Determining The Intake Of Upper Hudson River Fish By Species

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1.0 INTRODUCTION

In 1991, EPA issued a Phase I Report for the Reassessment RI/FS in which the Agency evaluated the potential human health risks for the Hudson River Superfund site. In this report, EPA (1991) determined that any risks to human health from PCBs in sediment occur through indirect exposure through the fish consumption pathway. Under Superfund Guidance, (EPA, 1989) evaluation of such exposures are specifically required not to consider the impact of any fishing regulations. However, fishing restrictions have been imposed by the State of New York, and thus the estimates of PCB exposure developed for the Upper Hudson River are hypothetical and an overestimation of actual exposures.

In the Phase I risk assessment, EPA (1991) acknowledged that New York anglers do not spend an equal amount of time fishing for each species. Instead, a large majority of time is spent fishing for bass, brown trout, and walleye (NYSDEC, 1990). Although EPA (1991) realized that the NYSDEC information did not specifically reflect fishing preferences of Hudson River anglers, the Agency believed that the statewide values generally reflected efforts on the Hudson. In spite of the availability of species preference data from the New York survey, EPA chose to average the PCB concentration data from all species sampled from the Hudson River to determine a single point estimate (95th percentile) of PCB concentration in fish tissue. EPA defended this decision citing the lack of appropriate sampling data for the species that could be eaten by anglers. Because specific PCB concentration data could not be defined for all species, EPA decided to include the available sampling data on all species of fish in the analysis. In addition, EPA stated that there were not sufficient differences in the PCB levels reported in the various species to warrant a species-specific evaluation of PCB levels in fish.

In the Final Phase 2 Work Plan and Sampling Plan, EPA (1992) stated that it would reevaluate the decision made in the Phase 1 document and possibly refine the estimates of exposure point PCB concentrations in fish to reflect interspecies variability and anglers' preferences for different species. Since the release of the Phase 1 document, additional sampling data on a greater number of species have been collected. In addition, several studies have been released which provide data to support the fact that anglers do select certain species in both their catch and in their consumption habits. This information combined with data on fish species presented in the Phase 1 document can be used to identify the major edible species selected by Hudson River anglers. This paper

presents a discussion of the technical and regulatory issues associated with the determination of the species preferences of Upper Hudson River anglers.

2.0 EXPOSURE CONCENTRATIONS FROM UPPER HUDSON RIVER FISH

Fish PCB Levels

Over 50 different species are known to be present in the Hudson River between Federal Dam and Fort Edward (Malcolm Pirnie, 1984). Earlier sampling efforts were focused on those species that were likely to be consumed by recreational anglers, such as bass, the most desirable game fish in the Hudson River (NYSDEC, 1990). However, recent sampling efforts have been expanded to include other less desirable species.

An examination of the recent sampling data indicates that PCB tissue levels in some species vary over a large range (Table 1). For example, the levels of PCBs in goldfish are estimated to be 20 times greater than levels found in pumpkinseed fish. The variation observed in PCB concentrations in fish is likely affected by the amount of lipid content of the fish. PCBs are highly lipophilic and tend to accumulate in those species with a higher fat content, such as goldfish, carp, or American eel (EPA, 1991). Although fish with more lipids will generally have higher PCB concentrations, there will be variations in individual PCB tissue levels due to the natural distribution within species.

Angler Preferences

Recent studies by the New York State Department of Environmental Conservation (NYSDEC) indicate that New York anglers preferentially select for certain species in both fishing effort and consumption (NYSDEC, 1990; Connelly et al., 1992). Many species (e.g., goldfish, carp) are not desirable sport species and are not likely to be consumed by anglers even if they are caught. In most cases, anglers preferentially fish for and consume species that have low lipid contents and which consequently accumulate lower levels of PCBs. Preferential selection of species by anglers is further supported by a mail recall survey conducted on Maine anglers (ChemRisk, 1992). This survey identified over 15 different species that were caught and consumed by recreational anglers;

Table 1. PCB Concentrations in Selected Species of Fish

	Average PCB Level 1975 - 1988[a]
Carp (goldfish)	137 ppm
White Perch	42 ppm
Bass (largemouth)	27 ppm
Pumpkinseed	10 ppm

a. Data from NYSDEC (1990).

however, over 85% of these fish were represented by only three species. The total intake of PCBs by recreational anglers is therefore, dependent on the concentration of PCBs in only a few select species and not the entire range of PCB concentrations recorded from all species.

3.0 SELECTION OF FISH SPECIES

All species found in the Hudson River will not be consumed by recreational anglers since only a small percentage of the species are considered desirable game fish. Information on species preferences specific to the Hudson is unavailable. However, based on data from Connelly et al. (1992), it is possible to identify species preferences among New York anglers that can be used as a surrogate for Hudson River anglers. Specifically, Connelly et al. (1992) surveyed 2,000 fishing license holders for the year beginning October 1990 and ending on September 30, 1991. Although the survey focused on assessing angler knowledge of the fish health advisories, the survey also was designed to "describe fishing behaviors (e.g., species, waterways) and fish consuming behaviors (e.g., species, preparation techniques used) of licensed anglers." Survey participants provided detailed information on the locations they fished in New York State, the number of fish caught, and the number of fish meals eaten from each of these locations.

An analysis of the data from Connelly et al. (1992) was conducted to select the appropriate information. Because many rivers in New York State are characterized as cold water and fast moving or are stocked with cold water species (e.g., trout), whereas the Upper Hudson is a cool to warm water stream with much slower flow, some of the survey results are not applicable to the Hudson River. Rivers and streams classified by New York State as warm water are likely to contain species similar to the Hudson River. These rivers were identified based on fishing data from New York State and discussions with regional fishery personnel (Table 2). Using the rivers and streams identified in Table 2, a distribution of fish species eaten by New York anglers was determined using appropriate portions of the results of the Connelly et al. survey (Table 3). Although the calculations used to arrive at the values in Table 3 are not presented in this issue paper, they can be provided at a later date.

Although chinook and coho salmon, rainbow trout, and brown trout are not expected to be caught by Upper Hudson River anglers, due to their preference for fast moving, cold waters, these

Table 2. New York State Warm Rivers and Streams Similar to the Upper Hudson

Name	County	Region	Potential Species Present
Allegheny river	Cattaraugus	9	smallmouth bass, muskellunge, northern pike, walleye, catfish, pan fish[a]
Batten Kill river	Washington	5	brown and brook trout
Black river	Lewis	6	largemouth and smallmouth bass, northern pike, walleye, pan fish, bullhead
Butternut creek - 2	Otsego	4	smallmouth bass, walleye, pickerel, trout
Butternut creek - 1	Onondaga	7	brown trout, walleye
Chemung river	Chemung	8	largemouth and smallmouth bass, walleye, pickerel, pan fish, bullhead
Chemung river	Steuben	8	largemouth and smallmouth bass, walleye, pickerel, pan fish, bullhead
Chenango river	Broome	7	largemouth and smallmouth bass, northern pike, walleye, pickerel, pan fish, bullhead
Chenango river	Chenango	7	largemouth and smallmouth bass, northern pike, walleye, pickerel, pan fish, bullhead
Chittenango creek	Madison	7	largemouth and smallmouth bass, northern pike, walleye, pickerel, pan fish, bullhead
Chittenango creek	Onondaga	7	largemouth and smallmouth bass, northern pike, walleye, pickerel, pan fish, bullhead
Delaware river	Delaware	4	smallmouth bass, pickerel, walleye, yellow perch, bullhead, pan fish
Delaware river	Orange	3	smallmouth bass, chain pickerel, walleye
Delaware river	Sullivan	3	smallmouth bass, walleye, yellow perch, bullhead, pan fish
East Branch Delaware river	Delaware	4	smallmouth bass, pickerel, walleye, yellow perch, bullhead, pan fish
Genesee river	Livingston	8	smallmouth bass, pan fish, bullhead
Genesee river	Monroe	8	smallmouth bass, rainbow and brown trout, pan fish, bullhead
Genesee river	Wyoming	9	bass, walleye, panfish
Hudson river	Warren	5	bass, pike
Lower Genesee river	Monroe	8	smallmouth bass, walleye, salmon, rainbow trout, steelhead
Mohawk river/barge canal	Herkimer	6	largemouth and smallmouth bass, tiger muskellunge, walleye
Mohawk river/barge canal	Montgomery	4	largemouth and smallmouth bass, tiger muskellunge, walleye
Mohawk river/barge canal	Oneida	6	largemouth and smallmouth bass, tiger muskellunge, walleye
Mohawk river/barge canal	Saratoga	5	largemouth and smallmouth bass, tiger muskellunge, walleye
Mohawk river/barge canal	Schenectady	4	largemouth and smallmouth bass, tiger muskellunge, walleye
Neversink river	Orange	3	smallmouth bass, brown trout
Oak Orchard creek	Genesee	8	bass, pike, salmon
Oswego river	Onondaga	7	walleye, catfish, carp, bass, sunfish

a. Panfish includes sunfish, rock bass and pumpkinseed.

Table 2. New York State Warm Rivers and Streams Similar to the Upper Hudson (cont'd)

Name	County	Region	Potential Species Present
Ramapo river	Orange	3	walleye, panfish, brown trout, rainbow trout
Raquette river	Franklin	5	smallmouth bass, northern pike, walleye, trout, panfish
Raquette river	St. Lawrence	6	smallmouth bass, northern pike, walleye, pan fish
Sandy creek - 1	Jefferson	6	smallmouth bass, northern pike, trout
Schoharie creek	Montgomery	4	smallmouth bass, walleye, pan fish
Schoharie creek	Schenectady	4	smallmouth bass, walleye, pan fish
Schoharie creek	Schoharie	4	smallmouth bass, walleye, pan fish
Schroon river	Warren	5	largemouth and smallmouth bass, northern pike
Seneca river	Seneca	8	largemouth and smallmouth bass, northern pike, walleye, pan fish, bullhead
Seneca river	Cayuga	7	largemouth and smallmouth bass, northern pike, walleye, pan fish, bullhead
Seneca river	Onondaga	7	largemouth and smallmouth bass, northern pike, walleye, pan fish, bullhead
Susquehanna river	Delaware	4	largemouth and smallmouth bass, northern pike, tiger musky, pickerel, pan fish, catfish
Susquehanna river	Otsego	4	largemouth and smallmouth bass, northern pike, tiger musky, pickerel, walleye, pan fish, catfish
Susquehanna river	Broome	7	largemouth and smallmouth bass, northern pike, walleye, pickerel, pan fish
Susquehanna river	Chenango	7	largemouth and smallmouth bass, northern pike, walleye, pickerel, pan fish
Susquehanna river	Tioga	7	largemouth and smallmouth bass, northern pike, walleye, pickerel, pan fish
Tonawanda creek	Genesee	8	largemouth and smallmouth bass, northern pike, walleye
Tonawanda creek	Erie	9	largemouth and smallmouth bass, northern pike, walleye
Tonawanda creek	Niagara	9	largemouth and smallmouth bass, northern pike, walleye, pan fish, bullhead
Tonawanda creek	Wyoming	9	largemouth and smallmouth bass, northern pike, walleye, pan fish, bullhead
Wallkill river	Orange	3	smallmouth bass, bullhead, pan fish
Wallkill river	Ulster	3	large and smallmouth bass, bullhead, pan fish, chain pickerel
West Branch Delaware river	Delaware	4	smallmouth bass, pickerel, walleye, yellow perch, bullhead, pan fish
West Branch Delaware river	Broome	7	smallmouth bass, pickerel, walleye, yellow perch, bullhead, pan fish

Table 3. Fish Species Distribution for Hudson - Like Rivers and Streams[a]

Species	Percent Meals Eaten
American Eel	0.9
Bass	17.4
Brown Bullhead	9.2
Brown Trout	27.8
Carp	0
Channel Catfish	0.5
Chinook Salmon	1.4
Coho Salmon	1.8
Lake Trout	0
Rainbow Trout	9.8
Walleye	7.5
White Perch	4.5
Other	19.1

a. Connelly et al. (1992)

species appear in Table 3. Their appearance may be due to either erroneous information provided by the survey respondents or the inclusion of rivers classified as Hudson-like that contain limited cold water sections. These cold water sections could contained salmonid species, however, the Hudson River contains no cold water sections and therefore will not contain salmonids. Data in NYSDEC (1990) indicate that the fishing effort in the Upper Hudson is primarily directed toward bass. Based upon this information, it is reasonable to assume that in the absence of good fishing opportunities for chinook and coho salmon, rainbow trout, and brown trout, anglers would instead fish for bass. Therefore, the percent meals eaten for these four species have been included in the percent meals eaten for bass (Table 4).

Table 3 also indicates that a significant percentage of fish meals eaten by New York anglers fall into an "other" category. Connelly et al. (1992) did not provide a method for respondents to identify species caught or eaten, but not specifically listed on the survey. Consequently, those species were attributed to the "other" category. Based on information contained in the Phase I document (EPA, 1991), NYSDEC (1990), and sampling data collected by NYSDEC, bluegill, rock bass, pumpkinseed, black crappie, northern pike, chain pickerel, and yellow perch are the most likely species that would fit within the "other" category for the Hudson. The "other" category percentage derived from Connelly et al. (1992) was divided evenly among these seven species.

Using this approach, a distribution of species preferences based on meals eaten can be identified that represents the distribution of species that would be eaten from the Upper Hudson River (Table 4). Although a distribution of species caught is also available (Connelly et al., 1992), a distribution of species eaten is more appropriately applied to an evaluation of exposure because many species caught by anglers are not eaten. For example, although a small number of carp were caught by anglers surveyed by Connelly et al., the carp were not eaten and are not included as desirable fish species for the Upper Hudson River. Instead, most anglers prefer bass, as indicated by the high percent consumption value of 58%. In addition, it is likely that anglers will consume a small number of bullhead, walleye, white perch, and other sunfish. EPA has reported PCB levels for most of the species listed in Table 4. However, in the absence of species-specific PCB data, concentration data for a similar species could be substituted. For example, PCB concentrations collected for bullhead are an appropriate surrogate for channel catfish, for which there is no PCB concentration data.

Table 4. Fish Species Distribution for Hudson River[a]

Species	Percent Meals Eaten
American Eel	0.9
Bass	58.2
Bullhead	9.7
Walleye	7.5
White Perch	4.5
Bluegill	2.7
Rock bass	2.7
Pumpkinseed	2.7
Black Crappie	2.7
Northern Pike	2.7
Chain Pickerel	2.7
Yellow Perch	2.7

a. Based on Connelly et al. (1992) and NYSDEC (1990).

4.0 CONCLUSIONS

Surveys conducted by NYSDEC (1990) and Connelly et al. (1992) to characterize the fishing behavior of New York State anglers clearly indicate that contrary to statements made by EPA (1991) in the Phase I Reassessment, fisherman do not eat all fish in equal amounts. Instead, anglers preferentially select for species in both catch and consumption. Sampling data collected to characterize PCB levels in fish also indicate that all fish do not contain the similar PCB levels. Therefore, the intake of PCBs is highly dependent on the species selected, and an accurate estimate of the risks to anglers from fish consumption should include species preferences.

The most appropriate method to incorporate the species selection of anglers is through the use of a probabilistic exposure assessment using synthetic life history or Microexposure Monte Carlo analysis. This type of analysis can account for species selection as well as the variations in PCB levels between fish species. Specifically, a Microexposure Monte Carlo analysis can identify a fish species and an associated PCB level, for each meal, based on the percent consumption identified in Connelly et al. (1992).

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