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Memo

Date: October 19, 2015

To: Greg Frey, SRA

From: John Rogers, Rebecca Birch, and David Marker

Subject: Review of Idaho Fish Survey

Westat was requested by SRA and EPA to review three documents and a translation procedure, all related to the findings from the Idaho Fish Survey. Our comments are as follows.

1. Overall comments:

In our comments, "fish" refers to fish and shellfish.

It is not very unclear how many days of dietary recall data were collected. First, the daily dietary recall questions were only answered if question FFQ3 [did you eat fish in the last 7 days] is Yes. So someone who ate fish only on day 8 would be excluded from the dietary recall questions. It appears that 8 days of daily recall were reported for those who ate fish yesterday but only 7 days for those who did not eat fish yesterday. If FCR24_1 [did you eat fish yesterday] is Yes, the questionnaire collects data about yesterday's fish consumption. Then the instructions for questions FCR7D_1_A through FCR7D_3_B distinguish between "excluding yesterday how many meals did you eat … that included fish or seafood in the past 7 days" [looks like 8 days total] if fish was eaten yesterday versus "… in the past 7 days how many meals did you eat …" and "Not including today, what was the most recent day of the week when you consumed …" if fish was not eaten yesterday [looks like 7 days total].

Given that the dietary recall data were collected only if the respondent said they ate fish in the past seven days, we think the fish consumption in the seven days prior to the call should be used when aggregating dietary recall data across multiple days, not 8 days.

The definition of consumption events is unclear. If two different types of fish are consumed at a meal, the FFQ seems to count this as one consumption event. Is this one or two consumption events in the dietary recall? Is every snack a consumption event regardless of size or how many types of fish were consumed?

Frequency of fish consumption was assessed using the FFQ and the multiple days of dietary recall data. The report says "the total number of consumption events estimated using the dietary recall questions is significantly lower than the total number of consumption events estimated using the food frequency questions" (page 81) but provides no data for comparison to quantify what "significantly lower" means. At the same time the report notes that the reported frequency of fish consumption drops as the days between the consumption event and the survey contact increases (page 75). Might this indication of recall bias explain some of the difference?

The report notes that there are differences between the portion size estimates from the FFQ and the average portion size estimates from the dietary recall. Interpretation of that difference is complicated by: 1) the skewed distribution of the amounts from the daily recalls; 2) how the respondent estimates long-term portion size; and 3) differences in what a portion means between the FFQ and dietary recall. If the respondent provides an estimate of the median portion size (as opposed to the mean), the difference between the log-transformed portion sizes may be less significant, and more normally distributed.

It is not clear how a "complete" survey was defined. Also the survey report gives weighted sample sizes (is this weighted population estimate scaled down to the sample size?). We would like to see unweighted sample sizes. Table 1 (page 10) in the IMS analysis report provides unweighted sample sizes. However, it is still unclear concerning the number of subjects that were consumers versus non-consumers.

In theory, usual fish intake can be estimated from 24-hour recalls or multiple-day recalls (in this case 7 or 8 day recalls). However, if the best estimate of usual fish intake is based on 24-hour recalls, then the decrease in the reported frequency of fish consumption with increasing length of the recall period (days between the consumption event and the survey contact) indicates that the estimate based on multiple-day recalls will be biased low. Correcting this bias requires making some assumptions (such as logit(probability of fish consumption) and log(amount consumed per day) changes linearly with the length of the recall period). With a reasonable assumption, this bias can be corrected by

1) fitting a more complicated version of the NCI model that includes an adjustment;
2) scaling the estimated usual fish consumption from the NCI model up to adjust for the bias (applying a multiplicative factor, perhaps (probability of fish consumption on Day 1)/(Probability of fish consumption on any day in the recall period)); or,
3) using only the first (yesterday) day of dietary recall to estimate usual fish consumption.

Using just the 24-hour recall, if separate models are fit for anglers and non-anglers, the NCI model may not converge due to few respondents with two recalls, both with fish consumption. Scaling the output when predicting data from several days may be the easiest option.

The NCI macro uses the NLMIXED procedure. The weights in the NLMIXED procedure are defined using the REPLICATE statement. The documentation for the REPLICATE statement states that "Only the last observation of the REPLICATE variable for each subject is used". Thus, the same weight is used for each recall within a person. The best weight to use is the weight for the respondent (used for the first recall). As a result, 1) the analysis file for the NI method should have the weight for the first recall on both the records for the first and second recall; and 2) the weight for the second recall defined by NRG is not used in the analysis.

In the IMS report, Table 1 (page 10) shows the sample sizes for anglers and non-anglers and the number of respondents used in the NCI model. It is not completely clear why some cases were not included in the NCI model. Does the line labeled "Annual Fish Consumption Unavailable" correspond to those that did not eat fish in the last year (non-consumers)? There are 243 cases labeled "Recall Data Unavailable (i.e. Missing)". What does this mean? There were 660 respondents that were dropped because various covariates were missing. Without knowing specifics about the missing values, perhaps imputed values could be used or missing values can be treated as a separate category of the categorical variables? How does the distribution of the demographic variables for those in the NCI model compare to the distribution for all fish consumers?

2. Idaho Fish Consumption Survey

SUBMITTED TO: Idaho Department of Environmental Quality
SUBMITTED BY: Northwest Research Group, LLC www.nwresearchgroup.com
DATE SUBMITTED: Final: August 25, 2015

We are interested in identifying any survey design factors that might introduce any uncertainty or bias/loss of accuracy in results of the fish consumption survey. In addition to whatever the reviewers identify as a potential issue, we would specifically like comments on the topics listed below.

2.1 Representativeness of sample using a telephone interview.

The methodology to collect data using a telephone interview using two frames (cell and landline) seems appropriate. According to the 2012 National Health Interview Survey only 2.7 percent of adults in Idaho are without a cell or land line phone. Those people will not be represented. While there may be some reason to think they have different fish consumption levels than others with otherwise similar demographics (since they are by definition living somewhat removed from society lives), there impact on overall estimates are likely to be small.

2.2 Methodology used to select land line and cell phone numbers and representativeness of sample

The methodology to select land line and cell numbers appears to be appropriate. The resulting samples of telephone numbers should be representative of the cell phone or landline populations. See item 2.11.

2.3 Stratification of sample based on Idaho health districts.

The stratification approach looks appropriate, trying to enforce geographic and gender representativeness in the sample minimizes variation in the weights.

2.4 Representation of anglers and non-anglers and weighting

They decided to use only the telephone landline and cell lists for sampling and classifying the anglers based on reported possession of a fishing license. This approach appears to be reasonable. The number of anglers estimated from the survey (33%) differs somewhat from the number estimated by IDFW (26%). It is possible that anglers were more likely to respond to a survey on fish consumption then non-anglers. At the same time, the list from IDFW has some uncertainty in that two lists of different sizes were provided.

2.5 Quotas for age, gender, and income and relation to representativeness of the sample

In general, enforcing the quotas helps to reduce the required effects of weighting. However, quota sampling has been discouraged for decades in government surveys because it can introduce biases that are not necessarily accounted for through the weighting process. In particular, it results in over-representing those who are easier to reach by telephone. Of particular interest in a fish consumption survey, those who spend a greater amount of time away from home (including fishing) are harder to reach, and thus are underrepresented in a quota sample. If they are reachable by cell phone this form of bias may be reduced, but it is hard to know for sure.

2.6 Consideration of race and representativeness of the survey sample

The racial breakdown of the population is only reported as White Alone versus Non-White (roughly 5%). Race was not used for weighting. Since quotas were not used for race, the sample may not be representative of the population racial distribution. A weighting adjustment based on race would improve the representativeness of the weighted sample with respect to race. See item 2.11.

The proportion of whites in the sample is higher than in the State of Idaho. Nationally, whites consume less fish than non-whites (EPA, 2014). If the weighting were to include race it might improve the accuracy of the estimates.

2.7 Impact of not being able to interview 5% of contacted households because of language issues.

Obviously, this subpopulation will not be represented in the survey results. To the extent that this subpopulation is similar to others with similar demographics, a weighting adjustment based on demographics might make the weighted sample more representative.

They report that early analysis indicated no significant differences in consumption rates between English speaking Hispanic and non-Hispanic respondents. However, this does not mean that there will be no difference between English speaking and non-English speaking respondents. They are assuming that English speaking Hispanics are more similar to non-English speaking Hispanics than they are to non-Hispanics in dietary behavior, which may or may not be true.

In particular, if the non-English speakers are Native Americans, their lack of English could be hypothesized to be correlated with following more traditional lifestyles, ones that involve consumption of much greater amounts of fish. In such a case their exclusion will underestimate the true fish consumption in Idaho.

2.8 Quantifying portion size:

2.8.1 Use of common objects to describe portion size

If the common object is familiar to the study population, it is likely easier for respondents to report their portion size in relation to the object than to estimate weight (grams or ounces) or volume (cups or tablespoons), unless they cooked it themselves. They did qualitative research among the population of interest to assist them in selecting common objects to be used as portion size references.

2.8.2 Asking respondents to quantify portion size in ounces

It is likely difficult for respondents to provide the amount of fish they consumed in ounces, unless they prepared the fish. However, they tested the use of portion size estimation aids (PSEA) to assess if using PSEAs would improve reporting of fish consumed in ounces. They report that the results showed saying the PSEA was equivalent to a specific number of ounces and asking respondents to then provide their consumption in ounces provided accurate estimates. This is the methodology they used. It seems reasonable and best available without pre-mailing (or directing to a website) portion size pictures like what are used in the ASA24.

2.8.3 Use of a deck of cards as the portion size estimation model

According to their research, most people thought about a deck of cards or palm of hand when estimating portion sizes and there was no difference in accuracy between these two PSEAs. They chose to go with a deck of cards. This choice seems reasonable given the research findings and that hand sizes vary by age and gender and other factors.

2.9 Use of an 8 day recall period, (SEE: p 24, item 6 describing recall issues for longer periods from qualitative research).

The use of a single versus multiple-day dietary recall for assessing usual fish consumption depends on a combination of bias and precision. The decrease in the reported frequency of fish consumption with increasing length of the recall period (page 75) will contribute to increased bias as the number of recall days increases. The bias can be corrected in various ways (an adjustment factor, modifying the NCI model, or using only the first day of dietary recall). The increasing imprecision of the respondent recall as the length of the recall period increases affects the precision of the estimates; but the NCI method can still be used to calculate those estimates if proper adjustments are made. As a result, increasing the recall period has diminishing benefit. We recommend either adjusting the estimates for bias associated with the longer recall period or calculating the usual fish consumption from only the first recall day. Disregarding this length bias, as was apparently done, can produce inaccurate estimates.

Assuming that respondents had a difficult time recalling fish consumption events beyond a few days (like they report), an 8 day recall period probably underestimates usual fish consumption due to the likely lowered estimated probability of consumption (for those that were reported no consumption and may have forgotten a fish consumption event).

2.10 Impact of response rate on survey results

Non-response contributes to possible bias and decreased precision of the survey estimates. NRG appeared to make reasonable efforts to increase or maintain response rates while collecting the data. Without independent estimates of fish consumption for the non-respondents it is not possible to truly assess the bias. A non-response adjustment to the weights can help to minimize the bias. An analysis of frequency and amount of fish consumption as a function of the effort used to collect the data (such as number of contacts to get a completed survey response) can be used to approximate the possible bias due to non-response. The non-response adjustment (post stratification) provides minimal adjustment for non-response. We recommend additional adjustments of the weights to account for different non-response rates for different demographic groups. NRG provided some adjustment of the weights for health region and gender; however did not provide more extensive adjustments for non-response (particularly with respect to an apparent imbalance in income) citing concerns for possible large weights in some health districts. While it is true that such adjustments may increase the variance, they will reduce the bias. In general this trade-off is worthwhile when the response rates are not high. We recommend additional non-response weight adjustments.

2.11 Weighting of results based on land vs. cell phones

The general approach to weighting the combined cell and landline samples, as represented by BW_1, is reasonable. However some details of the implementation are unclear or appear incorrect, in particular:

1) On page 35 they define CP as the number of cell phones but it appears to really be whether or not they have a cell phone used for making or receiving phone calls (this is ok, but should be corrected in the documentation)
2) On page 35, the numbers for the universe counts (ULL and UCP) seem very implausible....they must be larger. If these are in error, then obviously the weights are wrong.
3) On page 35, the formula for BW_1 is wrong (we assume it is just a typo, since the -1 should be an exponent)
4) They did not collect the number of adults in the household and therefore made a "fix" based on the number in the household; that is a potential source of bias
5) The question they used to determine phone service (TEL on page 104) is not a standard one and might lead to some errors. For example, the cell phone is based on personal use and the landline is household availability and the two are confused in this question.
6) The purpose and implementation of the adjustment in BW_2 on page 36 is unclear. Is the adjustment (BW_2) applied to all respondents in a health district or only the cell-phone-only respondents? It is not clear what some of the numbers in Table 12 are or where they came from. They appear to be household numbers; however the adjustment should be for adults; this may be a potential source of bias. Based on the numbers in the last three columns of Table 12, it looks like the purpose of BW_2 is to get the percentage of cell-only households in the sample to equal the corresponding percentage in the population; however, it is not clear how the equations for BW_2 and BWFinal achieve that for the "Non Wire-less Only" respondents.

2.12 Implementation of post stratification weighting

The post stratification provides some adjustment for non-response. However, it excluded adjustments by income level, household composition, and education.

2.13 Weighting for re-contact interviews

The weighting for the re-contact interviews provides a simple adjustment for non-response. If these weights were important, we would recommend a more complicated adjustment. However, since the NCI model only uses one weight per respondent (preferably the weight for the first recall, not a separate weight for each recall), the calculation of an adjusted weight for each recall is not required when using the NCI method for analysis.

2.14 Imputation used to populate missing values

The imputation used to populate missing values is not explained in detail. The discussion on page 42 says the values were imputed based on characteristics of their neighbors but provides no description of how "neighbors" are defined. It is not clear what values were or were not imputed. It is also not clear how the imputed values were used. Were they used to create Table 15? Were they used for weighting? The second bullet on page 42 seems to imply the imputed values were not used in the analysis file.

2.15 Data processing and calculations

We found no problems with what was presented. However, the description does not say how the 7 or 8 day fish consumption (average or sum?) was calculated from the daily values (only the calculation for daily values for yesterday is presented, we assume the other days consumption was calculated in a similar manner). We recommend the fish consumption be calculated for 7 and not 8 days, as noted in the overall comments.

2.16 Bootstrapping approach used to develop confidence limits

The Bootstrapping approach apparently does not incorporate the weights. As a result, for evaluating population differences, the confidence intervals may be smaller than appropriate. It is not clear how the confidence intervals were used. The word "significant" is used in several places. It is not clear if it refers to statistical significance.

2.17 Discussion Section

2.17.1 Addressing non-response bias

They say 25 percent is "significantly higher than the average response rate." Twenty-five percent is not unreasonable for a telephone survey these days, but it still leaves room for significant nonresponse bias if the respondents are not like the nonrespondents. It is difficult to know if the 75 percent that did not respond are systematically different in their fish consumption behaviors. This is of particular concern given that they used a quota sample rather than a traditional random sample. This might contribute to the over-representation of higher income individuals and anglers

– these groups may be more interested in the survey topic thus more likely to respond. Could non-response be adjusted for with weighting factors?

2.17.2 Impact of over-representation of higher income individuals and anglers

They mention that more complicated weights could be applied to adjust for these differences, but that could result in large weights within individual health districts. They could assess the impact of the over-representation by applying the weights, running the analysis, and comparing the results.

In general it is always true that weighting adjustments will reduce precision (larger standard errors for sampling), but the trade-off is that it will hopefully reduce bias. This is important because the confidence intervals, or tests of hypotheses, will only have the claimed level of accuracy (e.g. 95 percent) if the bias is trivial. If there are large biases all of these intervals will be incorrect. That is why we do typically adjust for known under-represented groups. In some cases it may be worthwhile to trim a few excessively large weights. This process is expected to produce smaller overall mean squared errors, and more appropriately-sized confidence intervals.

2.18 Review of the questionnaire and identification of any issues in accurately recording fish consumption. Of particular interest is review of the methodology for inquiry into consumption over the past 7 days.

As noted in the general comments above, clarification of when there is data for 7 days versus 8 days is needed. Also, given the decrease in the proportion of respondents reporting fish consumption with increasing length of the recall period, estimates based on multiple-day recalls are likely to be biased low without an appropriate adjustment.

3. NCI Method Estimates of Usual Intake Distributions for Fish Consumption in Idaho

This report was prepared under DEQ Contract K079 with Information Management Services, Inc.: Dennis W. Buckman, PhD, Ruth Parsons, BA, Lisa Kahle, BA, September 9, 2015.

We are interested in any NCI data analysis factors that might introduce uncertainty or bias/loss of accuracy in NCI results. We are particularly interested in whether or not the data analysis approach is sufficiently described. In addition to whatever the reviewers identify as potential issues, we would like comments on the topics listed below:

3.1 How well are the selection and impact of covariate choices documented?

The covariates used in the NCI model are listed in the report (page 11). No justification for using these covariates is provided. In addition to these covariates, three other variables that are apparently available are: gender, household composition (single versus multi-person, see page 40 of the survey report), and amount consumed from the FFQ. An easy approach to selecting covariates is to include all available covariates. Alternatively a combination of a weighted logistic regression (using the SAS SURVEYLOGISTIC procedure with the BRR weights created for calculating confidence intervals for usual fish consumption) predicting the probability of fish consumption in a recall, and a weighted linear regression predicting log-transformed (or Box-Cox transformed) amount of fish consumed (using the SAS SURVEYREG procedure), can be used to assess which predictors or interactions of predictors are statistically significant when predicting the outcome. For the NCI model, we recommend including the same predictors for both the probability and amount models, including predictors that are significant when predicting either probability of consumption or transformed amount. In general it is important to include predictors that are clearly significant ($p<.01$). Predictors that are believed to be related to fish consumption but not significant should also be included. We believe the amount consumed from the FFQ should be an important predictor of amount consumed in the NCI model. For continuous predictors (body weight, age, and amount consumed from the FFQ) the weighted regression models can be used to assess how the variables might be transformed and whether the relationships are linear.

3.2 Are there any issues associated with use of 8 days of dietary recall information rather than the last 24 hours?

Yes. At a minimum, compared to using only the last 24 hours, the estimates are biased without an adjustment for the decreasing frequency of reported fish consumption as the length of the recall period increases. See the general comments above.

3.3 Is the combination and weighting of general and angler populations done appropriately?

The details of how the NCI macros were applied to the data files are not completely clear. For each type of fish consumption, we suspect the NCI method was applied to the data from the angler and non-angler subpopulations in separate runs, that all runs used the survey weights, and the summary statistics calculated from the simulated usual intake values for each respondent (from the DISTRIB macro) were calculated using the survey weight associated with the first recall for each respondent. The summary statistics can be calculated after combining the output files from the runs of the DISTRIB macro. If these procedures were used, we believe the calculations were done appropriately.

3.4 How, and how well, is it documented that the results meet assumptions of the NCI model (e.g. transformed positive fish consumption rates are normally distributed)?

The report provides no information on the values of Box-Cox transformation parameter (lambda), whether the transformed consumption amounts are normally distributed (a normal quantile plot of the transformed consumption amounts (not the plot from the NCI Box-Cox macro that was used) would help), whether there are any outliers, and the estimates of the variance components from the NCI model fit (between person for the probability model and the within and between person components for the amount model). This information would help assess the model fit and why the NCI macro had problems estimating lambda and the correlation parameter. In our experience, setting lambda instead of fitting lambda in the model and ignoring the correlation parameter has little effect on the results when calculating usual intake of fish. Given the relatively large number of respondents with two recalls with reported fish consumption we are surprised that lambda and the correlation parameter could not be fit using the MIXTRAN macro; at the same time, we have no reason to question this result.

4. Development of Human Health Water Quality Criteria for the State of Idaho (Draft), Windward Environmental, September 15, 2015

We are interested in whether or not the probabilistic analysis is adequately described. Further, we are interested in any methodological issues that were inappropriately or incompletely addressed in the PRA. In addition to anything that the reviewers might provide, we are interested in the following topics:

4.1 Selection of input distributions, in particular development of a Nez Perce fish consumption rate distribution.

The distribution fit to the percentiles of body weight appears to provide a good fit to the data. The distribution fit to the percentiles of drinking water intake per body weight appears to provide a reasonable fit to the data. Given the limited data for fish consumption for the Nez Pierce tribe, interpolating while setting the lower 5 percent to the 5th percentile and setting a maximum value and interpolation for percentiles above the 95th percentile appears reasonable.

One might question how the maximum value was obtained. Based on the footnote on page 12 of the Windward report, the maximum was based on what might be the maximum simulated value from the NCI DRISTRIB macro for the Idaho general population (1,261 g/day) multiplied by 0.242. If we have understood the calculations, this approach appears somewhat arbitrary because 1) the maximum value depends on how many simulated values DISTRIB creates, and 2) the adjustment factor of 0.242 seems to be based on calculations that are unrelated to the relationship between the maximum of the two distributions. A possible alternative is to calculate the 95th and 99.9th percentile for the general Idaho population and assume the ratio of those percentiles is the same for the general Idaho populations and the Nez Pierce population.

4.2 Correlation

4.2.1 Between body weight and drinking water ingestion rate

Assuming the drinking water ingestion rate per body weight is independent of the body weight appears to be a reasonable assumption. If needed, analysis of NHANES data could be used to test the assumptions. Thus simulating body weight and independently simulating drinking ingestion rate per body weight appears to be reasonable.

4.2.2 Between body weight and fish consumption rate

We expect the fish consumption rate to increase with increasing body weight. The assumed distribution for the body weight appears to be a lognormal distribution. The distribution of fish consumption rate can often be reasonably approximated by a lognormal distribution. Thus, when assessing correlation, we strongly recommend plotting and calculating the correlation between the log-transformed body weight and the log-transformed FCR. The statistical assessment of correlation (here using regression) assumes the prediction errors are normally distributed with roughly constant variance. That assumption is clearly not true for the data plotted in Figure 2-3 of the Windward report. We expect a plot using the log-transformed values will have an approximate bivariate normal distribution.

5. Translation of NPT consumption of 'Group 2' fish to equivalent consumption of 'Idaho Fish'

We are interested in whether or not the approach is adequately documented and whether or not there are any issues with this analytical approach. In particular, we are interested in how IDEQ has processed weighting factors in deriving consumption rates of fish caught in Idaho.

In general the re-grouping of fish seems appropriate given the available data. We have three concerns:

1. The explanation of how the prorating was done is hard to follow. The prorating of event salmon (salmon + steelhead): If a participant reported 10 oz. of salmon at events and 6 oz. of chinook and 4 oz. of steelhead at nonevents, then they were assigned 4 oz. for event steelhead. Is this how it was done?

2. Why was Coho left out of the prorating? Is it sometimes confused with steelhead?

3. The fraction of salmon + steelhead that is chinook is apparently calculated separately for each respondent. Where does the 81.3% come from? This is apparently the weighted mean percent of chinook (out of salmon+chinook+ coho+steelhead) across all participants that reported nonevent salmon, chinook, coho, and steelhead, is that correct? Although the fraction you are interested in can be calculated for each respondent, the resulting fractions can be imprecise, resulting in biased overall estimates. As an alternative, we recommend calculating the ratio of the weighted mean chinook non-event consumption to the weighted mean salmon+chinook+ coho+steelhead non-event consumption and using one ratio for all respondents. If there is concern that the ratio may differ among respondents, the ratio can be calculated separately for different demographic groups.

The application of the weights seems appropriate. The resulting fraction of the Group 2 that was assigned as Idaho fish (0.242) was then multiplied by the results that were obtained from the NCI Method for the original Group 2.

Westat | An Employee-Owned Research Corporation

Memo

Date: October 26, 2015

To: Greg Frey, SRA, and Lon Kissinger, EPA

From: John Rogers

Subject: To-do list for improving the estimates of Idaho fish consumption

At the request of SRA, Westat provides the following recommended to-do list for predicting fish consumption from the ID survey. Note that these recommendations are based on our understanding of the data and the calculations used previously. The recommendations may need to be adjusted for unanticipated characteristics of the data. The to-do list refers to comments in our October 19, 2015 memo.

The to-do list:

Revise the survey weights:

- Recalculate the base weights, noting the comments in item 2.11.
- Review the imputation of the missing demographic variables. This needs to be described better.
- Adjust the base weights for non-response using raking. The variables used for raking would include those in Table 15 in the NRG report. This will create respondent weights adjusted for imbalance due to the sampling process and non-response, W_i. If a few weights are particularly large relative to most weights, those weights might be trimmed. The weights for other cases would be increased so that the sum of the weights is unchanged.
- Set the weight for the second recall to equal the weight for the first recall.

Revise the calculations to calculate fish consumption over 7 days.

- For each respondent and recall, calculate the quantity of fish consumed in each day of the recall ("yesterday" and the prior 7 days) as documented on page 116 of the NRG report, call this A_{ird}, i references the respondent (1 to N), r references the recall (1 or 2), and d references the day (1 to 8). Then calculate the average daily consumption over the first 7 days for each respondent and recall: $A_{ir(7)} = \frac{\sum_{d=1}^{7} A_{ird}}{7}$.

- Using only the first recall for each subject ($r = 1$), calculate the weighted mean of the fish consumption on the first day and the fish consumption across the first 7 days (the sums are over all completed recalls):

$$\bar{A}_1 = \frac{\sum_{i=1}^{N} A_{i11} W_i}{\sum_{i=1}^{N} W_i}$$

$$\bar{A}_{(7)} = \frac{\sum_{i=1}^{N} A_{i1(7)} W_i}{\sum_{i=1}^{N} W_i}$$

  Note: this is a slightly different formula than outlined in the comments.

- Calculate the ratio for adjusting the NCI estimate of usual fish consumption to estimate usual fish consumption adjusted for decreased recall over time.

$$R = \frac{\bar{A}_1}{\bar{A}_{(7)}}$$

Fitting the NCI model

- Decide what cases to include in the NCI model. Is there a reasonable way to include cases with missing demographic variables, such as treating the missing values as a separate category or using imputed demographic variables?

- Create BRR replicate weights for calculating variances.

- Decide what predictors to use:

  - Use the SAS SURVEYLOGISTIC procedure to identify significant predictors of reported fish consumption (Yes versus No) using the BRR weights. First identify significant main effects. Second identify significant two-way interactions of the significant main effects. Candidate predictors would be demographic variables (including body weight) and FFQ variables (frequency of fist consumption, amount consumed). It is worth considering transforming or categorizing the FFQ variables to handle non-linear relationships. Although it can be done different ways, we suggest 1) including main effects that are significant at the 5% level; 2) including interactions of the main effects that are significant at the 1% level; and 3) including any other main effects believed to be associated with fish consumption.

  - Use the SAS SURVEYREG procedure to identify significant predictors of log-transformed (or Box-Cox transformed) reported amount of fish consumed using the BRR weights, using the steps above.

- In the NCI model, we suggest using the same covariates for the probability and amount models.

- Fit the NCI model to $A_{ir(7)}$. If necessary, determine the Box-Cox transformation parameter (Lambda) before fitting the NCI model. If the correlated model cannot be fit, using the uncorrelated model is OK. Report the Lambda and the magnitude of the variance components from the NCI model when using the full sample weight.

- Multiply the usual fish consumption from the NCI DISTRIB macro by the ratio R from above to provide an unbiased estimate of usual fish consumption.

Do the calculations for the PRA:

- Revise the adjustment for estimating the top 5% of the Nez Pierce distribution, see comment 4.1.
- Consider a correlation between log-transformed body weight and log-transformed usual fish consumption. Alternatively, if the body weight is a significant predictor of usual fish consumption (in the probability and particularly the amount model), the distribution of fish consumption should be a function of body weight.
- Calculate the weighted fraction of chinook across all respondents when adjusting for different fish species categories (Group 2 versus ID fish). See comment 5, item 3.

Clarify various items, see comments, in particular:

- The process for developing imputed values when data were missing
- Weighting of angler and general populations in developing overall results
- Discussion in the NCI analysis report as to how well model assumptions are met

Review of DEQ Approach for Developing an NCI-Like Distribution of Idaho Caught Fish, 11/5/15

EPA requested Westat review DEQ's approach for developing an "NCI-like" fish consumption rate (FCR) distribution for fish from Idaho waters. This memo summarizes conversations between Lon Kissinger EPA Region 10 and Westat statistician Dr. John Rogers.

DEQ developed a Nez Perce distribution of consumption of Idaho caught fish by scaling the NCI-derived distribution for consumption of Category 2 fish, multiplying the percentiles by 0.242 to calculate the percentiles of the distribution of Nez Perce Idaho fish consumption. The scaling factor, 0.242, was the ratio of the average consumption of Idaho caught fish to the average consumption of Category 2 fish. Both of these averages were obtained from the Nez Perce FFQ survey. The resulting scaled or transformed NCI-distribution is referred to here as the "NCI-like" distribution.

After discussions with Westat regarding the relationship between the NCI-derived distributions for different types of fish, we suggest that further analysis be done on the approach used to develop a Nez Perce "NCI-like" distribution of Idaho caught fish. It appears that the current procedure is likely to underestimate the upper percentiles of the Idaho fish consumption distribution.

Given that FCR distributions are reasonably log normally distributed, there is likely a linear relationship between log transformed percentiles of the distribution of Idaho caught fish consumption and the distribution of Group 2 fish consumption (for which we have the NCI estimate of the distribution).

Let P_I represent percentiles of the distribution of Idaho caught fish consumption that are to be estimated. Let $P_{G2,NCI}$ represent percentiles of the distribution of Group 2 fish consumption estimated using the NCI method. Then assume:

$$Ln(P_i) = ln(S) + F*Ln(P_{G2,NCI}), \text{ or equivalently } P_i = S * (P_{G2,NCI})^F.$$

The problem is how to estimate S, a scaling factor, and F, a slope roughly equal to the ratio of the standard deviation of $Ln(P_i)$ to the standard deviation of $(lnP_{G2,NCI})$.

Using results from NHANES data previously analyzed for EPA Headquarters, Westat did a quick analysis comparing the NCI-derived distributions of fish consumption for different types of fish. Let R equal the ratio of the mean fish consumption for the fish type used as the dependent distribution to the mean fish consumption for the fish type used as an independent distribution. When predicting the distribution of a less consumed fish type from the distribution of a more consumed fish type (i.e., $R < 1$), it appears the F should be greater than 1.0 with higher slopes as R decreases.

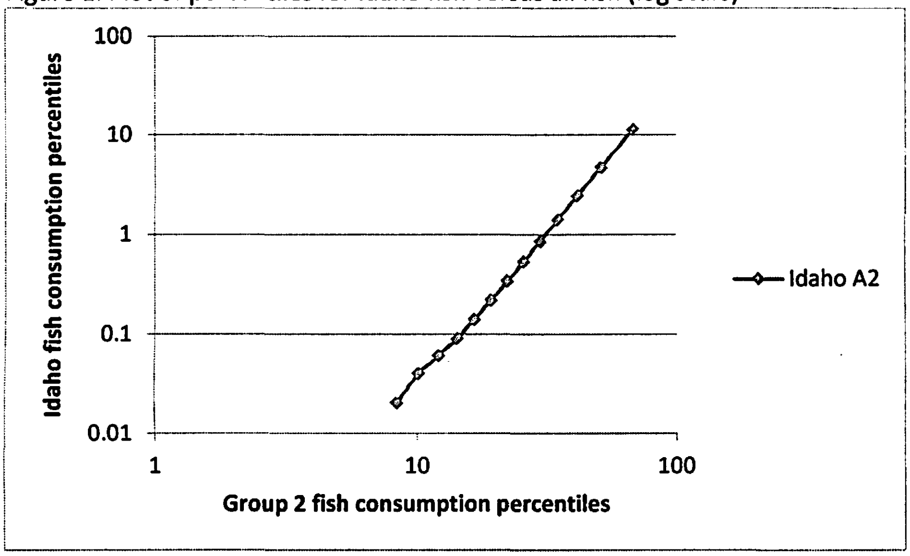
As an example of the calculations, Table 1 has the 35th through 95th percentiles of the consumption distributions for all fish and for Idaho caught fish from the Idaho state survey (see: NCI Method Estimates of Usual Intake Distributions for Fish Consumption in Idaho, Tables A1 and A2, using All Subjects). Lower percentiles were not included because the estimates were reported as "<.01" or were particularly imprecise.

Table 1 Percentiles of fish consumption for all subjects

Percentile	All Fish Table A1	Idaho fish Table A2
35	8.31	0.02
40	10.09	0.04
45	12.06	0.06
50	14.25	0.09
55	16.61	0.14
60	19.27	0.22
65	22.29	0.34
70	25.71	0.53
75	29.74	0.84
80	34.85	1.38
85	41.44	2.42
90	51.11	4.66
95	67.66	11.24

Figure 1 shows a plot of the percentiles of Idaho fish consumption as a function of the percentiles of all fish consumption, using log scales. As can be seen, the log-transformed percentiles fall on a roughly straight line.

Figure 1. Plot of percentiles for Idaho fish versus all fish (log scale)



Fitting a linear regression to predict the log-transformed percentiles for Idaho fish consumption from the log-transformed percentiles of all fish consumption gives a slope of F = 3.00. Although this analysis used selected percentiles, using all percentiles between the 1st and 99th percentiles and using more precision is recommended.

Different slopes will be obtained using different data or different subsets of the data (such as anglers only). For all subjects in the Idaho state survey the ratio of the means (R) is .106, smaller than the ratio of 0.242 estimated for the Nez Perce from the FFQ. Although one could use F = 3.00 for the Nez Perce, since F appears to increase as R decreases and R for the Idaho state data is less than for the Nez Perce, an appropriate slope for predicting Nez Perce Idaho fish consumption from Group 2 fish consumption may be less than 3.00. Some judgment is required to set the value of F. Considerations might include:

- calculations using Idaho data (as above),
- calculations using NHANES data, or possibly
- calculations using FFQ data (note that the precision and bias of FFQ data are uncertain and lower percentiles of FFQ estimated Idaho fish consumption are zero; it is not possible to calculate the log of zero).

Once F is set, calculate R, in the case of the Nez Perce based on the FFQ data. R is the ratio of the reported means of Idaho fish consumption and Group 2 fish consumption:

$$R = \text{Mean}(I_{FFQ}) / \text{Mean}(G2_{FFQ}) = 0.242$$

Also calculate the mean of $P_{G2,NCI}$ and $(P_{G2,NCI})^F$ across all percentiles (excluding the 0th and 100th percentile). These means are calculated using the percentiles from the DISTRIB macro because those are the data that are available.

The calculations assume the ratio of the mean Idaho fish consumption to the mean Group 2 fish consumption is the same for the FFQ data as for the NCI or "NCI-like" data, i.e.,:

$$\text{Mean}(I_{FFQ})/\text{Mean}(G2_{FFQ})=\text{Mean}(P_i)/\text{Mean}(P_{G2,NCI})$$

Since $\text{Mean}(P_i) = S^* \text{Mean}((P_{G2,NCI})^F)$, solving for S gives:

$$S = R * \text{Mean}(P_{G2,NCI}) / \text{Mean}((P_{G2,NCI})^F)$$

Finally, calculate the "NCI-like" distribution:

$$P_i = S * (P_{G2,NCI})^F$$

The mean of P_i across all percentiles (excluding the 0th and 100th percentile) should be equal to $\text{Mean}(I_{FFQ})$. Note that if F = 1.0, then S = R and the scaled NCI distribution is the same as calculated previously by Idaho DEQ. Using a slope (F) greater than 1.0 spreads out the distribution, particularly the upper tail, compared to using F = 1.

We expect the approach outlined above, using an estimated value of the slope F, will provide a better estimate of Nez Perce Idaho caught fish consumption distribution than assuming F equals 1.0.