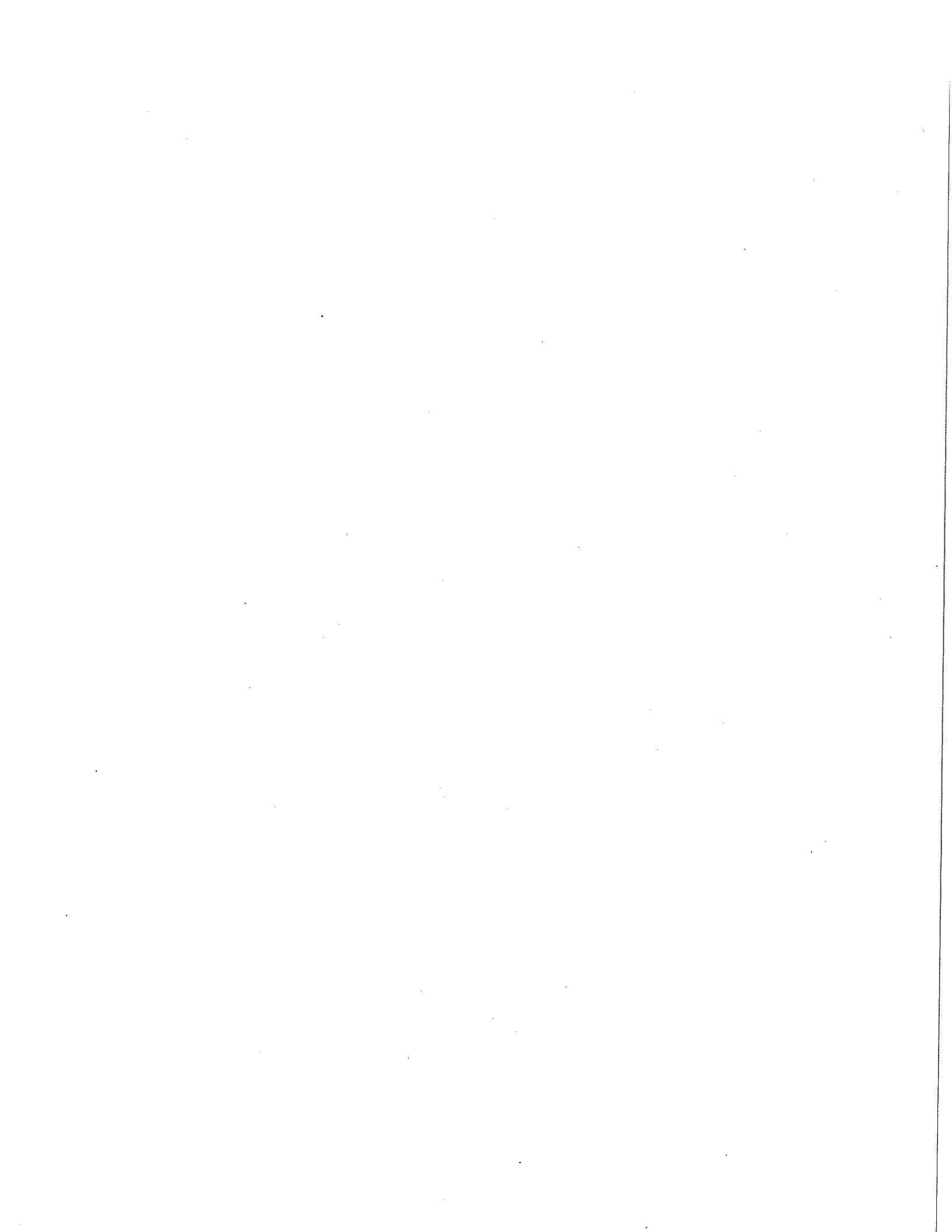


ATTACHMENT 11

Exposure Factors Handbook, U.S. EPA, August 1997





U.S. Environmental Protection Agency

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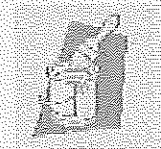
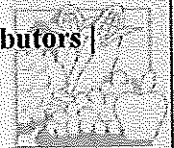
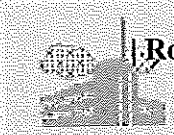
Exposure Factors Handbook

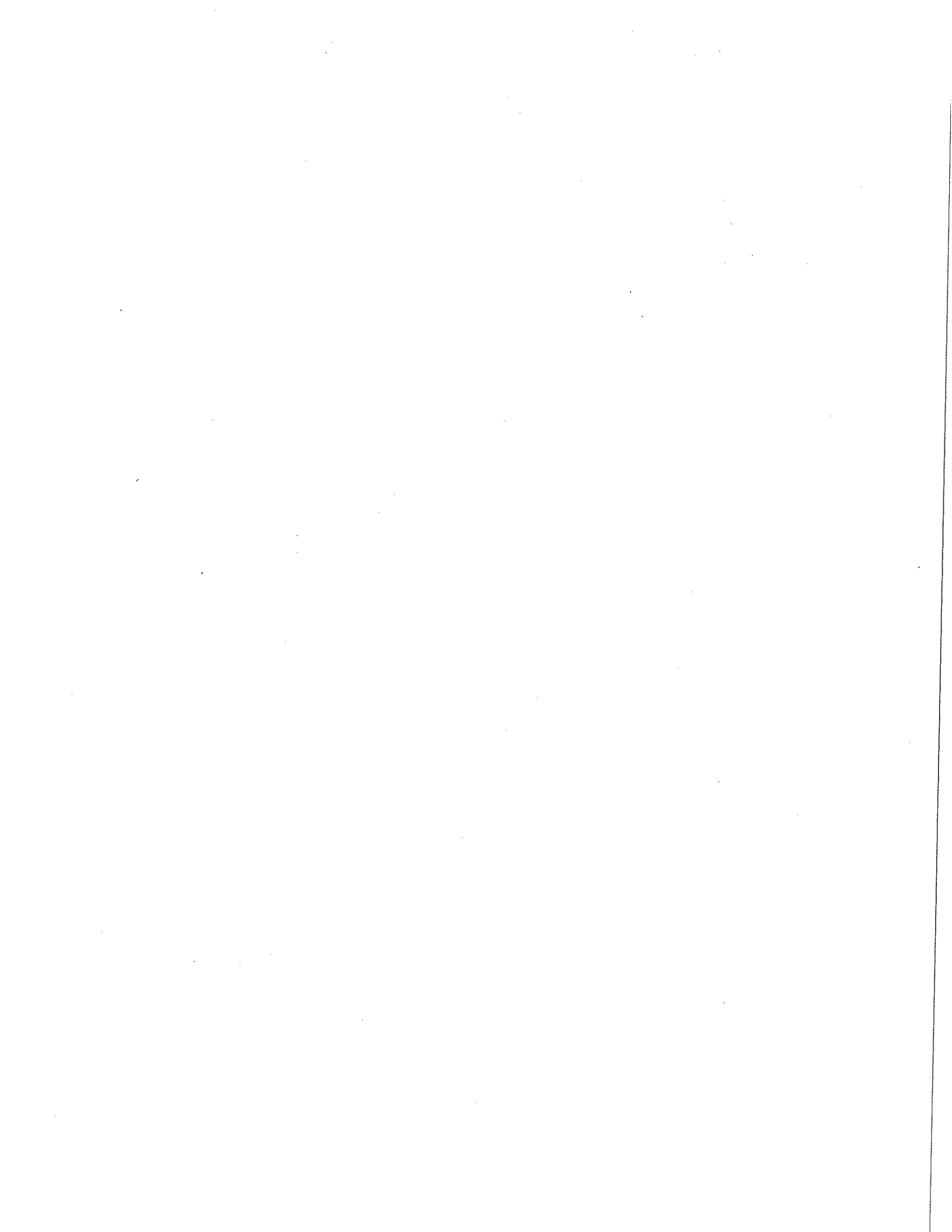


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Conduct a Word Search







GLOSSARY

Absorption fraction (percent absorbed) - The relative amount of a substance that penetrates through a barrier into the body, reported as a unitless fraction.

Accuracy - The measure of the correctness of data, as given by the difference between the measured value and the true or standard value.

Activity pattern (time use) data - Information on activities in which various individuals engage, length of time spent performing various activities, locations in which individuals spend time and length of time spent by individuals within those various environments.

Air exchange rate - Rate of air leakage through windows, doorways, intakes and exhausts, and "adventitious openings" (i.e., cracks and seams) that combine to form the leakage configuration of the building envelope plus natural and mechanical ventilation.

Ambient - The conditions surrounding a person, sampling location, etc.

Analytical uncertainty propagation - Examines how uncertainty in individual parameters affects the overall uncertainty of the exposure assessment. The uncertainties associated with various parameters may propagate through a model very differently, even if they have approximately the same uncertainty. Since uncertainty propagation is a function of both the data and the model structure, this procedure evaluates both input variances and model sensitivity.

As consumed intake rates - Intake rates that are based on the weight of the food in the form that it is consumed.

Average daily dose - Dose rate averaged over a pathway-specific period of exposure expressed as a daily dose on a per-unit-body-weight basis. The ADD is used for exposure to chemicals with non-carcinogenic non-chronic effects. The ADD is usually expressed in terms of mg/kg-day or other mass/mass-time units.

Best Tracer Method (BTM) - Method for estimating soil ingestion that allows for the selection of the most recoverable tracer for a particular subject or group of subjects. Selection of the best tracer is made on the basis of the food/soil (F/S) ratio.

Boneless equivalent - Weights of meat (pork, veal, beef) and poultry, excluding all bones, but including separable fat sold on retail cuts of red meat.

Carcass weight - Weight of the chilled hanging carcass, which includes the kidney and attached internal fat (kidney, pelvic, and heart fat), excludes the skin, head, feet, and unattached internal organs. The pork carcass weight includes the skin and feet but excludes the kidney and attached internal fat.

Chronic intake - The long term period over which a substance crosses the outer boundary of an organism without passing an absorption barrier.

Comparability - The ability to describe likenesses and differences in the quality and relevance of two or more data sets.

Consumer-only intake rate - The average quantity of food consumed per person in a population composed only of individuals who ate the food item of interest during a specified period.



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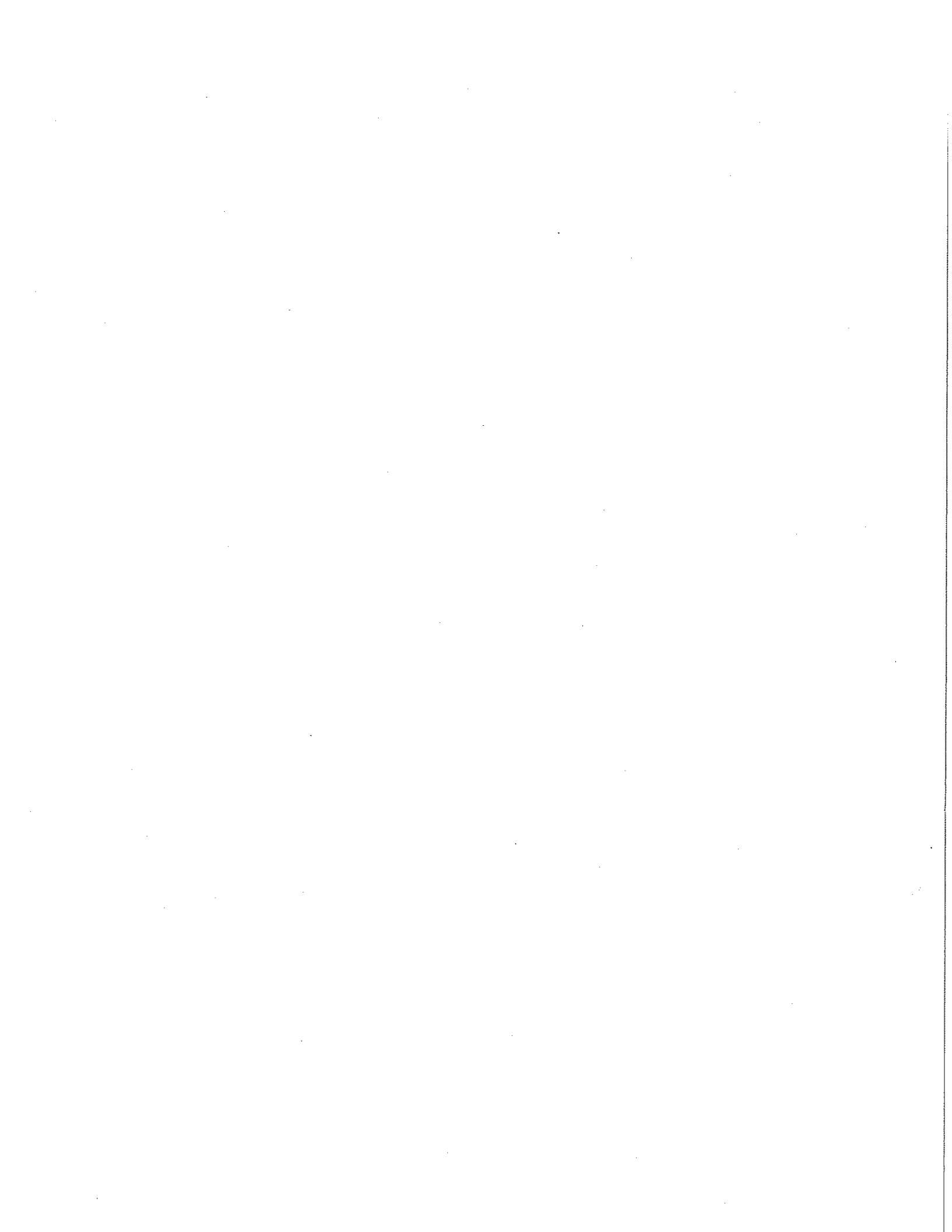
13. INTAKE RATES FOR VARIOUS HOME PRODUCED FOOD ITEMS

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- 13.2. METHODS
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13. INTAKE RATES FOR VARIOUS HOME PRODUCED FOOD ITEMS

13.1. BACKGROUND

Ingestion of contaminated foods is a potential pathway of exposure to toxic chemicals. Consumers of home produced food products may be of particular concern because exposure resulting from local site contamination may be higher for this subpopulation. According to a survey by the National Gardening Association (1987), a total of 34 million (or 38 percent) U.S. households participated in vegetable gardening in 1986. Table 13-1 contains demographic data on vegetable gardening in 1986 by region/section, community size, and household size.

Table 13-2 contains information on the types of vegetables grown by home gardeners in 1986. Tomatoes, peppers, onions, cucumbers, lettuce, beans, carrots, and corn are among the vegetables grown by the largest percentage of gardeners. Home produced foods can become contaminated in a variety of ways. Ambient pollutants in the air may be deposited on plants, adsorbed onto or absorbed by the plants, or dissolved in rainfall or irrigation waters that contact the plants. Pollutants may also be adsorbed onto plants roots from contaminated soil and water. Finally, the addition of pesticides, soil additives, and fertilizers to crops or gardens may result in contamination of food products. Meat and dairy products can become contaminated if animals consume contaminated soil, water, or feed crops. Intake rates for home produced food products are needed to assess exposure to local contaminants present in homegrown or home caught foods. Recently, EPA analyzed data from the U.S. Department of Agriculture's (USDA) Nationwide Food Consumption Survey (NFCS) to generate distributions of intake rates for home produced foods. The methods used and the results of these analyses are presented below.

13.2. METHODS

Nationwide Food Consumption Survey (NFCS) data were used to generate intake rates for home produced foods. USDA conducts the NFCS every 10 years to analyze the food consumption behavior and dietary status of Americans (USDA, 1992). The most recent NFCS was conducted in 1987-88. The survey used a statistical sampling technique designed to ensure that all seasons, geographic regions of the 48 conterminous states in the U.S., and socioeconomic and demographic groups were represented (USDA, 1994). There were two components of the NFCS. The household component collected information over a seven-day period on the socioeconomic and demographic characteristics of households, and the types, amount, value, and sources of foods consumed by the household (USDA, 1994). The individual intake component collected information on food intakes of individuals within each household over a three-day period (USDA, 1993). The sample size for the 1987-88 survey was approximately 4,300



households (over 10,000 individuals). This is a decrease over the previous survey conducted in 1977-78 which sampled approximately 15,000 households (over 36,000 individuals) (USDA, 1994). The sample size was lower in the 1987-88 survey as a result of budgetary constraints and low response rate (i.e., 38 percent for the household survey and 31 percent for the individual survey) (USDA, 1993). However, NFCS data from 1987-88 were used to generate homegrown intake rates because they were the most recent data available and were believed to be more reflective of current eating patterns among the U.S. population.

The USDA data were adjusted by applying the sample weights calculated by USDA to the data set prior to analysis. The USDA sample weights were designed to "adjust for survey non-response and other vagaries of the sample selection process" (USDA, 1987-88). Also, the USDA weights are calculated "so that the weighted sample total equals the known population total, in thousands, for several characteristics thought to be correlated with eating behavior" (USDA, 1987-88).

For the purposes of this study, home produced foods were defined as homegrown fruits and vegetables, meat and dairy products derived from consumer-raised livestock or game meat, and home caught fish. The food items/groups selected for analysis included major food groups (i.e., total fruits, total vegetables, total meats, total dairy, total fish and shellfish), individual food items for which >30 households reported eating the home produced form of the item, fruits and vegetables categorized as exposed, protected, and roots, and various USDA fruit and vegetable subcategories (i.e., dark green vegetables, citrus fruits, etc.). Food items/groups were identified in the NFCS data base according to NFCS-defined food codes. Appendix 13A presents the codes used to determine the various food groups.

Although the individual intake component of the NFCS gives the best measure of the amount of each food item eaten by each individual in the household, it could not be used directly to measure consumption of home produced food because the individual component does not identify the source of the food item (i.e., as home produced or not). Therefore, an analytical method which incorporated data from both the household and individual survey components was developed to estimate individual home produced food intake. The USDA household data were used to determine (1) the amount of each home produced food item used during a week by household members and (2) the number of meals eaten in the household by each household member during a week. Note that the household survey reports the total amount of each food item used in the household (whether by guests or household members); the amount used by household members was derived by multiplying the total amount used in the household by the proportion of all meals served in the household (during the survey week) that were consumed by household members.



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The individual survey data were used to generate average sex- and age-specific serving sizes for each food item. The age categories used in the analysis were as follows: 1 to 2 years; 3 to 5 years; 6 to 11 years; 12 to 19 years; 20 to 39 years; 40 to 69 years; and over 70 years (intake rates were not calculated for children under 1; the rationale for this is discussed below). These serving sizes were used during subsequent analyses to generate homegrown food intake rates for individual household members. Assuming that the proportion of the household quantity of each homegrown food item/group was a function of the number of meals and the mean sex- and age-specific serving size for each family member, individual intakes of home produced food were calculated for all members of the survey population using SAS programming in which the following general equation was used:

$$w_i = W_f \cdot \left[\frac{m_i q_i}{\sum_{i=1}^n m_i q_i} \right] \quad (\text{Eqn. 13-1})$$

where:

- w_i = Homegrown amount of food item/group attributed to member i during the week (g/week);
- W_f = Total quantity of homegrown food item/group used by the family members (g/week);
- m_i = Number of meals of household food consumed by member i during the week (meals/week); and
- q_i = Serving size for an individual within the age and sex category of the member (g/meal).

Daily intake of a homegrown food item/group was determined by dividing the weekly value (w_i) by seven. Intake rates were indexed to the self-reported body weight of the survey respondent and reported in units of g/kg-day. Intake rates were not calculated for children under one year of age because their diet differs markedly from that of other household members, and thus the assumption that all household members share all foods would be invalid for this age group. In Section 13.5, a method for estimating per-capita homegrown intake in this age group is suggested.

For the major food groups (fruits, vegetables, meats, dairy, and fish) and individual foods consumed by at least 30 households, distributions of home produced intake among consumers were generated for the entire data set and according to the following subcategories: age groups, urbanization categories, seasons, racial classifications, regions, and responses to the questionnaire.

Consumers were defined as members of survey households who reported consumption of the food item/group of interest during the one week survey period. In addition, for the major food groups, distributions were generated for each region by season, urbanization, and responses to the questionnaire. Table 13-3 presents the codes, definitions, and a description of the data included in each of the subcategories. Intake rates were not calculated for food items/groups for which less than 30 households reported



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home produced usage because the number of observations may be inadequate for generating distributions that would be representative of that segment of consumers. Fruits and vegetables were also classified as exposed, protected, or roots, as shown in Appendix 13A of this document. Exposed foods are those that are grown above ground and are likely to be contaminated by pollutants deposited on surfaces that are eaten. Protected products are those that have outer protective coatings that are typically removed before consumption. Distributions of intake were tabulated for these food classes for the same subcategories listed above. Distributions were also tabulated for the following USDA food classifications: dark green vegetables, deep yellow vegetables, other vegetables, citrus fruits, and other fruits. Finally, the percentages of total intake of the food items/groups consumed within survey households that can be attributed to home production were tabulated. The percentage of intake that was homegrown was calculated as the ratio of total intake of the homegrown food item/group by the survey population to the total intake of all forms of the food by the survey population.

As discussed in Section 13.3, percentiles of average daily intake derived from short time intervals (e.g., 7 days) will not, in general, be reflective of long term patterns. This is especially true regarding consumption of many homegrown products (e.g., fruits, vegetables), where there is often a strong seasonal component associated with their use. To try to derive, for the major food categories, the long term distribution of average daily intake rates from the short-term data available here, an approach was developed which attempted to account for seasonal variability in consumption. This approach used regional "seasonally adjusted distributions" to approximate regional long term distributions and then combined these regional adjusted distributions (in proportion to the weights for each region) to obtain a U.S. adjusted distribution which approximated the U.S. long term distribution.

The percentiles of the seasonally adjusted distribution for a given region were generated by averaging the corresponding percentiles of each of the four seasonal distributions of the region. More formally, the seasonally adjusted distribution for each region is such that its inverse cumulative distribution function is the average of the inverse cumulative distribution functions of each of the seasonal distributions of that region. The use of regional seasonally adjusted distributions to approximate regional long term distributions is based on the assumption that each individual consumes at the same regional percentile levels for each season and consumes at a constant weekly rate throughout a given season. Thus, for instance, if the 60th percentile weekly intake level in the South is 14.0 g in the summer and 7.0 g in each of the three other seasons, then an individual in the South with an average weekly intake of 14.0 g over the summer would be assumed to have an intake of 14.0 g for each week of the summer and an intake of 7.0 g for each week of the other seasons.



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Note that the seasonally adjusted distributions derived above were generated using the overall distributions, i.e., both consumers and non-consumers. However, since all the other distributions presented in this section are based on consumers only, the percentiles for the adjusted distributions have been revised to reflect the percentiles among consumers only. Given the above assumption about how each individual consumes, the percentage consuming for the seasonally adjusted distributions give an estimate of the percentage of the population consuming the specified food category at any time during the year.

The intake data presented here for consumers of home produced foods and the total number of individuals surveyed may be used to calculate the mean and the percentiles of the distribution of home produced food consumption in the overall population (consumers and non-consumers) as follows:

Assuming that IR_p is the homegrown intake rate of food item/group at the p^{th} percentile and N_c is the weighted number of individuals consuming the homegrown food item, and N_T is the weighted total number of individuals surveyed, then $N_T - N_c$ is the weighted number of individuals who reported zero consumption of the food item. In addition, there are $(p/100 \times N_c)$ individuals below the p^{th} percentile. Therefore, the percentile that corresponds to a particular intake rate (IR_p) for the overall distribution of homegrown food consumption (including consumers and nonconsumers) can be obtained by:

$$P_{\text{overall}}^{\text{th}} = 100 \times \frac{\left(\frac{P}{100} \times N_c + (N_T - N_c) \right)}{N_T} \quad (\text{Eqn. 13-2})$$



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For example, the percentile of the overall population that is equivalent to the 50th percentile consumer only intake rate for homegrown fruits would be calculated as follows:

From Table 13-8, the 50th percentile homegrown fruit intake rate (IR_{50}) is 1.07 g/kg-day. The weighted number of individuals consuming fruits (N_c) is 14,744,000. From Table 13-4, the weighted total number of individuals surveyed (N_T) is 188,019,000. The number of individuals consuming fruits below the 50th percentile is:

$$\begin{aligned} p/100 \times N_c &= (0.5) \times (14,744,000) \\ &= 7,372,000 \end{aligned}$$

The number of individuals that did not consume fruit during the survey period is:

$$\begin{aligned} N_T - N_c &= 188,019,000 - 14,744,000 \\ &= 173,275,000 \end{aligned}$$

The total number of individuals with homegrown intake rates at or below 1.07 g/kg-day is

$$\begin{aligned} (p/100 \times N_c) + (N_T - N_c) &= 7,372,000 + 173,275,000 \\ &= 180,647,000 \end{aligned}$$

The percentile of the overall population that is represented by this intake rate is:

$$\begin{aligned} P_{overall}^{th} &= 100 \times (180,647,000 / 188,109,000) \\ &= 96th \text{ percentile} \end{aligned}$$

Therefore, an intake rate of 1.07 g/kg-day of homegrown fruit corresponds to the 96th percentile of the overall population.

Following the same procedure described above, 5.97 g/kg-day, which is the 90th percentile of the consumers only population, corresponds to the 99th percentile of the overall population. Likewise, 0.063 g/kg-day, which is the 1st percentile of the consumers only population, corresponds to the 92nd percentile of the overall population. Note that the consumers only distribution corresponds to the tail of the distribution for the overall population. Consumption rates below the 92nd percentile are very close to zero. The mean intake rate for the overall population can be calculated by multiplying the mean intake rate among consumers by the proportion of individuals consuming the homegrown food item, N_c/N_T .

Table 13-4 displays the weighted numbers N_T , as well as the unweighted total survey sample sizes, for each subcategory and overall. It should be noted that the total unweighted number of observations in Table 13-4 (9,852) is somewhat lower than the number of observations reported by USDA because this study only used observations for family members for which age and body weight were specified.

As mentioned above, the intake rates derived in this section are based on the amount of household food consumption. As measured by the NFCS, the amount of food "consumed" by the household is a measure of consumption in an economic sense, i.e., a measure of the weight of food brought into the household that has been consumed (used



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up) in some manner. In addition to food being consumed by persons, food may be used up by spoiling, by being discarded (e.g., inedible parts), through cooking processes, etc.

USDA estimated preparation losses for various foods (USDA, 1975). For meats, a net cooking loss, which includes dripping and volatile losses, and a net post cooking loss, which involves losses from cutting, bones, excess fat, scraps and juices, were derived for a variety of cuts and cooking methods. For each meat type (e.g., beef) EPA has averaged these losses across all cuts and cooking methods to obtain a mean net cooking loss and a mean net post cooking loss; these are displayed in Table 13-5. For individual fruits and vegetables, USDA (1975) also gave cooking and post-cooking losses. These data are presented in Tables 13-6 and 13-7.

The following formulas can be used to convert the intake rates tabulated here to rates reflecting actual consumption:

$$I_A = I \times (1 - L_1) \times (1 - L_2)$$

(Eqn. 13-3)

$$I_A = I \times (1 - L_p)$$

(Eqn. 13-4)

where I_A is the adjusted intake rate, I is the tabulated intake rate, L_1 is the cooking loss, L_2 is the post-cooking loss and L_p is the paring or preparation loss. For fruits, corrections based on postcooking losses only apply to fruits that are eaten in cooked forms. For raw forms of the fruits, paring or preparation loss data should be used to correct for losses from removal of skin, peel, core, caps, pits, stems, and defects, or draining of liquids from canned or frozen forms. To obtain preparation losses for food categories, the preparation losses of the individual foods making up the category can be averaged.

In calculating ingestion exposure, assessors should use consistent forms in combining intake rates with contaminant concentrations. This issue has been previously discussed in the other food Chapters.

13.3. RESULTS

The intake rate distributions (among consumers) for total home produced fruits, vegetables, meats, fish and dairy products are shown, respectively, in Tables 13-8 through 13-32 (displayed at the end of Chapter 13). Also shown in these tables is the proportion of respondents consuming the item during the (one-week) survey period. Homegrown vegetables were the most commonly consumed of the major food groups (18.3%), followed by fruit (7.8%), meat (4.9%), fish (2.1%), and dairy products (0.7%). The intake rates for

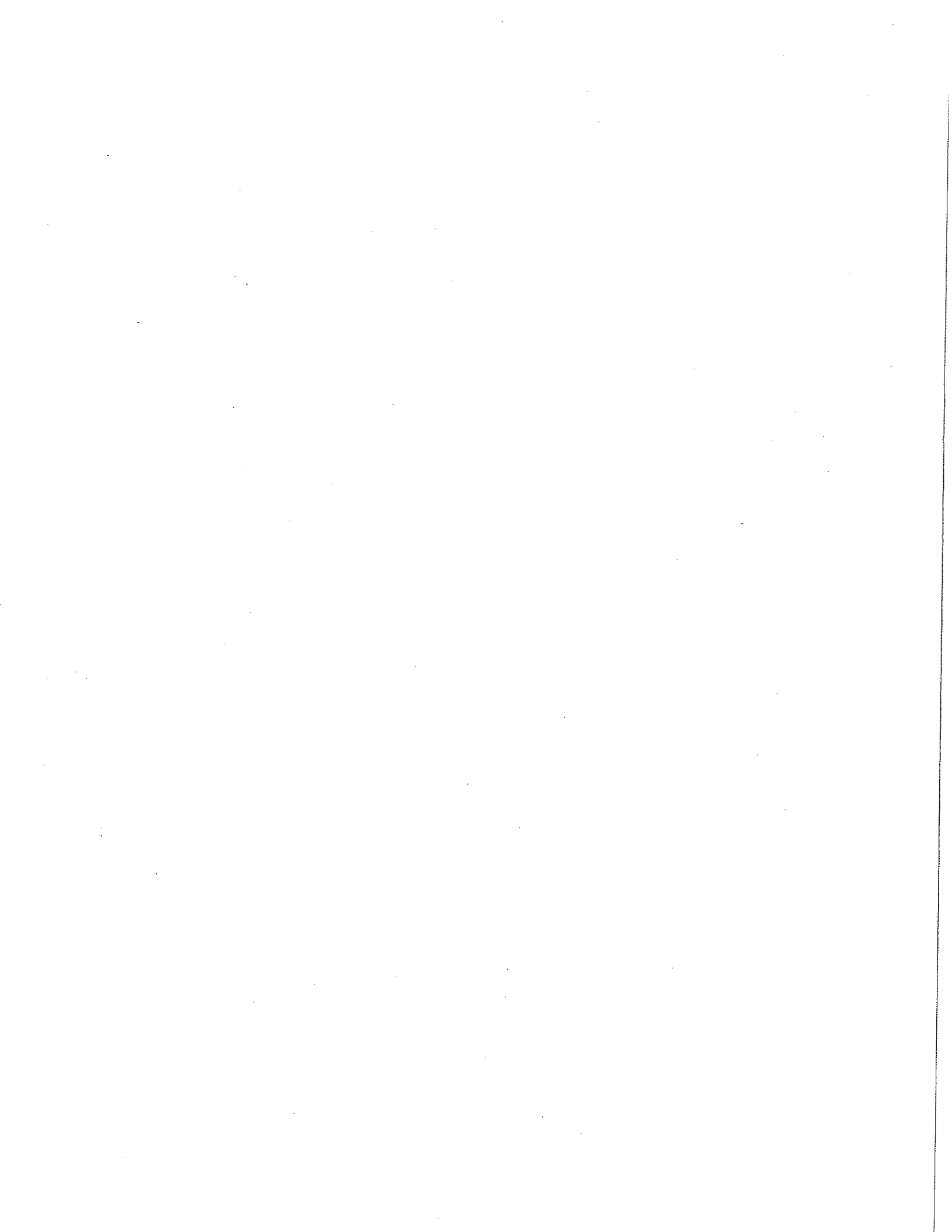


Table 13-23. Consumer-Only Intake of Home Caught Fish (g/kg-day) - All Regions Combined

Population Group	Nc world	Nc unweighted	% Consuming	Mean	SE	P1	P5	P10	P25	P50	P75	P90	P95	P99	P100
Total	3914000	239	2.08	2.07E+00	2.38E-01	8.16E-02	9.11E-02	1.95E-01	2.28E-01	4.31E-01	9.97E-01	2.17E+00	4.68E+00	7.83E+00	1.55E+01
Age															
01-02	82000	6	1.44	*	*	*	*	*	*	*	*	*	*	*	*
03-05	142000	11	1.75	*	*	*	*	*	*	*	*	*	*	*	*
06-11	382000	29	2.29	2.78E+00	8.40E-01	1.60E-01	1.60E-01	1.84E-01	2.28E-01	5.47E-01	1.03E+00	3.67E+00	7.05E+00	7.85E+00	2.53E+01
12-19	346000	21	1.69	1.52E+00	4.07E-01	1.95E-01	1.95E-01	1.95E-01	1.95E-01	3.11E-01	9.84E-01	1.79E+00	4.68E+00	6.67E+00	8.44E+00
20-39	962000	59	1.56	1.91E+00	3.34E-01	8.16E-02	8.16E-02	9.11E-02	1.18E-01	4.49E-01	1.06E+00	2.18E+00	4.46E+00	9.57E+00	1.30E+01
40-69	1524000	86	2.69	1.79E+00	2.56E-01	9.47E-02	9.47E-02	2.10E-01	2.75E-01	3.48E-01	9.85E-01	1.98E+00	4.43E+00	6.56E+00	1.08E+01
70 +	450000	24	2.83	1.22E+00	2.30E-01	9.88E-02	9.88E-02	2.33E-01	2.33E-01	5.68E-01	7.64E-01	1.58E+00	3.73E+00	3.73E+00	5.12E+00
Season															
Fall	1220000	45	2.56	1.31E+00	2.16E-01	1.84E-01	1.84E-01	1.96E-01	2.10E-01	3.18E-01	9.16E-01	1.79E+00	2.64E+00	3.73E+00	6.56E+00
Spring	1112000	114	2.41	3.08E+00	5.55E-01	9.88E-02	1.16E-01	3.09E-01	3.40E-01	5.99E-01	1.27E+00	2.64E+00	6.68E+00	1.08E+01	3.73E+01
Summer	911000	29	2.00	1.88E+00	4.24E-01	8.16E-02	8.16E-02	9.11E-02	2.04E-01	3.01E-01	7.64E-01	3.19E+00	4.43E+00	5.65E+00	9.57E+00
Winter	671000	51	1.38	2.05E+00	3.68E-01	9.47E-02	9.47E-02	1.11E-01	1.60E-01	5.10E-01	1.06E+00	2.09E+00	5.89E+00	7.85E+00	1.31E+01
Urbanization															
Central City	999000	46	1.77	1.79E+00	3.40E-01	9.47E-02	9.47E-02	1.60E-01	2.84E-01	6.08E-01	1.07E+00	1.85E+00	3.73E+00	9.57E+00	9.57E+00
Nonmetropolitan	1174000	94	2.61	3.15E+00	5.74E-01	9.88E-02	1.16E-01	3.10E-01	3.62E-01	5.68E-01	1.88E+00	3.86E+00	6.52E+00	7.83E+00	3.73E+01
Suburban	1741000	99	2.01	1.50E+00	2.30E-01	8.16E-02	8.16E-02	1.84E-01	2.01E-01	2.86E-01	5.87E-01	1.38E+00	4.37E+00	7.05E+00	1.08E+01
Race															
Black	593000	41	2.73	1.81E+00	3.74E-01	1.84E-01	1.84E-01	2.01E-01	2.86E-01	3.18E-01	9.84E-01	2.17E+00	4.68E+00	9.57E+00	9.57E+00
White	3228000	188	2.05	2.07E+00	2.81E-01	8.16E-02	8.16E-02	1.60E-01	2.27E-01	3.93E-01	9.97E-01	2.16E+00	4.99E+00	6.68E+00	1.61E+01
Response to Questionnaire															
Households who fish	3553000	220	8.94	2.22E+00	2.58E-01	8.16E-02	8.16E-02	1.84E-01	2.27E-01	4.66E-01	1.09E+00	2.23E+00	5.61E+00	7.85E+00	1.61E+01

* Intake data not provided for subpopulations for which there were less than 20 observations

NOTE: SE = standard error
P = percentile of the distribution
Nc unweighted = unweighted number of consumers in survey
Nc weighted = weighted number of consumers; Nc unweighted = unweighted number of consumers in survey.
Source: Based on EPA's analyses of the 1987-88 NFCS

