

FINAL REPORT
FISH CONSUMPTION ESTIMATES BASED ON THE
1991-92 MICHIGAN SPORT ANGLERS FISH CONSUMPTION SURVEY

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**U.S. Environmental Protection Agency
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Engineering and Analysis Division
401 M Street, SW.
Washington, DC 20460**

Submitted by:

**Science Applications International Corporation
Environmental and Health Sciences Group
Quantitative Analysis Division
7600-A Leesburg Pike
Falls Church, VA 22043**

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*F. Khuri
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1. INTRODUCTION

This report presents mean and upper percentile estimates of average daily per capita fish consumption for specific subpopulations in the 1991-92 Michigan Sport Anglers Fish Consumption Study (MSAFCS). Self-declared fish eaters within the population of Michigan sport anglers are the consumers of interest. Consumption estimates are reported for sport fish, commercial fish, and all fish. The Environmental Protection Agency (EPA) will use these estimates to support the Great Lakes Water Quality Guidance under Section 118(c)(2) of the Clean Water Act (CWA).

Point and interval estimates of upper percentiles from the distribution of MSAFCS average daily per capita fish consumption values are new to this report. Point and interval estimates of mean per capita fish consumption were originally reported by West, et al. in May, 1993.¹ Estimated point and interval estimates of average daily mean consumptions are listed in this report for completeness. The mean estimates verify those reported in the MSAFCS.

The MSAFCS was a mail survey of 7,000 licensed Michigan sport anglers. The study was funded by the Michigan Great Lakes Protection Fund. Section 2 of this report describes the survey and lists its strengths and weakness. Section 3 establishes data conventions, defines the subpopulations, and presents the statistical methodology.

Average daily per capita consumption estimates for sport fish, commercial fish, and all fish appear in Sections 4, 5, and 6, respectively. Sections 4 through 6 each present tabulated estimates for the following subpopulations of self-declared fish eaters in the Michigan sport angler population:

- Minority
- Non-minority
- Low-income
- Non-low-income
- Minority/low-income
- Non-minority/low-income.

Graphical presentations of the distributions of average daily per capita consumption by each subpopulation augment the tabulated estimates at the end of Sections 4 through 6. These graphical presentations are in the form of histograms and empirical, cumulative distribution functions. Section 7 summarizes the results.

¹West, P.C., J.M. Fly, R.Marens, F.Larkin, D. Rosenblatt. "1991-92 Michigan Sport Anglers Fish Consumption Study - Final Report to the Michigan Great Lakes Protection Fund, Michigan Department of Natural Resources." University of Michigan, School of Natural Resources, Natural Resource Sociology Research Lab., Technical Report #6. May, 1993.

2. SURVEY DESCRIPTION

The 1991-92 Michigan Sport Anglers Fish Consumption Study (MSAFCS) survey, financed by the Michigan Great Lakes Protection Fund, consisted of 7,000 licensed anglers sampled by mail. The objectives of the MSAFCS were to "(1) determine the average fish consumption for Michigan sport fishermen and variance around this mean over a full year period for use in relation to Michigan's Rule 1057, and (2) to provide data relevant to Michigan's fish consumption advisories."²

Section 2.1 defines the MSAFCS survey sample design and provides a brief description of the survey collection instrument. Section 2.2 examines the MSAFCS strengths and weaknesses.

2.1 MSAFCS Sample Design and Collection

The sampling frame for the MSAFCS was the population of "all Michigan sport anglers who purchased a resident fishing, trout stamp, salmon snagging, senior fishing, or sportsperson license in the license year 1988 (April 1, 1988 through March 31, 1989)."³ Non-resident and 1-day licenses were excluded. All anglers age 16 and older require a license.

A sample of 99,991 records was randomly selected from the sampling frame of 1,052,587 Michigan residents holding a fishing license.⁴ From this subset, a systematic sample was drawn to allow the use of stratification by geographic region and license type within region to ensure that each licensed angler had the same chance of being selected. By ordering the population by license type within region, a proportionate statewide distribution of anglers was achieved.

To determine fish consumption on an annual basis, questionnaires were mailed in 2-week cohorts throughout the year-long study period of January 30, 1991 through January 29, 1992. > Surveyed individuals were asked to report detailed fish consumption patterns during the preceding 7 days. Although surveys were mailed in equal cohorts, they were not returned proportionately from each 2-week period. Therefore, adjustment factors were applied to equalize response rates across time periods.⁵

> In addition to demographic information such as age, ethnic background, and household income, respondents were asked whether they currently eat fish. A response of "Yes" was used to define self-declared fish eaters. Enclosed with the survey were "two pictures of about 1/2

²Ibid. p.7.

³Ibid., Appendix C.

⁴Ibid.

⁵Ibid., Appendix G.

pound” of fish.⁶ Respondents were asked to indicate whether reported consumption at each meal was more, less, or about the same as the picture. Based on responses to this question, it was assumed that respondents consumed 10, 5, or 8 ounces of fish, respectively.⁷

2.2 Survey Strengths and Weaknesses

The strength of the MSAFCS is that the sample can be analyzed as a simple random sample if there is no correlation between pairs of units. Four weaknesses are inherent in the completed survey. The first is that, as the data is reported, it is not possible to adjust for nonresponse or to perform post-stratification. The second weakness is that a bias in estimated fish consumption is likely because of the limited choices for reporting the amount of fish consumed. These limited choices in reporting amounts led to the third weakness, limiting the types of analyses that could be performed to test for statistically significant differences. The final weakness of the MSAFCS is that the application of the adjustment factor used to standardize periodic response rates precludes analyzing the data as a simple random sample.

2.2.1 Strength

Because the stratified systematic sample of 7,000 Michigan sport anglers was drawn without regard to the actual consumption of fish, the sample can be analyzed as a simple random sample if there is no correlation between pairs of units in the systematic sample.⁸ That is, the population was sorted by region, type of license within region, and date of birth, not by fish consumption. Although these factors may be correlated with the amount of fish consumed, they are not the unit of measure. Therefore, the sample may be analyzed as a simple random sample if there is no correlation between pairs of fish consumption in the sample.

2.2.2 Weaknesses

1. The researchers reported a response rate of 46.8 percent. Due to a lack of population-size information on the stratum level, no nonresponse adjustment or post-stratification could be performed to compensate for potential nonresponse bias.
2. Reported amounts of fish consumption were restricted to three discrete choices (in addition to zero): 5, 8, or 10 ounces (142.86, 228.57, or 285.71 grams). These limited choices may have introduced a bias in the estimated fish consumption rates.

⁶Ibid. p. 14.

⁷Ibid. p. 14-15.

⁸Cochran, W.G. *Sampling Techniques - Third Edition*. John Wiley & Sons. 1977. p. 212-214.

3. In addition, the discrete, or discontinuous, reporting of meals containing fish consumed limited the types of analyses that could be used to test for statistically significant differences in fish consumption among subpopulation groups.
4. Although surveys were mailed in equal cohorts throughout the year, they were not returned at an equal rate from each period. That is, some 2-week periods had a higher response rate than others. For example, 121 surveys were returned in period 12 whereas 67 surveys were returned in period 25. To standardize each period during the year, an adjustment factor was calculated for each survey period based on the number of respondents. Due to this adjustment, estimates could no longer be analyzed as a simple random sample and were analyzed as combined ratio estimates.

3. DATA CONVENTION AND STATISTICAL METHODS

This report presents average daily per capita estimates of fish consumption for the subset of self-declared fish eaters in the Michigan Sport Anglers Fish Consumption Study (MSAFCS). Additionally, estimates are presented for consumption of sport fish, commercial fish, and all fish. Section 3.1 presents definitions of these parameters, as well as the conventions used for data analysis. Section 3.2 provides the statistical methods for generating point and interval per capita fish consumption estimates.

3.1 Data Conventions and Subset Definitions

Definitions of self-declared fish eaters and fish types are provided in this section, as are definitions of the subpopulations for which estimates are provided in each of the tables in Sections 4, 5, and 6.

3.1.1 Self-Declared Fish Eaters

Self-declared fish eaters in the MSAFCS are those respondents who answered "Yes" to the survey question "Do you currently eat fish?" Of the 2,681 respondents, 2,476 identified themselves as fish-eaters, and therefore are included in the statistical estimates. Of the respondents, 205 either indicated that they did not eat fish or did not respond to this question. Those who responded "No" or did not respond were excluded from the analyzed data.

3.1.2 Fish Types

Consumption estimates are reported for either sport, commercial, or all fish. All fish consumption is defined as the consumption of both sport and commercial fish. Commercial fish consumption is determined from the MSAFCS variable LOCNONCA. If the respondent recorded the value "1" to indicate "restaurant" or "2" to indicate "market," then the reported consumption value was classified as "Commercial Fish." In addition to values 1 and 2, the variable also can be recorded as "3" for "gift," "4" for "don't know," and "0" for "missing." These other fish consumption values (3, 4, and 0) were classified as "Sport Fish." This convention also was applied in the West report.⁹

The MSAFCS variable LOCNONCA records the location of non-self-caught fish. There are a total of 2,139 records in the variable LOCNONCA. The MSAFCS variable LOCSLFCA records the location of the catch for self-caught fish. This variable contains the records for 2,139 meals. Analyses of the two variables revealed that 116 of the records that listed a location in the variable LOCSLFCA, indicating that the fish was self-caught, also recorded that the fish

⁹West, et al. p. 29.

> was not self-caught and was purchased in a restaurant or market. Likewise, 215 records indicating that the fish was self-caught did not record a location. Therefore, in keeping with the convention applied by West, et al., sport fish were identified as the complement of Commercial fish.

3.1.3 Population Subgroups

Population subgroups were divided into ethnic groups, income groups, and ethnic and income groups. Of the 2,476 self-declared fish eaters who responded to MSAFCS survey, 2,451 reported their ethnic background. Ethnicity is recorded in the MSAFCS variable ETHNIC. Of these 2,451 self-declared fish eaters with a recorded ethnic background, 2,194 reported their income, which was recorded in the MSAFCS variable INCOME. In this categorical variable, income is recorded in \$5,000 intervals up to \$40,000. The last category is greater than \$40,000.

Ethnic Group. Participants were divided by ethnic group into minority and non-minority. The minority group comprises non-white sport fishing license holders in the population.

Income Group. Participants were divided by income group into low-income and non-low-income. The low-income group comprises sport fishing license holders whose annual household income in 1990 was less than \$25,000.

Ethnic and Income Group. Participants were divided by ethnic and income group was into minority low-income and non-minority low-income. The minority low-income group comprises non-white sport fishing license holders whose annual household income in 1990 was less than \$25,000.

3.2 Statistical Methods

The MSAFCS was based on a two-stage sampling design. The first stage consisted of a simple random sample of 99,991 individuals from the population of 1,052,587 license-holding Michigan sport anglers. The sample of 99,991 individuals forms a subgroup of the population (referred to as the "frame subset" in the West et al. report). The sample (subpopulation) was ordered by "License Type" and "Region" (regions are aggregated zip codes), and a systematic sample (stage two) was drawn such that each individual sampled represented 150.37 individuals in the population. The ordering was thus performed to ensure that each licensed angler had the same chance of being selected, as well as to achieve a proportionate statewide distribution of anglers. The systematic sample of 7,000 individuals was taken from this subpopulation (or frame subset) in the same order as the original frame.

3.2.1 Sample Data

3.2.1.1 Response Rate

A systematic sample of n=7,000 licensed anglers was selected for the study. The percent base for the calculation of the response rate was not based on the initial total sample size, but rather on the total sample-size base less bad addresses and part-time residents. Thus, the final response rate for the survey would be,

$$\text{Response Rate} = \frac{(\text{Total Respondents})}{(\text{Total Sample Size}) - (\text{Bad Addresses}) - (\text{Part Time})} * 100 = \frac{(2,681)}{(5,279)} * 100 = 46.8\%$$

3.2.1.2 Temporal Adjustments

Although surveys were mailed in equal cohorts for 26 periods of the year (every 2 weeks), they were not returned in equal numbers in each period. To determine fish consumption on an annual basis, a proportional adjustment factor was applied to the data received for each survey period, thus allowing the total sample size for each period to be equalized across the year. Consequently, some periods were weighted up and some periods were weighted down.¹⁰

3.2.1.3 Sample Data Base

The sample data base was prepared by person-level and meal-level, separately. The person-level data base contains all personal plus socioeconomic information including participant age, sex, income, race, education level, and address. The meal-level data base contains information on the size of meal and type of fish the individual consumed at each meal during the preceding 7 days, as well as the pattern of consumption. From the meals database, a variable was created to record the average daily consumption of sport, commercial, and all fish. For each self-declared fish eater, consumption classified as "sport" was summed across the 7 days. This sum was divided by 7 to create an average daily consumption of sport fish for the individual. A variable was created to record the average daily consumption of commercial fish and all fish using the same methodology.

3.2.2 Statistical Assumptions

Because the systematic sample (stage two) of 7,000 Michigan sport fishermen was drawn without regard to actual fish consumption characteristics, the sample can be analyzed as a simple

¹⁰Ibid. Appendix G.

random sample if there is no correlation between pairs of units in the systematic sample.¹¹ That is, the population was sorted by region, type of license within region, and date of birth, not by fish consumption. Although these factors may be correlated with amount of fish consumed, they are not the unit of measure. Therefore, the sample may be analyzed as a simple random sample if there is no correlation between pairs of fish consumption in the sample.

By the definition of the variance formula for the mean of a systematic sample,¹²

$$V(\bar{y}_{sy}) = \frac{1}{k} \sum_{i=1}^k (\bar{y}_i - \bar{Y})^2 \quad (1)$$

$$= \frac{S^2}{n} \left(\frac{N-1}{N} \right) [1 + (n-1)\rho_w], \quad \text{where } \rho_w = \frac{E(y_{ij} - \bar{Y})(y_{iu} - \bar{Y})}{E(y_{ij} - \bar{Y})^2} = \frac{2 \sum_{i=1}^k \sum_{j < u} (y_{ij} - \bar{Y})(y_{iu} - \bar{Y})}{(n-1)(N-1)S^2}$$

$$= \frac{S^2}{n} \left(\frac{N-1}{N} \right), \quad \text{iff } \rho_w = 0$$

$$= \frac{S^2}{n} \left(\frac{N-n}{N} \right), \quad \text{for large } N.$$

$$= V(\bar{y}_{srs}).$$

Implies that if,

$$\rho_w \rightarrow 0, \quad \text{then } V(\bar{y}_{sy}) \rightarrow V(\bar{y}_{srs}).$$

Thus, if any systematic sample, such as i , was drawn from the frame in random order of y_{ij} , it is sufficient to prove that,

¹¹Cochran. p.212-214.

¹²Ibid. p. 208-209.

$$\frac{\sum_{i=1}^n (y_i - \bar{y})(y_m - \bar{y})}{(n-1)(N-1)S^2} \rightarrow 0, \text{ for any given } i, \quad (2)$$

implies,

$$V(\bar{y}_{xy}) = V(\bar{y}_{xy}).$$

Initially a sample of 7,000 individuals was taken, but, as indicated in Appendix F of the MSAFCS survey, an adjustment was made for ineligibles resulting in a sample size of 5,729 individuals. Based on 2,681 individuals responding with 1,160 individuals consuming fish during the 7-day recall period, equation (2) generated a correlation of -0.0. Hence, the sample may be analyzed as a simple random sample.

3.2.3 Point and Interval Estimates

3.2.3.1 Mean Estimates

As previously stated, although surveys were mailed in equal cohorts for 26 periods of the year (every 2 weeks), they were not returned in equal numbers in each period. To determine fish consumption on an annual basis, a proportional adjustment factor was applied to the data received for each survey period, that standardized the number of responses for each period, replicating the total sample size. Due to this adjustment, estimates could no longer be analyzed as a simple random sample and were analyzed instead as combined ratio estimates.

The combined ratio estimate is defined as,

$$\hat{R}_c = \frac{\hat{Y}}{\hat{X}} = \frac{\sum_{i=1}^{26} \sum_{j=1}^{n_1} y_{(ij)} S_{(i)}}{\sum_{i=1}^{26} \sum_{j=1}^{n_1} I_{(ij)} S_{(i)}}$$

where,

$y_{(ij)}$ = 7 days average consumption for the individual j in the i^{th} temporal cohort.

$I_{(ij)}$ = 1, if the j^{th} individual is in sample and domain. 0, otherwise.

$S_{(i)}$ = temporal cohort adjustment factor for the j^{th} individual who belongs to the survey period i ($i = 1, 2, \dots, 26$).

To estimate the variance of the combined ratio, define,

$$g(\hat{X}, \hat{Y}) = \hat{R}_c = \frac{\hat{Y}}{\hat{X}}$$

$$MSE(\hat{R}_c) = E(\hat{R}_c - R)^2 = E(\hat{R}_c^2) - E^2(\hat{R}_c), \text{ since } E(\hat{R}_c) = R = E(R)$$

$$= E(g^2(\hat{X}, \hat{Y})) - E^2g(\hat{X}, \hat{Y}).$$

Taylor's theorem applied to continuous multivariate functions states that the expected value of $g(X, Y) = (Y/X)$ can be expanded about the expected values of X and Y , respectively. A partial expansion up to second-order terms can be expressed as follows,

$$E(g(\hat{X}, \hat{Y})) = g(\mu_x, \mu_y) + E(\hat{X} - \mu_x) \frac{\partial}{\partial X} g(x, y) \Big|_{\mu_x, \mu_y}$$

$$+ E(\hat{Y} - \mu_y) \frac{\partial}{\partial Y} g(x, y) \Big|_{\mu_x, \mu_y} + \frac{1}{2} \text{Var}(\hat{X}) \frac{\partial^2}{\partial X^2} g(x, y) \Big|_{\mu_x, \mu_y}$$

$$+ \frac{1}{2} \text{VAR}(\hat{Y}) \frac{\partial^2}{\partial y^2} g(x, y) \Big|_{\mu_x, \mu_y} + \text{Cov}(\hat{X}, \hat{Y}) \frac{\partial^2}{\partial x \partial y} g(x, y) \Big|_{\mu_x, \mu_y}$$

$$= \frac{\mu_y}{\mu_x} + \text{Var}(\hat{X}) \frac{\mu_y}{\mu_x^3} - \text{Cov}(\hat{X}, \hat{Y}) \frac{1}{\mu_x^2}$$

By making a similar Taylor's expansion on the function,

$$h(X, Y) = g^2(X, Y) = \frac{Y^2}{X^2},$$

it can be shown that the mean square error (MSE) of the combined ratio estimate is approximately,

$$MSE(\hat{R}_c) = \text{Var}(\hat{Y}) \frac{1}{\mu_x^2} + \text{Var}(\hat{X}) \frac{\mu_y^2}{\mu_x^2} - 2 \text{Cov}(\hat{X}, \hat{Y}) \frac{\mu_y}{\mu_x^3}$$

$$= \frac{(1-f)}{n \mu_x^2} \left\{ S_y^2 + \left(\frac{\mu_y}{\mu_x}\right)^2 S_x^2 - 2 \left(\frac{\mu_y}{\mu_x}\right) S_{xy} \right\}.$$

Thus, as an estimate of $MSE(\hat{R}_c)$, we get

$$\hat{v}(\hat{R}_c) = \frac{(1-f)}{n\bar{x}^2} (s_y^2 + \hat{R}_c^2 s_x^2 - 2\hat{R}_c s_{xy}),$$

which is identical to the formula given by Cochran.¹³

Upper and lower bounds of the 90-percent confidence interval about the mean are estimated as

$$\hat{R}_c \pm 1.645 * [\hat{v}(\hat{R}_c)]^{\frac{1}{2}}.$$

3.2.3.2 Percentile Estimation

Define,

$Y(ij)$ = 7-day average consumption of the individual j in time i .

$S(i)$ = temporal adjustment factor for the j^{th} individual who belongs to the survey period i ($i = 1, 2, \dots, 26$).

Let $Y(1), Y(2), \dots, Y(n)$ denote the sample order statistics corresponding to the y_{ij} sample value.

Define a sample based p^{th} percentile estimate as,

$$\hat{Y}_p = \inf_{y_{ij} \in S} \hat{F}(y_{ij}) \geq p$$

where,

¹³ibid. p. 155.

$$\hat{F}(x) = \frac{\sum_{ij \in S} S(i)I(y_{ij} \leq x)}{\hat{N}},$$

$$I(y_{ij} \leq x) = 1, \text{ if } y_{ij} \leq x \\ = 0, \text{ Otherwise.}$$

Thus, computing Y_p is equivalent to finding k ($k = 1, 2, \dots, n$) such that,

$$\hat{F}(y_{(k)}) \leq p < \hat{F}(y_{(k+1)})$$

and setting,

$$\hat{Y}_p = y_{(k)} + \frac{y_{(k+1)} - y_{(k)}}{(\hat{F}(y_{(k+1)}) - \hat{F}(y_{(k)}))} (p - \hat{F}(y_{(k)})).$$

3.2.3.3 Percentile Bootstrap Interval Estimates

In addition to point estimates of the median and upper percentiles of the empirical distributions of 7 days average daily fish consumption, the 90-percent interval estimates for the median, 90th, 95th, and 99th percentiles are reported. Reported interval estimates result from use of the bootstrapping techniques by Efron.¹⁴ A description of the methodology follows.

Step 1. Based on the sample size n , construct the cumulative frequency table for each original distinct consumption amount by aggregating the seasonal adjustment factors of the same consumption amount. Calculate the percent and cumulative percent of the aggregated weights for each distinct consumption amount. Using the cumulative percent of each distinct consumption, construct the range of probability of being selected. The upper bound of the range would be the cumulative percent of the current consumption, and the lower bound would be the upper bound of the previous consumption.

Step 2. Generate a random uniform number (ranged 0 to 1) for each observation in the sample. To generate a set of random uniform numbers, n , assign a new random seed for

¹⁴Efron, Bradley. *The Jackknife, the Bootstrap and Resampling Plans*. 1982. Philadelphia, Pennsylvania: Society for Industrial and Applied Mathematics.

the first unit in the sample and keep adding an arbitrary number to the seed, which will generate the seed of next unit.¹⁵ Using the set of seeds n , generate the random uniform numbers **per seed** to form a set of random uniform numbers n .

Step 3. Using the set of random uniform numbers generated in Step 2, pick up the random consumption amount using the weighted cumulative frequency table in Step 1. Each one of the random uniform numbers falls into a range of probability corresponding to a distinct consumption amount. Replace the random number with the selected consumption amount. An asterisk subscript designates a resampled observation from the original sample. Repeat the selection process until the set of random numbers is completely replaced with the set of random consumption amount. Call such a set of random consumption amount a "resample" (or a random group).

Step 4. Repeat Step 2 and Step 3 for 1,000 times by assigning a new random seed to the first observation of each resample. This produces the following 1,000 sets of resamples, designated R_1 through R_{1000} :

$$\begin{aligned} R_1 &= (x_1^*, x_2^*, \dots, x_n^*) \\ R_2 &= (x_1^*, x_2^*, \dots, x_n^*) \end{aligned}$$

$$\vdots$$

$$R_{1000} = (x_1^*, x_2^*, \dots, x_n^*)$$

Step 5. For each of the 1,000 resamples, calculate estimates of the 50th, 90th, 95th, and 99th percentiles for the estimated distribution of consumption amounts. This produces the following 1,000 sets of percentile estimates:

$$\begin{aligned} P_1 &= (P_{50}^*, P_{90}^*, P_{95}^*, P_{99}^*) \\ P_2 &= (P_{50}^*, P_{90}^*, P_{95}^*, P_{99}^*) \end{aligned}$$

$$\vdots$$

$$P_{1000} = (P_{50}^*, P_{90}^*, P_{95}^*, P_{99}^*)$$

Step 6. Using the 1,000 sets of percentile estimates, create the empirical distribution of each percentile. To illustrate, the lower bound of the 90-percent interval estimate for the 50th percentile would be the the value of 5th percentile in the empirical distribution of P_{50} 's. Likewise the upper bound would be the 95th percentile of P_{50} 's.

¹⁵SAS Language: Reference, Version 6. First Edition. 1990. SAS Institute Inc., Cary, NC.

Chapters 4, 5, and 6 present point and interval per capita fish consumption estimates by type of fish (sport, commercial, and all fish) for requested population subgroups divided by ethnic group (minority/non-minority), income group (low income/non-low-income), ethnic and income group (minority low-income/non-minority low-income), income level (\$0-\$14,999/\$15,000-\$24,999/\$25,000-\$39,999/\$40,000 or more), and species of fish consumed. Point estimates include mean, median, 90th, 95th, and 99th percentiles. Interval estimates include 90-percent confidence intervals about the mean, and 90-percent bootstrap intervals for the percentiles. Also provided are average per capita fish consumption estimates by species with 90-percent confidence intervals about the mean. All estimates are reported in grams/person/day.

4. SELF-IDENTIFIED FISH EATERS - SPORT FISH - TABLES AND FIGURES

Chapter 4 presents tables with point and interval per capita estimates of sport fish consumption for fish eater population subgroups. Subgroups are divided by ethnic group, income group, ethnic and income groups, and income level. Corresponding tables of estimates are numbered 4-1, 4-2, 4-3, and 4-4. Estimates also are presented for fish consumption by species of fish consumed (Tables 4-5 and 4-6) and by those fish eaters consuming less than 150 grams of sport fish per day (Table 4-7). Point estimates include mean, median, 90th, 95th, and 99th percentiles. Interval estimates include 90-percent confidence intervals about the mean, and 90-percent bootstrap intervals for the percentiles. Also provided are average per capita fish consumption estimates by species with 90-percent confidence intervals about the mean. All estimates are reported in grams/person/day.

Figures augmenting the estimates in Tables 4-1 through 4-3 appear at the end of this chapter. Table 4-1 shows average daily per capita estimates of sport fish consumption by self-reported fish eaters by ethnic group. The ethnic group is divided into classifications of minority, non-minority, and total (both minority and non-minority groups combined). Each of these divisions, or "classifications," has two graphics associated with it—one histogram and one empirical cumulative distribution of average daily per capita consumption. The figures are numbered to correspond to the tables. For example, Table 4-1 has six figures associated with it—two for each of the three ethnic group divisions (minority, non-minority, and total). All of these graphics begin as "Figure 4-1..." to correspond to Table 4-1. A letter designates the classification, such that the figure associated with the minority classification is designated "Figure 4-1a...", non-minority is designated "Figure 4-1b...", and total is designated "Figure 4-1c...." Because there are two graphics associated with each classification, they are labeled 4-1a.1 and 4-1a.2; the histogram being the first figure (4-1a.1) and the cumulative distribution being the second (Figure 4-1a.2).

TABLE 4-1. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION

Sport Fish, Michigan Sport Anglers, Fish Eaters by Ethnic Group

Classification	Statistic	Grams/person/day		
		Estimate	90% Interval*	
			Lower Bound	Upper Bound
Minority	Mean	23.22	15.20	31.23
n = 163	50th %	0.00	0.00	0.00
N = 24,210	90th %	63.19	45.56	75.20
	95th %	79.50	67.57	95.51
	99th %	386.68	92.82	489.79
Non-minority	Mean	16.28	15.13	17.43
n = 2,288	50th %	0.00	0.00	0.00
N = 344,347	90th %	61.23	45.08	62.27
	95th %	77.65	74.11	80.31
	99th %	145.20	126.69	155.24
Total	Mean	16.74	15.54	17.94
n = 2,451	50th %	0.00	0.00	0.00
N = 368,557	90th %	61.23	50.13	62.41
	95th %	77.90	74.96	80.35
	99th %	146.54	128.85	158.14

* Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

Note: Fish Eaters = self-identified fish eater

n = sample size

N = population size

Estimates are projected to the population of Michigan Sport Anglers, a sampled individual represents 150.37 individuals in the population.

TABLE 4-2. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION

Sport Fish, Michigan Sport Anglers, Fish Eaters by Income Group

Classification	Statistic	Grams/person/day		
		Estimate	90% Interval*	
			Lower Bound	Upper Bound
Low-income (<\$25,000)	Mean	20.82	17.88	23.76
n = 663	50th %	0.00	0.00	0.00
N = 99,094	90th %	63.24	61.23	64.91
	95th %	81.58	75.36	99.69
	99th %	183.95	128.04	260.00
Non-low-income (>=\$25,000)	Mean	15.93	14.56	17.30
n = 1,531	50th %	0.00	0.00	0.00
N = 230,818	90th %	61.22	40.82	62.45
	95th %	77.52	73.61	80.42
	99th %	143.03	122.45	152.43
Total	Mean	17.40	16.10	18.70
n = 2,194	50th %	0.00	0.00	0.00
N = 329,912	90th %	61.72	57.63	62.83
	95th %	78.71	75.76	81.17
	99th %	147.65	130.86	160.61

* Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

Note: Fish Eaters = self-identified fish eater

n = sample size

N = population size

Estimates are projected to the population of Michigan Sport Anglers, a sampled individual represents 150.37 individuals in the population.

TABLE 4-3. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION

Sport Fish, Michigan Sport Anglers, Fish Eaters by Ethnic Group and Income Group

Classification	Statistic	Grams/person/day		
		Estimate	90% Interval*	
			Lower Bound	Upper Bound
Minority/low-income	Mean	43.05	23.46	62.64
n = 61	50th %	0.00	0.00	18.71
N = 9,022	90th %	80.44	64.69	105.31
	95th %	109.67	79.49	470.20
	99th %	489.79	177.14	489.79
Non-minority/low-income	Mean	16.68	15.46	17.90
n = 2,133	50th %	0.00	0.00	0.00
N = 320,890	90th %	61.37	51.60	62.54
	95th %	78.01	74.75	80.62
	99th %	146.27	127.90	156.80
Total	Mean	17.40	16.10	18.70
n = 2,194	50th %	0.00	0.00	0.00
N = 329,912	90th %	61.72	57.63	62.83
	95th %	78.71	75.76	81.17
	99th %	147.65	130.86	160.61

* Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

Note: Fish Eaters = self-identified fish eater

n = sample size

N = population size

Estimates are projected to the population of Michigan Sport Anglers, a sampled individual represents 150.37 individuals in the population.

TABLE 4-4. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION

Sport Fish, Michigan Sport Anglers, Fish Eaters by Income Level

Classification	Statistic	Estimate	Grams/person/day	
			90% Interval*	
			Lower Bound	Upper Bound
0 - \$14,999 n = 285 N = 43,607	Mean	21.05	17.02	25.08
	50th %	0.00	0.00	0.00
	90th %	64.92	61.23	76.06
	95th %	93.11	76.33	109.33
	99th %	163.26	119.08	233.47
\$15,000 - \$24,999 n = 378 N = 55,487	Mean	20.63	16.43	24.82
	50th %	0.00	0.00	0.00
	90th %	62.19	41.74	64.11
	95th %	78.39	64.79	87.48
	99th %	185.78	116.08	431.67
\$25,000 - \$39,999 n = 658 N = 99,695	Mean	17.54	15.26	19.83
	50th %	0.00	0.00	0.00
	90th %	62.43	54.69	64.69
	95th %	80.49	75.62	95.55
	99th %	146.18	127.45	159.05
\$40,000 or more n = 873 N = 131,123	Mean	14.71	13.07	16.35
	50th %	0.00	0.00	0.00
	90th %	40.82	39.55	61.62
	95th %	74.32	64.78	78.92
	99th %	122.45	109.76	149.14
Total n = 2,194 N = 329,912	Mean	17.40	16.10	18.70
	50th %	0.00	0.00	0.00
	90th %	61.72	57.63	62.83
	95th %	78.71	75.76	81.17
	99th %	147.65	130.86	160.61

* Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

Note: Fish Eaters = self-identified fish eater

n = sample size

N = population size

Estimates are projected to the population of Michigan Sport Anglers, a sampled individual represents 150.37 individuals in the population.

TABLE 4-5. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION BY SPECIES

Sport Fish, Michigan Sport Anglers, Fish Eaters

Species	# of Individuals Consuming Each Species *	% of Population Consuming Each Species	Mean Estimate (grams/person/day)	90% Confidence Interval	
				Lower Bound	Upper Bound
1 Bass (Largemouth)	53	2.12	0.73	0.55	0.91
2 Bass (Smallmouth)	12	0.48	0.16	0.08	0.24
3 Bluegill	148	5.87	2.20	1.87	2.53
4 Bowfin	1	0.03	0.01	0.00	0.03
5 Buffalo	2	0.08	0.02	0.00	0.04
6 Bullhead	9	0.39	0.13	0.05	0.21
7 Burpot	2	0.07	0.03	0.00	0.06
8 Carp	2	0.07	0.03	0.00	0.06
9 Catfish	21	0.82	0.29	0.17	0.41
10 Cisco	1	0.05	0.01	0.00	0.03
11 Cod	7	0.30	0.07	0.02	0.12
12 Crappie	32	1.33	0.49	0.33	0.65
13 Drum	0	0.00	0.00	0.00	0.00
14 Gar	0	0.00	0.00	0.00	0.00
15 Haddock	1	0.04	0.02	0.00	0.05
16 Menominee	0	0.00	0.00	0.00	0.00
17 Musky (Nothern or Great Lake)	0	0.00	0.00	0.00	0.00
18 Musky (Tiger)	1	0.04	0.02	0.00	0.05
19 Orange roughy	2	0.07	0.02	0.00	0.04
20 Perch (Ocean)	5	0.18	0.05	0.02	0.08
21 Perch (Yellow)	199	8.12	3.03	2.62	3.44
22 Pike (Nothern)	60	2.46	0.97	0.72	1.22
23 Pollok	0	0.00	0.00	0.00	0.00
24 Quillback	0	0.00	0.00	0.00	0.00
25 Redfish	0	0.00	0.00	0.00	0.00
26 Redhorse	1	0.04	0.01	0.00	0.03
27 Rockbass	9	0.37	0.11	0.04	0.18
28 Salmon	55	2.23	0.95	0.69	1.21
29 Salmon (Atlantic)	0	0.00	0.00	0.00	0.00
30 Salmon (Coho)	18	0.70	0.29	0.17	0.41

* Sample Size = 2,451

Population = 368,557

TABLE 4-5. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION BY SPECIES

Sport Fish, Michigan Sport Anglers, Fish Eaters

Species	# of Individuals	% of Population	Mean Estimate	90% Confidence Interval	
	Consuming Each Species *	Consuming Each Species		Lower Bound	Upper Bound
31 Salmon (Chinook)	8	0.30	0.11	0.04	0.18
32 Salmon (King)	7	0.27	0.09	0.02	0.16
33 Salmon (Pink)	4	0.15	0.06	0.00	0.13
34 Sauger	0	0.00	0.00	0.00	0.00
35 Smelt	32	1.37	0.50	0.34	0.66
36 Splake (hybrid trout)	0	0.00	0.00	0.00	0.00
37 Sturgeon	0	0.00	0.00	0.00	0.00
38 Sucker (Longnose)	1	0.05	0.02	0.00	0.05
39 Sucker (White)	14	0.53	0.17	0.09	0.25
40 Sunfish	4	0.15	0.05	0.00	0.10
41 Trout (Brook)	22	0.87	0.31	0.19	0.43
42 Trout (Brown)	31	1.24	0.48	0.32	0.64
43 Trout (Lake)	45	1.86	0.70	0.52	0.88
44 Trout (Rainbow)	43	1.76	0.69	0.49	0.89
45 Tuna	8	0.33	0.14	0.04	0.24
46 Walleye	172	6.83	2.59	2.23	2.95
47 Warmouth Bass	0	0.00	0.00	0.00	0.00
48 Whitebass	6	0.24	0.07	0.02	0.12
49 Whitefish	15	0.57	0.21	0.11	0.31
50 Other Single Species	19	0.85	0.27	0.15	0.39
51 Bass and Bluegills	2	0.07	0.04	0.00	0.09
52 Perch and Bluegills	9	0.36	0.11	0.04	0.18
53 Pike and Perch	1	0.04	0.01	0.00	0.03
54 Walleye and Perch	1	0.05	0.01	0.00	0.03
55 Other Combinations	4	0.16	0.08	0.01	0.15
56 Species Not Recorded	41	1.78	0.40	0.28	0.52

* Sample Size = 2,451
Population = 368,557

TABLE 4-6. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION BY SPECIES

Sport Fish, Michigan Sport Anglers, Fish Eaters
 Minority/Low-Income Group **

Species	# of Individuals Consuming Each Species *	% of Population Consuming Each Species	Mean Estimate (grams/person/day)	90% Confidence Interval	
				Lower Bound	Upper Bound
1 Bass (Largemouth)	3	4.70	1.65	0.12	3.18
2 Bass (Smallmouth)	0	0.00	0.00	0.00	0.00
3 Bluegill	8	2.15	4.43	1.73	7.13
4 Bowfin	0	0.00	0.00	0.00	0.00
5 Buffalo	0	0.00	0.00	0.00	0.00
6 Bullhead	2	3.17	1.15	0.00	2.47
7 Burpot	0	0.00	0.00	0.00	0.00
8 Carp	1	1.43	0.58	0.00	1.53
9 Catfish	5	7.52	3.10	0.65	5.55
10 Cisco	0	0.00	0.00	0.00	0.00
11 Cod	0	0.00	0.00	0.00	0.00
12 Crappie	3	4.75	2.14	0.00	4.36
13 Drum	0	0.00	0.00	0.00	0.00
14 Gar	0	0.00	0.00	0.00	0.00
15 Haddock	0	0.00	0.00	0.00	0.00
16 Menominee	0	0.00	0.00	0.00	0.00
17 Musky (Nothern or Great Lake)	0	0.00	0.00	0.00	0.00
18 Musky (Tiger)	0	0.00	0.00	0.00	0.00
19 Orange roughy	0	0.00	0.00	0.00	0.00
20 Perch (Ocean)	0	0.00	0.00	0.00	0.00
21 Perch (Yellow)	9	4.30	9.66	1.67	17.65
22 Pike (Nothern)	3	4.06	1.66	0.11	3.21
23 Pollok	0	0.00	0.00	0.00	0.00
24 Quillback	0	0.00	0.00	0.00	0.00
25 Redfish	0	0.00	0.00	0.00	0.00
26 Redhorse	0	0.00	0.00	0.00	0.00
27 Rockbass	0	0.00	0.00	0.00	0.00
28 Salmon	1	1.43	0.58	0.00	1.53
29 Salmon (Atlantic)	0	0.00	0.00	0.00	0.00
30 Salmon (Coho)	1	1.56	0.51	0.00	1.35

* Sample Size = 61
 Population = 9,022

** Non-white sport fishing license holders whose annual household income in 1990 was less than \$25,000.

TABLE 4-6. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION BY SPECIES

Sport Fish, Michigan Sport Anglers, Fish Eaters
 Minority/Low-Income Group **

Species	# of Individuals Consuming Each Species *	% of Population Consuming Each Species	Mean Estimate (grams/person/day)	90% Confidence Interval	
				Lower Bound	Upper Bound
31 Salmon (Chinook)	1	1.56	0.51	0.00	1.35
32 Salmon (King)	1	1.80	0.73	0.00	1.93
33 Salmon (Pink)	0	0.00	0.00	0.00	0.00
34 Sauger	0	0.00	0.00	0.00	0.00
35 Smelt	2	3.31	0.97	0.00	2.11
36 Splake (hybrid trout)	0	0.00	0.00	0.00	0.00
37 Sturgeon	0	0.00	0.00	0.00	0.00
38 Sucker (Longnose)	0	0.00	0.00	0.00	0.00
39 Sucker (White)	3	4.50	1.10	0.03	2.17
40 Sunfish	2	3.17	1.15	0.00	2.47
41 Trout (Brook)	2	3.00	0.90	0.00	1.99
42 Trout (Brown)	2	2.97	1.09	0.00	2.34
43 Trout (Lake)	2	2.85	1.05	0.00	2.27
44 Trout (Rainbow)	1	1.43	0.58	0.00	1.53
45 Tuna	0	0.00	0.00	0.00	0.00
46 Walleye	4	6.51	2.22	0.36	4.08
47 Warmouth Bass	0	0.00	0.00	0.00	0.00
48 Whitebass	1	1.88	0.77	0.00	2.02
49 Whitefish	4	5.99	2.93	0.41	5.45
50 Other Single Species	3	4.88	1.99	0.11	3.87
51 Bass and Bluegills	0	0.00	0.00	0.00	0.00
52 Perch and Bluegills	0	0.00	0.00	0.00	0.00
53 Pike and Perch	0	0.00	0.00	0.00	0.00
54 Walleye and Perch	0	0.00	0.00	0.00	0.00
55 Other Combinations	0	0.00	0.00	0.00	0.00
56 Species Not Recorded	3	4.88	1.60	0.09	3.11

* Sample Size = 61

Population = 9,022

** Non-white sport fishing license holders whose annual household income in 1990 was less than \$25,000.

Table 4-7. Estimated Percent of Angler Population Consuming Less Than 150 Grams of Sport Fish per Day

Sport Fish, Michigan Sport Anglers, Fish Eaters

Sub Population	Sample Size	Estimated Population Size	Estimated No. of Individuals Consuming < 150g/day	Estimated Percent of Population Consuming < 150g/day	Lower 90% Bound for Percent Estimate	Upper 90% Bound for Percent Estimate
All	2,451	368,557	365,098	99.1	98.3	99.8
Minority/ Low Income*	61	9,022	8,571	95.0	91.8	98.2

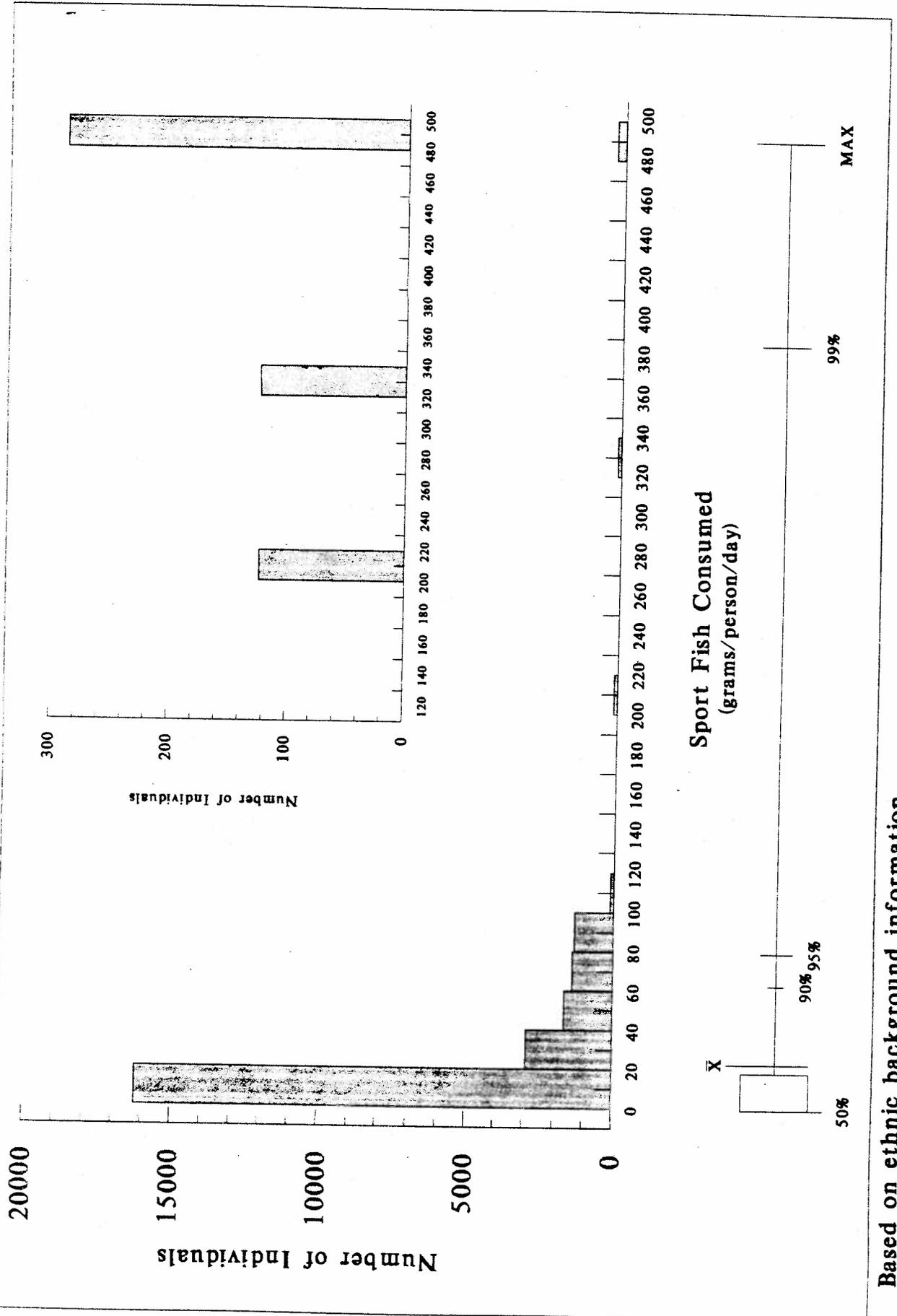
* Non-white sport fishing license holders whose annual household income in 1990 was less than \$25,000.

CHAPTER 4 FIGURES

Figure 4-1a.1. HISTOGRAM OF AVERAGE DAILY PER CAPITA FISH CONSUMPTION

Sport Fish, Michigan Sport Anglers, Fish Eaters

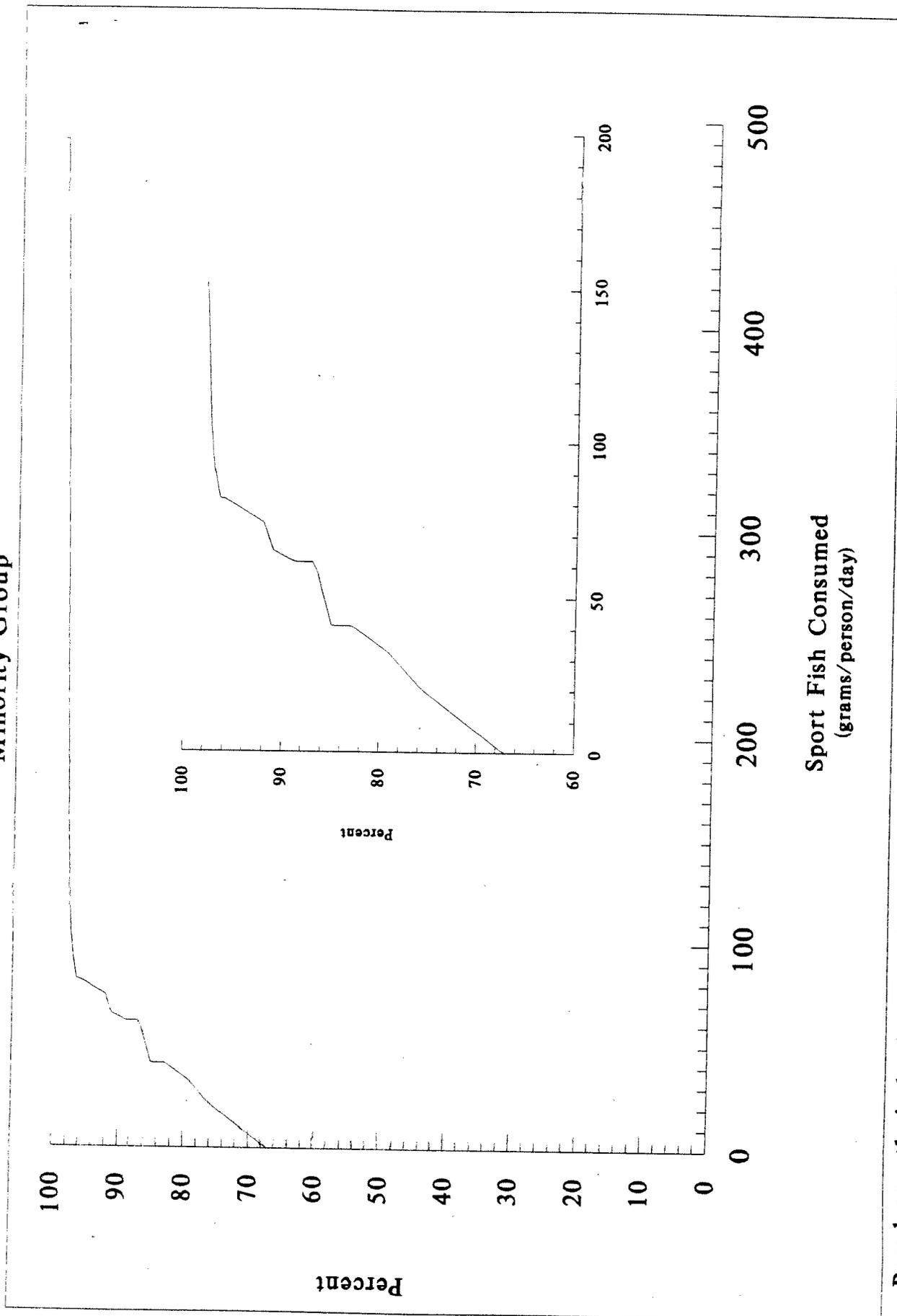
Minority Group



Based on ethnic background information.

Figure 4-1a.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION

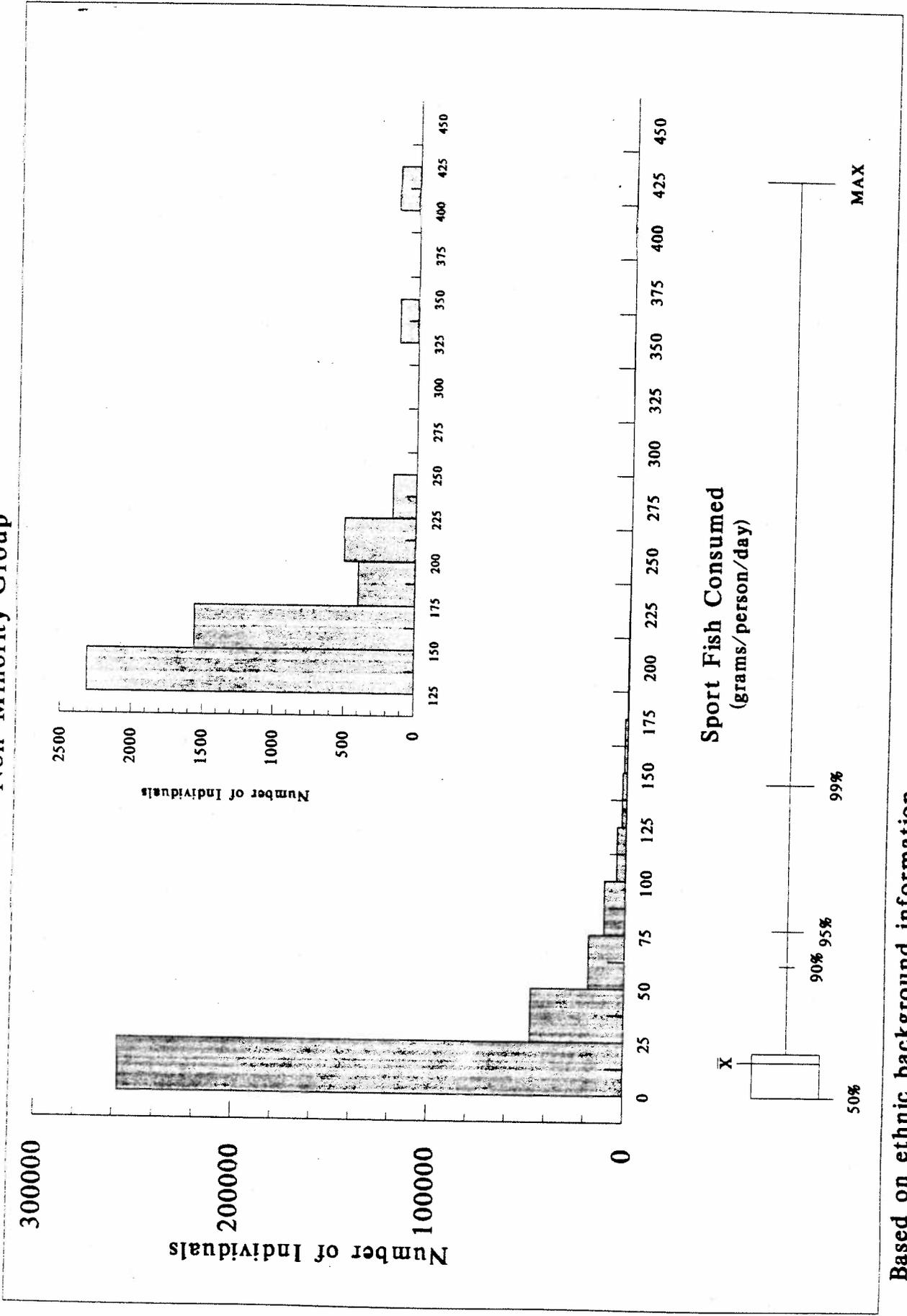
Sport Fish, Michigan Sport Anglers, Fish Eaters
 Minority Group



Based on ethnic background information.

Figure 4-1b.1. HISTOGRAM OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION

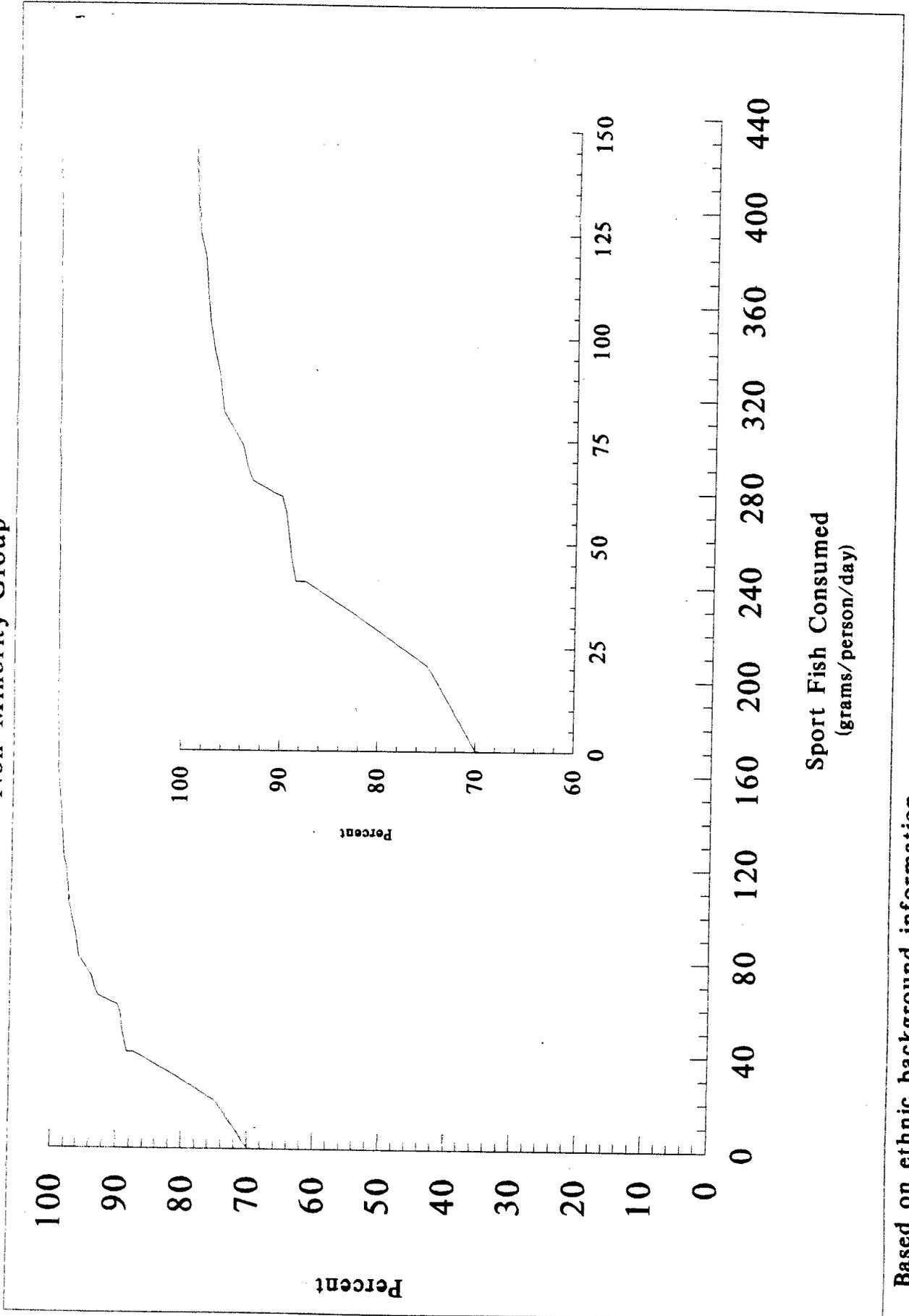
Sport Fish, Michigan Sport Anglers, Fish Eaters
Non-Minority Group



Based on ethnic background information.

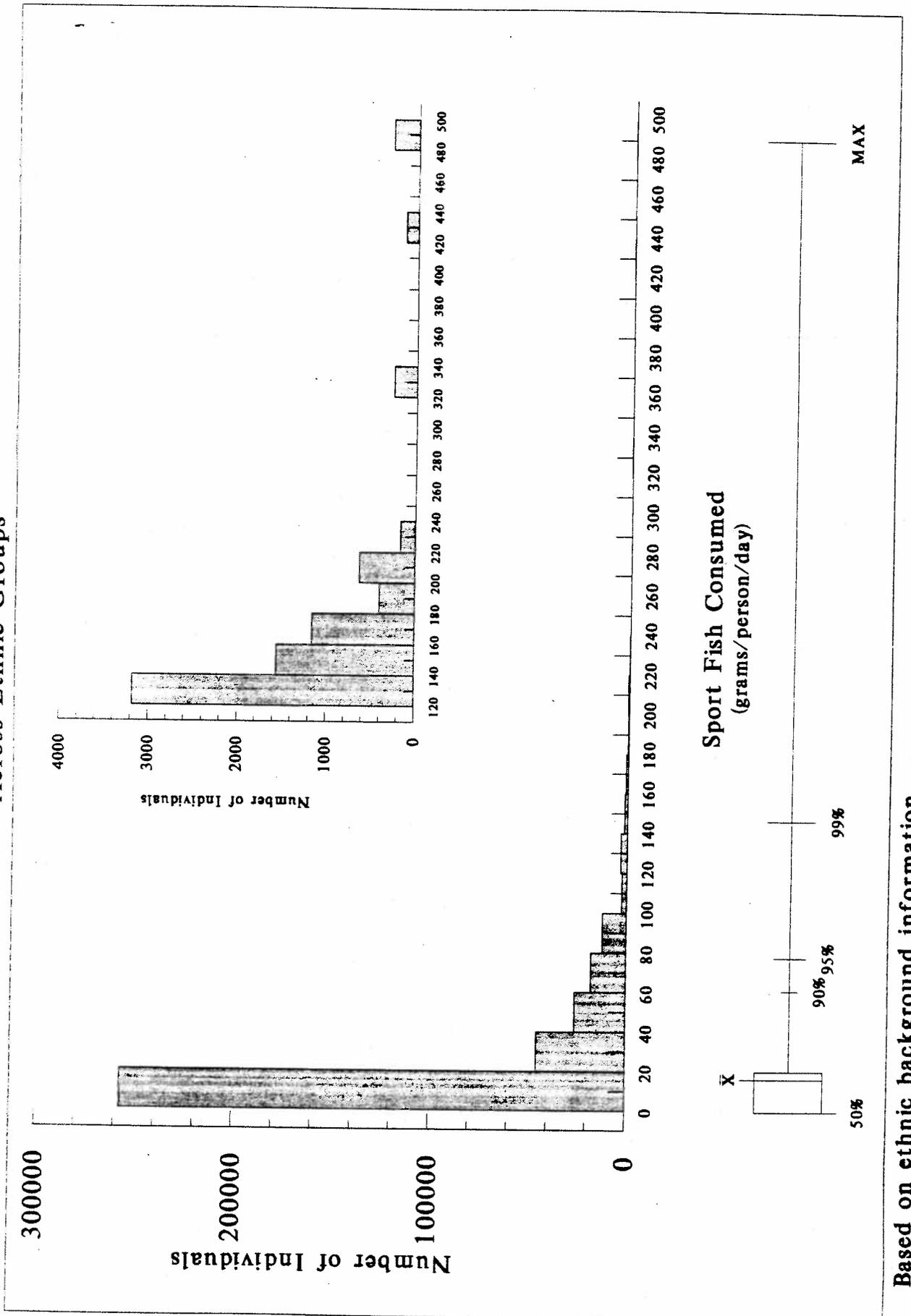
Figure 4-1b.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION

Sport Fish, Michigan Sport Anglers, Fish Eaters
 Non-Minority Group



Based on ethnic background information.

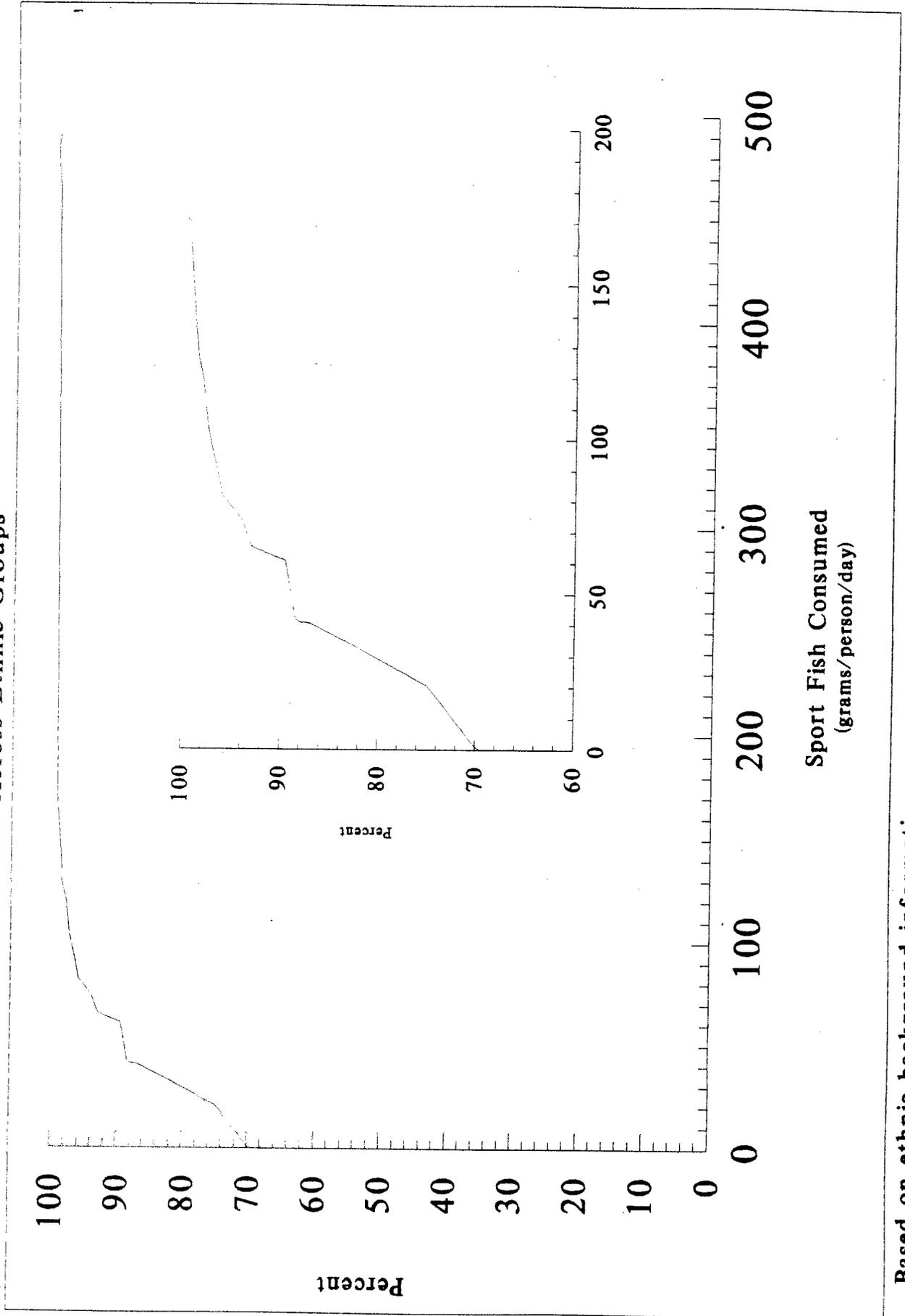
Figure 4-1c.1. HISTOGRAM OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION
 Sport Fish, Michigan Sport Anglers, Fish Eaters
 Across Ethnic Groups



Based on ethnic background information.

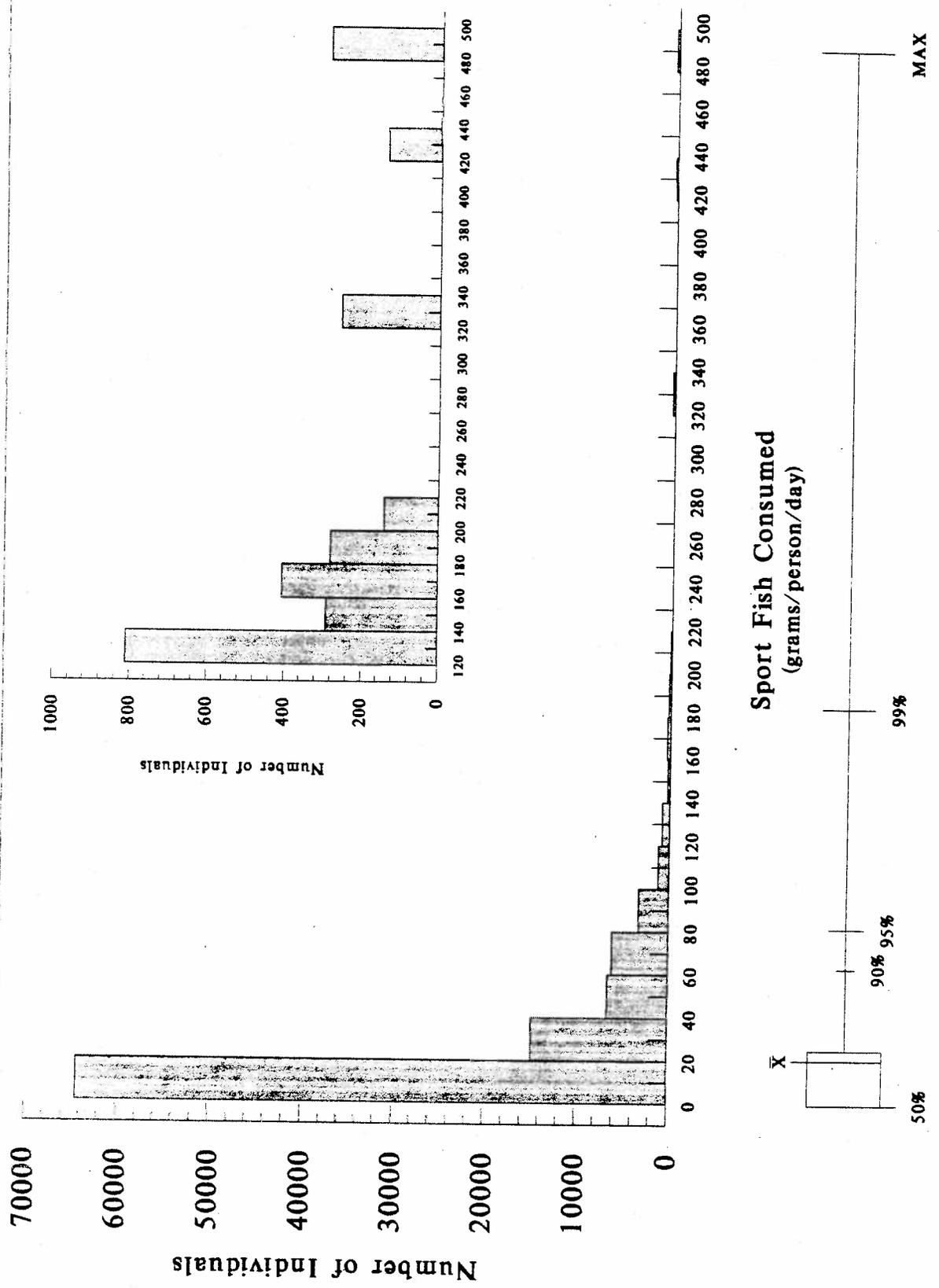
Figure 4-1c.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION

Sport Fish. Michigan Sport Anglers. Fish Eaters
 Across Ethnic Groups



Based on ethnic background information.

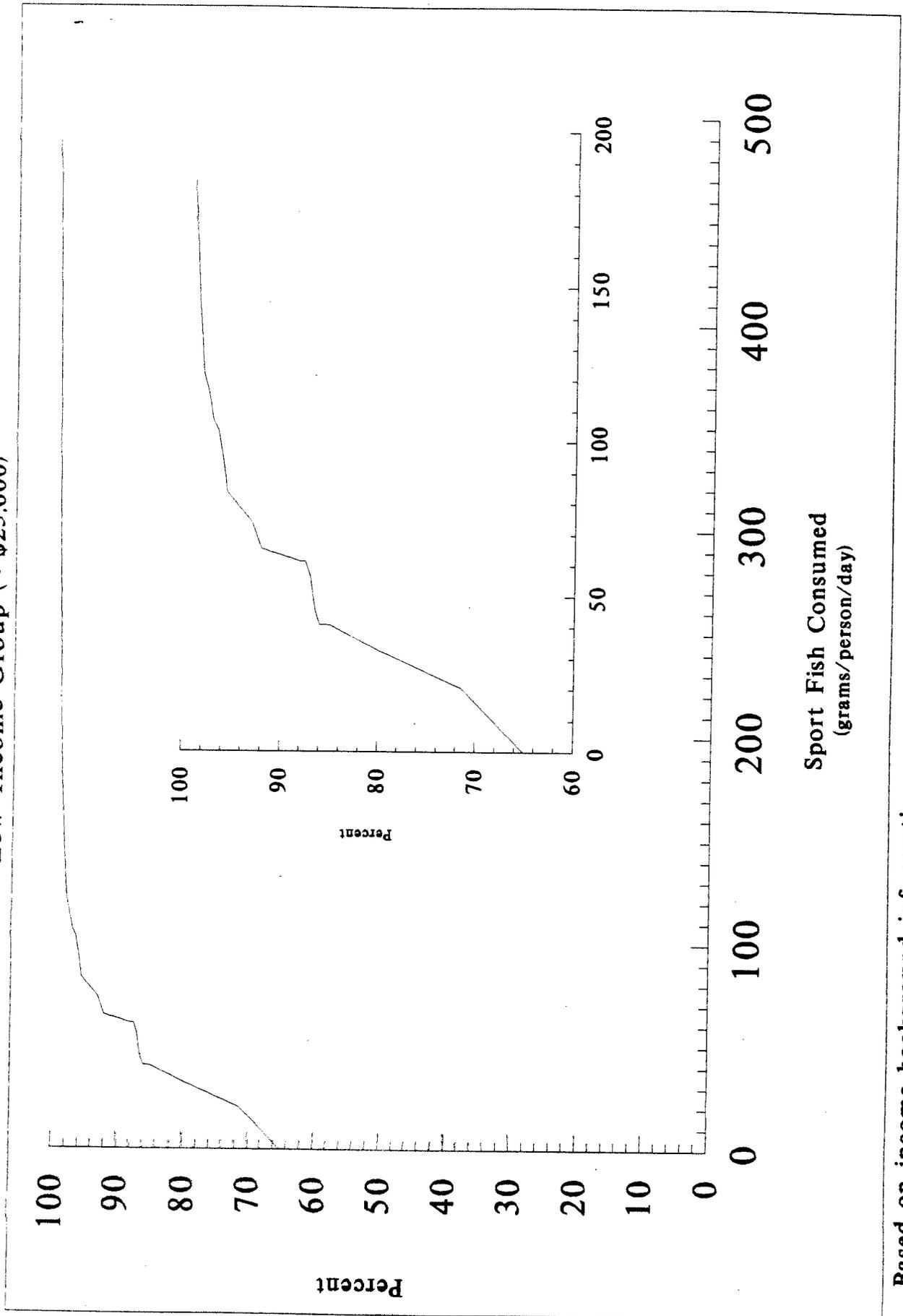
**Figure 4-2a.1. HISTOGRAM OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION
Sport Fish, Michigan Sport Anglers, Fish Eaters
Low-Income Group (< \$25,000)**



Based on income background information.

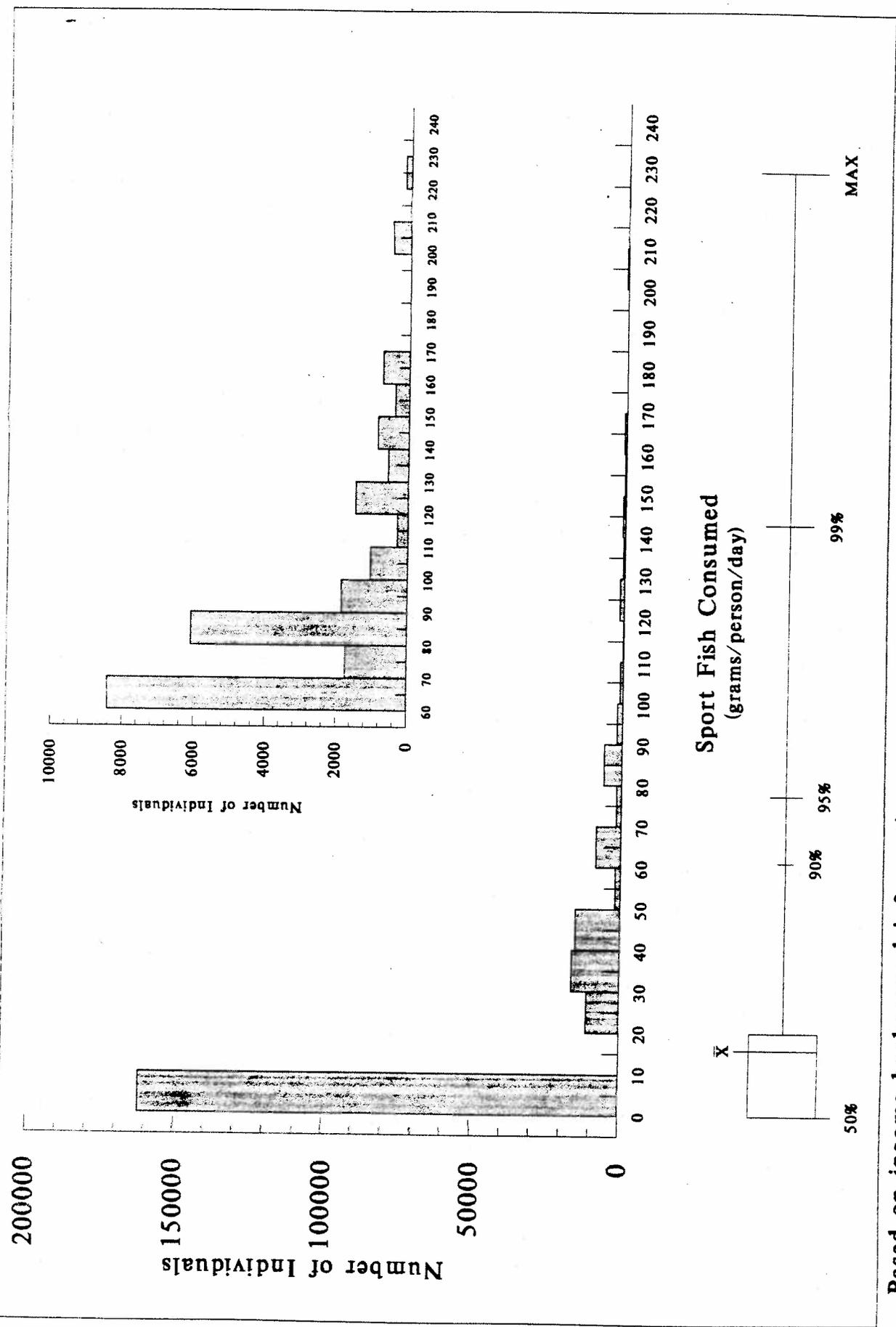
Figure 4-2a.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY PER CAPITA FISH CONSUMPTION

Sport Fish, Michigan Sport Anglers, Fish Eaters
 Low-Income Group (< \$25,000)



Based on income background information.

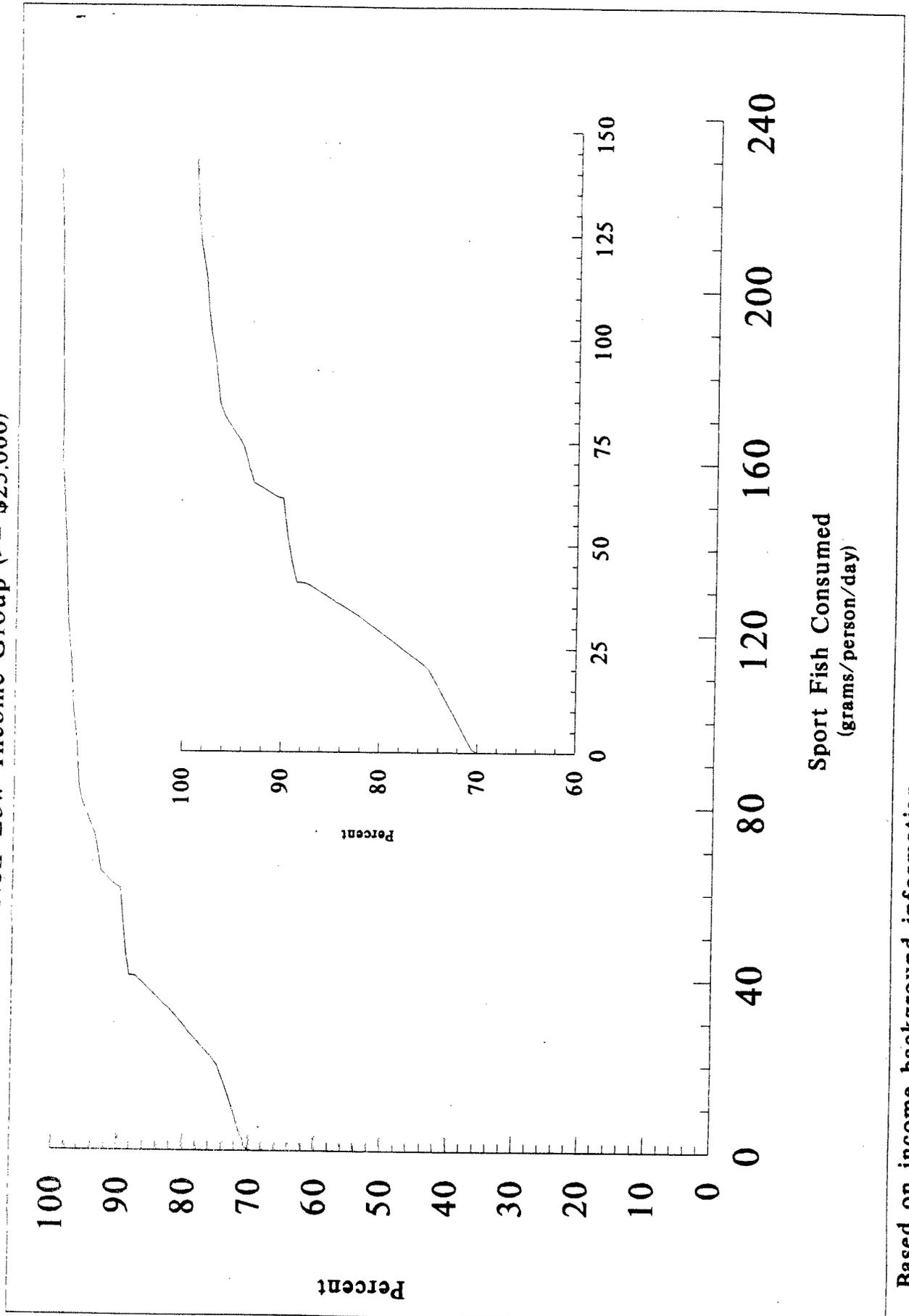
Figure 4-2b.1. HISTOGRAM OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION
 Sport Fish, Michigan Sport Anglers, Fish Eaters
 Non-Low-Income Group (>= \$25,000)



Based on income background information.

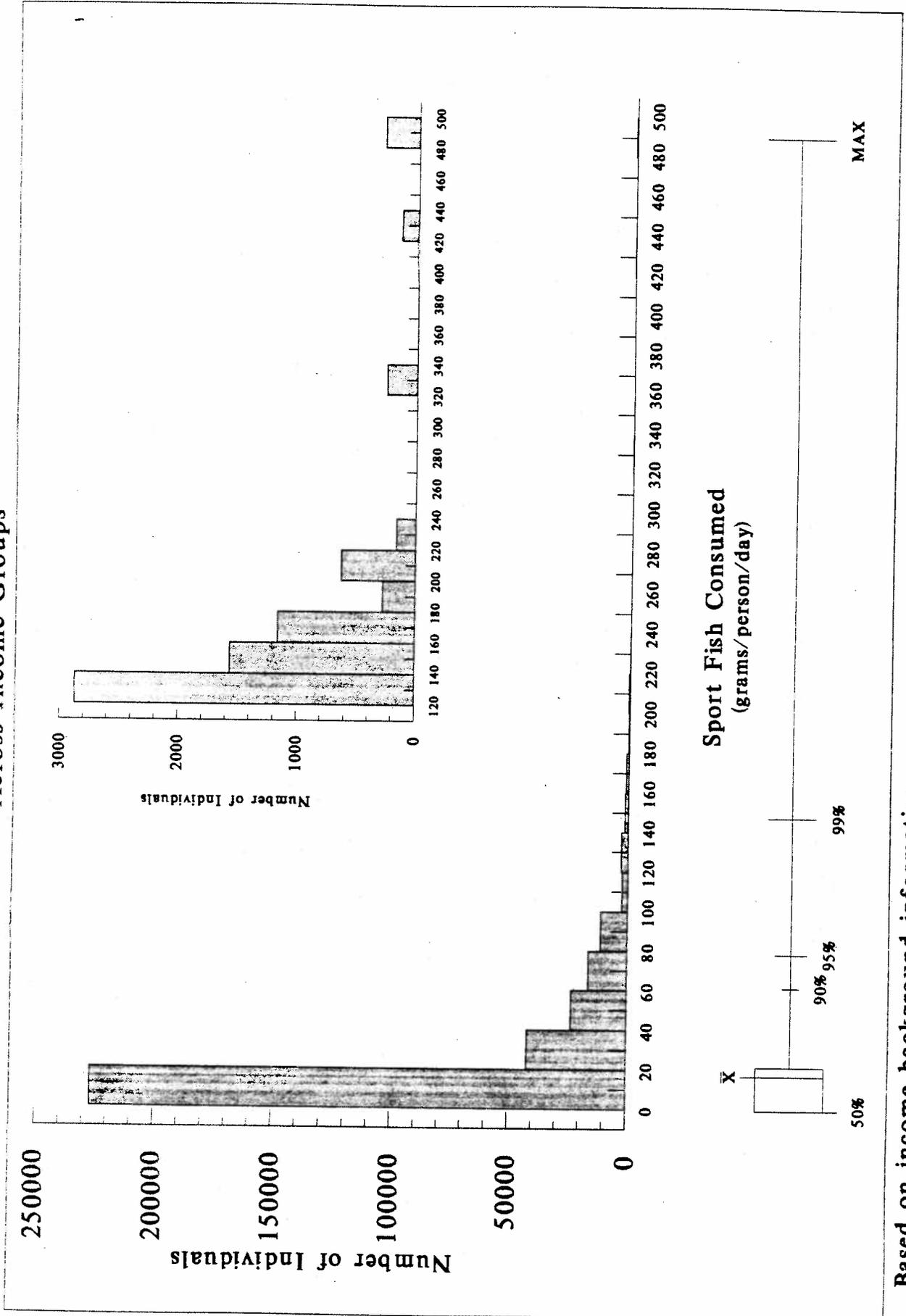
Figure 4-2b.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION

Sport Fish, Michigan Sport Anglers, Fish Eaters
Non-Low-Income Group (\geq \$25,000)



Based on income background information.

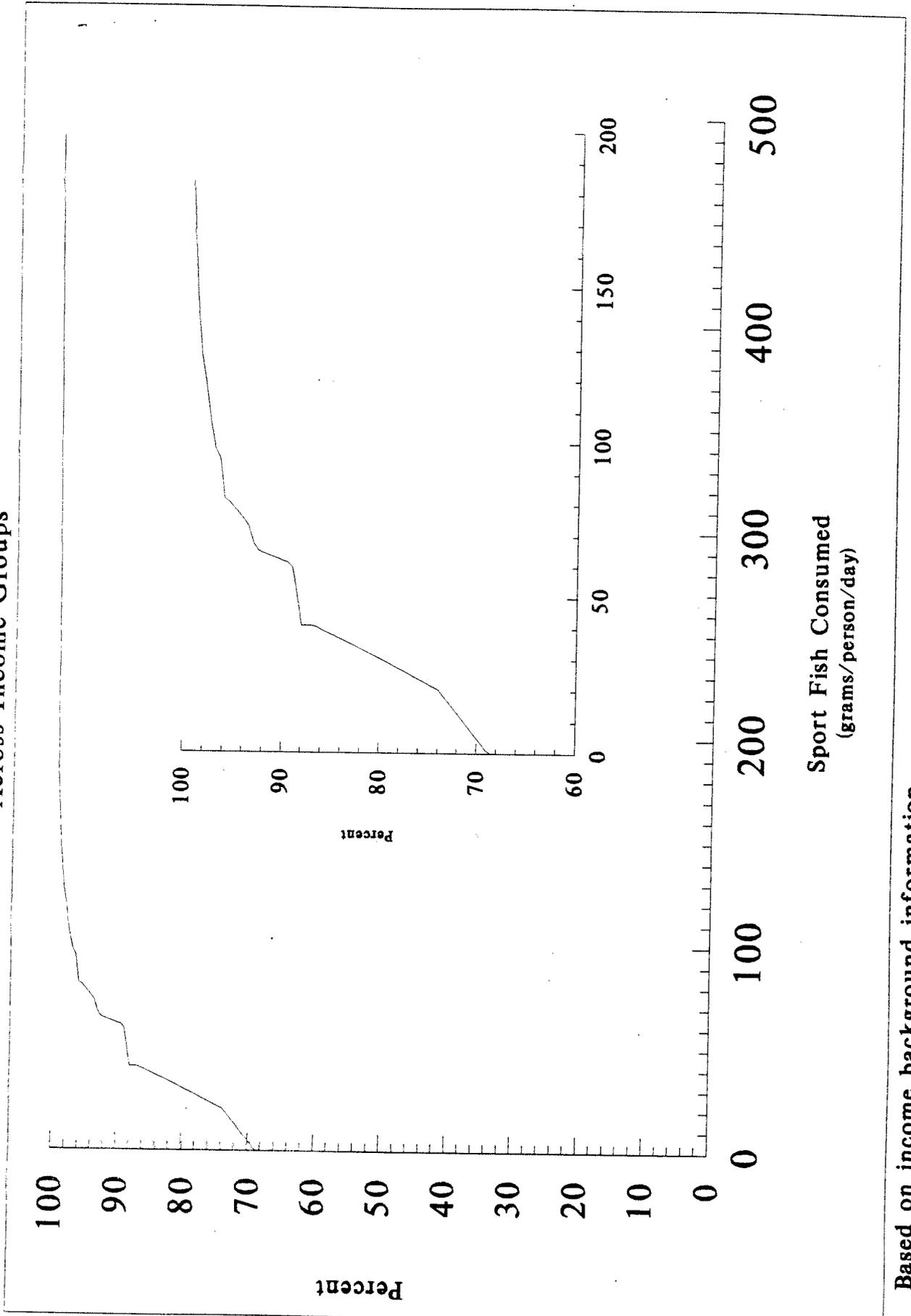
Figure 4-2c.1. HISTOGRAM OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION
 Sport Fish. Michigan Sport Anglers. Fish Eaters
 Across Income Groups



Based on income background information.

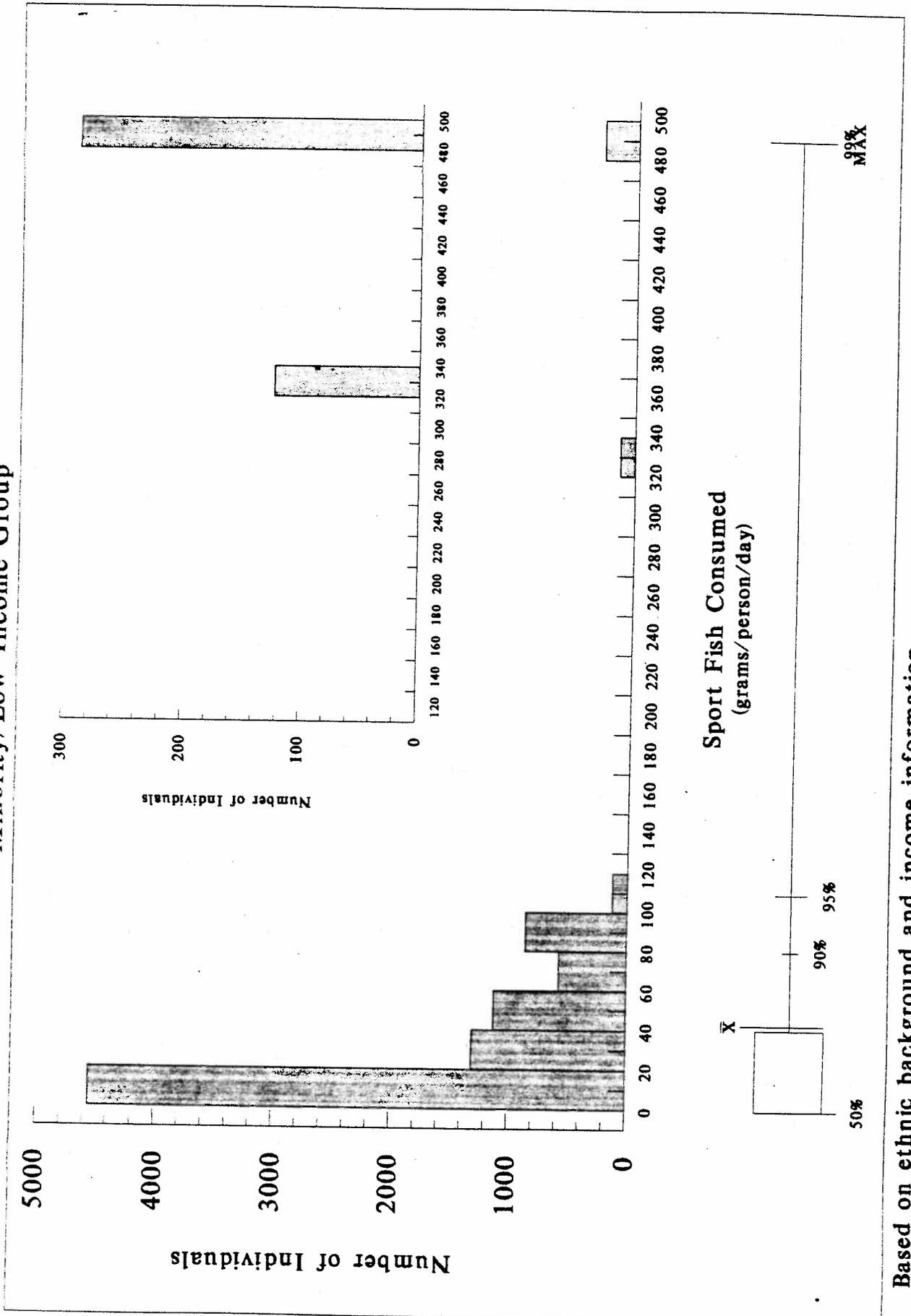
**Figure 4-2c.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION**

**Sport Fish. Michigan Sport Anglers. Fish Eaters
Across Income Groups**



Based on income background information.

Figure 4-3a.1. HISTOGRAM OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION
 Sport Fish, Michigan Sport Anglers, Fish Eaters
 Minority/Low-Income Group

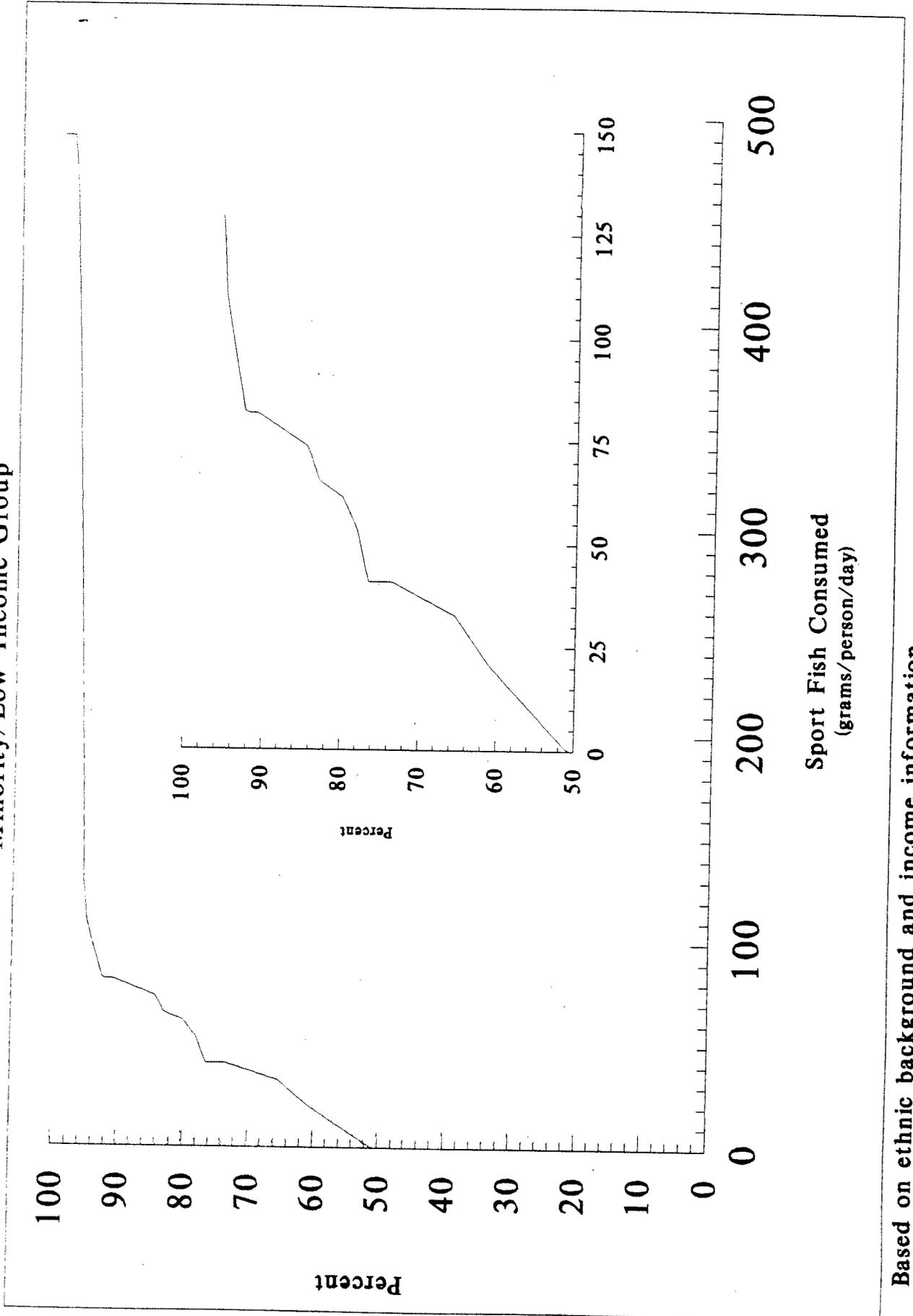


Based on ethnic background and income information.

Figure 4-3a.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY PER CAPITA FISH CONSUMPTION

Sport Fish, Michigan Sport Anglers, Fish Eaters

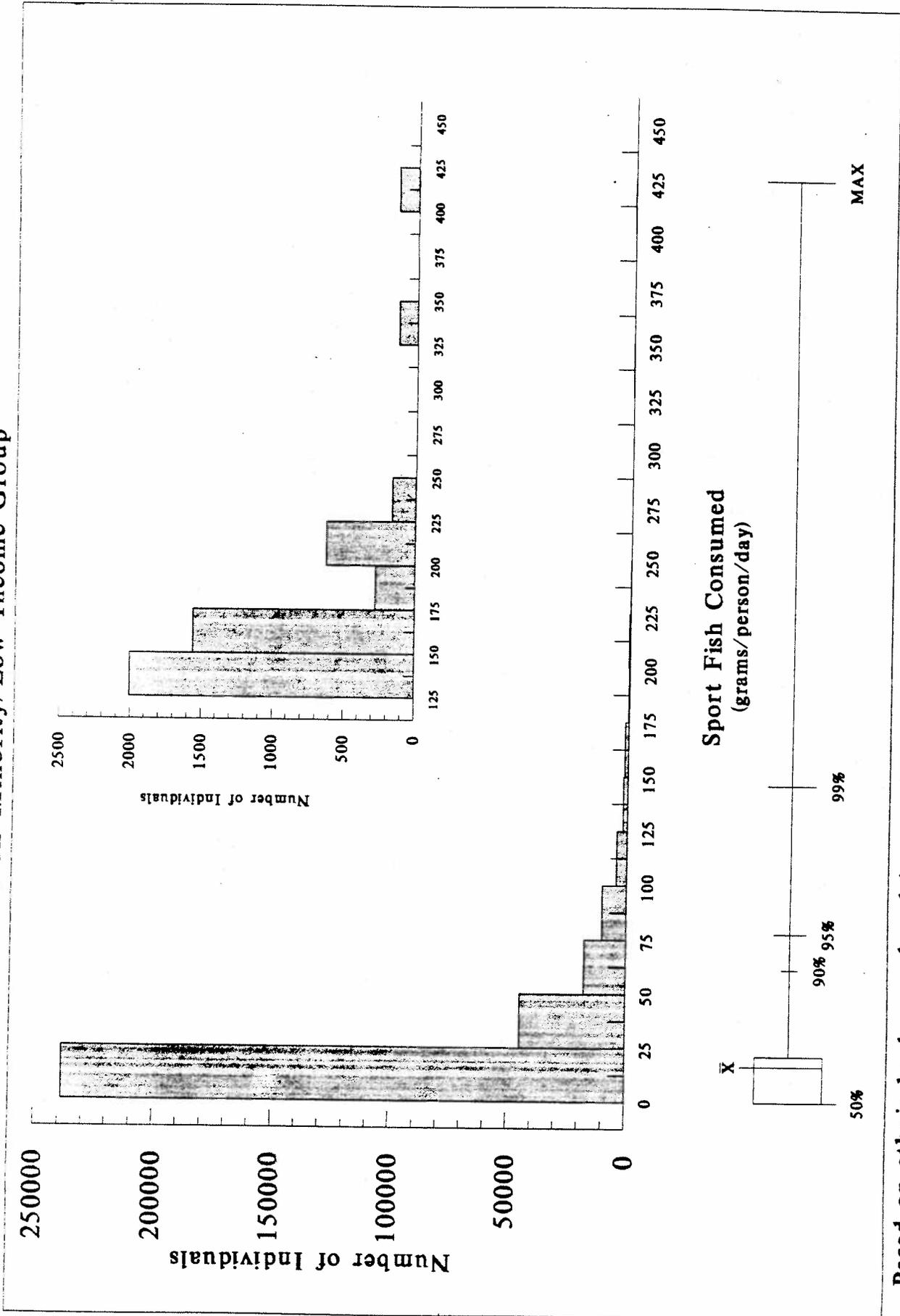
Minority/Low-Income Group



Based on ethnic background and income information.

Figure 4-3b.1. HISTOGRAM OF AVERAGE DAILY PER CAPITA FISH CONSUMPTION

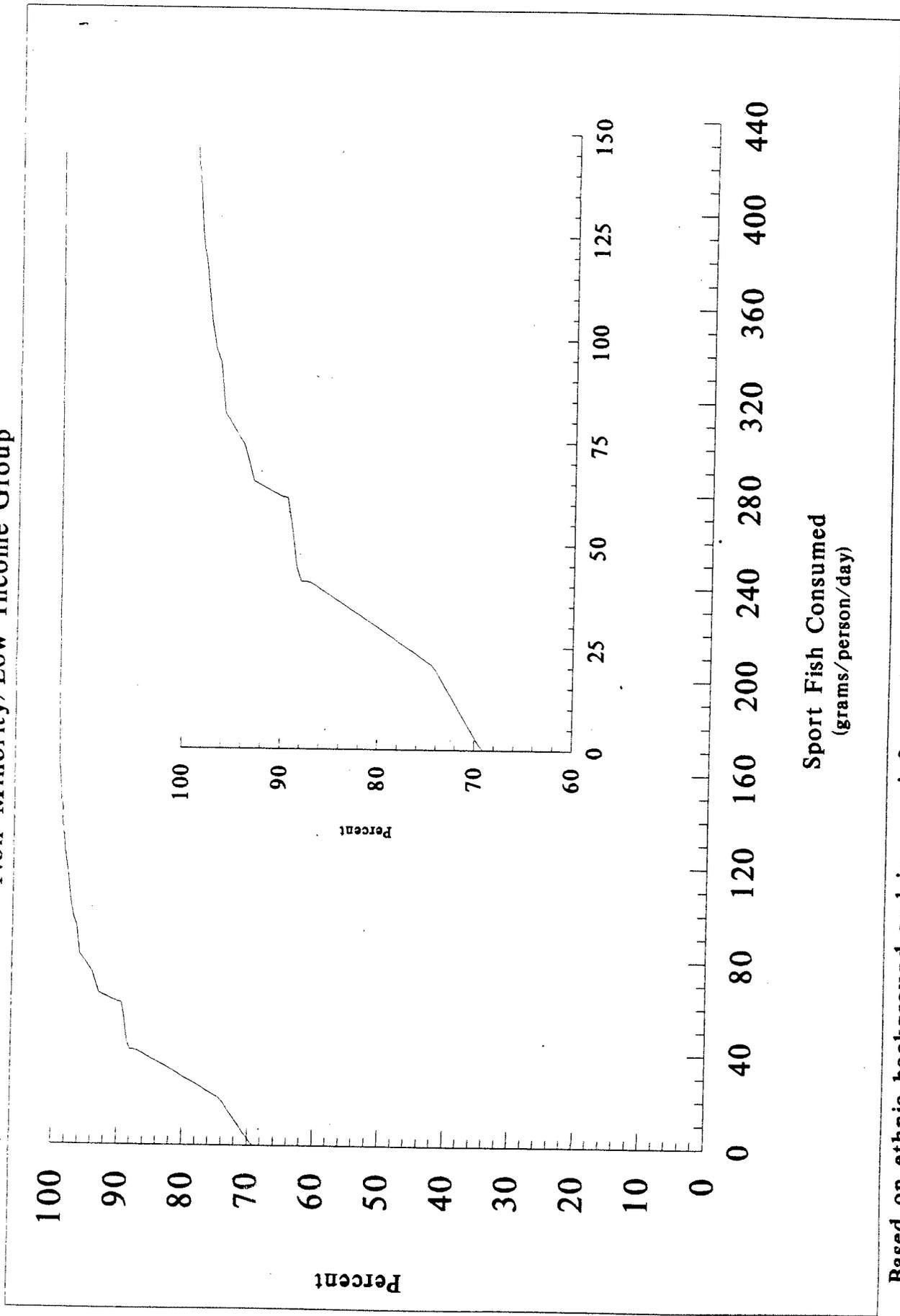
**Sport Fish, Michigan Sport Anglers, Fish Eaters
Non-Minority/Low-Income Group**



Based on ethnic background and income information.

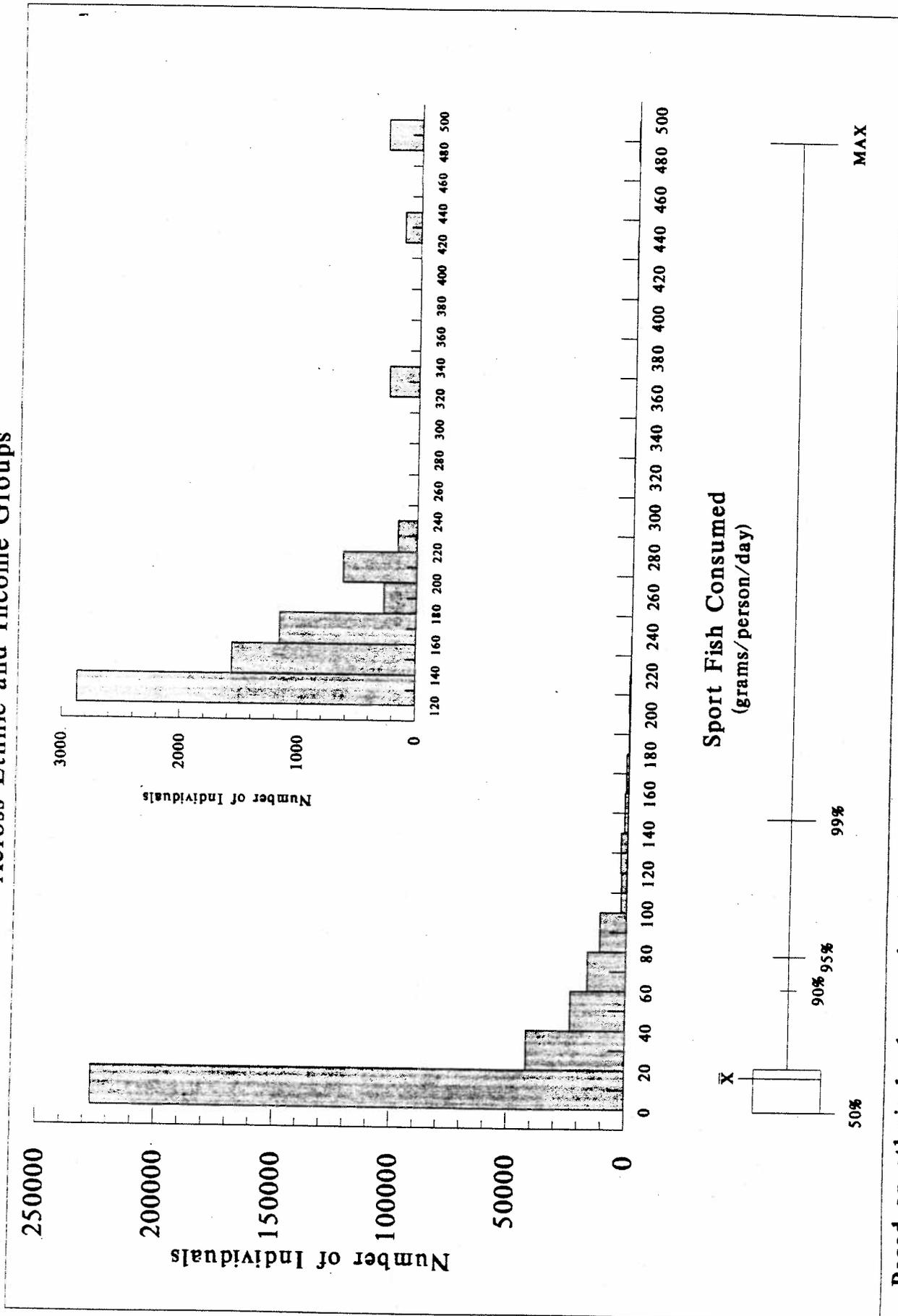
Figure 4-3b.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY PER CAPITA FISH CONSUMPTION

Sport Fish, Michigan Sport Anglers, Fish Eaters
Non-Minority/Low-Income Group



Based on ethnic background and income information.

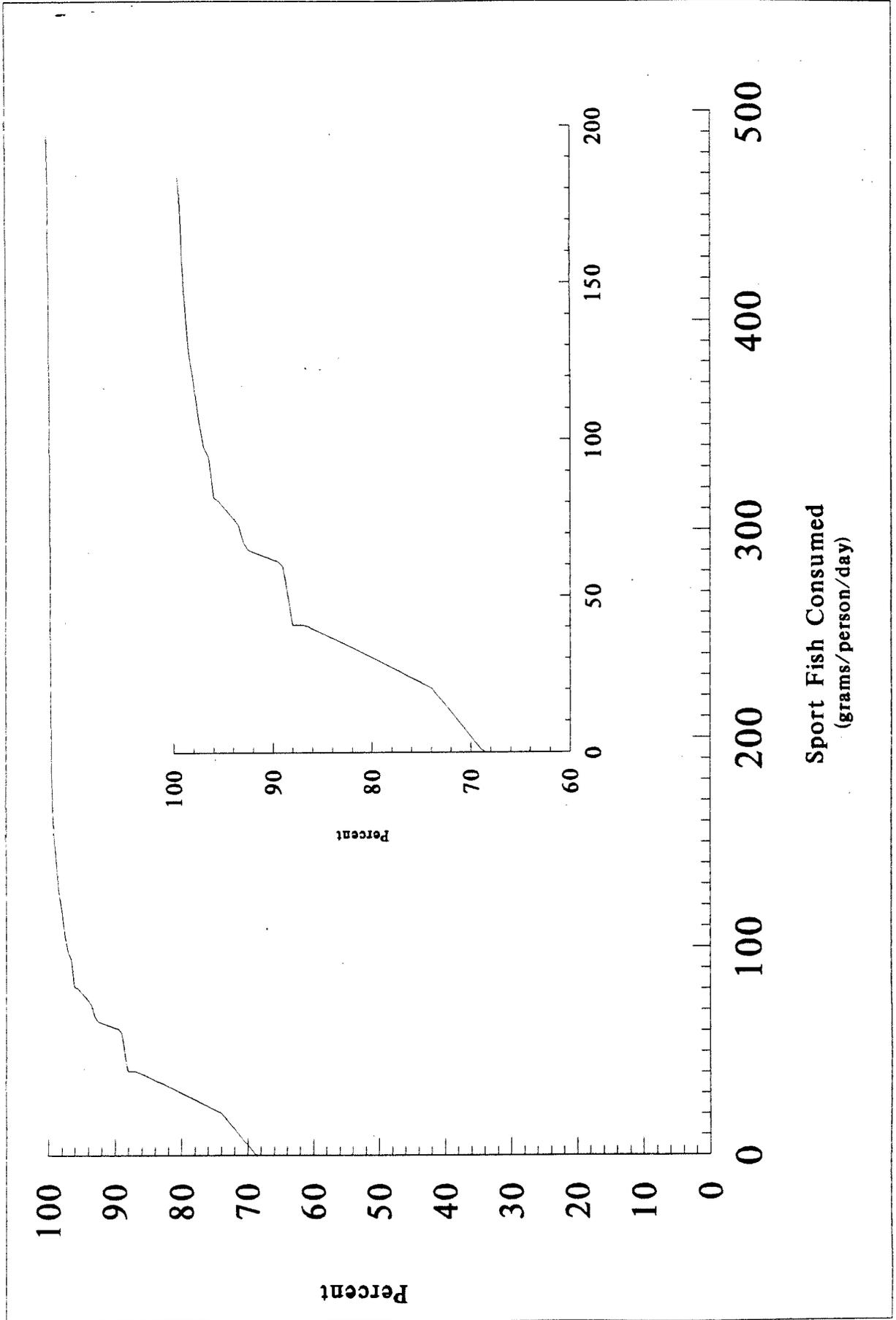
Figure 4-3c.1. HISTOGRAM OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION
 Sport Fish, Michigan Sport Anglers, Fish Eaters
 Across Ethnic and Income Groups



Based on ethnic background and income information.

Figure 4-3c.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION

Sport Fish, Michigan Sport Anglers, Fish Eaters
Across Ethnic and Income Groups



5. SELF-IDENTIFIED FISH EATERS -COMMERCIAL FISH - TABLES AND FIGURES

Chapter 5 presents tables with point and interval per capita estimates of commercial fish consumption for fish eater population subgroups. Subgroups are divided by ethnic group, income group, ethnic and income groups, and income level. Corresponding tables of estimates are numbered 5-1, 5-2, 5-3, and 5-4. Estimates also are presented for fish consumption by species of fish consumed (Tables 5-5, 5-5a, 5-5b, and 5-6) and by those fish eaters consuming less than 150 grams of commercial fish per day (Table 5-7). Point estimates include mean, median, 90th, 95th, and 99th percentiles. Interval estimates include 90-percent confidence intervals about the mean, and 90-percent bootstrap intervals for the percentiles. Also provided are average per capita fish consumption estimates by species with 90-percent confidence intervals about the mean. All estimates are reported in grams/person/day.

Figures augmenting the estimates in Tables 5-1 through 5-3 appear at the end of this chapter. Table 5-1 shows average daily per capita estimates of commercial fish consumption by self-reported fish eaters by ethnic group. The ethnic group is divided into classifications of minority, non-minority, and total (both minority and non-minority groups combined). Each of these divisions, or “classifications,” has two graphics associated with it—one histogram and one empirical cumulative distribution of average daily per capita consumption. The figures are numbered to correspond to the tables. For example, Table 5-1 has six figures associated with it—two for each of the three ethnic group divisions (minority, non-minority, and total). All of these graphics begin as “Figure 5-1...” to correspond to Table 5-1. A letter designates the classification, such that the figure associated with the minority classification is designated “Figure 5-1a...,” non-minority is designated “Figure 5-1b...,” and total is designated “Figure 5-1c....” Because there are two graphics associated with each classification, they are labeled 5-1a.1 and 5-1a.2; the histogram being the first figure (5-1a.1) and the cumulative distribution being the second (Figure 5-1a.2).

TABLE 5-1. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION

Commercial Fish, Michigan Sport Anglers, Fish Eaters by Ethnic Group

Classification	Statistic	Grams/person/day		
		Estimate	90% Interval*	
			Lower Bound	Upper Bound
Minority	Mean	12.75	8.39	17.12
n = 163	50th %	0.00	0.00	0.00
N = 24,210	90th %	36.19	27.75	55.10
	95th %	63.84	40.61	81.02
	99th %	147.06	79.29	225.74
Non-minority	Mean	9.64	8.88	10.40
n = 2,288	50th %	0.00	0.00	0.00
N = 344,347	90th %	32.30	30.51	34.66
	95th %	57.20	40.82	61.83
	99th %	96.06	83.26	102.21
Total	Mean	9.84	9.08	10.60
n = 2,451	50th %	0.00	0.00	0.00
N = 368,557	90th %	32.45	30.70	34.92
	95th %	60.26	43.38	62.04
	99th %	96.64	84.98	103.11

* Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

Note: Fish Eaters = self-identified fish eater

n = sample size

N = population size

Estimates are projected to the population of Michigan Sport Anglers, a sampled individual represents 150.37 individuals in the population.

TABLE 5-2. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION

Commercial Fish, Michigan Sport Anglers, Fish Eaters by Income Group

Classification	Statistic	Grams/person/day		
		Estimate	90% Interval*	
			Lower Bound	Upper Bound
Low-income (<\$25,000)	Mean	7.89	6.57	9.21
n = 663	50th %	0.00	0.00	0.00
N = 99,094	90th %	26.49	21.98	29.79
	95th %	38.80	34.02	55.26
	99th %	83.41	78.31	104.56
Non-low-income (>=\$25,000)	Mean	10.97	9.93	12.01
n = 1,531	50th %	0.00	0.00	0.00
N = 230,818	90th %	36.89	33.55	39.95
	95th %	62.37	57.68	64.01
	99th %	100.77	94.23	111.75
Total	Mean	10.05	9.23	10.87
n = 2,194	50th %	0.00	0.00	0.00
N = 329,912	90th %	33.26	31.18	35.67
	95th %	61.23	47.63	62.81
	99th %	97.69	88.87	106.37

* Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

Note: Fish Eaters = self-identified fish eater

n = sample size

N = population size

Estimates are projected to the population of Michigan Sport Anglers, a sampled individual represents 150.37 individuals in the population.

TABLE 5-3. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION

Commercial Fish, Michigan Sport Anglers, Fish Eaters by Ethnic Group and Income Group

Classification	Statistic	Estimate	90% Interval*	
			Lower Bound	Upper Bound
Minority/low-income	Mean	14.82	8.21	21.43
n = 61	50th %	0.00	0.00	0.00
N = 9,022	90th %	43.98	27.51	72.86
	95th %	75.73	40.41	84.48
	99th %	115.82	73.27	162.31
Non-minority/low-income	Mean	9.91	9.09	10.73
n = 2,133	50th %	0.00	0.00	0.00
N = 320,890	90th %	33.00	31.00	35.52
	95th %	61.22	45.25	62.51
	99th %	97.58	88.45	105.73
Total	Mean	10.05	9.23	10.87
n = 2,194	50th %	0.00	0.00	0.00
N = 329,912	90th %	33.26	31.18	35.67
	95th %	61.23	47.63	62.81
	99th %	97.69	88.87	106.37

* Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

Note: Fish Eaters = self-identified fish eater

n = sample size

N = population size

Estimates are projected to the population of Michigan Sport Anglers, a sampled individual represents 150.37 individuals in the population.

TABLE 5-4. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION

Commercial Fish, Michigan Sport Anglers, Fish Eaters by Income Level

Classification	Statistic	Estimate	Grams/person/day	
			90% Interval*	
			Lower Bound	Upper Bound
0 - \$14,999 n = 285 N = 43,607	Mean	8.48	6.55	10.42
	50th %	0.00	0.00	0.00
	90th %	29.05	23.47	34.11
	95th %	40.55	34.69	66.53
	99th %	81.63	76.46	86.33
\$15,000 - \$24,999 n = 378 N = 55,487	Mean	7.43	5.65	9.20
	50th %	0.00	0.00	0.00
	90th %	24.13	17.04	28.87
	95th %	36.83	30.77	47.55
	99th %	101.25	67.10	130.57
\$25,000 - \$39,999 n = 658 N = 99,695	Mean	8.36	7.07	9.65
	50th %	0.00	0.00	0.00
	90th %	31.11	26.79	35.88
	95th %	50.55	40.82	61.93
	99th %	80.30	69.17	99.54
\$40,000 or more n = 873 N = 131,123	Mean	12.96	11.44	14.47
	50th %	0.00	0.00	0.00
	90th %	40.42	36.64	40.82
	95th %	64.64	61.71	73.64
	99th %	107.46	96.78	124.84
Total n = 2,194 N = 329,912	Mean	10.05	9.23	10.87
	50th %	0.00	0.00	0.00
	90th %	33.26	31.18	35.67
	95th %	61.23	47.63	62.81
	99th %	97.69	88.87	106.37

* Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

Note: Fish Eaters = self-identified fish eater

n = sample size

N = population size

Estimates are projected to the population of Michigan Sport Anglers, a sampled individual represents 150.37 individuals in the population.

TABLE 5-5. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION BY SPECIES

Commercial Fish, Michigan Sport Anglers, Fish Eaters

Species	# of Individuals Consuming Each Species *	% of Population Consuming Each Species	Mean Estimate (grams/person/day)	90% Confidence Interval	
				Lower Bound	Upper Bound
1 Bass (Largemouth)	3	0.13	0.04	0.01	0.07
2 Bass (Smallmouth)	3	0.12	0.03	0.00	0.06
3 Bluegill	2	0.08	0.02	0.00	0.04
4 Bowfin	0	0.00	0.00	0.00	0.00
5 Buffalo	2	0.10	0.04	0.00	0.09
6 Bullhead	0	0.00	0.00	0.00	0.00
7 Burpot	0	0.00	0.00	0.00	0.00
8 Carp	0	0.00	0.00	0.00	0.00
9 Catfish	35	1.34	0.41	0.29	0.53
10 Cisco	0	0.00	0.00	0.00	0.00
11 Cod	115	4.56	1.56	1.30	1.82
12 Crappie	4	0.16	0.04	0.01	0.07
13 Drum	0	0.00	0.00	0.00	0.00
14 Gar	0	0.00	0.00	0.00	0.00
15 Haddock	7	0.25	0.07	0.02	0.12
16 Menominee	0	0.00	0.00	0.00	0.00
17 Musky (Nothern or Great Lake)	0	0.00	0.00	0.00	0.00
18 Musky (Tiger)	0	0.00	0.00	0.00	0.00
19 Orange roughy	32	1.28	0.43	0.28	0.58
20 Perch (Ocean)	25	0.95	0.31	0.19	0.43
21 Perch (Yellow)	121	4.80	1.56	1.31	1.81
22 Pike (Nothern)	3	0.18	0.05	0.00	0.12
23 Pollok	4	0.15	0.05	0.00	0.10
24 Quillback	0	0.00	0.00	0.00	0.00
25 Redfish	1	0.03	0.01	0.00	0.03
26 Redhorse	0	0.00	0.00	0.00	0.00
27 Rockbass	0	0.00	0.00	0.00	0.00
28 Salmon	36	1.41	0.41	0.29	0.53
29 Salmon (Atlantic)	0	0.00	0.00	0.00	0.00
30 Salmon (Coho)	1	0.03	0.01	0.00	0.03

* Sample Size = 2,451

Population = 368,557

TABLE 5-5. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION BY SPECIES

Commercial Fish, Michigan Sport Anglers, Fish Eaters

Species	# of Individuals Consuming Each Species *	% of Population Consuming Each Species	Mean Estimate (grams/person/day)	90% Confidence Interval	
				Lower Bound	Upper Bound
31 Salmon (Chinook)	0	0.00	0.00	0.00	0.00
32 Salmon (King)	1	0.04	0.01	0.00	0.03
33 Salmon (Pink)	1	0.04	0.01	0.00	0.03
34 Sauger	0	0.00	0.00	0.00	0.00
35 Smelt	15	0.56	0.19	0.11	0.27
36 Splake (hybrid trout)	0	0.00	0.00	0.00	0.00
37 Sturgeon	0	0.00	0.00	0.00	0.00
38 Sucker (Longnose)	0	0.00	0.00	0.00	0.00
39 Sucker (White)	1	0.03	0.01	0.00	0.03
40 Sunfish	0	0.00	0.00	0.00	0.00
41 Trout (Brook)	3	0.12	0.04	0.01	0.07
42 Trout (Brown)	2	0.08	0.03	0.00	0.06
43 Trout (Lake)	29	1.18	0.41	0.28	0.54
44 Trout (Rainbow)	3	0.12	0.04	0.01	0.07
45 Tuna	35	1.40	0.43	0.30	0.56
46 Walleye	60	2.37	0.79	0.61	0.97
47 Warmouth Bass	0	0.00	0.00	0.00	0.00
48 Whitebass	2	0.08	0.03	0.00	0.06
49 Whitefish	108	4.49	1.66	1.36	1.96
50 Other Single Species	67	2.60	0.99	0.74	1.24
51 Bass and Bluegills	0	0.00	0.00	0.00	0.00
52 Perch and Bluegills	0	0.00	0.00	0.00	0.00
53 Pike and Perch	0	0.00	0.00	0.00	0.00
54 Walleye and Perch	1	0.05	0.02	0.00	0.05
55 Other Combinations	2	0.07	0.02	0.00	0.05
56 Species Not Recorded	11	0.47	0.12	0.05	0.19

* Sample Size = 2,451
Population = 368,557

TABLE 5-5a. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION BY SPECIES

Michigan Sport Anglers, Fish Eaters
Commercial Fish - Restaurant

Species	# of Individuals	% of Population	Mean	90% Confidence Interval	
	Consuming Each Species *	Consuming Each Species	Estimate (grams/person/day)	Lower Bound	Upper Bound
1 Bass (Largemouth)	2	0.10	0.03	0.00	0.06
2 Bass (Smallmouth)	3	0.12	0.03	0.00	0.06
3 Bluegill	1	0.03	0.01	0.00	0.03
4 Bowfin	0	0.00	0.00	0.00	0.00
5 Buffalo	0	0.00	0.00	0.00	0.00
6 Bullhead	0	0.00	0.00	0.00	0.00
7 Burpot	0	0.00	0.00	0.00	0.00
8 Carp	0	0.00	0.00	0.00	0.00
9 Catfish	17	0.63	0.19	0.11	0.27
10 Cisco	0	0.00	0.00	0.00	0.00
11 Cod	91	3.58	1.26	1.01	1.51
12 Crappie	1	0.04	0.02	0.00	0.05
13 Drum	0	0.00	0.00	0.00	0.00
14 Gar	0	0.00	0.00	0.00	0.00
15 Haddock	4	0.14	0.04	0.01	0.07
16 Menominee	0	0.00	0.00	0.00	0.00
17 Musky (Nothorn or Great Lake)	0	0.00	0.00	0.00	0.00
18 Musky (Tiger)	0	0.00	0.00	0.00	0.00
19 Orange roughy	9	0.36	0.13	0.05	0.21
20 Perch (Ocean)	13	0.49	0.15	0.08	0.22
21 Perch (Yellow)	92	3.65	1.15	0.94	1.36
22 Pike (Nothorn)	2	0.14	0.04	0.00	0.09
23 Pollok	1	0.04	0.01	0.00	0.03
24 Quillback	0	0.00	0.00	0.00	0.00
25 Redfish	1	0.03	0.01	0.00	0.03
26 Redhorse	0	0.00	0.00	0.00	0.00
27 Rockbass	0	0.00	0.00	0.00	0.00
28 Salmon	9	0.36	0.11	0.04	0.18
29 Salmon (Atlantic)	0	0.00	0.00	0.00	0.00
30 Salmon (Coho)	0	0.00	0.00	0.00	0.00

* Sample Size = 2,451

Population = 368,557

TABLE 5-5a. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION BY SPECIES

Michigan Sport Anglers, Fish Eaters
Commercial Fish - Restaurant

Species	# of Individuals Consuming Each Species *	% of Population Consuming Each Species	Mean Estimate (grams/person/day)	90% Confidence Interval	
				Lower Bound	Upper Bound
31 Salmon (Chinook)	0	0.00	0.00	0.00	0.00
32 Salmon (King)	0	0.00	0.00	0.00	0.00
33 Salmon (Pink)	0	0.00	0.00	0.00	0.00
34 Sauger	0	0.00	0.00	0.00	0.00
35 Smelt	9	0.33	0.10	0.05	0.15
36 Splake (hybrid trout)	0	0.00	0.00	0.00	0.00
37 Sturgeon	0	0.00	0.00	0.00	0.00
38 Sucker (Longnose)	0	0.00	0.00	0.00	0.00
39 Sucker (White)	0	0.00	0.00	0.00	0.00
40 Sunfish	0	0.00	0.00	0.00	0.00
41 Trout (Brook)	3	0.12	0.04	0.01	0.07
42 Trout (Brown)	0	0.00	0.00	0.00	0.00
43 Trout (Lake)	18	0.75	0.24	0.14	0.34
44 Trout (Rainbow)	1	0.04	0.01	0.00	0.03
45 Tuna	8	0.30	0.09	0.02	0.16
46 Walleye	46	1.79	0.63	0.47	0.79
47 Warmouth Bass	0	0.00	0.00	0.00	0.00
48 Whitebass	1	0.05	0.01	0.00	0.03
49 Whitefish	73	3.02	1.04	0.83	1.25
50 Other Single Species	34	1.31	0.46	0.31	0.61
51 Bass and Bluegills	0	0.00	0.00	0.00	0.00
52 Perch and Bluegills	0	0.00	0.00	0.00	0.00
53 Pike and Perch	0	0.00	0.00	0.00	0.00
54 Walleye and Perch	1	0.05	0.02	0.00	0.05
55 Other Combinations	1	0.04	0.02	0.00	0.05
56 Species Not Recorded	8	0.36	0.08	0.03	0.13

* Sample Size = 2,451
Population = 368,557

TABLE 5-5b. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION BY SPECIES

Michigan Sport Anglers, Fish Eaters
Commercial Fish - Market

Species	# of Individuals	% of Population	Mean Estimate	90% Confidence Interval	
	Consuming Each Species *	Consuming Each Species		Lower Bound	Upper Bound
1 Bass (Largemouth)	1	0.03	0.01	0.00	0.03
2 Bass (Smallmouth)	0	0.00	0.00	0.00	0.00
3 Bluegill	1	0.05	0.01	0.00	0.03
4 Bowfin	0	0.00	0.00	0.00	0.00
5 Buffalo	2	0.10	0.04	0.00	0.09
6 Bullhead	0	0.00	0.00	0.00	0.00
7 Burpot	0	0.00	0.00	0.00	0.00
8 Carp	0	0.00	0.00	0.00	0.00
9 Catfish	18	0.72	0.23	0.13	0.33
10 Cisco	0	0.00	0.00	0.00	0.00
11 Cod	24	0.98	0.29	0.19	0.39
12 Crappie	3	0.11	0.03	0.00	0.06
13 Drum	0	0.00	0.00	0.00	0.00
14 Gar	0	0.00	0.00	0.00	0.00
15 Haddock	3	0.11	0.03	0.00	0.06
16 Menominee	0	0.00	0.00	0.00	0.00
17 Musky (Nothorn or Great Lake)	0	0.00	0.00	0.00	0.00
18 Musky (Tiger)	0	0.00	0.00	0.00	0.00
19 Orange roughy	23	0.92	0.30	0.18	0.42
20 Perch (Ocean)	12	0.46	0.17	0.09	0.25
21 Perch (Yellow)	30	1.19	0.41	0.28	0.54
22 Pike (Nothorn)	1	0.05	0.01	0.00	0.03
23 Pollock	3	0.11	0.04	0.01	0.07
24 Quillback	0	0.00	0.00	0.00	0.00
25 Redfish	0	0.00	0.00	0.00	0.00
26 Redhorse	0	0.00	0.00	0.00	0.00
27 Rockbass	0	0.00	0.00	0.00	0.00
28 Salmon	27	1.04	0.30	0.20	0.40
29 Salmon (Atlantic)	0	0.00	0.00	0.00	0.00
30 Salmon (Coho)	1	0.03	0.01	0.00	0.03

* Sample Size = 2,451

Population = 368,557

TABLE 5-5b. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION BY SPECIES

Michigan Sport Anglers, Fish Eaters
Commercial Fish - Market

Species	# of Individuals Consuming Each Species *	% of Population Consuming Each Species	Mean Estimate (grams/person/day)	90% Confidence Interval	
				Lower Bound	Upper Bound
31 Salmon (Chinook)	0	0.00	0.00	0.00	0.00
32 Salmon (King)	1	0.04	0.01	0.00	0.03
33 Salmon (Pink)	1	0.04	0.01	0.00	0.03
34 Sauger	0	0.00	0.00	0.00	0.00
35 Smelt	6	0.23	0.09	0.02	0.16
36 Splake (hybrid trout)	0	0.00	0.00	0.00	0.00
37 Sturgeon	0	0.00	0.00	0.00	0.00
38 Sucker (Longnose)	0	0.00	0.00	0.00	0.00
39 Sucker (White)	1	0.03	0.01	0.00	0.03
40 Sunfish	0	0.00	0.00	0.00	0.00
41 Trout (Brook)	0	0.00	0.00	0.00	0.00
42 Trout (Brown)	2	0.08	0.03	0.00	0.06
43 Trout (Lake)	12	0.49	0.16	0.08	0.24
44 Trout (Rainbow)	2	0.08	0.02	0.00	0.04
45 Tuna	29	1.18	0.34	0.22	0.46
46 Walleye	15	0.62	0.16	0.09	0.23
47 Warmouth Bass	0	0.00	0.00	0.00	0.00
48 Whitebass	1	0.04	0.01	0.00	0.03
49 Whitefish	35	1.47	0.62	0.41	0.83
50 Other Single Species	36	1.41	0.53	0.33	0.73
51 Bass and Bluegills	0	0.00	0.00	0.00	0.00
52 Perch and Bluegills	0	0.00	0.00	0.00	0.00
53 Pike and Perch	0	0.00	0.00	0.00	0.00
54 Walleye and Perch	0	0.00	0.00	0.00	0.00
55 Other Combinations	1	0.03	0.01	0.00	0.03
56 Species Not Recorded	4	0.15	0.04	0.01	0.07

* Sample Size = 2,451
Population = 368,557

TABLE 5-6. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION BY SPECIES

Commercial Fish, Michigan Sport Anglers, Fish Eaters
 Minority/Low-Income Group **

Species	# of Individuals	% of Population	Mean Estimate	90% Confidence Interval	
	Consuming Each Species *	Consuming Each Species		Lower Bound	Upper Bound
1 Bass (Largemouth)	1	2.48	0.51	0.00	1.33
2 Bass (Smallmouth)	0	0.00	0.00	0.00	0.00
3 Bluegill	0	0.00	0.00	0.00	0.00
4 Bowfin	0	0.00	0.00	0.00	0.00
5 Buffalo	2	4.06	1.45	0.00	3.11
6 Bullhead	0	0.00	0.00	0.00	0.00
7 Burpot	0	0.00	0.00	0.00	0.00
8 Carp	0	0.00	0.00	0.00	0.00
9 Catfish	5	8.54	2.69	0.67	4.71
10 Cisco	0	0.00	0.00	0.00	0.00
11 Cod	2	2.95	3.21	0.00	7.68
12 Crappie	1	1.26	0.26	0.00	0.69
13 Drum	0	0.00	0.00	0.00	0.00
14 Gar	0	0.00	0.00	0.00	0.00
15 Haddock	0	0.00	0.00	0.00	0.00
16 Menominee	0	0.00	0.00	0.00	0.00
17 Musky (Nothern or Great Lake)	0	0.00	0.00	0.00	0.00
18 Musky (Tiger)	0	0.00	0.00	0.00	0.00
19 Orange roughy	0	0.00	0.00	0.00	0.00
20 Perch (Ocean)	2	3.46	1.26	0.00	2.69
21 Perch (Yellow)	2	2.97	1.74	0.00	3.96
22 Pike (Nothern)	0	0.00	0.00	0.00	0.00
23 Pollok	0	0.00	0.00	0.00	0.00
24 Quillback	0	0.00	0.00	0.00	0.00
25 Redfish	0	0.00	0.00	0.00	0.00
26 Redhorse	0	0.00	0.00	0.00	0.00
27 Rockbass	0	0.00	0.00	0.00	0.00
28 Salmon	1	2.11	0.43	0.00	1.14
29 Salmon (Atlantic)	0	0.00	0.00	0.00	0.00
30 Salmon (Coho)	1	1.43	0.47	0.00	1.23

* Sample Size = 61
 Population = 9,022

** Non-white sport fishing license holders whose annual household income in 1990 was less than \$25,000.

TABLE 5-6. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION BY SPECIES

Commercial Fish, Michigan Sport Anglers, Fish Eaters
 Minority/Low-Income Group **

Species	# of Individuals Consuming Each Species *	% of Population Consuming Each Species	Mean Estimate (grams/person/day)	90% Confidence Interval	
				Lower Bound	Upper Bound
31 Salmon (Chinook)	0	0.00	0.00	0.00	0.00
32 Salmon (King)	0	0.00	0.00	0.00	0.00
33 Salmon (Pink)	0	0.00	0.00	0.00	0.00
34 Sauger	0	0.00	0.00	0.00	0.00
35 Smelt	0	0.00	0.00	0.00	0.00
36 Splake (hybrid trout)	0	0.00	0.00	0.00	0.00
37 Sturgeon	0	0.00	0.00	0.00	0.00
38 Sucker (Longnose)	0	0.00	0.00	0.00	0.00
39 Sucker (White)	0	0.00	0.00	0.00	0.00
40 Sunfish	0	0.00	0.00	0.00	0.00
41 Trout (Brook)	0	0.00	0.00	0.00	0.00
42 Trout (Brown)	0	0.00	0.00	0.00	0.00
43 Trout (Lake)	1	1.68	0.34	0.00	0.90
44 Trout (Rainbow)	0	0.00	0.00	0.00	0.00
45 Tuna	0	0.00	0.00	0.00	0.00
46 Walleye	2	3.20	1.05	0.00	2.25
47 Warmouth Bass	0	0.00	0.00	0.00	0.00
48 Whitebass	2	3.37	1.10	0.00	2.37
49 Whitefish	0	0.00	0.00	0.00	0.00
50 Other Single Species	1	1.58	0.32	0.00	0.85
51 Bass and Bluegills	0	0.00	0.00	0.00	0.00
52 Perch and Bluegills	0	0.00	0.00	0.00	0.00
53 Pike and Perch	0	0.00	0.00	0.00	0.00
54 Walleye and Perch	0	0.00	0.00	0.00	0.00
55 Other Combinations	0	0.00	0.00	0.00	0.00
56 Species Not Recorded	0	0.00	0.00	0.00	0.00

* Sample Size = 61

Population = 9,022

** Non-white sport fishing license holders whose annual household income in 1990 was less than \$25,000.

Table 5-7. Estimated Percent of Angler Population Consuming Less Than 150 Grams of Commercial Fish per Day

Commercial Fish, Michigan Sport Anglers, Fish Eaters

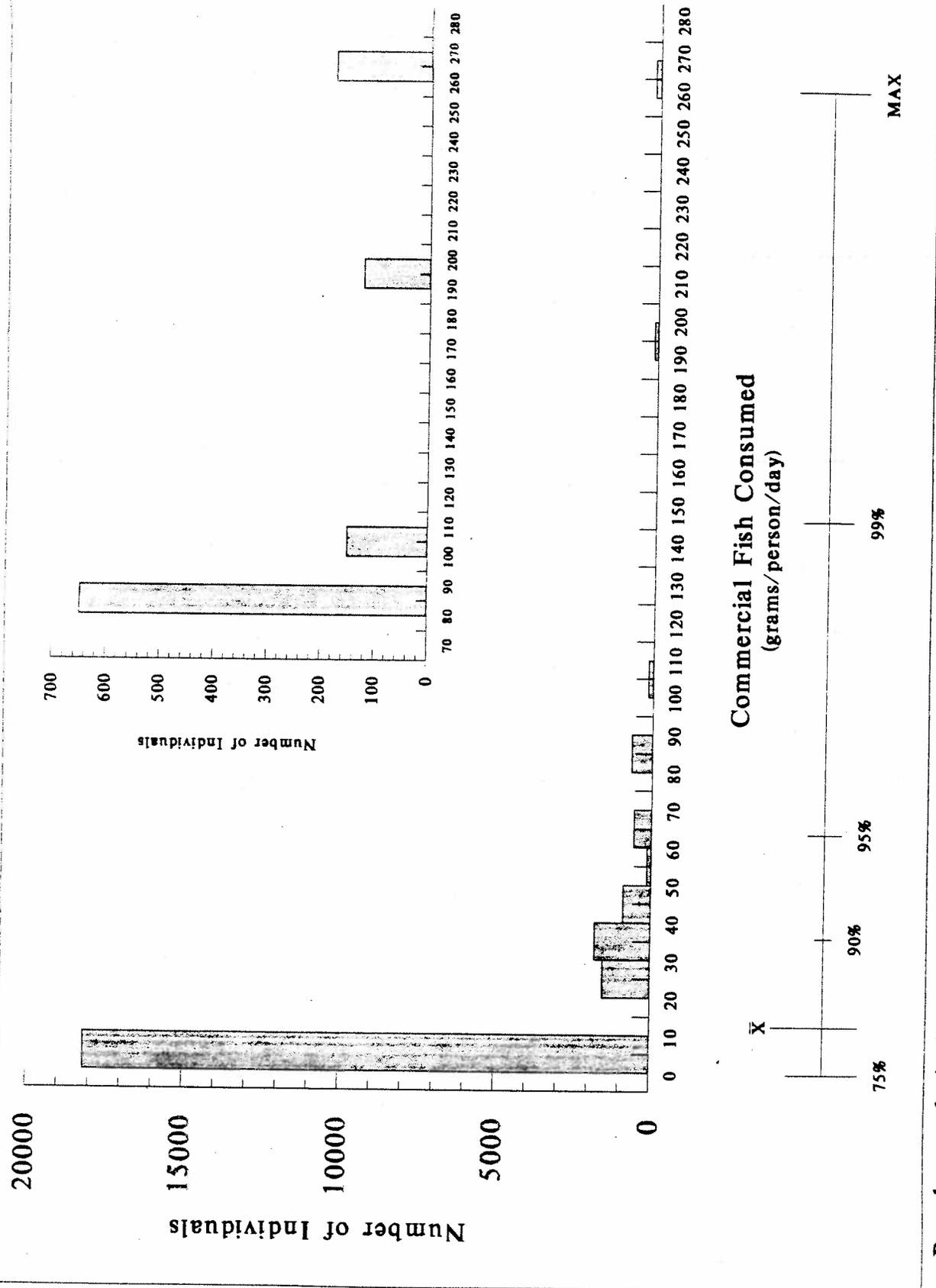
Sub Population	Sample Size	Estimated Population Size	Estimated No. of Individuals Consuming < 150g/day	Estimated Percent of Population Consuming < 150g/day	Lower 90% Bound for Percent Estimate	Upper 90% Bound for Percent Estimate
All	2,451	368,557	367,655	99.8	99.0	100.0
Minority/ Low Income*	61	9,022	8,872	98.3	95.1	100.0

* Non-white sport fishing license holders whose annual household income in 1990 was less than \$25,000.

CHAPTER 5 FIGURES

Figure 5-1a.1. HISTOGRAM OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION

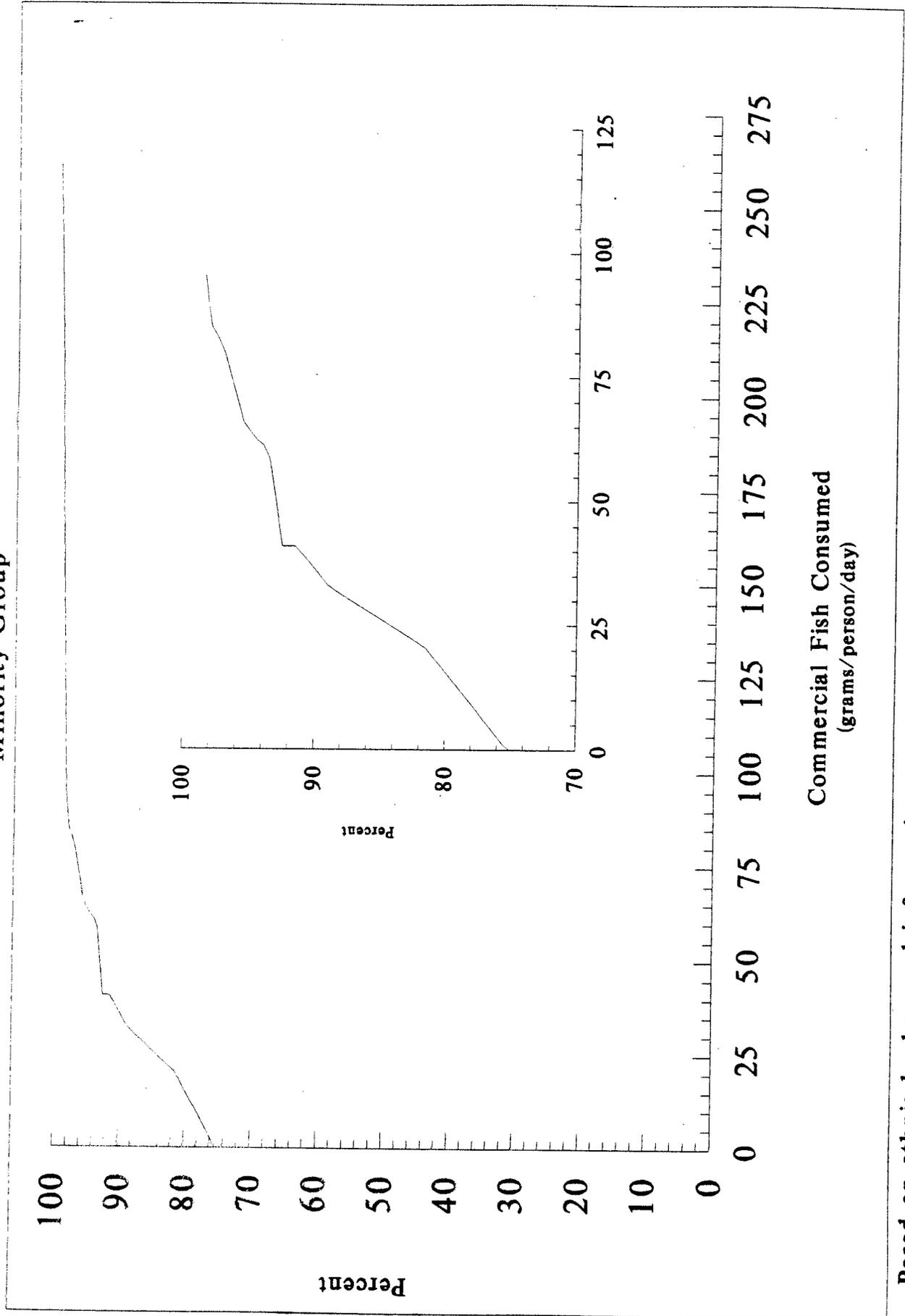
Commercial Fish, Michigan Sport Anglers, Fish Eaters
Minority Group



Based on ethnic background information.

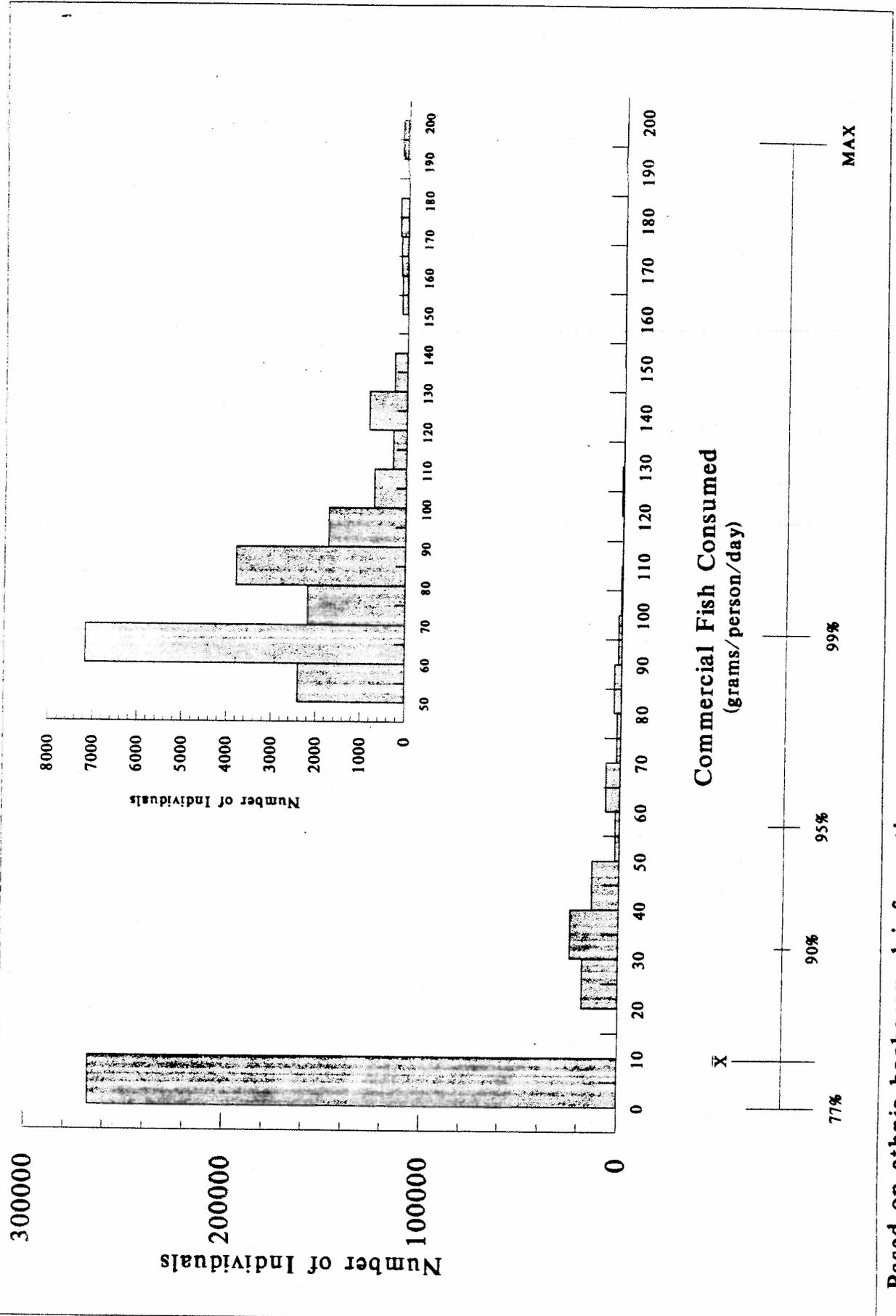
Figure 5-1a.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION

Commercial Fish, Michigan Sport Anglers, Fish Eaters
Minority Group



Based on ethnic background information.

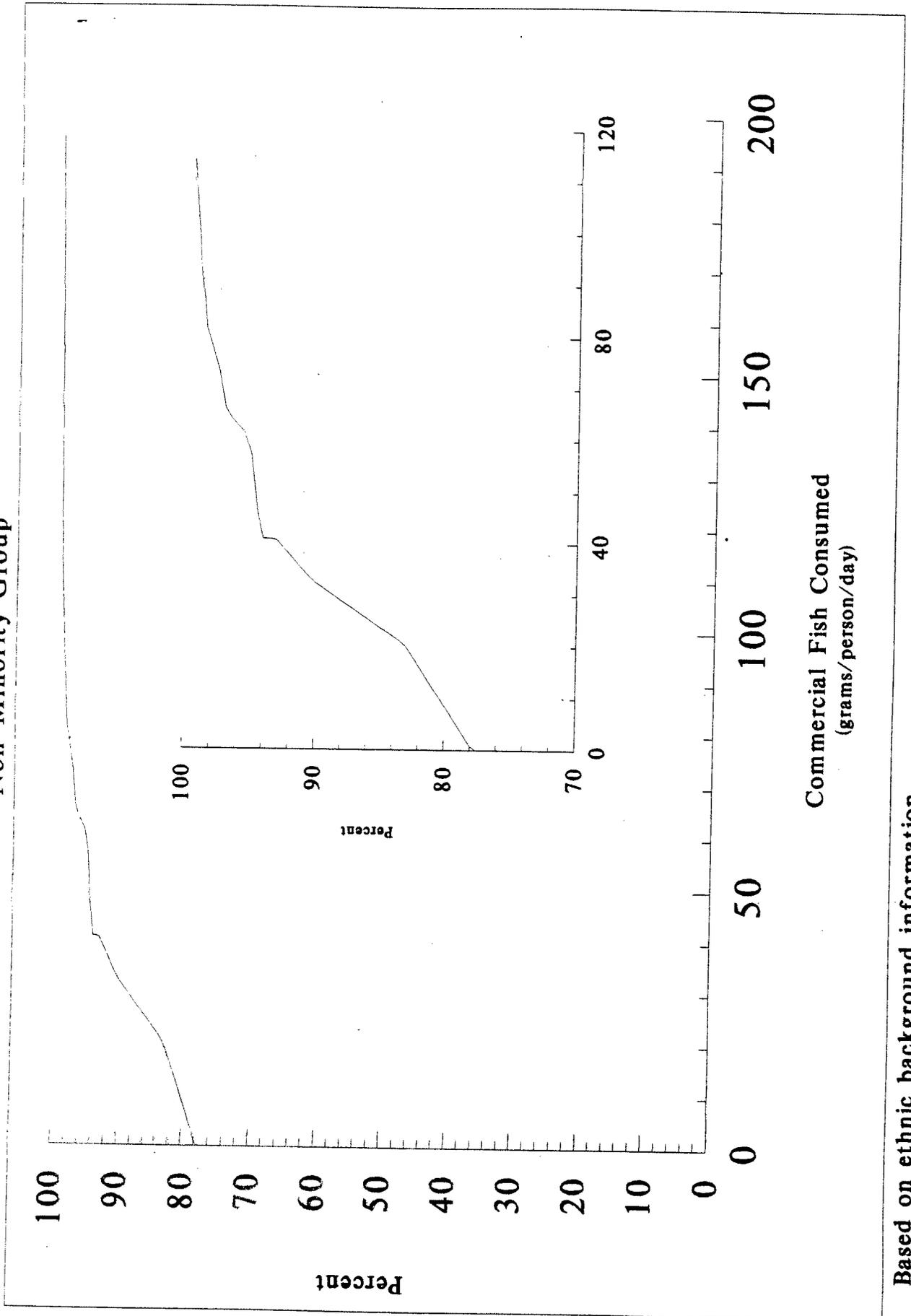
**Figure 5-1b.1. HISTOGRAM OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION
Commercial Fish. Michigan Sport Anglers, Fish Eaters
Non-Minority Group**



Based on ethnic background information.

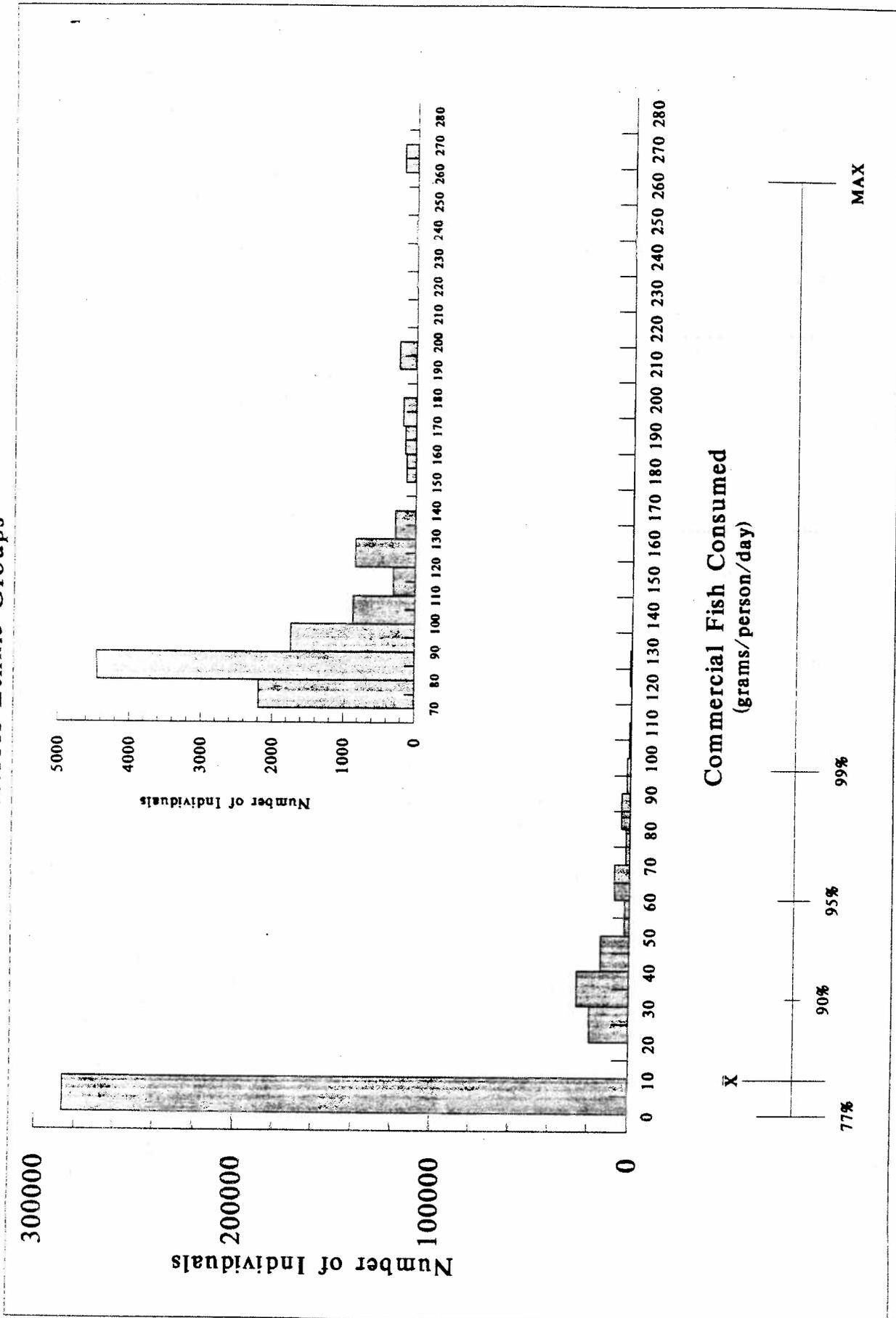
Figure 5-1b.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION

Commercial Fish, Michigan Sport Anglers, Fish Eaters
 Non-Minority Group



Based on ethnic background information.

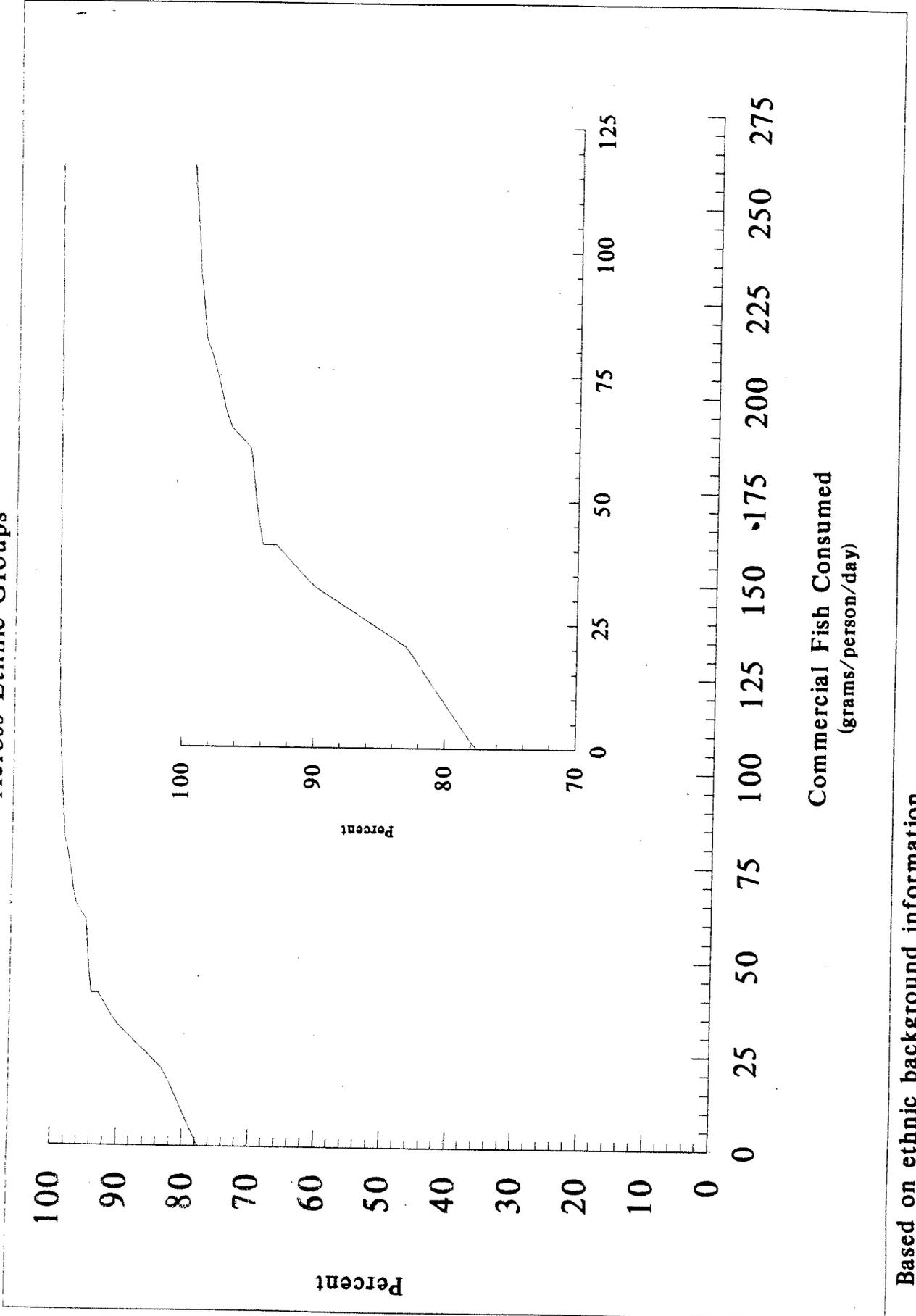
Figure 5-1c.1. HISTOGRAM OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION
 Commercial Fish, Michigan Sport Anglers, Fish Eaters
 Across Ethnic Groups



Based on ethnic background information.

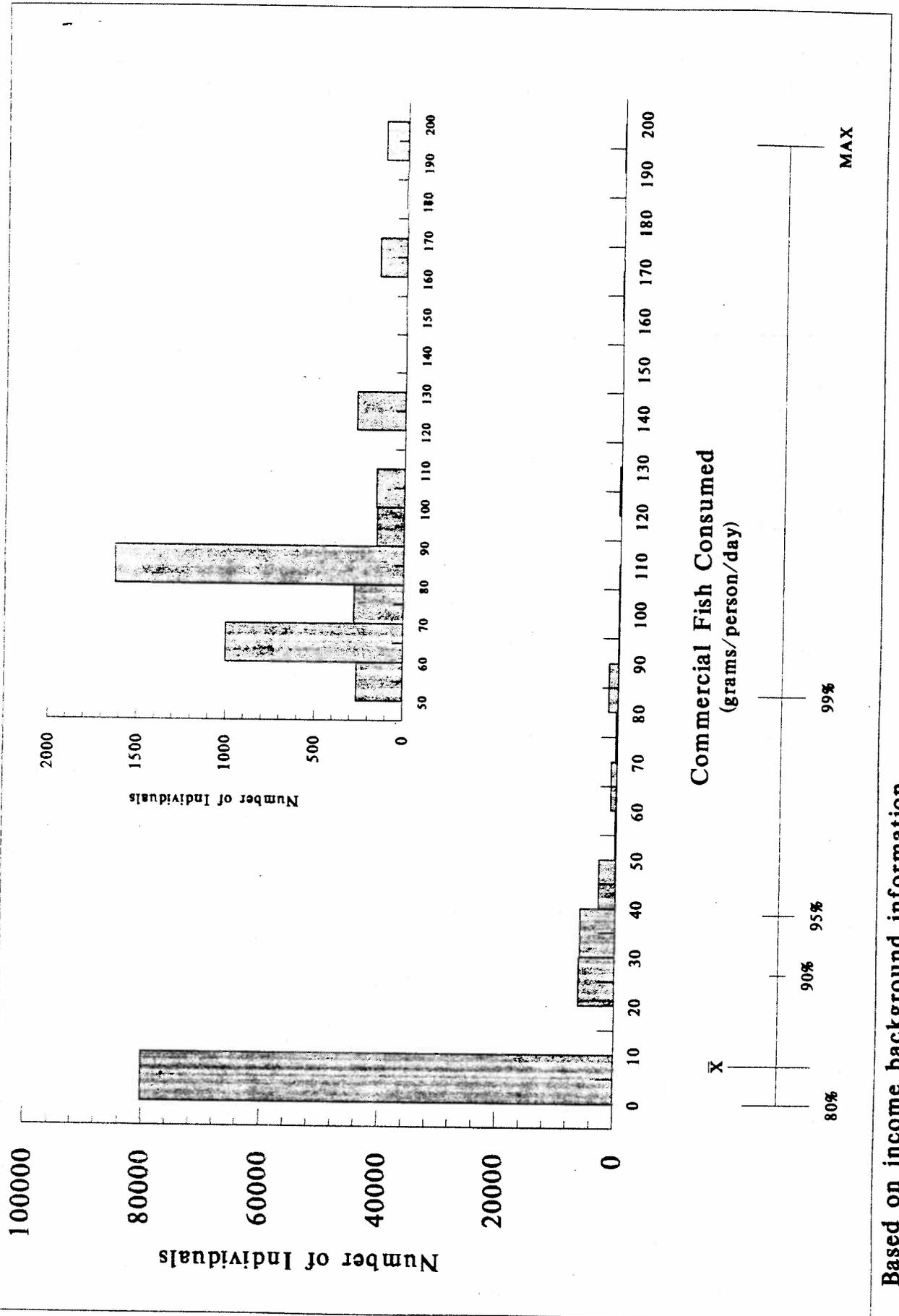
Figure 5-1c.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION

Commercial Fish, Michigan Sport Anglers, Fish Eaters
 Across Ethnic Groups



Based on ethnic background information.

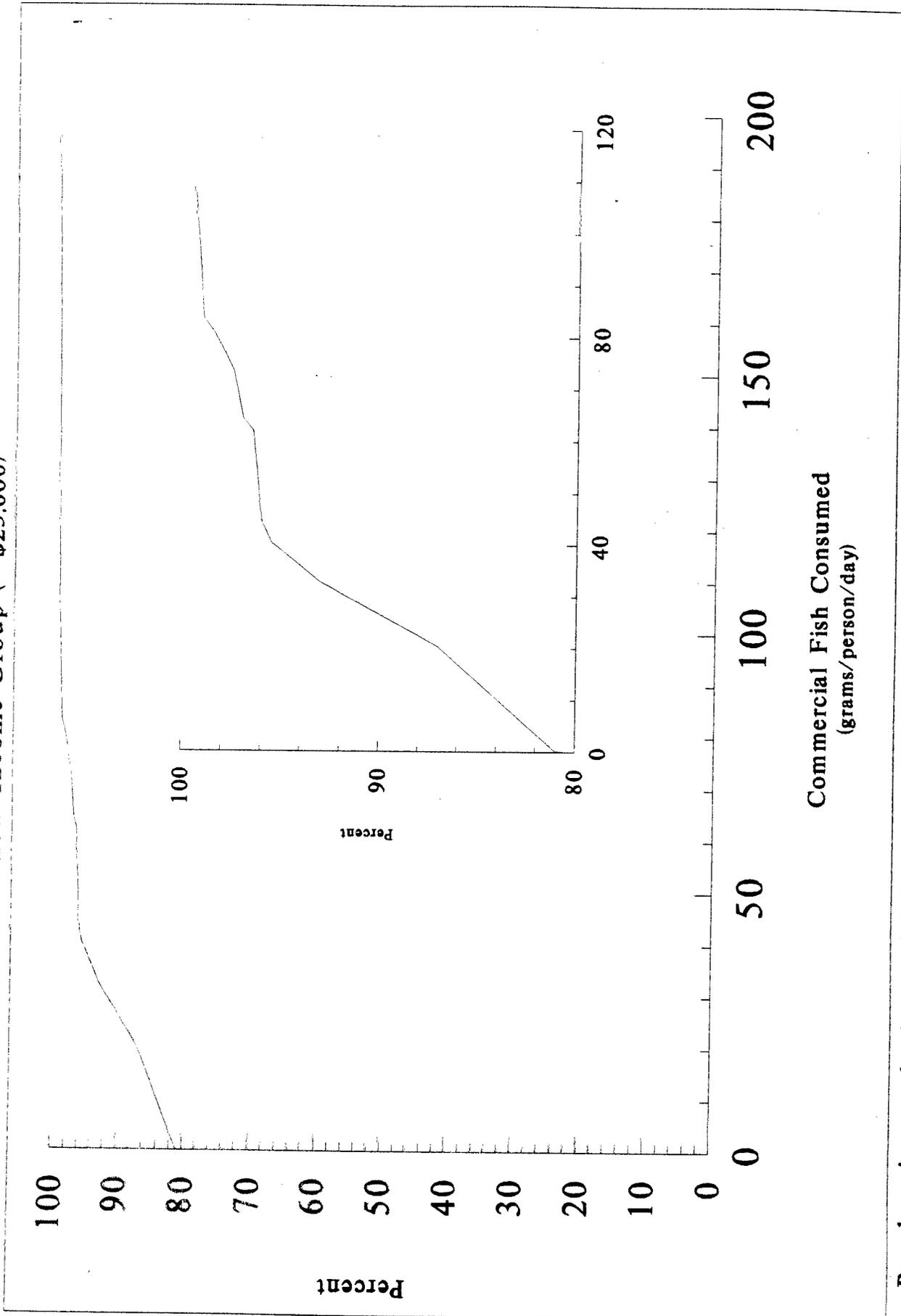
Figure 5-2a.1. HISTOGRAM OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION
 Commercial Fish, Michigan Sport Anglers, Fish Eaters
 Low-Income Group (< \$25,000)



Based on income background information.

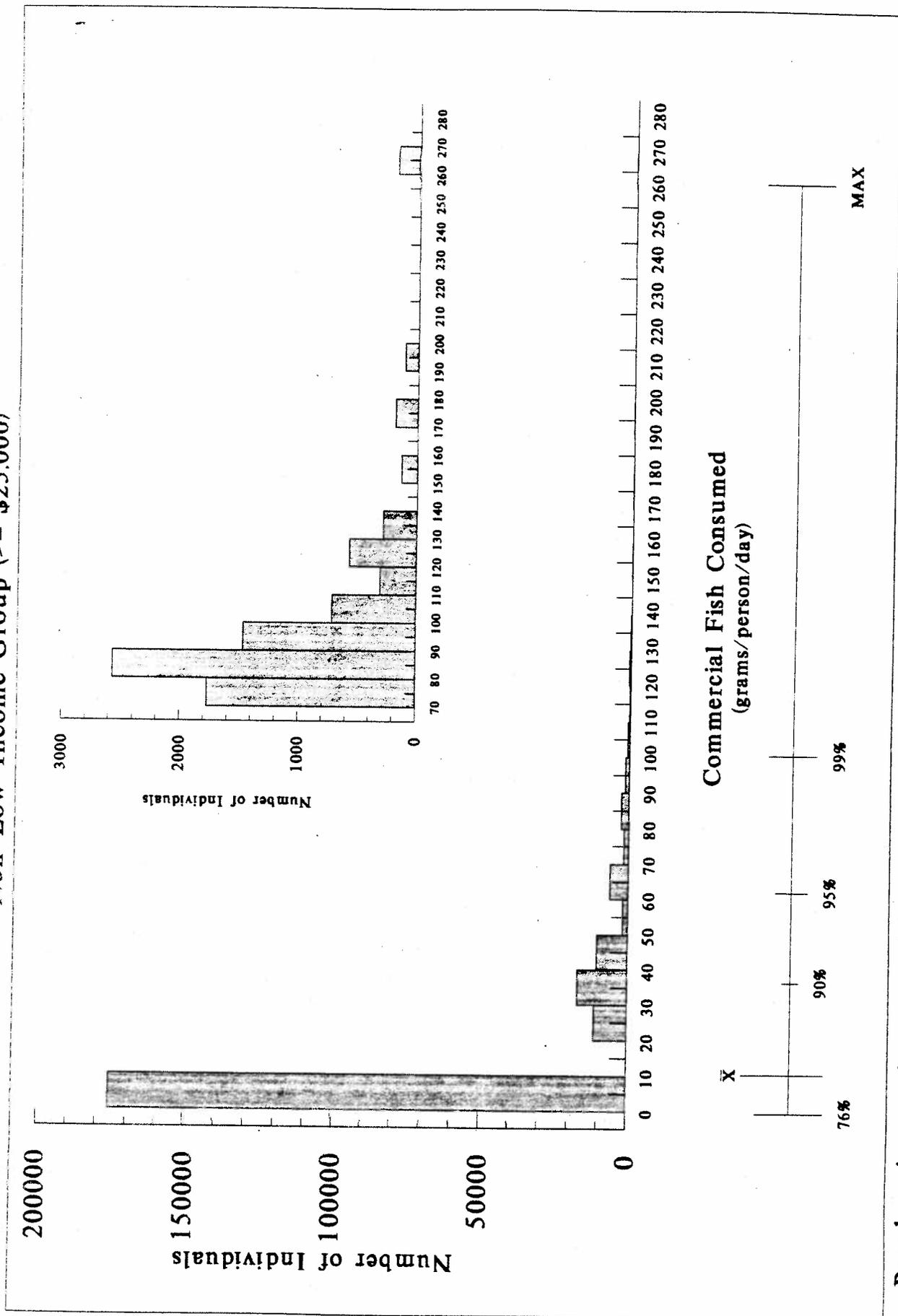
Figure 5-2a.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION

Commercial Fish, Michigan Sport Anglers, Fish Eaters
 Low-Income Group (< \$25,000)



Based on income background information.

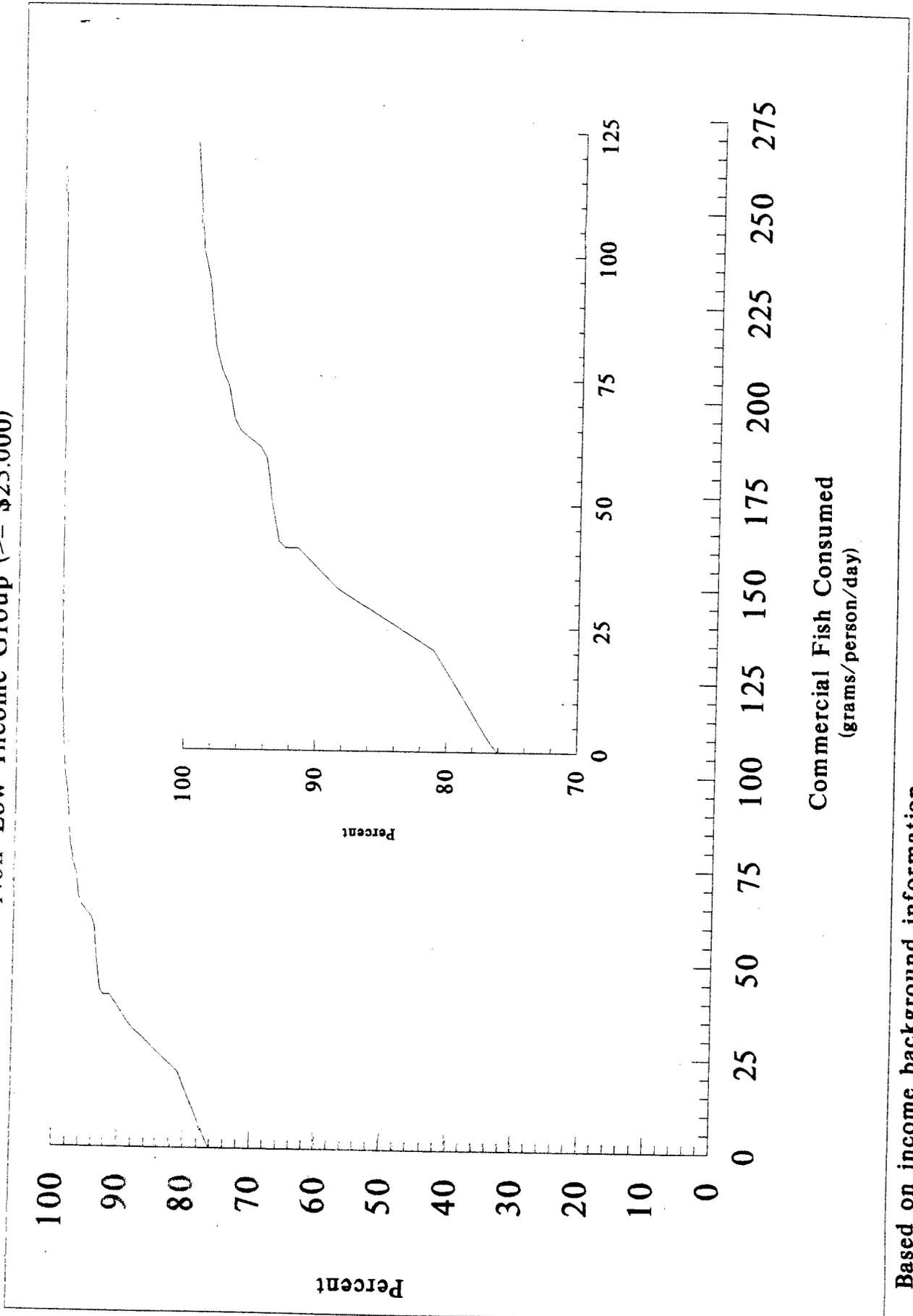
Figure 5-2b.1. HISTOGRAM OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION
 Commercial Fish, Michigan Sport Anglers, Fish Eaters
 Non-Low-Income Group (\geq \$25,000)



Based on income background information.

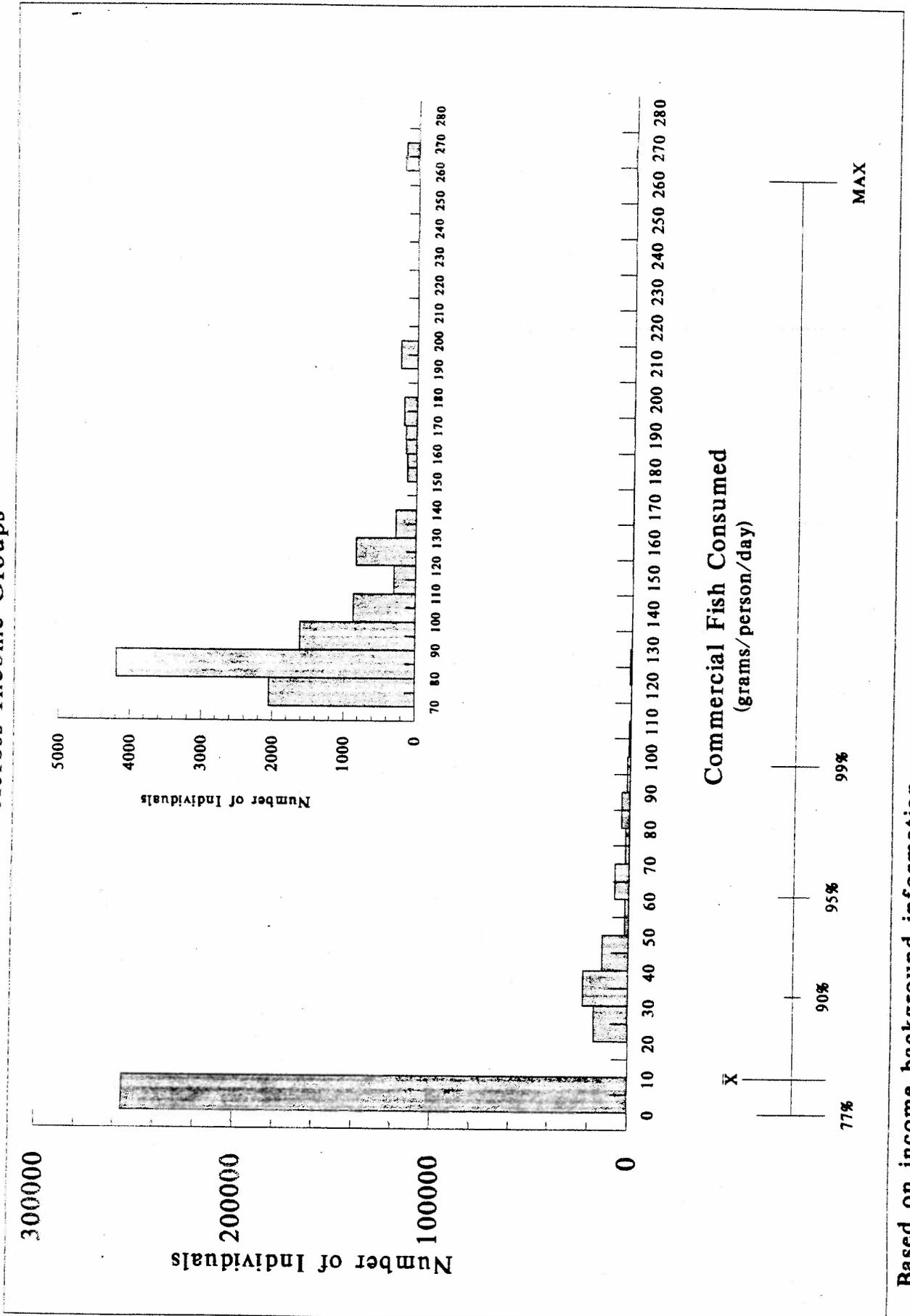
Figure 5-2b.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION

Commercial Fish, Michigan Sport Anglers, Fish Eaters
 Non-Low-Income Group (\geq \$25,000)



Based on income background information.

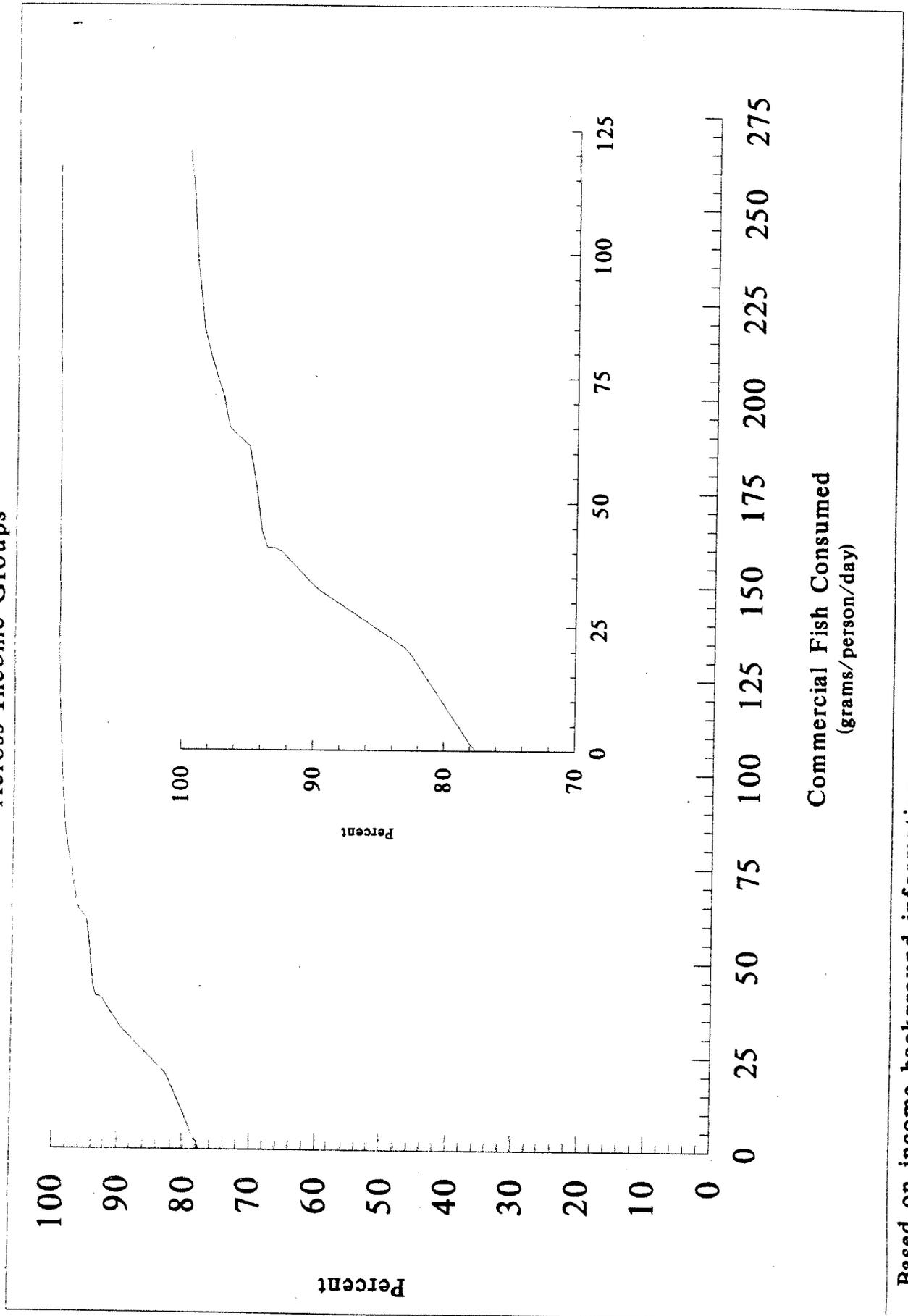
**Figure 5-2c.1. HISTOGRAM OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION
Commercial Fish, Michigan Sport Anglers, Fish Eaters
Across Income Groups**



Based on income background information.

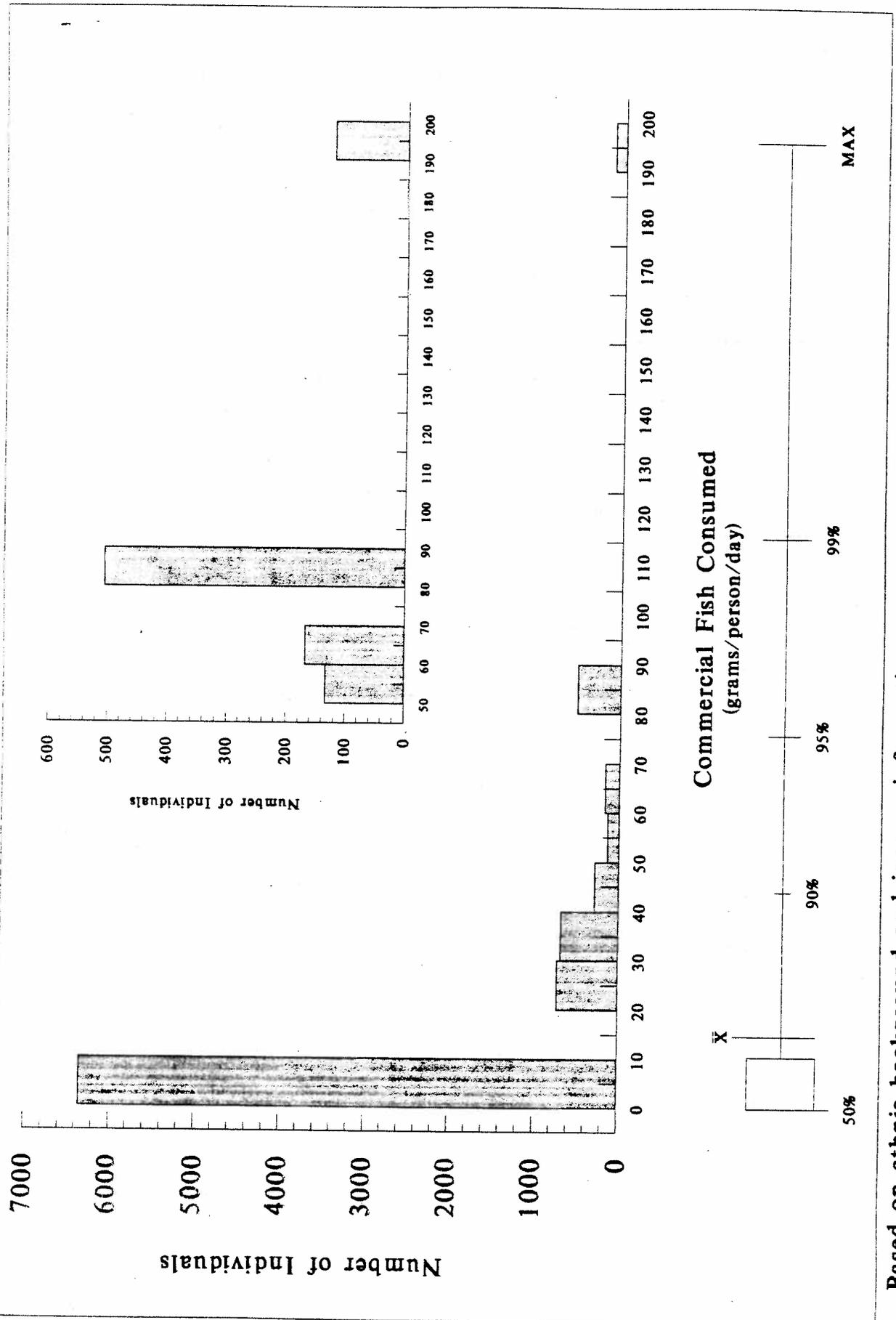
Figure 5-2c.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION

Commercial Fish, Michigan Sport Anglers, Fish Eaters
 Across Income Groups



Based on income background information.

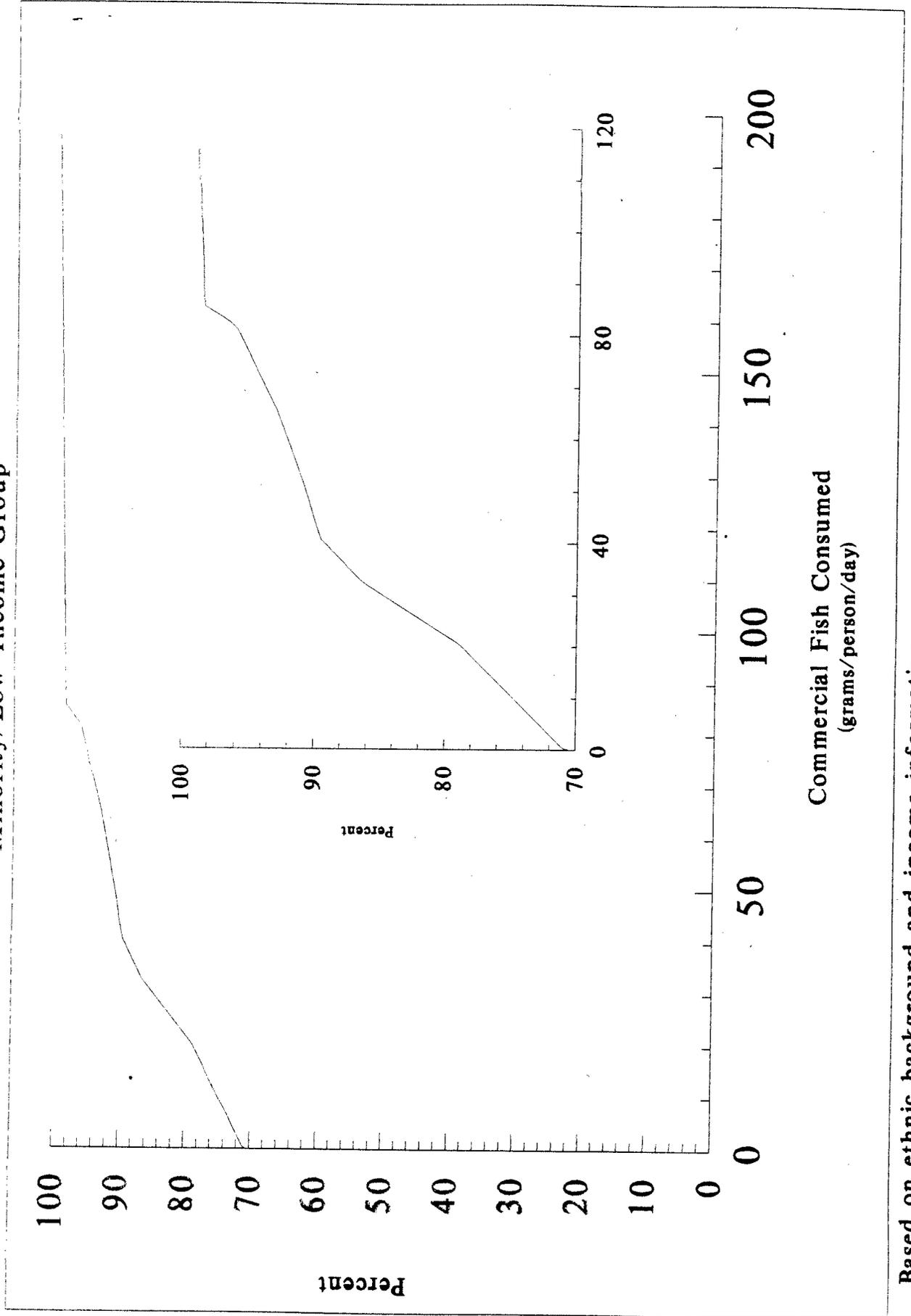
**Figure 5-3a.1. HISTOGRAM OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION
Commercial Fish, Michigan Sport Anglers, Fish Eaters
Minority/Low-Income Group**



Based on ethnic background and income information.

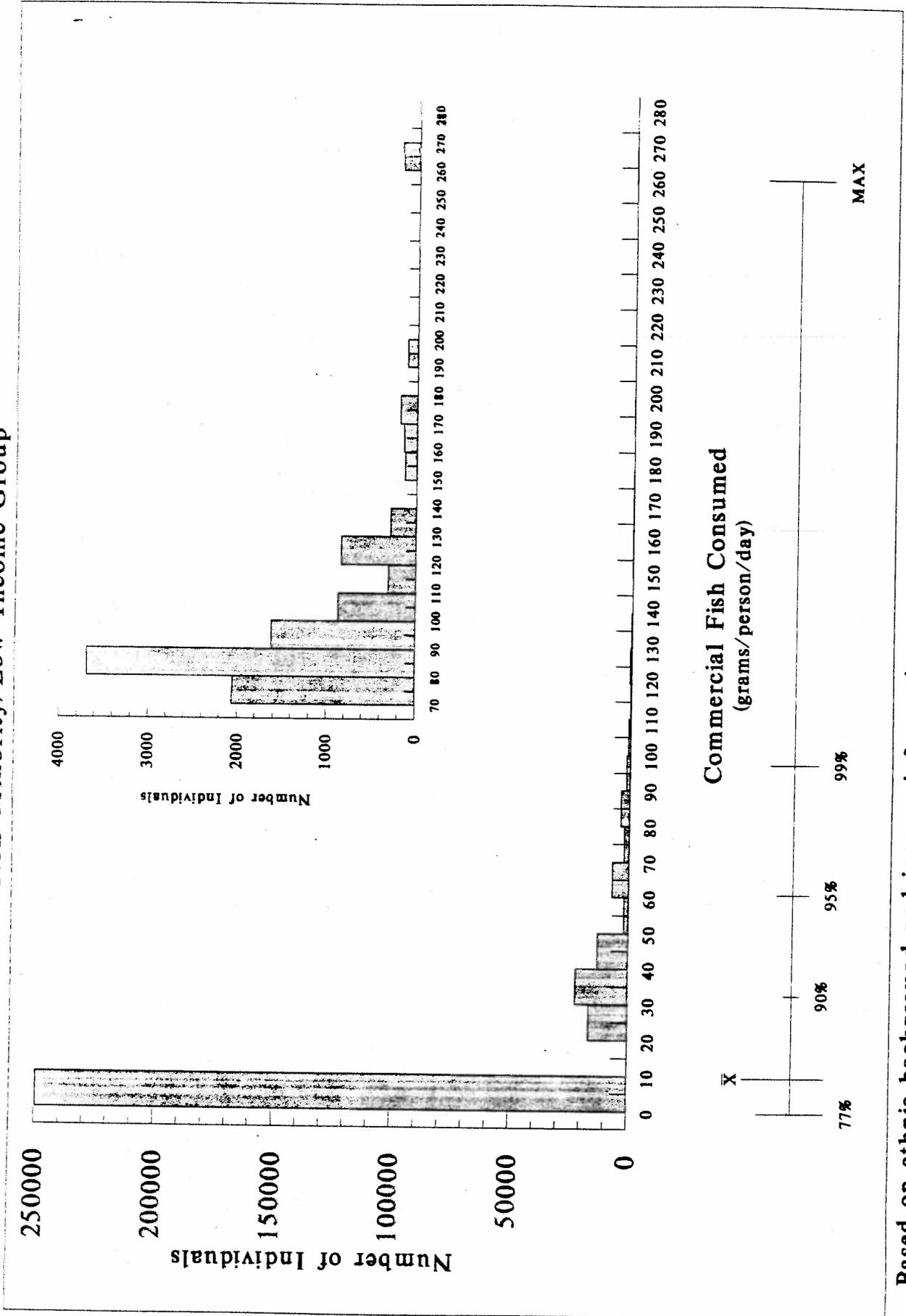
Figure 5-3a.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION

Commercial Fish, Michigan Sport Anglers, Fish Eaters
 Minority/Low-Income Group



Based on ethnic background and income information.

**Figure 5-3b.1. HISTOGRAM OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION
Commercial Fish, Michigan Sport Anglers, Fish Eaters
Non-Minority/Low-Income Group**

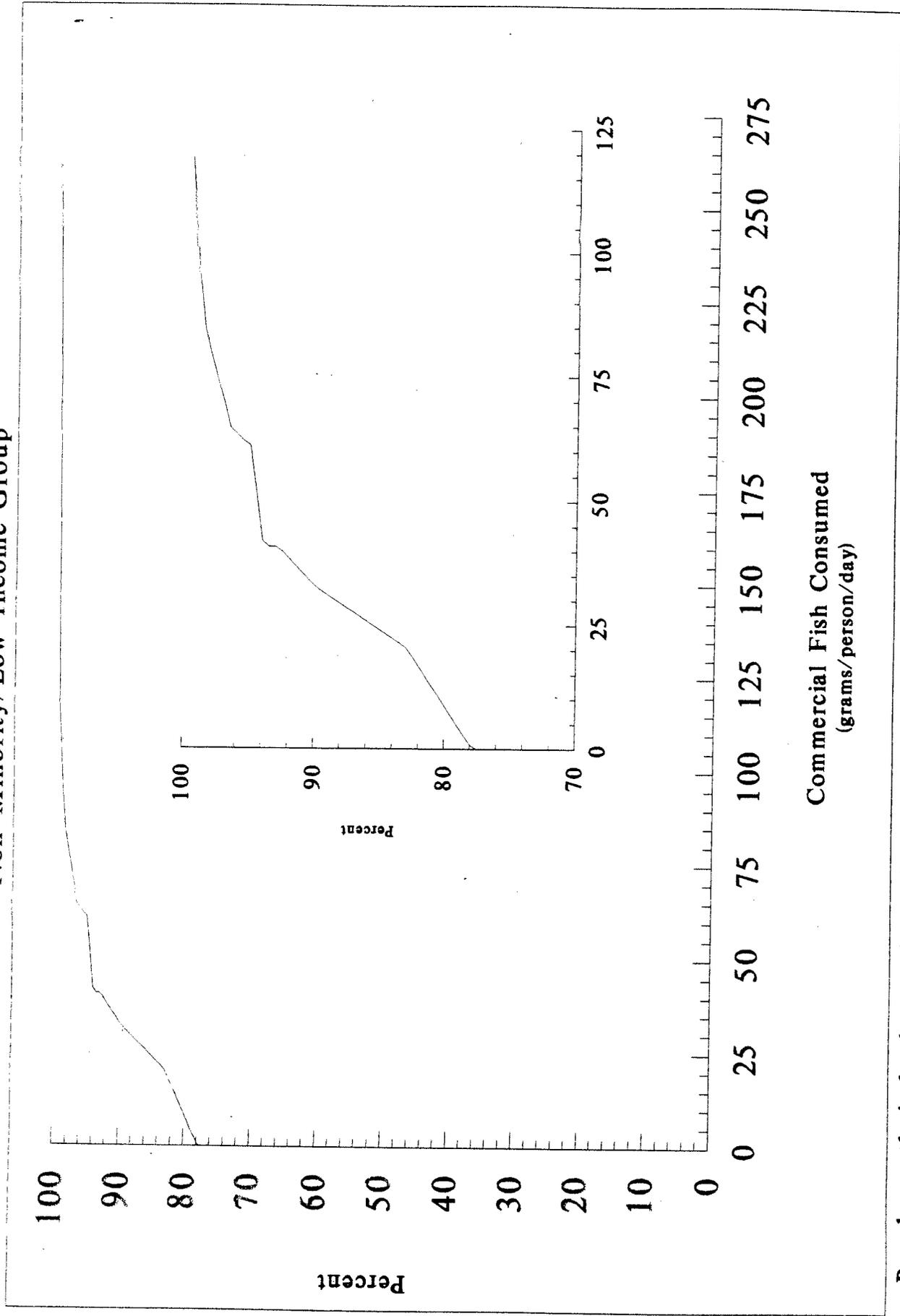


Based on ethnic background and income information.

Figure 5-3b.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY PER CAPITA FISH CONSUMPTION

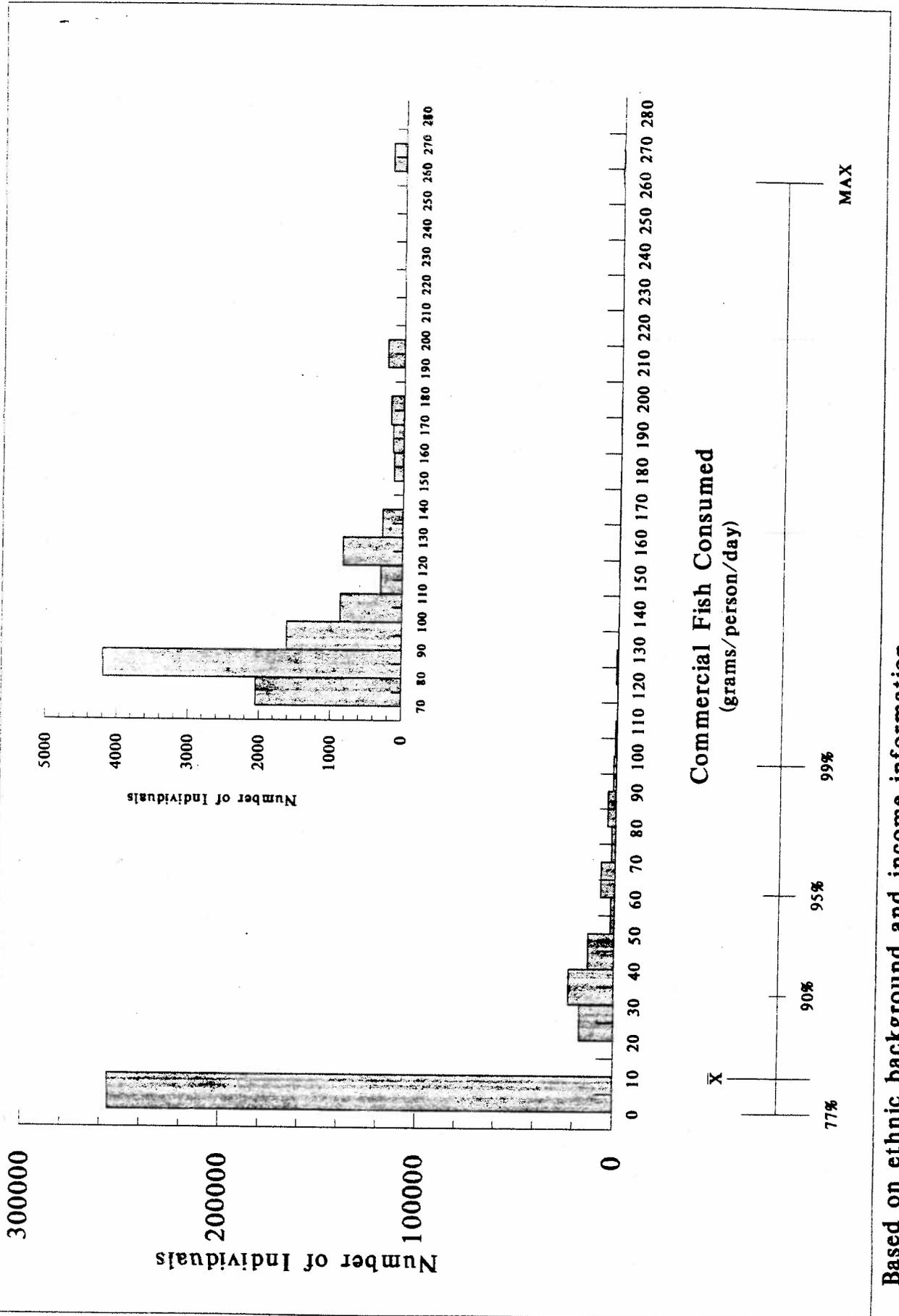
Commercial Fish, Michigan Sport Anglers, Fish Eaters

Non-Minority/Low-Income Group



Based on ethnic background and income information.

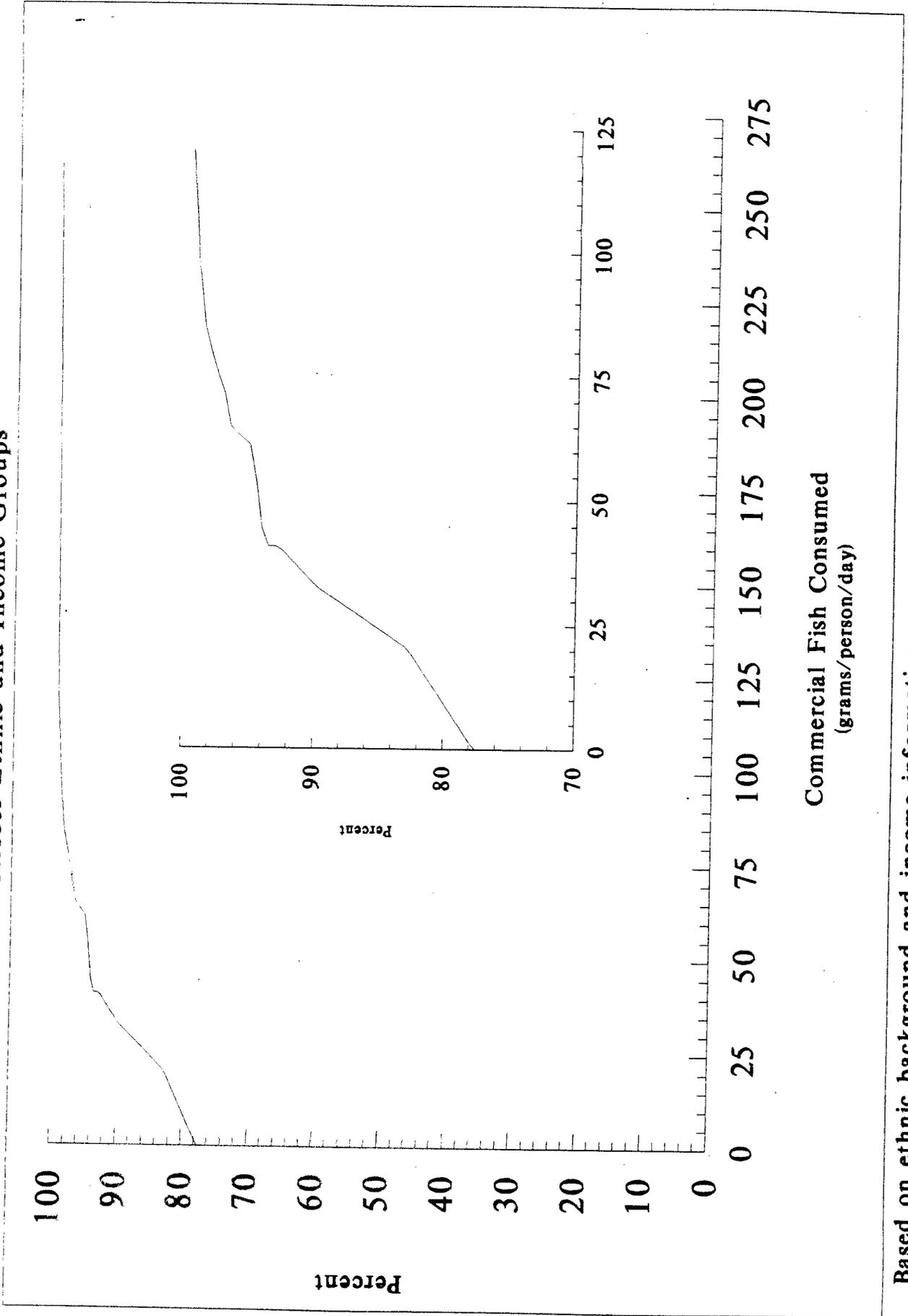
Figure 5-3c.1. HISTOGRAM OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION
 Commercial Fish, Michigan Sport Anglers, Fish Eaters
 Across Ethnic and Income Groups



Based on ethnic background and income information.

Figure 5-3c.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION

Commercial Fish, Michigan Sport Anglers, Fish Eaters
 Across Ethnic and Income Groups



Based on ethnic background and income information.

6. SELF-IDENTIFIED FISH EATERS - ALL FISH - TABLES AND FIGURES

Chapter 6 presents tables with point and interval per capita estimates of all fish consumption for fish eater population subgroups. Subgroups are divided by ethnic group, income group, ethnic and income groups, and income level. Corresponding tables of estimates are numbered 6-1, 6-2, 6-3, and 6-4. Estimates also are presented for fish consumption by species of all fish consumed (Tables 6-5 and 6-6) and by those fish eaters consuming less than 150 grams of all fish per day (Table 6-7). Point estimates include mean, median, 90th, 95th, and 99th percentiles. Interval estimates include 90-percent confidence intervals about the mean, and 90-percent bootstrap intervals for the percentiles. Also provided are average per capita fish consumption estimates by species with 90-percent confidence intervals about the mean. All estimates are reported in grams/person/day.

Figures augmenting the estimates in Tables 6-1 through 6-3 appear at the end of this chapter. Table 6-1 shows average daily per capita estimates of all fish consumption by self-reported fish eaters by ethnic group. The ethnic group is divided into classifications of minority, non-minority, and total (both minority and non-minority groups combined). Each of these divisions, or "classifications," has two graphics associated with it—one histogram and one empirical cumulative distribution of average daily per capita consumption. The figures are numbered to correspond to the tables. For example, Table 6-1 has six figures associated with it—two for each of the three ethnic group divisions (minority, non-minority, and total). All of these graphics begin as "Figure 6-1..." to correspond to Table 6-1. A letter designates the classification, such that the figure associated with the minority classification is designated "Figure 6-1a...", non-minority is designated "Figure 6-1b...", and total is designated "Figure 6-1c...." Because there are two graphics associated with each classification, they are labeled 6-1a.1 and 6-1a.2; the histogram being the first figure (6-1a.1) and the cumulative distribution being the second (Figure 6-1a.2).

TABLE 6-1. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION

All Fish, Michigan Sport Anglers, Fish Eaters by Ethnic Group

Classification	Statistic	Grams/person/day		
		Estimate	90% Interval*	
			Lower Bound	Upper Bound
Minority	Mean	35.97	27.17	44.77
n = 163	50th %	3.13	0.00	14.73
N = 24,210	90th %	80.90	64.68	102.04
	95th %	116.39	85.10	189.49
	99th %	386.68	173.78	489.79
Non-minority	Mean	25.92	24.54	27.30
n = 2,288	50th %	0.00	0.00	0.00
N = 344,347	90th %	73.47	69.48	76.64
	95th %	102.04	96.22	105.20
	99th %	162.83	156.67	177.97
Total	Mean	26.58	25.17	27.99
n = 2,451	50th %	0.00	0.00	0.00
N = 368,557	90th %	74.08	70.40	77.31
	95th %	102.04	96.72	106.00
	99th %	168.18	160.20	195.92

* Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

Note: Fish Eaters = self-identified fish eater

n = sample size

N = population size

Estimates are projected to the population of Michigan Sport Anglers, a sampled individual represents 150.37 individuals in the population.

TABLE 6-2. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION

All Fish, Michigan Sport Anglers, Fish Eaters by Income Group

Classification	Statistic	Grams/person/day		
		Estimate	90% Interval*	
			Lower Bound	Upper Bound
Low-income (<\$25,000)	Mean	28.71	25.50	31.92
n = 663	50th %	0.00	0.00	0.49
N = 99,094	90th %	76.38	67.46	81.49
	95th %	102.04	93.67	115.67
	99th %	200.23	161.55	266.65
Non-low-income (>=\$25,000)	Mean	26.91	25.22	28.60
n = 1,531	50th %	0.00	0.00	0.00
N = 230,818	90th %	75.42	71.33	79.54
	95th %	104.35	97.18	112.48
	99th %	163.15	153.05	178.96
Total	Mean	27.45	25.92	28.98
n = 2,194	50th %	0.00	0.00	0.00
N = 329,912	90th %	75.75	72.31	78.88
	95th %	103.46	97.64	108.63
	99th %	174.86	161.25	196.94

* Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

Note: Fish Eaters = self-identified fish eater

n = sample size

N = population size

Estimates are projected to the population of Michigan Sport Anglers, a sampled individual represents 150.37 individuals in the population.

TABLE 6-3. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION

All Fish, Michigan Sport Anglers, Fish Eaters by Ethnic Group and Income Group

Classification	Statistic	Grams/person/day		
		Estimate	90% Interval*	
			Lower Bound	Upper Bound
Minority/low-income	Mean	57.87	38.29	77.45
n = 61	50th %	32.27	17.35	40.82
N = 9,022	90th %	89.62	78.55	168.98
	95th %	181.58	85.51	472.65
	99th %	489.79	187.10	489.79
Non-minority/low-income	Mean	26.60	25.13	28.06
n = 2,133	50th %	0.00	0.00	0.00
N = 320,890	90th %	74.71	70.97	78.12
	95th %	102.75	97.32	106.21
	99th %	163.26	159.64	187.19
Total	Mean	27.45	25.92	28.98
n = 2,194	50th %	0.00	0.00	0.00
N = 329,912	90th %	75.75	72.31	78.88
	95th %	103.46	97.64	108.63
	99th %	174.86	161.25	196.94

* Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

Note: Fish Eaters = self-identified fish eater

n = sample size

N = population size

Estimates are projected to the population of Michigan Sport Anglers, a sampled individual represents 150.37 individuals in the population.

TABLE 6-4. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION

All Fish, Michigan Sport Anglers, Fish Eaters by Income Level

Classification	Statistic	Grams/person/day		
		Estimate	90% Interval*	
			Lower Bound	Upper Bound
0 - \$14,999	Mean	29.54	24.99	34.09
n = 285	50th %	0.00	0.00	6.51
N = 43,607	90th %	81.63	72.45	92.73
	95th %	104.68	93.30	131.25
	99th %	202.91	155.71	248.01
\$15,000 - \$24,999	Mean	28.06	23.58	32.54
n = 378	50th %	0.00	0.00	0.00
N = 55,487	90th %	70.14	63.99	78.62
	95th %	96.57	80.58	114.56
	99th %	196.76	149.59	431.67
\$25,000 - \$39,999	Mean	25.90	23.30	28.51
n = 658	50th %	0.00	0.00	0.00
N = 99,695	90th %	73.43	65.20	79.16
	95th %	100.16	93.88	111.84
	99th %	162.29	144.57	186.45
\$40,000 or more	Mean	27.67	25.43	29.91
n = 873	50th %	0.00	0.00	2.75
N = 131,123	90th %	77.13	72.33	81.63
	95th %	106.46	97.37	116.39
	99th %	163.72	146.94	188.85
Total	Mean	27.45	25.92	28.98
n = 2,194	50th %	0.00	0.00	0.00
N = 329,912	90th %	75.75	72.31	78.88
	95th %	103.46	97.64	108.63
	99th %	174.86	161.25	196.94

* Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

Note: Fish Eaters = self-identified fish eater

n = sample size

N = population size

Estimates are projected to the population of Michigan Sport Anglers, a sampled individual represents 150.37 individuals in the population.

TABLE 6-5. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION BY SPECIES

All Fish, Michigan Sport Anglers, Fish Eaters

Species	# of Individuals Consuming Each Species *	% of Population Consuming Each Species	Mean Estimate (grams/person/day)	90% Confidence Interval	
				Lower Bound	Upper Bound
1 Bass (Largemouth)	56	2.25	0.76	0.58	0.94
2 Bass (Smallmouth)	15	0.59	0.19	0.11	0.27
3 Bluegill	150	5.95	2.22	1.89	2.55
4 Bowfin	1	0.03	0.01	0.00	0.03
5 Buffalo	4	0.18	0.05	0.00	0.10
6 Bullhead	9	0.39	0.13	0.05	0.21
7 Burpot	2	0.07	0.03	0.00	0.06
8 Carp	2	0.07	0.03	0.00	0.06
9 Catfish	56	2.17	0.70	0.54	0.86
10 Cisco	1	0.05	0.01	0.00	0.03
11 Cod	122	4.86	1.63	1.37	1.89
12 Crappie	36	1.48	0.54	0.38	0.70
13 Drum	0	0.00	0.00	0.00	0.00
14 Gar	0	0.00	0.00	0.00	0.00
15 Haddock	8	0.30	0.09	0.04	0.14
16 Menominee	0	0.00	0.00	0.00	0.00
17 Musky (Nothern or Great Lake)	0	0.00	0.00	0.00	0.00
18 Musky (Tiger)	1	0.04	0.02	0.00	0.05
19 Orange roughy	34	1.35	0.45	0.30	0.60
20 Perch (Ocean)	30	1.13	0.36	0.24	0.48
21 Perch (Yellow)	314	12.68	4.59	4.11	5.07
22 Pike (Nothern)	63	2.65	1.02	0.77	1.27
23 Pollok	4	0.15	0.05	0.00	0.10
24 Quillback	0	0.00	0.00	0.00	0.00
25 Redfish	1	0.03	0.01	0.00	0.03
26 Redhorse	1	0.04	0.01	0.00	0.03
27 Rockbass	9	0.37	0.11	0.04	0.18
28 Salmon	91	3.63	1.36	1.08	1.64
29 Salmon (Atlantic)	0	0.00	0.00	0.00	0.00
30 Salmon (Coho)	19	0.73	0.30	0.17	0.43

* Sample Size = 2,451

Population = 368,557

TABLE 6-5. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION BY SPECIES

All Fish, Michigan Sport Anglers, Fish Eaters

Species	# of Individuals Consuming Each Species *	% of Population Consuming Each Species	Mean Estimate (grams/person/day)	90% Confidence Interval	
				Lower Bound	Upper Bound
31 Salmon (Chinook)	8	0.30	0.11	0.04	0.18
32 Salmon (King)	7	0.27	0.10	0.03	0.17
33 Salmon (Pink)	5	0.19	0.08	0.01	0.15
34 Sauger	0	0.00	0.00	0.00	0.00
35 Smelt	46	1.90	0.69	0.49	0.89
36 Splake (hybrid trout)	0	0.00	0.00	0.00	0.00
37 Sturgeon	0	0.00	0.00	0.00	0.00
38 Sucker (Longnose)	1	0.05	0.02	0.00	0.05
39 Sucker (White)	15	0.56	0.17	0.09	0.25
40 Sunfish	4	0.15	0.05	0.00	0.10
41 Trout (Brook)	24	0.95	0.35	0.22	0.48
42 Trout (Brown)	33	1.32	0.51	0.35	0.67
43 Trout (Lake)	73	3.00	1.10	0.87	1.33
44 Trout (Rainbow)	46	1.88	0.72	0.52	0.92
45 Tuna	42	1.68	0.57	0.39	0.75
46 Walleye	232	9.20	3.38	2.99	3.77
47 Warmouth Bass	0	0.00	0.00	0.00	0.00
48 Whitebass	8	0.32	0.10	0.03	0.17
49 Whitefish	123	5.06	1.87	1.56	2.18
50 Other Single Species	86	3.45	1.26	0.98	1.54
51 Bass and Bluegills	2	0.07	0.04	0.00	0.09
52 Perch and Bluegills	9	0.36	0.11	0.04	0.18
53 Pike and Perch	1	0.04	0.01	0.00	0.03
54 Walleye and Perch	2	0.10	0.04	0.00	0.09
55 Other Combinations	6	0.23	0.10	0.03	0.17
56 Species Not Recorded	52	2.25	0.52	0.39	0.65

* Sample Size = 2,451

Population = 368,557

TABLE 6-6. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION BY SPECIES

All Fish, Michigan Sport Anglers, Fish Eaters
 Minority/Low-Income Group **

Species	# of Individuals	% of Population	Mean	90% Confidence Interval	
	Consuming Each Species *	Consuming Each Species	Estimate (grams/person/day)	Lower Bound	Upper Bound
1 Bass (Largemouth)	4	7.18	2.15	0.44	3.86
2 Bass (Smallmouth)	0	0.00	0.00	0.00	0.00
3 Bluegill	8	12.15	4.43	1.73	7.13
4 Bowfin	0	0.00	0.00	0.00	0.00
5 Buffalo	2	4.06	1.45	0.00	3.11
6 Bullhead	2	3.17	1.15	0.00	2.47
7 Burpot	0	0.00	0.00	0.00	0.00
8 Carp	1	1.43	0.58	0.00	1.53
9 Catfish	10	16.06	5.79	2.73	8.85
10 Cisco	0	0.00	0.00	0.00	0.00
11 Cod	2	2.95	3.21	0.00	7.68
12 Crappie	4	6.01	2.40	0.15	4.65
13 Drum	0	0.00	0.00	0.00	0.00
14 Gar	0	0.00	0.00	0.00	0.00
15 Haddock	0	0.00	0.00	0.00	0.00
16 Menominee	0	0.00	0.00	0.00	0.00
17 Musky (Nothorn or Great Lake)	0	0.00	0.00	0.00	0.00
18 Musky (Tiger)	0	0.00	0.00	0.00	0.00
19 Orange roughy	0	0.00	0.00	0.00	0.00
20 Perch (Ocean)	2	3.46	1.26	0.00	2.69
21 Perch (Yellow)	11	17.27	11.41	3.20	19.62
22 Pike (Nothorn)	3	4.06	1.66	0.11	3.21
23 Pollok	0	0.00	0.00	0.00	0.00
24 Quillback	0	0.00	0.00	0.00	0.00
25 Redfish	0	0.00	0.00	0.00	0.00
26 Redhorse	0	0.00	0.00	0.00	0.00
27 Rockbass	0	0.00	0.00	0.00	0.00
28 Salmon	2	3.54	1.01	0.00	2.18
29 Salmon (Atlantic)	0	0.00	0.00	0.00	0.00
30 Salmon (Coho)	2	2.99	0.98	0.00	2.10

* Sample Size = 61
 Population = 9,022

** Non-white sport fishing license holders whose annual household income in 1990 was less than \$25,000.

TABLE 6-6. AVERAGE DAILY PER CAPITA ESTIMATES OF FISH CONSUMPTION BY SPECIES

All Fish, Michigan Sport Anglers, Fish Eaters
 Minority/Low - Income Group **

Species	# of Individuals	% of Population	Mean Estimate (grams/person/day)	90% Confidence Interval	
	Consuming Each Species *	Consuming Each Species		Lower Bound	Upper Bound
31 Salmon (Chinook)	1	1.56	0.51	0.00	1.35
32 Salmon (King)	1	1.80	0.73	0.00	1.93
33 Salmon (Pink)	0	0.00	0.00	0.00	0.00
34 Sauger	0	0.00	0.00	0.00	0.00
35 Smelt	2	3.31	0.97	0.00	2.11
36 Splake (hybrid trout)	0	0.00	0.00	0.00	0.00
37 Sturgeon	0	0.00	0.00	0.00	0.00
38 Sucker (Longnose)	0	0.00	0.00	0.00	0.00
39 Sucker (White)	3	4.50	1.10	0.03	2.17
40 Sunfish	2	3.17	1.15	0.00	2.47
41 Trout (Brook)	2	3.00	0.90	0.00	1.99
42 Trout (Brown)	2	2.97	1.09	0.00	2.34
43 Trout (Lake)	3	4.53	1.39	0.06	2.72
44 Trout (Rainbow)	1	1.43	0.58	0.00	1.53
45 Tuna	0	0.00	0.00	0.00	0.00
46 Walleye	6	9.71	3.27	1.10	5.44
47 Warmouth Bass	0	0.00	0.00	0.00	0.00
48 Whitebass	3	5.25	1.87	0.11	3.63
49 Whitefish	4	5.99	2.93	0.41	5.45
50 Other Single Species	4	6.46	2.31	0.37	4.25
51 Bass and Bluegills	0	0.00	0.00	0.00	0.00
52 Perch and Bluegills	0	0.00	0.00	0.00	0.00
53 Pike and Perch	0	0.00	0.00	0.00	0.00
54 Walleye and Perch	0	0.00	0.00	0.00	0.00
55 Other Combinations	0	0.00	0.00	0.00	0.00
56 Species Not Recorded	3	4.88	1.60	0.09	3.11

* Sample Size = 61

Population = 9,022

** Non - white sport fishing license holders whose annual household income in 1990 was less than \$25,000.

Table 6-7. Estimated Percent of Angler Population Consuming Less Than 150 Grams of All Fish per Day

All Fish, Michigan Sport Anglers, Fish Eaters

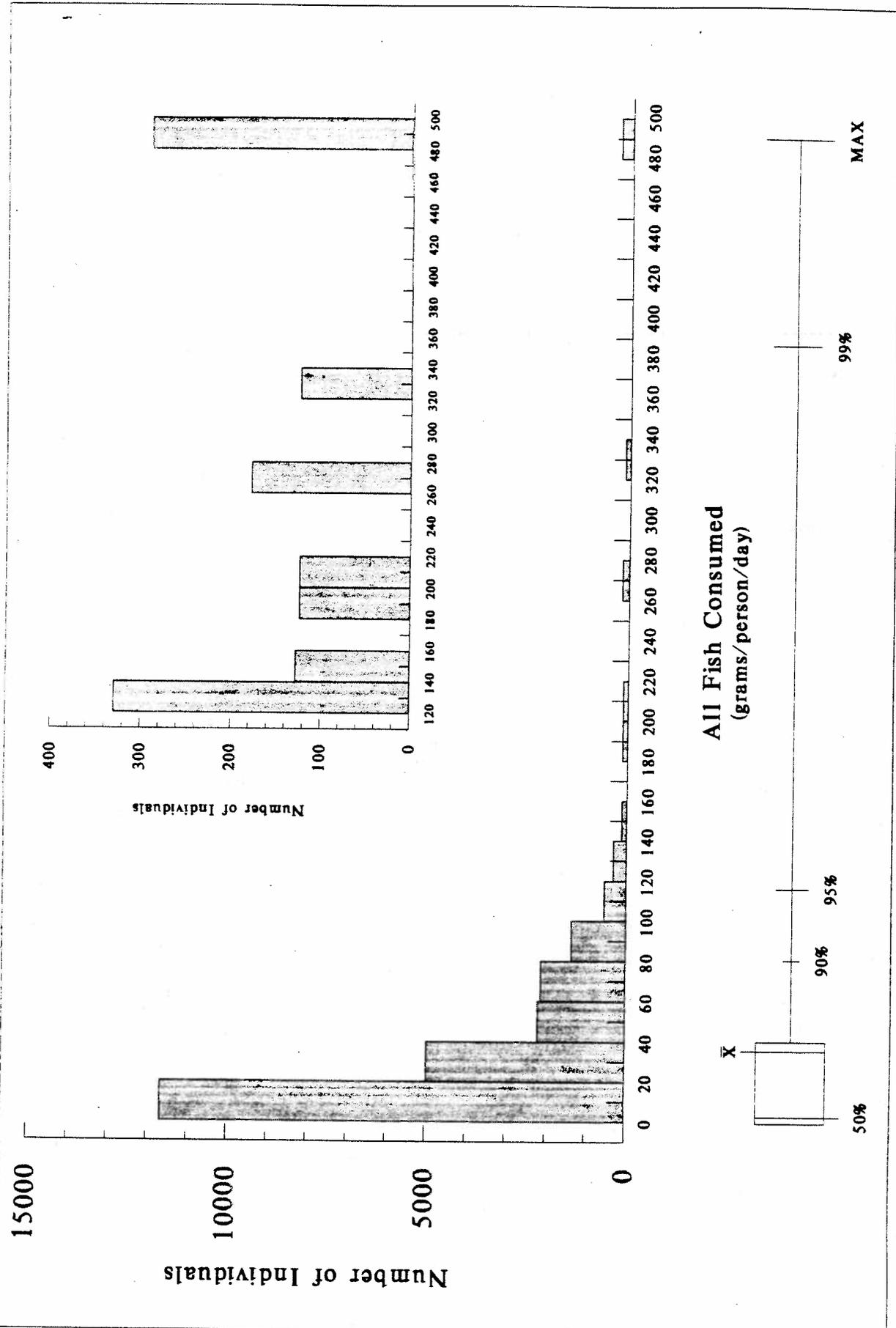
Sub Population	Sample Size	Estimated Population Size	Estimated No. of Individuals Consuming < 150g/day	Estimated Percent of Population Consuming < 150g/day	Lower 90% Bound for Percent Estimate	Upper 90% Bound for Percent Estimate
All	2,451	368,557	361,941	98.2	97.4	99.0
Minority/ Low Income*	61	9,022	8,571	95.0	91.8	98.2

* Non-white sport fishing license holders whose annual household income in 1990 was less than \$25,000.

CHAPTER 6 FIGURES

Figure 6-1a.1. HISTOGRAM OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION

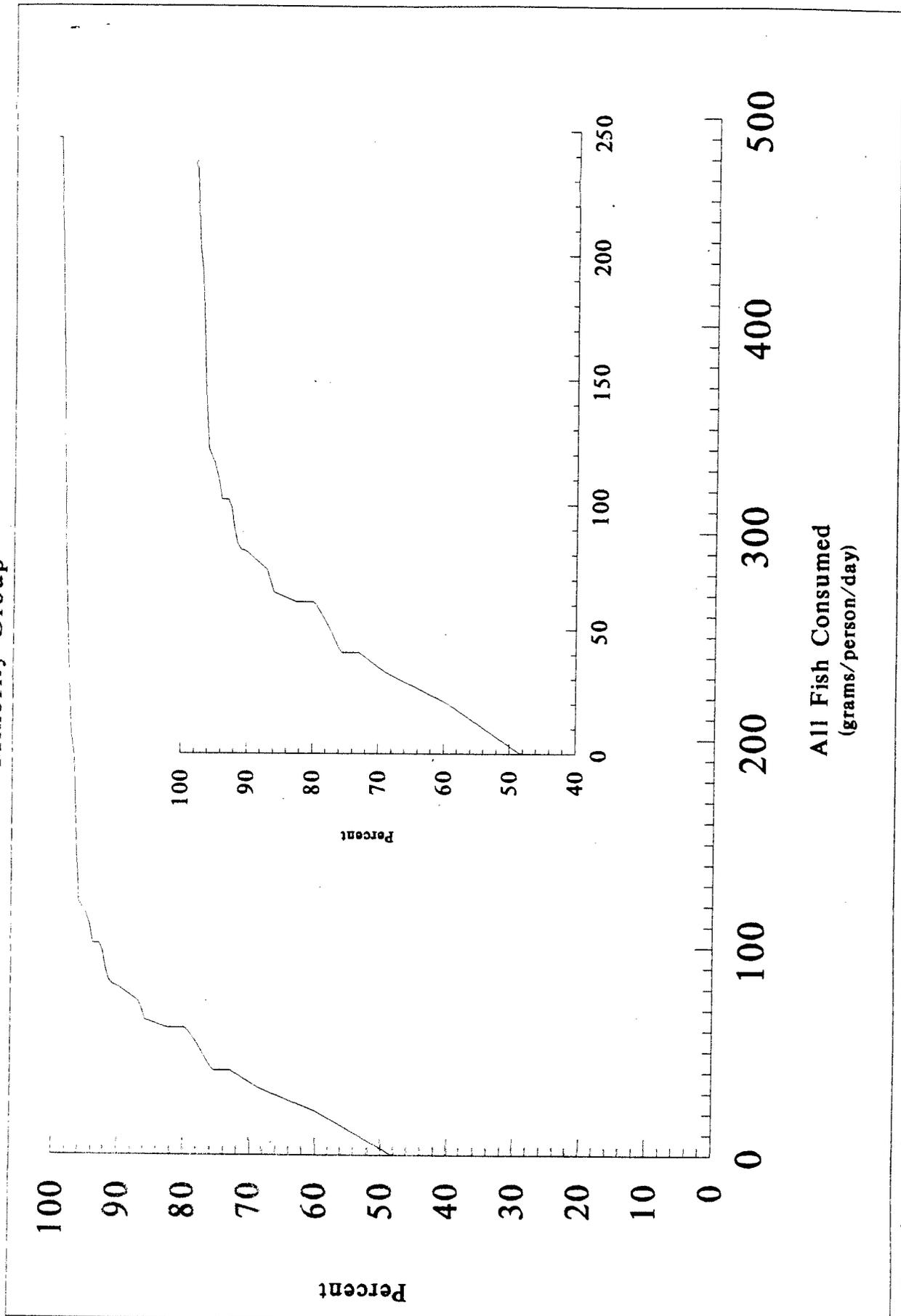
All Fish. Michigan Sport Anglers. Fish Eaters
Minority Group



Based on ethnic background information.

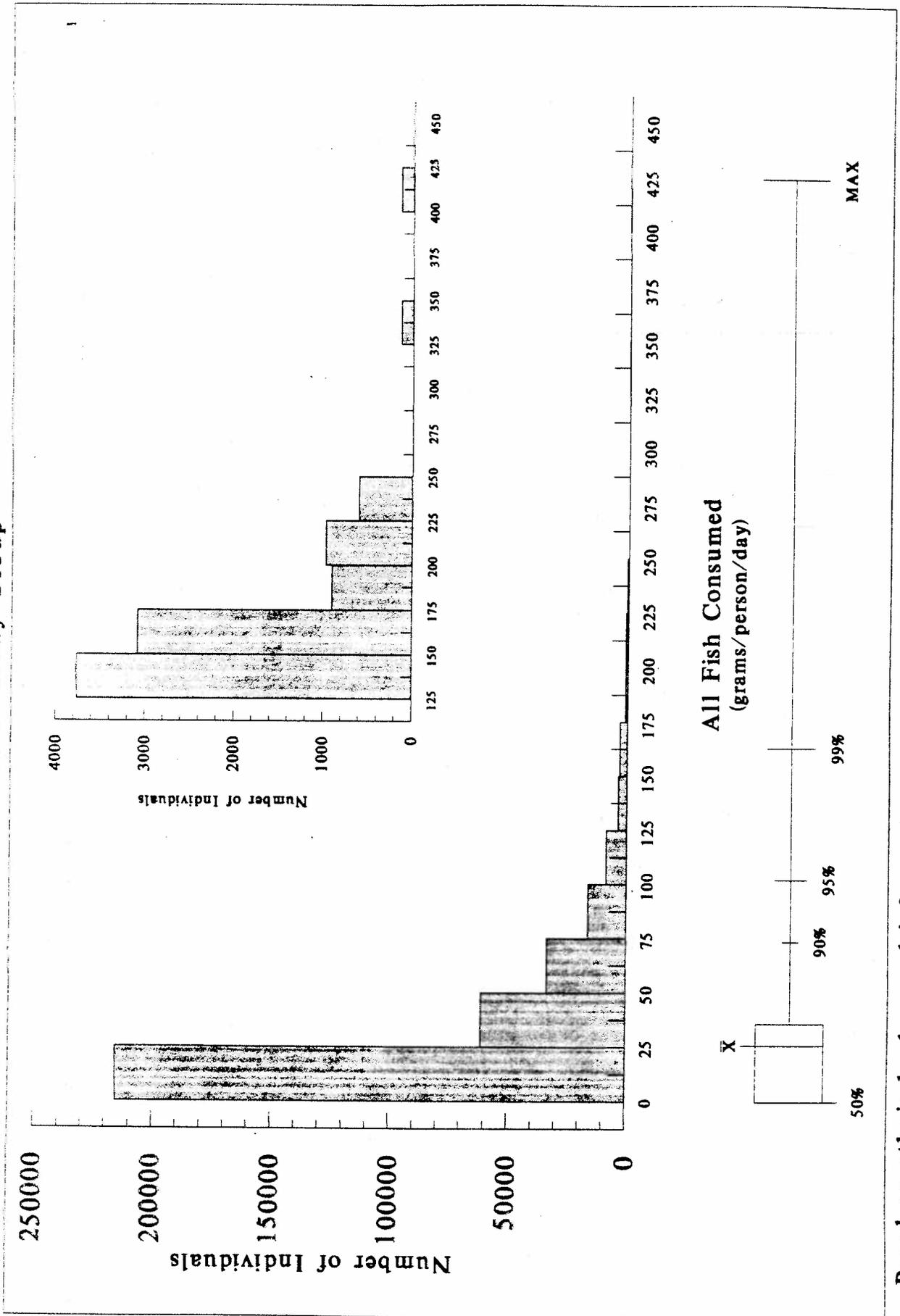
Figure 6-1a.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY PER CAPITA FISH CONSUMPTION

All Fish, Michigan Sport Anglers, Fish Eaters
Minority Group



**Figure 6-1b.1. HISTOGRAM OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION**

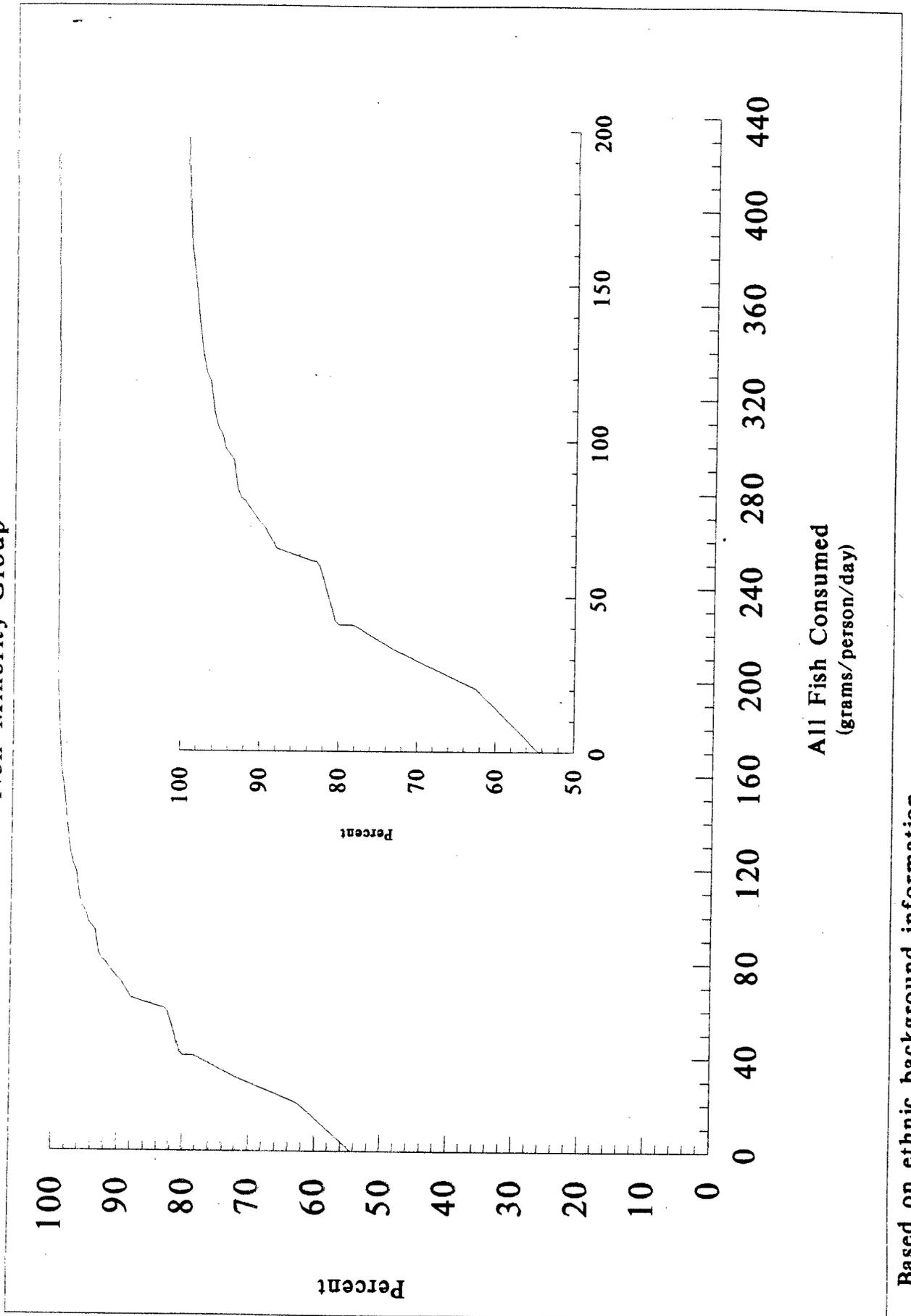
**All Fish. Michigan Sport Anglers. Fish Eaters
Non-Minority Group**



Based on ethnic background information.

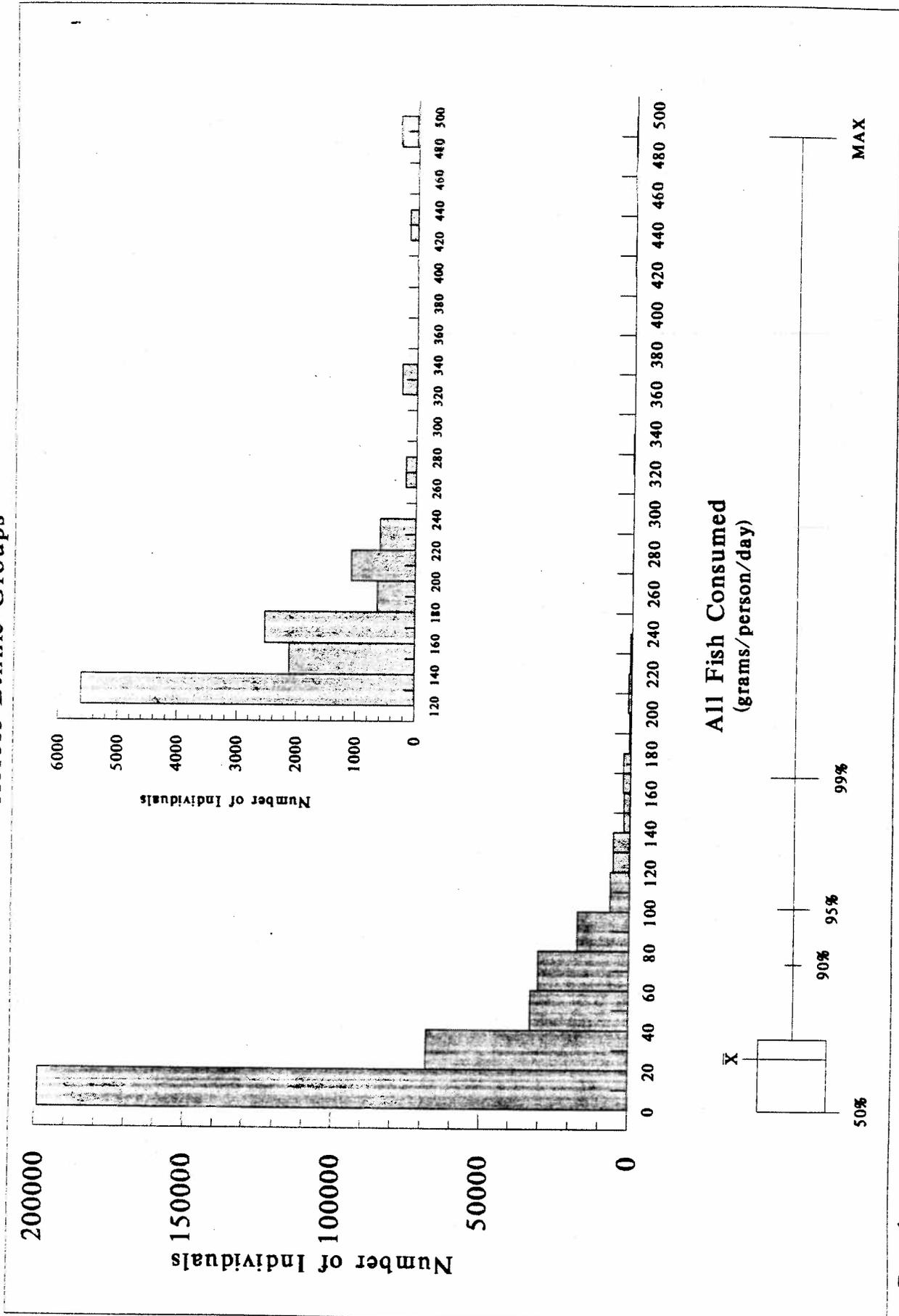
Figure 6-1b.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION

All Fish, Michigan Sport Anglers, Fish Eaters
Non-Minority Group



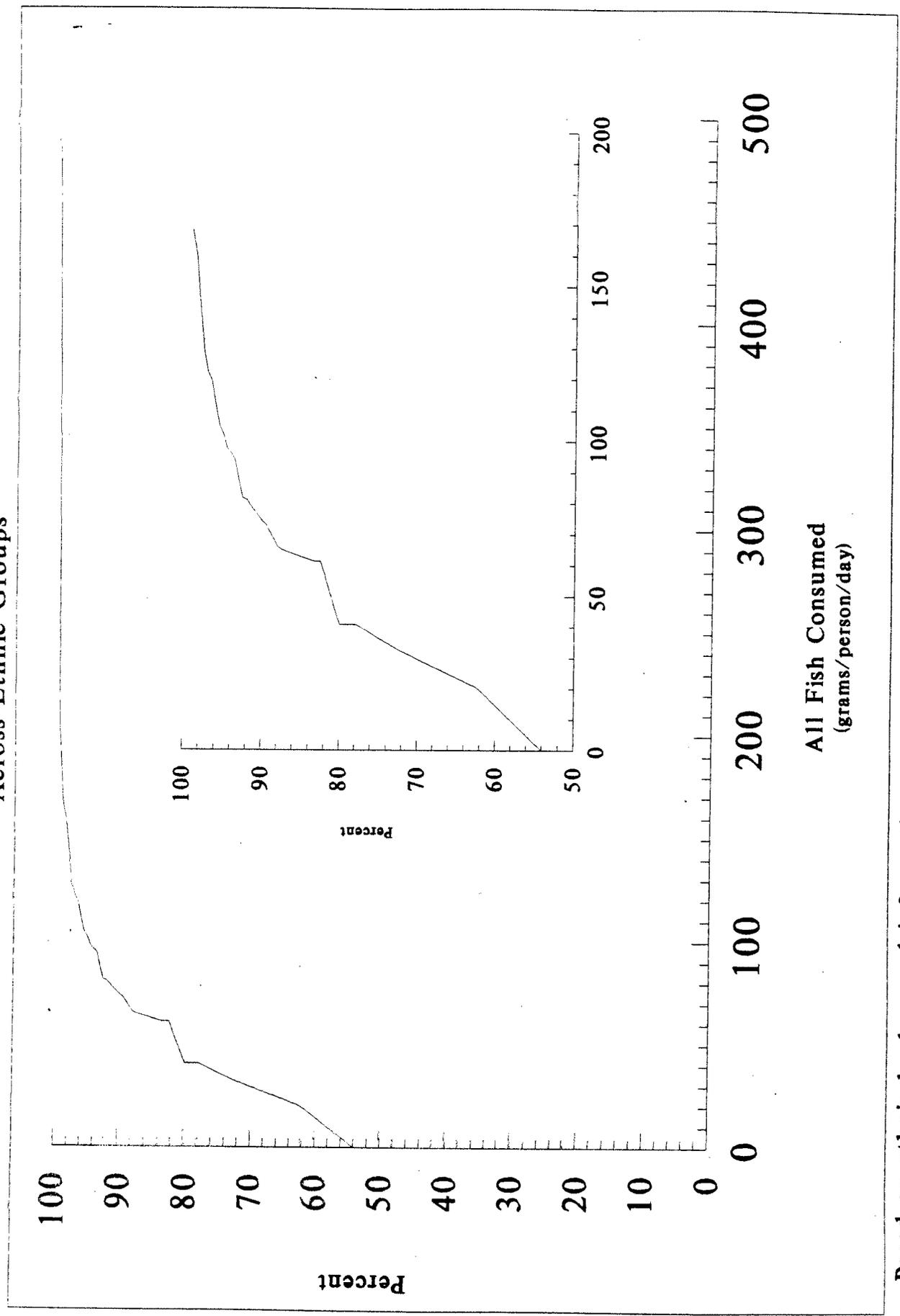
Based on ethnic background information.

**Figure 6-1c.1. HISTOGRAM OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION
All Fish, Michigan Sport Anglers, Fish Eaters
Across Ethnic Groups**



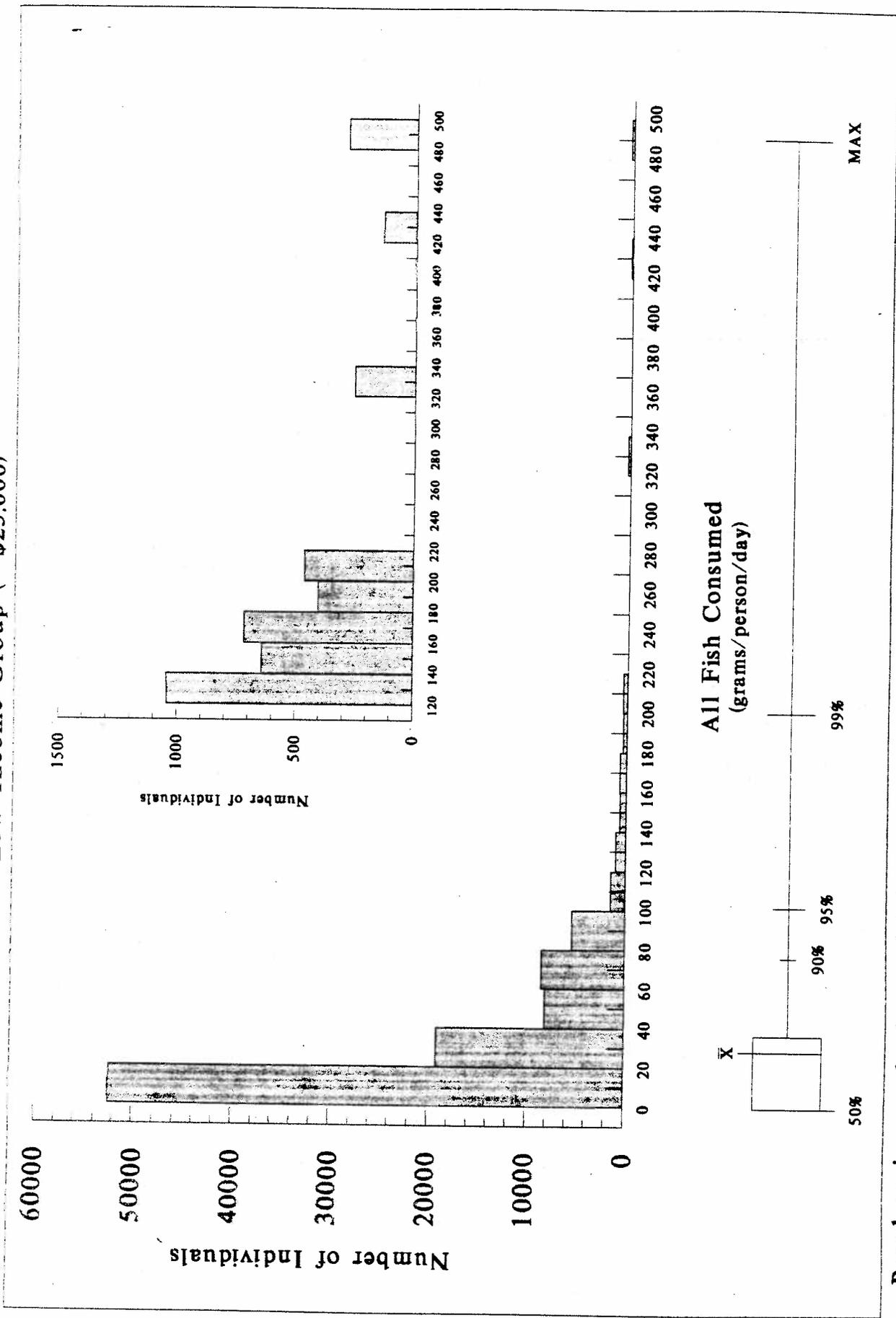
Based on ethnic background information.

Figure 6-1c.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY PER CAPITA FISH CONSUMPTION
 All Fish, Michigan Sport Anglers, Fish Eaters
 Across Ethnic Groups



Based on ethnic background information.

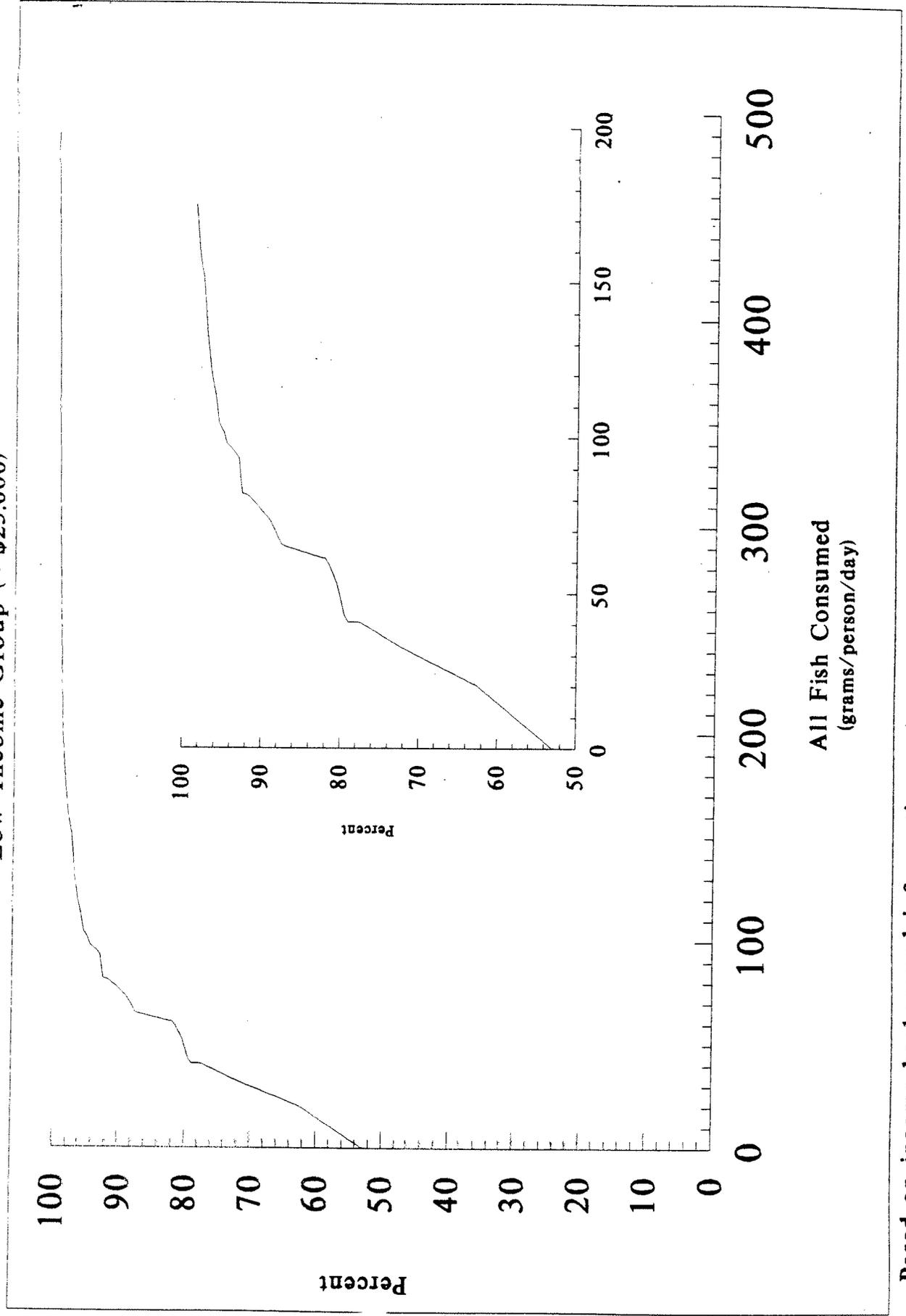
Figure 6-2a.1. HISTOGRAM OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION
 All Fish, Michigan Sport Anglers, Fish Eaters
 Low-Income Group (< \$25,000)



Based on income background information.

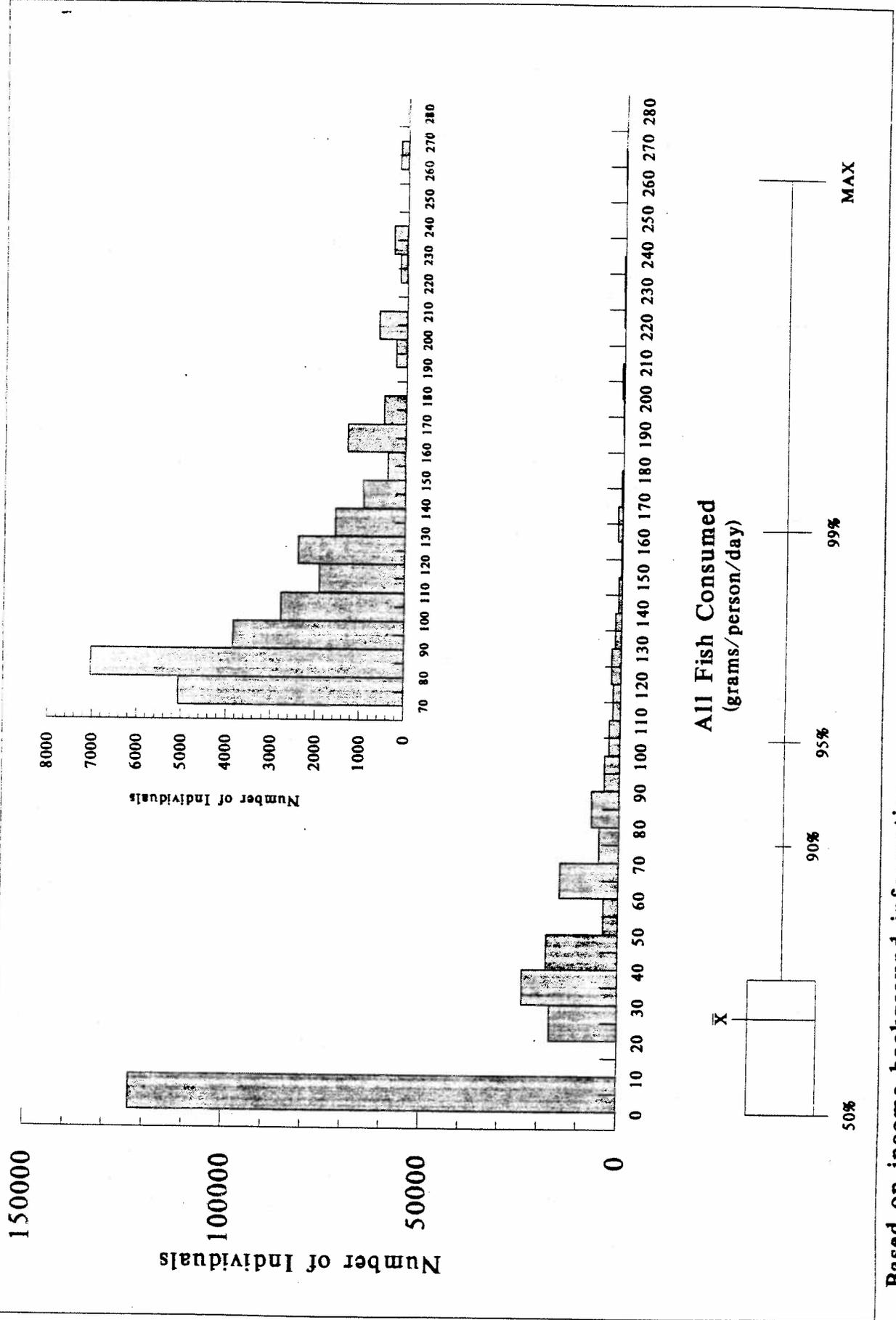
Figure 6-2a.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY PER CAPITA FISH CONSUMPTION

All Fish, Michigan Sport Anglers, Fish Eaters
 Low-Income Group (< \$25,000)



Based on income background information.

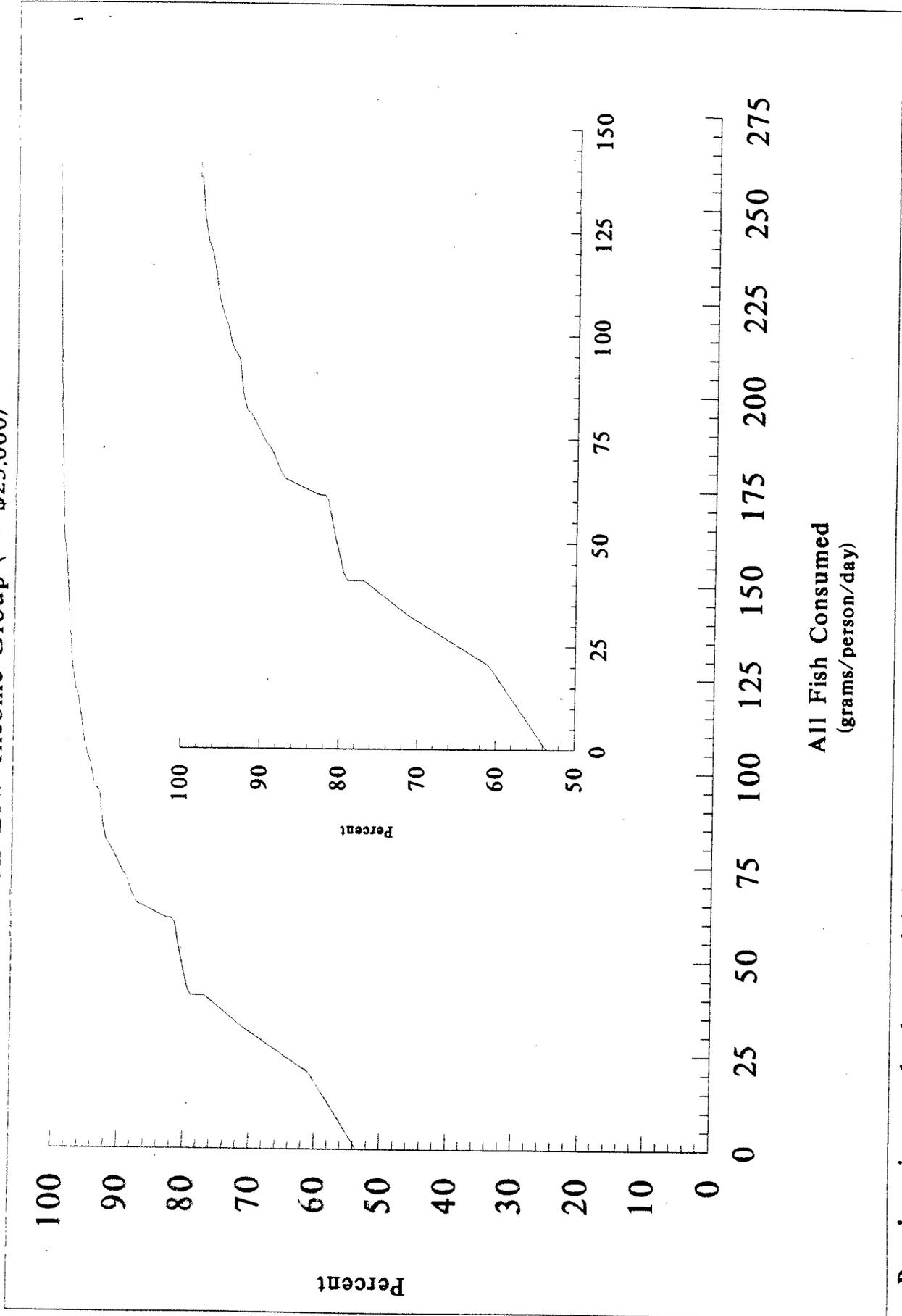
**Figure 6-2b.1. HISTOGRAM OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION
All Fish. Michigan Sport Anglers, Fish Eaters
Non-Low-Income Group (\geq \$25,000)**



Based on income background information.

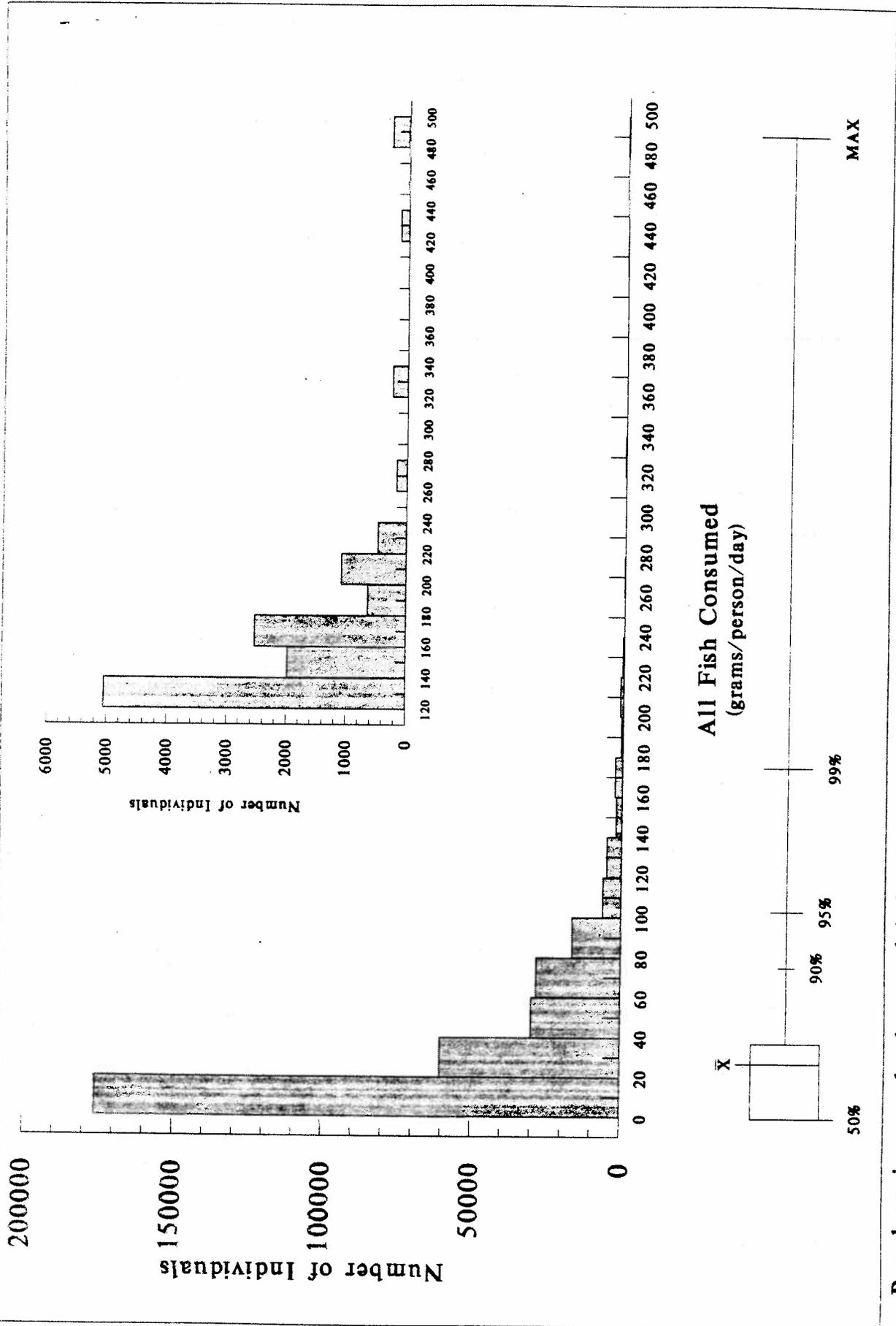
**Figure 6-2b.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION**

**All Fish, Michigan Sport Anglers, Fish Eaters
Non-Low-Income Group (\geq \$25,000)**



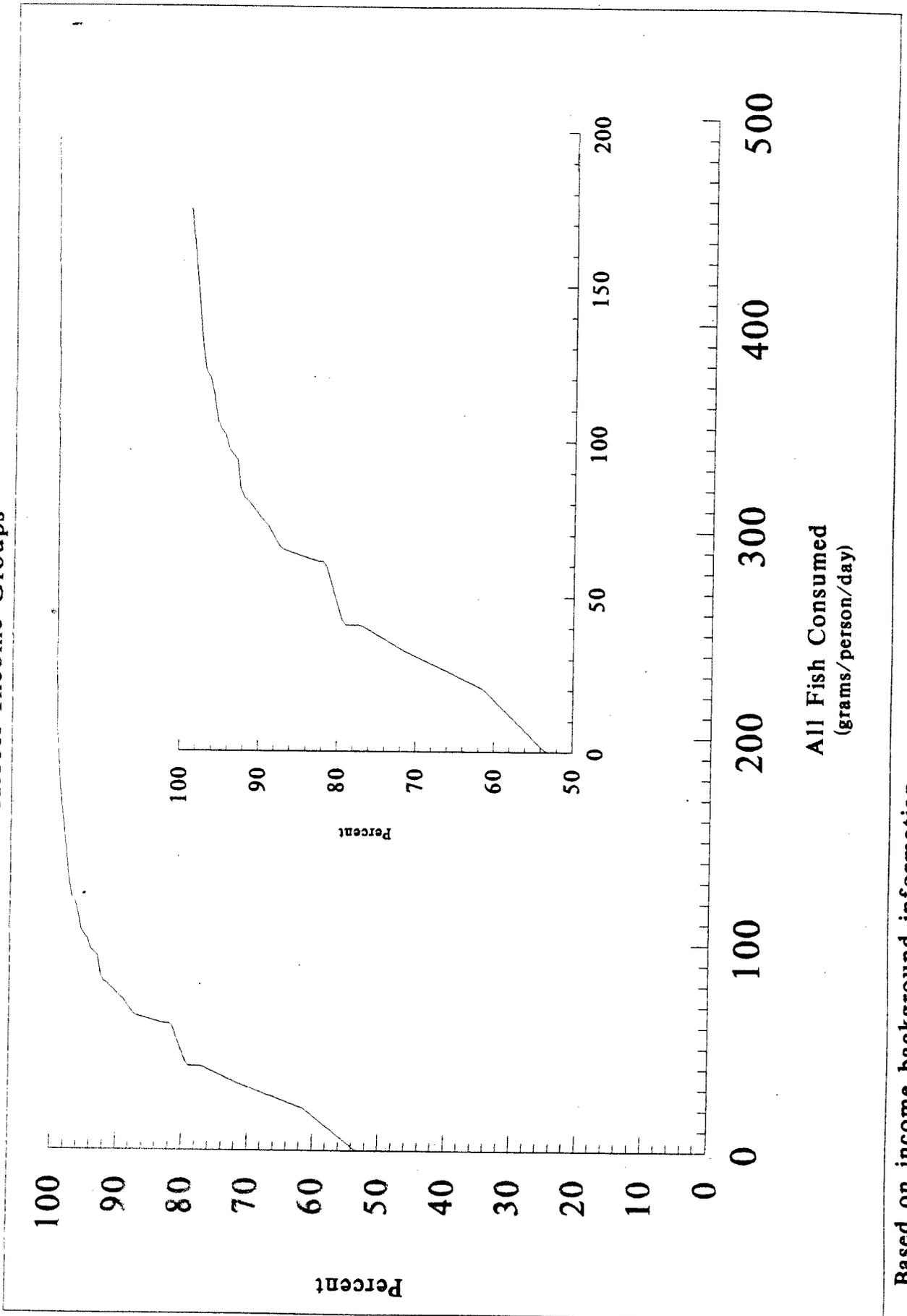
Based on income background information.

Figure 6-2c.1. HISTOGRAM OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION
 All Fish. Michigan Sport Anglers, Fish Eaters
 Across Income Groups



Based on income background information.

Figure 6-2c.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION
 All Fish. Michigan Sport Anglers, Fish Eaters
 Across Income Groups

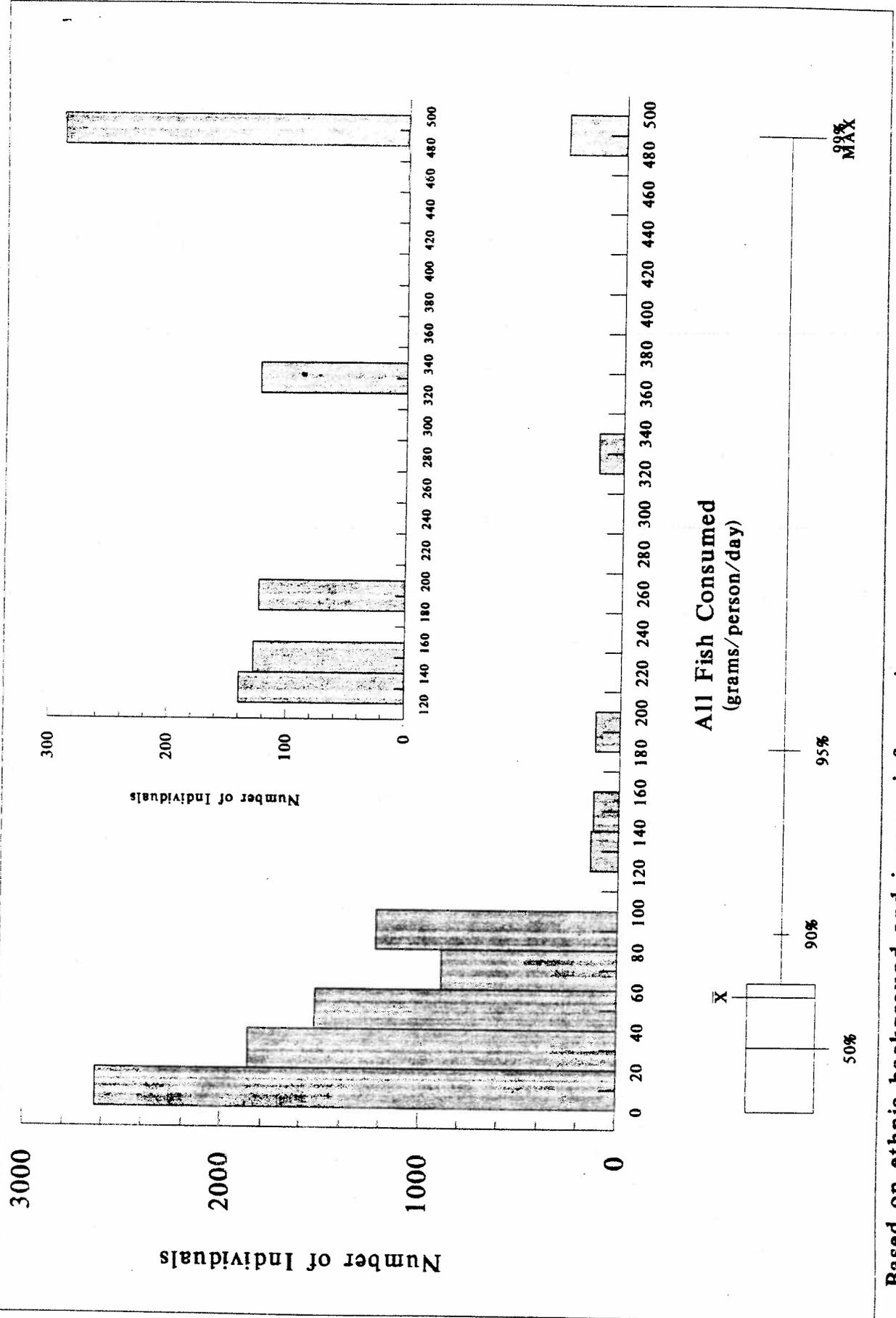


Based on income background information.

Figure 6-3a.1. HISTOGRAM OF AVERAGE DAILY PER CAPITA FISH CONSUMPTION

All Fish. Michigan Sport Anglers. Fish Eaters

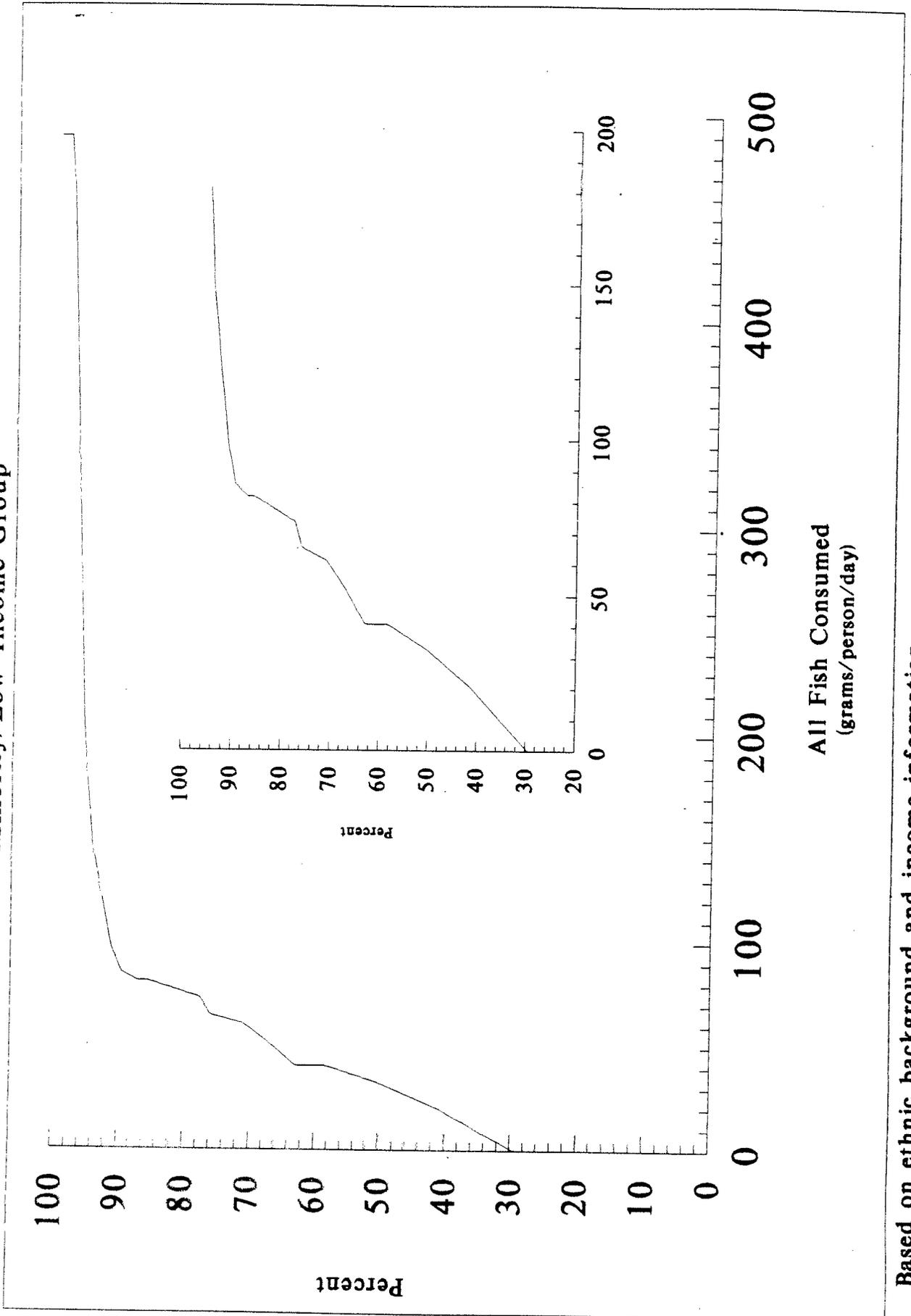
Minority/Low-Income Group



Based on ethnic background and income information.

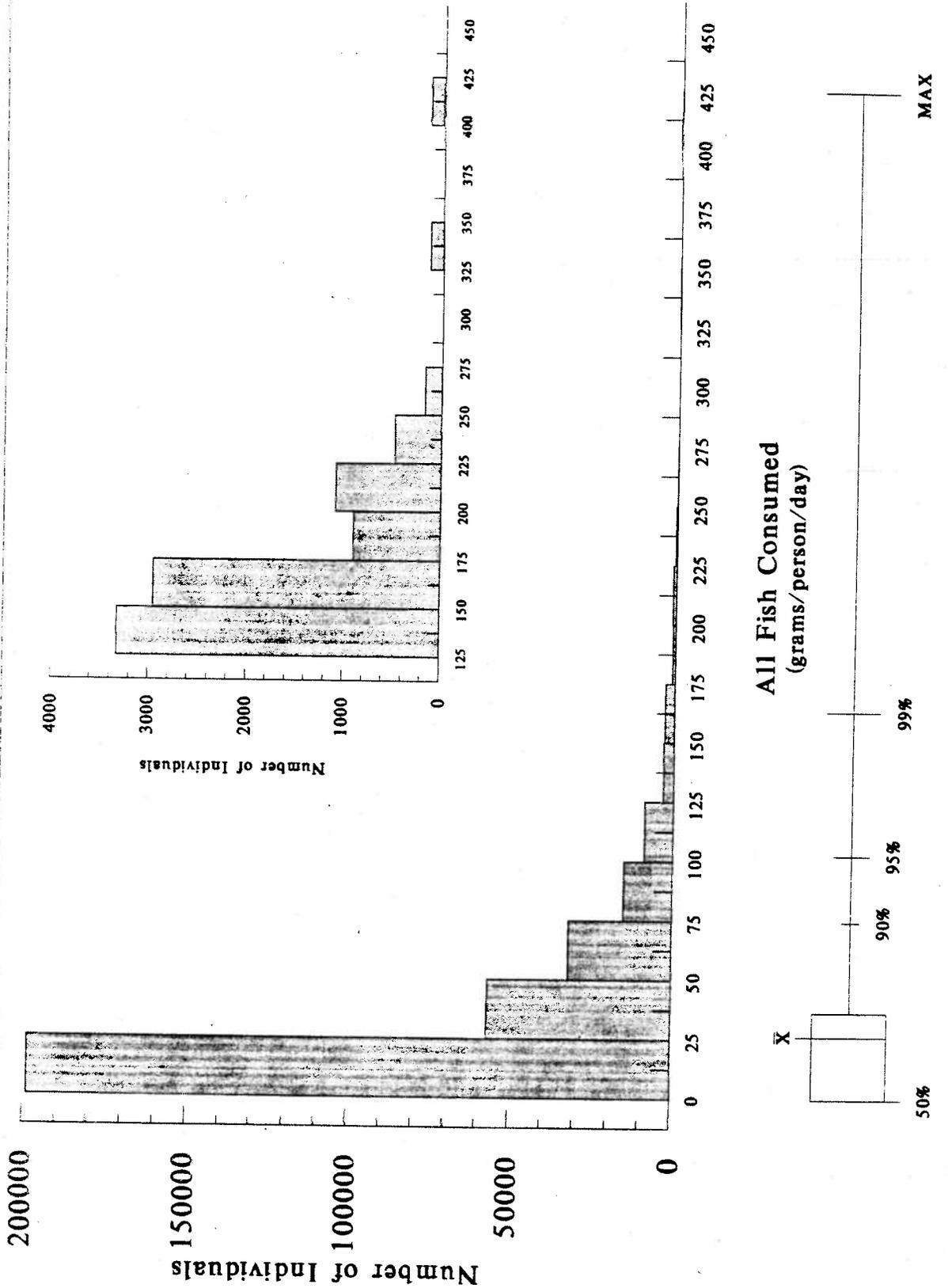
Figure 6-3a.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
PER CAPITA FISH CONSUMPTION

All Fish, Michigan Sport Anglers, Fish Eaters
Minority/Low-Income Group



Based on ethnic background and income information.

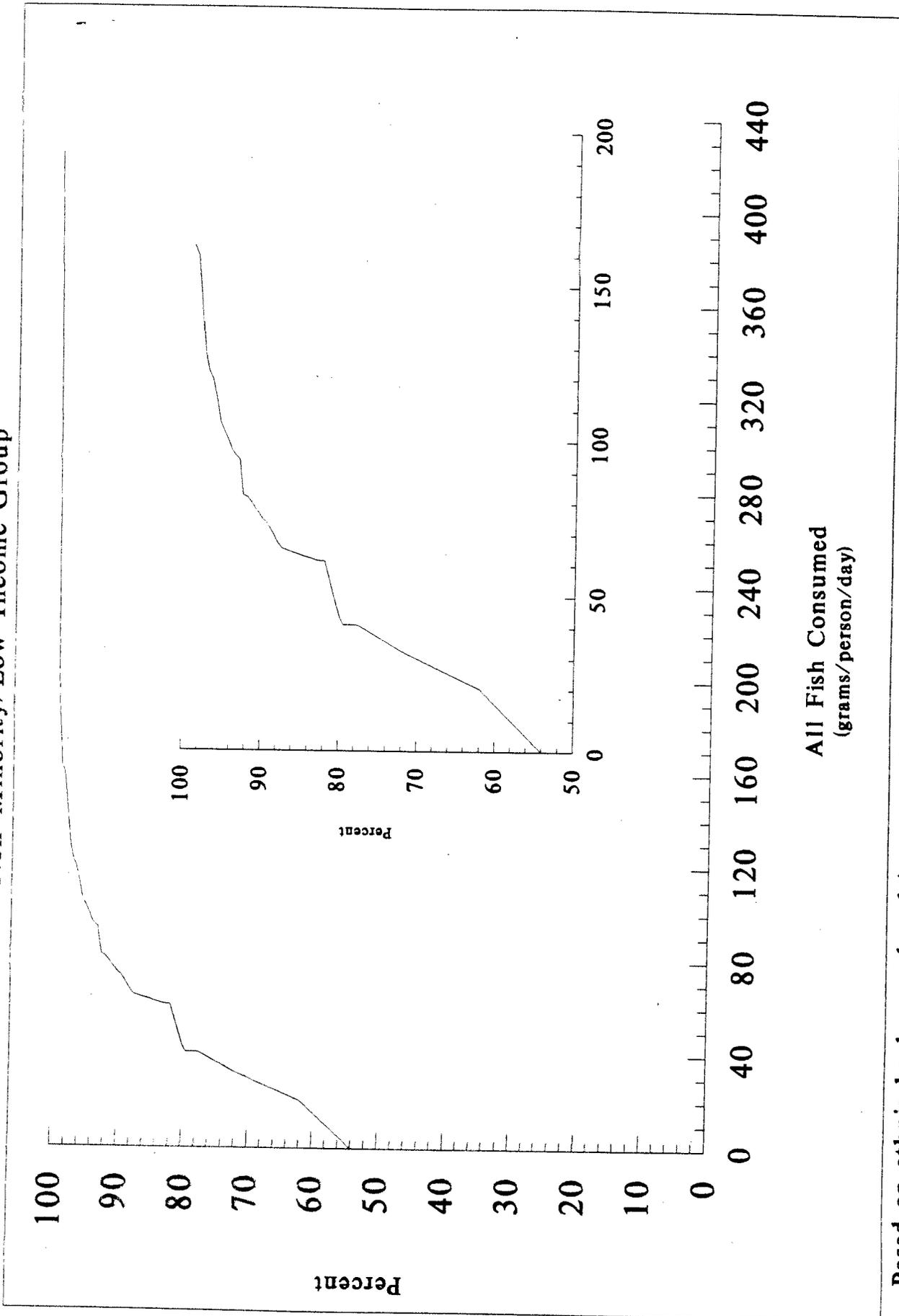
Figure 6-3b.1. HISTOGRAM OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION
 All Fish. Michigan Sport Anglers, Fish Eaters
 Non-Minority/Low-Income Group



Based on ethnic background and income information.

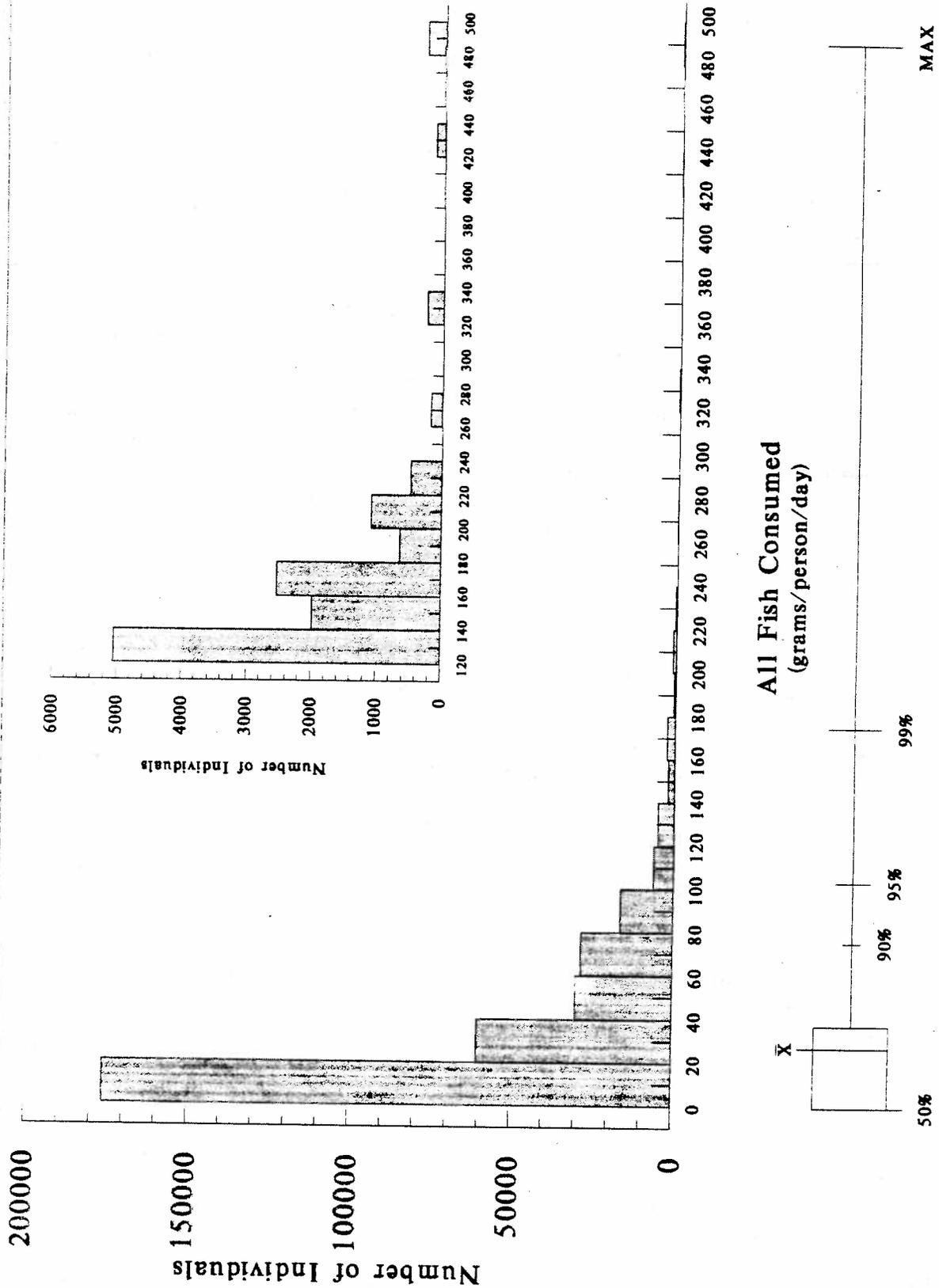
Figure 6-3b.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY PER CAPITA FISH CONSUMPTION

All Fish. Michigan Sport Anglers, Fish Eaters
Non-Minority/Low-Income Group



Based on ethnic background and income information.

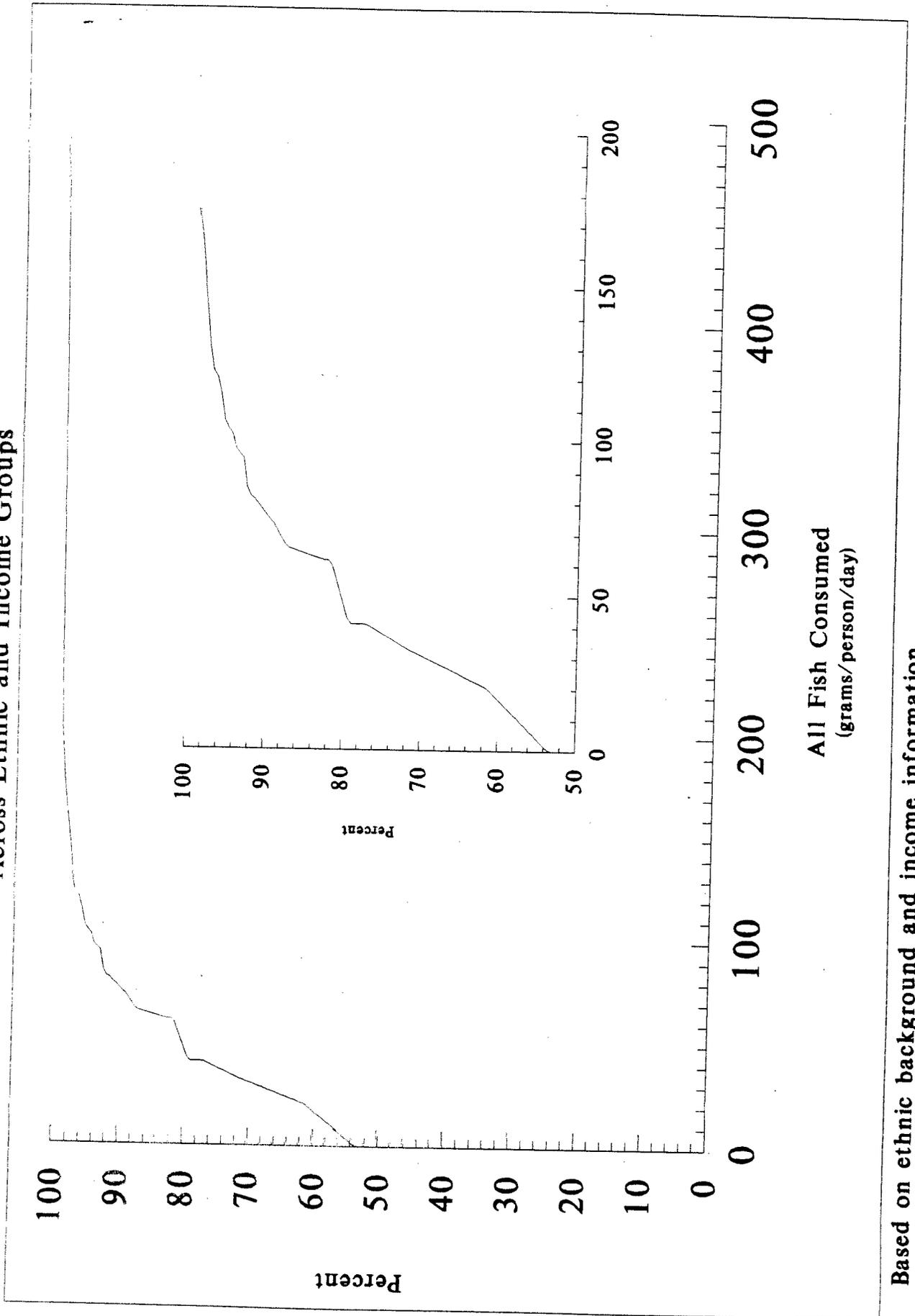
Figure 6-3c.1. HISTOGRAM OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION
 All Fish, Michigan Sport Anglers, Fish Eaters
 Across Ethnic and Income Groups



Based on ethnic background and income information.

Figure 6-3c.2. CUMULATIVE DISTRIBUTION OF AVERAGE DAILY
 PER CAPITA FISH CONSUMPTION

All Fish. Michigan Sport Anglers, Fish Eaters
 Across Ethnic and Income Groups



Based on ethnic background and income information.

7. SUMMARY OF RESULTS

This report presents estimates of average daily per capita fish consumption for select subpopulations of Michigan sport anglers. Mean and upper percentile consumption estimates were generated from the 1991-92 Michigan Sport Anglers Fish Consumption Study (MSAFCS). These estimates support the Environmental Protection Agency's (EPA) development of the Great Lakes Water Quality Guidance under Section 118 (c)(2) of the Clean Water Act (CWA).

Point and interval estimates of average daily per capita fish consumption are presented in Chapters 4, 5, and 6. All estimates are for the subpopulation of Michigan sport anglers who declared in the MSAFCS survey that they were fish eaters. Chapter 4 presents tabulated estimates and augmenting graphics for average daily per capita consumption of sport fish. Commercial fish consumption estimates are listed in Chapter 6. Chapter 7 follows estimates and graphics for average daily per capita consumption of all fish.

Commercial fish were identified in the MSAFCS as those fish purchased in either a restaurant or market. By convention, sport fish are declared as all fish not recorded by MSAFCS as being purchased in a restaurant or market.

The MSAFCS surveyed 7,000 licensed Michigan sport anglers. Of the 2,681 respondents, 2,476 individuals declared that they were fish eaters. From the respondents, the MSAFCS collected data about fish consumption over a consecutive, 7-day period. For each meal in the survey period, respondents were given a choice of four quantities to record their fish consumption. A more detail description of these choices is presented in Chapter 2 of this report.

For each self-declared fish eater that responded to the survey, an average daily fish consumption was computed by summing the recorded fish consumption across the 7 days and dividing this sum by 7. Estimates and empirical distributions of per capita consumption were generated from these daily averages.

For each fish type (sport, commercial, all) average daily per capita consumption estimates are presented for the following population subgroups: minority and non-minority, low-income and non-low-income, and minority/low-income and non-minority/low-income. Minority individuals are those respondents that recorded non-white in the ethnic variable of the MSAFCS. Individuals recording an annual income of less than \$25,000 constitute the low-income subpopulation.

Of the 2,476 self-declared fish eaters who responded to the MSAFCS survey, 2,451 individuals recorded their ethnic background. This projects to a population size of 368,557 fish-eating Michigan sport anglers. Likewise, a total of 2,194 respondents who declared that they eat fish also reported income. Therefore, income and minority/income based average daily per capita consumption estimates for self-declared fish eaters are based on data from 2,194 respondents. This projects to a Michigan sport angler population of 329,912 fish eaters.

The five sections that follow highlight results by subgroup across fish types as follows:

- Ethnic Group Results
- Income Group Results
- Ethnic and Income Group Results
- Species Results
- Estimated Percentage Consuming Less Than 150 grams/person/day.

7.1 Ethnic Group Results

Table 4-1 presents estimated sport-fish consumption for minority/non-minority, self-identified fish-eating Michigan sport anglers. From a sample of 163 individuals projected to 24,210 individuals in the population, the estimated mean average per capita sport-fish consumption for minority, self-identified fish-eating Michigan sport anglers is 23.22 ± 8.01 grams/person/day. For non-minority, self-identified Michigan sport anglers, the estimated mean average daily per capita sport-fish consumption is 16.28 ± 1.15 , based on a sample of 2,288 individuals projected to 344,347 individuals in the population. These results indicate that the minority subgroup consumed an average of about 43 percent more sport fish than the non-minority subgroup.

Mean average daily per capita estimates of sport fish consumption correspond to the mean estimates presented in Table 21 of the MSAFCS report by West et al. Point estimates of the 95th percentile of average daily per capita consumption of sport fish are 79.5 and 77.65 grams/person/day for the minority and non-minority subgroups, respectively. Estimates of the 90th and 95th percentiles do not largely differ between the two ethnic groups. However, the large difference in the estimated 386.68 grams for the minority 99th percentile compared to the 145.20 grams for the non-minority subgroup indicates that one or more individuals in the minority subpopulation consumed an extreme average daily consumption of sport fish. Extreme is with respect to other reported values. These extreme values also influences the mean estimate.

The same pattern is evident in consumption of commercial fish. Table 5-1 reports estimated average daily per capita commercial fish consumption estimates for minority/non-minority, self-identified fish-eating Michigan sport anglers. The estimated mean average per capita commercial fish consumption for minority, self-identified fish-eating Michigan sport anglers is 12.75 ± 4.37 grams/person/day. For non-minority, self-identified Michigan sport anglers, the estimated mean average daily per capita commercial fish consumption is 9.64 ± 0.76 grams/person/day. These results indicate that the minority subgroup consumed an average of about 32 percent more commercial fish than the non-minority subgroup.

Again with commercial fish consumption, point estimates of the 90th and 95th percentiles of the per capita consumption do not differ greatly. However, the 99th percentile consumption estimates differ by 51 grams. The larger 99th percentile estimate for the minority subpopulation suggests an extreme consumption rate, as compared to other reported amounts, in the subpopulation.

The same trend is evident on Table 6-1 for estimates of average daily per capita consumption of all fish by the two ethnic subpopulations. The estimates of mean, average daily per capita consumption of all fish reported on Table 6-1 verify those recorded in the West, et al. MSAFCS report on Table 22.

7.2 Income Group Results

Table 4-2 presents estimated average daily per capita sport fish consumption by income group for self-identified fish-eating Michigan sport anglers. Low-income is defined as an annual income of less than \$25,000. From a sample of 663 individuals projected to 99,094 individuals in the population, the estimated mean, average per capita sport-fish consumption for low-income, self-identified fish-eating Michigan sport anglers is 20.82 ± 2.94 grams/person/day. For non-low-income, self-identified Michigan sport anglers, the estimated mean average daily per capita sport-fish consumption is 15.93 ± 1.37 , based on a sample of 1,531 individuals projected to 230,818 individuals in the population. These results indicate that the low-income subgroup consumed about 31 percent more sport fish, on average, than the non-low-income subgroup.

Point estimates of the 95th percentile of average daily per capita consumption of sport fish are 81.58 and 77.52 grams/person/day for the low-income and non-low-income subgroups, respectively. Estimates of the 90th and 95th percentiles do not largely differ between the two income groups. However, the estimated 183.95 grams for the low-income 99th percentile compared to the 143.03 grams for the non-low-income subgroup indicates that one or more individuals in the low-income subpopulation consumed an extreme average daily consumption of sport fish. Extreme is with respect to other reported values. These extreme values also influences the mean estimate.

The pattern for commercial fish consumption indicates higher, mean consumption by the non-low-income subpopulation. Table 5-2 reports estimated average daily per capita commercial fish consumption for low-income/non-low-income, self-identified fish-eating Michigan sport anglers. The estimated mean, average per capita commercial fish consumption for low-income, self-identified fish-eating Michigan sport anglers is 7.89 ± 1.32 grams/person/day. For non-low-income, self-identified Michigan sport anglers, the estimated mean average daily per capita commercial fish consumption is 10.97 ± 1.04 grams/person/day. These results indicate that the low-income subgroup consumed an average of about 28 percent less commercial fish than the non-low-income subgroup.

As with the mean average daily per capita consumption of commercial fish, estimates of the 90th, 95th, and 99th percentiles of average daily per capita consumption are higher for the non-low-income group than for the low-income group. The 99th percentile consumption estimates differ by 17 grams.

Table 6-1 estimates of average daily per capita consumption of all fish by the two income subpopulations indicate that the mean and the 90th and 95th percentile estimates do not differ greatly between the two income groups. However, the 99th percentile estimate of all fish

consumed by the low-income group is 37 grams greater than that for the non-low-income group. This is most likely due to the dominance of an extreme commercial fish consumption value by the low-income group.

Table 4-4 indicates that mean, average daily per capita consumption of sport fish declines with increasing income group. The income groups are: less than \$15,000, \$15,000 but less than \$25,000, \$25,000 but less than \$40,000, and \$40,000 or more. Mean average daily per capita consumption of sport fish by self-declared fish-eating Michigan sport anglers are 21.05, 20.63, 17.54, and 14.71 grams/person/day, respectively. For the same income subcategories, Table 5-4 records mean average daily per capita consumption of commercial fish as : 8.48, 7.43, 8.36, and, 12.96 grams, respectively.

7.3 Ethnic and Income Group Results

Table 4-3 presents estimated average daily per capita sport fish consumption by ethnic and income group for self-identified fish-eating Michigan sport anglers. From a sample of 61 individuals projected to 9,022 individuals in the population, the estimated mean average per capita sport-fish consumption for minority/low-income, self-identified fish-eating Michigan sport anglers is 43.05 ± 19.59 grams/person/day. For non-minority/low-income, self-identified Michigan sport anglers, the estimated mean average daily per capita sport-fish consumption is 16.68 ± 1.22 , based on a sample of 2,133 individuals projected to 320,890 individuals in the population. These results suggest that the minority/low-income group consumed an average of about 158 percent more sport fish than the non-minority/low-income group, 85 percent more than the minority subgroup, and 107 percent more than the low-income subgroup. Upper percentile estimates of average daily consumption of sport fish are consistently higher for the minority/low-income group. The same trend is evident on Tables 5-3 and 6-3 which report average daily per capita consumption estimates for commercial and all fish, respectively. Notice that the median average daily per capita consumption estimate of all fish for the minority/low-income group, as reported on Table 6-3, is the only median interval estimate not containing zero.

7.4 Species Results

Table 4-5 presents the estimated mean average daily consumption of sport fish by species for self-identified fish-eating Michigan sport anglers. Perch, (yellow), walleye, and bluegill were the three species consumed at the highest rates. From a sample of 2,451 individuals projected to the population of 368,557 individuals, perch (yellow) had the highest mean average daily per capita consumption at 3.03 ± 0.41 grams/person/day, which applied to 8 percent of the self-declared fish-eating Michigan sport angler population. Walleye was the species with the second highest mean average daily per capita consumption rate at 2.59 ± 0.36 grams/person/day by 7 percent of the population. Bluegill had the next highest mean average daily per capita consumption rate at 2.20 ± 0.33 grams/person/day by 6 percent of the population of self-declared fish-eating Michigan sport anglers. Of the minority low-income subpopulation of self-

declared fish-eating Michigan sport anglers, 8 percent consumed catfish, and 7 percent consumed walleye and 6 percent consumed whitefish. Mean average daily per capita consumption of sport fish by species for the minority/low-income group are reported on Table 4-6.

Table 5-5 presents the estimated mean average daily consumption of commercial fish by species for self-identified fish-eating Michigan sport anglers. Perch, (yellow), cod, and whitefish were the three species consumed at the highest rates. From a sample of 2,451 individuals projected to the population of 368,557 individuals, perch (yellow) and cod had the highest mean average daily per capita consumption at 1.56 ± 0.25 grams/person/day, which applied to 5 percent of the population of self-declared fish-eating Michigan sport anglers. Whitefish was consumed at a mean average daily per capita rate of 1.66 ± 0.30 grams/person/day by 4 percent of the population. As indicated on Table 5-5a yellow perch, cod, and whitefish were the species consumed in restaurants by the highest percent of the population. Table 5-5b indicates that catfish, cod, orange roughy, yellow perch, salmon, tuna, walleye, whitefish, and other single species are the fish consumed from the market by the highest percentage of the population of self-declared fish-eating Michigan sport anglers. Each of these nine market purchased species were consumed by one percent of the population. Largemouth bass, catfish, buffalo, cod, ocean perch, yellow perch, salmon, walleye, and whitebass are the species reportedly consumed for market sources by the minority/low-income subgroup of fish-eating Michigan sport anglers. Table 5-6 presents these estimates.

Yellow perch, walleye, blue gill, and whitefish are the species consumed by the highest percentage of the self-declared fish-eating population when source is not considered. Bluegill, catfish, and yellow perch are the species consumed by the highest percentage of minority/low-income Michigan sport anglers. Tables 6-5 and 6-6 record these results, respectively.

7.5 Estimated Percentage Consuming Less Than 150 Grams/Person/Day

Tables 4-7, 5-7, and 6-7 present the estimated percent of the population of self-declared fish-eating Michigan sport anglers consuming an average of less than 150 grams of fish per day. The three tables record these percentages for sport fish, commercial fish, and all fish respectively. It is estimated that 99.1 percent of the population of Michigan sport anglers who declare that they eat fish consume an average of less than 150 grams of sport fish per day. An estimated 99.8 and 98.2 percent of the population consume less than 150 grams of commercial fish and all fish, respectively. For the minority/low-income group of self-declared fish-eating Michigan sport anglers, 95 percent consume less than 150 grams of sport fish, 98.3 consume less than 150 grams of commercial fish, and 95 percent consume less than 150 grams of all fish, regardless of the source.