APPROACHES TO ESTIMATING FISH CONSUMPTION
IN THE UNITED STATES

(Quick Response Report)

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prepared by
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FOREWORD

The Federation of American Societies for Experimental Biology (FASEB) recognizes that its resources are particularly suited to marshalling scientific expertise for review and assessment of topics in the biological and medical sciences. The Life Sciences Research Office (LSRO) was established by FASEB in 1962 as an operational arm of the Executive Director's staff to provide a means for conducting such scientific reviews and analyses. Reports of LSRO studies are based upon comprehensive literature reviews and the scientific opinions of knowledgeable investigators in specific areas of biology and medicine.

This Quick Response Report was prepared by Kenneth D. Fisher, Ph.D., Director, LSRO, FASEB in accordance with Order No. FDA-003459-01-87 for the Center for Food Safety and Applied Nutrition, Food and Drug Administration. Scientists who contributed information are noted in Appendix A; however, this report has not been reviewed by them. The listing of their names does not imply endorsement of the contents of this report.

In accordance with the policies and guidelines developed by the LSRO Advisory Committee, this report has been reviewed and approved for submission by the Chairman of the LSRO Advisory Committee. Reports prepared by LSRO do not necessarily reflect the opinion of the individual members of the FASEB constituent societies. The author and LSRO are solely responsible for the contents of this report.

[Signature]

Date: September 30, 1988

Kenneth D. Fisher, Ph.D.  
Director  
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I. INTRODUCTION

In discharging its responsibilities to ensure the nutritional adequacy and safety of the nation's food supply, FDA requires data on fish consumption as a component of its programs that monitor diet/health relationships and assess risks of adverse health effects. For this reason, FDA requested that LSRO prepare a Quick Response Report to address the following issues:

(1) Identify approaches for selecting a national sample of individuals that may be used to define "usual" fish consumption by the general U.S. population. The strengths and limitations of each approach shall be discussed in view of the need to adequately estimate U.S. fish consumption on a species and geographic basis as part of health and safety evaluations.

(2) Review considerations in selecting subpopulations of individuals (preferably from a national probability sample) that may be used to assess fish consumption by "heavy eaters" such as sports fishermen and persons in selected geographic regions. In developing approaches for sampling special population subgroups, emphasis will be placed on (a) special purpose sampling, (b) information on species of fish, and (c) frequency of consumption and amount consumed per eating occasion.

FDA further requested that LSRO consider several related issues in responding to the two questions. These included statistical inference, representativeness of data, geographical distributions, quantification of consumption for risk assessment and design of data collection instruments. Additionally, the issue of whether a single database could be used for both diet/health relationship evaluations and risk assessments needed consideration. Finally, a brief synopsis of procedures used in currently available databases and the appropriateness of the samples of fish consumers in these databases were requested.
II. STATEMENT OF PROBLEM OF ESTIMATING FISH CONSUMPTION

Estimation of fish consumption is a complex problem that may require different approaches depending upon the purposes for which the intake estimates are to be used. Further, approaches to collection of data on consumption and population sampling techniques need to accommodate the nonuniformity of fish consumption within the United States population, which appears to be influenced by a number of geographic, sociodemographic, and economic factors (Hu, 1985; Haines et al., 1987). These considerations have a marked impact on estimates of consumption and in turn, on interpretation of consumption estimates. The following paragraphs provide further definition of these aspects of the overall problem: (1) What "fish consumption" is being estimated? (2) What is the estimate to be used for? and (3) What are the attributes of fish consumption that make its estimation unique or difficult?

A. FACTORS RELATED TO FISH CONSUMPTION

Several critical factors influence approaches to estimation of fish consumption because they impact on the definition of "eaters":

- The term "fish" is usually defined as all sources of fin and shellfish (Pisces, Crustacea, and Mollusca) of fresh and marine water origin consumed as food (regardless of how obtained, where consumed, or what part is eaten).

- Fish as a food commodity includes a heterogeneous group of fresh water and marine species.

- Fish is a food that is not consumed by some individuals and preferentially consumed by others.

- Consumption, by those who do eat fish, may be sporadic in terms of seasonal and at-home versus away-from-home eating occasions.

- Among eaters, preferential selection of certain species exists for demographic, geographic, economic, and other reasons.

- For species purchased, distribution patterns for commercially available species, and labeling of fish products at the point of purchase obscure the geographic origin of the species consumed.

- For certain populations, in certain locations, and for various reasons, recreationally obtained fish or fish purchased outside normal commercial channels may constitute a significant proportion of actual intake.
Thus, determination of fish consumption for possible assessment of diet/health relationships and risks associated with its use as food requires consideration of a number of factors related to consumption. These include:

- Sociodemographic characteristics of consumers
- Geographic and seasonal variations in consumption
- Species of fish consumed
- Parts of the fish consumed
- Quantities consumed
- Geographic origin of species consumed

Because each of these aspects of consumption are variables that may interact with one another, they must be considered in designing approaches to data collection and analysis. Further, the intended use of these data for determining diet/health relationships and/or risk assessments will impact on both data collected and methods of collection. In general, diet/health relationships are usually derived from estimates of the distribution of usual intakes. In the case of fish consumption of the U.S. population, the population sample should reflect sociodemographic characteristics of the U.S. population and provide sufficient data for estimation of the unique characteristics associated with fish consumption. Evaluation of health and safety associated with fish consumption would require quantification of the consumption by either the representative sample of the U.S. population or the sample of special groups of eaters, the species and parts of fish consumed, and the quantification of the concentration of substances associated with the adverse health effects*.

B. DIET/HEALTH RELATIONSHIPS

Evaluation of diet/health relationships requires characterization of the nutritional, health, and demographic status of individuals or a population. Nutritional and health status assessment should include: medical history; physical examination for health status and clinical signs of deficiency or toxicity; food and nutrient intakes; body measurements; and hematological and biochemical tests (Woteki, 1986). Determination of any relationship between fish consumption and nutritional or health status would require data on fish consumption as well as data on nutritional and health status as noted by Woteki (1986).

* Although not addressed in this report, the heterogeneity of species used as food necessarily affects the approach to collection of data on concentration of toxicants or other substances in various species (e.g., concentration of the toxicant in adipose or other tissues). For example, if omega-3 fatty acids in fish are of concern, species could be grouped in broad categories; if PCBs in Great Lakes fish are of concern, exact data on concentrations in specific species would be essential.
For estimation of intake of the U.S. population, per capita fish intake might be derived from disappearance data. However, information on distribution of usual intakes of individuals within the total population or special population subgroups is frequently needed to examine relationships between patterns of fish consumption and specific health outcomes. Therefore, characterization of the patterns of dietary intake of individuals and health profiles of those individuals would be necessary.

Most relationships between dietary intake and a biological outcome (e.g., health effect) depend on intakes persisting over relatively long periods of time (Anderson, 1986). For various reasons (discussed subsequently), food frequency methods may provide a more efficient way to measure usual intake than quantitative daily measures of consumption for single or multiple days because food frequency methods permit representation of food intakes over longer periods of time. However, food frequency methods usually provide fewer data on quantitative intake by individuals (Anderson, 1986). Thus, collection of data reflecting consumption over time periods, a more reasonable approach to "usual intake," is accomplished at the expense of obtaining data on actual quantities consumed per eating occasion. With respect to fish consumption, this issue has increased importance because of the apparent nonuniformity of usual fish consumption by the U.S. population.

C. RISK ASSESSMENT

Risk assessment is usually concerned with possible adverse health effects associated with high levels of consumption, but may be concerned with usual intakes of a food or food substance. Most often, risk assessment is needed to determine whether a toxicant, contaminant, or other substance may be present in quantities that approach or exceed some possibly harmful level. Risk assessment requires estimation of the usual dietary intake of heavy consumers and comparison with an established action level (EAL) or acceptable daily intake (ADI). For example, assessment of risks from consumption of bluefish containing mercury and polychlorinated biphenyls has been performed because these substances had been found in certain fish at levels that might require federal action (U.S. Department of Commerce, 1987).
Risk assessment often involves determination of what population subsets may be at risk of adverse health effects from exposure. Quantification of intakes on some basis (per day, per kg body weight) requires attention to collection and derivation of both fish consumption data and toxicant concentration data. Quantitative daily consumption methods provide data on actual amounts consumed by individuals, but these techniques raise additional methodological issues which are discussed later (see p.29). Determination of toxicant exposure in "fish consumed" adds a further dimension of concern; that is, accuracy, precision, and reliability of the concentration data.

In some instances of risk assessment, data on a specific subgroup of the population (e.g., catfish eaters in the lower Mississippi River basin) are not available and must be estimated from other data sources. The use of intake or concentration data not collected for the specific purpose of risk assessment involves determination of the usefulness of such data. Such determinations require value judgments based in part on what data are available and what accuracy and precision are needed in the risk assessment process. For example, much of the data collected in the process of examining diet/health relationships are obtained by means of dietary records, recalls, or frequency of eating questionnaires. Although quantitative data on consumption are preferred, food frequency data can be used to estimate exposure. Although none of the currently available data include sufficient detail to estimate fish consumption for risk assessment purposes, there are approaches that should be considered in designing efforts to collect such data for purposes of determining both risk assessment and diet/health relationships (Anderson, 1988).

Because there is a paucity of data on exposures to toxicants at specific times in defined population groups, risk assessment continues to explore various approaches to assessing risks. One such approach has been developed for assessing hazards associated with exposure to contaminants in seafood (Brown et al., 1988). This concept involves a two-phase approach based on ranking of the potential hazards from exposure. Phase I utilizes toxicity data from multiple sources to establish potential hazard. An empirical scoring system is used to rank hazards of exposures. These exposure scores are used in Phase II to construct a dose-response relationship, estimate a no observed adverse effect level, and derive an allowable daily intake estimate. The techniques developed by Brown et al. (1988) are based primarily on toxicity and exposure data; actual consumption is not measured. Rather, the estimated high intake levels are calculated from usual intake data and weighting with several factors based upon assumptions deduced from other data. The use of such approaches is a consequence of the need for risk assessment in the absence of actual data on consumption by the exposed population. If actual consumption data were coupled with these techniques of exposure estimation, the accuracy and reliability of the process would be enhanced.
D. RESTATEMENT OF PROBLEM

In essence, the scope of work identified by FDA raises four problem areas for discussion. These may be phrased as follows:

- What are the possible approaches to obtaining data useful in assessing the "usual fish intake" of the U.S. population if the estimate of usual intake is to be used in evaluating diet/health relationships? For example, how would one approach the question as to whether regular consumption of fish affects occurrence of coronary heart disease in adults?

- What are the possible approaches to obtaining data useful in assessing the "usual fish intake" of the U.S. population if the estimate of usual intake is to be used in evaluating risk of exposure to toxic substances? For example, how might one address the issue of what percentage of adults who consume fish regularly may be at increased risk because they are exposed to levels of polychlorinated biphenyls that are above an acceptable level of daily intake?

- What are the possible approaches to obtaining data useful in estimating fish consumption of "heavy eaters" if the estimate is to be used in assessing diet/health relationships? For example, what approaches might be taken in addressing the question of whether the incidence of coronary heart disease is lower (or higher) in year-round avid sports fishermen?

- What are the possible approaches to obtaining data useful in estimating fish consumption of "heavy eaters" if the estimate is to be used in assessing risk of exposure to toxic substances? For example, how would one address a question of whether Atlantic coast sports fishermen are liable to greater exposures to polychlorinated biphenyls from consumption of bluefish, rockfish, or cod?

The remainder of this quick response report provides information on four major topics:

1) A synopsis of information on fish consumption available from existing databases as it relates to the four general problem areas.

2) An identification of strategies useful in developing dietary data needed for examination of associations between fish consumption and possible health relationships or safety evaluations in the general population.
3) An identification of strategies useful in developing dietary data needed for examinations of associations between preferential or higher than usual fish consumption and possible health relationships or safety considerations.

4) Some suggestions for future consideration by FDA in approaching these two aspects of estimating fish consumption.
III. INFORMATION AVAILABLE IN EXISTING DATABASES

Some information and data on fish consumption are available from previous studies, primarily those sponsored by the National Marine Fisheries Service (NMFS).

A. ESTIMATES OF FISH CONSUMPTION

Since 1969, three surveys of fish consumption have been undertaken. Data from these surveys have been used either in conjunction with or compared to data obtained in the 1977-1978 USDA Nationwide Food Consumption Survey. Characteristics of these surveys are provided in Table 1. Additional information on each of these four surveys has been summarized by Hu (1985). The following aspects are pertinent to FDA's purposes:


- Population represented - The total U.S. population was represented by a consumer panel of households selected in regard to total population distributions of income, geographic region, education, degree of urbanization, race, and age of household members.

- Sampling techniques used - Panelists' households were reportedly selected to be a nationally representative sample in accordance with Bureau of Census characteristics.

- Dietary methodology used - Household food diaries made twice each month for 12 months. [It is unclear from Javitz (1980) and Hu (1985)* who cite these data, but it is presumed that each household completed a diary of 14- to 15-days' duration twice each month for 12 months.]

- Aspects of intake measured - Purchases of fish products and dollars spent for at-home and away-from-home* consumption (30 major seafood items and 10 specialty items).

* According to Javitz (1980) away-from-home consumption data were collected; Hu (1985) questioned the reliability of these data and excluded them in her analyses.
<table>
<thead>
<tr>
<th></th>
<th>1969-70 (^2)</th>
<th>1973-74 (^3)</th>
<th>1977-78 (^4)</th>
<th>1981  (^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Consumer Panel Survey</td>
<td>Fish Consumption Survey</td>
<td>Nationwide Food Consumption Survey</td>
<td>National Seafood Consumption Survey</td>
</tr>
<tr>
<td></td>
<td>(Market Facts, Inc.)</td>
<td>(NPD Research Inc.)</td>
<td>(USDA)</td>
<td>(Market Research Corp. of America)</td>
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<tr>
<td>No. of Observations</td>
<td>4,864</td>
<td>1,586</td>
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<tr>
<td>No. of Fish Items</td>
<td>40</td>
<td>40</td>
<td>135</td>
<td>135</td>
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<td>Time of Survey Period</td>
<td>1 yr</td>
<td>1 yr</td>
<td>1 mo</td>
<td>1 mo</td>
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<tr>
<td>Purchase Data</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
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<td>Home Consumption Data</td>
<td>no</td>
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<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Away-From-Home</td>
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<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Consumption Data</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Sampling Weighting Factor</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
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<tr>
<td>Unit of Measurement</td>
<td>lbs</td>
<td>lbs</td>
<td>oz</td>
<td>oz</td>
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<tr>
<td>Food Cost Data</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>no</td>
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<td>not included</td>
<td>not complete</td>
<td>no</td>
<td>no amount only yes/no</td>
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<tr>
<td>Pregnancy</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>

\(^1\) Modified from Hu, 1985.
\(^2\) Supported by the National Marine Fisheries Service.
\(^3\) Supported by the Tuna Research Institute.
\(^4\) Supported by the National Marine Fisheries Service and the Human Nutrition Information Service.
Limitations - Individual consumption computed from household size; actual individual consumption and portion size were not measured but were derived from purchase data; validity of data on quantity of fish in mixtures and on away-from-home consumption uncertain. Data tapes require supplementation by NMFS publications (referenced by Hu, 1985, but citations not provided).

2. **Fish Consumption Survey (1973-1974)** Conducted for the Tuna Research Institute by NPD Research, Inc.

- Population represented - Hu (1985) reported the panel included 26,953 individuals in 7985 households. However, Javitz (1980) indicated the panel consisted of 9590 families, of which 72% were reported to be a representative sample of the U.S. population.

- Sampling technique used - Six thousand-nine hundred and eighty families on a national panel recruited to be representative of the U.S. population over several Bureau of Census definitions including state within census region, in/out of SMSA, family size, number and age of children, race, and age of housewife; plus 2400 families with female head under 35 and 210 black families. These 2610 families were not geographically balanced. Data analyses were done on seafood eaters only; data on noneaters are not retrievable. Javitz (1980) reported 7662 families of the 9590 completed the survey; Hu (1985) reported 7985.

- **Dietary methodology used** - Monthly food records were collected from questionnaires completed by the female head of the household. One-twelfth of the sample was surveyed in each of 12 consecutive months.

- **Aspects of intake measured** - Monthly records of date of purchase, amount prepared for meal, and meals eaten at home or away from home. Records included 135 seafood items.
• **Limitations** - Although the survey code book indicated codes for game fish, data reported are on fish purchases only. (Data tapes do not contain information on game fish.) Data were collected from households rather than individuals and away-from-home consumption data, while collected, are not retrievable. Weighting factors for estimation of per capita consumption were not provided, requiring use of population census information as a weighting factor. Data reported are in terms of per capita intake of seafood users (consumers); nonconsumers are not included. Hu (1985) concluded that estimates made by NPD, Inc. were overestimates of per capita consumption because of the basis used (consumers only).

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   Conducted by the U.S. Department of Agriculture.

• **Population represented** - Nationally representative of the 48 contiguous states.

• **Sampling technique used** - Stratified area probability sample of 48 continental states selected in four consecutive quarters April 1977-March 1978. Four geographical regions and three levels of urbanization were represented in 114 primary sampling units. Interviews were scheduled randomly on all seven days of the week throughout the year.

• **Dietary methodology used** - Household consumption from 7-day food records; individual intake from 1- to 3-day daily intake data (first day, 24-hour recall by personal interview; second and third days by written records).

• **Aspects of intake measured** - For households, purchase and consumption data in pounds per week for 350 seafood items; for individuals, at-home and away-from-home consumption in grams per eating occasion for 450 seafood items, including 350 seafood items plus combinations and mixed dishes (e.g., seafood casserole). Both data collections include cost information. Data weighted for nonresponse and uneven sampling.

• **Limitations** - Household members interviewed and asked to maintain a two-day diary included all individuals less than 20 years of age and over 60 years of age. One-half of the household members
age 20 to 60 were interviewed; no identification of the number of eaters vs. noneaters in households is possible from the data collected; food descriptors were quite general; away-from-home consumption was not recorded; the time period was quite limited (7 days for household food use, 1-3 days of individual food intakes). As pointed out by Hu (1985), the short period of survey is a severe constraint on projection of NFCS data to usual intake of the U.S. population over a year.


- Population represented - Probability sample of U.S. population balanced by sociodemographic characteristics used by Bureau of Census.

- Sampling technique used - Panel of 7500 households (12,000 individuals) selected from MRCA consumer panel cooperators.

- Dietary methodology used - Food diaries included 48 weeks of weekly purchase data and 14 months of monthly household consumption data from 7500 households and 12,000 individuals. At-home and away-from-home consumption is recorded as well as various sociodemographic factors. The purchase records include over 500 individual and combination fish and shellfish entries. This survey was conducted along with a survey of attitudes about seafood. The consumption estimates derived from net edible weight data do exclude waste, bones, skin, etc.

- Limitations - One major limitation has been the availability of MRCA data. Data tapes and tables are available from MRCA only at substantial cost. Within the data used by NMFS from the 1981 survey, errors in weighting factors and in computation of net edible weight consumed per individual appeared to be larger than expected (Hu, 1985). Hu (1985) also observed that calculated weights of fish and shellfish consumed per individual from this survey were lower than the individual consumption figures estimated by the other three surveys or from per capita estimates from annual fishery statistics on production.
B. OTHER DATABASES

There are several national surveys of food disappearance and food consumption by individuals or households. These, and those mentioned above, have been summarized in background material prepared by LSRO (Dr. S.A. Anderson) for a forthcoming report on "Estimation of Exposure/Intake to Substances in the Food Supply." Table 2 provides a synopsis of the characteristics of major databases used for estimating food consumption. In regard to estimation of fish consumption, these databases offer limited information. The NFCS/CSFII series provide information on portion sizes of consumed foods; the CSFII provides some time trend data for the groups surveyed. The Total Diet Study might provide some information on dietary fish as a source of contaminants and/or nutrients monitored in that study. NHANES II dietary intake data are from a single 24-hour recall which may limit their usefulness with a food such as fish where consumption is nonuniform; a food frequency instrument in this survey included a single question on fish consumption.

There are additional sources of information on fish as food that should be noted.

1. Fisheries of the United States

Prepared by NMFS, this document is published annually (Thompson, 1987). It is a source of data on commercial fisheries including saltwater and freshwater commercial catches, exports, imports, and inventories. It provides data on species of fish and shellfish used for food, fish converted to food products, and various other economic and production data. These data further document the recent apparent increase in consumption of fresh, frozen, and canned fish and shellfish by the U.S. population. However, as with all disappearance and production data, the derived per capita estimate (Table 3) does not accurately reflect such factors as wastage, game-fish catches, diversion to nonhuman use, and nonuniformity of consumption by the total population.

2. Economic Research Service, USDA

Data from the Economic Research Service, USDA, provide information on disappearance of various types of foods including fish and seafoods. These data include production, imports, exports, and military use; they are not corrected for nonfood uses such as pet food. Derived primarily from Fisheries of the United States, these data are converted from quantities available in the wholesale marketplace to retail-weight equivalents. These adjustments account for processing, trimming, shrinkage, and marketing losses. As expected, these data do show time trends in total disappearance of fish and shellfish at the retail market level (28% increase in total quantity per capita
<table>
<thead>
<tr>
<th></th>
<th>NFCS Foods Commonly Consumed</th>
<th>NFCS CSFII</th>
<th>NHANES II</th>
<th>MRCA Menu Census</th>
<th>NFID National Eating Trends</th>
<th>Seafood Consumption</th>
<th>USDA ERS</th>
<th>FDA Total Diet Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of data collection</td>
<td>1977-78</td>
<td>1977-78</td>
<td>1976-80</td>
<td>every 5 years</td>
<td>Annual</td>
<td>1973-74</td>
<td>Annual</td>
<td>Annual since 1961</td>
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<tr>
<td>Population surveyed</td>
<td>civilian; free-living; all ages</td>
<td>see NFCS</td>
<td>see NFCS</td>
<td>see NFCS</td>
<td>participants</td>
<td>participants</td>
<td>participants</td>
<td>participants net commodities in U.S. commerce</td>
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<tr>
<td></td>
<td></td>
<td>core &amp; poverty groups of women</td>
<td>free-living;</td>
<td>participants</td>
<td>In consumer survey; all ages</td>
<td>single person households</td>
<td>6 mo to 74 yr</td>
<td>survey; all ages; 11 age-sex groups reported</td>
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<tr>
<td></td>
<td></td>
<td>19-50 yr &amp; their children 1-5 yr</td>
<td>74 yr</td>
<td>11,800</td>
<td>balanced to census by n=34,000 households</td>
<td>excluded</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>4,000 (2,000 households)</td>
<td>balanced to census by household</td>
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<td></td>
<td></td>
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<tr>
<td>Sample design</td>
<td>stratified probability; of households n=34,000</td>
<td>see NFCS</td>
<td>stratified area probability</td>
<td>stratified probability of individuals; n=28,322</td>
<td>probability balanced to census</td>
<td>balanced to census by household</td>
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<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Aggregation of data</td>
<td>intake available for 3 single d and aggregated over 3 d</td>
<td>intake aggregated over 3 d</td>
<td>intake for a single day or aggregated over as many as 6 d</td>
<td>intake for 1 d aggregated over 14 d</td>
<td>intake aggregated over 14 d</td>
<td>Intake aggregated over 1 mo</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Eating circumstances and foods included</td>
<td>all at home &amp; away from home</td>
<td>200 most frequently consumed foods in NFCS</td>
<td>all at home &amp; away from home</td>
<td>all at home &amp; away from home</td>
<td>all at home &amp; away from home</td>
<td>all prepared or consumed at home</td>
<td>seafood; some freshwater</td>
<td>selected commodities</td>
</tr>
<tr>
<td>Drinking water</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
</tbody>
</table>

Table 2. Summary of Characteristics of Major Databases for Estimating Intake of Substances.
**Table 2. Continued**

<table>
<thead>
<tr>
<th>Type of instrument for food intake</th>
<th>NFCS Foods Commonly Consumed</th>
<th>NFCS CSFII</th>
<th>NHANES II Menu Census</th>
<th>NHANES II Eating Trends</th>
<th>Seafood Consumption</th>
<th>USDA ERS</th>
<th>FDA Total Diet Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-d recall &amp; 2-d record</td>
<td>see NFCS</td>
<td>6-d recalls: 1 personal &amp; 3 telephone at 2-mo intervals</td>
<td>single 24-hr recall &amp; food frequency</td>
<td>14-d diary</td>
<td>14-d diary</td>
<td>1-mo record</td>
<td>disappearance of commodities (production A market data)</td>
</tr>
<tr>
<td>Self or proxy reporting</td>
<td>self; proxy for some</td>
<td>self; proxy for child</td>
<td>self (private interview); proxy for child</td>
<td>homemaker reports for all one respondent for household</td>
<td>one respondent for household</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Portion size</td>
<td>estimated by respondent in household reported for 16 age/sex groups</td>
<td>estimated by respondent in household</td>
<td>estimated by respondent with food models</td>
<td>no data collected</td>
<td>no data collected</td>
<td>no data collected</td>
<td>no data collected</td>
</tr>
<tr>
<td>Specificity of identification:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brand name and lot number</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Brand name</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Specific aggregate</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Croad aggregate</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Commodity</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Packaging information</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Preparation method</td>
<td>some</td>
<td>some</td>
<td>some</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Seasonal variability</td>
<td>yes, for population</td>
<td>see NFCS</td>
<td>yes, for confounded with individual location</td>
<td>yes, for population</td>
<td>yes, for population</td>
<td>yes, for population whole year included</td>
<td>yes</td>
</tr>
<tr>
<td>Days of week</td>
<td>all</td>
<td>see NFCS all weekdays only all all all NA -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health data</td>
<td>self-reported ht &amp; wt; diet</td>
<td>self-reported ht &amp; wt; diet</td>
<td>extensive self-reported body wt; diet</td>
<td>no no no NA no</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. NFCS
2. CSFII
3. NHANES II
4. Menu Census
5. Eating Trends
6. Seafood Consumption
7. USDA ERS
8. FDA Total Diet Study
Table 2. Continued

<table>
<thead>
<tr>
<th>NFCS Foods Commonly Consumed</th>
<th>NFCS CSFI</th>
<th>PNAES II</th>
<th>MCEA Menu Census</th>
<th>NPD National Eating Trends</th>
<th>Seafood Consumption</th>
<th>USDA ERP</th>
<th>FDA Total Dietry Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimates possible</td>
<td>single day usual intake/d</td>
<td>single day usual intake/d</td>
<td>single day usual intake/d</td>
<td>single day usual intake/d</td>
<td>single day usual intake/d</td>
<td>per capita availability</td>
<td>usual 13</td>
</tr>
<tr>
<td>Form of estimate</td>
<td>mean frequency &amp; distribution for raw data for total population &amp; eaters only</td>
<td>mean frequency &amp; distribution for raw data for total population &amp; eaters only</td>
<td>mean frequency &amp; distribution for raw data for total population &amp; eaters only</td>
<td>mean frequency &amp; distribution for raw data for total population &amp; eaters only</td>
<td>mean frequency &amp; distribution for raw data for total population &amp; eaters only</td>
<td>mean number of servings; % of individuals using product</td>
<td>population since 1962 mean ± sd; SD</td>
</tr>
<tr>
<td>Units used in database</td>
<td>nutrient consumed/d</td>
<td>nutrient consumed/d</td>
<td>nutrient consumed/d</td>
<td>nutrient consumed/d</td>
<td>nutrient consumed/d</td>
<td>number of times used/14d</td>
<td>serving/mo weight/yr in commerce</td>
</tr>
</tbody>
</table>

From Anderson (1988); see literature cited in this report for references cited in footnotes.

2 Pao et al., 1982.
10 Data are now being collected for new cycles of NFCS and PNAES.
11 Does not exclude spillage, inedible components, plate waste, and use as pet food.
12 Data are available in specific aggregate form. Brand name information is available upon special request.
13 Usual Intake can be estimated by statistical adjustment (i.e., none of the quantitative surveys provide usual intake directly).
14 Group means only.
Table 3. Availability of Commercial Fish and Shellfish per Capita\textsuperscript{1}.

<table>
<thead>
<tr>
<th>Type of Fish and Shellfish</th>
<th>PER CAPITA DISAPPEARANCE (lbs)\textsuperscript{2,3}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1956</td>
</tr>
<tr>
<td>Fresh and frozen</td>
<td>5.7</td>
</tr>
<tr>
<td>Canned</td>
<td>4.0</td>
</tr>
<tr>
<td>Cured</td>
<td>0.7</td>
</tr>
<tr>
<td>Total</td>
<td>10.4</td>
</tr>
</tbody>
</table>

From Thompson (1987).

\textsuperscript{1} Calculated as raw edible meat; that is, excluding viscera, bones, shells, etc. and based on USDA estimate of net edible weight as 70-95\% retail weight.

\textsuperscript{2} Reported as "per capita U.S. consumption" by Thompson (1987).

\textsuperscript{3} These are actually data on commercially caught and imported supplies adjusted for inventories and exports, divided by U.S. population as of July 1st each year.
from 1965 to 1984; see Table 4). These data also support the view that, in general, consumption of fish and fish products by the U.S. population is rising.


The Universal Product Codes (UPC) database contains continuous updates of data on retail sales of products with UPC in 1300 to 1500 grocery stores nationwide. Availability and utility of data on seafood and fish purchases are unknown currently. The UPC database is known to lack specific information on fresh meat and produce and it may be assumed that specific data on fresh fish and seafood purchases are also absent. Further, data on game fish and away-from-home consumption of fish would not be available. Finally, these data are on purchases and not on individual consumption of purchased commodities. Although this source of data will not be useful for estimation of fish consumption, UPC might be a source of information on the range of products available commercially, trends in introduction of new products, and trends in use of products.

4. 1985 National Survey of Fishing, Hunting, and Wildlife Associated Recreation

The Fish and Wildlife Service, U.S. Department of the Interior, with assistance of the Bureau of the Census has conducted the National Survey of Fishing, Hunting, and Wildlife Associated Recreation every 5 years since 1955. The 1980 Survey has been published (1982) and the 1985 Survey will be published in 1988. The surveys provide data on various demographic characteristics of individuals who hunt, fish, hunt and fish, or undertake nonconsumptive wildlife recreational activities (e.g., photography). The surveys involve an initial telephone survey of households to determine who in the household hunts, fishes, or engages in related activities. A follow-up questionnaire and interview are used with a subsample selected from the first population sample. Data from the 1980 and 1985 Surveys made available to LSRO include numbers of fishermen in regions of the United States, days per year fishing, expenditures per year for fishing, types of fish caught, and similar data on certain demographic characteristics categorized by individual states.

Reports of the several surveys (1955-1985) contain no data on number or poundage of fish caught recreationally or on percentage of catch consumed. Efforts to obtain data on quantities of recreationally caught fish have been underway since 1979 but were not included in the 1985 National Survey.
Table 4. Per Capita Disappearance of Fish and Shellfish Marketed in the United States.

<table>
<thead>
<tr>
<th>Type of Fish and Shellfish</th>
<th>1965</th>
<th>1975</th>
<th>1984</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh and frozen</td>
<td>6.0</td>
<td>7.5</td>
<td>8.3</td>
</tr>
<tr>
<td>Canned</td>
<td>4.3</td>
<td>4.3</td>
<td>5.0</td>
</tr>
<tr>
<td>Cured</td>
<td>0.5</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Total</td>
<td>10.8</td>
<td>12.2</td>
<td>13.6</td>
</tr>
</tbody>
</table>

From Bunch (1985), see text for explanation.

1 Finfish edible weight equal to 45% live weight; shellfish edible weight based on meat-equivalent basis.

2 Most recent year for which figures are available.
C. UTILITY OF AVAILABLE DATA

Data from the four sources identified in Table 1 have been used to estimate fish consumption and to derive risk estimates that require consideration of fish consumption (Hu, 1985; Javitz, 1980; U.S. Department of Commerce, 1987). Major limitations of these four surveys include their relative age (all were completed 7 to 17 years ago), the absence of a uniform classification of the species of fish and of a list of fish products eaten as food that were included in the survey questionnaires or interviews, the lack of data on consumption of recreationally obtained fish (saltwater and freshwater catches), and the overall lack of detailed data collected on consumption by individuals.

In addition to the limitations noted above, the issue of data collection methodology constrains the utility of these surveys in deriving estimates of usual intake. For example, Hu (1985) noted that even after correction of weighting factors for net edible weights, the calculated weight consumed per individual in the 1981 National Seafood Consumption Survey was considerably smaller than the consumption figures estimated in the three other surveys (observed estimates had a ratio of about 1:2). This one-fold difference in mean quantity consumed per individual is probably related to the definition of what was consumed as fish; however, the existence of this now uncorrectable difference compromises the use of all four data sets as a baseline value for usual intake.

In regard to use of these surveys for risk assessment purposes, the techniques by which individual consumption data were quantified would be expected to introduce additional error terms. That is, except for the USDA Nationwide Food Consumption Survey, household food records or diaries were used. Individual intakes were derived from these and other data on household demographics. Quantities consumed by individuals were calculated subsequently using imputed data on portion sizes from USDA data. The USDA Nationwide Food Consumption Survey did collect both household and individual data from 24-hour recalls for day one and food records for days two and three. Thus, the surveys conducted over the longest periods of time have individual consumption data derived from household purchase and consumption data; the only survey collecting actual individual fish consumption data (NFCS), has a limited period of data collection and a limited set of food descriptors for fish. As with other topics related to risk assessment, these surveys, while extensive, did not, or could not, collect data on fish consumption that would be sufficiently detailed to meet the needs of risk assessment and evaluation of diet/health relationships.

Among the other databases, the ERS/USDA and Fisheries of the U.S. both document production and marketplace disappearance information that confirms the trend of increasing per capita
consumption of fish between 1956 and 1986. These data collections also document a trend of increasing demand and retail price. However, they do not address issues of increased consumption by certain consumers as contrasted with increased consumption by the total population. Nevertheless, the increases in per capita fish consumption suggest usual intake by the total population may be increasing. Indeed, these surveys provide marketplace disappearance data that could be used to identify geographic areas of high levels of fish disappearance, and thus, presumably, consumption. While they provide little or no information on extent of or quantities consumed by preferential eaters, taken together, these facts provide further justification for reexamination of the patterns of fish consumption by the total population and by preferential consumers for both assessing diet/health relationships and performing risk assessment studies.

The other databases noted in Table 2 contain some data on fish production, disappearance, and consumption. However, none of these surveys were designed to obtain estimates of usual intake or heavy fish consumption by the U.S. population or a special population group. For these reasons, these sources have only limited value in determining diet/health relationships and performing risk assessments associated with fish consumption. However, they may be useful, for comparative purposes, in examining the estimates derived from future efforts to estimate usual or preferentially high consumption of fish.

In summary, the primary sources of information on fish consumption patterns of the U.S. population are dated, have deficiencies in terms of reliability of estimates of intakes of individuals, and are inadequate in terms of describing the range of consumption (e.g., eaters vs. noneaters, preferentially high eaters, etc.). In addition, they lack information on recreationally caught and consumed fish species, extent of away-from-home consumption, detailed description of species eaten (and its geographic source), and detailed data on either total absence of consumption (one distinct population subset) or preferential or heavy consumption (another distinct population group). However, production and national disappearance data collected over the past decade suggest an upward trend in per capita consumption. For these reasons, there is a need for more recent and more detailed information on patterns of fish consumption in the United States to address issues relating fish consumption to health and safety. Reasoned judgment suggests these needs will require collection of additional data, either by expansion of currently planned nutrition surveys or by focused efforts to obtain such data from surveys on fish consumption.
IV. METHODOLOGICAL CONSIDERATIONS IMPORTANT IN ESTIMATING FISH CONSUMPTION

This and subsequent sections of this report, are predicated on the conclusion that currently available databases are inadequate in terms of FDA’s needs for data on fish consumption as a component of the agency’s programs that monitor diet/health relationships and assess risks of adverse health effects. Further, this report assumes that additional efforts will be made to develop strategies to collect information on usual fish consumption and preferentially high fish consumption of the U.S. population and special subsets of the U.S. population.

This section presents a brief introduction to various approaches to collecting data on fish consumption, followed by comments on strengths and weaknesses of each approach in regard to its use with a total population sample or a special population sample (e.g., heavy eaters) for purposes of evaluating diet/health relationships and assessing risks.

Regardless of the intended use of an estimate of fish consumption, two considerations are important in using available data or in designing approaches to collecting data. These are the methodology used to collect data on fish consumption and the population sampling techniques. The former is perhaps more complex because the dietary data collection method selected would depend on both the population surveyed and the purpose for deriving the estimate. The latter consideration is less critical in surveys of the total population because there are other national surveys that provide a basis for comparison of representativeness. Population sampling techniques become a more important consideration in surveying population subsets that preferentially consume fish because representativeness is an important aspect of such surveys.

A. COMMONLY USED FOOD CONSUMPTION METHODOLOGIES

Conceptually, there are several ways to estimate food consumption. Indirect approaches collect data on food disappearance into marketing channels or households; direct approaches collect data on actual food use or food consumed by a variety of methods. Indirect methods do not use the individual as the unit of observation whereas direct methods usually use a household or individual intakes as the variable measured. The most frequently used approaches are summarized in Table 5.
<table>
<thead>
<tr>
<th>Method</th>
<th>Respondent Literacy Required</th>
<th>Data Validity Ranking&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Suitability of Approach for Large Scale Studies&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Suitability of Approach for Small Scale Studies&lt;sup&gt;3&lt;/sup&gt;</th>
<th>Individual Consumption Data Provided</th>
<th>Respondent Burden</th>
<th>Field Staff Burden Cost</th>
<th>Processing Dietary Data</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>National food disappearance</td>
<td>No</td>
<td>6</td>
<td>Suitable</td>
<td>Unsuitable</td>
<td>No</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Crude estimate of consumption from disappearance data; waste, non-eaters, nonpurchased foods not usually considered.</td>
</tr>
<tr>
<td>Household food disappearance</td>
<td>Yes</td>
<td>5</td>
<td>Suitable</td>
<td>Suitable</td>
<td>No</td>
<td>Heavy</td>
<td>Heavy</td>
<td>Heavy&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Usually not corrected for waste; not applicable to household occupants unless age, sex data collected; even then estimates of individual intakes are derived indirectly. Participation of head of household needed.</td>
</tr>
<tr>
<td>Food diaries or records</td>
<td>Yes</td>
<td>3</td>
<td>Suitable</td>
<td>Suitable</td>
<td>Yes</td>
<td>Heavy</td>
<td>Medium; home visits and instruction</td>
<td>Heavy&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Record keeping may cause subject to eat differently. One of the more reliable methods especially when carried out over 7 days. Literate participants or enumerators necessary.</td>
</tr>
<tr>
<td>Weighed Intake</td>
<td>Yes</td>
<td>2</td>
<td>Unsuitable</td>
<td>Suitable</td>
<td>Yes</td>
<td>Heavy</td>
<td>Heavy; home visits</td>
<td>Heavy&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Same as food diaries. Experience with food balances necessary.</td>
</tr>
<tr>
<td>Dietary recall</td>
<td>No</td>
<td>3</td>
<td>Suitable</td>
<td>Suitable</td>
<td>Yes</td>
<td>Light</td>
<td>Heavy; individual interviews</td>
<td>Heavy&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Honesty and memory of subject critical; skill of interviewer important factor; 24-hour recall good response rate; response rate typically declines upon repeated interviews.</td>
</tr>
</tbody>
</table>
Table 5. Continued.

<table>
<thead>
<tr>
<th>Method</th>
<th>Respondent Literacy Required</th>
<th>Data Validity Ranking</th>
<th>Suitability of Approach for Large Scale Studies¹</th>
<th>Individual Consumption Data Provided</th>
<th>Respondent Burden Cost</th>
<th>Field Staff Processing Dietary Data</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food frequency</td>
<td>No</td>
<td>3</td>
<td>Suitable</td>
<td>Suitable</td>
<td>Yes</td>
<td>Medium</td>
<td>Heavy¹</td>
</tr>
<tr>
<td>Duplicate portion</td>
<td>No</td>
<td>1</td>
<td>Unsuitable</td>
<td>Suitable</td>
<td>Yes</td>
<td>Heavy</td>
<td>None</td>
</tr>
</tbody>
</table>


¹ Validity; how closely method measures daily intake (1 = most valid; 6 = least valid).
² Large scale - representative of entire population.
³ Small scale - representative of individuals or groups of individuals including households.
⁴ Computerized analysis will greatly facilitate staff burden.
1. Indirect Methods

These techniques develop data on foods disappearing from marketing channels or purchased for consumption. Actual individual intakes or quantification of individual intakes per eating occasion are not measured. Estimates of per capita disappearance are often derived by using some population estimate as a divisor. Such estimates provide a mean or median value for per capita disappearance. Unfortunately, per capita disappearance is often equated with per capita consumption.

a. National Disappearance Data

Disappearance of a food divided by the number of consumers yields an estimate of mean per capita food available for consumption. Disappearance data are useful in monitoring time trends and in checking estimates derived by other methods. However, per capita consumption derived from national disappearance data is actually an estimate of food available for consumption and can be expected to exceed mean consumption estimates from more direct methods.

There are multiple sources of data on fish as a commodity entering the marketplace. These include Fisheries of the United States, possibly Universal Product Code summaries, or other disappearance surveys (e.g., ERS/USDA data) at the retail level. However, national or marketplace disappearance data do not present a complete view of sources of fish consumed as food; for example, recreationally obtained fish used as food are not included. Because of the many sociodemographic factors that influence fish consumption patterns, use of the total population as a denominator is misleading. That is, disappearance data do not include production losses or wastage, noncommercial sources of fish used as food, and do not take into account eaters vs. non-eaters, frequency of consumption, or intake distributions. In addition, national disappearance data are geared to commodity identification for marketing purposes; they may or may not adequately reflect the sources or types of products consumed for purposes of identifying specific intake/health relationships or risks.

Despite these drawbacks, national disappearance data have been used for many years to estimate per capita disappearance (Bunch, 1985). These estimates are useful in that they provide a benchmark against which usual intake of the total population can be compared. In this case, national disappearance data provide an approach, albeit an epidemiologically weak one, to assess trends in diet/health relationships within or among the population of a country or several countries over prolonged time periods. Further, national disappearance data are useful in comparisons of trends of health outcomes among countries where such data are available; however, observation of such associative trends provides little information on risks to the populations.
National disappearance data provide little information for consumption/health outcomes analysis or risk assessments for subsets of the total population because these data do not include information on consumers other than the projected mean or median intake of the total population. Calculation of the range of intakes from national disappearance data requires use of other data sources (e.g., estimates of the number of eaters, estimates of the upper range of consumption of eaters, portion size, etc.). These aspects of deriving estimates from multiple data sources enlarge variance and errors, resulting in compromised reliability of the derived estimates.

For these reasons, national disappearance data have some utility in estimating trends in diet and health relationships in large populations. Their value in risk assessment and in assessing the influence of fish consumption on health or safety in special population subsets is quite limited.

b. Household Disappearance Data

This indirect approach is based on the assumption that household food disappearance data are more useful than marketplace data because the data collected are closer to, and thus more reflective of, actual consumption. Estimation of household or individual household member food consumption patterns requires knowledge of household characteristics (e.g., age and sex of occupants, number of meals consumed by persons in the household, etc.) and cooperation of the household head or food preparer. Typically, household disappearance data are collected by use of consumer panels or from grocery purchase data. In either technique, individual intake data are not collected and disappearance or purchase is equated with consumption.

Household disappearance and household characteristics data are useful in determining patterns of dietary intakes over time and do provide a more valid estimate of per capita intake than national disappearance data. For this reason, these types of data have been used to estimate usual intakes of various foods by samples of the total population. In instances where demographic data are obtained, for example, household characteristics, it may be possible to project usual intakes by various demographic variables. For example, the National Seafood Consumption Survey (1981) collected fish purchase by food diaries but also obtained data on consumption directly. While purchases were equated with disappearance via consumption, collection of other data (e.g., away-from-home consumption), and application of correction factors (e.g., net edible weight) provided a basis for making estimates of usual intake by individuals. However, in most household disappearance surveys, the data are not corrected for preparation and plate wastage. Similarly, most household disappearance data do not reflect away-from-home consumption or nonpurchased consumed fish.
The absence of actual intake data by individuals and the lack of quantification of actual intake per eating occasion compromise the usefulness of these data in developing reliable estimates of the range of intakes by individuals or the exposures of individuals to substances of interest. If efforts were directed to develop a future survey based on household disappearance data, consideration should be given to the generally accepted conclusion that the relative utility of data collected by either indirect method is lower than that of data collected directly from individuals (Table 5).

2. Direct Methods

As a group, direct methods collect data from households or individuals (usually the latter) on quantities of foods actually consumed per eating occasion or frequency of consumption of specific foods. For example, the 1977-1978 NFCS (discussed in Section III) used direct methods (dietary records and dietary recall) to obtain data on consumption of designated foods. The discussions presented below are oriented to strengths and weaknesses of several direct methods that might be used in the future to obtain data on fish consumption. Thus, their respective inclusion in any strategies for obtaining such data would require more detailed consideration and evaluation prior to their incorporation into any survey of fish consumption.

It should be noted that as a group, direct methods of collecting data on intakes are more resource-intensive than indirect methods. However, the validity of the data is greater in terms of reliability of estimates of usual or actual intake by individuals. The relative importance of obtaining data on actual fish intake from individuals versus the costs of collecting these data is a major decision point that should be considered early in the development of protocols for evaluating either usual or preferential intakes of fish regardless of the purpose for deriving the estimate of fish consumption.

Anderson (1986) summarized the attributes and limitations of direct approaches to quantification of daily consumption by individuals and estimation of the frequency of eating specific foods (Table 6). These attributes and limitations should be considered in developing protocols for estimation of usual intake of fish and estimation of consumption by special subgroups whatever the reason for making the estimates.

However, several direct methods of measuring the consumption patterns of individuals have limited usefulness in assessing usual or preferentially high consumption of fish because they are sufficiently labor- and resource-intensive to obviate their use in both a total population sample or a special
Table 6. Characteristics of Dietary Intake Methodology.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Quantitative Daily Consumption Methods</th>
<th>Food Frequency Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation Unit</td>
<td>Individual record of actual food consumption in a day or recall of food consumption during the previous 24 hours</td>
<td>Individual recall of usual dietary pattern during the target period of time</td>
</tr>
<tr>
<td>Parameter Estimated</td>
<td>Actual intake; may approximate usual intake if number of replicates is sufficient</td>
<td>Usual intake</td>
</tr>
<tr>
<td>Estimation Method</td>
<td>True mean intake of a dietary factor for an individual is estimated from a number of individual measurements</td>
<td>True mean intake by an individual is estimated directly</td>
</tr>
<tr>
<td>Usual Timespan Targeted</td>
<td>Shorter interval</td>
<td>Longer interval</td>
</tr>
<tr>
<td>Relative Accuracy of Data for Specific Days</td>
<td>More accurate</td>
<td>Less accurate</td>
</tr>
<tr>
<td>Meaningful Absolute Value</td>
<td>Yes</td>
<td>Less absolute</td>
</tr>
<tr>
<td>Preserving Rank Order</td>
<td>Yes, if a large number of replicates is used</td>
<td>Maybe</td>
</tr>
<tr>
<td>Problems Caused by Intraindividual Variation</td>
<td>Yes</td>
<td>Less serious</td>
</tr>
<tr>
<td>Seasonal Variation Taken into Account</td>
<td>Yes, if replicates are collected in different seasons</td>
<td>Yes, if designed properly</td>
</tr>
<tr>
<td>Inclusion of Infrequently Consumed Foods</td>
<td>Likely to miss if the number of replicates is small</td>
<td>Likely to include if list includes particular food(s)</td>
</tr>
<tr>
<td>Relative Feasibility</td>
<td>More difficult if a large number of measurements is needed</td>
<td>Easier</td>
</tr>
<tr>
<td>Major Problems</td>
<td>Intraindividual variability and inadequate number of measurements</td>
<td>Inaccuracy of estimates of intake</td>
</tr>
</tbody>
</table>

From Anderson (1986).
population sample sufficiently large for purposes of statistical validity. These include the following techniques that are not discussed subsequently:

- Weighed intake food records
- Duplicate portion studies.

The former might be used with consumer panels; weighed intake food records resolve problems of preparation and plate wastage but require additional motivation and cooperation of the participants over extended time periods. The latter is essentially a research investigation methodology and would be cost-prohibitive outside a laboratory setting.

Those direct methods which may have utility in collecting data on usual fish consumption of individuals representative of the total U.S. population or subsets thereof include the following:

a. **Food Diaries or Records**

   This technique relies on the individual or a reporter maintaining records of actual food intake over defined time periods such as 7 days, 14 days, 1 month, etc. When food records are kept for multiple days, the technique can provide reliable data on patterns of food intake. This approach requires literacy, motivation, and cooperation on the part of participants. A number of commercial organizations maintain consumer panels who complete food records for specific purposes. As noted above, in some instances these panels are able to maintain purchase diaries and food consumption records; for example, the Market Research Corporation of America (National Seafood Consumption Survey, 1981). Although actual intake records would be preferable to purchase data, the use of panels collecting purchase and/or household consumption data is often justified because of the cost of data collection.

b. **Dietary Recall**

   This technique is used widely as the method of choice for assessing actual food intake by individuals. Typically, the subject is asked to identify each meal component or food eaten at each meal and between meals for a specified time period. In addition, quantities of foods consumed can be derived from either recall using models of portion sizes or can be imputed from other data. Listing of foods results in a record of what the individual ate. Because dietary recall is dependent on subject memory, with or without prompting, the actual instruments used to collect data must be constructed carefully. The unit of observation used most widely is recall of food intake during the previous 24-hour period. In regard to estimating fish intake, dietary recall as an approach would require careful attention to instrument probes related to species consumed and to data collection over extended periods of time.
c. Food Frequency Data

This approach to collection of individual consumption data is often used when information on food consumption over longer time periods is desired. Usual portion size may or may not be indicated. If not indicated, it is usually imputed from some acceptable sources such as the NFCS data. Subjects are asked to respond to questions or prompted to indicate the number of times a food is consumed per week, per month, or per longer time periods. Food frequency methods are less precise in terms of quantities consumed per eating occasion than recall methods, but do provide a method to obtain data on food items eaten infrequently or irregularly over an extended time period.

B. SPECIAL CONSIDERATIONS IN APPLICATION OF DIRECT METHODS

The two approaches to collection of dietary intake identified in Table 6 usually have, for the most part, the intake of individuals as the unit of observation. Analogous data could be collected on households or families as the unit of observation. However, such an approach to determining usual daily fish consumption would require assumptions and cooperation of subjects to such an extent that collection of data on individual intakes would be equally or more efficient. For example, portion sizes for family members of varying age would need to be imputed; presence of guests and absence of family members would need to be known; and someone would need to record away-from-home consumption of fish for each member of the household. Thus, collection of data on dietary intakes of fish by individuals appears to be the more appropriate approach.

When applied to estimation of fish consumption of individuals, quantitative daily consumption methods (food records, diaries, and dietary recall) and food frequency methods each have inherent advantages and disadvantages in regard to usual or preferential fish consumption. Several of these attributes are related to the methods themselves (see Table 6) but more specifically, are related to their use in estimating consumption of a food such as fish which has unique attributes (see Section II-A).

1. Quantification Versus Frequency of Consumption

Quantitative daily consumption methods would provide information on eaters versus noneaters; number of eating occasions both at home and away-from-home; amounts consumed per eating occasion; and, if repeated or replicated sufficiently, patterns of consumption over extended periods.
Use of food records or diaries requires subject literacy. Keeping records in and of itself is known to affect dietary practices. Consequently, changes in motivation of subject as well as changes within food records over the data collection period could arise and the survey design should reflect an ability to analyze this factor. Food records or diaries would be an efficient method to obtain data on away-from-home meals that included fish or fish products. Where consumer panels are used to maintain food records, incentives for timely completion and submission may be necessary. If consumer panels are used, consistency of panel members would be preferred because demographic variables (e.g., region, season, income, etc.) are known to affect fish consumption.

Single-day 24-hour recalls by individuals could be used to estimate mean intakes of population groups if the subject population were large enough and the survey days were distributed throughout the year. The use of recall methods would also capture information on location of fish consumption such as away-from-home eating occasions. Data collection of this type does not require subject literacy and is amenable to telephone survey techniques. Collection of dietary recall data for multiple days would be more labor-intensive for interviewers and would require continued cooperation of subjects but would involve less work for subjects than multiple-day food records. Techniques which might be used to collect multiple day recalls include telephone surveys and follow-up calls, personal interviews, and combinations of the two.

However, in the case of fish consumption, the period of data collection becomes a paramount issue. Previous studies (Hu, 1985; Pao et al., 1982) have shown that fish consumption is non-uniform in terms of number of eaters in a population, frequency of consumption over time, and mean intake per eating occasion. One facet of the nonuniformity is the probable substitution of fish, poultry, red meat, pork, and other protein sources for one another over a series of days. Coupled with the previously identified but possibly changing seasonal influence, quantitative daily consumption methods would need to be continued over extended time periods. For example, several previous surveys, such as the Consumer Panel Survey (1969-1970) collected data over periods of one month from different households throughout the year. While food frequency questionnaires can be used over extended time periods more easily, they typically lack detailed data on aspects of consumption.

As noted by Anderson (1986), intraindividual variation is greater for intake of specific foods and food groups than for nutrients and/or calories. Additionally, intraindividual variation is much larger than interindividual variation in intake of specific foods (Beaton, 1982; Sempos et al., 1985, 1986). Therefore, single-day data would not be very useful for estimating an individual's usual fish consumption because most data indicate the pattern of fish use is nonuniform within individuals.
Single-day data might suffice for estimates of group mean intakes of fish and fish products if sample size were sufficiently large. The precision of the estimate could be improved by increasing the sample size or the number of days of data collection. It follows also that variability of intake of fish in a population would be overestimated by single-day data. Thus, multiple day data collection, spread out to accommodate possible seasonal influences would need to be incorporated in a survey design using a food recall technique.

Food frequency methods are generally the method of choice for recall of food intakes over extended time periods such as several weeks or one year. These methods are also used to estimate current and past intake by a series of probing questions. Food frequency methods typically involve questionnaires completed by trained interviewers or by the subjects themselves. The advantages of food frequency methods include covering longer time periods, the likelihood of eliciting information on patterns of food consumption, the increased potential for obtaining data on infrequently consumed foods, and the relatively lower resource requirements. Estimation of usual fish consumption would probably be best obtained by some food frequency method because use of these methods would permit representation of the apparent nonuniform consumption of fish over longer periods of time at a relatively lower resource requirement than quantitative daily measures of consumption for single or multiple days. However, these advantages may be offset in part by certain limitations such as reliance on subject memories, need for focused questions in the instrument, and the need for reliability of the instrument itself or the questioner. If the frequency questionnaire were to cover only fish consumption, there is the possible introduction of biased recall. The primary deficiency of food frequency methods is their inability to provide accurate data on quantities consumed.

Thus, the quantification of individual intake versus determination of frequency of eating by individuals is a critical issue that depends primarily on the purposes for which the data are to be used and the resources available for data collection. Quantitative daily consumption data provide a basis for determining mean and 90th centile values for intakes of the population surveyed. Distribution of intakes over time and sociodemographic variables can be obtained if the time period is sufficient, population size is adequate, and necessary replication is included in the design. Such an approach could provide data on consumption patterns for both assessing diet/health relationships and risks; however, the cost and resource utilization would be high. (Actual cost would depend on what the survey design and protocol included.) Food frequency methods are less costly in terms of time, effort, and resources; however, they would provide only a very limited basis for estimation of the quantitative aspects of intake distribution among individuals surveyed.
For monitoring diet/health relationships, data on usual intakes from food frequency probes would be adequate, but quantative daily consumption data would be more useful because the data could also be used for other purposes. For assessment of risks associated with consumption of fish or a particular type of fish product, identification of eaters and the quantities eaten would be essential. Such data are best obtained from quantative daily consumption methods but would be more costly.

2. Sources and Types of Products Consumed

As noted in Section III, previous surveys of fish consumption used species and product identifiers of varying complexity. In her review of these data, Hu (1985) condensed the major types of finfish eaten to 15 common species but excluded those primarily used as canned fish. A more complete list of finfish species and types used for food in the United States is provided by the USDA in its monograph series on composition of foods (Exler, 1987). Data on raw and processed types used for food include 78 species of finfish and 19 species of shellfish. However, the exact identity of products consumed can be an issue. For example, Exler (1987) lists four species of crab, but includes "imitation crab" as a type of Alaskan king crab.

The presence or absence of processing and preparation further complicates identity of sources. Fish may be fresh, frozen, or processed. The manner of processing and preparation is a further complicating aspect. For example, canned tuna may be dry-packed, canned in water, or canned in oil. Similarly, other species processed for retail purchase or away-from-home consumption can be frozen, dried, smoked, breaded, floured, steamed, fried, or otherwise prepared.

The point of the above discussion of identity of the commodities actually consumed is that fish as a generic food includes a wide diversity of fresh- and saltwater species of finfish and shellfish. Information on species eaten may be available for fish purchased at retail outlets or recreationally caught; however, identity of species used in mixtures such as chowders or stews and in prepared products such as fishsticks may be information unknown to the preparer or consumer. Furthermore, fish and fish products eaten away from home might be identified through recall of menu information but menus may or may not identify the species of fish served. Anecdotal information received by LSRO suggests major fast food chains each use only one or few sources of fish for fillet sandwiches or fried fish. For example, one chain reportedly purchases only whitefish species caught commercially by Canadian fishermen who fish the Northern Atlantic Ocean.
In essence, the issue of sources and types of fish actually consumed becomes a complex aspect of instruments that might be employed to obtain intake information from individuals. Food diaries or records would need to include entries or clues as to the detail required. Food frequency questionnaires could need a prolonged series of probing questions if exact information on sources and types of fish is sought. These considerations are more important in instances where specific information on consumption is desired, such as risk assessments where one or more sources of types of fish are of interest. For diet/health relationships, a condensed list, such as that constructed by Hu (1985) could be used as a means to reduce costs and time for data collection. Such an approach, using a panel recording food (including fish) consumption or a food frequency instrument with a condensed list of finfish species (Hu, 1985) could be used to obtain data on sources and types of products consumed and an estimate of total consumption of the population. Such data might further define demographic similarities and differences when unique or single sources of fish were known, would be useful in market and economic comparisons, and would provide useful background data should risk assessment studies be called for subsequently on one of the unique demographic subgroups. A quantitative daily consumption method (records or recalls) would also provide data on usual intake as well as distribution of intakes. If the concern were risk of exposure to a toxicant in many finfish species, a food record or dietary recall approach with a condensed list of sources could provide useful information. If the concern were only certain species of finfish, the data collection instrument with a condensed list such as that constructed by Hu (1985) would not be sufficiently precise for the purposes of the collection.

Thus, as with quantification versus frequency, the extent of inclusion of details on sources and types of fish products consumed depends upon the purposes for which the data are collected. In addition, the complexity or length of the collection instrument would be a factor to be considered in the approach to be taken in data collection.

3. Other Unique Characteristics of Fish Consumption

Several of these characteristics have been mentioned previously. As a group, they are factors that relate to the apparent nonuniformity of fish consumption in terms of sociodemographic, geographic location, and time of fish consumption. These factors can be expected to influence estimation of usual intakes and distribution of intakes in any population sampled. Thus, their consideration in developing the survey design and in determining methods of collecting consumption data is important. How these factors affect the survey design and methods of data collection will, in turn, introduce limits to interpretations of such data; that is, the purposes for which the data were being obtained. The following paragraphs illustrate these several unique characteristics:
a. Sociodemographic Factors

Data collected in the 1973-1974 Fish Consumption Survey and the 1981 National Seafood Consumption Survey indicate that any future effort to estimate fish consumption will need to consider identifying demographic variables common to national surveys of food consumption that are also considered important in terms of variables in fish consumption. The following variables have been identified as factors that influence usual intakes and patterns of intake:

- Age
- Community type
- Educational level of head of household or respondent
- Ethnic origin or race
- Family size and composition, including age and sex
- Geographic region
- Income
- Occupation of head of household
- Religion
- Season of the year
- Sex

Clearly, this number of factors will impact on the complexity of a food record sheet, the length of a food recall interview, or the detail of a food frequency questionnaire. The trade-offs of data collection instrument will be related to the purposes of data collection.

Within the above list, several items are unique in regard to fish consumption. Previous surveys have established geographic differences in patterns of usual intake of fish and shellfish (see Hu, 1985). For purposes of usual intake by the total population, geographic regions used in major national surveys (e.g., NFCS, NHANES) would be acceptable. However, where the need for risk assessment is related to a specific region, such as the lower Mississippi River, Minnesota lakes, etc., the use of major geographic regions (e.g., southern central U.S., northern central U.S.) would be less meaningful. A data collection instrument for a total population survey might use a standard geographic determination question; one designed for a specific area would not need such data. However, the ability to relate the latter to the former in different data sets would be a function of how detailed the geographic identification was in the total population survey.

Previous surveys have also established patterns of seasonal consumption between geographic regions (see Hu, 1985). Presumably, this influence extends beyond usual intake estimates to estimates of preferential eaters. However, this presumption would require documentation if it were to impact on selection of a data collection approach.
b. Consumers of Recreationally Caught Fish

While recreational fishermen are a distinct population, they and their families may include nonconsumers, preferential consumers who consume fish more frequently and/or in larger quantities, or consumers who are analogous to the U.S. population but whose only difference is a unique source for obtaining fish. Within this special group, several subgroups may be predicted such as tidal and marine fishermen, fresh water fishermen and a further subset of lake, river, farm pond, or stream fishermen. Further, the demographic variables noted previously can be expected to occur within this unique group. It would be necessary to give consideration to all these aspects in designing the approach to data collection methods because of the complexity of these factors.

To date, no survey has adequately reflected this population, although the number of recreational fishermen is relatively well known (U.S. Department of the Interior, 1982). The NMFS is reported to have explored the feasibility of surveying the consumption of recreationally obtained fish in one or more pilot studies within several states. The current status of these studies is unknown as a recently developed proposal has not been funded (Food Chemical News, 1988).

Thompson (1987) states that since 1970 consumption of recreationally caught fin and shellfish has been estimated at 3 to 4 lbs (edible meat) per capita per annum for the total population. The source for this widely quoted and often used estimate has not been documented by LSRO. Further documentation of the validity of this estimate should be considered in any future efforts to estimate usual intake as well as consumption by eaters only. Again, these needs would influence the data collection methodology used.

c. Other Unique Subgroups

The number of subgroups is potentially large but unpredictable except from experiential data or previous problems. In addition to those noted above, other unique subgroups might include the following:

- persons who obtain fish outside regular commercial channels;
- persons who obtain, purchase, or catch one or more species in a specific location such as Potomac River perch, Mississippi River catfish, Lake Michigan sturgeon, New England clams, etc.;
- persons who preferentially consume certain fish or fish products, such as sushi, gefilte fish, etc.
This consideration is more important in risk assessment where those population subgroups who may be affected by some contaminant or potentially toxic substance within the fish consumed need to be delineated. However, existence of such population groups could influence estimation of usual intakes of fish. In the former situation, use of a quantitative daily consumption method would be necessary; in the case of estimation of usual intakes, the sample population size would be more critical than the data collection approach.

d. Geographic Origin of Species Consumed

This aspect of fish consumption is probably more important to estimation of preferential eaters for risk assessment purposes. Thus the method of obtaining consumption data would need additional probes to determine geographic origin. The complexity of marketing channels and fish distribution to points of purchase in the U.S. suggests that it would be very difficult to obtain this type of information directly from consumers. This presumption should be tested prior to the elimination of any probe to determine the geographic origin of fish consumed by individuals.

In summary, previous surveys of fish consumption and indeed, other efforts to obtain data on intake of foods, indicate that these unique aspects of fish consumption will impact on the approach taken to the collection of individual consumption data. Again, the purposes for which the consumption data are collected are a paramount issue. In regard to fish consumption, several of these are clearly important and additional study would be required to determine their individual, collective, and interactive roles. Such studies would need to be undertaken prior to development of protocols for estimation of usual intake of the total population and/or excessive intakes of preferential consumers.

C. POPULATION SAMPLING TECHNIQUES

Conceptually, the representativeness of the population sample, its demographic characteristics and other attributes are important considerations in selecting the population to be sampled. In the case of fish consumption there are two purposes: 1) determination of usual intake by the total population or a subset; and, 2) estimation of possible high intakes within the total population or by individuals who are preferential consumers.

Design of population surveys and sampling techniques for events and populations that are nonuniform or infrequent presents statistical issues which result in an additional series of trade-offs (Kalton and Anderson, 1986; Sudman et al., 1988). In regard to estimation of usual intake of fish, sampling of the total population using techniques exemplified by those of
the Bureau of the Census would seem appropriate. However, the occurrence of heavy or preferential fish consumers in any total population sample can be expected to be nonuniformly distributed. Thus, a decision must be made as to whether the total sample should be enlarged or whether preferential eaters should be oversampled wherever found. The former approach would estimate usual intake but would provide limited data on preferential or heavy consumers. The latter approach would possibly skew estimates of usual intake by the total population, but would provide additional data on consumption by a subgroup of preferential eaters. Whether the same population sample might serve both purposes becomes a matter of evaluating trade-offs associated with resources available to support data collection from one larger sample versus two or more population samples. (This subject is discussed in Section VII-B.)

1. Selection of a Nationally Representative Sample

The most widely used methods of selecting nationally representative samples of the total U.S. population are based on the design for the national samples for either the Current Population Survey (CPS) or the Decennial Census (DC). Both designs are closely related and have been standardized by the Bureau of the Census. The geographic and sociodemographic data derived from these sources are also widely used. For example, the NCHS National Health Interview Survey (NHIS) has utilized the survey design of CPS since 1957 and draws its samples, as well as stratification and clustering strategies from the primary sampling units defined by the CPS. Similarly, the NFCS survey design as well as the NPD, Inc. and MRCA consumer panels are designed to emulate the distributions of various factors (e.g., household composition, income, geographic location, etc.) found in the Decennial Census.

The nationally representative samples developed by the Bureau of the Census and NCHS are based upon relatively well defined primary sampling units (PSUs) (NCHS, 1985b). Repeated use of the PSUs provides a basis for stratification by various geographic, economic, and demographic characteristics which can be examined each time strata are constructed. Thus, representative PSUs can be selected on the basis of known characteristics (e.g., sex, age, geography, etc.) and utilized in sample stratification. Further, the standardization of sampling by PSUs and the stratification of PSUs provide a basis for selection of ultimate sampling units. For example, in the NHIS, where subject interviews are the method of data collection, ultimate sampling units within PSUs are clusters of four households or the equivalent. Similarly, household occupants themselves are clusters within the household. This approach was devised to keep costs of interviewing as low as possible; it also keeps variance to a minimum and provides for equal probability of any ultimate sampling unit being selected.
Regardless of the techniques used to collect data, the major advantages of emulating the Bureau of the Census design are: a) the ability to use PSUs for which a wide variety of descriptive statistics are available; b) the power derived from using sampling procedures that are self-weighted and corrected for nonresponse bias; c) the ability to compare results with previously obtained information on the same, or similar PSUs; and d) the acceptability of the CPS geographic and sociodemographic data as truly representative of the U.S. population. These advantages are of particular importance in regard to any survey of fish consumption because the strata or clusters from PSUs developed by the Bureau of the Census and NCHS that might be identified for use in a survey of fish consumption already have data available on common demographic variables (age, sex, education, ethnicity, income, family size and composition, community type, etc.). Thus, collection of these data may not need to be extensive but only confirmatory. Any new approach that does not use or emulate the NHIS or CPS would need to establish validity of the representativeness of the total population sample surveyed. This aspect raises the major problem of resource commitment. For example, consider a total population survey of fish consumption with a total of 41 traits: 16 for age, sex, and physiological state (e.g., 21-45 years old, male or female, pregnant or lactating), 8 for geographic region of the U.S., 4 for type of community within region, 8 income levels, and 5 racial and ethnic types. The number of cells necessary for distributional analyses would be: 16 x 8 x 4 x 8 x 5 = 20,480. The number of individuals needed for each cell to reach a sample size yielding acceptable variance and error estimation would likely exceed resources available for conduct of the survey. Because the distribution of many of these demographic characteristics within the U.S. population is already known from previous Bureau of Census or NCHS surveys, it may be possible to collapse the study design and omit certain demographic characteristics. This may be more appropriate to collection of data on usual intakes of a large population sample than collection of data on high intakes of a special population.

An additional issue that may affect the methods of sampling the total population for usual fish intake is the consumption of fish relative to consumption of all protein sources. Production and marketplace disappearance data suggest fish consumption of the U.S. population is increasing. While not the subject of this paper, these data also suggest that there is a shift in dietary patterns of consumption of beef, pork, and/or chicken. Collection of data on usual intake of fish by the U.S. population as a component of data collection on usual intakes of major foods would provide data on trends in the relation of fish intake to total food intake. This could be an important consideration in examining diet/health relationships if fish consumption is only one of several variables that are changing. Collection of data on fish consumption alone will provide information on usual intakes, diet trends, regional, seasonal differences, etc.; however, collection of data on fish intake alone may introduce a respondent bias.
because of the narrower scope of the information sought. This issue could be resolved by experimental testing of the hypothesis on bias, but such testing would require additional effort, that is, a confirmational survey. Thus, determination of usual fish intake by means of a directed survey might provide additional data on fish consumption per se; it would probably be less costly, and could be accomplished in less time. However, changing patterns of meat, poultry, and fish consumption in the past decade suggest additional comparative data on sources of dietary protein are needed. For this reason, consideration should be given to estimation of usual fish intake of the U.S. population from a survey of overall food consumption patterns.

2. Considerations in Sampling Unique Populations

It is reasonable to expect that target populations of "heavy eaters" may exist for multiple reasons. For example, certain population subsets may be consumers of large quantities of certain types of fish, while other subsets preferentially consume fish of all types more frequently. Heavy consumers may eat larger quantities and/or eat fish more frequently for economic, ethnic, religious, or other reasons. Residents of seacoast or other geographic regions may be heavy consumers because of ease of availability of certain species of fish as a readily available dietary item. If the reasons why individuals are heavy eaters are an important consideration in surveying the distribution of intakes by those individuals, then sampling procedures will need to reflect these reasons.

An alternative approach to estimation of intakes of heavy or preferential consumers involves extrapolation of two or three standard deviations from the mean intake value. This approach has been used for nutrients, but not for foods. Whether such an approach is feasible is open to question. Use of any extrapolation technique would require assurance of the validity and representativeness of the mean intake values and would depend in part upon the purposes for which estimate of high intakes were to be used. Ramifications of this approach in regard to nutrient consumption are complex and have been discussed by Anderson (1986) and in a recent report of the National Research Council (1986).

As indicated previously, sample representativeness is an important consideration which needs to be established prior to analysis and interpretation of data. If the usual intake of heavy consumers is to be compared with usual intakes of the total population, the former sample must be selected from the latter. If the usual intake of heavy consumers is to be compared with some characteristic of their consumption (e.g., danger of excessive consumption of fish containing a toxicant), then the individuals sampled must represent the population of those eaters only and the definition of "eaters only" should be determined prior to data collection as it will affect both the population sampling design and the instruments used to collect data.
V. STRATEGIES FOR ESTIMATING USUAL INTAKE OF FISH

Previous sections of this report provide reasons why no one strategy of estimating usual fish intake can fulfill all possible needs for such data. Actual examples of a desired scope of data and their intended uses would be helpful in placing such discussions in the context of FDA's (and other agencies) needs. Two general strategies are available; either enlarge currently planned future studies to include fish consumption or conduct a survey dedicated to collection of data on fish consumption. The strengths and limitations of several approaches within these two strategies are outlined below.

A. MODIFICATIONS OF AND/OR SUPPLEMENTS TO PLANNED SURVEYS

Several national surveys are being planned for the next decade. Most of the federally sponsored surveys are based on the Bureau of the Census (CPS) or Decennial Census (DC) designs or upon analogous approaches (e.g., NFCS). Several national surveys should be considered in regard to their possible modification or supplementation to include collection of information on fish consumption. These include the 1990 Census, NFCS, NHANES, NHIS, and NSHF (National Survey of Hunting, Fishing, and Wildlife-Associated Recreation).

Several advantages to the strategy of modifying existing surveys are evident. The survey designs have been developed and tested repeatedly; they are recognized as national surveys of the total population; they already collect much of the basic demographic data needed in regard to characteristics of individuals who do or do not consume fish; and, to some extent, they may collect other data that could be useful for comparative purposes (e.g., total dietary intake, health conditions, or recreationally obtained food).

However, a number of limitations are also apparent; most notably, each survey is not designed to collect data on health conditions and dietary intakes, especially extensive data on fish consumption. Further, they are either multi-agency efforts or specific to one agency's programs. Each survey can be expected to be quite complex in its own right. Additional questions, probes, or other data collection instruments on fish consumption could be expected to affect survey design or sampling techniques as well as resources needed for collection of appropriate data. Even if appropriate, supplementation of the protocol would require long lead times and cooperation. These issues could become major concerns if there is initial agreement to consider inclusion of supplemental questions on fish consumption and if there is a need to test and evaluate these added data collection requirements.
Similarly, persons trained as interviewers for these several surveys may not have training or experience in nutrition survey techniques. Because of the particular nature and complexity of the information that might be sought on fish consumption, interviewer training would need to be accommodated. Thus, any supplement to or modification of an ongoing survey represents a major addition to the survey's intended purposes that would place an additional burden on respondents and survey staff, as well as altering the protocols for statistical analyses of data.

Additional comments related to each of these ongoing national surveys are as follows:

1) 1990 Census. Although extremely comprehensive, the Decennial Census has traditionally deferred collection of data on health and nutrition to other surveys. Further, the time frame available before the 1990 survey is too short to request consideration of a supplement.

2) NFCS. The USDA survey uses collection instruments that provide quantitative daily consumption data. The food records and 24-hour recall interview provide information on species, types, and parts of fish consumed; however, NFCS does not collect data on health conditions and it is unlikely that it could. Even if it did, the number of days of data collection would need to be enlarged to adequately account for the nonuniformity of usual intakes. (Data from 1977-78 NFCS, 1981 National Seafood Consumption Survey, (NSCS), and other sources on distribution of frequency of eating within the population are sources of frequency data that could be examined critically to project desired or optimal numbers of days of collection among survey participants.) Consideration might be given to exploring the use of the NFCS participants for further study in regard to health conditions. Such a follow-up or joint activity would require discussions with USDA on identification and access to those individuals who participated in the NFCS.

3) NHANES. The primary dietary intake instrument is a 24-hour recall for most subjects coupled with a limited food frequency questionnaire. A subset of the NHANES III sample will have two 24-hour recalls. However, these instruments would need to be expanded to provide detailed data on fish consumption. NHANES collects data on health and lifestyles which would be helpful in evaluating associations among fish consumption patterns and health outcomes. NHANES III is currently underway; thus, the opportunity to suggest modification of the dietary intake instrument will not exist until early in the next decade (NHANES IV).
4) NHIS. Since 1959 a number of supplemental sections have been added to the NHIS (National Center for Health Statistics, 1985b). This survey is continuous, its design is based on the CPS, and its conduct by trained interviewers is well standardized. Inclusion of an additional series of questions on usual intake of fish (frequency and portion size), types of fish consumed, eating locations and occasions, etc. could provide data on the distribution of usual intakes of the U.S. population. The format of the NHIS would accommodate a series of questions on fish consumption as a diet history or frequency of consumption instrument more readily than dietary recall. Another advantage of a supplement to the NHIS would be the possibility of generating data continuously on subsets of the population that represent noneaters as well as heavy or preferential consumers. For example, a supplement to NHIS could be used as a primary survey to evaluate the distribution of fish intakes among the persons surveyed. If follow-up were possible, this subset, or special groups within the subset, could be utilized to collect quantitative consumption data in a secondary survey. Although NHIS has not included extensive questioning on nutrition and dietary practices in previous surveys or supplements, it appears to be one national survey that might be used. Depending upon the instruments used and the size of the population sample studied, information on usual intakes of fish could be obtained rapidly and the potential exists to obtain data on preferential intakes.

5) NSFH. The NHFS is a two-stage survey. The initial contact (primarily by telephone), identifies hunters, fishermen, and wildlife observers (termed nonconsumptive users). The follow-up contact by personal interview of the selected subsample involves questionnaire completion. Up through the 1985 survey, questions on consumption of edible game, total fish consumption, or game fish consumption have not been included. However, a supplement to the NSFH similar to those added to the NHIS, or a modification of the NSFH itself, might be considered in the 1990 NSFH if the study design is not yet finalized (if finalized, 1995 would be the next possible date). This approach would address the particular issue of consumption of game fish. Indeed, the NSFH might also be useful in identifying game fish consumption by the total U.S. population as well. A second sample of nonhunters, nonfishermen, and nonwildlife observers who were representative of the U.S. population could be selected at the first stage for comparative purposes.
By extension of questioning in the interviews (second stage), data to estimate usual fish consumption patterns could be collected from both samples. Use of a supplement to the NSFH represents an alternate approach to consumption of game fish in a nationally representative group of the U.S. population who are presumed to be preferential fish eaters. Respondents could be expected to provide relatively more accurate information on species consumed than persons in a randomly selected sample because of their unique classification as fishermen. The two population samples selected in the initial phase and probing in the interview (second stage) could be used to establish samples of eaters, preferential eaters, noneaters, etc. for follow-up studies. This approach could provide further data on quantitative aspects of fish consumption for purposes of risk assessment. Such an extensive supplement to the NSFH would deviate significantly from the purposes of the Fish and Wildlife Service; however, the possibility of piggybacking a fish consumption survey should be explored.

6) NHIS and NSFH. Because the survey designs are similar (but not identical), consideration might be given to use of a similar instrument in both surveys. Utilizing both NHIS and NSFH would provide an opportunity to obtain a large initial population sample from which data on usual intake could be estimated. Using these surveys as the first stage, a second stage survey could probe aspects of fish consumption in greater detail. The second stage survey could involve a sample of preferential eaters selected from NHIS and NSFH.

In summary, there are several ongoing federally sponsored efforts to collect data on the U.S. population. While supplementation of one of these to probe for characteristics of fish consumption appears possible, in reality, the developmental needs and logistical requirements could be equivalent to conduct of a dedicated effort to survey fish consumption per se. For practical reasons, initial exploration of the possibilities for supplementation or modification should be directed to NHIS and NSFH. Because of its scope and content, the fact that it is continuous, and because it has accommodated supplements in the past, NHIS may be an appropriate approach to obtaining further data primarily on usual intakes. NSFH represents an alternative approach to collection of data on both usual and preferential intakes. A piggyback effort in the second stage of NSFH or as a separate second stage of both NHIS and NSFH might be considered as an approach to obtaining quantitative consumption data.
B. NEW SURVEYS OF FISH CONSUMPTION

The Bureau of the Census provides support and guidance to the NCHS and other federal agencies on collecting data on attributes of the U.S. population. A specially designed survey using the nationally representative population sampling as well as stratification and clustering techniques of the Bureau of the Census and NCHS could be conducted by personal interviews or by telephone contact. If the former technique were used, recalls, histories, and fish consumption frequency could be collected by extensive questionnaires and probing. If the survey were conducted by telephone, similar data might be collected although previous experience suggests a two-stage survey would be more efficient. That is, initial contact by telephone could be used to determine eligibility for inclusion, and then interview or further telephone contact would be appropriate for collection of more extensive information including information on both eating occasions and quantities consumed.

Regardless of the methods selected for collection of individual fish intake data, a special survey focused on fish intake alone would require major allocation of resources. Justification of such an effort would be required once the precise nature of the survey and costs of such an undertaking were determined.

Consideration should also be directed to approaches that emulate or are based upon CPS results as to the sociodemographic characteristics of the U.S. population. Such approaches could use either dietary records or food frequency instruments as noted below. Possible approaches include:

1) Use of Existing Consumer Panels. Various commercial organizations maintain consumer panels whose membership can be adjusted to emulate characteristics of the U.S. population that are identified for purposes of a specific study. This approach was used in the three specific surveys of fish consumption noted in Table 1. Food frequency questionnaires and diet histories or records are used more typically with these approaches than dietary recalls by interview. However, repeated 24-hour dietary recalls using telephone or personal interview might be used to validate food frequency or diet record data and to add information on quantities consumed per eating occasion.

2) Constitute New Consumer Panels. A variation of the above would be to constitute new panels of consumers, chosen or selected on the basis of predetermined characteristics derived from the CPS, NHIS, or other design. Again, frequency and quantification of fish consumption would be possible.
In either of the above approaches, two cautions are important. First, representativeness is a major issue. Experience suggests consumer panels may be selected to be representative; however, successful completion, dropout rate, and related factors over time may compromise representativeness. Furthermore, members of consumer panels are, with few exceptions, literate, a factor that affects their representativeness. Thus, survey designs using any type of panel should include a post-survey analysis to determine if representativeness of the total population has changed and if so, whether weighting factors can be applied appropriately to negate such effects. Second, survey instruments for a future study using consumer panels should include specific questions and codings for the data sought, for example: estimated portion size, source of fish (purchased, caught, or received as a gift), species of fish consumed, location of eating occasion, manner of preparation, etc. However, as a quantitative daily record or food frequency questionnaire increases in length and complexity, the issue of cooperator motivation and continued attention becomes increasingly important. This would be particularly important in regard to fish consumption because data would need to be collected over relatively long periods of time. Alternative approaches to address this issue would be use of members of a larger panel intermittently, or constitution of a series of intermittent panels that would be homogeneous in regard to sociodemographic characteristics.

3) **Telephone Surveys.** Use of telephone survey techniques either by themselves or as a component of a two-stage process could provide data on usual fish intakes, including geographic patterns and identification of fish species consumed. If a two-stage approach is used, additional information on quantities eaten, types and species eaten, and related data could be obtained. The use of telephone surveys is a highly sophisticated process which has grown in complexity in recent years. Current approaches are based on the following observations or factors: 1) use of telephone survey techniques will include only households with telephones, currently about 85-95% of the households depending on region of the country; 2) use of telephone directories is compromised by the increasing frequency of unlisted residences; 3) random-digit dialing overcomes this problem and can be coordinated with geographic locations nationwide (Bell Communications Research, Inc. has a directory of area code, prefix combinations for sale); 4) random-digit dialing by adding the last four numbers to the area code, prefix combinations is preferred to total random-digit dialing for local or directed telephone surveys; 5) random-digit dialing does
generate a number of calls to nonresidences, busy signals, or other system nonresponses that require modification of the survey design; and, 6) commercial lists of residence telephone numbers can be used to overcome certain problems of random-digit dialing, and list-assisted random-digit dialing is increasingly accepted as a preferred technique.

Use of list-assisted techniques provides a basis for two-stage or dual-frame telephone surveys. The two-stage technique is based on the fact that residence numbers are clustered within exchanges; thus, random numbers in area code, prefix combinations are used in the first stage to determine eligibility (e.g., residences). If the area code, prefix combination dialed is an eligible household, that area code, prefix code is sampled further (second stage). If not eligible (i.e., not a residence), the area code, prefix combination is not sampled further. The N for each stage can be predetermined based on the data required.

The dual-frame approach is based on random selection of telephone numbers from directories or a commercial list and by random-digit dialing. The results of the three populations (list generated, random-digit dialing generated, and numbers in both populations) are then compared.

Regardless of the initial strategy for making calls, telephone surveys and follow-up telephone calls represent an approach that is amenable to follow-up or repeated calls, or where necessary, to additional continuation of random contact of persons whose sociodemographic characteristics and fish consumption patterns match those prescribed by the survey. Telephone survey techniques have the added advantage of identifying not only the range of usual intakes by the total population, but also geographic or regional correlates of heavy or preferential consumers. Thus, a nationally representative sample of the total population surveyed by telephone could be used as the first stage of a more intensive telephone survey within geographic or regional areas. Similarly, telephone surveys are amenable to continued analysis of maintenance of representativeness of the respondents.

However, one emerging issue with these techniques is the matter of respondent cooperation and willingness to participate. In regard to collection of data on species and types of fish consumed, etc., the length of the interview might be a concern. Similarly, computer-assisted telephone
survey techniques, although efficient, might compromise the data collection if answers to extensive questioning are sought. These aspects of the telephone survey approach suggest time and effort would need to be devoted not only to instrument and protocol development but also to pilot-testing.

In addition to the above direct approaches to estimation of the usual fish intake of the total population, several indirect approaches are possible. These approaches do not provide actual intake data on individuals or are experimentally unproven. These include:

1) Comparison of fish purchases and total food purchases by UPC and/or automated checkout records. Such purchase data would provide household data and would require imputation of wastage. This approach would require supplemental data collection to establish away-from-home consumption. Theoretically, coupling of purchase data with follow-up telephone surveys or consumer panel records would provide extensive data.

2) The variety and diversity of finfish and shellfish consumed suggest that a survey based on consumption of an "indicator food" is not possible. However, previous surveys indicate certain types of fish, for example, canned tuna, catfish, crab, trout might serve as "indicator" species in a multistage survey of fish consumption. Potential advantages and limitations of this approach require additional research.

In summary, several approaches are available that are amenable to determining characteristics of fish consumption in both the total population and special subsets of the population. Similarly, depending on the instruments selected, data on usual intakes and distribution of intakes among the subjects sampled could be obtained. If quantified daily consumption instruments were used in the second stage, data on quantities of fish consumed could be obtained. Conduct of a new directed effort would require development time and resources sufficient for the intended purposes of data collection.
VI. STRATEGIES FOR ESTIMATING CONSUMPTION
BY PREFERENTIAL FISH EATERS

For purposes of this report, the terms "preferential fish eaters" or "heavy consumers," are used to denote persons that consume fish more frequently or in larger quantities than usual intake estimates for the U.S. population for whatever reason. Typically, this group includes those persons whose consumption is the 90th centile of the distribution of intakes.

Conceptually, two general strategies are possible. The first is based on use of data on usual fish intakes from a total population sample. The second series of strategies involves techniques that sample groups of individuals presumed to be heavy consumers directly without using a total population sample to screen for heavy fish consumption.

Regardless of the strategy used to estimate preferential consumption by the total population or by population subsets, the strengths and limitations of each approach must be considered in the context of the purposes for which the consumption estimates are being made. For example, if information on association of frequent fish consumption (perhaps defined as once per day or more than three times per week, etc.) with occurrence of coronary heart disease in adult males is sought, a major component of the survey design will be collection of data from a population sample of sufficient size and for a time period of sufficient length. Because the population under study would be defined as heavy consumers (or noneaters versus heavy consumers), quantification of consumption per eating occasion would not be necessary. Such a survey would require fewer resources than one which sought to establish the possible differences between adult males who preferentially consumed fish at different levels (e.g., one a day regularly versus at least three times per week). In this latter case, quantification of frequency would not be necessary but data on quantities actually eaten per occasion would not be needed for estimating degree of risk or benefit.

A. TWO-STAGE TECHNIQUES

These strategies are based on selection of a subsample of individuals identified as preferential consumers within a total population sample surveyed for distribution of fish intakes. Conceptually, these strategies would rely on the survey of usual intake of the total population as a screening technique to identify heavy consumers. Once these individuals are identified, a second-stage survey would further probe fish consumption characteristics. Within the category of two-stage techniques, there are two conceptual approaches. The first is to build the second stage onto or into an ongoing survey of the total population. The second includes a number of strategies in which the first and second stages are dedicated specifically to estimation
of fish consumption. There are no efforts to use any of these strategies currently underway; indeed, the following suggestions represent concepts that require further study.

A major advantage of the two-stage strategies is the rapidity with which a sample of heavy consumers can be identified. For example, assuming that the distribution of usual fish intakes in the total population was determined with appropriate attention to representativeness and minimal variance and acceptable weighting as required then the individuals whose usual intake exceeded the 75th, 90th or other centile could be designated as heavy consumers and would be selected for further study. However, the issue of sample size of the subsample becomes a matter of concern. For example, if the total population survey sample was 20,000 individuals, the number of individuals at or above the 90th centile of fish consumption is 2000. Whether 2000 units of observation are adequate is a function of the portioning of data (number of cells) sought in the second-stage effort; and of the representativeness of those 2000 individuals with respect to all heavy consumers. For example, if one assumes 1900 of the 2000 are adult males and females of approximately equal proportions, one can estimate usual intakes of heavy adult consumers with greater confidence than intakes of children who are heavy consumers.

Temporal relationships limit the use of a nationally representative population sample for selection of special subsamples. A major reason for conduct of special studies of certain subsets such as heavy consumers (e.g., catfish eaters in the Mississippi River Basin, etc.) is risk assessment; that is, estimation of the potential that a proportion of consumers may, by their consumption of fish, be exposed to a harmful level of contaminant or toxic substance. Use of the nationally representative population sample as the basis for selecting the special subgroup sample assumes that the nationally representative sample is known and is accessible for additional study. For this reason, use of a national representative population sample as the resource or basis of selecting subsamples implies a two-stage survey process. That is, first a survey of a nationally representative population sample must have been completed or be underway in order that, secondarily, it may be used as the basis of selecting the subjects who are heavy consumers. Theoretically, the logic of this approach is sound; in reality, the need for data on fish consumption of certain populations can not be predicted (e.g., monitoring toxic waste spill in a large lake, river, or ocean area). Thus, in some situations, time might not permit collection of these data or data already collected by these techniques might not address the issue under study.

Two-stage techniques that might be combined with existing or planned surveys include the following alternatives.
1. **Follow-up of NHIS Supplement or Special Survey Based on Use of Bureau of the Census PSUs**

Identification of respondents who report heavy intakes could be derived from information collected from a total population survey of these types. Mail or telephone contact to establish subject eligibility and willingness could be followed by personal interviews and administration of frequency instruments. If the sample size was insufficient to meet criteria for a probability sample or for statistical analysis, networking or snowballing could be used to enlarge the sample size. This could be useful in instances where unique geographic or other demographically distinct groups of heavy consumers need to be sampled for risk assessment purposes.

A further approach to use of a nationally representative survey as a screening technique is to use that sample to identify clusters of heavy consumers. If such clusters have a geographic basis, actual interviews can be used within the cluster. The process of identifying and surveying clusters would continue until the sample size and characteristics reach the predetermined number required. Because some individuals interviewed within any cluster may not have the characteristics sought (e.g., frequency of fish consumption), this process can be labor-intensive.

2. **Imputation of Preferential Consumption**

Assuming distribution of usual fish intakes of the total population were determined from NHIS, NHANES, or CSFII, then the 75th or 90th centiles of intake could be estimated from data on intake distribution. This strategy substitutes data analysis for collection of actual intakes. Depending upon the quantity and extent of information collected from the total population sample on consumption patterns, the nonuniformity of fish consumption might be addressed. Arbitrary selection of two or three standard deviations from the mean intake might suffice for an examination of association between fish consumption and a health outcome. However, this approach lacks both data on consumption by preferential eaters and actual quantities consumed; thus, it would have limited utility in assessment of risks.

3. **Use of Consumer Panels**

Although the number of heavy consumers of fish in consumer panels (e.g., the 90th centile of usual intake) would be a subsample of finite size, it would represent a group of heavy consumers who have exhibited willingness to cooperate. Data on species consumed, frequency of eating, and portion sizes could be collected either by quantitative daily consumption methods or food frequency questionnaires. If data were collected similarly from heavy consumers identified in several panels, a larger sample of heavy consumers could be synthesized by
combining data from several sources. Care would need to be taken in analysis to account for overlapping and to ensure the combined database exhibits characteristics of representativeness built into the original surveys of the several panels. Alternatively, heavy consumers identified as members of panels could be used as a source of additional subjects by networking or snowballing (see below). This technique could be useful where discrete geographic or other demographic characteristics are studied for risk assessment purposes.

4. Telephone Surveys

Theoretically, participants in nationally representative total population surveys could be contacted as a follow-up to focus on fish consumption patterns. In reality, the logistics and need to breach confidentiality of participant identity if the second effort were added may result in resource commitment equal to that of another agency's or organization's direct survey techniques which are discussed below.

B. DIRECT SURVEY TECHNIQUES

In a sense, populations of preferential fish consumers are a set of rare populations because there are several reasons for preferential eating which may or may not be related. Similarly, the species eaten, the quantity eaten, and the frequency of eating may be non-uniform. The design of efficient sampling techniques for rare populations is recognized as a formidable task (Kalton and Anderson, 1986; Sudman et al., 1988). Nevertheless, several ways to identify preferential consumers are available. Each of the following is a possible approach that would require considerable study and testing before use in determining preferential fish consumption by either the total or a subset of the population.

1. Telephone Surveys

This approach to direct identification of heavy consumers has the advantage of relative ease of identification of high consumers with relatively low resource use. Indeed, the initial contact could use a single question, "do you eat fish more than once a day, more than 10 times a week, or more than 5 times a week, etc.?" as the screening device. Such a two-stage approach based on random-digit dialing and list-assisted generation of residences has several advantages. Heavy eaters are screened in quickly and, the three populations (random-digit dialed, list-assisted, and individuals identified both ways) provide a basis for comparison of data on frequency of fish eating. Further, analysis of first stage results provides a method of identifying clusters (e.g., area code and prefix
combinations) that could be used to enlarge the sample size if geographic considerations are important in the survey of heavy eaters. If other considerations are paramount, networking and snowballing can be used to enlarge the sample size.

Once the sample is defined in the first stage and eligibility and cooperation are determined, the second stage probe could address detailed questions on patterns of fish consumption, species consumed, etc. As noted previously, most in-depth surveys of cooperative eligible subjects use personal interviews and food frequency questionnaires for this second stage. If such an approach were to be taken, the data collection instrument could be designed to collect frequency and quantity consumed per eating occasion.

Other approaches to identifying subsets of the population that are heavy consumers include a telephone survey that allows identification of clusters of heavy consumers by area code prefix combinations within the distribution of usual intakes or a consumer panel that identifies consumers whose mean intake is in the uppermost centiles of usual intake of the U.S. population. One major aspect of such an approach would be the size of the original sample (total population) versus that of heavy consumers (e.g., the 90th centile). This issue would be minimized by a two-stage survey of a relatively large number of subjects instead of a consumer panel of finite size. The number of subjects in the sample of the preferential consumers would need to be sufficient to maintain the representativeness upon which the survey was designed in order to compare consequences of preferential intakes with those of usual intakes. This would be important if data were being collected to evaluate diet/health relationships over prolonged time periods. For risk assessment purposes, the characteristics of the exposed population rather than the entire population would be the primary concern.

2. Mailed Questionnaires

An alternative to initial contact by telephone would be screening by means of a mailed questionnaire followed by a telephone interview of heavy consumers selected from the initial questionnaire. Use of mailed questionnaires adds the issue of nonresponse bias which can be lessened in two-stage telephone surveys. Previous efforts suggest that without incentives, response rates from mailed questionnaires are low; thus, this approach would require major resource commitment to identify a large number of preferential eaters.
3. Development of Panels from Telephone Surveys

An additional technique would be to use the initial stage to constitute panels of persons who were found to be eligible and cooperative. Such groups could be followed for extended periods, used repeatedly, or used as sources for subsequent identification of subjects. Again, assurances of representativeness would need to be built into the design.

4. Consumer Surveys at Public Locations

Use of personal interviews or requests to complete questionnaires on dietary recall or frequency of eating specific foods represents another approach to collection of individual fish consumption data. Contact with persons at fish piers, fish markets, or grocery stores might be used to identify the population of heavy fish eaters. Subsequent follow-up by telephone or interview could establish patterns of usual intake and categorize groups of fish consumers. This approach could be compromised by its nonrandomness of the population surveyed unless the number of locations and the number of individuals sampled were large enough to meet statistical design criteria.

5. Alternative Techniques

The most frequently used approaches select members of a rare population from a larger population; however, there are other strategies that should be considered:

a. Disproportionate Sampling

If the distribution of consumers of fish is disproportionately high in a geographic area, ethnic group, or some other sociodemographic group, then it may be efficient to oversample those groups. Disproportionate sampling may be of value in determining high levels of fish intake in clustered populations such as in geographic areas, or neighborhoods where fish consumption is high for ethnic, religious, or other reasons.

b. Network Sampling

This approach involves use of linkages of subjects to additional subjects. For example, data on fish intake collected from one household member could include identification of other household members or relatives known to the subject to be heavy consumers of fish. This approach requires special weighting techniques to ensure that the linkages defined allow determination of selection probabilities of sample members.
c. **Multiple Frame Sampling**

If certain characteristics identify preferential consumers, then multiple reference frames can be used to construct a larger population sample which may represent heavy consumers. Overlapping (occurrence of a subject in multiple frames) must be dealt with by statistical procedures.

d. **Snowballing**

A further modification of network sampling is snowballing. Snowballing involves use of known members of a rare population (e.g., heavy fish consumers) as the source of information on other individuals who are heavy consumers. These subjects in turn identify additional subjects. Such a technique is costly and time consuming, thus its use may not be appropriate except in instances where immediacy of risk assessments is of paramount importance. For example, if an acute toxicity were suspected from eating trout or bass from a polluted lake or river, fishermen and their families could be a source of information on other potential heavy consumers from that source. Even though this approach would be more costly than public warnings and/or prohibitions of consumption, it would be a logical way to establish data on exposure levels.

None of these four alternative approaches have been used to any great extent in estimating consumption of specific foods, let alone consumption of fish by preferential eaters. However, because these alternative techniques are especially directed to the population of interest, quantitative daily consumption data as well as frequency of consumption would be information that could be collected. This information could be used for both risk assessment and for monitoring diet/health relationships. Each of these four techniques and their permutations involve complex or novel survey design strategies. A considerable amount of research is needed before these approaches could be used to estimate fish consumption.
VII. CONCLUDING STATEMENTS

A. OBSERVATIONS

This Quick Response Report briefly reviews considerations in selecting a sample of individuals for a national survey of fish consumption. As evidenced by the time required for completion and the length of this report, the "considerations" are numerous, complex, interrelated, and in part associated with a food that is neither defined nor consumed uniformly. Indeed, it seems reasonable to conclude that a generic set of principles to guide development of protocols for estimating fish consumption has not been developed and may not be possible to do at this time.

The current situation is a consequence of several factors that are related to the uniqueness of fish consumption. These include the following observations:

- Fish, as a class of food, is regulated by several federal and state agencies. Consequently, the responsibilities for data collection, while shared, often reflect specific agency needs rather than data requirements of all agencies.

- Fish is not a single food, but a collection of various species used as foods. The definition of fish used as food is affected by sociodemographic, economic, geographic, and other factors.

- Fish, as a food, is unique because it is preferentially avoided or consumed for a multiplicity of sociodemographic, subjective, objective, and economic reasons.

- Recent reports have suggested fish as a source of protein that may provide less fat but additional other health promoting components. Acceptance of these reports in the past decade has led to changes in patterns of fish consumption within the U.S. population, although the patterns of change are not known with certainty.

- Estimates of the usual intake or distribution of usual intake of fish by the U.S. population are not available from available databases on food consumption.

- Available data on consumption of fish is, for the most part, derived from surveys conducted 8 to 20 years ago. Recent data from Fisheries of the United States (1982-1986) provide annual production and import data that document a trend of rising per capita intake since these
surveys were done. Thus, surveys of fish consumption conducted between 1969 and 1981 are probably outdated in terms of providing current estimates of usual intake and usual intake of heavy consumers.

However, numerous surveys, as well as research investigations, have established that consumption of fish in the U.S. is a dietary practice affected by numerous factors including sociodemographic characteristics, geography, ethnicity, availability of various species of fish, and season of the year. These aspects of the patterns of consumption make estimation of usual intakes and distributions of intakes difficult. Indeed, the need for further research on the appropriateness and utility of various approaches to obtaining fish consumption data is obvious.

FDA needs fish consumption data for purposes of monitoring diet/health relationships and for purposes of risk assessment. In a sense, the purposes for which FDA requires fish consumption data might be met by a comprehensive survey of the U.S. population that would collect data on frequency of eating and quantitative daily consumption. However, these two purposes may be made mutually exclusive by restraints imposed by availability of resources. For example, if monitoring of usual fish consumption by the total U.S. population or some subsample of the population is the objective, supplementation of ongoing surveys or initiation of a new survey might be appropriate. Data collection instruments could be less quantitative than those needed if risk assessment is the objective. In this case, quantitative daily consumption data would be required; yet, such data would most probably be needed on a more limited population. The nutrition survey techniques for obtaining these data differ, but the strengths and limitations of any approach to collection of such data continue to depend on the breadth of the purpose and the resources available. To reiterate, there are as yet few generic principles available to lay out approaches to data collection and to discuss the strengths and weaknesses of these several approaches.

B. SUGGESTIONS FOR FUTURE CONSIDERATION

The information reviewed in this report suggests the issues associated with estimation of usual and preferentially high intakes of fish are far more complex than anticipated in the suggested scope of work for this study. As noted throughout this report, the purposes for which an estimate of usual or preferentially high fish intake is sought, and the resources available to obtain such an estimate, are primary factors
controlling the selection of a strategy to obtain the desired data. Further, the permutations of strategies to obtain data on fish consumption are numerous. The generic principles involved in developing strategies to quantify usual and preferential intakes of the total population and of population subsets as developed in this Quick Response Report are too broad.

It is suggested that FDA information requirements might be approached differently. FDA should consider developing one or two specific scenarios where fish consumption data are needed. Strategy development and consideration of various approaches could then be tailored to identified needs.

These potential problem topics could exemplify in greater detail the considerations that FDA faces in making health and safety determinations. It is suggested that one specific scenario could pose a diet/health relationship issue and a second could focus on a related issue involving risk assessment. In essence, discussion of strengths and limitations of various approaches will remain conjectural unless boundaries are identified to focus efforts on discussion of survey protocols that meet FDA needs more directly. Specific scenarios appear to be a reasonable and practical approach at this juncture.
APPENDIX A

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APPENDIX B

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