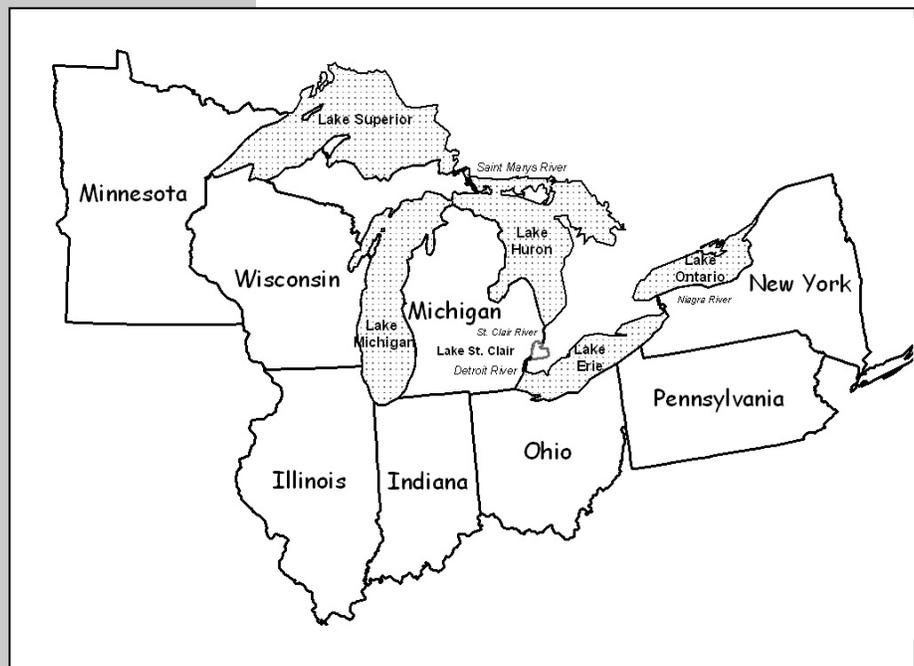

Factors Affecting Fish Consumption among Licensed Anglers Living in the Great Lakes Region



September 2012

HDRU Series No 12-3

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HUMAN DIMENSIONS RESEARCH UNIT PUBLICATION SERIES

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TO CITE THIS REPORT

Connelly, N.A., T.B. Lauber, J. Niederdeppe, and B.A. Knuth. 2012. Factors Affecting Fish Consumption among Licensed Anglers Living in the Great Lakes Region. HDRU Publ. No. 12-3. Dept of Nat. Resour., N.Y.S. Coll. Agric. And Life Sci., Cornell Univ., Ithaca, N.Y. 78 pp.

This report is available electronically at
<http://www2.dnr.cornell.edu/hdru/pubs/fishpubs.html#risk>

EXECUTIVE SUMMARY

Although toxic chemical substances in the Great Lakes have been reduced in recent decades, they remain at levels posing a potential health risk to people who consume Great Lakes fish. Fish consumption advisories have been issued by each of the Great Lakes states since the mid-1970s in response to these risks, both in Great Lakes waters and in other waters of each state. In addition to longer-term remediation and control activities, consumption advisories are the primary management strategy being implemented to address human exposure to contaminants in fish. In recent years, consumption advisories have also focused on communicating health benefits related to fish consumption.

A consortium of the eight Great Lakes states' health, environmental, and natural resource agencies formed in the 1980s to develop shared science-based protocols for fish consumption advice in the Great Lakes (Anderson et al. 1993, McCann et al. 2007). This Consortium has worked together since then, as time and funding have allowed, on various communication tools, data sharing, and additions to the protocols. The Consortium was funded in 2010 by the U.S. Environmental Protection Agency to work together to enhance state fish consumption advisory programs by determining how to communicate information to the public more effectively, 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.

As part of this work, Cornell University's Human Dimensions Research Unit was asked by the Consortium to conduct a survey of anglers living in the Great Lakes states. This report summarizes the results of the survey and serves as a baseline from which future work by the Consortium could be measured.

The specific objectives of the survey were to:

1. Quantify current fish consumption behaviors of anglers (and their household members);
2. Identify the most important factors influencing those behaviors;
3. Assess advisory awareness and general knowledge; and
4. Assess current and preferred sources of advisory-related information.

Methods

A sample of 8,001 licensed anglers was obtained from all states bordering the Great Lakes, except Ohio. A state executive order prohibited Ohio from releasing the names and addresses of anglers purchasing a fishing license in the state. A mail survey was implemented in September, 2011, with a telephone follow-up survey of 399 non-respondents to estimate the degree to which non-respondents differed from respondents.

Results and Recommendations

Of the 8,001 questionnaires mailed, 726 were undeliverable, and 1,712 completed questionnaires were returned. The adjusted response rate was 24%. Results of non-response bias comparisons are consistent with the conclusions of previous research that non-respondents fish less and are

less likely to be aware of a sport-caught fish advisory than respondents. Self-reported awareness of advisories for purchased fish was also lower among non-respondents than respondents.

Over 90% of licensed anglers responding indicated that they were aware of the sport-caught fish advisories. The non-respondent follow-up indicated that this percentage would likely be lower when extrapolating to all anglers in the Great Lakes region. Devoting resources to simply increasing awareness per se of sport-caught fish advisories likely will not result in much change, given the relatively high baseline level of self-reported awareness.

Self-reported awareness of purchased fish advisories was lower than awareness of sport-caught fish advisories among licensed anglers (70% vs. 92%). Not all state agencies focus efforts on making anglers aware of purchased fish advisories, perhaps explaining in part the lower level of awareness. Increasing state efforts (either on their own or by partnering with other organizations) to publicize purchased fish advisories may increase awareness above current levels.

Many anglers agreed with the statements testing some of the key messages stressed in the advisories (older and bigger fish generally have more contaminants than younger and smaller fish; contaminants can have a greater impact on children than adults; eating contaminated fish over time increases health risks). Those who indicated they were aware of advisory specifics also reported more certainty in their answers to the knowledge questions, but their answers to the knowledge questions suggest they had the same knowledge level as those who indicated only a general awareness of the advisory. This suggests that measuring perceived awareness of specific advisory details may reflect differences in confidence associated with understanding the advisory, rather than differences in knowledge about the details of the recommendations.

Anglers were more likely to indicate they didn't know the answer to a knowledge question than to choose the wrong answer. These responses suggest some strategies for agency communicators. Knowledge level of anglers could be targeted through communication programs, focusing on the most common "don't know" concepts. One key misperception, that may merit communication attention, is the fairly widely held perception that fish contaminated with chemicals will taste odd. Fewer than half of the anglers identified that contamination cannot be discerned by taste. Earlier work reported similar findings (Lauber et al. 2011a).

Anglers favor receiving information in the fishing regulations guide. This is the same source preferred by anglers in the 1991 Great Lakes angler survey (Connelly and Knuth 1993). The regulations guide typically does not provide a complete listing of all advisory information and recommendations. To address this concern, regulations guides could direct the reader to websites containing more complete information that some anglers (especially those with higher education levels) appear likely to access for advisory information. Some states already use the internet in this manner.

Most anglers only fished in the state in which they lived. However, some Illinois and Indiana anglers commonly traveled to nearby states, primarily Wisconsin and Michigan, to fish. Consistent advisory messages across states and shared water bodies may be less confusing to anglers, especially those who cross state borders to fish.

Anglers reported eating about 20 meals of fish per year, with three-quarters being purchased fish and the remainder sport-caught. Very few anglers (<1%) reported consuming sport-caught fish above the 52 meals per year statewide recommendation of some states. Consistent with previous research (Connelly et al. 1992), these findings suggest that over-consumption of fish by licensed anglers in relation to the general consumption advice provided by some states is not a major concern. However, many species-specific and water body-specific advisories exist. Tables 22-28 in this report may be compared against these more specific advisories to determine if fish consumption by anglers at least for certain species may exceed advisory recommendations.

Anglers were more likely to use fish cleaning techniques that reduce possible exposure to some types of contaminants than risk-reducing cooking techniques, similar to previous findings (e.g., Connelly et al. 1992). Most anglers reported always filleting their fish and removing the skin and belly fat, but only 7% always baked, roasted, broiled, or grilled their fish. Anglers appear to use, at least some of the time, cooking techniques such as pan frying or deep frying that are generally not recommended because they do not reduce exposure to certain contaminants. States might investigate in more detail why these behaviors occur and revise their messages accordingly. Reusing oil or fat from cooking fish in future meals, which is not recommended, appears to be done very infrequently.

The factors with the greatest influence on anglers' attempts to follow the fish consumption advisories seem to be anglers' level of concern about the risks associated with sport-caught fish consumption and the views of their family and friends concerning limiting the amount of contaminated sport-caught fish consumed. Concern about the risks was strongly correlated with beliefs about the risks and benefits of consumption. Many anglers believe that the risks are minor and that eating some types of sport-caught fish is fine, but many do not believe that the health benefits outweigh the health risks. Discussing the health benefits of fish consumption is a goal of many of the agencies that issue state fish consumption advisories (Lauber et al. 2011b), but is likely an area that will need additional attention through focused communication strategies. Three-quarters of anglers indicated interest in learning about health benefits from fish consumption. Such a message may also need to be communicated in a way that includes family and friends, whose views are important to anglers.

Agencies issuing advisories also target special audiences in their communication efforts for a variety of reasons. Respondents to this survey were grouped by socio-demographic characteristics that defined these audiences and analysis was done specifically for each subgroup. Some highlights are discussed below. State-by-state results are presented throughout the report and summarized in the discussion section along with recommendations.

Women of child-bearing age. Compared to anglers in households without women under age 50, anglers living in households with women under age 50 were less likely to be aware of the sport-caught or purchased fish advisories, and less likely to be aware of the specifics of either advisory if they were aware of the advisories at all. These anglers were also less likely to know that older fish generally have more contaminants than younger fish. Because special advice for women of childbearing age is often emphasized in most advisory communications, the lower level of awareness and knowledge among

anglers with such household members is of special concern. Targeting women of childbearing age more directly with fish consumption guidance may be more effective than relying on (mostly male) anglers to transmit this information to women in their households. Most states are already taking this approach.

Women under age 50 reported eating more purchased fish than did men or older women, but not more sport-caught fish. Canned tuna consumption was higher among women under age 50 compared to other groups. Very few women under age 50 reported eating swordfish, consistent with recommendations from many organizations against any consumption of this species for this group.

Anglers with lower education levels. This group of anglers was less likely to be aware of or knowledgeable about fish consumption advisories compared to anglers with higher education levels. They were more likely to indicate they didn't know the answers to the knowledge questions, and they were more likely to indicate that government agencies really don't know how much chemical contaminants are in fish. No source of information was favored more by this group; perhaps communication methods other than the standard ones should be considered. This group was more likely to report wanting to do what their family and friends think is best with regard to limiting the amount anglers themselves eat, suggesting communication methods that involve social networks might be effective.

Non-white anglers. Non-white anglers were less aware of sport-caught advisories than white anglers. They were also more likely to have the perception that fish contaminated with chemicals will taste odd. State communicators might focus communication efforts with non-white audiences on addressing this misperception.

We suggest two general avenues for future research with licensed anglers in the Great Lakes region. First, evaluation of new communication methods or messages could be conducted as state members of the Consortium use the results of this research and modify their advisory communication strategies. States may partner in implementing common changes across states or may make selective changes, both of which would benefit from evaluation. Second, research could focus on measuring progress toward the Consortium goal to increase public knowledge about the risks and benefits of fish consumption and reduce exposure of the public to toxic substances from consumption of contaminated fish, using this study as a baseline from which to measure progress toward that goal.

ACKNOWLEDGMENTS

This study was funded by the U.S. Environmental Protection Agency (EPA) under a grant to the Minnesota Department of Health, as part of the Great Lakes Consortium Fish Consumption Advisory Enhancement project.

A representative from each state in the Great Lakes Consortium helped formulate the objectives for this study, and reviewed the questionnaire and final report. This group included: Pat McCann (MN), Candy Schrank (WI), Ken Runkle (IL), Michelle Bruneau (MI), LaNetta Alexander (IN), Mylynda Shaskus (OH), Tom Barron (PA), and Faith Schottenfeld (NY). We wish to thank the many state agency representatives who assisted us in obtaining the sample of anglers licensed in each state in our study area.

We thank Human Dimensions Research Unit staff member, Karlene Smith, who assisted with sample selection, mailings, data entry, and table preparation. We also thank Meghan Baumer for typing the many tables in this report. The Survey Research Institute at Cornell University conducted the non-respondent telephone follow-up interviews.

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INTRODUCTION

Although toxic chemical substances in the Great Lakes have been reduced in recent decades, they remain at levels posing a potential health risk to people who consume Great Lakes fish. Fish consumption advisories have been issued by each of the Great Lakes states since the mid-1970s in response to these risks, both in Great Lakes waters and in other waters of each state. In addition to longer-term remediation and control activities, consumption advisories are the primary management strategy being implemented to address this human exposure to contaminants in fish. In recent years, consumption advisories have also focused on communicating health benefits related to fish consumption.

Adherence to the advisories is voluntary on the part of fish consumers and presumes that they are aware of the recommendations, understand them, and have enough knowledge to make an informed decision about whether to follow them or not (Knuth 1990). However, a variety of studies in different contexts have found that fish consumption advisories are only partially successful in achieving their goals. Awareness of fish consumption advisories is generally higher among anglers, one of the groups most likely to be exposed to contaminated fish, than the general population. Acceptance of advisory information and compliance with the recommendations in advisories may be low among anglers even if awareness is high (MacDonald and Boyle 1997, Pflugh et al. 1999, Burger and Gochfeld 2006). The most comprehensive work focused on anglers and fish consumption advisories in the Great Lakes region was conducted in 1991 (Connelly and Knuth 1993). Connelly and Knuth surveyed anglers who had fished in the Great Lakes in the preceding five years and found that while most were aware of the fish consumption advisories (83%), one-quarter had eaten at least one meal of fish for which the recommendation was “eat none.” Similar findings were reported in a study focused on New York state anglers, in which 85% were aware of New York’s sport-caught fish advisories, but 20% consumed more than the advisory recommended (Connelly et al. 1992). Connelly et al. (1996) found that more than 95% of Lake Ontario anglers were aware of fish consumption advisories, but 36% consumed fish in excess of recommended advisory limits. A variety of reasons for lack of compliance may exist, including a misunderstanding of advisory materials. Connelly et al. (1996) found that 90% of the anglers who exceeded recommended fish consumption limits believed that they were complying with advisory guidelines.

These findings suggest that public exposure to contaminated fish continues. Some groups are more likely to be exposed than others. For example, non-white anglers and anglers with lower levels of income and education are less likely to be aware of and comply with fish consumption advisories than their counterparts (Velicer and Knuth 1994, Tilden et al. 1997, Chess et al. 2005). Advisories have also evolved over time. They now cover new contaminants, as well as focusing more attention on the benefits of fish consumption. Communication methods and message emphasis have changed as well, in attempts to address some of the issues identified by earlier research and reach more of the populations most at-risk.

A consortium of the eight Great Lakes states’ health, environmental, and natural resource agencies formed in the 1980s to develop shared science-based protocols for fish consumption advice in the Great Lakes (Anderson et al. 1993, McCann et al. 2007). This Consortium has worked together since then, as time and funding have allowed, on various communication tools,

data sharing, and additions to the protocols. The Consortium was funded in 2010 by the U.S. Environmental Protection Agency to work together to enhance state fish consumption advisory programs by determining how to communicate information to the public more effectively, 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.

As part of this work, Cornell University's Human Dimensions Research Unit was asked by the Consortium to conduct a survey of anglers living in the Great Lakes states. This report summarizes the results of the survey and serves as a baseline from which future work by the Consortium could be measured.

The specific objectives of the survey were to:

1. Quantify current fish consumption behaviors of anglers (and their household members);
2. Identify the most important factors influencing those behaviors;
3. Assess advisory awareness and general knowledge; and
4. Assess current and preferred sources of advisory-related information.

The Theory of Planned Behavior (Ajzen 1989) was applied to guide identification of factors influencing adherence to fish consumption advisories. The Theory of Planned Behavior postulates that behaviors are influenced by three interrelated factors: (1) attitude toward the behavior (e.g., Does an individual think engaging in the behavior is good or bad?); (2) perceived behavioral control (e.g., How easy or difficult do individuals think the behavior is?); and (3) subjective norm (e.g., What social pressures exist for individuals to engage in the behavior?). These factors are themselves influenced by beliefs about outcomes of performing the behavior (behavioral beliefs), beliefs about the extent to which the behavior is under their control (control beliefs), and beliefs about how specific people or groups feel about performing the behavior (normative beliefs). This Theory was operationalized in the context of adherence to the fish consumption advisory as outlined in Figure 1, with the questions used shown in each box of the figure and responses generally measured on an agree/disagree scale.

METHODS

Sample Selection

A sample of 8,001 licensed anglers was obtained from all states bordering the Great Lakes, except Ohio. A state executive order prohibited Ohio from releasing the names and addresses of anglers purchasing a fishing license in the state. The sample was divided evenly among the remaining seven states (1,143 per state). "Licensed anglers" was defined as individuals purchasing an annual (not short-term) resident fishing license in the most recently completed license year. Licenses were not limited to those fishing in Great Lakes waters, but permitted fishing anywhere in the state where they were issued. Several special situations existed in the license data obtained:

1. Wisconsin has a check box on their license form that anglers check if they do not want their name and address disclosed. Contact information for these anglers was not available for this study. Approximately 80% of Wisconsin license buyers checked this

box. Differences could exist between those checking the box and those not checking the box. To assess this possibility, we obtained information on gender, date of birth, and zip code for all 2010 Wisconsin resident annual fishing license holders (N=987,245). Using this limited set of variables, socio-demographic characteristics of fishing license holders who had or had not checked the box were compared and very small differences were found. We concluded that there was no evidence of bias between the two groups with regard to these characteristics, although other differences could exist that could not be detected solely through these demographic indicators.

2. Illinois would not permit the release of anglers' names, only their mailing addresses. Therefore, the mailings were addressed to "angler living in the household." If more than one member of the household purchased a fishing license, the person who filled out the questionnaire may not have been the person drawn in the sample.
3. Minnesota has several license types for which a husband and wife can purchase a joint license. The sample was drawn by the Minnesota Department of Natural Resources in such a way that the husband and wife each had the same chance of being selected as any other license buyer.

Questionnaire Design

The questionnaire was designed based on previous work so that comparison of results over time would be possible (Connelly et al. 1992, Connelly and Knuth 1993). Additional questions were added to address specific project objectives, and reviewed by the members of the Great Lakes Consortium project advisory team. The questionnaire (Appendix A) included sections on fishing activity, fish consumption behaviors, advisory awareness and knowledge, sources of information, preferred topics for future advisory communications, factors influencing fish consumption behaviors, and socio-demographic characteristics.

In the questionnaire, we defined sport-caught fish as fish *caught* by you, your friends, or family in any of the 8 Great Lakes states; the type of fish (e.g., panfish, bass, trout) does not matter. We defined purchased fish as fish *purchased* at a store or restaurant.

Mail Survey Implementation and Non-respondent Telephone Follow-up

The mail survey was implemented in September, 2011. Up to three follow-up mailings were sent to non-respondents over the course of the next four weeks to encourage their response.

A telephone follow-up survey of 399 (57 per state) non-respondents was implemented approximately two months after the first mailing of the questionnaire to estimate the degree to which non-respondents differed from respondents. Key questions from the mail survey (listed in Appendix B) were asked over the telephone about fishing effort, fish consumption, advisory awareness, and beliefs about the health risks associated with fish consumption.

Analysis and Data Weighting

Data from returned questionnaires were entered into the computer and analysis was done using SPSS (IBM SPSS Statistics 19). Chi-square, t-tests, and Scheffe's test were used to test for

statistically significant differences between groups of anglers at the $P \leq 0.05$ level. Path analysis, a form of causal analysis, was used to test the strength of the relationships hypothesized in Figure 1. Path analysis involves conducting a series of ordinary least squares regressions on each dependent variable in the causal diagram (Blalock 1985). The standardized regression coefficients (equivalent in this case to the correlation coefficients) from these models provide a comparable measure of the strength of each hypothesized relationship.

Data reported by state of angler residence are unweighted and reflect the number of people who responded to the survey from that state. However, to make statements about anglers living in the Great Lakes states or certain target audiences, such as non-white anglers, respondent data had to be weighted in proportion to the number of licenses sold in each state. Therefore, all data reported for the Great Lakes region in general were weighted to the proportion of the number of licenses sold in each state, while state-specific data analyses did not use weights.

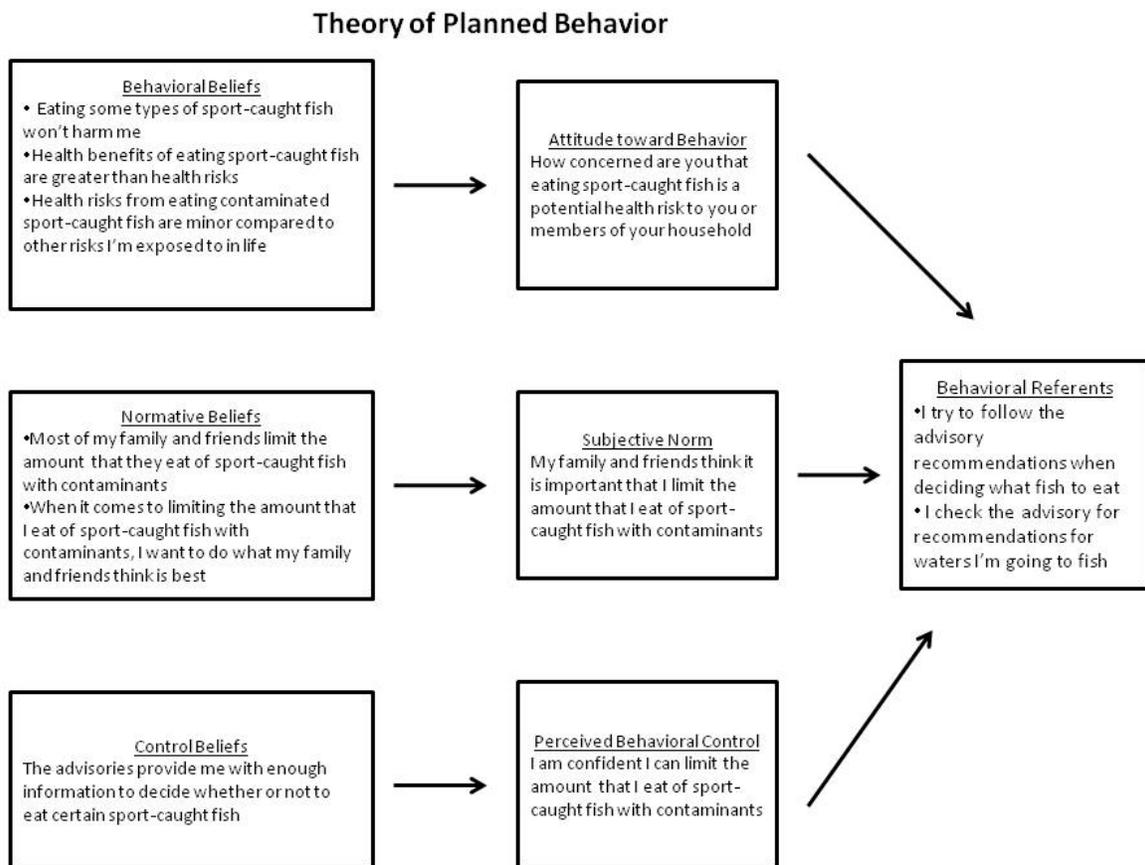


Figure 1. Diagram showing the use of the Theory of Planned Behavior as it applies to consumption of fish listed in fish consumption advisories.

RESULTS

Mail Survey Response

Of the 8,001 questionnaires mailed, 726 were undeliverable, and 1,712 completed questionnaires were returned. The adjusted response rate was 24%. Response rate differed by state with Minnesota being the highest and Illinois the lowest (Table 1).

Table 1. Response rate by state.

State	Initial Sample Size	Responses	Response rate adjusted for undeliverables
Illinois	1,143	137	13.9%
Indiana	1,143	198	19.7%
Michigan	1,143	279	26.4%
Minnesota	1,143	328	31.3%
New York	1,143	292	27.4%
Pennsylvania	1,143	218	20.5%
Wisconsin	1,143	258	24.5%
Overall	8,001	1,712*	23.5%

*Includes 2 cases that could not be identified by state.

Adjustments for Non-response Bias

Results of non-response bias comparisons are consistent with the conclusions of previous research that non-respondents fish less and are less likely to be aware of a sport-caught fish advisory than respondents (Connelly et al. 1990, Connelly et al. 1992, Connelly and Knuth 1993). Past research also noted that non-respondents ate less sport-caught fish than respondents, a finding that was not supported in this study. For the most recent period specified in the survey (summer) there was no difference between respondents and non-respondents in the number of meals consumed, and over the past 12 months non-respondents indicated they ate more meals of fish on average than respondents. These findings were the same when respondents and non-respondents were asked about purchased fish consumption.

Consistent with previous research on sport-caught fish advisories, awareness of advisories for purchased fish was lower among non-respondents than respondents. Non-respondents were less concerned than respondents about the risks associated with consumption of contaminated sport-caught fish and more positive about the health benefits of fish consumption. This difference could explain their higher levels of consumption. Non-respondents were more likely than respondents to have populations of special concern (women under 50 and children) living in their households and more likely to live in more urban areas. In future sections of the report, when

respondent data are discussed in more detail, non-respondent differences are reiterated and the implications of these differences for education programs are discussed. (Statistical comparisons between respondents and non-respondents are detailed in Appendix B.)

Organization of Results and Characterization of Respondents

All survey results are discussed for the Great Lakes region as a whole and separately by angler state of residence. Agencies issuing advisories also target special audiences (described below) in their communication efforts for a variety of reasons. Respondents to this survey were grouped by socio-demographic characteristics that defined these audiences and analysis was done specifically for each sub-group. As results are presented in subsequent sections, statistically significant differences ($p < 0.05$) for these sub-groups are highlighted. If no differences are reported for a particular sub-group when differences for other sub-groups are reported, the reader may assume there were no significant differences for that sub-group. The concluding sections of the report discuss these sub-groups and recommendations for communication strategies to address them.

Most advisories divide fish consumers into two groups (men/older women and women of childbearing age/children) and provide different advice for each group. The definitions of each group are currently not consistent across states, but for the purposes of this survey age and gender were used to define the two groups. The first group called “men and older women” was defined as men aged 15 and older and women aged 50 and older. The second group consisted of women aged 15 to 49 and children (male and female) aged 14 and younger. Since respondents to the survey had to be aged 18 or older, results discussing angler behaviors are by definition all aged 18 and older, but results focusing on household members include those under 18.

Ninety percent of respondents fell into the first group, “men and older women” (Table 2). However, 35% of this group had members of the second group, “women of childbearing age and children,” living in their household. In this report, the focus was on households with women under age 50 (including the respondent) as a sub-group, because the correlation between households with children and households with women of childbearing age was high (0.49), and advisory awareness was more strongly related to whether households contained women of childbearing age than to whether households contained children.

Reaching urban anglers with advisory communications has been an interest of many state agencies, so this audience, comprising 14% of respondents (Table 2), was examined as a sub-group. By necessity the definition of urban anglers in this report differs from that used in focus groups conducted in an earlier phase of this research project (Lauber et al. 2011a). For the focus groups, urban anglers were defined as anglers living and fishing in urban areas. In this study, fishing locations were not classified as urban or not, so the definition used in this study is limited to whether anglers lived in an urban area or not.

Table 2. Characteristics of responding anglers and their households.

Respondent Characteristics	Percent
Gender and age	
Men	80.1
Women \geq 50	9.7
Women < 50	10.2
Education	
Less than high school	3.6
High school diploma/G.E.D.	24.4
Some college or technical school	30.3
Associate's degree	11.0
College undergraduate degree (e.g., B.A., B.S.)	20.1
Graduate or professional degree (e.g., M.S., Ph.D., M.D., J.D.)	10.6
Hispanic, Latino, or Spanish Origin	
No	96.6
Yes	3.4
Race*	
White	94.9
Black or African American	1.8
Asian or Pacific Islander	1.3
Native American Indian	1.6
Other	4.0
Household Characteristics	
Households with women < 50	38.8
Households with children < 15	21.3
Primary Residence	
Urban residence	14.3
Suburban residence	37.0
Rural residence	48.7
Income	
< \$25,000	9.7
\$25,000 to \$49,999	27.2
\$50,000 to \$99,999	41.6
\$100,000 to \$199,999	18.5
\$200,000 or more	3.0

*Percentages add to more than 100% because more than one race can be checked.

The education level of a respondent was used to create sub-groups. As expected, income and education were highly correlated (0.42), but the income question was answered by fewer people than the education question (87% vs. 95%), so education level was used. Respondents were grouped into three groups – those with a high school diploma or less, those with some college, and those with a college or graduate degree. Roughly one-third of respondents fell into each group (Table 2).

Most respondents were white and not of Hispanic origin (Table 2). White respondents were compared with all other non-white respondents grouped together, as no other racial group responded in significant enough numbers to be examined as a distinct sub-group.

Awareness and Understanding of the Fish Consumption Advisory

Most anglers living in the Great Lakes region reported being at least generally or vaguely aware of the advisory for sport-caught fish, but many fewer were aware of advice for purchased fish (Tables 3a and 3b). As noted above, respondents were more likely to be aware of the advisory than non-respondents, so the percentages in these tables likely reflect higher awareness levels than is true for all anglers. Self-reported awareness of advice for *sport-caught* fish differed significantly between states; self-reported awareness of specific advice was highest among Michigan and Wisconsin anglers. Indiana anglers were the most likely to indicate they were not at all aware of the sport-caught fish advice. There was no difference between the states in awareness of advice for *purchased* fish, with about one-third not at all aware, 40-50% generally aware, and the remainder aware of the specifics.

Anglers' awareness of advisory information related to sport-caught fish was compared with their awareness of advisory information related to purchased fish. These analyses revealed that about one-quarter of all anglers indicated they were aware of the specifics of both advisories (Table 4). If an angler was not at all aware of the sport-caught advisory it was very unlikely that the angler would be aware of the purchased fish advisory.

Anglers living in households with women under age 50 were less likely than their counterparts to be aware of the sport-caught or purchased fish advisories, and less likely to be aware of the specifics of either advisory (Tables 5a and 5b). Because women of childbearing age are targeted with more stringent guidelines in most advisory communications, the lower level of awareness among anglers who might be communicating this advice to a woman is of special concern.

Race and education were also related to advisory awareness (Tables 5a and 5b). Non-white anglers were less aware of the sport-caught fish advisory than white anglers. There was no difference in the level of awareness for purchased fish advice. The higher the education level, the more likely the angler was to be generally or vaguely aware of either advisory, but not more likely that they were aware of the specifics of an advisory.

Table 3a. Angler awareness of the sport-caught advisories, overall and by state of residence.

	% Awareness of sport-caught fish advisory		
	Not at all	Generally or vaguely aware	Aware of specific advice
Overall	8.2	46.5	45.3
<u>State of Residence*</u>			
Illinois	8.0	50.4	41.6
Indiana	13.8	44.7	41.5
Michigan	7.4	39.5	53.1
Minnesota	7.8	54.4	37.8
New York	8.7	47.0	44.3
Pennsylvania	11.9	43.3	44.8
Wisconsin	3.9	44.2	51.9

*Statistically significant difference between states at $P \leq 0.05$ using chi-square test.

Table 3b. Angler awareness of the purchased fish advisories, overall and by state of residence.

	% Awareness of purchased fish advisory		
	Not at all	Generally or vaguely aware	Aware of specific advice
Overall	30.1	43.8	26.1
<u>State of Residence</u>			
Illinois	26.2	45.9	27.9
Indiana	32.2	43.9	23.9
Michigan	28.9	40.6	30.5
Minnesota	32.0	47.7	20.3
New York	36.0	38.3	25.7
Pennsylvania	31.3	45.3	23.4
Wisconsin	25.4	43.5	31.1

Table 4. Anglers' awareness of the sport-caught fish advisory compared with their awareness of the purchased fish advisory (percent of total).

Awareness of sport-caught fish advisory	Awareness of purchased fish advisory		
	Aware of specific advice	Generally or vaguely aware	Not at all aware
Aware of specific advice	24.3	11.7	8.6
Generally or vaguely aware	1.5	30.7	14.8
Not at all aware	0.1	1.4	6.9

Respondent’s advisory knowledge was tested with six statements (three generally true and three generally false), where they were asked to agree, disagree, or indicate they didn’t know (Table 6). Two-thirds to three-quarters of the respondents agreed with the true statements, fewer disagreed with the false statements. For the false statements they were more likely to indicate “don’t know” compared to the true statements. In general, respondents were more likely to select “don’t know” than to choose an incorrect answer.

Table 5a. Angler awareness of the sport-caught fish advisories, by race, education level, and the presence of a woman under age 50 living in the household.

	% Awareness of sport-caught fish advisory		
	Not at all	Generally or vaguely aware	Aware of specific advice
<u>Woman < 50 living in household*</u>			
No	6.7	44.6	48.7
Yes	10.3	49.2	40.5
<u>Race*</u>			
White	7.4	46.9	45.7
Non-white	18.1	38.9	43.0
<u>Education*</u>			
HS diploma or less	11.8	40.5	47.7
Some college	7.7	47.1	45.2
College or graduate degree	5.0	50.9	44.1

*Statistically significant difference between groups at $P \leq 0.05$ using chi-square test.

Table 5b. Angler awareness of the purchased fish advisories, by race, education level, and the presence of a woman under age 50 living in the household.

	% Awareness of purchased fish advisory		
	Not at all	Generally or vaguely aware	Aware of specific advice
<u>Woman < 50 living in household*</u>			
No	28.9	42.1	29.0
Yes	32.4	46.3	21.3
<u>Race</u>			
White	30.4	43.8	25.8
Non-white	28.4	41.9	29.7
<u>Education*</u>			
HS diploma or less	35.6	36.3	28.1
Some college	31.2	42.7	26.1
College or graduate degree	24.2	51.4	24.4

*Statistically significant difference between groups at $P \leq 0.05$ using chi-square test.

A knowledge score was created that reflects the number of correct responses ranging from 0 to 6 (Table 7). (Those who didn't know or were incorrect received a zero for that item.) The knowledge questions were not designed to comprehensively measure angler knowledge but more to reflect the types of messages states focused on in their advisory communication. Therefore, the knowledge score reflects angler understanding of some of the key messages of the sport-caught advisories. Almost 60% of anglers correctly answered 4 or more of the knowledge questions. The mean score was 3.6. As expected, the score was much lower for those not aware of the sport-caught advisories, but did not differ between those who indicated they had general versus specific knowledge. Anglers living in Illinois answered more questions correctly than did anglers living in Pennsylvania.

Two-thirds of respondents agreed that "older fish generally have more contaminants in them than younger fish" (Table 6). Almost 70% of respondents agreed that "contaminants from fish can have a greater impact on children than on adults," with anglers living in Illinois, Minnesota, and Wisconsin being the most likely to agree. Three-quarters of respondents agreed that "eating contaminated fish over many years increases my health risks," with Illinois and New York anglers most likely to strongly agree with this statement.

For statements that were generally false, disagreement with the statement indicated accurate knowledge. About half of the respondents disagreed with the statement "any health problems from eating fish contaminated with chemicals are mainly short term." Illinois and New York anglers were the most likely to disagree with this statement. The item "fish contaminated with chemicals will taste odd" was the item that elicited the most uncertainty in response. Less than half of the respondents disagreed with this statement. More agreed, incorrectly, with this statement than other statements, and the remainder indicated they were neutral or didn't know. There were no statistically significant differences by state for this item. The final statement, "smaller fish generally have more contaminants in them than larger fish," was understood to be false by over half of the respondents, and particularly those living in Minnesota and Wisconsin.

Table 6. Knowledge of advisory information (percent), overall and by state of residence.

Knowledge of advisory information	State of Residence							
	Overall	IL	IN	MI	MN	NY	PA	WI
Older fish generally have more contaminants in them than younger fish (<i>generally true</i>)	Percent							
Strongly agree	18.7	19.7	13.6	21.5	19.3	19.1	15.6	18.5
Agree	46.2	47.2	40.9	44.8	49.4	45.2	38.7	49.0
Neutral	10.4	8.7	9.9	11.1	10.1	11.9	11.8	9.2
Disagree	5.9	7.9	8.9	5.9	3.8	6.1	7.5	6.4
Strongly disagree	2.8	3.1	2.6	1.9	2.5	2.9	3.3	2.8
Don't know	16.0	13.4	24.1	14.8	14.9	14.8	23.1	14.1
Contaminants from fish can have a greater impact on children than on adults* (<i>generally true</i>)								
Strongly agree	19.4	24.4	20.0	18.9	19.5	21.5	16.6	16.9
Agree	49.7	49.7	39.5	51.1	52.5	44.2	43.2	54.6
Neutral	9.3	4.7	10.5	9.6	10.7	11.8	10.0	9.2
Disagree	3.4	3.9	4.2	3.0	1.6	5.0	4.7	3.2
Strongly disagree	1.8	0.0	2.1	1.5	2.2	3.2	0.9	3.2
Don't know	16.4	17.3	23.7	15.9	13.5	14.3	24.6	12.9
Eating contaminated fish over many years increases my health risks* (<i>generally true</i>)								
Strongly agree	25.1	33.3	29.8	24.2	21.7	35.1	24.1	19.5
Agree	50.6	51.6	46.1	48.7	53.5	46.2	48.6	53.7
Neutral	9.7	5.6	5.2	8.9	11.6	7.5	10.8	12.0
Disagree	2.6	2.4	1.6	3.3	1.3	1.1	2.4	4.4
Strongly disagree	0.8	0.0	1.6	1.9	0.3	1.1	0.9	1.2
Don't know	11.2	7.1	15.7	13.0	11.6	9.0	13.2	9.2
Any health problems from eating fish contaminated with chemicals are mainly short term* (<i>generally false</i>)								
Strongly agree	1.1	0.0	2.1	1.5	0.9	1.8	1.4	0.8
Agree	6.1	8.7	6.8	6.0	5.7	4.3	7.5	5.6
Neutral	18.1	14.3	15.3	20.6	21.1	16.2	16.4	20.0
Disagree	34.1	38.9	33.2	28.8	34.8	34.6	31.6	34.8
Strongly disagree	16.2	19.8	12.1	19.5	12.9	23.7	14.1	13.6
Don't know	24.4	18.3	30.5	23.6	24.6	19.4	29.1	25.2

Table 6 (cont.)

Knowledge of advisory information	State of Residence							
	Overall	IL	IN	MI	MN	NY	PA	WI
Fish contaminated with chemicals will taste odd <i>(generally false)</i>								
Strongly agree	2.4	2.4	3.7	3.0	0.6	4.0	3.8	2.0
Agree	8.6	11.0	8.4	7.8	6.6	9.1	9.0	12.1
Neutral	17.7	16.5	19.5	13.3	21.5	17.8	12.7	22.2
Disagree	34.2	33.1	33.2	37.3	35.0	34.3	30.2	30.6
Strongly disagree	12.0	13.4	8.4	12.6	10.4	9.4	13.2	12.5
Don't know	25.1	23.6	26.8	25.9	25.9	25.4	31.1	20.6
Smaller fish generally have more contaminants in them than larger fish* <i>(generally false)</i>								
Strongly agree	0.8	0.0	0.5	0.7	0.9	0.4	1.9	0.8
Agree	3.5	3.9	2.1	4.8	3.5	4.7	2.8	4.8
Neutral	13.9	12.6	13.8	11.9	12.9	15.1	19.8	12.5
Disagree	40.2	42.6	41.1	42.8	40.1	42.4	33.5	39.1
Strongly disagree	18.2	16.5	12.2	17.5	23.6	12.9	11.8	23.0
Don't know	23.4	24.4	30.3	22.3	18.6	24.5	30.2	19.8

*Statically significant differences between states at $P \leq 0.05$ using chi-square test.

As expected, education level was related to knowledge of advisory information (Table 8). The higher the education level the more likely a licensed angler was to agree with the true answers and disagree with the false answers. Those with the least education were the most likely to indicate “don’t know.”

Anglers living in households with women under age 50 were less likely than their counterparts to know that older fish have more contaminants than younger fish (59% vs. 68%). Non-white anglers were more likely than white anglers to think that fish contaminated with chemicals will taste odd (23% vs. 11%).

Knowledge tended to differ based on the level of awareness of the sport-caught advisory and less so for the purchased fish advisory. This makes sense given the type of knowledge questions asked. Therefore, comparisons are shown in Table 9 between knowledge and the level of awareness of the sport-caught fish advisory. For all knowledge questions, anglers who were not aware of sport-caught or purchased fish advice were two to three times as likely to indicate “don’t know” compared with those who had general or specific knowledge. Those who reported they had specific knowledge of the sport-caught fish advisory were more likely to strongly agree with the true statements and strongly disagree with the false statements than those generally aware. In other words, those who thought they had more specific knowledge appeared to be more certain they were correct in their answers to the knowledge questions, but were not necessarily more correct than those with a general awareness.

Table 7. Knowledge score, overall, by level of advisory awareness and by state of residence.

<u>Knowledge Score</u>	<u>Percent</u>
0 items correct	9.3
1 item correct	7.3
2 items correct	8.6
3 items correct	16.8
4 items correct	20.7
5 items correct	21.5
6 items correct	15.8

Overall	<u>Mean</u> 3.6
<u>Level of advisory awareness</u>	
Aware of specific sport-caught advice	3.8 ^a
Generally aware of sport-caught or purchased fish advice	3.6 ^a
Not aware of either advice	2.4 ^b
<u>State of Residence</u>	
Illinois	3.9 ^a
Indiana	3.3 ^{a,b}
Michigan	3.6 ^{a,b}
Minnesota	3.7 ^{a,b}
New York	3.7 ^{a,b}
Pennsylvania	3.2 ^b
Wisconsin	3.6 ^{a,b}

^{a,b}Values without a letter in common are significantly different at P = 0.05 using Scheffe's test.

Table 8. Knowledge of advisory information (percent), by education level.

Knowledge of advisory information	Strongly Agree or Agree	Neutral	Strongly Disagree or Disagree	Don't know
Older fish generally have more contaminants in them than younger fish				
<u>Education*</u>				
HS diploma or less	59.8	11.1	8.5	20.6
Some college	62.9	11.7	10.2	15.2
College or graduate degree	71.5	7.2	8.0	13.3
Contaminants from fish can have a greater impact on children than on adults				
<u>Education*</u>				
HS diploma or less	61.6	10.4	6.6	21.4
Some college	66.4	11.1	5.7	16.8
College or graduate degree	78.4	6.6	3.2	11.8
Eating contaminated fish over many years increases my health risks				
<u>Education*</u>				
HS diploma or less	67.8	11.3	4.7	16.2
Some college	75.3	10.3	2.6	11.8
College or graduate degree	84.8	7.0	2.8	5.4
Any health problems from eating fish contaminated with chemicals are mainly short term				
<u>Education*</u>				
HS diploma or less	10.3	20.4	39.9	29.4
Some college	6.8	19.7	48.4	25.1
College or graduate degree	5.4	14.5	61.6	18.5
Fish contaminated with chemicals will taste odd				
<u>Education*</u>				
HS diploma or less	15.4	19.4	34.2	31.0
Some college	11.9	17.3	45.8	25.0
College or graduate degree	7.8	16.6	54.4	21.2
Smaller fish generally have more contaminants in them than larger fish				
<u>Education*</u>				
HS diploma or less	6.9	15.2	51.5	26.4
Some college	4.6	14.2	55.9	25.3
College or graduate degree	3.8	11.8	67.3	17.1

*Statistically significant difference between groups at $P \leq 0.05$ using chi-square test.

Table 9. Knowledge of advisory information (percent) by level of advisory awareness.

Knowledge of advisory information	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
Older fish generally have more contaminants in them than younger fish*						
Aware of specific sport-caught advice	23.7	47.0	9.6	6.3	2.2	11.2
Generally aware of sport-caught or purchased fish advice	15.6	47.1	11.5	6.2	3.5	16.0
Not aware of either advice	9.6	34.4	8.8	3.2	1.6	42.4
Contaminants from fish can have a greater impact on children than on adults*						
Aware of specific sport-caught advice	25.7	45.2	9.2	4.2	1.7	14.0
Generally aware of sport-caught or purchased fish advice	14.6	56.0	9.9	2.8	1.6	15.1
Not aware of either advice	12.0	37.6	6.4	1.6	4.8	37.6
Eating contaminated fish over many years increases my health risks*						
Aware of specific sport-caught advice	29.9	45.5	10.6	3.8	0.9	9.3
Generally aware of sport-caught or purchased fish advice	21.4	57.7	9.8	1.8	0.7	8.5
Not aware of either advice	19.2	38.4	4.0	0.0	1.6	36.8
Any health problems from eating fish contaminated with chemicals are mainly short term*						
Aware of specific sport-caught advice	1.3	5.1	16.3	36.4	20.1	20.8
Generally aware of sport-caught or purchased fish advice	1.0	7.5	20.5	34.1	13.8	23.2
Not aware of either advice	0.8	3.2	14.4	22.4	8.0	51.2
Fish contaminated with chemicals will taste odd*						
Aware of specific sport-caught advice	2.9	7.7	19.4	36.0	13.7	20.3
Generally aware of sport-caught or purchased fish advice	1.0	9.4	17.4	35.3	11.5	25.4
Not aware of either advice	6.5	8.9	9.7	17.7	5.6	51.6
Smaller fish generally have more contaminants in them than larger fish*						
Aware of specific sport-caught advice	1.0	3.5	13.7	41.7	21.9	18.2
Generally aware of sport-caught or purchased fish advice	0.3	4.0	14.4	42.1	15.9	23.4
Not aware of either advice	2.4	0.8	11.4	22.8	10.6	52.0

*Statically significant difference between levels of awareness at $P \leq 0.05$ using chi-square test.

Sources of Information (Past and Future) and Important Topics for Future Communications

Two sources of information were considered very important by over half of anglers when deciding about eating fish: (1) posted warnings on waters that they fish and (2) the fishing regulations guide (Table 10). The importance of the posted warnings did not differ by state, but the fishing regulations guide was considered a very important source by more New York and Indiana anglers than those living in other states (Table 11). Healthcare providers were considered a very important source by one-third of anglers region-wide, but by a higher percentage in New York and Michigan. Web sites were a very important source for one-third of Illinois and Indiana anglers, but less so for anglers in other states. Other sources written in by a few respondents included outdoor magazines, social media, and personal contact with fisheries staff.

Anglers appear likely to report they expect to rely on the same sources of information in the coming year that they used in the past, with 40-50% checking posted warnings and the fishing regulations guide as likely future sources of information (Table 12). Fishing regulations guides were more likely to be used in the coming year by anglers in New York and Pennsylvania, as were websites (Table 13). Respondents living in Illinois were more likely to indicate use of information on iphone/Smartphone apps, but the percent checking this source was still very low.

Table 10. Importance of information sources to anglers in deciding about eating fish in the past (percent).

Sources of information	Not at all important	Somewhat important	Very important
Warnings posted on waters I fish	13.0	27.2	59.8
Fishing regulations guide	9.7	33.2	57.1
My healthcare providers	32.0	34.5	33.5
Friends or family	23.4	46.3	30.3
TV or radio reports	25.0	45.0	30.0
Charter boat operators or guides	40.9	31.9	27.2
Health advice brochures from government agencies	31.8	42.2	26.0
Newspaper articles	23.5	51.3	25.2
Web sites	36.5	39.4	24.1
Sportsman's or farm shows	45.2	37.5	17.3
iphone/Smartphone apps	76.8	17.0	6.2
Other information sources	67.4	15.0	17.6

Table 11. Importance of sources to anglers in deciding about eating fish in the past (percent), by state of residence.

Sources of information	State of Residence						
	IL	IN	MI	MN	NY	PA	WI
Warnings posted on waters I fish	Percent						
Not at all important	9.8	12.0	17.7	11.8	15.4	12.8	11.2
Somewhat important	29.5	20.0	25.4	27.8	22.4	24.4	34.6
Very important	60.7	68.0	56.9	60.4	62.2	62.8	54.2
Fishing regulations guide*							
Not at all important	8.6	12.1	10.6	9.2	6.4	8.1	12.3
Somewhat important	43.1	19.7	32.6	39.6	22.1	30.8	33.8
Very important	48.3	68.2	56.8	51.2	71.5	61.1	53.9
My healthcare providers*							
Not at all important	37.9	36.5	27.7	32.4	24.5	37.3	31.1
Somewhat important	29.1	28.9	33.3	39.3	29.1	30.2	41.3
Very important	33.0	34.6	39.0	28.3	46.4	32.5	27.6
Friends or family							
Not at all important	19.6	19.0	21.1	25.1	22.7	27.0	24.9
Somewhat important	42.9	44.7	48.1	50.5	46.7	44.3	43.5
Very important	37.5	36.3	30.8	24.4	30.6	28.7	31.6
TV or radio reports*							
Not at all important	23.4	21.8	26.2	24.1	20.5	28.7	27.4
Somewhat important	41.5	35.8	41.0	53.6	46.6	40.8	45.7
Very important	35.1	42.4	32.8	22.3	32.9	30.5	26.9
Charter boat operators or guides*							
Not at all important	41.5	35.7	39.8	43.5	31.3	38.8	47.6
Somewhat important	27.4	31.2	34.6	34.2	29.3	32.4	30.6
Very important	31.1	33.1	25.6	22.3	39.4	28.8	21.8
Health advice brochures from government agencies*							
Not at all important	30.2	30.4	30.3	33.5	25.5	35.1	33.8
Somewhat important	42.4	31.1	42.2	50.5	40.0	37.5	41.2
Very important	27.4	38.5	27.5	16.0	34.5	27.4	25.0
Newspaper articles							
Not at all important	24.8	27.4	23.7	24.5	15.9	24.9	23.7
Somewhat important	47.0	43.9	48.9	55.5	53.5	50.8	52.6
Very important	28.2	28.7	27.4	20.0	30.6	24.3	23.7
Web sites*							
Not at all important	30.6	34.0	37.4	37.8	30.3	37.9	41.7
Somewhat important	36.1	32.7	41.9	42.4	42.9	40.4	35.2
Very important	33.3	33.3	20.7	19.8	26.8	21.7	23.1
Sportsman's or farm shows*							
Not at all important	42.1	40.7	38.9	51.7	37.4	46.5	50.3
Somewhat important	36.3	35.7	39.8	37.0	38.9	34.5	39.0
Very important	21.6	23.6	21.3	11.3	23.7	19.0	10.7

Table 11 (cont).

Sources of information	State of Residence						
	IL	IN	MI	MN	NY	PA	WI
iphone or Smartphone apps	Percent						
Not at all important	70.1	75.0	73.5	79.3	74.8	81.9	78.2
Somewhat important	20.6	16.7	19.4	15.3	16.8	13.3	18.0
Very important	9.3	8.3	7.1	5.4	8.4	4.8	3.8

*Statically significant difference between states at $P \leq 0.05$ using chi-square test.

Table 12. Likelihood of using information source in deciding about eating fish in the next year (percent checking*).

Sources of information	Likely to use
Warnings posted on waters I fish	41.4
Fishing regulations guide	52.6
My healthcare providers	18.9
Friends or family	26.3
TV or radio reports	29.3
Charter boat operators or guides	12.2
Health advice brochures from government agencies	19.9
Newspaper articles	37.3
Web sites	28.7
Sportsman's or farm shows	13.8
iphone/Smartphone apps	6.6
Other information sources	2.9

*Percentages add to more than 100% because more than one source could be checked.

Anglers living in households with women under age 50 indicated certain sources of information, particularly healthcare providers, health advice brochures, and mass media, were less important than did other anglers (Table 14). They thought websites were more important and in the future they were more likely to seek information from websites, posted warnings, and the fishing regulations guide.

Non-white anglers were more likely than white anglers to identify the following sources as being very important: health care providers (57% vs. 33%), TV or radio (48% vs. 30%), websites (40% vs. 23%), and health advice brochures (40% vs. 25%). However, non-white anglers were not more likely than white anglers to indicate they expected to use these sources in the future. Posted warnings and the fishing regulations guides were still cited as the most likely sources to be accessed by all anglers in the coming year.

Anglers with the lowest levels of education were more likely to indicate most sources of information were very important to them compared with anglers with higher levels of education (Table 15). The only source of information positively associated with education was the use of

websites; those with higher education levels were more likely to indicate websites were very important to them, and they were more likely to expect to use them in the future.

Table 13. Likelihood of using information source in deciding about eating fish in the next year (percent checking*), by state of residence.

Sources of information	Illinois	Indiana	Michigan	Minnesota	New York	Pennsylvania	Wisconsin
Warnings posted on waters I fish**	34.7	45.9	33.6	43.1	37.8	46.5	47.0
Fishing regulations guide**	41.4	50.3	53.5	55.3	58.1	60.5	46.2
My healthcare providers	13.7	21.6	21.1	19.3	24.0	20.0	14.1
Friends or family	23.4	30.3	25.8	27.0	26.2	33.5	20.5
TV or radio reports	28.2	33.5	27.7	28.9	28.8	33.5	27.4
Charter boat operators or guides	8.1	14.1	12.1	10.0	15.0	17.5	10.7
Health advice brochures from government agencies**	9.7	24.3	22.7	19.9	25.1	20.0	17.9
Newspaper articles	29.8	36.2	39.1	35.7	42.7	40.5	36.3
Web sites**	30.6	29.7	26.2	27.7	32.2	36.5	22.6
Sportsman's or farm shows**	10.5	18.4	20.3	10.9	15.4	17.0	8.1
iphone/Smartphone apps**	11.3	5.4	5.5	7.4	8.2	7.5	2.6
Other information sources	2.4	2.7	3.5	2.6	3.4	3.0	3.0

*Percentages add to more than 100% because more than one source could be checked.

**Statically significant difference between states at $P \leq 0.05$ using chi-square test.

Respondents were asked how interested they were in receiving information about 12 topics that might help them make decisions about eating fish. Anglers appeared to have a similar level of interest in most of the topics listed in Table 16, with about one-third of respondents being interested, one-quarter being very interested and 15-20% being extremely interested. These topics cover the range of types of advice offered in most sport-caught fish advisories, from risks and benefits of fish consumption to where to fish and which species to eat. Interest in two topics differed somewhat from the others. Some anglers were not at all interested in the impacts of mothers' fish consumption on unborn or young children. The topic of least interest was how health risks from contaminants change as the amount of fish eaten changes. While there were statistically significant differences between states in the level of interest for all topics except interest in knowing about health benefits, none of the differences were particularly striking in magnitude (Table 17). Indiana and Michigan anglers seemed a bit more interested in most topics than anglers living in other states, but the differences were small. Non-white anglers were more likely to be very or extremely interested in the following topics than white anglers: health

problems that may occur in children (64% vs. 47%), health problems that may occur in children whose mothers eat contaminated fish (52% vs. 35%), and where to fish to reduce health risks (62% vs. 44%). There were no other socio-demographic differences, a surprising finding in light of the direct relevance to women of childbearing age of the health risk for children item.

Table 14. Importance of information sources (percent) and likely use of sources in the next year (percent checking*) by anglers living in households with women < 50 years old.

Sources of information	Importance in the past			Likely to use in next year
	Not at all important	Somewhat important	Very important	
Warnings posted on waters I fish	14.8	27.4	57.8	46.8**
Fishing regulations guide	10.5	32.3	57.2	58.9**
My healthcare providers	34.2**	37.7	28.1	20.0
Friends or family	22.9	46.0	31.1	31.5**
TV or radio reports	28.7**	44.8	26.5	30.4
Charter boat operators or guides	40.8**	35.4	23.8	12.8
Health advice brochures from government agencies	36.2**	43.1	20.7	18.1
Newspaper articles	28.4**	51.6	20.0	35.9
Web sites	31.4**	42.4	26.2	36.2**
Sportsman's or farm shows	49.1**	36.0	14.9	14.0
iphone/Smartphone apps	77.3	16.7	6.0	9.4**

*Percentages add to more than 100% because more than one source could be checked.

**Statistically significant difference between anglers living in households with women < 50 and other households at $P \leq 0.05$ using chi-square test.

Table 15. Importance of information sources (percent) and likely use of sources in the next year (percent checking*) by education level.

Sources of information	Importance in the past			Likely to use in next year
	Not at all important	Somewhat important	Very important	
Warnings posted on waters I fish				
<u>Education</u>				
HS diploma or less	11.2**	25.5	63.3	38.3
Some college	10.3	25.6	64.1	43.7
College or graduate degree	17.7	31.4	50.9	41.1
Fishing regulations guide				
<u>Education</u>				
HS diploma or less	8.2**	29.4	62.4	47.2**
Some college	8.1	33.0	58.9	53.5
College or graduate degree	12.7	35.3	52.0	55.9
My healthcare providers				
<u>Education</u>				
HS diploma or less	28.2**	32.1	39.7	17.9
Some college	28.5	34.1	37.4	20.4
College or graduate degree	38.2	38.2	23.6	18.4
Friends or family				
<u>Education</u>				
HS diploma or less	18.6**	44.2	37.2	24.7
Some college	22.4	48.8	28.8	25.9
College or graduate degree	28.4	45.1	26.5	27.7
TV or radio reports				
<u>Education</u>				
HS diploma or less	20.5**	38.6	40.9	28.6
Some college	24.5	44.8	30.7	29.3
College or graduate degree	28.8	50.5	20.7	29.3
Charterboat operators or guides				
<u>Education</u>				
HS diploma or less	36.9**	29.3	33.8	12.6
Some college	34.8	35.4	29.8	13.9
College or graduate degree	51.2	29.8	19.0	9.1
Health advice brochures from government agencies				
<u>Education</u>				
HS diploma or less	28.6**	35.5	35.9	20.1
Some college	30.4	42.9	26.7	20.1
College or graduate degree	35.5	46.7	17.8	19.4
Newspaper articles				
<u>Education</u>				
HS diploma or less	18.7**	48.9	32.4	36.6
Some college	25.0	50.0	25.0	35.9
College or graduate degree	25.2	53.7	21.1	39.2

Table 15 (cont).

Sources of information	<u>Importance in the past</u>			Likely to use in next year
	Not at all important	Somewhat important	Very important	
Websites				
<u>Education</u>				
HS diploma or less	43.5**	32.4	24.1	19.9**
Some college	32.3	41.7	26.0	31.5
College or graduate degree	35.9	41.6	22.5	32.5
Sportsman's or farm shows				
<u>Education</u>				
HS diploma or less	36.0**	40.8	23.2	15.7**
Some college	39.4	41.0	19.6	16.3
College or graduate degree	60.3	30.1	9.6	8.9
iphone/Smartphone apps				
<u>Education</u>				
HS diploma or less	75.9	15.2	8.9	5.6
Some college	75.9	17.7	6.4	6.9
College or graduate degree	78.9	16.8	4.3	7.6

*Percentages add to more than 100% because more than one source could be checked.

**Statistically significant difference between education levels at $P \leq 0.05$ using chi-square test.

Table 16. Interest in topics to help make decisions about eating fish (percent).

Topics	Not at all interested	Somewhat interested	Interested	Very interested	Extremely interested
Health problems that may occur in children who eat contaminated fish	12.3	12.1	27.8	26.6	21.2
Where to fish to reduce health risks of contaminants in fish	11.9	14.0	29.3	24.7	20.1
The contaminants in fish that cause advisories to be issued	9.9	14.2	31.0	26.4	18.5
Which sizes of fish to eat to reduce health risks	11.0	12.8	31.8	26.4	18.0
Health problems that may occur in adults who eat contaminated fish	9.4	12.7	31.8	28.6	17.5
Which species of fish to eat to reduce health risks	10.2	12.4	30.8	29.6	17.0
How government agencies decide which fish are safe to eat	14.0	17.4	28.9	23.7	16.0
Health benefits that may occur for people who eat fish	10.2	12.5	34.1	27.3	15.9
Health problems that may occur in children whose mothers eat contaminated fish, before or during pregnancy	20.8	17.3	26.0	20.3	15.6
How to cook fish to reduce health risks	11.9	14.6	29.8	28.5	15.2
How to clean fish to reduce health risks	14.5	14.9	29.8	26.6	14.2
How health risks from contaminants change as the amount of fish eaten changes	12.3	21.2	35.3	20.3	10.9

Table 17. Interest in topics to help make decisions about eating fish (percent), by state of residence.

Topics	State of Residence						
	IL	IN	MI	MN	NY	PA	WI
Health problems that may occur in children who eat contaminated fish*							
	Percent						
Not at all interested	10.7	13.0	9.7	14.3	10.3	12.1	14.3
Somewhat interested	13.9	13.0	10.1	15.3	9.9	11.6	10.4
Interested	33.5	21.2	19.8	32.1	28.5	28.1	28.3
Very interested	23.0	23.9	33.0	24.0	26.6	23.1	29.6
Extremely interested	18.9	28.9	27.4	14.3	24.7	25.1	17.4
Where to fish to reduce health risks of contaminants in fish*							
Not at all interested	8.2	12.4	11.3	13.4	9.5	11.0	4.8
Somewhat interested	9.8	9.7	13.0	18.2	8.0	13.5	18.3
Interested	36.1	23.3	25.1	32.2	30.0	28.5	27.7
Very interested	27.9	25.9	24.7	22.8	29.7	22.5	23.5
Extremely interested	18.0	28.7	25.9	13.4	22.8	24.5	15.7
The contaminants in fish that cause advisories to be issued*							
Not at all interested	9.0	12.1	9.6	10.7	6.5	6.5	13.4
Somewhat interested	11.5	12.6	11.6	16.9	9.9	15.0	17.7
Interested	32.0	25.8	27.2	37.0	30.5	31.0	28.6
Very interested	32.7	23.1	29.2	23.1	30.2	22.5	26.4
Extremely interested	14.8	26.4	22.4	12.3	22.9	25.0	13.9
Which sizes of fish to eat to reduce health risks*							
Not at all interested	8.9	12.4	8.8	12.6	8.0	11.5	13.4
Somewhat interested	8.9	12.4	12.0	15.2	9.5	13.0	14.7
Interested	35.0	25.2	26.7	37.2	32.3	30.5	31.2
Very interested	33.3	25.3	29.8	21.7	30.4	22.5	26.0
Extremely interested	13.8	24.7	22.7	13.3	19.8	22.5	14.7
Health problems that may occur in adults who eat contaminated fish*							
Not at all interested	8.1	12.4	8.8	11.4	7.3	7.1	9.9
Somewhat interested	12.2	10.8	10.4	16.3	6.9	14.1	13.8
Interested	38.2	26.5	26.4	34.5	32.7	26.8	35.3
Very interested	25.2	27.6	31.6	26.7	34.6	29.8	25.9
Extremely interested	16.3	22.7	22.8	11.1	18.5	22.2	15.1
Which species of fish to eat to reduce health risks*							
Not at all interested	8.1	9.7	8.4	13.5	6.8	9.0	12.0
Somewhat interested	11.3	7.5	12.4	13.5	6.8	12.5	16.7
Interested	32.3	25.8	24.8	34.6	35.1	29.0	32.2
Very interested	33.0	32.8	32.8	25.5	32.3	30.5	26.2
Extremely interested	15.3	24.2	21.6	12.9	19.0	19.0	12.9

Table 17 (cont).

Topics	State of Residence						
	IL	IN	MI	MN	NY	PA	WI
How government agencies decide which fish are safe to eat*							
	Percent						
Not at all interested	12.4	12.0	10.8	18.3	9.6	11.5	18.0
Somewhat interested	14.0	18.6	15.7	21.9	11.5	17.5	18.5
Interested	31.5	24.1	25.3	30.0	31.7	30.5	27.8
Very interested	28.9	20.2	28.1	20.3	28.0	21.5	21.5
Extremely interested	13.2	25.1	20.1	9.5	19.2	19.0	14.2
Health benefits that may occur for people who eat fish							
Not at all interested	9.8	13.0	8.4	12.7	7.3	9.0	10.8
Somewhat interested	12.3	9.2	10.8	14.0	8.8	13.6	15.1
Interested	36.1	28.4	30.4	36.8	39.2	30.7	34.8
Very interested	27.0	27.7	31.6	23.8	30.2	27.1	25.9
Extremely interested	14.8	21.7	18.8	12.7	14.5	19.6	13.4
Health problems that may occur in children whose mothers eat contaminated fish, before or during pregnancy*							
Not at all interested	23.6	19.1	14.1	23.9	16.9	23.6	22.4
Somewhat interested	11.4	19.7	16.5	19.0	14.9	19.1	18.4
Interested	36.6	20.8	22.6	28.3	28.0	22.1	23.7
Very interested	19.5	19.1	24.6	18.0	20.3	16.6	23.2
Extremely interested	8.9	21.3	22.2	10.8	19.9	18.6	12.3
How to cook fish to reduce health risks*							
Not at all interested	11.4	10.9	9.6	12.0	12.2	10.5	15.7
Somewhat interested	14.6	8.2	16.1	16.5	8.4	12.0	19.2
Interested	30.1	29.3	24.5	31.0	34.4	32.5	28.4
Very interested	30.1	33.1	28.5	28.8	29.0	27.5	25.8
Extremely interested	13.8	18.5	21.3	11.7	16.0	17.5	10.9
How to clean fish to reduce health risks*							
Not at all interested	13.6	12.5	10.8	16.2	14.5	16.5	15.7
Somewhat interested	16.0	13.0	14.4	16.2	8.8	14.5	18.3
Interested	28.8	27.2	27.2	33.0	34.3	27.5	28.6
Very interested	31.2	28.3	28.0	25.2	27.9	23.0	25.7
Extremely interested	10.4	19.0	19.6	9.4	14.5	18.5	11.7
How health risks from contaminants change as the amount of fish eaten changes*							
Not at all interested	11.7	12.2	12.9	13.4	7.6	11.6	14.2
Somewhat interested	21.7	19.3	19.4	23.5	15.2	20.1	25.3
Interested	34.1	28.7	34.2	39.7	37.7	31.6	35.1
Very interested	28.3	23.2	19.0	16.9	26.2	21.6	15.5
Extremely interested	4.2	16.6	14.5	6.5	13.3	15.1	9.9

*Statically significant difference between states at $P \leq 0.05$ using chi-square test.

Fishing Activity and Fish Consumption

Fishing Activity

Most anglers who bought a license fished somewhere in the state where they lived in the past year (Table 18). (Non-respondents to the survey were less likely to fish and if they did, they fished fewer days on average than respondents.) Few anglers fished in other states in the Great Lakes region; the exception was residents of Illinois and Indiana, where one-quarter to one-third had fished in other Great Lakes states. Illinois residents fished primarily in nearby states of Wisconsin (18%) and Michigan (11%), while Indiana residents fished primarily in Michigan (15%) and Ohio (8%). About one-quarter of all respondents fished Great Lakes waters, but this proportion was notably higher for Michigan and New York anglers. The average licensed angler fished about 25 days in the past year. The average was slightly lower among Minnesota anglers and slightly greater among Indiana anglers. Michigan anglers spent more days on average fishing Great Lakes waters than anglers in other states. Indiana anglers fished more on lakes and ponds than did anglers in most other states. Rivers and streams were more often accessed by Pennsylvania anglers than those living in other states. Fishing activity did not differ by residence area (i.e., urban, suburban, rural) in this study.

Table 18. Fishing participation between September 1, 2010 and August 31, 2011, overall and by state of residence.

	Fishing Home State	Fishing other Great Lake State(s)	Fishing Great Lakes Waters	Of those who fished:			
				Total	Great Lakes waters	Non-Great Lakes Rivers or Streams	Other Lakes or Ponds
	Percent			Mean days fished			
Overall	88.6	12.6	28.8	25.5	3.4	8.5	13.7
State of Residence							
Illinois	86.3*	31.3*	19.5*	23.7 ^{a,b}	1.7 ^b	5.5 ^b	16.5 ^{a,b}
Indiana	90.8	25.6	17.5	32.8 ^a	1.4 ^b	10.2 ^{a,b}	21.5 ^a
Michigan	91.5	5.0	56.5	30.4 ^{a,b}	9.8 ^a	7.5 ^{a,b}	13.2 ^b
Minnesota	88.9	10.4	10.7	18.7 ^b	0.7 ^b	5.2 ^b	12.9 ^b
New York	81.1	4.3	40.4	25.9 ^{a,b}	4.8 ^b	10.0 ^{a,b}	11.2 ^b
Pennsylvania	87.4	11.7	24.1	25.4 ^{a,b}	2.0 ^b	13.8 ^a	9.7 ^b
Wisconsin	91.8	12.7	29.5	28.4 ^{a,b}	2.7 ^b	10.9 ^{a,b}	15.0 ^{a,b}

*Statically significant difference between states at $P \leq 0.05$ using chi-square test.

^{a, b} Values without a letter in common are significantly different between states at $P = 0.05$ using Scheffe's test.

Fish Consumption by Anglers

Anglers reported eating on average 20 meals of fish in the past year, with three-quarters being purchased fish and the remainder sport-caught (Table 19). Anglers living in New York reported greater consumption overall, particularly of purchased fish, whereas Indiana and Minnesota anglers consumed less. Anglers with college or graduate degrees ate more purchased fish meals on average compared to those with less education (19 meals vs. 12-14 meals). Anglers living in

suburban areas ate more purchased fish meals compared to those living in urban areas (17 meals vs. 12 meals), with rural anglers being intermediary (14 meals).

Consumption of both sport-caught and purchased fish appeared greater in the summer months, particularly in Michigan and Minnesota. Anglers living in rural areas were more likely to eat both sport-caught and purchased fish in the summer months than anglers living in suburban or urban areas (2.5 sport-caught meals vs. 1.7-1.9 meals, 9.9 purchased meals vs. 6.9 meals).

Table 19. The average number of sport-caught, purchased and total fish meals consumed by anglers, overall and by state of residence.

	# fish meals eaten in past 12 months	# sport-caught fish meals eaten in past 12 months	# purchased fish meals eaten in past 12 months	# sport-caught fish meals eaten in summer	# purchased fish meals eaten in summer
Overall	20.5	5.9	15.1	3.7	8.2
State of Residence					
Illinois	24.0 ^{a,b}	5.9	18.7 ^{a,b}	2.9 ^{a,b}	6.0 ^{a,b,c}
Indiana	16.5 ^b	5.3	11.6 ^b	3.9 ^{a,b}	8.5 ^{a,b,c}
Michigan	17.4 ^{a,b}	5.3	13.2 ^{a,b}	5.0 ^a	10.2 ^a
Minnesota	16.1 ^b	5.1	11.2 ^b	4.5 ^a	9.8 ^{a,b}
New York	27.8 ^a	7.3	20.7 ^a	2.1 ^b	5.5 ^{b,c}
Pennsylvania	22.5 ^{a,b}	5.8	17.2 ^{a,b}	2.1 ^b	5.2 ^c
Wisconsin	22.0 ^{a,b}	7.0	15.4 ^{a,b}	4.0 ^{a,b}	9.6 ^{a,b,c}

^{a, b, c} Values without a letter in common are significantly different between states at P = 0.05 using Scheffe's test.

Fish consumption can also be examined based on categorization of the number of meals consumed, which mirror fish consumption advice issued by different state agencies and other organizations. Table 20 breaks down the number of meals eaten into commonly used categories – none, one meal a month or less (1-12 meals), more than one meal a month but not more than one per week (13-52 meals), and more than one meal per week (>52 meals). One-quarter of anglers had not eaten any fish meals in the past year (sport-caught or purchased). A little more than one-quarter had eaten one meal a month or less. Just over one-third estimated they ate between one meal a month and one meal a week. Ten percent of anglers indicated they ate more than one meal per week. Consumption varied by state, with Minnesota anglers least likely to consume fish.

Some states recommend that anglers do not consume more than 52 sport-caught fish meals per year. Very few anglers (<1%) reported consuming sport-caught fish above that recommendation (Table 20). The majority of anglers consumed 1 to 12 meals of sport-caught fish per year. One-third did not eat any sport-caught fish. However, virtually all anglers who ate sport-caught fish (>99%) also ate at least one meal of purchased fish.

Table 20. The number of sport-caught, purchased, and total fish meals consumed in the past 12 months (percent), overall and by state of residence.

	State of Residence							
	Overall	IL	IN	MI	MN	NY	PA	WI
# of fish meals eaten in past 12 months*	Percent							
None	24.2	26.4	24.9	24.1	29.1	21.6	24.3	18.5
1-12 meals	29.1	18.6	29.6	36.2	34.0	21.6	23.8	31.5
13-52 meals	37.2	42.6	39.2	32.7	30.0	42.8	39.3	40.8
>52 meals	9.5	12.4	6.3	7.0	6.9	14.0	12.6	9.2
# of sport-caught fish meals eaten in past 12 months**								
None	32.2	31.0	34.6	32.3	38.0	29.7	31.2	27.3
1-12 meals	56.6	58.9	59.0	58.2	53.1	54.7	52.7	60.5
13-52 meals	10.8	10.1	5.9	9.1	8.2	14.8	16.1	11.8
>52 meals	0.4	0.0	0.5	0.4	0.7	0.8	0.0	0.4
# purchased fish meals eaten in past 12 months*								
None	25.1	27.2	26.2	27.0	29.7	21.8	24.5	19.0
1-12 meals	40.5	33.6	42.6	42.2	46.0	34.0	33.0	44.8
13-52 meals	29.9	32.8	30.1	27.0	22.0	38.1	36.0	30.6
>52 meals	4.5	6.4	1.1	3.8	2.3	6.1	6.5	5.6

*Statically significant difference between states at $P \leq 0.05$ using chi-square test.

**Chi-square statistic could not be calculated because too many cells had an expected frequency of <5.

Fish consumption also was examined by species for some of the most commonly caught and purchased species (Table 21). The most commonly consumed type of fish from the list provided to respondents was canned tuna, with respondents eating an average of eight meals per year. About one-quarter of respondents indicated that they did not eat any canned tuna, so among those who did eat it, the average was almost one meal per month. Salmon purchased at a store or restaurant was eaten by over half of the respondents, with most of them eating one meal per month or less. Information on swordfish consumption was sought because many organizations recommend that people not consume this species, especially women of childbearing age. Among respondents, very few (10%) had eaten swordfish in the past year. Of those who did, half ate only one meal, with the others generally eating less than one meal per month.

Walleye and bluegill/sunfish were the most commonly eaten sport-caught fish among anglers living in the Great Lakes region (Table 21). About half of the respondents ate these fish. They typically ate 5-7 meals per year. Bass, crappie, and yellow perch were eaten by about one-third of anglers; they consumed in the 4-5 meals per year range. Fewer anglers ate the other species we asked about, but the average number of meals consumed by those who did was similar to the more popular species for bullhead, catfish, salmon, trout, and whitefish.

Table 21. Angler fish consumption over the past 12 months by species.

	All respondents	Among those who ate at least	None	1 meal	2-12 meals	13-52 meals	>52 meals
		1 meal of species					
Purchased Fish	Mean # meals		Percent				
Canned Tuna	8.1	11.3	28.0	3.8	51.1	15.9	1.2
Salmon	4.4	8.2	46.1	7.5	38.0	8.0	0.4
Swordfish	0.3	2.7	90.4	5.0	4.5	0.1	0.0
Sport-caught in Great Lakes States							
Bass	1.1	3.9	71.4	9.2	17.9	1.5	0.0
Bluegill/sunfish	3.0	6.9	56.3	6.9	31.6	5.0	0.2
Bullhead	0.2	5.4	96.0	1.4	2.4	0.2	0.0
Carp	0.1	3.3	97.7	0.8	1.5	0.0	0.0
Catfish	0.6	3.9	84.0	5.6	9.9	0.5	0.0
Crappie	1.5	4.7	67.2	8.6	21.9	2.2	0.1
Lake Trout	0.4	3.7	88.7	4.0	6.8	0.5	0.0
Northern Pike	0.7	3.2	79.1	7.3	12.9	0.7	0.0
Salmon	0.8	4.4	82.2	4.7	12.4	0.7	0.0
Suckers	0.1	3.0	98.5	0.4	1.1	0.0	0.0
Trout (brook, brown, rainbow)	0.8	4.7	82.5	4.5	12.1	0.8	0.1
Walleye	2.5	5.4	54.2	9.3	32.8	3.6	0.1
Whitefish	0.4	5.3	93.0	2.4	4.2	0.3	0.1
Yellow Perch	1.5	5.3	71.6	6.6	19.7	2.0	0.1

Consumption of different species varied by state. This was likely due to the availability of both purchased and sport-caught fish and perhaps due to advice regarding specific species in the state advisories. Tables 22 to 28 show consumption by species for each state. While these tables contain a great deal of detail specific to states, below are some notable differences between states:

- Illinois anglers were more likely to eat sport-caught catfish and crappie than anglers in most other states. Among those who ate canned tuna, Illinois anglers ate more meals on average than anglers in other states.
- Indiana anglers were more likely to eat sport-caught catfish and crappie than anglers in most other states. Among those who ate crappie, Indiana anglers ate more meals on average than did anglers in other states. Among those who ate purchased salmon, Indiana anglers ate fewer meals on average than did anglers in other states.
- Michigan anglers were more likely to eat lake trout, northern pike, sport-caught salmon, whitefish, and yellow perch than were anglers in other states.

- Minnesota anglers were more likely to eat crappie and northern pike than anglers in most other states. Among those who ate canned tuna, Minnesota anglers ate fewer meals on average than did anglers in other states.
- New York anglers were more likely to eat canned tuna, and less likely to eat purchased salmon or bluegill/sunfish than anglers in other states. However among those who ate purchased salmon, New Yorker anglers ate more meals on average compared to anglers in other states.
- Pennsylvania anglers were more likely to eat purchased salmon and sport-caught trout, but less likely to eat bluegill/sunfish than anglers in other states. Among those who ate crappie, Pennsylvania anglers ate fewer meals on average compared to anglers in other states.
- Wisconsin anglers were more likely to eat crappie, northern pike, sport-caught salmon, and yellow perch, but less likely to eat canned tuna compared to anglers in other states.

Table 22. Illinois angler fish consumption over the past 12 months by species.

	All respondents	Among those who ate at least	None	1 meal	2-12 meals	13-52 meals	>52 meals
		1 meal of species					
	Mean # meals		Percent				
Purchased Fish							
Canned Tuna	10.5	15.4	31.9	2.7	44.2	15.0	6.2
Salmon	5.4	10.4	47.8	6.2	33.6	11.5	0.9
Swordfish	0.3	NA	87.7	7.0	5.3	0.0	0.0
Sport-caught in Great Lakes States							
Bass	0.9	2.8	68.2	15.0	16.8	0.0	0.0
Bluegill/sunfish	2.3	5.5	58.5	8.8	29.2	3.5	0.0
Bullhead	0.2	NA	96.5	0.9	2.6	0.0	0.0
Carp	0.3	NA	92.1	3.5	4.4	0.0	0.0
Catfish	1.7	4.6	63.7	10.6	23.9	1.8	0.0
Crappie	2.2	6.2	64.0	11.4	20.2	4.4	0.0
Lake Trout	<0.1	NA	97.3	0.9	1.8	0.0	0.0
Northern Pike	0.2	NA	90.3	4.4	5.3	0.0	0.0
Salmon	0.5	NA	89.5	2.6	7.9	0.0	0.0
Suckers	<0.1	NA	99.1	0.0	0.9	0.0	0.0
Trout (brook, brown, rainbow)	0.1	NA	94.7	4.4	0.9	0.0	0.0
Walleye	0.9	3.3	71.9	7.9	20.2	0.0	0.0
Whitefish	0.2	NA	94.7	1.8	3.5	0.0	0.0
Yellow Perch	0.3	NA	91.2	3.5	5.3	0.0	0.0

NA = not available due to small sample size.

Table 23. Indiana angler fish consumption over the past 12 months by species.

	All respondents	Among those who ate at least	None	1 meal	2-12 meals	13-52 meals	>52 meals
		1 meal of species					
Purchased Fish	Mean # meals		Percent				
Canned Tuna	7.6	10.4	26.9	1.8	55.7	14.4	1.2
Salmon	3.3	5.7	41.3	7.2	45.5	6.0	0.0
Swordfish	0.1	NA	92.2	4.8	3.0	0.0	0.0
Sport-caught in Great Lakes States							
Bass	1.8	4.8	62.2	12.2	22.6	3.0	0.0
Bluegill/sunfish	5.1	8.6	40.9	7.9	41.5	9.1	0.6
Bullhead	0.1	NA	97.6	1.2	0.6	0.6	0.0
Carp	0.2	NA	95.8	0.0	4.2	0.0	0.0
Catfish	2.1	5.8	64.1	8.4	25.1	1.8	0.6
Crappie	3.2	8.3	60.5	6.6	25.7	6.6	0.6
Lake Trout	0.1	NA	96.4	0.0	3.6	0.0	0.0
Northern Pike	0.3	NA	92.2	4.2	2.4	1.2	0.0
Salmon	0.7	NA	88.1	3.6	7.7	0.6	0.0
Suckers	<0.1	NA	99.4	0.6	0.0	0.0	0.0
Trout (brook, brown, rainbow)	0.2	NA	94.6	1.2	4.2	0.0	0.0
Walleye	1.6	6.4	75.6	8.9	14.3	0.6	0.6
Whitefish	0.3	NA	94.0	3.6	1.8	0.6	0.0
Yellow Perch	0.6	NA	83.2	3.0	13.2	0.6	0.0

NA = not available due to small sample size.

Table 24. Michigan angler fish consumption over the past 12 months by species.

	All respondents	Among those who ate at least 1 meal of species	None	1 meal	2-12 meals	13-52 meals	>52 meals
Purchased Fish							
Canned Tuna	7.9	11.1	28.6	3.9	51.1	16.0	0.4
Salmon	3.9	7.1	45.0	7.4	42.0	5.6	0.0
Swordfish	0.2	NA	91.8	3.9	4.3	0.0	0.0
Sport-caught in Great Lakes States							
Bass	1.3	4.2	68.5	6.5	22.8	2.2	0.0
Bluegill/sunfish	4.2	8.3	49.3	4.3	37.7	8.7	0.0
Bullhead	0.1	NA	97.0	1.3	1.7	0.0	0.0
Carp	<0.1	NA	98.3	1.3	0.4	0.0	0.0
Catfish	0.4	2.7	86.6	5.2	7.8	0.4	0.0
Crappie	0.7	3.3	79.2	4.3	16.5	0.0	0.0
Lake Trout	0.8	3.7	77.1	8.2	13.4	1.3	0.0
Northern Pike	0.5	2.3	79.7	8.2	11.7	0.4	0.0
Salmon	1.8	5.2	66.3	6.9	25.1	1.7	0.0
Suckers	0.1	NA	96.1	0.4	3.5	0.0	0.0
Trout (brook, brown, rainbow)	0.9	4.6	79.6	3.9	15.2	1.3	0.0
Walleye	3.0	6.0	49.8	9.5	34.2	6.5	0.0
Whitefish	1.4	6.1	77.6	6.9	13.8	1.3	0.4
Yellow Perch	3.5	7.3	51.4	9.1	34.3	4.8	0.4

NA = not available due to small sample size.

Table 25. Minnesota angler fish consumption over the past 12 months by species.

	All respondents	Among those who ate at least	None	1 meal	2-12 meals	13-52 meals	>52 meals
		1 meal of species					
Purchased Fish	Mean # meals		Percent				
Canned Tuna	6.0	8.3	27.1	5.2	56.7	11.0	0.0
Salmon	4.1	7.8	46.8	7.2	38.2	7.8	0.0
Swordfish	0.2	NA	92.1	4.5	3.4	0.0	0.0
Sport-caught in Great Lakes States							
Bass	1.1	3.9	72.8	9.0	17.2	1.0	0.0
Bluegill/sunfish	3.5	7.2	51.2	7.5	35.8	4.8	0.7
Bullhead	0.2	NA	96.6	1.0	1.7	0.7	0.0
Carp	<0.1	NA	99.3	0.0	0.7	0.0	0.0
Catfish	0.2	NA	92.8	3.4	3.8	0.0	0.0
Crappie	1.9	4.1	54.6	11.3	31.4	2.7	0.0
Lake Trout	0.3	NA	90.5	4.1	5.1	0.3	0.0
Northern Pike	1.4	3.6	61.6	12.0	25.0	1.4	0.0
Salmon	0.6	5.3	89.1	1.7	8.5	0.7	0.0
Suckers	<0.1	NA	99.0	0.7	0.3	0.0	0.0
Trout (brook, brown, rainbow)	0.2	NA	92.1	3.1	4.8	0.0	0.0
Walleye	4.6	6.1	25.0	13.0	54.9	6.8	0.3
Whitefish	0.1	NA	96.9	1.4	1.7	0.0	0.0
Yellow Perch	0.9	4.3	79.5	6.5	12.6	1.4	0.0

NA = not available due to small sample size.

Table 26. New York angler fish consumption over the past 12 months by species.

	All respondents	Among those who ate at least 1 meal of species	None	1 meal	2-12 meals	13-52 meals	>52 meals
		Mean # meals					
Purchased Fish							
Canned Tuna	11.1	13.2	16.1	2.7	52.2	28.6	0.4
Salmon	5.8	12.2	52.4	5.7	29.7	10.9	1.3
Swordfish	0.8	4.4	82.2	6.1	11.3	0.4	0.0
Sport-caught in Great Lakes States							
Bass	1.1	4.3	74.0	9.5	14.3	2.2	0.0
Bluegill/sunfish	0.6	3.9	84.0	5.2	9.1	1.7	0.0
Bullhead	0.7	NA	91.8	2.2	5.6	0.0	0.4
Carp	0.1	NA	97.9	0.4	1.7	0.0	0.0
Catfish	0.1	NA	95.3	3.4	1.3	0.0	0.0
Crappie	0.9	7.0	87.1	1.7	9.9	0.9	0.4
Lake Trout	0.4	NA	88.4	4.7	6.0	0.9	0.0
Northern Pike	0.2	NA	91.4	3.0	5.6	0.0	0.0
Salmon	0.4	NA	88.8	5.2	5.6	0.4	0.0
Suckers	<0.1	NA	98.7	0.0	1.3	0.0	0.0
Trout (brook, brown, rainbow)	1.1	5.2	78.1	6.0	14.2	1.7	0.0
Walleye	0.9	5.3	83.2	4.3	10.3	2.2	0.0
Whitefish	0.1	NA	97.4	0.9	1.7	0.0	0.0
Yellow Perch	1.9	6.7	71.1	5.6	19.0	3.9	0.4

NA = not available due to small sample size.

Table 27. Pennsylvania angler fish consumption over the past 12 months by species.

	All respondents	Among those who ate at least	None	1 meal	2-12 meals	13-52 meals	>52 meals
		1 meal of species					
Purchased Fish	Mean # meals		Percent				
Canned Tuna	9.7	12.9	25.0	4.7	46.4	22.7	1.2
Salmon	4.9	7.8	38.2	11.0	41.0	9.2	0.6
Swordfish	0.3	NA	88.5	5.7	5.2	0.6	0.0
Sport-caught in Great Lakes States							
Bass	0.9	4.3	78.8	6.9	12.6	1.7	0.0
Bluegill/sunfish	0.7	NA	83.7	4.1	11.6	0.6	0.0
Bullhead	0.2	NA	96.6	1.1	2.3	0.0	0.0
Carp	<0.1	NA	98.3	0.0	1.7	0.0	0.0
Catfish	0.5	NA	84.4	4.0	11.0	0.6	0.0
Crappie	0.5	2.4	79.9	8.0	12.1	0.0	0.0
Lake Trout	0.4	NA	90.2	1.7	7.5	0.6	0.0
Northern Pike	<0.1	NA	98.3	1.1	0.6	0.0	0.0
Salmon	0.3	NA	89.1	4.0	6.9	0.0	0.0
Suckers	<0.1	NA	100.0	0.0	0.0	0.0	0.0
Trout (brook, brown, rainbow)	2.7	6.5	58.3	3.5	35.3	2.3	0.6
Walleye	0.9	4.0	77.0	5.2	17.2	0.6	0.0
Whitefish	0.1	NA	98.8	0.6	0.6	0.0	0.0
Yellow Perch	0.8	3.9	79.7	5.2	13.9	1.2	0.0

NA = not available due to small sample size.

Table 28. Wisconsin angler fish consumption over the past 12 months by species.

	All respondents	Among those who ate at least	None	1 meal	2-12 meals	13-52 meals	>52 meals
		1 meal of species					
Purchased Fish	Mean # meals		Percent				
Canned Tuna	7.1	11.0	35.9	3.2	48.9	11.1	0.9
Salmon	3.9	7.7	49.6	7.3	36.2	6.4	0.5
Swordfish	0.1	NA	93.6	4.6	1.8	0.0	0.0
Sport-caught in Great Lakes States							
Bass	1.1	3.7	70.8	9.1	18.7	1.4	0.0
Bluegill/sunfish	3.9	6.3	37.4	10.0	46.2	6.4	0.0
Bullhead	0.2	NA	95.5	1.8	2.7	0.0	0.0
Carp	<0.1	NA	98.6	0.9	0.5	0.0	0.0
Catfish	0.6	3.3	82.7	7.3	10.0	0.0	0.0
Crappie	2.0	4.6	55.7	12.8	28.8	2.7	0.0
Lake Trout	0.6	NA	88.1	4.6	6.8	0.5	0.0
Northern Pike	1.1	3.4	68.0	10.5	20.1	1.4	0.0
Salmon	1.0	3.6	72.6	8.2	18.3	0.9	0.0
Suckers	0.1	NA	97.7	0.9	1.4	0.0	0.0
Trout (brook, brown, rainbow)	0.6	3.0	81.3	8.2	10.0	0.5	0.0
Walleye	2.7	4.7	42.5	11.4	42.9	3.2	0.0
Whitefish	0.3	NA	93.6	1.8	4.1	0.5	0.0
Yellow Perch	1.8	4.3	58.9	9.1	30.6	1.4	0.0

NA = not available due to small sample size.

Fish Consumption by Women of Childbearing Age and Children

Table 29 compares the consumption of anglers divided into two groups (men/older women and women of childbearing age), because advisories provide somewhat different fish consumption advice for each group. Female anglers under age 50 were more likely than men/older women to consume fish, especially purchased fish. Over 80% ate some purchased fish. The current federal guidelines suggest that women of childbearing age “Eat up to 12 ounces (2 average meals) a week of a variety of fish and shellfish that are lower in mercury” (<http://www.fda.gov/Food/FoodSafety/Product-SpecificInformation/Seafood/FoodbornePathogensContaminants/Methylmercury/ucm115662.htm>). Very few women appeared to approach the maximum amount suggested in the guidelines.

Consumption by species group did not generally differ between the two groups of anglers (Table 29). For a few types of fish (canned tuna, bluegill/sunfish, northern pike, and walleye), women under age 50 were more likely than men and older women to indicate that they consumed the species, but the number of meals eaten by women under age 50 was generally lower. Swordfish

is generally not recommended for consumption by women under 50. About 8% of respondents in this group consumed at least one swordfish meal in the past year.

Table 29. Fish consumption of anglers who were men or older women compared with women < 50 years old (percent), by type of fish consumed.

	None	1-12 meals	13-52 meals	>52 meals	
All Sport-caught fish meals					
Men and older women	33.0	55.4	11.3	0.3	
Women < 50	28.2	61.8	9.6	0.6	
All Purchased fish meals*					
Men and older women	26.2	38.8	30.1	4.9	
Women < 50	17.8	53.2	25.7	3.3	
	None	1 meal	1-12 meals	13-52 meals	>52 meals
<u>Purchased Fish</u>					
Canned Tuna*					
Men and older women	28.7	2.9	51.0	16.4	1.0
Women < 50	20.4	12.0	54.9	10.6	2.1
Salmon					
Men and older women	45.8	7.4	38.3	8.2	0.3
Women < 50	50.0	9.9	33.8	5.6	0.7
Swordfish					
Men and older women	89.9	5.0	4.9	0.2	0.0
Women < 50	91.5	7.1	1.4	0.0	0.0
<u>Sport-caught in Great Lakes States</u>					
Bass					
Men and older women	71.2	9.0	18.5	1.3	0.0
Women < 50	71.4	10.7	15.0	2.9	0.0
Bluegill/sunfish*					
Men and older women	57.0	6.3	31.4	5.0	0.3
Women < 50	48.6	13.4	33.8	4.2	0.0
Bullhead					
Men and older women	96.0	1.5	2.2	0.2	0.1
Women < 50	94.4	1.4	4.2	0.0	0.0
Carp					
Men and older women	97.4	0.9	1.7	0.0	0.0
Women < 50	99.3	0.0	0.7	0.0	0.0
Catfish					
Men and older women	83.9	5.6	10.0	0.4	0.1
Women < 50	81.0	8.5	10.5	0.0	0.0
Crappie					
Men and older women	67.6	8.7	21.6	2.0	0.1
Women < 50	67.6	10.6	19.0	2.8	0.0
Lake Trout					
Men and older women	89.2	3.7	6.5	0.6	0.0
Women < 50	87.2	5.7	7.1	0.0	0.0
Northern Pike*					
Men and older women	79.0	6.8	13.5	0.7	0.0
Women < 50	78.0	12.8	7.8	1.4	0.0

Table 29 (cont).

	None	1 meal	1-12 meals	13-52 meals	>52 meals
Salmon					
Men and older women	82.1	4.7	12.5	0.7	0.0
Women < 50	85.3	4.2	10.5	0.0	0.0
Suckers					
Men and older women	98.6	0.4	1.0	0.0	0.0
Women < 50	97.2	0.7	2.1	0.0	0.0
Trout (brook, brown, rainbow)					
Men and older women	82.3	4.4	12.5	0.8	0.1
Women < 50	85.9	3.5	9.9	0.7	0.0
Walleye*					
Men and older women	54.7	8.6	32.9	3.7	0.1
Women < 50	47.2	19.0	31.0	2.8	0.0
Whitefish					
Men and older women	92.8	2.4	4.3	0.4	0.1
Women < 50	94.4	2.8	2.8	0.0	0.0
Yellow Perch					
Men and older women	71.1	6.7	19.8	2.2	0.2
Women < 50	76.8	7.0	16.2	0.0	0.0

*Statically significant difference between men/older women and women < 50 at $P \leq 0.05$ using chi-square test.

Women aged 15 to 49 living in the household with the responding angler appeared to eat approximately the same number of sport-caught fish meals as the angler (5.1 vs. 5.9 meals). These women did appear to consume more purchased fish meals than men or older women (Table 30 vs. 29), mirroring the trend among anglers reported in Table 29. In other words, both groups of women under age 50 that were examined appeared to be eating more purchased fish meals than male anglers or female anglers 50 or older. Consumption of sport-caught fish by women living in households with anglers varied by state (Table 30). Most notably, women living in New York were less likely to consume sport-caught fish, and women in Wisconsin were more likely to consume at least 1 to 12 meals per year than women in other states. No statistical differences were found for consumption of purchased fish by state of residence, but New York women consumed the highest average number of meals compared to women in other states.

Children living in households with anglers consumed similar numbers of sport-caught fish meals as women under age 50 also living in those households (4.8 vs. 5.1 meals). However differences by state showed that the majority of children living in New York did not consume any sport-caught fish, whereas in Minnesota over 80% of these children ate at least one meal in the past year (Table 31). Children ate fewer purchased fish meals than women under age 50 living in the household or responding anglers (mean 8.9 vs. 11.3 and 15.1 meals). Children living in Pennsylvania ate more meals on average than children in Illinois, Michigan, or Minnesota.

Table 30. Sport-caught and purchased fish consumption of women living in the household aged 15-49, overall and by state of residence.

	Mean # meals	None	1-12 meals	13-52 meals	>52 meals
		Percent			
Sport-caught fish consumption in past 12 months					
<i>Overall</i>	5.1	33.8	55.6	10.6	0.0
<u>State of Residence*</u>					
Illinois	3.9	38.5	57.7	3.8	0.0
Indiana	5.0	40.7	47.7	11.6	0.0
Michigan	5.6	35.2	50.7	14.1	0.0
Minnesota	5.4	24.6	64.0	11.4	0.0
New York	3.6	54.4	35.6	10.0	0.0
Pennsylvania	5.6	38.1	51.2	10.7	0.0
Wisconsin	5.7	19.7	69.0	11.3	0.0
Purchased fish consumption in past 12 months					
<i>Overall</i>	11.3	21.0	50.4	26.5	2.1
<u>State of Residence</u>					
Illinois	10.6	19.2	53.9	25.0	1.9
Indiana	9.5	26.2	50.0	22.6	1.2
Michigan	12.5	24.6	43.5	29.0	2.9
Minnesota	10.4	22.3	53.6	22.3	1.8
New York	15.0	25.6	33.3	37.8	3.3
Pennsylvania	12.1	20.9	47.7	29.1	2.3
Wisconsin	10.0	11.1	63.9	23.6	1.4

*Statically significant difference between states at $P \leq 0.05$ using chi-square test.

Table 31. Sport-caught and purchased fish consumption of children living in the household aged 0-14, overall and by state of residence.

Sport-caught fish consumption in past 12 months	Mean # meals	None	1-12 meals	13-52 meals	>52 meals
		Percent			
<i>Overall</i>	4.8	35.4	55.9	8.7	0.0
<u>State of Residence*</u>					
Illinois	3.7	38.3	61.7	0.0	0.0
Indiana	5.0	40.0	49.3	10.7	0.0
Michigan	5.7	38.5	48.7	12.8	0.0
Minnesota	6.0	18.3	71.8	9.9	0.0
New York	2.1	61.0	36.4	2.6	0.0
Pennsylvania	3.9	46.1	43.6	10.3	0.0
Wisconsin	4.8	31.7	58.2	10.1	0.0
Purchased fish consumption in past 12 months					
<i>Overall</i>	8.9	26.8	53.4	18.3	1.5
<u>State of Residence</u>					
Illinois	6.1 ^b	28.6	65.3	6.1	0.0
Indiana	8.0 ^{a,b}	27.0	54.1	18.9	0.0
Michigan	7.6 ^b	28.6	55.8	15.6	0.0
Minnesota	6.0 ^b	32.8	51.6	15.6	0.0
New York	11.5 ^{a,b}	22.7	52.0	24.0	1.3
Pennsylvania	15.4 ^a	23.8	36.2	35.0	5.0
Wisconsin	9.2 ^{a,b}	19.5	62.4	14.3	3.9

*Statically significant difference between states at $P \leq 0.05$ using chi-square test.

^{a,b}Values without a letter in common are significantly different between states at $P = 0.05$ using Scheffe's test.

Fish Preparation and Cooking Techniques

Most states recommend certain fish cleaning and cooking techniques to reduce exposure to contaminants in sport-caught fish. Many of these techniques were being used by anglers and their households when they prepared and cooked fish meals (Table 32). For cleaning techniques, two-thirds of anglers reported always filleting their fish, and half reported always removing the skin and belly fat. Use of cleaning techniques varied by state, with Minnesota anglers more likely to report always filleting and removing the skin, compared to New York anglers who were less likely to report always using these techniques. Michigan anglers were more likely than other states to report always removing the belly fat, whereas Pennsylvania anglers were less likely to report that behavior.

Pan frying and deep frying sport-caught fish is generally not recommended, but most anglers reported engaging in this practice at least some of the time (Table 32). Pennsylvania anglers were least likely to report deep frying their fish; Illinois and Indiana anglers reported engaging in this practice a bit more often than those in other states.

Baking, roasting, broiling, or grilling the fish are the preferred cooking methods to reduce certain contaminants. Two-thirds of anglers reported using those techniques at least some of the time when preparing sport-caught fish. New York and Pennsylvania anglers were more likely to report using these techniques than anglers in other states.

Reusing oil or fat from cooking fish in future meals is not recommended, and appears to be used very infrequently. Illinois and Wisconsin anglers were more likely to report using the technique at all, but only one-third of them reported ever using it.

Table 32. Fish preparation and cooking techniques used by angler households when preparing sport-caught fish (percent), overall and by state of residence.

Fish preparation and cooking techniques	State of Residence							
	Overall	IL	IN	MI	MN	NY	PA	WI
Fillet the fish*								
Never	5.3	4.4	7.2	4.3	3.7	9.4	11.5	2.1
Rarely	1.6	3.3	0.0	1.4	0.4	3.1	4.6	0.5
Sometimes	7.1	8.8	2.2	6.6	2.2	13.8	15.4	6.8
Usually	17.3	20.9	20.3	17.5	15.4	19.5	16.2	16.1
Always	68.2	61.5	70.3	70.2	77.9	52.9	52.3	73.5
Don't Know	0.5	1.1	0.0	0.0	0.4	1.3	0.0	1.0
Remove the skin*								
Never	11.2	6.9	14.3	13.9	7.5	17.8	17.7	7.4
Rarely	3.8	2.3	3.0	4.5	2.0	3.3	9.2	3.2
Sometimes	12.1	9.2	11.3	17.8	6.7	14.5	15.4	12.7
Usually	18.1	23.0	15.0	18.3	13.8	20.4	18.5	20.6
Always	54.0	56.3	56.4	45.5	70.0	42.0	39.2	54.0
Don't Know	0.8	2.3	0.0	0.0	0.0	2.0	0.0	2.1
Remove belly fat*								
Never	15.9	18.8	21.5	12.6	14.7	22.1	22.4	10.3
Rarely	3.5	2.4	6.2	2.9	2.8	4.0	5.6	3.3
Sometimes	8.1	9.4	9.2	7.3	6.4	3.4	14.4	8.2
Usually	14.4	15.3	10.0	13.1	14.7	15.4	12.8	16.8
Always	50.1	48.2	46.2	58.8	50.2	48.4	37.6	52.2
Don't Know	8.0	5.9	6.9	5.3	11.2	6.7	7.2	9.2
Pan fry*								
Never	10.7	16.0	10.7	8.6	8.0	16.8	17.5	6.5
Rarely	7.9	14.8	6.1	8.1	6.1	9.0	7.1	7.5
Sometimes	34.2	38.3	36.6	31.3	30.7	28.4	45.3	34.9
Usually	29.0	21.0	29.0	29.8	35.3	22.6	20.6	31.8
Always	17.9	8.6	17.6	22.2	19.9	21.9	9.5	18.8
Don't Know	0.3	1.2	0.0	0.0	0.0	1.3	0.0	0.5
Deep fry*								
Never	28.2	15.4	21.3	26.1	31.0	36.7	43.1	23.4
Rarely	15.0	12.1	15.4	18.1	16.3	12.5	15.4	12.8
Sometimes	31.3	25.3	30.9	35.6	31.9	27.1	26.0	35.6
Usually	16.4	28.5	18.4	9.6	13.5	17.4	10.6	21.8
Always	8.6	17.6	14.0	10.1	6.5	5.6	4.9	6.4
Don't Know	0.5	1.1	0.0	0.5	0.8	0.7	0.0	0.0

Table 32(cont).

Fish preparation and cooking techniques	State of Residence							
	Overall	IL	IN	MI	MN	NY	PA	WI
Bake, roast, broil, or grill fish*								
Never	18.3	19.7	27.1	14.1	24.4	18.7	12.9	13.8
Rarely	14.0	11.6	20.3	14.1	16.3	9.0	10.6	14.4
Sometimes	45.2	50.0	34.6	47.1	43.0	37.5	43.9	52.1
Usually	14.7	14.0	13.5	18.4	10.5	20.7	20.5	11.2
Always	7.3	3.5	4.5	5.8	5.4	13.5	12.1	8.0
Don't Know	0.5	1.2	0.0	0.5	0.4	0.6	0.0	0.5
Reuse oil or fat from cooking fish in future meals*								
Never	74.8	62.1	71.2	76.8	77.2	86.7	81.6	67.2
Rarely	8.0	12.6	3.9	6.4	5.1	5.3	10.0	12.4
Sometimes	7.8	13.8	15.5	5.9	7.8	5.3	1.5	9.1
Usually	5.8	6.9	7.8	6.9	6.7	0.0	3.8	6.5
Always	2.2	2.3	1.6	2.5	1.2	0.7	2.3	4.3
Don't Know	1.4	2.3	0.0	1.5	2.0	2.0	0.8	0.5

*Statically significant difference between states at $P \leq 0.05$ using chi-square test and "don't know" category removed, due to low expected cell counts in this category.

Self-Reported Behavioral Changes Attributed to the Advisory

Anglers were asked if they or other members of their household made any changes to their fish consumption behaviors primarily as a result of what they learned in the advisories. Over half of the anglers (55%) indicated they made at least one of the changes listed, but no single change was made by more than a third of the anglers (Table 33). The survey asked if other adults living in the household made the change and then households with women under age 50 were selected to see what changes were potentially made by this group. Very few changes were reported. This was similar in households with children, where few respondents indicated that children in their household changed their behaviors. The two changes made most frequently, but still by one-quarter or fewer people, were (1) eating smaller fish more often and (2) eating fewer sport-caught fish. Respondents were less likely to report changes that are not recommended in the advisories (e.g., eat larger fish more often, stop eating sport-caught fish), providing limited evidence that anglers were correctly attributing behavior change to the advisory.

Table 33. Changes made by household members as a result of what they learned in the advisory.

Changes made	Angler is a:		In a household with a woman < 50 (not the angler)	In a household with children < 15
	Man or older woman	Woman < 50		
	% making change*		% indicating other adult made change*	% indicating children made change*
Eat smaller fish more often	27.0	10.7	14.2	10.4
Eat fewer sport-caught fish	22.5	12.2	11.3	8.1
Changed species eaten	17.2	10.0	7.1	3.0
Changed the way we clean fish	16.2	5.0	4.2	1.0
Changed where fish	14.1	10.8	2.8	4.4
Eat more fish	13.2	14.3	7.9	4.1
Changed the way we cook fish	12.9	8.6	5.9	1.5
Eat fewer purchased fish	11.7	12.1	6.5	5.3
Stopped eating sport-caught fish	7.8	3.6	3.6	2.4
Eat larger fish more often	5.3	2.9	4.1	0.7

*Changes made can add to more than 100% because more than one change could be made.

Self-reported behavioral changes made were also examined at the state level because states emphasize different advice (Tables 34 through 40). Differences of note between states included:

- Indiana anglers were more likely to report changing where they fished than anglers in other states, and Indiana children were more likely to eat fewer sport-caught fish than children in other states.
- Michigan anglers were more likely to report changing the way they cleaned fish than anglers in other states.
- Minnesota households were more likely to eat smaller fish more often than anglers in other states.
- New York anglers were more likely to report eating fewer sport-caught fish or stop eating sport-caught fish altogether than anglers in most other states.
- Pennsylvania anglers were more likely to report eating fewer sport-caught fish than anglers in most other states.

Table 34. Changes made by household members as a result of what they learned in the advisory for Illinois anglers.

Changes made	Angler is a man or older woman	In a household with a woman < 50 (not the angler)	In a household with children < 15
	% making change*	% indicating other adult made change*	% indicating children made change*
Eat smaller fish more often	26.7	10.5	3.4
Eat fewer sport-caught fish	21.8	7.9	3.4
Changed species eaten	20.8	7.9	3.4
Changed the way we clean fish	14.9	2.6	0.0
Changed where fish	15.8	0.0	0.0
Eat more fish	13.9	10.5	10.3
Changed the way we cook fish	12.9	0.0	0.0
Eat fewer purchased fish	6.9	2.6	3.4
Stopped eating sport-caught fish	5.9	2.6	3.4
Eat larger fish more often	4.0	0.0	0.0

*Changes made can add to more than 100% because more than one change could be made.

Table 35. Changes made by household members as a result of what they learned in the advisory for Indiana anglers.

Changes made	Angler is a man or older woman	In a household with a woman < 50 (not the angler)	In a household with children < 15
	% making change*	% indicating other adult made change*	% indicating children made change*
Eat smaller fish more often	27.5	17.2	10.5
Eat fewer sport-caught fish	22.5	18.8	18.4
Changed species eaten	20.4	4.7	5.3
Changed the way we clean fish	16.9	3.1	2.6
Changed where fish	22.5	10.9	2.6
Eat more fish	16.9	7.8	2.6
Changed the way we cook fish	13.4	7.8	2.6
Eat fewer purchased fish	12.0	6.3	5.3
Stopped eating sport-caught fish	7.0	7.8	5.3
Eat larger fish more often	6.3	6.3	0.0

*Changes made can add to more than 100% because more than one change could be made.

Table 36. Changes made by household members as a result of what they learned in the advisory for Michigan anglers.

Changes made	Angler is a man or older woman	In a household with a woman < 50 (not the angler)	In a household with children < 15
	% making change*	% indicating other adult made change*	% indicating children made change*
Eat smaller fish more often	27.6	12.1	7.7
Eat fewer sport-caught fish	20.4	8.6	7.7
Changed species eaten	16.7	6.9	0.0
Changed the way we clean fish	22.6	8.6	0.0
Changed where fish	15.8	5.2	2.6
Eat more fish	13.1	13.8	5.1
Changed the way we cook fish	14.9	12.1	0.0
Eat fewer purchased fish	16.7	6.9	7.7
Stopped eating sport-caught fish	8.6	5.2	2.6
Eat larger fish more often	6.3	3.4	2.6

*Changes made can add to more than 100% because more than one change could be made.

Table 37. Changes made by household members as a result of what they learned in the advisory for Minnesota anglers.

Changes made	Angler is a man or older woman	In a household with a woman < 50 (not the angler)	In a household with children < 15
	% making change*	% indicating other adult made change*	% indicating children made change*
Eat smaller fish more often	31.3	22.4	16.7
Eat fewer sport-caught fish	16.5	15.3	4.5
Changed species eaten	13.9	8.2	3.0
Changed the way we clean fish	10.0	3.5	1.5
Changed where fish	10.4	1.2	6.1
Eat more fish	10.9	7.1	1.5
Changed the way we cook fish	11.7	8.2	4.5
Eat fewer purchased fish	12.2	7.1	3.0
Stopped eating sport-caught fish	5.2	0.0	0.0
Eat larger fish more often	3.5	5.9	0.0

*Changes made can add to more than 100% because more than one change could be made.

Table 38. Changes made by household members as a result of what they learned in the advisory for New York anglers.

Changes made	Angler is a man or older woman	In a household with a woman < 50 (not the angler)	In a household with children < 15
	% making change*	% indicating other adult made change*	% indicating children made change*
Eat smaller fish more often	25.9	9.7	2.2
Eat fewer sport-caught fish	30.0	6.9	10.9
Changed species eaten	22.3	11.1	2.2
Changed the way we clean fish	16.4	4.2	0.0
Changed where fish	15.9	0.0	4.3
Eat more fish	14.5	6.9	4.3
Changed the way we cook fish	15.5	2.8	2.2
Eat fewer purchased fish	12.7	5.6	4.3
Stopped eating sport-caught fish	13.6	6.9	4.3
Eat larger fish more often	7.7	5.6	0.0

*Changes made can add to more than 100% because more than one change could be made.

Table 39. Changes made by household members as a result of what they learned in the advisory for Pennsylvania anglers.

Changes made	Angler is a man or older woman	In a household with a woman < 50 (not the angler)	In a household with children < 15
	% making change*	% indicating other adult made change*	% indicating children made change*
Eat smaller fish more often	17.6	8.3	14.3
Eat fewer sport-caught fish	31.8	8.3	9.5
Changed species eaten	18.8	3.3	0.0
Changed the way we clean fish	15.3	0.0	0.0
Changed where fish	8.8	0.0	2.4
Eat more fish	10.0	6.7	4.8
Changed the way we cook fish	14.1	3.3	0.0
Eat fewer purchased fish	10.6	6.7	9.5
Stopped eating sport-caught fish	11.8	3.3	2.4
Eat larger fish more often	5.9	1.7	0.0

*Changes made can add to more than 100% because more than one change could be made.

Table 40. Changes made by household members as a result of what they learned in the advisory for Wisconsin anglers.

Changes made	Angler is a man or older woman	In a household with a woman < 50 (not the angler)	In a household with children < 15
	% making change*	% indicating other adult made change*	% indicating children made change*
Eat smaller fish more often	29.9	14.3	9.8
Eat fewer sport-caught fish	19.9	12.5	9.8
Changed species eaten	13.4	7.1	7.3
Changed the way we clean fish	17.9	7.1	2.4
Changed where fish	15.4	5.4	9.8
Eat more fish	15.9	3.6	2.4
Changed the way we cook fish	9.5	5.4	0.0
Eat fewer purchased fish	9.5	8.9	4.9
Stopped eating sport-caught fish	4.5	3.6	2.4
Eat larger fish more often	4.5	5.4	2.4

*Changes made can add to more than 100% because more than one change could be made.

Fish Consumption Suppression

Most anglers reported enjoying eating sport-caught fish (76%), and quite a few (43%) indicated they would eat more if health risks from contaminants did not exist. However, very few survey respondents (8%) fish because they or their family need food to eat. Anglers living in Michigan, Minnesota, and Wisconsin were the most likely to indicate they enjoyed eating sport-caught fish (Table 41). Anglers in New York were the most likely to indicate they would eat more fish if health risks didn't exist. There were no differences between states in the number of people fishing because they needed food. However, anglers with lower education levels were more likely to indicate they fished because they needed food than those with a college degree or higher (Table 42), as were female anglers under age 50 compared with other anglers (15% vs. 8%). Those with lower education levels were also more likely to indicate they would eat more sport-caught fish if health risks from contaminants did not exist. Similarly non-white anglers were more likely than white anglers to indicate they fished for food (15% vs. 8%), and would eat more fish if health risks from contaminants did not exist (62% vs. 43%). Female anglers under age 50 were less likely to indicate they would eat more sport-caught fish if the health risks from contaminants did not exist (31% vs. 45%).

A large number, but not the majority of anglers (43%) question if government agencies really know how much chemical contaminants are in fish (Table 41). Those with lower education levels were more likely to think that government agencies really don't know how much chemical contaminants are in fish (Table 42).

Table 41. Beliefs about fish consumption and the knowledge level of government agencies (percent), overall and by state of residence.

	State of Residence							
	Overall	IL	IN	MI	MN	NY	PA	WI
I enjoy eating sport-caught fish*								
Strongly agree	30.4	26.8	34.8	34.8	36.5	21.9	20.9	31.5
Agree	45.5	44.7	38.7	46.8	48.1	41.5	44.7	47.5
Neutral	14.4	22.0	11.0	13.3	10.2	19.1	16.9	12.6
Disagree	3.1	0.8	5.5	2.3	1.3	7.4	5.5	2.1
Strongly disagree	3.8	4.1	6.1	1.2	1.3	7.4	9.0	2.1
Don't know	2.8	1.6	3.9	1.6	2.6	2.7	3.0	4.2
I would eat more sport-caught fish if health risks from contaminants did not exist*								
Strongly agree	14.7	14.5	15.9	19.7	10.6	20.6	16.2	10.1
Agree	28.6	31.5	26.9	26.8	23.2	37.0	29.9	29.6
Neutral	26.2	29.0	26.5	24.0	31.7	21.4	22.5	25.8
Disagree	18.1	13.7	15.9	17.7	21.2	11.3	19.1	21.5
Strongly disagree	6.2	6.5	6.0	5.9	9.3	4.3	4.9	4.6
Don't know	6.2	4.8	8.8	5.9	4.0	5.4	7.4	8.4
I fish because I, or my family, need food to eat								
Strongly agree	2.1	1.6	2.8	2.8	2.0	1.2	1.5	2.5
Agree	6.3	2.5	5.5	4.8	6.6	6.3	4.5	11.3
Neutral	12.1	11.5	18.8	10.3	11.3	12.2	12.4	12.2
Disagree	37.5	43.5	37.6	37.3	35.9	35.6	33.6	39.9
Strongly disagree	39.4	39.3	32.0	42.4	41.9	42.3	45.0	30.7
Don't know	2.6	1.6	3.3	2.4	2.3	2.4	3.0	3.4
I don't think government agencies really know how much chemical contaminants are in fish								
Strongly agree	11.3	16.9	12.1	15.3	6.6	12.9	12.3	8.0
Agree	31.5	37.2	28.6	27.9	28.4	33.2	35.0	32.8
Neutral	25.9	25.8	29.6	23.1	28.4	25.0	22.7	26.9
Disagree	18.5	14.5	15.4	20.0	22.4	17.2	17.7	17.2
Strongly disagree	4.0	2.4	2.2	3.9	5.0	4.3	4.4	4.2
Don't know	8.8	3.2	12.1	9.8	9.2	7.4	7.9	10.9

*Statically significant difference between states at $P \leq 0.05$ using chi-square test.

Table 42. Beliefs and attitudes of anglers about fish consumption (percent), by education level.

	Strongly agree or Agree	Neutral	Strongly disagree or Disagree	Don't know
I enjoy eating sport-caught fish				
<u>Education</u>				
HS diploma or less	75.1	13.7	7.3	3.9
Some college	77.7	14.2	6.1	2.0
College or graduate degree	74.8	15.0	7.4	2.7
I would eat more sport-caught fish if health risks from contaminants did not exist				
<u>Education*</u>				
HS diploma or less	45.3	27.9	18.4	8.3
Some college	45.9	26.2	22.8	5.0
College or graduate degree	40.3	24.8	30.3	4.7
I fish because I, or my family, need food to eat				
<u>Education*</u>				
HS diploma or less	11.7	16.1	68.2	4.0
Some college	9.5	12.1	76.0	2.5
College or graduate degree	4.7	7.4	86.2	1.7
I don't think government agencies really know how much chemical contaminants are in fish				
<u>Education*</u>				
HS diploma or less	49.0	27.2	14.0	9.8
Some college	42.6	26.3	22.2	9.0
College or graduate degree	37.4	24.1	31.5	7.0
Eating <u>some</u> types of sport-caught fish won't harm me				
<u>Education*</u>				
HS diploma or less	49.8	23.5	11.0	15.7
Some college	48.9	26.8	10.9	13.4
College or graduate degree	59.7	21.4	9.3	9.5
Eating <u>all</u> types of sport-caught fish won't harm me				
<u>Education*</u>				
HS diploma or less	9.8	28.7	45.0	16.5
Some college	8.7	27.6	50.8	12.9
College or graduate degree	6.8	21.0	62.8	9.3
Health risks from eating contaminated sport-caught fish are minor compared to other risks I'm exposed to in life				
<u>Education</u>				
HS diploma or less	46.3	23.9	18.0	11.8
Some college	47.0	25.7	18.2	9.0
College or graduate degree	48.8	24.3	18.2	8.7

Table 42. (cont.)

	Strongly agree or Agree	Neutral	Strongly disagree or Disagree	Don't know	
Health benefits of eating sport-caught fish are greater than health risks					
<u>Education</u>					
HS diploma or less	34.3	31.8	17.4	16.4	
Some college	31.9	37.1	15.9	15.1	
College or graduate degree	40.0	30.5	16.1	13.3	
Most of my family and friends limit the amount that they eat of sport-caught fish with contaminants					
<u>Education</u>					
HS diploma or less	33.4	25.8	20.1	20.6	
Some college	35.6	24.6	21.9	17.9	
College or graduate degree	34.0	22.9	25.5	17.6	
When it comes to limiting the amount that I eat of sport-caught fish with contaminants, I want to do what my family and friends think is best					
<u>Education*</u>					
HS diploma or less	40.7	30.3	17.6	11.4	
Some college	35.5	35.4	21.9	7.2	
College or graduate degree	36.8	34.3	22.1	6.8	
My family and friends think it is important that I limit the amount that I eat of sport-caught fish with contaminants					
<u>Education*</u>					
HS diploma or less	30.7	33.2	19.4	16.7	
Some college	34.1	27.4	22.7	15.8	
College or graduate degree	28.3	26.6	28.3	16.7	
I am confident I can limit the amount that I eat of sport-caught fish with contaminants					
<u>Education*</u>					
HS diploma or less	61.2	22.0	6.4	10.4	
Some college	67.1	20.1	6.4	6.4	
College or graduate degree	74.7	13.9	6.2	5.1	
	Very concerned	Somewhat concerned	Slightly concerned	Not at all concerned	Don't know
How concerned are you that eating sport-caught fish is a potential health risk to you or members of your household					
<u>Education*</u>					
HS diploma or less	24.7	31.4	25.4	16.3	2.2
Some college	23.0	29.6	27.4	18.2	1.8
College or graduate degree	16.0	30.6	27.7	24.3	0.8

*Statistically significant difference between groups at $P \leq 0.05$ using chi-square test.

Factors Influencing Consumption of Likely Contaminated Fish

The Theory of Planned Behavior was used to identify factors influencing adherence to the fish consumption advisory. The Theory of Planned Behavior postulates that behaviors are influenced by three interrelated factors: (1) attitude toward the behavior (e.g., Does an individual think engaging in the behavior is good or bad?); (2) perceived behavioral control (e.g., How easy or difficult do individuals think the behavior is?); and (3) subjective norm (e.g., What social pressures exist for individuals to engage in the behavior?). These factors are themselves influenced by beliefs about outcomes of performing the behavior (behavioral beliefs), beliefs about the extent to which the behavior is under their control (control beliefs), and beliefs about how specific people or groups feel about performing the behavior (normative beliefs). This Theory was operationalized in the context of adherence to the fish consumption advisory as outlined in Figure 1, with the questions used shown in each box of the figure and responses generally measured on an agree/disagree scale. Results from a path analysis used to test the strength of the relationships are discussed at the end of this section.

Behaviors Being Predicted (Behavioral Referent)

Two behaviors were examined – following the advisory when deciding what fish to eat and checking the advisory for recommendations for waters about to be fished. Over half of the anglers indicated they tried to follow the advisory recommendations when deciding what fish to eat (Table 43). New York anglers were the most likely to indicate that they tried to follow the advisory. Fewer anglers indicated they checked the advisory for recommendations for waters they were going to fish; this was particularly true in Michigan, Minnesota, and Wisconsin where only about one-third of anglers indicated they checked the advisory. Anglers living in Illinois, Indiana, and New York were much more likely to check the advisory for recommendations for waters they were going to fish.

Table 43. Behavioral referents regarding the consumption of contaminated fish (percent), overall and by state of residence.

Behavioral Referents	State of Residence							
	Overall	IL	IN	MI	MN	NY	PA	WI
I try to follow the advisory recommendations when deciding what fish to eat*								
Strongly agree	14.2	16.7	19.2	14.3	10.0	22.2	12.0	12.6
Agree	43.1	37.6	40.1	45.4	41.5	44.8	49.3	41.3
Neutral	27.1	32.5	25.1	25.5	30.1	21.8	23.0	28.9
Disagree	8.3	7.0	4.8	9.6	9.7	4.0	7.9	10.5
Strongly disagree	3.5	1.8	3.6	2.4	5.2	1.6	3.1	5.0
Don't know	3.8	4.4	7.2	2.8	3.5	5.6	4.7	1.7
I check the advisory for recommendations for waters I'm going to fish*								
Strongly agree	10.0	14.9	15.0	8.8	6.2	14.5	10.9	7.6
Agree	27.6	30.8	32.2	26.4	22.5	34.3	28.2	27.7
Neutral	26.7	19.3	23.4	31.6	26.0	24.6	27.6	28.6
Disagree	20.9	18.4	16.2	21.2	27.7	14.5	18.2	21.4
Strongly disagree	9.8	9.6	7.8	9.2	12.8	8.1	7.8	10.1
Don't know	5.0	7.0	5.4	2.8	4.8	4.0	7.3	4.6

*Statically significant difference between states at $P \leq 0.05$ using chi-square test.

Behavioral Beliefs and Attitude toward Consumption of Contaminated Fish

Three behavioral beliefs and one related attitude that could influence the behaviors discussed above were examined. The majority of anglers (52%) believe that eating some types of sport-caught fish won't harm them, but very few (8%) believe that eating all types of sport-caught fish won't harm them (Table 44). A plurality (47%) think the health risks from eating contaminated sport-caught fish are minor compared to other risks they are exposed to in life. However, fewer (35%) believe that the health benefits of eating sport-caught fish are greater than the health risks.

Anglers living in Minnesota were more likely than anglers in other states to believe that the health benefits were greater than the risks and that the risks were minor compared with other risks, but the differences while statistically significant were not large in absolute terms (Table 44). Female anglers under 50 were more likely to believe the health benefits were greater than the health risks (41% vs. 34%). Illinois and Wisconsin anglers were the most likely to believe that eating some types of sport-caught fish won't harm them, as were those with college degrees or higher (Table 42).

One out of five anglers was very concerned that eating sport-caught fish was a potential health risk to themselves or members of their household. Almost one-third were somewhat concerned. Anglers living in New York were the most likely to be concerned, whereas anglers in Minnesota

and Wisconsin were the least likely to be concerned (Table 44). The higher the education level, the lower the level of concern (Table 42). Non-white anglers were more likely to be very concerned compared with white anglers (35% vs. 21%). Anglers living in households with women <50 were less likely to be very concerned (19% vs. 23%) and more likely to be not at all concerned (23% vs. 18%). The difference, while significant, was not large in practical terms. Female anglers under age 50 were not more or less likely to be concerned than other anglers.

Normative Beliefs and the Subjective Norm

Two normative beliefs and one measure of the subjective norm that could influence the behaviors discussed above were examined. About one-third of anglers agree that most of their family and friends limit the amount of sport-caught fish with contaminants that they eat; almost one-fifth didn't know what most of their family and friends do (Table 45). Michigan and New York anglers were most likely to agree that their family and friends limit their consumption, whereas Minnesota anglers were the least likely to agree. Further, when it comes to limiting the amount anglers themselves eat, about one-third want to do what their family and friends think is best. There was no difference between the states in terms of anglers wanting to do what their family or friends thought was best, but those with just a high school education or less were more likely to want to do what their family and friends thought was best (Table 42), as were non-white anglers compared with white anglers (53% vs. 37%).

Roughly one-third of anglers agreed that their family and friends believe it is important that they limit the amount of sport-caught fish with contaminants that they eat (Table 45). Michigan and New York anglers were the most likely to agree, whereas Minnesota anglers were the least likely to agree. Female anglers under age 50 were less likely to agree that their family and friends think it is important that they limit the amount they eat of sport-caught fish with contaminants (21%).

Control Beliefs and Perceived Behavioral Control

Two control beliefs and a measure of perceived behavioral control that could influence the behaviors discussed above were examined. Almost two-thirds of the anglers who were aware of the advisories agreed the sport-caught fish advisory provided them with enough information to decide whether or not to eat certain fish (Table 46). Comparatively fewer anglers (44%) agreed the purchased fish advisory provided them with enough information to decide whether or not to eat certain purchased fish. Minnesota anglers were the most likely to agree that they had enough information about purchased fish.

Two-thirds of anglers were confident they can limit the amount of sport-caught fish with contaminants that they eat (Table 46). Anglers with higher education levels were more likely to be confident (Table 42). Female anglers under age 50 were less likely to be confident than other anglers (61% vs. 68%).

Table 44. Behavioral beliefs and attitudes about consumption of contaminated fish (percent), overall and by state of residence.

Behavioral Beliefs	State of Residence							
	Overall	IL	IN	MI	MN	NY	PA	WI
Eating <u>some</u> types of sport-caught fish won't harm me*								
	Percent							
Strongly agree	8.1	8.9	9.9	6.7	7.3	4.7	8.9	10.9
Agree	44.1	47.5	38.2	43.7	43.5	42.8	42.4	47.6
Neutral	24.5	19.4	23.2	29.1	28.3	23.3	25.1	19.3
Disagree	8.1	10.5	12.7	6.3	7.3	10.1	7.4	6.7
Strongly disagree	2.1	0.8	1.1	2.4	2.0	4.7	3.9	0.4
Don't know	13.1	12.9	14.9	11.8	11.6	14.4	12.3	15.1
Eating <u>all</u> types of sport-caught fish won't harm me*								
Strongly agree	1.0	0.8	1.7	1.6	0.7	0.4	1.5	0.8
Agree	7.4	8.9	5.0	6.7	7.9	4.7	9.5	7.6
Neutral	26.3	26.0	27.1	24.7	29.4	22.4	25.5	26.7
Disagree	41.9	43.9	43.7	42.3	40.3	40.3	43.0	41.6
Strongly disagree	10.5	10.6	7.7	11.4	9.2	21.2	9.5	6.8
Don't know	12.9	9.8	14.9	13.3	12.5	11.0	11.0	16.5
Health risks from eating contaminated sport-caught fish are minor compared to other risks I'm exposed to in life*								
Strongly agree	7.3	6.6	4.9	10.3	7.6	4.7	7.0	7.6
Agree	40.1	44.2	33.1	34.9	46.1	33.5	36.8	43.7
Neutral	24.8	23.0	25.8	22.2	25.4	26.6	26.4	24.8
Disagree	14.4	15.5	14.8	17.5	11.6	21.5	13.9	10.5
Strongly disagree	3.4	2.5	6.6	6.0	1.7	4.3	5.0	0.8
Don't know	10.0	8.2	14.8	9.1	7.6	9.4	10.9	12.6
Health benefits of eating sport-caught fish are greater than health risks*								
Strongly agree	5.0	4.1	7.2	5.6	5.3	4.7	3.4	5.2
Agree	29.7	33.3	27.6	30.2	34.7	20.6	25.1	31.0
Neutral	33.9	33.3	30.9	32.0	35.2	34.2	35.6	34.0
Disagree	12.3	10.6	14.4	9.5	10.9	17.1	12.8	13.4
Strongly disagree	3.7	2.4	3.3	6.0	2.3	7.4	6.4	0.0
Don't know	15.4	16.3	16.6	16.7	11.6	16.0	16.7	16.4
Attitude toward Behavior								
How concerned are you that eating sport-caught fish is a potential health risk to you or members of your household*								
Very concerned	21.2	22.4	26.0	22.1	13.0	32.5	28.1	15.7
Somewhat concerned	30.6	31.2	30.9	31.2	30.9	32.2	28.1	29.4
Slightly concerned	26.4	24.0	23.8	30.9	28.8	18.6	22.6	29.8
Not at all concerned	20.3	19.2	18.2	14.2	25.7	15.1	21.2	23.4
Don't know	1.5	3.2	1.1	1.6	1.6	1.6	0.0	1.7

*Statically significant difference between states at $P \leq 0.05$ using chi-square test.

Table 45. Normative beliefs and the subjective norm related to consumption of contaminated fish (percent), overall and by state of residence.

Normative Beliefs	State of Residence							
	Overall	IL	IN	MI	MN	NY	PA	WI
Most of my family and friends limit the amount that they eat of sport-caught fish with contaminants*								
	Percent							
Strongly agree	6.9	4.9	8.3	6.7	3.6	13.0	10.3	5.5
Agree	27.5	26.8	25.4	33.7	22.0	31.2	28.2	26.4
Neutral	24.5	31.8	25.4	22.5	26.4	24.5	23.6	20.6
Disagree	16.5	8.9	14.4	17.4	21.7	11.1	10.8	22.3
Strongly disagree	6.2	8.9	5.0	5.5	8.9	3.6	5.4	4.6
Don't know	18.4	18.7	21.5	14.2	17.4	16.6	21.7	20.6
When it comes to limiting the amount that I eat of sport-caught fish with contaminants, I want to do what my family and friends think is best								
Strongly agree	6.6	8.9	8.8	6.0	4.0	9.5	9.9	3.8
Agree	30.6	29.3	28.7	32.3	31.3	33.2	26.7	30.9
Neutral	33.5	39.8	37.7	30.6	34.0	32.0	33.7	31.8
Disagree	14.3	10.6	9.9	17.5	15.8	11.9	12.9	15.7
Strongly disagree	6.9	6.5	6.6	6.4	8.6	5.1	5.9	7.2
Don't know	8.1	4.9	8.3	7.2	6.3	8.3	10.9	10.6
Subjective Norm								
My family and friends think it is important that I limit the amount that I eat of sport-caught fish with contaminants*								
Strongly agree	6.2	4.8	8.9	7.9	3.0	10.5	9.4	3.4
Agree	25.1	21.0	21.7	31.2	20.6	30.5	24.6	25.7
Neutral	28.6	33.9	27.2	30.0	30.3	26.6	24.6	26.9
Disagree	16.5	12.1	18.3	12.3	22.4	11.3	14.8	19.7
Strongly disagree	7.3	9.7	7.8	6.3	10.2	5.5	6.4	5.0
Don't know	16.3	18.5	16.1	12.3	13.5	15.6	20.2	19.3

*Statically significant difference between states at $P \leq 0.05$ using chi-square test.

Table 46. Control beliefs and perceived behavioral control over the consumption of contaminated fish (percent), overall and by state of residence.

Control Beliefs	State of Residence							
	Overall	IL	IN	MI	MN	NY	PA	WI
Advisories provide enough information to decide whether or not to eat certain <i>sport-caught</i> fish								
	Percent							
Strongly agree	13.4	17.2	13.8	13.1	11.4	20.0	9.3	13.0
Agree	50.1	40.6	43.6	51.2	55.8	49.1	54.4	47.7
Neutral	21.1	21.6	21.6	22.2	20.0	15.7	19.2	25.5
Disagree	7.8	10.3	9.6	7.9	6.6	9.0	8.8	5.4
Strongly disagree	2.5	3.4	5.4	1.6	2.1	2.7	2.1	2.5
Don't know	5.1	6.9	6.0	4.0	4.1	3.5	6.2	5.9
Advisories provide enough information to decide whether or not to eat certain <i>purchased</i> fish*								
Strongly agree	8.2	11.4	5.4	9.6	6.2	12.6	7.3	6.8
Agree	35.9	29.9	35.6	35.6	40.9	30.6	33.1	38.5
Neutral	23.7	17.5	22.9	20.8	23.5	21.3	25.4	30.1
Disagree	14.5	23.7	15.7	16.4	12.8	14.6	16.1	8.5
Strongly disagree	8.1	7.0	10.8	9.6	6.9	9.1	9.8	5.9
Don't know	9.6	10.5	9.6	8.0	9.7	11.8	8.3	10.2
Perceived Behavioral Control								
I am confident I can limit the amount that I eat of sport-caught fish with contaminants								
Strongly agree	19.2	22.0	16.7	19.5	17.9	21.3	23.6	15.3
Agree	48.0	50.4	48.9	45.0	48.8	51.2	44.8	48.4
Neutral	19.1	19.5	15.6	21.1	18.3	15.7	19.2	21.3
Disagree	4.2	2.4	6.1	4.4	5.0	3.9	3.0	4.3
Strongly disagree	2.4	2.4	3.3	3.2	2.0	2.4	3.0	1.3
Don't know	7.1	3.3	9.4	6.8	8.0	5.5	6.4	9.4

*Statically significant difference between states at $P \leq 0.05$ using chi-square test.

Relationships Between the Factors and the Behaviors

The Theory of Planned Behavior, in brief, suggests that beliefs influence attitudes, which in turn influence behavior. Of the behavioral beliefs examined, the belief that health risks from eating contaminated sport-caught fish are minor when compared to other risks was the most highly correlated with the attitude, concern that eating sport-caught fish was a potential health risk to themselves or members of their household (Fig 2.) The results of path analysis showed that anglers who think the risks are minor when compared with other risks were less concerned than anglers who think the risks are greater that eating sport-caught fish is a potential risk to them or members of their household. The other behavioral beliefs (eating some types of sport-caught fish won't harm me, and the health benefits are greater than the health risks) were also significantly and negatively correlated with concern about the potential health risks of eating sport-caught fish.

Of the normative beliefs examined, anglers' beliefs about what their family and friends do regarding limiting sport-caught fish consumption was very highly correlated with the subjective norm, what they think their family and friends think they should do (Fig. 2). As family and friends limit their consumption, the understanding on the part of the angler appears to be that his or her family and friends think he/she should limit his/her consumption.

The relationship between anglers' control beliefs about the advisory providing them with enough information and their confidence in their ability to limit the amount of sport-caught fish with contaminants that they consume was positive, but not as strong as the other comparisons discussed above (Fig. 2).

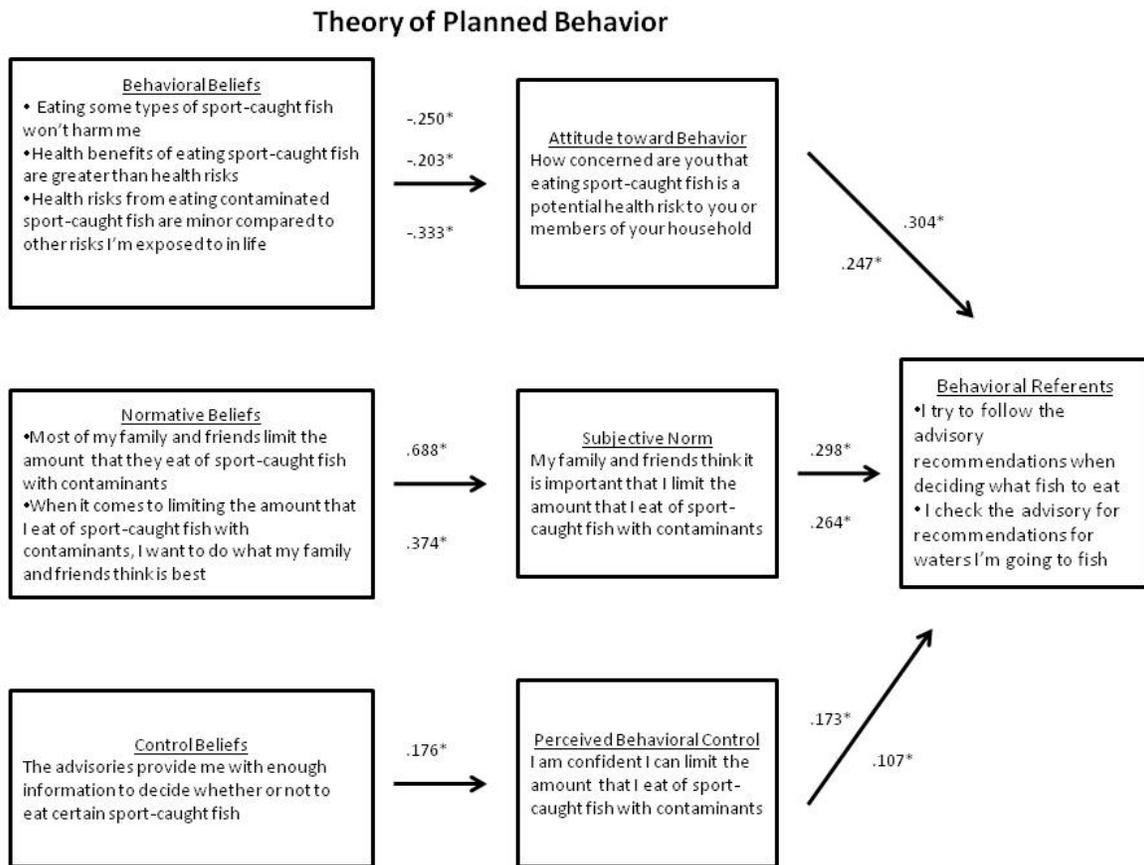


Figure 2. Path diagram showing the use of the Theory of Planned Behavior as it applies to adherence to the fish consumption advisory, with standardized regression coefficients from an ordinary least squares regression. (Asterisks indicate significant values at P=0.05.)

The two behavioral referents that were predicted from the attitudes and beliefs discussed above were following the advisory recommendations when deciding what fish to eat and checking the advisory for recommendations for waters to fish. Both were significantly related to all three attitude predictors (Fig. 2), but following the advisory when deciding what fish to eat was more

strongly correlated. This is not surprising because the attitudes measured deal more directly with fish consumption than deciding where to fish. Of the three attitude predictors, concern about the health risks and the importance others place on limiting the amount of contaminated fish consumed were the most strongly correlated with trying to follow the advisory recommendations.

DISCUSSION AND RECOMMENDATIONS

The Great Lakes Consortium for Fish Consumption Advisories is working together to enhance state fish consumption advisory programs by determining how to communicate information to the public more effectively, thereby increasing public knowledge about the risks and benefits of fish consumption and reducing public exposure to toxic substances from consumption of contaminated fish. A primary audience for communication is licensed anglers. Based on our analysis we have made some recommendations for agencies to help improve communication to this audience. We have organized our discussion and recommendations below based on the objectives for this survey, which were to:

1. Quantify current general fish consumption behaviors of anglers (and their household members);
2. Identify the most important factors influencing those behaviors;
3. Assess advisory awareness and general knowledge; and
4. Assess current and preferred sources of advisory-related information.

After discussing general recommendations, we will discuss needs of selected target audiences and make recommendations for future research.

Discussion and Recommendations for Agencies

One of the goals of Consortium agencies is to make anglers aware of the fish consumption advisories. Toward that end, agencies appear to have been quite successful, with over 90% of anglers indicating awareness of sport-caught fish advisories. (The non-respondent follow-up indicated that this percentage would likely be lower when extrapolating to all anglers in the Great Lakes region.) The level of awareness among anglers has been high and perhaps increasing modestly over time. For example, Connelly and Knuth (1993) surveyed anglers who had fished the Great Lakes in the preceding five years and found most were aware of the sport-caught fish advisories (83%). Devoting resources to simply increasing awareness per se of sport-caught fish advisories likely will not result in much change, given the relatively high baseline level of self-reported awareness. Self-reported awareness of the specifics of the advisory was more limited, but most anglers indicated the sport-caught fish advisory provided them with enough information to decide whether or not to eat certain fish.

Awareness of purchased fish advisories was lower than awareness of sport-caught fish advisories among licensed anglers (70% vs. 92%). Not all state agencies focus efforts on making anglers aware of purchased fish advisories, perhaps explaining in part the lower level of awareness. Increasing state efforts (either on their own or by partnering with other organizations) to publicize purchased fish advisories may increase awareness above current levels.

Many anglers agreed with the statements testing some of the key messages stressed in the advisories (older and bigger fish generally have more contaminants than younger and smaller fish; contaminants can have a greater impact on children than adults; eating contaminated fish over time increases health risks). Those who indicated they were aware of advisory specifics also reported more certainty in their answers to the knowledge questions, but their answers to the knowledge questions suggest they had the same knowledge level as those who indicated only a general awareness of the advisory. This suggests that measuring perceived awareness of specific advisory details may reflect differences in confidence associated with understanding the advisory, rather than differences in knowledge about the details of the recommendations.

Anglers were more likely to indicate they didn't know the answer to a knowledge question than to choose the wrong answer. These responses suggest some strategies for agency communicators. Knowledge level of anglers could be targeted through communication programs, focusing on the most common "don't know" concepts. One key misperception, that may merit communication attention, is the fairly widely held perception that fish contaminated with chemicals will taste odd. Fewer than half of the anglers identified that contamination cannot be discerned by taste. Earlier work reported similar findings (Lauber et al. 2011a).

Anglers favor receiving information in the fishing regulations guide. This is the same source preferred by anglers in the 1991 Great Lakes angler survey (Connelly and Knuth 1993). The regulations guide typically does not provide a complete listing of all advisory information and recommendations. To address this concern, regulations guides could direct the reader to websites containing more complete information that some anglers (especially those with higher education levels) appear likely to access for advisory information. Some states already use the internet in this manner.

Anglers indicated they were interested in a variety of topics to help them make decisions about fish consumption, some of which are more amenable to communication methods other than those most preferred by anglers. For example, many anglers want information on where to fish to reduce health risks associated with eating contaminants in fish. This type of information might best be provided in the fishing regulations guide or on posted signs. However, health problems that may occur in children who eat contaminated fish was a topic of great interest to anglers but is likely not appropriate for posted signs, and space considerations might keep it out of the fishing regulations guide. It might be more easily discussed on a web site or in a brochure directed at parents. We recommend agencies focus on using the methods preferred by anglers, but acknowledge that a variety of methods will be needed to reach anglers with comprehensive information.

Fishing effort reported in this study is similar to that reported in earlier studies of anglers in the region. Average yearly fishing was 25 days for anglers in this study; 26 days for anglers fishing in New York in 2009 (Connelly and Brown 2009), and 27 days for anglers in the 1991 Great Lakes study (Connelly and Knuth 1993). Most anglers only fished in the state where they lived. However, some Illinois and Indiana anglers traveled to nearby states, primarily Wisconsin and Michigan, to fish. Consistent advisory messages across states and shared water bodies may be less confusing for anglers, especially those who cross state borders to fish.

Anglers reported eating about 20 meals of fish per year, with three-quarters being purchased fish and the remainder sport-caught. Very few anglers (<1%) reported consuming sport-caught fish above the 52 meals per year statewide recommendation of some states. Consistent with previous research (Connelly et al. 1992), these findings suggest that over-consumption of fish by licensed anglers in relation to the general consumption advice provided by some states is not a major concern. However, many species-specific and water body-specific advisories exist. Tables 22-28 in this report may be compared against these more specific advisories to determine if fish consumption by anglers at least for certain species may exceed advisory recommendations.

Anglers were more likely to use fish cleaning techniques that reduce possible exposure to some types of contaminants than risk-reducing cooking techniques, similar to previous findings (e.g., Connelly et al. 1992). Most anglers reported always filleting their fish and removing the skin and belly fat, but only 7% always baked, roasted, broiled, or grilled their fish. Anglers appear to use, at least some of the time, cooking techniques such as pan frying or deep frying that are generally not recommended because they do not reduce exposure to certain contaminants. States might investigate in more detail why these behaviors occur and revise their messages accordingly. Reusing oil or fat from cooking fish in future meals, which is not recommended, appears to be done very infrequently.

Some anglers reported making changes in response to the advisory, with the two most popular changes being eating smaller fish more often or eating fewer sport-caught fish. Relatively few anglers reported making changes that were not suggested in the advisories, such as eating larger fish or stopping sport-caught fish consumption altogether. Taken together, these findings provide evidence consistent with the idea that advisories are impacting angler behavior in the ways desired, but it appears possible to increase the number of anglers making choices that would reduce their exposure in the future (such as eating smaller fish or changing the species eaten).

Agencies are concerned about fish consumption suppression (an angler's actual consumption lower than their desired consumption due to concerns about contaminants). Most anglers enjoy eating sport-caught fish (76%), and quite a few (43%) indicated they would eat more fish if health risks from contaminants did not exist, confirming the concerns of agencies that fish consumption suppression occurs with some regularity. Agencies are also concerned about the number of anglers who fish because they need food for themselves or their family. In this study, few anglers (8%) reported they fished because they needed food. However, those with lower education levels were more likely to indicate they fished for food, and since mail surveys are generally biased toward greater rates of response among those with higher education levels, the number of anglers region-wide who fish because they need food is probably somewhat higher.

The factors with the greatest influence on anglers' attempts to follow the fish consumption advisories seem to be anglers' level of concern about the risks associated with sport-caught fish consumption and the views of their family and friends concerning limiting the amount of contaminated sport-caught fish consumed (Fig. 2). Concern about the risks was strongly correlated with beliefs about the risks and benefits of consumption. Many anglers believe that the risks are minor and that eating some types of sport-caught fish is fine, but many do not believe that the health benefits outweigh the health risks. Discussing the health benefits of fish

consumption is a goal of many the agencies that issue state fish consumption advisories (Lauber et al. 2011b), but additional attention may be needed to communicate that to anglers. Three-quarters of the anglers reported this was a topic they would be interested in learning about. The message may also need to be communicated in a way that includes family and friends, whose views are important to anglers.

Needs of Selected Target Audiences

Many of the recommendations discussed above apply as well to the targeted audiences discussed below, but we also make some specific suggestions for target audiences of concern to many state agencies. One group for which we will not make any additional suggestions is urban anglers. We did not find any significant differences between anglers living in urban areas and those from suburban and rural areas. Differences may exist between anglers who live and fish in urban areas and those who do not, but we were not able to confirm that in this study.

Illinois. The knowledge level of Illinois anglers was generally higher than anglers in other states, so continuing the efforts and methods that led to these results is recommended, especially using web sites which were a very important source for one-third of Illinois anglers. It is also important to coordinate advisory messages with neighboring states, because some Illinois anglers travel outside their state to fish. Illinois anglers were among the most likely to believe that eating some types of sport-caught fish won't harm them, so the message of good and bad fish is reaching these anglers. They did deep fry their fish a little more often than those in other states, so cooking messages might be aimed at discouraging that behavior for contaminated species and/or suggesting desirable alternatives. Anglers were much more likely than those in most other states to check the advisory for recommendations for waters they were going to fish, so maintaining that type of information in advisory communications is important.

Indiana. Indiana anglers were the most likely to indicate they were not at all aware of the sport-caught fish advice, and their level of knowledge was somewhat lower than anglers in other states. A goal might be increasing awareness of the sport-caught advisory and knowledge of key messages. The fishing regulations guide was an important information source, as were web sites, so communication efforts utilizing these methods may be particularly effective. It is also important to coordinate advisory messages with neighboring states, especially Michigan, because some Indiana anglers travel outside their state to fish. Indiana anglers consumed fewer fish than anglers in most other states, so they may be exposed to lesser amounts of contaminants depending on the specific species consumed, but at the same time they are not getting the health benefits of fish consumption. They did deep fry their fish a little more often than those in other states, so cooking messages might be aimed at discouraging that behavior for contaminated species and/or suggesting desirable alternatives. Anglers were much more likely to check the advisory for recommendations for waters they were going to fish and they were more likely to have changed where they fish because of the advisory than anglers in most other states, so maintaining that type of information in advisory communications is important.

Michigan. Advisory awareness was high among Michigan anglers and their knowledge level was higher than some states for certain items, so continuing the efforts and methods that led to these results is recommended. Many Michigan anglers were fishing Great Lakes waters and they

spent more days on average fishing them than anglers in other states, so making sure they are aware of the Great Lakes advisory is very important. Anglers living in Michigan were among the most likely to indicate they enjoyed eating sport-caught fish. Consumption of both sport-caught and purchased fish appeared greater in the summer months. Michigan anglers were more likely than anglers in the other states to be consuming some of the species which the advisories recommend limiting. Michigan anglers were also more likely than anglers in other states to always remove the belly fat and report that they have changed their fish cleaning behaviors as a result of the advisory. These methods are good ways to reduce exposure to certain contaminants, and especially good if their consumption of contaminated species is a bit higher. Therefore messages about fishing cleaning methods are important to continue to communicate to anglers.

Minnesota. Anglers living in this state were more knowledgeable about some topics compared to anglers in other states. They were the most likely to indicate they had enough information about purchased fish. Minnesota households were more likely than households in other states to eat smaller fish more often as a result of the health advisory. Minnesota anglers were more likely to always fillet and remove the skin than anglers in other states. These findings suggest that current advisory communications are reaching and being understood by Minnesota anglers. Minnesota anglers were among the most likely to indicate they enjoyed eating sport-caught fish. However, they consumed less fish in general, but reported higher consumption in the summer months than anglers in other states. Is the timing of consumption an issue for Minnesota anglers? Are they getting too much exposure to contaminants in the summer? These questions cannot be answered by this study, but might be worth exploring in future research. Minnesota children living in angler households ate fewer purchased fish meals on average compared to children in other states, but 80% of them ate at least one sport-caught fish meal in the past year. Although many anglers felt they had enough information about purchased fish, fewer children ate fish, so the health benefits of fish consumption for children might be an area for increased emphasis.

New York. Anglers living in New York were more knowledgeable about some topics compared to anglers in other states. They were the most likely to be concerned about the health risks from eating sport-caught fish, and the most likely to indicate they would eat more fish if health risks didn't exist. They were more likely than anglers in most other states to eat fewer sport-caught fish or stop eating sport-caught fish altogether as a result of the advisory. These findings indicate a knowledgeable, but cautious audience. Is the level of caution warranted? Anglers favor the fishing regulations guide as a source of information, and they would like information in the future from web sites along with the guide. Anglers living in New York reported greater fish consumption overall, particularly of purchased fish. New York anglers were more likely than anglers in most other states to eat canned tuna, and less likely to eat purchased salmon or bluegill/sunfish. However among those who ate purchased salmon, New York anglers ate more meals on average. Women living in households with anglers were less likely to consume sport-caught fish, and the majority of children living in angler households did not consume any sport-caught fish. New York anglers were the most likely to indicate that they tried to follow the advisory, perhaps accounting for the lower consumption among women and children who are advised not to eat any fish from waters with advisories in New York. New York anglers were less likely than anglers in most other states to use some of the recommended cleaning techniques,

but more likely to use the recommended cooking techniques. Changes might be made in the advisory materials to emphasize cleaning techniques, although many anglers were using these techniques, just not as high a proportion as in other states. Anglers were much more likely than anglers in other states to check the advisory for recommendations for waters they were going to fish, so maintaining that type of information in advisory communications is important.

Pennsylvania. Anglers living in Pennsylvania were the most likely to indicate they didn't know the answers to the knowledge questions. They would like to see information in the fishing regulations guide and websites, so these sources might be the best places for information aimed at increasing the knowledge level of anglers. Pennsylvania anglers were less likely than anglers in most other states to use some of the recommended cleaning techniques, but more likely to use the recommended cooking techniques. Changes might be made in the advisory materials to emphasize cleaning techniques, although many anglers were using these techniques, just not as high a proportion as in other states. Pennsylvania anglers were more likely than anglers in most other states to eat fewer sport-caught fish as a result of the advisory.

Wisconsin. Advisory awareness was high among Wisconsin anglers and their knowledge level was higher than that of anglers in some states for certain items. Continuing the efforts and methods that led to these results is recommended. Anglers living in Wisconsin were among the most likely to indicate they enjoyed eating sport-caught fish, and to believe that eating some types of sport-caught fish won't harm them. They were the least likely to be concerned about the potential health risks associated with eating sport-caught fish.

Women of childbearing age and children. Compared to anglers in households without women under age 50, anglers living in households with women under age 50 were less likely to be aware of the sport-caught or purchased fish advisories, and less likely to be aware of the specifics of either advisory if they were aware of the advisories at all. These anglers were also less likely to know that older fish generally have more contaminants than younger fish. Because special advice for women of childbearing age is often emphasized in most advisory communications, the lower level of awareness and knowledge among anglers with such household members is of special concern. Targeting women of childbearing age more directly with fish consumption guidance may be more effective than relying on (mostly male) anglers to transmit this information to women in their households. Most states are already taking this approach.

Women under age 50 reported eating more purchased fish than did men or older women, but not more sport-caught fish. Canned tuna consumption was higher among women under age 50 compared to other groups. Very few women under age 50 reported eating swordfish, consistent with recommendations from many organizations against any consumption of this species for this group.

Angler reports suggest that two-thirds of children living in households with anglers were consuming sport-caught fish, but most were consuming 12 or fewer meals per year. These reports also suggest that children were eating fewer purchased fish meals than others in their household. (A cautionary note: Consumption estimates were being made by the angler. We have no reason to suspect that anglers were either over or under estimating consumption, but the accuracy of the reported number is uncertain.)

Anglers with lower education levels. This group of anglers was less likely to be aware of or knowledgeable about fish consumption advisories compared to anglers with higher education levels. They were more likely to indicate they didn't know the answers to the knowledge questions, and they were more likely to indicate that government agencies really don't know how much chemical contamination is in fish. No source of information was favored more by this group; perhaps communication methods other than the standard ones should be considered. This group was more likely to report wanting to do what their family and friends think is best with regard to limiting the amount anglers themselves eat, suggesting communication methods that involve social networks might be effective.

Anglers in this group ate fewer purchased fish meals than their counterparts, perhaps due to the cost. They were more likely to report they fished because they needed food, but the percentage was still low (12%) compared with other anglers. They were more concerned about the potential health risks, and less confident that they could limit the amount of contaminated sport-caught fish they consumed. Communication with this group will continue to be a challenge.

Non-white anglers. Non-white anglers were less aware of sport-caught advisories than white anglers. They were also more likely to have the perception that fish contaminated with chemicals will taste odd. State communicators might focus communication efforts with non-white audiences on addressing this misperception.

Non-white anglers were more likely than white anglers to identify the following sources as being very important information sources in the past: health care providers, TV or radio, websites, and health advice brochures. However, they were not more likely to indicate they would use these sources in the future compared with white anglers. The fishing regulations guide was still the most likely sources to be accessed. Non-white anglers were more likely than white anglers to be very or extremely interested in the following topics: health problems that may occur in children, health problems that may occur in children whose mothers eat contaminated fish, and where to fish to reduce health risks. These interests suggest that both sources used in the past, such as information from health care providers, and sources they indicated they would access in the future, such as the fishing regulations guide, are important for future communications. This group was more likely to indicate they fished because they needed food, but the percentage was still low (15%) compared with white anglers. Two-thirds indicated they would eat more fish if health risks from contaminants did not exist. One-third were very concerned about the potential health risks. Communication with this group is challenging because non-white anglers are not a homogeneous group; we did not have sufficient sample size to analyze by specific racial or ethnic groups. However, in general, we recommend that communication with non-white anglers address their concerns about the health risks, and perhaps emphasize the health benefits of fish consumption.

Discussion and Recommendations for Research

The low response rate to this survey is consistent with trends observed nationwide regarding mail surveys (Groves et al. 2002). Connelly et al. (2003) showed that response rates to natural resource-focused mail surveys they had conducted were declining at a rate of about 1% per year.

Possible explanations they offered for the decline included increasing junk mail being delivered to the household making it difficult for a particular survey to stand out, and loss of public trust in survey research. Today we would add the increasing use of the internet for conducting important business and a subsequent decline in use of postal services for those activities, making mail received perceived as less important. With a low response rate, a non-respondent follow-up becomes vital to assess the representativeness of the responding anglers. In this study, non-respondents fished less and were less likely to be aware of the advisories, but did not consume fewer fish. Researchers should continue to develop approaches to increase response rates, including consideration of alternative methods of data collection (e.g., web-based surveys).

In future implementation of survey-based research with similar objectives and purpose to this study, some questions included in this study should be reexamined and perhaps modified. For example, the question asking respondents to assess their own level of advisory awareness (i.e., none, general, or specific) may be measuring a different construct than intended. The intention of the question included in this study was to measure the level of detail that anglers perceived they were familiar with in the fish consumption advisories. However, because the level of advisory knowledge did not differ between those who reported being generally aware of advisories vs. those who reported being very aware of the specifics of the advisories, it seems possible that the question was measuring perceived confidence or certainty of knowledge about the advisories, because those who said they were aware of the specifics were more likely to strongly agree or disagree with the knowledge statements.

Similarly, the question about sources of advisory information should be reconsidered and perhaps modified. The large number of respondents indicating that “warnings posted on waters I fish” was an important source of information for them is incongruent with the current practice of most Great Lakes states not posting warning signs or posting very few (Consortium members, pers. comm.). We do not know what anglers were considering when they responded to this question. If anglers believe that no fish consumption advisories exist for a particular water because they see no postings at the fishing site, different communication strategies would be needed to properly inform anglers about the actual reasons most states do not post waters (i.e., the cost and logistics of posting). Future research should examine how respondents interpret the lack of physically posted signs at fishing sites.

The measure of perceived behavioral control used in this study, “I am confident I can limit the amount that I eat of sport-caught fish with contaminants,” was not strongly correlated with the two measures of behavioral intention. This may be related to most people agreeing with the statement that they were confident. However, this result could reflect challenges in using the term “confident” to gauge the broader concept of perceived behavioral control in the context of fish consumption advisories. For instance, it is possible that a single item using the word “confident” did not capture broader beliefs about factors that undermine the extent to which anglers can control the amount they eat of sport-caught fish with contaminants. These factors may include access to waters with lower levels of contamination, a lack of understanding about conditions that lead fish to have higher levels of contaminants, or the need to fish for subsistence. A subsequent study currently underway replaces “confident” with alternative measures that gauge perceived barriers in “access” to less-contaminated fish.

A series of questions in the survey asked anglers to indicate how interested they were in a set of topics that might be included in advisory communications. As in previous research (Connelly and Knuth 1993), anglers appeared to have a similar level of interest in most of the topics. This lack of differentiation between topics does not provide useful insight into what topics are most important to communicate. Other methods to elicit this type of information should be developed, for example, asking anglers to indicate what types of information would be most likely to encourage them to change their behavior and follow the advisory recommendations (if they were already following the guidelines). Alternative methods may be needed to explore this issue as well, such as personal interviews or focus groups.

Two general avenues for future research with licensed anglers in the Great Lakes region may be productive. First, evaluation of new communication methods or messages could be conducted as state members of the Consortium use the results of this research and modify their advisory communication strategies. States may partner in implementing common changes across states or may make selective changes, both of which would benefit from evaluation. Second, research could focus on measuring progress toward the Consortium goal to increase public knowledge about the risks and benefits of fish consumption and reduce exposure of the public to toxic substances from consumption of contaminated fish, using this study as a baseline from which to measure progress toward that goal.

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APPENDIX A
Study Questionnaire

**A SURVEY OF
ANGLERS LIVING IN THE
GREAT LAKES REGION:
Fishing and Eating Fish**



69



Cornell University
Human Dimensions Research Unit

AND

A CONSORTIUM OF THE 8 GREAT LAKES' STATES
(Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio,
Pennsylvania, New York)

**A SURVEY OF ANGLERS LIVING IN
THE GREAT LAKES REGION**

Research conducted by the
Human Dimensions Research Unit
Department of Natural Resources
Cornell University

The purpose of this survey is to learn about your fishing experiences, how much you eat of the fish you catch, and your opinions about health advisories related to fish consumption. Cornell University is working with environmental and public health experts in all 8 states in the Great Lakes region to find better ways to let anglers know about the benefits and risks associated with eating fish. Your participation in this survey will help us to understand where you are fishing, if you eat the fish you catch, and what information you would like to know about the health risks and health benefits of eating the fish you catch. If you don't eat fish, it is still important for you to fill out the survey so we can learn about the decisions you have made.

Your name was randomly selected from a list of people who had a license that allowed fishing in your home state in 2010-2011.

Please complete this questionnaire as soon as you can, seal it with the white re-sealable label provided, and drop it in any mailbox; return postage has been paid. Your participation in this survey is voluntary, but we sincerely hope you will take just a few minutes to answer our questions. Your identity will be kept confidential and the information you give us will never be associated with your name.

THANK YOU FOR YOUR HELP!

1. Did you fish in the state where you live between September 1, 2010 and August 31, 2011?

- No (SKIP to Question 3)
 Yes (GO TO Question 2)

2. In the state where you live, about how many days did you fish on each type of water between Sept. 1, 2010 and Aug. 31, 2011?
(When we say "Great Lakes waters," we mean the 5 Great Lakes and major rivers or streams that run into them or connect them, like the St. Mary's River or the Niagara River. See map on front cover.)

Water Type	Number of Days
Great Lakes Waters	
Non-Great Lakes Rivers or Streams	
Other Lakes or Ponds	

3. Which of the Great Lakes states (pictured on the front cover) did you fish in between September 1, 2010 and August 31, 2011?
(Check all that apply.)

- Illinois Indiana Michigan Minnesota
 New York Ohio Pennsylvania Wisconsin

Some Definitions that Apply to the Rest of the Questionnaire

“Sport-caught fish” means fish *caught* by you, your friends, or family in any of the 8 Great Lakes states; the type of fish (e.g., panfish, bass, trout) does not matter

“Purchased fish” means fish *purchased* at a store or restaurant

4. About how many meals of fish did you eat from the following sources this past summer? How many in total for the past year?

	Number of Meals Eaten Between June 1 and August 31	Total Number of Meals Eaten in Past 12 Months
Sport-caught fish in any of the 8 Great Lakes states		
Purchased fish		

IF YOU DID NOT EAT ANY FISH IN THE PAST 12 MONTHS, PLEASE SKIP TO QUESTION 7.

5. How many meals of the following types of fish did you eat in the past 12 months? (Please write in zero “0” if you didn’t eat any of that fish. If you know you ate the fish, but can’t remember how many meals, give us your best guess or put a question mark (?) next to the fish.)

Purchased Fish			
	# of Meals in past 12 months		
Salmon			
Swordfish			
Canned Tuna			
Sport-caught Fish in the 8 Great Lakes States			
	# of Meals in past 12 months		# of Meals in past 12 months
Bass		Northern Pike	
Bluegill/Sunfish		Salmon	
Bullhead		Suckers	
Carp		Trout (brook, brown, rainbow)	
Catfish		Walleye	
Crappie		Whitefish	
Lake Trout		Yellow Perch	

IF YOU DID NOT EAT ANY SPORT- CAUGHT FISH IN THE PAST 12 MONTHS, SKIP TO QUESTION 7.

6. How often are sport-caught fish prepared or cooked in the following ways in your household? (Check one box for each technique.)

Fish preparation and cooking techniques	Never	Rarely	Sometimes	Usually	Always	Don't know
Remove belly fat	<input type="checkbox"/>					
Remove the skin	<input type="checkbox"/>					
Fillet the fish	<input type="checkbox"/>					
Pan fry	<input type="checkbox"/>					
Deep fry	<input type="checkbox"/>					
Bake, roast, broil, or grill fish	<input type="checkbox"/>					
Reuse oil or fat from cooking fish in future meals	<input type="checkbox"/>					

7. Some fish have been found to contain chemical contaminants (such as mercury or PCBs), that may cause health problems for people who eat the fish. Government agencies provide fish consumption advisories recommending limiting how much of certain kinds of fish you eat. Before getting this survey, did you know about these advisories for sport-caught fish in the 8 Great Lakes states? For purchased fish? (Check one in each row.)

	Yes, aware of specific advice	Yes, generally or vaguely aware	Not at all aware
a. Sport-caught fish in the 8 Great Lakes states	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Purchased fish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

IF YOU ARE NOT AT ALL AWARE OF THE GOVERNMENT ADVISORIES, PLEASE SKIP TO QUESTION 10.

8. How much do you agree or disagree with the following statements? (Check one box for each statement.)

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
The advisories provide me with enough information to decide whether or not to eat certain sport-caught fish	<input type="checkbox"/>					
The advisories provide me with enough information to decide whether or not to eat certain purchased fish	<input type="checkbox"/>					
I try to follow the advisory recommendations when deciding what fish to eat	<input type="checkbox"/>					
I check the advisory for recommendations for waters I'm going to fish	<input type="checkbox"/>					

9. Have you or members of your household made any of the following changes because of what you learned in the advisories? (Check all that apply.)

	I made the change	Other adult household members made the change	Children in the household made the change
a. Eat smaller fish more often	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Eat larger fish more often	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. Eat more fish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. Eat fewer sport-caught fish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Stopped eating sport-caught fish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. Eat fewer purchased fish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g. Changed the species of fish eaten	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
h. Changed where we fish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
i. Changed the way we clean fish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
j. Changed the way we cook fish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

10. Please indicate how strongly you agree or disagree with the following statements. (Check one box for each statement.)

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
Any health problems from eating fish contaminated with chemicals are mainly short term	<input type="checkbox"/>					
Older fish generally have more contaminants in them than younger fish	<input type="checkbox"/>					
Fish contaminated with chemicals will taste odd	<input type="checkbox"/>					
Smaller fish generally have more contaminants in them than larger fish	<input type="checkbox"/>					
Contaminants from fish can have a greater impact on children than on adults	<input type="checkbox"/>					
Eating contaminated fish over many years increases my health risks	<input type="checkbox"/>					



11. How important have the following sources been in the past to help you make decisions about eating fish? Which sources are you likely to use in the next year?

Information Sources	Importance of source in the past (Choose one)			Likely to use in the next year (Check all that apply.)
	Not at all important	Somewhat important	Very Important	
Newspaper articles	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fishing regulations guide distributed with fishing license	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Web sites	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Health advice brochures from government agencies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Warnings posted on waters I fish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Television or radio reports	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Friends or family	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Charter boat operators or guides	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My health care providers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
iPhone/Smartphone apps	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sportsman's Shows or Farm Shows	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other (please specify):	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

In the following questions, “*health risk*” refers to the possibility of health problems from chemical contaminants in sport-caught or purchased fish.

12. How interested would you be in having information on the following topics to help you make decisions about eating fish:
(Check one box for each topic.)

Topics	Not at all interested	Somewhat interested	Interested	Very interested	Extremely interested
How health risks from contaminants change as the amount of fish eaten changes	<input type="checkbox"/>				
How to clean fish to reduce health risks	<input type="checkbox"/>				
How to cook fish to reduce health risks	<input type="checkbox"/>				
Which species of fish to eat to reduce the health risks	<input type="checkbox"/>				
The health benefits that may occur for people who eat fish	<input type="checkbox"/>				
The health problems that may occur in adults who eat contaminated fish	<input type="checkbox"/>				
The health problems that may occur in children who eat contaminated fish	<input type="checkbox"/>				
The health problems that may occur in children whose mothers eat contaminated fish, before or during pregnancy	<input type="checkbox"/>				
How government agencies decide which fish are safe to eat	<input type="checkbox"/>				
The contaminants in fish that cause advisories to be issued	<input type="checkbox"/>				
Where to fish to reduce health risks of contaminants in fish	<input type="checkbox"/>				
Which sizes of fish to eat to reduce health risks	<input type="checkbox"/>				

13. Please indicate how strongly you agree or disagree with the following statements. (Check one box for each statement.)

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
Health benefits of eating sport-caught fish are greater than health risks	<input type="checkbox"/>					
Health risks from eating contaminated sport-caught fish are minor compared to other risks I'm exposed to in life	<input type="checkbox"/>					
I would eat more sport-caught fish if health risks from contaminants did not exist	<input type="checkbox"/>					
I don't think government agencies really know how much chemical contaminants are in fish	<input type="checkbox"/>					
Eating <i>some</i> types of sport-caught fish won't harm me	<input type="checkbox"/>					
Eating <i>all</i> types of sport-caught fish won't harm me	<input type="checkbox"/>					
My family and friends think it is important that I limit the amount that I eat of sport-caught fish with contaminants	<input type="checkbox"/>					
Most of my family and friends limit the amount that they eat of sport-caught fish with contaminants	<input type="checkbox"/>					
When it comes to limiting the amount that I eat of sport-caught fish with contaminants, I want to do what my family and friends think is best	<input type="checkbox"/>					
I fish because I, or my family, need food to eat	<input type="checkbox"/>					
I am confident I can limit the amount that I eat of sport-caught fish with contaminants	<input type="checkbox"/>					
I enjoy eating sport-caught fish	<input type="checkbox"/>					

14. How concerned are you that eating sport-caught fish is a potential health risk to you or members of your household? (Circle one.)

Very Concerned Somewhat Concerned Slightly Concerned Not at all Concerned Don't Know

BACKGROUND INFORMATION

15. Are you male or female? (Check one.) Male Female

16. In what year were you born? 19____

17. Is your primary residence: (Check one.)

Urban Suburban Rural

18. Other household members: (Please fill in the chart below for other people living in your household.)

Household member's relationship to you (e.g., wife, son)	Gender (M or F)	Age	Estimated number of meals of sport-caught fish eaten in past 12 months	Estimated number of meals of purchased fish eaten in past 12 months

19. What is the highest level of education you have completed? (Check one.)

- Less than high school
- High school diploma / G.E.D.
- Some college or technical school
- Associate's degree
- College undergraduate degree (e.g., B.A., B.S.)
- Graduate or professional degree (e.g., M.S., Ph.D., M.D., J.D.)

20. What was the total income of your household before taxes last year?

- Less than \$25,000
- \$25,000 to \$49,999
- \$50,000 to \$99,999
- \$100,000 to \$199,999
- \$200,000 or more

21. What is your race? (Check all that apply.)

- White
- Black or African-American
- Asian or Pacific Islander
- Native American Indian
- Other

22. Are you of Hispanic, Latino, or Spanish origin?

- No Yes

Please use the space below for any comments you wish to make.

Hold for back cover with business reply

Thank you for your time and effort!

To return this questionnaire, simply seal it with the white removable seal, and drop it in the mail (return postage has been paid).

APPENDIX B

Table B-1. Tests for non-response bias.

Questions	Respondents	Non-respondents
	Percent	
Fish in state of residence between Sept. 1, 2010 and Aug. 31, 2011		
No	11.8	29.8
Yes	88.2	70.2
	($x^2 = 80.8$, $df = 1$, $p < 0.001$)	
Aware of sport-caught fish advisory		
No	8.8	21.1
Yes, generally aware	46.3	53.8
Yes, aware of specific advice	44.9	25.1
	($x^2 = 76.6$, $df = 2$, $p < 0.001$)	
Aware of purchased fish advisory		
No	30.3	60.4
Yes, generally aware	43.6	28.8
Yes, aware of specific advice	26.1	10.8
	($x^2 = 128.1$, $df = 2$, $p < 0.001$)	
Health benefits of eating sport-caught fish are greater than health risks		
Strongly agree	5.1	17.0
Agree	28.9	40.1
Neutral	33.6	19.5
Disagree	12.7	11.5
Strongly disagree	4.0	3.8
Do not know	15.7	8.1
	($x^2 = 109.2$, $df = 5$, $p < 0.001$)	
Health risks from eating contaminated sport-caught fish are minor compared to other risks I'm exposed to in life		
Strongly agree	7.0	20.8
Agree	38.9	47.9
Neutral	24.9	11.3
Disagree	15.0	10.0
Strongly disagree	3.8	4.0
Do not know	10.4	6.0
	($x^2 = 109.1$, $df = 5$, $p < 0.001$)	
Level of concern that eating sport-caught fish is a potential health risk to you or members of your household		
Very concerned	22.7	10.5
Somewhat concerned	30.7	12.3
Slightly concerned	25.5	23.8
Not at all concerned	19.6	51.3
Do not know	1.5	2.1
	($x^2 = 186.1$, $df = 4$, $p < 0.001$)	

Table B-1 (cont.)

	Respondents	Non-respondents
	Percent	
Gender		
Male	80.6	79.9
Female	19.4	20.1
	NS	
Women under age 50 living in household		
No	60.6	49.2
Yes	39.4	50.8
	($\chi^2 = 16.8$, $df = 1$, $p < 0.001$)	
Children under age 15 living in household		
No	78.6	69.0
Yes	21.4	31.0
	($\chi^2 = 16.2$, $df = 1$, $p < 0.001$)	
Primary residence area		
Urban	14.0	20.0
Suburban	37.8	35.4
Rural	48.2	44.6
	($\chi^2 = 8.7$, $df = 2$, $p = 0.01$)	
	Mean	
Average # of days fished in state of residence	25.9	19.9
	($t = 2.69$, $df = 402$, $p = 0.004$)	
Average # sport-caught fish meals eaten in summer	3.5	4.1
	NS	
Average # sport-caught fish meals eaten in past 12 months	5.9	8.8
	($t = 2.75$, $df = 492$, $p = 0.006$)	
Average # purchased fish meals eaten in summer	7.8	8.6
	NS	
Average # purchased fish meals eaten in past 12 months	15.4	23.5
	($t = 4.9$, $df = 507$, $p < 0.001$)	
Age	50.8	50.3
	NS	