

# Patterns of Harvest and Consumption of Lake Champlain Fish and Angler Awareness of Health Advisories



Lake Champlain  
Basin Program

Prepared by  
Nancy A Connelly and Barbara A. Knuth

for  
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#### Lake Champlain Basin Program Technical Reports

1. *A Research and Monitoring Agenda for Lake Champlain.* Proceedings of a Workshop, December 17-19, 1991, Burlington, VT. Lake Champlain Research Consortium. May, 1992.
2. *Design and Initial Implementation of a Comprehensive Agricultural Monitoring and Evaluation Network for the Lake Champlain Basin.* NY-VT Strategic Core Group. February, 1993.
3. (A) *GIS Management Plan for the Lake Champlain Basin Program.* Vermont Center for Geographic Information, Inc., and Associates in Rural Development. March, 1993.  
  
(B) *Handbook of GIS Standards and Procedures for the Lake Champlain Basin Program.* Vermont Center for Geographic Information, Inc. March, 1993.  
  
(C) *GIS Data Inventory for the Lake Champlain Basin Program.* Vermont Center for Geographic Information, Inc. March, 1993.
4. (A) *Lake Champlain Economic Database Project. Executive Summary.* Holmes & Associates. March 1993.  
  
(B) *Socio-Economic Profile, Database, and Description of the Tourism Economy for the Lake Champlain Basin.* Holmes & Associates. March 1993  
  
(B) *Socio-Economic Profile, Database, and Description of the Tourism Economy for the Lake Champlain Basin. Appendices.* Holmes & Associates. March 1993  
  
(C) *Potential Applications of Economic Instruments for Environmental Protection in the Lake Champlain Basin.* Anthony Artuso. March 1993.  
  
(D) *Conceptual Framework for Evaluation of Pollution Control Strategies and Water Quality Standards for Lake Champlain.* Anthony Artuso. March 1993.
5. *Lake Champlain Sediment Toxics Assessment Program. An Assessment of Sediment - Associated Contaminants in Lake Champlain - Phase 1.* Alan McIntosh, Editor, UVM School of Natural Resources. February 1994.  
  
*Lake Champlain Sediment Toxics Assessment Program. An Assessment of Sediment - Associated Contaminants in Lake Champlain - Phase 1. Executive Summary.* Alan McIntosh, Editor, UVM School of Natural Resources. February 1994.
6. (A) *Lake Champlain Nonpoint Source Pollution Assessment.* Lenore Budd, Associates in Rural Development Inc. and Donald Meals, UVM School of Natural Resources. February 1994.  
  
(B) *Lake Champlain Nonpoint Source Pollution Assessment. Appendices A-J.* Lenore Budd, Associates in Rural Development Inc. and Donald Meals, UVM School of Natural Resources. February 1994.

**FINAL REPORT**

**Patterns of Harvest and Consumption  
of Lake Champlain Fish  
and Angler Awareness of Health Advisories**

Prepared by

Nancy A. Connelly and Barbara A. Knuth

Human Dimensions Research Unit  
Department of Natural Resources  
Cornell University  
Ithaca, NY 14853

For

Lake Champlain Management Conference

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## EXECUTIVE SUMMARY

In early 1992, the Lake Champlain Research Consortium assigned a high research priority to obtaining information about the actual rates of fish consumption by local populations and data on fish consumption associated with Lake Champlain. This study is a result of that high research priority. Our objectives were to: (1) identify patterns of fish consumption and fish cooking and cleaning methods used by Lake Champlain anglers and their households; (2) assess fish consumption advisory awareness and understanding among Lake Champlain anglers; (3) describe fishing activities of Lake Champlain anglers, including fishing locations, frequencies, and species harvested; (4) determine the sociodemographic characteristics of Lake Champlain anglers, and identify relationships between these characteristics and fishing activities, fish consumption patterns, and awareness of the Lake Champlain health advisory; and (5) recommend improvements to fish flesh monitoring programs and health advisory communication programs based on the results of the study. Because funds to support this research effort were quite limited, we used a 12-month recall mail survey to estimate fish consumption, rather than more accurate (and more costly) methods such as shorter recall periods or diary approaches. We selected a systematic sample of 2,000 1992 resident fishing licenses from the eight counties bordering Lake Champlain, evenly split between New York and Vermont. The mail survey was implemented in September, 1993.

## RESULTS

The final adjusted response rate was 48.4%. A telephone nonresponse follow-up survey indicated few significant differences between mail survey respondents and nonrespondents. Nonrespondents were less likely than respondents to have fished Lake Champlain in the preceding five years, less likely to be aware of health advisories, and less likely to have graduated high school and have completed some years of college-level education. Population-level estimates were corrected for nonresponse bias where possible, and include various weighting factors reflecting the sampling strategy used.

### Advisory Awareness

Approximately 60% of the license buyers in the eight counties surrounding Lake Champlain fished the Lake in the preceding five years. These anglers were used as the basis of most further analyses. An estimated 71% of these licensed anglers were aware of the health advisories. Advisory awareness differed by sociodemographic characteristics, with awareness lower among younger respondents, those with lower incomes, and non-whites. Few respondents held inaccurate knowledge about the effects of contaminants on fish, negative health effects of contaminated fish consumption, positive health effects of fish consumption, and risk-reducing behaviors, but many (29-55%) were unsure about the correct answers.

### Attitudes Toward the Advisories and Health Risks

The majority of respondents who were aware of the health advisories felt the advisories provided them with enough information to decide whether or not to eat certain fish. About 40% of respondents thought the health risks from eating contaminated sport-caught fish were minor when compared to other risks to which they were exposed.

### Fishing-related Behaviors

On average, respondents fished 20.5 days per year, with almost half of those days attributed to fishing from boats. Respondents were most likely to fish the mid-lake section or the area around Grand Isle, although distribution of fishing effort reported was lake-wide. Respondents estimated harvesting 9 fish per day of fishing effort. The most frequently harvested fish was yellow perch. Respondents reported consuming an average of 30 fish meals per year from all sources (range 0-300). Respondents who fished Lake Champlain in 1992-93 reported consuming an average of 17.4 fish meals in 1992-93 from fish caught in Lake Champlain. Of those who fished the Lake, 34% said they did not eat any fish from the Lake in that year. The average fish consumption for those eating Lake Champlain fish was 26.2 meals per year. Respondents were assigned to one of four groups based on their level of adherence to the specific Lake Champlain health advisory. About 72% of respondents were in the first group; they fished Lake Champlain but did not harvest or eat species listed in the health advisory. The second group (5%) harvested listed species (e.g., lake trout over 25", walleye over 19"), but did not eat any of them. The third group (18%) harvested listed species and ate them, but kept within the limits recommended in the advisory of no more than one meal per month. Few anglers' consumption (5%) exceeded the levels recommended in the advisory. Most of these anglers (90%) were New York license-buying women of childbearing age, for whom "exceeding the advisory" means consumption of any Lake Champlain fish. Thus, almost all New York license-buying women not of childbearing age, Vermont license-buying women of all ages, and men are following the species-specific Lake Champlain advisory. A plurality (48%) of these women of childbearing age who were exceeding the



consumption recommendations said they were unsure what was recommended in the health advisory for women of childbearing age. The more fish meals an angler consumed, the more likely he/she was to use fish cleaning techniques that reduce risks from some contaminants (e.g., PCBs).

## RECOMMENDATIONS

Although awareness of health advisories among licensed anglers was only moderate, fish consumption was generally within the limits recommended in the health advisories. Fish consumption recommendations seem to be exceeded, however, for a potentially high-risk group, New York license-buying women of childbearing age. Health advisory communication programs should:

1. Expand current communication strategies that have resulted in a 71% awareness rate among licensed Lake Champlain anglers.
2. Target specific locations and audiences with increased risk communication efforts.
3. Include the health advisory in the fishing regulations guide in both states.
4. Acknowledge the differences between the New York and Vermont health advisories, and the reasons for them, particularly for women of childbearing age and children.
5. New York should clarify the advice for women of childbearing age and children under 15 for Lake Champlain fish not specifically listed in the advisory.
6. Evaluate the use of posted warnings.
7. Emphasize both the benefits and the limits of risk-reducing fish preparation techniques.

8. Develop communication partnerships.

Fish flesh monitoring programs should:

1. Sample frequently-fished in-shore areas.
2. Include regular sampling of yellow perch.
3. Consider regular monitoring programs for the primary species consumed in each major fishing location.
4. Ensure monitoring programs sample extensively at those areas producing the highest rates of fish consumption.
5. Consider expanding monitoring programs to include more extensive sampling in areas fished by at least 20% of Lake Champlain anglers.

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## INTRODUCTION

Lake Champlain, New York and Vermont, is subject to a fish consumption health advisory. The advisory is due primarily to the presence of mercury and polychlorinated biphenyls (PCBs) in some fish tested. During the period of this study (1992-1993), the advisory applied to lake trout greater than 25" (for PCBs) and walleye greater than 19" (for mercury) caught in Lake Champlain (NYSDOH 1992; VTDOH 1989, 1990). The Lake Champlain health advisory recommended that consumption of these fish be limited to no more than one meal per month. However, infants, children under the age of 15, and women of childbearing age were advised in the New York advisory not to eat fish from Lake Champlain; this special recommendation did not apply in Vermont. The Lake Champlain health advisory also included a recommendation that consumption of American eel and brown bullhead from Cumberland Bay within Cumberland Head to Valcour Island be limited to no more than one meal per month (NYSDOH 1992).

A primary objective underlying health advisories is to protect the health of certain target populations by inducing them to limit their fish consumption according to the recommendations in the health advisory (Knuth and Connelly 1991). Evaluating whether this management objective is being achieved can be complex. Evaluation should assess the awareness of the advisory and extent of knowledge about the advisory among potential fish consumers, and compare actual fish consumption behavior with recommendations in the advisory (Knuth 1990, Connelly et al. 1992).

In early 1992, the Lake Champlain Research Consortium assigned a high research priority to obtaining information about the actual rates of fish consumption by local populations and data on fish consumption (specific to species) associated with Lake Champlain (LCRC 1992). This study is a result of that high research priority. A primary objective of the research project



was to estimate fish consumption. Funds to support the research priority were limited, however. Thus, a 12-month recall survey was used to estimate fish consumption rather than more accurate but more costly methods such as shorter recall or diary approaches.

Estimates of fish harvest were also important to obtain. Creel survey data gathered by fishery management programs provide a basis for comparing fish catch and associated consumption data collected through a targeted fish consumption study. Differences between the two data sets can be used to assess potential bias in the fish consumption estimates.

A variety of data are needed to help explain observed fish consumption patterns and assess what relationship fish consumption patterns have to potential human health concerns. Information needs include what species of fish people eat and in what quantities; description of fish preparation methods used; sociodemographic characteristics of fish consumers; and awareness and understanding of the health advisory.

A theoretical framework and previous empirical studies conducted by the authors in the Great Lakes and Ohio River Valley provided the conceptual foundation for this study. Both attitudes and behaviors must be measured to evaluate the impacts of health advisories on anglers. The Theory of Planned Behavior (Ajzen and Fishbein 1980; Ajzen 1989) guided research instrument development and analysis (Fig. 1).

The Theory of Planned Behavior holds that behavior is a result of several determinants, including a set of external variables, and a host of beliefs and attitudes. Connelly et al. (1992) and Knuth et al. (1993) used this theory to demonstrate that behavioral responses of potential fish consumers to recommendations in health advisories are a function of a set of

external variables (i.e., sociodemographic characteristics, awareness and knowledge of the health advisory), beliefs, and attitudes. Understanding these relationships for Lake Champlain anglers and comparing them with anglers in other regions where different health advisory communication strategies are used could help identify potential improvements to the Lake Champlain advisory that might result in greater "compliance" with the advisory recommendations.

### Objectives

The objectives of this study were to:

- (1) identify patterns of fish consumption and fish cooking and cleaning methods used by Lake Champlain anglers and their households;
- (2) assess fish consumption advisory awareness and understanding among Lake Champlain anglers;
- (3) describe fishing activities of Lake Champlain anglers, including fishing locations, frequencies, and species harvested;
- (4) determine the sociodemographic characteristics of Lake Champlain anglers, and identify relationships between these characteristics and fishing activities, fish consumption patterns, and awareness of the Lake Champlain health advisory;
- (5) recommend improvements to fish flesh monitoring programs and health advisory communication programs based on the results of this study.

## METHODS

### Sample Selection

A systematic sample of 2,000 licenses (1,000 each from New York and Vermont) was selected for the 1992 license year. All licenses permitting resident fishing, which were purchased in the eight counties bordering Lake Champlain (Clinton, Essex, Washington, Grand Isle, Franklin, Chittenden, Addison, and Rutland), formed the population from which the sample was drawn. Using only resident licenses addressed the Lake Champlain Research Consortium priority of assessing fish consumption by local populations and prevented the possible duplication of names between the New York and Vermont samples. Using data from a previous study of New York license buyers (Connelly et al. 1990), we estimated that 53% of anglers who fished Lake Champlain from New York purchased their license in one of the three counties bordering Lake Champlain. Similar data were not available for Vermont anglers, but we made the same assumption that anglers purchasing a license in the counties bordering Lake Champlain were most likely to fish the Lake. Using counties bordering the Lake was the most economical way to draw a sample likely to have fished Lake Champlain. Licenses from Vermont and from urban areas bordering Lake Champlain (i.e., Clinton and Chittenden counties) were drawn in excess of their true proportions in the population. Oversampling was necessary to ensure a sufficient number of responses for statistical analysis by state and by urban vs. rural areas within the Lake Champlain Basin. Weighting was used during certain analyses to reflect true population proportions when discussing overall lakewide results, as described later in this section.

### Questionnaire Development

A mail questionnaire was developed to measure harvest and consumption of Lake Champlain fish for a 12-month period beginning September 1, 1992. Emphasis was placed on determining those species most frequently caught and those most likely to be affected by contaminants. The draft questionnaire was reviewed by members of the Technical Advisory Committee of the Lake Champlain Basin Program. Data were collected to allow comparisons between harvest measured in the current study and harvest rates developed from previous creel surveys (Vermont Fish and Wildlife Department 1990, 1991a, 1991b, 1991c, 1992a, 1992b, [in press]a, [in press]b). The questionnaire also contained some questions similar to those asked in previous studies of New York, Great Lakes, and Ohio River anglers (Connelly et al. 1992, Connelly and Knuth 1993, Knuth et al. 1993). These questions included reasons for not fishing Lake Champlain, fish preparation and cooking methods, awareness of health advisories, knowledge of specific health advisory information, and general attitude questions. Including these questions allowed comparison between the results of the current study and the previous studies in other regions, so that Lake Champlain health advisory communication strategies might be enhanced by learning from other programs. Questions were also asked about household composition, Lake Champlain fish consumption by household members and general sociodemographic characteristics. Respondents were asked to estimate overall annual fish consumption from all sources including sport-caught and fish purchased at a grocery store or restaurant. This estimate was intended as a general measure of fish consumption. More detailed estimates of consumption of fish from Lake Champlain were obtained by asking respondents to break down

consumption by both species and lake location. (See Appendix A for exact content and wording of the questionnaire.)

#### Mail Survey Implementation

The mail survey was implemented in September, 1993. Up to three follow-up mailings were sent to nonrespondents over the course of the next month. Returned questionnaires were coded and entered onto the computer using the SPSS Data Entry II software package.

#### Telephone Nonresponse Follow-up

A telephone nonresponse follow-up survey was conducted in early November 1993 with 100 mail survey nonrespondents to provide an estimate of the degree to which nonrespondents differed from respondents. Two hundred and fifty nonrespondents were systematically sampled from all nonrespondents. Calls were made to the 250 person sample until 100 interviews were completed. (See Appendix A for exact content and wording of the nonresponse follow-up instrument.) Nonrespondents contacted by telephone were considered to be representative of all nonrespondents.

#### Methods Experiment

Concurrent with this study was an experiment funded by the Western Regional Methods Project W-183 (Hatch - Agricultural Experiment Station funds) to examine the effects of question order bias and survey methodologies (mail versus telephone) on responses. An additional sample of Vermont and New York licensed anglers was drawn for this experiment using the same methods outlined earlier. The sample was divided into three groups. The first group (n=600) was sent a mail questionnaire with wording identical to the original Lake Champlain questionnaire (Appendix A) but the question order was changed such that questions about health advisory awareness and knowledge appeared before

questions on fish consumption. The second group (n=600) was contacted by telephone with a shorter instrument but with question order the same as the original questionnaire. The third group (n=600) was also contacted by telephone but with the question order changed. Results from the experiment, to be reported in a separate document prepared under the Western Regional Project W-183, will enhance our understanding of the effects of question order on respondents' reported fish consumption and health advisory awareness.

Initial analysis of the experiment showed very few differences between the two mail questionnaires but many differences between the mail and telephone questionnaires. Thus, data from the two telephone questionnaires were not used in any analysis reported herein. Data from the two mail questionnaires were combined for the analysis reported herein except on the two questions where significant differences were found between the two data sets. For these questions (Q12 and Q14d in Appendix A) only data from the original Lake Champlain questionnaire were used in the analysis. It is noted in the Results section where those data appear.

### Weighting

Data from the sample were weighted to account for the oversampling of Vermont and urban license buyers described earlier (Table 1). Weighting of respondents by county of license purchase was necessary to provide results in true proportion to the population. Respondents to the Western Regional Project mail questionnaire were added to the original Lake Champlain respondents to form the base for the weighting. This was possible because all licenses were drawn in the same systematic fashion. Three weight factors were created. One factor was used when New York versus Vermont comparisons were made to account for oversampling in urban areas. The second weight factor was

Table 1. Calculation of weight factors to account for the oversampling of license buyers in Vermont and in urban counties.

County of License Purchase	1991 License Sales	Proportion of License Sales	Number of Respondents	Weighted Number of Respondents	State Weight Factor	Overall Weight Factor
New York	13,864	0.392	374	251	0.671	0.790
Clinton	11,548	0.327	149	210	1.409	1.660
Essex	9,949	0.281	118	180	1.525	1.796
Washington	35,361	1	641	641		
NY sub-total						
Vermont	<u>Number of Inches<sup>a</sup></u>					
Chittendon	57.00	0.339	276	188	0.681	0.541
Franklin	32.75	0.195	78	108	1.385	1.100
Addison	21.25	0.126	51	70	1.372	1.089
Rutland	44.25	0.263	116	146	1.259	1.000
Grand Isle	13.00	0.077	33	42	1.273	1.011
VT sub-total	168.25	1	554	554		
New York	<u>Estimated</u>				Urban/	
Vermont	<u>Number of Licenses</u>				Rural	
Total	35,361	0.632	641	755	Weight	
	20,600	0.368	554	440	Factor	
	55,961	1	1195	1195		

<sup>a</sup>Number of resident fishing licenses sold by county was not available in Vermont. The number of inches of all license types sold in Vermont by county was measured. A subsample was examined and the number of resident fishing licenses per inch was obtained. From this, an estimate of the number of resident fishing licenses sold by county could be calculated.

used when urban versus rural residents of the Lake Champlain Basin were compared to account for oversampling in Vermont. The third weight factor was used for comparisons involving the whole sample and accounted for both the Vermont and urban oversampling.

#### Definition of Lake Champlain Basin Residents

Respondents were grouped into three categories based on their zipcode to enable comparisons between urban and rural residents. Urban residents of the Lake Champlain Basin were defined as having zipcodes (12901, 12903, 05401-7, 05452-3) in the City of Plattsburg, Plattsburg Air Force Base, and the Burlington Urbanized Area (as defined by the 1990 Census [Burlington, South Burlington, Winooski, and Essex Junction]). Rural residents had zipcodes outside the urban areas but within the eight county area surrounding Lake Champlain. The remaining respondents who lived in areas outside the Lake Champlain Basin, but who had purchased their license in the eight county area, were not used in analyses herein which specify "Basin residents' results only." These are included otherwise.

#### Analysis

Analysis was conducted using the SPSSX computer program (SPSS Inc. 1986). Chi-square tests to compare percentages between 2 or more groups, t-tests to compare means for 2 groups, and Scheffe's test to compare means for more than 2 groups were used to test for statistically significant differences at the  $P \leq .05$  level. Comparisons described in the text were statistically significant at the  $P \leq .05$  level unless specifically stated as being not significant. In tables where means were reported the standard error was also reported as a measure of dispersion. Approximately two times the standard error would yield the 95% confidence interval. In calculating the t-test



results, separate variance estimates were used if the F value was significant; otherwise, pooled variance estimates were used.

## RESULTS

### Survey Response

Of the 2,600 questionnaires mailed (2,000 from the Lake Champlain project, 600 from the Western Regional Methods experiment), 123 were undeliverable and 1,200 completed questionnaires were returned. This resulted in an adjusted response rate of 48.4%. Five completed questionnaires were deleted from the file because state of license purchase and urban/rural residence could not be determined and thus the cases could not be weighted properly. (See Table 1 for the number of respondents by state of license purchase and urban versus rural counties.)

### Adjustments to the Data: Nonresponse Bias and Weighting Factors

Weighting factors were used as described in the Methods section to account for the oversampling of license buyers in Vermont and in urban counties (Table 1). Nonresponse bias comparisons showed few significant differences between respondents and nonrespondents. No differences were found in fishing activity, harvest or consumption, nor did respondents and nonrespondents differ in their attitudes toward the health advisory. (Detailed comparisons can be found in Appendix B.)

Three significant differences, however, were found between respondents and nonrespondents. First, nonrespondents were less likely than respondents to have fished Lake Champlain in the past five years. This is not surprising considering the survey asked primarily about Lake Champlain fishing experiences. Attempts in the cover letters to encourage anglers who did not

fish Lake Champlain to respond were patterned after past studies in which such efforts were successful in reducing nonresponse bias (Knuth et al. 1993). These efforts appeared to have less effect for this survey.

Second, nonrespondents were less likely to be aware of health advisories than respondents. This finding was similar to previous studies (Connelly et al. 1990, 1992, Knuth et al. 1993). Third, respondents were more likely to have graduated high school and have some years of college level education than nonrespondents.

We made nonresponse bias adjustments to population-level estimates for two variables: percent of anglers who had fished Lake Champlain in the past five years, and percent aware of health advisories (detailed in Appendix B). These results are presented in detail in the sections of the report discussing past fishing experience and health advisory awareness. Population-level estimates also include the application of weighting factors described earlier.

#### Respondents Who Had Not Fished Lake Champlain In The Past Five Years

Because the sample was drawn from license buyers in the counties bordering Lake Champlain and not from a creel census of Lake Champlain anglers, it was possible that some anglers who were contacted had not fished Lake Champlain. It was also possible that these anglers had fished Lake Champlain sometime in the past but did not fish anymore because of contaminants. To better define Lake Champlain anglers, the first question on the questionnaire asked anglers if they had fished Lake Champlain in the past five years and if not, why not. Approximately 60% of license buyers in the eight counties surrounding Lake Champlain fished the Lake in the past five years (adjusted for nonresponse bias). (Future references to "license buyers" or "licensed anglers" refer only to those anglers who bought their license in

the eight counties surrounding Lake Champlain.) Anglers who bought their license in Vermont or who lived in the urban areas within the Basin were more likely to have fished Lake Champlain than New York or rural anglers (Table 2).

The majority of license buyers who did not fish Lake Champlain in the past five years preferred other fishing locations or did not have the necessary boat or equipment (Table 3). Contaminants and lack of a fishing companion were cited by 16 to 17% of anglers. Other reasons were checked less frequently. Vermont license buyers were more likely to cite contaminants (24% vs. 15%) and crowded fishing locations (8% vs. 3%) as reasons for not fishing Lake Champlain than New York license buyers. No differences were found between urban and rural Basin residents.

Table 2. Percent of respondents who had fished Lake Champlain in the past five years, overall, by state of license purchase, and by residence area.

	<u>Fished Lake Champlain in past five years</u>	
	<u>Yes</u>	<u>No</u>
Overall, adjusted for nonresponse bias (resp. n=1195, nonresp. n=100) <sup>a</sup>	59.7	40.3
<u>State of License Purchase</u>		
New York (n=641)	57.5	42.5*
Vermont (n=554)	74.4	25.6
<u>Lake Champlain Basin Residents</u>		
Urban (n=222)	83.2	16.8*
Rural (n=872)	65.2	34.8

<sup>a</sup>See Appendix B for details of calculation of percentages.

\*Statistically significant difference between groups at  $P \leq .05$  using Chi-square test.

Table 3. Percent of respondents who had not fished Lake Champlain in the past five years checking various reasons why they had not done so (n=418).

<u>Reasons for not fishing Lake Champlain in the past five years</u>	<u>Percent<sup>a</sup></u>
Prefer to fish other locations	54.4
Don't have the necessary boat or equipment	42.2
Due to contaminants, wouldn't want to eat the fish	17.1
Don't have a companion interested in Lake Champlain fishing	16.7
Not interested in types of fish available	5.1
Fishing locations are too crowded	4.2
Not interested in sizes of fish available	1.3
Other	25.0

<sup>a</sup>Percents add to more than 100 because more than one reason could be checked.

Respondents could check as many reasons for not fishing as they wished. Only 2% of respondents who had not fished Lake Champlain in the past five years listed the presence of contaminants in fish as the only reason for not fishing the Lake. Thus, contaminants appear to be the sole reason for dissuading only a few of the currently-licensed anglers from fishing Lake Champlain. We do not have information about potential anglers who have not purchased a fishing license due to concerns about contaminants.

#### Respondents Who Fished Lake Champlain In The Past Five Years

The remainder of the report will deal only with respondents who have fished Lake Champlain in the past five years. Using the model developed from the Theory of Planned Behavior as a guide, the following sections focus first on the external variables of advisory awareness and knowledge, information sources, and sociodemographic characteristics, then address issues of attitudes and behaviors (Fig. 1).

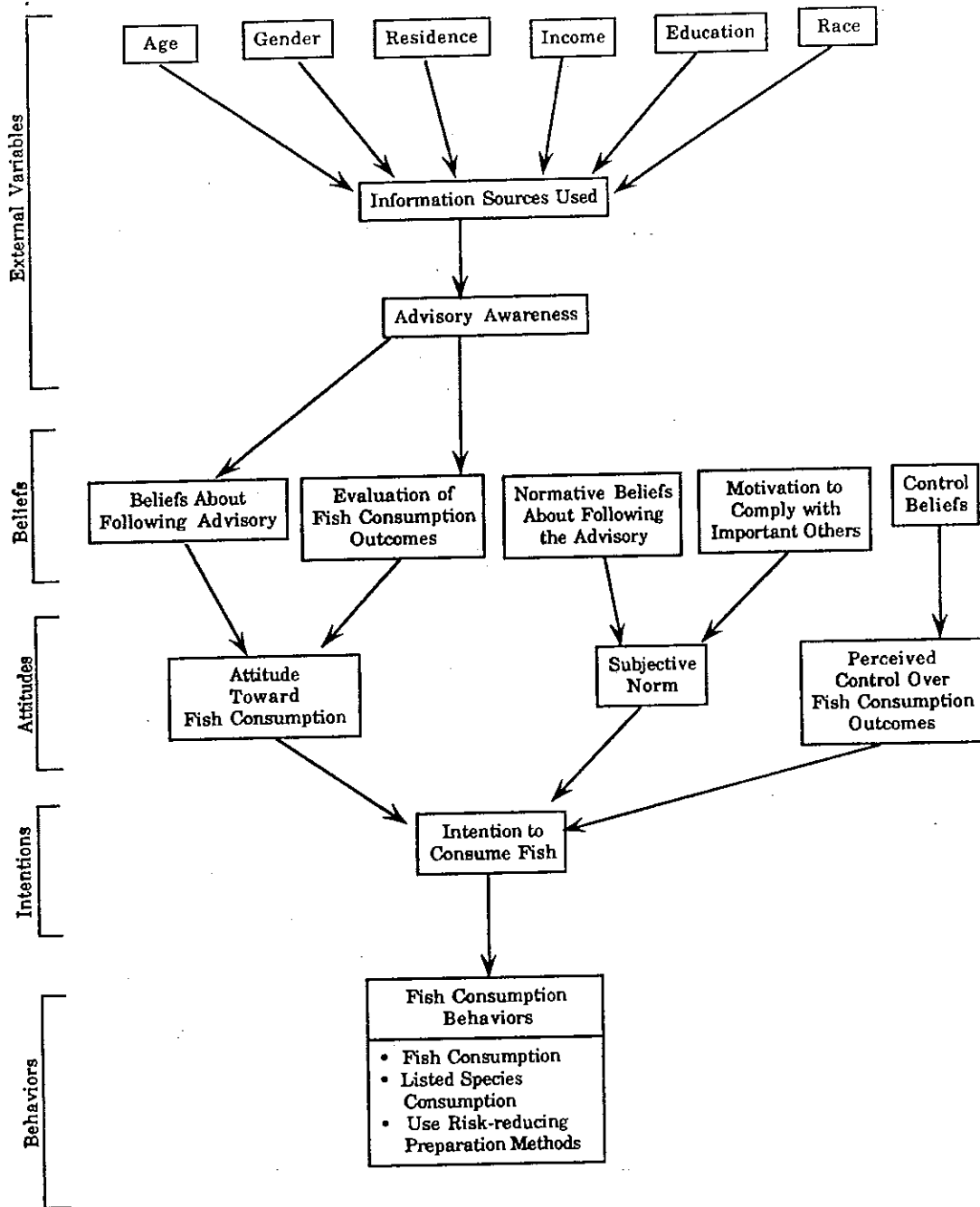


Figure 1. Conceptual diagram of social-psychological process determining response to health advisories, derived from the Theory of Planned Behavior (Ajzen 1989), and modified from Knuth et al. (1993).

### Sociodemographics

Respondents who had fished Lake Champlain in the past five years were compared with the general population that live in townships included in the Lake Champlain Basin. Information on the general population was obtained from Holmes & Associates (1993) who used data from the 1990 Census. Respondents appeared more likely to be male, middle-aged, and better educated than the Lake Champlain Basin general population (Appendix Table C-1). They did not appear to differ in terms of racial background or median household income. Given that our sample was not limited to those residing in the Lake Champlain Basin and that anglers are a subsample of the general population, the differences we found were not at all surprising.

### Awareness and Understanding of the Advisory

#### Awareness

An estimated 71% of licensed anglers (adjusted for nonresponse bias) who had fished Lake Champlain in the past five years said they were aware of the health advisories. Less than half of this group said they were aware of specific species or areas of the Lake listed in the advisories, whereas the majority were only generally or vaguely aware of the advisories. Awareness did not differ by state of license purchase, but did differ by urban or rural residence. Urban residents of the Lake Champlain Basin who fished Lake Champlain were more likely to be aware of the advisory and feel they were aware of the advisory specifics than rural residents (Table 4). Awareness also appeared to differ by lake location fished (as identified in Fig. 2), with those fishing in the far north and south of the lake being less aware of the advisory than those who fished in the mid-section of the lake (Table 4). Statistical comparisons regarding awareness were not possible between lake

Table 4. Percent of respondents who fished Lake Champlain in the past five years who were aware of the health advisories, overall, by state of license purchase, by residence area, by fishing location and by significant sociodemographic characteristics.

	<u>Aware of Health Advisories</u>		
	<u>No</u>	<u>Generally Aware</u>	<u>Aware of Specifics<sup>a</sup></u>
		<u>Percent</u>	
Overall (n=744)	15.6	45.6	38.8
<u>State of License Purchase</u>			
New York (n=359) <sup>b</sup>	15.5	44.2	40.3
Vermont (n=405)	15.6	47.5	36.9
<u>Lake Champlain Basin Residents</u>			
Urban (n=183)	6.5	45.5	48.0*
Rural (n=556)	15.4	44.9	39.7
<u>Fishing Location</u>			
South Basin (1) <sup>c</sup> (n=128)	17.8	43.8	38.4 <sup>d</sup>
Westport Section (2) (n=129)	9.1	45.3	45.6
Mid-lake Section (3) (n=179)	5.4	42.7	51.9
Inner Burlington Harbor (4) (n=22)	12.2	38.9	48.9
East of Grand Isle (5) (n=143)	14.3	46.1	39.6
U.S. Portion of Missisquoi Bay (8) (n=40)	20.9	40.4	38.7
Bay within Cumberland Head (6) (n=110)	9.5	53.8	36.7
West of Grand Isle (7) (n=174)	13.0	42.9	44.1
<u>Age</u>			
16-29 (n=171)	25.6	52.0	22.4*
30-39 (n=227)	16.7	48.3	35.0
40-49 (n=197)	11.0	45.2	43.8
50+ (n=143)	8.7	34.2	57.1
<u>Income</u>			
≤ \$25,000 (n=186)	26.4	40.3	33.3*
\$26,000-\$37,000 (n=162)	13.5	52.1	34.4
\$38,000-\$50,000 (n=166)	9.2	45.2	45.6
≥ \$51,000 (n=145)	5.1	50.1	44.8
<u>Race</u>			
White (n=699)	14.9	46.4	38.7*
Other (n=27)	36.5	24.5	39.0

<sup>a</sup>Aware of specifics refers to awareness of advisories for certain types of fish and/or areas of the Lake (Question 7, Appendix A).

<sup>b</sup>Because a different set of weight factors was used for state of license purchase, the resulting sample size is slightly higher than the overall sample size. (See Appendix B for calculation of weight factors.)

<sup>c</sup>Numbers refer to locations identified in Fig. 2.

<sup>d</sup>Statistical comparisons were not possible between lake locations because anglers could fish more than one location.

\*Statistically significant differences between groups at  $P \leq .05$  using Chi-square test.

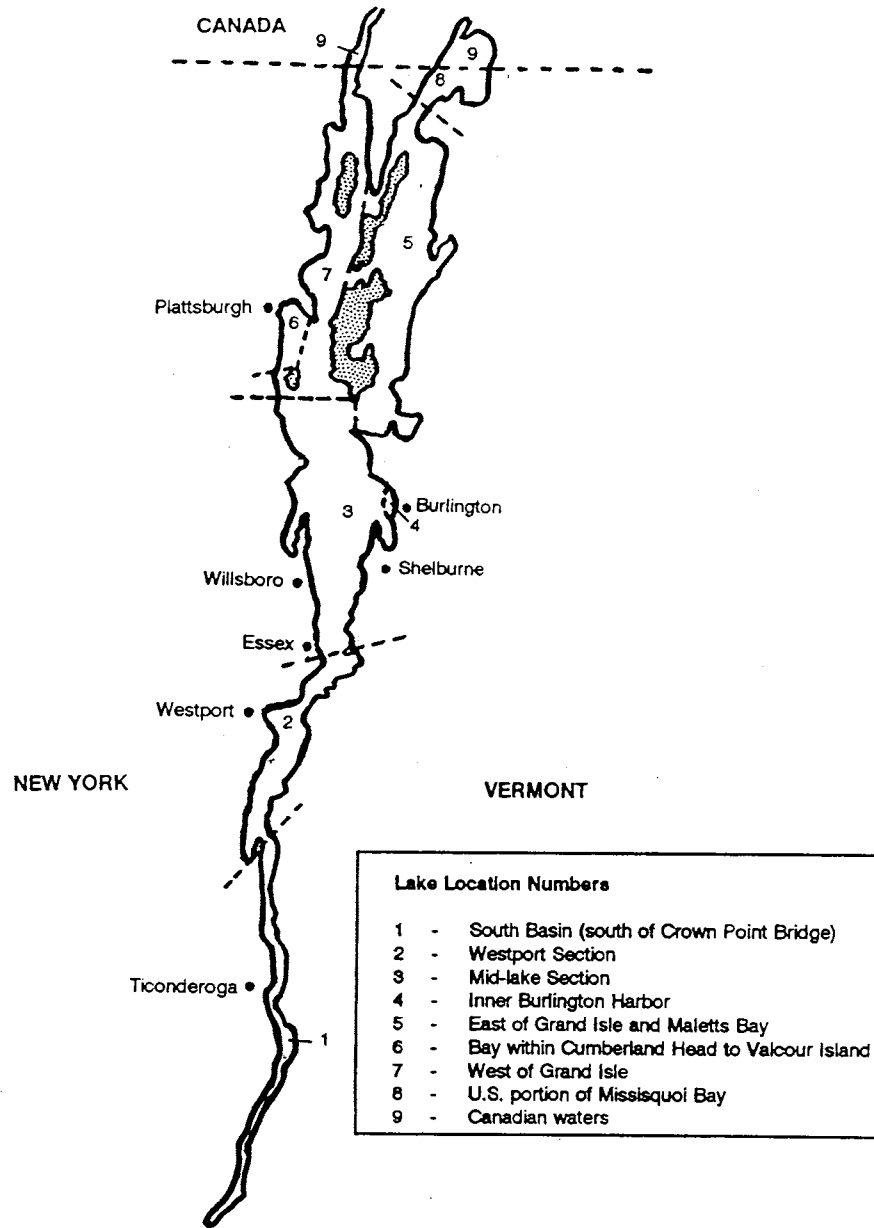


Figure 2. Map of study area provided to the survey audience in the mail questionnaire.



locations fished because anglers could have fished more than one location, violating the assumption of independence of observations. However, information on awareness by lake location fished can be valuable to health and fishery managers who have identified areas with particular fish contaminant problems and wish to know the extent of advisory awareness among anglers who fish those areas or potential factors related to awareness. For example, anglers who fished Sections 1 and 8 (corresponding to areas with highest unawareness) had statistically significantly lower income levels than anglers who did not fish in those sections.

As in other studies of health advisories (Connelly et al. 1990, 1992, 1993, Knuth et al. 1993), awareness differed by sociodemographic characteristics. Younger respondents and those with lower incomes were less likely to be aware of the advisory and its specifics (Table 4). Non-whites were more likely than whites to be completely unaware of the health advisories. However, caution should be used when examining the magnitude of this difference because race comparisons, though statistically significant, were based on a small sample of non-whites (n=27). (Of the sample of non-whites, 14 were Asian, 11 were Hispanic, and 2 were of another racial background.)

#### Sources of Information

New York and Vermont issued similar advisories for Lake Champlain, but the methods by which the information was communicated were different. In Vermont, the advisory (at the time of this study) was issued only through news releases, which may be picked up by a variety of mass media sources. In New York, the advisory was issued through news releases, printed in the fishing regulations guide, and available through special New York Health Department

brochures. Consequently, New York license buyers were more likely than Vermont license buyers to think the fishing regulations guide was a very important source of information (Table 5). (Since 42% of Vermont license buyers found the guide to be very important we must assume that they were referring to the New York guide.) As would be expected, Vermont license buyers were more likely than New York license buyers to identify newspaper articles and television or radio as being very important sources of information. The fishing regulations guide and newspaper articles were rated highest in mean importance followed by television or radio, posted warnings, and friends or family.

Posted warnings were very important to a higher proportion of urban residents (39%) compared to rural residents (31%). There was also a trend in importance by education and income level with those at the lower levels indicating that posted warnings were more important than indicated by those at the higher levels. (This difference was not statistically significant for income.)

Few sociodemographic differences were found related to information sources. Women, however, judged special health advice brochures and friends or family as more important on average than did men (2.2 vs. 1.8 for brochures and 3.0 vs. 2.6 for friends or family [measured on a 5-point scale where 1=not at all important and 5=extremely important]).

#### Health Advisory Knowledge

Respondents' knowledge of health advisory information was assessed using 14 questions which measured knowledge in each of the following six areas (see Appendix A questionnaire): effects of contaminants on fish (Q9c,Q9d), negative

Table 5. Mean importance rating assigned by respondents to various sources of health advisory information, and importance broken down by state of license purchase.

Source of Health Advisory Information	Overall mean importance of source (st. error) (n=605) <sup>a</sup>	New York (n=290) <sup>b</sup>			Vermont (n=332)		
		Not at all important	Some importance	Very to extremely important	Not at all important	Some importance	Very to extremely important
							Percent
Fishing regulations booklet distributed with fishing license	3.6 (0.06)	7.1	27.1	65.8	19.2	38.3	42.5*
Newspaper article or editorial	3.1 (0.05) 2.7 (0.06)	19.1 35.5	45.4 37.0	35.5 27.5	9.3 23.1	45.4 38.1	45.3* 38.8*
Television or radio Warnings posted at fishing access sites	2.7 (0.06) 2.7 (0.06) 2.3 (0.05)	32.2 29.0 34.6	32.6 40.6 44.1	35.2 30.4 21.3	39.9 24.5 40.0	29.4 49.0 45.7	30.7 26.5 14.3
Newsletters from environmental interest groups	1.9 (0.05)	55.9	28.3	15.8	58.1	31.9	10.0
Health advice brochures available by special request	1.9 (0.06)	61.2	24.2	14.6	60.2	27.1	12.7
Newsletters from fishing clubs	1.9 (0.05)	59.0	26.9	14.1	61.6	26.9	11.5

<sup>a</sup>Importance was measured on a 5-point scale where 1 = not at all important and 5 = extremely important.

<sup>b</sup>Because a different set of weight factors was used for state of license purchase, the resulting sample size is slightly higher than the overall sample size. (See Table 1 for calculation of weight factors.)

\*Statistically significant differences between states at  $P \leq .05$  using Chi-square test.

health effects of fish consumption (Q9b), positive health effects of fish consumption (Q14a,Q14b), risk-reducing behaviors (Q9e1-4), advisory recommendations (Q10,Q11,Q12), and advisory process (Q13a,Q13b). Responses were recoded as either correct, incorrect, or not sure/don't know. Table 6 lists the responses to each question and breaks down the information by New York and Vermont license buyers. With the exception of questions dealing with the positive health effects of fish consumption, respondents answering the knowledge questions had also said they were aware of the health advisory.

For the questions measuring effects of contaminants on fish, negative health effects of fish consumption, positive health effects of fish consumption, and risk-reducing behaviors, few respondents had inaccurate knowledge but a fair proportion (29-55%) were unsure about the correct answer (Table 6). Differences between New York and Vermont license buyers indicated that New York license buyers were more likely correct, while Vermont license buyers were more likely unsure.

For the questions measuring knowledge of the advisory recommendations and advisory process, over one-third of respondents were incorrect in their answers (Table 6), except for the item about who to contact for information about contaminant levels in fish. There was little difference for these questions between New York and Vermont license buyers, except that New York license buyers were more likely to be incorrect in knowing who to contact for more information about the health effects from exposure to chemical contaminants.

Differences in knowledge were associated with various sociodemographic characteristics. Most notable were higher percentages of unsure respondents among women, younger respondents, and those with lower income and education

Table 6. Percent of respondents answering health advisory knowledge questions, overall and by state of license purchase.

<u>KNOWLEDGE QUESTIONS</u>	Overall (n=610)	New York (n=295) <sup>a</sup> Percent	Vermont (n=330)
<u>Effects of Contaminants on Fish</u>			
<i>Older fish have more contaminants than younger fish</i>			
Correct (Yes)	54.6	58.5	49.5*
Not Sure	39.5	37.3	42.5
Incorrect (No)	5.9	4.2	8.0
<i>More chemical contaminants in fatty fish than lean fish</i>			
Correct (Yes)	63.4	68.6	56.6*
Not Sure	33.6	29.3	39.3
Incorrect (No)	3.0	2.1	4.1
<u>Negative Health Effects of Fish Consumption</u>			
<i>Negative health effects include nervous system disorders and cancer</i>			
Correct (Yes)	43.1	46.9	38.2*
Not Sure	52.9	50.1	56.6
Incorrect (No)	4.0	3.0	5.2
<u>Positive Health Effects of Fish Consumption</u>			
<i>Increasing fish consumption reduces dietary fat and helps control weight</i>			
Correct (Yes)	70.3	73.6	66.2
Not Sure	21.7	19.1	25.0
Incorrect (No)	8.0	7.3	8.8
<i>Eating fish oils decreases risk of heart disease</i>			
Correct (Yes)	36.9	39.4	33.7
Not Sure	45.5	44.5	46.8
Incorrect (No)	17.6	16.1	19.5
<u>Risk Reducing Behaviors</u>			
<i>To reduce the levels of some contaminants you should:</i>			
<i>Remove the belly fat</i>			
Correct (Yes)	69.2	72.4	65.0
Not Sure	29.4	26.5	33.3
Incorrect (No)	1.4	1.1	1.7

Table 6. (Continued)

<u>KNOWLEDGE QUESTIONS</u>	<u>Overall (n=610)</u>	<u>New York (n=295)<sup>a</sup> Percent</u>	<u>Vermont (n=330)</u>
<i>Pan fry the fish</i>			
Correct (No)	33.1	34.9	30.9
Not Sure	55.6	53.0	58.9
Incorrect (Yes)	11.3	12.1	10.2
<i>Broil the fish on a rack</i>			
Correct (Yes)	39.9	43.1	35.8
Not Sure	52.1	48.1	57.2
Incorrect (No)	8.0	8.8	7.0
<i>Remove the skin</i>			
Correct (Yes)	63.5	67.8	57.9*
Not Sure	33.3	29.2	38.7
Incorrect (No)	3.2	3.0	3.4
<u>Advisory Recommendations</u>			
<i>Maximum number of fish meals for fish listed in Lake Champlain advisory</i>			
Correct (1 per month)	34.4	37.0	31.0
Don't Know	22.7	20.3	26.0
Incorrect (other amount chosen)	42.9	42.7	43.0
<i>Maximum number of fish meals women of childbearing age and children under 15 should eat for fish listed in Lake Champlain advisory (applicable to New York license buyers only)</i>			
Correct (None)		32.3	
Don't Know		29.4	
Incorrect (Other Amount Chosen)		38.3	
<i>Maximum number of fish meals women of childbearing age and children under 15 should eat for Lake Champlain fish not specifically listed in the advisory (applicable to New York license buyers only)<sup>b</sup></i>			
Correct (None)		13.5	
Don't Know		40.3	
Incorrect (Other Amount Chosen)		46.2	

Table 6. (Continued)

<u>KNOWLEDGE QUESTIONS</u>	<u>Overall (n=610)</u>	<u>New York (n=295)<sup>a</sup> Percent</u>	<u>Vermont (n=330)</u>
<u>Advisory Process</u>			
<i>Who should be contacted to learn more about health effects from exposure to chemical contaminants</i>			
Correct (NY or VT Dept. of Health)	49.2	44.0	56.1*
Don't Know	4.6	4.2	5.0
Incorrect (Other Agency Chosen)	46.2	51.8	38.9
<i>Who should be contacted to learn more about contaminant levels in fish</i>			
Correct (NYSDEC or VT Fish & Wildlife)	68.8	71.6	65.1
Don't Know	4.8	4.7	5.0
Incorrect (Other Agency Chosen)	26.4	23.7	29.9

<sup>a</sup>Because a different set of weight factors was used for state of license purchase, the resulting sample size is slightly higher than the overall sample size. (See Table 1 for calculation of weight factors.)

<sup>b</sup>Only respondents to the Lake Champlain mail questionnaire are used in this analysis. (New York n=223.)

\*Statistically significant difference between states at  $P \leq .05$  using Chi-square test.

levels for questions on the effects of contaminants on fish, negative health effects of fish consumption, and risk-reducing behaviors (Tables 7 and 8). Men, older respondents, and those with higher income and education levels were more likely to be correct in their knowledge of these areas. Rural residents of the Lake Champlain Basin were more likely than urban residents to know that pan frying does not reduce contaminants. Rural residents were also more likely to believe that broiling does not reduce contaminants when in fact it may reduce certain contaminant levels in fish (e.g., PCBs, but not mercury). Older respondents were more likely to know about the positive health benefits of fish consumption (Table 7).

Respondents who came from households with women of childbearing age or children under 15 were less likely to be unsure of their knowledge of advisory recommendations but that knowledge was just as likely to be incorrect as correct (Table 9). These differences for the general Lake Champlain advisory question cannot be attributed to state of license purchase, as no significant differences were found within groups by state of license purchase. Among households in which the fishing license was purchased in New York, few correctly identified the maximum number of fish meals women of childbearing age and children under 15 should eat for Lake Champlain fish not specifically listed in the advisory. Respondents either did not know or answered incorrectly.

#### **Attitudes Toward the Health Advisories and Health Risks**

The majority of respondents who said they were aware of the health advisories said they felt the advisories provided them with enough information to decide whether or not to eat certain fish (Table 10). Older respondents were more likely than younger respondents to think the advisories provided



Table 7. Percent of respondents answering health advisory knowledge questions dealing with effects of contaminants on fish, negative and positive health effects of fish consumption, and risk-reducing behaviors, by sex and age of respondents.

	Age				Percent
	16-29 (n=126)	30-39 (n=184)	40-49 (n=168)	50+ (n=127)	
	Male (n=521)	Female (n=85)			
<b>KNOWLEDGE QUESTIONS</b>					
<u>Effects of contaminants on Fish</u>					
<i>Older fish have more contaminants than younger fish</i>					
Correct (Yes)	57.2	38.9*	41.3	60.9	55.5
Not Sure	37.4	52.4	52.2	33.3	40.9
Incorrect (No)	5.4	8.7	6.5	5.8	3.6
<i>More chemical contaminants in fatty fish than lean fish</i>					
Correct (Yes)	65.8	47.8*	43.1	69.0	67.3
Not Sure	31.3	49.0	52.0	29.2	29.6
Incorrect (No)	2.9	3.2	4.9	1.8	3.1
<u>Negative Health Effects of Fish Consumption</u>					
<i>Negative health effects include nervous system disorders and cancer</i>					
Correct (Yes)	44.3	36.0	31.6	48.5	49.4
Not Sure	52.1	57.7	64.8	48.2	47.1
Incorrect (No)	3.6	6.3	3.6	3.3	3.5
<u>Positive Health Effects of Fish Consumption</u>					
<i>Increasing fish consumption reduces dietary fat and helps control weight</i>					
Correct (Yes)	70.0	71.7	60.1	69.5	74.6
Not Sure	21.8	21.5	27.6	22.5	19.9
Incorrect (No)	8.2	6.8	12.3	8.0	5.5
					77.8*
					15.7
					6.5

Table 7. (Continued)

	Age					Percent
	16-29 (n=126)	30-39 (n=184)	40-49 (n=168)	50+ (n=127)		
<b>KNOWLEDGE QUESTIONS</b>						
<i>Eating fish oils decreases risk of heart disease</i>						
Correct (Yes)	36.5	39.1	28.6	34.9	40.8	44.5*
Not Sure	45.6	45.6	54.4	42.0	46.5	39.5
Incorrect (No)	17.9	15.3	17.0	23.1	12.7	16.0
<b>Risk-Reducing Behaviors</b>						
<i>To reduce the levels of some contaminants, you should:</i>						
<i>Remove the belly fat</i>						
Correct (Yes)	70.9	58.2*	53.2	75.1	72.5	71.1*
Not Sure	27.5	41.8	44.8	23.7	26.4	27.3
Incorrect (No)	1.6	0.0	2.0	1.2	1.1	1.6
<i>Pan fry the fish</i>						
Correct (No)	35.1	21.7	24.0	37.8	36.8	31.9
Not Sure	52.8	72.1	61.5	53.0	52.9	55.3
Incorrect (Yes)	12.1	6.2	14.5	9.2	10.3	12.8
<i>Broil the fish on a rack</i>						
Correct (Yes)	41.2	32.3	25.5	44.0	49.3	35.8*
Not Sure	50.4	62.1	67.5	46.4	45.0	53.9
Incorrect (No)	8.4	5.6	7.0	9.6	5.7	10.3
<i>Remove the skin</i>						
Correct (Yes)	64.5	57.8	55.0	66.4	64.1	67.2
Not Sure	31.9	41.3	42.4	30.0	33.6	28.2
Incorrect (No)	3.6	0.9	2.6	3.6	2.3	4.6

\*Statistically significant difference between groups at  $P \leq .05$  using Chi-square test.

Table 8. Percent of respondents answering health advisory knowledge questions dealing with effects of contaminants on fish, negative health effects of fish consumption, and risk-reducing behaviors, by education and income level of respondents.

KNOWLEDGE QUESTIONS	Education				Income			Percent	
	Grades 1-11 (n=48)	Grad. High School (n=210)	Some College (n=210)	Grad. College (n=66)	Some Post Grad. (n=67)	Income			
						<\$25,000 (n=131)	\$26,000-\$37,000 (n=140)		\$38,000-\$50,000 (n=144)
<u>Effects of Contaminants on Fish</u>									
<i>Older fish have more contaminants than younger fish</i>									
Correct (Yes)	51.0	49.8	52.4	69.7	63.7	46.8	53.5	55.5	
Not Sure	40.6	42.5	42.9	25.8	34.7	48.4	39.6	38.2	
Incorrect (No)	8.4	7.7	4.7	4.5	1.6	4.8	6.9	6.3	
<u>More chemical contaminants in fatty fish than in lean fish</u>									
Correct (Yes)	54.0	55.9	62.8	72.2	84.0*	52.1	61.5	70.4	
Not Sure	44.4	39.6	34.8	25.3	14.5	44.8	35.6	26.7	
Incorrect (No)	1.6	4.5	2.4	2.5	1.5	3.1	2.9	2.9	

Table 8. (Continued)

	Education			Income					
	Grades 1-11 (n=48)	Grad. High School (n=210)	Some College (n=210)	Grad. College (n=66)	Some Post Grad. (n=67)	<\$25,000 (n=131)	\$26,000-\$37,000 (n=140)	\$38,000-\$50,000 (n=144)	>\$51,000 (n=135)
<b>KNOWLEDGE QUESTIONS</b>									
<u>Negative Health Effects of Fish Consumption</u>									
<i>Negative health effects include nervous system disorders and cancer</i>									
Correct (Yes)	21.9	35.8	42.4	54.7	70.4*	37.5	36.4	47.1	54.6*
Not Sure	72.4	59.9	53.5	42.1	27.1	59.8	58.8	50.9	40.1
Incorrect (No)	5.7	4.3	4.1	3.2	2.5	2.7	4.8	2.0	5.3
<u>Risk-Reducing Behaviors</u>									
<i>To reduce the levels of some contaminants you should:</i>									
<i>Remove the belly fat</i>									
Correct (Yes)	63.8	68.3	66.7	71.3	78.6	63.2	70.0	72.8	70.6
Not Sure	34.5	29.9	32.0	27.1	21.4	36.4	28.8	25.5	28.0
Incorrect (No)	1.7	1.8	1.3	1.6	0.0	0.4	1.2	1.7	1.4
<i>Pan fry the fish</i>									
Correct (No)	15.1	25.9	37.8	46.8	40.0*	26.2	29.8	42.8	33.9*
Not Sure	64.8	60.0	53.2	45.5	51.3	55.0	60.8	48.7	56.4
Incorrect (Yes)	20.1	14.1	9.0	7.7	8.7	18.8	9.4	8.5	9.7

Percent

Table 8. (Continued)

	Education			Income					
	Grades 1-11 (n=48)	Grad. High School (n=210)	Some College (n=210)	Grad. College (n=66)	Post Grad. (n=67)	<\$25,000 (n=131)	\$26,000- \$37,000 (n=140)	\$38,000 \$50,000 (n=144)	>\$51,000 (n=135)
<b>KNOWLEDGE QUESTIONS</b>									
<i>Broil the fish on a rack</i>									
Correct (Yes)	15.8	31.5	43.6	52.5	55.2*	33.7	35.0	49.0	43.1*
Not Sure	76.0	58.8	48.8	39.5	40.8	63.8	53.6	44.1	48.6
Incorrect (No)	8.2	9.7	7.6	8.0	4.0	2.5	11.4	6.9	8.3
<i>Remove the skin</i>									
Correct (Yes)	52.8	64.3	62.3	64.0	69.0	58.6	65.0	66.6	65.3
Not Sure	45.3	32.3	34.2	30.0	31.0	38.4	33.2	29.8	31.4
Incorrect (No)	1.9	3.4	3.5	6.0	0.0	3.0	1.8	3.6	3.3

\*Statistically significant difference between groups at  $P \leq .05$  using Chi-square test.

Table 9. Percent of respondents answering health advisory knowledge questions dealing with advisory recommendations, by households with and without women of childbearing age or children under 15 years old. Two advisory recommendations applied only to New York license buyers, as noted.

	Households			
	With Women of Childbearing Age	Without Women of Childbearing Age	With Children Under 15	Without Children Under 15
	(n=406)	(n=208)	(n=267)	(n=347)
<b>ADVISORY RECOMMENDATIONS</b>				
<i>All Households</i>				
<i>Maximum number of fish meals for fish listed in Lake Champlain advisory</i>				
Correct (1 Per Month)	36.9	29.3*	39.5	30.5*
Don't Know	19.4	29.4	18.1	26.3
Incorrect (Other Amount Chosen)	43.7	41.3	42.4	43.2
<i>New York License-Buyer Households Only</i>				
<i>Maximum number of fish meals women of childbearing age and children under 15 should eat for fish listed in Lake Champlain advisory</i>				
Correct (None)	30.5	22.9	33.0	24.0*
Don't Know	28.3	39.9	24.1	38.4
Incorrect (Other Amount Chosen)	41.3	37.2	43.0	37.6
<i>Maximum number of fish meals women of childbearing age and children under 15 should eat for Lake Champlain fish not specifically listed in the advisory<sup>a</sup></i>				
Correct (None)	11.5	11.1*	14.4	9.0
Don't Know	43.6	59.4	47.5	49.4
Incorrect (Other Amount Chosen)	44.9	29.5	38.1	41.6

<sup>a</sup>Only respondents to the Lake Champlain mail questionnaire were used in this analysis (n=173, n=79, n=110, n=141, respectively).

\*Statistically significant difference between groups at  $P \leq .05$  using Chi-square test.

Table 10. Respondents' attitudes toward the health advisories and health risks associated with contaminated fish, overall and by age of respondents.

	Health Advisories Provide Me With Enough Information to Decide Whether or Not to Eat Certain Fish		
	<u>Yes</u>	<u>Not Sure</u> Percent	<u>No</u>
Overall (n=614)	58.7	20.6	20.7
<u>Age</u>			
16-29 (n=126)	45.2	19.7	35.1*
30-39 (n=185)	61.9	19.7	18.4
40-49 (n=170)	57.6	25.6	16.8
50+ (n=128)	70.0	14.8	15.2
	Health Risk From Eating Contaminated Sport-caught Fish is Minor When Compared With Other Risks I'm Exposed to		
	<u>Yes</u>	<u>Not Sure</u> Percent	<u>No</u>
Overall (n=739)	39.6	34.6	25.7
<u>Age</u>			
16-29 (n=171)	31.0	39.6	29.4*
30-39 (n=227)	33.6	34.7	31.7
40-49 (n=194)	47.1	31.1	21.8
50+ (n=143)	49.1	33.3	17.6

\*Statistically significant difference between groups at  $P \leq .05$  using Chi-square test.

them with enough information. No significant differences were found between New York and Vermont license buyers or urban and rural residents.

Approximately 40% of respondents thought the health risks from eating contaminated sport-caught fish were minor when compared to other risks to which they were exposed. Older respondents were more likely to think the risks were minor compared with younger respondents (Table 10). No other

statistically significant differences existed for this variable and socio-demographic characteristics, residence area or state of license purchase.

### Fishing-related Behaviors

#### Fishing Effort

Most respondents appear to fish Lake Champlain (defined as the Lake but not its tributaries) on a consistent basis, with 80% of those fishing the Lake in the past five years also fishing the Lake in 1992-93. On average, respondents fished 20.5 days per year (range 1-300 days). Almost 50% of the days were attributed to fishing from boats with the remainder divided between shore and ice fishing (Table 11). Anglers who purchased their licenses in Vermont were more likely to spend time fishing from a boat and less likely to fish from shore than New York license buyers. Also, rural residents were less likely to spend time fishing from shore and more likely to participate in ice fishing. The only sociodemographic variable with significant differences in

Table 11. Percent of days using various fishing methods, overall, by state of license purchase, and by residence area.

Fishing Method	Overall (n=621)	State of License Purchase		Lake Champlain Basin Residents	
		New York (n=295) <sup>a</sup>	Vermont (n=345)	Urban (n=162)	Rural (n=476)
	Percent of days				
Boat	49.1	46.6	52.4*	51.8	49.3
Shore	22.4	26.4	17.2*	28.3	19.6*
Ice Fishing	28.5	27.0	30.4	19.9	31.1*

<sup>a</sup>Because a different set of weight factors was used for state of license purchase, the resulting sample size is slightly higher than the overall sample size. (See Table 1 for calculation of weight factors.)

\*Statistically significant difference between average percent of days at  $P \leq .05$  using t-test.



days fished was gender, with men fishing more days than women (21.2 versus 15.3 days).

The distribution of fishing effort was spread throughout the Lake (Table 12). (Refer to the map in Fig. 2 for exact divisions of the Lake used by respondents in estimating effort by section.) Respondents were most likely to fish the mid-lake section or the area around Grand Isle. Consequently, most of the fishing effort on the Lake took place in those areas. Total angler days fished in each section was calculated by first estimating the number of license buyers in the eight county area sampled who fished Lake Champlain (using data from the current study, 55,961 licenses sold x .597 proportion fish Lake in past five years = 33,409 x .803 proportion fish Lake in 1992-93 = 26,827), then expanding that number (using data from the 1988 New York statewide angler survey [Connelly et al. 1990], 26,827 ÷ .528 proportion of New York anglers who bought their license in 1988 in the three counties sampled = 50,809) to the total number of residents who fished Lake Champlain and bought a license in New York or Vermont. This expansion assumes the proportion of Vermont license buyers who bought their licenses outside of the counties sampled was the same as in New York in 1988. Mean days fished by section was multiplied by the estimated number of anglers derived above (50,809) to arrive at the estimated total angler days (Table 12). These numbers are roughly three to five times higher than estimates from Vermont creel survey work (Table 12).

As expected, anglers who bought their licenses in New York were more likely to fish New York portions of the Lake, while Vermont license buyers were more likely to fish Vermont portions of the Lake such as east of Grand Isle and Inner Burlington Harbor (Table 13). Similarly, rural residents of

Table 12. Percent of respondents fishing an area, mean days fished, estimated angler days, and estimated angler days from Vermont creel studies by lake location fished (n=581).

<u>Fishing Location</u>	<u>Percent of Respondents Fishing Area<sup>a</sup></u>	<u>Mean Days Fished (st. error)</u>	<u>Estimated Total Angler Days</u>	<u>Estimated Total Angler Days From Vermont Creel Surveys</u>
South Basin (1) <sup>b</sup>	21.4	2.5 (0.3)	127,022	37,315 <sup>c</sup>
Westport Section (2)	22.1	2.6 (0.3)	132,103	27,738 <sup>d</sup>
Mid-lake Section (3)	30.6	3.0 (0.4)		
Inner Burlington Harbor (4)	3.6	0.5 (0.3)		
Sum of Mid-lake and Inner Burlington Harbor			177,831	22,121 <sup>e</sup>
East of Grand Isle (5)	23.8	3.9 (0.6)	198,155	
U.S. Portion of Missisquoi Bay (8)	6.5	0.9 (0.4)	45,728	
Sum of East of Grand Isle and U.S. Portion of Missisquoi Bay			243,883	85,746 <sup>f</sup>
Bay within Cumberland Head (6)	17.5	2.2 (0.3)		
West of Grand Isle (7)	28.3	4.8 (0.7)		
Sum of West of Grand Isle and Bay within Cumberland Head			355,663	21,180 <sup>g</sup>
Canadian Waters (9)	0.9	0.1 (0.1)	5,081	
Total	100.0	20.5 (1.3)	1,041,583	194,100

<sup>a</sup>Percents do not sum to 100% because a respondent could have fished in more than one area.

<sup>b</sup>Numbers refer to locations identified in Fig. 2.

<sup>c</sup>Source: 1991 Lake Champlain, Zone 1, Summer Angler Survey and Winter Angler Survey.

<sup>d</sup>Source: 1990 Lake Champlain, Zone 2-5, Summer Angler Survey and 1993 Winter Angler Survey.

<sup>e</sup>Source: 1990, 1991 Lake Champlain, Zone 2-5, Summer Angler Survey and 1991 Winter Angler Survey.

<sup>f</sup>Source: 1993 and 1992 Lake Champlain Summer Angler Survey, and 1991 Winter Angler Survey.

<sup>g</sup>Source: 1992 and 1990 Lake Champlain Summer Angler Survey, and 1991 Winter Angler Survey.

Table 13. Mean days fished for each Lake Champlain fishing location by state of license purchase and residence area.

Fishing Location	State of License Purchase		Lake Champlain Basin Residents	
	New York (n=279)	Vermont (n=317)	Urban (n=149)	Rural (n=444)
	Mean days fished (st. error)			
South Basin (1) <sup>a</sup>	3.2 (0.5)	1.7 (0.4)*	0.3 (0.1)	2.1 (0.3)*
Westport Section (2)	2.4 (0.5)	2.8 (0.5)	0.9 (0.3)	2.3 (0.4)*
Mid-lake Section (3)	2.9 (0.4)	3.1 (0.6)	4.7 (1.0)	3.0 (0.4)
Inner Burlington Harbor (4)	0.0 (0.0)	1.3 (0.6)*	2.5 (1.4)	0.2 (0.1)
East of Grand Isle (5)	0.9 (0.4)	7.9 (1.1)*	3.9 (1.0)	3.9 (0.7)
U.S. Portion of Missisquoi Bay (8)	0.3 (0.2)	1.8 (0.7)*	0.9 (0.5)	0.8 (0.4)
Bay within Cumberland Head (6)	3.7 (0.6)	0.1 (0.1)*	6.3 (1.1)	1.8 (0.3)*
West of Grand Isle (7)	6.3 (0.9)	2.7 (1.1)*	6.4 (1.1)	5.3 (0.9)
Canadian Waters (9)	0.1 (0.1)	<0.1 (<0.1)	<0.1 (<0.1)	0.1 (0.1)
Total	19.8 (1.6)	21.4 (1.9)	25.9 (3.0)	19.5 (1.3)*

<sup>a</sup>Numbers refer to locations identified in Fig. 2

\*Statistically significant differences between groups at  $P \leq .05$  using t-test.

the Basin were more likely to fish more rural sections such as the South Basin, whereas urban residents were more likely to fish near Plattsburg and Burlington. On average urban residents of the Basin fished more than rural residents.

#### Harvest Estimates

Overall, respondents estimated harvesting 9 fish per day of fishing effort. Harvesting was defined in the questionnaire as the number of fish "caught and kept" by the angler. Almost one-quarter (23%) of respondents never harvested any fish during their 1992-93 trips. This is not an estimate of zero-catch days, although some may not have caught any fish. Rather, this indicates that some anglers catch but do not eat any fish. Anglers were asked to estimate the number of fish harvested by major species within locations fished. Sample size by location fished was too small for estimates by species, so locations were summed to provide an estimate of harvest Lakewide by species. The most frequently harvested fish was yellow perch (Table 14). As with fishing effort, harvest estimates from the current survey were substantially higher than estimates from the creel surveys.

#### Fish Consumption

Respondents reported consuming an average of 30 fish meals per year (range 0-300) from all sources including sport-caught and those purchased at a grocery store or restaurant. We did not measure meal size (e.g., grams) in this study. Respondents who fished Lake Champlain in 1992-93 reported consuming an average of 17.4 fish meals in 1992-93 from fish caught in Lake Champlain (range 0-644). Sixteen percent of respondents listed a higher total consumption from Lake Champlain than from all sources combined. Eight percent of respondents provided a Lake Champlain consumption estimate that exceeded

Table 14. Mean harvest per respondent, estimated total harvest, and estimated total harvest from the Vermont creel surveys by species (n=579).

	Mean Harvest Per Respondent (st. error)	Estimated Total Harvest	Estimated Total Harvest From Vermont Creel Surveys <sup>a</sup>
American Eel	0.07 (0.04)	3,557	
Atlantic Salmon	1.50 (0.31)	76,213	4,427
Smallmouth Bass	4.35 (0.88)	221,019	13,521
Largemouth Bass	3.73 (1.04)	189,517	8,056
Black Crappie	5.66 (1.16)	287,579	38,909
Brown Bullhead	4.89 (1.28)	248,456	1,313
Lake Trout ≤25"	1.34 (0.21)	68,084	
Lake Trout >25"	0.83 (0.18)	42,171	
Total Lake Trout	2.17 (0.34)	110,255	16,757
Northern Pike	2.74 (0.53)	139,217	12,119
Smelt	12.74 (3.45)	647,307	241,822
Walleye ≤19"	0.48 (0.13)	24,388	
Walleye >19"	0.85 (0.18)	43,188	
Total Walleye	1.33 (0.24)	67,576	6,132
White Perch	8.32 (3.28)	422,731	26,573
Yellow Perch	169.44 (41.36)	8,609,077	3,255,806
Other	2.84 (1.08)	144,298	

<sup>a</sup>Source: 1990 Lake Champlain Zones 2-5 Summer Angler Survey, 1991 Lake Champlain Zone 1 Summer and Winter Angler Surveys, 1991 Lake Champlain Zones 2-5 Winter Angler Survey, and 1992 Lake Champlain Zones 2-5 Summer Angler Survey.

total consumption reported by 1 to 9 meals. Some extreme outliers were dropped from analysis if it appeared the question of Lake Champlain fish consumption was interpreted as number of fish eaten rather than the number of fish meals eaten. For example, one respondent was dropped who reported eating over 1,000 fish meals of smelt. We assumed the answer was in fact number of smelt and not meals of smelt. Of those who fished the Lake, 34% said they did not eat any fish from the Lake in 1992-93. The average fish consumption for those eating Lake Champlain fish was 26.2 meals per year.

No significant differences in Lake Champlain fish consumption were found by state of license purchase, urban or rural residence, or for any socio-demographic characteristics except gender. Male respondents ate more Lake Champlain fish meals on average than female respondents (19.1 versus 8.3 meals). No significant differences in Lake Champlain fish consumption were found for female respondents based on state of license purchase, urban or rural residence, income, or education.

Respondents' average fish consumption by area of the Lake where the fish was harvested is outlined in Table 15. The highest average consumption was found for fish harvested in the areas east of Grand Isle and in the South Basin. These were also areas where a high percentage of anglers who fished those areas consumed the fish they caught (Table 15). None of the primary species consumed from these locations were subject to the fish consumption health advisory, except for lake trout in the mid-lake section. The area with the estimated highest number of anglers consuming fish from that area was the mid-lake section. Yellow perch was the most popular species lakewide.

Another way to examine the range of fish meals consumed at each location is to examine the number of meals consumed by anglers at or below different percentiles (Table 16). For example, for fish caught in the South Basin area 50% of anglers ate 2 meals or less from that area; 75% ate 11 meals or less; 90% ate 26 meals or less; and 95% ate 85 meals or less. The areas with high local consumption were the South Basin and the area east of Grand Isle.

As mentioned previously, approximately one-third of respondents who fished Lake Champlain did not consume any Lake Champlain fish; one-third consumed 1 to 10 meals and the remaining third consumed over 10 meals. Examination of anglers who consumed more than 10 meals per year revealed they

Table 15. Mean number and range of meals consumed, percent of anglers who consumed fish, estimated number of anglers who ate fish, and primary species consumed by fishing location for anglers fishing that location.

Fishing Location	Mean Number of Meals	Range of Meals	% of Anglers		Primary Species Consumed
			Fishing Location Who Consumed Fish	Estimated # of Anglers Who Ate Fish <sup>a</sup>	
South Basin (1) (n=124) <sup>b</sup>	13.6	0-157	63.5	6,904	Yellow perch, smelt, white perch
Westport Section (2) (n=128)	10.4	0-310	67.1	7,535	Yellow perch, smelt
Mid-lake Section (3) (n=178)	8.1	0-216	65.9	10,246	Yellow perch, smelt, lake trout, Atlantic salmon
Inner Burlington Harbor (4) (n=21)	5.7	0-104	38.5	704	Yellow perch
East of Grand Isle (5) (n=138)	17.2	0-271	60.9	7,364	Yellow perch, northern pike, smallmouth bass, brown bullhead
U.S. Portion of Missisquoi Bay (8) (n=38)	6.0	0-114	54.2	1,790	Yellow perch
Bay within Cumberland Head (6) (n=102)	7.3	0-205	50.6	4,499	Yellow perch, smallmouth bass
West of Grand Isle (7) (n=164)	8.8	0-134	60.3	8,670	Yellow perch, northern pike, smallmouth bass
Canadian Waters (9) <sup>c</sup>					

<sup>a</sup>The estimated number of anglers who ate fish at each location was calculated by multiplying the estimated number of license buyers who fished Lake Champlain (50,809) by the percent who fished that location and then by the percent who consumed fish from that location.

<sup>b</sup>Numbers refer to locations identified in Fig. 2.

<sup>c</sup>Sample size was too small at this location for meaningful analysis.

Table 16. Lake Champlain fish consumption rate percentiles (meals/year) by fishing location where the fish was caught.

Fishing Location	Number of Meals Per Year			
	50 <sup>th</sup> Percentile	75 <sup>th</sup> Percentile	90 <sup>th</sup> Percentile	95 <sup>th</sup> Percentile
South Basin (1) (n=124) <sup>a</sup>	2	11	26	85
Westport Section (2) (n=128)	1	7	12	35
Mid-lake Section (3) (n=177)	1	6	14	26
Inner Burlington Harbor (4) (n=21)	0	1	8	23
East of Grand Isle (5) (n=138)	2	12	32	95
U.S. Portion of Missisquoi Bay (8) (n=38)	0	5	14	25
Bay within Cumberland Head (6) (n=102)	0	4	13	28
West of Grand Isle (7) (n=164)	1	9	22	41
Canadian Waters (9) <sup>b</sup>				
Total (n=581)	3	12	33	87

<sup>a</sup>Numbers refer to locations identified in Fig. 2

<sup>b</sup>Sample size was too small at this location for meaningful analysis.



were more knowledgeable about contaminants in fish fat and how to reduce the level of contaminants by trimming the fat and removing the skin than anglers who ate fewer or no fish (Table 17). Anglers who consumed more than 10 fish meals per year were also more likely to believe that eating fish oils in general decreases the risk of heart disease. These anglers, however, were also more likely to believe that pan-frying fish reduces contaminant consumption, a technique that is not recommended in the advisory.

Respondents were assigned to one of four groups based on their level of adherence to the specific Lake Champlain health advisory. The first group, those who fished Lake Champlain but did not harvest or eat species listed in the health advisory, contained most anglers (72%). The second group (5%) harvested listed species (i.e., lake trout over 25" and walleye over 19" caught anywhere, and American eel or brown bullhead caught within Cumberland Bay) but did not eat any of them. The third group (18%), harvested listed species and ate them, but kept within the limits recommended in the advisory of no more than one meal per month. Few anglers' consumption (5%) exceeded levels recommended in the advisory (based on species-specific limits as well as the general no-consumption advice for women of childbearing age in the New York advisory. Because of the difference in advisories between New York and Vermont, there was a significant difference in the percent of anglers in the consumption groups. Nine percent of New York license buyers consumed in excess of the New York advisory limits, while less than 1% of Vermont license buyers consumed in excess of the Vermont advisory limits. Careful examination of those exceeding the advisory recommendations (group four) revealed that 90% of this group were New York license-buying women of childbearing age (15-45 years old) for whom "exceeding the advisory" means consumption of any Lake

Table 17. Percent of respondents who fished Lake Champlain in 1992-93 answering knowledge questions dealing with certain health advisory information, by the amount of Lake Champlain fish they consumed.

	Ate no	Ate 1 to	Ate >10 meals
	Lake Champlain fish in '92-'93 (n=151)	10 meals of Lake Champlain fish in '92-'93 (n=168)	of Lake Champlain fish in '92-'93 (n=151)
	Percent		
<b>Knowledge Questions</b>			
<i>More chemical contaminants in fatty fish than lean fish</i>			
Correct (Yes)	53.9	64.4	74.7*
Not Sure	41.6	33.3	22.7
Incorrect (No)	4.5	2.3	2.6
<i>To reduce the levels of some contaminants you should:</i>			
<i>Remove the belly fat</i>			
Correct (Yes)	64.1	68.7	81.3*
Not Sure	33.6	30.4	17.4
Incorrect (No)	2.3	0.9	1.3
<i>Remove the skin</i>			
Correct (Yes)	56.3	66.5	73.7*
Not Sure	40.1	31.6	21.4
Incorrect (No)	3.6	1.9	4.9
<i>Pan fry the fish</i>			
Correct (No)	28.2	35.1	44.4*
Not Sure	58.6	55.9	40.9
Incorrect (Yes)	13.2	9.0	14.7
<i>Broil the fish on a rack</i>			
Correct (Yes)	36.7	40.3	48.5
Not Sure	55.8	51.2	42.3
Incorrect (No)	7.5	8.5	9.2
<i>Eating fish oils decreases risk of heart disease</i>			
Correct (Yes)	33.8	31.3	44.8*
Not Sure	50.9	51.5	36.3
Incorrect (No)	15.3	17.2	18.9

\*Statistically significant difference between fish consumption groups at  $P \leq .05$  using Chi-square test.

Champlain fish. Thus, almost all New York license-buying women not of childbearing age, Vermont license-buying women of all ages, and men are following the species-specific Lake Champlain advisory.

Women of childbearing age who bought their fishing license in New York did not consume fewer fish than their Vermont counterparts, nor did they stop consuming Lake Champlain fish altogether as is specifically recommended in the New York health advisory.

New York license-buying women of childbearing age who were consuming Lake Champlain fish had similar sociodemographic characteristics as the rest of the respondents. They came in similar numbers from urban and rural areas as the rest of the respondents. They consumed primarily fish not specifically listed in the advisory (i.e., yellow perch, smallmouth bass and largemouth bass). Less than 15% of these women ate lake trout over 25" or walleye over 19". Many (42%) said they were aware of health advisory specifics, slightly less were generally aware (37%), and few (21%) were unaware. Fifty-one percent knew the recommendation for consumption of listed species that applies to men and women not of childbearing age. None of the respondents knew that the New York advisory recommended that women of childbearing age not eat any fish from Lake Champlain. A plurality (48%) said they were unsure what was recommended in the health advisory for women of childbearing age.

In 78% of respondents' households where another person was present, that person consumed Lake Champlain fish. In 90% of households in which the respondent ate Lake Champlain fish, another household member also ate Lake Champlain fish. Respondents reported that other men or women not of childbearing age in the household ate an average of 10 to 12 Lake Champlain fish meals in 1992-93. Overall, household women of childbearing age and

children under 15 ate an average of 7 to 8 meals. Among New York license buyers, household women of childbearing age and children under 15 ate an average of 8 to 10 meals, although the advisory recommends they eat no Lake Champlain fish.

A majority (69%) of New York license-buying households had at least one household member who was a woman of childbearing age or a child under 15. Anglers who came from such households were somewhat more likely to fish the central and northern sections of the Lake than the southern sections (Table 18). Statistical comparisons were not done because anglers could fish more than one section of the Lake.

Table 18. Percent of New York license-buying anglers living in households with women of childbearing age or children under 15 versus households without such people for each fishing location.

<u>Fishing Location</u>	<u>Percent of New York License-buying Anglers</u>	
	<u>Households with women of childbearing age or children under 15</u>	<u>Households with no women of childbearing age and no children under 15</u>
South Basin (1) <sup>a</sup> (n=73)	70.6	29.4
Westport Section (2) (n=65)	67.1	32.9
Mid-lake Section (3) (n=90)	78.6	21.4
Inner Burlington Harbor (4) <sup>b</sup>		
East of Grand Isle (5) <sup>b</sup>		
U.S. Portion of Missisquoi Bay (8) <sup>b</sup>		
Bay within Cumberland Head (6) (n=90)	73.7	26.3
West of Grand Isle (7) (n=121)	73.8	26.2
Canadian Waters (9) <sup>b</sup>		

<sup>a</sup>Numbers refer to locations identified in Fig. 2.

<sup>b</sup>Sample size was too small in this location for meaningful analysis.

### Fish Preparation Methods

Certain cleaning and cooking techniques can be used to reduce the health risks associated with the consumption of some potentially contaminated fish (e.g., contamination from PCBs). Respondents used many of the generally accepted risk-reducing fish cleaning techniques for most if not all of their fish meals (Table 19). Filleting the fish was the most commonly used technique, especially among New York license purchasers. The more fish meals an angler consumed the more likely he/she was to use risk-reducing cleaning techniques.

The risk-reducing cooking techniques of baking, roasting, broiling, or grilling were not used as frequently as pan frying, a non-risk reducing technique (Table 19). Other non-risk reducing techniques such as making fish soup and reusing fish oil were used infrequently by all anglers.

Most (>75%) respondents, especially those who consumed over 10 meals per year, reported that at least sometimes they froze or canned their fish for later use. This behavior may support the use of certain risk assessment models that assume fish consumption is distributed throughout the calendar year.

### Fish Consumption Suppression

A slight majority of respondents (54%) would eat more sport-caught fish if health risks from chemical contaminants did not exist. New York license purchasers were more likely than Vermont license purchasers to say they would consume more fish if health risks did not exist (Table 20). This difference might be attributed to the more extensive New York health advisory involving more waterbodies than the Vermont advisory. Fish consumption suppression

Table 19. Percent of respondents using specific fish preparation methods, overall, by state of license purchase, and by amount of Lake Champlain fish consumed.

Fish Preparation Methods	'92-'93 Lake Champlain						
	State of License Purchase			Fish Consumption			
	Overall (n=481)	New York (n=231) <sup>a</sup>	Vermont (n=263) Percent	None (n=87)	1-10 Meals (n=157)	>10 Meals (n=146)	
<b>Risk-reducing<sup>b</sup></b>							
<i>Remove fat along back</i>							
No meals	45.1	46.5	43.3	47.6	45.5	39.0	
Some meals	12.0	12.7	11.2	12.4	9.6	17.0	
Most to all meals	42.9	40.8	45.5	40.0	44.9	44.0	
<i>Remove belly fat</i>							
No meals	28.8	33.9	22.3*	35.1	31.8	16.9*	
Some meals	10.7	11.3	10.0	7.6	10.0	16.3	
Most to all meals	60.5	54.8	67.7	57.3	58.2	66.8	
<i>Remove skin</i>							
No meals	15.0	17.7	11.7*	23.6	15.7	6.0*	
Some meals	16.9	19.7	13.3	18.2	12.8	17.6	
Most to all meals	68.1	62.6	75.0	58.2	71.5	76.4	
<i>Fillet fish</i>							
No meals	9.1	5.1	14.7*	17.4	9.5	1.6*	
Some meals	20.8	13.6	30.8	19.2	21.5	21.8	
Most to all meals	70.1	81.3	54.5	63.4	69.0	76.6	
<i>Bake, roast, broil, or grill</i>							
No meals	36.2	37.3	34.8	39.4	40.8	28.0*	
Some meals	44.5	44.2	44.9	42.8	35.3	54.6	
Most to all meals	19.3	18.5	20.3	17.8	23.9	17.4	
<i>Smoke fish</i>							
No meals	77.4	79.0	75.2	81.2	81.3	69.1	
Some meals	20.1	19.1	21.5	14.9	17.0	26.6	
Most to all meals	2.5	1.9	3.3	3.9	1.7	4.3	

Table 19. (Continued)

Fish Preparation Methods	State of License Purchase			'92-'93 Lake Champlain Fish Consumption		
	Overall (n=481)	New York (n=231) <sup>a</sup>	Vermont (n=263) Percent	None (n=87)	1-10 Meals (n=157)	>10 Meals (n=146)
<u>Not Risk-reducing</u>						
<u>Eat whole fish</u>						
No meals	62.9	63.8	61.6	69.8	64.1	61.0*
Some meals	20.7	21.7	19.4	15.5	14.1	28.3
Most to all meals	16.4	14.5	19.0	14.7	21.8	10.7
<u>Pan fry</u>						
No meals	16.6	17.6	15.5	22.2	20.0	11.1
Some meals	32.8	35.1	29.9	30.1	31.1	36.1
Most to all meals	50.6	47.3	54.6	47.7	48.9	52.8
<u>Deep fry</u>						
No meals	43.9	36.0	54.4*	46.7	50.4	35.0
Some meals	34.4	37.9	29.9	31.3	32.7	38.5
Most to all meals	21.7	26.1	15.7	22.0	16.9	26.5
<u>Make fish soup</u>						
No meals	66.5	68.6	63.9	61.6	76.6	57.2*
Some meals	30.9	28.3	34.1	32.9	22.9	39.3
Most to all meals	2.6	3.1	2.0	5.5	0.5	3.5
<u>Microwave</u>						
No meals	90.2	88.8	92.0	87.1	93.9	90.3
Some meals	7.8	8.6	6.8	8.9	5.0	7.9
Most to all meals	2.0	2.6	1.2	4.0	1.1	1.8

Table 19. (Continued)

	State of License Purchase			'92-'93 Lake Champlain Fish Consumption		
	Overall (n=481)	New York (n=231) <sup>a</sup>	Vermont (n=263) Percent	None (n=87)	1-10 Meals (n=157)	>10 Meals (n=146)
<u>Fish Preparation Methods</u>						
<u>Not Risk-reducing</u>						
<u>Reuse fish oil</u>						
No meals	88.0	87.8	88.3	85.4	92.5	85.1
Some meals	8.4	8.5	8.2	6.7	6.1	10.3
Most to all meals	3.6	3.7	3.5	7.9	1.4	4.6
<u>Other Methods</u>						
<u>Eat frozen or canned fish caught at an earlier time</u>						
No meals	23.9	22.0	26.2	33.2	31.1	10.7*
Some meals	56.0	54.4	58.0	50.5	50.7	64.6
Most to all meals	20.1	23.6	15.8	16.3	18.2	24.7

<sup>a</sup>Because a different set of weight factors was used for state of license purchase, the resulting sample size is slightly higher than the overall sample size. (See Table 1 for calculation of weight factors.)

<sup>b</sup>Techniques listed are generally risk-reducing for lipophilic contaminants (e.g., PCB's) but not for heavy metals (e.g., mercury).

\*Statistically significant difference between groups at  $P \leq .05$  using Chi-square test.



(actual consumption lower than desired consumption due to contaminants) therefore appears to exist among Lake Champlain anglers. We did not measure the magnitude of fish consumption suppression in this study.

Table 20. Percent of respondents who would eat more sport-caught fish if health risks did not exist, overall, and by state of license purchase.

	Would Eat More Sport-caught Fish if Health Risks From Chemical Contaminants Did Not Exist <sup>a</sup>		
	<u>Yes</u>	<u>Not Sure</u> Percent	<u>No</u>
Overall (n=552)	54.2	13.2	32.6
<u>State of License Purchase</u>			
New York (n=264) <sup>b</sup>	61.2	11.0	27.8*
Vermont (n=304)	45.2	16.1	38.7

<sup>a</sup>Only respondents to the Lake Champlain mail questionnaire were used in this analysis.

<sup>b</sup>Because a different set of weight factors was used for state of license purchase, the resulting sample size is slightly higher than the overall sample size. (See Table 1 for calculation of weight factors.)

\*Statistically significant difference between groups at  $P \leq .05$  using Chi-square test.

## DISCUSSION AND RECOMMENDATIONS

Concerns about the patterns of fish consumption in the Lake Champlain Basin motivated this research project, particularly as those patterns relate to fish consumption health advisories issued for the Lake. Overall, although awareness of health advisories among licensed anglers was moderate, fish consumption was generally within the limits recommended in the health advisory. Factors associated with advisory compliance (e.g., advisory knowledge), however, were more variable. Fish consumption limits appear to be

exceeded for a potentially high-risk group, women of childbearing age (based on the New York health advisory). Specific findings from this study suggest improvements may be possible in the health advisory program to improve compliance with recommendations among high-risk populations, increase understanding of technical issues associated with fish consumption, and identify Lake areas meriting systematic fish-tissue monitoring efforts.

#### Limitations of the Data

Interpretation and application of the data reported herein should consider several limitations of this study. First, using 12-month recall to assess harvest and fish consumption patterns may include substantial recall bias compared to studies using shorter recall times. The 12-month recall approach was used because of budget limitations combined with a desire for annual harvest and consumption data. Second, the sampling frame consisted of resident license buyers who purchased licenses in the counties bordering Lake Champlain. Again, budget considerations demanded we design a sampling strategy most likely to produce Lake Champlain anglers. These data may not represent the behaviors or attitudes of anglers who purchased their licenses outside the eight county areas used in this study, or other anglers who may be unlicensed. The data also do not represent very local groups of anglers who may have different fish consumption patterns than reflected by the general licensed angler population (e.g., Vietnamese, American Indians). Third, the corrective weight factors are based on New York license sale purchase proportions from 1991, and an estimate of Vermont resident license sales by county, as described in Table 1. Fourth, estimates of total angler days fished were based on data expansions from the 1988 New York statewide angler survey. Angler behavior may have changed during the 4 years between these

studies. Fifth, nonresponse corrections for population data, as described in the Results section, assume the nonrespondents interviewed were representative of all respondents. Sixth, the sample included low numbers of non-whites, which may affect the quality of the data reported for these groups. Seventh, discrepancies in reported fish consumption exist for at least 16% of those respondents who listed a higher total consumption from Lake Champlain than from all sources combined. Prompting people to list fish consumption by species consumed from specific lake locations may account for the larger range in sport-caught than in general fish meals reported (Connelly and Knuth 1993).

#### Attitudes and Knowledge

Although about 40% of anglers purchasing fishing licenses in the Lake Champlain Basin did not fish the Lake, only 17% of these avoided the Lake due at least in part to a perception that fish were too contaminated to be eaten. The most common reasons for not fishing Lake Champlain were a preference for other fishing locations, or a lack of necessary equipment. Only 2% did not fish the Lake solely because of a concern about contaminants. We did not assess the extent to which concerns about the presence of contaminants may have influenced the choice of former or potential anglers to fish in Lake Champlain. A general public survey of residents in the Basin would be required to calculate such estimates.

General awareness about the Lake Champlain health advisory among licensed anglers fishing the Lake (71%) was lower than the extent of advisory awareness reported for licensed anglers in other locations (e.g., 83% in Ohio River Valley [Knuth et al. 1993]; 85% in New York State [Connelly et al. 1992]; 95% for Lake Michigan [Connelly and Knuth 1993]).

Degree of advisory awareness differed between locations within Lake Champlain. Health, environmental, and fishery professionals should study the findings on advisory awareness by location and compare these to Lake areas which are of particular concern due to the presence of elevated contaminant levels. For example, a special advisory is issued for the Bay within Cumberland Head. Although few anglers were unaware of the advisory, over half of anglers fishing that area were only generally or vaguely aware of the health advisory. These anglers might not know the specific components of the advisory for the area they fished.

Comparing advisory awareness and locations fished will help determine if current health advisory communication efforts are sufficient, particularly in heavily-contaminated areas, or if additional strategies should be instituted to reach people eating fish caught from these areas of concern. Lower levels of advisory awareness among younger anglers and those with lower incomes suggest target audiences who may require more intensive advisory-education efforts than have been used to date. Lower advisory awareness among anglers who fish the far north and south reaches of the Lake may indicate the need for better advisory dissemination methods in these areas.

Anglers identified a range of advisory information sources important to them. New York license-buyers indicated the fishing regulations guide was particularly important. Vermont license-buyers indicated newspapers, television, and radio were important advisory information sources. These responses correspond to the major information dissemination techniques used in New York and Vermont, respectively, indicating some success of the chosen technique in reaching the 71% of anglers who were aware of the advisory.

Women placed greater importance than did men on special health advice brochures for advisory information. Such brochures are a key component of the communication program of the New York Department of Health. The brochures are particularly relevant for women because they explain in more detail than the press release or the fishing regulations guide the effects of contaminants on unborn and young children and the specific consumption advice for women of childbearing age.

A substantial proportion of anglers (about one-third) indicated posted warnings are an important advisory information source even though posted warnings are not a major component of advisory communication efforts in either state. Although posted warnings can be effective at limiting consumption from the posted site, such warnings generally do not provide information on alternative fishing sites, nor as detailed information about the effects of fish contaminants on human health as can be found in sources such as the fishing regulations guide. Since posted warnings were noted as important information sources for certain (potentially high-risk) groups, advisory communicators should consider whether posted warnings can or are providing the groups who rely on them enough information.

Given that New York State has a more-established, more involved health advisory communication program than Vermont, it is not surprising that New York license purchasers were more knowledgeable about the effects of fish consumption and risk-reducing behaviors than Vermont license purchasers. Although few anglers in either state expressed incorrect knowledge about the effects of fish consumption and use of risk-reducing behaviors, Vermont license purchasers were more likely unsure than New York license purchasers. Vermont's intention to print the health advisory in the fishing regulations

guide distributed with the fishing license seems appropriate, and should result in increased knowledge of advisory specifics among Vermont anglers. The 1994 Vermont fishing laws digest, however, contains only the most rudimentary health advisory recommendations (several lines) compared to the several pages of explanation included in the New York fishing regulations guide.

Caution should be used when communicating about risk-reducing fish consumption behaviors. In New York State, many waterbodies listed in the health advisory are affected by lipophilic contaminants that can be reduced through fish preparation techniques that decrease the amount of fish fat eaten. The Lake Champlain advisory exists, however, due to concerns about PCBs, a set of lipophilic contaminants, and mercury, a heavy metal that is not removed as fat is removed from the fish. Care is warranted to convey to anglers that not all contaminants in all fish can be reduced through fat-trimming or rendering processes.

Accurate knowledge of health advisory recommendations was more limited among all anglers than the fish-related information noted above. Ignorance of fish consumption recommendations has important implications for potential levels of compliance with advisory recommendations. Of particular concern may be households with women of childbearing age or children under 15. In such New York license-buying households, anglers were more likely to be incorrect or unsure rather than correct when answering questions about specific fish consumption advice listed in the health advisory. Ensuring that accurate information is reaching and is understood by these high-risk households should be a high priority for health advisory communication programs. Public health clinics, obstetrics/gynecology practices, women's services, pediatric

practices, and youth programs are potential communication partners that could be explored by health advisory communicators.

### Behaviors

Anglers fished Lake Champlain an average of 20 days in 1992-93, and harvested an average of 9 fish per day. Few licensed anglers were dissuaded from fishing Lake Champlain because of contaminants. The species harvested most commonly was yellow perch, a species not listed specifically in the health advisory. None of the primary species consumed for any location were species listed in the health advisory, except for lake trout in the mid-lake section.

Since the estimates of fishing effort and harvest were higher in this study than in studies conducted via creel surveys, the estimates of fish consumption in this report may also be higher than would be obtained using other methods. Twelve-month recall studies are prone to error in activity estimates (Westat, Inc. 1989). Westat, Inc. (1989) found a significant overestimate of fishing trips, days and expenditures on a 12-month recall survey compared with 3-month and 1-month recall surveys. Westat, Inc. (1989) also reported that memorable events tended to be overreported, while typical or mundane activities may tend to be underreported. Due to resource constraints, we implemented an annual recall study, but hoped that the degree of disparity between this study and creel survey data could inform us about potential biases in fish consumption estimates from this study.

Although attempts were made to make the characteristics of data from the current survey comparable with the Vermont creel surveys, several differences between the two research methods contribute to disparities in the datasets for fishing effort and harvest estimates. First, the current survey asked anglers

to estimate yearly fishing effort on the Lake. The creel surveys covered the summer and winter seasons only, and did not cover heavy spring shore fishing or night fishing (Brian Chipman, pers. comm.). The creel survey estimates were adjusted using twice the pre-interview time to estimate angler days from angler hours. This may overestimate trip length, underestimating days because the probability of encounter favors anglers who fish longer (Brian Chipman, pers. comm.). The creel surveys also did not cover winter (ice) fishing in New York waters, nor summer fishing in South Bay, New York waters north of Ingraham, or the "gut" (Vermont waters between Grand Isle and North Hero). It is believed that significant effort is expended in these areas (Brian Chipman, pers. comm.). The current survey sampled people who bought their licenses in the counties surrounding the Lake. Most of these people were also residents of the counties and thus may have had easier access to the Lake year round, increasing their average number of days fished. The expanded current survey estimates included only resident license buyers. Some effort by nonresident license buyers may be included in our estimates, however. Residents of either New York or Vermont could buy a resident license in their respective state, and a nonresident license in the neighboring state. The sampling frame of resident license buyers provides these individuals have only 1 chance of being selected, but the data they provide for Lake Champlain fishing and fish consumption could have occurred under either license. The degree of dual license purchase is unknown. The creel surveys included nonresident license buyers from outside New York and Vermont, unlicensed anglers, children, and Vermont seniors (whose licenses were not generally current nor available for sampling). Differences between these groups in fishing behavior, in addition to the issues discussed above, may have caused our fishing effort estimates to



be different than those reported on the basis of creel surveys.

Data from the 1988 New York statewide angler survey (Connelly et al. 1990) indicates that New York license buyers spent 482,170 days fishing Lake Champlain. If Vermont license buyers fished an equal amount, the total would be similar to the 1 million days estimated in this report. However, readers should be cautioned to recall that the figure estimated in this report (>1 million days) uses data and assumptions from the 1988 survey in deriving the estimate so the two numbers are not independently derived as is the case with the Vermont creel survey data.

Previous work by the authors indicates that anglers overestimate days of effort by an average of 45%, but do not overestimate per day expenditures or catch using a 12-month recall questionnaire (similar to the Lake Champlain survey) versus angler diaries (Connelly and Brown 1995). Applying this overestimate correction factor to our data, the total estimated angler days would drop from 1,041,583 to 718,333 days. This is still considerably higher than the 194,100 days estimated from the Vermont creel surveys. Slight overestimates (approximately 10%) of fish consumption were also found in the 12-month recall questionnaire compared with the diary method (Connelly and Brown 1995). Thus, some overestimate of fish consumption compared with actual consumption could be anticipated using 12-month recall as in this study. The extent of this difference, however, is probably not as great as the difference between the results of this study and that of the creel surveys.

Fishing behavior reported by licensed anglers has implications for health advisory programs. Urban anglers were more likely to fish from shore. Health advisory communication efforts might effectively include shore-based efforts such as posted notices, particularly in urban areas. Fish contaminant

monitoring programs should sample such in-shore areas that are likely to be fished frequently. Anglers were more likely to fish in the state waters of the state in which they purchased their license. This suggests location-specific health advisory information should be included in that state's fishing regulations guide to reach the Lake Champlain anglers fishing a particular location.

Licensed anglers who fished Lake Champlain and ate the fish harvested consumed an average of 26 Lake Champlain fish meals per year. Approximately one-third of anglers did not eat any Lake Champlain fish, one-third ate between 1 and 10 meals of fish, and one-third ate more than 10 Lake Champlain fish meals. Depending on the location, consumption at the 95<sup>th</sup> percentile ranged from 23 to 95 fish meals per year.

Although we did not measure fish meal size (grams), recent research with New York's Lake Ontario anglers estimated sport-caught fish meal size at 232 g/meal (Connelly, Knuth, and Brown [unpublished data]). To interpret our Lake Champlain data relative to other studies reported in terms of grams of fish per day, we assumed a 226.8 g meal size (8 oz.). Average annual Lake Champlain fish consumption among licensed anglers who ate Lake Champlain fish averaged 16.2 g/day. Consumption at the 95<sup>th</sup> percentile ranged from 14.3 g/day for the Inner Burlington Harbor to 59.0 g/day east of Grand Isle. Lakewide, 95<sup>th</sup> percentile consumption was 54.1 g/day. These consumption figures are for Lake Champlain fish only; they do not reflect consumption of fish caught in other locations or purchased fish. USEPA (1989) recommended using 6.5 g/day to represent average consumption of all fish and shellfish from estuarine and fresh waters by the U.S. population; 20 g/day to represent average consumption of fish and shellfish from marine, estuarine, and fresh

waters by the U.S. population; and 165 g/day to represent average consumption of fish and shellfish from marine, estuarine, and fresh waters by the 99.9<sup>th</sup> percentile of the U.S. population. Lake Champlain licensed anglers appear to be slightly to greatly above fish consumption rates for the U.S. population as a whole.

Lake Champlain locations producing the highest average rates of fish consumption included the South Basin and the area east of Grand Isle. These areas also exhibited the highest consumption rate for 95<sup>th</sup> percentile consumption. The mid-lake section had the highest estimated number of anglers who ate fish. These locations should be examined by health and environmental quality managers to determine if existing fish tissue monitoring programs are extensive enough relative to the fish harvest and consumption occurring in those areas. In addition, yellow perch was the most-consumed fish species from the Lake. Fish tissue monitoring programs conducted for human health protection objectives should consider targeting yellow perch regularly due to its importance for human consumption, rather than periodically as with the current monitoring scheme. Species in specific locations of special contaminant concern (e.g., smallmouth bass in Cumberland Bay) should also be considered for special monitoring attention.

Compliance with health advisory recommendations was very high (95%), and was generally higher than in studies conducted in other locations (e.g., 46% for Lake Ontario anglers of childbearing age [Connelly et al. 1993]; 75% for Great Lakes anglers [Connelly and Knuth 1993]; 89% for Ohio River anglers [Knuth et al. 1993]), even though advisory awareness (71%) was low compared to these other studies. Most anglers did not consume species listed specifically in the Lake Champlain advisory.

Average Lake Champlain fish consumption was lower among female anglers than male anglers surveyed in this study. However, virtually all (90%) of the anglers who were not complying with the advisory recommendations were New York license-buying women of childbearing age who were advised to eat no Lake Champlain fish. As noted earlier, knowledge of the specific health advisory recommendations for women of childbearing age and children was low among New York license buyers. For example, none of the female anglers consuming fish above the recommended limit correctly answered what level of fish consumption the New York advisory recommended for their age and gender. Almost one-half of this group indicated they were unsure what was recommended for women of childbearing age. New York license-buying anglers whose households contained women of childbearing age and/or children under 15 (for whom the no-consumption recommendation applies) indicated many of these individuals were in fact eating Lake Champlain fish. Health advisory communication programs, at least in New York, should therefore emphasize the special consumption advice for women of childbearing age and children, and what the consequences of not following the advice may be. Efforts should be made to distribute this enhanced health advisory advice not only to licensed anglers, but to the members of their households as well. Additionally, efforts may be necessary to explain the reasons for the discrepancy in advice between the New York and Vermont advisories.

As in other studies of fish consumption (e.g., Connelly et al. 1993; Knuth et al. 1993), the more fish meals an angler consumed, the more likely he or she was to use fish cleaning techniques that can reduce exposure to lipophilic contaminants. As noted earlier, however, the Lake Champlain health advisory exists in part because of concerns about mercury, a contaminant for

which exposure is not easily reduced through certain fish cleaning or cooking techniques. Efforts should be made to ensure that fish consumers, especially the more frequent fish consumers, understand that risk-reducing fish preparation techniques are effective for only some contaminants. The alternative is a false sense of security resulting in consumption of greater quantities of Lake Champlain fish while believing (sometimes incorrectly) that the contaminant burden can be reduced through proper trimming or cooking.

### Summary Management Recommendations

In summary, health advisory communication programs should:

1. **Expand current communication strategies that have resulted in a 71% awareness rate among licensed Lake Champlain anglers.** Although compliance with advisory recommendations is high (95%), awareness and knowledge about advisories and contaminants is relatively low, particularly for some audiences. High rates of compliance may reflect transient conditions (e.g., quality of fishery, recreation time available) that, if changed, could result in higher fish consumption rates. Ideally, high rates of both advisory awareness and advisory compliance would be attained.
2. **Target specific locations and audiences with increased risk communication efforts.** These include New York women of childbearing age and their households; anglers at the extreme north and south ends of the Lake and at locations in the Lake experiencing particularly elevated contaminant levels; and younger and lower income audiences. Specialized materials (e.g., brochures) and dissemination strategies for these audiences may be required. This recommendation also includes specific localized advisory areas as new advice is issued (e.g., Cumberland Bay

yellow perch was added to the New York health advisory restricted species list in 1995).

3. **Include the health advisory in the fishing regulations guide (law digest) of both states.** The regulations guides are supposed to be distributed to all licensed anglers, providing an efficient means of reaching this audience with health advisory information. At the time this report was written, a 6-line Lake Champlain advisory was included in the 1994 Vermont laws digest. The New York regulations guide devoted several pages to explaining the advisory and its recommendations.
4. **Acknowledge the differences between the New York and Vermont health advisories, and the reasons for them, particularly for women of childbearing age and children.** A substantial number of Vermont license buyers indicated the fishing regulations guide was an important advisory information source, even though the Vermont license guide did not contain health advisory information. It is likely that some New York and Vermont anglers read or become aware of the other state's advisory recommendations. A key risk communication tenet is to maintain credibility with your audiences. Credibility may be questioned, however, when states issue differing advice for the same waterbody.
5. **New York should clarify the advice for women of childbearing age and children under age 15 for Lake Champlain fish not specifically listed in the advisory.** Very few (near 10%) respondents who purchased a license in New York knew the correct advice. The recommendation should be stated clearly, explicitly, and simply.
6. **Evaluate the use of posted warnings deemed desirable by certain target audiences, particularly in urban and limited-access areas.**

7. **Emphasize both the benefits and the limits of risk-reducing fish preparation (cleaning and cooking) techniques.** Such techniques reduce exposure to PCBs, but not to mercury. Fish consumers may mistakenly rely on these techniques to reduce exposure to contaminants in all fish eaten.
8. **Develop communication partnerships with mass media, and with specialized outlets such as family health clinics, women's services, and youth programs.**

Fish flesh monitoring programs should:

1. **Sample frequently-fished in-shore areas, especially in urban areas as urban anglers tend to fish from shore.**
2. **Include regular sampling of yellow perch, the most frequently consumed fish species.**
3. **Consider regular monitoring programs for the primary species consumed in each major fishing location.** Based on numbers of anglers, this would include mid-Lake, east and west of Grand Isle, and the South Basin. Primary species include yellow perch, smelt, white perch, Atlantic salmon, lake trout, northern pike, smallmouth bass, and brown bullhead.
4. **Ensure monitoring programs sample extensively at those areas producing the highest rates of fish consumption, such as the South Basin and east of Grand Isle.**
5. **Consider expanding monitoring programs to include more extensive sampling in areas fished by at least 20% of Lake Champlain anglers (such as the Westport section, which is currently not sampled heavily).**

### Recommendations for Future Research

Fish consumption suppression (actual consumption lower than what an angler would eat if contaminants did not exist) was identified for Lake Champlain, but not quantified. Fishing effort suppression (actual effort lower than what would occur in the absence of contaminants) was not measured. Targeted studies focused on certain angling populations and/or the general public would be necessary to produce this information.

If health advisories on Lake Champlain are lifted in the future, fish consumption and fishing effort may increase due to the perception that contaminants are no longer a problem. If this occurs, fish consumption patterns may change. Further quantification of fish consumption suppression or then-current fish consumption patterns may be warranted.

Conversely, if health advisory recommendations become more restrictive, it is unclear if anglers will comply. For example, at the time of the study, no species-specific recommendation existed for yellow perch, and yellow perch was the most frequently consumed fish. In Spring 1995, however, the New York State Department of Health issued an advisory for Cumberland Bay that recommended no more than 1 meal per month of yellow perch be consumed from that location. A localized assessment of response to that new advisory recommendation may be warranted.

As noted in the objectives and methods for this study, the focus of this project was on Lake Champlain licensed anglers based on resident licenses purchased in counties bordering Lake Champlain. Due to budget limits, we were not able to assess the extent of fish consumption statewide among licensed anglers, or among unlicensed anglers or other subpopulations who may have been missed through a licensed angler survey. Data from this study may be coupled



with knowledge from Lake Champlain Basin managers to identify areas that merit further attention regarding fish consumption. For example, urban licensed anglers generally exhibited greater fish consumption than rural anglers. Urban fishing access is generally more limited than rural access, so that anglers may frequent one location rather than switching among several. For these reasons, on-site research techniques in urban areas (e.g., personal interviews) may be warranted for obtaining more detailed data from licensed as well as unlicensed anglers. Future research may target local areas that are heavily-fished and affected by contaminants (e.g., Cumberland Bay), those areas with substantial ethnic populations with whom the English health advisory may be ineffective (e.g., Vietnamese in the Burlington area), or those areas with substantial American Indian populations who may be frequent fish consumers (e.g., northwestern Vermont, northeastern New York).

Although overall compliance with health advisory recommendations was high, advisory awareness was moderate. Evaluation research could be coupled with the implementation of new or expanded risk communication efforts to assess changes in advisory awareness and knowledge among the target populations. Knowledge areas other than those assessed in this study could be included, e.g., knowledge of the process by which health advisories are developed. This study indicates that most male licensed anglers are maintaining their fish consumption within advisory limits. Male subpopulations may not be a high priority for further study. Women of childbearing age, however, were least likely to comply with the New York health advisory recommendations targeted toward them. Future evaluation research could be coupled with improvements in the health advisory communication program in an experimental sense. Improved techniques to reach

women of childbearing age may be instituted for certain groups in certain locations. Research to evaluate the success of those techniques would produce recommendations for Basin-wide communication efforts.

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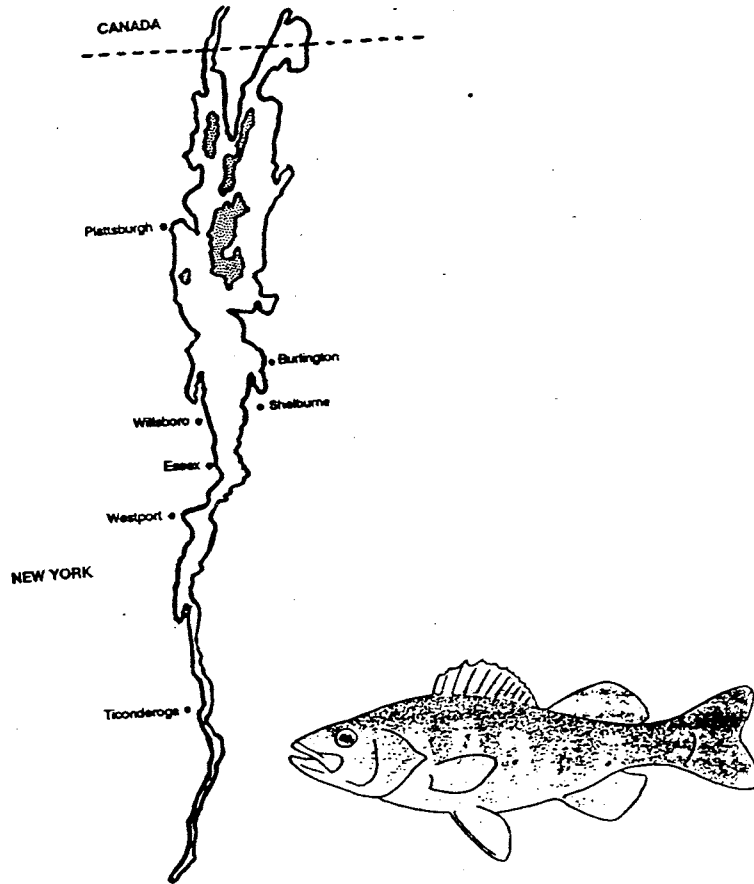
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APPENDIX A:  
Mail Questionnaire  
and Telephone Nonrespondent Interview

Mail Questionnaire

# LAKE CHAMPLAIN ANGLER SURVEY



Human Dimensions Research Unit  
Department of Natural Resources  
New York State College of Agriculture and Life Sciences  
A Statutory College of the State University  
Cornell University, Ithaca, N. Y.



# LAKE CHAMPLAIN ANGLER SURVEY

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

sponsored by  
the New England Interstate Water Pollution  
Control Commission  
in cooperation with  
the Lake Champlain Basin Program

The purpose of this survey is to learn more about fishing in Lake Champlain. We're interested in the activities and opinions of anglers related to fishing and eating fish from Lake Champlain. Your answers will help improve the process of advising anglers about the safety of eating freshwater fish taken from Lake Champlain.

Please complete this questionnaire at your earliest convenience, seal it, and drop it in any mailbox (no envelope is needed); return postage has been provided. Your responses will remain confidential and will never be associated with your name.

**THANK YOU FOR YOUR ASSISTANCE!**



Printed on recycled paper

The following questions refer to fishing and eating fish associated with Lake Champlain, not its tributaries.

1. Have you gone fishing on Lake Champlain within the past 5 years?

\_\_\_ Yes (SKIP TO QUESTION 3)

\_\_\_ No → Why not? (Check any important reason; you may check more than 1 reason):

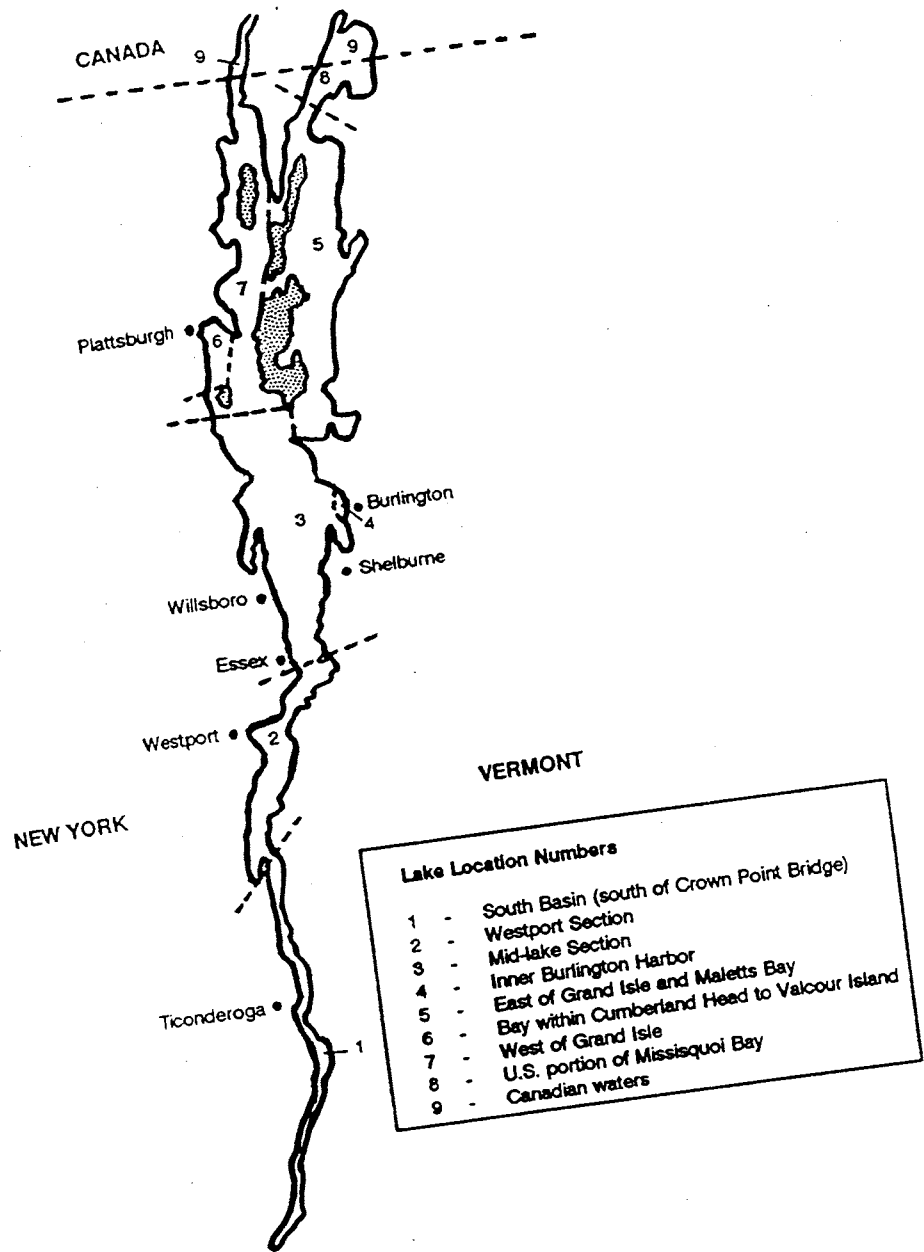
- \_\_\_ I do not have the necessary boat or equipment
- \_\_\_ I do not have a companion who is interested in Lake Champlain fishing
- \_\_\_ I would not want to eat the fish due to contaminants
- \_\_\_ I think the fishing locations are too crowded
- \_\_\_ I am not interested in the sizes of fish available to be caught
- \_\_\_ I am not interested in the types of fish available to be caught
- \_\_\_ I prefer to fish other locations
- \_\_\_ Other (Please list: \_\_\_\_\_)

2. If you have not fished Lake Champlain in the past 5 years and have not eaten fish from Lake Champlain in the past year, please SKIP TO QUESTION 16.

3. About how many meals of fish (fresh or saltwater) did you eat in the past year (September 1, 1992 - August 31, 1993)? (We are interested in any fish that you ate, whether sport-caught or purchased fresh, canned, or frozen at a store or restaurant.)

I ate approximately \_\_\_\_\_ fish meals in the past year.







5. Of the days you spent fishing on Lake Champlain between September 1, 1992 and August 31, 1993, about what percent were spent:

Fishing from shore	_____ %
Fishing from a boat	_____ %
Ice Fishing	_____ %
	_____ 100%

6. How often are your household's Lake Champlain fish meals prepared or cooked in the following ways? Circle one number for each item to best describe how your household prepares or cooks Lake Champlain fish meals. SKIP TO QUESTION 7 if your household does not eat fish caught in Lake Champlain.

1=No meals; 2=Few meals; 3=Some meals; 4=Most meals; 5=All meals

	<u>No meals</u>			<u>All meals</u>	
a. Remove the strip of fat along the back of the fish	1	2	3	4	5
b. Remove belly fat	1	2	3	4	5
c. Remove the skin	1	2	3	4	5
d. Eat whole, gutted fish	1	2	3	4	5
e. Fillet the fish	1	2	3	4	5
f. Pan fry	1	2	3	4	5
g. Deep fry	1	2	3	4	5
h. Make fish soups or chowders	1	2	3	4	5
i. Bake, roast, broil, or grill fish	1	2	3	4	5
j. Microwave fish	1	2	3	4	5
k. Reuse oil or fat from cooking fish	1	2	3	4	5
l. Eat frozen or canned fish caught at an earlier time	1	2	3	4	5
m. Smoke fish	1	2	3	4	5

7. Vermont and New York issue fish consumption health advisories to let people know how to limit their exposure to chemical contaminants by limiting the amount of some types of fish they eat. Only some types of fish from Lake Champlain are affected by health advisories.

Prior to receiving this survey, were you aware of fish consumption advisories or health advisories issued for fish caught from Lake Champlain? (Check one.)

- YES, aware of advisories for certain types of fish and/or areas of the Lake  
 YES, generally or vaguely aware  
 NO (SKIP TO QUESTION 14)

8. How important have the following information sources been to help you learn about health advisories for Lake Champlain fish? (Circle one number for each information source.)

1=Not At All Important      4=Very Important  
 2=Somewhat Important      5=Extremely Important  
 3=Important

	<u>Not at all Important</u>			<u>Extremely Important</u>	
a. Newspaper article or editorial	1	2	3	4	5
b. Magazine article	1	2	3	4	5
c. Fishing regulation booklet distributed with fishing license	1	2	3	4	5
d. Newsletters from fishing clubs	1	2	3	4	5
e. Newsletters from environmental interest groups	1	2	3	4	5
f. Warnings posted at fishing access sites	1	2	3	4	5
g. Health advice brochures available by special request from government agencies	1	2	3	4	5
h. Friends or family	1	2	3	4	5
i. Television or radio	1	2	3	4	5

9. Please check YES, NO, or NOT SURE for each statement below:

	<u>Yes</u>	<u>No</u>	<u>Not Sure</u>
a. The health advisories provide me with enough information to decide whether or not to eat certain fish.	_____	_____	_____
b. The potential negative health effects from eating contaminated fish include nervous system disorders and cancer.	_____	_____	_____
c. Older fish generally have more contaminants in them than younger fish.	_____	_____	_____
d. Many chemical contaminants are found in greater amounts in fatty fish than in lean fish.	_____	_____	_____
e. To reduce the levels of some chemical contaminants in fish you should:			
1. remove the belly fat	_____	_____	_____
2. pan fry the fish	_____	_____	_____
3. broil the fish on a rack	_____	_____	_____
4. remove the skin	_____	_____	_____

10. What do you think the States recommend as the maximum number of meals of fish that a person should eat from Lake Champlain for any species listed in the advisory? (Check one.)

_____ None	_____ 1 per week	_____ 5-6 per week
_____ 1 or less per mo.	_____ 2 per week	_____ 1 per day
_____ 2-3 per mo.	_____ 3-4 per week	_____ Don't Know

11. What do you think the States recommend as the maximum number of meals of fish that women of childbearing age and children under 15 should eat from Lake Champlain for any species listed in the advisory? (Check one.)

_____ None	_____ 1 per week	_____ 5-6 per week
_____ 1 or less per mo.	_____ 2 per week	_____ 1 per day
_____ 2-3 per mo.	_____ 3-4 per week	_____ Don't Know

12. What do you think the States recommend as the maximum number of meals of fish that women of childbearing age and children under 15 should eat from Lake Champlain, for species not specifically listed in the health advisory? (Check one.)

- |  |                                       |                                       |
|--|---------------------------------------|---------------------------------------|
| <input type="checkbox"/> None              | <input type="checkbox"/> 1 per week   | <input type="checkbox"/> 5-6 per week |
| <input type="checkbox"/> 1 or less per mo. | <input type="checkbox"/> 2 per week   | <input type="checkbox"/> 1 per day    |
| <input type="checkbox"/> 2-3 per mo.       | <input type="checkbox"/> 3-4 per week | <input type="checkbox"/> Don't Know   |

13. For questions 13a and 13b, please use this list of government agencies to answer the questions:

- a. New York or Vermont State Department of Health
- b. County/City Department of Health
- c. New York State Department of Environmental Conservation or Vermont Fish and Wildlife
- d. Don't Know

13a. If someone wanted to know more about health effects from exposure to chemical contaminants, which government agency do you think the person should contact?

(Write one letter from the list above.)

13b. If someone wanted more information about contaminant levels in fish, which government agency do you think the person should contact?

(Write one letter from the list above.)

14. Please check YES, NO, or NOT SURE for each statement below:

	<u>Yes</u>	<u>No</u>	<u>Not Sure</u>
a. Eating fish oils decreases the risk of coronary heart disease.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Increasing fish consumption reduces dietary fat and helps to control weight.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. The health risk from eating contaminated sport-caught fish is minor when compared with other risks I'm exposed to.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. I would eat more sport-caught fish if health risks from chemical contaminants did not exist.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**HOUSEHOLD INFORMATION**

**15. Please provide the following information for each member of your household, not including yourself.**  
*(Give estimates where you are unsure.)*

Household Members (Other Than Yourself)	Sex	Age	Relationship to Respondent	Does He or She Eat Lake Champlain Fish?	Approximate Number of Lake Champlain Fish Meals Eaten Between Sept. 1, 1992 and Aug. 31, 1993
1					
2					
3					
4					
5					
6					
7					
8					

16. In what year were you born? 19 \_\_\_\_

17. Are you male or female? \_\_\_\_ Male \_\_\_\_ Female

18. Which of the following best describes the area where you currently live? (Check one.)

- \_\_\_\_ Rural, town, or village (under 5,000 population)  
 \_\_\_\_ Small city of 5,000 to 24,999 population  
 \_\_\_\_ City of 25,000 to 99,999 population  
 \_\_\_\_ Large city of 100,000 population or over

19. How many years of school did you complete, counting 12 years for high school graduation, and 1 year for each additional year of college, technical, or vocational training?

\_\_\_\_ years

20. Please circle your approximate 1992 TOTAL HOUSEHOLD INCOME before taxes, in thousands of dollars:

Less than 10 10 12 14 16 18 20 22 24 26 28 30 32  
 34 36 38 40 45 50 55 60 65 70 75 80 85 90 95  
 More than 95

21. What is your race?

- \_\_\_\_ White, not of Hispanic origin  
 \_\_\_\_ White, of Hispanic origin  
 \_\_\_\_ Black or African-American  
 \_\_\_\_ Asian or Pacific Islander  
 \_\_\_\_ Native American Indian  
 \_\_\_\_ Other

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

**Thank You For Your Time and Effort!**

To return this questionnaire, simply seal it (postage has been provided) and drop it in the nearest mailbox.



Telephone ID # \_\_\_\_\_

**Lake Champlain Nonrespondent  
Telephone Follow-up**

Put label here that has NAME, PHONE, and ID1

	Date	Day of Week	Time	Result
Initial Call:	_____	_____	_____	_____
1st Call Back:	_____	_____	_____	_____
2nd Call Back:	_____	_____	_____	_____
3rd Call Back:	_____	_____	_____	_____

Good (Morning, Afternoon, Evening):

My name is \_\_\_\_\_. I work for the Department of Natural Resources at Cornell University. May I speak to \_\_\_\_\_.

(IF INDIVIDUAL IS UNAVAILABLE, FIND OUT WHEN IT WOULD BE CONVENIENT TO CALL AGAIN AND ENTER ON COVER SHEET.)

I'm calling you in regard to the questionnaire that we mailed out to you recently about fishing along Lake Champlain. We realize that you may have been too busy to fill out the questionnaire or that you don't fish very often, but we hope we can include your input on a few key questions so our information reflects the opinions of all anglers who might fish Lake Champlain.

Would you be willing to spend about 5 minutes now answering a few questions? (IF NO, ASK FOR A MORE CONVENIENT TIME TO CALL BACK AND ENTER ON COVER SHEET.)

The questions I'm going to ask refer to fishing and eating fish associated with Lake Champlain, not its tributaries.

1. Have you gone fishing on Lake Champlain within the past 5 years?

\_\_\_\_\_ No

\_\_\_\_\_ Yes (SKIP to Question 3.)

2. I'm going to read 3 possible reasons you might have had for not fishing Lake Champlain in the last 5 years. Tell me if any of them were your reasons for not fishing.

\_\_\_\_\_ You don't have the necessary boat or equipment

\_\_\_\_\_ You wouldn't want to eat the fish due to contaminants

\_\_\_\_\_ You prefer to fish other locations

(SKIP to Question 4.)

3. How many days did you fish Lake Champlain between September 1, 1992 and August 31, 1993? (Count any part of a day as a whole day; Write 0 if they did not fish.)

\_\_\_\_\_ days

4. How many meals of fish caught in Lake Champlain did you eat between September 1, 1992 and August 31, 1993?

\_\_\_\_\_ Lake Champlain meals

(If they have not fished Lake Champlain in the past 5 years (No on Q1) and have not eaten Lake Champlain fish in the past year, SKIP to Question 11.)

5. Did you catch and keep any lake trout over 25" in length from your fishing trips between September 1, 1992 and August 31, 1993?

\_\_\_\_\_ Yes      How Many? \_\_\_\_\_ fish

\_\_\_\_\_ No

6. How many meals of lake trout, which when caught were over 25", did you eat between September 1, 1992 and August 31, 1993?

\_\_\_\_\_ Lake trout meals

7. Did you catch and keep any walleye over 19" in length from your fishing trips between September 1, 1992 and August 31, 1993?

\_\_\_\_\_ Yes      How Many? \_\_\_\_\_ fish

\_\_\_\_\_ No

8. How many meals of walleye, which when caught were over 19", did you eat between September 1, 1992 and August 31, 1993?

\_\_\_\_\_ Walleye meals

Vermont and New York issue fish consumption health advisories to let people know how to limit their exposure to chemical contaminants by limiting the amount of some types of fish they eat. Only some types of fish from Lake Champlain are affected by health advisories.

9. Prior to receiving our survey, were you aware of health advisories issued for fish caught from Lake Champlain?

\_\_\_\_\_ No (SKIP to Question 10b.)

\_\_\_\_\_ Yes

10. Please tell me if you agree, disagree or are not sure about each of the following statements.

- a. The health advisories provide me with enough information to decide whether or not to eat certain fish.

\_\_\_\_\_ Agree      \_\_\_\_\_ Disagree      \_\_\_\_\_ Not Sure

- b. The health risk from eating contaminated sport-caught fish is minor when compared with other risks I'm exposed to.

\_\_\_\_\_ Agree      \_\_\_\_\_ Disagree      \_\_\_\_\_ Not Sure

- c. I would eat more sport-caught fish if health risks from chemical contaminants did not exist.

\_\_\_\_\_ Agree      \_\_\_\_\_ Disagree      \_\_\_\_\_ Not Sure

11. Which of the following best describes the area where you currently live?

Rural, town, or village (under 5,000 population)

Small city of 5,000 to 24,999 population

City of 25,000 to 99,999 population

Large city of 100,000 population or over

12. In what year were you born? 19

13. How many years of school did you complete, counting 8 years for finishing the 8th grade, 12 years for high school graduation, and 1 year for each additional year of college, technical, or vocational training?

years

14. What is your race?

White, not of Hispanic origin

White, of Hispanic origin

Black or African-American

Asian or Pacific Islander

Native American Indian

Other

Thank you very much for taking the time to answer my questions.  
End Interview here.

Interviewer comments:

Respondent's sex  Male  Female

APPENDIX B:

Tests for Nonresponse Bias and  
Calculations for Nonresponse Adjustments

Table B-1. Tests for nonresponse bias.

Questions	Respondents		Nonrespondents	
	Percent	n	Percent	n
<i>Fish Lake Champlain Within Past 5 Years?</i>				
No	31.3	376	41.0	41
Yes	68.7	824	59.0	59
	(x <sup>2</sup> = 4.0, df = 1, p = .05)			
<i>Didn't Fish Because Didn't Have Necessary Boat or Equipment?</i>				
No	57.9	209	63.6	21
Yes	42.1	152	36.4	12
	NS			
<i>Didn't Fish Because of Contaminants?</i>				
No	81.2	293	78.1	25
Yes	18.8	68	21.9	7
	NS			
<i>Didn't Fish Because You Prefer Other Location?</i>				
No	47.1	170	44.1	15
Yes	52.9	191	55.9	19
	NS			
<i>Catch and Keep Lake Trout Over 25" in '92-'93?</i>				
No	89.5	574	87.8	43
Yes	10.5	67	12.2	6
	NS			
<i>Catch and Keep Walleye Over 19" in '92-'93?</i>				
No	86.0	551	81.6	40
Yes	14.0	90	18.4	9
	NS			
<i>Aware of Health Advisories?</i>				
No	13.6	110	33.9	21
Yes	86.4	697	66.1	41
	(x <sup>2</sup> = 18.4, df = 1, p = .05)			
<i>Health Advisories Provide Me With Enough Information to Make Own Decision</i>				
Agree	58.8	399	70.7	29
Disagree	20.0	136	9.8	4
Not Sure	21.2	144	19.5	8
	NS			
<i>Health Risks Are Minor Compared With Other Risks</i>				
Agree	39.3	314	50.0	31
Disagree	26.1	209	25.8	16
Not Sure	34.6	277	24.2	15
	NS			

Table B-1. (Continued)

<u>Questions</u>	<u>Respondents</u>		<u>Nonrespondents</u>	
	<u>Percent</u>	<u>n</u>	<u>Percent</u>	<u>n</u>
<i>I Would Eat More Fish If Health Risks</i>				
<i>Didn't Exist<sup>a</sup></i>				
Agree	53.4	318	51.6	32
Disagree	33.3	198	41.9	26
Not Sure	13.3	79	6.5	4
			NS	
<i>Residence Area</i>				
Rural	67.5	794	68.6	61
Small City (5,000 to 24,999 pop.)	21.9	258	21.3	19
City (25,000 to 99,999 pop.)	8.8	103	10.1	9
Large City (100,000 or over pop.)	1.8	21	0.0	0
			NS	
<i>Education</i>				
Grades 1-11	8.3	97	18.9	17
Grad. High School	33.3	390	38.9	35
Some College	33.4	392	20.0	18
Grad. College	13.4	157	12.2	11
Some Post Grad.	11.6	136	10.0	9
	(x <sup>2</sup> = 16.1 df = 4, p = .05)			
<i>Race</i>				
White	97.1	1124	96.6	86
Other	2.9	34	3.4	3
			NS	
<i>Sex</i>				
Male	85.5	1008	88.0	88
Female	14.5	171	12.0	12
	<u>Mean</u>	<u>n</u>	<u>Mean</u>	<u>n</u>
<i>Average # Days Fished Lake Champlain '92-'93</i>	20.8	641	17.6	46
			NS	
<i>Average # Lake Champlain Fish Meals</i>	17.3	641	12.1	48
			NS	
<i>Average # Lake Trout Over 25" Caught</i>	0.87	641	0.96	49
			NS	
<i>Average # Lake Trout Over 25" Eaten</i>	0.24	641	1.06	49
			NS	
<i>Average # Walleye Over 19" Caught</i>	0.92	641	0.61	49
			NS	

Table B-1. (Continued)

<u>Questions</u>	<u>Respondents</u>		<u>Nonrespondents</u>	
	<u>Mean</u>	<u>n</u>	<u>Mean</u>	<u>n</u>
<i>Average # Walleye Over 19" Eaten</i>	0.41	641	0.55	49
		NS		
<i>Age</i>	40.1	1176	40.1	90
		NS		

<sup>a</sup>Due to significant differences between the two versions of the mail questionnaire only the responses to the original survey were used in the analysis.



Calculations to Account for Nonresponse Bias

From the original sample of 2,600, 123 were undeliverable, 1,200 responded, and the rest (1,277) were nonrespondents. From the nonrespondents, 100 were interviewed by telephone. We assume that those interviewed by telephone are representative of all nonrespondents. Undeliverable surveys will be dropped from the analysis here because we know nothing specific about their fishing behavior and we assume that they are similar to the general angling public.

After examining the nonrespondent data we assumed that urban county residents in each state were similar and rural county residents were similar. Thus, we combined data to increase the sample size. After adjusting for nonresponse bias, we weighted the data to be representative of the population from which the sample was drawn.

The following calculations were made to estimate the percentage of the survey population (respondents and nonrespondents) in each category.

Fished Lake Champlain in Past Five Years

	<u>n</u>	x	Percent Fished Lake Champlain in Past Five Years	=	<u>n Fished Lake Champlain in Past Five Years</u>
Urban Respondents	650		76.9		500
Urban Nonrespondents	<u>692</u>		70.9		<u>490</u>
	1,342		73.8		990
Rural Respondents	545		58.9		321
Rural Nonrespondents	<u>585</u>		44.4		<u>260</u>
	1,130		51.4		581

	1991 Est. License Sales	Proportion	Weighted Sample	Percent Fished Lake Champlain in Past Five Years	Weighted Sample Fished Lake Champlain in Past Five Years
Urban Counties	20,847	.373	922	73.8	680
Rural Counties	<u>35,114</u>	<u>.627</u>	<u>1,550</u>	51.4	<u>797</u>
	55,961	1	2,472	59.7	1,477

Aware of Health Advisories

	<u>n</u>	x	<u>Percent Aware of Health Advisories</u>	=	<u>n Aware of Health Advisories</u>
Urban Respondents	491		90.2		443
Urban Nonrespondents	490		68.3		335
	981		79.3		778
Rural Respondents	316		80.4		254
Rural Nonrespondents	260		47.6		124
	576		65.6		378

	<u>1991 Est. License Sales</u>	<u>Proportion</u>	<u>Weighted Sample</u>	<u>Percent Aware of Health Advisories</u>	<u>Weighted Sample Aware of Health Advisories</u>
Urban Counties	20,847	.373	581	79.3	461
Rural Counties	35,114	.627	976	65.6	640
	55,961	1	1,557	70.7	1,101

APPENDIX C:

Comparison of Sociodemographic Characteristics  
of the General Population in Lake Champlain Basin Townships  
With Responding License Buyers Who Fished Lake Champlain  
in the Past Five Years

Table C-1. Sociodemographic characteristics of the 1990 general population residing in Lake Champlain Basin townships as compared with respondents who fished Lake Champlain in the past five years.

	1990 Lake Champlain Basin Towns <sup>a</sup>	Respondents Who Fished Lake Champlain in the Past Five Years
	Percent	
<u>Sex<sup>b</sup></u>		
Male	49.7	84.7
Female	50.3	15.3
<u>Age<sup>c</sup></u>		
18-21	11.2	5.1
22-64	74.3	92.3
65+	14.5	2.7
<u>Race<sup>b</sup></u>		
White	97.3	96.3
Other	2.7	3.7
<u>Educational Attainment (Persons 25 years and over)</u>		
Grades 1-11	20.9	8.1
Grad. High School	34.2	35.6
Some College	22.9	33.7
Grad. College	13.7	11.1
Some Post Grad.	8.3	11.5
<u>Median Household Income</u>	\$30,470	\$35,000

<sup>a</sup>Source: 1990 Census data for towns included in Lake Champlain Basin, prepared by Holmes & Associates, 1993.

<sup>b</sup>1990 Census data includes children <16 years old, respondents to the survey are  $\geq$  16 years old.

<sup>c</sup>16 and 17-year olds who responded to the survey were deleted from the analysis so that comparisons of like-aged individuals could be made.