A REVIEW AND ANALYSIS OF FISH CONSUMPTION
SURVEY METHODS AND APPROACHES

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SUMMARY

Although several studies have demonstrated that fish/shellfish consumption rates differ throughout the country and for specific subpopulations, most States do not have available sufficient data to calculate local consumption rates or identify special populations at risk. Examples of these special populations are those recreational and subsistence fishermen and members of their households-in particular, women of child-bearing age, children, and the elderly—who frequently consume fish/shellfish obtained from contaminated sites. This report was designed as a critical assessment of fish/shellfish tissue consumption rate survey approaches and methods and their applicability for estimating consumption rates in recreational and subsistence fishing populations. Additional information is provided to assist Federal and State agencies in developing appropriate surveys to answer questions and resolve issues related to the fish consumption rates of special populations.

Five approaches to obtaining fish/shellfish consumption data were reviewed: (1) recalled information collected by telephone; (2) recalled information collected by in-person (face-to-face) interviews; (3) recalled information requested on self-administered mailed questionnaires; (4) diaries maintained by fishermen; and (5) on-site creel censuses. The effectiveness of the approach to obtain adequate information for fish/shellfish consumption rate calculations varied with the objective(s) of the survey. For example, creel censuses usually failed to collect data on consumption. Many of the surveys reviewed combined two or more approaches in order to maximize the number of respondents or validate the information obtained. Several studies addressed actual contaminant exposures through physical exams and measurement of blood serum levels of contaminants, while others investigated risk perception and compliance with fish consumption advisories and bans by the targeted anglers.

Five elements common to all the surveys were identified, and specific methodological details were provided to help solve problems that may be encountered when undertaking a fish consumption survey. (1) Survey design should address the purpose for which the survey is to be conducted and the resources available for carrying it out, including time and funding available, and the approach to be used. (2) Survey participants must be identified from a pool of subsistence or recreational fishermen, and the method by which the sample is selected may vary depending on the approach that will be used to collect the data and how the data will be analyzed. (3) The information to be collected should examine sociodemographic factors that may influence fish consumption rates, as well as those factors that are needed to calculate fish consumption rates, minimizing the number of assumptions made that could compromise these results. The survey length and complexity should also be carefully considered to elicit maximum cooperation from respondents. (4) Appropriate quality assurance procedures need to be developed before beginning the survey and quality control must be carefully monitored during the survey to ensure the validity of the data before statistical analyses are conducted. (5) Data processing procedures and statistical analyses should be performed not only to provide the desired information and correlations but also to meet the objectives of the survey.
INTRODUCTION

Concern over potential human health risks associated with the consumption of chemically-contaminated fish and shellfish tissues has led many States to issue fish/shellfish consumption advisories and bans in an effort to limit exposures to certain organic compounds and metals that may become concentrated in these organisms from polluted habitats. However, the processes and procedures by which States issue fish/shellfish consumption advisories and bans have been varied. In a recent effort to improve the fish advisory process in the States, the U.S. Environmental Protection Agency (EPA) provided a grant for the American Fisheries Society (AFS) to conduct a survey of State fish advisory practices (Cunningham et al., 1990). In the survey, State representatives were asked to describe their fish advisory process and procedures, to identify State concerns related to the advisory process, and to recommend actions that could be undertaken by the Federal government to improve the effectiveness of the advisories.

To follow up on the State recommendations for Federal action, EPA invited officials from State agencies to attend a Federal-State Forum on August 30, 1990, in Pittsburgh. Representatives of agencies from 27 States and the District of Columbia, as well as several Federal agencies, including EPA, the Food and Drug Administration (FDA), the National Oceanic and Atmospheric Administration (NOAA), the Fish and Wildlife Service (FWS), the Tennessee Valley Authority (TVA), and the Agency for Toxic Substances and Disease Registry (ATSDR) were present. The agenda for the Forum contained a list of the Federal action items identified in the AFS survey. Participants were asked to rank proposed Federal action items as short- or long-term priorities and to recommend other action items not previously identified in the survey. Each participant was also requested to submit the three action items that were most important to his/her program. The second most frequently requested short-term action item contributed by Forum participants was to conduct surveys/studies to assess fish consumption rates in various regions of the country by the various subpopulations in those regions (Southerland, 1991).

Fish/shellfish consumption rates differ throughout the country and for specific subpopulations (e.g., Hu, 1985). The use of an "average" consumption rate for typical households, recreational fishermen, and subsistence fishermen may not accurately reflect the local consumption rate in a particular subpopulation and may overestimate or underestimate the risk associated with the consumption of contaminated fish tissue by different members of households. Presently, most States do not have available sufficient data to calculate local consumption rates or identify special populations at risk. As a result, a variety of methods are used for estimating consumption rates when calculating risk associated with the consumption of chemically-contaminated fish/shellfish tissue (USEPA, 1989). To further complicate the issue, recreational fishermen may catch fish/shellfish from contaminated sites for sport, but not consume them, while subsistence fishermen may be obtaining a large
proportion of their diet from contaminated resources because they cannot afford to purchase other foods. There are also commercial-type subsistence fishing operations, which obtain fish/shellfish on a larger scale to provide these items to communities. The amount of time spent in these activities may also vary depending on the weather and the state of the fishery (seasonal restrictions, for example).

Human exposures to chemical contaminants (e.g., dioxins or polychlorinated biphenyls from industrial sources, pesticides from nonpoint sources, or mercury from natural sources) through fish/shellfish consumption are a function of the quantities of these foods consumed by humans, in addition to the ability of different species of fish/shellfish to bioconcentrate the chemicals of concern. The EPA, FDA, the National Marine Fisheries Service (NMFS/NOAA), and other organizations are responsible for monitoring the chemicals found in these organisms. A number of recent studies, however, have pointed out that the national surveys that are the basis for many human health risk assessments fail to target some of the most potentially high-risk populations, including recreational and subsistence fishermen and their families.

Early studies of fish/shellfish consumption provided only limited data (e.g., Nash, 1971; Hu, 1985). Although the number of fish meals were tallied, socioeconomic or demographic questions were few and no distinction was made between recreationally (self-caught) and commercially harvested (including processed/canned) fish consumed. Furthermore, there was usually no characterization of types of fish consumed (an exception was the National Marine Fisheries Service Survey 1973-74), and most surveys were either specific to particular regions of the country or national in scope (nonspecific). Thus, while these databases did provide important information on consumers and frequency of consumption of various fish/shellfish products, there were no efforts to specifically identify subsistence and recreational fishermen obtaining their catches from polluted waters. These data could not be used in consumption rate calculations for other areas of the country with any validity (Rupp et al., 1980). Another review by SRI International (1980) found that the most reliable source of data on human fish consumption was a national questionnaire survey conducted during 1973-1974 by NPD Research Inc. (National Purchase Diary Fish Consumption Survey). SRI performed additional tabulations of the corrected data to obtain mean consumption rates for various demographic categories and fish species.

Wagstaff et al. (1986) examined three types of national studies: (1) commercial production data on landings, imports, and exports of food fish; (2) surveys of food (including fish) intake; and (3) surveys specific for fish intake. Commercial fish production data failed to include commercial freshwater fish, recreationally caught fish, or marine fish sold at roadside stands (see also report by SRI International, 1980; Kleiman, 1985). General food intake surveys were limited in scope, season, or demographic and socioeconomic data. Specific fish intake surveys, based on weekly diaries for periods up to a year, included all fish meals, whether caught or bought, but
recreational catch information was sparse to nonexistent. Although different estimates of per capita fish consumption based on these surveys were similar, Wagstaff et al. (1986) concluded from their review that improved survey design and implementation of quality control in conducting, documenting, and reporting the results of such a survey were needed. Fisher (1988) also reviewed nine early surveys and found that none of them were helpful in providing the types of data needed to estimate usual or heavy fish intake or to examine recreationally-caught and consumed fish species. Hence, these surveys had only limited value in determining diet/health relationships or performing risk assessments associated with fish consumption. He noted, however, that since studies suggested an upward trend in per capita consumption, more recent and more detailed information collection was needed "either by expansion of currently planned nutrition surveys or by focused efforts to obtain such data from surveys on fish consumption."

Despite numerous limitations of these early studies, calculations of fish consumption rates suggested that certain subpopulations, based on race, ethnic origin, age, sex, income, and residence, did consume more fish than other groups. More recent surveys of Michigan sport fishermen and their families by West et al. (1989a,e) revealed that minorities from cities, rural Native Americans, and the elderly also caught and consumed more fish. These and other observations of fishing activity at known chemically-contaminated sites (e.g., Puffer et al., 1982a,b; Belton et al., 1985; Smith and Enger, 1988; Smith and Thompson, 1989) indicated that more detailed surveys targeting subsistence and recreational fishermen were warranted to improve calculations of fish consumption rates and risk assessments for specific subgroups. Some recent surveys have also attempted to link fish consumption rates to epidemiologic studies of health status (USEPA, 1984b) or body burden levels of contaminants (Fiore et al., 1989). Such information is also important for determining the success of advisories and bans issued to reduce health risks from eating contaminated fish and/or of changing waterbody management policies to reduce or eliminate toxic chemical inputs.

EPA recognizes that studies of fish consumption patterns need to be conducted to update current information and to focus on potentially high-risk geographical or cultural populations to improve our ability to assess public health risk associated with consuming contaminated fish tissue in relation to the beneficial aspects of a fish-based diet (Wagstaff et al., 1986). To address this need, EPA has implemented a three-phased approach for assisting the States in estimating fish tissue consumption rates in potentially high-risk populations. This approach includes the following steps:

- Review and critically evaluate existing fish tissue consumption rate survey methods and determine their applicability for estimating consumption rates in recreational and subsistence fishing populations.
• Conduct a workshop for the States presenting the results of the review and critical evaluation of fish tissue consumption survey methods.

• Provide direct support to the States in conducting fish tissue consumption surveys, targeting recreational and subsistence fishermen.

This document was prepared to meet the first step in this process. Existing literature concerning fish tissue consumption surveys of recreational and subsistence fishermen was reviewed, and selected surveys were evaluated to identify approaches (recall vs. diary vs. creel census) and methods for survey design and analysis to determine regional consumption rates, targeting the specific subpopulations of concern.

The purpose of this report is to assess the shortcomings and favorable attributes of these approaches and to explore the underlying methods involved in designing and conducting fish consumption surveys. The report also presents the pros and cons of the types of questions that need to be asked, rather than recommending a specific protocol for use by the States. The methods, approaches, and questions chosen will depend on the goals, objectives, and situations of the particular State and may also vary for the high risk subpopulation to be investigated. Therefore, a variety of options and guidelines for designing and executing surveys are presented. This document is intended to assist Federal and State agencies in revising surveys so that the types of information needed for valid statistical analyses to adequately address human health risks in subsistence and recreational fishermen and their families can be collected efficiently and cost-effectively.

DIFFERENT SURVEY APPROACHES

A variety of approaches have been utilized in attempts to develop appropriate estimates of fish consumption rates. Fisher (1988) examined approaches to obtaining data for a "national" sample of individuals and for samples of subpopulations that might be more frequent fish/shellfish consumers. He noted that the complex problem of estimating fish consumption for possible assessment of diet/health relationships and risks associated with its use as food required consideration of the following:

• Sociodemographic characteristics of consumers;

• Geographic and seasonal variations in consumption;

• Species of fish and geographic origin of species consumed;

• Parts of fish consumed; and

• Quantities consumed.
The approaches to collecting data on fish consumption were categorized as follows:

- **Indirect approaches** - data collected on food disappearance into marketing channels or households (the unit of observation) and

- **Direct approaches** - data collected on actual food use or food consumed by a variety of methods (i.e., the household or individual intake is the variable measured).

Indirect approaches were usually deemed unsuitable for small-scale studies and did not allow for correction of waste or individual intakes. Direct approaches, such as food diaries or records, weighed intake, dietary recall, food frequency, and duplicate portion studies, provided individual consumption data but were more labor-intensive both in data gathering and analysis. More information on the attributes and limitations of direct approaches to quantification of daily consumption by individuals was provided in Anderson (1986).

Five different approaches to conducting surveys of subsistence and recreational fishermen were identified during this review of recent fish/shellfish consumption surveys. In this section, each approach will be described and the advantages and disadvantages presented. Four categories of information considerations similar to those listed above by Fisher (1988) have been compiled and are presented in Appendix A. These categories include questions that need to be answered or issues that need to be resolved in order to be able to calculate fish/shellfish consumption rates for special populations. The questions were derived from this review of recent fishing/shellfishing surveys and comments from representatives of Federal and State agencies and other organizations. Although the types of data on sociodemographic characteristics, fishing activities, preparation and consumption patterns, and fish advisory awareness and understanding will be discussed in more detail below, the ability of each approach to adequately address these information needs will be examined in this section, in particular:

- Can the approach assess region-specific consumption rates (rather than being national in scope)?

- Can the approach target and identify specific subpopulations of concern (i.e., subsistence and recreational fishermen)?

The use of any particular approach will depend on the specific objectives of the study, as well as other factors. These will be discussed further under "Important Method Considerations" below.
Recall - Telephone

The recall - telephone survey approach makes contact with respondents by telephone and asks questions to elicit information on current or recent fishing trips and fish meal consumption. The answers are recorded directly on preprinted questionnaires, usually by interviewers working from one central location under the supervision of an experienced researcher. Although this approach "is rapidly becoming the principal method of collecting survey data in research situations where probing or in-depth exploration of the issues is not required" (USEPA, 1984a), interestingly, none of the surveys reviewed relied exclusively on data collected by telephone interviews. Instead, these surveys combined this technique with either on-site personal interviews or mailed questionnaires. A comparison study of different protocols examined by USEPA (1984a) found that a telephone interview based on a written questionnaire previously mailed to the respondent was the most effective approach because the respondent had had time to review the questions and survey information. Often, the telephone was employed to gather information on non-response bias or to confirm, adjust, or add to data collected in the field (see West, 1989b; National Marine Fisheries Service, 1991). Telephone surveys may minimize recall bias and have a better overall response than mail surveys because of the personal contact involved.

Telephone surveys may be quite appropriate for collecting certain types of information where long-term recall or familiarity with certain facts is not required (such as species names of fish caught/consumed). SRI International (1980) noted that a 7-day recall period could be quite inaccurate. Fisher (1988) found that single-day 24-hr recalls could be used to estimate mean intakes of population groups if the days were distributed throughout the year and if the survey population were large enough. Although large numbers of respondents could often be reached at a cost savings over personal interviews (e.g., the National Marine Fisheries Service studies), the types of information that could be reliably collected by this approach are limited. For example, fishermen may not divulge their fishing/shellfishing sites or give accurate answers for certain sociodemographic data. To maintain cooperation, each interview should not last longer than 10 minutes, so the number of questions must be limited. Hence, the surveys examined in this review usually relied on other approaches as their primary means of gathering data.

A number of problems were found in the use of telephone surveys, including difficulty in scheduling to make contact with selected respondents, absence of respondents at time of calling, unlisted numbers, and lack of a phone. The last could be a problem when trying to include low-income, suspected subsistence, fishermen in the sample. Wendt (1986) observed that low-income fishermen did consume more New York State freshwater fish than those with higher incomes, although the mail survey conducted by ChemRisk (1991a), found that those recreational fishermen who reported incomes of less than $10,000 apparently did not consume Maine freshwater
fish. List-assisted dialing, in which respondents were identified from lists of licensed anglers, participants in fishing tournaments, or other such preselected lists, was considered to be better than random-digit dialing techniques (see Human Sciences Research Inc., 1981, for an example of the latter) because specific populations of fishermen could be more easily identified. Computer-assisted survey techniques (i.e., Computer Assisted Telephone Interviewing or CATI, USEPA, 1984a) may be more efficient and less prone to errors made when transferring written data to computers since printed questionnaires are not used. If extensive narrative questioning is the basis of the survey, however, the use of CATI could compromise data collection. Verification of the information given is important and could require much additional work.

Advantages:

- This approach can assess region-specific consumption rates, depending on how the respondents are selected, i.e., determined by residence or proximity to a particular waterbody.
- The telephone survey approach is generally less expensive (by approximately one-half) and less time-consuming than personal interviews (since less training of interviewers is required and travel costs are not necessary), so large numbers of respondents may be contacted (see USEPA, 1984a).
- Recall bias and other potential errors may be minimized.
- A high rate of success for completing interviews is likely, although 5 percent lower than for personal interviews (USEPA, 1984) because of lack of personal contact.
- This approach provides immediate responses to questions, so analyses may be completed more quickly.

Disadvantages:

- This approach cannot target and identify specific subpopulations of concern unless these populations can be preselected on some basis or specific limiting questions are included on the surveys.
- Interviewers cannot reach people who do not have phones or those with unlisted numbers.
- Interviews need to be limited in scope and length to keep interviews under 10 minutes, so the number of questions must be carefully chosen.
It is difficult to verify information given.

To Solve These Problems:

- Use telephone interviews only as a follow-up to collecting information by other approaches.
- Use other approaches to contact low-income people; use random-digit dialing to reach those with unlisted numbers (USEPA, 1984a).
- Have one very specific objective for the survey, such as fish/shellfishing activities or fish consumption patterns, to limit the number of questions.
- Carefully design the survey to examine specific subpopulations and carefully prepare the questions to be asked to obtain optimal responses and to serve as self-checks on information given.
- Use combined mail/telephone technique to provide questions and visual aids or other information prior to contact.

Recall - Mail Survey

A number of surveys utilized the self-administered recall - mailed questionnaire to obtain information from recreational fishermen. As noted by USEPA (1984a), these mail surveys are best for collecting detailed technical data, especially if the respondents need to think about the questions or consult their records. The types of information ranged from simple creel census-harvest/angler use data (Swanson and Stephenson, 1982) to more detailed data on fish meals consumed by the household and methods of cooking. The Wisconsin survey (Wisconsin Department of Health and Social Services, 1987) additionally obtained blood samples for chemical analyses from some of the respondents who agreed to participate in a follow-up study. A mailed survey by Diana (1989) investigated behavioral groupings that indicated compliance with fish consumption advisories and respondents' knowledge of the fish contaminant situation. The available sample population for recall - mail fish consumption surveys was most often identified from records of anglers holding State fishing licenses and was sometimes geographically stratified to target those anglers nearest waterbodies of concern (e.g., the Great Lakes, coastal counties, specific rivers).

A wide variety of success rates in the return of completed questionnaires was reported. SRI International (1980) considered an 80 percent response rate to be acceptable, but many surveys have fallen far short of this goal. Cox et al. (1987) distributed three sets of questionnaires with the "Guide to Eating Ontario Sportfish." In 1978 questionnaires were sent randomly to people who had requested a guide in
response to newspaper advertising. In 1983, the questionnaire was included in the back of book, and 807 responses were received; in 1986, 1483 responses were received using the questionnaire that had been included in the back of the book. The most recent mailing in 1989 included 100,000 questionnaires placed in the back of the book and distributed at fishing tournaments or mailed out, but only 913 responses were received (Cox et al., 1990). This very low response rate indicated that other methods, including providing incentives or tracking down nonrespondents, would be necessary to improve the sample size (C. Cox, Ministry of the Environment, Toronto, Canada, personal communication). However, questionnaires sent to a 10 percent random sample of Arizona’s resident 1980 Class A and F license holders with a postage-prepaid return envelope resulted in only a 35 percent return rate (Swanson and Stephenson, 1982). Most of the other surveys had more success with returned surveys, but they spent relatively more money and time, sending out advance letters, sending surveys with stamped return envelopes, sending reminder letters or postcards, sending a second mailing of the survey to nonresponders, and finally using follow-up telephone calls to check on non-response bias. A variation of this technique, known as the "Dillman Method" (Dillman, 1978), in which advance notices and several reminders are also mailed, increased the response rates up to 50 - 65 percent: 50 percent (Wisconsin Department of Health and Social Services, 1987); 62.4 percent (Connelly et al., 1990); 47.3 percent (West, 1989a); 64.5 percent (ChemRisk, 1990a). The actual costs for this will vary with the state, the length of the survey and number of questionnaires sent, the number of reminders, and the type of follow-up performed. Babbie (1973) also reported greater success when the survey questionnaire was either personally delivered to the respondent or picked up later.

The types and amount of information collected were typically based on recall periods of days to months, up to 1 year (Wisconsin Department of Health and Social Services, 1987). Thus, these surveys were all subject to problems of longer term recall accuracy. West et al. (1989b) examined several possible modes for conducting their survey and concluded that of the 1-day recall, 7-day recall, or 7-day diary record, the 7-day recall would be best. The 7-day recall proved to be as accurate as 1-day recall when determining group means and was more representative of fluctuations over time. They noted, however, that this time period could be subject to "telescoping," in which respondents tend to include events from a longer time frame than is called for. West et al. (1989b) used the "bounded recall" technique to minimize this by first having respondents mark out in a one-week calendar the meals at which fish were eaten before providing detailed consumption information. The ChemRisk (1991a) study noted that in addition to the length of recall period (up to 1 year in this survey), the self-reporting nature of the mailed questionnaire survey, social desirability of the sport (prestige bias), importance of fishing to the individual, and frequency of fishing trips were also contributing factors to overestimates of consumption. Avid anglers were more successful and therefore consumed more; consequently, 10 percent of the anglers consumed 90 percent of the fish in that study.
The mailed questionnaire surveys did target recreational fishermen but usually did not examine the occurrence of subsistence fishing specifically (except to include questions from which analysts might infer subsistence fishing, such as income levels). Waterbodies fished were not usually linked to the consumption of fish from those waterbodies (e.g., ChemRisk, 1991a; but see Connelly et al., 1990, which targeted Lake Ontario fish consumption; other Great Lakes examined by Wisconsin Department of Health and Social Services, 1987; West et al., 1989b). The information collected to calculate fish consumption rates varied in complexity and ease of analysis, but certain assumptions needed to be made to cover recall bias identified from follow-up surveys.

Advantages:

- This approach can assess region-specific consumption rates, depending on how the respondents are selected (obtaining addresses from license applications, fishing tournament entries, etc.).

- Mailed surveys are the least costly since no interviewers are required except for obtaining follow-up information. Large numbers of respondents may be contacted over a broad area (see USEPA, 1984a).

- Respondents are most likely to provide honest answers and fewer "socially-desirable" responses (USEPA, 1984a).

- Complex technical data may be obtained because the respondent can take time to consider the questions asked and consult other sources if necessary.

- Survey can be longer in length and cover more types of questions, so more than one objective may be evaluated.

Disadvantages:

- This approach cannot target and identify specific subpopulations of concern unless these populations can be preselected on some basis or specific limiting questions are included on the surveys.

- Mail surveys cannot reach people who lack mailing addresses, such as migrant workers. If addresses are obtained from specific sources, such as licensed fishermen, the survey will miss unlicensed fishermen and others who may prove to be at high risk from fish consumption.

- Questions must be carefully designed to compensate for the lack of social interaction provided by telephone or personal interviews and must
provide adequate instructions to elicit satisfactory responses and motivate the respondents to cooperate (USEPA, 1984a).

- Questions must be limited in scope and complexity, preferably requiring only short answers or checking off multiple choices, to maintain cooperation by the respondent.

- Long-term recall may produce substantial bias in estimates of fish consumption and other variables.

- Voluntary mail surveys require substantial follow-up efforts to achieve reasonable response rates (either by conducting telephone interviews or by offering the respondents the choice of phoning in their answers).

- The recall - mail survey is likely to produce a higher number of inaccurate and incomplete responses because of lack of personal contact, provided by other approaches, to instruct and motivate (USEPA, 1984a).

- This type of survey may miss respondents who are illiterate, or who have difficulty understanding the questions, or who cannot read the language in which the questions are written.

To Solve These Problems:

- Use recall - mail surveys in conjunction with telephone interviews or other approaches to check on non-response and recall biases.

- Increase the return success rate by sending out several waves of follow-up reminders, conducting follow-up telephone interviews, offering respondents the choice of phoning in their answers, or personally picking up the completed questionnaires.

- Use other approaches, such as personal interviews, to contact low-income people or subsistence fishermen, or those who cannot fill out the questionnaires because of literacy or language problems.

- Carefully design the survey to examine specific subpopulations, and carefully prepare the questions to be asked to obtain optimal responses and to serve as self-checks on information given (see USEPA, 1984a).

- Carefully plan and pretest the questions to be answered to minimize the length of recall time required.
See Babbie (1973) for more information on how to conduct self-administered questionnaire surveys.

Recall - Personal Interview

Personal interviews were conducted in a variety of surveys to obtain information ranging from angler use to fish consumption patterns. The interviews occurred either directly at known fishing sites (where personnel may have to cover up to 18 hours per day at the site to catch early morning and late evening fishermen) or at home. Home interviewees were selected from samples of licensed anglers identified by State fish and game departments, or households located near fishing locations (Wolfe and Walker, 1987). Subsistence fishermen were also specifically identified because they were participating in special programs, such as that conducted by the Expanded Food and Nutrition Education Program of Cornell University Cooperative Extension Service (Wendt, 1986). In all cases, the respondents were asked a fixed set of questions, and the answers were recorded on the questionnaires.

Although the questions in most on-site interviews were limited to those of a creel census nature (see Creel Census below), a few interviews collected data for fish consumption rates. Two similar surveys were done in the Puget Sound area (McCallum, 1985; Landolt et al., 1985, 1987). The Landolt et al. studies targeted shoreside anglers and boating anglers as they returned to boat ramps. Over 4,000 shoreside angler interviews were conducted during the first year, but only 437 boating anglers were interviewed the second year. Landolt et al. noted that the latter interviews produced fewer cooperative respondents (only 83 percent), and the anglers either refused to give the exact sites of their fishing activities or only vaguely identified them. The McCallum (1985) study interviewed all anglers, crabbers, and clammers from one end of the beach or pier to the other end at specific sites throughout the year. The survey was advertised at local marinas and bait shops to aid in eliciting cooperation from respondents.

Other types of personal interviews were conducted at home. The Nationwide Food Consumption Surveys conducted by the U.S. Department of Agriculture asked individuals to provide from one day to six separate days of dietary data at intervals of 2 months over a 1-year period (see USDA 1985c, 1986b). The first day’s data were collected by personal interview, with subsequent data collected by telephone interview. Unfortunately, these studies did not target recreationally-caught fish/shellfish, and the consumption of potentially chemically-contaminated fish/shellfish could not be determined from the questions administered. The U.S. Department of Health and Human Services (USDHHS, 1989) survey of fishing patterns and contaminant exposure in Lake Coeur d’Alene, Idaho conducted personal interviews with 299 households, using recall periods of up to 1 month for data. Another study by Wendt (1986) targeted low-income freshwater fish consumption by carrying out
personal interviews with respondents identified as participants in the Expanded Food and Nutrition Education Program at Cornell University. She found that these interviews took time (30 minutes each) and required the presence of aides to serve as go-betweens or to keep children entertained during the interview. They did, however, yield interesting information on the fish consumption patterns of the participants. While the on-site interviews could collect information on the species of fish caught and consumed, household interviews suffered from the inability of the respondents to identify species of fish and recall bias. Both on-site and household interviews encountered literacy (understanding) and language barriers.

Advantages:

* This approach can assess region-specific consumption rates, by targeting the waterbody or residence of the respondent.

* This approach can also identify specific subpopulations of concern by obtaining data from known contaminated fishing/shellfishing sites or by using specific programs to provide potential respondents.

* Personal interviews can provide first-hand observations of the respondents and the interview sites.

* Recall bias can be minimized by providing appropriate visual aids (for portion or meal size) or basing the survey on the fish/shellfish caught at the time of the interview.

* This approach has a high rate of success for completing interviews because of personal contact and the ability to clarify confusing questions or neutrally probe for answers.

* Verification of information may be easier, especially if data collected are based on the actual catch of the day. It is also easier to obtain sensitive information and to utilize special techniques such as visual aids and probing.

Disadvantages:

* The number and complexity of survey questions must be limited so that surveys can be performed quickly.

* Interviewers may encounter literacy and language barriers.

* Recall - personal interviews are the most costly approach, requiring the coordination, hiring, training, and close supervision of interviewers and
field staff at more than one location, as well as additional paperwork to control the fieldwork and processing operations (USEPA, 1984a).

To Solve These Problems:

- Conduct the survey in different languages and provide visual aids to assist in obtaining information from the respondents. McCallum (1985) cited the most problems with questions on the parts of the catch eaten, fishing frequency, and how the fish were prepared for eating.

- Use the "clustering" technique to hold down costs, by limiting the number of sites or grouping the residences where interviews will be held.

- Carefully prepare the survey questions to minimize the length of the survey yet provide the precise information needed for the objectives.

- Provide adequate training, including practice interviews, and supervision of interviewers throughout the survey.

- See Babbie (1973) for more information on how to conduct interviews for surveys.

Diary

While complete food consumption diaries have been used in general nutrition surveys, none of the fish consumption surveys examined for this report employed this approach for obtaining data. Brock (1982) found that diary methods were subject to selective forgetting or lapses in diary keeping even after only a few days, and it was hard to get respondents committed to the project, especially if no personal contact was involved. However, Fisher (1988) noted that such records, kept at home for periods of days to months, can provide reliable data on patterns of food intake. This approach does require respondent literacy, and the act of keeping records itself may affect dietary practices, so there is a need to analyze for changes that may occur in motivation of the subject or changes in food records (Fisher, 1988). West et al. (1989b) observed that other earlier studies have shown that the most valid and accurate studies of fish consumption have been diary studies involving repeated personal contact with the study subjects. Such contact probably maximized motivation and minimized alterations in recording and diet by the respondents. Diary records may provide sound information for examining fish consumption patterns if the survey is carefully designed and monitored.
Advantages:

- This approach can assess region-specific consumption rates, depending on how the respondents are selected.

- Diary records are less expensive and less time-consuming than personal interviews (less training of interviewers is required) and can be administered to persons lacking telephones, so larger numbers of respondents may be included.

- This approach results in minimal recall bias, although other potential sources of error or alterations in record-keeping may occur.

- Diaries can provide data over long periods of time for particular subpopulations of concern, if they have been appropriately preselected.

Disadvantages:

- Using the diary approach requires respondent literacy, a high degree of motivation, and constant monitoring to maintain consistency in the data collected.

To Solve These Problems:

- Use the diary approach with other approaches to provide additional, in-depth, or longer term information on fish/shellfish consumption patterns.

Creel Census

The creel census approach is used to obtain harvest data collected on-site, either by single fishermen (hook and line, castnet, clam rake, etc.) or by larger scale commercial-type operations (trawl, gill nets, etc.) that obtain fish/shellfish for a specific community. A number of creel censuses have been done in Georgia, such as Scott (1981), Hottell et al. (1983), Schmitt and Hornsby (1985), Fowler and Holder (1987), and Spencer (1987). These on-site interviews examined the species fished for, species caught, weight caught, method, bait, origin, and type of fishing (boat, bank, dock, bridge), but did not include questions on fish consumption or sociodemographic data. These surveys also failed to distinguish whether the fish caught were going to be consumed, given away, sold, or released. Other surveys of this type include Mullis (1989), who obtained data on angler effort associated with striped bass fishing on the Roanoke River, and Ranthum (1975) who used 5 years of creel censuses that recorded lengths and weights of species of fish caught. Ranthum used a combination of two consecutive census days, then varied an early (7-11 am),
mid (11 am - 3 pm), and late (3-7 pm) schedule for on-site interviews during the 2-month study period each year. The Wisconsin series of creel censuses (e.g., Thuemler, 1981; Heizer 1986, 1988; Schumacher, 1987) used a random stratified sampling schedule for two-hour periods. Chandler and Brown (1978) examined marine recreational fishing/shellfishing harvest data for the Atlantic and Gulf coasts, while Human Sciences Research Inc. (1981) looked at recreational shrimping along the Gulf coast. ChemRisk (1991a) found that creel censuses were often used to estimate angler use and fish harvest from specific waterbodies, but noted that because individual anglers may fish in more than one location, such a survey might not completely characterize the total freshwater fish harvest or consumption for individuals and others sharing their catch.

Five creel census-type surveys were conducted that attempted to obtain direct information on the fish consumption patterns and habits of recreational and subsistence fishermen. An early study by Pierce et al. (1981) sampled fishing/shellfishing effort at 4 subareas around Commencement Bay in Washington State that were suspected of having potentially hazardous seafood. The on-site interviews were followed by telephone surveys to determine whether the fish that were caught that day had been eaten and how they had been prepared. The study suffered from problems in changes of sampling sites and the number of survey days during the study, but did identify important information on fish consumption patterns for the area.

Puffer et al. (1982a) examined the consumption of potentially hazardous marine fish and shellfish at 12 sites known to be fished and polluted in the Los Angeles area. Teams of 2 surveyors per site conducted 1,059 interviews with anglers on different days of the week and at different times (61 percent of interviews were held during the week, 39 percent on weekends, for a total of 400 site visits). Incentives for cooperation included fishing maps, copies of regulations, and/or recipes sent following the interviews. Photographs were frequently taken to ensure the correct taxonomic identification of the fish caught, to document site conditions, and to confirm sportfishermen counts. Initially, the surveyors recorded the number of fishermen present at a site and their sex, race, and approximate age. Then only those anglers who had actually caught fish were interviewed (if more than 20 had, a systematic sampling approach was used), resulting in a bias toward frequent fishermen. The more successful the fishing, the more frequently the fisherman was inclined to fish. The information necessary for accurate fish consumption rate calculations was weak, and there were problems with having to change sites during the study because of weather, sewage overflows, and chemical disposal problems. However, the study did indicate a need to assess health risks to consumers at specific sites and for specific subpopulations.

On the east coast, Belton et al. (1985) examined fishing effort at sites known to be chemically contaminated and where specific fishing bans had been instituted along
the Raritan River and other sites in New Jersey from May to December in 1983. An interesting aspect of this study was that the interviewers initially conducted only visual observations and informal interviews at the six sites (cross-cultural anthropological fieldwork techniques) because they were concerned that this population of anglers might be leery of formal surveys and distrustful of outsiders. Later, a subsample of the fishing population was selected to answer the questionnaire by personal interview at the site. A monetary incentive of $10 was provided for those who agreed to participate in a long-term study. Although the questionnaire was fairly thorough and easy to interpret for determining anglers' risk perceptions, the data collected for fish consumption rate calculations were incomplete. The questionnaire included no questions on size of portions consumed per meal or species. Assumptions were made to allow such calculations, but data from other studies were used to evaluate the health risks involved.

Smith and Enger (1988) conducted 703 interviews at fishing sites along the Tittabawassee River in Michigan. Although fishing bans had been announced because of contamination with dioxins on the river, the survey found that fishing effort had increased as the result of the successful restocking of the river with walleye. Only 2.7 percent of the anglers interviewed said that they were fishing for food, but the authors suspected that this was not the correct number. This particular survey relied on long-term (up to 1 year) recall of the anglers' fish consumption habits and did not target the actual catch of the day. Despite recall bias and the fact that weather conditions prohibited fishing in some parts of the river later in the summer (suggesting that this was not the best representation of the normal fishing effort and catch there), the study did target a specific local population where chemical exposure through fish consumption was of concern.

Finally, Kleinschmidt Associates (1989) examined the fish consumption patterns of anglers from two areas on the Androscoggin River in New Hampshire. The areas were the relatively pristine section of the river north of Berlin to the Errol Dam near the Maine-New Hampshire border and the river below the James River Corporation's paper mill at Berlin. The New Hampshire Division of Public Health Service had issued a fish consumption advisory for that portion of the river downstream from Berlin. While spending approximately equal periods of time in each area on three weekends in August, the interviewers were only able to find three anglers fishing in the lower area, resulting in 5.26 hours per initiated interview there, compared to 66 interviews in the upper area taking approximately 0.3 hour per interview. Interviewees in the lower area did not consume the fish they caught there because of health/safety concerns. The report concluded that the fish consumption advisory had been effective. The consumption data collected were based on recall of how often the fishermen ate fish from the particular section of the river (per week or month) and an average estimate of the meal size (in number of 8-to-10 inch fish). These data were easy to obtain, but the ambiguous nature of some of the questions would make calculations of fish consumption rates impossible (and rates were not determined).
Advantages:

- The creel census approach, as a personal interview approach, can assess region-specific consumption rates by targeting specific waterbodies.

- This approach can also identify specific subpopulations at high risk by obtaining data from actual fishermen at known contaminated fishing/shellfishing sites.

- Creel censuses can provide first-hand observations of the respondents, their fishing activities, and the interview sites.

- Recall bias can be minimized by providing appropriate visual aids (for portion or meal size) and by basing the survey on the fish/shellfish caught at the time of the interview.

- The rate of success for completing interviews is high because of personal contact.

- Verification of information may be easier, especially if data collected are based on the actual catch of the day. It is also easier to obtain sensitive information and utilize special techniques such as visual aids and probing).

- When the appropriate questions are included, this type of survey can more accurately assess fishing behavior by anglers at these sites, fish/shellfish species can be more accurately identified to species, and important information on consumption rates and characteristics of the fishermen can be easily obtained and verified.

Disadvantages:

- The number and complexity of survey questions must be limited so that surveys can be performed quickly.

- Interviewers may encounter literacy and language barriers.

- Creel censuses are more costly because they require the coordination, hiring, training, and close supervision of interviewers and field staff for quality control, as well as additional paperwork to control the fieldwork and processing operations.
If the number of interviews that can be conducted must be limited to control costs, a statistically valid subsampling of the population may be impossible to attain.

To Solve These Problems:

- As for personal interviews, conduct the creel census in different languages and provide visual aids should be provided to increase the response rates while minimizing the level of effort and time needed to conduct the interviews.

- Use the "clustering" technique to hold down costs by limiting the number of sites where interviews will be held. Try to select sites where there will be more respondents over longer periods of time or at different seasons, to limit the time needed to "search" for respondents at a site.

- Carefully prepare the survey questions to minimize the length of the survey and the time needed to conduct each interview yet still provide the precise information needed for the objectives.

**IMPORTANT METHOD CONSIDERATIONS**

Fisher (1988) noted that two considerations were important in using available data or in designing approaches to collecting data:

- The methodology used to collect data on fish consumption and

- The population sampling techniques.

He explained that the former was more complex because the dietary data collection method (or "approach" as defined in this document) selected would depend on both the population surveyed and the purpose for deriving the estimate. Population sampling techniques were important in surveying population subsets that preferentially consume fish because representativeness becomes important in statistical analyses. Fisher (1988) further stated that fish, as a food item, has unique attributes, so that any of the approaches taken to collect these data will each have inherent advantages and disadvantages in regard to usual or preferential fish consumption.

Many of the recent surveys examined for this report used more than one approach to obtain information. For example, a simple on-site creel census might be combined with a personal interview to include additional characteristics of the fishing population and whether the catch was going to be consumed. Or, a questionnaire mail survey might ask for general fish consumption information and then include a
table to be filled in asking for more specific fish consumption data over a period of several days. Other surveys have combined recall-mail surveys with follow-up telephone surveys to check on non-response bias or to obtain more complete information. Springer (1990) used several different types of questionnaires and either mailed surveys or conducted personal interviews depending on the target audience (the latter for migrant farm workers and low-income individuals, the former for recreational anglers, fisheries, and health care experts) to investigate risk communication theories and the effectiveness of fish advisories and bans. Therefore, it should be noted that more than one approach may need to be used to make the survey as informative and useful as possible for the desired objective. The choice of the approach to collect data will also depend on the characteristics of the target population, data requirements, obligation to reply, target response rate, time available, and funds available (USEPA, 1984a).

The approaches, however, did share a number of common elements for the execution of the survey, including design, selection of respondents, information to be sought, quality assurance procedures, and statistical analyses. For the purposes of this document, the most important criteria for preparing a fish/shellfish consumption survey are the following:

- Thoroughness;
- Applicability to subpopulations of concern;
- Scientific/analytical validity;
- Ease in interpreting results;
- Reasonableness of assumptions made; and
- Sufficient data to evaluate potential risks.

This section addresses various elements of survey design and analysis that need to be considered prior to undertaking a survey for the collection of specific regional or subpopulation data to estimate fish consumption rates. Additional information and references can be found in Babbie (1973), Dillman (1978), and USEPA (1983, 1984a). These resources also recommend discussing the survey plans with qualified, experienced survey research consultants and statisticians who can provide the best answers to any questions that may arise while planning the survey. This step should ensure that the design will meet the particular survey objectives and adequately sample the populations of concern.
Survey Design

Fisher (1988) noted that the primary factors controlling the selection of a strategy to obtain the desired data were: (1) the purposes for which an estimate of usual or preferentially high fish intake is sought and (2) the resources available to obtain such an estimate. Because of these factors, no one strategy may fulfill all possible needs for such data, yet each survey may be quite complex in its own right. He emphasized that the purpose of the survey must be narrowly defined and tailored to address the identified needs, such as whether the survey was to be used for diet/health concerns or risk assessment.

Since differences in preferred species, availability, access, length of fishing season, and cultural heritage greatly influence freshwater fish consumption in a particular region (ChemRisk, 1991a), these factors must also be examined when planning a survey. The period of data collection is important in fish consumption studies. Will most of the subsistence and recreational fishermen be active during the summer months only or during the open season for a particular fish? If information is required for an entire year, can recall be depended upon to provide the answers or should a year-long continuing survey be conducted? The level of literacy for potential respondents should also be estimated. Will the respondent be able to understand the written or spoken questions? The types of questions should be prepared and tested with respect to simplicity and clarity, as well as their ability to elicit the desired information. Language barriers may also exist, further limiting the amount of data that may be gathered from important constituencies. Thus, surveys may need to be conducted under more than one approach or in more than one language to adequately cover all of the subsistence and recreational fishermen in a particular area.

Another general consideration for survey design is the level of detail required for the purpose. Although more information may be desired for various programs, longer surveys will require more time and resources for the conduct of the survey and analysis of the data. Furthermore, increased length and complexity of the survey design may limit the cooperativeness of respondents, resulting in inadequate or incomplete data that are ultimately useless. Incentives may need to be provided to reduce non-response bias (Fisher 1988). All of the surveys reviewed for this report experienced problems in getting participants to cooperate and complete the questionnaire materials. To improve participation rates, some of the surveys provided incentives, such as lapel pins or additional information in brochures, or sent respondents copies of the survey results. Other surveys limited the number of questions, but lost valuable information that would have been helpful for fish consumption rate calculations.

The approach taken to collect the data will affect the cost of the survey. As a general guideline, personal interviews cost at least twice as much and take twice as long as telephone interviews. Both of these methods are more costly than a mail
survey (USEPA, 1983). However, if personal interviews are clustered at specific locations to maximize the number of respondents needed to obtain the fish consumption rates of recreational/subsistence fishermen, less time and effort will be involved than if the same number of respondents who fished at those specific sites had to be culled from extensive telephone or mail surveys of the general population or licensed fishermen.

Examples of the level of effort and approximate costs for different types of recent surveys are presented in Appendix B. Most of the surveys did not include such information in their reports, but limited data on level of effort, length of time to conduct the survey, and costs were obtained by contacting the individual or agency responsible for some of the surveys. Amounts cited ranged widely depending on the type of survey and its extent. Some surveys were conducted by volunteers or graduate students to reduce costs or were conducted as part of normal in-house responsibilities. Hence, it would be difficult to determine a meaningful "average" cost-per-survey. As noted by West (1989a), however, funding levels may hinder obtaining statistically valid sample sizes. Therefore, it is important to have a clear understanding of the amount of funding and number of personnel available in order to achieve the best balance of resources for the desired survey. This analysis should include what work can be done in-house versus the work that must be done by outside consultants or by recruiting volunteers, if any, and other pertinent factors that may constrain the financial considerations.

The survey design should specify the following (see USEPA (1983) for more information):

- The objectives of the survey, clearly stated in terms of the kinds of information to be collected, the problems to be solved, the hypotheses to be tested, and the key survey variables. For example, if the objective is to determine fish consumption rates, what are the minimum questions that need to be answered? What hypotheses will be tested--consumption rates related to income, ethnic group, or frequency of fishing? Each of the key survey variables, the specific data to be collected to meet the stated objectives, must then be defined.

- The population to be surveyed and the extent of coverage (e.g., regional, site-specific, recreational fishermen).

- Identification of respondents by probability sampling. This means that every unit, e.g., person/household, has a known nonzero chance of being included in the sample, allowing for statistically valid inferences about the entire population the sample is designed to represent.
The required level of precision, specified in terms of sampling error—that is, the difference between the statistics and the values that would have been obtained had all the members of the target population been surveyed. It will depend on the survey purpose, intended use of the data, level of effort, and available funds. Nonsampling errors, such as random deliberate wrong or unintentional replies or systematic one-sided errors or biases, must also be considered.

The target response rate, defined as the ratio of the number of completed interviews divided by the total number of eligible units in the sample. As noted above, a 75 percent response rate is acceptable for an in-person or telephone survey, but a mail survey may receive less than a 40 percent response unless telephone calls or personal visits can raise the initial response rate. Follow-up activities may be required for all of the approaches to ensure an appropriate response rate.

Selection of Respondents

Another important consideration is the method used to select the fishermen to be interviewed, the sampling frame (USEPA, 1983). A variety of sources for this sample have been used depending on the approach to be taken to obtain the data on fish consumption. National surveys have used random-digit dialing to obtain their samples. However, the targeted recreational or subsistence fishermen would not be captured by this technique (if, indeed, any actual fishermen). On the regional or local level, approaches such as telephone, diary, and written questionnaires may obtain stratified (based on particular type of license or geographic reference, such as counties located close to the waterbody in question) samples of those persons who hold sport fishing licenses from the appropriate State agency. Intercept or on-site interview approaches may attempt to question everyone, interview only those who have caught fish at the time (non-uniform), or randomly select fishermen to be questioned. The Georgia creel censuses used non-uniform probability sampling, interviewing fishermen on a predetermined basis up to a certain number required for statistical validity. The number of interviews needed was based on preliminary surveys, then these numbers were readjusted every 6 months to reflect possible changes in the fishing population. Other strategies may be required to obtain samples of recreational and subsistence fishermen depending on the objectives of the survey. The sample may consist only of the anglers or may include members of their households.

Sample selection must be carefully planned to achieve the numbers necessary for statistical validity. Final sample size will depend on the population being sampled. The Bureau of Census may be consulted to obtain information about total population and/or subpopulation numbers present in a particular area. Then probability tables can
be generated to determine the minimum numbers of respondents required. This technique can also be used to select subsamples of licensees or other designated groups. Sample stratification in the Bureau of Census design also allows for sampling procedures that are self-weighted and corrected for non-response bias. Additional numbers of respondents may need to be added to the pool to provide sufficient numbers if there are problems in obtaining the interviews (e.g., loss of questionnaires in the mail, non-responders, language barriers, etc.). Babie (1973) contains detailed information on the selection of a survey population, probability sampling theory, and sampling distributions.

- It is essential to work with a statistician to ensure that appropriate and representative sample sizes of the population to be examined are obtained by whatever technique is selected prior to analysis and interpretation of the data.

**Information Sought**

The types of information and their content will depend on the purposes for which the data are collected, as well as the complexity and length of the survey (single or multiple seasons, multi-year) to be conducted. Some of the surveys reviewed for this document were designed to collect information for purposes other than measuring fish consumption and therefore did not ask the "right" questions (e.g., creel censuses). Many assumptions have to be made in order to obtain estimates of fish consumption in these cases, and errors of overestimation or underestimation may be large. Questions on sociodemographic characteristics, fishing/shellfishing activities, preparation and consumption patterns, and awareness of fish/shellfish advisories and bans can all contribute data that may be used to analyze fish consumption rates. Examples of questions that need to be answered or issues that need to be resolved for fish/shellfish consumption rate determinations are presented in Appendix A.

Sociodemographic data may indicate important influences on intake and patterns of intake reflected in age, community type, educational level of head of household or respondent, ethnic origin or race, family size and composition (age and sex), geographic region, income, occupation of head of household, and religion. Current employment status may affect the amount of time spent in fishing/shellfishing activities and the amounts of these foods consumed. However, this information may be difficult and controversial to obtain (for example, income level, race, ethnic group, language spoken at home, religion) and may decrease the number of successful interviews or completed questionnaires. Although the residence of anglers may indicate that they are fishing at potentially contaminated waterbodies, it is more important to determine whether there is a known possible contaminant exposure problem at the particular fishing site(s). Other information on fishing activities, such
as distance from residence and mode of fishing, may be irrelevant for some surveys but may provide important data for others, depending on the objective(s) of the survey.

Accurate identification of the type and amount of fish/shellfish caught and consumed is important. Levels of contamination vary with the preferred habitat of the organism and its trophic level (for example, bottom-feeding versus planktivore) as well as the waterbody. Pictures of the fish may need to be taken for verification if identification in the field is impossible. The level of detail required for fishing activities may also be difficult to obtain, especially since anglers often keep their fishing spots secret. However, providing visual aids such as maps of fishing areas may produce more accurate information from respondents when recalling the location(s) of fishing activities. Persons involved in illegal sales of fish/shellfish from contaminated sites would probably refrain from answering these questions.

The actual amounts of fish/shellfish consumed need to be determined as accurately as possible. Silverman (1990) noted that “data on average meal size is glaringly absent...” from most studies. Pictures of portion sizes may be provided to aid in estimating the size of fish/shellfish portions consumed (although it should be noted that this may vary with the species involved). West et al. (1989b) included pictures of an 8-ounce steak and fillet portion on a normal size plate for comparison, then estimated “more” as 10 ounces and “less” as 5 ounces for their survey. Cox et al. (1990) found that 8 ounces was the portion most commonly reported. These and other product identifiers can provide clues as to the level of detail required in the answers. The survey should also specify whether the amounts eaten are to be determined for the fisherman only or for all household members.

Other information that may be useful in examining consumption patterns and levels of exposure to potentially contaminated fish/shellfish include the following:

- Whether a part of or the whole animal is eaten: for fish - muscle only, skin, head, entrails, broth; for shellfish - muscle, hepatopancreas, entrails.
- Method(s) of preparation (raw, dried, canned, smoked, steamed, boiled, baked, fried, stewed, marinated, barbecued; or whole, filleted, skin removed, etc.); accompaniments used in preparation (butter, lemon/lime juice, tomato sauce, garlic).
- Other types of aquatic organisms consumed from the same site(s): quantities, frequency consumed, methods of preparation (snapping turtles, frogs, sea cucumbers, sea urchins, squid, algae or other vegetation, etc.).
• Whether fish are also consumed from other sources (market, restaurant, or gifts).

Finally, recent surveys have been concerned with whether the angler has been informed of potential health risks from consuming contaminated fish/shellfish. Questions covering this information may address the knowledge of fish consumption advisories or bans present in a particular fishing area and whether the angler has changed his or her fishing and fish preparation behavior because of these concerns. Several surveys have also investigated links between diet and health. As noted by Fisher (1988), such studies may include questions on medical history, a physical examination for health status and clinical signs of deficiency or toxicity, food and nutrient intakes, body measurements, and hematological and biochemical tests (USEPA, 1984b; Wisconsin Department of Health and Social Services, 1987). The objectives of the particular survey may require an assessment of the awareness of health advisories and an understanding of contamination issues. The impact of advisories may be reflected in changes in fishing locations and in the species, sizes, and parts of fish/shellfish kept and consumed, which may introduce other biases into the survey if these issues are not addressed.

The information requirements for the survey must be carefully planned, again taking the type of approach to be used into account. For example, food frequency recall approaches may need to include some probing questions to jog memories for consumption of fish/shellfish meals over periods of weeks to a year (and will not provide accurate data on quantities consumed). Personal interviews and telephone surveys may also need such "neutral probing" to obtain complete, clear, relevant, and specific answers. The survey questions must be worded for understandability. Several surveys, such as that by ChemRisk (1991a), pretested survey questions and revised them as necessary before beginning the full survey. Actual phrasing of the questions is critical to obtaining usable data. For example, "preparation" of the fish may mean different things if the purpose is for cooking, for eating, or for preservation but may provide acceptable data on portion sizes consumed or whether the preparation minimized exposure to contaminants.

Equally important is ensuring that the wording of the question will provide the correct data for evaluation, rather than give a vague or potentially uninterpretable response that becomes useless when calculations are to be made. The information to be collected may need to be modified depending on whether the survey will be answered directly by the respondent or through proxy. Conducting the interviews in more than one language may also be necessary to reach the population of concern (for example, see Puffer et al., 1982a, and the National Marine Fisheries Service studies). Babbie (1973) discusses how to construct questions and order them in the survey to avoid many common pitfalls, as well as providing sufficient clear instructions so the survey can be completed, and describes how to conduct and evaluate pre-tests and pilot studies (see also Sudman and Bradburn, 1982).
The selection of questions to meet the survey objectives is critical. As noted in USEPA (1984), there can be too many questions or the specificity of some questions may be offensive. The questions must ultimately be used only for the purposes intended and not stretched to try to fit other unrealistic purposes, introducing serious biases.

It is most important to work with professionals involved in social research and writing questionnaires, as well as the statistician who will be involved in the final data analyses, to reduce problems in obtaining the data required. The American Fisheries Society and the Sport Fishing Institute are other resources that may be consulted for assistance in survey development.

Quality Assurance

Appropriate quality assurance procedures must be determined while in the planning stages of the survey and followed carefully during the execution of the survey. The types of quality controls proposed will ultimately depend on the approach to be taken, but should include the following (USEPA, 1983):

- Validation of 10 percent of the interviews to verify that the interviews did take place and that answers to a few key questions are rechecked to establish whether errors occurred in collecting the data.
- Manual checking of questionnaires for completeness and proper entry of answers.
- Checks on the manual coding operations and comparisons of results and error rates found by different interviewers.
- Verification of correct data entry; for example, by having all of the data entered twice and then compared.
- Computer edits to detect inadmissible and out-of-range values.

For fish consumption surveys, some of these quality assurance considerations include the qualifications and training of interviewers (can they conduct interviews pleasantly and correctly, can they identify the fish to species, etc.); arranging for close supervision throughout the survey (to make sure all data are entered and recorded on the forms correctly, all interviewers are performing similarly, and each interview session is conducted like the previous ones); and that data are validated or information is verified as necessary (checked for clarity and completeness, correct names, phone numbers used, etc.). Some surveys used responses given in one
category to check those in another, such as fishing history vs. fish consumption, although this may not always work. The Landolt et al. (1987) report noted that procedures that were important included three training sessions for each of the interviewers and then testing to ensure that they could identify local marine fish species. In addition, each interviewer was carefully monitored to be sure he/she was doing the job correctly. For mailed questionnaires, each questionnaire should be assigned an identifying number both at the time of delivery to the respondent and on completion or receipt. This procedure will allow monitoring of the number of questionnaires returned each day, as well as the cumulative total returned (Babbie, 1973), to help plan follow-up mailings and reminders.

Statistical Analyses

After the information has been collected, data on the numbers of respondents for each category and questions and their answers must be compiled and numerically analyzed. It is essential to work with experienced statisticians during the design of the survey, and to conduct pretests, to determine on whether there is adequate representation of the survey population, and to ensure that test conditions, including the questions and instructions, are appropriate for the survey's purposes. The final report will be based on the calculations and analyses performed to test the stated hypotheses. Appropriate correlations cannot be made if the data are weak or missing.

Additional problems may be encountered when attempting to look at special subpopulations, such as those who eat fish frequently. Fisher (1988) cited studies by Kalton and Anderson (1986) and Sudman et al. (1988). These authors reported that the design of population surveys and sampling techniques for events and populations that are non-uniform or infrequent present statistical issues that result in an additional series of trade-offs. Fisher (1988) examined the case of looking for preferential fish consumers and noted that a larger total sample may be required. The recent ChemRisk (1991a) survey based the size of the population sample on the most constraining piece of data among the questions to be answered and calculated the sample size required to ensure that the minimum number of replies needed for statistically valid results would be received. In this case, the inverse of the participation rates for perch harvested from warmwater riverine fisheries was multiplied by the desired number of consumption observations for perch (believed to represent the rarest subpopulation to be encountered) and concluded that a minimum of 1,363 completed surveys would be required. ChemRisk (1991a) then estimated the expected proportion of undeliverable mailed surveys and the potential response rate of anglers who received the surveys and calculated a minimum sample size of 2244. The final number of 2500 surveys were mailed out, selected from a pool of 2953 drawn randomly from the fishing license files to represent different resident categories and other special types (every 75th license holder was selected from 225,000 license holders).
Other statistical considerations include the accuracy of the responses that can be expected depending on the approach used to collect the data. For example, Carline (1972) found that harvest rates on the number of fish caught per day or per year were much higher than the catch rates determined by personal interviews of anglers. Swanson and Stephenson (1982) observed that the numbers of fish reported caught were often rounded off to 5, 10, 20, etc., indicating that biases and sources of error were greater for recall of angler harvests than of angler effort. The inaccuracy of respondents’ memories is troublesome for recall approaches, in addition to the inability of respondents to accurately identify fish species, confusion over the questions/questionnaires, and frank exaggeration. Also, additional checks may need to be made to examine non-response bias. West et al. (1989a) found that those who did not return the surveys ate less fish, thereby resulting in a skewed calculation of consumption rates if the results were assumed to be accurate for the entire subpopulation originally sent the questionnaires. Weighting techniques may need to be applied, based on demographic characteristics or other factors to allow more accurate determinations of consumption rates for various subpopulations (e.g., USDA, 1982).

The final statistical calculations should be carefully planned and based solidly on the data collected in order to minimize assumptions that could compromise the results. For example, were the questions correctly phrased to elicit the number of fish meals per angler or per household? If the latter, were the members of the household enumerated, or must an average size household be assumed to determine the individual fish consumption rates? Can the data be used to calculate fish consumption by race or ethnic group, income, education, sex, or other factors that the survey may wish to test? A number of multivariate analyses may be used to compare differences in consumption rates for many factors. Detailed discussions on statistical analyses that may be used with survey data are presented in Babbie (1973). Whenever possible, these should be investigated and the appropriate information and numbers of responses planned prior to the collection of data, for optimum results.

- It is important to consider using data management protocols that will allow the data to be readily accessible. These include using standard formats, such as dBase or Lotus, standard statistical packages, and simple coding systems for ease in interpretation of the survey data.
- Archiving of the data (both paper and computer records) and future access should also be determined prior to completion of the study, and this information should be included in the final report, to aid other researchers on fish/shellfish consumption.
DISCUSSION

Wagstaff et al. (1986) noted that fish constitute the only class of foods subject to total governmental prohibition in large geographic areas of the United States for substantial time periods because of exposure to potentially hazardous environmental pollutants. Therefore, nutritionists, the medical community, marketing specialists, fishery resource managers, and ecosystem administrators would benefit most from fish consumption databases that are "well-defined, validated, and accessible."

A variety of methods and approaches have been utilized in the fish consumption surveys presented in this report, but it appears that a thoroughly satisfactory survey remains to be conducted. Although the surveys may have been satisfactory for the objectives of the designers at the time, the goal of obtaining valid fish consumption rate data for high-risk subsistence fishermen remains elusive. On-site interviews are more likely to reach subsistence/recreational fishermen, who may not be licensed, but more accurate data may be obtained by diaries and written questionnaires. Many questions remain. Over what period of time must a survey be conducted (for one day, seasonally, or for one year)? What is the best approach for reaching the most fishermen in a particular region? How have fish/shellfish consumption bans and advisories affected the utilization of these resources and changed the public’s perception of risks? Silverman (1990) reviewed recent national and Great Lakes regional studies and noted the absence of detailed information about the public’s consumption of sport fish. She also found that fish consumption had been partitioned into commercial vs. recreational portions that were not adequately covered in the surveys. Important information was missing on the sport fish consumption habits of the non-fishing public. Silverman (1990) described the West et al. (1989b) survey as one of the best of its type because fish consumption was reported based on demographic variables. However, other variables, such as fishing frequency, may prove necessary to our understanding of fish consumption rates.

Clearly, additional efforts will be required to improve the survey methods and identify the best approach(es) to obtaining the desired data for fish consumption rates of subsistence and recreational fishermen and special subpopulations of concern. It is hoped that the information in this document will assist fisheries managers and health officials in designing and conducting surveys that will more accurately assess the fish consumption rates by various subpopulations in different regions of the country.
BIBLIOGRAPHY


Olson, L.J., 1988. Fish consumption rate literature survey compilation. Wisconsin Dept. Health and Social Services, Madison, WI.


APPENDIX A

ISSUES AND INFORMATION REQUIREMENTS
FOR FISH/SHELLFISH CONSUMPTION SURVEYS
ISSUES AND INFORMATION REQUIREMENTS
FOR FISH/SHELLFISH CONSUMPTION SURVEYS

Sociodemographic Characteristics of Fisherman:

- Age
- Occupation/employment status
- Income level
- Education level attained
- Number of household members
- Race/ethnic group, sex, age, height, and weight of the fisherman and each household member
- Pregnancy/lactation status of women in the household
- Language spoken at home
- City of residence

Fishing Activities:

- Location(s) of fishing/shellfishing activities (specific sites, type of waterbody)
- Distance(s) of fishing/shellfishing activities from principal residence
- Seasonal and temporal distribution of fishing/shellfishing activities (total number of days per season, which months of the year, for each location)
- Fishing/shellfishing effort (hours/outing, hours/day, outings/month, days/month)
- Purpose for fishing/shellfishing
- Mode of fishing/shellfishing (nets, traps, hook and line, etc.; pier, shore, private boat, charter boat, SCUBA)
- Type of fish/shellfish captured (general category such as bottomfish, flatfish; or identified to species or groups of species)
- Numbers of fish/shellfish captured per outing by species
- Size ranges of fish/shellfish captured (minimum and maximum weights and lengths by species)
- How the fish/shellfish were disposed of (released, consumed by household, sold, given away)
- How long involved in fishing/shellfishing activities and consuming self-caught fish (new to sport or years)
Preparation and Consumption Patterns:

• Portions of fish/shellfish consumed (may vary with the species)
• How the fish/shellfish were prepared for eating (skinned, fillet, steak, etc.)
• How fish/shellfish were cooked (baked, fried, etc.)
• Amounts (weight) of wild-caught fish/shellfish eaten per meal/day/week/month for each person in household
• Special cultural/ethnic practices in fish/shellfish consumption and preservation
• Consumption of fish purchased in supermarkets, fish markets, roadside stands, at the dock, or obtained by bartering (amounts, frequency)
• Consumption of other aquatic organisms, waterfowl, or wildlife that may have consumed fish/shellfish from same sites (amounts, frequency)
• Fish/shellfish frozen or preserved and eaten throughout the year or eaten only when fresh
• Participation in food assistance program
• Source of home water supply
• Voluntary risk patterns (smoking, drinking, eating)

Fish Consumption Advisory Awareness and Understanding:

• Has the fisherman heard, from announced fishing/shellfishing bans or posted notices, of the possible contamination of fish/shellfish by chemical or biologic agents in areas where presently fishing or where planning to fish?
• If the answer to the previous question is yes, has it affected his/her fishing/shellfishing activities, fish preparation methods, or consumption patterns?
• What would stop the fisherman from eating the fish/shellfish he/she has caught?
• Did the fisherman ever get sick from eating self-caught/self-prepared fish or shellfish?
• Did the fisherman ever observe any abnormalities, internal or external, in captured fish/shellfish? Were the fish/shellfish consumed, thrown out, or given away?
APPENDIX B

SUMMARY OF ACTUAL SURVEY METHODS INFORMATION
### SUMMARY OF SURVEY METHODS INFORMATION

<table>
<thead>
<tr>
<th>Title of Survey</th>
<th>Type of Survey</th>
<th>Contact Address Phone No.</th>
<th>Level of Effort</th>
<th>Time</th>
<th>Cost</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Pretest of an Approach to Collection of Marine Recreational Fishing Data on the East and Gulf Coasts</td>
<td>creel census, recall - telephone survey</td>
<td>Given in report: K.A. Chandler and G.L. Brown, HSR-PR-78/1-C1, 25 January 1978, prepared for NMFS</td>
<td>6,077 telephone surveys, 1,644 fishermen interviewed at 3 locations to estimate sample sizes required and number of days</td>
<td>for a total of 18,800 fish to provide estimates of the proportional distribution of fish caught for an area (not to determine fish consumption rates), estimated 132 days to interview 3,003 fishermen in Rhode Island, 120 days for 3,087 interviews in South Carolina, 282 days of interviewing 6,373 in Texas</td>
<td>costs for interviews: RI $2.29 per fisherman/hr; SC $2.59 per fisherman/hr; TX $2.26 per fisherman/hr; assumed 10 hours of interviewing per day</td>
<td>Noted cost per interview for surf fishermen may be higher</td>
</tr>
</tbody>
</table>
### SUMMARY OF SURVEY METHODS INFORMATION (continued)

<table>
<thead>
<tr>
<th>Title of Survey</th>
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<tbody>
<tr>
<td>Fishing Effort and Harvest by Arizona's Licensed Resident Anglers (May 1982)</td>
<td>recall - mail survey, creel census</td>
<td>Eric Swanson&lt;br&gt;Arizona Game and Fish Department&lt;br&gt;Phoenix, AZ&lt;br&gt;(602) 942-3000 ext 608</td>
<td>sent out 18,000 surveys (10% of registered fishermen) 33% response</td>
<td>About 9 months including set-up, data gathering &amp; analysis</td>
<td>funded through Federal aid</td>
<td>Ball park estimates Have done subsequent surveys</td>
</tr>
<tr>
<td>Commencement Bay Seafood Consumption Study</td>
<td>creel census</td>
<td>Doug Pierce&lt;br&gt;Tacoma-Pierce County Health Department,&lt;br&gt;Tacoma, WA&lt;br&gt;(206) 591-5543</td>
<td>5 months in the field collecting data. 7 months report writing.</td>
<td>1 year</td>
<td>$25,000 primarily to pay contract staff</td>
<td>Cost does not include analysis done by EPA</td>
</tr>
<tr>
<td>1981 fisheries Surveys: Atamaha River St. Mary's River</td>
<td>creel census</td>
<td>Dan Holder&lt;br&gt;Georgia Dept. Nat. Resources, Game &amp; Fish Div.&lt;br&gt;Atlanta, GA&lt;br&gt;(912) 285-6094</td>
<td>10 month creel survey using college students random samples</td>
<td>10 month or 12 month creel survey</td>
<td>$9,077 (based on $5.50/hr wage for surveys)</td>
<td>Ball park estimates Have done subsequent surveys</td>
</tr>
<tr>
<td>1982 A Study of Toxic Hazards o Urban Recreational fishermen and Crabbers</td>
<td>recall - personal interview, creel census</td>
<td>Bruce Ruppel&lt;br&gt;NJ Dept. Environ. Protection,&lt;br&gt;Trenton, NJ&lt;br&gt;(609) 884-6548</td>
<td>87 interviews on-site</td>
<td>2 years for entire study</td>
<td>estimate $50,000. funded by the State</td>
<td>Also funds from Hudson River Foundation</td>
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<td>1983</td>
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<tr>
<td>Evaluation of Methods Used to Determine Potential Health Risks Associated with Organic Contaminants in the Great Lakes Basin 1983</td>
<td>recall - telephone and mail surveys</td>
<td>Given in report: USEPA Environmental Research Laboratory, Duluth, MN</td>
<td>collected data by 3 different protocols, 587 respondents</td>
<td>about 2 years</td>
<td>about $21 per participant for each protocol, excluding data analysis</td>
<td></td>
</tr>
<tr>
<td>Recreational and Subsistence Catch and Consumption of Seafood from Three Urban Industrial Bays of Puget Sound 1983-1984</td>
<td>recall - personal interview, creel census</td>
<td>Mary McCallum Washington State Division of Health, Epidemiology Section, Seattle, WA</td>
<td>1643 interviews on-site</td>
<td>data collection over a 12-month period, 2 years total</td>
<td>grant - $100,000 for salary of supervisor</td>
<td></td>
</tr>
<tr>
<td>Low Income Families' Consumption of Freshwater Fish Caught from New York State Waters 1985</td>
<td>recall - personal interview</td>
<td>Marie Wendt KVRHA 122 State Street Augusta, ME 04330</td>
<td>40 personal interviews over a 2 week time frame</td>
<td>data collection and analysis - 1 year</td>
<td>graduate student thesis - funded through Sea Grant</td>
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<tr>
<td>Title of Survey</td>
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<tr>
<td>Potential Toxicant Exposure Among Consumers of Recreationally Caught Fish from Urban Embayments of Puget Sound</td>
<td>recall - personal interview, creel census</td>
<td>Dr. Marsha Landolt, School of Fisheries, University of Washington Seattle, WA (206) 543-4270</td>
<td>1st year - 4,181 angler interviews; 2nd year - 437 interviews on-site at boat ramps</td>
<td>2 years</td>
<td>$207,000 (excluding indirect costs)</td>
<td>Significant portion of funds were for analytical chemistry, rest for data entry and analysis, salaries of interviewers, etc.</td>
</tr>
<tr>
<td>Study of Sport Fishing and Fish Consumption Habits and Body Burden Levels of PCBs, DDE, and Mercury of Wisconsin Anglers</td>
<td>recall - mail survey</td>
<td>Beth Fiore Wisconsin Division of Health Madison, WI (608) 266-6914</td>
<td>1600 surveys mailed 801 returned</td>
<td>about 1 year</td>
<td>estimate of $27,250</td>
<td>Phone follow-up to mail out 50% responded Cost does not include blood analyses for contaminants Would use two-tiered approach next time 1) Great Lakes 2) general</td>
</tr>
<tr>
<td>Marine Recreational Fishery Statistics Survey. Atlantic and Gulf Coasts</td>
<td>creel census</td>
<td>Mark Holliday National Marine Fisheries Service, NOAA, Washington, DC (301) 427-2328</td>
<td>46,000 intercept interviews and 74,000 telephone interviews (1986)</td>
<td>Data collection 1 year - data ready for distribution within 4 months</td>
<td>collaboration with 5 State agencies - $2,000,000</td>
<td>The 1987 - 1989 survey is now available Have done similar surveys for the Pacific coast</td>
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<td>Title of Survey</td>
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<tr>
<td>Relationship of Human Levels of Lead and Cadmium to the Consumption of Fish Caught on and around Lake Coeur d' Alene, Idaho</td>
<td>recall - personal interview or telephone</td>
<td>Mike Greenwell Agency for Toxic Substances and Disease Registry Public Health Service US Dept of Health &amp; Human Service Atlanta, GA (404) 639-0700</td>
<td>299 households, follow-up study on 33 individuals</td>
<td>about 2 years</td>
<td>done in house</td>
<td>Done by Division of Health Studies, Sharon Campolmi</td>
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<td>1986-1987</td>
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<tr>
<td>- A Survey of Attitudes and Fish Consumption of Anglers on the Lower Tittabawassee River, Michigan</td>
<td>creel census</td>
<td>John Hesse Michigan Department of Public Health, Lansing, MI (517) 355-8353 (8350)</td>
<td>5 interviewers conducted 703 interviews</td>
<td>4 months for surveys (1 May to 31 Aug)</td>
<td>$6,500</td>
<td>Follow-up telephone survey done by Michigan University as part of a survey class</td>
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<td>1987</td>
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<tr>
<td>Angler Use and Harvest on Fox Lake, WI</td>
<td>creel census</td>
<td>James C. Congdon DNR Madison Wisconsin Bureau of Fisheries Mgmt Horicon County (414) 485-3003</td>
<td>1/2 FTE doing creel survey for entire fishing season (May-March 15, 11 1/2 mos.)</td>
<td>11 1/2 months</td>
<td>funded with state funds</td>
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<td>1987</td>
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</tbody>
</table>
### Michigan Sports Anglers Fish Consumption Survey
- **1988**
- **Type of Survey**: recall - mail survey, recall - telephone
- **Contact**:
  - Dr. Patrick West
  - School of Natural Resources
  - University of Michigan
  - (313) 764-7206
  - (313) 763-2200
- **Level of Effort**: 2,600 surveys mailed out 4 waves of mailings & follow-up phone calls for non-response bias
- **Time**: 1 year
- **Cost**: $30,000
- **Comments**: funded by Dept. Environ. Conserv., Bureau of Fisheries, State of New York

### New York Statewide Angler Survey
- **1988**
- **Type of Survey**: recall - mail survey
- **Contact**:
  - Dr. Nancy Connelly
  - Cornell University
  - NY State College of Agriculture and Life Sciences, Fernow Hall, Ithaca, NY
  - (607) 255-2830
- **Level of Effort**: 17,000 mailed out 3 follow-up mailings 200 telephone follow-ups for non-response bias 10,314 quest. returned
- **Time**: 10 months, total time about 18 months
- **Cost**: $10-11,000 to put surveys in books, $370 mailing costs
- **Comments**: Would do differently in future due to low response rate

### Study of the Consumption Patterns of Great Lakes Salmon and Trout Anglers
- **1989**
- **Type of Survey**: recall - mail survey
- **Contact**:
  - Chuck Cox
  - Water Resources Branch, Ministry of the Environment, Toronto, CANADA
  - (416) 323-4994
- **Level of Effort**: 100,000 surveys distributed at tournaments or mailed, 913 responses
- **Time**: 4 months for data collection and analysis
- **Cost**: $10-11,000 to put surveys in books, $370 mailing costs
<table>
<thead>
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<th>Time</th>
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</table>
| Consumption of freshwater Fish by Marine Anglers | recall - mail survey | Ellen Elbert
ChemRisk
1685 Congress St.
Portland, ME
(207) 744-0012 | 2,500 mailed out
1,612 returned | 9 months | client confidential | Revised draft report available |