



# Considerations in Fish Consumption Survey Design

Lon Kissinger, Office of  
Environmental Assessment, Risk  
Evaluation Unit, EPA Region 10

# Topics to Be Covered

- Desirable properties of surveys for AWQC development.
- Use of short term vs. long term recall survey methods.
- National fish consumption data used by EPA.
- Data collection and factors affecting the quality of FCR studies
- Suppression

# Purposes for Fish Consumption Surveys

1. To determine trends in seafood consumption
2. To determine fishing pressures on water bodies
3. To assess water body or site specific risks posed by contaminants in seafood.
  - a) Environmental regulation
  - b) Fish consumption advisories
    - i. Identification of water bodies where fish consumption advisories are needed
    - ii. Determine effectiveness of fish consumption advisories
4. To support development of water quality criteria

# Properties of an Ideal Fish Consumption Survey for Water Quality Standards Development

1. Representative of population
2. Data required for general population and high consumers
3. Characterizes consumption of desired groups
4. Rates not suppressed due to environmental contamination
5. Provides information on relevant statistics.
6. Addresses consumption of relevant species.
7. Addresses consumption of relevant fish preparations
8. Identifies sources of fish
9. Accounts for temporal variation in fish consumption

# Short Term vs. Long Term Recall

## Short term

- Pros:
  - Not cognitively challenging
  - Accurately record recent consumption
- Cons:
  - Variable
  - Difficult to predict long term consumption.
  - Can be difficult to predict consumption of infrequently consumed items

## Food Frequency Questionnaire (FFQ)

- Pros:
  - Provides estimate of long term consumption
  - Found to have low variability
- Cons:
  - Not accurate predictors of long term intake
  - Cognitively challenging
  - Estimates affected by recent diet

# Validating Short Term and FFQ

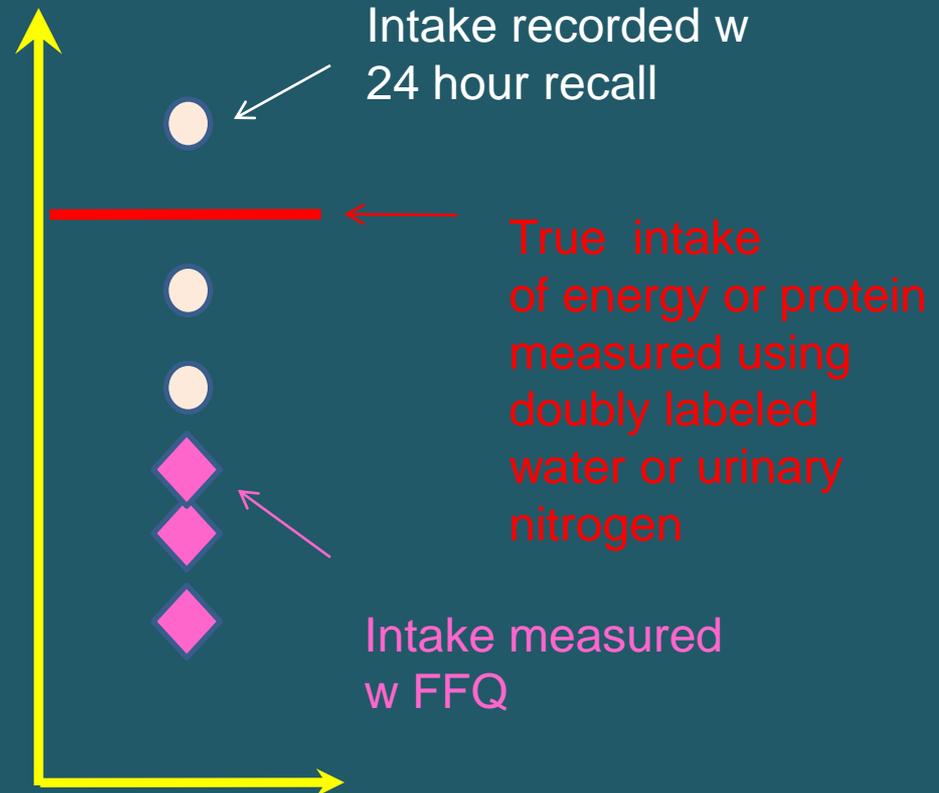
- Record protein and energy intake using short term and FFQ instruments
- Measure biomarkers of dietary intake
  - Energy: Using doubly labeled water (deuterium and oxygen-18) to track CO<sub>2</sub> production and consequently energy
  - Protein: Measured using urinary nitrogen
- Compare recorded vs. measured intake and describe error

# Observing Protein and Energy Nutrition (OPEN) (Subar et al. 2003)

- 261 men and 223 women aged 40-69 years in Maryland
- Measured protein and energy intake.
- Recorded protein and energy intake:
  - Interviewer-administered 24HR
  - FFQ (Diet History Questionnaire)

# Results of “Open”

- 24 hour intakes more accurate predictors of usual intake (UI) but have higher variance
- FFQ intakes less accurate predictors of usual intake but have lower variance
- Both 24 hour and FFQ underestimate UI, though FFQ does so to a greater degree



# National Data: Uses, Sources, Analysis

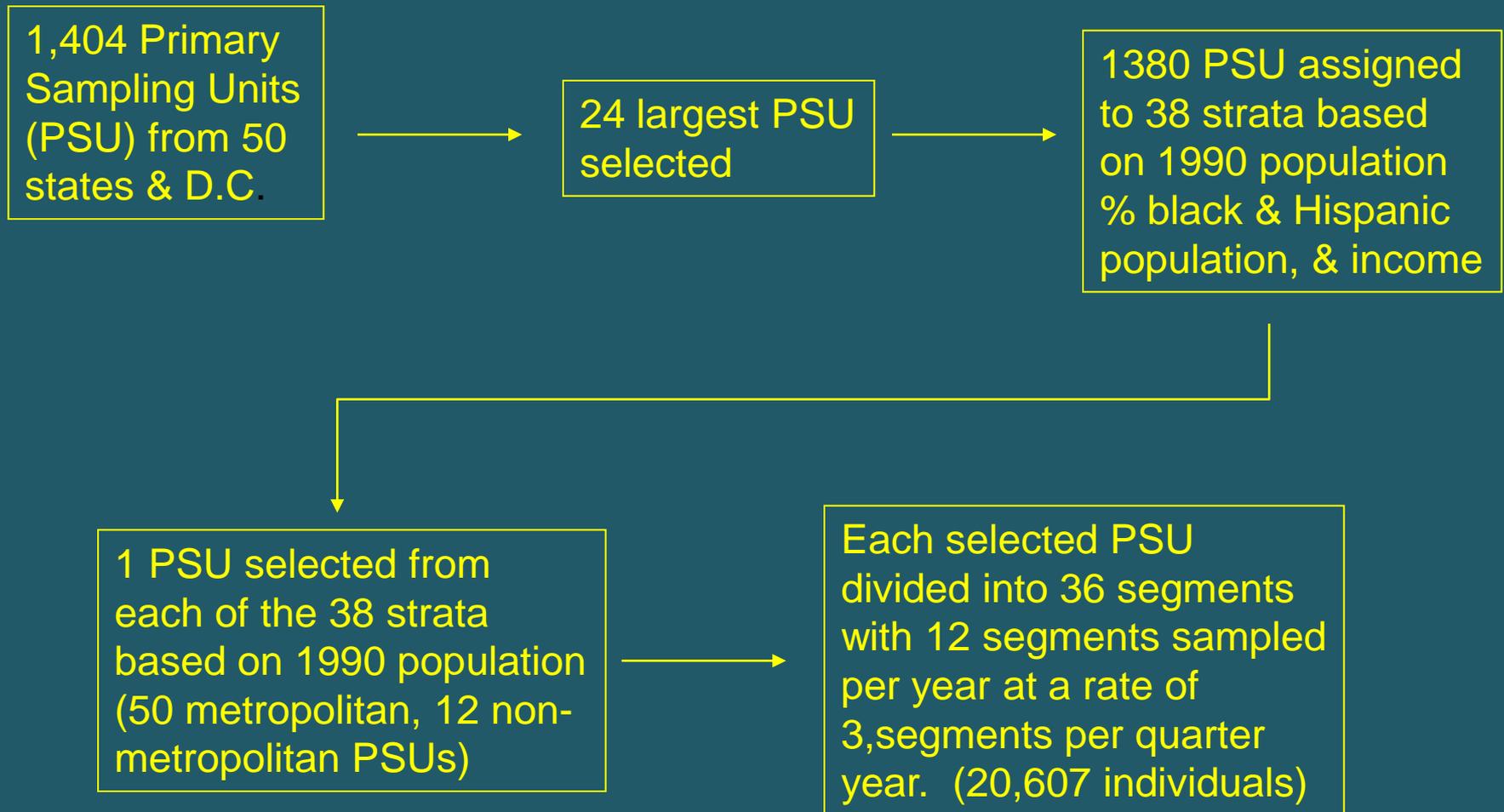
## Office of Water

- Ambient Water Quality Criteria
- Continuing Survey of Food Intake by Individuals, 1994-1996
  - U.S. EPA 2002. Estimated Per Capita Fish Consumption in the United States.
  - U.S. EPA. 2000. Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health.

## Superfund

- Used for CERCLA/RCRA risk assessments
- National Health and Examination Survey, 2003-2006
  - U.S. EPA. 2011. Exposure Factors Handbook 2011 Edition (Final). Chapter 10: Consumption of Fish and Shellfish.

# National Data: CSFII 1994-'96 & 1998: Sampling Strategy



# National Surveys and Fish Consumption

- Characterizes average intake
- Individuals record two 24 hour recall intakes on non-consecutive days
- Consumers defined as individuals that consumed fish on either survey day
- Records some source information

# Issues with the National Data

- Representative of the United States but potentially not representative for specific regions
- Not representative of all minority groups
- Short observational period, designed to derive average consumption, is not ideal for predicting upper percentiles of consumption.
- Does not provide detailed source of fish information

# National FCR Data, Including Non-consumers? Yes or No?

- Including non-consumers (i.e. those did not consume on either interview day)
  - Shouldn't include non-consumers in consumption rate estimates, as they aren't exposed!
  - Including non-consumers decreases estimates of average and FCR percentiles relative to “true” values.
- Using consumer only data
  - Short observational period increases estimated FCR relative to true values. Increased days of observation decrease FCRs by averaging in days without consumption.
  - Consumption rates reflect distribution of portion sizes.

# A better approach! Model long term usual FCR distributions from 24 hour national data

- WA used National Cancer Institute Methodology developed for nutritional surveys (the NCI Method)  
<http://riskfactor.cancer.gov/measurementerror/>
- Method to develop fish consumption distributions from NHANES 2003-2006 data assuming:
  - There is an underlying fish consumption distribution for the population.
  - An individual's fish consumption varies from day to day.
  - Each individual has some probability of consuming fish on any given day.
  - There may be a correlation between the frequency of fish consumption and the amount of fish consumed.

# Re-analysis of NHANES, 2003-2006 FCRs

## Consumer Only Data Without Adjustment

Species	N	Mean	50%	75%	80%	85%	90%	95%	99%
All	2,853	56.0	37.9	78.8	87.6	105.2	127.9	168.3	255.7
Finfish	2,200	49.9	34.6	68.9	82.4	95.4	115.3	149.8	217.0
Shellfish	1,113	43.0	25.7	54.4	63.0	75.0	100.5	146.6	249.6

## NCI Method Model Using Consumer Only<sup>1</sup> Data

Species	N	Mean	50%	75%	80%	85%	90%	95%	99%
All fish	6,465	18.8	12.7	24.8	28.9	34.5	42.5	56.6	90.8
Finfish	6,465	14.0	9.0	18.1	21.2	25.5	31.8	43.3	72.7
Shellfish	6,465	5.4	2.4	6.0	7.5	9.7	13.2	20.5	43.8

<sup>1</sup>A question “Do you ever consume fish,” was used to ID individuals that were fish consumers.

Nayak L. Polissar, Moni Neradilek, Aleksandr Y. Aravkin, Patrick Danaher, John Kalat. 2012. Statistical Analysis of National and Washington State Fish Consumption Data

# National Recommended Rates

- Water Programs – U.S. EPA  
2000 Human Health  
Methodology

- FCR data hierarchy:
  1. Local watersheds
  2. Similar populations
  3. FCRs from national data
  4. Defaults, CSFII '94-' 96
- 17.5 g/d general & recreational anglers
- 142.4 g/d subsistence

- CERCLA – U.S. EPA. 2011,  
EFH Ch 10

- General population: NHANES 2003-2006
- Recreational marine: National marine Fisheries Service 1993
- Recreational fresh: No specific recommendation
- Native American: No specific recommendation

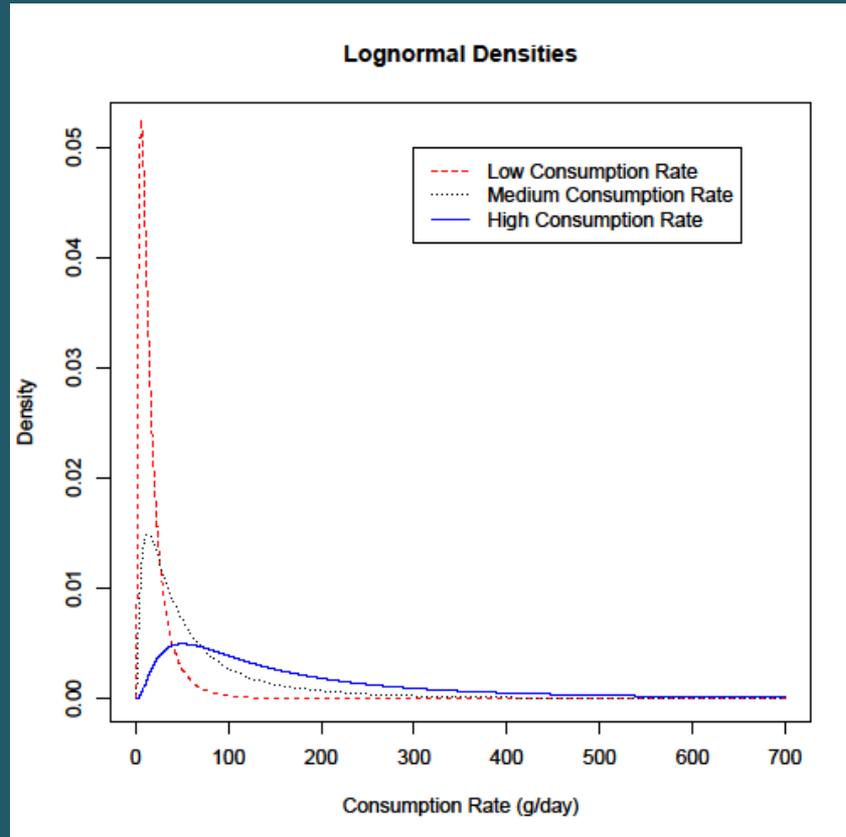
# Data Collection and Factors Affecting the Quality of FCR Studies

# Sample Size

- Required sample size depends on groups you want to draw conclusions about.
- Computation
  - Based on desired percent difference between the mean and an upper confidence limit on the mean.
  - Regional tribal surveys computed sample size assuming log normal FCR distributions and 95% UCL is 20% > mean
    - $\exp(1.96 \times \text{SDV} / \text{SqRt}(n) \times \text{SqRt}(1 - n/N)) = 1.2$
    - Where: N = population size, n = sample size, SDV = standard deviation
- Should we be looking at sample size based on deriving robust upper percentiles??

# Sample Size and Statistics Variance (1)

Population: consumption rate	Mean consumption rate: g/day	95 <sup>th</sup> percentile: g/day	Similar to (but not same as) these populations:
Low	19	55	US general pop.
Medium	82	275	Tulalip Tribes
High	214	665	Suquamish Tribe

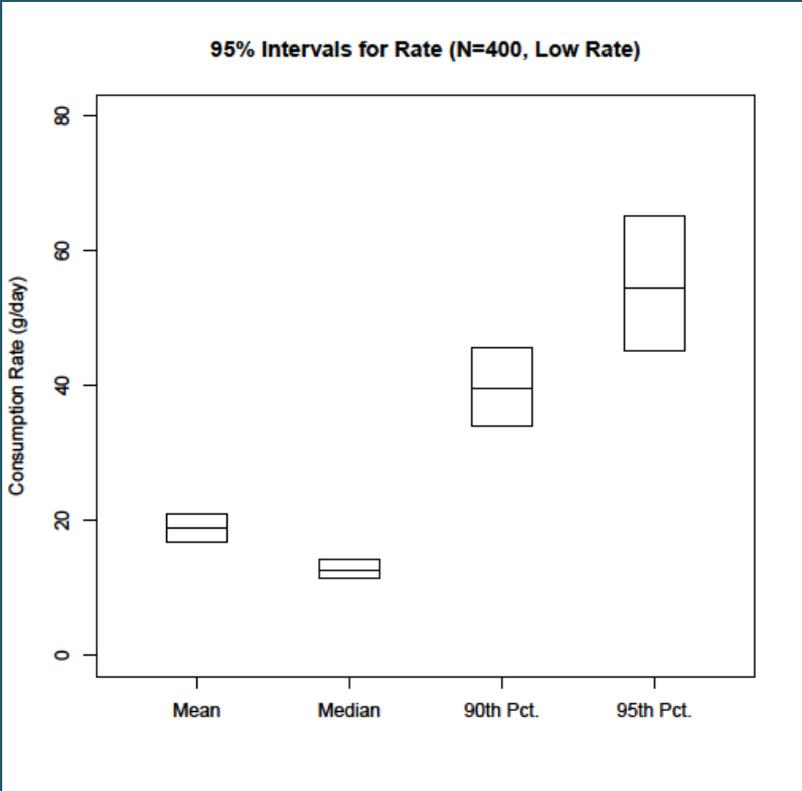
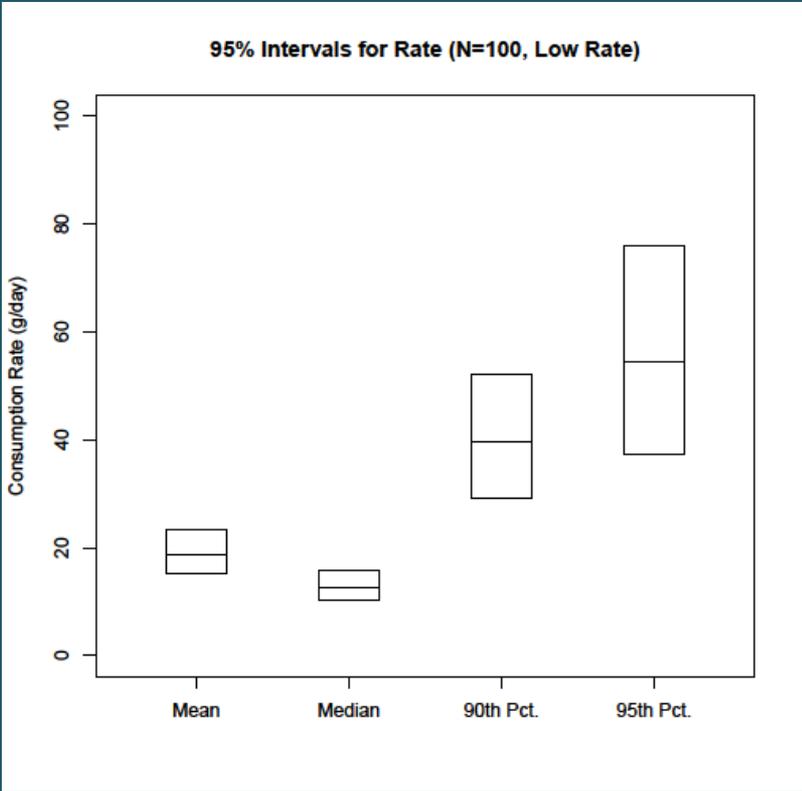


# Sample Size Impact and Statistics

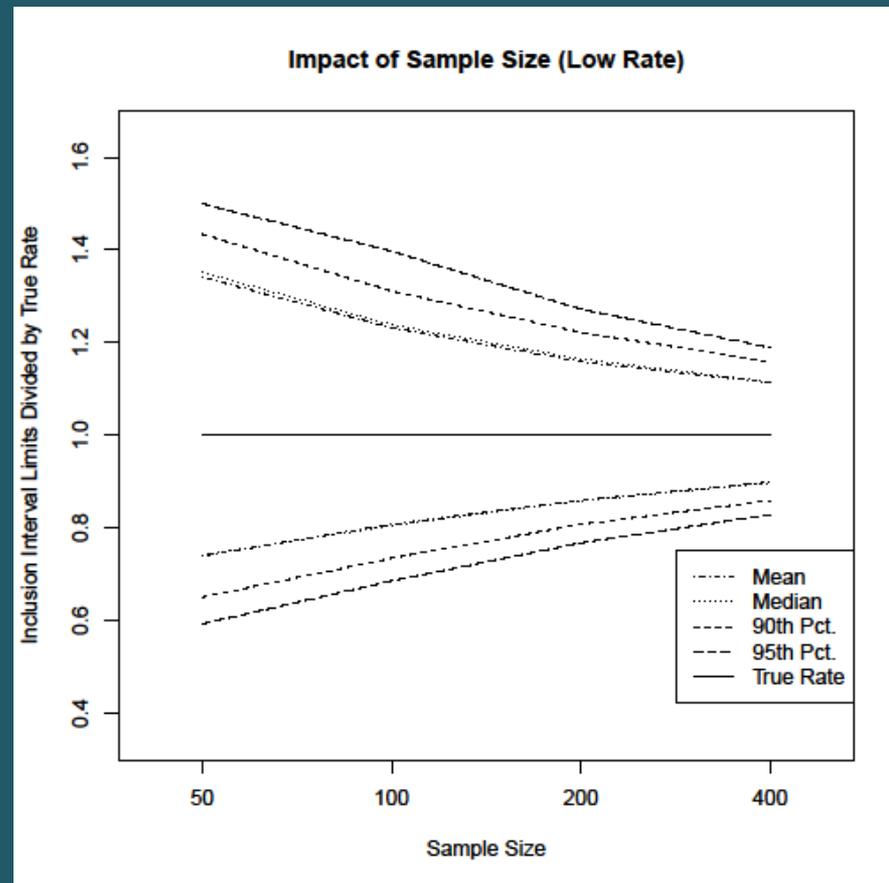
## Variance (2)

- **Select a sample size**
- **Generate sample from the population**
- **Calculate relevant statistics**
- **Repeat sample selection and calculations 10,000 times**
- **Determine how much the sample values vary around the true value**

# Sample Size and Statistics Variance (3)



# Sample Size Impact on Statistics Variance (3)



# Data Collection Instruments

Refer to table: Comparing data collection instruments

- Personal interview
- Creel survey
- Mail
- Internet
- Telephone
- Diary

Derived from: U.S. EPA 1998, Guidance for Conducting Fish and Wildlife Consumption Surveys, U.S. EPA, Science and Technology, EPA-823-B-98-007

# Accounting for Temporal Trends in Fish Consumption

- Consumption impacted by conditions at the time of interview.
  - What was recently consumed
  - Availability of fish
- Approaches for dealing with temporal trends
  - Repeat interviews of individuals over time
  - Interview fractions of sample population over time
  - Creel surveys: Conduct interviews throughout the fishing season and cover relevant times

# Data Analysis

- Outliers
  - Real or errors?
  - Affects statistics
    - Accuracy of upper percentile rates
    - Impact on average consumption
- Weighting: Adjusting representativeness of FCRs obtained from different groups within a sample population to reflect the population the survey will be applied to.

# Survey Quality Considerations

- Formation of a planning group with appropriate membership.
- Pilot testing of survey with subsequent modification.
- Interviewer training
- Re-interviewing
- Data analysis and data quality measures clearly defined and documented
- Peer review and potentially publication

# Suppression and Study Selection

“A suppression effect occurs when a fish consumption rate for a given subpopulation reflects a current level of consumption that is artificially diminished from an appropriate baseline level of consumption for that subpopulation . . . . When agencies set environmental standards using a fish consumption rate based upon an artificially diminished consumption level, they may set in motion a downward spiral whereby the resulting standards permit further contamination and/or depletion of the fish and aquatic resources.”

*National Environmental Justice Advisory Committee, 2002.*

# Causes of Suppression

- 1) Impacts of chemical contamination.
- 2) Degradation of habitat
- 3) Loss of access to resources
- 4) Changes in family social structure

How/should current suppressed rates be adjusted to account for suppression?

Questions?