



000094

PUBLIC COMMENT
ENDS OCT 27

Housatonic River Area PCB Exposure Assessment Study

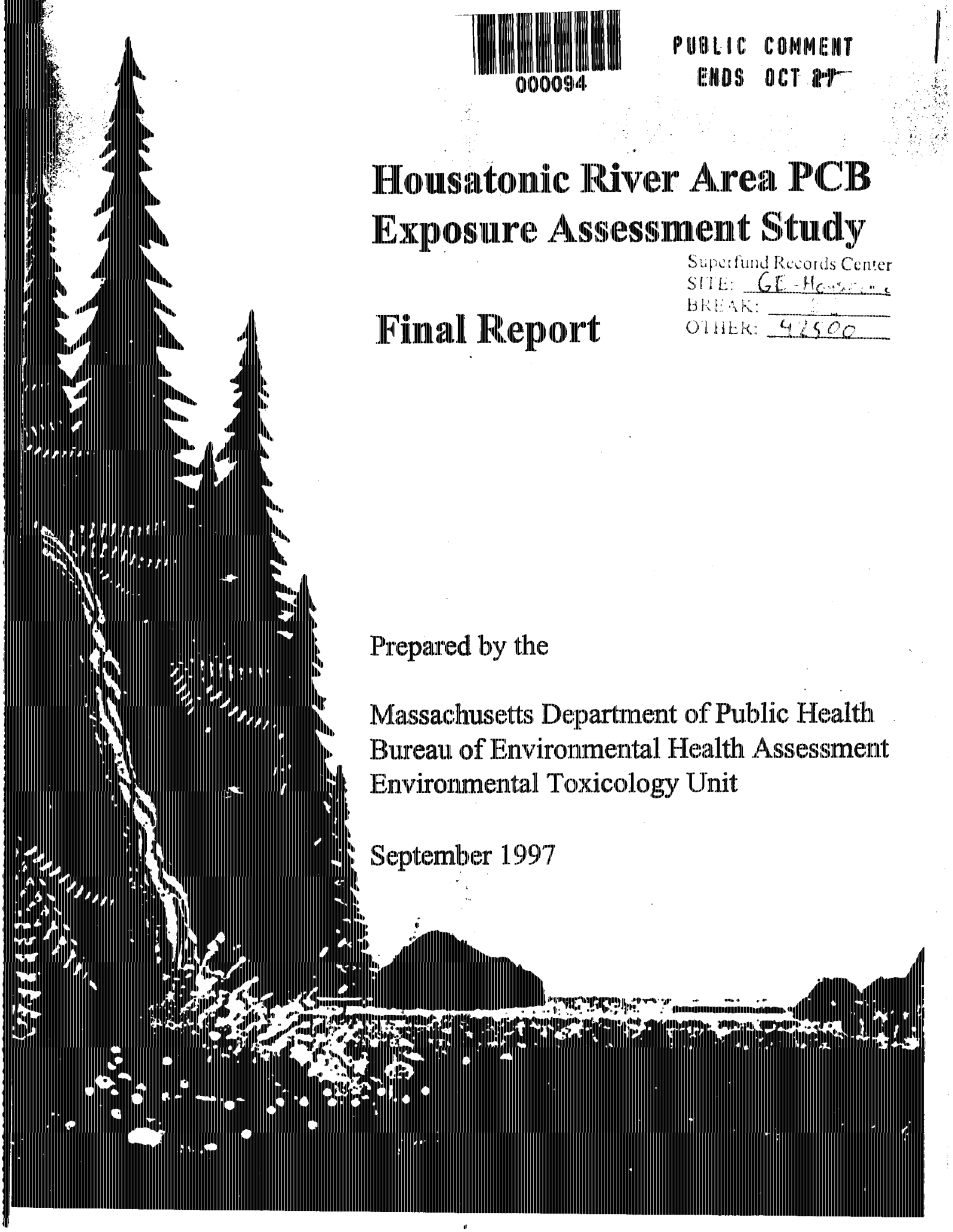
Final Report

Superfund Records Center
SITE: GE-Housatonic
BREAK: _____
OTHER: 42500

Prepared by the

Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Environmental Toxicology Unit

September 1997



Final Report
of
The Housatonic River Area
PCB Exposure Assessment Study

Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Environmental Toxicology Unit

250 Washington Street
Boston, Massachusetts

September, 1997

This report was supported in part by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) trust fund provided to the Massachusetts Department of Public Health from the Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services. Additional support was provided by the Massachusetts Department of Environmental Protection through an Interagency Service Agreement.

ACKNOWLEDGEMENTS

The Massachusetts Department of Public Health gratefully acknowledges the participation and support from the residents of Lanesborough, Dalton, Pittsfield, Lee, Lenox, Stockbridge, Great Barrington, and Sheffield. Local Boards of Health or Health Departments, Town or City Clerks, and citizens' groups in these communities provided support and help for this project. We want also to extend our thanks to the Housatonic River Initiative and its Steering Committee members and members of the Housatonic River Advisory Committee for Health Studies for their support.

The funding for this project was provided by the Massachusetts Department of Public Health, the Massachusetts Department of Environmental Protection and the Agency for Toxic Substances and Disease Registry of the U.S. Department of Health and Human Services.

CONTENTS

LIST OF TABLES	v
LIST OF FIGURES	vi
LIST OF APPENDICES	vii
ABSTRACT.....	1
INTRODUCTION.....	3
BACKGROUND.....	3
ENVIRONMENTAL CONTAMINATION	4
Sediment.....	4
Floodplain Soil	4
Freshwater Fish	5
Aquatic Plants.....	5
Ambient Air.....	6
EXPOSURE OPPORTUNITIES FOR LOCAL RESIDENTS	6
COMMUNITY HEALTH CONCERNS/INVOLVEMENT	7
METHODS	8
STUDY DESIGN	8
STUDY POPULATION	8
SAMPLE SELECTION.....	9
SURVEY INSTRUMENT DEVELOPMENT	9
RECRUITMENT OF SUBJECTS	10
SCORING SCENARIO USED TO SELECT INDIVIDUALS FOR BLOOD TESTING	12
PHLEBOTOMY	13
LABORATORY ANALYSIS.....	14
Specimen Collection & Shipping	14
Serum PCB Analysis	14
DATA MANAGEMENT	14
DATA ANALYSIS.....	15
QUALITY ASSURANCE & QUALITY CONTROL.....	15
RESULTS	16
EXPOSURE PREVALENCE STUDY - PART ONE: HOUSEHOLD INTERVIEWS.....	16
Response Rate and Background Characteristics.....	16
Fish Consumption.....	17

Recreational Activities along the Housatonic River and its Floodplain18

Other Exposure Opportunities19

EXPOSURE PREVALENCE STUDY - PART TWO: BIOLOGICAL SAMPLING19

 Participation Rate and Background Characteristics19

 Total Serum PCB Concentration20

 Correlation of Total Serum PCB and Study Variables20

VOLUNTEER STUDY - PART ONE: HOUSEHOLD INTERVIEWS22

 Background Characteristics22

 Fish Consumption22

 Recreational Activities along the Housatonic River and its Floodplain23

 Other Exposure Opportunities23

VOLUNTEER STUDY - PART TWO: BIOLOGICAL SAMPLING23

 Participation Rate and Background Characteristics23

 Total Serum PCB Concentration24

 Correlation of Total Serum PCB and Study Variables24

DISCUSSION26

 HOUSEHOLD INTERVIEW26

 BIOLOGICAL SAMPLING27

 ADDITIONAL CONSIDERATIONS28

LIMITATIONS30

CONCLUSIONS31

RECOMMENDATIONS32

BIBLIOGRAPHY33

TABLES36

FIGURES61

APPENDICES76

6

LIST OF TABLES

Table 1. Points Assigned to Each Category of the Household Screening Questionnaire.....	37
Table 2. Comparison of Participants and Non-participants of Household Screening Survey - Exposure Prevalence Study.....	38
Table 3. Age, Sex, and Region Distribution of Household Screening Survey Participants - Exposure Prevalence Study.....	39
Table 4. Percentages of Residents who Reported Eating Freshwater Fish in General - Exposure Prevalence Study.....	40
Table 5. Fish Consumption - Exposure Prevalence Study.....	41
Table 6. Percentages of Residents who Reported Fishing in the Housatonic River - Exposure Prevalence Study.....	42
Table 7. Percentages of Residents who Reported Canoeing in the Housatonic River - Exposure Prevalence Study.....	43
Table 8. Percentages of Residents who Reported Birdwatching on or next to the Housatonic River - Exposure Prevalence Study.....	44
Table 9. Percentages of Residents who Reported Doing Other Recreational Activities on or next to the Housatonic River - Exposure Prevalence Study.....	45
Table 10. Percentages of Residents who Reported Eating Fiddlehead Ferns from the Housatonic River Area - Exposure Prevalence Study.....	46
Table 11. Percentages of Residents who Reported Hunting in the Housatonic River Area - Exposure Prevalence Study.....	47
Table 12. Percentages of Residents who Reported Doing Vegetable Garden at their Current Residence - Exposure Prevalence Study.....	48
Table 13. Percentages of Residents who Reported Doing Other Yard Work at their Current Residence - Exposure Prevalence Study.....	49
Table 14. Participation for Blood Work - Exposure Prevalence Study.....	50
Table 15. Comparison of Participants and Non-participants of Blood Work - Exposure Prevalence Study.....	51
Table 16. Serum PCB Levels (ppb) by Age, Sex, and Region - Exposure Prevalence Study.....	52
Table 17. Serum PCB Levels (ppb) by Different Environmental Exposure Categories - Exposure Prevalence Study.....	53
Table 18. Age, Sex, and Region Distribution of the Participants in the Household Interview Part of the Volunteer Study.....	54
Table 19. Percentages of Residents Who Reported Activities on or next to Housatonic River and its Floodplain - Volunteer Study.....	55
Table 20. Fish Consumption - Volunteer Study.....	56
Table 21. Comparison of Participants and Non-participants of Blood Work - Volunteer Study.....	57
Table 22. Serum PCB Levels (ppb) by Age, Sex, and Region - Volunteer Study.....	58
Table 23. Serum PCB Levels (ppb) by Different Environmental Exposure Categories - Volunteer Study.....	59
Table 24. Validity Analysis of the Household Screening Survey as Compared with the Personal Interview - Exposure Prevalence Study.....	60

LIST OF FIGURES

Figure 1. The Housatonic River Area.....62

Figure 2. Population and Sample Estimates - Exposure Prevalence Study.....63

Figure 3. Household Screening Survey Flowchart - Exposure Prevalence Study.....64

Figure 4. Response to Household Screening Survey - Exposure Prevalence Study.....65

Figure 5. Proportion of Local Residents Who Reported Eating Fresh Water Fish.....66

Figure 6. Reported Purposes of Fishing in the Housatonic River, Berkshire County, Massachusetts. 67

Figure 7. Distribution of Serum PCB Levels - Exposure Prevalence Study.....68

Figure 8. Distribution of Serum PCB Level with Occupational Status and Age - Exposure Prevalence Study.....69

Figure 9. Distribution of Serum PCB Level with Consumption of Freshwater Fish and Age - Exposure Prevalence Study.....70

Figure 10. Distribution of Serum PCB Levels - Volunteer Study.....71

Figure 11. Distribution of Serum PCB Level with Occupational Status and Age - Volunteer Study...72

Figure 12. Distribution of Serum PCB Level with Consumption of Freshwater Fish and Age - Volunteer Study.....73

Figure 13. Distribution of Serum PCB Level with Scores - Exposure Prevalence Study.....74

Figure 14. Distribution of Serum PCB Level with Scores - Volunteer Study.....75

LIST OF APPENDICES

- Appendix A Household Screening Questionnaire
- Appendix B Refusal Questionnaire
- Appendix C Letter to Randomly Selected Households
- Appendix D Public Service Announcement (PSA) for Exposure Prevalence Study
- Appendix E Public Service Announcement (PSA) for Volunteer Study
- Appendix F Letter to Prospective Volunteers
- Appendix G Letter to Selected Individuals for Blood Testing
- Appendix H Questionnaire Used during Blood Testing
- Appendix I Consent Form
- Appendix J Specimen Collection and Shipping Protocol
- Appendix K Analytical Protocol for the Quantification of Polychlorinated Biphenyls in Human Serum
- Appendix L List of Variables used in Epi Info Data File for Household Screening Survey
- Appendix M List of Variables used in Epi Info File for Data from Blood Testing Questionnaire

ABSTRACT

The Housatonic River and nearby localized areas are known to be contaminated with polychlorinated biphenyls (PCBs) from a former electrical manufacturing facility in Pittsfield, Massachusetts. Extensive environmental sampling has documented widespread contamination of sediments, floodplain soil, fish and other biota. However, the extent and nature of PCB exposure opportunities among residents of the Housatonic River Area (HRA) had not been completely characterized. This exposure assessment study was undertaken by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) to address these concerns. The area on which the study focused comprises eight communities in Berkshire County, Massachusetts: Lanesborough, Dalton, Pittsfield, Lee, Lenox, Stockbridge, Great Barrington, and Sheffield.

The overall goal of the HRA PCB Exposure Assessment Study was to identify possible patterns of PCB exposure and to measure serum PCB levels among HRA residents. The specific objectives of this study were: 1) to identify patterns of different activities offering a potential for exposure to PCBs - this was done by means of a household screening questionnaire administered to residents of 800 randomly selected households located within a half mile of the Housatonic River between Pittsfield and the Connecticut border; 2) to assess the relationship between reported potential exposure pathways and serum PCB levels among residents determined to be at the greatest risk of exposure. This is referred to as the Exposure Prevalence Study. As a public service, the same household screening questionnaire and serum tests were also offered to a volunteer group of residents of South Berkshire County communities, regardless of their household location relative to the river. The responses of this group were also analyzed for reported potential exposure pathways and serum PCB levels.

A total of 658 households (response rate: 84%, representing 1529 individuals) participated in the Exposure Prevalence Study. Out of these 1529 individuals, 120 were selected based on an exposure risk scoring system and invited to take part in blood testing for PCBs, and 69 (57.5%) agreed to submit to a blood test. A total of 65 households (representing 158 individuals) participated in the Volunteer Study. All individuals 18 years old or over (126) were invited to take part in blood testing for PCBs, and 79 (62.7%) participated.

In the Exposure Prevalence Study, over one-third of the participants had eaten freshwater fish for an average of 25 years. About three percent had eaten fish from the Housatonic River for an

average of 20 years. A considerable number of local residents participated in a variety of recreational activities on or adjacent to the Housatonic River and its floodplain. Similar results were found in the Volunteer Study.

Of the 69 participants in the Exposure Prevalence Study, one (1.4%) had a serum PCB level over 20 ppb. The mean and median levels of this group were 5.44 ppb and 3.93 ppb respectively. Five out of the 79 participants (6.3%) in the Volunteer Study had serum PCB levels over 20 ppb. The mean and median of this group were 9.07 ppb and 6.60 ppb. The serum PCB levels found among participants of both studies were generally within typical background estimates for a non-occupationally exposed U.S. population. ATSDR reports that, for U.S. populations without occupational exposure, mean serum PCB levels were usually between 4 and 8 ppb, with 95% of the individuals having concentrations less than 20 ppb. Since the results of this study represented individuals with the highest risk of exposure, it is reasonable to assume that serum PCB levels of most non-occupationally exposed residents in the HRA communities are within the US background range, though individual differences may likely occur.

As observed in a number of studies previously conducted by MDPH and others, age was found to be the prominent predictor of serum PCB level in general. Considering all the potential exposure pathways examined, serum PCB levels tend to be higher in older people who are frequent and/or long-term fish-eaters. In addition there is some indication that other activities (e.g. fiddlehead fern consumption, gardening) may contribute slightly to serum PCB levels. People who reported opportunities for occupational exposure had higher serum PCB levels than those who did not report these opportunities.

INTRODUCTION

Polychlorinated biphenyls (PCBs) are a group of synthetic organic compounds that were once widely used as liquid coolants and insulators in industrial (e.g. electrical) equipment. In addition, PCBs were used throughout the U.S. in plasticizers, surface coatings, inks, adhesives, pesticide extenders, etc. There are a total of 209 possible individual compounds (known as congeners) with varying harmful effects. PCBs were used in the manufacture of electrical and associated products in Pittsfield, Massachusetts from 1932 to 1972. They reached the Housatonic River in large quantities both from direct discharges and indirect discharges through the ground water (MDEP 1995).

The Housatonic River Area (HRA) comprises eight communities in Berkshire County, Massachusetts: Lanesborough, Dalton, Pittsfield, Lee, Lenox, Stockbridge, Great Barrington, and Sheffield (Figure 1). During 1993, officials from the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA), met with concerned citizens and local health and elected officials in the HRA to discuss their health concerns related to the PCB contamination of the HRA. Subsequently, MDPH BEHA, under its cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR), released a Health Consultation on PCB exposure among residents of the HRA. MDPH recommended that an exposure assessment study should be conducted. The data and information evaluated in the Health Consultation were reviewed by ATSDR's Health Activities Recommendation Panel (HARP), and the panel agreed that testing designed to measure PCBs as a marker of exposure in human sera should be conducted. MDPH subsequently launched its Housatonic River Area PCB Exposure Assessment Study. Partial funding for this study was also provided through an interagency service agreement with the Massachusetts Department of Environmental Protection (MDEP).

BACKGROUND

PCBs were first discovered in sediment and fish from the Housatonic River in the 1970s (Blasland & Bouck Engineers, 1991). In 1982, MDPH issued the state's first freshwater fish consumption advisory for the Housatonic River due to PCBs. The advisory warned individuals against eating fish, turtles, or frogs from the Housatonic River downstream of Dalton. The Department also recommended that fish taken from feeder streams to the Housatonic River should be trimmed of fatty tissue prior to cooking.

ENVIRONMENTAL CONTAMINATION

During the 1980s and 1990s, environmental samples were collected through MDEP actions from the Housatonic River and its floodplain to determine the extent of contamination in the HRA. These samples included sediments, floodplain soil, ambient air, fish and other biota. This sampling remains on-going.

SEDIMENT

Initial sediment samples from 62 miles of the Housatonic River (from Dalton to the Connecticut state border) were collected in 1981. Subsequent sampling concluded that the most heavily contaminated area was between New Lenox Road and Woods Pond, a four-mile stretch of the river (MDEP 1995).

Since then, continued sampling has been done to determine the extent of contamination. In May 1997, the Massachusetts Department of Environmental Protection (MDEP) Western Regional Office (WRO) summarized surficial sediment (0 to 0.5 inch in depth) sampling data as follows (in dry-weight parts per million or ppm, certain area excluded, arithmetic average concentrations shown):

- the former General Electric manufacturing facility in Pittsfield to Holmes Road: 20 ppm (n=64, range: 0.16 - 266 ppm),
- Holmes Road to New Lenox Road: 20 ppm (n=24, range: 4.1 - 89 ppm),
- New Lenox Road to Woods Pond Headwaters: 30 ppm (n=13, range: 0.16 - 220 ppm),
- Woods Pond: 15 ppm (n=5, range: 3.3 - 27 ppm),
- Rising Pond: 3.1 ppm (n=2, range: 0.24 - 6.0 ppm).

Sediment concentrations in Silver Lake (all depths) were as high as 20,689 ppm, with an average of 407 ppm (MDEP 1997). In May 1996, surficial sediment samples (0 to 6 inches in depth) taken from the Housatonic River adjacent to the former General Electric facility in Pittsfield showed an average sediment PCB concentration of 1,550 ppm with a maximum of 54,000 ppm (MDEP 1997).

FLOODPLAIN SOIL

In 1992, 78 surface soil samples (0-6 inches in depth) were collected and analyzed from properties within the approximate 10-year floodplain of the Housatonic River between the former General Electric facility in Pittsfield and the Woods Pond Dam. Five percent of the samples had PCB concentrations between 50 and 100 ppm, 45 percent had PCB concentrations between 10 and 50 ppm, and 50 percent had soil PCB concentrations below 10 ppm. Of the 78 samples analyzed, five contained Aroclor 1254 and Aroclor 1260, and the other 73 contained only Aroclor 1260 (Blasland,

Bouck, & Lee 1992). In May 1997, the MDEP, WRO summarized floodplain soil sampling data as follows (from all depth by reach, average concentrations shown):

- Former General Electric facility in Pittsfield to Holmes Road: 12 ppm (n=270, range: non-detectable to 110 ppm),
- Holmes Road to New Lenox Road: 22 ppm (n=245, range: non-detectable to 230 ppm),
- New Lenox Road to Woods Pond Headwaters: 22 ppm (n=231, range: non-detectable to 430 ppm),
- Woods Pond: 2.4 ppm (n=150, range: non-detectable to 22 ppm),
- Rising Pond: 0.5 ppm (n=91, range: non-detectable to 3.1 ppm).

PCB levels in floodplain soil from Pittsfield and Lenox were higher than the ones from the rest of the HRA communities. In March 1996, riverbank surface soil samples taken in an area adjacent to the former General Electric manufacturing facility in Pittsfield showed an average PCB level of 7,550 ppm, with a maximum of 102,000 ppm (MDEP 1997).

FRESHWATER FISH

In 1982, over 400 fish samples were collected by the Stewart Laboratories from a 70-mile stretch of the Housatonic River with eight sampling locations from the headwaters to the Massachusetts and Connecticut state line. PCB concentrations as high as 260 ppm were detected in the fish; the U.S. Food and Drug Administration action level for PCBs in fish at that time was 5 ppm and is now 2 ppm. Fish concentrations in the section of the river down to the Massachusetts and Connecticut state line had elevated concentrations as well, with the maximum concentration (9.2 ppm) found in largemouth bass. In 1990, additional fish toxins data generated by the Interim Phase II investigation indicated that PCB levels in fish were still significantly elevated (MDPH 1994). Further testing conducted in 1994 and 1996 showed continued elevations in PCB levels in adult fish and Young-of-the-Year fish (i.e., any fish prior to their first fall/winter) from the Housatonic River (MDEP 1997).

A snapping turtle and bullfrogs were also collected in 1982 from Woods Pond. A single composite of 12 frogs had a total wet tissue PCB concentration of 4.4 ppm, and the snapping turtle had a total wet tissue PCB concentration of 2.1 ppm. (MDEP 1995).

AQUATIC PLANTS

Samples of aquatic plant species (duck potato, water milfoil, and lesser duckweed) were also collected from numerous areas along the Housatonic River (MDEP 1994). Detectable dry weight

total PCB concentrations in duck potato ranged from 0.20 ppm in sediment containing 2.1 ppm total PCBs, to 0.84 ppm in sediment containing 7.0 ppm total PCBs. Dry weight total PCB concentrations in milfoil and duck weed ranged from 0.93 ppm in sediment containing 130 ppm total PCBs, to 3.9 ppm in sediments containing 151 ppm total PCBs.

AMBIENT AIR

Ambient air samples were collected from August 1991 to August 1992, at six air monitoring stations located on industrial property of the former General Electric electrical manufacturing facility in Pittsfield (MDEP 1995). The average yearly PCB level found there was 6 ng/m³ with the highest of 30 ng/m³. Additional sampling was done in 1993. The high volume samples with the highest PCB concentrations were found at Silver Lake (23 ng/m³) and the Newell Street Rear location (35 ng/m³). The low volume samples with the highest PCB concentrations were found at the same locations, 350 ng/m³ at Silver Lake and 142 ng/m³ at the Newell Street. Between May 1995 and August 1995, air monitoring was conducted at four locations: Silver Lake, Woods Pond, along the Housatonic River at Fred Garner Park and at a background location at Berkshire Community College. High Volume Samples were collected at all four locations, with the highest level of 36 ng/m³ found in the sample collected at Silver Lake at. Overall, ambient air PCB levels were higher during the summer months, and very low, often non-detectable, in the winter months.

EXPOSURE OPPORTUNITIES FOR LOCAL RESIDENTS

Based on historical industrial information, on the environmental data that have been collected, and on the persistence of PCBs in the environment, residents in the HRA have had the opportunity for exposure to PCBs since at least the 1940s. Possible ways that exposure to PCBs could have occurred include residential/recreational activities in the HRA, and consumption of PCB-contaminated fish or of other biota (e.g., waterfowl, fiddlehead ferns) from the Housatonic River. Specifically, exposure to PCBs may occur through incidental ingestion of, or dermal contact with, contaminated soil; through ingestion of garden vegetables grown in PCB-contaminated soil in the river's floodplain or elsewhere; or through consumption of other animals hunted for food. In addition, residents living along the Housatonic River may have been exposed to PCBs through contaminated groundwater that may have flooded basements. Finally, employment in the electronics industry and construction work along the floodplain are other potential ways for exposure to PCBs.

COMMUNITY HEALTH CONCERNS/INVOLVEMENT

The communities in the HRA have long expressed concerns about the extent of contamination in groundwater, surface water, sediment, and floodplain soil of the river and its tributaries, and about activities (recreational or other) related to the Housatonic River and its floodplain. Many residents from this area asked MDPH to analyze their blood for PCBs (MDEP 1995). Various citizens' groups have voiced health concerns and advocated for accelerating cleanup activities. A number of citizens participated in the decision-making process concerning remedial alternatives.

In the fall of 1993, MDPH announced its intention to conduct an exposure assessment study at a public meeting held at the Tri-town Health Department in Lee. Subsequently, funding was obtained, staff hired, and a research protocol developed. In October 1994, MDPH presented the research protocol of this study at a well-attended public meeting at the Italian-American Club in Pittsfield. MDPH established a public comment period for the research protocol that extended through November 1994. MDPH also had the Housatonic River Initiative (HRI, a citizens' advocacy group) and MDEP review and comment on the research protocol and survey instrument in order to ensure that MDPH would cover all important potential exposure pathways. In June 1995, MDPH formerly initiated health studies and formed the Housatonic River Area Advisory Committee for Health Studies. The committee comprised local citizens, epidemiologists, toxicologists, representatives from the offices of elected officials and local health departments. MDPH staff held periodic meetings (most recently in November 1996) with the committee members to report status and get feedback on the conduct of this study as well as other studies being conducted in this area of Western Massachusetts. In addition, MDPH has been conducting ongoing outreach with the local health community to inform them of the study and its objectives. For example, MDPH staff held Grand Rounds in 1993 and 1996 at the Berkshire Medical Center (BMC) to disseminate information about this study.

METHODS

The overall goal of the PCB exposure assessment study was to identify possible patterns of PCB exposure and to measure serum PCB levels among residents of the HRA. The specific research objectives were as follows:

- To identify patterns of different activities offering a potential for exposure to PCBs;
- To measure PCB body burden among residents of the HRA, and to assess the relationship between potential exposure pathways and serum PCB levels among those residents considered to be at the greatest risk of exposure.

STUDY DESIGN

Numerous discussions were held as to which approach would be most appropriate to address environmental and health concerns in the HRA communities. MDPH, BEHA concluded that the most appropriate approach would be to focus primarily on the evaluation of a randomly selected sample of HRA households in order to systematically and scientifically assess opportunities for PCB exposure (Exposure Prevalence Study); and, in addition, to examine supplementary information from a sample of volunteers in order to address the concerns of individuals who were not included in the randomly selected exposure prevalence group. Each study component (i.e. the Exposure Prevalence Study and the Volunteer Study) was comprised of two parts. The first part involved administering a household screening survey that could identify patterns of potential exposure by different pathways; and the second was to select individuals determined to be at the greatest risk of exposure to be offered blood tests for PCB analysis.

STUDY POPULATION

For the Exposure Prevalence Study, an approach which is commonly used in this type of study was adopted to define the study area and population. Starting at Lanesborough and Dalton, and going south through Pittsfield, Lenox, Lee, Stockbridge, Great Barrington, Sheffield to the Massachusetts and Connecticut border, the study area for the Exposure Prevalence Study was defined as a half-mile radius from the Housatonic River. Included in this area are the 10-year floodplain and most of MDEP's priority disposal sites under M.G.L. c. 21E. Many of these 21E sites involved PCBs as an important contaminant of concern. Through this information, MDPH would be able to assess opportunities for exposure through contact with contaminated river sediments, floodplain soil, and biota.

The study population included the residents of HRA who were living within a half mile of the Housatonic River at the time of administration of the MDPH survey. A geographic information system, MAPINFO, was used to identify the streets and street numbers that fell within the defined study area. Those streets and street numbers were then matched to the most current town lists from each of the eight communities to identify the study population.

SAMPLE SELECTION

A stratified systematic cluster sampling scheme was used to select households for the Exposure Prevalence Study. According to 1990 census data, Pittsfield alone had more than two-thirds of the total population in the HRA. Residents in Pittsfield, a relatively urban community, were thought to have different outdoor activity patterns (e.g., residential and recreational activities, frequency of gardening) than would residents in the other HRA communities, which are rural. Thus, an equal number of sampling units (in this case, households) was drawn from two strata: Pittsfield and the rest of the HRA communities (Levy et al 1991). In this way, the sample drawn would better represent the total population of the HRA than would a proportional sample (whereby the same percentage of households would be selected for each town, thus heavily weighting the results to reflect the experience of Pittsfield households). A random start was placed on each of two alphabetically arranged lists, one from Pittsfield and one from the rest of the HRA communities, for sample selection. Since an MDPH exposure assessment survey has been previously demonstrated to be the most efficient survey strategy for reaching the greatest number of individuals, this technique was used to efficiently identify potential PCB exposure pathways for study participants.

Figure 2 summarizes the population and sample estimates for the Exposure Prevalence Study. The study area contained nearly 13,000 households, about 39 percent of the total households in the HRA communities. Over 8,600 households were in Pittsfield alone. A random sample of 800 households, 400 each from Pittsfield and from the rest of the HRA communities, was selected for administration of the screening survey.

SURVEY INSTRUMENT DEVELOPMENT

The household screening questionnaire (used for both the Exposure Prevalence Study and Volunteer Study) included questions on sociodemographic characteristics, residential history, freshwater fish consumption patterns, occupational history, and recreational activities on or next to the Housatonic River and its floodplain (Appendix A). The following sources were used to develop the household screening questionnaire:

- MDPH's prior experience with PCB exposure assessments (e.g., MDPH 1984, 1987, Miller et al 1991);
- review of recent literature;
- review of environmental sampling data for the HRA;
- feedback from the community, citizens groups, local and state agencies, and other experts.

Once finalized, the screening questionnaire was pre-tested by MDPH staff. The time needed to complete the questionnaire was generally about 15-20 minutes. MDPH staff also designed a refusal questionnaire (Appendix B) to get information on households that refused to participate in the survey. This information included basic demographic characteristics (e.g., age, sex) and opportunities for environmental PCB exposure in a highly abbreviated format.

RECRUITMENT OF SUBJECTS

Figure 3 shows the procedure used by MDPH to recruit study subjects for the Exposure Prevalence Study. An introductory letter (Appendix C) was sent to selected households about one week before MDPH staff began contacting them. In addition, a public service announcement (PSA) for the study was placed in local media outlets (Appendix D) with the help of the HRI. The screening questionnaire was administered by telephone or by visiting the selected households. Home visits were necessary for households that did not have telephones, or whose telephone numbers were unlisted or disconnected. In general, MDPH asked for the female head of household to answer the questionnaire; if the female head of household was not available, MDPH asked whether anyone else in the household could answer questions for all household members. Before designating a household as "non-respondent," at least six attempts were made to contact it by telephone. For those households interviewed in home visits, at least three attempts were made to contact them. For the telephone interviews, at least one attempt was made in each of the following time periods: one weekend day and, on weekdays, 9 AM-12 noon, 12 noon to 5 PM, and 5 PM to 8 PM. For the home visits, at least one attempt was made in each of the following periods: one weekend day, one morning, and one afternoon. Most of the household screening interviews for the Exposure Prevalence Study were completed between February and May 1995. As part of an effort to improve the Exposure Prevalence Study (i.e., the "Enhancement" effort), MDPH continued its intensive drive to reach non-responding households by conducting repeated calls, letters, and home visits throughout the HRA from August 1995 to early October 1995.

Once the data collection for the Exposure Prevalence Study, including recruitment of randomly selected households and blood drawing from selected residents, was completed (December 1995), the Volunteer Study began by making screening questionnaire available to all HRA residents who were not selected in the Exposure Prevalence Study. To publicize the survey and encourage participation, MDPH, with assistance from HRI, did the following:

- Local radio stations and newspapers were contacted and they voluntarily aired or printed a PSA for the Volunteer Study (Appendix E); an informational article about this study was also published in one of the most popular local newspapers to further publicize MDPH's willingness to offer opportunities for all HRA residents to participate in the Volunteer Study.
- A letter notifying potential participants of this opportunity (Appendix F) was mailed to residents who were listed on two extensive mailing lists that were obtained through MDEP. These two lists have been maintained by the General Electric facility in Pittsfield as part of its responsibilities under the MDEP's public involvement plan for the Housatonic River and the industrial disposal sites in Pittsfield. Residents on these two lists who had already participated in the Exposure Prevalence Study were excluded from the mailing.
- In the MDPH Boston office, an 800 toll-free telephone number was set up as the "Information Hot Line" to announce the locations, dates and times of the volunteer questionnaire administration and was accessible 24 hours a day, 7 days a week during the actual time period of the survey.

MDPH staff administered the household screening questionnaire at three locations: Great Barrington Senior Center, the Tri-town Health Department in Lee, and the Berkshire Athenaeum in Pittsfield. At each of these three locations, questionnaires were administered on three consecutive days, including evening and weekend hours. Individual volunteers answered questions for themselves and their family members. When someone was unable to answer questions for their family members, MDPH followed up by contacting the individuals or their family members to complete the interviews. Most of the household screening questionnaires of the Volunteer Study were administered during March and April 1996. In late April, to increase the number of volunteer participants and following suggestions after a meeting with the Housatonic River Advisory Committee for Health Studies, MDPH placed another PSA in two commercial papers to publicize additional opportunities to complete the survey. Lastly, a two-week period in May 1996 was made available for interested

volunteers to call MDPH at a toll-free number and answer the household screening questionnaire over the phone.

SCORING SCENARIO USED TO SELECT INDIVIDUALS FOR BLOOD TESTING

The MDPH used a scoring system to identify the individuals who had the greatest opportunity for exposure to PCBs. The scoring system was based on MDPH's past experience with PCB exposure surveys (e.g., MDPH 1984, 1987, Miller 1991). In brief, the screening system uses established risk factors previously investigated (e.g., age, fish consumption, etc.) and is given additional weight as frequency and duration of various activities increase. Because this survey was primarily designed to capture individuals with opportunities for exposure from environmental and recreational activities, occupational opportunities for exposure were recorded but were not scored.

Table 1 shows the specific number of points assigned to various exposure categories. The maximum number of possible points was 464. The criteria and rationale for assigning points were as follows:

- More points were assigned as the participant's age increased. Age is an important predictor of serum PCB levels (MDPH 1987, Miller et al, 1991).
- More points were assigned as the length of residence in the HRA increased.
- Under fish consumption, points were assigned for three subcategories:
 1. increasing points for the frequency of consuming freshwater fish
 2. increasing points for greater numbers of years consuming freshwater fish
 3. points for consuming freshwater fish from the Housatonic River
- Points were given for both farming and construction activities where the participants reported contact with the Housatonic River. Increasing points were assigned as the number of years performing these activities increased. In addition, more points were assigned if the activities occurred in Pittsfield or Lenox, areas with documented PCB contaminated soil.
- Recreational activities associated with the river (e.g., canoeing, birdwatching, dirt biking, or jogging/walking) and a category of "other yard work" were scored with fewer points than the previous categories because the potential for exposure is expected to be lower due to the low contact with, or intake of, contaminated media.

- Because fiddlehead ferns located along the Housatonic River may be contaminated with PCBs, increasing points were assigned as the frequency and duration of fern consumption increased.
- Vegetable gardening involves contact with soil; hence, more points were assigned for this activity than for the recreational activities along the river described above. In addition, the points were doubled if the participant lived in Lenox or Pittsfield, since environmental sampling data demonstrated that PCB levels in floodplain soil from these two towns were higher than in other HRA towns.
- Participants who reported frequent consumption of food that they had hunted were given points only if the hunted food was in the category of "birds." It is not expected that other hunted animals (e.g., deer) would have bioaccumulated significant levels of PCBs due to their mostly vegetarian or insectivorous diet. The category of birds likely included waterfowl that may have derived at least some food (e.g., fish) from the Housatonic River and had a higher fat content (PCBs accumulate in fat tissue) (Kim 1985). Thus, PCBs could have bioaccumulated in these waterfowl.

All individuals included in the Exposure Prevalence Study were assigned a score that was used to select our target population of 100 participants with the highest scores for blood testing. MDPH also aimed to enroll 100 participants from the volunteer sample.

PHLEBOTOMY

MDPH notified all residents determined to be at the greatest risk of exposure with a letter asking for their participation in the second part of this study (Appendix G). MDPH staff then called within a week to schedule appointments for blood tests. Participants were asked to fast for 12 hours before the blood draw. Most of the blood drawing and all the sample processing was conducted through a contract with Berkshire Medical Center (BMC) in Pittsfield. The MDPH also provided home phlebotomy service for individuals who found it inconvenient to go to BMC, and who preferred MDPH/BMC staff to visit their homes to draw the sample. Before each draw, participants were given a short questionnaire (Appendix H) by MDPH staff to verify selected information obtained from the screening survey and to gather additional information (e.g., dietary intake over the last 24 hours). They were also asked to read and sign a consent form (Appendix I). After the draw, the samples were processed and delivered to the MDPH State Laboratory Institute (SLI) in Jamaica Plain for analysis.

23

LABORATORY ANALYSIS

SPECIMEN COLLECTION & SHIPPING

Staff from the MDPH SLI trained BMC personnel in sample collection, handling, and shipment with the MDPH Specimen Collection and Shipping Protocol (Appendix J). Prior to actual blood drawing of participants, BMC staff conducted a pilot test to ensure that the MDPH protocol was implemented correctly and that no contamination would occur during sample processing.

Blood samples were collected from study participants for PCB analysis. Forty-five milliliters of blood were collected from each participant using three 15 ml red top (anticoagulant free) vacutainers. The tubes remained at room temperature for 30 minutes to facilitate clotting, and then were centrifuged to separate serum from red blood cells. The serum portion of each tube was then decanted into solvent-rinsed crimp-top vials and placed in the refrigerator for several hours to gently cool. The vials were then frozen at -4°C, remained frozen during shipment from BMC to SLI, and were kept frozen until analysis.

SERUM PCB ANALYSIS

PCBs were analyzed using a modification of a method developed by the United States Centers for Disease Control (CDC Laboratory Update 81-108) (Appendix K). Proteins present in the serum were precipitated with methanol and removed. PCBs in the serum were extracted with organic solvents, and extraneous contaminants in the extract were removed by adsorption chromatography. The extract was then identified and quantified by wide-bore open tubular gas chromatography (DB5) with electron capture detection (Perkin-Elmer Autosystem, Perkin-Elmer Sigma 2000). Chromatographic data were integrated using Turbochrom chromatographic software (Perkin-Elmer/Nelson). PCBs were quantified on the basis of 21 peak areas and reported as the Aroclor 1260, the sample chromatographic pattern most closely resembled.

DATA MANAGEMENT

The completed screening surveys were coded and contracted out for data entry and, for quality control purposes, double data-entry was performed. The information collected during blood drawing was coded and double-data-entered by MDPH staff. The electronic data files were read into DBASE III Plus files, which were then converted into Epi Info data files for analysis. The variables used in the Epi Info data files for household screening surveys and blood samples are included in Appendix L & Appendix M.

DATA ANALYSIS

Univariate analysis was conducted to examine the individual study variables. Since the sample of Exposure Prevalence Study was selected using the cluster sampling scheme, cluster sampling analysis was conducted. In the analysis, the household was used as the primary sampling unit (PSU) of which each household member was a part. The above analyses were carried out using Epi Info 6.02.

Stratified analysis was performed to assess the relationship between and among study variables. In addition, multiple regression analysis was applied to explore the relationship between serum PCB level and other study variables. In this case, some of the variables were transformed so as to best fit the regression analysis assumptions.

Since serum PCB levels do not usually follow a normal distribution, median levels were used for comparison of different groups. Arithmetic mean (hereafter, "mean") was also included so that our results can be compared with other published studies.

QUALITY ASSURANCE & QUALITY CONTROL

All the steps of data collection and analysis were carefully designed to eliminate any possible errors. An interviewer's manual was developed in order to ensure that the interviewers understood the background and objectives of the study. They were trained to familiarize themselves with the interviewing procedure and standardize the wording of questions. The field supervisor checked the completeness of the finished questionnaires, which were then coded and double-entered so as to minimize transcription errors. Logical checks of the completed databases added another quality control procedure to the process.

Internal quality control measures at SLI as well as external analysis were employed in the laboratory analysis of serum PCBs. For internal quality control at SLI, NIST standard reference material 1589 and goat serum from CDC containing 75 µg/L of the Aroclor were analyzed concurrently with study samples (Appendix K). After SLI finished all the lab analysis, a 10% subset of samples, selected from low, medium, and high range based on SLI serum PCB results, was sent out to the CDC laboratory for external quality control analysis.

RESULTS

EXPOSURE PREVALENCE STUDY - PART ONE: HOUSEHOLD INTERVIEWS

RESPONSE RATE AND BACKGROUND CHARACTERISTICS

Of the 800 households randomly selected, 617 households were contacted over the telephone and 183 did not have telephones, had unlisted telephone numbers, or had disconnected phone numbers. MDPH subsequently learned that 17 of the 183 households without readily available phone numbers were unoccupied at the time of contact (9 from Pittsfield; 8 from other HRA communities). Thus the final sample size was 783 households.

A total of 658 households (representing 1529 individuals) completed the screening questionnaire, which yielded a response rate of 84 percent (Figure 4). For some participants, bilingual interviews were arranged in Polish, Russian, and Korean.

Of the 125 households that did not participate, the occupants of four households were in nursing homes at the time of contact. Ninety-seven households refused to participate when contacted by MDPH staff. MDPH staff were unable to contact 14 households despite a minimum of six calls and usually more than 20 calls at different times of the day, including the weekend. At four households, MDPH staff left reply forms three times or more, at different times of the day, on both weekdays and weekends, but did not establish contact (Figure 4).

A Refusal Questionnaire was mailed to all the 125 households that did not participate. Twenty-nine households, or 23 percent, responded. Table 2 shows results of comparison of participants and refusers. These two groups were about similar with regard to the average size of the household, the mean and median age of the population, frequency of consuming freshwater fish from the Housatonic River, and rate of farming or construction works on or next to the Housatonic River. They were also similar with regard to recreational activities (e.g., canoeing, birdwatching) if only the activities on a regular basis (i.e., once a week or more) were counted.

For the 658 households or 1529 individuals enrolled in the screening survey (Table 3), 327 households or 743 individuals were from Pittsfield with 357 males, 386 females, and a median age of 38 years. The other 331 households or 786 individuals were from the remaining HRA communities. Sixty-one individuals (28 males, 33 females; median age 41 years) came from Lanesborough, 96 (42 males, 54 females; median age 41 years) from Lee, 38 (15 males, 23 females; median age 43 years) from Lenox, 87 (48 males, 39 females; median age 44 years) from Stockbridge, 166 (76 males, 90

females; median age 39 years) from Great Barrington, and 72 (36 males, 36 females; median age 40 years) from Sheffield.

FISH CONSUMPTION

Five hundred and twenty-seven residents, or 34 percent, had eaten freshwater fish (from any water body, not necessarily the Housatonic River). Similar percentages of respondents in Pittsfield versus the rest of the HRA reported eating freshwater fish.

The freshwater fish consumption rate differs with respect to age and sex (Table 4 & Figure 5). Older residents are more likely to eat fish than are younger residents: 17 percent of residents aged 19 and under, 36 percent of those aged 20 to 39, 44 percent of those aged 40 to 59, and 42 percent of those over 60 years old. This observation is true for both males and females. Males are more likely to eat freshwater fish than females (38% versus 32%). However, when controlled for age, the significant difference disappeared except in residents ages 20 to 39 from the HRA communities other than Pittsfield.

The most frequently consumed freshwater fish species were trout (85% of the fish eaters had eaten trout), bass (50%), and perch (50%), followed by bullhead (13%) and pickerel (9%). Regarding frequency of fish consumption during the season (usually from May through October), about one percent reported eating fish three times or more per week; 26 percent ate fish once or twice a week; 32 percent ate fish one to four times a month; and 42 percent ate fish less than once a month. Regarding the number of years of fish consumption, over half of the fish eaters had eaten fish for more than 20 years. The average number of years of consuming fish was 25. Seventy-five percent of fish eaters caught fish themselves or ate fish caught by family or friends (Table 5).

Fifty residents, or 10 percent, reported that they had at some point eaten fish from the Housatonic River. It is not known how many of them continue to eat fish from the Housatonic River. For those 52 individuals who reported eating fish from the Housatonic River at least once, the most frequently consumed fish species were trout, perch, and bass, followed by bullhead and pickerel. Other responses for these 52 individuals included the following:

- Eighteen (35%) reported eating fish from the Housatonic River at least once a week;
- Twenty-eight (54%) reported having eaten fish from the Housatonic River for at least 20 years;
- All but one reported catching and eating fish themselves or eating fish caught by family or friends.

RECREATIONAL ACTIVITIES ALONG THE HOUSATONIC RIVER AND ITS FLOODPLAIN

The survey results showed the following activity patterns among all the individuals enrolled in the first part of the Exposure Prevalence Study:

- **Fishing:** Twelve percent of the respondents (205/1529) had fished in the Housatonic River. Most of these people (66 %) did only catch-and-release fishing, and 28 percent ate the fish they caught from the Housatonic (Figure 6). No one reported catching fish for the purpose of selling them. There were no significant differences of self-reported fishing activity among different age groups (Table 6). However, male residents fished more in the Housatonic River than females. Among female residents under the age of 60, those residing in Pittsfield fished less in the Housatonic River than the ones from the rest of the HRA communities (2% versus 12%).
- **Canoeing:** One hundred seventy-nine respondents, or 11 percent, had canoed on the Housatonic River (Table 7). The self-reported rates of canoeing varied with age: 9%, 11%, 17%, 6% respectively for age groups 0-19, 20-39, 40-59, 60 and over. No significant gender difference was observed for this activity. Among male residents aged 20 to 39, those living in Pittsfield canoed less than those from the rest of the HRA communities (10% versus 28%).
- **Bird Watching:** Sixty-five respondents, or about 4 percent, reported birdwatching in the HRA (Table 8). The percentage of residents from Pittsfield who reported birdwatching was generally similar to that of the residents from the other HRA communities.
- **Other Recreational Activities (e.g., swimming, hiking, walking, jogging, river cleanup activities):** Two hundred thirty-five respondents, or 16 percent, had participated in this category of activities (Table 9). Overall, similar participation rates were observed among residents from Pittsfield and from the other HRA communities.
- **Eating Fiddlehead Ferns:** Seventy-five residents, or 5 percent, had eaten fiddlehead ferns from the HRA. No significant difference in consumption of fiddlehead ferns was observed with regard to age, gender or region (Pittsfield versus the other HRA communities) (Table 10).
- **Hunting:** Table 11 shows that seven percent of all participants in the household screening survey had hunted in the HRA. Most hunted for food (93 percent). About one-third of those who hunted were residents of Pittsfield, and two-thirds resided in the other HRA communities.

- **Vegetable Gardening:** Four hundred fifty-one residents, or 29 percent, had done vegetable gardening at their current residence. The percentage of residents who gardened varied with age: 7%, 27%, 43%, 42% respectively for age groups 0-19, 20-39, 40-59, 60 and over. No significant differences were found with regard to gender or region (Table 12).
- **Other Yard Work:** Fifty-four percent of the residents enrolled in the household screening survey had done other yard work (e.g., flower gardening, lawn mowing) at their current residence (Table 13). In general, residents from Pittsfield did less yard work than did the residents from the other HRA communities, but the difference was not statistically significant.

OTHER EXPOSURE OPPORTUNITIES

- **Construction:** Forty-one, or 2.5 percent, had had construction jobs that may have brought them into contact with the Housatonic River and its floodplain. All of these jobs were held by males. The percentages of residents from Pittsfield and the rest of the HRA communities held construction jobs were similar (2.4% and 2.9% respectively).
- **Farming:** Nine residents, or 0.5 percent, had done farm work that may have brought them into contact with the Housatonic River and its floodplain. Out of these nine residents, two came from Pittsfield, and seven came from the rest of the HRA communities.
- **Occupational Exposure:** Although this survey was designed to assess environmental (rather than occupational) exposure to PCBs in the HRA, 87 of the respondents had had opportunities for occupational exposure (e.g. electrician, electrical manufacturing) for periods ranging from three to 47 years.

EXPOSURE PREVALENCE STUDY - PART TWO: BIOLOGICAL SAMPLING

PARTICIPATION RATE AND BACKGROUND CHARACTERISTICS

Of the total 1529 participants enrolled in the household screening survey, 120 were selected and invited to participate in blood testing for PCBs. Children less than 18 years of age were not selected to participate because the three main predictors of serum PCB levels are age, occupational exposure, and consumption of contaminated fish and seafood. Moreover, children were not likely to

have significantly higher exposure than adults, hence, not likely to have higher blood PCB levels. Therefore, MDPH did not believe that the risk of drawing blood from minors was justified.

Of these 120 individuals, 103 were chosen because they scored the highest on the screening survey (the maximum score was 304; the range of scores for selected participants was 93 to 203), and 17 were selected because of their potential for unique exposures that were of particular concern to local residents (e.g. canoeing).

A total of 69 individuals participated in blood testing (57.5%). All but five of them had their blood drawn at BMC; the others had their blood drawn in their homes by a visiting phlebotomist.

Fifty-one of the individuals selected for blood testing chose not to participate. Thirty-two refused because they were not interested. Four had appointments scheduled at least two different times, but did not show up for their appointments. Two moved away without leaving forwarding addresses. Two were unable to fast overnight due to their work schedules. Finally, eleven were in poor health, including two individuals with diabetes (Table 14).

Table 15 compares participant versus nonparticipant characteristics. These two groups were very similar with regard to age, male/female ratio, fish consumption, and recreational activities related to the Housatonic River and its floodplain. Nonparticipants generally had lived longer in the HRA than participants, but the difference was not statistically significant.

TOTAL SERUM PCB CONCENTRATION

Total serum PCBs, which were quantified as Aroclor 1260, ranged from non-detectable to 35.81 ppb, with a mean of 5.44 ppb and a median of 3.93 ppb (Table 16 & Figure 7). One participant had a serum PCB level over 20 ppb.

Thirty-five Pittsfield participants had an average PCB level of 6.76 ppb (median 4.91 ppb), and 34 residents from other HRA communities had an average PCB level of 4.08 ppb (median 3.61 ppb). The above difference was mainly attributable to age differences: Pittsfield participants were older than non-Pittsfield participants.

CORRELATION OF TOTAL SERUM PCB AND STUDY VARIABLES

The forty-seven participants who were under 65 years old had a mean serum PCB level of 3.85 ppb (median 3.43 ppb); the twenty-two participants who were 65 or over had an average serum PCB level of 8.82 ppb (median 7.30 ppb) (Table 16). This difference remains significant when controlling for occupational status (Kruskal-Wallis $H=19.11$, $df=1$, $p<0.001$). Serum PCB level increases when age increases (Figure 8).

Of the 69 participants in the Exposure Prevalence Study, fifty-two did not report opportunity for occupational exposure. This group had a mean serum PCB level of 4.49 ppb (median 3.67 ppb; range <1.34 ppb - 11.60 ppb). Those with opportunities for occupational exposure¹ had a mean serum PCB level of 8.33 ppb (median 5.60 ppb; range 1.13 ppb - 35.81 ppb). This difference remains statistically significant after controlling for age (Kruskal-Wallis $H=4.99$, $df=1$, $p<0.05$) (Figure 8).

Of the 52 participants who did not report opportunity for occupational exposure, 14 who reported having eaten freshwater fish² at least twice a month (i.e., the frequent eaters) had a mean of 5.33 ppb (median 3.86 ppb); 26 who reported having eaten freshwater fish less than twice a month had a mean of 3.97 ppb (median 3.67 ppb); and 12 who reported never having eaten freshwater fish had a mean of 4.64 ppb (median 3.39 ppb). It seems that there is a slight indication that serum PCB level increases as the frequency of freshwater fish consumption increases, but this association can not be further examined due to the small size of this study and because individual participants may have had multiple non-workplace exposure opportunities (Figure 9). Serum PCB level also tends to increase as the duration of fish consumption increases (Table 17). People who did not report opportunity for occupational exposure tended to have higher serum PCB levels when they ate fish more frequently or for a longer period of time.

Of the 52 participants without opportunity for occupational exposure, eight individuals reported eating fiddlehead ferns and had an average serum PCB level of 4.12 ppb (median 4.30 ppb), and 44 reported having never eaten fiddlehead ferns and had a mean of 4.56 ppb (median 3.62 ppb). People who reported no opportunity for occupational exposure and who reported having eaten fiddlehead ferns had a slightly higher median serum PCB level than those who reported not having eaten them, although this difference is not statistically significant (Table 17).

Of the 52 participants without opportunity for occupational exposure, twenty-one individuals who reported having canoed on the Housatonic River had an average serum PCB level of 4.53 ppb (median 3.53 ppb), while 31 who had never canoed had a mean of 4.47 ppb (median 3.78 ppb), a non-significant difference (Table 17).

¹ People with opportunities for occupational exposure were defined as those who worked in a industry where they would encounter PCBs in the manufacturing process or in which PCBs were an integral component of their work, e.g., electrical manufacturing, electrician, etc. Excluded from this definition would be such as farming where workers would not normally encounter PCBs as part of their normal work.

² Unless otherwise specified, discussion of freshwater fish consumption refers to freshwater fish from any source including the Housatonic River.

Of the 52 participants without opportunity for occupational exposure, three participants who reported birdwatching along the Housatonic River had a mean of 3.31 ppb (median 3.59 ppb) while 49 non-birdwatchers had a mean of 4.56 ppb (median 3.70 ppb). Again, this is a non-significant difference (Table 17).

For all the participants without opportunity for occupational exposure, 36 individuals who gardened at their current residence had an average serum PCB level of 4.55 ppb (median 3.86 ppb). Those who did not garden had an average of 4.36 ppb (median 3.30 ppb). Forty-five individuals who reported doing other types of yard work at their residence had a mean of 4.50 ppb and a median of 3.70 ppb; seven who did not had a mean of 4.42 ppb and a median of 1.74 ppb. People who gardened or did other types of yard work had slightly higher serum PCB levels than those who did not, though, these differences were not statistically significant.

VOLUNTEER STUDY - PART ONE: HOUSEHOLD INTERVIEWS

BACKGROUND CHARACTERISTICS

A total of 65 households, representing 158 individuals, participated in our volunteer survey by completing the questionnaires. One hundred seventeen individuals were from Pittsfield (54 males, 63 females), and their median age was 48 years. The remaining 41 individuals (22 males, 19 females) had a median age of 46 years. Among all 158 individuals, nearly 70 percent were less than 60 years old (Table 18).

FISH CONSUMPTION

One hundred and five of 158 respondents, or 67 percent, had eaten freshwater fish from any water body (i.e., not necessarily the Housatonic River) (Table 19). The most frequently consumed fish species were trout, perch, bass, bullhead and pickerel. Nobody reported having eaten fish more than twice a week during the season. Twelve individuals (11 percent) reported eating fish once or twice a week; 31 individuals (33 percent) reported eating fish one to four time a week; and 60 individuals (57 percent) reported eating fish less than once a month. Thirty-six percent of the fish eaters had eaten fish for less than 10 years, 22 percent had eaten fish for 10 to 19 years, and 42 percent had eaten fish for more than 20 years. The average number of years of eating fish was 12. Eighty-four percent had caught the fish themselves or had eaten fish caught by family or friends.

Nine respondents (about nine percent) reported that they had eaten fish from the Housatonic River at least once. The most frequently consumed fish species from the Housatonic River were

trout, perch, bullhead, and bass (Table 20). Nobody reported having eaten fish more than twice a week during the season. Of those who had been eating fish from the Housatonic River, one had been doing so for less than 10 years, two for 10 to 19 years, and six for more than 20 years.

RECREATIONAL ACTIVITIES ALONG THE HOUSATONIC RIVER AND ITS FLOODPLAIN

Table 18 shows the patterns of activities related to the Housatonic River and its floodplain reported by participants of the household screening survey of the Volunteer Study. These activities include consuming fiddlehead ferns, fishing, canoeing, bird-watching, vegetable gardening and doing other yard work.

OTHER EXPOSURE OPPORTUNITIES

- Construction: Seven participants had held construction jobs that may have brought them into contact with the Housatonic River. Two were from Pittsfield and five were from the rest of the HRA communities.
- Farming: One participant had done farm work that may have brought him in contact with the contaminated riverbank soil.
- Occupational Exposure: Thirty respondents had had opportunities for occupational exposure (e.g. electrician, electrical manufacturing) for a range of nine to 50 years. Most of them reported having direct contact with PCBs during their employment.

VOLUNTEER STUDY - PART TWO: BIOLOGICAL SAMPLING

PARTICIPATION RATE AND BACKGROUND CHARACTERISTICS

Out of 158 respondents enrolled in the volunteer household screening survey, 126 were 18 years or over. These 126 individuals were all invited to participate in blood testing for PCBs, and 79 (62.7 %) accepted. (Survey responses were scored but because not all individuals who participated in the household screening survey were interested in participating in the blood drawing, it was possible to invite all adults to participate.) Seventy-four individuals had their blood drawn at BMC and five had their blood drawn in their homes by a visiting phlebotomist. Forty-seven individuals were selected but did not participate:

- Seventeen refused to participate because they were not interested;
- Ten had at least two appointments scheduled but did not show up for them;
- Five were unable to fast overnight due to their work schedules;
- Two were unable to participate because they were in poor health;

- Thirteen individuals were unable to be contacted despite multiple attempts.

Table 21 compares participants' and non-participants' characteristics. In general, the participants were older and tended to have lived longer in the HRA than the non-participants. The two groups were similar with regard to fish consumption and recreational activities related to the Housatonic River and its floodplain. Participants tended to do more vegetable gardening and hunting, and were more likely to eat the animals they hunted than were non-participants.

TOTAL SERUM PCB CONCENTRATION

Seventy-nine participants had serum PCB levels ranging from non-detectable to 114.78 ppb, with a mean of 9.07 ppb and a median of 6.60 ppb (Table 22 & Figure 10). Five people, or six percent, had a serum PCB level over 20 ppb.

CORRELATION OF TOTAL SERUM PCB AND STUDY VARIABLES

The forty-six participants who were under 65 years old had a mean serum PCB level of 5.97 ppb (median 4.32 ppb); the thirty-three participants who were 65 or over had an average serum PCB level of 13.40 ppb (median 9.39 ppb) (Table 22). This difference remains significant when controlling for occupational status (Kruskal-Wallis $H=19.88$, $df=1$, $p<0.001$). Serum PCB level increases when age increases (Figure 11).

Fifty-three out of the 69 participants without opportunity for occupational exposure had a mean serum PCB level of 5.77 ppb (median 4.86 ppb). Those with opportunities for occupational exposure had a mean serum PCB level of 15.79 ppb (median 8.81 ppb). This difference remains statistically significant after controlling for age (Kruskal-Wallis $H=13.01$, $df=1$, $p<0.01$). People who had opportunities for occupational exposure had higher serum PCB levels than those who had not across all the age group (Figure 11).

Of the 53 participants without opportunity for occupational exposure, 8 who reported having eaten freshwater fish at least twice a month (i.e. the frequent eaters) had a mean of 6.36 ppb (median 7.13 ppb); 30 who reported having eaten freshwater fish less than twice a month had a mean of 4.84 ppb (median 4.32 ppb); and 12 who reported never having eaten freshwater fish had a mean of 7.33 ppb (median 5.24 ppb). It seems that median serum PCB levels are slightly higher among those who are frequent fish-eaters than among those who eat less frequently or not at all. This observation is consistent for the different age groups (Table 23). Individuals who reported having eaten freshwater fish tended to have higher levels than those who reported not having eaten freshwater fish when the age was broken down further into four groups: 18-34, 35-49, 50-64, 65 and over; however individuals

within each group may have had multiple non-workplace exposure opportunities that may affected the serum PCB level (Figure 12). It was also found that median serum PCB level tended to increase as the duration of fish consumption increased, and this tendency remained across different age groups (Table 23). People without opportunities for occupational exposure tended to have higher median serum PCB levels as they ate more frequently or for a longer period of time.

Of the 53 participants without opportunity for occupational exposure, seven individuals reported having eaten fiddlehead ferns and had an average serum PCB level of 5.63 ppb (median 6.93 ppb), and 46 individuals who had never eaten them had a mean of 5.80 ppb (median 4.84 ppb). People who did not report opportunity for occupational exposure but who reported having eaten fiddlehead ferns had a slightly higher median serum PCB level than those who reported not having eaten ferns (Table 23), this difference is not statistically significant.

Of the 53 participants without opportunity for occupational exposure, sixteen individuals reported having canoed on the Housatonic River and had an average serum PCB level of 3.55 ppb (median 3.13 ppb), while 37 who had never canoed had a mean of 6.73 ppb (median 5.24 ppb), a non-significant difference (Table 23).

Of the 53 participants without opportunity for occupational exposure, one participant reported birdwatching along the Housatonic River and had a serum PCB level of 7.33 ppb, while 52 non-birdwatchers had a mean of 5.74 ppb (median 4.84 ppb). This data did not allow us to determine if birdwatching contributed to serum PCB levels among volunteers (Table 23).

Of the 53 participants without opportunity for occupational exposure, 38 individuals who gardened at their current residence had an average serum PCB level of 6.22 ppb (median 5.01 ppb). Those who did not garden had an average of 4.66 ppb (median 3.24 ppb). People who had no opportunities for occupational exposure and who gardened tended to have higher serum PCB levels than those who did not garden (Table 23), though this difference is not statistically significant.

Of the 53 participants without opportunities for occupational exposure, forty-six individuals reported doing other types of yard work at their residence and had a mean of 5.12 ppb and a median of 4.84 ppb; seven who did not had a mean of 10.05 ppb and a median of 7.90 ppb. This difference was mainly caused by this group's highest level (i.e., 31.41 ppb) which, because of the small cell numbers, had a heavy statistical impact (Table 23).

DISCUSSION

PCB contamination of Housatonic River sediments, floodplain soil, ground water, and biota is well documented (MDEP 1995, 1997). PCBs have also been found in ambient air near some of the heavily contaminated sites (MDEP 1994). The potential for exposure to PCBs through residential and recreational activities on or next to the Housatonic River and its floodplain has been an important concern of residents in the HRA communities as well as public health and environmental regulatory agencies.

HOUSEHOLD INTERVIEW

The first part of the Exposure Prevalence Study showed that many residents have opportunities for environmental exposure to PCBs:

- Twelve percent of the Exposure Prevalence Study participants fished in the Housatonic River, and about three percent had eaten fish from the Housatonic River;
- Eleven percent canoed in the Housatonic River;
- Four percent birdwatched in the HRA;
- Sixteen percent participated in other recreational activities on or next to the Housatonic River;
- Seven percent hunted in the HRA, and the majority of respondents ate the animals that they hunted;
- Twenty-nine percent did vegetable gardening at their current residence;
- Fifty-four percent did other yard work at their current residence;
- Five percent ate fiddlehead ferns from wetland adjacent to the Housatonic River.

In addition, 41 residents, or 2.5 percent, did construction work that may have incidentally brought them into contact with the Housatonic River or its floodplain. Nine residents, or 0.5 percent, did farming work along the contaminated riverbank.

In general, residents of Pittsfield did not differ significantly from the rest of the HRA communities with respect to reported activities related to the Housatonic River or its floodplain. However, Pittsfield residents did report significantly less canoeing and hunting compared to the rest of the HRA communities. In addition, male participants overall showed much higher participation in fishing and hunting.

Consumption of contaminated fish is believed to be one of the most important environmental exposure pathways for PCBs (ATSDR 1996). The household screening survey for the Exposure

Prevalence Study showed that over one-third of the participants had eaten freshwater fish for an average of 25 years. Moreover, 10 percent of freshwater fish eaters had consumed fish obtained from the Housatonic River. Older people were more likely to have eaten fish than were young people, and males were more likely to have eaten freshwater fish than were females. The most frequently consumed fish species from the Housatonic River were trout, perch, bass, bullhead and pickerel.

Participants of the Volunteer Study were slightly older than those from the exposure prevalence study. Results from the volunteer household screening survey showed slightly higher rates than the Exposure Prevalence Study with regard to canoeing, birdwatching, doing vegetable gardening and other types of yard work, eating fiddlehead ferns, consuming freshwater fish and reporting opportunities for occupational exposure. Due to a small size of this group and a self-selected nature, caution should be used to interpret this data.

BIOLOGICAL SAMPLING

Since biological sampling data (including serum PCB levels) do not usually follow a normal distribution, median levels were used for comparison among different groups. Mean levels were also reported to allow for comparison with other similar studies.

Participants from the Exposure Prevalence Study who received blood tests had a mean serum PCB level of 5.44 ppb and a median level of 3.93 ppb, with one person (1.4 %) over 20 ppb. Participants in the Volunteer Study had a mean serum PCB level of 9.07 ppb and a median level of 6.60 ppb, with five persons (6.3 %) over 20 ppb.

Among the Exposure Prevalence Study participants, those without opportunities for occupational exposure had a mean serum PCB level of 4.49 ppb and a median level of 3.67 ppb, with no one over 20 ppb, while people with opportunities for occupational exposure had a mean serum PCB level of 8.33 ppb and a median level of 5.60 ppb with one person over 20 ppb. Among volunteer participants, those without opportunity for occupational exposure had a mean serum PCB level of 5.77 ppb and a median level of 4.86 ppb, with one person over 20 ppb, while people with opportunities for occupational exposure had a mean serum PCB level of 15.79 ppb and a median level of 8.81 ppb, with four persons over 20 ppb. ATSDR reports that, in the United States, typical PCB levels in the serum of non-occupationally exposed individuals range from about four to eight ppb, with 95 percent at or below 20 ppb (ATSDR 1996). The serum PCB levels found in the Exposure Prevalence Study and Volunteer Study were generally consistent with reports of non-occupationally exposed individuals. Since the levels obtained from the Exposure Prevalence Study were from the

participants with the highest risk of potential environmental exposures (the ones selected due to residence within half a mile of the river and due to highest scores), it is reasonable to believe that serum PCB levels of most non occupationally-exposed residents in the HRA communities should be in the national background range.

Similar to what was found in other published studies (Miller et al 1991, MDPH 1984, ATSDR 1996), age was found to be the most significant predictor of serum PCB level. It is likely that PCB levels increase as age increases because of the tendency of PCBs to bioaccumulate from multiple opportunities of exposure over a person's life time. This age trend remains significant among groups in different occupational and environmental exposure categories, and is found in both the Exposure Prevalence Study and the Volunteer Study.

Regarding the opportunities for environmental exposure investigated in the exposure prevalence study, it is important to note that people without opportunity for occupational exposure tended to have slightly higher serum PCB levels when they ate freshwater fish (including fish from the Housatonic River) more frequently or for a longer period of time (Figures 9 and 12). Though it is not statistically significant, this observation remains even when the statistics are broken down by age, a main confounder of serum PCB level. Although not statistically significant, similar observations were also seen in the Volunteer Study.

People who reported no opportunities for occupational exposure and who reported having eaten fiddlehead ferns grown in the wetland of the Housatonic River had slightly higher levels than those who reported having not eaten them. For all the people without occupational exposure, those who gardened, or in the cases of the Exposure Prevalence Study participants did yard work at their current residence also had slightly higher levels than those who did not.

One participant who reported having had no opportunity for occupational exposure had serum PCB levels over 20 ppb. This person (31.41 ppb) reported having had multiple opportunities for environmental exposure.

ADDITIONAL CONSIDERATIONS

Overall, serum PCB levels found among HRA residents with the highest risk of exposure to PCBs were generally within the background range reported for the non-occupationally exposed population in the U.S. However, this study did provide some indication that when people ate freshwater fish more frequently or for a longer period of time, they tended to have higher serum PCB levels. People who reported having eaten fiddlehead ferns and having gardened, or in the cases of the

Exposure Prevalence Study participants having done yard work also tended to have slightly higher levels than those who did not. These results should be interpreted in light of the following aspects of the study:

- Eighty-four percent of the randomly selected households participated in this study. In addition, analysis of information collected from Refusal Questionnaires shows that those households that participated and the ones that were unable to participate were similar with regard to the main variables of study interest (Table 2). Thus, the information collected from the household screening survey of the Exposure Prevalence Study should be reasonably representative of the entire study area defined in this project.
- The scoring scenario was developed based on MDPH's past experience with PCB exposure assessments in Greater New Bedford and Norwood. Given the uniqueness of the HRA, special attention was given to a variety of activities on or next to the river. The total score for each individual was found to be very closely related to serum PCB levels ($r=0.8046$, $p<0.01$, Figure 13 & Figure 14) among all the blood test participants of the Exposure Prevalence Study and the Volunteer Study, indicating that the scores were good predictors of serum PCB levels. Thus, individuals with lower scores (who were not selected for blood testing) are not likely to have higher serum PCB levels than study participants.
- The biomarker used as the indicator of exposure in this study was serum PCB. PCBs are lipophilic and preferentially stored in adipose tissue; they are present in serum, blood plasma, and human milk. Serum or plasma PCB concentrations can be significantly influenced by serum lipid content due to partitioning of PCBs between adipose tissue and serum lipids. In this study participants fasted 12 hours prior to sample collection, which should minimize any potential for serum lipid variation. Differences between different congeners in metabolic profiles (the higher the chlorination of a congener, the longer the half-life) would also influence the serum concentration at any given time. Since potential contact through the HRA environmental media has existed for HRA residents even since the pollution started, serum PCB level should be a reasonable reflection of the most recent environmental exposure to PCBs.

LIMITATIONS

The HRA PCB exposure assessment study, involved serum collected on individuals who were screened for exposure opportunity and determined to be at greater risk. For this reason the number of individuals in each exposure classification was small. This, coupled with the diversified, multiple opportunities for environmental exposure reported by HRA residents, does not allow for detailed analysis of every individual exposure opportunity. In addition, a long history of recognition of the problem may have resulted in changes in human behaviors to prevent or decrease personal risks (e.g., MDPH's fish consumption advisory in 1982 and subsequent posting of the river is likely to have led to decreased recreational fish consumption). Therefore it is possible that serum PCB levels could be lower than in the past, and lower than would have been observed had these interventions not occurred. In spite of these limitations, we did see results generally consistent with published studies.

Information collected through the household screening questionnaire was checked against similar information collected during the second, shorter questionnaire administered at the time of the blood draw. The information collected from the household screening questionnaire was from a representative of the household, while information collected during blood drawing was from a personal interview. The overall agreement between the two surveys' responses regarding exposure-related activities along the Housatonic River was above 80 percent, with very reasonable sensitivity and specificity (Table 24).

CONCLUSIONS

1. The serum PCB levels found among participants with the highest risk of exposure to PCBs in this study were generally within the background range reported for the non-occupationally exposed population in the U.S. While there may be individual exceptions, it is unlikely that residents in the HRA communities in general will have serum PCB levels greater than those seen in this study.
2. Serum PCB levels tend to be higher in older residents of the HRA who are frequent and or long-term fish eaters or who report opportunities for occupational exposure. This finding is consistent with results of other similar studies. In addition there is some indication that other activities (e.g. fiddlehead fern consumption, gardening) may contribute slightly to serum PCB levels.
3. Age was found to be the most significant variable strongly related to serum PCB level. Among all the blood test participants, those who had had opportunities for occupational exposure had higher average serum PCB level than the rest. However, the risk of occupational exposure to PCBs has also greatly diminished, since PCBs have reportedly not been used in manufacturing in Pittsfield since 1977.
4. This study used a randomly selected sample. A second volunteer sample was also evaluated to examine possible patterns of PCB exposure and to measure body burden among residents of the HRA. Over one-third of the participants in the Exposure Prevalence Study had eaten freshwater fish for an average of 25 years. About three percent had eaten fish from the Housatonic River for an average of 20 years. A considerable number of local residents had participated in a variety of recreational activities related to the Housatonic River and its floodplain. The Volunteer Study showed similar results.
5. The findings suggest that the EPA ban of open-system use of PCBs in 1979 and the MDPH fish advisory against eating fish, frogs, and turtles in 1982, coupled with the considerable efforts of the MDEP and US EPA related to the extensive PCB problem and the hazards of eating PCB contaminated fish may well have contributed to behavioral changes that may have led to reductions of opportunities for exposure through food chain and other exposure opportunities in recent years.

4/1

RECOMMENDATIONS

The MDPH makes the following recommendations:

1. Findings from this study demonstrate that opportunities for environmental exposures to PCBs through multiple exposure pathways among the HRA residents exist. Based on potential exposures as reported by HRA residents and widespread contamination documented in environmental investigations conducted under the oversight of state and federal environmental regulatory agencies, efforts should continue to complete these investigations and to evaluate and implement appropriate remedial actions for contaminated areas in this region in order to minimize present and future opportunities for exposure to PCBs.
2. The current MDPH fish advisory for the Housatonic River should remain in effect until measurements in aquatic life decline to acceptable standards. Periodic monitoring should be conducted, and targeted on those species found to be consumed with the greatest frequency by the HRA residents.
3. Based on the results of this exposure assessment study, follow-up epidemiological studies on PCB body burden among the general public do not seem to be indicated; however, MDPH should continue to provide on-going technical assistance or health advice to individuals, who may have opportunities for exposure (in some cases, multiple exposures) to PCBs, or to their physicians.
4. MDPH will continue to provide on-going technical assistance to the environmental regulatory agencies and others in addressing health and exposure concerns and will continue to promote behavioral changes that contribute to exposure reduction until such time as permanent environmental protection has been achieved.
5. MDPH should offer follow-up blood testing and health consultation services to residents who are found to be residing on PCB-contaminated properties.

BIBLIOGRAPHY

- Agency for Toxic Substance and Disease Registry (ATSDR): Health Assessment for the Rose's Disposal Pit. Atlanta, GA, 1989.
- Agency for Toxic Substance and Disease Registry (ATSDR): Toxicological Profile for Selected Polychlorinated Biphenyls (PCBs: Aroclor -1260, -1245, -1248, -1242, -1232, -1221, and -1016) - Update. Atlanta, Georgia. 1993.
- Beck GJ: Housatonic River PCB study - Statistical analysis. Connecticut State Department of Health Services, Apr. 1981.
- Beck GJ: PCBs in Housatonic River Fish: Statistical Analysis. Prepared under contract from the Connecticut State Department of Health Services. 21pp.+ appendices, 1982.
- Blasland & Bouck Engineers, P.C.: Addendum to MCP Interim Phase II Report/Current Assessment Summary for Housatonic River. Syracuse, New York, August 1991.
- Blasland & Bouck Engineers, P.C.: Evaluation of need for short-term measures in the Housatonic River floodplain. Syracuse, New York, November 1992.
- Blasland & Bouck Engineers, P.C.: Evaluation of need for short-term measures in the Housatonic River floodplain. Syracuse, New York, Nov. 1992.
- Blasland & Bouck Engineers, P.C.: MCP Interim Phase II Report/Current Assessment Summary for Housatonic River. Syracuse, New York, December 1991.
- Blasland & Bouck Engineers, P.C.: Report on January 1993 Housatonic River floodplain property sampling and analysis. Syracuse, New York, Feb. 1993.
- Blasland, Bouck & Lee, Inc.: Supplemental Phase II/RCRA Facility Investigation Report for Housatonic River and Silver Lake. Syracuse, New York, January 1996
- Emmett EA, Maroni M, Jefferys J et al: Studies of Electrical Repair Workers Exposed to PCBs: II. Results of Clinical Laboratory Investigation. Am. J. Ind. Med. 14(1):47-62. 1988.
- Falck F, Ricci A, Wolff MS et al: Pesticides and polychlorinated biphenyl residues in human breast lipids and their relation to breast cancer. Arch. Environ. Health. 47(2):143-146, 1992.
- Fiore BJ, Anderson HA, Hanrahan LP et al: Sport fish consumption and body burden levels of chlorinated hydrocarbons: a study of Wisconsin anglers. Arch. Environ. Health. 44(2):82-88, 1989.
- Hovinga ME, Sowers M, Humphrey HE: Environmental exposure and lifestyle predictors of lead, cadmium, PCB, and DDT levels in Great Lakes fish eaters. Arch. Environ. Health. 48(2):98-104, 1993.

LB

Jacobson JL, Jacobson SW, Humphrey HEB: Effects of Exposure to PCBs and Related Compounds on Growth and Activity in Children. *Neurotoxicol. Tera.* 12(4):319-326, 1990.

Kalina I, Sram RJ, Konecna H et al: Cytogenetic Analysis of Peripheral Blood Lymphocytes in Workers Occupationally Exposed to Polychlorinated Biphenyls. *Tera. Carcinogene. Mutagene.* 11:77-82, 1991.

Kim HT, Kim KS, Kim JS, Stone WB: Levels of polychlorinated biphenyls, DDE and mirex in waterfowl collected in New York State (USA), 1981-1982. *Arch. Environ. Contam. Toxicol.* 14 (1): 13-18, 1985.

Levy PS, Lemeshow S: Sampling of Populations: Methods and Application. John Wiley & Sons, Inc. p99-106, 1991.

Massachusetts Department of Environmental Protection (MDEP): Revised Public Involvement Plan for the Housatonic River and General Electric Company Pittsfield Disposal Sites. Springfield, Massachusetts, April 1995.

Massachusetts Department of Environmental Protection (MDEP) Western Regional Office (WRO): Handouts of Public Involvement Meeting: General Electric/Pittsfield Hazardous Waste Sites and the Housatonic River; Building 68 Fact Sheet. Pittsfield, Massachusetts, May 1997.

Massachusetts Department of Public Health (MDPH): PCB Exposure Assessment in Norwood. Massachusetts Department of Public Health, Boston, Massachusetts. 1984.

Massachusetts Department of Public Health (MDPH): Final Report of Great New Bedford PCB Health Effects Study 1984-1987. Massachusetts Department of Public Health, Boston, Massachusetts. 1987.

Massachusetts Department of Public Health (MDPH): Health Consultation: General Electric (Pittsfield) Cerclis Number MAD002084093, PCB Exposure Assessment among Residents in the Housatonic River Area of Western Massachusetts. MDPH under Cooperative Agreement with the Agency for Toxic Substances and Disease Registry, Boston, MA, July 1994.

Miller DT, Condon SK, Kutzner S, Phillips DL, Krueger E, Timperi R, Burse VW, Cutler J, Gute DM: Human exposure to polychlorinated biphenyls in Greater New Bedford, Massachusetts: a prevalence study. *Arch. Environ. Contam. Toxicol.* 20:410-416, 1991.

Rosenman KD: Assessment of PCB serum levels in Pittsfield, Massachusetts. 1980.

Safe S: Polychlorinated biphenyls (PCBs): mutagenicity and carcinogenicity. *Mutat. Res.* 220:31-47, 1989.

Safe S: Toxicology, structure function relationship, and human and environmental health impacts of polychlorinated biphenyls: progress and problems. *Environ. Health. Perspect.* 100:259-268, 1992.

Silberhorn EM, Glauert HP, Robertson LW: Carcinogenicity of polyhalogenated biphenyls: PCBs and PBBs. *Crit. Rev. Toxicol.* 20:440-496, 1990.

14

Taylor PR, Stelma JM, Lawrence CE: The Relation of Polychlorinated Biphenyls to Birth Weight and Gestational Age in the Offspring of Occupationally Exposed Mothers. *Am. J. Epidemiol.* 129(2):395-406, 1989.

USEPA: Consumption surveys for Fish and Shellfish - A Review and Analysis of Survey Methods. U.S. Environmental Protection Agency, Office of Science and Technology, Washington DC. EPA Contract No. 68-C9-0013. 55 pp. 1990.

Wegman DH, et al: A report to the General Electric Company concerning a case-control study of cancer mortality at the General Electric Pittsfield facility. Vol. I & II, University of Lowell, Jan. 1990.

Wolff MS, Toniolo PG, Lee EW et al: Blood Levels of Organochloride Residues and risk of Breast Cancer. *JNCI.* 85(8):648-652, 1993.

TABLES

Table 1. Points Assigned to Each Category of the Household Screening Questionnaire.

1. Age:		2. Length Of Residence:	
18 - 34 -- 0		< 5 -- 0	
35 - 39 -- 5		5 - 9 -- 5	
40 - 44 -- 10		10 - 19 -- 10	
45 - 49 -- 15		20 - 29 -- 15	
50 - 54 -- 20		30 - 39 -- 20	
55 - 59 -- 25		40 - 49 -- 25	
60 + -- 30		50 + -- 30	
3. Fish Consumption:		3.3 Sources	
3.1 Frequency		Housatonic -- 40	
1-3/m -- 5	3.2 Year	Other -- 0	
1-2/w -- 10	5 - 9 -- 5		
3-4/w -- 20	10 - 19 -- 10		
5-6/w -- 30	20 - 29 -- 20		
>=7/w -- 40	30 - 39 -- 30		
	40 + -- 40		
4. Farming(year, x2 for PT & LX)*:		5. Construction(year, x2 for PT & LX)*:	
< 5 -- 0		< 5 -- 0	
5 - 9 -- 5		5 - 9 -- 5	
10 - 19 -- 10		10 - 19 -- 10	
20 - 29 -- 15		20 - 29 -- 15	
30 - 39 -- 20		30 - 39 -- 20	
40 - -- 25		40 - -- 25	
6. Canoeing:	7. Bird Watching:	8. Dirt Biking:	9. Jogging/Walking:
1-3/m -- 2	1-3/m -- 0	1-3/m -- 0	1-3/m -- 0
1-2/w -- 4	1-2/w -- 2	1-2/w -- 2	1-2/w -- 2
3-4/w -- 8	3-4/w -- 4	3-4/w -- 4	3-4/w -- 4
5-7/w -- 12	5-7/w -- 6	5-7/w -- 6	5-7/w -- 6
10. Fiddlehead Ferns:	11. Vegetable Gardening:	12. Other Yard Work:	
1-3/w -- 5	1-3/m -- 5	1-3/w -- 0	
1-2/w -- 10	1-2/w -- 10	1-2/w -- 3	
3-4/w -- 15	3-4/w -- 15	3-4/w -- 6	
5-6/w -- 20	5-7/w -- 20	5-7/w -- 9	
>=7/w -- 25	(x2 for PT & LX)*		
13. Hunt For Food:	13.2 Frequency		
13.1 Preys	1-3/m -- 5		
Birds -- 20	1-2/w -- 10		
Other Preys -- 0	3-4/w -- 20		
	5-6/w -- 30		
	>=7/w -- 40		

* If farming, construction, or vegetable gardening occurred in Pittsfield or Lenox, scores would be doubled accordingly.

Table 2. Comparison of Participants and Non-participants of Household Screening Survey - Exposure Prevalence Study.

Contents	Completed Screening Survey Questionnaires	Completed Refusal Questionnaires
Average size of the household (persons)	2.32 (1529/658)	2.14 (62/29)
Mean and median age of the population (years)	44.0 / 43.5	38.9 / 39.0
Ever ate freshwater fish from the Housatonic River (%)	3.3 (50/1529)	3.2 (2/62)
Ever did farming or construction work on or next to the Housatonic River (%)	3.2 (49/1529)	1.6 (1/62)
Ever did any recreational activities (e.g., canoeing, bird watching, jogging) on or next to the Housatonic River (%)	25.6 (392/1529) ¹	9.7 (6/62)

Notes: ¹ Question asked in screening survey was "Have you ever done", versus "Have you done on a regular basis" in refusal questionnaire.

Table 3. Age, Sex, and Region Distribution of Household Screening Survey Participants - Exposure Prevalence Study.

Age Group (years)	Pittsfield			The rest of the HRA communities ¹			Total (%)
	Male (%)	Female (%)	Subtotal (%)	Male (%)	Female (%)	Subtotal (%)	
0-19	110 (30.8)	93 (24.1)	203 (27.3)	102 (27.8)	97 (23.2)	199 (25.3)	402 (26.3)
20-39	94 (26.3)	102 (26.4)	196 (26.4)	80 (21.8)	104 (24.8)	184 (23.4)	380 (24.9)
40-59	86 (24.1)	90 (23.3)	176 (23.7)	119 (32.4)	137 (32.7)	256 (32.6)	432 (28.3)
60+	67 (18.8)	101 (26.2)	168 (22.6)	66 (18.0)	81 (19.3)	147 (18.7)	315 (20.6)
Total	357 (100)	386 (100)	743 (100)	367 (100)	419 (100)	786 (100)	1529 (100)

Note: ¹ The rest of the HRA communities include Lanesborough, Dalton, Lee, Lenox, Stockbridge, Great Barrington, and Sheffield.

Table 4. Percentages of Residents who Reported Eating Freshwater Fish in General - Exposure Prevalence Study.

Age Group (Years)	Pittsfield		The rest of the HRA communities ¹				Total (%; 95% CI) ²
	Male (%)	Female (%)	Subtotal (%)	Male (%)	Female (%)	Subtotal (%)	
0-19	21/110 (19.1)	10/93 (10.8)	31/203 (15.3)	19/102 (18.6)	22/97 (22.7)	41/199 (20.6)	72/402 (17.0, 12.0 - 22.0)
20-39	36/94 (38.3)	35/102 (34.3)	71/196 (36.2)	36/80 (45.0)	29/104 (27.9)	65/184 (35.3)	136/380 (35.9, 30.0 - 41.8)
40-59	43/86 (50.0)	36/90 (40.0)	79/176 (44.9)	53/119 (44.5)	53/137 (38.7)	106/256 (41.4)	185/432 (43.5, 37.7 - 49.2)
60+	32/67 (47.8)	38/101 (37.6)	70/168 (41.7)	33/66 (50.0)	31/81 (38.3)	64/147 (43.5)	134/315 (42.2, 35.3 - 49.1)
Total	132/357 (37.0)	119/386 (30.8)	251/743 (33.8)	141/367 (38.4)	135/419 (32.2)	276/786 (35.1)	527/1529 (34.2, 30.8 - 37.7)

Notes: ¹ The rest of the HRA communities include Lanesborough, Dalton, Lee, Lenox, Stockbridge, Great Barrington, and Sheffield.
² Rates and confidence intervals (CI) were calculated from cluster sample scheme analysis with weighting of two strata: Pittsfield vs. the rest of the HRA communities.

49

30

Table 5. Fish Consumption - Exposure Prevalence Study.

	Ever ate fresh water fish in general		Ever ate fish from the Housatonic River	
	n	Percentage (%)	n	Percentage (%)
Species of fish consumed				
Bass	265	50.3	24	46.2
Trout	449	85.2	42	80.8
Perch	262	49.7	30	57.7
Sunfish	9	1.7	1	1.9
Pickrel	49	9.3	5	9.6
Bullhead	66	12.5	8	15.4
Crappie	14	2.7	0	0.0
Shiners	0	0.0	0	0.0
Suckers	0	0.0	0	0.0
Goldfish	0	0.0	0	0.0
Carp	2	0.4	0	0.0
Other	24	4.6	1	1.9
Frequency of fish consumption¹				
>=3 per week	5	0.9	2	3.8
1-2 per week	135	25.6	16	30.8
1-4 per month	167	31.7	18	34.6
< 1 per month	220	41.7	16	30.8
Total	527	100.0	52	100.0
Years of fish consumption				
0-4	67	12.7	4	7.7
5-9	57	10.8	8	15.4
10-19	112	21.3	12	23.1
20-29	105	19.9	4	7.7
30-39	70	13.3	10	19.2
40 +	98	18.6	14	26.9
Don't know	18	3.4	0	0.0
Total	527	100.0	52	100.0
Source of fresh water fish				
Catch Own	215	40.8	38	73.1
Family/friends caught	179	34.0	13	25.0
Other local fishermen	11	2.1	1	1.9
Supermarket/grocery store	95	18.0	0	0.0
Don't know	27	5.1	0	0.0
Total	527	100.0	52	100.0
Places where fish were caught				
Housatonic River	52	9.9	-	-
Hoosic River	7	1.3	-	-
Other Locations	291	55.2	-	-
Don't know	177	33.6	-	-
Total	527	100.0	-	-

Note: ¹ Frequency of fish consumption reflected experiences during season (usually from May through October).

Table 6. Percentages of Residents who Reported Fishing in the Housatonic River - Exposure Prevalence Study.

Age Group (years)	Pittsfield		The rest of the HRA communities ¹				Total (%; 95% CI) ²
	Male (%)	Female (%)	Subtotal (%)	Male (%)	Female (%)	Subtotal (%)	
0-19	16/110 (14.5)	2/93 (2.2)	18/203 (8.9)	21/102 (20.6)	12/97 (12.4)	33/199 (16.6)	51/402 (11.3, 7.7 ~ 15.0)
20-39	18/94 (19.1)	8/102 (7.8)	26/196 (13.3)	21/80 (26.3)	12/104 (11.5)	33/184 (17.9)	59/380 (14.7, 10.8 ~ 18.6)
40-59	19/86 (22.1)	2/90 (2.2)	21/176 (11.9)	35/119 (29.4)	9/137 (6.6)	44/256 (17.2)	65/432 (14.1, 10.7 ~ 17.5)
60+	7/67 (10.4)	4/101 (4.0)	11/168 (6.5)	16/66 (24.2)	3/81 (3.7)	19/147 (12.9)	30/315 (8.4, 5.1 ~ 11.8)
Total	60/357 (16.8)	16/386 (4.1)	76/743 (10.2)	93/367 (25.3)	36/419 (8.6)	129/786 (16.4)	205/1529 (12.3, 10.4 ~ 14.3)

Notes: ¹ The rest of the HRA communities include Lanesborough, Dalton, Lee, Lenox, Stockbridge, Great Barrington, and Sheffield.
² Rates and confidence intervals (CI) were calculated from cluster sample scheme analysis with weighting of two strata: Pittsfield vs. the rest of the HRA communities.

Table 7. Percentages of Residents who Reported Canoeing in the Housatonic River - Exposure Prevalence Study.

Age Group (years)	Pittsfield			The rest of the HRA communities ¹			Total (% 95% CI) ²
	Male (%)	Female (%)	Subtotal (%)	Male (%)	Female (%)	Subtotal (%)	
0-19	13/110 (11.8)	6/93 (6.5)	19/203 (9.4)	6/101 (5.9)	9/97 (9.3)	15/199 (7.5)	34/402 (8.8, 4.8 ~ 12.7)
20-39	9/94 (9.6)	6/102 (5.9)	15/196 (7.7)	22/80 (27.5)	14/104 (13.5)	36/184 (19.6)	51/380 (11.4, 7.8 ~ 14.9)
40-59	14/86 (16.3)	13/90 (14.4)	27/176 (15.3)	26/119 (21.8)	23/137 (16.8)	49/256 (19.1)	76/432 (16.9, 12.5 ~ 21.4)
60+	7/67 (10.4)	3/101 (3.0)	10/168 (6.0)	4/66 (6.1)	4/81 (4.9)	8/147 (5.4)	18/315 (5.8, 2.7 ~ 8.9)
Total	43/357 (12.0)	28/386 (7.3)	71/743 (9.6)	58/367 (15.8)	50/419 (11.9)	108/786 (13.7)	179/1529 (11.0, 8.6 ~ 13.3)

Notes: ¹ The rest of the HRA communities include Lanesborough, Dalton, Lee, Lenox, Stockbridge, Great Barrington, and Sheffield.
² Rates and confidence intervals (CI) were calculated from cluster sample scheme analysis with weighting of two strata: Pittsfield vs. the rest of the HRA communities.

Table 8. Percentages of Residents who Reported Birdwatching on or next to the Housatonic River - Exposure Prevalence Study.

Age Group (years)	Pittsfield			The rest of the HRA communities ¹			Total (%; 95% CI) ²
	Male (%)	Female (%)	Subtotal (%)	Male (%)	Female (%)	Subtotal (%)	
0-19	1/110 (0.9)	3/93 (3.2)	4/203 (2.0)	1/102 (1.0)	3/97 (3.1)	4/199 (2.0)	8/402 (2.0, 0.1 ~ 3.9)
20-39	6/94 (6.4)	3/102 (2.9)	9/196 (4.6)	2/80 (2.5)	2/104 (1.9)	4/184 (2.2)	13/380 (3.8, 1.5 ~ 6.2)
40-59	7/86 (8.1)	7/90 (7.8)	14/176 (8.0)	7/119 (5.9)	10/137 (7.3)	17/256 (6.6)	31/432 (7.4, 4.3 ~ 10.5)
60+	2/67 (3.0)	1/101 (1.0)	3/168 (1.8)	4/66 (6.1)	6/81 (7.4)	10/147 (6.8)	13/315 (3.3, 1.3 ~ 5.2)
Total	16/357 (4.5)	14/386 (3.6)	30/743 (4.0)	14/367 (3.8)	21/419 (5.0)	35/786 (4.5)	65/1529 (4.2, 2.7 ~ 5.7)

Notes: ¹ The rest of the HRA communities include Lanesborough, Dalton, Lee, Lenox, Stockbridge, Great Barrington, and Sheffield.
² Rates and confidence intervals (CI) were calculated from cluster sample scheme analysis with weighting of two strata: Pittsfield vs. the rest of the HRA communities.

Table 9. Percentages of Residents who Reported Doing Other Recreational Activities on or next to the Housatonic River - Exposure Prevalence Study.

Age Group (years)	Pittsfield			The rest of the HRA communities ¹			Total (%; 95% CI) ²
	Male (%)	Female (%)	Subtotal (%)	Male (%)	Female (%)	Subtotal (%)	
0-19	22/110 (20.0)	21/93 (22.6)	43/203 (21.2)	10/102 (9.8)	12/97 (12.4)	22/199 (11.1)	65/402 (17.9, 12.4 ~ 23.5)
20-39	19/94 (20.2)	10/102 (9.8)	29/196 (14.8)	16/80 (20.0)	23/104 (22.1)	39/184 (21.2)	68/380 (16.8, 12.3 ~ 21.3)
40-59	22/86 (25.6)	15/90 (16.7)	37/176 (21.0)	19/119 (16.0)	20/137 (14.6)	39/256 (15.2)	76/432 (18.6, 14.1 ~ 23.2)
60+	8/67 (11.9)	4/101 (4.0)	12/168 (7.1)	9/66 (13.6)	5/81 (6.2)	14/147 (9.5)	26/315 (10.7, 4.1 ~ 11.6)
Total	71/357 (20.0)	50/386 (13.0)	121/743 (16.3)	54/367 (14.7)	60/419 (14.3)	114/786 (14.5)	235/1529 (15.7, 12.9 ~ 18.5)

Notes: ¹ The rest of the HRA communities include Lanesborough, Dalton, Lee, Lenox, Stockbridge, Great Barrington, and Sheffield.
² Rates and confidence intervals (CI) were calculated from cluster sample scheme analysis with weighting of two strata: Pittsfield vs. the rest of the HRA communities.

54

Table 10. Percentages of Residents who Reported Eating Fiddlehead Ferns from the Housatonic River Area - Exposure Prevalence Study.

Age Group (years)	Pittsfield				The rest of the HRA communities ¹			
	Male (%)	Female (%)	Subtotal (%)	Male (%)	Female (%)	Subtotal (%)	Total (%; 95% CI) ²	
0-19	1/110 (0.9)	1/93 (1.1)	2/203 (4.2)	0/102 (0.0)	3/97 (3.1)	3/199 (1.5)	5/402 (1.2, 0 ~ 2.8)	
20-39	4/94 (4.3)	8/102 (7.8)	12/196 (6.1)	4/80 (5.0)	4/104 (3.8)	8/184 (4.3)	20/380 (5.6, 2.6 ~ 8.6)	
40-59	5/86 (5.8)	6/90 (6.7)	11/176 (6.3)	9/119 (7.6)	15/137 (10.9)	24/256 (9.4)	35/432 (7.5, 4.7 ~ 10.4)	
60+	4/67 (6.0)	3/101 (3.0)	7/168 (4.2)	6/66 (9.1)	2/81 (2.5)	8/147 (5.4)	15/315 (4.5, 2.0 ~ 7.1)	
Total	14/357 (3.9)	18/386 (4.7)	32/743 (4.3)	19/367 (5.2)	24/419 (5.7)	43/786 (5.5)	75/1529 (4.7, 3.3 ~ 6.1)	

Notes: ¹ The rest of the HRA communities include Lanesborough, Dalton, Lee, Lenox, Stockbridge, Great Barrington, and Sheffield.
² Rates and confidence intervals (CI) were calculated from cluster sample scheme analysis with weighting of two strata: Pittsfield vs. the rest of the HRA communities.

Table 11. Percentages of Residents who Reported Hunting in the Housatonic River Area - Exposure Prevalence Study.

Age Group (years)	Pittsfield		The rest of the HRA communities ¹				Total (%; 95% CI) ²
	Male (%)	Female (%)	Subtotal (%)	Male (%)	Female (%)	Subtotal (%)	
0-19	2/110 (1.8)	0/93 (0.0)	2/203 (1.0)	6/102 (5.9)	0/97 (0.0)	6/199 (3.0)	8/402 (2.2; 0.4 ~ 2.8)
20-39	11/94 (11.7)	1/102 (1.0)	12/196 (6.1)	20/80 (25.0)	3/104 (2.9)	23/184 (12.5)	35/380 (8.1; 5.4 ~ 10.8)
40-59	15/86 (17.4)	1/90 (1.1)	16/176 (9.1)	29/119 (24.4)	1/137 (0.7)	30/256 (11.7)	46/432 (10.2; 1.5 ~ 7.2)
60+	8/67 (11.9)	1/101 (1.0)	9/168 (5.4)	16/66 (24.2)	3/81 (3.7)	19/147 (12.9)	28/315 (7.6; 4.6 ~ 10.6)
Total	36/357 (10.1)	3/386 (0.8)	39/743 (5.2)	71/367 (19.3)	7/419 (1.7)	78/786 (9.9)	117/1529 (6.8; 5.4 ~ 8.2)

Notes: ¹ The rest of the HRA communities include Lanesborough, Dalton, Lee, Lenox, Stockbridge, Great Barrington, and Sheffield.
² Rates and confidence intervals (CI) were calculated from cluster sample scheme analysis with weighting of two strata: Pittsfield vs. the rest of the HRA communities.

Table 13. Percentages of Residents who Reported Doing Other Yard Work at their Current Residence - Exposure Prevalence Study.

Age Group (years)	Pittsfield				The rest of the HRA communities ¹				Total (% 95% CI) ²
	Male (%)	Female (%)	Subtotal (%)	Male (%)	Female (%)	Subtotal (%)	Subtotal (%)		
0-19	26/110 (23.6)	24/93 (25.8)	50/203 (24.6)	31/102 (30.4)	30/97 (30.9)	61/199 (30.7)	111/402 (26.6, 20.7 - 32.4)		
20-39	50/94 (53.2)	54/102 (52.9)	104/196 (53.1)	53/80 (66.3)	62/104 (59.6)	115/184 (62.5)	219/380 (56.0, 50.0 - 62.0)		
40-59	64/86 (74.4)	57/90 (63.3)	121/176 (68.8)	95/119 (79.8)	102/137 (74.5)	197/256 (77.0)	318/432 (72.1, 67.3 - 77.0)		
60+	46/67 (68.7)	53/101 (52.5)	99/168 (58.9)	53/66 (80.3)	53/81 (65.4)	106/147 (72.1)	205/315 (62.8, 56.7 - 69.0)		
Total	186/357 (52.1)	188/386 (48.7)	374/743 (50.3)	232/367 (63.2)	247/419 (58.9)	479/786 (60.9)	853/1529 (53.9, 50.7 - 57.2)		

Notes: ¹ The rest of the HRA communities include Lanesborough, Dalton, Lee, Lenox, Stockbridge, Great Barrington, and Sheffield.
² Rates and confidence intervals (CI) were calculated from cluster sample analysis with weighting of two strata: Pittsfield vs. the rest of the HRA communities.

Table 14. Participation for Blood Work - Exposure Prevalence Study.

	Pittsfield	The rest of the HRA communities ¹	Total
Blood work done	35	34	69
Appointments made and no show at least twice	3	1	4
Not interested	13	19	32
Subjects moved away without forwarding address	2	0	2
Not feasible to fast overnight due to work schedule	1	1	2
Illness/poor health condition ²	5	6	11
TOTAL (Participation Rate %)	59 (59.3%)	61 (55.7%)	120 (57.5%)

Notes: ¹ The rest of the HRA communities include Lanesborough, Dalton, Lee, Lenox, Stockbridge, Great Barrington, and Sheffield.

² Among them, 2 individuals were diabetic and were unable to fast.

Table 15. Comparison of Participants and Non-participants of Blood Work - Exposure Prevalence Study.

	Blood work participants (n=69)	Non-participants (N=51)
Mean and median age (years)	56.0, 58.0	59.6, 58.0
Mean and median years of living at Housatonic River Area	45.4, 45.0	54.6, 56.0
Male/female ratio	1:0.50 (46/23)	1:0.55 (33/18)
Ever ate freshwater fish in general (%)	79.7%	90.2%
Ever ate freshwater fish from the Housatonic (%)	37.7%	25.5%
Ever did farming or construction work on or next to the Housatonic River (%)	13.0%	21.6%
Ever did canoeing, bird watching, or other recreational activities on or next to the Housatonic River (%)	46.4%	31.4%
Ever ate fiddlehead ferns (%)	14.5%	21.6%
Did vegetable gardening at their current residence on a weekly basis during the season (%)	59.4%	64.7%
Did other yard work at their current residence on a weekly basis during the season (%)	69.6%	86.3%
Ever ate the preys hunted from the Housatonic River Area (%)	30.4%	37.3%

60

Table 17. Serum PCB Levels (ppb) by Different Environmental Exposure Categories - Exposure Prevalence Study¹

	Age: 18-64 years			Age: 65 years and over			Total		
	Mean	Median	n	Mean	Median	n	Mean	Median	n
Ever ate freshwater fish ² (frequency):									
Yes, at least twice a month	3.93	3.52	10	8.85	10.09	4	5.33	3.86	14
Yes, less than twice a month	3.70	3.59	23	6.05	5.27	3	3.97	3.67	26
No	4.05	2.57	7	5.48	5.31	5	4.64	3.39	12
Ever ate freshwater fish ² (duration):									
Yes, at least 30 years	3.93	3.53	18	7.80	8.31	5	4.77	3.78	23
Yes, less than 30 years	3.57	3.57	15	7.29	7.29	2	4.00	3.61	17
No	4.05	2.57	7	5.48	5.31	5	4.64	3.39	12
Ever ate fiddlehead ferns:									
Yes	3.95	3.93	7	5.27	5.27	1	4.12	4.30	8
No	3.79	3.43	33	6.88	6.99	11	4.56	3.62	44
Ever Canoed:									
Yes	4.13	3.35	17	6.22	4.95	4	4.53	3.53	21
No	3.58	3.61	23	7.01	7.65	8	4.47	3.78	31
Ever Birdwatched:									
Yes	3.08	3.08	2	3.78	3.78	1	3.31	3.59	3
No	3.85	3.43	38	7.02	6.99	11	4.56	3.70	49
Ever Did Vegetable Gardening:									
Yes	3.75	3.62	26	6.63	6.15	10	4.55	3.86	36
No	3.93	3.13	14	7.33	7.33	2	4.36	3.30	16
Ever Did Other Yard Work:									
Yes	3.82	3.51	34	6.60	5.31	11	4.50	3.70	45
No	3.77	1.69	6	8.32	8.32	1	4.42	1.74	7

Notes: ¹ Participants with opportunities for occupational exposure were excluded from analysis. Associations can not be further examined due to the small size of this study and because individual participants may have had multiple non-workplace exposure opportunities.

² Freshwater fish from any source including the Housatonic River.

Table 18. Age, Sex, and Region Distribution of the Participants in the Household Interview Part of the Volunteer Study.

Age Group (years)	Pittsfield		The rest of the HRA communities ¹					Total (%)
	Male (%)	Female (%)	Subtotal (%)	Male (%)	Female (%)	Subtotal (%)		
0-59	38 (70.0)	45 (71.4)	83 (70.9)	12 (54.4)	12 (63.2)	24 (58.5)	107 (67.7)	
60+	16 (30.0)	18 (28.6)	34 (29.1)	10 (45.5)	7 (36.8)	17 (41.5)	51 (32.3)	
Total	54 (100)	63 (100)	117 (100)	22 (100)	19 (100)	41 (100)	158 (100)	

Note: ¹ The rest of the HRA communities include Lanesborough, Dalton, Lee, Lenox, Stockbridge, Great Barrington, and Sheffield.

Table 19. Percentages of Residents Who Reported Activities on or next to Housatonic River and its Floodplain - Volunteer Study.

Activities	Male (%)	Female (%)	Total (%)
Ever eating freshwater fish	54/76 (71.1)	51/82 (62.2)	105/158 (66.5)
Ever fish in the Housatonic river	24/76 (31.6)	4/82 (4.9)	28/158 (17.7)
Ever eating Fiddlehead Ferns from the Housatonic River Area	7/76 (9.2)	6/82 (7.3)	13/158 (8.2)
Ever canoeing on the Housatonic river	22/76 (28.9)	12/82 (14.6)	34/158 (21.5)
Ever bird-watching along the Housatonic river	4/76 (5.3)	8/82 (9.8)	12/158 (7.6)
Ever doing vegetable garden at current residence	41/76 (53.9)	42/82 (51.2)	83/158 (52.5)
Ever doing other yard work at current residence	50/76 (65.8)	50/82 (61.0)	100/158 (63.3)

Table 20. Fish Consumption - Volunteer Study.

	Ever ate fresh water fish in general		Ever ate fish from the Housatonic River	
	n	Percentage (%)	n	Percentage (%)
Species of fish consumed				
Bass	25	23.8	1	11.1
Trout	97	92.4	9	100.0
Perch	50	47.6	5	55.6
Sunfish	3	2.9	0	0.0
Pickereel	11	10.5	0	0.0
Bullhead	21	20.0	4	44.4
Crappie	0	0.0	0	0.0
Shiners	0	0.0	0	0.0
Suckers	0	0.0	0	0.0
Goldfish	0	0.0	0	0.0
Carp	3	2.9	0	0.0
Other	1	1.0	0	0.0
Frequency of fish consumption				
>=3 per week	0	0.0	0	0.0
1-2 per week	12	11.4	1	11.1
1-4 per month	33	31.4	4	44.4
< 1 per month	60	57.1	4	44.4
Total	105	100.0	9	100.0
Years of fish consumption				
0-4	27	25.7	1	11.1
5-9	11	10.5	0	0.0
10-19	23	21.9	2	22.2
20-29	16	15.2	1	11.1
30-39	14	13.3	2	22.2
40 +	14	13.3	3	33.3
Don't know	0	0.0	0	0.0
Total	105	100.0	9	100.0
Ways of obtaining fish				
Catch Own	40	38.1	4	44.4
Family/friends caught	48	45.7	5	55.6
Other local fishermen	2	1.9	0	0.0
Supermarket/grocery store	13	12.4	0	0.0
Don't know	2	1.9	0	0.0
Total	105	100.0	9	100.0
Places where fish were caught				
Housatonic River	9	8.6	-	-
Hoosic River	0	0.0	-	-
Other Locations	70	66.7	-	-
Don't know	26	24.8	-	-
Total	105	100.0	-	-

Table 21. Comparison of Participants and Non-participants of Blood Work - Volunteer Study.

	Blood work participants (n=79)	Non-participants (N=47)
Mean and median age (years)	58.8, 58.0	45.3, 45.0
Mean and median years of living at Housatonic River Area	48.1, 51.0	31.9, 25.0
Male/female ratio	1:1.93 (41/38)	1:1.24 (21/26)
Ever ate freshwater fish in general (%)	70.9%	72.3%
Ever ate freshwater fish from the Housatonic (%)	6.3%	4.3%
Ever did farming or construction work on or next to the Housatonic River (%)	6.3%	6.4%
Ever did canoeing, bird watching, or other recreational activities on or next to the Housatonic River (%)	59.5%	66.0%
Ever ate fiddlehead ferns (%)	12.7%	6.4%
Did vegetable gardening at their current residence on a weekly basis during the season (%)	63.3%	38.3%
Did other yard work at their current residence on a weekly basis during the season (%)	79.7%	42.6%
Ever ate the preys hunted from the Housatonic River Area (%)	17.7%	8.5%

Table 22. Serum PCB Levels (ppb) by Age, Sex, and Region - Volunteer Study

Age Group (years)	Pittsfield										Other communities ¹													
	Male					Female					Subtotal			Male			Female			Subtotal				
	Mean	Median	n	Mean	Median	n	Mean	Median	n	Mean	Median	n	Mean	Median	n	Mean	Median	n	Mean	Median	n	Mean	Median	n
18-64	6.64	5.15	25	2.81	1.00	15	5.21	4.12	40	13.07	13.07	1	10.65	7.33	5	11.05	9.02	6	5.97	4.32	46			
65+	10.20	10.65	11	9.00	8.13	14	9.53	9.65	25	26.84	8.39	6	21.39	21.39	2	25.48	8.39	8	13.40	9.39	33			
Total	7.73	6.43	36	5.80	5.24	29	6.87	6.26	65	24.88	9.39	7	13.72	7.33	7	19.30	8.39	14	9.07	6.60	79			

Note: ¹ Mainly, Lanesborough, Dalton, Lee, Lenox, Stockbridge, Great Barrington, and Sheffield.

65

Table 23. Serum PCB Levels (ppb) by Different Environmental Exposure Categories - Volunteer Study¹

	Age: 18-64 years			Age: 65 years and over			Total		
	Mean	Median	n	Mean	Median	n	Mean	Median	n
Ever ate freshwater fish ² (frequency):									
Yes, at least twice a month	4.26	3.24	5	9.87	10.23	3	6.36	7.13	8
Yes, less than twice a month	3.60	2.93	20	7.30	7.63	10	4.84	4.32	30
No	6.61	1.66	8	8.16	7.53	7	7.33	5.24	15
Ever ate freshwater fish ² (duration):									
Yes, at least 30 years	4.69	6.64	7	9.85	10.02	4	6.57	7.10	11
Yes, less than 30 years	3.36	2.92	18	7.02	7.69	9	4.58	4.05	27
No	6.61	1.66	8	8.16	7.53	7	7.33	5.24	15
Ever ate fiddlehead ferns:									
Yes	4.57	5.09	4	7.04	7.69	3	5.63	6.93	7
No	4.41	2.81	29	8.15	7.90	17	5.80	4.84	46
Ever Canoeed:									
Yes	2.67	1.00	12	6.18	5.98	4	3.55	3.13	16
No	5.43	3.13	21	8.44	7.98	16	6.74	5.24	37
Ever Birdwatched:									
Yes	7.33	7.33	1	-	-	-	7.33	7.33	1
No	4.34	2.83	32	7.99	7.80	20	5.74	5.84	52
Ever Did Vegetable Gardening:									
Yes	4.75	1.92	20	7.84	7.61	18	6.22	5.01	38
No	3.94	3.13	13	9.28	9.28	2	4.66	3.24	15
Ever Did Other Yard Work:									
Yes	3.72	2.93	30	7.76	7.61	16	5.12	4.84	46
No	11.58 ³	2.32	3	8.91	9.89	4	10.05 ³	7.90	7

Notes: ¹ Participants with opportunities for occupational exposure were excluded from analysis. Associations can not be further examined due to the small size of this study and because individual participants may have had multiple non-workplace exposure opportunities.

² Freshwater fish from any source including the Housatonic River.

³ The means were heavily influenced by the highest level (31.41 ppb) of the Volunteer Study due to small cell numbers. This outlier did not change observations for other exposure categories.

Table 24. Validity Analysis of the Household Screening Survey as Compared with the Personal Interview - Exposure Prevalence Study.

Comparison of Household Screening Survey versus Personal Interview ¹	Sensitivity ² (%)	Specificity ³ (%)	Overall Agreement ⁴ (%)
Ever did construction work that brought them in contact with the Housatonic River	75.0	95.4	94.2
Ever did farming work that brought them in contact with the Housatonic River	100.0	100.0	100.0
Ever did work other than construction or farming that brought them in contact with the Housatonic River	75.0	98.4	95.7
Ever ate freshwater fish	98.1	86.7	95.7
Ever fished in the Housatonic River	73.3	92.3	84.1
Ever ate fiddlehead ferns from the Housatonic River Area	71.4	100.0	94.2
Ever did canoeing on the Housatonic River	76.0	95.5	88.4
Ever did birdwatching in the Housatonic River Area	75.0	93.8	92.8
Ever did any other recreational activities on or next to the Housatonic River	65.2	93.5	84.1
Ever hunted in the Housatonic River Area	86.4	95.7	92.8
Ever did vegetable gardening at their current residence	93.2	68.0	84.1
Ever did other yard work at their current residence	98.2	66.7	92.8

Notes

- ¹ Data were used from the 69 individuals who participated in blood testing.
- ² Percent of the time that the screening interviewers correctly picked up the activity.
- ³ Percent of the time that the screening interviewers correctly ruled out the activity.
- ⁴ Percent of responses for which the screening and personal interviewers agreed.

67

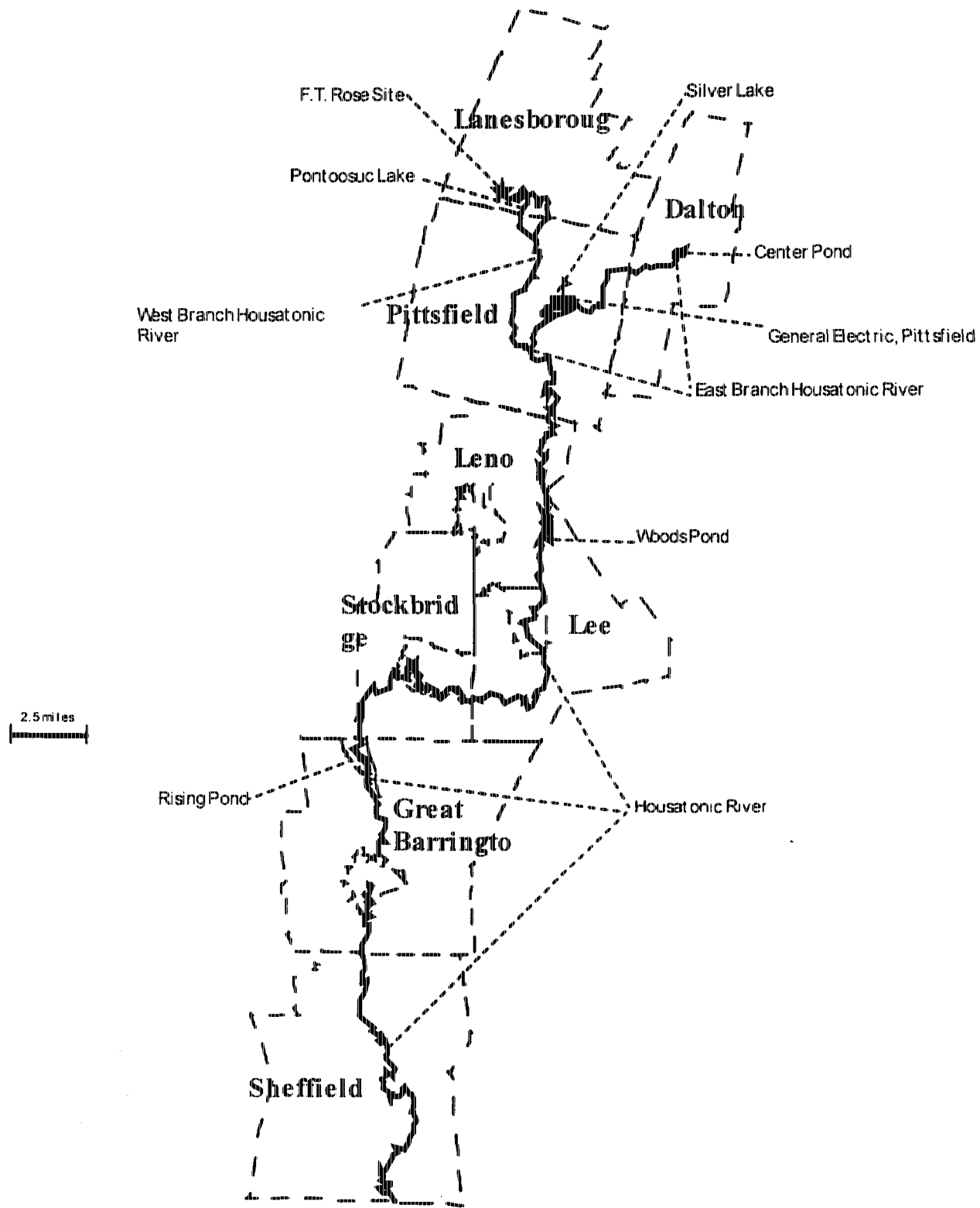


Figure 1. The Housatonic River Area.

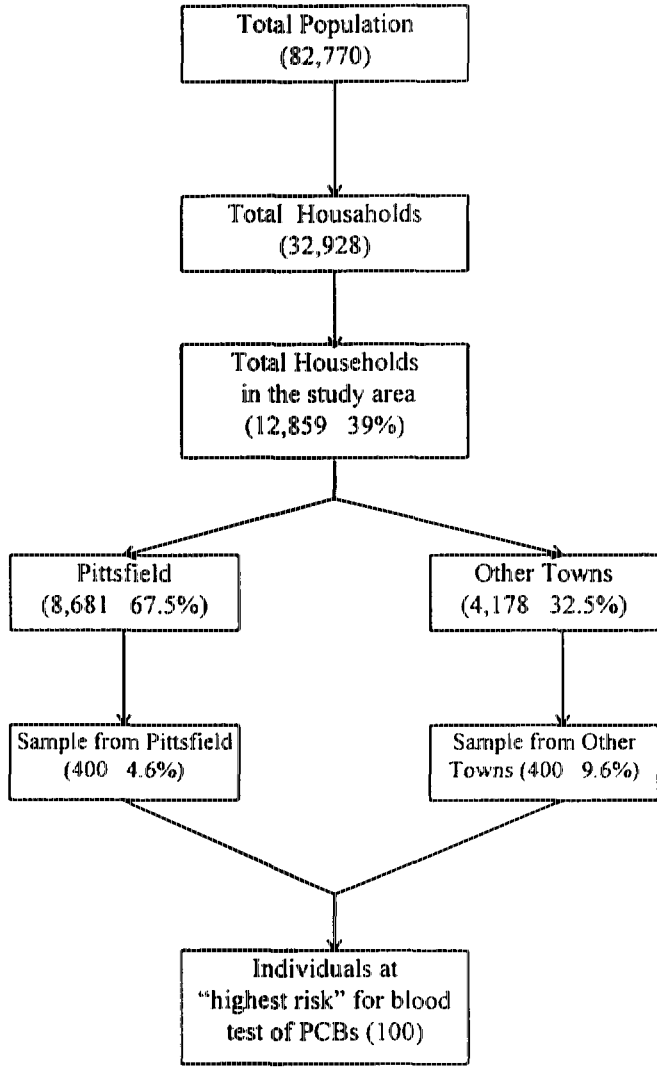


Figure 2. Population and Sample Estimates - Exposure Prevalence Study.

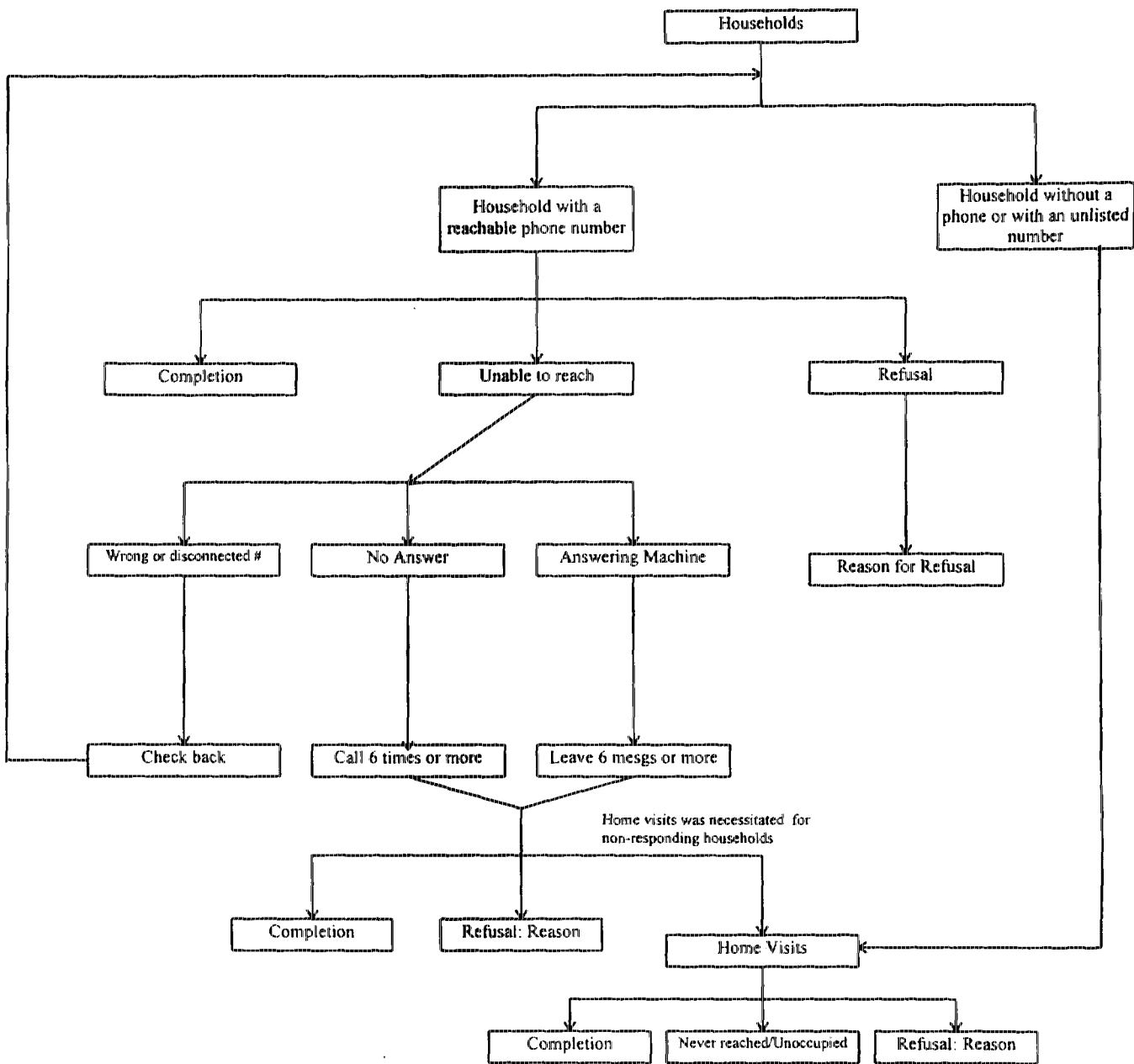


Figure 3. Household Screening Survey Flowchart - Exposure Prevalence Study.

11

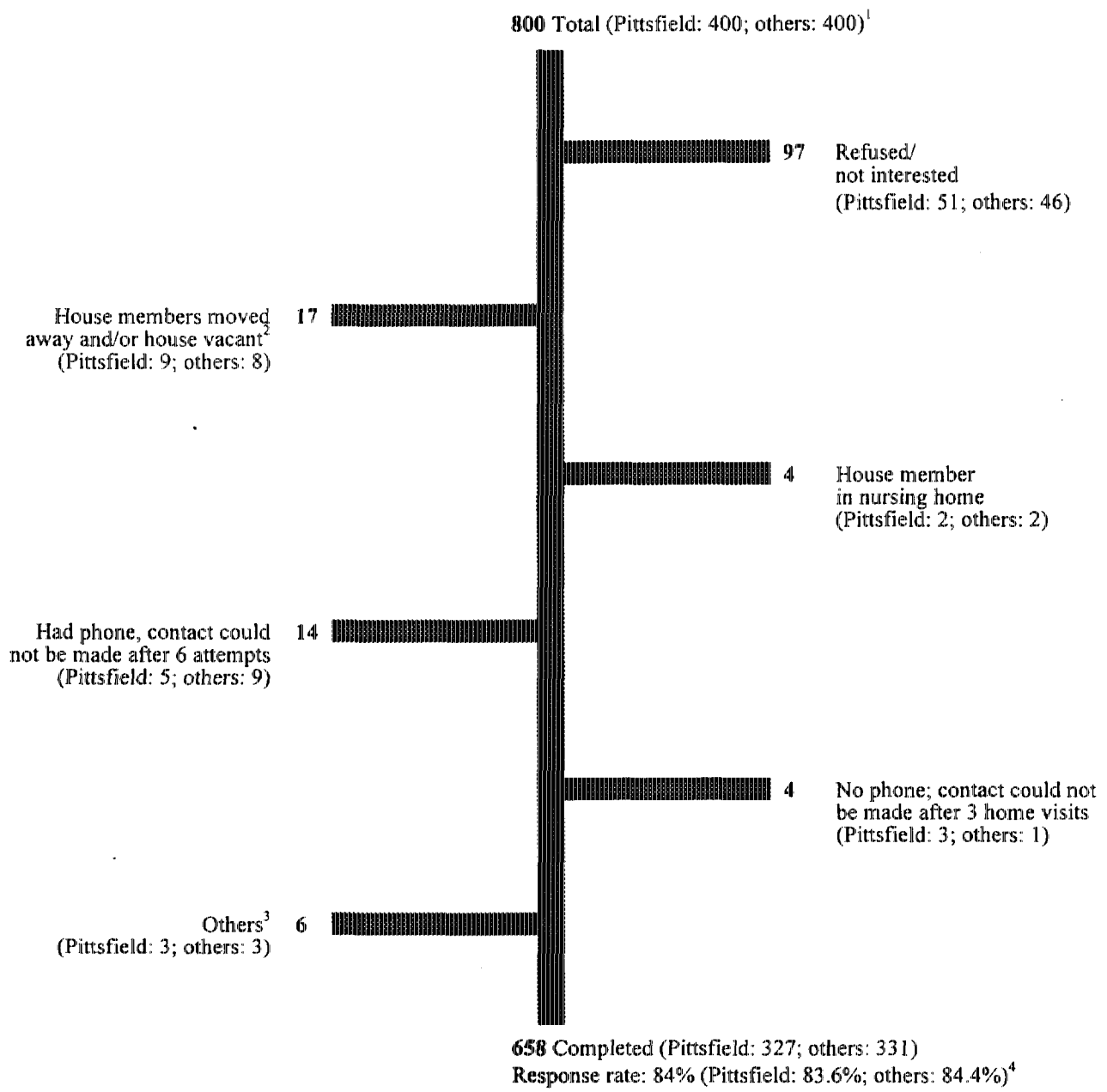


Figure 4. Response to Household Screening Survey - Exposure Prevalence Study

Notes:

¹ Numbers in parentheses break the total into the respective numbers for Pittsfield and the other HRA communities. The other HRA communities are Lanesborough, Dalton, Lee, Lenox, Stockbridge, Great Barrington, and Sheffield.

² No forwarding address available and house vacant at the time of attempted home visit.

³ Including mentally disabled, poor health conditions, etc.

⁴ Response rate = 658/783 (Pittsfield: denominator excludes 17 vacant, and therefore ineligible, households).

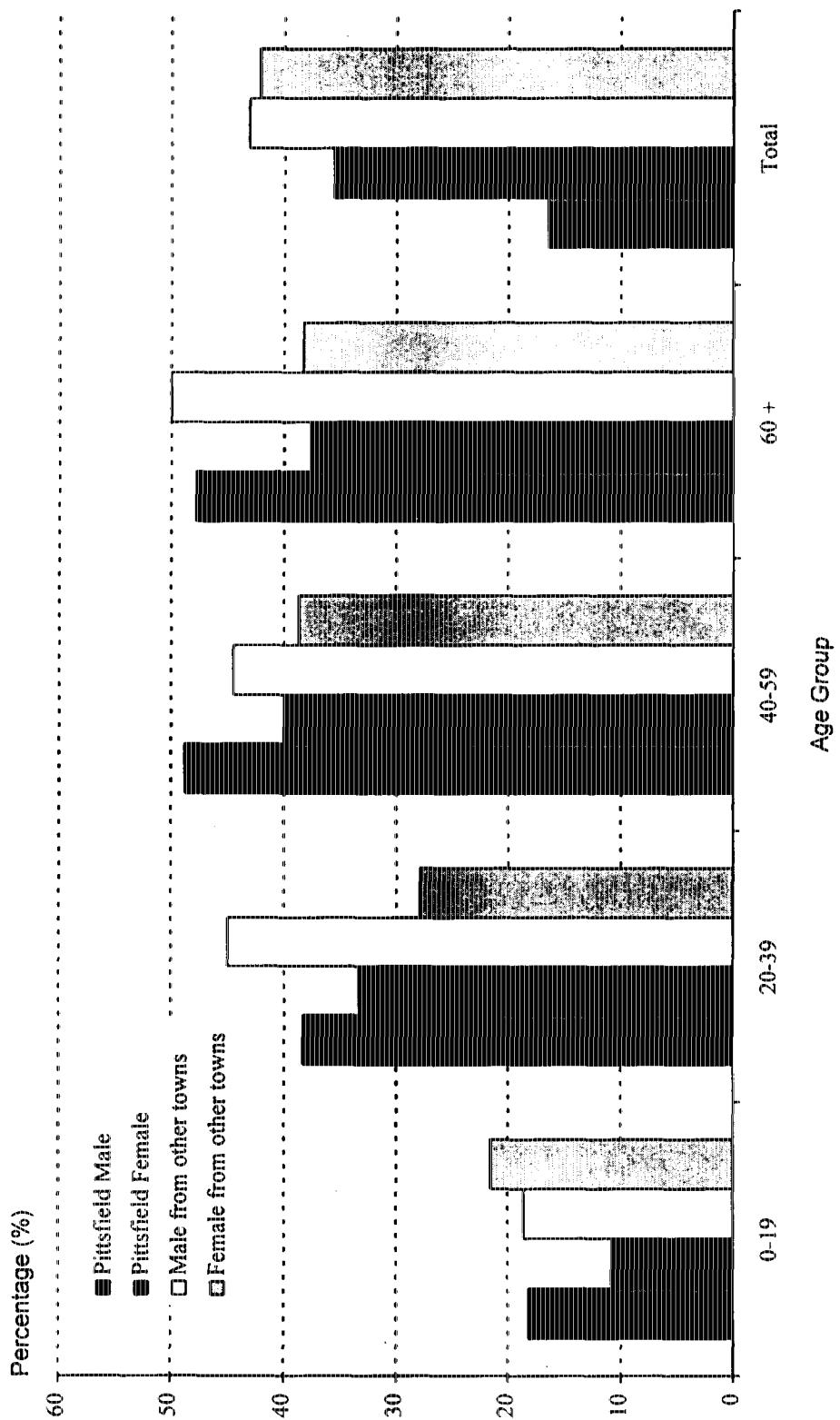
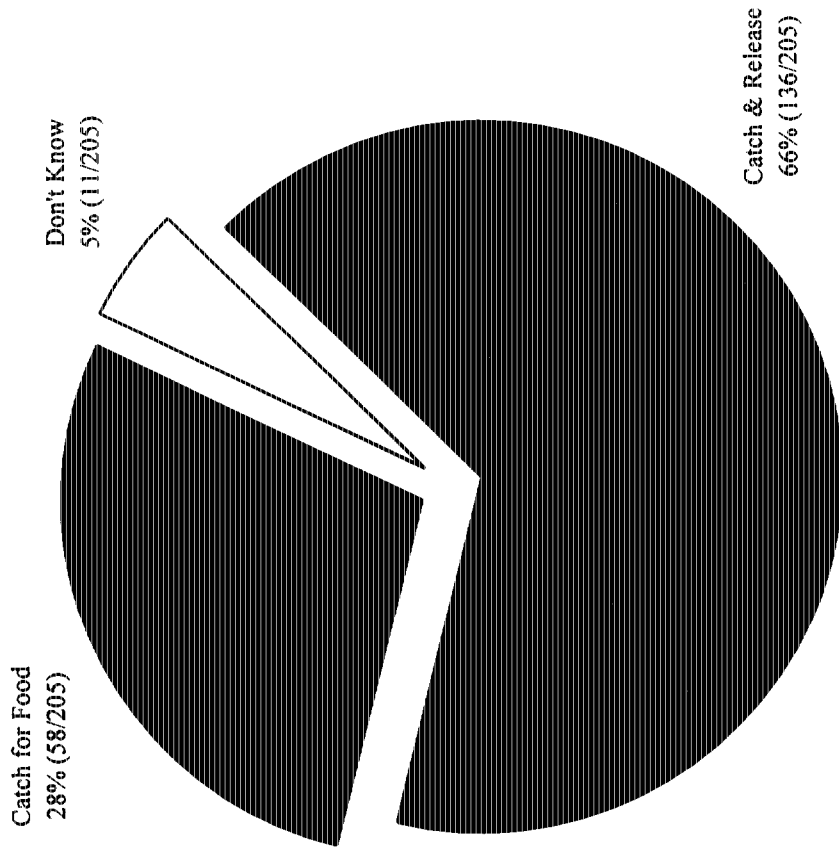


Figure 5. Proportion of Local Residents Who Reported Eating Fresh Water Fish.

72



** No one reported catching fish from Housatonic River for sale

Figure 6. Reported Purposes of Fishing in the Housatonic River, Berkshire County, Massachusetts.

28

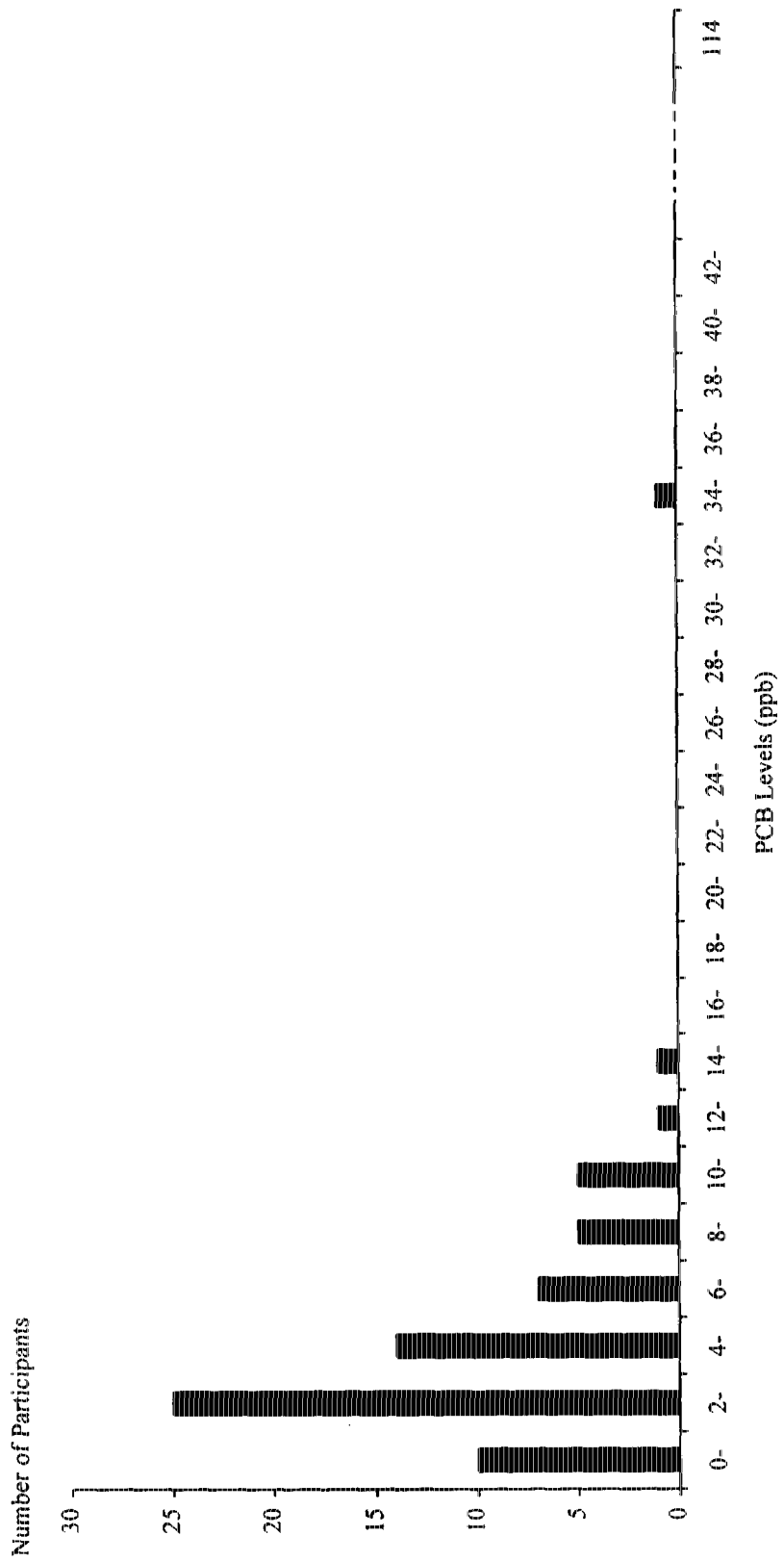


Figure 7. Distribution of Serum PCB Levels - Exposure Prevalence Study.

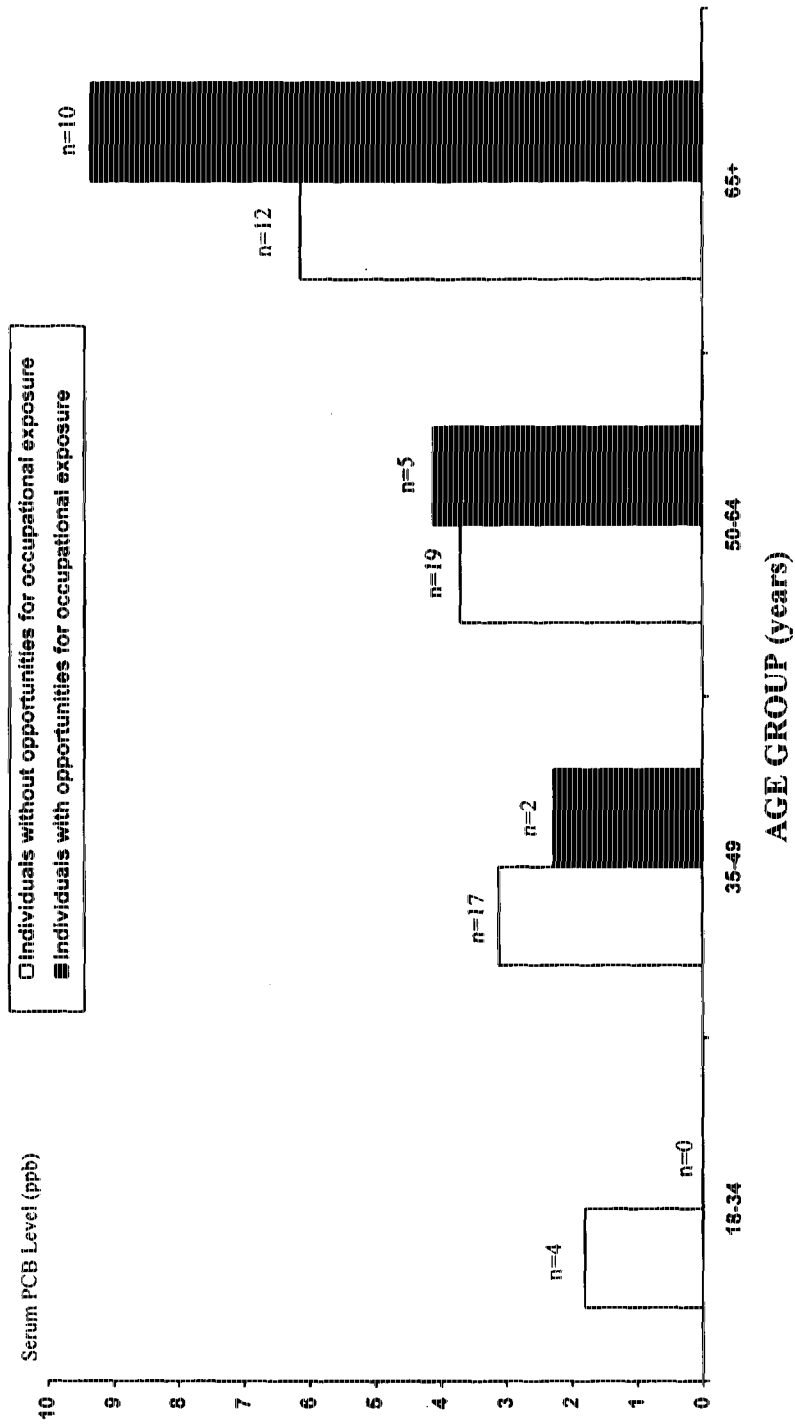


Figure 8. Distribution of Serum PCB Level with Occupational Status and Age - Exposure Prevalence Study

Notes:
 1 Individuals within each group may have had multiple non-workplace exposure opportunities.
 2 Bars represent median serum PCB levels.

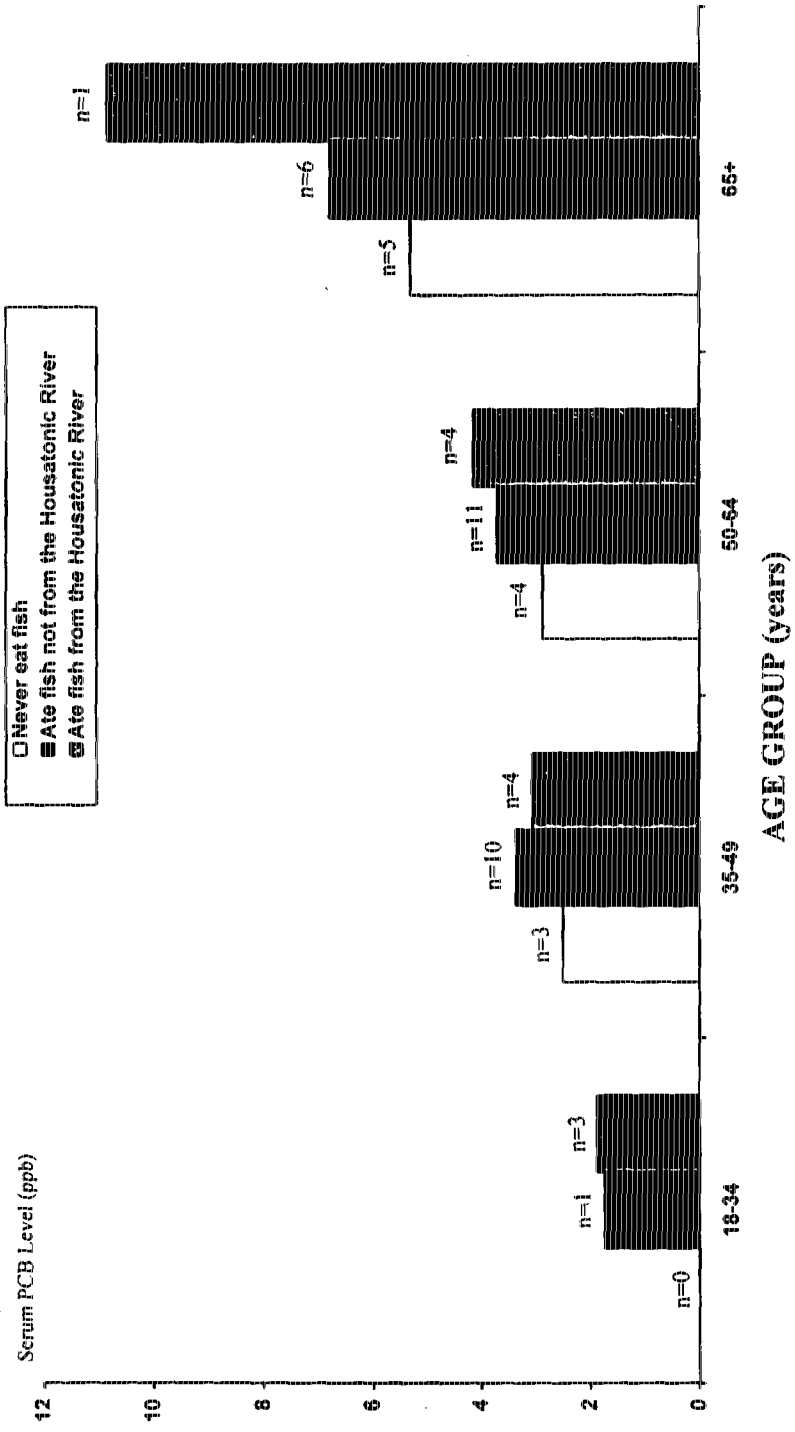


Figure 9. Distribution of Serum PCB Level with Consumption of Freshwater Fish and Age - Exposure Prevalence Study

- Notes:
- ¹ Participants with opportunities for occupational exposure were excluded from analysis.
 - ² Individuals within each group may have had multiple non-workplace exposure opportunities.
 - ³ Bars represent median serum PCB levels.

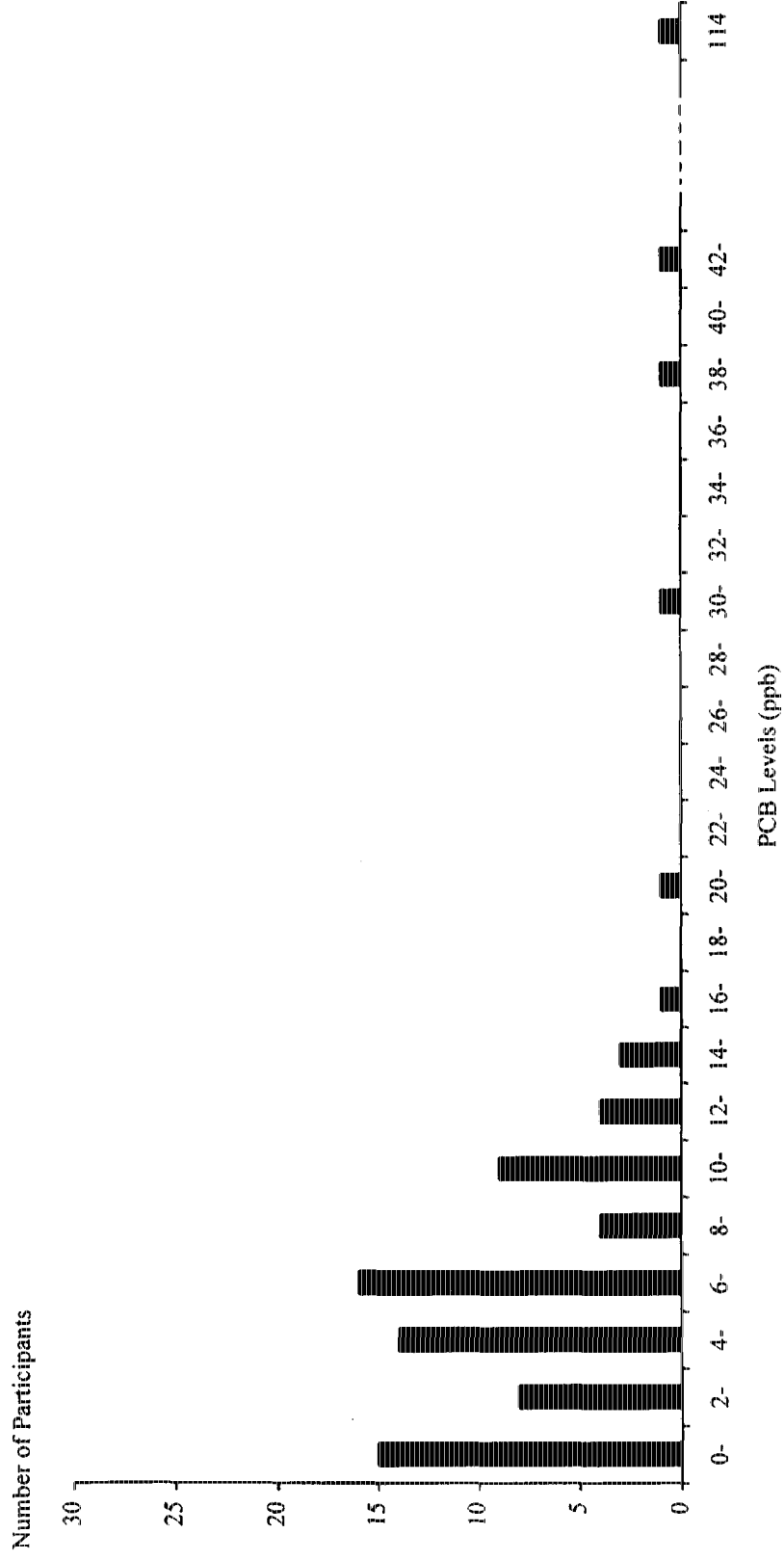


Figure 10. Distribution of Serum PCB Levels - Volunteer Study.

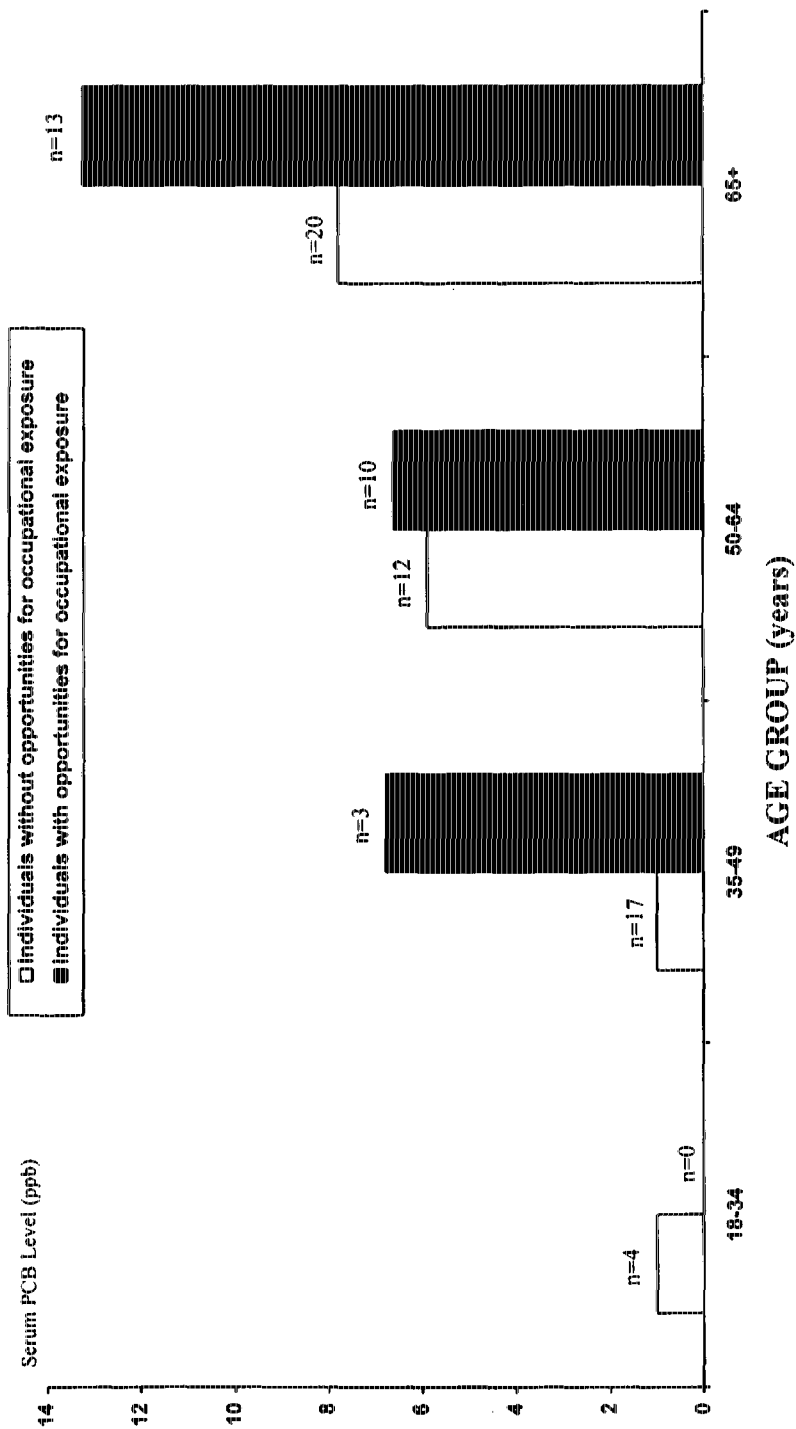


Figure 11. Distribution of Serum PCB Level with Occupational Status and Age - Volunteer Study

Notes: ¹ Individuals within each age group may have had multiple non-workplace exposure opportunities. ² Bars represent median serum PCB levels.

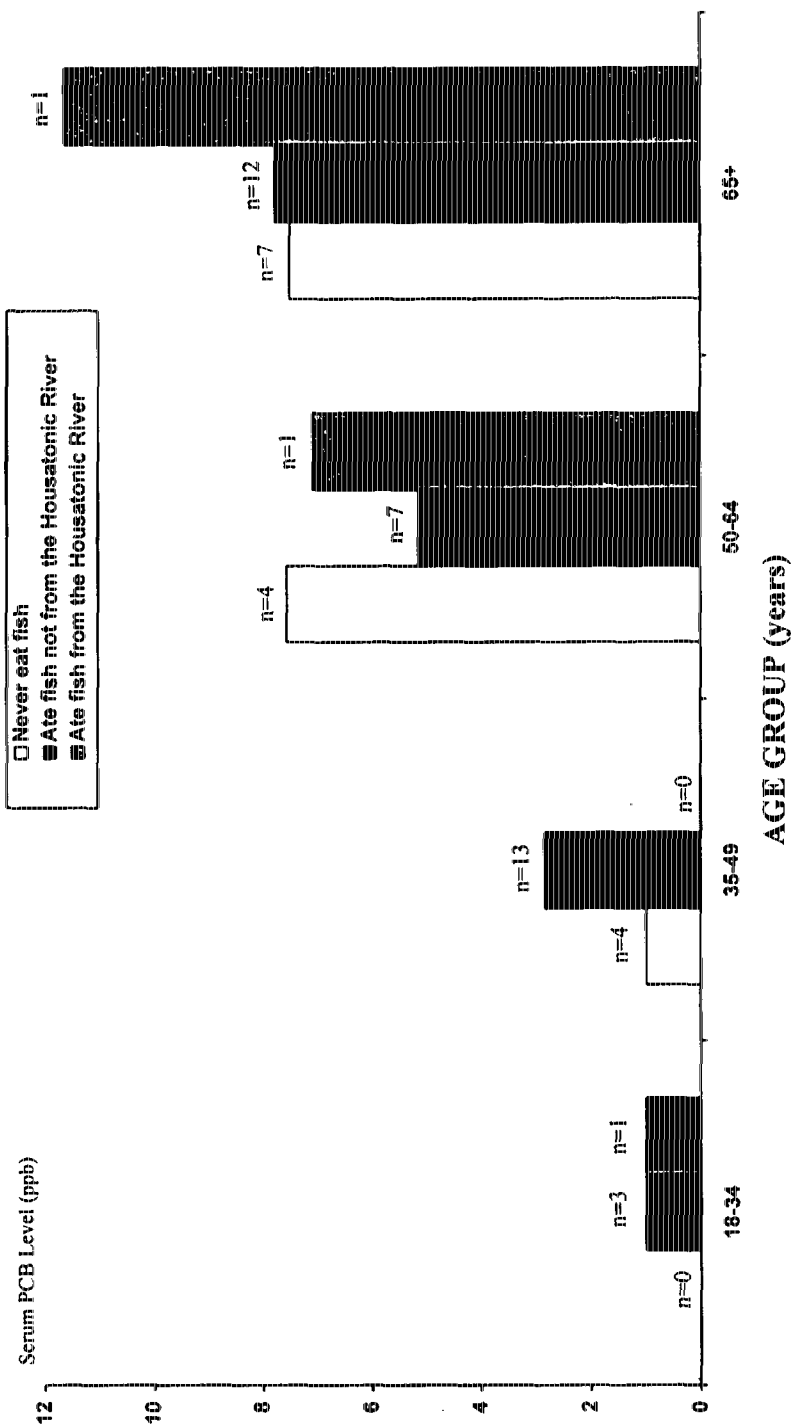


Figure 12. Distribution of Serum PCB Level with Consumption of Freshwater Fish and Age - Volunteer Study

- Notes:
- ¹ Participants with opportunities for occupational exposure were excluded from analysis.
 - ² Individuals within each age group may have had multiple non-workplace exposure opportunities.
 - ³ Bars represent median serum PCB levels.

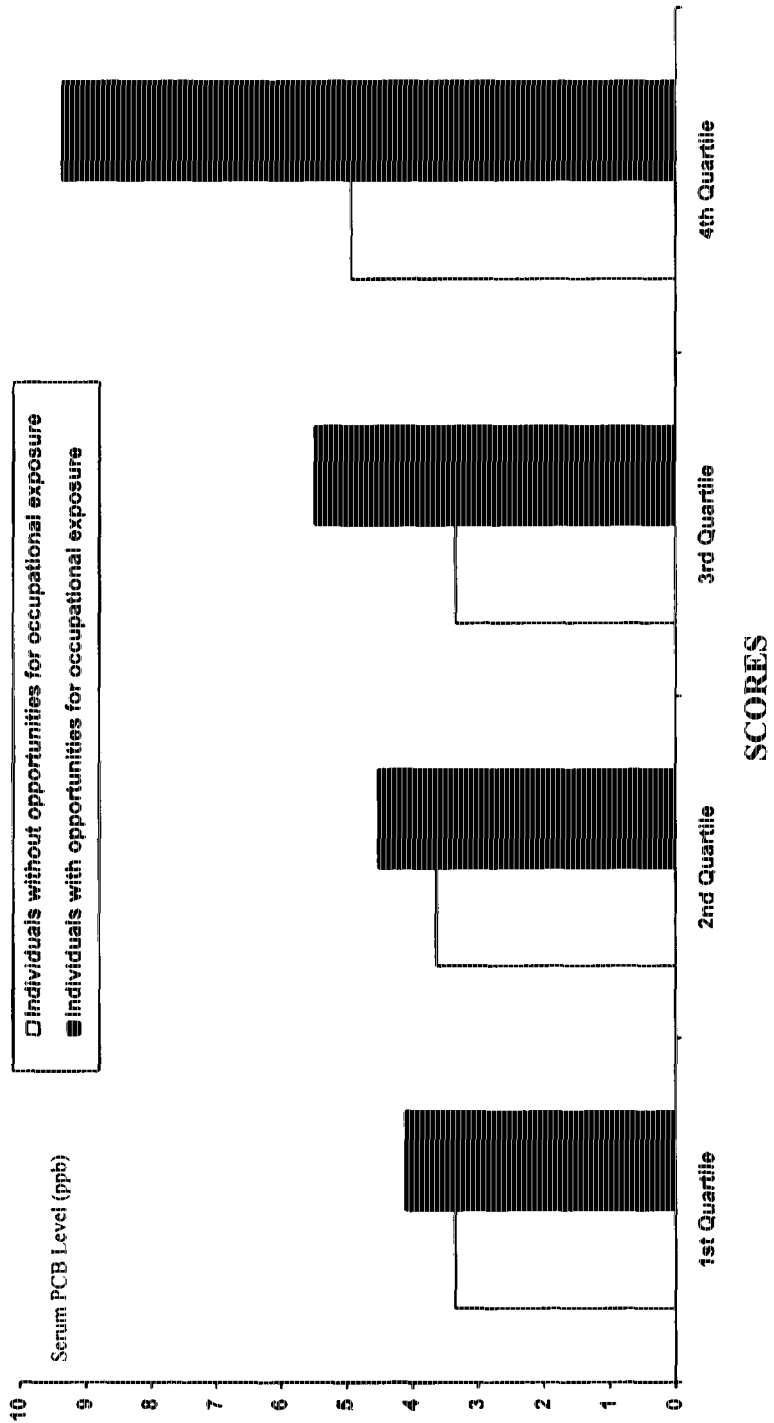


Figure 13. Distribution of Serum PCB Level with Scores - Exposure Prevalence Study

Note: Bars represent median serum PCB levels.

80

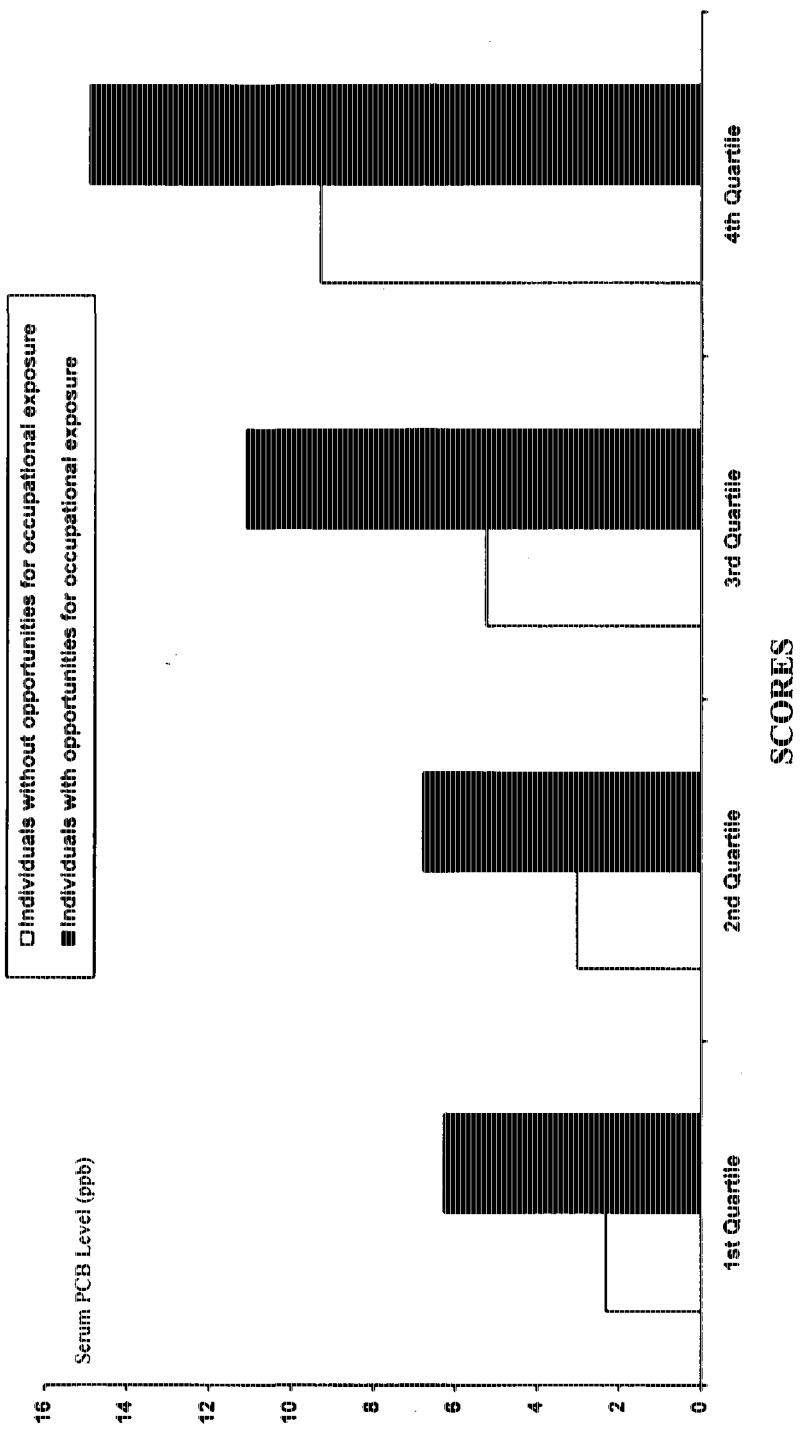


Figure 14. Distribution of Serum PCB Level with Scores - Volunteer Study

Note: Bars represent median serum PCB levels.

81

APPENDICES

Appendix A Household Screening Questionnaire

34

Study Id: _____

MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH
HOUSATONIC RIVER AREA PCB EXPOSURE ASSESSMENT STUDY

HOUSEHOLD SCREENING QUESTIONNAIRE

Subject's Name: _____ Date: _____

Interviewer: _____ Time began: _____

1 Hello, may I speak with _____ (name of subject) _____?

IF NOT AVAILABLE:

My name is (your name), and I am calling on behalf of the Massachusetts Department of Public Health. You should have received a letter from the Department about our PCB Exposure Assessment study in the Housatonic River Area (HRA). We would like to ask a few questions about current members of your household as part of our study. This survey usually takes about 10 - 15 minutes.

Are you a household member who could answer questions about other family members?

- Yes..... 1
- No(ask for appropriate person)..... 2
- Refused..... 7

IF AVAILABLE:

My name is (your name), and I am calling on behalf of the Massachusetts Department of Public Health. You should have received a letter from the Department about our PCB Exposure Assessment study in the Housatonic River Area (HRA). We would like to ask a few questions about current members of your household as part of our study. This survey usually takes about 10 - 15 minutes.

First, could you please tell me your full name?

First Name _____ Last Name _____

(Use interviewing schedule to verify the address and phone number)

Street Name and Number _____

City/Town, State/Zip _____

() Telephone _____

What is your relationship to the other members of your household?

- | | | | |
|-------------|-----------------|--------------------------|---------------------|
| 1 - Mother | 5 - Grandfather | 9 - Daughter | 13 - House/Roommate |
| 2 - Father | 6 - Grandmother | 10 - Son | 14 - Others |
| 3 - Husband | 7 - Aunt | 11 - Cousin | |
| 4 - Wife | 8 - Uncle | 12 - Non-Relative/Friend | |

Now, I'd like to ask you some more questions about each member of your household. Let's start with the eldest person first.

Questions	1. Eldest household member	2. Next eldest household member	3. Next eldest household member
1. What is this person's name?	First name _____ Last name _____	First name _____ Last name _____	First name _____ Last name _____
2. Is this person a male or female?	1 - Male _____ 2 - Female _____	1 - Male _____ 2 - Female _____	1 - Male _____ 2 - Female _____
3. What was your {his/her} age on your {his/her} last birthday?	_____ years	_____ years	_____ years
4.1 How long have you {has he/she} lived at your current address?	_____ years	_____ years	_____ years
4.2 Where did you {he/she} live before?	_____ years	_____ years	_____ years
4.3 How long had you {he/she} lived there?	_____ years	_____ years	_____ years
4.4 Can you estimate how long you {he/she} ever lived in the Housatonic River Area?	_____ years	_____ years	_____ years
5.1 What has been your {his/her} usual occupation?	occupation _____ (month/year) _____	occupation _____ (month/year) _____	occupation _____ (month/year) _____
5.2 Which company did you {he/she} usually work for?	_____	_____	_____
5.3 How many years did you {he/she} work there?	_____ years	_____ years	_____ years
6.1 Have you {Has he/she} ever been employed in a job that brought you {he/she} into contact with the Housatonic River?	Construction Y, N, D _____ Farming Y, N, D _____ Others (month/year) Y, N, D _____	Construction Y, N, D _____ Farming Y, N, D _____ Others (month/year) Y, N, D _____	Construction Y, N, D _____ Farming Y, N, D _____ Others (month/year) Y, N, D _____
6.2 (If YES), how long?	_____ years	_____ years	_____ years
7. Have you {Has he/she} ever eaten freshwater fish in general (or from any source)? (If No or Don't Know, skip the next 4 questions)	1. Yes _____ 2. No _____ 9. Don't know _____	1. Yes _____ 2. No _____ 9. Don't know _____	1. Yes _____ 2. No _____ 9. Don't know _____
8. I'm going to read a list of fish species, please tell me which of these fish you have consumed. They are bass, trout, perch, sunfish, pickerel, bullhead, crappie, shiners, suckers, goldfish, and carp (HELP THE RESPONDENT TO SELECT THE THREE TOP MOST FREQUENTLY EATEN FISHES).	1 - bass _____ 2 - trout _____ 3 - perch _____ 4 - sunfish _____ 5 - pickerel _____ 6 - bullhead _____ 7 - crappie _____ 8 - shiners _____ 9 - suckers _____ 10 - goldfish _____ 11 - carp _____ 12 - others (specify) _____	1 - bass _____ 2 - trout _____ 3 - perch _____ 4 - sunfish _____ 5 - pickerel _____ 6 - bullhead _____ 7 - crappie _____ 8 - shiners _____ 9 - suckers _____ 10 - goldfish _____ 11 - carp _____ 12 - others (specify) _____	1 - bass _____ 2 - trout _____ 3 - perch _____ 4 - sunfish _____ 5 - pickerel _____ 6 - bullhead _____ 7 - crappie _____ 8 - shiners _____ 9 - suckers _____ 10 - goldfish _____ 11 - carp _____ 12 - others (specify) _____
9. Can you estimate the frequency and total number of years you have {he/she} has been eating these types of fish?	Frequency: _____ years	Frequency: _____ years	Frequency: _____ years

Total # of household members: _____ ID#: _____

	1. Eldest household member	2. Next eldest household member	3. Next eldest household member
10. How did you{he/she} usually obtain those fish?	1 - Have no idea _____ 2 - Catch own _____ 3 - Family/friends caught _____ 4 - Other local fishermen _____ 5 - Supermarket/grocery stores _____ 1. - Have no idea _____ 2. - Housatonic River _____ 3. - Hoosic River _____ 4. - Others(specify) _____	1 - Have no idea _____ 2 - Catch own _____ 3 - Family/friends caught _____ 4 - Other local fishermen _____ 5 - Supermarket/grocery stores _____ 1. - Have no idea _____ 2. - Housatonic River _____ 3. - Hoosic River _____ 4. - Others(specify) _____	1 - Have no idea _____ 2 - Catch own _____ 3 - Family/friends caught _____ 4 - Other local fishermen _____ 5 - Supermarket/grocery stores _____ 1. - Have no idea _____ 2. - Housatonic River _____ 3. - Hoosic River _____ 4. - Others(specify) _____
11. (If answer 2, 3 or 4 to Q10) Do you know where the fish were usually caught?	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____
12.1 Have you{Has he/she} ever fished in the Housatonic River?	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____
12.2 (If YES), what did you{he/she} do with the fish?	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____
13.1 Have you{Has he/she} ever taken or consumed fiddlehead ferns from the Housatonic River Area?	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____
13.2 (If YES), how often?	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____
14.1 Have you{Has he/she} ever participated in the following activities on or next to the Housatonic River?	Canoeing: Y, N, D _____ Frequency: _____ Bird Watching: Y, N, D _____ Frequency: _____ Others(specify): Y, N, D _____ Frequency: _____	Canoeing: Y, N, D _____ Frequency: _____ Bird Watching: Y, N, D _____ Frequency: _____ Others(specify): Y, N, D _____ Frequency: _____	Canoeing: Y, N, D _____ Frequency: _____ Bird Watching: Y, N, D _____ Frequency: _____ Others(specify): Y, N, D _____ Frequency: _____
14.2 (If YES), how often?	Canoeing: Y, N, D _____ Frequency: _____ Bird Watching: Y, N, D _____ Frequency: _____ Others(specify): Y, N, D _____ Frequency: _____	Canoeing: Y, N, D _____ Frequency: _____ Bird Watching: Y, N, D _____ Frequency: _____ Others(specify): Y, N, D _____ Frequency: _____	Canoeing: Y, N, D _____ Frequency: _____ Bird Watching: Y, N, D _____ Frequency: _____ Others(specify): Y, N, D _____ Frequency: _____
15.1 Have you{he/she} ever hunted in the Housatonic River Area?	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____
15.2 (If YES), did you{he/she} hunt for food?	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____
15.3 (If YES), what types of prey do you {does he/she} usually eat?	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____
15.4 How often?	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____
16.1 Have you{Has he/she} ever done gardening or yard work at current address?	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____
16.2 (If YES), how often?	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____
17. Now, I would like to ask the last question. Can you think of any other important ways you may have come in contact with PCB that I have not mentioned in this interview?			

Questions	4. Next eldest household member	5. Next eldest household member	6. Next eldest household member
1. What is this person's name?	First name: _____ Last name: _____	First name: _____ Last name: _____	First name: _____ Last name: _____
2. Is this person a male or female?	1 - Male _____ 2 - Female _____	1 - Male _____ 2 - Female _____	1 - Male _____ 2 - Female _____
3. What was your {his/her} age on your {his/her} last birthday?	_____ years	_____ years	_____ years
4.1 How long have you {has he/she} lived at your current address?	_____ years	_____ years	_____ years
4.2 Where did you {he/she} live before?	_____ years	_____ years	_____ years
4.3 How long had you {he/she} lived there?	_____ years	_____ years	_____ years
4.4 Can you estimate how long you {he/she} ever lived in the Housatonic River Area?	_____ years	_____ years	_____ years
5.1 What has been your {his/her} usual occupation?	_____	_____	_____
5.2 Which company did you {he/she} usually work for?	_____	_____	_____
5.3 How many years did you {he/she} work there?	_____ years	_____ years	_____ years
6.1 Have you {Has he/she} ever been employed in a job that brought you {he/she} into contact with the Housatonic River?	Construction Y, N, D 1, 2, 3 Farming Y, N, D 1, 2, 3 Others (specify) Y, N, D 1, 2, 3	Construction Y, N, D 1, 2, 3 Farming Y, N, D 1, 2, 3 Others (specify) Y, N, D 1, 2, 3	Construction Y, N, D 1, 2, 3 Farming Y, N, D 1, 2, 3 Others (specify) Y, N, D 1, 2, 3
6.2 (if YES), how long?	_____ years	_____ years	_____ years
7. Have you {Has he/she} ever eaten freshwater fish in general (or from any source)? (If No or Don't Know, skip the next 4 questions)	1. Yes _____ 2. No _____ 9. Don't know _____	1. Yes _____ 2. No _____ 9. Don't know _____	1. Yes _____ 2. No _____ 9. Don't know _____
8. I'm going to read a list of fish species, please tell me which of these fish you have consumed. They are bass, trout, perch, sunfish, pickerel, bullhead, crappie, shiners, suckers, goldfish, and carp (HELP THE RESPONDENT TO SELECT THE THREE TOP MOST FREQUENTLY EATEN FISHES).	1 - bass _____ 2 - trout _____ 3 - perch _____ 4 - sunfish _____ 5 - pickerel _____ 6 - bullhead _____ 7 - crappie _____ 8 - shiners _____ 9 - suckers _____ 10 - goldfish _____ 11 - carp _____ 12 - others (specify) _____	1 - bass _____ 2 - trout _____ 3 - perch _____ 4 - sunfish _____ 5 - pickerel _____ 6 - bullhead _____ 7 - crappie _____ 8 - shiners _____ 9 - suckers _____ 10 - goldfish _____ 11 - carp _____ 12 - others (specify) _____	1 - bass _____ 2 - trout _____ 3 - perch _____ 4 - sunfish _____ 5 - pickerel _____ 6 - bullhead _____ 7 - crappie _____ 8 - shiners _____ 9 - suckers _____ 10 - goldfish _____ 11 - carp _____ 12 - others (specify) _____
9. Can you estimate the frequency and total number of years you have {he/she} has been eating these types of fish?	Frequency: _____ years	Frequency: _____ years	Frequency: _____ years

Total # of household members: _____ ID#: _____

	4. Next eldest household member	5. Next eldest household member	6. Next eldest household member
10. How did you{he/she} usually obtain hose fish?	1 - Have no idea _____ 2 - Catch own _____ 3 - Family/friends caught _____ 4 - Other local fishermen _____ 5 - Supermarket/grocery stores _____ 1. - Have no idea _____ 2. - Housatonic River _____ 3. - Hoosic River _____ 4. - Others(specify) _____	1 - Have no idea _____ 2 - Catch own _____ 3 - Family/friends caught _____ 4 - Other local fishermen _____ 5 - Supermarket/grocery stores _____ 1. - Have no idea _____ 2. - Housatonic River _____ 3. - Hoosic River _____ 4. - Others(specify) _____	1 - Have no idea _____ 2 - Catch own _____ 3 - Family/friends caught _____ 4 - Other local fishermen _____ 5 - Supermarket/grocery stores _____ 1. - Have no idea _____ 2. - Housatonic River _____ 3. - Hoosic River _____ 4. - Others(specify) _____
11. (If answer 2, 3 or 4 to Q10) Do you know where the fish were usually caught?	1. Yes _____ 2. No _____ 9. Don't know _____ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes _____ 2. No _____ 9. Don't know _____	1. Yes _____ 2. No _____ 9. Don't know _____ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes _____ 2. No _____ 9. Don't know _____	1. Yes _____ 2. No _____ 9. Don't know _____ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes _____ 2. No _____ 9. Don't know _____
12.1 Have you{Has he/she} ever fished in the Housatonic River? 12.2 (If YES), what did you{he/she} do with the fish?	1. Yes _____ 2. No _____ 9. Don't know _____ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes _____ 2. No _____ 9. Don't know _____	1. Yes _____ 2. No _____ 9. Don't know _____ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes _____ 2. No _____ 9. Don't know _____	1. Yes _____ 2. No _____ 9. Don't know _____ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ 1. Yes _____ 2. No _____ 9. Don't know _____
13.1 Have you{Has he/she} ever taken or consumed fiddlehead ferns from the Housatonic River Area? 13.2 (If YES), how often?	1. Yes _____ 2. No _____ 9. Don't know _____ Frequency: _____ Canoeing: Y, N, D 1, 2, 9 Bird Watching: Y, N, D 1, 2, 9 Others (month): Y, N, D 1, 2, 9	1. Yes _____ 2. No _____ 9. Don't know _____ Frequency: _____ Canoeing: Y, N, D 1, 2, 9 Bird Watching: Y, N, D 1, 2, 9 Others (month): Y, N, D 1, 2, 9	1. Yes _____ 2. No _____ 9. Don't know _____ Frequency: _____ Canoeing: Y, N, D 1, 2, 9 Bird Watching: Y, N, D 1, 2, 9 Others (month): Y, N, D 1, 2, 9
14.1 Have you{Has he/she} ever participated in the following activities on or next to the Housatonic River? 14.2 (If YES), how often?	1. Yes _____ 2. No _____ 9. Don't know _____ Frequency: _____ Canoeing: Y, N, D 1, 2, 9 Bird Watching: Y, N, D 1, 2, 9 Others (month): Y, N, D 1, 2, 9	1. Yes _____ 2. No _____ 9. Don't know _____ Frequency: _____ Canoeing: Y, N, D 1, 2, 9 Bird Watching: Y, N, D 1, 2, 9 Others (month): Y, N, D 1, 2, 9	1. Yes _____ 2. No _____ 9. Don't know _____ Frequency: _____ Canoeing: Y, N, D 1, 2, 9 Bird Watching: Y, N, D 1, 2, 9 Others (month): Y, N, D 1, 2, 9
15.1 Have you{he/she} ever hunted in the Housatonic River Area? 15.2 (If YES), did you{he/she} hunt for food?	1. Yes _____ 2. No _____ 9. Don't know _____ 1. Yes _____ 2. No _____ 9. Don't know _____ type of prey _____ type of prey _____	1. Yes _____ 2. No _____ 9. Don't know _____ 1. Yes _____ 2. No _____ 9. Don't know _____ type of prey _____ type of prey _____	1. Yes _____ 2. No _____ 9. Don't know _____ 1. Yes _____ 2. No _____ 9. Don't know _____ type of prey _____ type of prey _____
15.3 (If YES), what types of prey do you {does he/she} usually eat? 15.4 How often?	1. Yes _____ 2. No _____ 9. Don't know _____ type of prey _____ type of prey _____	1. Yes _____ 2. No _____ 9. Don't know _____ type of prey _____ type of prey _____	1. Yes _____ 2. No _____ 9. Don't know _____ type of prey _____ type of prey _____
16.1 Have you{Has he/she} ever done gardening or yard work at current address? 16.2 (If YES), how often?	1. Yes _____ 2. No _____ 9. Don't know _____ Frequency: _____ Vegetable: Y, N, D 1, 2, 9 Others (months, years, etc): Y, N, D 1, 2, 9	1. Yes _____ 2. No _____ 9. Don't know _____ Frequency: _____ Vegetable: Y, N, D 1, 2, 9 Others (months, years, etc): Y, N, D 1, 2, 9	1. Yes _____ 2. No _____ 9. Don't know _____ Frequency: _____ Vegetable: Y, N, D 1, 2, 9 Others (months, years, etc): Y, N, D 1, 2, 9
17. Now, I would like to ask the last question. Can you think of any other important ways you may have come in contact with PCB that I have not mentioned in this interview?			

Questions	7. Next eldest household member	8. Next eldest household member	9. Next eldest household member
1. What is this person's name?	First name _____ Last name _____	First name _____ Last name _____	First name _____ Last name _____
2. Is this person a male or female?	1 - Male _____ 2 - Female _____	1 - Male _____ 2 - Female _____	1 - Male _____ 2 - Female _____
3. What was your {his/her} age on your {his/her} last birthday?	_____ years	_____ years	_____ years
4.1 How long have you {has he/she} lived at your current address?	_____ years	_____ years	_____ years
4.2 Where did you {he/she} live before?	_____ years	_____ years	_____ years
4.3 How long had you {he/she} lived there?	_____ years	_____ years	_____ years
4.4 Can you estimate how long you {he/she} ever lived in the Housatonic River Area?	_____ years	_____ years	_____ years
5.1 What has been your {his/her} usual occupation?	_____	_____	_____
5.2 Which company did you {he/she} usually work for?	_____	_____	_____
5.3 How many years did you {he/she} work there?	_____ years	_____ years	_____ years
6.1 Have you {Has he/she} ever been employed in a job that brought you {he/she} into contact with the Housatonic River?	Construction Y, N, D 1, 2, 9 Farming Y, N, D 1, 2, 9 Others (specify) Y, N, D 1, 2, 9	Construction Y, N, D 1, 2, 9 Farming Y, N, D 1, 2, 9 Others (specify) Y, N, D 1, 2, 9	Construction Y, N, D 1, 2, 9 Farming Y, N, D 1, 2, 9 Others (specify) Y, N, D 1, 2, 9
6.2 (If YES), how long?	_____ years	_____ years	_____ years
7. Have you {Has he/she} ever eaten freshwater fish in general (or from any source)? (If No or Don't Know, skip the next 4 questions)	1. Yes _____ 2. No _____ 9. Don't know _____	1. Yes _____ 2. No _____ 9. Don't know _____	1. Yes _____ 2. No _____ 9. Don't know _____
8. I'm going to read a list of fish species, please tell me which of these fish you have consumed. They are bass, trout, perch, sunfish, pickerel, bullhead, crappie, shiners, suckers, goldfish, and carp (HELP THE RESPONDENT TO SELECT THE THREE TOP MOST FREQUENTLY EATEN FISHES).	1 - bass _____ 2 - trout _____ 3 - perch _____ 4 - sunfish _____ 5 - pickerel _____ 6 - bullhead _____ 7 - crappie _____ 8 - shiners _____ 9 - suckers _____ 10 - goldfish _____ 11 - carp _____ 12 - others (specify) _____	1 - bass _____ 2 - trout _____ 3 - perch _____ 4 - sunfish _____ 5 - pickerel _____ 6 - bullhead _____ 7 - crappie _____ 8 - shiners _____ 9 - suckers _____ 10 - goldfish _____ 11 - carp _____ 12 - others (specify) _____	1 - bass _____ 2 - trout _____ 3 - perch _____ 4 - sunfish _____ 5 - pickerel _____ 6 - bullhead _____ 7 - crappie _____ 8 - shiners _____ 9 - suckers _____ 10 - goldfish _____ 11 - carp _____ 12 - others (specify) _____
9. Can you estimate the frequency and total number of years you have {he/she} has been eating these types of fish?	Frequency: _____ years	Frequency: _____ years	Frequency: _____ years

Total # of household members: _____ ID#: _____

	7. Next eldest household member	8. Next eldest household member	9. Next eldest household member
10. How did you{he/she} usually obtain those fish?	1 - Have no idea _____ 2 - Catch own _____ 3 - Family/friends caught _____ 4 - Other local fishermen _____ 5 - Supermarket/grocery stores _____ 1. - Have no idea _____ 2. - Housatonic River _____ 3. - Hoosic River _____ 4. - Others(specify) _____	1 - Have no idea _____ 2 - Catch own _____ 3 - Family/friends caught _____ 4 - Other local fishermen _____ 5 - Supermarket/grocery stores _____ 1. - Have no idea _____ 2. - Housatonic River _____ 3. - Hoosic River _____ 4. - Others(specify) _____	1 - Have no idea _____ 2 - Catch own _____ 3 - Family/friends caught _____ 4 - Other local fishermen _____ 5 - Supermarket/grocery stores _____ 1. - Have no idea _____ 2. - Housatonic River _____ 3. - Hoosic River _____ 4. - Others(specify) _____
11. (If answer 2, 3 or 4 to Q10) Do you know where the fish were usually caught?	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ Frequency: _____
12.1 Have you{Has he/she} ever fished in the Housatonic River? 12.2 (If YES), what did you{he/she} do with the fish?	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1 - Catch and release _____ 2 - Catch for food _____ 3 - Catch for sale _____ Frequency: _____
13.1 Have you{Has he/she} ever taken or consumed fiddlehead ferns from the Housatonic River Area? 13.2 (If YES), how often?	1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ Frequency: _____
14.1 Have you{Has he/she} ever participated in the following activities on or next to the Housatonic River? 14.2 (If YES), how often?	Canceling: Y, N, D _____ Frequency: _____ Bird Watching: Y, N, D _____ Frequency: _____ Others(month): Y, N, D _____ Frequency: _____	Canceling: Y, N, D _____ Frequency: _____ Bird Watching: Y, N, D _____ Frequency: _____ Others(month): Y, N, D _____ Frequency: _____	Canceling: Y, N, D _____ Frequency: _____ Bird Watching: Y, N, D _____ Frequency: _____ Others(month): Y, N, D _____ Frequency: _____
15.1 Have you{he/she} ever hunted in the Housatonic River Area? 15.2 (If YES), did you{he/she} hunt for food?	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____ Type of prey: _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____ Type of prey: _____ Frequency: _____	1. Yes ___ 2.No ___ 9.Don't know ___ 1. Yes ___ 2.No ___ 9.Don't know ___ Type of prey: _____ Frequency: _____ Type of prey: _____ Frequency: _____
15.3 (If YES), what types of prey do you {does he/she} usually eat? 15.4 How often?	Type of prey: _____ Frequency: _____ Type of prey: _____ Frequency: _____	Type of prey: _____ Frequency: _____ Type of prey: _____ Frequency: _____	Type of prey: _____ Frequency: _____ Type of prey: _____ Frequency: _____
16.1 Have you{Has he/she} ever done gardening or yard work at current address? 16.2 (If YES), how often?	Vegetable: Y, N, D _____ Frequency: _____ Others(flowers, lawn, etc): Y, N, D _____ Frequency: _____	Vegetable: Y, N, D _____ Frequency: _____ Others(flowers, lawn, etc): Y, N, D _____ Frequency: _____	Vegetable: Y, N, D _____ Frequency: _____ Others(flowers, lawn, etc): Y, N, D _____ Frequency: _____
17. Now, I would like to ask the last question. Can you think of any other important ways you may have come in contact with PCB that I have not mentioned in this interview?			

This is the end of the survey. Thank you very much for your assistance and cooperation in this important project! *** END OF INTERVIEW ***

TIME ENDED

Appendix B Refusal Questionnaire

Massachusetts Department of Public Health
Housatonic PCB Exposure Assessment Study
-- Refusal Questionnaire --

1. What is the total number of people (including children) currently living in your households? Can you tell us the age and sex of your household members (including yourself) respectively?

No.	Age	Sex
<u>1</u>	_____	_____
<u>2</u>	_____	_____
<u>3</u>	_____	_____
<u>4</u>	_____	_____
<u>5</u>	_____	_____
<u>6</u>	_____	_____

2. Has anybody in your household ever eaten freshwater fish from the Housatonic River?

Yes ____ No ____

If YES, how many? _____ person(s)

3. Has anybody in your family done construction or farming on or next to the Housatonic River?

Yes ____ No ____

If YES, how many? _____ person(s)

4. Has anybody in your family done any recreational activities (like canoeing, bird watching, jogging, etc.) on or next to the Housatonic River on a regular basis?

Yes ____ No ____

If YES, how many? _____ person(s)

Appendix C Letter to Randomly Selected Households



The Commonwealth of Massachusetts
Executive Office of Health and Human Services
Department of Public Health
150 Tremont Street, Boston MA 02111

WILLIAM F. WELD
GOVERNOR

ARGEO PAUL CELLUCCI
LIEUTENANT GOVERNOR

GERALD WHITBURN
SECRETARY

DAVID H. MULLIGAN
COMMISSIONER

April 20, 1995

Dear Resident:

Your household has been selected for participation in the Massachusetts Department of Public Health (MDPH) PCB Exposure Assessment Study, a scientifically planned study of Housatonic River Area residents who may have been at the risk of exposure to polychlorinated biphenyls (PCBs). You may have heard about PCB contamination of the Housatonic River and its floodplain, currently being investigated by the Massachusetts Departments of Public Health and Environmental Protection. The purpose of the MDPH study is to investigate human exposure to PCBs among the residents of Dalton, Great Barrington, Lanesborough, Lee, Lenox, Pittsfield, Sheffield, and Stockbridge.

Beginning the week of April 24, 1995, residents will be contacted by phone and asked a series of questions regarding fish consumption, recreational activities along the Housatonic River and its floodplain, residential and occupational history. You and other participants will be making an important contribution to our knowledge of the patterns and body burden of PCB exposure among residents of the Housatonic River Area. The information collected will be used only for statistical and research purposes and will be kept in strict confidence.

If you have questions regarding this letter, please call Zi Zhang, Project Director of the PCB Exposure Assessment study or Elaine Krueger, Chief of Environmental Toxicology Program at 617-727-7170. Thanks!

Sincerely,

Suzanne K. Condon, Director
Bureau of Environmental Health

Appendix D Public Service Announcement (PSA) for Exposure Prevalence Study

PUBLIC SERVICE ANNOUNCEMENT

Do you live near the Housatonic River in Dalton, Lanesborough, Pittsfield, Lenox, Lee, Great Barrington, Stockbridge and Sheffield? Significant PCB contamination has been identified in the Housatonic River and its floodplain. The Massachusetts Department of Public Health is conducting a health study to investigate exposure to PCBs and possible health problems. This is a very important study. If you receive a letter or phone-call to participate, please take the time to answer their questions. For more information, please call Massachusetts Department of Public Health Bureau of Environmental Health Assessment at (617)727-7170.

Appendix E Public Service Announcement (PSA) for Volunteer Study

PUBLIC SERVICE ANNOUNCEMENT

The Massachusetts Department of Public Health (MDPH) has been conducting an environmental health assessment in Berkshire County. The MDPH randomly selected 800 households near the Housatonic River to determine whether people may have been exposed to PCBs as a result of living and working in the floodplain of the river. Interviews and phlebotomy work for this phase of our study is now complete. The MDPH is now offering an opportunity for residents who weren't randomly selected for the phase I study to participate in a phase II volunteer study. The MDPH is now encouraging other concerned residents to participate in the volunteer study. During the weeks of March 28 through April 13, 1996, the MDPH staff will be stationed at Berkshire Athenaeum in Pittsfield, Tritown Health District at Railroad Street in Lee, and Great Barrington Senior Center to administer the questionnaire.

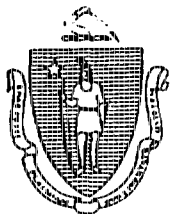
For more information about the volunteer study including each facility's schedule, please call Massachusetts Department of Public Health Housatonic PCB Exposure Assessment Study Hotline: 1-800-240-4266.

PUBLIC SERVICE ANNOUNCEMENT
(Revised for volunteer phase additional outreach)

The Massachusetts Department of Public Health (MDPH) has been conducting an environmental exposure assessment survey in Berkshire County as a result of widespread concern about PCB pollution in the environment. The MDPH has already surveyed 800 households near the Housatonic River to determine whether people may have been exposed to PCBs as a result of living and working in the floodplain of the river. Interviews and blood work for this phase of our study have been complete. During the weeks of March 28 through April 13, 1996, the MDPH staff were available at Great Barrington Senior Center, Tritown Health District at Railroad Street in Lee, and Berkshire Athenaeum in Pittsfield to administer an exposure questionnaire to concerned residents who had not been previously surveyed.

For the concerned residents who missed the chance of doing the survey and who still wish to have their opportunities for exposure to PCBs evaluated by the MDPH, please call the Housatonic PCB Exposure Assessment Study information line toll free at: 1-800-240-4266 24 hours a day, 7 days a week, and leave your name and phone number for MDPH staff to contact you, or call Department's Bureau of Environmental Health Assessment at 617-624-5757 between 9:00am to 5:00pm weekdays. You will have an opportunity to participate in this survey until May 10, 1996.

Appendix F Letter to Prospective Volunteers



102

The Commonwealth of Massachusetts
Executive Office of Health and Human Services
Department of Public Health
250 Washington Street, Boston, MA 02108-4619

WILLIAM F. WELD
Governor

ARGEO PAUL CELLUCCI
Lieutenant Governor

GERALD WHITBURN
Secretary

DAVID H. MULLIGAN
Commissioner

March 21, 1996

Dear Resident:

As you may know, the Massachusetts Department of Public Health (MDPH) has been conducting an environmental health assessment study in Berkshire County. The purpose of the study is to determine whether people may have been exposed to PCBs as a result of living, working or participating in recreational activities in the floodplain of the Housatonic River. The MDPH has been implementing the study in two phases. In phase I, 800 households were randomly selected into the scientific survey. The interview and blood work for the phase I of our study is now complete and results are being analyzed. The MDPH is now offering an opportunity for residents who weren't randomly selected for the phase I study to participate in a phase II volunteer study.

During the weeks of March 28 through April 13, 1996, the MDPH staff will be stationed at Berkshire Athenaeum in Pittsfield, Tritown Health District at Railroad Street in Lee, and Great Barrington Senior Center to administer the questionnaire. The MDPH is encouraging all concerned residents to participate in the volunteer study by being interviewed by our project staff. The completed interviews will then be assessed, and those participants with the greatest opportunities for exposure will be asked to undergo a blood test for PCBs. The detailed schedule for the public portion of the phase II volunteer study is as following:

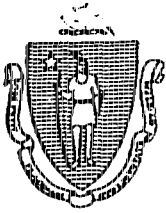
Location	Date	Time
Great Barrington Senior Center	Thursday March 28, 1996	12:00noon - 8:00pm
	Friday March 29, 1996	9:00am - 5:00pm
	Saturday March 30, 1996	9:00am - 12:00noon
Tritown Health District in Lee	Thursday April 4, 1996	12:00noon - 8:00pm
	Friday April 5, 1996	9:00am - 5:00pm
	Saturday April 6, 1996	9:00am - 12:00noon
Berkshire Athenaeum in Pittsfield	Thursday April 11, 1996	12:00noon - 8:00pm
	Friday April 12, 1996	9:00am - 5:00pm
	Saturday April 13, 1996	10:00am - 1:00pm

For more information about the volunteer study, please call Dr. Zi Zhang, Project Director, or Elaine Krueger, Chief of Environmental Toxicology at (617)624-5757. Thank you!

Sincerely,

Suzanne K. Condon, Director
Bureau of Environmental Health Assessment

Appendix G Letter to Selected Individuals for Blood Testing



The Commonwealth of Massachusetts
Executive Office of Health and Human Services
Department of Public Health
150 Tremont Street, Boston MA 02111

104

WILLIAM F. WELD
GOVERNOR

ARGEO PAUL CELLUCCI
LIEUTENANT GOVERNOR

GERALD WHITBURN
SECRETARY

DAVID H. MULLIGAN
COMMISSIONER

June 21, 1995

Dear

You have been selected to participate in the Phase II Housatonic River Area PCB Exposure Assessment Study. The purpose of this phase is to determine whether people who appear to have had more opportunities for exposure to PCBs actually have higher levels of PCBs in their blood.

We will be calling selected residents to request that they participate in the study and to arrange an appointment to have their blood drawn at Berkshire Medical Center for subsequent PCB analysis. In addition, we will ask you a few more questions to supplement information that you have already provided in our previous survey. We expect that the entire visit should not take more than 30 minutes. All information provided by study subjects will be kept confidential; each person will receive their individual results. Summary data will be provided in a final report at the completion of the project.

We greatly appreciate your participation to date, and look forward to your continued participation. If you have any questions, please contact Zi Zhang, Project Director, or Elaine Krueger, Chief of Environmental Toxicology, at (617)727-7170.

Sincerely,

Suzanne K. Condon, Director
Bureau of Environmental Health
Assessment

Appendix H Questionnaire Used during Blood Testing

106.

MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH
HOUSATONIC RIVER AREA PCB EXPOSURE ASSESSMENT STUDY

STUDY QUESTIONNAIRE

Name: «FRSTNAME» «LASTNAME»

Study ID: «IDD»

Date of Birth: ____/____/____

Address: «ADDRESS»

«CITYZIP»

Phone #: (413) «Telephone»

Consent Form Signed: [Yes]____ [NO]____

Phlebotomy Done: [YES]____ [NO]____

Do you have any significant health problems? [currently or in the past]
[YES]____ [NO]____

[If YES, please specify]

Do you take any medications? [YES]____ [NO]____

[If YES, please specify?]

- 1. _____ How long? _____
- 2. _____ How long? _____
- 3. _____ How long? _____

Have you smoked cigarettes? [currently or in the past]
[YES]____ [NO]____

[If YES, how many cigarettes/day]

_____/day [average] Starting Age:____ Ending Age:____ [if applicable]

Have you consumed alcohol? [currently or in the past]
[YES]____ [NO]____

[If YES, answer the following]

Beer _____/week Years _____
 [average # of 12-oz cans, bottles or glasses]

Wine _____/week Years _____
 [average # of 4-oz glasses]

Liquor or Mixed _____/week Years _____
 [average # of 1.5-oz liquor]

What is your weight? _____
Approximate date weight was measured ____/____/____

What is your height? _____
Approximate date height was measured ____/____/____

10.0 Have you ever taken or consumed fiddlehead ferns? (If YES), How often?
«FREQFRNN»/«FREQFRNC»

11.0 Have you ever participated in the following activities on or next to the Housatonic River? (If YES), how often?

- 11.1 Canoeing: «FREQCANN»/«FREQCANC»
- 11.2 Bird Watching: «FREQBDWN»/«FREQBDWC»
- 11.3 Others: «FREQROTN»/«FREQROTC» [«ROTHERDP»]

12.1 Have you ever hunted in the Housatonic River Area? «HUNTLG»

12.2 (If YES), did you hunt for food? «HUNTFDLG»

12.3 (If YES), what types of prey do you usually eat? How often?

- PREY1 «PREY1» «FREQPY1N»/«FREQPY1C»
- PREY2 «PREY2» «FREQPY2N»/«FREQPY2C»

13.0 Have you ever done gardening or yard work at your current address? (If YES), how often?

- 13.1 Vegetable: «FREQVGTN»/«FREQVGTC»
- 13.2 Others: «FREQGOTN»/«FREQGOTC»

What have you eaten in the last 24 hours?

Breakfast: _____

Lunch: _____

Dinner: _____

Other: _____

Other significant concerns the respondent may have:

Interviewer's Initials: _____

Date: ____/____/____

Appendix I Consent Form

110

MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH
HOUSATONIC RIVER AREA PCB EXPOSURE ASSESSMENT STUDY

CONSENT FORM

I understand that the Massachusetts Department of Public Health is conducting a Housatonic River Area PCB Exposure Assessment Study that was described in a letter to me on June 21, 1995, and that I have been asked to participate in this study.

A blood sample will be taken from me as part of this study to determine the level of PCBs or other environmental contaminants in the blood. The blood will be taken from a vein in my arm and will require the use of a hypodermic needle and syringe. Approximately 55 ml of blood will be drawn which is equal to slightly more than 3.5 tablespoons. This procedure usually involves little pain or discomfort, but occasionally some discomfort may occur after the blood sample is obtained. Other risks, while unlikely, will be explained by the staff from Berkshire Medical Center. My blood sample will be tested for PCBs, and a portion of my blood will be stored at the State Laboratory Institute in Jamaica Plain for future testing of environmental contaminants.

An interview will be administered by the project staff as previously explained.

I understand that the Massachusetts Department of Public Health and all persons who conduct this study will use information that I provide and the results of my tests only in accordance with the confidentiality provisions of the study protocol (M.G.L. Ch. 111, Sec. 24A) and will not make public any particular information that could readily be associated with me.

I understand that I will not be notified of the result of my PCB blood test until after the completion of all blood collection and analyses. The results will be published in a summary report, a copy of which will be provided to me. Further, I understand that this step is being taken to allow time for the laboratory test to be completed and to ensure the scientific integrity of the final study results by eliminating possible sources of bias.

I understand that I am not under any obligation to participate in the study and that I can end my participation at any time. I also consent to being recontacted for follow-up questions at a later date.

I have read and understand the above statement, and I hereby agree to participate in the study.

Name: _____

Date: _____

Witness: _____

Date: _____

111

Appendix J Specimen Collection and Shipping Protocol

112

**MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH
HOUSATONIC RIVER AREA PCB EXPOSURE ASSESSMENT STUDY
SPECIMEN COLLECTION PROTOCOL**

Specimen collection and handling are extremely important aspects of accurate polychlorinated biphenyl (PCB) analysis. PCBs are common environmental contaminants present in dust, among other things. It is important that environmental sources of PCBs do not contaminate the blood or serum collected for analysis in this study.

All the glassware used in this study was solvent rinsed to remove any PCBs on the surface of the glassware. It is important that you do not touch any surface that will come in contact with the sample. **PLEASE DO NOT USE GLASSWARE OTHER THAN THAT PROVIDED BY THE STATE LABORATORY INSTITUTE!**

The gas chromatography instrumentation used to identify and quantify PCBs is very sensitive to interferences particularly those found in plasticizers. Therefore, plastic labware must never contact the sample.

Collection Materials

Supplies Provided by SLI

- Alcohol swabs
- Vacutainers, red top, anticoagulant free
- Solvent rinsed transfer pipets
- Solvent rinsed 30 mL Wheaton bottles
- Solvent rinsed 5 mL Wheaton vials
- Test tube racks
- Powder free gloves

Supplies Provided by BMC

- Needles
- Bandages
- Refrigerator
- Freezer
- Centrifuge

Specimen Collection

Polychlorinated Biphenyl (PCB) Analysis

- Draw three 15 mL red top vacutainers for PCB analysis.
- Affix the appropriate labels.
- Allow the specimens to clot at room temperature for 30 minutes.
- Centrifuge at 2000 rpm for 15 minutes.
- Combine the decanted serum from both tubes into a single labeled 30 mL Wheaton bottle, gently swirl to mix, taking care not to have excessive contact with the cap.
- Aliquot approximately 4.5 mL of serum into three labeled 5 mL Wheaton bottles.
- Refrigerate specimens for 1-2 hours, then freeze.

113

**MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH
HOUSATONIC RIVER AREA PCB EXPOSURE ASSESSMENT STUDY
FIELD SPECIMEN COLLECTION PROTOCOL**

Specimen collection and handling are extremely important aspects of accurate polychlorinated biphenyl (PCB) analysis. PCBs are common environmental contaminants present in dust, among other things. It is important that environmental sources of PCBs do not contaminate the blood or serum collected for analysis in this study.

All the glassware used in this study was solvent rinsed to remove any PCBs on the surface of the glassware. It is important that you do not touch any surface that will come in contact with the sample. **PLEASE DO NOT USE GLASSWARE OTHER THAN THAT PROVIDED BY THE STATE LABORATORY INSTITUTE!**

The gas chromatography instrumentation used to identify and quantify PCBs is very sensitive to interferences particularly those found in plasticizers. Therefore, plastic labware must never contact the sample.

Collection Materials

- | | |
|--|------------|
| • Alcohol swabs | Needles |
| • Vacutainers, red top, anticoagulant free | Bandages |
| • Test tube racks | Cooler |
| • Powder free gloves | Cold Packs |

Specimen Collection

Polychlorinated Biphenyl (PCB) Analysis

- Draw three 15 mL red top vacutainers for PCB analysis.
- Place specimens upright in cooler.
- Transport to Chemistry Laboratory at Berkshire Medical Center for processing.

Revised 11/28/95

114

MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH
HOUSATONIC RIVER AREA PCB EXPOSURE ASSESSMENT STUDY
SHIPPING PROTOCOL

Specimens must be sent to the laboratory in a timely fashion for accurate sample analysis.

Supplies Provided by SLI

- Coolers
- Packing slips
- Test tube racks

Supplies Provided by BMC

Dry ice

Polychlorinated Biphenyls

- Place frozen specimens vials in cooler with dry ice or freezer packs. Samples must remain frozen.
- Complete sample packing slip and place in a zip lock bag on top of specimens. (Keep a copy of the packing slip for your records).
- Ship specimens Federal Express to the State Laboratory Institute, third party billing account number 1210-5085-4.

Ship to: Julianne Nassif
 Environmental Chemistry Laboratory
 State Laboratory Institute
 305 South Street
 Jamaica Plain, MA. 02130

(617) 983-6651

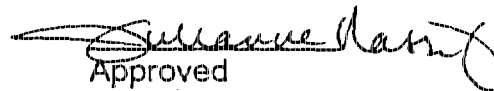
Appendix K Analytical Protocol for the Quantification of Polychlorinated Biphenyls in Human Serum

116

**Analytical Protocol for the Quantification of
Polychlorinated Biphenyls in Human Serum**
(Open Tubular Gas Chromatography with Electron Capture Detection)

**Analytical Chemistry Laboratory
Division of Environmental Chemistry
State Laboratory Institute
Massachusetts Department of Public Health
305 South Street
Boston, Massachusetts, 02130
(617) 983-6650**

Updated 10/95



Approved
Julianne Nassif
Laboratory Director

SAFETY PRECAUTIONS

Serum

The American Red Cross and the Center for Disease Control recommend that laboratory personnel handling blood products take the following precautions:

- Always work with samples in a chemical fume hood with the sash down or in a biological safety cabinet.
- Always wear rubber gloves to prevent transmission of pathogens via dermal abrasions or cuts (Wearing double gloves is preferred).
- Always wear eye protection to prevent transmission across mucous membranes in the eye.
- Decontaminate all glassware with bleach, phenol or a commercial decontamination product (i.e., Amphyl).
- Sterilize all glassware and disposables by autoclaving at 270 psi for 20 minutes.
- Discard disposable items in accordance with State Laboratory Institute (SLI) infectious waste disposal policy

Organic Solvents and Polychlorinated Biphenyls

- Many of these compounds are classified as potential human carcinogens by the Environmental Protection Agency.
- Always work with these compounds in a chemical fume hood to reduce exposure via inhalation.
- Always wear rubber gloves to prevent dermal absorption.
- Always wear eye protection to prevent eye damage resulting from chemical splashes or organic vapors.
- Never wear contact lenses in the laboratory because vapors from organic solvents may become trapped behind the lens resulting in severe eye burns.

REAGENTS & STANDARDS

1. Aroclors 1242, 1254, 1260 and Decachlorobiphenyl

Available from the Environmental Protection Agency Research Triangle Park, North Carolina and Analabs company New Haven, Connecticut.

Analytical standards are prepared (w/v) in hexane.

Stock solutions - 1000 ug/L are prepared every 6 months.

Working solutions are prepared from the stock solution every 30 days.

All standards must be stored with very little headspace in actinic glass or foil wrapped glass vials with Teflon lined screw caps.

Seal the vials with Teflon tape.

Standards are stored upright in a - 20°C freezer.

2. Hexane (pesticide grade).
3. Ethyl Ether (pesticide grade).
4. Acetone (pesticide grade).
5. Methanol (pesticide grade).
6. Keeper Solution (1% Paraffin oil (v/v) in hexane). Keeper solution helps to preserve PCBs during the evaporation of the final extract.
7. Anhydrous Sodium Sulfate
Rinse with hexane and vacuum filter through sharkskin filter paper. Cover beaker with punctured oil free aluminum foil and store in a drying oven at 130°C. Allow sodium sulfate to come to room temperature in a vacuum desiccator prior to use.
8. Glass Wool (Silanized and Phosphoric Acid washed).

9. Woelm Silica Gel (activated, 100-200 μm , 70-150 mesh).
- Solvent rinse a 150 mL beaker with acetone and hexane.
 - Weigh 20.1 g into the beaker and cover with oil free aluminum foil.
 - Puncture holes in the aluminum foil store in a drying oven at 130°C for at least 24 hours.
 - Remove beaker from the oven and place in a vacuum desiccator for 6-12 hours (overnight).
 - Transfer silica gel into a tared, solvent rinsed 125 mL Erlenmyer flask with a Teflon lined screw cap.
 - Weigh and record the exact weight of the silica gel.
 - Wash distilled water with hexane three times.
 - Add sufficient hexane washed water to equal 3% of the silica gel weight. Drizzle water down the inside of the flask.
 - Cap flask and shake manually for 30 seconds or until there is no evidence of clumping.
 - Rotate flask on a mechanical rotator for 3 hours.
 - Remove flask from rotator and allow to stand capped at ambient conditions overnight prior to use.
 - Silica gel retains its chromatographic properties for 7 days.

120

GLASSWARE

All glassware must be solvent rinsed with pesticide grade acetone and hexane. DO NOT USE PLASTIC LABWARE.

1. Wheaton Vials (30 mL, crimp top).
2. Wheaton Vials (5 mL, Teflon-lined screw cap).
3. Culture Tubes (16 X 125 mm, Teflon-lined screw cap).
4. Culture Tubes (20 x 150 mm, Teflon lined screw cap).
5. Erlenmeyer Flasks (125 mL, Teflon-lined screw cap).
6. Pasteur Pipets (disposable, capillary).
7. Centrifuge Tubes (15 mL, conical, Teflon-lined screw cap).
8. Chromatographic Columns (18 cm x 9 mm).
9. Graduated Cylinders (25 mL).
10. Filter Flasks (500 mL)
11. Volumetric Pipets

Recommended Labware: Teflon squirt bottles, Teflon lined re-pipet devices.

121

EQUIPMENT

1. Drying Oven.
2. Vortex Mixer.
3. Mechanical Rotator, GLAS-COL Apparatus Company, # 80-950 or an equivalent model.
4. Centrifuge, Correl Table Top GLC-2 or an equivalent model.
5. Desiccator
6. Gas Chromatography with Electron Capture Detection and Data Integration System.
7. High Resolution DB-5, 30m wide bore open tubular column, 0.53 mm ID, 1.5 μ m film thickness, (J+w Scientific)
8. Chemical Fume Hood.
9. N-EVAP Analytical Evaporator with Water Bath.

Extraction Procedure (Adapted from the Center for Disease Control Laboratory Update 81-108.)

Entire sample extraction and clean up should be performed in a chemical fume hood.

I. Sample Extraction

- a.* Pipet 4 mL serum into a 16 x 125 mm screw cap (Teflon lined) culture tubes.
- b.* Add 2 mL methanol to the tube to denature blood proteins. (The methanol volume should always be one half the serum volume).
- c.* Vortex for 30 seconds.
- d.* Add 5 mL of a 1:1 mixture of hexane and ethyl ether.
- e.* Vortex for 30 seconds.
- f.* Agitate sample on a mechanical rotator (setting = 50-55)
- g.* Centrifuge at 1800 RPM for 6 minutes.
- h.* Transfer supernatant to a 20 x 125 mm screw cap (Teflon lined) culture tube.
- i.* Repeat steps b-h two times pooling the supernatant in a single 20 x 125mm culture tubes.
- j.* Add two drops Keeper Solution to preserve PCBs during evaporation.
- k.* Reduce solvent volume to 0.5 mL at room temperature using a gentle stream of nitrogen.
DO NOT ALLOW SAMPLE TO GO TO DRYNESS.
(At this point, samples may be stored in the freezer overnight).

II. Sample Clean-up (Adsorption Chromatography)

- a.* Pack chromatography column (18 cm x 9 mm) with:

A plug of silanized glass wool,
1 cm of anhydrous sodium sulfate,
3.0 g of silica gel and
1 cm of anhydrous sodium sulfate.

- b.* Pre-wet the column with 20 mL hexane.
DO NOT COLLECT THE ELUATE IN STEPS b-e.
- c.* When eluant is very near the top layer of sodium sulfate, transfer sample extract to the column head.
- d.* Rinse the sample tube three times with 0.5 mL hexane and transfer to the head of the column.
- e.* Elute the column with 5 mL of hexane. (PCBs are retained on the column).
- f.* Elute the column with 15 mL of hexane.
BEGIN COLLECTING ELUATE IN A 15 mL CONICAL CENTRIFUGE TUBE.
- g.* Collect 15 mL.
- h.* Add two drops Keeper Solution.
- i.* Evaporate solvent with a gentle stream of nitrogen.
- j.* Just as the sample goes to dryness, add 1 mL decachlorobiphenyl.
- k.* Store sample extract in the freezer until gas chromatographic analysis.
(Samples may be stored in autosampler vials).

QUALITY ASSURANCE

1. Obtain and/or prepare the following quality control materials:

- Calibration standards (w/v) prepared in hexane for Aroclors 1242, 1254 and 1260. (Working range 5-200 ug/L).
- Base bovine serum (BBS).
- Bovine serum fortified (in vitro) with:
 - Aroclor 1242 (IVT-42)
 - Aroclor 1254 (IVT-54)
 - Aroclor 1260 (IVT-60)
 - Chlorinated Pesticides (CPS)

In vitro Spiking Protocol (CDC Laboratory Update 81-108).

Analyze pooled bovine serum to determine the base PCB concentration. Fortify this serum with an Aroclor standard prepared (w/v) in acetone. The volume of acetone in the final product must not exceed 1% of the total volume of the fortified serum.

For example to prepare a 15 ug/L PCB fortified serum pool:

$$\begin{aligned} (5\text{mL}) (x) &= (500\text{mL}) (15 \text{ ug/L}) \\ (x) &= 1500 \text{ ug/L} \end{aligned}$$

Therefore, 5 mL of 1500 ug/L PCB brought to volume of 500 mL with serum achieves the desired result of a 15 ug/L fortified serum without exceeding the maximum allowable acetone volume.

Mix the fortified serum for 48-72 hours in a cold room. Alocquot into 9-10 mL volumes under sterile conditions and freeze.

CPS fortified serum pools are prepared in a similar manner. This quality control material should contain chlorinated pesticides that would likely be detected in human sera such as; aldrin, lindane, dieldrin, endrin, DDE, DDT, heptachlor and heptachlor epoxide. A mixture containing these compounds should be prepared in acetone and used to fortify the serum as described above.

2. Check the linearity of calibration standards and plot total area vs concentration.

- This assures the analyst that the concentrations of interest are in the linear dynamic range of the instrument.
(Miller, J.C. and Miller J.N., Statistics for Analytical Chemistry, 1994, Ellis

125

Horwood Limited, West Sussex, England and Ettre L.S., Practical Gas Chromatography, 1973, Perkin-Elmer Corporation, Norwalk, Connecticut).

3. Establishment target values for the BBS, CPS, IVT-42, IVT-53 and IVT-60.
 - Extract and analyze each of the quality control pools ten times.
 - Calculate the mean value. Sample values + 3 SD should be excluded from the mean calculation.
 - Adopt the mean as the target value.

4. Include a BBS, CPS and one or more of the following; IVT-32, IVT-54 or IVT-60 in each analytical run.
 - Extraction and analysis of a BBS establishes the detection limit of the assay and serves as an extraction blank.
 - Extraction and analysis of PCB fortified serum determines the efficiency of the extraction procedure. Calculated concentrations for the control materials must be ± 2 SD of the target value.
 - Extraction and analysis of a CPS allows the analyst to monitor the efficacy of the absorption chromatography and to determine the elution characteristics of these compounds.

5. Calibrate the gas chromatography with prepared calibration standards.
 - Analysis and quantitation of calibration standards monitors detector response and linearity.
(Miller and Miller, 1984 and Ettre, 1973)

GAS CHROMATOGRAPHY

Instrument Perkin-Elmer Autosystem Gas Chromatography with Integral Autosampler and Electron Capture Detector.

Data Handling PE Nelson Turbochrome Multinstrument Software Operation with Model 600 Link Interface.

Column J+W Scientific High Resolution Gas Chromatography Column DB-5-MS 30 meter, 0.53 mm ID, 1.5 (micron) film thickness.

Instrument Conditions

Temperature Program

Temp.	150°	275°	-
Time	0.50	0.5	
Rate	4°/min.		Run time 36.8 min.

Injector temp. 250°
Detector temp. 390°

Carrier Gas Helium 5.7 mL/min
Make up gas Nitrogen 60 mL/min.

Injection Volume 1 uL

127

Quantification of Polychlorinated Biphenyls

Chromatographic data are processed using Turbochrom data acquisition software (Perkin-Elmer Corp.). PCBs are identified based on comparison of sample and standard retention times and retention times relative to the internal standard, decachlorobiphenyl. Three point calibration curves are constructed daily for each Aroclor of interest. Calibration standards bracket every 10 study and quality assurance sample and update the calibration curve during the chromatographic run. Samples within the brackets are reported based on the revised curve.

Aroclor 1260

The Aroclor 1260 calibration curve is comprised of 21 PCB peaks at 20, 40, and 80 ppb. Since serum extracts are concentrated 4 fold the response of these calibration standards simulate study samples with 5, 10, and 20 ppb. Serum Aroclor 1260 concentrations are calculated based on peak area of the 21 component peaks of interest.

Data Review and Management

1. The laboratory analyst reviews all chromatographic data, performs any necessary calculation and enters these data into the PCB database. The analyst prints draft reports which are submitted to the laboratory supervisor for review.
2. The laboratory supervisor or designee performs a secondary review and initials the data subsequent extractions are not initiated until the review process is complete.
3. Data and laboratory results are submitted to the Director for statistical analysis and/or dissemination.

Appendix L List of Variables used in Epi Info Data File for Household Screening Survey

Variable Name	Type	Length	Description
ID	Text	6	Identification number for household
IDD	Text	6	Identification number for individual
HOUSEMBN	Number	8	Total number of household members
NOHOUSEM	Number	8	n th number of household member
FRSTNAME	Text	15	First name
LASTNAME	Text	15	Last name
SEX	Number	8	Sex
AGE	Number	8	Age
YEARCURT	Number	8	Years at current address
PLACEPVC	Number	8	Previous residence
YEARPREV	Number	8	Years at previous residence
YEARHRA	Number	8	Total years living in the HRA
OCCUPATN	Text	15	Occupation
COMPANY	Text	15	Company
OCCUYEAR	Number	8	Years at work
CONSTR LG	Number	8	Ever done construction in HRA
CONSTR YR	Number	8	Years at work
FARMLG	Number	8	Ever done farming work in HRA
FARMYR	Number	8	Years at work
OTHERLG	Number	8	Ever done other work having contact with PCB
OTHERYR	Number	8	Years at work
OTHERDES	Text	15	Description of the work
FRSHFISH	Number	8	Ever eaten freshwater fish
FISHTYP1	Number	8	Fish type
FISHTYP2	Number	8	Fish type
FISHTYP3	Number	8	Fish type
FISHTYPD	Text	15	Fish type
FREQFSHN	Number	8	Frequency of fish consumption (a)
FREQFSHC	Text	1	Frequency of fish consumption (b)
FISHYEAR	Number	8	Number of years consuming fish
FISHWAYS	Number	8	How the fish was caught
PLACEFSH	Number	8	Where the fish was caught
PLACEFHD	Text	15	Name of the place where the fish was caught
HRAFSHLG	Number	8	Ever fished in the Housatonic River
HRAFSHD1	Number	8	What was done with the Housatonic fish (a)
HRAFSHD2	Number	8	What was done with the Housatonic fish (b)
FERNSLG	Number	8	Ever eaten fiddlehead ferns in the Housatonic River
FREQFRNN	Number	8	Frequency of consuming fiddlehead ferns (a)
FREQFRNC	Text	1	Frequency of consuming fiddlehead ferns (b)
CANOELG	Number	8	Ever canoed
FREQCANN	Number	8	Frequency of canoeing (a)
FREQCANC	Text	1	Frequency of canoeing (b)
BRIDWLG	Number	8	Ever bird-watched
FREQBDWN	Number	8	Frequency of bird-watching (a)
FREQBDWC	Text	1	Frequency of bird-watching (b)
ROTHERLG	Number	8	Ever done other recreational activities

Appendix M List of Variables used in Epi Info File for Data from Blood Testing Questionnaire

FREQROTN	Number	8	Frequency of doing other recreational activities in HRA (a)
FREQROTC	Text	1	Frequency of doing other recreational activities in HRA (b)
ROTHERDP	Text	15	Description of other recreational activities
HUNTLG	Number	8	Ever hunted in the HRA
HUNTFDLG	Number	8	Ever hunted for food
PREY1	Number	8	Type of prey
FREQPY1N	Number	8	Frequency of consumption (a)
FREQPY1C	Text	1	Frequency of consumption (b)
PREY2	Number	8	Type of prey
FREQPY2N	Number	8	Frequency of consumption (a)
FREQPY2C	Text	1	Frequency of consumption (b)
VEGETLG	Number	8	Ever done vegetable gardening
FREQVGTN	Number	8	Frequency of doing vegetable gardening (a)
FREQVGTC	Text	1	Frequency of doing vegetable gardening (b)
GOTHERLG	Number	8	Ever done other yard work
FREQGOTN	Number	8	Frequency of doing other yard work (a)
FREQGOTC	Text	1	Frequency of doing other yard work (b)
COMMENTEXP	Text	150	Additional comments on exposure to PCBs

Variable Name	Type	Length	Description
ID	Text	6	Identification number for household
IDD	Text	6	Identification number for individual
SALUTATION	Text	3	Salutation
FRSTNAME	Text	15	First name
LASTNAME	Text	15	Last name
SEX	Number	8	Sex
AGE	Number	8	Age
BIRTHDATE	Date/Time	8	Date of birth
PHONENBM	Text	8	Telephone number
SCORES	Number	8	
COLLECTION	Date/Time	8	Date of Specimen Collection
PCB	Number	8	Serum PCB level (ppb)
CHOLESTROL	Number	8	Cholesterol level
TRIGLYCERI	Number	8	Triglyceride level
HLTHPRB1	Text	15	Significant health problem
HLTHPRB2	Text	15	Significant health problem
HLTHPRB3	Text	15	Significant health problem
MEDICIN1	Text	20	Type of medicine taken
MEDYEAR1	Number	8	Number of years medicine taken
MEDICIN2	Text	12	Type of medicine taken
MEDYEAR2	Number	8	Number of years medicine taken
MEDICIN3	Text	12	Type of medicine taken
MEDYEAR3	Number	8	Number of years medicine taken
SMOKING	Text	1	Ever smoked
CIGARETTES	Number	8	Number of cigarettes per day
AGE_START	Number	8	Age started smoking
AGE_END	Number	8	Age quit smoking
ALCOHOL	Text	1	Ever had alcohol beverage
BEERN	Number	8	Frequency of drinking beer (a)
BEERC	Text	1	Frequency of drinking beer (a)
BEER_YEAR	Number	8	Number of years drinking beer
WINEN	Number	8	Frequency of drinking wine (a)
WINEC	Text	1	Frequency of drinking wine (a)
WINE_YEAR	Number	8	Number of years drinking wine
LIQUORN	Number	8	Frequency of drinking liquor (a)
LIQUORC	Text	1	Frequency of drinking liquor (a)
LIQR_YEAR	Number	8	Number of years drinking liquor
WEIGHT	Number	8	Weight (lbs.)
WEIGHT_DT	Date/Time	8	Date measured
HEIGHT_FT	Number	8	Height (feet) (a)
HEIGHT_IN	Number	8	Height (inches) (b)
HEIGHT_DT	Date/Time	8	Date measured
YEARCURT	Number	8	Years at current address
PLACEPVC	Number	8	Previous residence
YEARPREV	Number	8	Years at previous residence
YEARHRA	Number	8	Total years living in the HRA

OCCUPATN	Text	15	Occupation
COMPANY	Text	15	Company
OCCUYEAR	Number	8	Years at work
CONSTRYR	Number	8	Years of doing construction in HRA
FARMYR	Number	8	Years of doing farming work in HRA
OTHERYR	Number	8	Years of doing other work having contact with PCB
OTHERDES	Text	15	Description of the work
FRSHFISH	Number	8	Ever eaten freshwater fish
FISHTYP1	Number	8	Fish type
FISHTYP2	Number	8	Fish type
FISHTYP3	Number	8	Fish type
FREQFSHN	Number	8	Frequency of fish consumption (a)
FREQFSHC	Text	1	Frequency of fish consumption (b)
FISHYEAR	Number	8	Number of years consuming fish
FSHCHANGE	Text	20	Change of fish consumption over time
FISHWAYS	Number	8	How the fish was caught
PLACEFSH	Number	8	Where the fish was caught
HRAFSHLG	Number	8	Ever fished in the Housatonic River
HRAFSHDO	Number	8	What was done with Housatonic fish
FREQFRNN	Number	8	Frequency of consuming fiddlehead ferns (a)
FREQFRNC	Text	1	Frequency of consuming fiddlehead ferns (b)
FREQCANN	Number	8	Frequency of canoeing (a)
FREQCANC	Text	1	Frequency of canoeing (b)
FREQBDWN	Number	8	Frequency of bird-watching (a)
FREQBDWC	Text	1	Frequency of bird-watching (b)
FREQROTN	Number	8	Frequency of other recreational activities in HRA (a)
FREQROTC	Text	1	Frequency of other recreational activities in HRA (b)
ROTHERDP	Text	15	Description of other recreational activities
HUNTLG	Number	8	Ever hunted in the HRA
HUNTFDLG	Number	8	Whether hunted for food
PREY1	Number	8	Type of prey
FREQPY1N	Number	8	Frequency of consuming prey (a)
FREQPY1C	Text	1	Frequency of consuming prey (b)
PREY2	Number	8	Type of prey
FREQPY2N	Number	8	Frequency of consuming prey (a)
FREQPY2C	Text	1	Frequency of consuming prey (b)
FREQVGTN	Number	8	Frequency of doing vegetable gardening (a)
FREQVGTC	Text	1	Frequency of doing vegetable gardening (b)
FREQGOTN	Number	8	Frequency of doing other yard work (a)
FREQGOTC	Text	1	Frequency of doing other yard work (b)
BF24HRS	Text	50	24-hour diet history: breakfast
LN24HRS	Text	50	24-hour diet history: lunch
DI24HRS	Text	50	24-hour diet history: dinner
OT24HRS	Text	50	24-hour diet history: other
ADDRESS	Text	30	Address
CITYZIP	Text	30	City/Zip Code
COMMENTS	Text	254	Additional comments