. The decrease in purchased fish meals in Rochester (1.27) was larger than that in Kalamazoo (0.23) or Erie (0.45), and the decrease in sport-caught fish meals was larger in Erie (1.01) than in Rochester (0.34).

Table 2
Characteristics of diary participants by study site.

	Kalamazoo, MI	Erie, PA	Rochester, NY
Sample Size	316	349	376
Age (mean)	51.4	45.4	49.0
Gender – % male	81	83	80
Annual Income (median)	\$75,000-\$99,999	\$75,000-\$99,999	\$75,000-\$99,999
Education – % w/ college degree	64	49	57
Race – % white	97	96	93

Table 3
Mean number of fish meals consumed by urban anglers at each study site[1].

	Kalamazoo, MI	Erie, PA	Rochester, NY
2014			
Purchased fish	13.84[a]	11.20[b]	17.57[c]
Sport-caught fish	4.16[a]	4.12[a]	1.86[b]
Total fish	18.00[a]	15.32[b]	19.43[a]
2015			
Purchased fish	13.98[a]	11.51[b]	16.35[c]
Sport-caught fish	3.33[a]	3.12[a]	1.52[b]
Total fish	17.31[a]	14.63[b]	17.86[a]

[1]Within each row, figures with different superscripts differ significantly ($p<0.05$).

Because urban anglers did not always know the length and occasionally the species of fish they had eaten, we estimated advisory exceedance using both liberal and conservative assumptions. Overall, 17-22% of anglers exceeded advisory limits in 2014 (Table 4), but the proportion varied considerably from one study site to another: from 27-40% of anglers in Kalamazoo to 7-10% in Rochester. In 2015, advisory exceedance ranged from 26-37% in Kalamazoo to 2-3% in Rochester. Female anglers were more likely to exceed advisory guidelines than men (Table 5). Exceedance of advisories was greater for older anglers and for nonwhite anglers (Table 5). Advisory exceedance was not correlated with education or income.

3.4 Experimental Results

We combined the data from the three sites in our analyses of the results of the experiment. We tested whether the brochure intervention influenced either: (a) advisory exceedance; or (b) amount of fish consumed. We detected no effects of the brochure on advisory exceedance, so the remaining results portray the effects of the brochure on fish consumption.

Table 4

Advisory exceedance by study site.

	2014		2015	
	Liberal Estimate	Conservative Estimate	Liberal Estimate	Conservative Estimate
Kalamazoo, MI	25.7%	40.3%	25.7%	37.3%
Erie, PA	19.2%	22.3%	13.5%	14.3%
Rochester, NY	4.0%	6.9%	1.5%	2.8%

Table 5
Advisory exceedance (liberal assumptions) by study participants in 2014[1].

	Liberal Assumptions
Gender	
Male[a]	14%
Female[b]	23%
Age	
Under 35[a]	12%
35 to 49[a,b]	15%
50 to 59[a]	14%
60 or over[b]	21%
Race	
Nonwhite[a]	29%
White[b]	16%

[1]Within each category, figures with different superscripts differ significantly ($p<0.05$).

The intervention led to a small but significant drop in the number of fish meals eaten by the treatment group compared to the control group (p=0.016). The version of the brochure did not matter.[22] The treatment group ate 1.30 (SEM=0.26) fewer meals in 2015 than in 2014. The decrease in fish meals in the control group (0.20, SEM=0.38) was nonsignificant. A similar pattern was detected for purchased fish consumption. Those anglers who received the brochure ate 0.57 (SEM=0.25) fewer purchased fish meals on average than in 2014, which was significantly different from a nonsignificant increase of 0.44 (SEM=0.36) purchased fish meals in the control group. For sport-caught fish meals, the pattern was different. Anglers ate fewer sport-caught fish meals in year 2 in both the treatment group (0.75 fewer meals, SEM=0.10) and the control group (0.62 fewer meals, SEM=0.15), and these decreases were not significantly different from each other.[23]

[22]Awareness by urban anglers that states issued guidelines for fish consumption prior to participating in the study did not contribute significantly in any of the models we tested.

[23]These findings match participants' beliefs about changes in their fish consumption between years 1 and 2. Those receiving the brochure were more likely to believe they were eating fewer purchased fish meals but not sport-caught fish meals than the control group.

Because fish consumption guidelines are only intended to reduce consumption of contaminated fish in individuals who are at risk, we assessed whether the effect of the brochure intervention was mediated by anglers' level of fish consumption in 2014 or by whether individuals exceeded the fish consumption guidelines in 2014. We developed OLS regression models to estimate the number of total, purchased, and sport fish meals consumed in year 2 for anglers who did and did not receive the intervention, while controlling for meals (total, purchased, or sport-caught) consumed in year 1.

To test whether the effects of the brochure differed for those anglers who consumed greater amounts of fish in 2014, we allowed for an interaction term between the number of meals consumed in 2014 and "intervention." The improvement in the models was almost significant ($p=0.060$) for total fish consumption and significant for purchased fish consumption ($p=0.035$) and sport-caught fish consumption ($p<0.001$) (Table 6). The results for the significant models are depicted graphically in Figures 2 and 3.

Table 6

Terms (and standard errors) for OLS regressions estimating total, purchased, and sport-caught fish consumption in 2015.

	Total Fish Consumption	Purchased Fish Consumption	Sport-caught Fish Consumption
Constant	2.521***	2.415***	0.114
	(0.675)	(0.575)	(0.172)
Meals2014[1] (total, purchased, or sport-caught)	0.847*** (0.033)	0.865*** (0.033)	0.775*** (0.028)
Intervention	0.159	0.135	0.573**
	(0.814)	(0.699)	(0.207)
Intervention*Meals2014	-0.073	-0.083*	-0.210***
	(0.039)	(0.039)	(0.033)

[1]Number of meals consumed in 2014.
*p<0.05, **p<0.01, ***p<0.001

The brochure significantly decreased purchased fish consumption in anglers who ate 12 or more meals of purchased fish over the course of the summer (48% of anglers in the sample). The brochure significantly decreased sport-caught fish consumption in anglers who ate 4 meals of fish or more over the course of the summer (24% of the sample). In both cases, the decrease was larger for anglers who ate more fish initially. The brochure also, however, led to a slight *increase* in sport-caught fish consumption in anglers who ate very little sport-caught fish initially. Anglers who ate 1 sport-caught fish in the summer of 2014 increased their fish consumption by 0.4 fish and those who ate no sport-caught fish in 2014 increased their consumption by 0.6 fish.

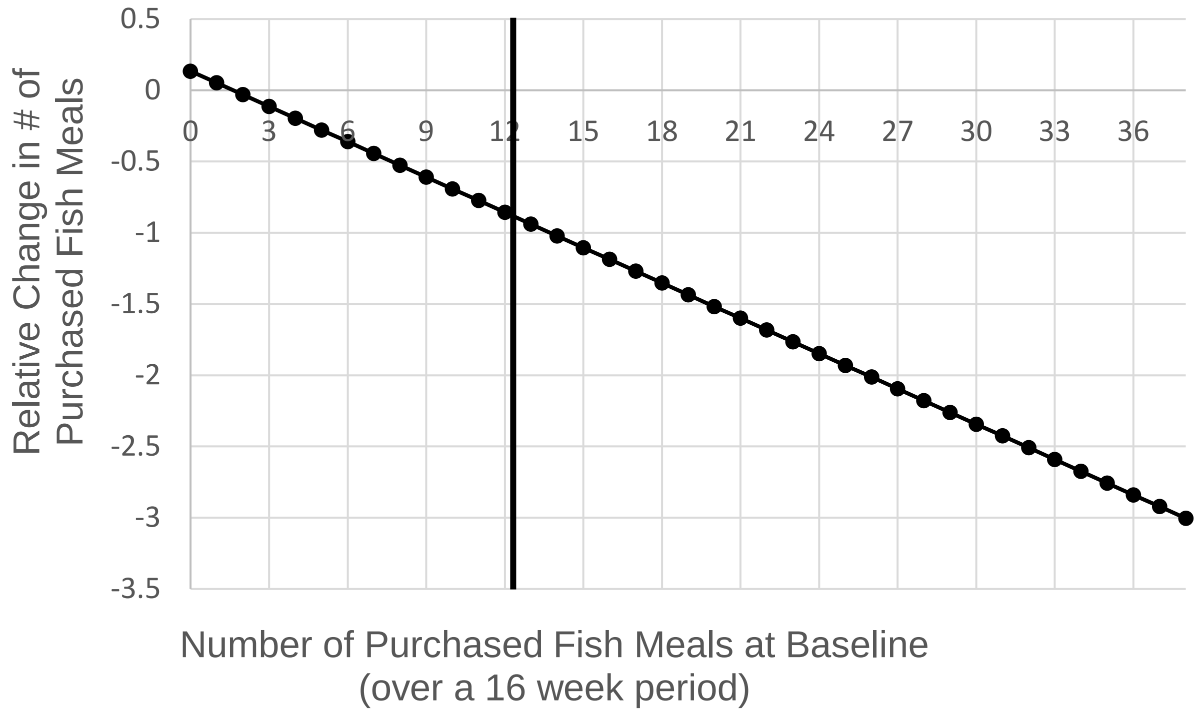

Fig. 2. Predicted change in purchased fish consumption in 2015 for intervention compared to control group based on regression. Vertical line indicates point at which decrease in fish consumption becomes significant.

Although the interaction term in these models between “Intervention” and “Meals2014” provides some indication of whether anglers who are at greater risk are more affected by the brochure intervention, it is an imperfect indication. Anglers who eat more fish may not be at risk if they choose the types of fish carefully. Consequently, we also tested whether the effects of the brochure differed for those anglers who exceeded the guidelines in 2014. To do this, we included a dichotomous term in the model for “advisory exceedance” and allowed for an interaction term between “advisory exceedance” and the brochure intervention (“intervention”).

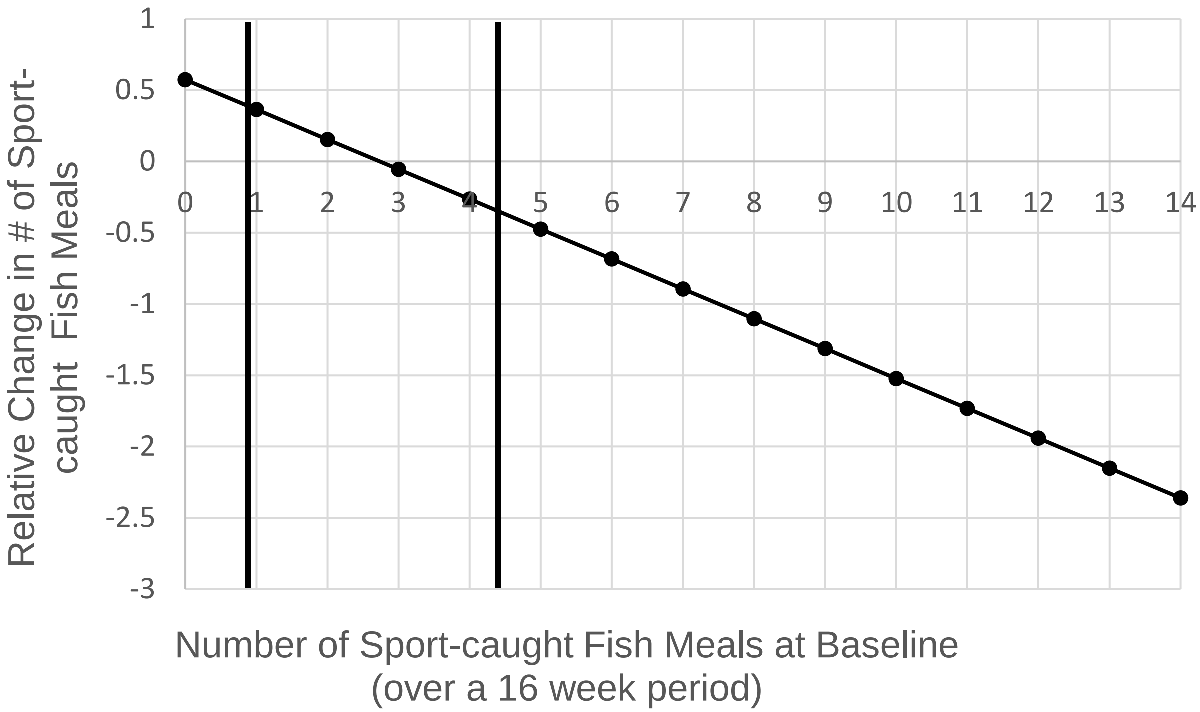

Fig. 3. Predicted change in sport-caught fish consumption in 2015 for intervention compared to control group based on regression. Vertical lines indicate points at which increase or decrease in fish consumption become significant.

The models for total and purchased fish consumption showed no evidence that anglers who exceeded the guidelines were more likely than those who did not to reduce their fish consumption in response to the brochure. The model for sport-caught fish consumption, however, contained a significant interaction term between "intervention" and "advisory exceedance" under the conservative assumptions (Table 7). The significant interaction between the intervention and advisory exceedance and the lack of a significant main effect for the intervention indicates that the brochure only influenced sport-caught fish consumption among those anglers who exceeded the advisories in 2014. In those individuals, the brochure led to the consumption of nearly 2 fewer sport-caught fish meals over the course of the 4-month summer period in 2015. (The version of the brochure did not matter.).

Although the results above indicate that the brochure led to a reduction in fish consumption among urban anglers, they do not demonstrate the degree of reduction in risk. If anglers reduce their fish consumption by a given amount, they are more likely to reduce their risk if they reduce their consumption of high-contaminant rather than low-contaminant fish. Therefore, we assessed how the brochure affected both high-contaminant fish meals (those for which guidelines recommend fewer than one meal/week) and low-contaminant fish meals (those for which guidelines allow one meal/week or more). We reestimated the models we had developed for total, purchased, and sport-caught fish consumption replacing the dependent variables (total, purchased, and sport-caught fish consumption in 2015) with both high-contaminant fish consumption in 2015 (total, purchased and sport-caught) and low-contaminant fish consumption in 2015 (total, purchased and sport-caught) (Table 8). The significant negative interaction terms in each model indicate that that the brochure reduced consumption of high-contaminant fish (total, purchased, and sport-caught) and low contaminant sport-caught fish for individuals who ate relatively large amounts of fish.

Table 7
Terms (and standard errors) for OLS regression estimating sport-caught fish consumption in 2015.

	Sport-caught Fish Consumption
Constant	0.418**
	(0.162)
Meals2014[1] (sport-caught)	0.635***
	(0.021)
Intervention	0.144
	(0.191)
AdvisoryExceedance (conservative assumptions)	1.121*
	(0.446)
Intervention*Advisory Exceedance	-1.964***
	(0.502)

[1]Number of meals consumed in 2014.
*p<0.05, **p<0.01, ***p<0.001

Table 8
Terms (and standard errors) for OLS regressions estimating high-contaminant total, purchased, and sport-caught fish consumption and low-contaminant sport-caught fish consumption in 2015.

	High-Contaminant Total Fish Consumption	High-Contaminant Purchased Fish Consumption	High-Contaminant Sport-caught Fish Consumption	Low-Contaminant Sport-caught Fish Consumption
Constant	-0.134	-0.253	-0.210	0.215
	(0.323)	(0.144)	(0.139)	(0.121)
Meals2014[1] (total, purchased, or sport-caught)	0.112***	0.056***	0.428***	0.260***
	(0.016)	(0.008)	(0.022)	(0.019)
Intervention	0.631	0.378*	0.338*	0.196
	(0.389)	(0.175)	(0.168)	(0.146)
Intervention*Meals2014	-0.046*	-0.033***	-0.090***	-0.096***
	(0.018)	(0.010)	(0.027)	(0.023)

[1]Number of meals consumed in 2014.
*p<0.05, **p<0.01, ***p<0.001

The pattern of reduction in consumption was similar in all of these reestimated models (Table 9). The reduction in fish consumption was larger for anglers who ate more fish initially. The top 13-28% of total, purchased, and sport-caught fish consumers significantly reduced their consumption of high-contaminant fish and low-contaminant sport-caught fish if they received the brochure. The brochure also affected fish consumption in anglers who ate little to no purchased fish and sport-caught fish initially. These anglers *increased* their consumption of high-contaminant purchased fish and high-contaminant sport-caught fish if they received the brochure. None of the changes in fish consumption were particularly large.

Table 9
Brochure effects on consumption of high-contaminant total, purchased, and sport-caught fish and low-contaminant sport-caught fish based on OLS regression models.

	Initial Fish Consumption over 1st 16-week Period (Total, Purchased, or Sport-caught)	Percentile	Change in High- or Low-Contaminant Fish Consumption over 2nd 16-week Period
High-Contaminant Total Fish Consumption	25[1]	78	-0.5
	34	90	-0.9
High-Contaminant Purchased Fish Consumption	0	4	+0.4
	2[2]	8	+0.3
	19[1]	72	-0.2
	30	90	-0.6
High-Contaminant Sport-caught Fish Consumption	0[2]	40	+0.1
	8[1]	87	-0.4
Low-Contaminant Sport-caught Fish Consumption	5[1]	76	-0.3
	9	90	-0.7

[1]Initial level of consumption above which decrease in high- or low-contaminant fish consumption is significant.
[2]Initial level of consumption below which increase in high- or low-contaminant fish consumption is significant.

4. Discussion

We showed, through a randomized experiment, that carefully designed fish consumption guidelines brochures can have an effect on fish consumption by urban anglers. We are not aware of any other studies showing such effects experimentally. Most previous work on fish consumption guidelines has used indirect evidence to assess their effects, and, while important, this prior work has not conclusively demonstrated that these guidelines can influence behavior. Roosen et al. (2009) and Verger et al. (2007) used an experimental approach to establish the effects of advisories, but their fish consumption guidance was communicated during an in-person visit, which might be expected to have a greater impact on fish consumption behavior. Brochures are able to reach people more cheaply than in-person interventions.

We found mixed indications as to whether the brochures influenced fish consumption behavior in urban anglers as intended. We did not find evidence that the brochures caused people who were exceeding guidelines to change their behavior so that they no longer exceeded guidelines. Although that would have been the preferred effect, it is possible that a person could reduce their consumption of high-contaminant fish (and, therefore, their exposure to contaminants), but not reduce it enough to achieve compliance with the guidelines.

Consequently, we also tested whether the intervention reduced fish consumption. It did, but only for people who ate comparatively large amounts of fish and people who exceeded the advisories. Receiving the brochure led those eating 30 meals of purchased fish over the summer of 2014 (90^{th} percentile of fish eaters) to eat 2.3 fewer purchased fish meals in 2015. The brochure led those eating 9 meals of sport-caught fish over the summer of 2014 (90^{th} percentile) to eat 1.3 fewer sport-caught fish meals in 2015. In addition, those anglers who exceeded the guidelines in 2014 reduced their consumption of sport-caught fish by nearly 2 sport-caught fish over the summer of 2015 if they received the brochure compared to the control group. Thus, the brochure affected urban anglers who were at highest risk.

A reduction in fish consumption, in and of itself, is not the desired outcome. The key outcome is a reduction in the consumption of contaminants, which could be most easily achieved by reducing the consumption of heavily contaminated fish or switching from eating heavily contaminated fish to eating less contaminated fish (Teisl et al. 2011). The intervention did lead to a reduction in the consumption of high-contaminant fish (total, purchased, and sport-caught) for heavy fish consumers, but it also led to a reduction in low-contaminant sport-caught fish. It did not lead to a reduction in low-contaminant purchased fish. These reductions in fish consumption were all relatively small, but even small reductions in high-contaminant fish consumption can be important in reducing exposure to contaminants. Roosen et al.'s (2009) experimental study of the effects of a fish consumption intervention also reported a decrease in fish consumption, but they did not find a decrease in consumption of the most contaminated fish. Future research that pairs data on fish consumption with estimates of the contaminants in different types of fish could provide a more detailed indicator of how interventions affect the contaminant burdens in urban anglers.

In addition to leading to decreases in fish consumption for anglers who ate relatively large amounts of fish, the brochure also led to *increases* in fish consumption for anglers who ate very little of certain types of fish (0-2 meals over a 16-week period). We observed these increases for sport-caught fish consumption, high-contaminant sport-caught fish consumption, and high-contaminant purchased fish consumption. These increases in fish consumption are also beneficial as long as they do not result in anglers exceeding consumption guidelines. Fish consumption, even the consumption of high-contaminant fish (which we defined as fish anglers were advised to eat less than once/week), has many health benefits. Consequently, anglers who were eating almost no fish initially could benefit from increased consumption.

Our study had several limitations that could affect the degree to which the results that we obtained would be observed in other contexts. First, outreach programs targeting urban anglers often focus on subpopulations that are considered at particular risk (low-income and racial and ethnic minorities). We attempted to recruit a representative sample of urban anglers, which was predominantly white. There was also substantial variation in the data set, so the responses of individuals to consumption guidelines might be much greater or much less than the levels we reported here. Finally, our method of distributing the fish guidelines brochures is not an approach that outreach programs typically use; we sent the brochures to individuals who had already agreed to participate in our study and who were communicating with us at least biweekly through the fish consumption diaries. The effects of brochures distributed through other means might be either less (e.g., if anglers were sent the brochure unsolicited) or more (e.g., if anglers were given the brochure by a trusted health professional).

It is clear, however, that fish consumption guidelines brochures can have effects on target audiences. Future research that could improve our understanding of the effects of such interventions might assess the effects of brochure interventions on contaminant ingestion, explore the effectiveness of different delivery methods for brochures, or explore the effectiveness and cost-effectiveness of different types of interventions.

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APPENDIX A: USE OF DIARIES TO RECORD FISH CONSUMPTION

Participants could record information as often as they wanted within each two-week period. Did most participants record all of the meals they ate at one time or did they record them more often, suggesting that they reported them at the time when they were eaten? During some two-week periods, participants ate only one meal (28% of periods for WCBA, 35% of periods for urban anglers); information from these periods was not used in answering the question of interest in this Appendix. Among the periods when more than one meal was eaten, in 48% of these periods for WCBA and 49% of these periods for urban anglers all meals were recorded at one time. This suggests that half of the time when two or more meals are eaten in a two-week period, participants record the meals in their diary at one point in time and likely not at the time when they were eaten. These findings do not provide insight into ideal diary period length.

APPENDIX B: RESULTS FROM NORTHERN MINNESOTA WOMEN OF CHILDBEARING AGE SPECIAL SAMPLE

The Minnesota Department of Health (MN DOH) conducted a related study in northern Minnesota. The MN DOH recruited twenty-six WCBA for that study, not necessarily anglers, to participate in the diary as a separate sample. Complete results from that sample are listed in all tables as "MN (special sample)" in the Year 1 report to the Consortium (Connelly et al. 2015). We present a summary of the most relevant findings below.

Sixteen of the 26 Northern Minnesota WCBA recruited provided information throughout the Year 1 study period. (One WCBA provided partial information and is not included in the following results.) We compare WCBA in the special sample (n=16) to WCBA from Minnesota living in counties bordering Lake Superior who participated in the larger diary study (n=69) in the tables below.

Table B-1. Select socio-demographic characteristics by study strata.

	Percent with children aged 15 or younger in household	Percent white	Mean age
Minnesota	36.4	98.5	33.0
MN (special sample)	32.2	100.0	32.6

Table B-2. Education level by study strata.

	Percent		
	H.S. diploma or less	Some college	College degree or more
Minnesota	4.5	39.4	56.1
MN (special sample)	35.7	35.7	28.6

Table B-3. Average number of meals consumed during study period (total, purchased, and sport-caught) and the proportion of meals that were sport-caught by study strata.

	Average number of meals consumed during study period			% Sport-caught
	Total	Purchased	Sport-caught	
Minnesota	14.6	10.2	4.4	32.5
MN (special sample)	12.1	7.1	4.9	33.7

Table B-4. Most popular purchased fish meals by study strata.

	Percent of purchased fish meals					
	Shellfish[1]	Salmon	Canned light tuna	Canned white tuna	Cod	Haddock
Minnesota	25.7	16.5	18.3	11.1	4.0	1.0
MN (special sample)	8.8	9.6	20.2	13.2	12.3	3.5

[1] Shellfish included as examples shrimp, crabs, scallops, and clams.

Table B-5. Percent exceeding the fish consumption guidelines, as defined for our study and the primary species associated with exceeding the guidelines by study strata.

	Percent exceeding guidelines[1]	Primary species associated with exceeding the guidelines
Minnesota	33-41	Canned "white" tuna, walleye.
MN (special sample)	19-25	Canned "white" tuna.

[1] Estimates are presented as ranges because some advice is based on the length of the fish caught; if consumers did not know the length of the fish they ate then we estimated their consumption assuming both the most and least conservative consumption recommendations

Twelve Northern Minnesota WCBA participated in the second year of the project. They did not receive a version of the experimental brochure that contained the narrative. Therefore, no analysis could be done to see if these women consumed more fish in Year 2, similar to the findings of the larger group that received a narrative version of the brochure.

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Appendix C: Do Individuals Eat a Variety of Purchased Fish?

We found that WCBA, on average, ate 4.1 different purchased species over a 16-week period, with a range of 1 to 13 species. Thirteen percent ate only one species over a 16-week period.

We found that urban anglers, on average, ate 4.7 different purchased species over a 16-week period, with a range of 1 to 16 species. Ten percent ate only one species over 16-week period.

Note: The surveys did not distinguish between various forms of shellfish (shrimp vs. scallops, etc.). Therefore, the analyses above treat all shellfish as one species, and thus may underestimate the variety of seafood species consumed.

Table C-1. Number of different purchased fish species eaten during a 16-week period by WCBA and urban anglers.

	Percent	
Number of different purchased fish species eaten	WCBA	Urban anglers
1	12.8	10.4
2	14.5	11.4
3	17.4	14.6
4	17.1	15.3
5	13.4	15.0
6	9.7	11.2
7	6.8	8.8
8	3.9	5.4
9	2.1	4.1
10	1.3	1.6
11	0.8	0.7
12	0.1	0.8
13	0.1	0.3
14	0.0	0.3
15	0.0	0.0
16	0.0	0.1

APPENDIX D: WOMEN OF CHILDBEARING AGE: PROFILE OF TOP 10% OF FISH CONSUMERS AND OF WOMEN WHO EXCEED FISH CONSUMPTION GUIDELINES

Table D-1. Socio-demographic characteristics of WCBA who were among the top 10% of fish consumers or were among those who exceeded the guidelines in Year 1.

	Percent	
Socio-demographic characteristics	**Top 10% of fish consumers**	**Those exceeding liberal guidelines**
Age		
18-29	21.1	22.6
30-39	34.5	37.0
40-49	44.4	40.4
Race		
White	89.1	93.5
Non-white	10.9	6.5
Education level		
H.S. or less	8.8	7.4
Some college	39.0	45.5
College degree	39.0	33.5
Graduate or professional degree	13.2	13.6
Household income		
< $25,000	9.1	14.4
$25,000-$49,999	18.2	17.9
$50,000-$74,999	15.9	19.7
$75,000-$99,999	23.9	22.2
$100,000-$149,999	19.3	16.6
$150,000 +	13.6	9.2
Might get pregnant in next 5 years	33.5	32.6
Children 15 or younger in the household	38.7	45.0

Table D-2. Percent of purchased and locally-caught meals eaten by WCBA in Year 1, by those who ate the most meals (top 10%) versus others.

	Percent of meals	
Fish meals eaten in Year 1	**Top 10% of fish consumers**	**Other 90% of fish consumers**
Locally-caught fish	15.8	18.7
Purchased fish	84.2	81.3
Shellfish	25.9	24.7
Salmon	14.7	9.9
Canned “light” tuna	5.8	8.6
Cod	4.8	6.9
Canned “white” tuna	5.0	6.6
Tilapia	5.7	4.1
Fish sticks/fast food sandwiches	2.2	3.5
Haddock	1.9	2.7
Tuna (not canned)	2.8	2.0
Catfish (farm-raised)	2.3	0.8
Perch (purchased)	0.6	0.9
Other purchased fish	12.5	10.6

APPENDIX E: WOMEN OF CHILDBEARING AGE: RESULTS FROM TWO SURVEYS ON AWARENESS OF GUIDELINES, BELIEFS ABOUT FISH CONSUMPTION, AND SOCIO-DEMOGRAPHIC CHARACTERISTICS BY STATE

Note: In some cases results for neighboring states were combined due to small sample sizes in certain states. The initial sample design was not intended to provide state-specific results.

Table E-1. Population and sample sizes for WCBA diary study, overall and by state groupings.

Sample Sizes	Overall	NY	OH/PA	IL/IN	MI	WI/MN
WCBA angler population	125,040	18,154	16,954	13,813	40,514	35,605
Recruited	2,014	360	233	230	608	583
Included in Year 1 analysis	1,395	240	165	155	424	411
Included in experiment analysis	1,173	205	137	123	348	360

Table E-2. Socio-demographic characteristics for WCBA diary participants, overall and by state groupings.

	Percent					
Socio-demographic characteristics	**Overall**	**NY**	**OH/PA**	**IL/IN**	**MI**	**WI/MN**
Age						
18-29	27.7	33.8	33.9	36.1	26.4	20.0
30-39	33.2	34.1	23.0	26.5	36.1	36.3
40-49	39.1	32.1	43.1	37.4	37.5	43.7
Race						
White	94.6	94.6	94.8	87.3	96.3	95.4
Non-white	5.4	5.4	5.2	12.7	3.7	4.6
Hispanic origin						
Yes	2.6	1.4	3.9	10.9	1.5	1.0
No	97.4	98.6	96.1	89.1	98.5	99.0
Education Level						
H.S or less	8.9	11.0	11.7	8.5	7.8	7.8
Some College	39.6	36.2	41.5	31.2	48.2	38.1
College degree	36.5	32.6	31.9	39.7	34.2	41.7
Graduate or professional degree	15.0	20.2	14.9	20.6	12.8	12.4
Household income						
< $25,000	10.9	12.5	9.2	12.1	15.8	5.5
$25,000-$49,999	19.1	21.7	19.3	15.4	17.3	20.5
$50,000-$74,999	22.4	18.4	28.4	18.7	22.2	23.8
$75,000-$99,999	22.9	27.0	19.3	23.0	17.7	27.1
$100,000-$149,999	17.4	17.8	16.5	16.5	19.5	15.8
$150,000 +	7.3	2.6	7.3	14.3	7.5	7.3
Pregnant or breastfeeding during Year 1 study	5.8	5.8	2.7	5.5	3.7	9.2
Pregnant or breastfeeding between Year 1 and Year 2	5.9	7.1	3.6	2.2	5.1	8.1
Pregnant or breastfeeding during Year 2 study	5.9	6.5	3.6	1.1	6.3	7.7
Might get pregnant in next 5 years	33.8	40.0	42.3	41.8	30.1	29.1
Children 15 or younger in household	51.4	52.0	49.0	42.3	52.6	54.0

Table E-3. Average fish consumption (# of meals in 16-week study period) for WCBA diary participants, overall and by state groupings.

	Mean					
Fish Consumption	**Overall**	**NY**	**OH/PA**	**IL/IN**	**MI**	**WI/MN**
# of meals	14.7	14.7	15.6	16.6	14.0	14.3
# of purchased meals	12.3	13.0	13.7	15.4	10.9	11.5
# of locally-caught meals	2.4	1.7	1.9	1.2	3.1	2.8

Table E-4. Percent of meals of various species and portion sizes eaten in Year 1 by WCBA, overall and by state groupings.

	Percent of meals					
Purchased fish meals eaten in Year 1	**Overall**	**NY**	**OH/PA**	**IL/IN**	**MI**	**WI/MN**
Shellfish	30.4	35.0	34.4	29.7	28.1	27.9
Salmon	13.6	8.1	16.6	15.6	14.4	12.9
Canned “light” tuna	9.7	8.1	10.9	9.5	10.2	9.5
Cod	7.8	4.5	5.4	5.1	7.2	13.3
Canned “white” tuna	7.6	9.4	5.9	9.0	7.3	7.2
Tilapia	5.5	6.2	4.8	8.0	5.2	4.5
Fish sticks/fast food sandwiches	3.9	3.5	4.5	3.6	4.2	3.5
Haddock	3.1	11.7	0.7	0.6	0.5	3.5
Tuna (not canned)	2.7	3.1	2.2	3.1	3.0	2.3
Catfish (farm raised)	1.4	1.0	1.3	2.3	1.7	1.0
Perch (purchased)	1.0	0.0	0.4	0.2	1.4	1.7
Other	13.3	9.4	12.9	13.3	16.8	12.7
<u>Portion size of purchased fish</u>						
< 8oz. uncooked	50.7	48.5	50.1	52.9	50.2	52.1
8oz. uncooked (6oz. cooked)	38.0	37.6	38.4	37.3	38.2	38.1
> 8oz. uncooked	11.3	13.9	11.5	9.8	11.6	9.8
<u>Portion size of locally-caught fish</u>						
< 8oz. uncooked	31.4	37.6	26.1	34.9	32.1	29.2
8oz. uncooked (6oz. cooked)	44.9	49.1	40.7	39.7	44.6	45.9
>8oz. uncooked	23.7	13.3	33.2	25.4	23.3	24.9

Table E-5. Awareness of fish consumption guidelines by WCBA, overall and by state groupings.

	Percent					
	Overall	**NY**	**OH/PA**	**IL/IN**	**MI**	**WI/MN**
Heard about govt. agencies providing guidelines	65.5	63.5	62.1	57.9	67.4	68.9
<u>Aware of guidelines for locally-caught fish</u>						
Not at all	46.4	48.4	53.9	55.8	44.8	40.6
Generally	45.7	44.3	37.5	37.1	46.6	52.0
Aware of specifics	7.9	7.3	8.6	7.1	8.6	7.4
<u>Aware of guidelines for purchased fish</u>						
Not at all	64.4	69.1	64.1	57.9	62.5	66.2
Generally	33.2	26.8	34.6	37.1	35.5	32.5
Aware of specifics	2.4	4.1	1.3	5.0	2.0	1.3

Table E-6. Views on guidelines and beliefs about following the guidelines by WCBA, overall and by state groupings.

	Percent					
	Overall	**NY**	**OH/PA**	**IL/IN**	**MI**	**WI/MN**
Guidelines provide enough information to decide whether or not to eat locally-caught fish						
Agree	57.1	65.3	37.4	50.6	61.6	57.3
Neutral	18.9	17.4	26.5	19.2	19.4	16.7
Disagree	13.7	10.7	26.5	15.1	11.4	12.6
Don’t Know	10.3	6.6	9.6	15.1	7.6	13.4
Guidelines provide enough information to decide whether or not to eat purchased fish						
Agree	36.4	36.9	38.6	49.3	37.1	30.9
Neutral	26.0	27.0	26.5	19.2	25.3	28.0
Disagree	23.3	23.0	22.9	19.2	22.8	25.2
Don’t know	14.3	13.1	12.0	12.3	14.8	15.9
I try to follow the guidelines when deciding types of fish to eat						
Agree	57.0	59.1	47.5	54.9	61.9	55.1
Neutral	26.2	29.6	22.0	28.2	24.8	26.7
Disagree	16.8	11.3	30.5	16.9	13.3	18.2
I try to follow the guidelines when deciding how much fish to eat						
Agree	52.4	52.6	39.8	53.5	55.2	53.6
Neutral	27.5	31.9	22.9	26.8	29.6	25.3
Disagree	20.1	15.1	37.3	19.7	15.2	21.1

Table E-7. Sources of guideline information and their perceived usefulness by WCBA, overall and by state groupings.

	Percent					
Information sources seen	**Overall**	**NY**	**OH/PA**	**IL/IN**	**MI**	**WI/MN**
Fishing regulations guide	31.1	30.9	23.9	21.8	35.5	32.9
Friends or family	19.8	18.8	21.9	20.4	18.9	20.3
Websites	19.8	23.3	18.7	21.8	19.9	17.5
Health information brochures	15.8	11.2	16.8	17.6	16.1	17.0
Newspaper articles	14.7	12.1	9.0	14.1	14.4	19.0
TV or radio	14.0	14.3	14.2	15.5	11.4	15.9
Posted warnings at fishing locations	13.2	7.2	9.7	12.0	13.6	18.0
Healthcare providers	10.7	5.8	9.0	8.5	13.2	12.3
Sportsman's shows or outdoor expos	3.8	3.6	2.6	2.8	4.0	4.6
iPhone/smartphone apps	2.9	3.6	2.6	2.1	2.2	3.6
<u>Source rated as very useful</u>						
Fishing regulations guide	45.4	45.2	47.1	41.4	48.5	42.5
Friends or family	26.5	21.1	--	--	30.6	27.8
Websites	34.9	36.2	--	--	38.4	27.7
Health information brochures	27.8	--	--	--	33.3	20.7
Newspaper articles	19.5	--	--	--	21.1	15.5
TV or radio	21.5	--	--	--	23.9	21.4
Posted warnings at fishing locations	55.4	--	--	--	48.0	66.2
Healthcare providers	36.2	--	--	--	44.0	36.6
Sportsman's shows or outdoor expos	30.8	--	--	--	--	--
iPhone/smartphone apps	17.6	--	--	--	--	--

--sample size too small

Table E-8. Belief statements included in Year1 survey for WCBA, overall and by state groupings.

Belief statements-Year 1	**Percent** **Overall**	**NY**	**OH/PA**	**IL/IN**	**MI**	**WI/MN**
Any health problems from eating fish contaminated with chemicals are mainly short-term						
Agree	8.2	5.4	10.3	7.0	10.2	7.2
Neutral	16.3	19.8	14.8	12.0	15.7	17.0
Disagree	55.6	50.9	56.2	57.1	55.9	57.3
Don't know	19.9	23.9	18.7	23.9	18.2	18.5
Benefits outweigh risks if women eat fish low in mercury and other contaminants						
Agree	46.4	39.0	45.9	52.1	49.7	45.5
Neutral	19.4	27.8	20.6	14.1	16.9	18.5
Disagree	21.6	20.6	18.7	19.7	23.4	22.1
Don't know	12.6	12.6	14.8	14.1	10.0	13.9
Most of the women I know ate fish when they were pregnant						
Agree	38.2	35.1	30.3	37.3	37.9	43.8
Neutral	15.9	18.5	18.7	12.0	16.5	14.1
Disagree	25.1	29.3	27.1	27.5	23.7	22.6
Don't know	20.8	17.1	23.9	23.2	21.9	19.5
Women who follow the guidelines can get a lot of the health benefits of eating fish with very little risk to themselves or their children						
Agree	68.0	64.8	69.6	69.0	68.5	68.3
Neutral	16.9	22.1	14.2	16.9	16.5	15.5
Disagree	4.1	4.1	3.9	4.2	4.0	4.1
Don't know	11.0	9.0	12.3	9.9	11.0	12.1
Children's health can be harmed more than adults' health by chemical contaminants in fish						
Agree	57.8	53.3	58.7	63.4	58.7	57.3
Neutral	13.8	18.1	14.2	9.9	13.7	12.6
Disagree	8.8	10.0	11.0	6.3	7.5	9.5
Don't know	19.6	18.6	16.1	20.4	20.1	20.6

Table E-8. (cont.)

Belief statements-Year 1	Percent					
	Overall	NY	OH/PA	IL/IN	MI	WI/MN
An unborn baby's health can be harmed more than it's mother's health by chemical contaminants in the fish that the mother eats						
Agree	65.5	64.7	63.2	67.7	66.0	65.4
Neutral	11.6	15.4	11.6	7.0	12.2	10.6
Disagree	4.7	4.1	6.5	4.2	4.0	5.4
Don't know	18.2	15.8	18.7	21.1	17.8	18.6

Table E-9. WCBA's perception of changes in fish consumption between Year 1 and Year 2, overall and by state groupings.

	Percent					
	Overall	NY	OH/PA	IL/IN	MI	WI/MN
Changed amount or types of fish consumed between Year 1 and Year 2	34.1	35.6	40.0	38.5	33.0	30.6
Ate more purchased fish	13.3	13.5	14.3	16.1	11.8	13.4
Ate less purchased fish	14.0	18.4	20.5	18.3	10.7	10.7
Changed type of purchased fish	6.4	6.7	9.8	9.7	4.6	5.7
Ate more locally-caught fish	6.9	4.9	1.8	3.2	9.3	8.7
Ate less locally-caught fish	14.5	13.5	16.1	14.0	15.0	14.1
Changed type of locally-caught fish	1.8	2.5	1.8	2.2	2.1	1.0

Table E-10. For WCBA receiving an experimental brochure, recollection of brochure and views on impact and content, overall and by state groupings.

For those in experimental group	Percent					
	Overall	**NY**	**OH/PA**	**IL/IN**	**MI**	**WI/MN**
Recall seeing the brochure						
No	24.2	22.3	41.3	22.0	24.6	19.1
Yes, in the mail	63.2	67.9	49.3	64.4	66.7	62.3
Yes, online	16.6	11.6	13.3	22.0	12.6	22.6
For those who recall seeing the brochure						
Agreement with:						
The brochure was easy to read and understand	90.7	93.0	93.2	93.5	89.9	88.8
The brochure was NOT relevant to me or my life circumstances	10.1	7.1	6.8	8.7	9.4	13.7
The brochure provided enough information to decide how often to eat certain purchased fish	72.1	65.5	75.0	76.1	69.6	75.8
The brochure provided enough information to decide how often to eat locally-caught fish	74.4	74.7	70.5	58.7	78.3	76.4
Reading the brochure made me feel more more comfortable about eating fish	49.2	36.0	61.4	52.2	47.4	53.4
Reading the brochure made me want to eat less fish	13.9	14.9	22.7	6.5	18.8	8.7
Reading the brochure made me want to eat more fish	14.8	11.5	9.1	28.9	12.4	16.3
Reading the brochure made me want to change the types of fish I ate	33.1	34.5	38.6	42.2	30.4	30.4
Reading the brochure made me worry more about chemicals in fish	50.9	52.9	50.0	53.3	58.0	43.5

Table E-11. Belief statements included in Year 2 survey for WCBA, overall and by state groupings.

Belief statements- Year 2	Percent					
	Overall	**NY**	**OH/PA**	**IL/IN**	**MI**	**WI/MN**
Any health problems from eating fish contaminated with chemicals are mainly short-term						
Agree	8.5	7.0	8.1	6.8	7.7	10.6
Neutral	20.1	18.8	23.0	16.9	19.7	21.1
Disagree	54.5	55.4	50.0	49.2	55.1	56.7
Don't Know	16.9	18.8	18.9	27.1	17.5	11.6
Eating fish that is low in mercury every week can help pregnant women have healthier babies						
Agree	35.8	36.5	30.6	43.8	29.5	40.7
Neutral	21.6	18.8	22.7	21.1	23.5	21.1
Disagree	27.3	31.3	26.7	12.3	31.2	26.1
Don't know	15.3	13.4	20.0	22.8	15.8	12.1
Some people will have health problems from eating fish contaminated with chemicals, while others won't						
Agree	51.5	48.2	46.7	51.7	57.8	49.3
Neutral	18.3	18.8	24.0	8.6	14.8	22.1
Disagree	17.9	20.5	16.0	19.0	14.8	19.6
Don't know	12.3	12.5	13.3	20.7	12.6	9.0
Benefits outweigh risks if you eat fish low in mercury and other contaminants						
Agree	60.1	57.2	60.0	56.9	57.9	64.8
Neutral	21.9	20.5	26.7	19.0	24.0	19.6
Disagree	10.7	12.5	8.0	10.3	9.9	11.6
Don't know	7.3	9.8	5.3	13.8	8.2	4.0
Children's health can be harmed more than adults' health by chemical contaminants in fish						
Agree	74.0	75.0	72.0	75.9	77.0	70.9
Neutral	12.0	13.3	9.3	10.3	8.7	15.6
Disagree	5.9	5.4	6.7	5.2	6.6	5.5
Don't know	8.1	6.3	12.0	8.6	7.7	8.0

Table E-11. (cont.)

Belief statements- Year 2	Percent					
	Overall	NY	OH/PA	IL/IN	MI	WI/MN
An unborn baby's health can be harmed more than it's mother's health by chemical contaminants in the fish that the mother eats						
Agree	74.9	73.0	76.0	75.9	77.6	72.8
Neutral	11.0	11.7	9.3	10.3	10.4	12.1
Disagree	4.0	4.5	2.7	3.5	3.3	5.0
Don't know	10.1	10.8	12.0	10.3	8.7	10.1
Women who follow the fish eating guidelines can minimize their health risks						
Agree	87.8	91.0	88.0	87.9	90.1	83.9
Neutral	7.8	4.5	9.3	6.9	6.6	10.6
Disagree	1.0	0.9	0.0	0.0	0.0	2.5
Don't Know	3.4	3.6	2.7	5.2	3.3	3.0

APPENDIX F: SPECIES OF FISH CONTRIBUTING THE MOST TO WOMEN OF CHILDBEARING AGE EXCEEDING FISH CONSUMPTION GUIDELINES

We estimated the degree to which advisory exceedance was affected by the consumption of particular species of fish, consumption of fish from particular water bodies, and the consumption of too much lower mercury purchased fish[24]. To estimate the contribution of particular species of fish to advisory exceedance, we eliminated the consumption data from each species of fish in turn, recalculated advisory exceedance, and calculated the percentage reduction in advisory exceedance. For example, to get an estimate of how much walleye consumption contributed to advisory exceedance, we calculated advisory exceedance without any data on walleye consumption. We used a similar approach to estimate the degree to which consumption of fish from particular local water bodies contributed to advisory exceedance. For some individuals, advisory exceedance was not caused by the consumption of particular contaminated fish, but by consumption of too much purchased fish with lower levels of mercury. To estimate the degree to which consumption of too much purchased fish contributed to advisory exceedance, we eliminated the consumption data for lower mercury purchased fish, recalculated advisory exceedance, and calculated the percentage reduction in advisory exceedance.

We selected just those individuals who exceeded the advisory guidelines based on conservative assumptions and calculated the relative contributions of different types of fish consumption to advisory exceedance (Table F-1). Walleye and swordfish, made a sizeable contribution to the exceedance of WCBA across several states. The consumption of too much lower mercury purchased fish made a significant contribution to advisory exceedance in several states. In New York, where WCBA are advised not to consume any fish from certain Great Lakes waters, consumption of fish from Lake Ontario, more so than the St. Lawrence River, contributed to advisory exceedance.

[24] We defined low-mercury purchased fish as fish classified in a state's guidelines as 2/week or 1/week (for MN, MI, WI, and IN). For states that followed federal guidelines for purchased fish (NY, PA, OH, IL), we defined purchased fish as all fish, except the do not eat species.

Table F-1. Percentage reduction in advisory exceedance from eliminating certain types of fish consumption from data set.

	NY	PA	OH	IN	IL	MI	WI	MN
Purchased fish								
Canned “white” tuna	0	0	0	0	0	10	23	21
Shark	6	0	17	0	0	2	10	0
Swordfish	16	25	22	0	14	4	8	7
Too much low-mercury purchased fish[1]	7	25	44	0	64	22	4	0
Sport-caught fish								
Chinook salmon	0	0	0	0	7	3	4	0
Coho salmon	0	0	0	0	14	2	3	0
Lake trout	0	0	0	0	0	4	0	0
Walleye	0	25	0	0	0	21	7	36
White perch	0	38	11	0	0	1	0	0
Fish from specific water bodies								
Lake Ontario	40	-	-	-	-	-	-	-
St. Lawrence River	16	-	-	-	-	-	-	-

[1]Purchased fish with recommended limits of one/week or two/weeks in MN, MI, WI, and IN; and all fish, except the do not eat species, for those following federal guidelines (NY, PA, OH, IL).

APPENDIX G: URBAN ANGLERS: RESULTS FROM TWO SURVEYS ON AWARENESS OF GUIDELINES, BELIEFS ABOUT FISH CONSUMPTION, AND SOCIO-DEMOGRAPHIC CHARACTERISTICS BY STATE

Table G-1. Population and sample sizes for urban angler diary study, by urban area.

Sample Sizes	Kalamazoo, MI	Erie, PA	Rochester, NY
Urban angler population	16,016	11,804	36,963
Recruited	610	705	784
Included in Year 1 analysis	414	449	500
Included in experiment analysis	327	364	390

Table G-2. Socio-demographic characteristics for urban angler diary participants, by urban area.

Socio-demographic characteristics	Percent		
	Kalamazoo, MI	**Erie, PA**	**Rochester, NY**
Gender			
Male	82.3	83.7	81.6
Female	17.7	16.3	18.4
Age			
18-34	18.2	24.3	19.8
35-49	26.6	29.2	26.8
50-59	19.9	29.6	23.4
60+	35.3	16.9	30.0
Race			
White	95.3	95.0	91.5
Black	1.3	1.4	5.0
Other	3.4	3.6	3.5
Hispanic Origin			
Yes	0.8	1.0	0.8
No	99.2	99.0	99.2
Education Level			
H.S. or less	7.8	17.2	11.5
Some college	30.0	36.2	35.8
College degree	34.0	28.0	29.4
Graduate or professional degree	28.2	18.6	23.3
Household Income			
< $25,000	5.7	5.1	3.5
$25,000-$49,999	15.9	20.1	15.8
$50,000-$74,999	23.2	21.7	21.8
$75,000-$99,999	17.1	25.1	23.2
$100,000-$149,999	26.3	19.3	26.2
$150,000+	11.8	8.7	9.5
Children 15 or younger in household			
Yes	34.4	39.0	31.8
No	65.6	61.0	68.2

Table G-3. Average fish consumption (# of meals in 16 week study period) for urban angler diary participants, by urban area.

Fish consumption	Mean		
	Kalamazoo, MI	**Erie, PA**	**Rochester, NY**
# of meals	18.4	15.7	19.5
# of purchased meals	14.3	11.2	17.2
# of locally-caught meals	4.1	4.5	2.3

Table G-4. Percent of meals of various species and portion sizes eaten in Year 1 by urban anglers, by urban area.

Purchased fish meals eaten in Year 1	Percent		
	Kalamazoo, MI	**Erie, PA**	**Rochester, NY**
Shellfish	23.3	29.3	30.5
Salmon	18.9	13.3	13.7
Canned "light" tuna	6.8	8.8	7.2
Cod	10.5	7.4	3.5
Canned "white" tuna	6.4	8.4	10.2
Tilapia	4.7	4.5	4.9
Haddock	1.4	4.2	13.3
Other	28.2	24.0	16.7
<u>Portion size of purchased fish</u>			
< 8oz. uncooked	45.6	44.2	44.2
8oz. uncooked (6oz. cooked)	40.5	40.9	40.8
> 8oz. uncooked	13.9	14.9	15.0
<u>Portion size of locally-caught fish</u>			
< 8oz. uncooked	23.8	20.1	24.8
8oz. uncooked (6oz. cooked)	44.5	37.5	41.3
> 8oz. uncooked	31.7	42.4	33.9

Table G-5. Awareness of fish consumption guidelines by urban anglers, by urban area.

	Percent		
	Kalamazoo, MI	**Erie, PA**	**Rochester, NY**
Heard about govt. agencies providing guidelines	81.3	78.2	77.9
Aware of guidelines for locally-caught fish			
Not at all	23.5	26.9	26.9
Generally	56.9	53.1	57.9
Aware of specifics	19.6	20.0	15.2
Aware of guidelines for purchased fish			
Not at all	54.5	56.5	59.8
Generally	40.7	38.2	36.2
Aware of specifics	4.8	5.3	4.0

Table G-6. Views on guidelines and beliefs about following the guidelines by urban anglers, by urban area.

	Percent		
	Kalamazoo, MI	**Erie, PA**	**Rochester, NY**
Guidelines provide enough information to decide whether or not to eat locally-caught fish			
Agree	68.5	70.7	68.5
Neutral	19.6	16.1	14.9
Disagree	7.6	10.3	8.3
Don't know	4.3	2.9	8.3
Guidelines provide enough information to decide whether or not to eat purchased fish			
Agree	35.2	35.0	33.6
Neutral	26.2	27.7	23.9
Disagree	28.6	27.3	25.3
Don't know	10.0	10.0	17.2
I try to follow the guidelines when deciding the types of fish to eat			
Agree	64.7	54.5	63.0
Neutral	21.9	26.4	25.3
Disagree	13.4	19.1	11.7
I try to follow the guidelines when deciding how much fish to eat			
Agree	59.7	48.7	55.5
Neutral	20.8	28.6	29.5
Disagree	19.5	22.7	15.0

Table G-7. Sources of guideline information and their perceived usefulness by urban anglers, by urban area.

	Percent		
Information sources seen	**Kalamazoo, MI**	**Erie, PA**	**Rochester, NY**
Fishing regulations guide	51.9	51.4	49.4
Friends or family	21.4	18.0	26.3
Websites	23.3	21.8	22.5
Health information brochures	12.7	14.7	17.1
Newspaper articles	33.6	33.4	35.0
TV or radio	21.7	17.3	14.8
Posted warnings at fishing locations	25.6	13.7	10.0
Healthcare providers	6.2	5.2	5.8
Sportsman’s shows or outdoor expos	11.1	7.8	7.3
iPhone/smartphone apps	1.6	3.3	2.9
<u>Source rated as very useful</u>			
Fishing regulations guide	47.0	48.8	56.8
Friends and family	24.0	13.9	18.6
Websites	42.2	37.3	43.8
Health information brochures	41.9	25.9	28.6
Newspaper articles	16.2	16.8	22.2
TV or radio	17.1	9.1	20.0
Posted warnings at fishing locations	52.8	29.6	52.3
Healthcare providers	--	--	--
Sportsman’s shows or outdoor expos	24.3	27.6	26.7
iPhone/smartphone apps	--	--	--

--Sample size too small

Table G-8. Belief statements included in Year 1 survey for urban anglers, by urban area.

Belief statements-Year 1	Percent		
	Kalamazoo, MI	**Erie, PA**	**Rochester, NY**
Any health problems from eating fish contaminated with chemicals are mainly short term			
Agree	9.0	8.7	8.2
Neutral	12.4	18.5	13.1
Disagree	66.5	56.4	61.7
Don't know	12.1	16.4	17.0
People who follow the fish eating guidelines can minimize their health risks and maximize their health benefits			
Agree	79.9	72.2	77.3
Neutral	10.8	18.0	14.1
Disagree	3.9	3.7	2.5
Don't know	5.4	6.1	6.1
Most of my family and friends try to follow the fish eating guidelines in their state			
Agree	43.3	32.2	40.5
Neutral	21.9	27.7	22.0
Disagree	16.8	25.1	17.1
Don't know	18.0	15.0	20.4
My family and friends think it is important that I follow the fish eating guidelines in my state			
Agree	37.7	31.7	37.1
Neutral	29.6	32.5	27.6
Disagree	17.1	22.6	16.0
Don't know	15.6	13.2	19.3
Children's health can be harmed more than adults' health by chemical contaminants in fish			
Agree	80.2	77.5	74.4
Neutral	9.1	8.7	7.2
Disagree	3.4	4.0	4.1
Don't know	7.3	9.8	14.3

Table G-8. (cont.)

Belief statements-Year 1	Percent Kalamazoo, MI	Erie, PA	Rochester, NY
I don't think government agencies really know how much chemical contaminants are in fish			
Agree	43.6	44.2	40.6
Neutral	20.6	20.3	22.0
Disagree	31.7	27.3	31.2
Don't know	4.1	8.2	6.2

Table G-9. Urban angler perception of changes in fish consumption between Year 1 and Year 2, by urban area.

	Percent Kalamazoo, MI	Erie, PA	Rochester, NY
Changed amount or types of fish consumed between Year 1 and Year 2	26.4	37.1	28.5
Ate more purchased fish	17.8	16.2	17.7
Ate less purchased fish	5.9	10.1	10.4
Changed type of purchased fish	3.0	6.5	6.6
Ate more locally-caught fish	6.3	5.8	2.5
Ate less locally-caught fish	16.7	19.8	6.9
Changed type of locally-caught fish	2.6	0.7	1.6

Table G-10. For urban anglers receiving an experimental brochure, recollection of brochure and views on impact and content, by urban area.

For those in experimental group	Percent		
	Kalamazoo, MI	**Erie, PA**	**Rochester, NY**
Recall seeing brochure			
No	26.5	37.1	28.3
Yes, in the mail	61.1	46.8	54.2
Yes, online	20.0	19.9	22.2
For those who recall seeing brochure			
Agreement with:			
The brochure was easy to read and understand	91.1	94.9	85.5
The brochure was NOT relevant to me or my life circumstances	14.8	12.8	17.2
The brochure provided enough information to decide how often to eat certain purchased fish	72.4	76.7	69.7
The brochure provided enough information to decide how often to eat certain locally-caught fish	74.1	82.9	79.5
Reading the brochure made me feel more comfortable about eating fish	45.2	38.8	49.3
Reading the brochure made me want to eat less fish	10.4	12.9	16.6
Reading the brochure made me want to eat more fish	13.3	6.0	13.8
Reading the brochure made me want to change the types of fish I ate	34.1	34.2	33.6
Reading the brochure made me worry more about chemicals in fish	44.4	45.7	49.3

Table G-11. Belief statements included in Year 2 survey for urban anglers, by urban area.

	Percent		
Belief statements-Year 2	**Kalamazoo, MI**	**Erie, PA**	**Rochester, NY**
Any health problems from eating fish contaminated with chemicals are mainly short-term			
Agree	9.3	8.6	7.9
Neutral	17.5	20.5	18.3
Disagree	58.7	57.6	59.6
Don't know	14.5	13.3	14.2
Fish contaminated with chemicals will taste bad			
Agree	8.2	15.1	11.7
Neutral	18.2	19.1	15.6
Disagree	60.2	57.2	58.7
Don't know	13.4	8.6	14.0
Some people will have health problems from eating fish contaminated with chemicals, while others won't			
Agree	56.8	52.2	50.0
Neutral	19.0	20.7	19.3
Disagree	13.4	17.0	20.6
Don't know	10.8	10.1	10.1
People who follow the fish eating guidelines can minimize their health risks			
Agree	86.2	86.0	85.9
Neutral	10.1	11.2	10.7
Disagree	1.1	1.4	0.6
Don't know	2.6	1.4	2.8
My family and friends think it is important that I follow the fish eating guidelines in my state			
Agree	51.3	40.9	49.5
Neutral	27.5	33.0	28.6
Disagree	8.6	14.1	9.2
Don't know	12.6	12.0	12.7

Table G-11. (cont.)

Belief statements-Year 2	Percent Kalamazoo, MI	Erie, PA	Rochester, NY
Eating fish can lower your risk of heart disease			
Agree	85.5	78.4	78.8
Neutral	9.7	18.0	11.7
Disagree	0.7	0.7	1.6
Don’t know	4.1	2.9	7.9
I don’t think government agencies really know how much chemical contaminants are in fish			
Agree	49.4	50.4	46.5
Neutral	16.4	23.7	19.0
Disagree	28.6	23.0	28.5
Don’t know	5.6	2.9	6.0

Appendix H: Urban Anglers: The Amount of Fish Eaten for Each Type of Fish Identified in the Guidelines for Each Study Site

Table H-1. Meals of fish listed in the guidelines and the percent of people eating them, by water in Kalamazoo, MI.*

Fish listed in the guidelines and eaten from:	# of meals over 16-weeks	% of all meals from water	Of people who ate fish from this water, % who ate species
Austin Lake (n=24)			
Bullhead >10”	2	2.1	8.3
Bullhead unknown length	1	1.1	4.2
Carp <30”	3	3.2	8.3
Carp 30-34”	1	1.1	4.2
Carp >34”	1	1.1	4.2
Carp unknown length	1	1.1	4.2
Largemouth bass <18”	10	10.5	20.8
Largemouth bass >18”	4	4.2	12.5
Largemouth bass unknown length	3	3.2	12.5
Smallmouth bass <18”	4	4.2	16.7
Smallmouth bass >18”	4	4.2	8.3
Smallmouth bass unknown length	2	2.1	8.3
Eagle Lake (n=17)			
Largemouth bass <18”	5	23.8	23.5
Gourdneck Lake (n=17)			
Northern pike	3	5.9	17.6
Gull Lake (n=30)			
Largemouth bass	25	23.8	23.3
Northern pike	10	9.5	16.7
Smallmouth bass	3	2.9	3.3
Kalamazoo River (from Morrow Dam to Allegan Dam) (n=8)			
Catfish	1	3.8	12.5
Crappie	4	15.4	37.5
Sunfish	12	46.2	12.5
Walleye	3	11.5	25.0
Other species not listed	6	23.1	37.5

Table H-1 (cont.)

Fish listed in the guidelines and eaten from:	# of meals over 16-weeks	% of all meals from water	Of people who ate fish from this water, % who ate species
Kalamazoo River (between Ceresco Dam and Morrow Dam, including Morrow Lake) (n=6)			
Bluegill	20	87.0	83.3
Sunfish	3	13.0	16.7

*No one ate a species with a guideline from Barton Lake, Portage Creek (up or downstream of Monarch Mill Dam), or Ruppert Lake.

Table H-2. Meals of fish listed in the guidelines and the percent of people eating them, by water in Erie, PA.*

Fish listed in the guidelines and eaten from:	# of meals over 16 weeks	% of all meals from water	Of people who ate fish from this water, % who ate species
Lake Erie & tributaries Except Conneaut Creek (n=271)			
Carp <20”	2	0.2	0.7
Channel catfish	1	0.1	0.4
Coho salmon	2	0.2	0.7
Freshwater drum	5	0.4	0.7
Lake trout <30”	23	1.9	4.8
Lake trout unknown length	5	0.4	1.8
Lake whitefish	11	0.9	2.9
Smallmouth bass	20	1.6	2.9
Steelhead (rainbow trout)	37	3.0	10.0
Walleye	467	38.4	55.0
White bass	14	1.2	3.3
White perch	293	24.1	40.2
Presque Isle Bay (n=105)			
Bowfin	1	0.3	0.9
Carp	2	0.6	1.9
Coho salmon	2	0.6	0.9
Freshwater drum	1	0.3	0.9
Northern Pike	4	1.2	3.8
Smallmouth bass	24	7.0	12.4
Steelhead (rainbow trout)	9	2.6	6.7
White perch	67	19.5	40.0

*No one ate a species with a guideline from Conneaut Creek.

Table H-3. Meals of fish listed in the guidelines and the percent of people eating them from Lake Ontario near Rochester, NY.

Fish listed in the guidelines and eaten from:	# of meals over 16 weeks	% of all meals from water	Of people who ate fish from this water, % who ate species
Lake Ontario (n=108)			
Brown trout <20”	15	4.0	5.5
Brown Trout >20”	13	3.5	8.3
Brown Trout unknown length	2	0.5	1.8
Carp	1	0.3	0.9
Channel catfish	20	5.3	5.5
Chinook salmon	41	10.9	14.8
Coho salmon	20	5.3	11.1
Lake trout <25”	10	2.7	9.2
Lake trout >25”	18	4.8	10.2
Lake trout unknown length	13	3.5	6.5
Rainbow trout	26	6.9	14.8
White perch	40	10.6	23.1
White sucker	3	0.8	0.9

APPENDIX I: PROFILE OF URBAN ANGLERS WHO EXCEED FISH CONSUMPTION GUIDELINES

Table I-1. Socio-demographic characteristics of urban anglers who exceeded the liberal guidelines in Year 1.

	Percent
Socio-demographic characteristics	**Those exceeding liberal guidelines**
Gender	
Male	78.3
Female	21.7
Age	
18-34	16.8
35-49	23.5
50-59	23.9
60+	35.8
Race	
White	90.1
Black	4.1
Other	5.8
Education level	
H.S. or less	11.8
Some college	33.7
College degree	30.9
Graduate or professional degree	23.6
Household income	
< $25,000	4.3
$25,000-$49,999	18.1
$50,000-$74,999	21.7
$75,000-$99,999	16.7
$100,00-$149,999	24.7
$150,000+	14.5
Children 15 or younger in household	25.7

Appendix D:
Mercury Screening Project (MSP) Reports

Lake County Mercury Screening Project (MSP)

The Lake County Mercury Screening Project (MSP) was a collaborative effort by Lake County Health and Human Services Women, Infants, and Children program (LCHHS WIC) and the Minnesota Department of Health (MDH). The project focused on reducing mercury exposure in women who are or may become pregnant and, therefore, in future babies by raising awareness about risks and benefits of eating fish. Participants included 121 women of childbearing age who live in Lake County, Minnesota.

Most people's exposure to mercury comes from eating fish. All 121 women reported eating fish in the last 2-3 months. In general, women who ate more fish meals had higher levels of mercury. However, the mercury results for most participants were below the level considered safe for women of childbearing age and a growing fetus.

Choosing fish wisely to maximize benefits and minimize risks is often challenging. Benefits outweigh risks if the fish women eat are low in mercury and other contaminants. MSP increased awareness about the health benefits and risks of eating fish to women of childbearing age.

MSP is an extension of the Fish are Important for Superior Health (FISH) Project currently underway in Cook County, Minnesota. Both North Shore projects are in response to a 2011 study (*Mercury in Newborns in the Lake Superior Basin*) that showed that 10% of Minnesota babies tested from the North Shore area had mercury in their blood above the level considered safe. The protocol followed in MSP was developed based on the FISH project. MSP participants answered the same 3 screening questions as FISH participants and provided a blood sample that was tested for mercury.

The project protocol, report to the community, local media coverage of project completion, and a summary of LCHHS WIC staff comments about MSP are attached.

Lake County MINNESOTA

MDH Minnesota Department *of* Health

Protocol for
Lake County Mercury Screening Project

Table of Contents

Overview

The **Lake County Mercury Screening Project** is part of a larger project funded by a grant received by the Minnesota Department of Health (MDH) in 2013 from the U.S. Environmental Protection Agency Great Lakes Restoration Initiative. The overall project is focused on reducing mercury exposure in women of childbearing age.

Lake County Health and Human Services Women, Infants, and Children (WIC) program is partnering with the Minnesota Department of Health (MDH) on this project. The Mercury Screening Project is an extension of the Fish are Important for Superior Health (FISH) Project currently underway in Cook County, Minnesota. This WIC-based project has 2 main purposes:

1. To find out the blood mercury level in women who are currently pregnant or have children age 5 or younger.
2. To test 3 mercury screening questions to see if they predict the mercury level found in participants' blood.

Women from families who receive WIC services from Lake County Public Health and Lake County Health and Human Services (LCHHS) employees aged 18 to 50 will be asked to take part. All women enrolled through WIC will either be pregnant or have children 5 years old or younger. All participants will be given a $20 Visa gift card and receive their individual results. Because fish consumption affects a person's blood mercury level, women will also receive information about wisely choosing fish to eat. A summary report will be publicly available once completed. The project will begin in late summer 2014.

Lake County WIC clients and LCHHS employees will be recruited and enrolled in this Project to expand evaluation of the FISH Project mercury screening tool as a predictor of high mercury exposure. In FISH, participants are asked three questions about the amount and type of fish they have eaten in the past two to three months. The questions were designed to be used as a rapid screen during a regular office visit to identify patients at risk for high mercury exposure. The ability of the FISH screening tool to predict mercury exposure is tested by comparison with a blood sample taken during the same clinic visit.

In the Mercury Screening Project, participants will be screened using the FISH screening tool and provide a capillary blood sample to test for total mercury. WIC clients are tested for hemoglobin at the first prenatal visit and first post-partum visit using a finger stick (commonly referred to as a "finger poke" in this clinical setting). From these clients, WIC staff will collect an additional capillary sample. Participants who would not otherwise be tested for hemoglobin will also be recruited and have a capillary sample collected, if they agree to be enrolled. Blood will be analyzed for total mercury by the MDH Public Health Laboratory (MDH PHL).

Women who participate in this Project will receive the results of their blood tests and an explanation of their meaning from Lake County WIC. Participants will also receive materials that provide information on the risks and benefits of eating fish and healthy fish choices.

This Manual provides procedural details of the Mercury Screening Project recruitment, enrollment, consent, mercury screening, blood sampling, and results communication.

Background

A 2011 study (*Mercury in Newborns in the Lake Superior Basin*) showed that 10% of Northeast Minnesota babies tested had mercury in their blood above the level considered safe. This project is working to help reduce mercury exposure in women who are or may become pregnant and therefore in future babies.

Most people's exposure to mercury comes from eating fish. Mercury in Minnesota waters and fish is a result of emissions from coal combustion, mining, other human activities, and natural sources. Fish and fishing are an important part of history and culture for communities in Northeast Minnesota. People living along the North Shore of Lake Superior may eat more fish than other people in Minnesota.

Mercury exposure can affect a person at any age. However, the developing fetus and young children are most at risk from mercury in fish. They are more sensitive to mercury exposure. In the fetus, small amounts of mercury can damage a brain that is starting to form or grow. Too much mercury can affect a child's behavior and lead to learning problems later in life.

Recruitment

Women will be invited to take part during routine WIC clinics held by Lake County Public Health. WIC clinics take place about three times each month; most women are seen about every three months. The goal is to enroll 75 women. Eligible LCHHS employees will self-refer for study participation and will provide informed consent and undergo the same study procedures as WIC clients. WIC staff will invite LCHHS employees to take part using department internal communication methods (word-of-mouth or email).

During the WIC appointment, staff will inquire about the woman's interest in the Project. Women who are interested will be asked to extend their normal WIC appointment another 15-20 minutes to take part, or they may wait until their next WIC appointment. Staff will document if a woman does not want to participate, so she is not asked again at a future appointment.

Eligibility

To take part, participants must meet the following criteria:

1. Woman or her child currently receives WIC services through Lake County Public Health OR she is an employee of LCHHS between ages 18 and 50
2. Answer 3 mercury screening questions
3. Allow blood to be collected and tested for mercury

If women express interest in participating (e.g. through Project publicity or word-of-mouth) and do not meet these requirements, they are not eligible and cannot enroll.

Staff Training

WIC staff training will be provided by MDH prior to enrolling participants and include:

- Project steps
- Obtaining consent
- Incentive tracking
- Blood collection, packaging, and shipping
- Safe-Eating Guidelines and fish consumption
- Data entry and transfer

Steps and Procedures for Participant Visit

The visit steps are described below and will typically take place during a normal WIC appointment with WIC staff from Lake County Public Health. During the visit, WIC Project staff will be in possession of a pre-filled participant folder, lab packet, and incentive items. LCHHS employees will not participate through a WIC clinic, but the same steps and procedures will be followed.

The participant folder contains:

- Informed Consent Form
- Participant ID labels
- Mercury Screening Form
- MDH Safe-Eating Guidelines handout
- Visit Checklist

The lab packet contains:

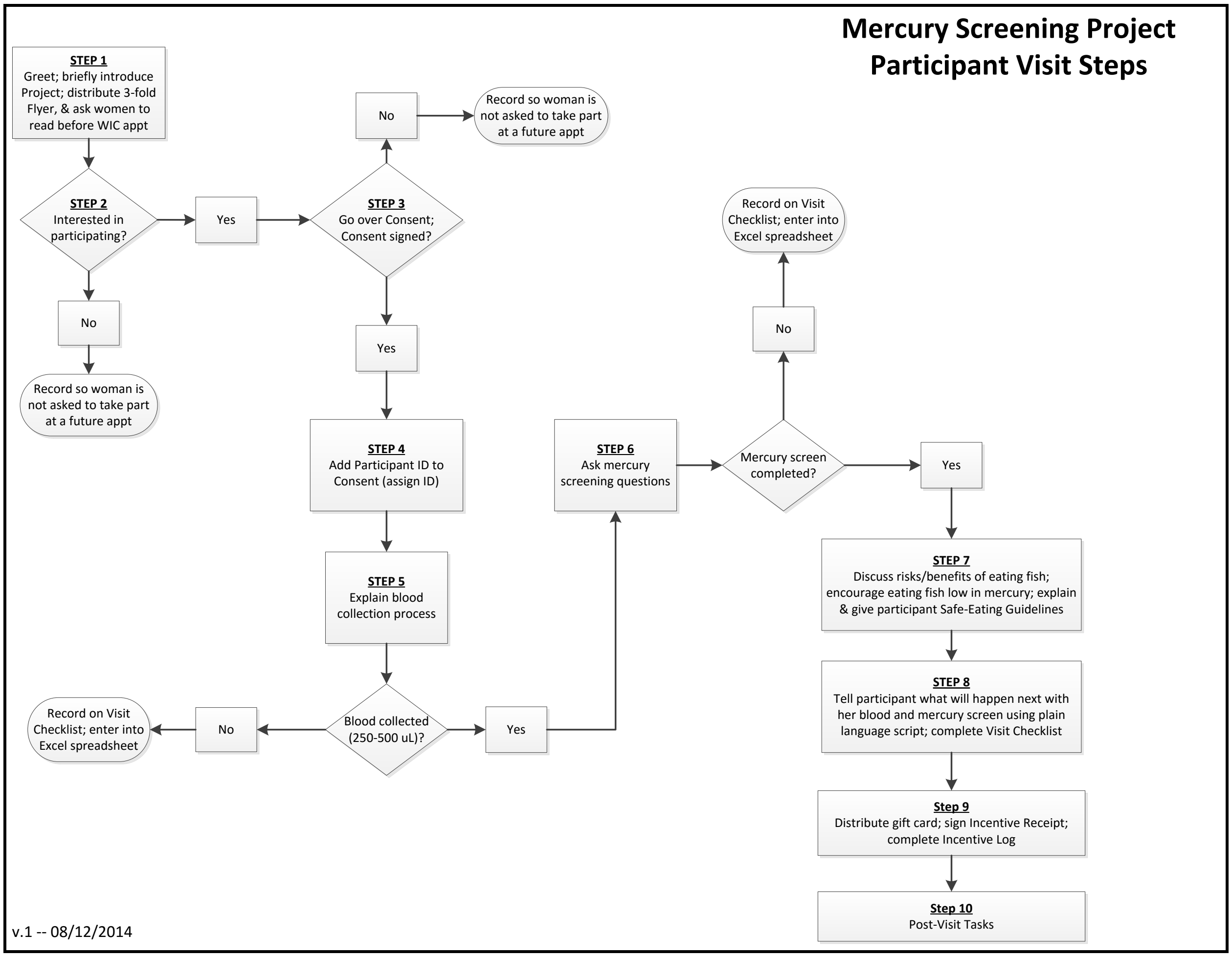
- Blood collection labels (specimen ID labels)
- Blood collection supplies
    - o BD microtainer contact-activated lancet (2.0 mm depth, 1.5 mm width blade, Fisher catalog # 02-657-102)
    - o RAM Scientific SAFE-T-FILL Capillary Blood Collection Tubes (# 07 7051, EDTA Capillary Collection 200 µL)
- Chain of Custody (COC) Form

The incentive items include:

- $20 Visa gift card
- Incentive Receipt Form

- Incentive Log

The flowchart below gives an overview of the Visit Steps (also found in Appendix A):



The Visit Checklist (found in Appendix A) will be used throughout the appointment to assist WIC staff with project steps.

Step 1: Introduce Project

When women check-in for a WIC clinic, staff will briefly tell them about the Project and ask them to read the Project Three-fold Flyer before their WIC appointment begins.

The Project Three-fold Flyer is found in Appendix A.

Step 2: Determine Interest

WIC staff will describe the Project, answer questions, and ask each woman if she would like to take part.

- **No, not interested** – Staff will document the woman's choice not to take part so that she is not asked to take part again.

- **Yes, interested** - Staff continues with Step 2.

Step 3: Obtain Consent

WIC staff will go through the Project Informed Consent with the woman to make sure she understands what she will do as a participant and her rights. After all questions have been answered, the woman will be asked to sign and date the consent if she would like to take part. Her participation is voluntary; she can decide at any time to not continue with the Project. A signed copy will also be offered to her.

The Informed Consent is found in Appendix A.

Step 4: Assign Participant ID

After the consent is signed, the woman becomes a participant and is assigned a Participant ID by WIC staff. This ID (pre-printed labels) will be used on all forms and her blood sample so that her identity will be protected.

Step 5: Collect Blood Sample

The nurse will explain the blood collection to the participant and then collect the sample to test for mercury. A small amount of blood will be collected from the participant as follows:

1. Staff will do a finger poke using the lancet and collect blood in a capillary tube.
2. When full (200 µL of blood), the capillary tube will be inverted so the blood flows into the specimen container. Then the capillary tube will be disposed.
3. The specimen container will be capped, inverted several times to mix the blood and anticoagulant, and properly labeled with the Participant ID and Specimen ID.
4. Staff will fill out the Chain of Custody (COC) form.
5. The container and COC will be stored securely in a refrigerator at Lake County Public Health until shipment.

The lab packet includes the Specimen ID labels and supplies needed for the mercury test. Routine blood collection supplies (gloves, alcohol swabs, gauze or tissue, and bandages) will be supplied by WIC.

A copy of the COC will be kept by WIC. The original COC will be shipped with the blood sample to MDH PHL.

If a blood sample cannot be collected, the nurse will document the reason on the Visit Checklist (see Appendix A). The woman will still receive a $20 gift card if she is poked with the lancet but is unable to give enough blood for mercury analysis. However, she is not a participant and will not complete the rest of the Project steps.

A detailed description of blood collection and storage procedures is found in Appendix B.

Step 6: Ask Mercury Screening Questions

Next, WIC staff will use the Mercury Screening Form to ask the participant 3 questions about the fish she has eaten in the past 2-3 months. Her answers to these questions will be compared to the mercury level in her blood.

1. How many times a <u>week</u> did you eat <u>any kind of fish</u>?
2. How many times a <u>month</u> did you eat any of these fish – Walleye, Northern Pike, Bass, or Lake Trout from Lake Superior?
3. Did you eat Shark or Swordfish?

The Mercury Screening Form is found in Appendix A.

Step 7: Provide Education

After the blood sample and mercury screen, WIC staff will:

- Discuss risks and benefits of eating fish with the participant.
- Encourage eating fish low in mercury.
- Explain how to use the MDH Safe-Eating Guidelines to plan fish meals.

Staff will answer any questions the participant may have about which fish to eat. She will be encouraged to take the Safe-Eating Guidelines home and refer to them when choosing fish to eat for herself and her family.

The MDH Safe-Eating Guidelines are found in Appendix A.

Step 8: Describe Final Steps

WIC staff will explain to the participant what will happen next using a plain language script similar to the following.

1. Your blood will be sent to the MDH Public Health Laboratory (PHL) and tested for mercury.
2. Your answers to the screening questions will be sent to MDH and compared with your blood mercury result. MDH will get your age and the ZIP Code where you live.
3. Only your Participant ID will be on your blood sample and the information given to MDH, not your name or any other personal information about you.
4. After your blood is tested, your mercury result will be given to WIC staff at Lake County Public Health.
5. WIC staff will mail your mercury result to you within 60-90 days of your appointment and describe what it means.
6. If you have any questions, contact information will be provided in the result letter.

The Result Letter Templates are found in Appendix A.

The nurse will also complete any remaining items on the Visit Checklist (see Appendix A) and document the visit outcome.

Step 9: Distribute Gift Card and Farewell

Before she leaves, WIC staff will give each participant a $20 Visa gift card, thank them for their time and participation in the Project, and end the visit. Each participant must sign the Incentive Receipt to acknowledge she has received the gift card. WIC staff will record which gift card was given to the participant on the Incentive Log.

Details for incentive tracking are described in Appendix A as well as the Incentive Receipt and Incentive Log.

Step 10: Post-Visit Tasks

WIC staff will do the following tasks as soon as possible after the participant leaves:

1. Verify all forms are labeled with a Participant ID.
2. Verify consent is clearly written and complete.
3. Verify responses to mercury screening questions are clearly written and complete.
4. Carefully enter Participant ID, age, ZIP Code, and responses to mercury screening questions into an Excel spreadsheet.
5. Verify incentive receipt and log are clearly written and complete.
6. Verify the Visit Checklist, Consent, Mercury Screening, and Incentive Receipt are in the participant's folder.

Administrative Tasks

WIC staff will have a variety of on-going administrative tasks throughout the Project period.

Project Promotion

Staff will…

- Distribute Project Three-fold Flyers to women to read while they are waiting for their WIC appointment.

Communication

Staff will…

- Respond to inquiries from the public and participants about the Project and follow-up with appropriate staff, as needed.
- Regularly update MDH on Project activities, progress, issues, and delays.
- Match mercury results (ID only) with participants' personal information and mail out individual result letters.
- Inform participants of Project updates, summaries, and reports when they become available.

Shipping Blood Samples

Staff will…

- Keep all blood samples properly stored until packaged for shipping.
- Use gel packs and properly labeled shipping coolers to maintain a temperature-controlled environment for samples en route from Lake County WIC to MDH PHL.
- Prepare samples for shipment shortly before FedEx arrives for pickup (to minimize the time samples are in coolers).

- Package and ship blood to MDH PHL on a regular basis (typically twice per month) for mercury analysis. Specimens will not be shipped on Thursdays or Fridays.
- Fill out a Chain of Custody Form (COC) for each specimen. Make a copy for WIC and include the original with the cooler (one COC per cooler).

See Appendix B for packaging and shipment procedures and the COC.

__Data Entry and Data Transfer__

Staff will…

- Enter the participant's contact information and data for each visit into an Excel spreadsheet as soon as possible after the visit
    - Participant ID
    - First and last name
    - Mailing address (street address, city, state, ZIP)
    - Birthdate and age at Project visit
    - Indicate whether person is with the WIC program or a LCHHS employee
    - Visit Outcome (e.g. completed, refused, not interested)
    - Consent/visit date
    - WIC staff completing the visit
    - Responses to mercury screening questions

- Email information (collected from participants) to MDH on a regular basis using encrypted email:
    - Participant ID
    - Participant age
    - Participant ZIP code
    - Responses to mercury screening questions

  MDH will use this information and the participant's mercury result to:
    - Give advice to the participant about her mercury exposure.
    - Compare participants' mercury screening responses to their mercury results.
    - Determine if screening responses predict the mercury results.
    - Create summaries and reports.

  Encrypted email procedures for MDH are found in Appendix A.

- Enter Project data for each participant into the Excel spreadsheet (once received from MDH):
    - Mercury result
    - Which result letter template to use for participant result letter

__Incentives__

Staff will…

- Complete the Incentive Log using the Participant ID and distribution date
- Submit the Incentive Log to MDH on a regular basis (at least monthly)

See Appendix A for the Incentive Log.

Reporting

Reporting will occur on three levels: individual participants, the community/North Shore area, and nationally/regionally/GLRI/funding agency. Summaries and reports will be publicly available. Only participants will receive individual mercury results.

Lake County Public Health

- Prepare and send individual mercury result letters to participants within 60-90 days of their appointment
- Review community report
- Assist with public presentation, community events, etc. if scheduled

MDH

- Review mercury results from MDH PHL and send to Lake County Public Health with appropriate advice
- Prepare and distribute summaries and reports for community, Great Lakes states, EPA; may include posting on websites (MDH, Lake County)
- Coordinate with local media for report dissemination

Appendix A

Participant Visit Steps Flowchart

Three-fold Flyer

Visit Checklist

Participant Informed Consent Form

Mercury Screening Form

MDH Safe-Eating Guidelines

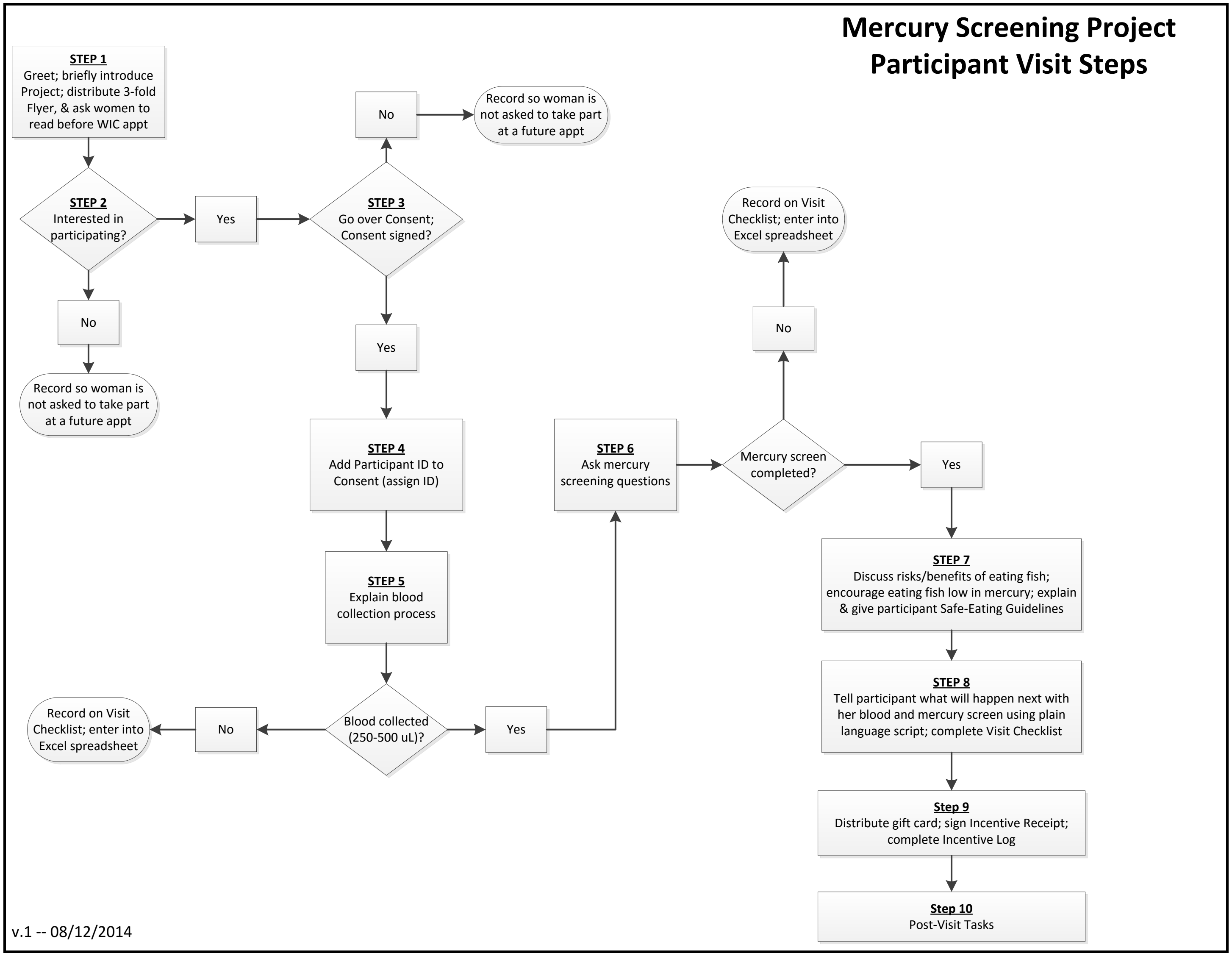
Result Letter Templates

Incentive Receipt

Incentive Log

MDH Encrypted Email Procedures

Participant Visit Steps Flowchart



Three-fold Flyer

Reading level: 5.3

Mercury Screening Project

Women and their families enjoying the health benefits of eating fish while lowering their exposure to mercury

YOU can take part in the Mercury Screening Project!

For More Information

Molly Gadsby
Public Health Nurse
Lake County Public Health
(218) 834-8434

Mercury Screening Project

Project Partners

Lake County Public Health
Minnesota Department of Health

Mercury Screening Project

Why are we doing the Mercury Screening Project?

A recent study showed that 10% of Northeast Minnesota babies tested had mercury in their blood above the level considered safe.

We want women to choose to eat fish that are low in mercury.

Women and their families can have the health benefits of eating fish while lowering their exposure to mercury.

Who can participate?

Women from families who receive WIC services from Lake County Public Health can take part.

Why should I take part?

You will...

- Find out how much mercury is in your body.
- Get information to improve your health and the health of your family.
- Help your community and other communities where people catch and eat fish.

If I decide to take part, what will I do?

You will...

- Have a small amount of blood taken from your finger.
- Answer 3 questions about the fish you have eaten in the last 2-3 months.
- Learn how to choose locally caught and purchased fish for healthy eating.

We will...

- Test your blood sample for mercury found in fish.
- Send you your blood results and what they mean.
- Compare your mercury result to your answers to the 3 fish questions to see if they are related.

How long will it take?

This Project takes **15-20 minutes**. It can be done today during your WIC appointment.

Women who complete the 3 questions and give a blood sample will receive a $20 VISA gift card.

Is my information private?

Yes. Participant names linked with personal results will only be seen by some Lake County Public Health staff.

Why should I eat fish?

Fish are an important part of a healthy diet. Catching and eating fish are part of the history and culture of the Great Lakes region.

- Fish are a great source of low-fat protein.
- Fish contain Omega-3 fatty acids that are important for the developing eyes and brains of a fetus.

Eating fish low in contaminants is good for the health of adults and children.

Visit Checklist

Mercury Screening Project: Visit Checklist Participant ID: | | | | |

1. Person would like to take part:

   ☐ Yes ☐ No –> Visit Outcome: **Not Interested**

2. Consent completed; give copy to participant:

   ☐ Yes ☐ No –> Visit Outcome: **Not Interested**

3. Assign Participant ID (add label to top of Checklist)

4. Blood sample collected (between 250-500 uL blood):

   ☐ Yes (add Specimen ID label) **Specimen ID: (attach here)**

   ☐ No, did not give enough blood –> Visit Outcome: **Not Eligible**

   ☐ No, refused to give blood –> Visit Outcome: **Refusal**

5. Mercury screen completed:

   ☐ Yes ☐ No –> Visit Outcome: **Refusal**

6. Fish consumption information explained; copy of Safe-Eating Guidelines given to participant; next steps for results described:

   ☐ Yes ☐ No

7. Visit Outcome (*choose one*):

   ☐ **Not Interested** (Person does not want to take part and did not sign the **CONSENT**)

   ☐ **Visit Complete** (**CONSENT** and **MERCURY SCREEN** completed; sufficient blood sample obtained)

   ☐ **Not Eligible** (Insufficient blood sample)

   ☐ **Refusal** (Participant refused **MERCURY SCREEN** or blood sample after **CONSENT**)

8. Gift card:

   ☐ Gift card given to participant

   ☐ Incentive Receipt signed

   ☐ Incentive Log completed

WIC Staff

☐ WIC ☐ LCHHS

Initials: ________

Date: _____/_____/________

Visit Checklist_v1_2014_07_07

Participant Informed Consent Form

Reading level: 7.3

Participant ID: | | | | |

Participant Informed Consent Form

Mercury Screening Project

Purpose: This project will: (1) measure mercury in women of childbearing age; and (2) help women choose fish to eat that are low in mercury.

Lake County Public Health and the Minnesota Department of Health (MDH) are partners in this Project. Funding is from the U. S. Environmental Protection Agency (EPA).

What we will ask you to do: We will ask you to: (1) have a small amount of blood taken from your finger; (2) answer three questions about the kinds of fish that you eat; and (3) talk to a nurse about how to get the health benefits of eating fish while lowering your exposure to mercury in fish.

This will take about 20 minutes.

Project Steps:

- **Giving blood:** A nurse from Lake County Public Health will take a small amount of blood from your finger. The blood will only be tested for mercury.
- **Screening:** The nurse will ask you 3 questions about fish you have eaten in the last 2-3 months. Your answers will be compared to the mercury level found in your blood sample.

All blood will be destroyed at the end of the Project.

- **Health Education Information:** The nurse will talk to you and give you a brochure about choosing which fish to eat and how often to eat fish.

Test Results: Lake County Public Health staff will send your results in a letter with information about what they mean. A summary of Project results will be shared with the public. This will happen after Lake County Public Health has read and approved the report. Participants will not be identified in this report.

Risks: You might feel a slight sting or "pinch" when we take your blood. Your finger may be sore. A small number of people may feel dizzy or faint.

Benefits: Getting your own test result can be helpful. You will know more about the amount of mercury in your body. This Project will help you to plan healthier meals for yourself and your family. We will use what we learn from this Project to help people in your area and other communities where people catch and eat fish.

Privacy Protection: All information about you is private. Project records will be in locked files or password-protected computers at Lake County Public Health and MDH. Only Project staff at Lake County Public Health will be able to see information about you. We will share test results and interview answers with EPA. We will not give them any information that could identify you. Personal information will not leave Lake County Public Health.

Costs: The only costs to you are your time and any travel expense. To thank you, we will give you a $20 Visa gift card at the end of your appointment. If staff try and are unable to collect a blood sample, you will still get the gift card but cannot participate in the Project.

Taking part is your choice: You can choose to participate or not. You may refuse any part or quit at any time. Your choice will not affect your relationship with or services from Lake County Public Health, MDH, or the federal government.

Questions: For more information, you may call Lake County Public Health at 218-834-8434. If you have questions about your rights as a participant in this study, please call Pete Rode, Administrator of the Minnesota Department of Health Institutional Review Board, at 651-201-5942.

Participant ID: | | | |

Participant Informed Consent Form

Mercury Screening Project

By marking the boxes and signing below, you are saying you had a chance to ask questions about the Project and freely choose to take part in it. You are also saying that you will allow Project staff to collect, store, and share your Project information as described above. You may keep a copy of this form.

I have read the consent form (or have had it read to me) and understand the information.

☐ Yes ☐ No

I choose to answer the 3 screening questions and give a sample of my blood to be tested for mercury.

☐ Yes ☐ No

Name (print) ____

First name *Middle Initial* *Last Name*

Signature ____ Date: __________

First name *Middle Initial* *Last Name*

Staff Signature ____________________________________

First name *Middle Initial* *Last Name*

WIC Staff

Initials: ________

Date: _____/_____/________

Participant ID: ☐☐☐☐

Mercury Screening Form

Mercury Screening Project

Now, I am going to ask you three questions about the fish you have eaten in the past two to three months. We will compare your answers to the mercury level in your blood.

When answering these questions, please keep in mind how much fish you ate, on average, <u>during the last two to three months</u>.

1. How many times a <u>week</u> did you eat <u>any kind of fish</u>?

   (Include fish you ate that were caught or purchased at a store or restaurant - all fresh, frozen, or packaged fish. Examples: walleye, herring from Lake Superior, salmon, shrimp, canned tuna, fish sticks or patties, fast food fish sandwiches, pickled fish, canned sardines.)

   ________ times a <u>week</u> (if less than 1 time per week, write <1)

2. How many times a <u>month</u> did you eat any of these fish – Walleye, Northern Pike, Bass, or Lake Trout from Lake Superior?

   ________ times a <u>month</u> (if less than 1 time per month, write <1)

3. *Did you eat Shark or Swordfish?*

   ☐ Yes ☐ No

<u>WIC Staff</u>

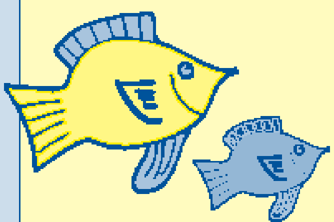
Initials: ________

Date: ______/______/________

Mercury Screen, v1, 2014_07_07

Page 1 of 1

A Family Guide to Eating Fish



Safe eating guidelines for fish from Minnesota lakes and rivers, and for fish bought in restaurants and stores.

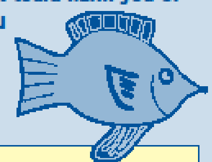
MINNESOTA MDH DEPARTMENT OF HEALTH

Fish are an excellent low-fat food. Eat a variety of fish as part of your balanced food choices.

There are many reasons to enjoy a variety of fish often:

- Fish are a great source of protein, vitamins and minerals.
- The oils found in fish are important for unborn and breast-fed babies.
- Eating fish may play a role in the prevention of heart disease in adults.

However, fish may contain contaminants that could harm you or your family if you eat certain types of fish or eat fish too often.

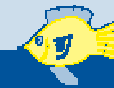


If you are pregnant, planning to be pregnant, breastfeeding or have young children, read on to learn how to include fish as part of healthy, balanced food choices.

This brochure will help you to:

- decide *which fish* to eat
- determine *how often* to eat fish
- identify fish high in contaminants

Do you eat...



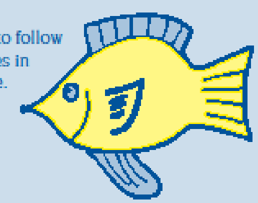
- **large walleyes or northern pike?**
- **canned "white" tuna, fresh tuna or halibut more than once a month?**
- **swordfish or shark?**

If so, you may need to change the *kinds of fish* you eat or *how often* you eat fish.

Your body can handle some exposure to contaminants. However, a developing child or unborn baby can handle less than an adult. If you are pregnant, planning to be pregnant or breastfeeding, you need to be more careful.

Should I just stop eating fish?

NO ...
just be sure to follow the guidelines in this brochure.



This brochure was produced as a collaborative effort between the Minnesota Department of Health and dietitians from HealthPartners, Inc.

What kinds and how much fish should I eat?

The following guidelines are for women of child-bearing age and children under 15 years of age.

Kind of fish	How often can you eat it?
Catfish (farm-raised), cod, crab, flatfish, herring, oysters, pollock, salmon*, sardines, scallops, shrimp, tilapia, and other purchased fish low in mercury *salmon - farm raised or wild, Pacific and Atlantic - not Great Lakes	2 meals per week
OR	
Canned "light" tuna **Minnesota caught:** Sunfish, crappie, yellow perch, bullheads	1 meal per week
AND	
Canned "white" tuna, chilean seabass, grouper, halibut, marlin, orange roughy, tuna steak **Minnesota caught:** Bass, catfish, walleye shorter than 20 inches, northern pike shorter than 30 inches, and other MN gamefish	1 meal per month

What is a meal of fish?

The amount of fish in a meal depends on your body weight. A person's weight is important, because body size affects how the body processes contaminants.

If you weigh 150-pounds, you could safely eat one-half pound/8 ounces of fish in a meal (precooked weight) to stay within the MDH fish consumption guidelines.

How to Follow the Consumption Guidelines -- Example of fish choices for one month:

1 meal of halibut
AND
Week 1: 1 meal of catfish (farm-raised) and 1 meal of tilapia
Week 2: 1 meal of MN-caught Bluegill
Week 3: 2 meals of salmon
Week 4: 1 meal of canned light tuna

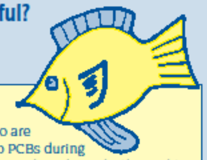
To adjust the meal size for a lighter or heavier weight - subtract or add 1 ounce of fish for every 20 pounds of body weight. For example, one meal would be:

- 7 ounces for a 130-pound person, and
- 9 ounces for a 170-pound person.

Be sure to space out meals thoughout the month. For example, don't eat all of your fish meals for the entire month within a few days. Give your body time to handle the contaminants in-between fish meals.

Don't eat:
Shark, swordfish, tile fish, king mackerel
Minnesota caught: walleye longer than 20 inches, northern pike longer than 30 inches, muskellunge

How can contaminants in fish be harmful?



Fish advisories in Minnesota are based on levels of mercury, PCBs and PFOS in the fish.

Mercury

Small amounts of mercury can damage a brain that is just starting to form or grow. That's why young children, unborn and breast-fed babies are at most risk. Too much mercury may affect a child's behavior and lead to learning problems later in life.

Mercury can also harm older children and adults, but it takes larger amounts. It may cause tingling, prickling or numbness in hands and feet or changes in vision.

PCBs

Babies who are exposed to PCBs during pregnancy may have lower birth weight, reduced head size and delayed physical development. Exposure to PCBs may also cause cancer.

PFOS

Studies of laboratory animals exposed to low levels of PFOS show decreases in high-density lipoprotein (HDL or good cholesterol) and changes in thyroid hormone levels. The concern about PFOS is with long-term exposure: Consuming larger amounts of fish over a long period of time.

By following the guidelines in this brochure, you can reduce your exposure to the contaminants in fish and help reduce your health risks.

Methods for cleaning and cooking fish:

Mercury and PFOS are not removed through cooking or cleaning. However, by removing fat when you clean and cook fish, you *can* help to reduce the amount of other contaminants like PCBs.

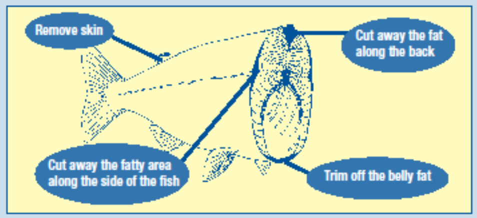


Diagram from Wisconsin Fish Advisory

Where do the contaminants in fish come from?

Mercury in Minnesota's lakes and rivers comes from air pollution. About 70 percent of the mercury in the air is the result of emissions from coal combustion, mining, incineration of mercury-containing products and other human sources. All fish have some mercury.

PCBs are man-made substances that were once used in electrical transformers, carbonless papers, cutting oils and hydraulic fluids. PCBs were banned in 1976. Although levels have declined, PCBs are still found in the environment. They are found mainly in the Great Lakes and major rivers such as the Mississippi River.

PFOS (Perfluorooctane sulfonate), a chemical in the perfluorochemical (PFC) group, has been measured in fillets of several species of fish from the Mississippi River and metro lakes. PFCs are a family of manmade chemicals that have been used for decades to make products that resist heat, oil, stains, grease and water. The Pollution Control Agency is leading an investigation into environmental contamination from perfluorochemicals.

For more information on fish consumption guidelines call 651/201-4911 or 1-800-657-3908 or visit our Web site at www.health.state.mn.us

Minnesota Department of Health
625 Robert Street North
P.O. Box 64975
St. Paul, MN 55164-0975

To request this document in another format, such as large print, Braille or cassette tape, call 651/201-4911; TDD 651/201-5797 or toll-free through the MN Relay Service, 1-800-627-3529.

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March 2009

Result Letter Templates

Template used for participants who reported eating fish on Mercury Screening Form and have a mercury result above 5.8 µg/L of blood. Reading level: 8.6 (7.9 with Minnesota Department of Health Fish Advisory Program removed)

Date

[First Name] [Last Name]
[Address]
[City], [State] [ZIP]

Dear [First Name] [Last Name],

Thank you for taking part in the Mercury Screening Project! One main purpose of this Project was to test your blood for mercury. Your mercury result is below.

Appointment: <insert date>
Your Total Mercury: <insert value> µg/L (micrograms per liter of blood)

Your total mercury is above 5.8 µg/L, which is the level considered safe for women who are or may become pregnant. Based on your responses to the screening questions, you could reduce your mercury by ______.

At the end of your visit, WIC staff talked with you about eating fish low in mercury as part of a healthy diet. Following that advice (also found in the take-home materials) is important for keeping the mercury in your body at a level safe for your health.

If you have questions about your result or eating fish, please contact Pat McCann at (651) 201-4915. She works for the Minnesota Department of Health Fish Advisory Program and is leading this Project.

Thank you again for being a part of the Mercury Screening Project!

Sincerely,

Template used for participants who reported eating fish on Mercury Screening Form and have a mercury result below 5.8 µg/L of blood. Reading level: 8.9 (8.2 with Minnesota Department of Health Fish Advisory Program removed)

Date

[First Name] [Last Name]
[Address]
[City], [State] [ZIP]

Dear [First Name] [Last Name],

Thank you for taking part in the Mercury Screening Project! One main purpose of this Project was to test your blood for mercury. Your mercury result is below.

Appointment: <insert date>
Your Total Mercury: <insert value> µg/L (micrograms per liter of blood)

Your total mercury is below 5.8 µg/L, which is the level considered safe for women who are or may become pregnant. Based on your responses to the screening questions and your mercury result, we encourage you to eat more fish low in mercury.

At the end of your visit, WIC staff talked with you about eating fish low in mercury as part of a healthy diet. Following that advice (also found in the take-home materials) is important for keeping the mercury in your body at a level safe for your health.

If you have questions about your result or eating fish, please contact Pat McCann at (651) 201-4915. She works for the Minnesota Department of Health Fish Advisory Program and is leading this Project.

Thank you again for being a part of the Mercury Screening Project!

Sincerely,

Template used for participants who did NOT report eating fish on Mercury Screening Form and have a mercury result above 2.0 µg/L of blood. Note: if the mercury level is above 2 µg/L and the participant doesn't eat fish, their exposure is most likely to inorganic mercury. The level of concern for inorganic mercury is lower than methylmercury, the form of mercury in fish. Reading level: 8.7 (8.2 with Minnesota Department of Health Fish Advisory Program removed)

Date

[First Name] [Last Name]
[Address]
[City], [State] [ZIP]

Dear [First Name] [Last Name],

Thank you for taking part in the Mercury Screening Project! One main purpose of this Project was to test your blood for mercury. Your mercury result is below.

Appointment: <insert date>
Your Total Mercury: <insert value> µg/L (micrograms per liter of blood)

Based on your responses to the screening questions, you eat very little fish or no fish at all. However, your total mercury is above 2.0 µg/L, which is higher than expected for someone who eats little or no fish. **Please call Carl Herbrandson at (651) 201-4906 to talk about your results and discuss other possible sources to mercury.** He works for the Minnesota Department of Health (MDH).

At the end of your visit, WIC staff talked with you about eating fish low in mercury as part of a healthy diet. Following that advice (also found in the take-home materials) is important for keeping the mercury in your body at a level safe for your health.

If you have questions about eating fish, please contact Pat McCann at (651) 201-4915. She works for the MDH Fish Advisory Program and is leading this Project.

Thank you again for being a part of the Mercury Screening Project!

Sincerely,

Incentive Tracking

Preloaded Visa gift cards ($20 each card) will be purchased by MDH. An Incentive Log is created by MDH each time a batch of cards is ordered. The Incentive Log lists every card in the batch by its unique tracking number (found on the back of each card).

Upon arrival, MDH will check that each card in the batch is listed on the Incentive Log. Once accounted for, cards will be hand-delivered by MDH to WIC staff with the Incentive Log. After delivery, WIC staff are responsible for all cards. Cards are to be securely locked when not in use and only accessible to staff working on the Project.

Following each visit, WIC staff will have each participant sign the Incentive Receipt stating they have received a gift card for participating in the Project. Staff will write the Participant ID and date on the Incentive Log to record the card was given to the participant. Women who are poked with the lancet but are unable to provide enough blood for mercury analysis will also be given a $20 gift card.

When the Incentive Log is complete (or when requested), WIC staff will make a copy and return the original to MDH for auditing and record keeping purposes.

WIC staff will return any unused cards at the end of the Project to MDH.

Incentive Receipt

Reading level: 7.2

Mercury Screening Project
Incentive Receipt

Participant ID:

I have received a $20 gift card for my participation in the Mercury Screening Project. This signed receipt will remain in my private file.

Print Name: ______________________________

Sign Here: ______________________________

Date: ______________________________

Card #: ______________________________

Incentive Log

MINNESOTA DEPARTMENT OF HEALTH

SECTION OF FINANCIAL MANAGEMENT

INCENTIVE RECONCILIATION REPORT

FISCAL YEAR 2015

Date of Memo:
Requestor:
Name of Program:
Type of Card:
Budget:
Program Contact:
Amount Requested:

Please complete this section quarterly:

Reconciliation for Quarter Ending (Indicate): 3/31 6/30 9/30 12/31 FINAL

Number of cards available for distribution from list:	
Physical count of cards held in secure storage:	
Report completed by:	
Date completed:	

This section needs to be completed quarterly and sent to Financial Management by the 15th day of the month following quarter end.
Please send this reconciled report to Jane Olson in FM by interoffice mail or email:
Jane.R.Olson@state.mn.us

Date received in FM:

#	FM Distribution Date	Denomination	Gift Card Number	Program Distribution Date	Name/Recipient ID#
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					

Page 1

MN.IT SERVICES

Encrypted Messaging and How to use it

Encrypted or “secure” messaging is a server based approach to protect sensitive email data when it is sent to citizens, businesses or anyone outside the Enterprise Unified Communication and Collaboration (EUCC) Email system. One advantage over classical (un-encrypted) email is that confidential and authenticated exchanges can be started immediately by any internet user worldwide since there is no requirement to install any software. MN.IT Services uses Microsoft’s Exchange Hosted Encryption to provide email encryption services.
Note: Messages sent to between EUCC Email recipients stay within the State’s secure system and therefore do not use Microsoft Exchange Hosted Encryption. However these messages are transmitted securely between email servers, using the Transport Layer Security (TLS) network protocol.

When should I use encrypted messaging?

In approved or mandated situations, encrypted email should be used to communicate sensitive information to the recipient(s). You should always check your organization’s policy about the type of information suitable for email communication as some information should NEVER be communicated via email.

Where is my encrypted message stored?

Encrypted messages are stored in the end user’s email inbox, not in Microsoft’s Exchange Hosted Encryption system. Microsoft’s servers simply decrypt the message for recipients; they do not store it.

Are my attachments encrypted?

The entire email, including attachment(s), are encrypted using an Identity Based Encryption (IBE) algorithm. This means the recipient’s email address is used as part of the encryption key. Once the encryption is unlocked, however, recipients can save attachments and distribute them without encryption.

What is the difference between TLS and encrypted email?

Transport Layer Security or TLS is used to encrypt mail at the communication level - email between messaging systems. The EUCC email system is configured to be “TLS opportunistic” which means it tries to use TLS, but if the destination system does not support it, the message is sent unencrypted. Encrypted messaging means the email message itself is encrypted and then communicated to the recipient’s email system. Therefore, whether or not the message is encrypted at the communication level is irrelevant.

How to send an encrypted message

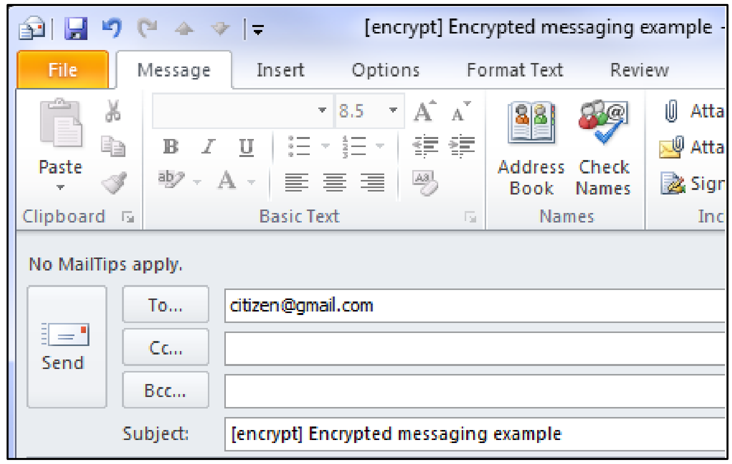
1) Create a new in Outlook or Outlook Web App (OWA)

2) Enter the recipients in the To: and Cc: lines

3) Type [encrypt] in the beginning of your subject line, then enter the subject of the message (see Outlook 2010 example to the right.)

Note: The [encrypt] term indicates to the messaging service that you want the message encrypted to external recipients.

4) Compose the message and then click **Send**.



What do recipients receive?

Recipients will receive a notification when they are sent an encrypted email asking them to open an attachment to view the email. At that point, they are redirected to the Exchange Hosted Encryption website to unlock the encrypted message (see the example to the right.)

How to read an encrypted message

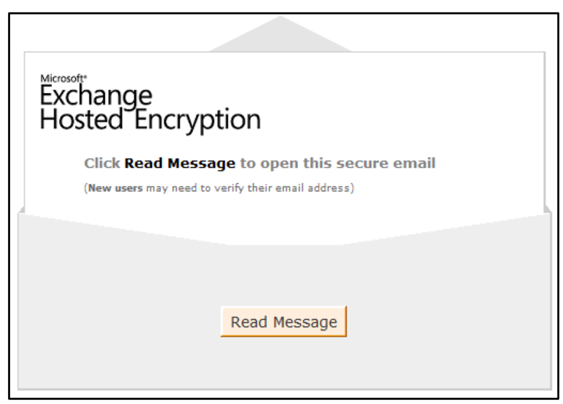
1) At the bottom of the Exchange Hosted Encryption message you will see “message_zdm.html”. Click **View** (see example from previous section)

2) In the window that opens, click **Read Message** (see example to the right).

3) Login to the Exchange Hosted Encryption system.

   a. If you have already registered in the system, you just need to enter your password.

   b. If you have NOT registered, you will need to do so. The registration prompts/instructions are direct and easy to follow. You must enter your full name and choose (and confirm) a password.



4) A window opens with the message including the From, To, Sent, Subject and message body.

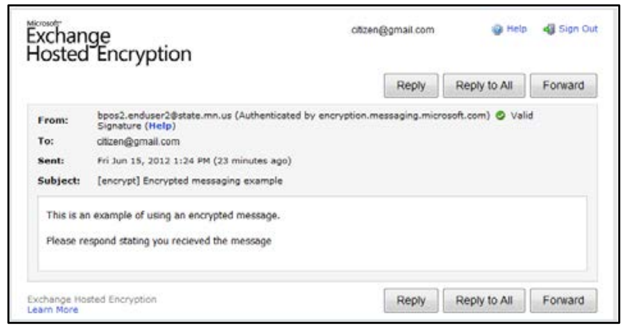
Note: Each subsequent time the recipient receives an encrypted message, they will simply login to view it.

How to forward/reply to an encrypted message

Once opened in Exchange Hosted Encryption, messages can be forwarded or replied to, and will remain encrypted. (See the example to the right.)

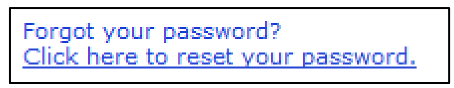
1) Open the encrypted message.
2) Click **Reply**, **Reply to All**, or **Forward**.
3) Enter a reply message.
4) Click the **Send Secure** button.

Note: The recipient of a reply or forwarded message will be required to log into Microsoft Exchange Hosted Encryption to view it (even if they are in the EUCC Email system).



How to reset your password

There is an easy-to-find link on the Microsoft Exchange Hosted Encryption login page to reset a forgotten password (see example to the right). Once clicked, users are sent an email with instructions on how to complete the resetting process.



For more information, please visit our website at mn.gov/mnit or contact OET Client Relations at 651-296-4466 oet.services@state.mn.us

Appendix B

Blood Collection and Storage Procedure

Specimen Shipping and Handling

Chain of Custody (COC) Form

Blood Collection and Storage Procedure

Procedure for collecting capillary blood for mercury analysis

Supplies:

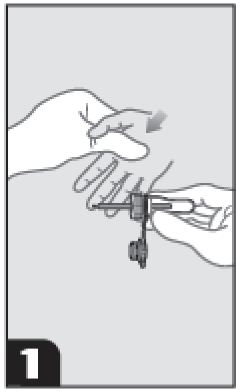
- BD Microtainer Contact-Activated Lancets (2.0 mm depth, 1.5 mm width blade, Fisher catalog # 02-657-102)
- RAM Scientific SAFE-T-FILL Capillary Blood Collection Tubes (# 07 7051, EDTA Capillary Collection 200 µL)
- Gloves
- Alcohol swabs
- Gauze or tissue
- Bandages

Specimen Collection Procedure for Mercury Analysis:

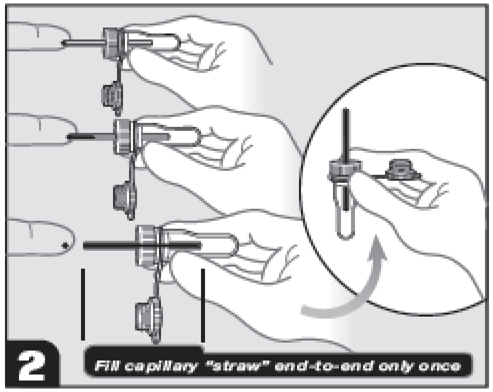
1) Follow the same procedure as for hemoglobin testing (see below). Massage the fleshy portion of the finger and wipe the puncture site with an alcohol swab.
2) Perform the puncture at the side of the finger with the BD Microtainer lancet. Make the puncture deep enough for blood to flow freely. If blood flow is inadequate, gently massage the proximal portion of the finger and then press firmly on the distal joint of the finger.
3) Wipe off the first droplet of blood with a sterile gauze or cotton ball. Do not let the blood run down the finger or onto the fingernail.
4) Touch the tip of the capillary tube to the beaded drop of blood. Draw the blood into the tube maintaining a continuous flow of blood.
5) When the tube is full (2µL of blood), invert it so the blood flows out and into the specimen container. Cap the container and invert the container several times to mix the blood with the anticoagulant. Properly dispose of capillary tube.
6) Check that the container is properly labeled (with the Specimen ID and Participant ID labels). Store in the refrigerator with the Chain of Custody (COC) until shipment to MDH PHL.
7) Stop the bleeding and cover the finger with a bandage.

The blood collection procedure is also illustrated below.

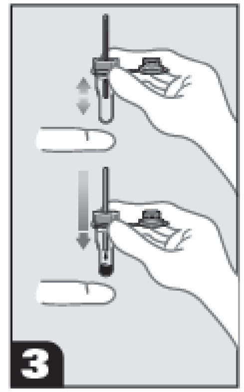
Instructions: SAFE-T-FILL® Capillary Blood Collection Tube



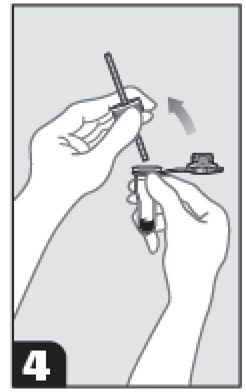
Hold the open end of the SAFE-T-FILL® Capillary Blood Collection Tube close to the puncture site at a horizontal or slight angle so that the end of the capillary "straw" touches **only** the blood drop.



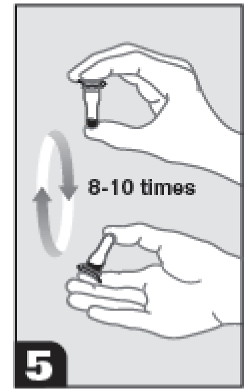
The blood drop will be pulled into the straw via capillary action. Repeat drawing capillary blood from the puncture site until the capillary straw is **filled end-to-end only once**. A complete end-to-end fill of the capillary straw is equal to the stated fill volume. Invert the tube to a vertical position to allow the blood to flow down into the microtube.



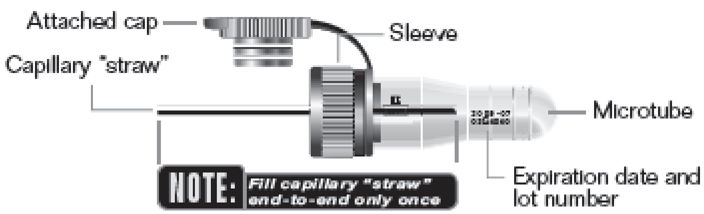
Gently tap the bottom of the microtube on a soft surface (finger or palm) to drop the blood from the capillary straw into the microtube.



Remove the capillary straw together with its colored sleeve from the microtube and properly discard the capillary straw and colored sleeve in a biohazard container.



Close the microtube with attached cap. Mix by holding the tube between thumb and forefinger and inverting 8-10 times. Label the tube and process the sample according to your organization's guidelines.



RAM SCIENTIFIC

RAM Scientific Customer Service at 1.800.535.6734 or visit us on the web at www.ramsci.com

Procedure for Hemoglobin Testing
(excerpted and reformatted from Lake County policy 5.3.2 Hematologic Assessment, Federal Regulation 7 CFR 246.7; dated August 1, 2001)

Equipment, Reagents, and Supplies:

- HemoCue® photometer
- HemoCue® calibration cuvette
- HemoCue® microcuvettes, (store at room temperature – see Note no. 1)
- Blood lancets single use, spring-loaded and retractable (e.g., Genie Vacutainer, Unistick or Saf-T-Pro
- Gloves
- Alcohol
- Gauze or tissue
- Bandages

Specimen Collection Procedure for Hemoglobin Testing:

Blood may be obtained from capillaries in the ear, finger, toe, or heel of an infant. For an infant, obtaining the capillary blood sample from the toe or heel may be easier. The procedure explained here is for obtaining a sample from a finger.

1. Remove a cuvette from the vial and immediately replace the cap tightly to avoid humidity damage to the remaining cuvettes.

2. It is important that the blood circulate freely in the sample finger, so fingers with rings on should not be used. The patient's fingers should be straight but not tense, to avoid the stasis effect which occurs when the fingers are bent.

3. Using your thumb in a gentle rocking movement, lightly press the finger from the top knuckle to the tip. This stimulates the flow of blood to the sampling point. Circulation can be stimulated by having the WIC applicant hold her/his hand down below her/his heart and making a fist several times.

4. Cleanse the skin with a 70% alcohol swab and dry the finger before making the puncture. Drying the finger prior to the stick is important because alcohol is painful in a cut, and it could mix with and dilute the blood giving a spuriously low reading or it could cause clotting of the sample.

5. Using gentle pressure, hold the finger at the top knuckle with your thumb. Perform the puncture at the side of the fingertip with a lancet. Make the puncture deep enough so blood will FLOW FREELY from the puncture. Do NOT "milk" or squeeze the finger because this forces tissue fluid into the sample resulting in an incorrectly low reading.

6. Using a dry gauze, wipe away the first three good size drops of blood. This stimulates blood flow and "clears" tissue fluid from the site which could dilute the specimen. Do not use cotton balls. Cotton fibers may hinder the flow of blood.

7. Apply light pressure until another drop of blood appears but avoid squeezing the finger near the puncture site. Make sure that the drop of blood is big enough to fill the cuvette completely. Place the cuvette tip in the middle of the drop of blood. The cuvette should fill in a continuous process.

8. Wipe off any excess blood from the outside of the cuvette, being careful not to touch the curved edge. Check for the presence of air bubbles in the center of the cuvette. If present, a new sample should be tested. Small air bubbles around the edge do not influence the result.

9. Place the filled cuvette into the holder and insert to the “measuring” position. The results will be displayed in approximately 45 seconds. Record hemoglobin result immediately.

10. Discard the cuvette in an appropriate bio-hazard container.

Specimen Shipping and Handling

Lake County WIC staff are responsible for packaging specimens for shipment to MDH PHL by FedEx. **Staff are required to wear latex or nitrile gloves when handling specimens.** Specimens will be shipped approximately twice per month. Specimens will not be shipped on Thursdays or Fridays.

Pre-shipment Inventory

1. Remove all specimens from the refrigerator.
    - Verify all tubes have a Participant ID label and a Specimen ID label.
    - Inspect tubes for leaks or breakage.
    - Document any broken tubes and report these to Pat McCann (MDH Project Investigator) as soon as possible after discovered.
2. Verify that each specimen has a COC and the COC is complete. Make one copy for WIC and keep the original for shipment with the specimen.

Specimen Packaging and Shipping

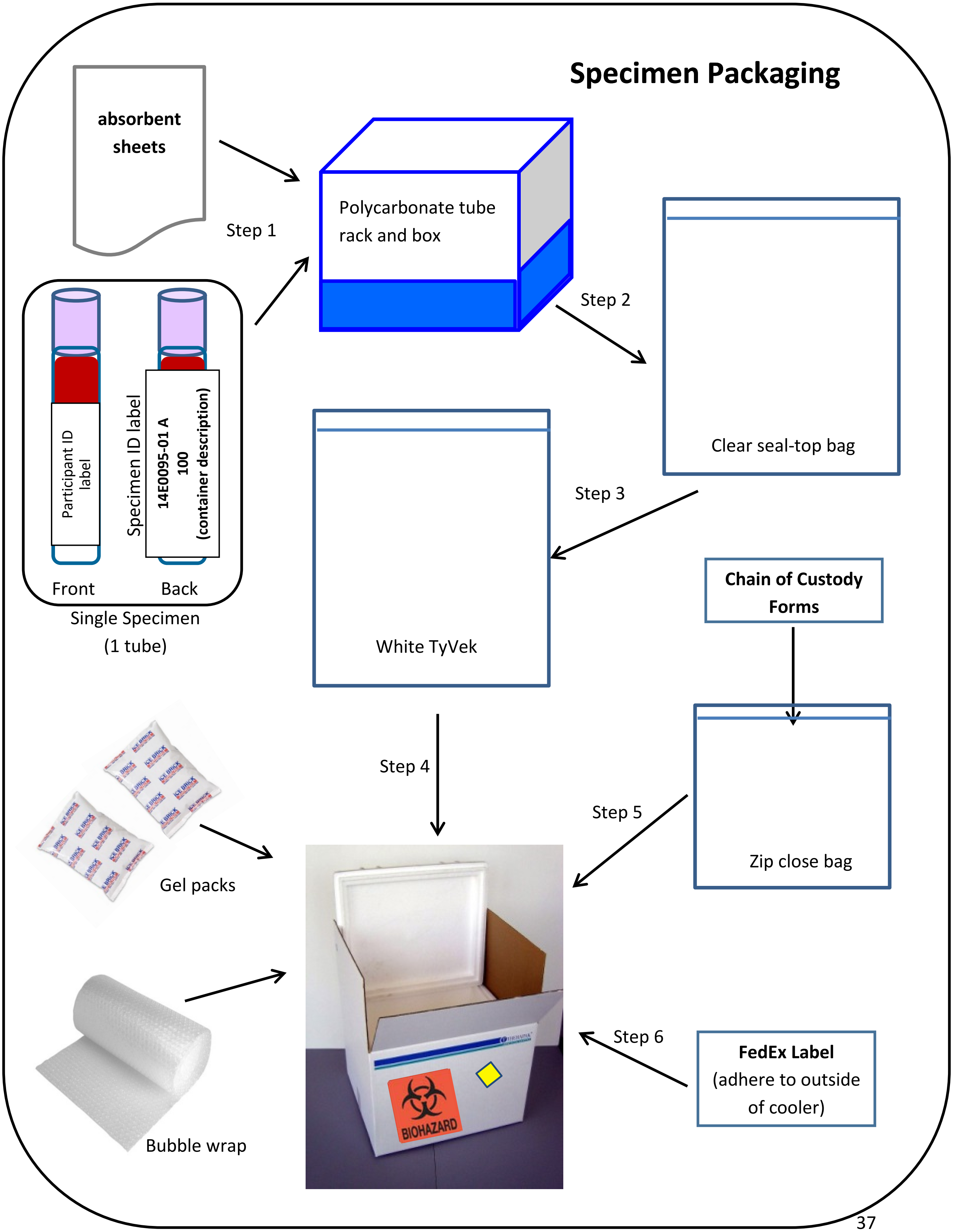
Shipment of biospecimens must meet specific requirements. The specimen packaging picture on the next page visualizes the packaging steps described below.

1. Add specimen tubes to polycarbonate box (if not already in box). Place 2 absorbent sheets on top of the tubes and add bubble wrap to keep tubes from moving around before replacing the box cover.
2. Place polycarbonate box into clear seal-top bag. Remove as much air from inside the bag as possible and seal. Only put 1-2 boxes per seal-top bag.
3. Place bagged box inside the white Tyvek Saf-T-Pak ® envelope. Seal white TyVek securely.
4. Put gel packs in bottom of cooler. Place packaged specimens on top of gel packs. Make sure box is situated so that specimens remain upright. Add more gel packs on top of specimens and then bubble wrap (if needed) to fill space around and on top of the specimens to minimize movement during transport.
5. Add COC forms for all specimens into a zip top bag. Place bag on top of packed specimens.
6. Securely tape cooler closed and attach FedEx tracking form to cooler.

MDH PHL

Upon arrival, MDH PHL staff will…

1. Inspect all specimens for leaks or container breakage.
2. Verify that each specimen is listed on the COC and in the cooler.
3. Document any partial samples, broken containers, or discrepancies between COC and cooler contents and report these to Pat McCann (MDH Project Investigator) as soon as possible after discovered.
4. Log specimens into PHL sample receiving database.



Specimen Packaging
absorbent sheets
Step 1
Polycarbonate tube rack and box
Participant ID label
Specimen ID label
14E0095-01 A
100
(container description)
Front
Back
Single Specimen
(1 tube)
Step 2
Clear seal-top bag
Step 3
White TyVek
Chain of Custody Forms
Step 4
Gel packs
Step 5
Zip close bag
Bubble wrap
Step 6
FedEx Label
(adhere to outside of cooler)
BIOHAZARD

Chain of Custody (COC) Form

MINNESOTA MDH DEPARTMENT OF HEALTH

Chain-of-Custody Form

Minnesota Department of Health
Environmental Laboratory
601 Robert St. North
St. Paul, MN 55155-2531
651-201-5300
www.health.state.mn.us/divs/phl/environmental/index.html

Page 1 of 1

Lab Use Only

Program Code (2 Letters)

Project Name: MSP

Client / Agency: Environmental health

Site ID: Lake Co Health and Human Services

Project Manager Name / Phone: Patricia McCann

Report to Name: Patricia McCann

Report to Email: patricia.mccann@state.mn.us

☒ Standard Chain of Custody

Potential Hazard ☒ Yes ☐ No ☐ Unknown
If Yes please add information to Sampler Comments below

TAT ☒ Standard ☐ Priority ☐ Emergency

Matrix Codes
DW = Drinking Water; WP = Wipe; OT = Other
NW = Non-potable Water; AR = Air; TS = Tissue
SD = Soil/Solid; BL = Biological Material

Sampled by (print)

Affiliation

Sampler Signature

Phone

#	MDH # (Lab Use Only)	Location ID (Unique Identifier)	Sample Point	Collection Date	Collection Time (24 Hour)	Matrix Code	Unpreserved	Hydrochloric Acid	Sulfuric Acid	Nitric Acid	Sodium Hydroxide	Sodium Thiosulfate	Ascorbic Acid	Other	Total # Containers	Samples Field Filtered Y / N	Analyses: Blood Mercury	Seal Intact Y / N / NA	Lab Temp (°C)
1						BL	0	0	0	0	0	0	0		1	N			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			

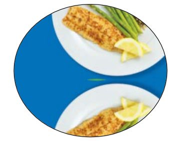
Sampler Comments

Whole blood samples

Receiving Comments

Relinquished By / Affiliation	Date	Time	Accepted By / Affiliation	Date	Time
(Sampler)					

Revised 2/2012



Community Report for the Lake County Mercury Screening Project

August 2015

Women of childbearing age recently participated in a project with Lake County Health and Human Services Women, Infants, and Children program (LCHHS WIC) and the Minnesota Department of Health (MDH). The Lake County Mercury Screening Project (MSP) focused on reducing mercury exposure in women of childbearing age.

Why did we do this project?

We did MSP to reduce mercury exposure in women who are or may become pregnant and, therefore, in future babies by raising awareness about fish consumption.

- A 2011 study (Mercury in Newborns in the Lake Superior Basin) showed that 10% of Minnesota babies tested from the North Shore area had mercury in their blood above the level considered safe.
- Fish and fishing are an important part of history and culture for communities in Northeast Minnesota. Women living along the North Shore of Lake Superior have reported frequently eating fish with higher levels of mercury.

MSP is an extension of the Fish are Important for Superior Health (FISH) Project currently underway in Cook County. Information gathered from MSP and FISH will be combined to evaluate how predictive screening questions are for blood mercury levels.

In the future, screening questions could aid doctors and nurses in quickly screening patients for high mercury exposure. Screening would guide patient education for choosing fish low in mercury to lower exposures.

Mercury Screening Project Goals

1. Measure mercury in blood to see if women have exposure above a level of concern
2. Educate women on health benefits of eating fish and eating fish low in mercury
3. Determine if screening questions predict blood mercury level

What did a MSP participant have to do?

Between September and December 2014, 121 women age 16 to 49 who participate in LCHHS WIC or work as LCHHS employees took part in MSP. They each provided a blood sample to be analyzed for mercury and answered three screening questions about fish they recently ate.

Participants were given information about the health benefits of eating fish and how to choose fish to eat that are low in mercury. Most women completed the project in 20-30 minutes.

Each participant received her personal mercury blood result, information on wisely choosing fish to eat, and a $20 gift card for taking part.

How much fish did participants report eating?

Responses to three screening questions described how much fish participants ate in the last 2-3 months.

Screening Question #1

How many times a <u>week</u> did you eat <u>any kind of fish</u>?

All 121 participants reported eating fish in the last 2-3 months. Overall, younger women tended to eat fewer fish meals than older women.

- Benefits from eating fish are maximized at 1-2 meals per week. 38% of women said they ate 1 or more fish meals per week.

Screening Question #2

How many times a <u>month</u> did you eat any of these fish – Walleye, Northern Pike, Bass, or Lake Trout from Lake Superior?

About 12% of women reported eating 2 or more meals per month of walleye, northern pike, bass, or lake trout from Lake Superior.

- This is more frequent than the fish safe-eating guidelines recommend. In general, these fish should be eaten up to one meal per month.

Screening Question #3

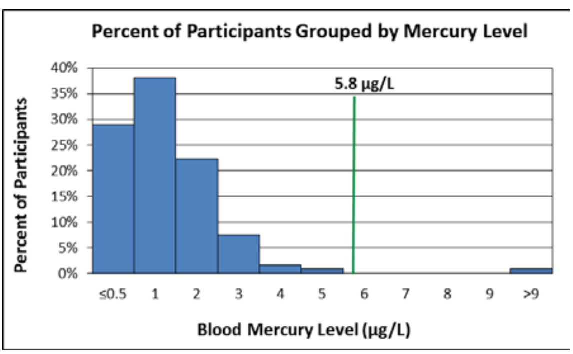
Did you eat shark or swordfish?

No one reported eating shark or swordfish in the last 2-3 months.

- Both shark and swordfish are high in mercury and should be avoided by women of childbearing age.

What mercury levels were found in participants' blood?

The mercury level in blood considered safe for women who are or may become pregnant is 5.8 µg/L or below. This level is protective for a growing fetus. The mercury results for most participants were below this level (shown as a green line in the graph below).



In general, women who ate more fish meals had higher levels of mercury. Participants with a mercury level above 5.8 µg/L were given specific advice to lower mercury exposure by choosing to eat lower mercury fish and fewer meals of higher mercury fish.

Less than 1% of MSP participants were above 5.8 µg/L compared to about 2% in the U.S.

Source: 2011-2012 National Health and Nutrition Examination Survey (NHANES)

It's important to note that fish consumption varies by season and so can mercury levels, depending on the types of fish eaten. MSP blood samples were collected between September and December.

Why is mercury a concern?

Most people's exposure to mercury comes from eating fish. Mercury in Minnesota waters and fish is a result of worldwide emissions from coal combustion, mining, other human activities, and natural sources.

Mercury exposure can affect a person at any age. However, the developing fetus and young children are most at risk from mercury in fish. Too much mercury can affect a child's ability to learn and process information.

All fish contain at least a small amount of mercury. Some fish have more than others. Bigger/older fish have more mercury than smaller/younger fish of the same species. When you eat fish, the mercury in the fish gets into your body. Your body is able to get rid of mercury over time.

Following the **MN Safe-Eating Guidelines** will give you the benefits of eating fish while keeping your exposure to contaminants low. Find them here: **www.health.state.mn.us/fish**

Are there benefits from eating fish?

Even though fish contain mercury and possibly other contaminants, there are good reasons to eat fish. Fish is low in bad fats and a good source of protein, iodine, and vitamin D. Fish is also one of the only foods naturally high in DHA and EPA omega-3 fatty acids, which are needed by the body, especially for eye and brain development.

In research studies, moms who at more fish during pregnancy had a lower risk of premature birth, fewer pregnancy complications, and children with better development and higher IQ.

Should women eat fish?

Choosing fish wisely to maximize benefits and minimize risks is often challenging. MSP increased awareness about the health benefits and risks of eating fish to women of childbearing age.

MDH recommends eating fish as part of a healthy and nutritious diet. Experts agree eating fish 1-2 times per week will maximize benefits. Benefits outweigh risks if the fish women eat are low in mercury and other contaminants.

Many women who took part in MSP said they ate fish less than 1 time per week. Both the number of fish meals eaten per week and the mercury levels measured in blood indicate that women in MSP could eat more fish.

By choosing fish wisely, women could gain more of the benefits of eating fish for their health and their future children while still keeping their exposure to mercury low and at a safe level.

Questions?

LCHHS WIC
(218) 834-8434

Lake County MINNESOTA

Pat McCann
MDH Fish Advisory Program
(651) 201-4915
patricia.mccann@state.mn.us

MINNESOTA MDH DEPARTMENT OF HEALTH

Report is also available at www.co.lake.mn.us

Local Fish Project Wraps Up, Report Available

The Community Report for the Lake County Mercury Screening Project (MSP) was recently completed by Lake County Health and Human Services Women, Infants, and Children program (LCHHS WIC) and the Minnesota Department of Health (MDH). The report is a summary of results from MSP. The project focused on reducing mercury exposure in women who are or may become pregnant and, therefore, in future babies by raising awareness about risks and benefits of eating fish. Participants included 121 women of childbearing age who live in Lake County.

Most people's exposure to mercury comes from eating fish. All 121 women reported eating fish in the last 2-3 months. In general, women who ate more fish meals had higher levels of mercury. However, the mercury results for most participants were below the level considered safe for women of childbearing age and a growing fetus.

There are good reasons to eat fish. Fish is low in bad fats and a good source of protein, iodine, and vitamin D. Fish is also one of the only foods naturally high in DHA and EPA omega-3 fatty acids, which are needed by the body, especially for eye and brain development. Benefits of eating fish outweigh risks if the fish are low in mercury and other contaminants.

MDH recommends eating fish as part of a healthy and nutritious diet. Studies show that benefits to developing babies are maximized when women who are or may become pregnant eat fish 1-2 times per week. Benefits outweigh risks if the fish women eat are low in mercury and other contaminants.

MSP is an extension of the Fish are Important for Superior Health (FISH) Project currently underway in Cook County. Both North Shore projects are in response to a 2011 study (Mercury in Newborns in the Lake Superior Basin) that showed that 10% of Minnesota babies tested from the North Shore area had mercury in their blood above the level considered safe.

Information gathered from MSP and FISH will be combined to evaluate how predictive screening questions are for blood mercury levels. In the future, screening questions could aid doctors and nurses in quickly screening patients for high mercury exposure. Screening would guide patient education for choosing fish low in mercury to lower exposures.

Choosing fish wisely to maximize benefits and minimize risks is often challenging. MSP increased awareness about the health benefits and risks of eating fish to women of childbearing age.

The full MSP Report is available at:
http://www.co.lake.mn.us/departments/health_and_human_services/women_infants_and_children_(wic).php

For questions, please contact LCHHS WIC at (218) 834-8434.

WIC Staff Evaluation of the Lake County Mercury Screening Project

August 2015

Lake County Health and Human Services (LCHHS) WIC recently partnered with the Minnesota Department of Health (MDH) Fish Consumption Advisory Program for the Lake County Mercury Screening Project (MSP). MSP focused on reducing mercury exposure in women of childbearing age and, therefore, in future babies by raising awareness about fish consumption. While the project was viewed positively by staff and clients, improvements can always be made to guide planning and enhance future projects. The lessons learned and ideas for improving future projects follow in a Q&A with LCHHS WIC.

Project Snapshot

Between September and December 2014, 104 women from LCHHS WIC and 23 LCHHS female employees were asked to take part. Out of 127 women, 125 agreed to give a small sample of blood for the mercury test and answer three screening questions about fish they recently ate. Collection of capillary blood occurred with a finger poke using a lancet and collection tube. Four women were unable to give enough blood for the test, and 121 women completed the blood sample and screening.

Participants were given information about the health benefits of eating fish and how to choose to eat fish that are low in mercury.

Most women completed the informed consent, screening questions, blood sample, and education in 20-30 minutes.

Each participant received her personal mercury blood result, information on wisely choosing fish to eat, and a $20 gift card for taking part.

While no significant differences were seen in blood mercury levels, older participants tended to eat more fish.

MSP Staff Feedback

Evaluating MSP identified weaknesses and strengths in project design and implementation. The following Q&A with MDH and Molly Gadsby, WIC nurse for LCCHS, provides valuable insight that could be applied to improve future screening projects.

Q: How much time did it take for each participant to complete the project steps?

A: It took approximately 25 minutes per person from start to finish. This included both our clerk's time briefly explaining the project and getting the folders ready, and the CPA's time doing the consent, blood work, screening questions, and gift card.

This project did add time to a mid-certification or a certification appointment. However, during a Nutrition Education appointment, it was nice for that mom who did not have any questions regarding their health or eating because we were able to discuss safe fish eating habits.

Q: How much time did it take WIC staff to do the post-visit data entry, data transfer to MDH, and results spreadsheet to send results letters?

A: It took the most time to enter the post-visit data, about 3-5 minutes per person. This is because I had to look up each participant's address and DOB. If this is done in the future, the address and DOB should be added as part of the consent form.

Because of the MDH templates, the data transfers and prepping the results spreadsheet for letters were quite easy and very simple, only taking about 10-15 minutes. The time-consuming part was stuffing and labeling the envelopes. Overall, each batch of approximately 30 result letters took about 1.5 hours.

Q: What worked well? What didn't work? What could be improved?

A: Everything went pretty well. MDH had so much of the legwork completed for us that it was really just entering data and shipping blood samples after WIC clinics. Everything was well spelled out in the protocol, and MDH staff were readily available for questions.

It was completely worth our time – both staff and clients. It would have been great to start the screening in June when women may have been eating more fish over the summer fishing season instead of September.

As I stated earlier, I would just change the consent form so it included the participant's DOB and address.

Q: What's your impression – how did participants feel about the project?

A: Participants were very excited about the $20 gift card and seemed interested in knowing their mercury level. A lot of moms had no idea the harm of too much mercury and were glad to have the information.

Q: If funding were available in the future, would you consider adding mercury screening questions and the blood collection to your WIC clinics?

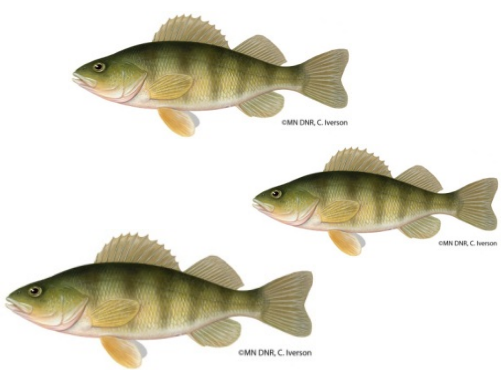
A: If we had someone who strictly did the mercury screening after participant's WIC appointments, we would be completely willing to add this to our WIC clinics with adequate funding. However, it does make for a longer appointment when a mom has three or five children with them, and we have to get through all of the other things required by WIC.

Q: Would you recommend the mercury screen (questions and blood collection) to WIC in other counties?

A: We would definitely recommend this to other clinics. It is a great educational piece for our moms and staff to know. It would work well if it could be offered to clients coming in for Nutrition Educations versus a mid-certification or certification.

Q: What are your personal thoughts on the project from a staff perspective?

A: Overall, we have very positive thoughts about the project. At times, clinic was very hectic, and it would have made it a lot easier not to offer the screening, but for the majority of the time is was good. As LCHHS employees, we took part and enjoyed finding out what our own mercury levels were.



Project Key Points

MSP provided valuable lessons for reaching women of childbearing age and improving future projects to reduce mercury exposure.

Education is the Key! Because all fish contain at least a small amount of mercury, exposure isn't going to go away. Educating women on how to choose fish to eat low in mercury will help them maximize benefits for themselves and their families while keeping exposure to mercury and other contaminants low.

WIC is one venue for reaching women of childbearing age in Minnesota about wisely choosing fish to eat.

MSP offered opportunity to discuss fish in diet! LCCHS WIC found MSP to be a great avenue for discussing fish consumption with WIC clients. Participants found the screening questions easy to answer. Mercury results and fish consumption education materials were helpful for future meal planning. And with the $20 gift card and mercury results, it was worthwhile!

More MSP future projects! With minor modifications to the consent form and possibly additional staff with adequate funding, LCCHS WIC would be willing to do MSP again as part of their WIC clinics. Since WIC's focus includes women of childbearing age and young children, LCCHS WIC also recommends MSP to other WIC programs in MN in order to lower mercury exposures and increase fish consumption education.

Appendix E:
Fish are Important for Superior Health (FISH) Project Risks and Benefits Training

Putting Fish on Your Plate
&
Preventing Mercury Exposures in Babies

Training for Health Care Providers

FISH Project Partners
Grand Portage Health Clinic
Sawtooth Mountain Clinic
Cook County North Shore Hospital
Grand Portage Trust Lands
Minnesota Department of Health

Funding for FISH Project: US EPA Great Lakes Restoration Initiative

Eating fish is good
Eating fish is bad

Lots of conflicting information on risks and benefits of eating fish

All “sides” agree…

Benefits outweigh risks for eating fish low in mercury & other contaminants

Challenge is knowing:

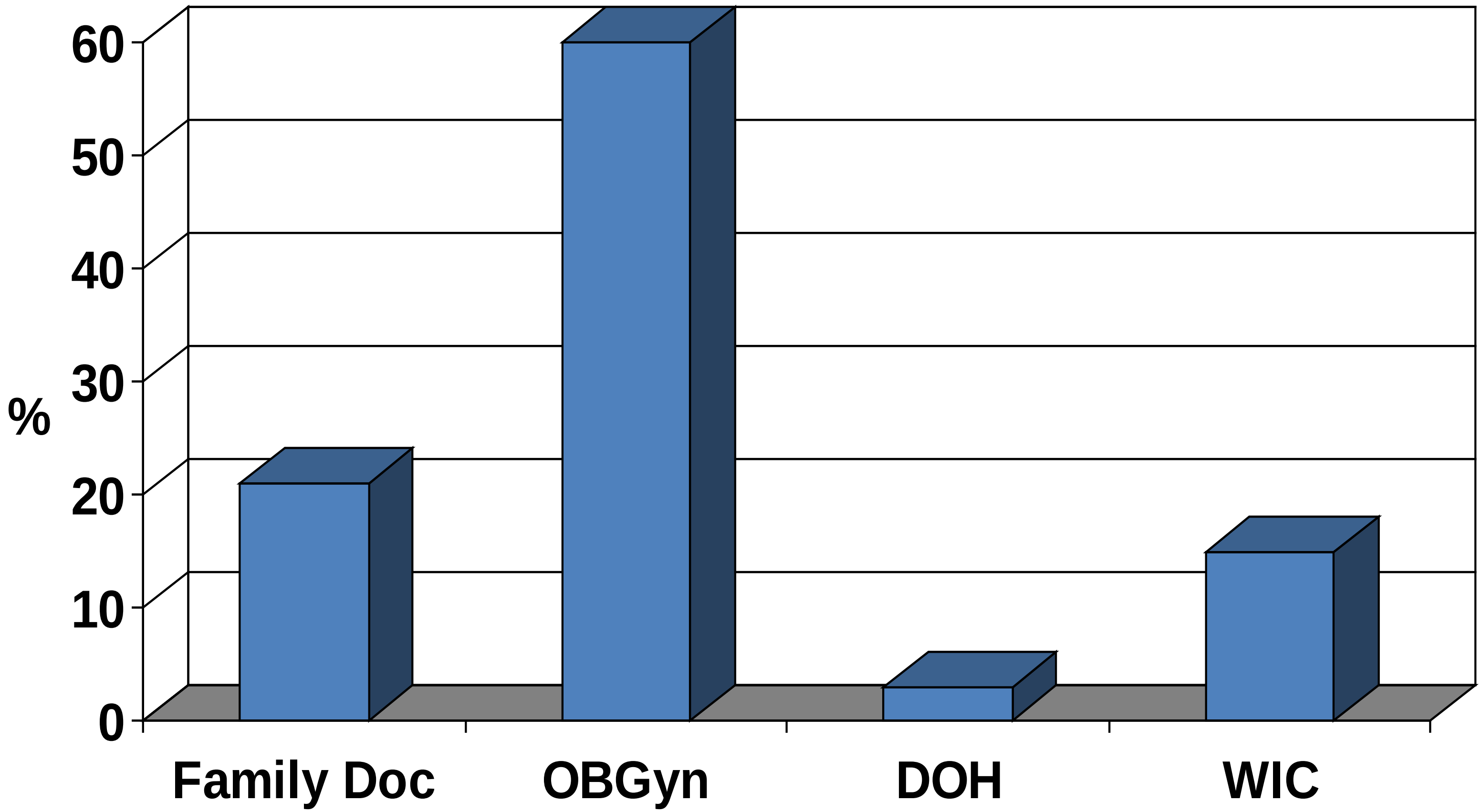
- Which fish are low in contaminants?
  - Fish are not all the same
    - Salmon = very low in mercury
    - Shark = very high in mercury

- Who needs to be most careful about exposure?
  - Risks and benefits are different for
    - developing fetus
    - adult with CVD

Health Care Provider Role

- Dietary guidance for patients
  - Difficult in the presence of conflicting recommendations about the risks and benefits of eating fish.
  - Need to be careful about the message
    - Unintended consequences
  - Promote substitution rather than avoidance
  - Substitution requires knowledge and effort
- HCP are good source of information for WCBA
  - To promote health fetus/baby, WCBA need to more careful about fish selection
  - Fetus is most sensitive to exposures

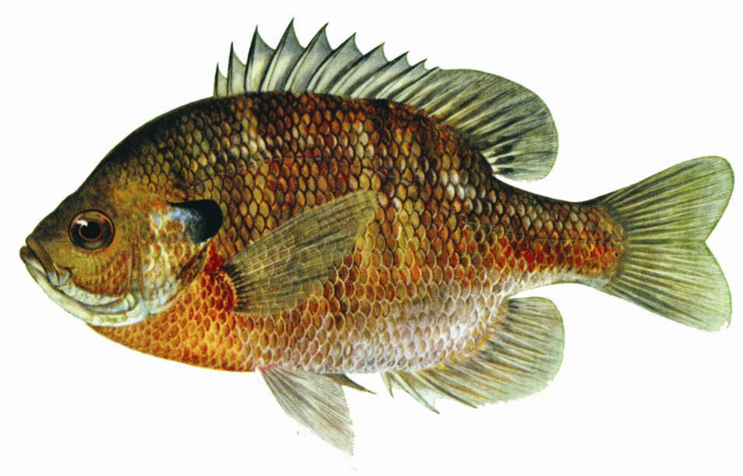
Source for Mom's Guide

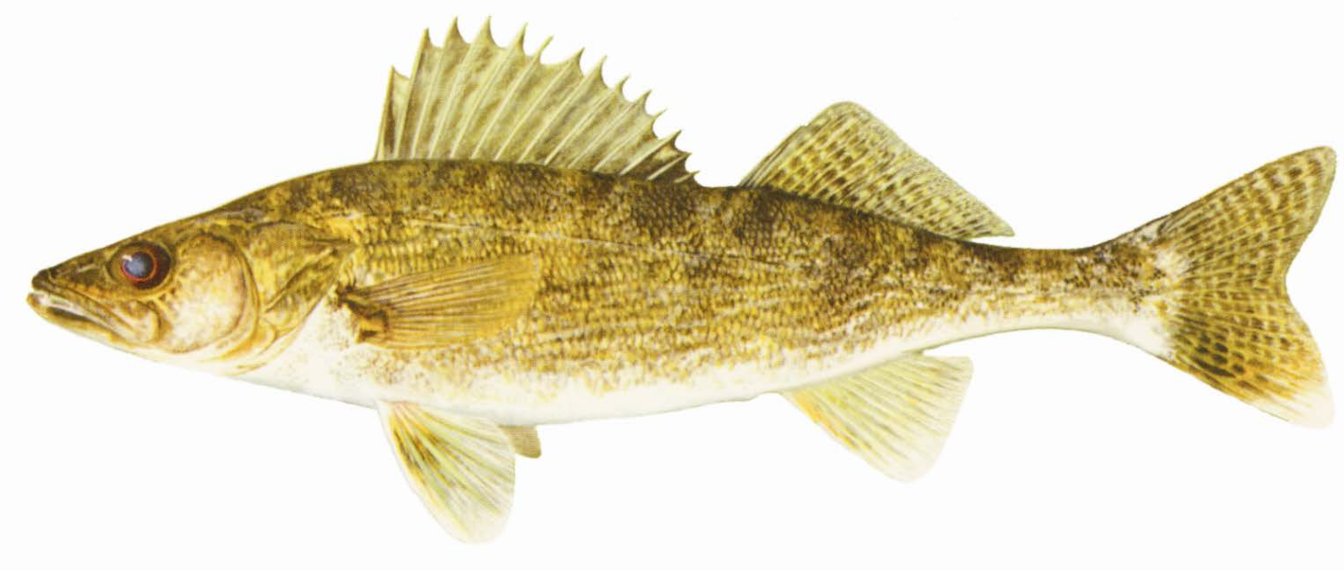


Training

- Summarize benefits and risks
- Fish consumption guidelines
- Screening and counseling

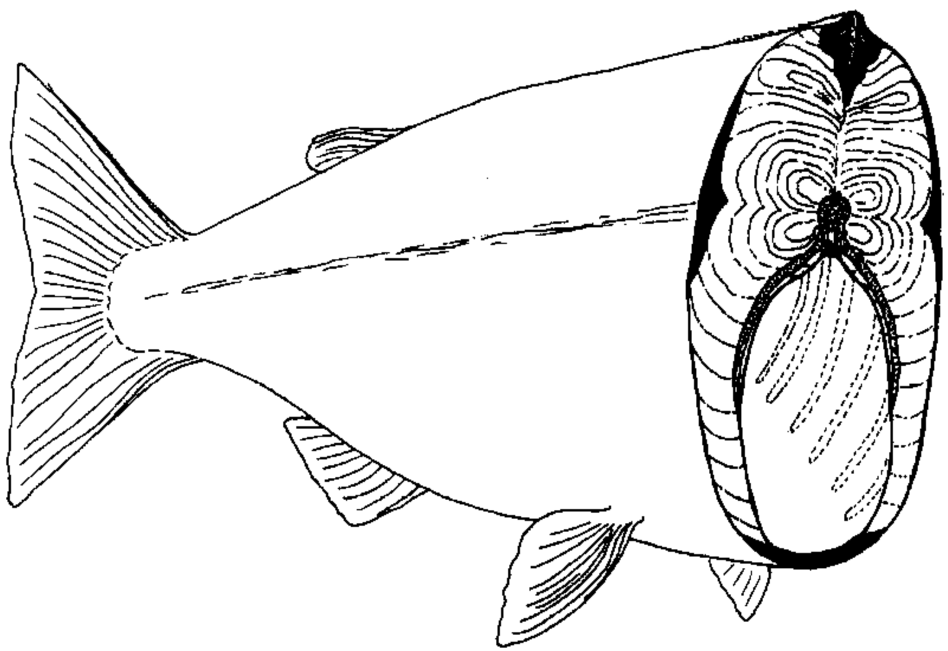
Which fish has more mercury?





Which lake has higher levels of mercury in the fish?

Is mercury in the fatty parts of fish or in the fillet?



A pregnant women should not eat fish (T/F)

Why eat fish?

- Nutritional Benefits
  - Low fat (saturated) protein
  - Vitamins and minerals
  - Omega-3 fatty acids
- Cultural, recreational, social and economic benefits
- Focus for this training: developmental benefits & why pregnant women should eat fish

Benefits - Observational Studies

- Higher maternal consumption of fish results in children showing better neurological function than those whose mothers ate low amounts or no fish

What is it about fish?

- DHA?
- Other nutrients in fish? e.g. Se, I, Fe
- Substitution for higher fat protein?
- Surrogate for a healthy lifestyle?

- Whatever the reason - All support eating fish

Omega-3 Supplements

- Meta-analysis of randomized trials of formula supplementation have not found persistent benefit on physical, visual, neurodevelopmental outcomes of term or pre-term infants
- Limited evidence from randomized trials of fish oil supplements in pregnancy supports cognitive benefit for offspring

DHA

- ALA, EPA and DHA are omega-3 fatty acids
- Structural component of the brain and eyes
- Most brain DHA is derived by uptake from plasma
- Dietary DHA is well absorbed and is readily incorporated into plasma and blood cell lipids in humans
- Primary dietary sources of EPA and DHA are fish and seafood
- Major dietary sources of ALA are soybean and canola oils, flax seed oils and some nuts
- Conversion of ALA to EPA to DHA is < 1%

DHA

- DHA is required for brain development
- Depletion of DHA from brain and retina interferes with normal neurogenesis and neurological function, and visual signaling pathways
- Pre- and post-natal periods likely critical period for incorporation into neural tissues

DHA Recommended Intake

- No dietary recommended intake (DRIs)
  - Guidelines in literature of 100-300 mg/day are based on observed and estimated intakes, and intervention studies
- No conversion available for dietary intake to blood levels
- Fish oil: may be a good choice if no or low fish consumption

Preliminary DHA Data
200 mg/day = 1400 mg/week

Species	DHA mg/8 oz serving
Salmon	1836 - 4941
Halibut	681
Lake Superior fish*	
Chinook Salmon	1362
Chub	1816
Herring	1362
Smelt	454
Whitefish	454
Lean Lake Trout	2270
Siscowet Lake Trout	4086
Inland fish	
Herring	424
Lake Trout	518
Northern	226
Rainbow Trout	637
Walleye	265
Perch	197

*Source: Addis, 1990

Unfortunately
Fish have Environmental Contaminants

- PCBS are an issue in the Great Lakes, major rivers and contaminated sites.
  - Levels are going down in fish
  - PCBs accumulate in fatty fish and in beef and diary products.
  - Babies exposed to PCBs during pregnancy may have lower birth weight, reduced head size, and delayed physical development.
- Farm raised fish – feed can have contaminants
- Mercury is found in all fish

Dartmouth Toxic Metals
Superfund Research Program

Mercury: From Source to Seafood

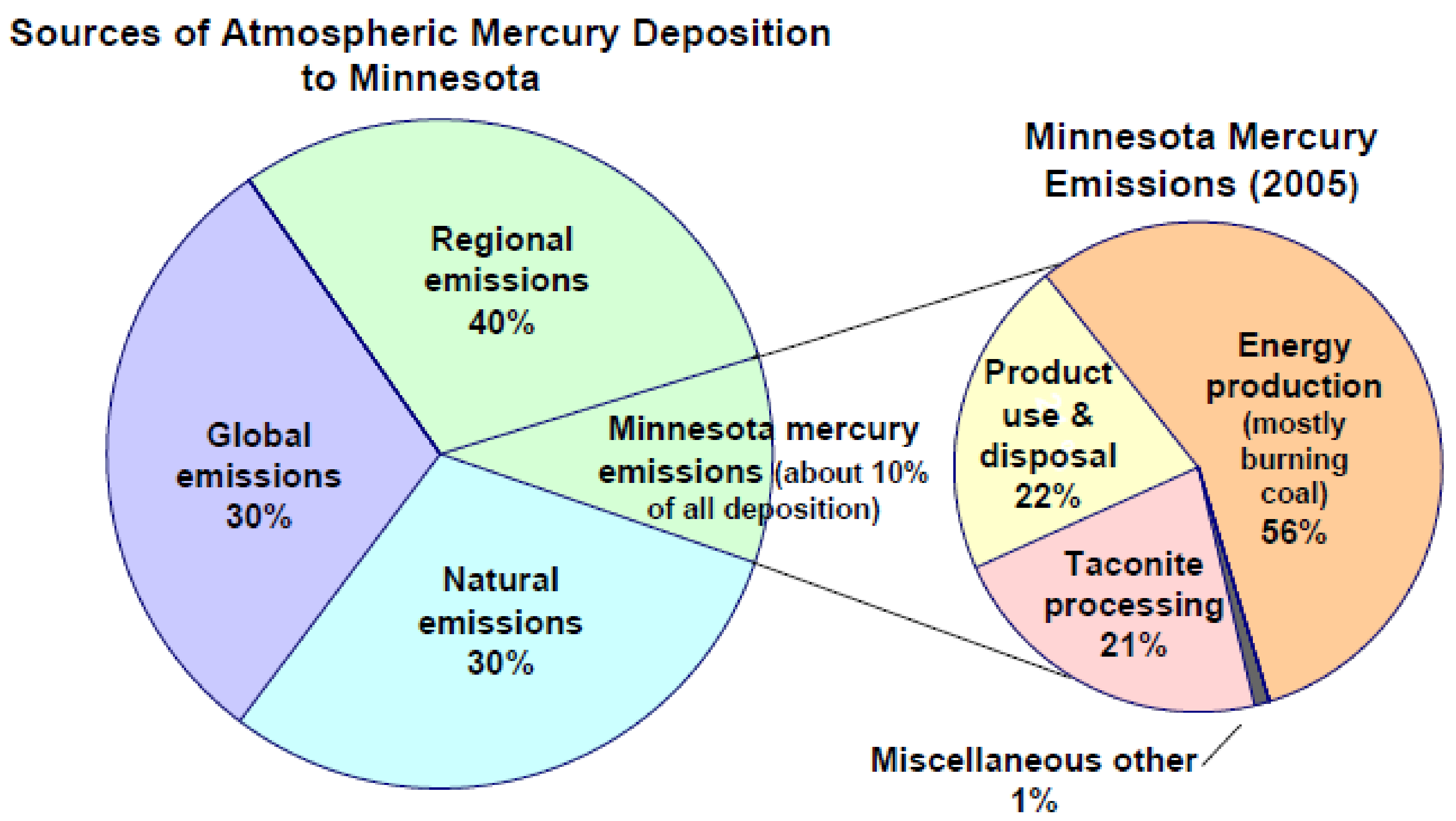
A ten minute web-based film explaining how mercury gets into the seafood we eat, why it is important to eat low-mercury fish for good health, and the need to keep mercury out of the environment.

Post-video – comments

- NE MN fish tend to have higher levels of mercury
- Temporal trend in fish unclear

Which MN fish have the most mercury?

- walleye, northern, bass


Sources of Atmospheric Mercury Deposition to Minnesota
Regional emissions 40%
Global emissions 30%
Natural emissions 30%
Minnesota mercury emissions (about 10% of all deposition)
Minnesota Mercury Emissions (2005)
Energy production (mostly burning coal) 56%
Product use & disposal 22%
Taconite processing 21%
Miscellaneous other 1%

Source: MPCA

Mercury Species

Form of mercury influences how it moves in environment and within the body

- Elemental (Hg^0) or metallic - vapor
- Inorganic (Hg^+, Hg^{++}) – occupational (products)
- Organic
  - Methylmercury (MeHg)(CH_3Hg^+) – fish
  - Ethylmercury – thimerosal preservative in vaccines
  - Dimethylmercury – chemistry lab
  - Phenylmercurics – fungicides in latex paint

Methylmercury in the Body

- >95% of MeHg is absorbed in the gastrointestinal tract and distributed via the blood to **all organs** in about 30-40 hours after ingestion.
- meHg in blood is assumed to reflect amount in body
- meHg crosses the blood-brain barrier
- meHg crosses the placenta. Levels in umbilical cord blood are on average 1.7x higher than maternal blood levels.

ref: Silbernagel et. al. Powerpoint presentation, "Recognizing and Preventing Overexposure to Methylmercury: Information for Physicians" provides manuscript content, slightly updated from 2011 publication, in slide format. (9/2013)

MeHg in the Body, continued

- meHg and demethylated (inorganic) mercury are gradually removed from the body, mainly via liver bile and feces.
  - Some meHg is stored in hair and nails.
- The half-life of meHg in blood is about 50-70 days in adults.

ref: Silbernagel et. al. Powerpoint presentation, "Recognizing and Preventing Overexposure to Methylmercury: Information for Physicians" provides manuscript content, slightly updated from 2011 publication, in slide format. (9/2013)

Methylmercury Toxicity

- Neurotoxic
- Developing nervous system is especially sensitive
- Fetal toxicity can occur in the absence of clinical signs or symptoms in the mother

Exposure to mercury

- EPA Reference Dose
  - Safe dose over a lifetime, within an order of magnitude
  - Neurodevelopmental effects
  - **0.1 µg/kg/day**
  - Uncertainty factor of 10

  - Equivalent blood concentration = 5.8 µg/l

- Safe dose for general population ~ 3X higher (~20 µg/l)

“Safe” exposure level

- Based on observational studies of prenatal mercury exposure and child development in fish eating populations
  - Cohorts were initiated to determined what level of methylmercury exposure is “safe”
  - Neuropsychological tests indicate deficits involved with a child’s ability to learn and process information
    - Not clinically observable
- Supported by many human and animal studies
- Small uncertainty factor compared to most risk assessments for environmental contaminants
- Still some debate about exact “safe” dose

Risks & Benefits

- Historically studies either looked at risk or benefit, not both
- A few recent observational studies have looked at both risk and benefit
- All conclude eating fish low in contaminants is beneficial for development

Fish Consumption Advice

- Concern that negative messages will scare people from eating fish and result in loss of benefits
- Mercury and beneficial nutrients are both present in fish
  - Data on omega-3 levels in fish, particularly freshwater fish, is lacking
- Benefits addressed qualitatively…..for now
  - Working towards a framework to quantitatively include both

- Overall Goal: Minimize people’s exposure to contaminants in fish while promoting the many benefits of eating fish.

Put Fish on Your Plate

A Family Guide to Eating Fish

Benefits outweigh risks if you
eat fish low in mercury
& other contaminants

Women in Grand Portage think
eating fish is more than healthy... *it's essential*

Put Fish on Your Plate

A Family Guide to Eating Fish

Benefits outweigh risks if you
eat fish low in mercury
& other contaminants

Women on the North Shore think
eating fish is more than healthy ... *it's essential*

Benefits — eating fish 1-2 times per week has benefits for people of all ages.

Fish are a source of lean protein, vitamins, minerals and omega-3 fatty acids. EPA and DHA are omega-3 fatty acids found in fish. Our bodies can't make EPA and DHA — eating fish is the primary way to get these fatty acids.

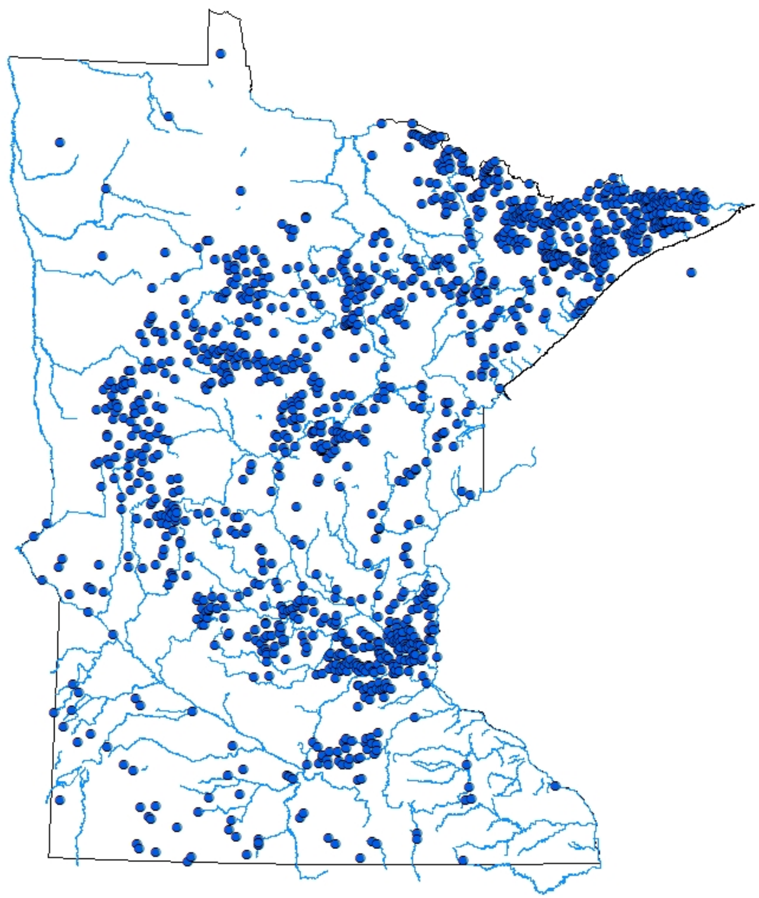
- DHA is a building block of the brain and eyes.
- Pregnant women and breastfeeding moms can eat fish to give DHA to their babies.
- Children of women who ate lower mercury fish every week have been found to do better developmentally.

Eating fish has also been shown to lower the risk of heart disease in adults.

Benefits are maximized with fish higher in EPA and DHA but lower in mercury. Fish from Lake Superior are generally higher in EPA and DHA than fish from inland lakes and rivers. Fatty fish like salmon have the highest levels.

2 servings/week	0.1 µg/g	**Purchased fish:** Salmon, Shrimp, Tilapia **Lake Superior fish:** Herring (Cisco), Coho Salmon, Rainbow trout/Steelhead **Inland fish:** Rainbow trout
1 serving/week	0.2 µg/g	**Purchased fish:** Canned Light Tuna **Lake Superior fish:** Lake Whitefish, Menominee, Lake Trout <22", Chinook <32" **Inland fish:** Herring (Cisco), Lake Whitefish, Splake, Perch
1 serving/month	0.4 µg/g	**Purchased fish:** Canned White (albacore) Tuna, Tuna (steak/fillet/sushi), Halibut **Lake Superior:** Lake Trout 22" to 37", Chinook Salmon 32"+, Walleye **Inland fish:** Walleye, Northern Pike
Avoid	1 µg/g	**Purchased fish:** Shark, Swordfish **Lake Superior:** Siscowet Lake Trout > 36"

Minnesota Fish Contaminant Database: 1967-2012



Source: Monson, 2014

Species and Advice

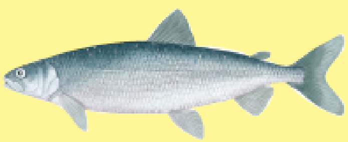
- Focus on species that can be eaten 1 – 2 times per week
- List species that are most popular based on national data and available in MN markets
- Acknowledge that people eat fish with moderate mercury

Eating Guidelines for Women who are or may become pregnant and Children under 15

Serving Guideline			Species (Kind of Fish)
2 per week	LOW	0.1 μg/g	Purchased Fish: Salmon (Atlantic and canned), Shrimp, Sardines, Scallops,Tilapia, Crab, Cod, fast food fish sticks and sandwiches Lake Superior Fish: Herring (Cisco), Coho Salmon, Rainbow Trout/Steelhead, Smelt Inland Fish: Rainbow Trout
1 per week		0.2 μg/g	Purchased Fish: Canned Light Tuna Lake Superior Fish: Lake Whitefish, Menominee, Brown Trout, Lake Trout <22", Chinook <32" Inland Fish: Herring (Cisco), Lake Whitefish, Splake, Sunfish, Crappie, Yellow Perch
1 per month		0.4 μg/g	Purchased Fish: Canned White (albacore) Tuna, Tuna (steak/fillet/sushi), Halibut Lake Superior Fish: Lake Trout 22" to 37", Chinook Salmon 32"+, Walleye Inland Fish: Walleye, Northern Pike, Trout (Lake, Brown, Brook)
Avoid	HIGH	1 μg/g	Purchased Fish: Shark, Swordfish Lake Superior Fish: Siscowet Lake Trout > 36"

Mercury Concentration

μg/g = micrograms of mercury per gram of fish



Bonus: During one month you can eat up to one serving of fish in the "1 per month" group AND eat fish from either the "1 per week" or "2 per week" groups.

Things to Consider When Choosing Your Fish

Who You Are

Women who are or may become pregnant, and children under 15 need to be more careful about which fish they eat because mercury has a greater effect on babies and young children.

Women not planning to be pregnant and men face fewer health risks from mercury. For that reason, they are able to eat more kinds of fish (species) more often.

Species

Mercury is in all fish but the amount depends on the species (and size). Some species of fish have higher levels of mercury than others because of what they eat and how long they live.

Size

Generally, smaller fish have less mercury than larger, older fish of the same species. Unlike people, fish don't get rid of mercury. Older, larger fish have had more time for mercury to build up in their bodies.

Source

Inland lakes and rivers, and purchased fish contain mercury, the main contaminant of concern for eating fish. Fish from lakes in northeastern MN generally have higher amounts of mercury than southern and central MN.

Lake Superior fish contain mercury and may also contain PCBs and other contaminants.

Fish Consumption Guidelines

- Provided by many government agencies and other organizations
  - Different purposes/charters

2 servings/week | 0.1 µg/g | **Purchased fish:** Salmon, Shrimp, Tilapia

0.2 µg/g | **Purchased fish:** Canned Light Tuna

1 serving/week | 0.4 µg/g | **Purchased fish:** Canned White (albacore) Tuna, Tuna (steak/fillet/sushi), Halibut

Avoid | 1 µg/g | **Purchased fish:** Shark, Swordfish

FDA/EPA advice

- Do not eat Shark, Swordfish, King Mackerel, or Tilefish because they contain high levels of mercury.
- Eat up to 12 ounces (2 average meals) a week of a variety of fish and shellfish that are lower in mercury.
  - Five of the most commonly eaten fish that are low in mercury are shrimp, canned light tuna, salmon, pollock, and catfish.
  - Another commonly eaten fish, albacore ("white") tuna has more mercury than canned light tuna. So, when choosing your two meals of fish and shellfish, you may eat up to 6 ounces (one average meal) of albacore tuna per week.
- Check local advisories about the safety of fish caught by family and friends in your local lakes, rivers, and coastal areas. If no advice is available, eat up to 6 ounces (one average meal) per week of fish you catch from local waters, but don't consume any other fish during that week

FDA/EPA advice and MDH advice

- Assume average consumer, mixed species in diet
- MDH approach provides info on differences between species
  - Many people have favorite fish
  - Different advice for tuna
  - Uses FDA mercury data

Mercury Levels in Commercial Fish and Shellfish (1990-2010)

See also Mercury Concentrations in Fish: FDA Monitoring Program

Table 1. Fish and Shellfish With Highest Levels of Mercury

SPECIES	MERCURY CONCENTRATION (PPM)					NO. OF SAMPLES	SOURCE OF DATA
	MEAN	MEDIAN	STDEV	MIN	MAX		
MACKEREL KING	0.730	N/A	N/A	0.230	1.670	213	GULF OF MEXICO REPORT 2000
SHARK	0.979	0.811	0.626	ND	4.540	356	FDA 1990-2007
SWORDFISH	0.995	0.870	0.539	ND	3.220	636	FDA 1990-2010
TILEFISH (Gulf of Mexico)	1.450	N/A	N/A	0.650	3.730	60	NMFS REPORT 1978

Table 2. Fish and Shellfish With Lower Levels of Mercury

SPECIES	MERCURY CONCENTRATION (PPM)					NO. OF SAMPLES	SOURCE OF DATA
	MEAN	MEDIAN	STDEV	MIN	MAX		
ANCHOVIES	0.017	0.014	0.015	ND	0.049	14	FDA 2007-2010
BUTTERFISH	0.058	N/A	N/A	ND	0.36	89	NMFS REPORT 1978
CATFISH	0.025	0.005	0.057	ND	0.314	57	FDA 1991-2010
CLAM *	0.009	0.002	0.011	ND	0.028	15	FDA 1991-2010
COD	0.111	0.066	0.152	ND	0.989	115	FDA 1991-2010
CRAB [1]	0.065	0.050	0.096	ND	0.610	93	FDA 1991-2009
CRAWFISH	0.033	0.035	0.012	ND	0.051	46	FDA 1991 -2007

Dietary Guidelines for Americans

- In addition to the health benefits for the general public, the nutritional value of seafood is of particular importance during fetal growth and development, as well as in early infancy and child-hood.
- Moderate evidence indicates that intake of omega-3 fatty acids, in particular DHA, from *at least* 8 ounces of seafood per week for women who are pregnant or breastfeeding is associated with improved infant health outcomes, such as visual and cognitive development.
- Therefore, it is recommended that women who are pregnant or breast-feeding consume at least 8 and up to 12 ounces of a variety of seafood per week, from choices that are lower in methylmercury.
- Obstetricians and pediatricians should provide guidance to women who are pregnant or breastfeeding to help them make healthy food choices that include seafood.

AHA Recommendation

- We recommend eating fish (particularly fatty fish) at least two times (two servings) a week. Each serving is 3.5 oz. cooked, or about ¾ cup of flaked fish

How Much Fish Makes a Serving?

- The amount of fish in a serving is based on the body weight of the person eating the fish.
  - We assume a 150 pound person eats a serving of one-half pound (eight ounce) of uncooked fish to stay within the MDH Safe-Eating Guidelines. Eight ounces of uncooked fish is equal to about six ounces of cooked fish.
- To adjust meal size for a heavier or lighter weight person, add or subtract one ounce of fish for every 20 pounds of body weight.

Do people eat enough fish to be concerned?

Duluth News Tribune

Study: 1 in 10 babies in Lake Superior region are born with high levels of mercury

One of every 10 babies born in the Lake Superior region of Minnesota has unsafe levels of toxic mercury in his or her bloodstream, according to a Minnesota Department of Health study released Thursday.

By: **John Myers**, Duluth News Tribune

WTIP North Shore Community Radio 90.7 FM

StarTribune

High levels of mercury found in North Shore babies

Article by: JOSEPHINE MARCOTTY , Star Tribune

Updated: February 2, 2012 - 11:04 PM

Blood samples showed surprisingly elevated concentrations.

4 WCCO

Study: High Mercury Levels In North Shore Babies

February 3, 2012 6:05 PM

MINNEAPOLIS (WCCO)

MinnPost.com

A THOUGHTFUL APPROACH TO NEWS

Earth Journal: Ron Meador on Environment

After decades of warnings and pollution controls, newborns arrive with a burden of mercury

By Ron Meador | Published Mon, Feb 6 2012

Case Study – Minnesota

- Two MN women
  - ~ 2 meals/day of predatory fish for years
  - Fatigue, lethargy (one reported memory loss)
  - Blood mercury levels 20 µg/l and 25 µg/l
- One women treated with DMSA (by private physician)
- Other women received no chelation
- Both advised to limit fish consumption
- Mercury levels normalized and symptoms resolved within several months in both women

(source: Dr. Beth Baker, 2004 North American Congress of Clinical Toxicology Annual Meeting)

Is Chelation Recommended?

- Chelation can be a valuable intervention for inorganic mercury poisoning, but it poses its own risks.
- Except in rare cases, it is not generally warranted for patients with elevated MeHg from fish consumption.
- Some practitioners mistakenly use DMSA or DMPS provocation challenge when they test a patient’s urine for mercury. This gives highly misleading results that overestimate mercury exposure.

ref: Silbernagel et. al. Powerpoint presentation, "Recognizing and Preventing Overexposure to Methylmercury: Information for Physicians" provides manuscript content, slightly updated from 2011 publication, in slide format. (9/2013)

Imported Seabass as a Source of Mercury Exposure: A Wisconsin Case Study

Lynda M. Knobeloch,[1] Meg Ziarnik,[1] Henry A. Anderson,[1] and Vernon N. Dodson[2]

[1]Wisconsin Bureau of Public Health, Department of Health and Social Services, Madison, WI 53703 USA; [2]University of Wisconsin Hospital and Clinics, Madison, WI 53703 USA

that he was experiencing sleep disturbances and had difficulty concentrating, and asked whether these symptoms might be due to mercury exposure. The caller was especially concerned about his 2.5-year-old son's exposure to mercury.

The family's diet included 3-4 fish meals per week

- Imported seabass (2 meals/week),
- Lake Superior whitefish (1-2 meals/month),
- Lake Superior trout (1-2 meals/month),
- Farm-raised trout (1-2 meals/month)
- Farm-raised salmon(1-2 meals/month)

Table 2. Mercury content of fish

Type of fish	Mercury content (μg/g)
Lake Superior whitefish	< 0.02
Lake Superior trout	< 0.02
Farm-raised salmon	0.05
Farm-raised trout	0.05
Seabass	
Filet 1	0.5
Filet 2	0.7

Table 1. Medical test results and personal data

	Man	Woman	Son
Age	40	42	2.5
Body weight kg (lbs)	57 (126)	52 (115)	13 (30)
Fish meals/week	3-4	3-4	3-4
Fish/meal (g)	227	150	75
Hair mercury (μg/g)	12	10	NA
Blood mercury (μg/L)			
Day 0	58	37	37
Day 15	45	24	NA
Day 70	24	14	NA
Day 200	5	3	NA
Hair Hg/blood Hg ratio	207	270	NA

NA, not available.

Environmental Medicine | Articles

Mercury Levels in High-End Consumers of Fish

Jane M. Hightower[1] and Dan Moore[2]

- Serial blood mercury levels in 67 subjects
  - Dropped rapidly within 3 weeks after being told not to eat fish or greatly reduce consumption fish with high levels of mercury
  - All dropped to < 5 ug/l within 41 weeks except 2 who continued to eat large predatory fish

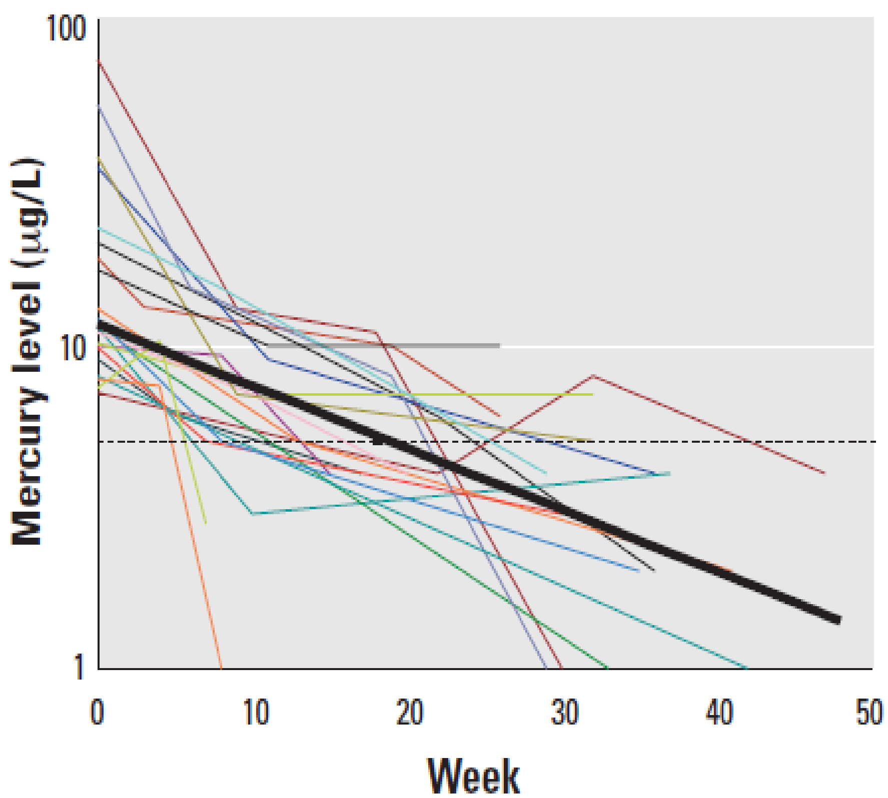


Figure 1. Blood mercury levels in 21 subjects with three or more measurements over time. Levels for individual patients are designated by straight lines. The thick line shows an exponentially declining fit to data from all 67 subjects. The horizontal dashed line is at 5 µg/L.

Clinical MeHg Poisoning

- Some people eat a lot of fish, as often as 5 to 20 meals per week.
- Some people prefer to eat predatory species like swordfish that contain high mercury levels.
- Such individuals can get high doses of methylmercury from their diets, and some may develop clinical meHg toxicity.
- Cases of methylmercury poisoning are rare and most physicians have never encountered one; symptoms may easily go unrecognized unless dietary habits are considered.

ref: Silbernagel et. al. Powerpoint presentation, "Recognizing and Preventing Overexposure to Methylmercury: Information for Physicians" provides manuscript content, slightly updated from 2011 publication, in slide format. (9/2013)

The Gelfond Fund for Mercury Research and Outreach

Case Reports of Methylmercury Poisoning

1. Grand Round presentation: "Medical Masquerade: One Man's Experience with Methylmercury Poisoning"
This unique one-hour video presentation about the clinical presentation of methylmercury poisoning includes three parts: the perspective of someone who experienced it himself; clinical information from an expert in methylmercury poisoning; and perspectives from a scientist who studies mercury in the marine environment. The video was made at a grand round presentation for the Department of Medicine at Stony Brook University Medical Center in November 2010.

Presenters included: Richard Gelfond, CEO and Director, IMAX Corporation and Chair, Stony Brook Foundation; Michael Gochfeld, MD, PhD, Professor, University of Medicine and Dentistry of New Jersey; and Nicholas Fisher, PhD, Distinguished Professor, SBU School of Marine and Atmospheric Sciences and Director of the Consortium for Inter-Disciplinary Environmental Research.

Environmental Health News

Search

14 February **Less acid rain could mean more mercury in fish.** Regulations on mercury emissions in Europe have led to a steady decline in mercury entering the environment since the 1990s. So government scientists in Norway were surprised to discover in 2009 that mercury levels in lake fish had strongly increased since 1991. Chemical & Engineering News.

14 February **The Yamuna is poisoned and so are your vegetables.** Fresh, green spinach leaves that Delhiites put on their plates contain more than just nutrients. A recent study indicates the presence of heavy metals in the vegetables that are grown with water from the Yamuna. Hindu, India.

Identifying Patients with meHg Poisoning

- Clinical manifestations vary with intensity and duration of exposure
- Symptoms can vary significantly among individuals
- Symptoms may be delayed from time of exposure
- Symptoms may emerge when body’s ability to compensate for the damage is depleted
- Genetic variation or food/nutrient interactions may affect mercury metabolism

ref: Silbernagel et. al. Powerpoint presentation, "Recognizing and Preventing Overexposure to Methylmercury: Information for Physicians" provides manuscript content, slightly updated from 2011 publication, in slide format. (9/2013)

(Nonspecific) symptoms associated with chronic lower level MeHg exposure:

- sleep disturbance
- headache
- fatigue
- difficulty concentrating
- depression
- memory loss
- diminished fine motor coordination
- muscle and joint pain
- gastrointestinal upset
- hair thinning
- heart rate disturbance
- hypertension
- tremor
- numbness or tingling around the mouth

ref: Silbernagel et. al. Powerpoint presentation, "Recognizing and Preventing Overexposure to Methylmercury: Information for Physicians" provides manuscript content, slightly updated from 2011 publication, in slide format. (9/2013)

Symptoms associated with higher meHg exposures:

- numbness or tingling in hands and feet
- clumsy gait, difficulty walking (ataxia)
- slurred speech
- tunnel vision
- diminished visual acuity

ref: Silbernagel et. al. Powerpoint presentation, "Recognizing and Preventing Overexposure to Methylmercury: Information for Physicians" provides manuscript content, slightly updated from 2011 publication, in slide format. (9/2013)

Variability of symptoms

- Multiple research studies and personal observations by the authors indicate that individuals vary widely in sensitivity to MeHg toxicity.
- Milder symptoms have been seen at relatively low blood mercury levels.
- People vary in susceptibility to mercury, and not everyone with high exposure experiences adverse effects.

ref: Silbernagel et. al. Powerpoint presentation, "Recognizing and Preventing Overexposure to Methylmercury: Information for Physicians" provides manuscript content, slightly updated from 2011 publication, in slide format. (9/2013)

Testing for Mercury

- High exposure is rare, routine Hg testing is not indicated
- Better to ask about diet than test, promote change in diet if indicated
- Consider testing if symptoms or extreme diet
- Majority of mercury exposure will decline in about 3 months with correct fish consumption
- We are testing in this project to evaluate our mercury screening questions

Patient Communication

- Screen (questions in EMR)
- In the last 2 to 3 months…
  – How many times a week did you eat any kind of fish?
  – How many times a month did you eat any of these fish? walleye, northern, bass or lake trout from Lake Superior
  – Did you eat shark or swordfish?
- Further probing into diet if indicated
- Provide eating guidelines – try to be specific to individual

More Information

- FISH Project Nurses
- Dr. Sampson
- MDH
  - Pat McCann
  - Deborah Durkin

  www.health.state.mn.us/fish

Appendix F:
Testing the Dissemination of Fish Consumption Information

Final Report: Testing the Dissemination of Fish Consumption Information

Prepared for the Minnesota Department of Health in fulfillment of Grant #GL00E01283

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HealthPartners Institute

September 16, 2016

Introduction

This report describes work performed under a subgrant from the Minnesota Department of Health with funding by the Environmental Protection Agency (EPA) (GL00E01283). The ultimate purpose of this project is consistent with the parent EPA grant: to improve messaging to women of child bearing age to assist them in decision making about safe fish consumption for them and their families. This work builds on previous work done earlier in partnership with MDH, also through EPA grant GL00E01283, designed to identify which messages about safe fish consumption resonated most with the target audience and inform the design of the brochure that was used in the Cornell diary study. Our current work is distinct in its focus on both barriers and facilitators to eating safe fish and was designed to explicitly solicit and manifest additional strategies to empower women with the information and tools needed to achieve optimal fish consumption.

The research described herein was conducted within the HealthPartners Institute and engaged the participation of HealthPartners patients and members. HealthPartners is the largest consumer-governed nonprofit health care organization in the country, providing care, coverage, research and education to improve health and well-being in partnership with its members, patients and community. HealthPartners Institute is a nonprofit organization dedicated to conducting public-domain health research. In developing the deliverables for this grant, it was important to build upon the existing knowledge base regarding safe fish consumption, while being responsive to the unique messaging environment that we have as a part of HealthPartners' integrated health system.

All work described herein was approved by the HealthPartners Institute Institutional Review Board and the EPA's Human Subjects Research Review Office.

A series of focus groups were conducted with HealthPartners members to understand barriers and facilitators to safe fish consumption as well as where and how women want to receive this information. Results from the focus groups were used to develop and strengthen existing key messages about eating clean fish for women of childbearing age. Focus groups also revealed mode preferences for communication of these messages, which included QR codes, posters in clinic waiting rooms, exam rooms, or grocery stores, and links in MyChart or MyHealth. Because of demand for easily accessible, portable information that women could reference at home while planning meals and in the grocery store or elsewhere while selecting foods, we chose to develop a mobile-responsive website (Appendix D) in addition to a paper brochure (Appendix C). Although the brochure and website were developed through a sub-grant from MDH (EPA grant GL00E01161), they have been included in this report to illustrate the key messages we developed for this grant, GL00E01283.

Findings from the focus groups were central to the design of our brochure and website. Initially, a literature review was completed to inform the topics and questions for the focus groups, included as a separate attachment. The complete focus group findings are detailed in Appendix B. This report is organized to highlight how these findings informed design and content decisions for the brochure and website and is based on the results tables from that focus group report. The following is a narrative describing these new tables (Tables 1-3) and the explicit links between the focus group findings and the brochure and website design decisions.

Literature review

A literature search was conducted prior to the focus groups to help frame the focus group discussions as well as to serve as a backstop for the findings.

To complement earlier work done by the Great Lakes Restoration Initiative, this literature was limited specifically to work that focused on barriers to consumption. As such, barriers and consumption were key elements in the literature search, which included terms “fish, fishes” and “consumption” or “eating” or “eat” or “consum*”. The search was conducted June 23, 2015 for English language peer-reviewed literature for the previous 10 years. Retrieval was high (1,259 citations). The search was narrowed by selecting review articles, general information, and systematic review, as well as these terms: and “behavior,” or “barrier,” or “factors” or “accept*” or “encourage” or “health knowledge, attitudes, practice,” or “nutrition policy,” or “choice behavior” or “attitude” or “consumer behavior,” or “advice*” or “advis*.”

The articles found through that search are included in Appendix A.

Project staff reviewed the literature findings both to build on previously conducted research rather than duplicating it, and to be informed of past findings. The literature review was used in combination with the focus group findings to help us identify things that had been previously reported and to elicit additional perspectives on those topics. In some cases, the literature review was referenced to ensure that barriers to fish consumption that were not uncovered in the focus group findings were addressed in the web content.

Focus group findings

The following segments of this report are based on the focus group findings; for a more detailed account of focus group respondents and results, see the report in Appendix B. From these findings, the results tables were excerpted, and additional columns were added describing how each piece of information gleaned from the focus group was incorporated into the brochure and the website. Only results which were used to inform brochure or web design and content were kept in the following revised tables; the comprehensive results tables are found in Appendix B.

Table 1: Behaviors and preferences when buying and consuming fish
This segment of the focus group results focuses on general behaviors and preferences of women regarding fish consumption. Women listed a variety of fish they prefer to consume, and the website includes recipes for a majority of these types of fish. The most frequently-preferred fish for women was salmon, so a salmon recipe was chosen for the back cover of the brochure. Taste and flavor were the most important factors when women chose which fish to buy, so our website has an interactive flavor and texture profile table, which allows women to identify the taste/texture they prefer and choose their fish accordingly.

Preparation was frequently described as a barrier to eating fish in the focus group discussions, so our website has videos, step-by-step instructions, and recipes that describe how to choose, thaw, prepare, and cook fish. A major perceived risk of eating fish was mercury and other contaminants, so the consumption guidelines in both the brochure and website group fish species by mercury content and recommended frequency of consumption. Additional information about mercury and why it is a concern is also discussed in the brochure and website.

Table 1. Highlights on key topics from focus groups: fish preferences, barriers, influences, and perceived benefits and risks (descending order of frequency; N=24; some participants provided more than 1 answer within a key topic)

Fish preferences		
Results	**Brochure incorporation**	**Website incorporation**
Salmon (18)	Salmon recipe and photo on back cover	Included in recipes
Tilapia (9)	Suggested tilapia substitution for recipe on back cover	Included in recipes
Tuna, canned (6)	Photo on first inside page; brochure discusses canned fish	Included in recipes
Shrimp (6)		Included in recipes
Crappie (4)		Included in recipes
Cod (2)		Included in recipes
Trout (2)		Included in recipes
Whitefish (2)		Included in recipes
Factors in choice		
Results	**Brochure incorporation**	**Website incorporation**
Taste and flavor (8)	Recipe on back cover describes taste and texture of salmon and tilapia	Interactive texture and flavor profiles table allows sorting fish by flavor and texture
How prepared, time, knowledge, ease, pre-seasoned, frozen (7)	Recipe on back cover is simple and requires minimal preparation and cooking time	"Cook Fish" tab
Sustainability (4)	Addresses sustainability	Addresses sustainability
Texture (2)	Recipe on back cover describes taste and texture of salmon and tilapia	Interactive texture and flavor profiles table allows sorting fish by flavor and texture
Benefits (1)	"Benefits of Fish" panel	"What Makes Fish a Great Catch?" page
Avoid mercury (1)	"Fresh, Frozen or Canned" panels	"Contaminants" page
Barriers to eating		
Results	**Brochure incorporation**	**Website incorporation**
Cost (9)	"Bought or Caught" section mentions cost differences for canned tuna varieties; Low cost tuna casserole dish is pictured in "Fresh, Frozen or Canned" section	Low-cost recipes such as tuna casserole are included in "Recipes" page
Hard to prepare (5)	Recipe includes preparation instructions	"How to Cook Fish" page includes videos and step-by-step instructions from buying fish to thawing to cooking.
Taste (4)	Recipe describes taste of salmon and tilapia	Flavor profiles table helps people identify the taste they're looking for and choose their fish accordingly

Lack of knowledge re how to prepare (4)	Recipe is easy to follow and requires minimal preparation and cooking time	"How to Cook Fish" page includes videos and step-by-step instructions, from buying fish to thawing to cooking.
Lack of knowledge re what each fish tastes like (2)		Flavor profiles table helps people identify the taste they're looking for and choose their fish accordingly
What sides to serve with fish (1)	Suggestions of sides to serve with recipe are included	"Recipes" page includes some recipes with suggested sides
Slimy/texture (1)		"Fish Flavors and Textures" page describes texture of each fish so people can choose accordingly
Influences for eating more		
Results	**Brochure incorporation**	**Website incorporation**
Knowing how often to eat when not pregnant (2)	Guidelines panels describe consumption recommendations for pregnant women and other populations	"Fish to Eat" page describes consumption recommendations for pregnant women and other populations
More recipes (2)	Recipe on the back of brochure	"Recipes" section of website includes 43 recipes whose ingredients can be populated to a personalized shopping list
Emphasizing omega 3s (1)	"Fresh, Frozen or Canned" panels describe omega3's and their benefits	"What Makes Fish a Great Catch" page describes omega 3's and their benefits
Perceived risks		
Results	**Brochure incorporation**	**Website incorporation**
Mercury (12)	Guidelines panels describe safe consumption and mercury levels in different fish species; "Fish to Avoid" panel highlights high-mercury fish	"Fish to Eat" page describes mercury levels and consumption guidelines; Fish to avoid section describe which fish contain high levels of mercury; Contaminants section describes what mercury is
Contaminants, pollution (2)	"Fresh, Frozen, or Canned" panels describe mercury and other contaminants	"Contaminants" page describes mercury and PCB's
Sustainability, how raised, caught (1)	Addresses sustainability	Addresses sustainability

Table 2: Preferences for type and format of fish consumption information
This subset of results highlights where, what, and how women would like to receive information about safe fish consumption. Women listed venues such as stores, restaurants, home, and Pinterest as places where they make decisions about fish consumption. To provide information in all of these venues, we developed our website to be mobile-responsive, and included an icon in the brochure designed to prompt women to take a photo of the guidelines to share or save for later. Additionally, the website is Pinterest-friendly; the guidelines and recipes all include buttons which link that page directly to Pinterest.

Regarding type of information, women want to know about both the risks and the benefits of fish consumption. Our website and brochure highlight the benefits and acknowledge the risks, while maintaining a positive, encouraging tone to alleviate concerns. For example, the brochure encourages women to "Dish up some fish" and the website helps people "Choose your fish." In nearly every instance, we opted to use affirmative language geared toward positive action, rather than trying to frighten women or tell them what not to do. Additionally, women requested fish consumption recommendations for non-sensitive populations such as men, older boys, and women who are not and will not become pregnant. Serving recommendations for these populations are called out in the guidelines both in the brochure and on the website.

Women overwhelmingly requested fish recipes, and many requested pictures as well, mentioning Pinterest as an example. For these reasons, we carefully selected the photos for the brochure and website, making sure they were realistic and appealing without showcasing parts of the fish that may be off-putting such as eyes and tails, similar to the photos on Pinterest. A recipe was included on the back of the brochure, and a recipe section was designed for the website. Careful consideration went into the recipe section of the website: fish recipes are presented with large photos in a layout similar to Pinterest; a shopping basket was designed for women to populate with their chosen recipes; an editable shopping list is created based on the chosen recipes; and women can print the recipes or share via social media or email.

An important element of communicating effectively was to use appropriate language for the audience. Park Nicollet's patient education team, expert in literacy considerations both in writing and in design, were a welcome addition to the team. They helped turn "incorporate" into "include," as just one of many examples, and the quality of the materials was far better for it.

Table 2. Highlights on key topics from focus groups: decision venue, information and format preferences, and access in health care (descending order of frequency; N=24; some participants provided more than 1 answer within a key topic)

Decision-making venue		
Results	**Brochure incorporation**	**Website incorporation**
Stores (11)	Brochure suggests taking a picture of the guidelines for access from mobile phone	Mobile-responsive website can be used anywhere they have their phone
Restaurant (6)	Brochure suggests taking a picture of the guidelines for access from mobile phone	Mobile-responsive website can be used anywhere they have their phone
Home (4)	Brochure can be taken home	Mobile-responsive website can be used anywhere they have their phone
Pinterest (3)	Brochure suggests taking a picture of the guidelines to pin on Pinterest	Website is Pinterest-friendly; each recipe has a button for easy pinning
Traveling (1)	Brochure suggests taking a picture of the guidelines for access from mobile phone	Mobile-responsive website can be used anywhere they have their phone
Information wanted		
Results	**Brochure incorporation**	**Website incorporation**

Source, where fish comes from (6)	"Fresh, Frozen or Canned" section mentions a variety of fish types; "Bought or Caught" section describes light and white canned tuna	Mention of farm-raised or sustainably sourced differences
Benefits (6)	"Fresh, Frozen or Canned" section describes benefits of fish	"What Makes Fish a Great Catch" page describes fish relationship to heart disease risk, omega 3's and brain development
Risks (5)	"Fresh, Frozen or Canned" section describes mercury and contaminants; "Fish to Avoid" panel describes about mercury and raw fish	"Fish to Avoid," "Contaminants," "How to Reduce your Risk" pages
Careful language (safe vs unsafe, emphasize positive over negative) (2)	Language carefully chosen to highlight the positives of eating fish. Guidelines page called "ChooseYourFish"	Website titled "Choose YourFish" and uses a positive tone, e.g. "preparing a dish with fish can be simple"
Taste, texture (2)	Recipe describes taste and texture for salmon and tilapia	Interactive texture and flavor profiles table allows sorting fish by flavor and texture
Freshness, when caught (2)		Videos show what characteristics to look for when buying fresh fish
Brands high in omegas, low in mercury (1)	Guidelines panels describe mercury levels and omega 3 levels	Guidelines describe mercury levels and omega 3 levels
Fish type and level of mercury by lake (1)	"Bought or Caught" section describes general mercury information for different lakes throughout MN	Website links to MN DNR lake finder for mercury levels by lake
How long take to prepare (1)		“Recipes” section makes this very clear
Format for information wanted		
Results	**Brochure incorporation**	**Website incorporation**
Recipes (with pic, in email, on package, mini recipe book, with health benefits noted) (9)	Recipe on back of brochure	Recipe page with 43 recipes and a shopping cart; incorporates pictures and is printer-, email-, and Pinterest-friendly
Pictures (of prepared fish, on Pinterest, in a chart) (4)	Photos in brochure carefully chosen to be realistic and appealing	Photos on website carefully chosen to be realistic and appealing; recipes all have pictures
Website (3)	Website mentioned in brochure	ChooseYourFish.org
App (3)		Mobile-responsive website
Something that has pics of kids in it (1)		Sawtooth videos include children
Access to information in health care setting		
Results	**Brochure incorporation**	**Website incorporation**
Info, brochure in waiting room (9)	Brochure in waiting room	
Doctor, annual exam (7)	Included in prenatal packet	
At the front desk (1)	In waiting room?	
“Able to pull up on phone” (1)		Mobile responsive website
Doctor (2)	Included in prenatal packet	

One-on-one conversation with provider (2)	Included in prenatal packet	
Pediatrician (1)	Included in prenatal packet	

Table 3: Discussion of current MDH guidelines table
This final subset of focus group results includes information about the current MDH consumption guidelines table and how it could be improved. Women liked how colorful it was, so appealing color schemes were incorporated into the new brochure and website. Women wanted the "why": why fish is important, why mercury is of concern, etc. Our brochure includes some of that information, and points to the website, which goes much more in-depth about these topics. In the focus groups, women said they were likely to take a picture of the fish guidelines and keep it on their phone for reference, so our brochure was designed with an icon prompting women to do just that.

Table 3. Highlights on key topics from focus groups: MDH guidelines table (descending order of frequency; N=24; participants provided more than 1 answer within a key topic)		
Clarity of information		
Results	**Brochure incorporation**	**Website incorporation**
Colorful (5)	Colorful; photos carefully chosen	Colorful; photos carefully chosen
Like MDH label (2)	MDH logo	MDH logo
Likes bullet points (1)	More bullets and less paragraphs in brochure	Used bullets
How to make more useful		
Results	**Brochure incorporation**	**Website incorporation**
Include the "why" (11)	"Fresh, Frozen or Canned" panels describe why fish is beneficial and why mercury is a concern	"What Makes Fish a Great Catch" page
Include guidelines for non-sensitive populations (8)	Guidelines describe that other populations can consume 3 times more	
More info on mercury levels (6)	"Fish to Avoid" panel	"What about Contaminants" page
Explain what a serving size is (4)		At bottom of guidelines
Explain "white" vs "light" tuna (4)	On "Bought or Caught" panel	"How to Reduce Your Risk" page
Explain what happens if you eat the fish on the not-eat list (3)	"Fresh, Frozen or Canned" section mentions why mercury is bad and why pregnant women are more at-risk	"What About Contaminants" page
What are the benefits of eating fish in the top 2 lists (2)	Benefits discussed	Benefits discussed
Define farm raised (1)	"Bought or Caught" section discusses source	"Fish to Avoid" page discusses source
Put info online (1)	ChooseYourFish.org	ChooseYourFish.org
Put info as mobile app (1)	Mobile responsive website	Mobile responsive website
How likely to use		

Results	Brochure incorporation	Website incorporation
Would take a pic of handout and put on phone (6)	Brochure prompts to do this	Mobile-responsive website
Would put on Pinterest (2)	Brochure prompts to do this	Pin button on recipes and guidelines page
Would share it on Facebook (1)	Brochure prompts to do this	Share button on recipes and guidelines page
Title recommendations		
Results	**Brochure incorporation**	**Website incorporation**
Take out sensitive populations in title (4)	Done	
Use “recommendations” instead of “guidelines” (3)	"These recommendations are for women…"	
Make less scientific (1)	Target reading level was 6^{th}-8^{th} grade	
Play up that fish is safe (1)	Positive framing that extended to subtitles and content	
Put fish in the title (1)	"Dish Up Some Fish"	"ChooseYourFish"

Additional website considerations
The website design timeline was furtitous in that we could incorporate findings from the Cornell diary study finding that women preferred narratives that showcased women like them over declarative lists or instructions about what to do. Specifically, we partnered with the Sawtooth Mountain Clinic, Grand Portage Health Service to showcase two women in narrative videos titled, “*I learned I could be eating a lot more fish that I had been,”* and “*There are a lot of nutrients and beneficial things in fish you can’t get in other places.”*

Next Steps
Through a sub-grant from MDH (EPA grant GL00E01161), the key messages developed from this work have been incorporated into a brochure (Appendix C) and website (Appendix D), which will be pilot tested with HealthPartners patients and members. The brochures are being distributed through pilot HealthParnters clinics as well as the materials being mailed directly to a subset of HealthPatners members that are part of the target audience. An evaluation survey is in the field that asks about the reach and effectiveness of the materials. It will be used to further refine the materials for submission by January 2017.

Appendix A: Literature Review

Year/Authors	Title	Journal/PMID	Description of study (from abstract)	Research methods (qualitative or quantitative, brief detail)	Barriers to eating fish	Incentives to eating fish
2015/Carluccia D, Nocellab G, De Devitiisc B, Viscecchiac R, Bimbod F, Nardonec G	Consumer purchasing behavior towards fish and seafood products. Patterns and insights from a sample of international studies	Appetite/25453592	Systematic review assessing consumer purchasing behavior towards fish and seafood products in developed countries; looks at main drivers and barriers of fish consumption and consumer preferences	systematic review	sensory dislike of fish; lack of convenience; lack of self-confidence in selecting or preparing fish; health risk concern; lack of fish availability; high price	positive attitude toward fish; perception that fish is a healthy food
2015/Niederdeppe J, Connelly NA, Lauber TB, Knuth BA	Using Theory to Identify Beliefs Associated with Intentions to Follow Fish Consumption Advisories Among Anglers Living in the Great Lakes Region	Risk Anal/25946393	Mail survey of 1,712 licensed anglers to gauge advisory awareness, cognitive factors influencing fish consumption behaviors, and sociodemographic characteristics	cross-sectional survey	n/a	n/a
2015/Skuland SE	Healthy Eating and Barriers Related to Social Class. The case of vegetable and fish consumption in Norway	Appetite/25982927	2000 Norwegians surveyed to explore whether barriers reduce consumption of vegetables and fish	quantitative, survey	taste; competence; time; price; quality; limited selection	n/a
2014/Connelly NA, Lauber TB, Niederdeppe J, Knuth BA	How can more women of childbearing age be encouraged to follow fish consumption recommendations?	Environmental Research/5262080	857 woman surveyed (via mail), 130 surveyed (via telephone), and 25 women participated in focus groups to better understand what might be done to encourage women of childbearing age to eat healthy fish	mixed method--survey and focus groups	n/a	n/a
2014/Lin S, Herdt-Losavio ML, Chen M, Luo M, Tang J, Hwang SA	Fish consumption patterns, knowledge and potential exposure to mercury by race.	Int J Environ Health Res/23865562	421 adults surveyed to compare fish consumption, knowledge of benefits/warnings, and potential of Hg exposure from fish in Chinese -Americans and non-Chinese Americans	questionnaire	n/a	healthy (Chinese Am); good for the brain; good for the heart (non-Chinese Am)
2013/Engelberth H, Teisl MF, Frohmberg E, Butts K, Bell KP, Stableford S, Smith AE	Can fish consumption advisories do better? Providing benefit and risk information to increase knowledge.	Environ Res/24074700	808 women surveyed to evaluate effectiveness of Maine's fish consumption advisory on improving knowledge	survey (mail and web)	n/a	benefits of Omega-3s (promoting neurological development in babies)
2013/Hall TE, Amberg SM	Factors influencing consumption of farmed seafood products in the Pacific northwest	Appetite/23428939	1159 people living in Pacific Northwest surveyed on general seafood preferences (familiarity, price, freshness, health and environmental concerns), beliefs and attitudes specific to aquaculture versus wild products, and how those cognitive factors affect decisions to consume types of farmed seafood products	mail survey	n/a	price, freshness, and familiarity= most important determinants of seafood choices

Year/Authors	Title	Journal/PMID	Description of study (from abstract)	Research methods (qualitative or quantitative, brief detail)	Barriers to eating fish	Incentives to eating fish
2013/LePrevost CE, Gray KM, Hernández-Pelletier M, Bouma BD, Arellano C, Cope WG	Need for Improved Risk Communication of Fish Consumption Advisories to Protect Maternal and Child Health: Influence of Primary Informants	Int J Environ Res Public Health/23629591	109 anglers interviewed to study effectiveness of a fish consumption advisory sign for Badin Lake	interviews	n/a	n/a
2013/Oken E, Guthrie LB, Bloomingdale A, Platek DN, Price S, Haines J, Gillman MW, Olsen SF, Bellinger DC, Wright RO	A pilot randomized controlled trial to promote healthful fish consumption during pregnancy: the Food for Thought Study	Nutr J/23496848	61 women involved in pilot study to increase consumption of high-DHA, low-mercury fish in pregnancy (advice group; advice + gift card group; control group)	randomized control trial	n/a	n/a
2013/Raatz SK, Silverstein JT, Jahns L, Picklo MJ	Issues of Fish Consumption for Cardiovascular Disease Risk Reduction	Nutrients/23538940	A review to provide an overview of the issues affecting this shortfall of intake and to describe the relationship between fish intake and CVD risk reduction as well as the other nutritional contributions of fish to the diet	literature review	n/a	n/a
2012/Clonan A, Holdsworth M, Swift JA, Leibovici D, Wilson P	The dilemma of healthy eating and environmental sustainability: the case of fish	Public Health Nutr/21619717	842 people; whether health and/or sustainability are motivating factors when purchasing and consuming fish and whether there are sociodemographic trends	survey	n/a	health benefits; understanding what type of fish to eat for health reasons
2012/Driscoll D, Sorensen A, Deerhake M	A multidisciplinary approach to promoting healthy subsistence fish consumption in culturally distinct communities.	Health Promot Pract/21730195	Formative and evaluative research to determine knowledge, attitudes, and practices related to fish consumption and develop/evaluate educational materials on fish consumption	interviews	n/a	n/a
2012/Grieger JA, Miller M, Cobiac L	Knowledge and barriers relating to fish consumption in older Australians	Appetite/22727774	854 Australians surveyed on fish intake, barriers, and knowledge regarding fish	cross-sectional survey	high cost, smell, cooking	n/a
2012/Mertens F, Saint-Charles J, Mergler D	Social communication network analysis of the role of participatory research in the adoption of new fish consumption behaviors	Soc Sci Med/22172976	Follow-up on a participatory intervention to reduce methylmercury exposure while maintaining fish consumption; explored change in fish consumption and discussion networks about methylmercury	interviews	n/a	n/a

Year/Authors	Title	Journal/PMID	Description of study (from abstract)	Research methods (qualitative or quantitative, brief detail)	Barriers to eating fish	Incentives to eating fish
2011/Bloomingdale A, Guthrie LB, Price S, Wright RO, Platek D, Haines J, Oken E	A qualitative study of fish consumption during pregnancy.	Am J Clin Nutr/20844071	22 pregnant women participated in a study to determine knowledge, behaviors, and received advice regarding fish consumption among pregnant women who are infrequent consumers of fish	focus groups	lack of knowledge regarding which fish types are safer to eat during pregnancy; women's inability to remember which fish types are more or less healthful; pregnancy-related nausea or aversions; cost; women's preference to eat only very fresh fish; perception that fish can be difficult to prepare; fact that other family members, especially children, may not like fish	if family members ate it
2011/Tan ML, Ujihara A, Kent L, Hendrickson I	Communicating fish consumption advisories in California: what works, what doesn't.	Risk Anal/21231943	46 key informant interviews conducted to characterize barriers to understanding fish advisories and make recommendations to improve advisory communications	interviews	n/a	n/a
2011/Teisl MF, Fromberg E, Smith AE, Boyle KJ, Engelberth HM	Awake at the switch: improving fish consumption advisories for at-risk women.	Sci Total Environ/21663945	769 new mothers surveyed to assess effect of Maine's CDC advisory on fish consumption	survey	n/a	n/a
2010/Pieniak Z, Verbeke W, Scholderer J	Health-related beliefs and consumer knowledge as determinants of fish consumption.	J Hum Nutr Diet/20831707	4786 people from European countries surveyed to determine knowledge and health beliefs and how those affect fish consumption frequency	survey	n/a	n/a
2007/Olsen SO, Scholderer J, Bruns K, Verbeke W	Exploring the relationship between convenience and fish consumption: a cross-cultural study.	Appetite/17261344	Households from Netherlands, Spain, Belgium, Denmark, and Poland surveyed/interviewed to explore cross-cultural differences in convenience orientation and the relationships between convenience orientation, perceived product inconvenience, attitudes, and consumption in the context of fish	interviews, surveys	perceived inconvenience (indirectly effects attitude and directly effects consumption choices)	n/a
2003/Trondsen T, Scholderer J, Lund E, Eggen AE	Perceived barriers to consumption of fish among Norwegian women	Appetite/14637329	9407 Norwegian women surveyed about eating habits, perceived barriers to fish consumption, socioeconomic status, and questions related to health	survey	lack of supply of fresh fish; lack of 'pre-prepared dishes'; variation of quality; family did not like fish; taste; price; region of residence	n/a

Year/Authors	Title	Journal/PMID	Description of study (from abstract)	Research methods (qualitative or quantitative, brief detail)	Barriers to eating fish	Incentives to eating fish
2005/Verbeke W, Vackier I	Individual determinants of fish consumption: application of the theory of planned behavior	Appetite/15604034	429 people completed questionnaires to investigate consumer behavior towards fish in Belgium using theory of planned behavior	questionnaire	safety, smell, bones in fish	sensory liking
2005/Verbeke W, Sioena I, Pieniaka Z, Van Campa J, De Henauwa S	Consumer perception versus scientific evidence about health benefits and safety risks from fish consumption	Public Health Nutr/15975189	429 people completed questionnaires to investigate consumer perceptions of fish consumption benefits and risks and then compared these to scientific evidence	questionnaire	n/a	n/a

Year/Authors	Specific key messages that worked	Specific messages that did not work	Successful communications modes	Failed/poor communications modes	Demographic differences found (describe age/race-ethnicity/education level, income, etc)	Other
2015/Carluccia D, Nocellab G, De Devitiisc B, Viscecchiac R, Bimbod F, Nardonec G	n/a	n/a	n/a	n/a	children under age 10 express increased dislike towards fish; older, well educated individuals experience more motivational factors toward consumption; pregnant women, nursing mothers, and mothers of young children have higher risk perception related to fish consumption	
2015/Niederdeppe J, Connelly NA, Lauber TB, Knuth BA	n/a	n/a	n/a	n/a	n/a	study identified that several beliefs with likely room to change and strong associations with intentions to follow fish consumption advisories include: beliefs about the long-term health risks of chemical contaminants, norms surrounding the use of fish consumption advisories, and those about the utility of advisories in helping anglers to choose healthier fish to eat
2015/Skuland SE	n/a	n/a	n/a	n/a	lower education=more constrained by food knowledge barriers; lower income= more constrained by food quality barriers; low education and low income= more constrained by both knowledge and quality food access	
2014/Connelly NA, Lauber TB, Niederdeppe J, Knuth BA	n/a	n/a	succinct statements rather than longer ones; statements that described positive characteristics of fish not shared by many other foods; statements about Omega-3s; statements with particular relevance to the individual	messages about health risks made it difficult for women to reconcile information about the benefits	more educated women ate more fish during pregnancy; more educated women also report decreasing fish consumption during pregnancy than before; higher educated women report receiving information about consumption of purchased fish than lower educated	women who report receiving information during pregnancy were more likely to decrease fish consumption than those who didn't receive information
2014/Lin S, Herdt-Losavio ML, Chen M, Luo M, Tang J, Hwang SA	n/a	n/a	n/a	n/a	higher general knowledge about fish warnings among non-Chinese Americans; higher consumption of potentially high-Hg fish by non-Chinese Americans	
2013/Engelberth H, Teisl MF, Frohmberg E, Butts K, Bell KP, Stableford S, Smith AE	switching from "don't" messaging to positive messaging; information on how to buy, store, and prepare fish; info on how to eat 2 fish meals/week on limited budget	n/a	booklets with information on benefits of Omega-3s (promoting neurological development in babies); positive messaging about fish consumption; guide depicting fish both high in Omega-3s and low in MeHg and fish to avoid during pregnancy distributed through WIC clinics and healthcare providers; posters with images of fish and mercury level in waiting rooms of health care offices	n/a	n/a	
2013/Hall TE, Amberg SM	n/a	n/a	n/a	n/a	n/a (presented demographic differences only in relation to fresh vs. wild)	included because while the article seeks to compare wild vs. farmed fish, it also touches on general factors influencing consumption, Table 1

Year/Authors	Specific key messages that worked	Specific messages that did not work	Successful communications modes	Failed/poor communications modes	Demographic differences found (describe age/race-ethnicity/education level, income, etc)	Other
2013/LePrevost CE, Gray KM, Hernández-Pelletier M, Bouma BD, Arellano C, Cope WG	n/a	n/a	sign did result in a significant increase in knowledge of the fish consumption advisory was found for the entire sample of study participants (however, not the subgroup of anglers who share fish with women and children)	sign did not produce statistically significant increase in knowledge about the fish consumption advisory on Badin Lake among anglers who share fish with women and children	Knowledge of the Badin Lake-specific advisory significantly increased with age for the overall sample and the subsample of anglers who share with women and children	
2013/Oken E, Guthrie LB, Bloomingdale A, Platek DN, Price S, Haines J, Gillman MW, Olsen SF, Bellinger DC, Wright RO	n/a	n/a	booklet that summarized the health effects of DHA in pregnancy encouraged fish intake and included a list of recommended low-mercury fish sorted according to DHA content; shopping list notepad that included the list of recommended low-mercury fish ranked by their DHA content; wallet-sized card summarizing the information in the brochure; "Weekly Thoughts" email about fish and recipe	n/a	n/a	
2013/Raatz SK, Silverstein JT, Jahns L, Picklo MJ	n/a	n/a	n/a	n/a	younger adults were more cognizant of the health risks of fish consumption; older adults had more awareness of health benefits and perceived fish consumption as healthy; higher education level leads to higher awareness of health risk	listed as factors influencing fish consumption (not listed as barriers or incentives): taste and convenience, demographic factors such as age , cultural background , socio-educational status , economic factors such as affordability and availability , knowledge of health benefits from eating n-3-rich fish, toxicological concerns such as contamination by mercury and dioxin, and environmental concerns of overfishing and habitat destruction
2012/Clonan A, Holdsworth M, Swift JA, Leibovici D, Wilson P	n/a	n/a	n/a	n/a	Participants from the oldest age group (61–91 years) were more likely to agree that they 'buy fish mainly for the health benefits'	included because the study includes data on attitudinal factors found to influence fish consumption, Table 5
2012/Driscoll D, Sorensen A, Deerhake M	n/a	n/a	tri-fold brochure (successful in increased perceptions to vulnerability to MeHg and perceptions of risk severity)	n/a	African American participants in high-risk group intended to cease consumption of fish entirely (not limit like suggested in materials); Latino participants intended to continue consuming fish with no change; high risk Native Americans intended to eat fish with low levels of MeHg as described in educational materials	
2012/Grieger JA, Miller M, Cobiac L	n/a	n/a	information from health providers; word of mouth; magazines; current affairs reports; television advertisements; news; scientific reports	n/a	n/a	
2012/Mertens F, Saint-Charles J, Mergler D	n/a	n/a	interpersonal discussion on mercury issues; spousal interaction; individual involvement in health studies	n/a	women who participated in health studies were more active in the discussion network related to mercury than men	

Year/Authors	Specific key messages that worked	Specific messages that did not work	Successful communications modes	Failed/poor communications modes	Demographic differences found (describe age/race-ethnicity/education level, income, etc)	Other
2011/Bloomingdale A, Guthrie LB, Price S, Wright RO, Platek D, Haines J, Oken E	n/a	messages only about fish you should not consume	portable list of safe fish and advice from OB (potentially successful)	n/a	n/a	
2011/Tan ML, Ujihara A, Kent L, Hendrickson I	advisories focused on frequency of consumption; advisories giving info about mercury levels as reason for recommendation; providing new knowledge about fish (not just consumption limits); visual using 2 adult hands with different portions to show adult and child portions; circular meter for mercury level	advisories relying on controlled portion size; words including: women of childbearing age, anglers, meal, uncooked and Omega-3 fatty acids; visual images of adult and child hands to show portion size; vertical and horizontal mercury meters	word of mouth (friends); fishing magazines	n/a	n/a	
2011/Teisl MF, Fromberg E, Smith AE, Boyle KJ, Engelberth HM	providing risk-benefit information (induced switch behavior to safer fish consumption)	providing only risk-related information	brochure describing safe eating guidelines for commercial and sport caught fish distributed at WIC clinics, OBGYN offices, family physicians practicing obstetrics, nurse midwives	n/a	n/a	
2010/Pieniak Z, Verbeke W, Scholderer J	interest in healthy eating; subjective knowledge about fish; objective knowledge about fish	n/a	n/a	n/a	older people had higher frequency of fish consumption	
2007/Olsen SO, Scholderer J, Bruns K, Verbeke W	n/a	n/a	n/a	n/a	n/a	included because this study highlights the need to educate consumers about where to buy and how to prepare fish in convenient forms, and change some consumers' beliefs and attitudes about fish as an inconvenient product
2003/Trondsen T, Scholderer J, Lund E, Eggen AE	n/a	n/a	n/a	n/a	responding positively to "do you eat enough fish" increased in women following recommendations for f/v consumption; those reporting higher physical activity level increased with age and in households with children below age 7 and with 2 people vs. 1; people w/ increased education reported less barriers to eating fish	

Year/Authors	Specific key messages that worked	Specific messages that did not work	Successful communications modes	Failed/poor communications modes	Demographic differences found (describe age/race-ethnicity/education level, income, etc)	Other
2005/Verbeke W, Vackier I	n/a	n/a	n/a	n/a	presence of children <18 y.o. in household, lower consumption; age positively correlated with attitudes toward consumption; higher intention to eat fish with higher education level	
2005/Verbeke W, Sioena I, Pieniaka Z, Van Campa J, De Henauwa S	n/a	n/a	n/a	n/a	higher tendency for women to eat fish weekly than men; >40 y.o. higher fish consumption frequency than younger age groups; families with children had significantly higher fish consumption frequency than those without children	study included data on beliefs about harmful substances in fish, belief that fish is healthy, data on understanding of nutrient content of fish---did not link those beliefs directly to consumption but found differing beliefs among different demographic groups

Appendix B: Focus group report

Report on Patient Focus Groups on Healthy Eating and Fish
12.4.15

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Executive Summary

Seven focus groups of women of child-bearing age were conducted for 4 different microsegments in 2 geographic regions to collect information from women of child-bearing age on preferences for delivery of messages about the risks and benefits of fish consumption through the health care system and who delivers the messages. The 2 geographic regions included the Twin Cities Metro (East and West) and Duluth, Minnesota.

Three focus groups included “young singles and starter families” (including 1 group in Duluth); 1 focus group was a “mixed” microsegment (in Duluth); 1 focus group included “flourishing families;” and 2 focus groups included “prosperous, established couples.” Participation in all 7 focus groups was less than enrollment projections, with 5 focus groups having 4 or fewer women participating. Actual attendance was about 65% of committed enrollment. While we did not have sufficient focus group participation to reach a saturation level, we had robust conversations that met our needs and provided sufficient information to move forward in the project.

A set of IRB-approved questions was asked in each focus group. For the last question, a handout of formatted information from the Minnesota Department of Health (MDH) website was distributed to the participants to solicit feedback and how to strengthen key messages about eating clean fish.

The focus group revealed several areas to address in strengthening key messages to close the knowledge gap that currently exists. Participant feedback validated that a gap exists between knowing fish is healthful to eat and knowing which and how much fish is safe to eat. Most of the participants said they know fish should be part of a healthy diet and accurately described various benefits (omega-3s, vitamin D, low fat, low calorie, high protein), but most also said they do not eat fish as often as other protein sources.

Commonly cited barriers to eating more servings of fish included:

- Cost (9)
- Perception that preparation is difficult (5) and time-consuming (4)
- Lack of knowledge about how to prepare fish (4)
- The smell (4) and taste of fish often is not appealing (4)
- Husband or family doesn’t like fish (3)
- Lack of knowledge about what different types of fish taste like (2)

The need for meals that work for all in the family was voiced throughout the discussion.

Participant feedback also revealed that women predominantly want to hear the messages (information) about fish in the grocery store, on fish packaging, followed by in the restaurant, at home or via Pinterest. Additionally, the type of messaging the participants sought included information on the benefits and risks—risks not just for mercury exposure but also, for example, exposure to other contaminants, source (farm raised vs wild caught), sustainability, catch location and how bony a particular species is.

In terms of preferences for formatting messaging, participants overwhelming requested recipes to provide ideas in busy schedules and increase confidence and familiarity with preparation. Some feedback specified inclusion of additional details with the recipes, such as photos, time to

prepare, flavor description, ease in preparation, health and nutrition benefits, and risks. Other vehicles noted for formatting included QR codes on print material and Pinterest followed by PSAs, websites and apps.

In terms of receiving the information in the health care setting, strong interest was expressed in receiving the information in the clinic waiting area; seeing a poster in the clinic was specifically cited as a preferred format. Participants also expressed interest in accessing the information through MyChart or MyHealth. Health incentive programs also were noted with enthusiasm.

In terms of who could best provide information within the health care setting, some participants noted the information coming from their primary care clinician would be preferred or carry more weight, but some participants also noted the information could come from others in the clinic setting (e.g., dietitian, front desk, pediatrician, RN), or from the health plan via the website or mail, or at employer's website.

While participants overall found the MDH handout clear and said they would likely use it, they noted various areas to make it more useful, including adding the "whys" behind much of the existing information as well as guidelines for other members of the family. Specifically, they asked for details on what happens if you eat a fish on the do-not eat list and the benefits of eating fish species listed in the other boxes.

In general, participants were apt to reflect holistically about the topic of safe fish and fish consumption. For example, in addition to mentioning mercury in response to questions asked (general and specific to the consumption guidelines table), they expressed concern about other factors in decision-making surrounding fish consumption. These are detailed further in the report below.

Introduction

The focus groups were conducted to collect information from women of child-bearing age on preferences for delivery of messages about the risks and benefits of fish consumption through the health care system and who delivers the messages. Focus groups were designed building on previous research on this topic, including by the grantee, MDH, to identify what will help women of child-bearing age close the gap that exists between knowing fish is healthful to eat and knowing which fish are healthful and how much fish to eat. Focus groups also explored *how* women want to hear these messages and from *what* sources.

The focus groups were conducted in multiple microsegments. Two focus groups were proximal to Duluth, Minnesota, to ensure that any variation due to that unique geography would be captured.

Methodology

The population of interest for this research is women of child-bearing age. HealthPartners Institute identified 900 eligible English-speaking female HealthPartners members ages 18–40 whose membership was current in the first quarter of 2015 with no more than a 1-month break in eligibility. The population is further refined to women living in or near the 2 largest metropolitan areas in Minnesota, the Twin Cities and Duluth metro areas. Six hundred women were selected from the Twin Cities 7-county metro area and 300 from the St. Louis, Lake or Carlton county area of northern Minnesota.

A novel element of this research is the inclusion of "microsegment" information about health plan members. Microsegment data consists of public data about individuals that is collected (in this case by Experian) and used by companies representing a variety of industries to better understand their audience. At HealthPartners, microsegment data is added to patient or member data when possible to form a "best available" data snapshot of our patients and members. It is used to improve engagement, to better understand patients and members, and to help enroll new patients and members.

The microsegment data provides HealthPartners insight into how different groups of people pursue well-being, what motivates them, what barriers exist and what messages and communications modes are most useful to reach them.

Our strategy in using the microsegments was to create intentional heterogeneity across focus groups and intentional homogeneity within focus groups. This was both to encourage conversation within groups and help us to identify potentially different communications messages or modes across groups.

Focus group participants were selected from among the 3 most frequently occurring microsegments for each region. (Microsegment clusters are grouped by letters.)

In the Twin Cities, those microsegments were:

- *O*: Singles and starters, young singles starting out and some starter families in diverse urban communities
- *B*: Flourishing families—Affluent middle aged families and couples earning prosperous incomes and living very comfortable, active lifestyles
- *C*: Booming with confidence—Prosperous, established couples in their peak earning years living in suburban homes

In the Duluth area, those microsegments were:

- *O*: Singles and starters, young singles starting out and some starter families in diverse urban communities
- *E*: Thriving boomers—Upper middle-class baby boomer-aged couples living comfortable lifestyles settled in town and exurban homes
- *I*: Family union—Mid-scale middle-aged families living in homes supported by solid blue-collar occupations

Six of 7 focus groups comprised women from a single microsegment, while 1 Duluth focus group was mixed.

Focus groups were scheduled at community locations that were central to the population, not affiliated with specific religious or other ideological beliefs, could accommodate meals for participants and offered free and convenient parking.

The HealthPartners Institute Survey Research Center (SRC) contacted eligible women first by mail with a letter stating that we were seeking focus group participants, explaining the study, giving them the option to opt-out of the research and alerting them that the SRC would attempt to call them to ascertain eligibility and interest in focus group participation. Follow-up phone calls were conducted (with up to 8 contact attempts) to complete focus group recruitment. Individuals successfully contacted by telephone were asked if they would be interested in seeing if they were eligible for participation; 159 women were interested. These women were asked up to 4 screening questions with the following purposes:

- To gauge ability/willingness to articulate (2 individuals screened out)
- To determine if fish is avoided for religious or medical reasons (0 individuals screened out)
- To determine if individual is a vegetarian or vegan who avoids fish (3 individuals screened out)
- To ascertain likelihood of having children in the future (35 individuals screened out as not at all likely to have children in the future).

After these 4 questions, individuals were asked if they would be willing to join a small group of women for a discussion on the topic. An additional 4 women that were otherwise eligible said they were not interested. We had anticipated up to 10 participants across 9 focus groups; 60 individuals met all the screening criteria and were interested, but were not available at the time of the focus groups. A total of 37 individuals were successfully recruited and ultimately 24 participated in 1 of 7 focus groups.

The focus group script was developed iteratively by the project team and piloted with a group of women similar to the target population to ensure that the script was understood and appropriate for the length of the focus group. Based on the pilot focus group, the script was further refined and approved by the HealthPartners IRB (see Appendix A).

An opening question about a common meal that included fish was included to ease into the topic. This was followed by 5 additional open-ended questions with probes about decision making for including fish in one’s diet, barriers to eating fish, where decisions about fish consumption are made, perceived risks and benefits to fish consumption, and where women would like to get information on fish consumption, focusing on the health care setting. These questions were followed by a deeper discussion of reaction to a guide to safe fish consumption developed from MDH’s existing content (see Appendix B).

Focus group participants signed consent forms and received a meal and a $50 gift card to Target. Focus groups lasted about 70 minutes. At the end of each focus group, a representative from MDH corrected any potentially misleading statements that may have been made by participants during the course of the discussion. During this time, women also volunteered additional questions that they may have had on the topic that were addressed by the MDH partner.

Results

Overview

A total of 5 microsegment groupings were identified for recruitment of the focus group sample:

- Young singles and starter families
- Flourishing families
- Prosperous, established couples
- Thriving boomers
- Middle-aged, blue-collar families

In addition to the note taker, facilitator and MDH staff scientist, either the principal investigator or the project manager or both sat in during some of the focus groups to observe the discussion. Appendix C lists questions asked by participants during the focus groups. Answers from the MDH scientist observing are not included.

Total participation among enrollees

Microsegments for middle-aged, blue-collar, families and for thriving boomers were included in the recruitment process for the Duluth location. However, an insufficient number of participants enrolled in these microsegment sessions, so a mixed microsegment group was formed for 1 of the 2 focus groups in Duluth.

Consequently, 7 focus groups were conducted for 4 microsegments—3 of which aligned with the original 5 microsegments identified—in 3 geographic regions: East Twin Cities Metro, West Twin Cities Metro and Duluth.

A total of 37 women were scheduled to participate in the focus group through mail and telephone recruitment. Of those, 24 (65%) attended a focus group. Representation varied across microsegments as follows:

East Twin Cities Metro	West Twin Cities Metro	Duluth
• Flourishing families: 2 out of 4 • Prosperous, established couples: 3 out of 4 • Young singles and starter families: 4 out of 8	• Prosperous, established couples: 2 out of 3 • Young singles and starter families: 5 out of 7	• Mixed microsegment: 5 out of 6 • Young singles and starter families: 3 out of 5

Tables 1, 2 and 3 below show total results for each of the following summary paragraphs.

Fish preferences

Question: Describe a meal including fish that you typically eat with family or friends. If you do not eat fish, describe any typical meal. (Warm-up question)

- Salmon was indicated as a choice across all microsegments.
  - » Salmon, tilapia and sushi were the only types of fish preferred among flourishing families.
  - » Crappies, walleye and shrimp were among additional preferences indicated by the other microsegments.

- The greatest variety in preferences for type of fish was described by the young singles and starter families.

A wider variety of fish that were local to their region and Wisconsin (e.g., sunfish, Pollack, pike, bluegill and bass), because they or their husband or family members were anglers, was indicated by young singles and starter families in Duluth.

Frequency of eating fish

Question: For those of you who eat fish, how often do you eat fish?

- 1 time a month was most commonly (7) cited.
- 1 time a week was noted next most common (4).
- Either 2 to 3 times a week or 2 times a week was indicated by participants in the young singles and starter families (West Metro).
- Seasonal variation, with eating more fish in summer, was noted by participants in the mixed microsegment (2) and young singles and starter families in East Metro (1).

Factors in choice

Question: How do you choose what fish you eat?

- Taste or flavor and sustainability were factors in choice of fish for all microsegments except the Duluth young singles and starter families.
- Husband's or family member's catch of the day was a factor in choice of fish in the mixed microsegment (in Duluth).
- Ease in preparation as a factor in choice of fish was mentioned by all groups except flourishing families.
- Cost as a factor in choice of fish was only mentioned in flourishing families.

Quotes from participants regarding factors in choice:

I grew up eating the fried walleye, sunfish, crappie, but as I got older we switched to organic foods and healthier foods so we switched to eating tilapia. I would be open to still eating those others but I think it tastes fishy unless you fry it.

I buy what's accessible in stores: salmon, cod, tilapia. You don't need to clean it, no bones, and easy to cook. It's in the market on the shelf. I don't have to go to a special market.

I just eat whatever he brings home, whatever is available in Minnesota. He will go walleye fishing or salmon or trout fishing on the river. It depends on where he chooses to go.

Barriers to eating

Question: What, if anything, keeps you from eating fish more often?

- Hard to prepare, time-consuming to prepare (except Duluth young singles and starter families) and cost were barriers to eating fish more often indicated by all microsegments.
- A lack of knowledge of how to prepare fish as a barrier to eating fish more often was noted by young singles and starter families (except in Duluth) and prosperous, established couples.
- Concerns about mercury were a barrier to eating fish more often for flourishing families.
- Husbands not liking fish was a barrier to eating fish more often for young singles and starter families and the mixed microsegment (in Duluth).

Quotes from participants regarding barriers to eating:
The cost of what I want, and my husband and I don't like it reheated. Usually we make it because it is a fast meal but then we don't have leftovers the next day. Also I am looking at the cost of how many meals we are getting out of it.

It seems labor-intensive, too. With fish fry, you skin it, batter it, have to fry it. And also cooking it in your own home and the smell of it lingering.

And you spend all that time and it doesn't work out.

To me, it's all so intimidating. If you overcook it, you can't do anything with it. You can overcook ground beef and throw it in spaghetti. You can't do that with fish. Fish can be cooked unevenly.

Influences for eating more
Question: What might influence you to eat more fish? (Probe)
Specific responses were varied and limited to 1 to 2 participants and to within 1 to 2 microsegments per response. For example, "having recipes would influence them to eat more" was noted by 2 participants, 1 from young singles and starter families in Duluth and 1 from prosperous, established couples.

Quotes from participants regarding influences for eating more:
Recipes, I like it when there's a recipe on the package, that's a good idea. I want to make it at home.

It's not great for leftovers. If you could make it last longer that might help. But knowing you can only make it and eat that night is not as appealing.

Perceived benefits
Question: As a woman, how do you think about the risks and benefits of eating fish?
- "Health benefits" as a benefit was indicated by all microsegments except flourishing families.
  - » Specific health benefits, such as vitamin D, high protein and low fat, however, were mentioned more in flourishing families.
- Omega 3s were noted by young singles and starter families.
- Variety in kid's diet as a benefit was mentioned by all microsegments except young singles and starter families in Duluth.

Quotes from participants regarding perceived benefits:
I know it's really good for you, and I am a nurse, always telling patients to eat a heart-healthy diet, so I kind of try to practice what I preach. If I am telling more people to eat walleye, I should probably do it myself. I want to eat well for my well-being but also because I tell patients what to do.

One that comes to my mind is that it has omega 3s. I am not a vitamin taker, so I get it through what I eat.

Perceived risks
Question: As a woman, how do you think about the risks and benefits of eating fish?

- Mercury was a concern in all microsegments.
- Mercury was not a concern or "never think about it" was noted in young single and starter families.
- "Don't think about the risks unless pregnant" also was noted in young single and starter families.

Quotes from participants regarding perceived risks:
That mercury thing I hear about, that's really just not a factor. I don't care about that. I just assume the fish I eat is safe.

I didn't think about it until becoming pregnant. That's when I found out about the mercury levels.

It scares me hearing about mercury and all the other things the animals are eating and being polluted with. And I don't know who to trust and who not to. For every one who says this fish is good, someone will say this fish is bad. And then, omega 3s vs omega 6s . . . .I just think whew, I'll just take a pill.

I don't eat a lot of fish out of the St. Louis River area. There's something of the color of their belly meant they had more mercury or fishy stuff with them, but I will catch it in a lake outside of there or in the store. I think about where the fish comes from, and I'm not the best at cleaning them. And the bones. I worry about the kids choking.

Decision-making venue
Question: Where are you when making a choice about what fish to eat or buy?

- In the grocery store was indicated in all microsegments.
- At home was indicated in all microsegments except for young singles and starter families in Duluth.
- Pinterest as a source for choosing the type of fish to eat was noted by young singles and starter families in the metro.

Quote from participant regarding decision-making venue:
[I am] standing in the grocery store, looking at the prices and what looks better.

I go to Pinterest. I get a lot of ideas from there before I go shopping

I call myself a Pinhead because I am always on Pinterest. I get recipes. I like trying new stuff but I am not that brave when it comes to fish.

Information wanted

Question: What kind of information might help you make those choices? (note kind and format and what to do with the information)

- None of the responses were represented by all microsegments.
- Knowing the source—where the fish comes from—would be helpful in prosperous, established couples and young singles and starter families (Duluth only).
- Knowing more about the benefits (e.g., vitamin D, protein, what's healthier in general) was wanted by flourishing families and young singles and starter families (except in Duluth).
- Knowing more about the risks was wanted by young singles and starter families (except in Duluth).
- Information on level of mercury for each fish type in surrounding lakes would be helpful in young single and starter families in Duluth.
- Information/language should emphasize the positive over the negative, what's safe over what's not, also per the young single and starter families in Duluth.

Quotes from participants regarding information wanted:

Be careful with the language in whatever form. Safe fish consumption means there is an unsafe fish consumption . . . You don't need to omit anything, but if you could magnify the positives on the front end, it probably would have made a difference.

The different kinds of fish out there, the risks and benefits and how to prepare them.

I would like to know what part of the world the fish comes from. So same format that the ground beef and chicken have—grass fed with no antibiotics.

I think the MDH has on their website, you can pick which lake and they will tell you what kind of fish is in there and how much mercury they have. I like online instead of paper because I lose paper.

Format for information wanted

Question: How would you like this information available to you

- A preference for having information placed directly on the fish packaging was expressed in all microsegments except for flourishing families.
- Recipes and QR codes were wanted in prosperous, established couples, and young singles and starter families (except in Duluth).
  - » However, *not* wanting a QR code also was expressed by participants in both microsegments.
- Visual aids, such as pictures, charts and Pinterest were noted in prosperous, established couples and young singles and starter families (except in Duluth).
- An app, website and PSA (except in Duluth) was mentioned by prosperous, established couples and young singles and starter families.
  - » However, *not* wanting an app also was indicated by participants in prosperous, established couples.

Quotes from participants regarding format for information wanted:
Smart app, website, brochure—any of those would be good.

Unless there is an incentive, it would be difficult to go on an app. Check out this website and receive a coupon for $5 off fish.

I would want to have that information when I am shopping. It would be cool to have a little picture or QR code that you could scan, something that I could think about when I am shopping.

Access to information in health care setting
Question: From what point in the care process would you be interested in learning about resources for safe fish consumption (clinic visit, plan info, email through MyChart, employer website, prenatal class, letter following cessation of birth control, after-visit summary, direct mail, PSA)?

- A preference for getting the information in the waiting room was indicated in prosperous, established couples and young singles and starter families (except in Duluth).
- Getting information from a doctor visit or at an annual exam was a preference in all microsegments, except for young singles and starter families in Duluth.
- A poster in the waiting room was wanted in prosperous, established couples, young singles and starter families (except in Duluth) and the mixed microsegment (in Duluth).
- Getting information in the mail, along with a coupon (this could be from health plan or direct mail) was indicated as a preference in prosperous, established couples and young singles and starter families (except in Duluth).
- Getting the information through healthy living incentive program was suggested by young singles and starter families (except in Duluth).

Quotes from participants regarding where want to access information in the health care setting:
In the exam room and waiting room, I will have a tendency to not pick them [brochures] up because I think about all the sick people touching them. I like the poster, the free-standing ones that get your attention.

I like the idea of links in MyHealth, because we can always go back there another time, and brochures in the waiting room are nice because we have time to read them. You have a captive audience.

I also did Take Charge through MyHealth. They had an eating one. It was the most boring thing ever. It had the portioning, and all that is great. But if they had something on fish, it would be interesting.

Who provides information in health care setting
Question: Is there a person other than your primary care clinician who could provide that information to you?

- "Doesn't matter who" was the most commonly cited answer (4, included flourishing families and young singles and starter families except for in Duluth) followed by dietitian (3) and doctor (2).
- Dietitian/nutritionist was noted by young singles and starter families, including in Duluth.

Quotes from participants regarding who want to provide information in the health care setting:
For me it doesn't matter which provider. But I'm trying to think if I would want it in the beginning, like in the waiting room, or at the end. It doesn't matter if from front desk or doctor. I may prefer I would have it in the beginning from the front desk in case I have questions.

I think it would be valuable to have it in MyChart because the providers don't have a lot of time—doctors and nurses. So it would be beneficial, and you can send MyChart questions to a nutritionist.

I don't have a primary care doctor. I have faith in the co-op [grocery store] to give me that information so I don't know if I would search for that through the doctor.

Clarity of information of MDH consumption guidelines table
Question: How clear is the information?

- "Like the color scheme" of the table was noted in all microsegments except mixed and young singles and starter families in Duluth.
- Content is "pretty clear" was indicated in the mixed microsegment (in Duluth), young singles and starter families (except in Duluth) and prosperous, established couples.
- "Not clear," confusion about where website links located in the table, and "*OK* should be in caps" were among the comments regarding what was not clear, the majority of which came from the prosperous, established couples.
- "It was a lot to read" was noted by only 1 participant in the mixed microsegment (in Duluth).

Quotes from participants regarding clarity of information in the MDH table:
I like the color scheme. It flows well. It's not too much information.

It's pretty clear, I like that it's colorful. I would want more information on the do-not-eat list, why you shouldn't eat them. Then I would want information on why it's OK to eat only 1 serving in that middle section and what would be the repercussions.

How make more useful

Question: What might make it more useful to you?

- Including the "why"—for example, why the length of fish matters, why you can't eat salmon from the Great Lakes, why you should eat less white albacore tuna vs light tuna, why fish have mercury levels, why pregnant women and children have to be more careful than other people, why mercury is bad to eat—was expressed in all microsegments except for young singles and starter families in Duluth.
- Guidelines for non-sensitive populations was wanted in all microsegments except for the mixed microsegment (in Duluth).
- More information about mercury was wanted by prosperous, established couples and young singles and starter families (except in Duluth).
- Clarification about the difference between *white* and *light* tuna was wanted by prosperous, established couples and young singles and starter families.
- Clarification about what a serving size is, was requested in prosperous, established couples, young singles and starter families (except in Duluth) and the mixed microsegment (in Duluth).
- Delineating details—for example, explaining the difference between "OK vs Good," what happens if you eat fish on the not-eat list, and the benefits of eating the fish on the top list—were among various other recommendations for improving the information voiced by participants (1 to 3) across the microsegments.

Quotes from participants regarding what would make the MDH handout more useful:
A magnet on the fridge—and basically memorize when I was shopping. If you just take the top one [green portion of the handout], turn it into a magnet, I would use it.

It would be good to say how or why they have these levels.

When it says "do not eat these fish," I would want to see why. It would be helpful to state why we should eat these fish.

I feel like there's a lot of what I am unaware about in terms of what's healthy or why it's unhealthy.

How likely to use

Question: How likely are you to use this information to choose which fish to eat and how often?

- "Likely" or "very likely" to use the handout was indicated in all microsegments.
- Taking a photo of the handout with cell phone was indicated in prosperous, established couples and young singles and starter families (except in Duluth).
  - » Taking a photo of the handout with cell phone and sharing on Pinterest or Facebook was noted by participants (3) from young singles and starter families.
- Unlikely to use or follow guidelines was indicated by 3 participants (2 would use it but not necessarily comply with the guidelines; the other indicated she "wouldn't likely use this ") in the prosperous, established couples and flourishing families.

Quotes from participants regarding how likely to use the MDH guidelines table:
I am very likely to use this—for making choices for what I am eating and how many times. It's short and sweet, I like it. If you want more information, you can do a search on the Internet. This is a first good reference.

Just because it's red [a fish is listed in the red "do not eat" box on the handout] doesn't mean I'm not going to eat it.

I would use it as a reference, but I would still probably not always follow it. I would eat swordfish if I could . . . because I don't know the repercussions.

Title recommendations
Question: Any ideas of what to title this information?
- Taking out "sensitive populations" in the title was recommended in the prosperous, established couples, the mixed microsegment (in Duluth), and young singles and starter families (except in Duluth).
- Using the term *recommendations* rather than *guidelines* to convey a softer approach was suggested in the mixed microsegment (in Duluth).
- Making the title shorter or less scientific and including the word *fish* were among other individual comments.

Quotes (title ideas) from participants regarding revising the title on MDH guidelines table:
How to Safely Include Fish in Your Family's Diet

Fish and You

Table 1. Highlights on key topics from focus groups: fish preferences, barriers, influences, and perceived benefits and risks (descending order of frequency; N=24; some participants provided more than 1 answer within a key topic)

Fish preferences	Factors in choice	Barriers to eating	Influences for eating more	Perceived benefits	Perceived risks
• Salmon (18) • Tilapia (9) • Tuna, canned (6) • Shrimp (6) • Walleye (5) • Crappie (4) • Sushi (3) • Sunfish (3) • Cod (2) • Catfish (2) • Trout (2) • Whitefish (2) • Pike (2) • Lox (1) • Pollock (1) • Whitefish, smoked (1) • Salmon, smoked (1) • Bluegill (1) • Bass(1) • Swai (1) • Hake (1) • Crab legs (1) • Mahi mahi (1)	• Taste and flavor (8) • How prepared, time, knowledge, ease, pre-seasoned, frozen (7) • Sustainability (4) • Whatever the anglers bring home, what's in season (3) • Least amount of bones (2) • Texture (2) • Benefits (1) • Avoid mercury (1) • What's available in store (1) • Cost (1) • Sustainability (1) • Call father, chef (1) • Comfort food (1)	• Cost (9) • Hard to prepare (5) • Taste (4) • Smell, odor (4) • Time-consuming to prepare (4) • Lack of knowledge re how to prepare (4) • Sustainability, source (3) • Husband doesn't like fish (3) • Lack of knowledge re what each fish tastes like (2) • Bones (2) • Not as filling as other protein sources (1) • What sides to serve with fish (1) • Slimy/texture (1) • Mercury (1) • Can't find in store (1) • Availability at affordable restaurants (1) • Food allergies (1)	• Knowing how often to eat when not pregnant (2) • More recipes (2) • Desire to lose weight (1) • More selection in stores (1) • More availability at work cafeteria (1) • More options (1) • More on sale (1) • Samples at grocery store (1) • Packaging with fish, seasoning and recipe (1) • If my family would eat it (1) • Tips for working into a busy life (1) • Emphasizing omega 3s (1)	• Health benefits for self, family (8) • High protein (4) • Variety for kids' diet (3) • Vitamin D (3) • Vitamins, minerals (2) • Less fat (2) • Low calorie (1)	• Mercury (12) • Don't think about risks unless pregnant, never think about risks, mercury not a concern (12) • Bones, choking (2) • Contaminants, pollution (2) • Just take fish oil pill (2) • Sustainability, how raised, caught (1) • Who sells the product, brand (1) • Eating raw fish (1) • Taste not appealing to child (1) • Thinks affects gender equally (1)

Table 2. Highlights on key topics from focus groups: decision venue, information and format preferences, and access in health care (descending order of frequency; N=24; some participants provided more than 1 answer within a key topic)

Decision-making venue	Information wanted	Format for information wanted	Access to information in health care setting
• Stores (11) • Restaurant (6) • Home (4) • Pinterest (3) • Traveling (1) • Angler choice (1)	• Source, where fish comes from (6) • Benefits (6) • Risks (5) • Careful language (safe vs unsafe, emphasize positive over negative) (2) • Taste, texture (2) • Freshness, when caught (2) • Brands high in omegas, low in mercury (1) • Fish type and level of mercury by lake (1) • How long take to prepare (1) • Fun facts, did you know? (1) • Nothing, set in my ways (1)	• On packaging, label (flavoring, fishiness scale, number-based) (9) • Recipes (with pic, in email, on package, mini recipe book, with health benefits noted) (9) • QR codes (4) • Pictures (of prepared fish, on Pinterest, in a chart) (4) • PSA (3) • Website (3) • App (3) • Stand in grocery store (2) • Poster (1) • Online coupon (1) • Word of mouth (1) • Butcher recommendation (1) • Brochure at fish counter (1) • Fish taste sampling in store (1) • Group meeting, discussion (1) • Letter (1) • Something to put on refrigerator (1) • Mailer (1) • Something that has pics of kids in it (1) • No QR (2) • No app (2) • No brochure (1) • No email (1) • No website (1)	• Info, brochure in waiting room (9) • Doctor, annual exam (7) • Link on MyChart, MyHealth (7) • Poster in clinic (5) • Mail (with coupon, from health plan, direct mail) (5) • Health incentive program (3) • Health plan website (2) • Health plan (2) • Info in exam room (2) • At the front desk (1) • Employer website (1) • Credible website (1) • Email from health plan (1) • AVS (1) • "Able to pull up on phone" (1) • Email (1) • Doesn't matter who (4) • Dietitian (3) • Doctor (2) • One-on-one conversation with provider (2) • Pediatrician (1) • Front desk person (1) • Call from RN (1) • Employer gym (1) • Co-op, wouldn't rely on provider (1)

Table 3. Highlights on key topics from focus groups: MDH guidelines table
(descending order of frequency; N=24; participants provided more than 1 answer within a key topic)

Clarity of information	How make more useful	How likely to use	Title recommendations
• Pretty clear (6) • Colorful (5) • Like MDH label (2) • Good info (1) • Short and sweet (1) • Flows well (1) • Likes bullet points (1) • OK not to have "why" since info from MDH (1) • Yes, is clear if pay attention to sensitive populations (1) • Like 1 or 2 serving (1) • How often and who is at risk is clear (1) • Not clear (1) • Too clinical (1) • Not clear that mercury is the only factor discussed (1) • Links to websites are confusing where located (1) • Too much to read (1) • Not clear if statewide (1)	• Include the "why" (11) • Include guidelines for non-sensitive populations (8) • More info on mercury levels (6) • Explain what a serving size is (4) • Explain "white" vs "light" tuna (4) • Explain what happens if you eat the fish on the not-eat list (3) • Explain "OK" vs "Good" (3) • Put info on a magnet (3) • Length of fish is not helpful if buying (3) • Define sensitive populations (2) • What are the benefits of eating fish in the top 2 lists (2) • Give source for each fish (2) • Put info in email, but not buried in a newsletter in email (2) • Put OK in capital letters (1) • Define farm raised (1) • Put links to websites at bottom (1) • URLs should be on 1 line, do not break (1) • Include a QR code to link to more information (1) • Put info online (1) • Put info in direct mail (1) • Put info as mobile app (1) • Give a rating for each fish (1) • Include fish from Wisconsin (1) • Explain why can't have Great Lakes fish (1) • Put on front side what can eat, and on back side what can't eat (1)	• Would take a pic of handout and put on phone (6) • Likely (6) • Very likely (6) • Would put on refrigerator (3) • Would share with family or others (3) • Would put on Pinterest (2) • Would like in grocery store for when shopping (2) • Would use it if pregnant (1) • Would look at before shopping (1) • Would share it on Facebook (1) • Would use it but not comply (2) • Not likely (1)	• Take out sensitive populations in title (4) • Use "recommendations" instead of "guidelines" (3) • Make shorter (2) • Make less scientific (1) • Make it seem important/warning (1) • Play up that fish is safe (1) • Put fish in the title (1) • "Safe Fish Consumption" (1) • "Statewide Safe Eating Guidelines" (1) • "Fish and You" (1) • How to Safely Include Fish in Your Family's Diet (1) • Didn't even look at title (1)

General Observations
Participation and engagement varied from group to group, regardless of microsegment. Groups with more participants provided more variation in response and more discussion among participants.

Additional Thematic Considerations
As noted in the tables above, participants in general were apt to reflect holistically about the topic of safe fish and fish consumption. For example, in addition to mentioning mercury in response to questions asked (general and specific to the guidelines table), they expressed concern about other factors in decision-making surrounding fish consumption, including:

- Pollutants/contaminants
- Wild caught vs farm-raised fish
- GMOs
- Sustainability
- Healthiness/quality of regional waters in which they or family member fish
- Making meals for the whole family—not just themselves
- Wanting information about safe fish consumption for other family members not in the sensitive population

Appendix A. Focus Group Questions

1. Describe a meal including fish that you typically eat with family or friends. If you do not eat fish, describe any typical meal. (Warmup)
   - For those who don't eat fish, what keeps from you eating fish?
   - For those who do eat fish, how often do you eat fish?
2. How do you choose what fish you eat?
   a. (Probe) Do you choose by species of fish?
3. What, if anything, keeps you from eating fish more often?
   a. (Probe) What might influence you to eat more fish?
   b. (Possible probe) Please say more about (topic raised by participant)…
4. As a woman, how do you think about the risks and benefits of eating fish?
   a. (Probe) For those of you who are mothers, how do you think about the risks and benefits of eating fish?
5. Where are you when making a choice about what fish to eat or buy?
   a. What kind of information might help you make those choices? (note kind and format and what to do with the information)
   b. How would you like this information available to you? (website, brochure, app)
6. Now that we have talked about what information you want, let's turn to where you might like to get that information. Think about how you interact with the health care system.
   a. From what point in the care process would you be interested in learning about resources for safe fish consumption (clinic visit, plan info, email through mychart, employer website, prenatal class, letter following cessation of birth control, after-visit summary, direct mail, PSA)?
   b. Is there a person other than your primary care clinician who could provide that information to you?
7. Please look at this table (NOTE TO IRB: Uploaded separately as "SafeEatingGdlnesFish071315.pdf").
   a. How clear is the information?
   b. How likely are you to use this information to choose which fish to eat and how often?
   c. What might make it more useful for you?
   d. Any ideas of what to title this information?

Appendix B. MDH Information Formatted as Handout and Distributed for Focus Group Question 7.

MINNESOTA MDH DEPARTMENT OF HEALTH

Statewide Safe-Eating Guidelines for Sensitive Populations:

Pregnant Women, Women Who Could Become Pregnant and Children under Age 15

Every week eat some of these fish

2 SERVINGS of any of these fish:

Purchased fish:

- Catfish (farm-raised)
- Cod
- Crab
- Flatfish
- Herring
- Oysters
- Pollock
- Salmon (Atlantic or Pacific; not Great Lakes)
- Sardines
- Scallops
- Shrimp
- Tilapia

OR

1 SERVING of any of these fish:

Purchased fish:

- Canned "light" tuna

Minnesota caught fish:

- Bullhead
- Crappie
- Sunfish
- Yellow perch

You may add other purchased fish that are low in mercury to this list.

For a list of mercury levels in purchased fish, see the United States Food and Drug Administration (FDA) list of Mercury levels in Commercial Fish and Shellfish. www.fda.gov/food/foodborneillnesscontaminants/metals/ucm115644.htm

And, Once a Month it is also OK to eat 1 serving of these fish

1 SERVING EACH MONTH of any of these fish:

Purchased fish:

- Canned "white" tuna
- Chilean seabass
- Grouper
- Halibut
- Marlin
- Orange roughy
- Tuna steak

Minnesota caught fish:

- Bass
- Catfish
- Northern pike smaller than 30 inches
- Walleye smaller than 20 inches
- Other Minnesota species

If you eat fish from just a few lakes and rivers in Minnesota, follow site specific advice for lakes and rivers that you catch and eat fish from regularly. www.health.state.mn.us/divs/eh/fish/eating/sitespecific.html

Do Not Eat these fish

Purchased fish:

- King mackerel
- Shark
- Swordfish
- Tilefish

Minnesota caught fish:

- Muskellunge
- Northern pike longer than 30 inches
- Walleye longer than 20 inches

7.20.15

Appendix C: Frequently Asked Questions During the 7 Focus Groups

How does the mercury get into the water?

Why does the size of the fish matter?

Is it even important to eat fish during pregnancy? Shouldn't you avoid it altogether?

Why are you doing these focus groups?

How were people selected to participate in this study?

Why do you have a handout just for women who are pregnant or could become pregnant—and kids under 15?

What about for people who are not within the sensitive populations? Do they get to eat as much as they want?

Why were you asking about the health care system? Why would that be important?

Why is it so hard to change the labeling of fish?

Why don't you include information about sustainability or GMOs? Why don't you talk about the issues with farm-raised versus wild caught?

What about fish caught locally? Can we buy that in markets?

What about the quality of fresh vs frozen fish?

What about other different types of fish?

What's the difference between canned light tuna and canned white tuna? Why are we able to eat one more than the other?

What about raw fish?

What exactly do you mean when you say "or who could become pregnant?"

Should we avoid fishing in lakes and rivers that look really dirty or polluted?

How are we supposed to know all this—that a fish is safe to eat? Does the DNR regulate this?

But what if there is a lake that you are absolutely not supposed to fish because the fish are contaminated? How would I know this?

Are there really that many walleye out there that are longer than 20 inches? [Guidelines for

How are we supposed to know the length of the fish if we are eating in a restaurant?

What exactly are the benefits of eating fish? And wouldn't it be better just to take a supplement?

You talked about omega-3s as a benefit. What about omega-6s?

I heard that the feed given to the farmed fish can be higher in omega 6s.

I say, if it's in the store, it's safe to eat. Is that a wrong assumption?

Can you buy Great Lakes salmon in the store? Do I need to pay better attention to that? And why is it not good to eat the Great Lakes salmon?

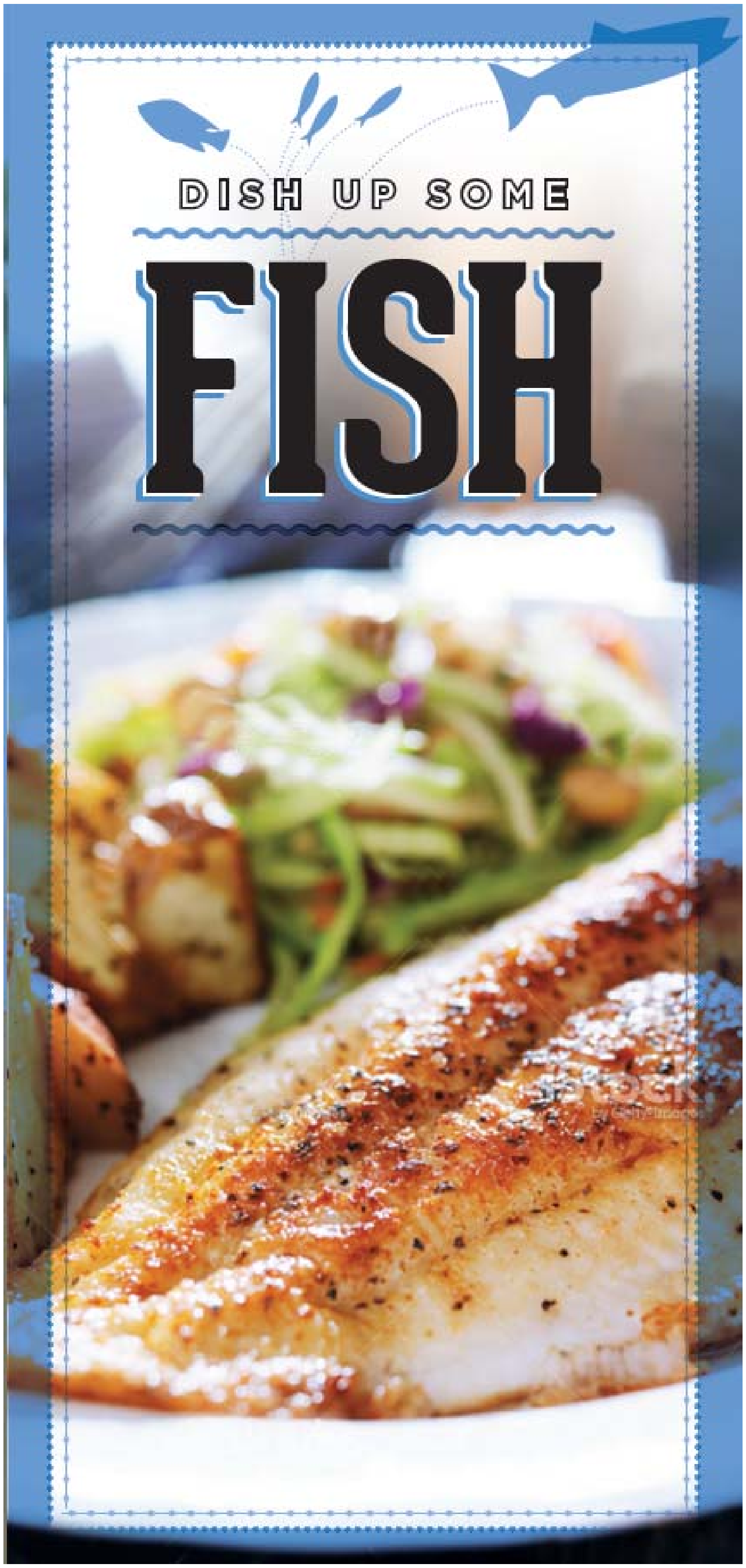
Is there a difference between Coho salmon and Chinook salmon?

Are these guidelines only statewide or is this a nationwide thing to follow?

What exactly is a serving size for the fish listed in this handout?

Appendix C: "Dish Up Some Fish" brochure

Cover page shown here; full brochure found on the following pages



outside: panel 1

Bought or Caught

Think: species, size and source

How much mercury is in fish depends on the:

- **Species.** Some fish have more mercury than others because of what they eat and how long they live.
- **Size.** Smaller fish generally have less mercury than larger, older fish of the same species. Unlike people, fish do not get rid of mercury.
- **Source.** Fish from lakes in northeastern Minnesota generally have more mercury than in southern and central Minnesota. How clean a lake looks is not a sign of how safe the fish are to eat.

  Fish bought at a store or restaurant also contain mercury. Farm-raised fish, such as salmon, are low in mercury but can contain other contaminants that may be found in fish feed. The amount of contaminants is small enough that farm-raised salmon are still good to eat 2 times a week.

  Choosing sustainably sourced fish is a personal choice. Sustainably sourced fish are either caught or farmed without harming other types of fish or the environment.

LIGHT OR WHITE CANNED TUNA?

Choose canned light tuna more often than canned white tuna. Canned light tuna has 3 times less mercury than canned white (albacore) tuna and is less expensive.

outside: panel 2

Cooking, cleaning and contaminants

- You **cannot remove mercury** through cleaning, trimming fat or cooking. Mercury gets into the flesh of fish.
- You **can reduce some other contaminants** by trimming skin and fat when you clean and cook fish.

outside: panel 3

Fish to Avoid

Mercury levels are too high

Do not eat the following fish if you are pregnant or may become pregnant, or are under 15 years old:

- **King mackerel**
- **Muskellunge (muskie)**
- **Shark**
- **Swordfish**
- **Tilefish**

Raw fish may cause illness

If you are or might be pregnant, eat only cooked fish. Parasites and bacteria in uncooked fish, such as sushi, can cause illness.

FOR MORE INFORMATION

Check out the resources below to learn more about contaminants in fish and to find recommendations for specific Minnesota lakes and rivers.

- **Minnesota Department of Health**
  health.state.mn.us/fish
  800-657-3908
- **Minnesota Department of Natural Resources LakeFinder**
  dnr.state.mn.us/lakefind/index.html

outside: back cover (MDH version)

Parmesan Salmon

Try this easy, tasty recipe for serving up a good source of omega-3s. Salmon has a rich, buttery taste and tender, large flakes. Serve with brown rice and a mixed green salad for up to 4 people.

What you need

1 pound salmon fillet (not steak)
2 tablespoons grated Parmesan cheese
1 tablespoon horseradish, drained
1/3 cup plain nonfat yogurt
1 tablespoon Dijon mustard
1 tablespoon lemon juice

How to prepare

1. Arrange the fillet, skin side down, on foil-covered broiler pan.
2. Combine remaining ingredients and spread over fillet.
3. Bake at 450°F or broil on high for 10 to 15 minutes, until you can easily flake the fillet with a fork. Do not overcook fish.

Other options

- Grill on foil sprayed with cooking oil for 10 to 15 minutes.
- You can use tilapia, which has a mild, sweet taste and tender, large flakes. Tilapia has fewer calories and fat, and also fewer omega-3s.

FOR MORE RECIPES

Visit **ChooseYourFish.org** to learn how to select and cook fish.

Developed by HealthPartners Institute in partnership with the Minnesota Department of Health, 2016.

outside: front cover (MDH version)

DISH UP SOME FISH

MDH Minnesota Department *of* Health

Fresh, frozen or canned, store-bought or locally caught—fish tastes good and is good for you. Getting hooked on eating fish is easy when you know:

- Why eating fish regularly is important for you and your family
- Which fish are better to eat
- How often to eat fish

Do the body and brain good

Eating fish 1 to 2 times a week has health benefits for people of all ages.

With a variety of types, tastes and textures to pick from, fish are a great choice for serving up tasty lean protein with plenty of vitamins and minerals. Fish also are a natural source of omega-3 fatty acids—a good kind of fat!

The omega-3 fatty acids found in fish are called *EPA* and *DHA*. Our bodies cannot make EPA and DHA. Eating fish is the main way to get these important fatty acids that you do not get from other foods. (Supplements may not be as beneficial.) Here is the best part:

- DHA is a building block of the brain and eyes
- Pregnant women and breastfeeding moms can eat fish to give DHA to their babies
- Eating fish can lower the risk of heart disease

What about mercury and other contaminants?

The benefits of eating fish outweigh the risks when eating fish low in mercury and other contaminants.

Young children (under 15 years old) and fetuses are more sensitive to mercury. Too much mercury can cause lasting problems with understanding and learning. But studies show children benefit developmentally when moms eat fish low in mercury during pregnancy.

What to do?

- Eating some fish regularly is important for you and your family.
- Eat fish as recommended in this brochure to prevent mercury and other contaminants from building up in your body.
- Contaminants take time to leave the body, so spread out your fish meals over time.
- Visit **ChooseYourFish.org** for more information.

CHOOSE YOUR FISH

Take a photo of these recommendations to save, share, post or pin.

These recommendations are for **women who are or may become pregnant and children under 15 years old.**

EVERY WEEK: EAT 2 TIMES

VERY LOW MERCURY

From stores and restaurants

- Catfish (farm raised)
- Cod
- Herring ♥
- Mackerel (Atlantic) ♥
- Pollock
- Salmon (Atlantic and Pacific) ♥
- Sardines ♥
- Shellfish (such as shrimp)
- Tilapia

♥ Higher in omega-3s

OR

EVERY WEEK: EAT 1 TIME

LOW MERCURY

From stores and restaurants

- Canned light tuna

From Minnesota lakes and rivers

- Bullhead
- Crappie
- Lake herring (Cisco)
- Lake whitefish
- Sunfish
- Yellow perch

AND

EVERY MONTH: EAT 1 TIME

MEDIUM MERCURY

From stores and restaurants

- Canned white (albacore) tuna
- Chilean sea bass
- Grouper
- Halibut
- Marlin
- Tuna steak

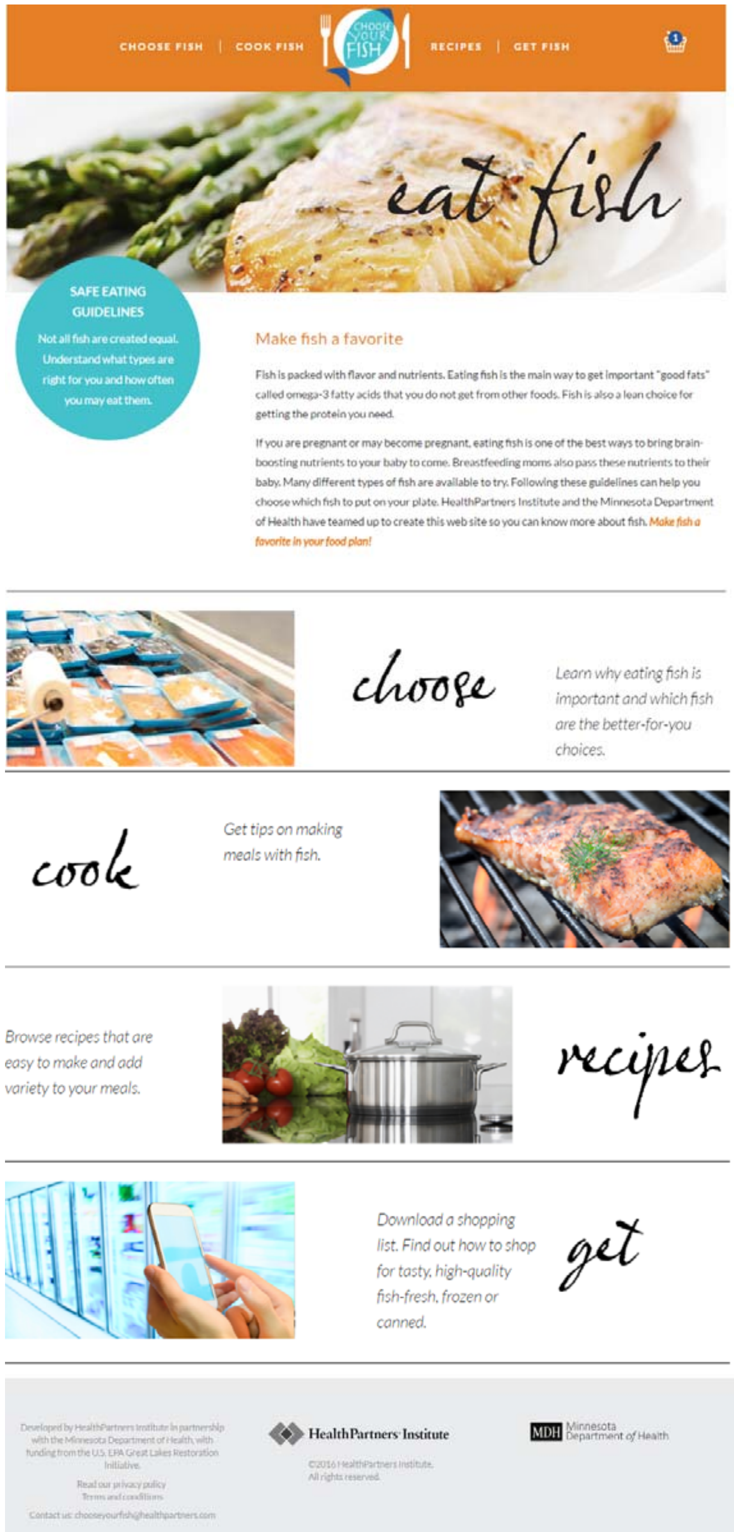
From Minnesota lakes and rivers

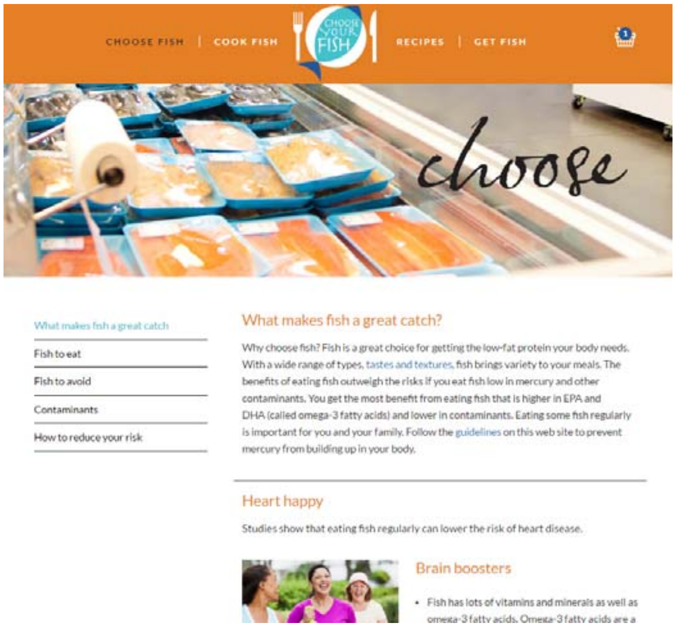
- Bass
- Catfish
- Lake trout
- Northern pike
- Walleye
- All other Minnesota species not listed

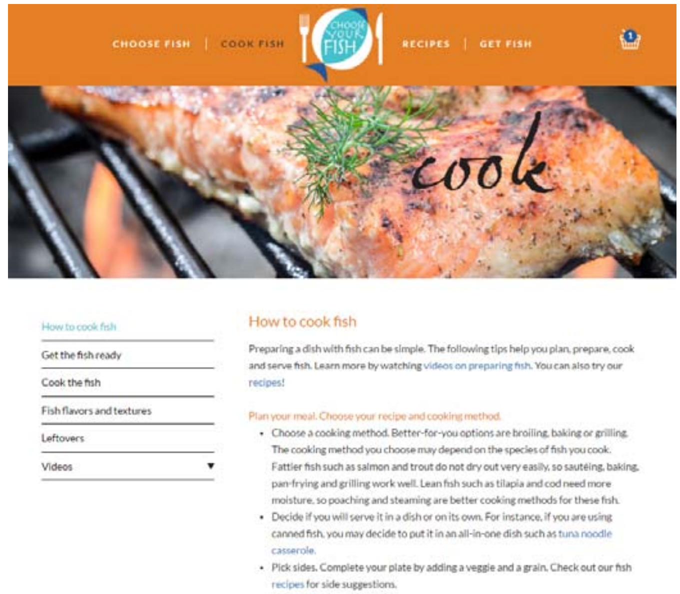
Men, older boys and women who are not and will not become pregnant can eat these fish about **3 times as often** as recommended above.

Appendix D: www.ChooseYourFish.org

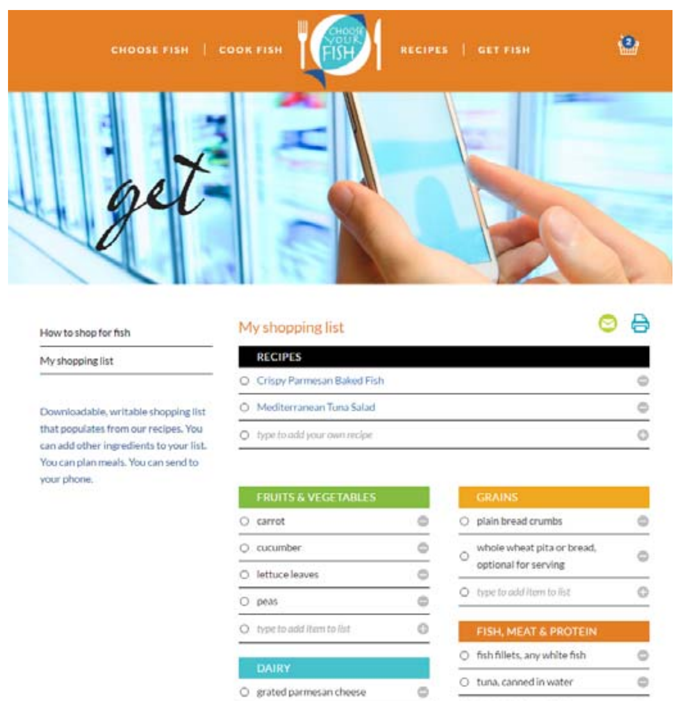
For full review of the website, please visit www.ChooseYourFish.org. Included below are screenshots highlighting each section of the site.




CHOOSE FISH | COOK FISH
CHOOSE YOUR FISH
RECIPES | GET FISH
choose
What makes fish a great catch
Fish to eat
Fish to avoid
Contaminants
How to reduce your risk
What makes fish a great catch?
Why choose fish? Fish is a great choice for getting the low-fat protein your body needs. With a wide range of types, tastes and textures, fish brings variety to your meals. The benefits of eating fish outweigh the risks if you eat fish low in mercury and other contaminants. You get the most benefit from eating fish that is higher in EPA and DHA (called omega-3 fatty acids) and lower in contaminants. Eating some fish regularly is important for you and your family. Follow the guidelines on this web site to prevent mercury from building up in your body.
Heart happy
Studies show that eating fish regularly can lower the risk of heart disease.
Brain boosters
Fish has lots of vitamins and minerals as well as omega-3 fatty acids. Omega-3 fatty acids are a


CHOOSE FISH | COOK FISH
CHOOSE YOUR FISH
RECIPES | GET FISH
cook
How to cook fish
Get the fish ready
Cook the fish
Fish flavors and textures
Leftovers
Videos
How to cook fish
Preparing a dish with fish can be simple. The following tips help you plan, prepare, cook and serve fish. Learn more by watching videos on preparing fish. You can also try our recipes!
Plan your meal. Choose your recipe and cooking method.
Choose a cooking method. Better-for-you options are broiling, baking or grilling. The cooking method you choose may depend on the species of fish you cook. Fattier fish such as salmon and trout do not dry out very easily, so sautéing, baking, pan-frying and grilling work well. Lean fish such as tilapia and cod need more moisture, so poaching and steaming are better cooking methods for these fish.
Decide if you will serve it in a dish or on its own. For instance, if you are using canned fish, you may decide to put it in an all-in-one dish such as tuna noodle casserole.
Pick sides. Complete your plate by adding a veggie and a grain. Check out our fish recipes for side suggestions.


CHOOSE FISH | COOK FISH
CHOOSE YOUR FISH
RECIPES | GET FISH
recipes
Use the tags at right to review recipes. You can add a recipe to your shopping basket, and then click the basket to see your grocery list. For tips on preparing fish, click here.
All tags
Search: salmon, salad, etc.
Grilled Asparagus and Shrimp Quinoa Salad with Lemon Vinaigrette
Crispy Parmesan Baked Fish
Fish Taco Salad


CHOOSE FISH | COOK FISH
CHOOSE YOUR FISH
RECIPES | GET FISH
get
How to shop for fish
My shopping list
Downloadable, writable shopping list that populates from our recipes. You can add other ingredients to your list. You can plan meals. You can send to your phone.
My shopping list
RECIPES
Crispy Parmesan Baked Fish
Mediterranean Tuna Salad
type to add your own recipe
FRUITS & VEGETABLES
carrot
cucumber
lettuce leaves
peas
type to add item to list
DAIRY
grated parmesan cheese
GRAINS
plain bread crumbs
whole wheat pita or bread, optional for serving
type to add item to list
FISH, MEAT & PROTEIN
fish fillets, any white fish
tuna, canned in water
type to add item to list