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RE: RESPONSE TO EPA QUESTIONS

Dear Mr. Tomchuk:

The purpose of this letter is to respond to questions about the Hudson River risk assessment that have been raised between the U.S. EPA Region II (EPA), General Electric (GE), Gradient Corporation, and ChemRisk. In particular, the EPA has asked a number of questions concerning the exposure assessment via the fish consumption pathway:

a. How did the Maine angler survey address recall bias?
b. How did the Maine angler survey deal with nonrespondents?
c. Did fishing advisories bias the fish consumption rates estimated from the Maine angler survey?
d. Should exposure of young children via fish consumption be considered?
e. Is the effect of lifespan duration double counted when factors for angler cessation and mobility are incorporated into the model?
f. Is the survey of Michigan anglers appropriate for use on the Hudson River?
g. Does PCB loss differ between pan frying and deep frying?
h. Do the people who pan fry fish, eat the drippings?
i. Is there information available to determine how smoking of fish reduces PCB levels?
j. Is the loss of PCB during cooking dependent on the starting concentration?
k. Is the amount of PCB loss overestimated if the risk assessors are modeling a cooking practice that produces a substantial loss, but that cooking method is rarely used to prepare the species of fish being modeled?
l. Are alternative approaches available for evaluating species preference?
m. Is the Sloop Clearwater Survey appropriate for the Upper Hudson River risk assessment?
n. Are the most commonly consumed species the same for Maine and New York anglers?

In addition, ChemRisk met with Ms. Jackie Moya, Mr. Paul White, and Mr. Kevin Garrahan of the U.S. EPA Exposure Assessment Branch, National Center for Environmental Assessment, to discuss issues related to the Maine angler survey. Our responses detailed in this letter also reflect the issues discussed at that meeting.

a. How did the Maine angler survey address recall bias?

The issue of recall bias was considered in the design of the Maine angler survey and in the evaluation of the study results. However, ChemRisk did not adjust for recall bias when estimating rates of fish consumption based on the survey results. A review of the relevant survey and recall bias literature indicates that the effect of recall bias in surveys like Ebert et al. (1993) would be an over-reporting of fish consumption by the surveyed anglers (Connelly and Brown, 1995). Consequently, it is likely that if the survey results had been adjusted for recall bias, the estimated intakes would have been lower rather than higher.

For certain activities, it is traditional to view recall bias as a possible cause of under-reporting of exposure-related events. The underlying assumption is that the potential for forgetting events increases with the length of time between the occurrence of those events and the time of the survey, thereby leading to under-reporting. In the last two decades, many recall studies have reported that long recall periods result in under-reporting of events; however, the exceptions to this general finding are recall surveys of recreational activities, product purchases, and alcohol consumption (Westat Inc., 1989; Connelly and Brown, 1995).

A study conducted by Westat, Inc. (1989) on behalf of the U.S. Fish and Wildlife Service reported that six-month to one-year recall periods resulted in over-reporting, rather than under-reporting of recreational fishing and hunting activities. The Westat study used a state-of-the-art experimental design and examined a recall issue that closely resembles the reporting of fish consumption. The study concluded:

> "an important difference between the outcome of our study and those of most other recall studies conducted in the past 20 years is the direction of recall bias. In the majority of earlier studies, researchers found that longer recall periods resulted in under-reporting of events. However, our study consistently found evidence of an over-reporting bias" (Westat, Inc., 1989).

More recently, Connelly and Brown (1995) conducted a study of the differences in recall accuracy for diary studies and year-long recall studies of angler activities. For this study, they evaluated a population of anglers who participated in a 12-month recall mail survey at the end of 1991, and a year-long diary study in 1992. These authors reported that a comparison between the mail survey and diary study data indicated that the reported number of days fished and rates of fish consumption were significantly higher in the recall survey than in the diary study. Because diary studies are considered to be more accurate than recall surveys, the authors primarily attributed these differences to long-term recall bias. While the data would not allow them to calculate a specific correction factor for fish consumption rates, the authors did report that angler-days (the number of days an angler spent fishing) were overestimated by 44 to 45 percent in the recall survey. They recommended that this percentage might serve as an initial estimate of a correction factor for future studies.

Based on conclusions by Westat, Inc. (1989), Connelly and Brown (1995), and a review of the survey methodology literature, it is unlikely that the one-year recall period in the Ebert et al. (1993) study led to under-reporting of fishing and consumption activities. Rather, the most likely outcome is that participation, harvest, and consumption were overestimated as a result of recall bias.

b. How did the Maine angler survey deal with nonrespondents?

A follow-up effort to contact anglers who did not respond to the Maine angler survey was beyond the scope of our research. However, studies of angler participation rates and consumption have shown that nonrespondents tend to have lower participation rates and consume less fish than do respondents (Brown and Wilkins, 1978; West et al., 1989; NYSDEC, 1990; Connelly et al., 1992; Connelly and Brown, 1995). West et al. (1989) used the information obtained in their follow-up survey of nonrespondents to reduce their estimate of fish consumption by more than 10 percent. Similarly, Connelly et al. (1992) used information collected from nonrespondents to adjust their sport-caught fish consumption estimates by 45 percent. We did not adjust the results of our survey of Maine anglers in this fashion.

The results from these recreational surveys are consistent with the finding that response rates tend to be positively correlated with the salience of the issue for the respondent (Heberlein and Baumgartner, 1978). It is reasonable to expect that a survey on fishing is less salient to individuals who do not do much fishing than to those who are avid anglers. Consequently, respondents to a survey are likely to be biased towards anglers who fish more often. As a result, fish consumption estimates based only on responders are likely to overestimate the consumption rates for the total population of anglers in the surveyed population.

In addition, the response rate for the Maine angler survey was excellent. Completed questionnaires were received from 64 percent of the anglers selected for the sample and 70 percent of those to whom the survey could be delivered. The percentage of deliverable surveys is the appropriate response rate to report in survey research. A 70 percent response rate is well within the range of response rates achieved in surveys of recreational behavior (Brown et al., 1989). The response rate for the Ebert et al. (1993) survey was also higher than the response rates for other fish consumption surveys. NYSDEC (1990) reported a response rate of 62.5 percent for the *New York Statewide Angler Survey*, the response rate reported by West et al. (1989) for their fish consumption survey of Michigan sport anglers was 47.3 percent, and the response rate reported by Connelly et al. (1992) was 52.8 percent. Because of this high response rate, the magnitude of the bias introduced by not correcting for nonrespondents is likely to be small.

ChemRisk believes that the anglers who responded to the 1990 Maine Angler Survey are representative of Maine anglers in general. Prior to our 1990 survey, two other mail surveys of Maine anglers were conducted in a largely similar manner. Each survey was based on random samples and each shared similar respondent characteristics. A survey pretest was conducted to assess survey difficulty and complexity among potential respondents, and the final survey instrument was refined following the pretest effort. Based on these facts, we believe that the respondents to the 1990 Maine Angler Survey were representative of Maine anglers characterized in previous angler surveys, despite the added length and complexity of the 1990 survey as compared to the previous angler surveys.

In our meeting with the individuals from EPA's Office of Exposure Assessment, Paul White raised the question of whether the format of detailed questions about numbers and length of fish caught and consumed might have proved too difficult or challenging to respondents and, as a result, whether anglers might begin but not complete answering these questions. Were this to occur, then fish consumption rates might be underestimated. Based on the results of the survey pretest, we do not believe that this type of complexity-related under-reporting or associated bias is present in survey results. Were there a systematic effect due to respondents only partially completing the questions, then the consumed quantities by species might show a decreasing trend moving down the species order in the survey. No such trend is noted. Furthermore, the species identified and the relative numbers consumed across species and fishing modes correspond to expectations for Maine anglers (e.g., smelt, white perch, and brook trout being the most-consumed species from ice fishing, lakes/ponds, and rivers/streams, respectively).

c. Did fishing advisories bias the fish consumption rates estimated from the Maine angler survey?

It is highly unlikely that fish consumption advisories biased the results of the Maine angler survey. Only a few waterbodies in Maine had consumption advisories in place at the time that the survey was conducted and these advisories were limited to certain reaches of the larger warmwater rivers. Because there was no history of pollution on the other rivers, streams or brooks, or on any of the lakes and ponds in the State, Maine anglers had their choice of hundreds of non-advisory lakes, ponds, streams and rivers in which to fish. Of the approximately 37,000 miles of rivers, streams, and brooks in the State of Maine, only about 200 miles of mainstream, warmwater rivers had any history of pollution or advisories at the time of the survey. Out of a total of 748 fishing locations identified by respondents, only 27 were at potentially impacted waters. In addition, no individual angler identified only potentially impacted locations as his or her top five preferred fishing locations.

There are two implications of these findings. First, very few anglers would be affected by bans or advisories because only a small portion of the available bodies of water were affected. Second, because of the availability of nearby, multiple alternative bodies of water, it is more likely that advisories on a particular waterbody would simply result in substitution by anglers of non-advisory fisheries for advisory fisheries, rather than a suppression of fishing activities.

Confirmation of this can be seen in the results of the Maine angler survey. Figure 1 presents a flow diagram that follows 1990 Maine angler survey respondent awareness of and behavior responses to fish consumption advisories. Of the 1369 anglers who responded to the Maine angler survey, 35 percent were aware of the advisory. Of these anglers, 27 percent (or 9 percent of all anglers) fished at an advisory location. Seventy-four percent of those who fished advisory waters (or 7 percent of all anglers) modified their consumption behavior for fish from these location as a result of the advisory. In addition, only 18 percent of those aware of advisories (or 6 percent of all anglers) would have fished additional waters in absence of advisories. Together these responses suggest that the presence of advisories does not substantially limit fishing effort among Maine anglers.

d. Should exposure of young children via fish consumption be considered?

Children should be evaluated as part of the Hudson River risk assessment. Consideration of risks to children differs for carcinogenic and noncarcinogenic risk assessments. The estimated dose that children receive at specific ages is compared to the RfD when evaluating noncarcinogenic hazards. In carcinogenic risk assessment, the average daily dose is calculated for each year of a child's life from the age the child's exposure begins to the age when it ceases and the estimates are used to derive a lifetime average daily dose. The doses are derived using age-specific body weights and consumption rates (EPA, 1992a).

Because of the differences in estimating carcinogenic and noncarcinogenic risks, there are two questions to address when evaluating risks to children. First, do children receive doses on a body weight basis that are higher than adults and consequently may exceed an RfD? Second, do individuals receive doses when they are infants or children that should be considered when estimating lifetime average daily doses? The answer to the first question can be obtained by reviewing the available information on fish consumption rates among children.

A preliminary assessment of the available literature suggests that children do not consume large amounts of freshwater fish. National studies of fish consumption (Javitz, 1980; Rupp et al., 1980; Pao et al., 1982; USDA, 1992) have consistently reported that consumption of fish from both freshwater sources and from all sources is lower for children and adolescents than for adults. In addition, consumption of fish meals occurs more infrequently for children (Pao et al., 1992). Studies of freshwater recreational anglers also indicate that the majority of freshwater anglers are adults (West et al., 1989, 1993; Barclay, 1993; Ebert et al., 1995). The nonparticipation of children in freshwater angling suggests that children have no special interest in consuming recreationally caught fish. In fact, the results of the Sloop Clearwater survey indicate that those children who do fish are less likely than adults to eat their catch (Barclay, 1993). The results of a second survey (Ebert et al., 1995) indicate that children's intake of recreationally caught fish are significantly lower than adults even on a body weight basis.

Based on the available data, it appears that the distribution of dose rates for children will be smaller than the distribution of dose rates for adults. Therefore, a finding of acceptable levels of risk in adults implies that children will also be protected from any noncarcinogenic effects of PCBs.

The second issue as to whether individuals receive doses when they are infants or children that should be considered when estimating lifetime average daily doses is already addressed in the proposed Microexposure Monte Carlo analysis. The analysis assumes that individuals as young as 10 years old may consume recreationally-caught fish from the Upper Hudson. In addition, the distribution of consumption rates assumes that 10 to 17 year olds eat fish at rates similar to adults. Based on the studies cited above, this likely overestimates fish consumption for this age group.

Although the Microexposure program currently includes individuals whose ages range from 10 through 70 years, the program can be modified to separately estimate exposures for the subpopulation of anglers who are 10 years old. This can be done by setting the program to select anglers at a starting age of 10 years, and then follow the individual's consumption to the year that the individual ceases to consume fish from the Upper Hudson River. Under this modified approach, the program would produce a distribution of dose rates for a subpopulation of Hudson River anglers who are ten years of age when they begin to fish the Hudson and continue until they give up angling, move away, or reach the end of their lifespan.

The distribution of lifetime average daily dose rates for a subpopulation of 10-year old anglers is expected to be slightly lower than the dose rates for the general population. The reason for this is that while the intake rates for fish are assumed to be the same as adults, the mobility of teenagers and young adults is much higher than middle aged or older adults (EPA, 1992b). As a result, the modeled duration of their exposures will tend to be smaller than those of the general population of anglers, resulting in lower estimates of lifetime average daily dose rates.

In summary, it appears that the risks to children and adolescents from exposure to PCBs via fish consumption are not elevated. The current model can be modified to investigate the contribution of childhood exposures to lifetime average daily dose rates, but the contribution is not likely to be significant, because it occurs in the fraction of the population with high mobility.

e. Is the effect of lifespan duration double counted when factors for angler cessation and mobility are incorporated into the model?

Double counting the effect of lifespan duration would occur if either the frequency of moving or cessation of angling had already incorporated the probability of vacating a house or giving up fishing because the individual had reached the end of his/her lifespan. However, the proposed factor for angler cessation and the mobility distribution used in the Microexposure model do not incorporate this probability; hence, lifespan is not double counted. The rate of angler cessation is derived from the age distributions in the Maine angler survey, which showed that the number of anglers consuming fish dropped off after age 40. Lifespan effects are eliminated by correcting the number of anglers by the age distribution of Maine residents. This correction is performed by dividing the number of anglers at each age by the number of Maine residents of the same age. The result of the correction is an estimate of the number of anglers per 1,000 Maine residents of the same age. After this correction for lifespan, a significant age-related decline in the number of anglers is still observed for anglers between 30 and 60 years of age. This decline is the basis of the angler cessation information included in the Microexposure Monte Carlo analysis.

Mobility distributions used in the Microexposure model are based on data from the US Census Bureau, which develops mobility data from special surveys performed annually. During these surveys, the Bureau asks such questions of individuals as:

Did you move during the past year?
Did you move in the last five years?
When did you move to your current home?

Based upon the responses to these questions and information on the age of individuals, the Census Bureau develops age-specific estimates of the probability of individuals moving from one home to another. Because the data collected are based upon living individuals reporting past moves, the estimates of mobility do not count vacancies that occur as a result of death. Mortality is a separate factor in determining residence time, as recognized by EPA (1992b) in their analysis of residential duration in which mobility and mortality were considered to be independent factors that affect duration of residency.

f. Is the survey of Michigan anglers appropriate for use on the Hudson River?

West et al. (1989) conducted a mail survey of a stratified sample of Michigan sport fish license holders (*Michigan Sport Anglers Fish Consumption Survey - A Report to the Michigan Toxic Substance Control Commission*). Fish meals included self-caught fish, market fish, restaurant fish and gift fish. The average fish consumption rate was 18.3 g/person/day, adjusted downward by a factor of 2.2 to adjust for nonresponse bias. A distribution of consumption rates was provided for various age groups. Frequency of fish meals within fish species category was reported; these same data were reported by age groups and by race as well. The species type was reported by source of fish, i.e., frequency for each specie type was given for restaurant, market, gift or self-caught. No breakdown of waterbody type is provided for self-caught, thus data include fish caught from Great Lakes. West et al. (1993) published a second paper entitled *Minority Anglers and Toxic Fish Consumption: Evidence from a Statewide Survey of Michigan.* In this paper, the authors analyzed the 1989 survey for evidence on fish intake by minority groups. However, the paper contained no new data on fish consumption rates.

ChemRisk regards the West et al. (1989; 1993) results to be inappropriate for use in the Hudson River risk assessment because the study measured fish consumption from all sources (purchased and restaurant meals), rather than just self-caught fish. The survey also included fish taken from multiple waterbodies including the Great Lakes. It may be appropriate to use this study in support of the average fish consumption rate from the Maine survey and Connelly et al. (1992). It is possible to calculate an average percentage for self-caught fish from the data on species type and source of fish. This average of 36 percent, if applied to the average consumption rate (18.3 g/day), yields an average fish consumption rate for self-caught fish of approximately 7 g/person/day. The mean consumption rate for anglers consuming fish from all freshwaters in the Maine angler survey was 6.4 g/day (Ebert et al., 1993) and the average New York angler consumed self-caught freshwater fish at a rate of 7 g/day (Connelly et al., 1992).

g. Does PCB loss differ between pan frying and deep frying?

There are seven studies that investigate either pan frying or deep fat frying (Skea et al., 1981; Puffer and Gossett, 1983; Armbruster et al., 1987;1989; and Zabik et al., 1992;1995a,b). Of the published studies with data that could be represented as a percent change in PCBs on a mass basis, two reported on pan frying and two reported on deep fat frying. Figure 2 presents the range of PCB reductions reported in the published studies for the two methods. As the figure indicates, both frying methods result in similar ranges of removal rates. The actual difference between the two methods can not be readily identified from the data because the available studies did not test the two types of frying on the same types of fish. Because the degree of reduction produced by a cooking method is affected by the percent lipids in the fish, and factors such as trimming or skin removal, a comparison of data across studies is only possible using more refined analyses. However, the literature is clear that both methods are capable of removing considerable amounts of PCBs.

h. Do the people who pan fry fish, eat the drippings?

A portion of PCBs lost during frying may remain with rendered fats or pan drippings. If individuals consume such drippings, then their total intake of PCBs will not be reduced to the extent predicted in studies of cooking losses. However, the available data suggest that the consumption of the pan drippings is relatively rare in anglers likely to consume Upper Hudson River fish. Connelly et al. (1992) and Sloop Clearwater (Barclay, 1993) surveyed anglers to determine whether or not they reused or consumed either pan drippings or fats used in frying fish harvested from waterbodies in New York State. Connelly et al. (1992) reported that 93 percent of all surveyed anglers rarely or never reused fish oil. The number increased to 97 percent, when Connelly et al. (1992) considered those anglers who consumed large amounts of fish. Barclay (1993) reported that more than 90 percent of surveyed anglers never reused oil or fat. Based upon these reported results, the consumption of pan drippings or oil used to fry fish is a rare event and does not invalidate the consideration of the large reductions in PCBs reported for frying.

i. Is there information available to determine how smoking of fish reduces PCB levels?

Skea et al. (1981) evaluated how smoking the fish effects PCB levels in brown trout collected from the Hudson River and Lake Ontario. Reductions in PCB concentrations were determined by comparing the concentrations in a standard uncooked fillet and a standard smoked fillet. The results indicated that smoking caused a 26.7 percent reduction in Aroclor 1254. This finding suggests that smoking of fish can result in PCB losses similar to baking or broiling.

j. Is the loss of PCB during cooking dependent on the starting concentration?

Two studies were identified in the literature which discussed the influence of initial PCB concentration on cooking losses. Puffer and Gossett (1983) evaluated reductions in PCB concentration in white croaker from Santa Monica Bay and Orange County. Fish from Santa Monica Bay had PCB concentrations eleven times higher than Orange County. Pan frying Santa Monica Bay fillets caused a 65 percent reduction in PCB concentrations compared to only 28 percent in Orange County fillets. The authors speculated that the greater loss in the Santa Monica fillets may have been related to the higher initial concentrations in the fish from that source; however, no evidence was offered in support of the hypothesis. In the second study, Zabik et al. (1995a) compared the reduction in PCB concentrations from pan frying white bass from Lake Erie and Lake Huron. In this study, the fish from Lake Erie had higher PCB concentrations than the fish from Lake Huron (0.76 ppm vs 0.5 ppm); however, Lake Erie fish had only an 18 percent reduction in total PCBs compared to 44 percent for Lake Huron. The implications of this finding were not discussed by the authors. Based upon the published literature, the role of initial PCB concentrations is inconclusive.

On a theoretical basis, it is possible that the percent loss of PCBs may be correlated with initial PCB concentration. The correlation could occur because both PCB concentration in fish and percent loss of lipids are associated with the percent lipids in fish tissue. It is well known that fish with higher percent lipids accumulate more PCBs (on a wet weight basis) than fish with low lipid fractions (Swackhamer and Hites, 1988; Hooper et al., 1990; Thomann et al., 1992; Porte and

Albaiges, 1993). Given that fish with high percent lipids may lose greater amounts of PCBs when compared to fish with low percent lipids (Sherer and Price, 1993), it is possible that some correlation between PCB loss and initial concentration (wet weight basis) could occur. Under these circumstances, a higher initial PCB concentration suggests a higher rate of PCB removal.

k. Is the amount of PCB loss overestimated if the risk assessors are modeling a cooking practice that produces a substantial loss, but that cooking method is rarely used to prepare the species of fish being modeled?

According to our analysis of Connelly et al. (1992), recreational anglers catch striped bass and bullhead 60 percent of the time. Preparation of these two species is almost exclusively by pan frying, which is the method associated with the greatest loss of PCBs. Although the Microexposure Monte Carlo model does not directly link fish species with cooking method, the approach is not likely to result in an overestimate of the impact of cooking loss on the final dose estimate, and it is quite accurate for specific species of pan fish.

l. Are alternative approaches available for evaluating species preference?

Various studies have been conducted which indicate that anglers do preferentially select for certain species in both fishing effort and consumption (NYSDEC, 1989; Connelly et al., 1992). In the January 1995 issue paper, *Determining the Intake of Hudson River Fish by Species*, ChemRisk presented one approach for evaluating the catch and consumption of fish by Hudson River anglers. ChemRisk has reevaluated the assumptions used in that approach presented, and has identified several options that may be used to develop alternative estimates of species preference (Table 1). However, it is likely that the options will produce similar results, i.e., the majority of fish caught will be dominated by bass and bullhead.

m. Is the Sloop Clearwater Survey appropriate for the Upper Hudson risk assessment?

Gradient has stated that is considering the creel survey of the Hudson River performed by Sloop Clearwater (Barclay, 1993) as a source of information for angler consumption rates. The results of the survey are relevant to the Upper Hudson, but there a number of factors that limit the usefulness of the survey's results.

First, the survey was designed to evaluate the entire Hudson River and as a result contains information on only a limited number of anglers on the Upper Hudson. While the survey reports the results of interviews with a total of 336 anglers, only 60 anglers on the Upper Hudson were surveyed. Among these 60 anglers, 13 (22 percent) reported eating some or all of their catch. Such a small number of consuming anglers cannot provide a meaningful description of the distribution of consumption rates for the Upper Hudson site. Because of significant differences between the Lower Hudson and the Upper Hudson, such as differences in fish species, public access and the demographics of the anglers, the results from the entire survey can not be used to evaluate the Upper Hudson.

Second, because the Sloop Clearwater survey is a creel survey, its results will be biased towards the frequent anglers (Price et al., 1994). As a result, the range and mean of the intake rates for the 13 anglers will likely be an overestimate of the distribution of actual intake rates for the population that uses the Upper Hudson.

Third, creel surveys are essentially a snapshot of an angler's behavior on a single day. Extrapolation of anglers' behavior from a single day to a longer period of time can result in significant uncertainties in distributions of intake (Ebert et al., 1994; Finley et al., 1994).

For these reasons, we believe that the results of the Sloop Clearwater survey are not adequate to develop a distribution of fish consumption rates. However, the results of the survey may be useful in a qualitative fashion as a confirmation of the reasonableness of any distribution of fish consumption rates used in the Hudson River risk assessment. The survey may also provide other insights on Upper Hudson River anglers. For example, the survey indicated that 59 of the 60 anglers interviewed were white, suggesting that relatively few minorities fished at the two locations surveyed on the Upper Hudson. ChemRisk currently does not have access to the raw data from the survey, but if EPA obtains a copy of the raw data, we would be interested in obtaining a copy.

n. Are the most commonly consumed species similar in Maine and New York anglers?

Table 2 presents the top three species consumed by New York anglers (Connelly et al., 1992) and the Maine angler survey (Ebert et al., 1993). As the table demonstrates, there is considerable similarity between the species reportedly consumed by anglers in the two states.

This completes our response to the fish consumption issues discussed by EPA, ChemRisk, General Electric and Gradient. We sincerely trust that the additional analyses and discussion provided in this letter will help to clarify and resolve many of the questions raised on the Hudson River risk assessment. Please contact us if additional clarification is needed.

Sincerely,

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Figure 1

Awareness of and Behavior Responses to Fish Consumption Advisories
All Survey Respondents

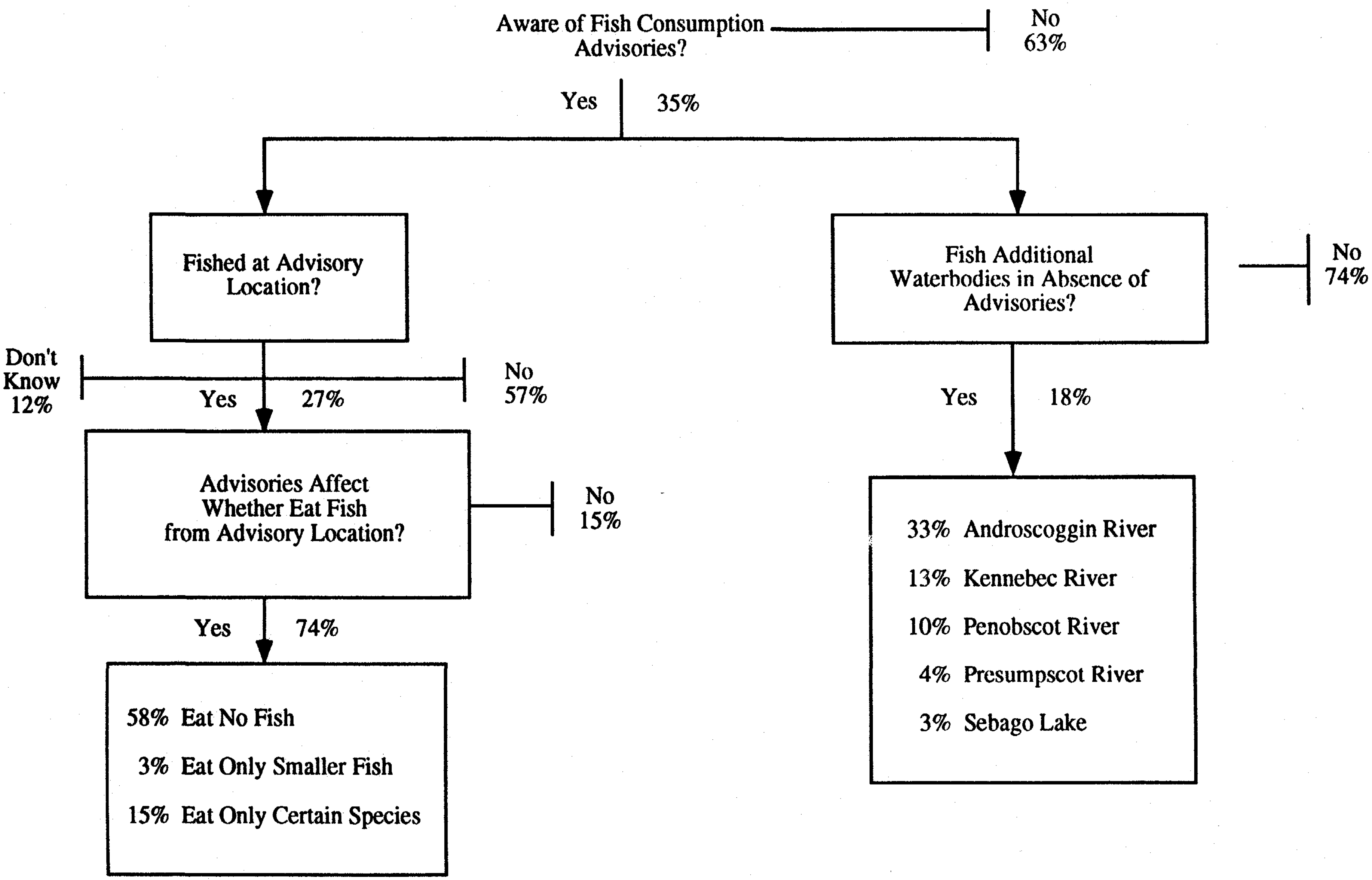

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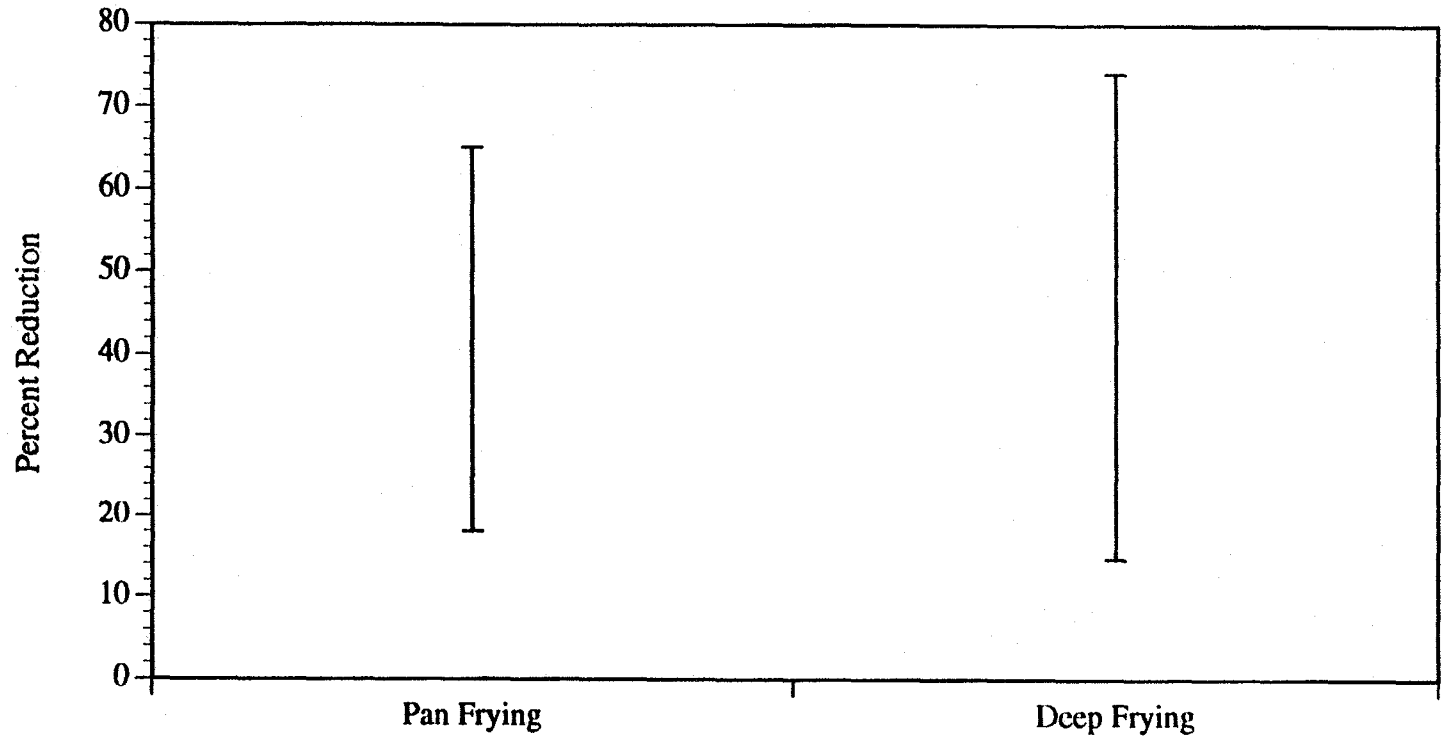
Figure 2. Percent Reduction in PCB Concentrations in Fish Due to Pan and Deep Frying



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1580.004\1-96 Deliv.\Tomchuk\Fig 2

Table 1

Steps and Options for Identifying Species Preference

Step	Proposed Approach	Option A	Option B	Option C
1. Selection of the source of data	Use Connelly et al. (1992) survey data Upper Hudson River	Use Sloop Clearwater survey data for the Upper Hudson River	Use Maine data on species preference	
2. Selection of a subset of waters resembling the Hudson	Identify warm water rivers/ streams in New York State	Refine selection of warm water rivers/streams to remove salmon and other non-Hudson fish	Limit selection of warm water rivers/streams to a few waterbodies with characteristics similar to the Hudson	
3. Reconciliation of species reported by Connelly with those known to occur in the Hudson	Distribute fish listed in Connelly but not found in Hudson to other fish species	Distribute fish not found in Hudson or fish without PCB data to the "other" category	Remove fish not found in Hudson or fish without PCB data from list and scale up all remaining fish categories including "other"	Equally distribute fish not found in Hudson or fish without PCB data
4. Evaluation of the "other" category	Distribute the "other" category to seven species of fish found in Hudson but not listed in the Connelly survey	Distribute the "other" category to species found in Hudson and listed by Connelly	Remove fish in "other" category from list and scale up remaining species	

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Table 2

Species Preferences Comparison

Species	1990 ME Angler Survey*	1990-91 NY Angler Survey
Trout	1	1
White Perch	2	5
Bass	3	2
Bullhead/Catfish	9	3

*Based on consumption from rivers and streams

Overview of the Human Health Risk Assessment in the Hudson Reassessment

I. Risk assessment approach
   - A. Calculate risks based on RME exposure estimates using site-specific point values
   - B. Calculate risks based on central tendency exposure estimates using site-specific point values
   - C. Conduct a Monte Carlo analysis
     1. Evaluate the available literature and data to determine the most appropriate approach
     2. Characterize the variability in the risk estimates
     3. Analyze uncertainty by quantifying the dependence of the risk estimates on the selection of different plausible assumptions

II. Summary of each component in the exposure equation for the risk assessment
   - A. Fish concentrations
   - B. Fraction of each fish species ingested
   - C. Fish ingestion rate
   - D. Exposure duration
   - E. Body weight
   - F. Averaging time

$$Intake\ (mg/kg/day) = \frac{Fish\ Concentration \times Fish\ Ingestion\ Rate \times ExposureDuration}{Body\ Weight \times Averaging\ Time}$$

where

$$Fish\ Concentration = \sum \frac{Arochlor\ Concentration}{Species} \times Fraction\ Species\ Ingested$$

III. Fish concentrations
   - A. Develop a "composite" fish concentration (95% UCL), averaged over the exposure duration (most likely 30 years) and weighted based on the fraction of each fish species ingested
   - B. Consider aggregating data either over the entire Upper Hudson (RM 153 to RM 195), or considering specific reaches
   - C. Determine Aroclor concentrations for evaluating non-cancer toxicity, and total PCB concentrations for evaluating cancer risks, recognizing the inherent uncertainties
   - D. Consider a correction factor to adjust concentrations measured in whole fish to concentrations measured in fillets

IV. Fraction of each fish species ingested
   - A. Characterize species-specific consumption patterns based on a review of the available data, most likely based on information provided in the Connelly 1992 report and the Clearwater Angler 1993 survey
   - B. Consider fact that species-specific consumption patterns may include fish for which concentration data is not available
   - C. Consider other species, such as crabs, if appropriate data are available

V. Fish ingestion rate

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A. Develop a point estimate and distribution from a northeast, freshwater study - most likely based on the published data or requested primary data from one or a combination of the Connelly, Clearwater, or Ebert surveys.
B. Consider subsistence anglers
C. Consider the impact of fishing advisories and bans

VI. Exposure duration
A. Do not consider adjustments for mortality to avoid double counting
B. Consider county mobility rates and distances traveled to fish, if appropriate data are available
C. Consider cessation of angling, if determined appropriate

VII. Body weight
A. Consider the use of gender-specific distributions, which are readily available in published literature

VIII. Averaging time

IX. Toxicity factors
A. Non-cancer
1. Currently RfDs are established for Aroclor 1016 and 1254
2. Consider evaluating site risks either based on the most conservative Aroclor toxicity value, or based on a weighted average value according to the distribution of PCB congeners (and the most similar Aroclor mixtures) present at the site
3. Consider any revised RfD values which may become available before the risk assessment is completed
B. Cancer
1. Currently the CSF is for total PCBs
2. Consider any revised CSF values which may become available from EPA before the risk assessment is completed, possibly based on data from the GE bioassays where appropriate

X. Additional issues which will be considered as to whether or not to address them in the Phase II risk assessment
A. Consider childhood exposures (verify whether adult risks are higher)
B. Consider accounting for cooking and trimming losses
C. Consider evaluating the risks in the Lower Hudson - particularly from striped bass in the mid-Hudson region, below the Troy dam

XI. Risk characterization memo - March 21, 1995
A. Consider any new requirements, as appropriate
B. Monitor forthcoming EPA guidance, such as a draft implementation guide, as appropriate

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