# APPENDIX B

## POPULATION EXPOSURE ASSESSMENT—CONSUMPTION PATTERNS AND SURVEYS

# APPENDIX B

# POPULATION EXPOSURE ASSESSMENT—CONSUMPTION PATTERNS AND SURVEYS

Selecting appropriate population exposure data is critical in both risk estimation and in fish advisory program planning. Whenever possible, state agencies are encouraged to conduct local surveys to obtain information on consumption patterns. The time and resources required to conduct onsite surveys, however, can be prohibitive. If only limited local data are available, that information may be used and supplemented with the best available data from other sources. If local or regional data are not available and surveying is not feasible, other sources may be used to characterize the consumption patterns of a population.

## B.1 HIERARCHY OF FISH CONSUMPTION INFORMATION

Table B-1 lists a hierarchy of information sources on fish consumption that may be considered in obtaining data for developing fish advisories. Care should be taken when selecting a matched population and consumption data set to use as "representative" of the target population. Matches should be made based on similar consumption patterns, rather than on generalizations about ethnic behavior or other attributes.

Matching groups with high consumption rates to previously studied groups having similar characteristics is particularly important. These groups with high consumption rates are often those of greatest concern due to their higher potential risks. They are at greater risk than the general population if their consumption is underestimated and may also be more severely jeopardized by losing their fish food sources than the general population if their consumption rates are overestimated.

Many studies are not appropriate for use in exposure assessment. Surveys may be based on only those fishers who apply for licenses through state agencies; this often underestimates consumption rates in some subpopulations. In some areas, the results may reflect a combination of commercially caught fish as well as subsistence- or sport-caught fish and may therefore provide an incomplete picture of fish consumption patterns in a particular region. Often, qualitative or anecdotal information is available to corroborate or challenge the results of older data; this can help to assess the need for additional data collection. For example, a survey may have been conducted in a state with a large urban Asian-American population, commonly known to eat large quantities of fish, yet only a small

**Table B-1. Hierarchy of Data Sources[a]**

1. Local fish consumption survey (creel surveys)
2. Local fish consumption survey with limited scope (e.g., acquired by fish licenses only)
3. Regional or state survey data from other areas having matching characteristics[b]
   - Behavioral Risk Surveillance Survey (BRSS)
   - Anecdotal information
4. National fish or food consumption data taking into consideration demographic data
   - *National Survey of Fishing, Hunting, and Wildlife Associated Recreation* (U.S. Fish and Wildlife Service, 1993)
   - U.S. Department of Agriculture Continuing Survey of Food Intake by Individuals (CSFII) studies
   - Other national surveys that estimate fish consumption patterns
   - Census data

[a] This hierarchy is generally applicable; however, the utility of any data source is dependent on the match between the population studied in the data source and that being considered by the risk managers. For example, when a better match is available through national or regional fish consumption data than can be found through limited local fish surveys, then the national, regional, or state data are preferable. Special care should be taken that data for highly exposed subpopulations are obtained from sources that considered populations with equally high exposures.

[b] Secondary data sources can be used most effectively in conjunction with qualitative data and anecdotal information (e.g., informal discussions with community groups, clerks, and other qualitative studies).

number of the survey respondents were Asian-American. If the survey was conducted by fishing license registration, it is likely that a large portion of the exposed population was unintentionally excluded from the survey and thus was not adequately represented in the consumption estimates.

### B.1.1 Local Fish Consumption Data

#### B.1.1.1 Creel Surveys—

Another source of information concerning fishing habits (applicable indirectly to consumption estimates) is obtained through the creel surveys. Most state

agencies involved with fish and wildlife management perform creel surveys or censuses. These surveys consist of clerks interviewing fishers onsite and recording the size and species of fish they take home (and presumably eat). These surveys are performed to calculate fishing pressures and evaluate stocking programs for state lakes and streams. These surveys generally contain little demographic information beyond the fisher's home county, though they may be modified to ask additional questions about demographics and fish consumption.

Creel surveys are subject to reporting biases, which may include a reluctance of fishers to report a poor catch or a catch that exceeds allowable limits (see a discussion of data collection problems below). The clerks themselves know a great deal of anecdotal information about fishers because of their direct contact with these individuals. Clerks, area fisheries managers, and conservation officers are excellent sources of information on fisher demographics and should be contacted during research into most fisher populations (Shubat, 1993). Like surveys taken only from licensed fishers, however, this qualitative information may be restricted to certain fishers and fishing locations.

#### B.1.1.2 Fishing License Surveys—

Fishing license tracking may be a good source for obtaining demographic information for target populations. Fishing licenses include information on the name, age, and address of fishers, location where the license was sold, and the approximate length of the fishing trip (e.g., 4-day, seasonal). Although the information on the license is limited, some researchers have used the addresses on licenses to send out more detailed surveys. Several fish advisory programs, including those in Minnesota and Canada, insert detailed demographic and consumption surveys in their informational booklets, which fishers may fill out and return in exchange for receiving the following year's materials. These surveys by definition, however, reach only a portion of respondents already aware of the fish programs (Shubat, 1993). They also do not reach fishers who do not purchase licenses for economic or other reasons. In addition, Native American groups who are often legally entitled to fish on tribal waterbodies without licenses will not be accessed by this method.

### B.1.2 Regional or State Consumption Data

#### B.1.2.1 Anecdotal Information—

Anecdotal information is vital in directing the search for data on fish consumption patterns. For example, anecdotal information suggests that urban and rural fishers often sell their products "informally" (i.e., without commercial licenses) in geographic areas near where they fish and have customers with "standing orders" for regular fish delivery. This practice has been observed in Missouri, Mississippi, Alaska, and in the Chicago and Milwaukee metropolitan areas and is common to both rural and urban areas (Carlson, 1994). Health officials have raised concerns that "customers," who tend to be from minority or low-income populations, may

be exposed to contaminant concentrations over a long period of time. These groups, while not composed entirely of fishers, may have exposure levels as high as those for subsistence fishers (Carlson, 1994). Another exposed group that may not be well-characterized in some surveys is made up of fishers' family members, including extended families to whom fish is supplied.

Under these circumstances of unlicensed distribution it is likely that

- Those consuming the fish are unaware of the fish advisories, even if the actual fisher is aware

- Contacting the fisher is often difficult and the fisher, once reached, may be very reluctant to provide data on fish catch rates for fear of prosecution.

To obtain an estimate of consumption occurring via these routes, information can be acquired through informal discussions with local community groups in areas of potential exposure.

#### B.1.2.2 Behavioral Risk Surveillance Surveys—

Most states already participate in random telephone surveys under the Behavioral Risk Surveillance System (BRSS). The BRSS surveys are often the only random, state-level survey information readily available to states. They are funded by the Agency for Toxic Substances and Disease Registry (ATSDR), a department within the Center for Disease Control and Prevention (CDC). Some states have already used federal grant money to add questions on fisher demographics and consumption to the BRSS surveys (Shubat, 1993).

### B.1.3 National Consumption Data

#### B.1.3.1 National Survey of Fishing, Hunting and Wildlife—

The U.S. Fish and Wildlife Service (FWS) conducts a survey every 5 years that includes data on sport fishing. The most recent survey is entitled *1991 National Survey of Fishing, Hunting and Wildlife Associated Recreation* (U.S. FWS, 1993) and is available from the FWS. This survey provides information by state on fishers, broken down by age, sex, race/ethnic group, and state of residence. The FWS data can be used in combination with local data on the size of the fishing population overall to estimate the numbers of exposed individuals with relevant exposure characteristics. For example, using the FWS data, one could estimate the percentage of fishers in the state in a certain age group and apply this percentage to local fishing population data (from fishing licenses, for example) to estimate the number of local fishers in that age group.

#### B.1.3.2 U.S. Department of Agriculture (USDA) CSCFII Study—

The Continuing Survey of Food Intake by Individuals (CSFII) is a national food consumption survey conducted annually by the USDA. It consists of multistage, stratified-area probability samples from all states except Alaska and Hawaii. In the CSFIIs, dietary intake data collection is distributed over a year-long period. Survey participants provide 3 consecutive days of data. On the first day of the survey, participants provide information to an in-home interviewer. On the second and third days, data are taken from self-administered dietary records. Meals consumed both at home and away from home are recorded (U.S. EPA, 1998b).

## B.2 FISH CONSUMPTION SURVEY METHODS

If time and money permit, researchers are encouraged to conduct their own surveys to characterize fisher populations. EPA's guidance manual, *Guidance for Conducting Fish and Wildlife Consumption Surveys* (U.S. EPA, 1998a) may be useful in planning demographic surveys. Researchers also may consider coordinating survey efforts with other existing programs. For example, many state agencies conduct educational outreach programs to provide information or explain new regulations to fishers. Health agencies and natural resource offices can combine efforts to target subpopulations not yet reached through other mechanisms.

### B.2.1 Key Considerations

Table B-2 lists key considerations in conducting effective fish consumption surveys. Although surveying of a specific population can provide the most accurate exposure information about it, care must be taken in conducting the survey. The credibility of the survey results must be ensured through careful survey preparation, sample selection, and administration.

Population selection is one of the most significant components of an exposure assessment. A tiered approach is a logical recommendation for selecting populations of concern. First, examine the areas surrounding waterbodies that have been identified as contaminated or supporting potentially contaminated fish (e.g., anadromous fish arriving from contaminated estuaries).

Following this range identification, collect as much anecdotal information as possible from local populations surrounding these waterbodies. Qualitative data will indicate what communities are supported by the waterbodies, whether people are traveling long distances to fish in the waters, and other useful information to help direct further steps of the consumption evaluations. At this point, review the following information to determine whether a further investigation should be carried out:

- Anecdotal information suggesting high consumption rates
- Fish consumption patterns indicating potentially high exposure

**Table B-2. Key Considerations for Effective Fish Consumption Surveys**

| | |
|---|---|
| Population Selection | What population is to be surveyed? |
| | Based on what criteria (e.g., jurisdictional region, region with known fish contamination)? |
| Population Access | How will the identified population be reached? |
| | Will separate methods be used for distinct subpopulations (e.g., fish licensing for sport fishers, community groups for urban subsistence fishers)? |
| Consumption Rates | What method will be used to estimate consumption rates (e.g., recall, recordkeeping, catch rate)? |
| | What assumptions are made in these estimations (e.g., meal size, household size)? |
| Consumption Patterns | How are variations in consumption patterns accommodated (e.g., preparation methods, type of fish eaten, parts of fish consumed)? |
| Duration of Study | Have consumption rates been estimated for each different season or generalized? |
| | Have large fish catches that have been frozen or preserved for nonfishing seasons been addressed? |

- Subpopulations known to have high consumption rates living in the region or identified as fishing in the waters of concern, whether or not any anecdotal evidence exists to support high consumption or exposure rates.

Once the target population is selected, some method must be chosen to survey these individuals. As mentioned earlier, using fishing licenses as a survey tool may miss a large portion of the fishing population. It may be most useful to enlist the help of local agencies or community groups to help access some of the subpopulations at high risk, such as urban low-income populations or individuals of a particular ethnicity. Both identifying populations and collecting data may rely heavily on qualitative or anecdotal evidence on fishers to evaluate exposures of highly exposed populations. Consumption patterns affecting the overall consumption rate and toxicity must be discerned as well, including:

- Species of fish consumed
- Portions of fish that are consumed (fillet only or whole body)
- Preparation and cooking methods.

A determination must be made as to whether fish is a major source of protein in the diet of the subpopulation of concern. If advisories are developed based on the survey results, this information can provide some clue about the impact of fishing restrictions as one risk management option.

Several methods can be used to estimate a population's consumption rate. Actual recordkeeping for some period of time is the most accurate method, although a long-term commitment is needed from the respondents. Memory-recall is another method used to estimate consumption rates. This method can take the form of either "*how many meals of fish (or what amount of fish) have you (and household members) eaten in this past week*?" or "*how many meals of fish (or what amount of fish) do you (and household members) eat each week in general*?" While the length of recall can vary, long-term recall introduces uncertainties and inaccuracies. Individuals knowing the objective of the survey may be biased in their memory recall as well.

Meal size is another feature of determining consumption patterns. Many fish advisories are developed based on assumptions regarding meal size or specific consumption limits for a specific meal size. If information is not collected on meal size, risk managers may wish to use the average meal size assumption recommended by EPA of 227 g (8 oz) of fillet per 70 kg consumer body weight for adults. This value has been cited as appropriate in many documents on fish consumption (Anderson and Amrhein, 1993; Dourson and Clark, 1990; Minnesota Department of Health, 1992; Missouri Department of Health, 1992; U.S. EPA, 1988, 1995). This 8-oz fish meal weight may be considered an average meal size.

For those populations who consume fish whole, or who consume nonfilleted portions of the fish, meal sizes should be obtained from qualitative data or direct surveys. Readers are urged to collect information on meal size specific to their areas and populations of concern, especially if very large meals are known to be consumed during fishing trips, festivals, or under other circumstances. Information regarding maximum meal size may also be valuable in determining whether risks are likely to arise from large short-term exposures (bolus doses).

### B.2.2 Data Collection Problems

Conducting surveys to assess the consumption of noncommercially caught fish can be particularly challenging. Numerous individuals involved with fish consumption surveys have raised issues not mentioned in prior guidance documents. Their most notable concern was that of assessing the consumption rates of urban fishers or minority groups that were not registered for fishing licenses. In addition, surveys were often returned with consumption rates that were inconsistent with observed habits and the available qualitative data.

Surveys conducted using traditional methods can exclude major portions of the fish-consuming population. Several localities have attempted to conduct surveys to more accurately reflect the true consumption patterns existing within each

subpopulation. However, they found that, in some cases, unregistered fish consumers were answering survey questions inaccurately for any number of reasons, including the following:

- Fishers associated the state or local agency conducting the survey with enforcement and provided responses they thought the surveyors wanted to hear.
- Individuals who run illegal fish markets and are afraid of being caught responded inaccurately.
- Fish consumers who purchased fish from illegal fish markets and believed them to be commercial fish responded with lower consumption values.
- Surveys were not conducted in the native languages, and the details of the survey were lost in translation when individuals had conversational English skills only.
- Individuals surveyed relied heavily on fish for basic nutritional needs due to economic necessity, or because of personal preference and/or cultural traditions, and were afraid of restrictions that might jeopardize their family.
- Fishers understood the implications of the survey and responded inaccurately out of pride.
- Surveys addressed only certain species of fish that were caught, yet fishers caught and consumed numerous species of bottomfish.
- Questions were asked that made assumptions about the parts of fish consumed when the whole fish, including organs, may have been consumed.

Each of these issues has been addressed in more than one recent fish consumption survey in the past 2 years. Many fisheries resources and health officials therefore believe that approaches that utilize community-level organizations facilitate the survey process. This approach builds on the established trust between the community organization and its members and enables surveyors to develop a more accurate representation of fish consumption patterns.

Fish catch rates have also been used to estimate consumption rates, but variations in preparation methods, illegal resale of fish, and catching and preserving fish for later consumption in other seasons and for extended families and friends all add significantly to the uncertainty of these estimates. The duration of the survey may include only times of high exposure or can be comprehensive and address consumption rates year round to include variations in catch rates and preservation and preparation methods.

Some specific concerns have arisen over the use of license survey methods. Performance exaggeration has been noted for sport fisher respondents, particularly for individuals who associate fishing with prestige or who travel greater distances to reach a particular fishing location. Nonresponse bias has also been noted with surveys conducted on licensed fishers: typically, fishers who traveled shorter distances to reach a fishing destination, or who fished less frequently or consumed smaller quantities of fish, were less likely to respond to surveys than were more frequent fishers. Consequently, consumption rates may have been overestimated somewhat from surveys conducted in this manner.

### B.2.3 Intake Patterns and Bolus Dose

When characterizing the consumption patterns of fishers, it is important to consider the intake patterns. Patterns of exposure are critical to evaluating potential health risks. As discussed in Section 2.4.3.2, toxicity is related to both the overall exposure to a contaminant and the time over which the contaminant is consumed. Exposure durations and exposure frequency are important factors in estimating whether toxicity may occur. Consuming a few large meals over a very short period (a bolus dose) may cause acute exposure health effects, whereas consumption of the same total quantity spread over a month or year may cause chronic exposure effects, or no effects at all.

Bolus dose exposure may pose significant risks to:

- Children who
  - consume greater quantities in relation to their body weight than adults
  - have greater susceptibility to some contaminants
  - have less capability to detoxify some contaminants.

- Pregnant women, if the contaminant is known to cause fetal damage following prenatal exposure. Evidence from animal or human data presented in Section 5 shows that prenatal exposure to many of the target analytes may cause damage to offspring.

- Persons with special susceptibilities due to illness (e.g., persons with kidney, liver, or other diseases may be especially vulnerable to toxicants that attack those systems).

The reader is urged to review the toxicity data provided in Section 5 for contaminants of interest in their areas to determine if there are population subgroups requiring particular attention.

Fish consumption is often intermittent based on fish availability, cultural practices, weather, and other factors. Determining whether a large intake is likely to occur over a brief period of time is required to assess whether acute toxicity or developmental toxicity may occur. It is important to obtain descriptive or quantitative information on the timing of consumption over a calendar year.

### B.2.4 Calculation of Intake

When information is collected on both consumption patterns and contaminant level, the contaminant exposure can be estimated. The contaminant exposure is calculated using the fish consumption estimates for a specified time period (e.g., 1 week, 1 month). The concentration of the contaminant in the fish (in milligrams of contaminant per gram of fish) is multiplied by the amount of fish consumed (in grams) during the time period to obtain the total contaminant exposure during that time period (in milligrams). For example, if the contaminant concentration is 0.01 mg/g of fish tissue, and 1,000 g of fish are consumed in 1 month, then 0.01 mg/g is multiplied by 1,000 g/mo to obtain a total exposure of 10 mg/mo.

To facilitate the risk assessment process, exposure is expressed in terms of the daily average. The average daily exposure is calculated by dividing the total amount of chemical contaminant ingested (in milligrams) during the specified period by the number of days in the time period. For example, when data are collected for a 1-month period, the following equation can be used to calculate daily exposure:

$$\text{average daily exposure (mg/d)} = \frac{\text{contaminant ingested over 1 month (mg/mo)}}{\text{days per month (d/mo)}} \quad \text{(D-1)}$$

Although this equation uses 1 month as an averaging period, other averaging periods could be used by changing the time periods in both the numerator and denominator of the equation (e.g., 1 week).

Toxicity and risk values are expressed as intake in milligrams of chemical contaminant per kilogram of body weight per day (mg/kg-d). To adapt the exposure data to these units, the average daily exposure (in milligrams) is divided by the body weight of the consumer (in kilograms):

$$\text{average daily intake (mg/kg-d)} = \frac{\text{average daily exposure (mg/d)}}{\text{body weight of consumer (kg)}} \quad \text{(D-2)}$$

The most accurate body weight information is obtained directly from the local population. Table 3-5 in Section 3 of this volume provides body weights for men, women, and children of various ages from a national survey for use when local data are not available.

To determine the potential for acute or prenatal toxicity, the total intake over a short period of time (e.g., 3 days, 1 week) can be calculated. Depending on the toxicity data being used, the time period of interest will vary (see Section 5 for

chemical-specific information). The total intake is expressed as milligrams per kilogram of body weight, as in the following equation:

$$\text{total intake (mg/kg)} = \text{average daily intake (mg/kg-d)} \times \text{number of days (d)} . \quad \text{(D-3)}$$

Information regarding the duration and periodicity of exposure is needed for both determining potential risks and identifying the most appropriate consumption limits. It should be described when exposure information is presented for use in risk assessment.

## B.3 FISH CONSUMPTION DATA FOR VARIOUS POPULATIONS

This section describes the results of fish consumption surveys. If state agencies cannot conduct local surveys of fish consumption, these surveys can be used to estimate fish consumption rates for the populations that an agency wishes to target when issuing fish advisories. To use these data appropriately, it is important to match the population surveyed in the reported studies as closely as possible to the local fisher population. This section contains tables summarizing consumption data for sport and subsistence fishers from studies conducted in various regions of the United States. If a study is to be used as the basis for risk assessment and setting advisory limits, agencies are strongly encouraged to review the actual study data to determine its applicability to their local conditions.

Two categories of fisher survey data are discussed: sport fishers and subsistence fishers. In these groups there is wide variability in consumption patterns. Although the surveys are divided into these two categories for ease of presentation, these two categories cannot be strictly defined. The results of many of these surveys are summarized in Tables B-3 through B-6. They are presented by Region, proceeding from east to west across the United States.

Tables B-3 and B-5 present consumption rate data for sport and subsistence fishers, respectively. The tables list consumption in grams per day; however, it should be noted that these values are estimates that are generally obtained by recall, not strict log-keeping. In addition, surveys generally ask about the number of meals eaten in a given time frame, but the size of these meals is generally imprecisely estimated. In addition to quantitative data, information regarding the types of fish included in the consumption rates is included with the consumption rate, because it directly impacts the quantitative data presented in the rate tables. These distinctions include

- Inclusion of freshwater fish, saltwater fish, or both
- Inclusion of sport and/or commercially caught fish.

Survey methods used to collect the data reported in Tables B-3 and B-5 are listed in Tables B-4 and B-6. The methods of conducting fish consumption surveys and the reporting of information from these surveys may differ among studies and many of the differences are highlighted in the survey methods tables.

Methods of averaging fish consumption information also differ among studies. Some studies average the consumption rates over all individuals, regardless of whether they ate fish, while other surveys average the information only for those individuals who reported eating fish. For example, Cox et al. (1993) report consumption rates averaged for the fish-eating population, whereas the Alabama Department of Environmental Management (ALDEM, 1993) reports a rate averaged for both the fish-consuming and nonconsuming populations. Although some of the survey characteristics are noted in the tables, agencies should consult the individual surveys to obtain the most complete descriptions of the study and resulting consumption rates.

In addition to the studies of sport and subsistence fishers, national survey results are discussed at the end of this section. In the absence of local data, national fish consumption data may be used.

### B.3.1 Sport Fishers

As noted previously, sport fishers differ with respect to their catch and consumption habits. Some may fish for 1 week during a year or for several weekends each year. Others may fish for much longer periods during a year or may fish year-round. Surveys of the general sport fishing population may include those who primarily fish for recreational purposes or eat fish for a small portion of the year but may also include some individuals who eat fish as a main staple in their diets. Fish consumption data obtained from sport fisher surveys are summarized in Table B-3 and the survey methods used to collect the data are summarized in Table B-4.

## Table B-3. Sport Fishers[a] Consumption Data

| Fisher Group | Consumption Rates (g/d) | | | | | Fish Type |
|---|---|---|---|---|---|---|
| | Mean | Median | 80th Percentile | 90th Percentile | 95th Percentile | |
| Alabama fishers[1] | 45.8 | | | | 50.7 | F+S, F+C |
| Louisiana (coastal) fishers[2] | | 65 | | | | F+S, F+C |
| New York fishers[3] | 28.1 | | | | | F+S, R+C |
| New York (Hudson River) fishers[4] | 40.9 | | | | | F+S, R |
| Michigan fishers[5] | 14.5 | | 30 | 62 | 80 | F+S, R |
| Michigan fishers[6] | 18.3 | | | ≈50 | | F+S, R+C |
| Michigan fishers[7] | 44.7 | | | | | F, R |
| Wisconsin fishers (10 counties)[8] | 12.3 | | | | 37.3 | F, R |
| Wisconsin fishers (10 counties)[8] | 26.1 | | | | 63.4 | F, R+C |
| Ontario fishers[9] | 22.5 | | | | | F, R |
| Los Angeles Harbor fishers[10] | | 37 | | 225 | | S, R |
| Washington State (Commencement Bay) fishers[11] | | 23 | | 54 | | S, R |
| Washington State (Columbia River) fishers[12] | 7.7 | | | | | F+S, R+C |
| Maine fishers (inland waters)[13] | 6.4 | 2.0 | | 13 | 26 | F, R |

F = freshwater, S = saltwater, R = recreationally caught, C = commercially caught.

[a] Sport fishers may include individuals who eat sport-caught fish as a large portion of their diets.

SOURCES:

1. ALDEM (1993).
2. Dellenbarger et al. (1993).
3. Connelly et al. (1990).
4. Barclay (1993).
5. West et al. (1993).
6. West et al. (1989).
7. Humphrey (1976).
8. Fiore et al. (1989).
9. Cox et al. (1993).
10. Puffer et al. (1982).
11. Pierce et al. (1981).
12. Honstead et al. (1971).
13. Ebert et al. (1993).

## Table B-4. Sport Fishers[a] Survey Description

| Fisher Group | Number Surveyed | Contact Method/ Instrument | Reporting Method[b] | Catch vs. Consumption[c] | Individual vs. Household | Data Available | Duration |
|---|---|---|---|---|---|---|---|
| Alabama fishers[1] | 1,586 | Onsite/personal interview | Log | Catch | Individual | Age, ethnicity, income, region, sex | 12 mo |
| Louisiana (coastal) fishers[2] | 1,100 | Random/telephone | Recall | Consumption | Household | Age, education, ethnicity, income, other | 1 mo |
| New York fishers[3] | 4,530 | Fish license/mail/ followup by telephone | Recall | Catch | Individual | Age, income, region | 12 mo |
| New York (Hudson River) fishers[4] | 336 | Onsite/personal interview | Recall | Consumption | NA | NA | NA |
| Michigan fishers[5] | 2,684 | Fish license/mail | Recall | Consumption | Household | Age, education, ethnicity, income, region, sex | 12 mo |
| Michigan fishers[6] | 1,104 | Fish license/mail | Recall | Consumption | Household | Age, education, ethnicity, income, region, sex | 6 mo |
| Michigan fishers[7] | 182 | Fish license/NA | Log | Catch | Individual | NA | 24 mo |
| Wisconsin fishers (10 counties)[8] | 801 | Fish license/mail | Recall | Consumption | Individual | Age, education, ethnicity, region, sex | NA |
| Ontario fishers[9] | 494 | Fish license/mail | Recall | Consumption | Individual | Age, region, sex | Summer, fall |
| Los Angeles Harbor fishers[10] | 1,059 | Onsite/personal interview | Recall | Catch | Individual | Age, ethnicity | 12 mo |
| Washington State (Commencement Bay) fishers[11] | 508 | Fish license/personal interview/followup by telephone | Recall | Catch | Individual | NA | Summer, fall |
| Washington State (Columbia River) fishers[12] | 10,900 | Fish license/personal interview | Recall | Consumption | Household | NA | 12 mo |
| Maine fishers (inland waters)[13] | 1,612 | Fish license/mail/ followup by mail | Recall | Consumption | Individual **and** household | NA | 12 mo |

NA = Not available.

[a] Sport fishers may include some individuals who eat fish as a large portion of their diets.

[b] Respondents recorded consumption information in a log or recalled consumption information during interview.

[c] Catch: Original data from catch rates extrapolated to consumption rates. Consumption: Data obtained on consumption patterns.

SOURCES:

[1] ALDEM (1993).

[2] Dellenbarger et al. (1993).

[3] Connelly et al. (1990).

[4] Barclay (1993).

[5] West et al. (1993).

[6] West et al. (1989).

**Table B-5. Subsistence Fishers[a] Consumption Data**

| Fisher Group | Consumption Rates (g/d) | | | Fish Type |
|---|---|---|---|---|
| | Mean | 95th percentile | Max | |
| Great Lakes tribes[1] | 351 | | 1,426 | F |
| Columbia River tribes[2] | 58.7 | 170 | | F |
| High-end Caucasian consumers on Lake Michigan[3] | 48[b] | | 144 | F |
| | 27[c] | | 132 | F |
| Native Alaskan adults[4] | 109 | | | F+S |

F = fish, S = shellfish.

[a] Subsistence fishers include individuals who may eat sport-caught fish at high rates but do not subsist on fish as a large part of their diet.

[b] Data from 1982 survey of fish eaters.

[c] Data from 1989 survey of fish eaters.

SOURCES:

[1] Kmiecik and Ngu (1994).

[2] CRITFC (1994).

[3] Hovinga et al. (1992, 1993).

[4] Nobman et al. (1992).

### B.3.2 Subsistence Fishers

Subsistence fishers consume fish as a major staple of their diet. These fishers rely on fish to meet nutritional needs, as an inexpensive food source, and, in some cases, because of their cultural traditions. Subsistence fishers often have higher consumption rates than other fisher groups; however, consumption rates vary considerably among subsistence fishers. Consequently, generalizations should not be made about this fisher group. If studies contained in this section are used to estimate exposure patterns for a subsistence population of concern, care should be taken to match the dietary and population characteristics of the two populations as closely as possible.

Subsistence fishers include a wide variety of people who differ in many respects. This section is not suggesting that similarities exist between populations, other than in their consumption of a relatively large quantity of fish. Information is provided below on some qualitative characteristics of specific subsistence population groups.

## Table B-6. Subsistence Fishers[a] Survey Description

| Fisher Type[b] | Number Surveyed | Contact Method/ Instrument | Reporting Method[b] | Catch vs. Consumption[c] | Individual vs. Household | Data Available | Duration (months) |
|---|---|---|---|---|---|---|---|
| Great Lakes tribes[1] | 69 | Tribe/mail | Recall | Consumption | Individual | NA | 2 |
| Columbia River tribes[2] | 717 | Tribe/random/personal interview | Recall | Consumption | Individual | Age, ethnicity, region, sex | 12 |
| High-end Caucasian consumers on Lake Michigan[3] | 115 | Other[d]/personal interview | Recall | Consumption | Individual | Age, sex, education, other | 7 |
| Native Alaskan adults[4] | 351 | Tribe/random/personal interview | Recall | Consumption | Individual | Age, ethnicity, sex, other | 18 |

NA = Not available.
[a] Subsistence fishers include individuals who may eat sport-caught fish at high rates but do not subsist on fish as a large part of their diets.
[b] Respondents recorded consumption information in a log or recalled consumption information during interview.
[c] Catch: Original data from catch rates extrapolated to consumption rates. Consumption: Data obtained on consumption patterns.
[d] Fishers identified in a Michigan Department of Health study in 1982.

SOURCES:
[1] Kmiecik and Ngu (1994).
[2] CRITFC (1994).
[3] Hovinga et al. (1992, 1993).
[4] Nobman et al. (1992).

Subsistence fishers may consume different types or portions of fish than sport fishers (e.g., organs, whole fish), although individual tastes will vary. Their consumption patterns in this regard may result in greater exposure to contaminants. For example, many Asian-American subsistence fishers eat raw fish, liver, hepatopancreas, kidneys, brains, and eyes of bottom-dwelling fish such as carp and catfish that bioaccumulate more toxicants due to the scavenging habits). They may use whole fish in soup stocks and consume seaweed and other aquatic species that may contain the same contaminants as fish. Fish advisory programs have only recently begun to address concerns associated with this subpopulation, and some studies are underway to evaluate consumption patterns. Current information is primarily qualitative; however, differing patterns have been identified among the populations considered: Laotians, Hmong, Cambodian, and Vietnamese (Allbright, 1994; Cung, 1994; Den, 1994; Lorenzano, 1994; Nehls-Lowe, 1994; Pestana, 1994; Shubat et al., 1996; University of Wisconsin Sea Grant, 1994; Young, 1994 ).

Native American groups in some areas include fish extensively in their cultural, ceremonial, and dietary patterns. Many of the surveys of Native American groups indicate a high fish consumption rate. Most of the study information is recent and many studies are still ongoing.

Rural fishers make up a large segment of subsistence fishers. For example, more than half the noncommercial fishing in Idaho is conducted in Washington County, Idaho. Within Washington County, a community considered by some researchers to be subsistence fishers is located in the area surrounding Brownlee Reservoir, a major fishing location. The local community has a high unemployment rate, with over 40 percent of the population on public assistance. The sport and subsistence fishers in the area often catch 100 to 300 lb of crappies during a fishing trip and freeze much of the catch for year-long consumption. Many fishers are dependent on fish as a major source of protein for themselves and their families. Fishing activities also bring needed economic resources to the area. However, elevated pollutant levels have been found in the reservoir. Community leaders have concerns regarding tradeoffs between fish advisories developed to reduce health risks and the negative economic and nutritional impacts the advisories might have on the fisher population (Richter and Rondinelli, 1989).

Several surveys evaluating the consumption patterns of subsistence fishers have been initiated in the past several years. Some of these have been completed and many more are currently being carried out, with results expected in the near future. Although many of these surveys provide only a range of consumption rates, a great deal of qualitative information has been gained through these surveys, both about the individual populations that were studied and about effective survey methods for different groups of subsistence fishers. The consumption rates reported by these surveys are presented in Table B-5 and the survey methods used to collect the data are summarized in Table B-6.

### B.3.3 General Population

For the purposes of risk assessment or risk management, the consumption rates derived from national surveys can provide a useful picture of the distribution of fish consumption for the U.S. population. However, since sport and subsistence fishers generally have higher consumption rates than the national rates, the distributions for these groups will differ. That is, the point estimates of the mean and upper percentiles of fish consumption will generally be higher for the sport and subsistence fishers than for the general U.S. population. National survey data are the least preferred for use in developing local advisories.

Fish consumption data from three national studies are reported in Table B-7. The details of the survey methods used in these studies are summarized in Table B-8. Note that two of the three studies (National Purchase Diary [NPD] and Market Facts) were conducted more than 20 years ago. Also, study results conflict in some respects. For example, the NPD study found the lowest consumption rate in New England, and the Market Facts study found the highest rates in New England. There is also concern that the reported rates in these dated studies do not reflect current consumption patterns.

### B.3.4. Sensitive Subpopulations

States with consumption rate information specific to sensitive subpopulations (e.g., women of reproductive age and children) may wish to use such information when assessing exposure. For example, a recent study was conducted to determine fish consumption patterns among the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin in Washington and Oregon (CRITFC, 1994). This study found that adults in these four tribes consume an average of 58.7 g/d and that children (5 years and younger) from these four tribes consumed 19.6 g/d. Mean fish consumption was more than nine times higher among adults and over three times higher among children in these tribes than for adults in the general population (assuming a consumption rate of 6.5 g/d). Many of the contaminants examined in Section 5 of this volume have develop-mental effects of particular concern to women of reproductive age and children.

If data are available for only the general population, however, the consumption rates for the populations of interest may be calculated by using values for meal size and body weights specific to those subgroups using the methods described in Section 3 of this volume. In cases where studies do not separate consumption rates by age and gender, an exposure assessment based on these rates would reflect exposure to the general population only.

Population size estimates may need to be adjusted to include family members of fishers who share their catch. While children may not constitute a large fraction of fishers, they may be exposed by eating fish that their parents or older siblings catch. Site-specific data on family size can be used to make this estimate, if

**Table B-7. National Studies Consumption Data**

| Population | Consumption Rates (g/d) | | | | Fish Type |
|---|---|---|---|---|---|
| | Mean | 90th Percentile | 95th Percentile | 99th Percentile | |
| US[1] | 6.6 | NA | 47.3 | NA | F+E, C+R |
| US[2] | 6.5 | NA | NA | NA | F+E, C+R |
| US[2] | 14.3 | NA | 41.7 | NA | F+S, C+R |
| US[3] | 16.7 | NA | NA | NA | F+S, C+R |
| US[4] | 20.1 | 70.1 | 102.0 | 173.2 | F+S+E, C+R |
| US[4] | 5.9 | 15.9 | 40.0 | 107.6 | F+E, C+R |

F = Freshwater, S = Saltwater, E = Estuarine, C = Commercial, R = Recreational.

SOURCES:
[1] Continuing Survey of Food Intake by Individuals (CSFII) conducted by USDA (1991).
[2] National Purchase Diary (NPD) Fish Consumption Survey (as cited in Javitz, 1980; Rupp et al., 1980).
[3] Market Facts Survey (as cited in Javitz, 1980).
[4] Continuning Survey of Food Intake by Individuals (CSFII) conducted by USDA, 1988, 1990, 1991, U.S. EPA (1998b).

available. In the absence of these data, U.S. census data on average family size can be used.

Other susceptible subpopulations among the fisher populations should be considered as well. The presence of these groups will depend on local demographics and the nature of the contaminants present in fish. Section 5 of this volume provides information on especially susceptible subgroups for many of the target analytes. Some chemical contaminants interfere or act synergistically with pharmaceuticals; others attack particular organ systems and may cause people with related illnesses to be at elevated risk. Information on any susceptible subgroup should be considered both in estimating risks and establishing health-based exposure limits.

## Table B-8. National Studies Survey Description

| Population | Number Surveyed | Contact Method/ Instrument | Reporting Method[a] | Catch vs. Consumption[b] | Individual vs. Household | Data Available | Duration |
|---|---|---|---|---|---|---|---|
| US[1] | 11,912 | Census/personal interview | Log/recall | Consumption | Individual | Age, sex | 12 mo (3 d recall/ person) |
| US[2] | 23,213 | Census/NA | Log | Consumption | Household | Age, sex, region | 12 mo |
| US[3] | 4,864 | Census/NA | Log | Consumption | Household | Education, ethnicity, income | 12 mo |
| US[4] | 11,912 | Census/personal interview | Log/recall | Consumption | Individual | Age, sex | 12 mo (3 d recall/ person) |

NA = Not available.

[a] Respondents recorded consumption information in a log or recalled consumption information during interview.

[b] Catch: Original data from catch rates extrapolated to consumption rates. Consumption: Data obtained on consumption patterns.

SOURCES:

[1] Continuing Survey of Food Intake by Individuals (CSFII) conducted by USDA (1991).

[2] National Purchase Diary (NPD) Survey (as cited in Javitz, 1980; Rupp et al., 1980).

[3] Market Facts Survey (as cited in Javitz, 1980).

[4] Continuing Survey of Food Intake by Individuals (CSFII) conducted by USDA, 1989,1990, 1991, U.S. EPA (1998b).

## B.4. CONSUMPTION SURVEY DATA ORGANIZATION

In assembling the exposure data, it is most appropriate to build a population exposure database in the form of data groupings for each waterbody and population subgroup (e.g., population consumption characteristics for individuals living around or using a particular lake, river, etc.). Because most contamination data are maintained for specific waterbodies, they serve as a natural unit for evaluating exposure.

Further subdividing of a population may be necessary, depending on population size and the area being considered. If a large or diverse population of concern (e.g., a city or large geographic area) is to be evaluated, subgroups within the population of interest may need to be identified. These subgroups, which may have higher than average exposures, can include groups of subsistence fishers or sport fishers known to fish in contaminated waters. If attention is focused on smaller groups (e.g., sport fishers at a single lake, subsistence fishers from a particular tribe), further subdividing the population into subgroups may not be necessary for purposes of evaluating exposures.

A template is provided in Section 2, Table 2-4, of this volume on which exposure data may be entered. It is located in that section because risk managers are encouraged to evaluate other aspects of exposure in addition to consumption patterns. These factors include exposure modifications that may be associated with fish cleaning (skinning and trimming) and cooking fish procedures (discussed in Appendix C) and additional exposures to the contaminant of concern that may arise from other sources such as air, water, other foods, and soil (discussed in Section 2.4.5.6 of this volume).

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