INDUSTRIAL ECONOMICS, INCORPORATED

2067 Massachusetts Avenue Cambridge, Massachusetts 02140 Telephone: 617/354-0074 Telecopier: 617/354-0463

MEMORANDUM

January 28, 1997

TO: Housatonic River NRD Agency Contacts

FROM: John Weiss

SUBJECT: Preliminary Natural Resource Damage Assessment Report

---

Enclosed please find IEc's final report entitled "Housatonic River Preliminary Natural Resource Damage Assessment." Multiple copies are included, as appropriate. Please call if you have any questions.

HOUSATONIC RIVER
PRELIMINARY NATURAL RESOURCE
DAMAGE ASSESSMENT

Prepared for:

Mark Barash
Department of the Interior
Northeast Region Solicitor's Office

Anton P. Giedt
National Oceanic and Atmospheric Administration
Office of General Counsel

Matt Brock
Massachusetts Office of the
Attorney General

John Looney
Connecticut Office of the
Attorney General

Prepared by:
Robert E. Unsworth, John C. Weiss, Marla A. Markowski
Industrial Economics, Incorporated
2067 Massachusetts Avenue
Cambridge, MA 02140

TABLE OF CONTENTS

INTRODUCTION CHARTER 1

Under contract to the U.S. Fii and Wildlife Service (FWS) and the Massachusetts Department of Environmental Protection (MADEP) (as a subcontractor to TRC Environmental Corporation), Industrial Economics, Incorporated (IEc) was asked to conduct a preliminary assessment of damages associated with injuries to natural resources caused by the release of hazardous materials by the General Electric Company (GE) to the Housatonic River. In general, this assessment was to include descriptions of:

- Injuries that have resulted from the release of hazardous materials to the river;
- Recreational and passive use losses resulting from these injuries;
- The type and scale of restoration actions necessary to restore the injured resources (Le., primary restoration); and
- The type and scale of additional restoration actions that would compensate the public for interim losses (i.e., compensatory restoration).

IEc described the scope of the tasks required to achieve the project's objectives in the Proposed Technical Approach prepared under FWS Contract Number 14-48-0009-95-005, Delivery Order I-001. This Technical Approach combined the requirements of the Statements of Work issued by each of the funding agencies.[1]

The objective of this preliminary damage assessment is to (1) assist the trustees in the development of an appropriate strategy for presenting a damage claim, (2) provide information that will be of value in crafting a settlement position, should the trustees enter into negotiations

[1] The Commonwealth of Massachusetts, U.S. Department of the Interior, the National Oceanic and Atmospheric Administration, and the U.S. Environmental Protection Agency provided funding to support this effort.

with the responsible party, and (3) serve as a first step in planning more detailed injury and damage assessment activities that could lead to the litigation of a natural resource damage claim. An assessment such as this includes elements of both the "preassessment screen" and the "preliminary estimate of damages," which are described in the Department of the Interior (DOI) regulations for damage assessments (43 CFR §§ 11.23-l 1.25 and 43 CFR 511.35, respectively). In completing this assessment, we have worked within DOI's regulatory framework, which identities four primary damage assessment components: documenting a release of hazardous substances to the environment; documenting injuries resulting from this release; calculating the economic damages associated with the injury, and determining appropriate restoration activities that will return the injured resources to their pre-release, or baseline. Trustees may elect to identify additional restoration activities that will compensate the public for the economic losses incurred during the period between release and restoration.

SUMMARY OF FINDINGS

The following summarizes the results of our efforts to assess potential injuries, to calculate estimates of compensable damages associated with recreational and passive use losses, and to begin to evaluate the appropriate type and scale of restoration actions.

- Resources with characteristics that satisfy the definitions of injury provided in the DO1 regulations include surface water and certain biological resources (including fish, frogs and turtles).

- Extensive data suggest, but do not confirm, that contamination of the sediment portion of the surface water resource may be the source of injuries to a variety of biological resources, including invertebrates, fish, reptiles and amphibians, birds and mammals.

- Injury may also be occurring as a result of the exposure of biological resources to contaminated floodplain soils.

- Additional injury assessment studies would be needed to further document injuries associated with sediment and soil contamination.

- The release of PCBs to the Housatonic River has resulted in the posting of fish consumption advisories and changes in fishery management practices in both Massachusetts and Connecticut. These factors have resulted in a reduction in the utilization of the Housatonic River fishery (i.e., fewer trips are taken) and have diished the value of the remaining trips.

- On the basis of available data, our best estimate of damages associated with lost or diished recreational fishing and boating trips is $11 million - $32 million.

- The release of hazardous substances to the Housatonic River has also resulted in a reduction in the passive use value of the resource. Based on household willingness-to-pay data **from** existing contingent valuation studies and an **estimate** of the probable "market" for this resource, we estimate that passive use damages are in the range of **$25** million - $250 million.

- A wide variety of options are available to compensate the public for interim losses of natural resources (**i.e., the** loss **between the** initial **release** df hazardous substances and **the restoration** of the resources **to their** baseline condition). Based on extensive interviews with representatives of national and local conservation organizations, state and federal agencies, and local recreational groups, we have identified options in the following general categories: enhancement of water quality, enhancement of recreational fisheries, enhancement of other **recreational** uses, general land/wetland **conservation, and other.**

LIMITATIONS

The nature of existing, readily available data and infotmation liited our ability to complete all of the objectives described in the Statements of Work. In particular, our **injury** assessment does not identify and quantify all of the natural resource injuries **likely** to be present in the Housatonic Rive-r environment. Consequently, we have not **recommended** specific restoration alternatives that are explicitly linked to **documented** injuries. The following discussion provides additional detail regarding these and other areas that may require further data collection and analysis.

- **Cont[redacted]ts of concern:** Polychlorinated biphenyls **(PCBs)** are the primary contaminants of concern at this stage of the damage assessment. Though there are other hazardous substances present in the Housatonic River that may contribute to natural resource injuries. we have not addressed potential injuries resulting **from** exposure to substances other than **PCBs.**

- **Geographic Scope:** Our **preliminary** assessment has focused on' the Housatonic River and floodplain **downstream** of the GE facility in Pittsfield, MA. We have not assessed potential injuries and damages associated with Silver **Lake** and Unkamet Brook. Both may require. additional scrutiny. In addition, we have not addressed specific injuries and damages that might be associated with the former **oxbows** located in Pittsfield, though we do recognize the potential importance. of these areas to a **final** determination of restoration and compensation requirements. Furthermore, we recognize that these areas may be sources of continuing contamination to the Housatonic **River.**

- **Injury Assessment:** Existing data are available to characterize the nature and extent of contamination in the Housatonic River environment but do not in all cases provide sufficient information to document natural resource injury. As a result, our injury assessment focused on a summary of the existing contaminant concentration data and the likelihood that those data are indicative of natural resource injuries (which could be documented through additional data collection and/or analysis).

- **Restoration:** Due to the limitations of the injury data and the dependence of restoration planning on the injury assessment, we focused our efforts in this area on the preliminary identification of categories of activities as well as specific activities that might be appropriate for the purpose of compensatory restoration. These activities do not include primary, physical restoration of natural resources (e.g., sediment removal), the specification of which would be the primary outcome of a completed injury assessment

REPORT ORGANIZATION

The results of our prehminary assessment of natural resource injuries and damages are summarized in the following five chapters. Chapter 2 describes the injuries that can be documented on the basis of available data, and further evaluates these data in the context of relevant injury literature. Chapter 3 summarizes our prehminary estimate of compensable damages, with a focus on damages associated with injury to recreational resources and passive use values. We present our calculations supporting these estimates, as well as descriptions of our methodologies and assumptions, in Appendices A-D.. . Chapter 4 provides a preliminary inventory of compensatory restoration options and briefly describes the habitat equivalency approach, which can be used to scale restoration based on the provision of replacement or equivalent resources as compensation for habitat that has been degraded by the release of hazardous substances. Chapters 5 and 6 describe approaches for the evaluation of two additional categories of damages: those associated with injury to groundwater resources and those associated with the added cost of development resulting from natural resource injury.

ASSESSMENT OF INJURIES **TO NATURAL RESOURCES** CHAPTER2

INTRODUCTION

This chapter **summarizes information** regarding the **nature and** extent of possible **injury to** natural resources resulting from the release to tbe Housatonic River of hazardous substances from the General Electric (GE) **facility** in Pittsfield, Massachusetts. We obtained site-specific data for our assessment from the following documents:

1. MCP Interim Phase II Report/Current Assessment Summary for Housatonic River, December 1991 **(BB&L** 1991)

2. Addendum to MCP Interim Phase II **Report/Current** Assessment Summary for **Housatonic** River, August 1992 **(BB&L** 1992) ,

3. Aquatic Ecology Assessment of the Housatonic River, Massachusetts, May 1994 (Chadwick **&** Assoc. 1994)

4. **Evaluation** of Terrestrial **Ecosystem** of the Housatonic River Valley, July 1994 **(ChemRisk** 1994)

5. Work Plan for the Ecological Risk Assessment of the Housatonic River Site, **February** 1995 (ChemRisk 1995)

6. Supplemental Phase **II/RCRA** Facility Investigation Report for Housatonic River and Silver Lake, January 19% **(BB&L** 1996)

7. Report on the Preliminary Investigation of Corrective **Measures (PICM)** for Housatonic River and Silver Lake Sediment, May 1996 **(HE&C** 1996).

We also consulted both peer-reviewed **literature** and other information **sources** to aid in the evaluation of possible injuries to Housatonic River **resources.** Whenever possible, we have evaluated injury on the basis of the definitions provided in the Department of the Interior's **(DOI)** regulations for damage assessment (43 CFR Part 11). The goal of this effort is to assess the ability of the available data to support the injury determination component of the Housatonic damage assessment, with a focus on identifying those injuries that require restoration. We also outline the issues associated with further documenting injury either on the basis of literature-based expert reviews or on the basis of primary field studies.

The Housatonic River trustees are faced with the task of planning assessment activities, that will produce litigation-quality results at a reasonable cost. While there are numerous assessment activities that could be undertaken to evaluate potential injuries to a broad range of natural resources, there is no guarantee that the data generated through these activities will conclusively document injury. Therefore, a cautious, phased approach is warranted in order to avoid a situation in which significant expenditures produce inconclusive results. Our intenton is to provide sufficient background relative to the Housatonic River case to aid in the prioritization of future activities and the development of a strong damage claim.

Exhibit 2-1 summarizes our findings and conclusions. We also include the following section, describing specific factors that the trustees should consider in planning the next phase of this assessment.

FACTORS ASSOCIATED WITH INJURY ASSESSMENT

Co[redacted] of Concern

- The primary contaminants of concern in the Housatonic River downstream of the GE facility in Pittsfield are polychlorinated biphenyls (PCBs), as reflected by .the focus on these compounds' during past assessment activities. Therefore, our assessment will focus on injuries resulting from the release of PCBs to the Housatonic River environment.[1] However, the analysis of enviromnental samples from the Housatonic River environment has also included testing for a wide range of organic and inorganic compounds.

Baseline

- In order to quantify natural resource injuries for the purpose of scaling restoration, the DO1 regulations require an evaluation of and comparison to the baseline wndition of the resources and associated services (i.e., the "conditions that would have been expected at the assessment area had the . . . release of hazardous substances not occurred . . ..").

[1] Unless otherwise indicated, all references to PCB levels reflect total, rather than congener-specific, PCB concentrations.

Exhibit 2-1

INJURY ASSESSMENT SUMMARY:HOUSATONIC RNER NRDA

Resource	Injury Assessment	Comments
Surface water	Injury can be established on the basis of the DOI regulations.	Need to establish that the AWQC was not exceeded prior to the release of PCBs from GE.
Sediment	Injury cannot be established definitively on the basis of the DOI regulations; however, sediment concentrations generally exceed suggested thresholds for adverse biological effects.	Sediments are the key link in the pathway to biological resource injuries. Sediment toxicity testing and/or a comprehensive review of the sediment toxicity literature is recommended.
Soil	Injury cannot be established definitively on the basis of the DOI regulations.	Contaminated floodplain soils may also be an important link in the pathway to biological resource injuries. Toxicity testing may be warranted.
Pih	Injury can be established on the basis of the DOI regulations (tissue concentrations in excess of FDA standard; existence of consumption advisories); literature suggests that it may be possible to document additional measures of injury (e.g., reproductive impairment).	Literature-based analysis to document biological injury would be beneficial to the development of a strong injury case (i.e., one based on the propagation of injuries through the food chain).
Invertebrates	Injury cannot be established on the basis of the DOI regulations; sediment threshold values suggest that some injury may be occurring.	Sediment toxicity testing may be valuable (see sediment injury); literature-based weight of evidence approach may also provide sufficient argument for injury.
Birds	Injury cannot be established definitively on the basis of the DOI regulations.	Lack of organism-specific data limits current value of existing toxicity literature; expert opinion needed to judge likelihood of injury given PCB concentrations to which birds are potentially exposed.
Mammals	Injury cannot be established on the basis of the DOI regulations.	Lack of organism-specific data limits current value of existing toxicity literature; expert opinion needed to judge likelihood of injury given PCB concentrations to which mammals are potentially exposed; sensitivity of mink to PCBs suggests literature-based analysis may be warranted.
Reptiles and Amphibians	Injury can be established on the basis of the DOI regulations (existence of consumption advisory).	Existing literature is not conclusive regarding biological effects of PCBs on reptiles and amphibians.
Groundwater	Injury cannot be established on the basis of the DOI regulations.	Would be based on contamination of existing or potential drinking water supply; groundwater may be a continuing source of PCBs to the Housatonic River.
Air	Injury cannot be established on the basis of the DOI regulations.	Even if injury could be established, contribution to damage claim would be minimal.

001935

- Baseline conditions can be established, in genera& through the review of historical data from the assessment **area,** historical data **from** an appropriate control (or reference) area, or current data from an appropriate control (or reference) area.

- **The** data available to us do not include applicable baseline information. We make the initial assumption that the baseline **concentration** of **PCBs** in all media is zero. However, given **the** generally widespread occurrence of PCBs in the **environment,** and the existence of other potential sources of PCBs **in the Housatonic River watershed (e.g.,** other industries), this assumption may result in an overstatement of injuries. We **do** not anticipate that this overstatement will be significant, as we believe that GE has **been** the primary source of hazardous substance releases.

- In order to complete the damage assessment, it will **be necessary** to **establish the** baseline condition of **the** Housatonic River enviromnent, in terms of both resource **characteristics** and **resource services.**

Geographic Scope

- Exhibit 2-2 illustrates the Housatonic River watershed. PCB contamination is present in **Housatonic River** resources **from** Pittsfield south to Long Island Sound. The highest concentrations are observed in the area between Pittsfield and Woods Pond. Since this upstream portion of the river serves **as** a continuing source of **contamination** to **downstream** areas, and **since** data are more comprehensive for this area than for those downs&am, it is appropriate to focus the injury assessment on the Pittsfield-Woods Pond stretch Nevertheless, we consider injury to resources and/or services **downstream** of Woods Pond to the extent that **sufficient** data are available to support this assessment.

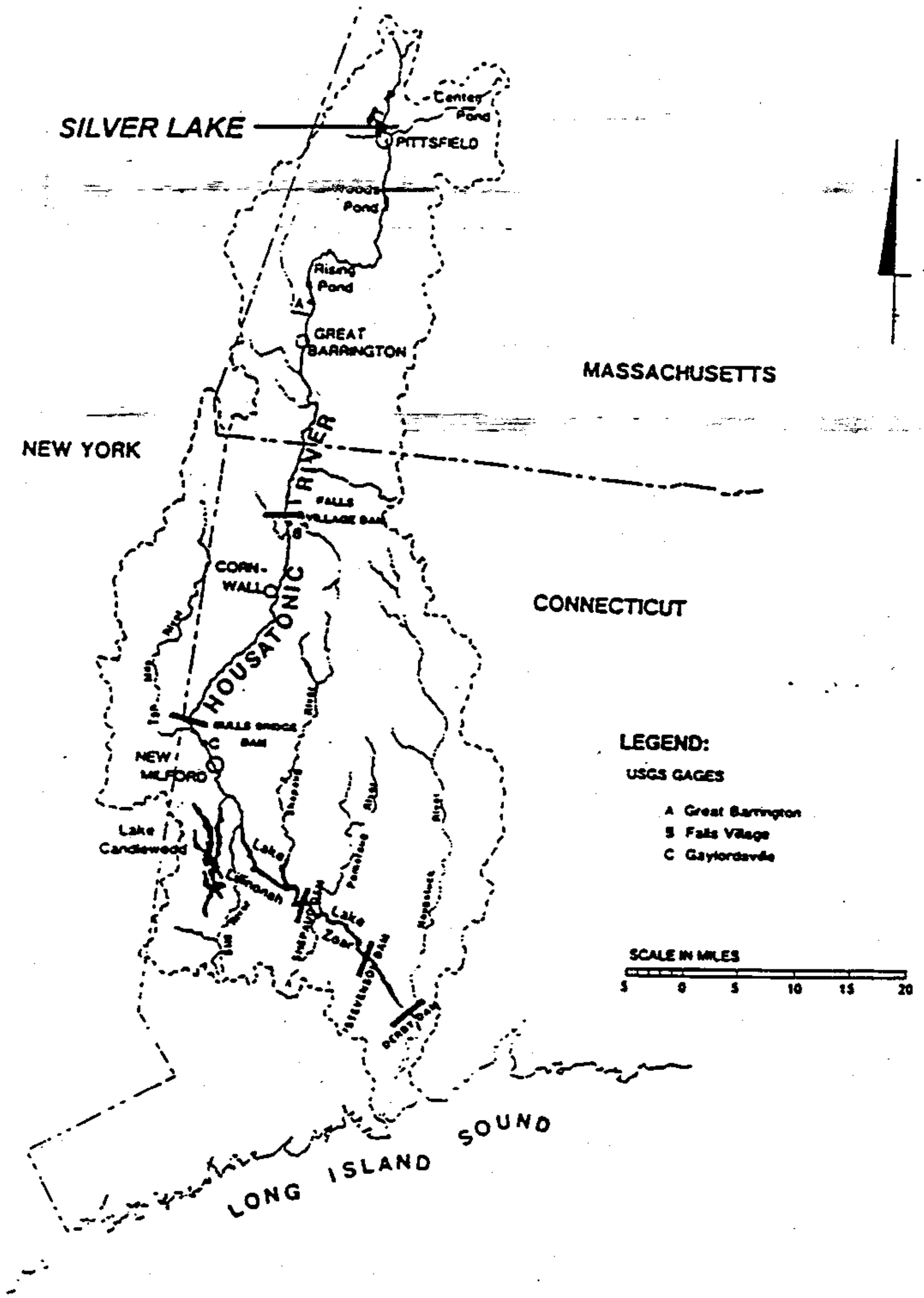
Temporal Scope

- Releases of **PCBs** to the Housatonic River, and injuries to natural resources, begin at an undetermined point in the **past. PCBs** were reportedly in use at the GE facility in Pittsfield between 1932 and 1977 **(BB&L** 1996). **PCBs** were **first** detected in fish and sediments approximately 20 **years** ago, suggesting that the period of injury is now in excess of 20 years.

- Many damage assessments have limited the quantification of injury and damages to the period that began with the promulgation of CERCLA in December 1980.

Exhibit 2-2

HOUSATONIC RIVER WATERSHED



Source: BB&L 1996 (based on Frink et al. 1982)

- The first significant, systematic program of data collection in and near the Housatonic River occurred in the early 1980s. Therefore, we use the date of CERCLA promulgation as a conservative starting point for injury determination and quantification.

Endangered/Threatened Species

- As reported in the PICM (HE&C 1996), a total of 120 species of flora and fauna that have protected status at the state or federal level are known or likely to occur in the Housatonic River environment. We do not currently have information that would lead us to conduct a focused injury assessment of one or more of these species.

- Determination of injury to a federally listed species would provide 'the trustees with the authority to undertake specific restoration activities pursuant to the Endangered Species Act (i.e., outside of the NRDA context). State statutes may provide similar authority.

Collateral Injury During Remediation

- Our assessment of injury focuses on the current state of resources associated with the Housatonic River. However, for restoration planning purposes, it may be necessary to estimate the extent of additional injury that might occur as a result of remedial activities (e.g., loss of wetlands due to dredging) and include this estimate in the final accounting of injury.

Data Quality

- An independent review of the data contained in tbe reports listed above is beyond the scope of this injury assessment task To the best of our knowledge, all environmental samples were collected and analyzed in accordance with applicable protocols and have been subject to appropriate quality control/quality assurance reviews. It will be necessary to confirm that the available data, and all subsequently collected data, are of sufficient quality to support a damage assessment.

INJURY ASSESSMENT

- Our evaluation of potential injuries associated with observed PCB concentrations is based on the comparison of these concentrations to known thresholds and standards, or through the comparison of these concentrations to the concentrations associated with observed'or suspected PCB effects on comparable resources associated with other sites.

- At present, data associated with Housatonic River resources are limited to concentrations of PCBs and other hazardous substances in specific enviromnental media (e.g., fish tissue, riverbed sediment). Under the DOI regulations, the only resources for which trustees can confirm injurysolely on the basis of observed PCB concentrations are fish (and other edible organisms), surface water and groundwater, through exceedance of an FDA standard or a posted state consumption advisory, Ambient Water Quality Criteria, and Maximum Contaminant Levels, respectively. However, the data that are currently available, combined with previously published research on PCB effects, may be helpful in constructing an injury case using a weight of evidence approach

- The PCB literature focuses on the effects of PCB exposure on aquatic organisms (fish, invertebrates), mammals and buds. The effects are generally reported as the results of controlled laboratory dosing expenments, although some field studies have been undertaken. In general, field studies involve determining PCB concentrations in organisms that have exhibited a particular effect, such as mortality or reproductive impairment. However, due to other factors that are typically present in the study area (such as the presence' of other contaminants), it may be difficult to use field studies to draw definitive conclusions regarding the specific effect(s) of PCB exposure.

- The organization of the following discussion follows the resource-specific organization of the DO1 regulations (43 CFR 11.62)

Surface Water Resources - Surface Water

Data Review

- Total PCB concentrations in the Housatonic River water column have been evaluated multiple times over the past 20 years, as summarized in Exhibit 2-3. The reported concentrations have generally been in the low part Per billion (ppb) range, which is typical for PCBs in the aqueous phase given their low water solubility (BB&L 1991).

Exhibit 2-3

SUMMARY OF TOTAL PCB CONCENTRATIONS IN THE HOUSATONIC RIVER WATER COLUMN

Date of Sample(s)	Location	Concentration Range (ppb)	Notes
1978-1980	Great Barrington, MA Falls Village, CT Gaylordsville, CT	BDL - 0.6 BDL - 0.2 BDL - 0.1	Samples collected during five high flow events; no detection limit reported
1982	Lenox, MA Great Barrington, MA MA-CT border	BDL - 0.07 BDL - 0.1 BDL - 0.15	Samples collected during three flow regimes (low, moderate, high); detection limit = 0.03 ppb
1984-1988	Great Barrington, MA Ashley Falls, MA Canaan, CT Falls Village, CT Kent, CT	BDL - 0.5 BDL - 0.1 BDL - 0.1 BDL - 0.1 BDL - 0.2	Samples collected during five high flow events; detection limit = 0.1 ppb
1989-1991	six locations, Pittsfield to Great Barrington, MA	BDL - 0.58	unfiltered PCB concentrations; no detection limit reported
1995	five locations, Pittsfield to just downstream of Woods Pond Dam	BDL - 1.1	detection limit = 0.65 ppb

BDL = below detection liiit
Sources: BB&L 1991, 1996

Injury Assessment

- Surface water resources have been injured ifconcentrations of hazardous substances exceed water quality criteria establiied under section 304(a)(1) of the Clean Water Act (43 CFR 11.62(b)(1)(iii)).

- PCB concentrations in the Housatonic River have frequently exceeded the national ambient water quality chronic criterion for the protection of freshwater aquatic life (0.014 ppb). No samples have exceeded the criterion for acute toxicity (2 ppb) (EPA 1986).

- If PCB concentrations in the Housatonic River did not exceed the chronic criterion prior to the initial release of PCBs from the GE facility, then the observed concentrations are sufficient to demonstrate injury. We believe that such a claim can be made, as we do not believe that there are any local sources of PCBs comparable in magnitude to GE.

Surface Water Resources Sediments

Data Review

- Under the DOI regulations, the Housatonic River's bank and bed sediments (as well as the sediments in Silver Lake) are classified as surface water resources (43 CFR 11. 14(s)).

- A large proportion of the existing data report PCB concentrations in riverbed sediments (reflecting the focus on characterization of the contamination). Riverbed samples have been collected primarily between Pittsfield and Woods Pond; liited additional sampling has been conducted in the impoundments located downstream of Woods Pond in both Massachusetts and Connecticut. Additional sampling has been conducted in Silver Lake. Exhibit 2-4 presents a broad summary of existing PCB sediment data. This summary is intended only to illustrate the general magnitude of PCB concentrations in Housatonic River and Silver Lake sediments.

Exhibit Z-4

SUMMARY OF TOTAL PCB CONCENTRATIONS IN HOUSATONIC RIVER AND SILVER LAKE SEDIMENTS

Location	Average PCB Concentration (ppm)	Notes
Pittsfield - Woods Pond Dam	≈ 29	Concentrations exceed 200 ppm at multiple locations; maximum observed concentration > 10,000 ppm; average thickness of contaminated sediments = 2.4 feet
Woods Pond Dam - Rising Pond Dam	≈ 3	
Rising Pond Dam - MA/CT horder	< 1	
Silver Lake-shallow water	168	Maximum concentration of 21.000 ppm detected in NE comer of lake (1992)
Silver Lake-deep water	150	Maximum concentration = 6,350 ppm
Sources: BB&L 1991.1996: Chadwick 1994		

Injury Assessment

- If concentrations of hazardous substances in bed and bank sediments are sufficient to have caused injury to groundwater, air, geologic or biological resources, then the surface resource is considered to be injured (43 CFR 11.62 (b)(l)(v)).

- The surface water resource also is injured if concentrations of substances in the sediments are sufficient to cause the sediments to exhibit characteristics listed pursuant to section 3001 of the Solid Waste Disposal

Act (43 CFR 11.62 (b)(1)(iv)). As a class of compounds, PCBs are not currently liied as hazardous substances in the regulations (40 CFR Part 261) that defme these characteristics.[2]

- Observed concentrations of PCBs in fish, sufficient to document injury to that resource (as described below), suggest that the sediments have in fact caused injury to biological resources (through a food chain pathway).

- The relationship between sediient PCB concentrations in the Housatonic River and- injury to biological resources is also suggested (but not definitively established) through comparison. to concentrations that have been determined to be benchmarks, or thresholds, for potential adverse biological effects. For example, Hull and Suter (1994) report a "sediment quality benchmark" of 20.52 ppm (assuming one percent total organic carbon in the sediment). This benchmark was calculated on the basis of water quality benchmarks for the protection of aquatic life (including water quality criteria when available) and partition coefficients for PCBs in water. Exceedance of this benchmark indicates only the need for more site-specific data collection and analysis.

- On the basis of the results of numerous field and laboratory studies, Long et al. (1995) concluded that total PCB concentrations in sediment equal to or greater than 0.18 ppm will "frequently" cause adverse biological effects. However, it should be. noted that (1) this value was derived specifically for marine and estuarine sediments, and (2) relative to other compounds, PCBs exhibited one of the poorest relationships between observed concentrations and the incidence of effects.

- Without enforceable sediment quality criteria for PCBs, it is necessary to demonstrate that the concentrations observed in the bed and bank are sufficient to cause adverse biological effects. Comparison of Housatonic River data to the results of sediment toxicity evaluations at other sites may be a valuable tool for building a weight of evidence case.

- Since the sediments of the Housatonic River are the locus of PCB contamination, and are possibly the basii for injuries that are propagated through multiple trophic levels, site-specific toxicity testing for chronic effects may be warranted.

---

[2] Note that PCBs are regulated under the Toxic Substances Control Act (TSCA). Any material, including sediment or floodplain soil with a PCB concentration equal to or greater than 50 ppm is subject to TSCA regulations. These regulations specify three options for the disposal of contaminated sediments or soils: incineration, disposal in a licensed chemical waste landfill, or an alternative accepted by the EPA Regional Administrator (EPA 1994).

Geologic Resources - Floodplain Soils

Data Review

- Floodplain sampling has focused on 11 transects located between Pittsfield and the Massachusetts/Connecticut border.
- The maximum detected floodplain soil concentration is 230 ppm. The average concentration of PCBs in floodplain soils between GE and Woods Pond is approximately 16 ppm. Concentrations greater than one ppm are generally limited to the region within the IO-year floodplain (BB&L 1996). Downstreamof Woods Pond, PCBs are present in the floodplain at lower concentrations (averaging less than two ppm) and in a narrower region (generally within 150 feet of the river) (BB&L 1996).

Injury Assessment

- Floodplain soils fall under the DOI definition of geologic resources (43 CFR 11.14(pp)).
- As described at 43 CFR 11.62(e), measurement of a variety of changes in the physical or chemical quality of 5oodplain soils can be used to document injury, including measurement of concentrations of hazardous substances sufficient to:

  1. Cause a toxic response in soil invertebrates;
  2. Cause a phytotoxic response such as retardation of plant growth; or
  3. Have caused injury to surface water, groundwater, air, or biological resources:

- Existing data associated with this resource are liited to total PCB concentrations; they do not describe any specific adverse physical, chemical, or biological responses associated with the presence of PCBs. Therefore, unless additional data become available, our assessment of injury to 5oodplain soils must be based on the evaluation of other resource injuries tbat can be attributed to those resources' direct or indiit exposure to the PCBs contained in the soils.
- A potentially large amount of floodplain habitat is degraded as a result of PCB contamination of floodplain soils. As with river sediments, it is necessary to establish a link between the observed PCB concentrations and injury to other resources (probably through food chain exposure pathways). The following discussion of biological injuries provides some

data relating PCB concentrations in organisms to adverse effects. However, we 'do not have data on the levels that are expected in an organism following exposure to contaminated soil.

- Other measures of injury that might be applicable include concentrations of PCBs in the soils that are sufficient to impede soil microbial respiration or to cause a phytotoxic response (such as retardation of plant growth) (43 CFR 11.62(e)(5) and (10)). We are unaware of existing studies that suggest that PCB concentrations in the Housatonic River floodplain are sufficient to cause either of these effects.

Biological Resources

- Biological monitoring and data collection has not been a priority of past assessments. Past sampling of sediment, soil and surface water emphasii characterizing ~~the magnitude~~ and extent of PCB contamination in the Housatonic River environment rather than establishing injury in the NRDA context

- In general, an observed PCB concentration in the tissue of an organism is not conclusive evidence of injury (except in cases where a regulatory standard has been exceeded, as with fish). The observed concentration may suggest injury if, in a laboratory setting, an equal or lower concentration is observed to have an adverse biological effect on that organism or on a comparable species.

- The results of previous laboratory analyses can show that consumption of the contaminated organism by another organism higher in the food chain would provide a sufficient dose to cause an adverse effect in the higher organism.

- However, it may be difficult to "prove" injury on the basis of comparisons to the results of studies conducted in other systems. This difficulty may be compounded by the lack of correlation between the parameters of existing studies (e.g., the species and PCB compound that were studied) and Housatonic River conditions.

Biological Resources - Fish

Data Review

- Multiple sampling events over the past 20 years have demonstrated that PCB concentrations in the tissue of fish from the Massachusetts and Connecticut portions of the Housatonic 'River downstream of the GE facility are elevated relative to the Food and Drug Administration's standard for human consumption (two ppm). In and above Woods Pond, total PCB concentrations in fish tissue have consistently measured in excess of the two ppm standard, regardless of species. Below Woods Pond, concentrations greater than two ppm have been observed at the most downstream sampling locations (Lakes Lillinonah, Zoar and Housatonic), and in a variety of species, although the frequency of such observations decreases with downstream distance (BB&L 1991, 1996).

- We note that an aquatic ecology assessment of the Housatonic River (Chadwick & Assoc. 1994) examined the "structure and general health" of fish communities between the GE facility and the Massachusetts-Connecticut border, and concluded that "there is no pattern of population parameters that appear to be related to sediment PCB levels." The parameters of this study included species composition, abundance, size structure, and overall abundance. This study did not include any sampling or analysis of fish tissue.

Injury Assessment

- The DOI regulations state that injury to a biological resource has occurred if the concentration of a hazardous substance that has been released is sufficient to: (1) cause the resource or its offspring to have undergone an adverse change in viability (e.g., death, disease, physiological malfunction); (2) exceed an action level established under the Food, Drug and Cosmetic Act; or (3) cause a State health agency to issue a directive to limit or ban consumption of the resource (43 CFR 11.62(f)(1)).

- Concentrations of PCBs in fish in the Housatonic River are sufficient to establish injury on the basis of two of these three injury criteria; the concentrations exceed the federal action level of two ppm, and they have caused both the Massachusetts and Connecticut Departments of Health to issue consumption advisories.

- The concentrations of PCBs in fish tissue may also be sufficient to have caused injury on the basis of adverse changes in viability. Niimi (1996) provides a good overview of the adverse effects of PCBs in aquatic organisms. He notes that "[t]here are no specific clinical symptoms that are associated with PCB-induced toxicity in aquatic organisms." However, Niii also reports that high part per billion to low part per million concentrations of PCBs in fish tissue are generally sufficient to cause cellular changes and/or biochemical changes.

- Other observations reported in the literature also suggest that injury to fish might be documented on the basis of adverse changes in viability:

  - Rainbow trout with tissue concentrations of 0.4 ppm have been observed to produce eggs with low survival rate and numerous fry deformities (Eisler 1986); the tissue from two rainbow trout collected from sampling locations in Connecticut in 1977 and 1983 had PCB concentrations of 14.5 and 2.4 ppm, respectively (BB&L 1991).

  - Mehrle et al. (1982, as cited in Niimi 1996) reported lower vertebral strength in Hudson giver bass compared to hatchery-reared fish with lower PCB content.

- As reported in Niii (1996), a number of field studies have reported adverse effects in fish found to contain PCBs. For example, Mehrle et al. (1982) reported lower vertebral strength in Hudson River bass compared to hatchery-reared fish with lower PCB content; also, fm rot observed in the field was induced in the laboratory through the exposure of fish to PCBs (Schimmel et al. 1974). Unfortunately, many of the field studies reported in the literature examined marine rather than freshwater species.

- Many laboratory studies have examined the effects of PCBs on fish. For example, the following results have been reported:

  - Waterborne PCB concentrations greater than 10 ppb are lethal within a few days, white concentrations greater than one ppb may be lethal over longer periods (Nebeker, Puglisi and DeFoe 1974 and DeFoe et al. 1978, as cited in Niii 1996). Note that waterborne concentrations in the Housatonic River have almost always been less than one ppb.

  - Body burdens greater than 100 ppm are generally lethal in young fish, while the lethal body burden for older fish is generally greater than 250 ppm (Hattula and Karlog 1972, Mayer et al. 1977 and Mauck et al. 1978, as cited in Nii 1996). The highest reported total PCB concentration in fish collected from the Housatonic giver is 228 ppm. Among all tissue samples reported in previous assessments, this was the only sample in excess of 200 ppm; only two others were in excess of 100 ppm. Most tissue wncentrations have been in the 1 - 30 ppm range.

- Hose and Cross (1994) twice measured reproductive potential and ovarian wncentrations of DDT and PCBs in white croaker collected from San Pedro Bay (CA). In the first experiment, four of the five measures of

G01946

reproductive potential were significantly lower, and ovarian DDT and PCB concentrations were significantly higher, in the San Pedro fish compared to a reference population. While their results are not conclusive, the authors found "no evidence sufficient to reject the hypothesis of PCB causality."

- A literature-based analysis of potential fish injury (i.e., one that focuses on lost or impaired resources rather than lost human uses of the resources) ~~could be of significant value to the damage assessment.~~ For example, it may be possible to use data from the literature to establish a probable link between Housatonic sediment concentrations and injury to fish species residing in the river.

Biological Resources - Invertebrates

Data Review

- Invertebrates were sampled in Connecticut (at Cornwall) from 1978 through 1981 and from 1984 through 1990. Three species were collected, caddisfly larvae to represent filter feeders and hellgrammite larvae and stonefly nymphs to represent predatory insects. Total PCB concentrations in 20-gram composite samples of these organisms wore highest in 1978 (18.9 ppm for filter feeders and 22.9 ppm for predators), and lowest in 1985 (0.5 ppm for filter feeders, 0.8 ppm for predators). In 1990, total PCB concentrations were 1.2 ppm and 1.9 ppm, respectively (BB&L 1991).

- We note that an aquatic ecology assessment of the Housatonic River between GE and Woods Pond (Chadwick & Assoc. 1994) examined the richness, density and diversity of the invertebrate community. This study concluded that the invertebrate communities in shallow water sites downstream of GE are "healthy, diverse, [and] balanced" and "show no adverse impacts" in comparison to upstream sites. Deep water sites, including Woods Pond, are described as "relatively diverse, healthy and balanced. . .."

Injury Assessment

- Injury to the invertebrate population is determined primarily through observations of adverse effects (acute or chronic) caused by the exposure of particular organisms to hazardous substances in sediments or the water column

- Observed water column concentrations (which are generally in the one ppb range) are generally lower than values reported in the literature as having been acutely toxic to invertebrate species. The lowest LC_{50} reported in Eisler (1986) is 1.3 ppb for a cladoceran species (*Daphnia magna)* exposed to Aroclor 1254 for a period of 21 days.

- The PCB concentrations observed in Housatonic River invertebrates by themselves are not sufficient to document injury. We are not aware of any site-specific testing that would demonstrate the toxicity of the water column or sediments to one or more invertebrate species.

- However, as noted above, PCB concentrations in the Housatonic River sediment are significantly higher than the threshold above which adverse biological effects may be expected to occur (Long et al. 1995). Despite the limitations of this threshold relative to PCB toxicity, we believe that the magnitude of the exceedances provides a sufficient basii for sediment sampling and analysis designed to reveal invertebrate injuries.

- The PCB concentrations that have been observed in Housatonic River sediments generally exceed the values that are suggested as thresholds for injury to sediientdwellmg organisms (see for example Long et al. 1995). Although thresholds for PCB-induced injury to freshwater organisms are not firmly established, available benchmarks are generally lower than the concentrations measured in the Housatonic River sediments, suggesting that the sediments may be causing some adverse effects in invertebrate. populations. While sediient toxicity studies are the strongest route to injury determination, it may be possible to use a literature-based, weight of evidence approach to document injury.

Biological Resources - Birds

Data Review

- Previous investigations have not included the collection of organism-specific data that could be used to assess the effect of PCBs on bird populations tbat utilii habitat provided or influenced by the Housatonic River.

- We note that a terrestrial ecosystem assessment (ChemRisk 1994) evaluated the density, diversity and reproductive success of avian species in a 5.85 hectare portion of the floodplain forest between New Lenox Road and Woods Pond. Data collected in this study area were compared to similar data collected in two reference areas, one in Maryland and one in North Carolina. This study concluded that the weight of evidence indicates that the "floodplain ecosystem . . . is not impacted by the presence of PCBs." This conclusion was based on results associated with four assessment endpoints: absence of a species normally expected to be present, reduction of a population or subpopulation, change in community structure, and bioaccumulation associated with an adverse effect.

Injury Assessment

- The lack of site-specific data related to Housatonic giver bird populations liits our ability to draw preliminary conclusions regarding injury.

- The relationship between bids and PCBs has been explored through numerous laboratory and field studies. While the results of these studies do not provide evidence. of injury to bii in the Housatonic River ecosystem, they should help determine whether additional research is warranted. The following summary includes data associated only with species that are known or likely to exist in the Housatonic River study area (as catalogued in HE&C 1996, Appendix A).

- One study used five-day feeding trials with Aroclor 1254 to determine LC_{50}s for a variety of species. Northern bobwhite, ring-necked pheasants and mallards were determined to have LC_{50}s of 604 ppm, 1091 ppm and 2697 ppm, respectively (Heath et al. 1972, as cited in Kamrin and Ringer 1996).

- Dahlgren et al. (1972, as cited in Kamrin and Ringer 1996) used pheasants in a dosing study and concluded that "a brain residue level of 300 to 400 ppm was indicative of death due to PCB toxicosis."

- Stickel et al. (1984, as cited in Kamrin and Ringer 1996) treated common grackles, red-winged blackbirds, brown-headed cowbirds and starlings with a diet that included Aroclor 1254 at–1500 ppm in order to estimate lethal brain residues. The authors conclude that 310 ppm is "diagnostic for a high probability of PCB-induced mortality.",

- Stone and Okoniewski (1983) concluded that a brain residue level of 357 ppm may have been lethal to great homed owls collected in New York state.

- Several species, including ring-necked pheasant and mourning dove, have experienced reproductive impairment after receiving experimental doses of PCBs. Other species, such as mallards, appear to have less reproductive sensitivity. No effect was observed in mallards receiving Aroclor 1254 at 25 ppm in the diet for one month prior to egg laying (Custer and Heinz 1980, as cited in Kamrin and Ringer 1996). However, Haseltine and

Prouty (1980, as cited in Kamrin and Ringer 1996) observed an 8.9 percent decrease in eggshell thickness for mallards fed Aroclor 1242 at 150 ppm for 12 weeks (though hatching 'success was not unpaired).

- Embryo mortality, reduced hatching success, and high chick mortality have been observed in the field (relative to controls) among herring gulls breeding at organochlorine-contaminated Great Lakes sites. The associated PCB concentration in the eggs was 550 ppm; another organochlorine (DDE) was also present at a high concentration (Gilbertson 1974, as cited in Kanuin and Ringer 1996).

- Before planning any bid injury assessment activities, the trustees should establish some degree of confidence that species inhabiting the Housatonic River environment are likely to be exposed to PCB concentrations comparable to those that have been observed, in field and laboratory studies; to cause adverse impacts.

Biological Resources - Mammals

Data Review

- Previous investigations have not included the collection of organism-specific data that could be used to assess the effect of PCBs on mammal populations that utilii habitat provided or influenced by the Housatonic River.

- We note that a terrestrial ecosystem assessment (ChemRisk 1994) evaluated the population structure, age structure and reproductive success of mammalian species in the flood plain forest and shrub meadow habitats of the Housatonic River ecosystem between New Lenox Road and Woods Pond. This assessment focused on four species: white-footed mice, southern red-backed voles, short-tailed shrews and masked shrews. Data collected in the study area wen compared to similar data collected in two reference areas, one in Connecticut and one in Illinois. This study concluded that the weight of evidence indicates that the "floodplain ecosystem. . . is not impacted by the presence of PCBs." This conclusion was based on results associated with four assessment endpoints: absence of a species normally expected to be present, reduction of a population or subpopulation, change in community structure, and bioaccumulation associated with an adverse effect.

- IEc has learned that a sample of livers from the resident mink population has been collected but has not yet been analyzed.

Injury Assessment

- The lack of site-specific data related to Housatonic River mammal populations limits our ability to draw preliminary conclusions regarding injury. However, we note that the Housatonic River is known to support a mink population and that controlled studies of mink have established a link between PCB exposure and reproductive impairment (Kamrin and Ringer 1996).
- Kamrin and Ringer (1996) note that there is "very little scientifically valid information linking [PCB residue levels in mammals] to toxic effects . . . in field populations."
- Laboratory studies indicate that a mink liver PCB level greater than four ppm can be associated with lethality and that reproductive impairment occurs at a wet-weight fat concentration greater than 10 ppm (Kamrin and Ringer 1996).
- Reproductive failure is documented in mink administered an unspecified dose of Aroclor 1254, with resulting liver concentrations of 0.87 to 1.33 ppm; a higher (unspecified) dose was lethal and resulted in 11.99 ppm in the liver (Platonow and Karstad 1973, as cited in Kamrin and Ringer 1996).
- A study in which mink were fed PCB-contaminated fish linked reproductive hnpairment with a fat concentration of 13.3 ppm and reproductive failure with a fat concentration of 24.8 ppm (Hornshaw et al. 1983, as cited in Kamrin and Ringer 1996).
- Foley et al. (1988) note that Lake Ontario and Hudson River fish could provide a diet for mink that contains PCB concentrations in the range of 0.64 to 5 ppm, which has been sufficient to inhibit reproduction in controlled feeding studies.
- As with bii populations, the trustees should not undertake additional assessment activities without some degree of confidence that mammals in the Housatonic River environment have been or are being exposed to PCB concentrations comparable to those previously reported to cause adverse effects. Given the known sensitivity of mink to PCBs, a literature-based study may be a useful method for assessing injury to this resource category.

Biological Resources - Reptiles and Amphibians

Data Review

- Twelve bullfrogs and one snapping turtle were collected from Woods Pond in 1982. The total wet weight tissue PCB concentration in a composite sample of the frogs was 4.4.ppm. The total wet weight tissue PCB concentration in the turtle was 2.1 ppm (BB&L 1991).
- During the terrestrial ecosystem evaluation conducted in 1993, most amphibian and reptile species expected to be present in the Housatonic River valley were in fact observed (ChemRisk 1994).

Injury Assessment

- Warning signs posted along the Housatonic River in Massachusetts advise the public against consuming frogs and turtles due to the presence of PCBs. Tbis advisory satisfies the DOI criterion for injury stated at 43 CFR 11.62(f)(1)(iii) (concentrations of hazardous substances in an organism sufficient to "exceed levels for which an appropriate State health agency has issued directives to limit or ban consumption of such organism").
- There is a growing body of research suggesting that the bioaccumulation of organochlorines (including PCBs) in reptiles and amphibians may cause adverse effects sufficient to establiih injury. However, this area of research has not matured to the point where observed tissue concentrations can be linked to specific effects.
- As with other wildlife species, reptiles and amphibians can accumulate PCBs in fat, muscle and other tissues. For example, twenty snapping turtles collected from the Hudson River had an average PCB concentration of nearly 3,000 ppm in their fat. Twenty-two liver and skeletal muscle samples had average PCB concentrations of 66.05 and 4.24 ppm, respectively (Stone et al. 1980).
- Bryan et al. (1987) studied snapping turtle eggs from the upper Hudson River in order to test the hypothesis, suggested by other studies, that fat reserves provide protection against the accumulation of toxic PCB congeners in the eggs. The authors concluded that fat reserves do not provide such protection.
- A considerable amount of research into the effects of organochlmines (including PCBs) on reptiles and amphibians is ongoing, though there

does not yet appear to be strong evidence of a link between PCB exposure and injurious effects. We would not advise additional assessment of this resource category given the lack of existing data with which to design studies and compare the results. However, the trustees can use the advisory against frog and turtle consumption in Massachusetts as a determinant of injury to these resources.

Groundwater Resources

Data Review

- We have not reviewed the groundwater data collected as part of investigations of the other GE-Pittsfield disposal sites.

Injury Assessment

- In general, groundwater is injured if concentrations of hazardous substances in the groundwater exceed existing standards for a potable drinking water supply. Injury can also be established if concentrations of hazardous substances in the groundwater are sufficient to cause injury to other natural resources (e.g., surface water) (43 CFR 11.62(c)(1)(iv)).

- As noted in Chapter 5, injury to groundwater resources would be a significant concern if the injury were based on the degradation of a public water supply. Without such an occurrence, the groundwater resource would be important only in the context of its contribution to the contamination of surface water.

Air Resources

Data Review

- In 1993, air samples were collected on the eastern shore of Silver Lake and at five other locations near the Housatonic River. The mean, 24-hour high volume ambient PCB concentrations at these locations ranged from 0.0015 micrograms per cubic meter ($\mu g/m^3$) to 0.015 $\mu g/m^3$.

- Additional air monitoring was conducted in 1995 at Silver Lake and two downstream locations (Fred Garner Park and Woods Pond). The Silver Lake results were similar to those observed in 1993. The mean high lume

PCB concentrations at the two downstream locations were 0.0055 $\mu g/m^3$ and 0.0033 $\mu g/m^3$, respectively (BB&L 1996).

Injury Assessment

- In general, injury to an air resource has occurred if concentrations of emissions arc in excess ~~of federal standards~~ (under Section 112 of the Clean Air Act) or applicable state standards. Emissions of PCBs are not regulated under Section 112. We are not ~~currently aware of any~~ exceedances of state air quality standards..

- Further assessment of possible injury to air resources does not appear to be warranted for this case.

SUMMARY

- On the basis of the DOI regulations, the existing data are sufficient to establish injury to surface water, fish, frogs and turtles, without further data collection or analysis. Attribution of these injuries to GE depends on confirmation of baseline conditions.

- Potentially significant concentrations of PCBs have been detected in other resources, including river sediments, floodplain soils and aquatic invertebrates. However, these observations by themselves am not sufficient to document injury.

- The services that the Housatonic River provides can be divided into three general categories: human use-recreational, human nonuse (*i.e.*, passive value), and ecological (i.e., habitat). In terms of restoration, the first two services are addressed separately through our calculation of a preliminary estimate of compensable values for recreational and passive use losses (which relies largely on the observed injury to fish). Additional injury assessment must be geared toward the third category. Therefore, future data collection and/or analysis must focus on the exposure of different resources to PCBS through a variety of pathways. This effort should emphasize the effects that PCBs in the environment have had or are having on biological resources.

- The trustees must now work toward building a case that will allow them to argue that 1) a variety of Housatonic River resources have been injured by the release of PCBs, and 2) there are specific restoration activities that can restore baseline ecological services and compensate the public for the past loss of these services.

- Future assessment activities should focus on two related areas. First, the trustees should seek to document injury to a range of biological resources broad enough to support the argument that other resources are likely to be similarly injured. Second, the trustees should use analytic techniques such as food web modeling and sediment toxicity studies to establish a clear pathway from contaminated soils and sediments to the injured biological resources. The latter activity will allow the trustees to begin to delineate areas serving as likely sources of injury-causing PCB concentrations. These areas could then provide the basis for scaling primary and compensatory restoration actions.

- The delineation of likely source areas would be aided substantially by the initiation of the mapping exercise proposed by the Wetlands Restoration and Banking Program and the University of Massachusetts. Mapping should focus first on the Pittsfield-Woods Pond stretch of the river. As the assessment progresses through the restoration planning stage, additional mapping of the watershed may be appropriate as a means of identifying compensatory habitat.

- In addition to the mapping exercise, an appropriate next step for the damage assessment would be to initiate literature-based analyses of key resource categories. These analyses could (1) establish weight of evidence arguments for injury to these resources, and (2) identify indicator species that could potentially be the subjects of additional, site-specific research.

REFERENCES FOR CHAPTER 2

Blasland, Bouck & Lee. 1991. MCP Interim Phase II Report/Current Assessment Summary for Housatonic River. December.

Blasland, Bouck & Lee. 1992. Addendum to MCP Interim Phase II Report/Current Assessment Summary for Housatonic River. August.

Blasland, Bouck & Lee. 1996. Supplemental Phase II/RCRA Facility Investigation Report for Housatonic River and Silver Lake. January.

Bryan, A.M., W.B. Stone, and P.G. Olafsson. 1987. Disposition of toxic PCB congeners in snapping turtle eggs: expressed as toxic equivalents of TCDD. Bull. Environ. Contam. Toxicol. 39:791-796.

Chadwick & Associates.. 1994. Aquatic Ecology Assessment of the Housatonic River, Massachusetts. May.

ChemRisk. 1994. Evaluation of Term&al Ecosystem of the Housatonic River Valley. July.

ChemRisk. 1995. Work Plan for the Ecological Risk Assessment of the Housatonic River Site. February.

Custer, T.W., and G.H. Heinz 1980. Reproductive success and nest attentiveness of mallard ducks fed Aroclor 1254. Environ Pollut. 21:313-318.

Dahlgren, RB., RJ. Bury, R.L. Linder, and RF. Reidinger, Jr. 1972. Residue levels and histopathology in pheasants given polychlorinated biphenyls. J. Wildl. Manage. 36:524-533.

DeFoe, D.L., G.D. Veith, and RW. Carlson. 1978. Effects of Aroclor 1248 and 1260 on the fathead minnow (*Pimephales promelas*). J. Fii Res. Board Can. 35:997-1002.

Eisler, R 1986. Polychlorinated biphenyl hazards to fish, wildlife, and invertebrates: a synoptic review. Biol. Rep. No. 85(1.7). Fiih and Wildlife Service, U.S. Department of the Interior, Washington, D.C.

Foley, RE., SJ. Jacklmg, RJ. Sloan, and M.K. Brown 1988. Organochlorine and mercury residues in wild mink and otter: comparison with fish. Environ Toxicol. Chem. 7:363-374.

Gilbertson, M. 1974. Pollutants in breeding herring gulls in the lower Great Lakes. Can. Field Nat. 88:273-280.

Harrington Engineering & Construction. 1996. Report on the Preliminary Investigation of Corrective Measures for Housatonic River and Silver Lake Sediment. May.

Haseltine, S.D.. and RM. Prouty. 1980. Aroclor 1242 and reproductive success of adult mallards (*Anas platyrhynchos*). Environ. Res. 23:29-34.

Hattula, M.L., and 0. Karlog. 1972. Toxicity of PCBs to goldfish. Acta Pharmacol. Toxicol, 31:238-240.

Heath, RG., J.W. Spann, E.F. Hill, and J.F. Kreitzer. 1972. Comparative dietary toxicities of pesticides to birds. U.S. Fish Wildl. Serv. Spec. Sci..Rep. Wildl. 152, 57 pp.

Hornshaw, T.C.. R.J. Aulerich, and H.E. Johnson. 1983. Feeding Great Lakes fish to mink: effects on mink and accumulation and elimination of PCBs by mink. J. Toxicol. Environ. Health 11:933-946.

Hose, J.E., and J.N. Cross. 1994. Evaluation of evidence for reproductive impairment in white croaker induced by DDT and/or PCBs. For submittal to NOAA. September 26.

Hull, R.N., and G.W. Suter II. 1994. Toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota: 1994 revision. Energy Systems Environmental Restoration Program, ORNL *Environmental* Restoration Program.

Kamrin, Michael A. and Robert K. tiger. "Toxicological Implications of PCB Residues in Mammals." *In Environmental Contaminants in Wildlife: interpreting Tissue Concentrations,* edited by W. N. Beyer, G. H. Heinz, and A. W. Redmon-Norwood. Boca Raton: Lewis Publishers, 1996.

Long, E.R., D.D. *MacDonald*, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environ. Manage. 19:81-97.

Mauck, W. L., P.M. Mehrle, and F.L. Mayer. 1978. Effects of the polychlorinated biphenyl Aroclor 1254 on growth survival, and bone development in brook trout (*Salvelinus fontinalis*). J. Fish. Res. Board Can 35:1084-1088.

Mayer, F.J.. P.M. Mehrle, and H.O. Sanders. 1977. Residue dynamics and biological effects of polychlorinated blphenyls in aquatic organisms. Arch Environ. Contam. Toxicol. 5:501-511.

Mehrle, P.M., T.A. Haines, S. Hamilton, J.L. Ludke, F.L. Mayer, and M.A. Ribick. 1982. Relationship between body contaminants and bone development in East-Coast striped bass. Trans. Am. Fish Soc. 111:231-241.

Nebeker, A.V., F.A. Pugliii. and D.L. DeFoe. 1974. Effect of polychlorinated biphenyl compounds on survival and reproduction of the fathead minnow and flagfish. Trans. Am. Fish. Soc. 103:562-568.

Niii, Arthur J. "PCBs in Aquatic Organisms." *In Environmental Contaminants in Wildlife: Interpreting Tissue Concentrations*, edited by W. N. Beyer, G. H. Heinz, and A. W. Redmon-Nonvood. Boca Raton: Lewis Publishers, 1996.

Platonow. N.S., and L.H. Karstad. 1973. Dietary effects of polychlorinated biphenyls on mink. Can. J. Comp. Med. 37:391-400.

Schimmel, S.C., D.J. Hansen, and J. Forester. 1974. Effects of Aroclor 1254 on laboratory-reared embryos and fry of sheepshead minnows (*Cyprinodon variegatus*). Trans. Am. Fish. Soc. 103:582-586.

Stickel, W.H., L.F. Stickel, RA. Dyrland, and D.L. Hughes. 1984. Aroclor 1254 residues in birds: lethal levels and loss rates. Arch Environ. Contam. Toxicol. 13:7-13.

Stone, W.B., E. Kiviat, and S.A. Butkas. 1980. Toxicants in snapping turtles. NY Fish and Game Journal. 27:39-50.

Stone, W.B., and J.C. Okoniewski. 1983. Organochlorine toxicants in great homed owls from New York, 1981-82. Northeastern Environmental Science. Vol. 2, No. 1.

U.S. Environmental Protection Agency. 1986. Quality Criteria for Water 1986. Office of Water Regulations and Standards. EPA 440/5-86-001. May 1.

U.S. Environmental Protection Agency. 1994. ARCS Remediation Guidance Document. EPA 905-B94-003. Great Lakes National Program Office, Chicago, IL.

PRELIMINARY ESTIMATE OF DAMAGES CHAPTER 3

INTRODUCTION

IEc has completed a prelii estimate of recreational and passive use damages associated with elevated levels of PCBs in the Housatonic River environment in Massachusetts and Connecticut[1] The purpose of this chapter is to summa&e the results of this effort. Appendices A-D provide detailed doeumentation of the assumptions made, data sources used and *calculations performed in* developing these preliminary estimates. Note that Massachusetts and Connecticut state resource managers have reviewed and provided comments on these appendices.

The preliminary estimates we present in this chapter am based entirely on existing data, including interviews with resource managers and other knowledgeable parties, a review of studies of recreational behavior on the Housatonic and other rivers in Massachusetts and Connecticut, and a review of the economics literature. The results presented are for settlement and case management purposes only. These analyses could be extended and refined through primary data collection and analysis at this site.

SUMMARY OF RESULTS

Exhibit 3-l summarizes the results of this effort. As shown, compensable damages *for those categories for which preliminary damage estimates have been developed* include $11 million to $32 million in direct use losses and $25 million to $250 million in passive use losses.[2] Recreational fishing damages are estimated to be. on the order of $10 million to $30 million.

[1] These are by no means the only categories of damages associated with this site. Other categories (e.g., primary restoration costs, diminished ecological servicer) are being addressed in separate analyses.

[2] We do not sum our estimates of dii use and passive use losses to generate a total damage estimate, since some degree of double counting might result. In this case, double counting might occur if some of the households included in the preliminary passive use damage calculation also participate in fishing and boating at the site.

This range reflects uncertainty in the assumed recovery period (i.e., the date on which the human health risk advisories will be lifted), as well as uncertainty in the damages associated with fishing trips still taken to the river, despite the presence of elevated levels of PCBs. Recreational boating damages are believed to fall in the range of $1 million to $2 million; this range also reflects uncertainty in the assumed recovery period. Compensable losses associated with changes in recreational behavior can also be expressed in terms of the number of "trips lost" or "trips with diminished value," as described in the following sections. Passive use losses are thought to fall in the range of $25 million to $250 million. This range reflects uncertainty in the extent of the "market" for passive use values for the Housatonic environment, as discussed below.

While the presence of elevated levels of PCBs has likely had an effect on hunting and trapping activities near the Housatonic River, the relatively small number of participants involved leads us to conclude that this category of damages is liiely to be small. In addition, wildlife viewing and other general outdoor activities may have been, and continue to be, affected by the presence of PCBs. However, no data are available to quantify this category of loss. Finally, economic damages may be associated with (1) reductions in the value of state-owned land in the Housatonic River floodplain; (2) contamination of groundwater resources in the vicinity of the GE facility; (3) the increased cost of development in and near the river, as a result of the presence of PCBs; and (4) a diminishment in ecological services provide by this resource. These categories of damage, however, are outside the mope of this prelii damage assessment.

Exhibit 3-1

SUMMARY OF COMPENSABLE DAMAGES DUE TO PCB CONTAMINATION OF THE HOUSATONIC RIVER ENVIRONMENT

Category of Damage	Present Value Damages (millions of 1996 $)
Recreation	
Fiihiig	$10 - $30 *
Boating	$1 - $2 *
Hunting/Trapping	small
Wildlife Viewifig/General Activities	not assessed
Reduced Market Value of State Owned Land	not assessed
Groundwater Damages	not assessed
Increased Cost of Development	not assessed
Diminished Ecological Services	not assessed
Passive Use Losses	$25 - $250 **

* Range reflects alternate resource recovery scenarios.
* * Range reflects uncertainty in the "market" for Housatonic River resource.

A PRELIMINARY ESTIMATE OF RECREATIONAL FISHING DAMAGES

The nature and characteristics of the Housatonie River vary widely from Pittsfield, Massachusetts to the Stevenson Dam in Connecticut. In addition, fisheries management approaches, including responses to elevated levels of PCBs, are different in Massachusetts and

001960

Connecticut. As a result, the river has and continues to provide a number of distinct fisheries, resulting in a complex compensable damage estimation exercise. For purposes of developing a preliminary estimate of damages, we generate estimates of (1) the number of trips lost or displaced as a result of the contamination; (2) the number of trips that were taken to the site despite the contamination, but with reduced value; and (3) the value of these lost or diminished value trips.

In order to develop estimates of lost or diminished value, we generally look to compare fishing pressure at a contaminated site prior to the issuance of public health advisories with current pressure (i.e., pressure given the presence of contaminants). Such comparisons of baseline angler behavior with behavior given a contaminant problem allow us to estimate, at a minimum, the number of trips lost or displaced from the site. In this instance., however, data on fishing pressure prior to the public health advisories generally do not exist. In addition, overall water quality has improved over time, resulting in a changing -- and improving -- baseline. Thus, in order to develop a preliminary damage estimate we need to estimate both actual trips (Le., given contamination) as well aspotential fishing trips (i.e., in the absence of contamination) for each relevant section of the river.

In both Massachusetts and Connecticut, public health agencies have issued advisories regarding the consumption of fish from the Housatonic River below Pittsfield, Massachusetts. Exhibit 3-2 summarizes the nature of these advisories as they have occurred over time. The current advisory in Massachusetts (as posted by the Department of Public Health at locations such as Woods Pond) reads:

> "The State Department of Public Health advises the public that fish, frogs and turtles in these waters not be used for food because they contain concentrations of PCBs, which may be harmful to humans. The Division of Fisheries and Wildlife asks anglers to release unharmed any fish caught in the Housatonic River."

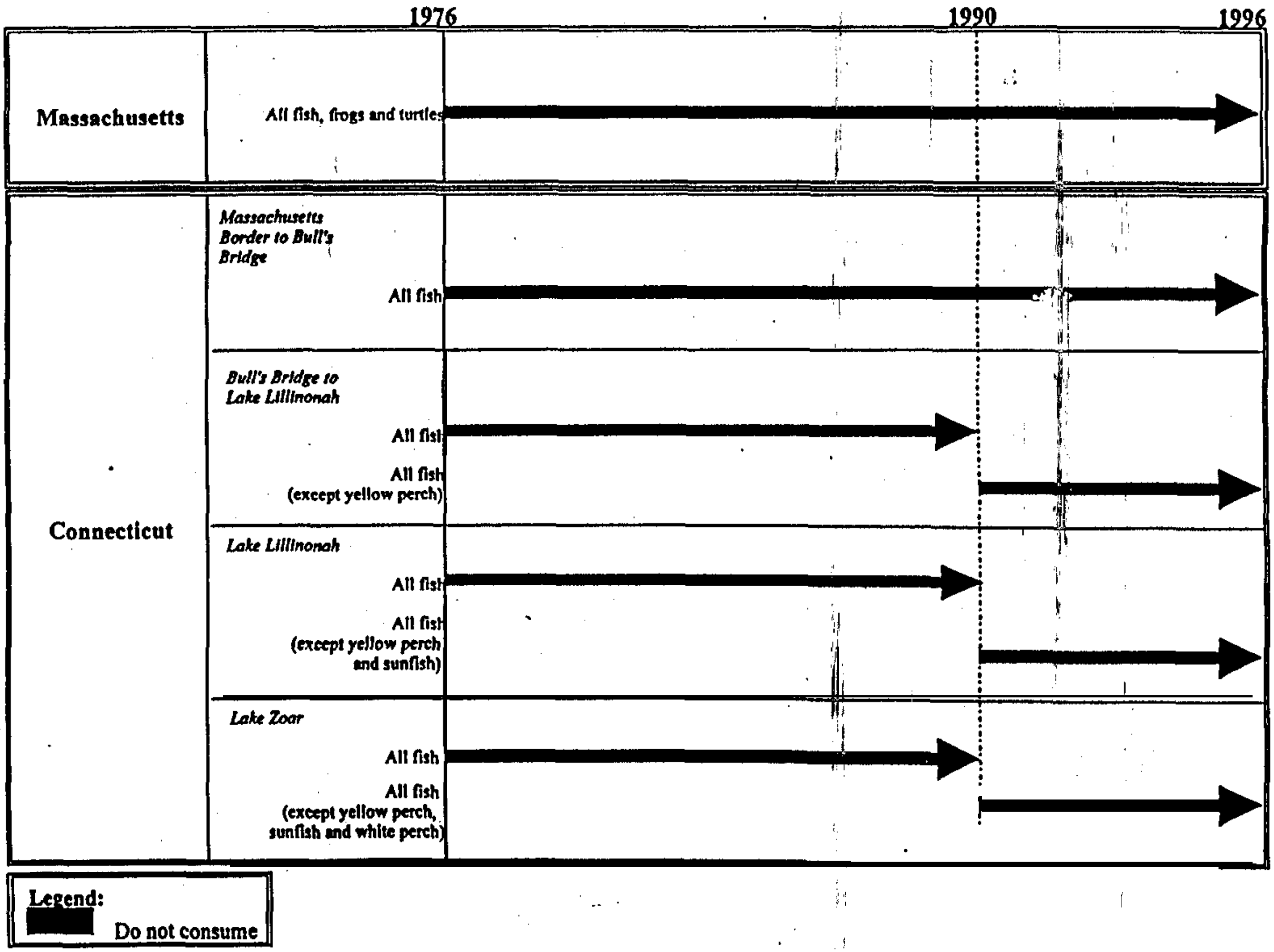
In Connecticut, the Housatonic River north of Stevenson Dam is included in the state's "Group 1" advisory category due to the presence of PCBs; the state recommends that species of fish caught in Group 1 water bodies should not be eaten by anyone. For the Housatonic River, exceptions are made for yellow perch caught in the Bull's Bridge area; yellow perch and sunfish caught in Lake Lillinonah; and yellow perch, white perch and sunfish caught in Lake Zoar. Note that the Group I advisory applied to ALL fish north of the Stevenson Dam prior to 1990.

Given the differences in river characteristics and management strategies in Massachusetts and Connecticut, we divide the river into discrete segments for purposes of prelii damage estimation. In Massachusetts, these segments include:

New Lenox Road (Decker Boat Launch) to Woods Pond (warm water)
Glendale to Housatonic (trout)
Sheffield to Connecticut Border (warm water)
Remaining Stretches (generally warm water)

Exhibit 3-2

Housatonic River Consumption Advisories



In Connecticut, these segments include:

Trout Management Area (the "TMA")
Lower Stretches (Lakes Lillinonah and Zoar) (warm water)
New Milford Walleye Fishery (a proposed stocked walleye fishery)

For each of these segments we consider both current and potential fishing pressure based on various data sources and assumptions. For example, for the New Lenox Road to Woods Pond segment we use data from a 1985-86 Connecticut angler. survey to estimate potential fishing trips. Specifically, we use the data from Lakes Lillinonah and Zoar given their comparability to the New Lenox Road-Woods Pond segment in term of fishery type (warm water), fish species, and fishing method (boat). We then assume that the 1985-86 data provide an adequate approximation of annual potential fishing pressure from 1980 forward. To estimate actual fishing trips for the New Lenox Road-Woods Pond segment, we use data from a 1992 creel survey that includes fishing pressure estimates for Woods Pond and for the river segment between Woods Pond and Pittsfield. We calculate the fishing pressure per mile on the latter segment in order to estimate the number of trips on the portion of the segment downstream of New Lenox Road. Appendices A and B include our assumptions, data sources and calculations in detail for all river segments.

Exhibits 3-3 summarizes the results of this effort. Exhibit 3-3 provides, by segment, a general description of the fishery, the time period and nature of the loss experienced as a result of elevated levels of PCBs, estimates of the annual number of trips lost (or experiencing reduced value) due to the contamination, and the present value loss over the relevant time period. For example, the New Lenox Road to Woods Pond Dam segment of the river provides a warmwater fishery, which we believe, has experienced a reduction in fishing trips since at least 1980. and which will continue to experience a loss of fishing trips as long as a public health advisory exists. We estimate that approximately 1,000 trips per year have been lost or displaced from this segment of the river as a result of the contamination. Thus, present value losses are on the order of 40,000 trips (under a 20-year recovery scenario) to 60,000 trips (under a no recovery scenario)[3]. Exhibit 3-3 also breaks these losses out into estimated past losses (i.e., through 1996), and estimated future losses (1997 on, under 20-year, SO-year and no recovery scenarios).

[3] All present value calculations in this report use a three percent real discount rate

Exhibit 3-3

RECREATIONAL FISHING DAMAGES DUE TO PCB CONTAMINATION OF THE HOUSATONIC RIVER

Stretch of River	Nature of Fishery	Time Period of Loss	Nature of Loss	Annual Number of Trips Lost or Diminished	Present Value Past Lost or Diminished Trips (through 1996)	Present Value Future Lost or Diminished Trips (1997 on) *	Present Value Total Number of Trips Lost or Diminished (1996)*	Total Present Value Damages (millions 1996$)*
Massachusetts								
New Lenox Road (Decker) to Woods Pond Dam	Warm Water	1980-	Lost Trips	1,000	23,000	16,000-36,000	39,000-59,000	$0.6-$0.9
Glendale to Housatonic	Trout	1980-	Lost Trips	700-2,600	34,000	38,000-86,000	72,000-120,000	$2.4-$3.9
Sheffield to Connecticut Border	Warm Water	1980-	Lost Trips	1,000	21,000	14,000-31,000	35,000-52,000	$0.5-$0.8
Remaining Stretches	Warm Water	1980-	Lost Trips	2,700	60,000	40,000-90,000	100,000-150,000	$1.5-$2.3
AllStretches	Warm Water/ Trout	1980-	Diminished Enjoyment	Not Assessed**	Not Assessed**	Not Assessed**	Not Assessed**	Not Assessed**
Connecticut								
TMA	Trout	1978-1986	Lost Put-and-Take Trips	8,000	130,000	30,000-60,000	160,000-190,000	$8.1-$9.0
		1987-	Lost Catch and Release	1,700				
		1981-1986	Diminished Enjoyment	1,600	14,000		14,000	s0.4
Lower Stretches (Lakes Lillinonah and Zoar)	Warm Water	1977-	Diminished Enjoyment	10,000	260,000	140,000-320,000	400,000-580,000	f6.0d8.7
New Milford Walleye Fishery	Stocked Walleye	1999-	Lost Trips	1,550		20,000-49,000	20,000-49,000	$1.5-$3.7
TOTAL								$21.0-$29.7
ESTIMATED TOTAL ADJUSTED FOR UNCERTAINITY								$10-$30

- * Ranges reflect alternative resource recovery scenarios
- ** Data necessary for this analysis are not available

001964

We assign economic values to these lost and diiinished trips **following** a benefits transfer approach. Benefits transfer involves the application of existing benefit (or damage) estimates developed for one site and/or situation to another site and/or situation. For example, the economics literature may provide a value for a **recreational** fishing day on a set of Connecticut lakes (not including Lake Lillinonah), which we might choose as a proxy measure for the lost **value** associated with a fishing trip not taken to Lake Lillinonah as a result of PCB contamination. In this case we reviewed the available economics **literature** and used professional judgment to assign economic values to **each** type of fishing experience provided by the injured **resource. Specifically, we assigned a value of:**

- $60 to all lost put-and-take trout fishing trips;
- **$30** to all lost catch-and-rekase trout fishing trips;
- $15 to lost **warmwater** fishing trips in Massachusetts;
- $75 to lost walleye **fishing** trips ~~**in Connecticut;**~~
- $30 to all diminished enjoyment trout fishing trips in Connecticut; and
- **$15** to **all** dished enjoyment **warmwater** fishing trips in Connecticut.

The information used and assumptions made in generating these value estimates are detailedin Appendix C.

Exhibit 3-3 **summarizes** the results of this effort For example, applying the warmwater trip value of $15 to the 40,000 • 60,000 present value lost trips associated **with the** New **Lenox** Road to Woods Pond Darn segment of the river results in an economic damage estimate of $600,000 • $900,000. Total damages across all **segments** are in the range of **$21** million to **$30** million. The range reflects alternative assumptions regarding the recovery period of the injured resources (i.e., 20 years, 50 years, and no **recovery).** Given the high degree of uncertainty in these estimates, particularly associated with the estimated number of trips experiencing dished enjoyment and the value associated with this **diminishment,** we report an estimate of *total* damages adjusted for uncertainty. This adjusted estimate is **$10** to **$30 million.**

*It is important to note that, due to the complex nature of **this fishery,** the general absence of detailed site specific data, the need to make assumptions regarding the management of the **fishery** in the absence of **PCBs,** and the lack **of** public perceptions **data, our preliminary** damoge estimate is, ot best, order-of-magnitude.*

There are a number of important caveats associated with this analysis, as summarized below.

- Existing site-specific data are extremely **limited,** especially for the earlier years of our analysis.

- In many cases, we make assumptions regarding potential fishing pressure in contaminated areas using pressure estimates for other rivers or other segments of the Housatonic. To the extent that the characteristics of these other river segments are not, similar to those for which we generate damage estimates (in terms of demographics, access, management regime, water quality, habitat, aesthetics, etc.) these assumptions will introduce errors into the-analysis.

- The segments used to establish baseline (i.e., uncontaminated) pressure may also be affected by the contamination, directly or indirectly.

- The assigned economic values are based on benefits transfer.

- The analysis makes many assumptions regarding fisheries management practices in the absence of PCBs.

- The analysis does not consider additional losses that might occur during site remediation.

- The analysis does not reflect the potential effect of a statewide mercury advisory issued in 1996 in Connecticut. Estimating the maximum potential impact of this advisory by assuming that the diminished value of fishing trips beginning in 1996 is solely a result of the mercury warning results in a 38 to 57 percent decrease in the number of present value trips with dished value, depending on the recovery scenario. However, since the mercury warning has not been as widely publicized as the PCB warning and has been in effect for only a short period of time, we do not believe that it is currently causing a significant behavioral change among Connecticut anglers.

- The analysis assumes that fish tissue levels will not drop below the FDA standard in Connecticut or Massachusetts during the period over which damages are calculated

A PRELIMINARY ESTIMATE OF RECREATIONAL BOATING DAMAGES

The Housatonic River provides numerous and varied recreational boating opportunities throughout its length (e.g.. flatwater in Massachusetts, rapids in northern Connecticut, power boating on lakes). Interviews with regional recreational planners, resource managers and commercial operators indicate that users are generally aware of the presence of elevated levels of PCBs in the river's environment. In Massachusetts, this awareness has resulted in a change in recreational behavior (e.g., the cancellation of an annual river race, which included 350 parsons from 1978 to 1987). We believe that this behavioral change began in the late 1970s, and will continue as long as elevated levels of PCBs are present in the sediments. While we do not believe that the presence of PCBs is currently affecting boating participation in Connecticut, we do believe that boating activity in Connecticut was likely affected by public announcements regarding the presence of PCBs in the late 1970s and early 1980s. However, we do not have data that allow us to quantify the magnitude of past damages associated with boating in Connecticut.

To estimate the number of boating trips lost in Massachusetts as a result of elevated PCB concentrations, we estimate actual (i.e., with PCBs) and potential (i.e., without PCBs) activity-levels for the Massachusetts stretch of the river- While we would like to compare use levels prior to public knowledge-of the contamination with current use levels, prior to 1976 the river suffered from other water quality problems and boating was not as popular as it is today. Instead, we base our estimate of actual use levels on interviews with representatives of organizations that run trips to the river. Actual use has been between approximately 200 and 300 trips per year on the Decker boat launch to Woods Pond stretch, and approximately 700 trips per year on the Ashley Falls to Falls Village stretch Our potential use estimate is based on current use levels for a flatwater stretch of the Housatonic in Connecticut (since no comparable recreational boating opportunities exist in western Massachusetts). Using data on recreational boating on the Housatonic River in Connecticut, we estimate potential use to be approximately 1,100 trips/year on each of the two relevant stretches in Massachusetts. A detailed discussion of the data sources used, assumptions made and calculations performed is provided in Appendii D.

We estimate that approximately 49,000 present value boating trips have been lost due to PCBs since 1990 (the first year for which reliable data are available). This assessment assumes that for the foreseeable future the river will not be remediated and boaters will continue to modify their behavior in response to PCB concerns. If we assume that the river is remediated and/or baseliie activity levels return in 20 years, the estimated present value number of lost boating trips is 26,000. Based on a review of the economics literature and best professional judgment, we estimate a value of $40 for each lost boating trip on the Massachusetts Housatonic. Therefore, we estimate that damages associated with lost recreational boating opportunities are on the order of $ 1 million to $2 million

There are a number of important caveats associated with this analysis, as summarized below.

- This damage estimate does not include independent trips (i.e., trips by individuals not associated with an organization or commercial operation);
- This estimate does not reflect any reduced value for trips that were taken despite the contamination;
- This estimate only reflects damages from 1990 forward, since data prior to that time are not available;
- This estimate does not reflect additional losses that might be incurred during the site remediation process.

A PRELIMINARY ESTIMATE OF PASSIVE USE LOSSES

Individuals value natural resources for many reasons other than those related to diit use of those resources. The passive use (or nonuse) value of a resource reflects the value held by he public for a resource for reasons other than its use, and are compensable values that are properly included in damage claims under CERCLA.

The primary technique for measuring these values is the contingent valuation method (CVM).[4] A CV survey in this case might assess the public's willingness to pay to accomplish additional cleanup of the Housatonic River environment (e.g., beyond that proposed under a RCRA corrective action), or to accomplish this cleanup ~~more quickly than would occur naturally~~. We are unaware- of any studies that have estimated the public's willingness to pay to remediate and restore the Hdusatonic River environment. Thus, we ask the question, "If a high quality CV instrument were developed and administered at this site, what magnitude of willmgness to pay would be demonstrated?"

Two factors will determine the resultant total willingness to pay: the size of the "market" area for the Housatonic River environment (i.e., the geographic area in which a significant fraction of households are likely to hold passive use values for the Housatonic River), and the willingness to pay per household within that market area. We attempted to develop a conservative estimate of the relevant market area for the Housatonic River environment through (1) a review of articles from the popular press (i.e., newspapers and magazines) that mention the river. (2) consideration of membership/participant lists of organizations/activities associated with the river. and (3) interviews with representatives of state tourism bureaus, non-profit organizations, and other informed parties. This estimate is conservative in that it is more likely to understate the market area for this resource than to overstate it.

We reviewed a range of newspapers, magazines and news services for purposes of this analysis, including the Hartford Courant, the Boston Globe, the Boston Herald, the New York Times, New York Newsday, the Albany Times Union, Bicycling, Colonial Homes, Field and Stream, Fly Fisherman, McCall's, Outdoor Life, PR Newswire, and the Westchester County Business Journal. In most cases, we used online resources to identify and retrieve relevant articles. We reviewed each article and noted if it addressed one or more of the following issues: PCBs, recreation or travel, other enviromnental issues, and eagles. We present the results of this effort in Exhibit 3-l. For example, we identified 22 articles that mentioned the Housatonic River in the Boston Globe over the period 1980 to 1996, seven of which explicitly mentioned PCBs. Many of the articleswe found dealt with regional travel and recreational opportunities, with the Housatonic River mentioned as a component of the regional experience. As shown in Exhibit 3-4

[4] Other. related techniques, such as contingent ranking and conjoint analysis have been used to gain a better understanding of passive use values held by the public for natural resources.

Exhibit 3-4

MENTION OF HOUSATONIC RIVER/PCBs IN NEWSPAPERS/MAGAZINES

Newspaper (years available on-line)	Article Topic				Total (Discuss PCBs)
	PCBs	Recreation/Travel (Discuss PCBs)	Other Environmental Issues (Discuss PCBs)	Eagles (Shepaug Dam area)	
Hartford Courant (1991-1996)	0	6[1] (2)	5	0	11 (2)
Boston Globe (1980-1996)	7	4	9 (4)	2	22 (11)
Boston Herald (1994-1996)	0	1	0	0	1
New York Times (1980-1996)	3	20 (7)	8 (3)	6	37 (13)
New York Newsday (1987-1996)	1	2	0	0	3 (1)
Albany Times Union (1986-1996)	0	2	1 (1)	1	4 (1)
Magazine Articles[2]	3	7	1	0	11 (3)
Total	14	42 (9)	24 (8)	9	89 (31)

[1] Total number includes both those articles that do and do not mention PCBs.

[2] Magazines include: *Bicycling, Colonial Homes, Environmental Science & Technology, Field and Stream, Fly Fisherman, McCall's, Outdoor Life, PR Newswire, R&D, Science,* and *Westchester County Business Journal.*

the Housatonic River environment is not an infrequent topic in the Boston, New York and Hartford papers. We believe that this result would justify the inclusion of the Boston, New York and Hartford metropolitan areas in the areas in the estimation of the Housatonic River market as we assume that the editorial content of these papers is an accurate reflection of the topics of interest to the papers' readers.

In addition to reviewing the popular press, we obtained data on membership in regional organizations, and participation in activities, associated with the Housatonic River. These data included membership in the Housatonic River Fly Fishing Association and the Housatonic Valley Association, and participation in canoe trips led by Massachusetts Audubon Society staff. These groups provided counts of participants by five-digit zip code, which gives us a general sense of the "market" area from which these groups draw members and participants. As shown in Exhibits 3-5 through 3-8, these groups generally draw members from western Massachusetts and western and central Connecticut, with some members coming from the New York metropolitan area and the Boston area.

Interviews with individuals from government and private sector organizations with information on regional tourism indicate that many individuals come to the Housatonic River region in large part due to the perceived high quality of the regional *environment*, and for the overall aesthetic beauty of the area Some of these individuals take part in activities directly associated with the river (e.g., canoeing), while for others the river reflects the general rural character of the region. These individuals are drawn from a tide geographic area, with the Albany, greater New York City, Hartford, and Boston areas beiig important in terms of total visitation. Unfortunately, data on point of origin for these tourists were not available for this analysis.

The above information, provides us with a general sense of the market area for the Housatonic River environment. Specifically, we believe that, at a minimum, a significant percentage of households in the counties of Massachusetts and Connecticut through which the river flows would express a williigness to pay to conduct more extensive, or more timely cleanup of the river's environment. The information presented above also indicates that some households outside of these counties would also express a willingness to pay for restoration of the river. Thus, we believe that additional studies would yield a more geographically extensive market area, possibly incorporating all of Massachusetts and Connecticut, as well as parts of the New York metropolitan area.

In order to generate a prelii estimate of passive use losses, we also need to estimate the williigness to pay per household that a CV survey would reveal for this market area For purposes of this preliminary assessment we consideredestimates that have been generated for other regionally important resources. For example, a one-time willingness to pay of approximately $55 per California household to prevent 45 years worth of damage was generated for the Southern California Bight NRDA (this case involves PCB and DDT contamination of a marine system, affecting a range of fish and birds, including several endangered species). Other CV studies have generated willingness to pay estimates of similar magnitude.

Exhibit 3-5

Housatonic Valley Association Members, by Zip Code

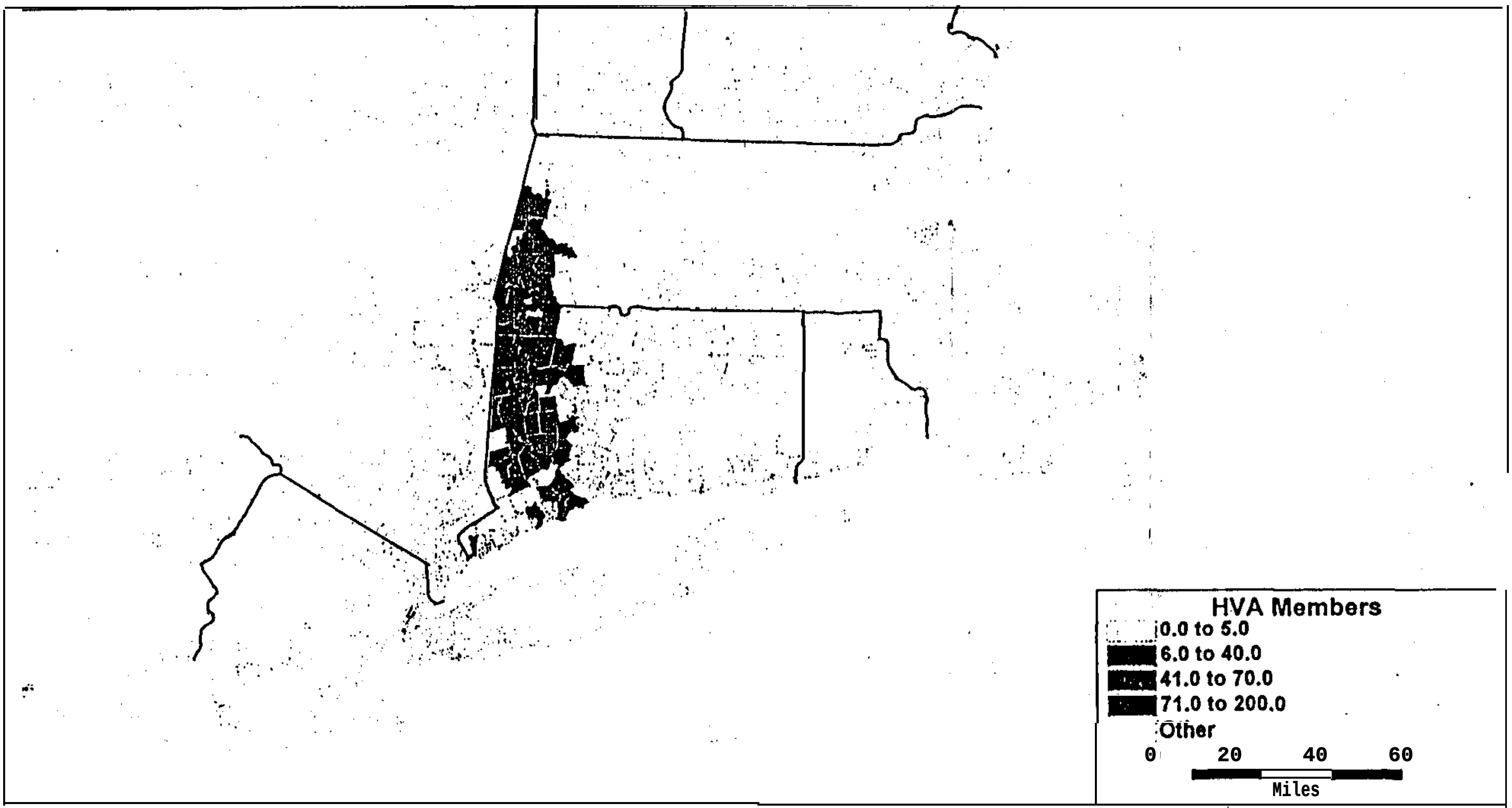


Exhibit 3-6

Housatonic Fly Fishing Association Members, by Zip Code

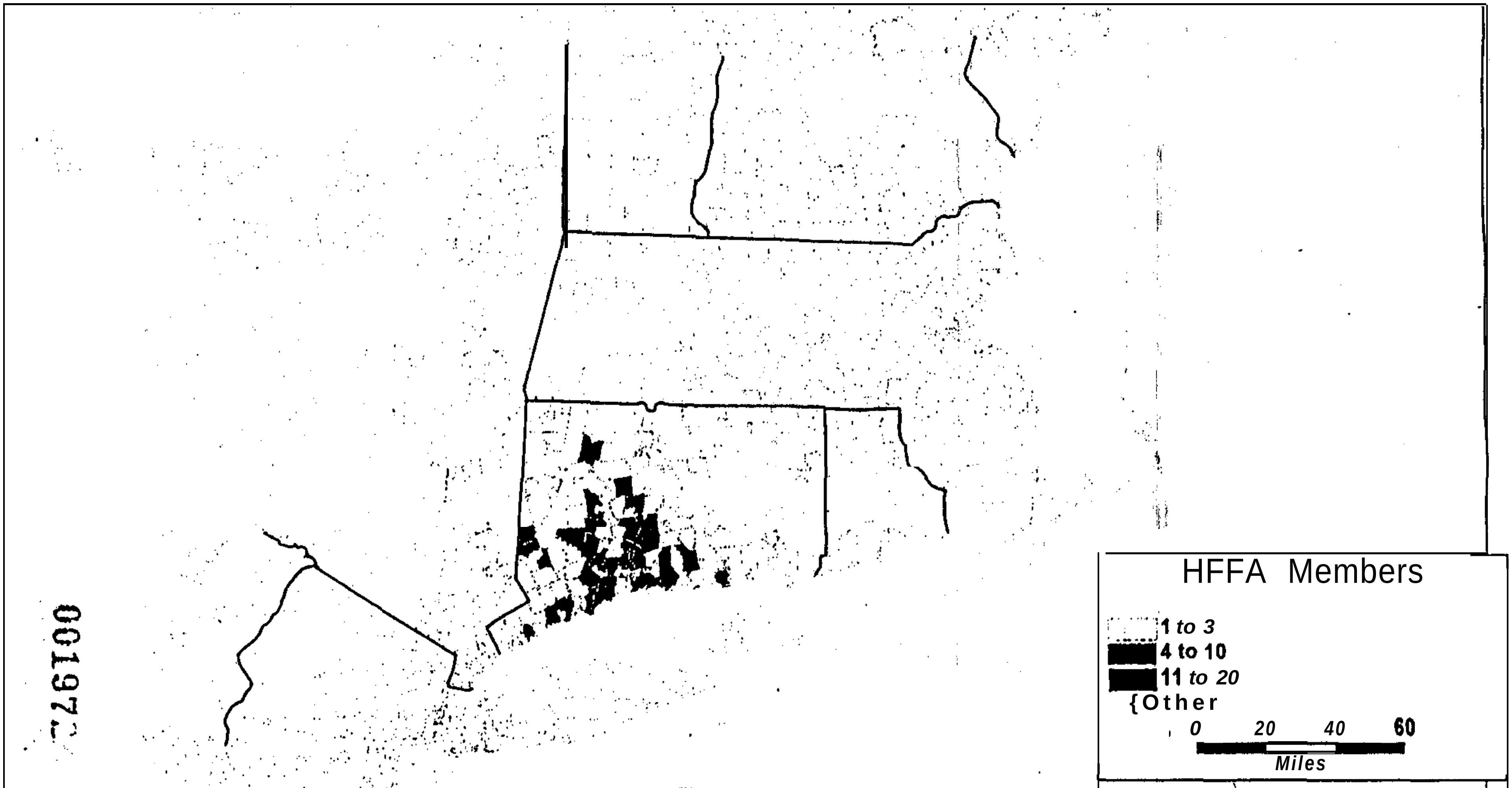
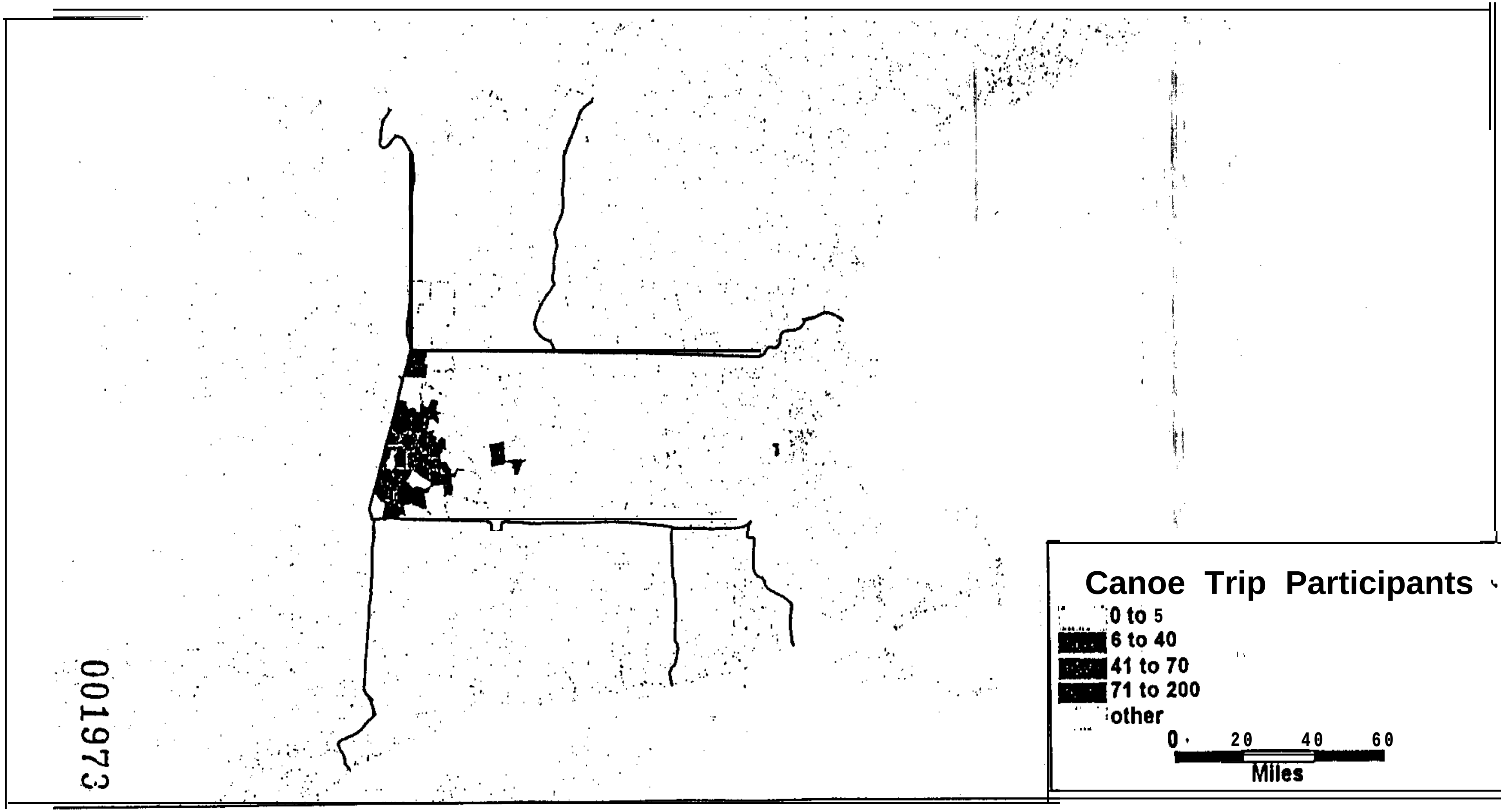


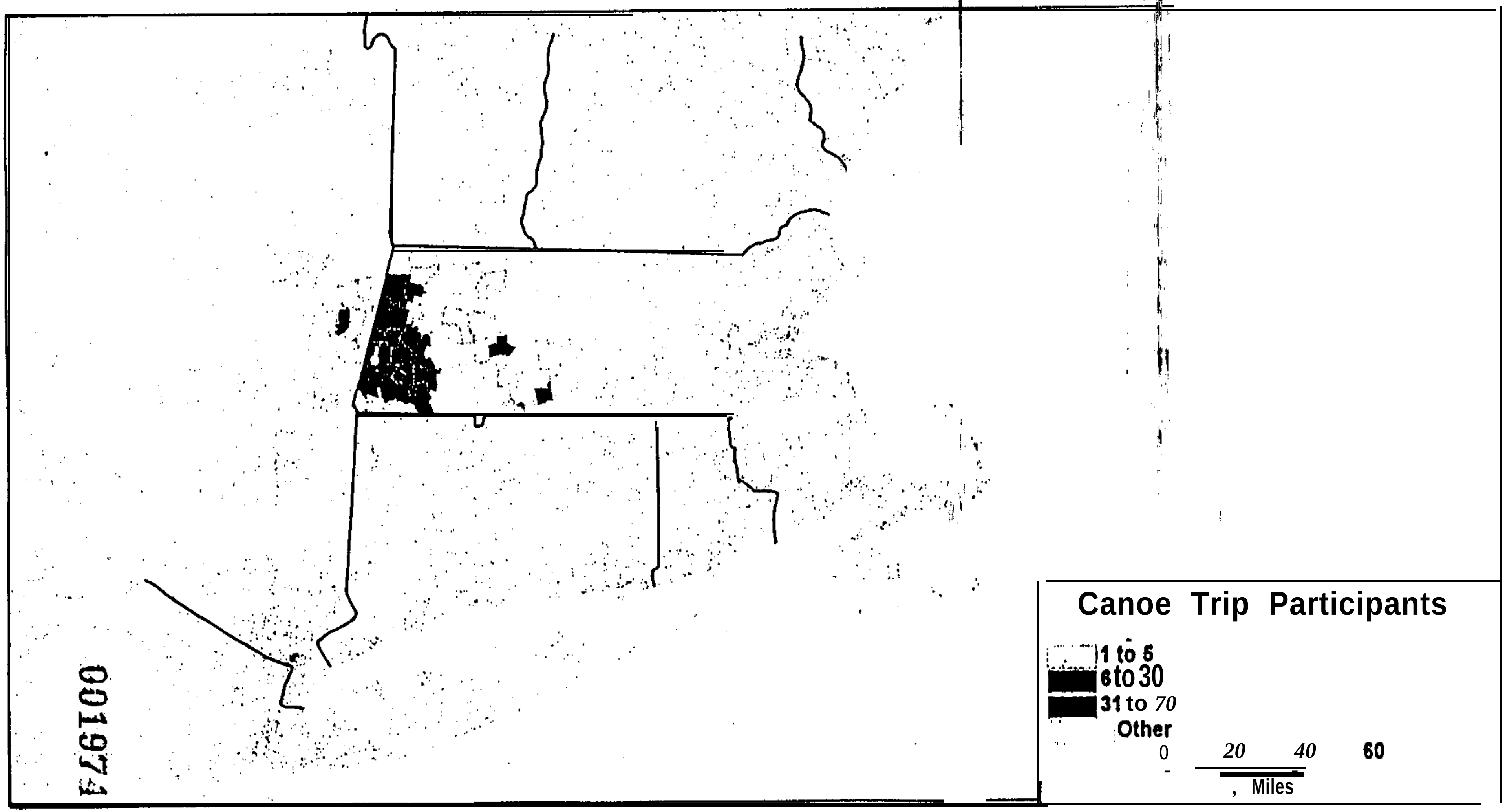
Exhibit 3-7

Massachusetts Audubon Society Canoe Trip Participants, by Zip Code
Decker Launch to Woods Pond, 1983-1989



'Exhibit 3-8

Massachusetts Audubon Society Canoe Trip Participants, by Zip Code
Decker Launch to Woods Pond, 1990 to 1995



Considering this information, we establish two scenarios to bound the potential range of passive use losses. Scenario 1 assumes that households in counties in Massachusetts and Connecticut through which the Housatonic River flows would be willing to pay to expand or expedite restoration of the river. Scenario 2 assumes that all households in Massachusetts and Connecticut would be willing to pay to expand or expedite restoration of the river. As shown in Exhibit 3-9, these two scenarios result a total willingness to pay estimate of between $24 million and approximately $200 million.[5] As discussed above, we believe that some households outside of these two states would be willing to pay to address the contamination present in the Housatonic River environment On this basis, we estimate that a carefully constructed CV instrument might yield a total willingness to pay as high as $250 million. The greatest source of uncertainty in this range is the assumed market area for this resource.

OTHER CATEGORIES OF POTENTIAL DAMAGES

As noted above, there are several categories of compensable losses for which preliminary damage estimates have not *been* developed. Based on our preliminary analysis, we have concluded that, while 'hunter and trapper behavior may have changed as a result of PCB contamination of the Housatonic River environment, the number of individuals affected is probably small. Thus, the total magnitude of losses is liiely to be small. We also considered the potential magnitude of impacts on wildlife viewing and other general outdoor activities involving the Housatonic River environment. In this case, while the number of participants affected may be large, no data exist to allow us to generate a prelii damage estimate. As diited by the trustees, we have not estimated the magnitude of damages associated with the following three categories of potential economic loss: potential impacts on the economic value of state owned lands in the Housatonic River floodplain; the increased cost of development in the floodplain associated with PCB contamination; and the diminishment in ecological services provided by wetlands and other floodplain habitats.

Exhibit 3-9

ESTIMATED DAMAGES ASSOCIATED WITH PASSIVE USE LOSSES IN THE HOUSATONIC RIVER ENVIRONMENT

	Households Included in Market	Assumed Willingness to Pay	Estimated Damager
Scenario 1 *	440,000	$55/household	$24 million
scenario 2 • *	3,600,000	$55/household	$ 198 million

• Berkshire, Litchtield and Fairfield counties.

• * All Massachusetts and Connecticut counties.

[5] Based on county and state population data reported in the 1990 census.

GG3.975

PRELIMINARY EVALUATION OF RESTORATION OPTIONS — CHAPTER 4

IEc has completed an initial inventory of options for compensatory restoration of the Housatonic River. Note that these options would provide compensation for interim losses of natural resources and services and not primary restoration (i.e., return of the injured natural resources and services to baseline). Appropriate scaling of restoration options will depend on the quantification of observed injuries, Attached is a table describing the options identified through this effort.

In formulating this list, we interviewed a wide range of knowledgeable individuals from national and local conservation organizations, recreational groups, state and federal agencies, and non-profit environmental organizations.[1]

This initial inventory includes all of the options that ware suggested to us. Consequently, some of them may not be appropriate for restoring injured natural resources (i.e., the resources or services provided may not have sufficient connections to the injuries sustained). In addition, some of the proposed options listed may duplicate actions taken or resource protection achieved pursuant to the Rivers Bill or FERC relicensing of downstream dams. Ultimately, we would eliminate from consideration any option confirmed to be duplicative. However, this inventory is also not exhaustive and thus may not include ah possible restoration options. We also note that multiple locations, in addition to those listed, may be available for the implementation of the listed options. Some options are lacking key information, most noticeably cost estimates, which would require case-specific reviews.

[1] Primary contributors of options include Bob Orciari of the CT DEP Fisheries Division, Lynn Werner of the Housatonic Valley Association, Tom Keefe of the MA Division of Fisheries and Wildlife, Tii Gray of the Housatonic River Initiative, George Wislocki of the Berkshire Natural Resources Council, Frank Lowenstein of The Nature Conservancy, Joe Hickey of the State of CT Parks and Land Management, Bob Mellace of the Pittsfield Greenway Project, and Peter Milanesi, land acquisition agent of the MA Fisheries and Wildlife Division. These individuals have not, however, reviewed this document.

We expect that this inventory will evolve as the trustees identify additional projects that could provide resources or services comparable to those lost due to the contamination (i.e., that would provide appropriate compensation). As stated previously, the final selection of one or more restoration actions will be contingent upon the results of the injury assessment, which will provide a measure of the appropriate scale of restoration actions.

The following table is organized into five major categories of resources and services that the options would provide: enhancement of water quality, enhancement of recreational fisheries, enhancement of other recreational uses, general land/wetlands conservation, and other. Some of these categories may overlap, such as enhancement of water quality and wetlands conservation, and some options are subsets of other options. For instance, "create farmland buffer strips" is a subset of "control nonpoint source pollution." *For* each option, we list (to the extent currently practicable) the project or action name and description, location, the quantity and quality of resources or services provided, estimated cost, and any other relevant information.

One option for restoration of the Housatonic River watershed is land acquisition. This option would involve either purchasing land in fee or aquiring conservation easements for parcels in the Housatonic River watershed. Land acquisition could potentially provide a variety of benefits, including (1) preservation/enhancement of wildlife habitat; (2) improved/protected watershed aesthetics; (3) protection of water quality; (4) creation of public access to the river; and (5) general benefits of land conservation.

We list land acquisition options in a separate table at the end of this chapter because the resources and services that this option would provide are varied and cut across many of the other categories. The specific parcels listed in this table have been recommended for purchase by people we have interviewed. We assume that this table is not a complete inventory of the lands that might be available for compensatory restoration. As 'the damage assessment process continues, we expect to expand and refine this inventory. For example, the wetland mapping project proposed by the University of Massachusetts could be expected to identify additional locations for consideration (i.e., former wetlands which, if restored., would provide measurable services comparable to those that have been lost). The final determination of appropriate acquisitions will depend on the results of the injury assessment (to determine the necessary scale of compensatory habitat) and evaluation of the suitability of available parcels (e.g., are existing contamination problems severe enough to significantly reduce or eliminate the restoration benefit provided?).

The habitat equivalency approach is an appropriate methodology for determining the necessary scale of compensation based on the acquisition of equivalent resources, such as land. The basic premise of this approach is that the public can be compensated for interim service losses through the provision of additional services of the same type in the future. The unique aspect of this approach is that the measure of compensable values is not dollars, but the diminished service itself. For example, the measure of compensable values can be expressed in terms of wetland (or other habitat) acres.

001977

We have undertaken some preliminary work to provide the trustees with a framework for applying the habitat equivalency approach to this case. The appropriate level of compensation will depend on a determination of the number of acres of habitat that have been injured, and the nature of the injury. Since this injury quantification step is not yet complete, we do not provide quantitative estimates of compensatory acreage in this chapter. instead, we provide the following summary of key assumptions or determinations the trustees must make before completing the habitat equivalency calculation.

- What PCB (or other contaminant) concentration should serve as the threshold for injury (i.e., what concentration(s) -will be used to -identify injured-acreage for which compensation must be provided)?

- Which habitat types should the trustees include in the analysis? In general, there are five potential habitat categories that might be included in the analysis: emergent wetland., forested wetland, lacustrine wetland (e.g., Woods Pond), riverine wetland, and upland

- 'What is the nature of the loss associated with each habitat type? That is, has the ecological value of the habitat been completely eliminated, or does the habitat retain some percentage of its baseline value? An assumption of 100 percent loss might reflect a finding that these areas, while supporting some species, also serve as a continuing source of contamination. With regard to this issue, the trustees need to consider whether the general ecological value of each injured habitat, in its baseline state, is great enough to warrant the short-term environmental impact that would be associated with physical restoration (i.e., sediment removal). Similarly, the trustees should be prepared to consider the possibility that physical restoration might result in a "new" baseline (i.e., a different set of ecological characteristics) and decide whether achieving that baseline in a shorter timeframe is preferable to achieving the "original baseline over a longer timeframe (i.e., largely through natural recovery).

- What date should the trustees use for the onset of injury?

- How many years will pass before baseline recovery is achieved at the injured sites? While the trustees should make a technically defensible estimate of the recovery path a range of assumptions can be made to test the sensitivity of the results to this factor.

- How should the trustees describe the recovery path of each injured habitat type? Options include a linear recovery rate (i.e., one that describes a constant annual improvement in habitat quality), and an exponential recovery rate (i.e., one that results in greater improvements during the latter years of recovery).

- When will the first compensatory habitat be provided and on what schedule will the remainder of the habitat be provided? Note that it may take some time 'to reach agreement' on the properties that will serve as compensation and to complete the required transactions.

- Will the characteristics of the compensatory habitat represent the full ecological value of the land, or, due to contamination or other factors, will the habitat be provided at some reduced value?

- How many years will pass before the compensatory habitat reaches its maximum ecological value (if it is not provided at full value)?

- How should the recovery path of the compensatory habitat be described (if not provided at full value)?

- At full value, will the compensatory habitat have the same ecological value as the injured habitat had in its baseline condition? If not, it would be necessary to scale the compensatory habitat requirement using "productivity" ratios (e.g., if the full value of 'the compensatory habitat were only 50% of the value of the injured habitat in its baseline condition, the compensation would *need to* be doubled to make the public whole).

- What discount rate should be used?

SUMMARY OF RESTORATION ALTERNATIVES
HOUSATONIC RIVER WATERSHED

Project/ Action	Description	Location	Quantity and Quality of Resources/Services Provided	cost	Notes
CATEGORY: ENHANCEMENT OF WATER QUALITY					
Control Nonpoint Source Pollution	Reduce nutrients released to river/ tributaries from POTWs, golf courses, lawns, and agricultural lands.	Throughout the length of the Housatonic. CT has identified several potential areas. including the area south of New Milford, CT near Danbury and Lakes Zoar and Lillinonah	Reduction in nutrient loading will reduce algal biomass, thereby improving water quality and enhancing riverine and lacustrine biological communities. May reduce loadings of toxics, also improving water quality.		
Create Farmland Buffer Strips	Create farmland buffer strips to separate cultivated land from the river.	MA along river, CT near MA border	Reduction in silt and nutrient loading and water temperature elevation associated with farm practices; creation of streamside habitat; possible aesthetic improvements and recreational access.	In some cases, it may be possible to construct buffer 'strips through cost-share arrangements with landowners (i.e.; fee ownership may hot be required). In other cases it may be necessary to obtain fee ownership or conservation easements.	
Create Greenway Buffer Strlpr	Establish parallel 200 foot greenway buffer along river through conservation restriction with public access or acquisition.	For example, from Pomeroy Ave. south to the Housatonic Valley Wildlife Management Area, and from Lee south to Connecticut state line.	A 400 foot buffer (200' x 2) along the rivet's edge under a conservation restriction or acquisition with public access would further protect the riverine resources and banks.		The new Massachusetts Rivers Bill provides some administrative protection.
Reduce Leaching Fmm Landfills in Watershed	Reduce leachate losses to the river and assure stability of the landfill cover.	For example, Pittsfield, Lenox, Dalton, and possibly Lee.	Improve waler quality.		Coordination with site closure or management activities necessary.

SUMMARY OF RESTORATION ALTERNATIVES
HOUSATONIC RIVER WATERSHED

Project/ Action	Description	Location	Quantity and Quality of Resources/Services Provided	cost	Notes
Upgrade Septic Systems In Watershed	Reduce discharge of leachate from home and business septic systems.		Improve waler quality.		
Protect Upstream Areas from Development	Identify undeveloped areas in the headwaters of the Housatonic and its tributaries and protect them from development.		Protection of river from silt and nutrient loading.		
Address CSOs	Identify CSOs and develop alternatives for discharges.		Improve water quality.		

SUMMARY OF RESTORATION ALTERNATIVES
HOUSATONIC RIVER WATERSHED

Project/ Action	Description	Location	Quanlity and Quality of Resources/Services Provided	Cost	Notes
ENHANCEMENT OF RECREATIONAL FISHERY					
Minimum Flow at Falls Village Hydro Dam	operate falls at minimum flow to protect cold water refuges. Use a high efficiency turbine to enhance power generation.	ˀalls Village	Constant or natural flow would be beneficial to fish and would lead to reduced fish kills and longer seasons, and thus, more fishing days. This would bring in more out-of-state anglers. If minimum flows are passed over falls rather than power canal, this option would enhance the view of the falls from the Appalachian Trail. Using a high efficiency turbine could enhance power generation under minimum or natural flow. Another turbine would also give NE Utilities an additional generating capacity of 600 cfs during high flows.	ᴺo lost power generation n terms of kilowatts, but a oss of capacity during ɔeak usage. Potential to nake up for lost peak ;eneration is available at he Rocky River home :torage facility in New Milford.	boaters' concerns/ ome loss of boating lays (can't float below :00 cfs) lost generation of ɔower during peak lemand

001982

SUMMARY OF RESTORATION ALTERNATIVES
HOUSATONIC RIVER WATERSHED

Project/ Action	Description	Location	Quantity and Quality of Resources/Services Provided	Cost	Notes
Changes in Stocking Regime	**Stock additional areas, e.g., below the TMA.**		Increased fishing opportunities.		
	Stock northern pike, tiger muskie, and largemouth bass.	For example, above Woods Pond, from Pomeroy Avenue to New Lenox Road.	Increased fishing opportunities.		There is limited access for anglers along some stretches; thus, stocking regime changes would need to be combined with improvements in access.
	Stock larger fish after fish kills.	Cornwall and Sharon	Maintenance of populations of large fish in trout management areas.		Requires change in management objective. CT DEP wants to manage it as a natural fishery, if possible. Large hatchery fish are not aesthetically pleasing, especially for out-of-state anglers. Could be forced into this by the FERC relicensing. Many private clubs have been denied permits to do this.

001983

SUMMARY OF RESTORATION ALTERNATIVES
HOUSATONIC RIVER **WATERSHED**

Project/ Action	Description	Location	Quantity and Quality Resources/Servicer Provided	Cost	Notes
Improved Access	**Expand parking area.**	**For example, below Bulls Bridge, near Ten Mile River**	**Improved access on east bank. If NE Utilities could move gate back closer to the picnic area, there would be more parking for anglers.** Fishing here is currently for **smallmouth** bass. Improved access would increase the number of anglers fishing here.		**There are currently (?) 10-15 parking spaces.** **Area is owned by NE Utilities.**
	Improve parking.	**For example, upper end of Stanley Tract area, below the Cornwall Bridge**	Increased fishing **opportunities,** ease of access. Would spread out **anglers.**		Currently **5-10** spaces. Could be **15-20** spaces.
	Create access/ parking sites.	**For example, Glendale**	Improved access to river. For Glendale example, private property **in** the area does not provide practical access. Route **183 runs** along one side of **the** river here, but **parking** along the road is still **limited.**		Currently, **some** anglers cut across the railroad tracks to get to river. Enforcement of the railroad trespass law would make access more **difficult.**

001984

SUMMARY OF RESTORATION ALTERNATIVES
HOUSATONIC RIVER WATERSHED

Project/ Action	Description	Location	Quantity and Quality of Resources/Services Provided	cost	Notes
Expand Management Resources to Assure Protection of Public Health	Employ game wardens to enforce baa on fish consumption. (already done in parts of CT).	MA, areas of CT	Might enhance/promote recreational use of portions of river as catch-and-release fishery.		
Protection of Cold Water Areas	Identify cold water areas and implement strategies to keep temperatures low.	For example, Ivy Mountain Brook or Carse Brook, CT	Improved water temperature. leading to reduced fish kills and longer fishing seasons.		Beaver dams may be jeopardizing these cold water areas. However. because the brooks currently supply the Housatonic with relatively cool water, the impact of the beaver dams is probably not acute.
Enhance Tributary Habitat	Implement strategies to make tributary habitats more hospitable to fish.		Increased fish survival in summer, leading to maintenance of an older population.		Summer impacts are partly due to the Falls Village hydm power facility

SUMMARY OF RESTORATION ALTERNATIVES
HOUSATONK RIVER WATERSHED

Project/ Action	Description	Location	Quantity and Quality of Resources/Services Provided	cost	Notes
ENHANCEMENT OF OTHER RECREATIONAL USES					
Improve Boating Access	Improve and upgrade state-owned boat launches.	For example, two sites on Lake Lillinonah: Route 133 and Pond Brook. One site on Lake Zoar.	Improved access for boaters.		
	Improve parking areas.	For example. Bleachey Dam (near New Milford High)	Improved access for boaters.		Might improve access for low income or disadvantaged groups in area.
	Increase access for canoe/car top boats and anglers by creating access/parking sites.	For example, between Great Barrington and Bartholomew's Cobble	Increased access to river. which is currently limited due to the large number of privately held tracts along the river.		
	Build canoe launch site with picnic area and improved/ expanded parking.	For example, old covered bridge in Sheffield	Improved access for canoers.		The banks here are not steep, so access to the river would be fairly easy. The land is also publicly-owned.

001980

SUMMARY OF RESTORATION ALTERNATIVES
HOUSATONIC RIVER WATERSHED

Project/ Action	Description	Location	Quantity and Quality of Resources/Services Provided	Cost	Notes
Improve Boating Access (cont'd)	**Build canoe launch site at areas with existing parking.**	**For example, Rannapow Bridge at** Bartholomew's Cobble, Route 7A or Maple **Street in Sheffield**	**Improved access for canoers, who currently** enter the river here **due to good** mad access for cars and **trailers.** However, **there are currently no formal boat launches.**		**At the Maple Street site there is a field to the left of the bridge where approx. 20 cars could park.**
	Build a car-top canoe launch.	**For example, Goodrich Pond, 1/4 mile from the East branch of the Housatonic, near GE facility**			**City has a "Lake and Pond Grant" of $5,000 from** the state (matched **by an additional $5,000 from the city) to increase recreational resources and begin this project.**
Improve Access to **Wildlife Management Area**	**Improve October Mountain Road, develop areas for parking,** maintain area **(including** actions to reduce illegal dumping).	**Above Woods Pond,** leads to the Housatonic **Valley Wildlife Management area**	**Improved access to Housatonic Valley Wildlife Management area. October Mountain Road is the only legal access route to the area. It is** currently **in very** poor shape.		**The road is officially under** the jurisdiction of **two** towns: Lee continues the upkeep of its stretch, while **Lenox** has abandoned care of its segment. Because **this** road is close to Woods Pond, improvements may have to wait until **remediation** of the **Pond** is complete.

SUMMARY OF RESTORATION ALTERNATIVES
HOUSATONIC RIVER WATERSHED

Project/ Action	Description	Location	Quantity and Quality of Resources/Services Provided	Cost	Notes
nprove Access to 'overed Bridge	Improve covered bridge access site. Add access spot for boaters. Build walk-in for canoers, who access site via Route 4. Build composting toilet facility.	West Cornwall, CT, just downstream of Rte. 128.	Improved access to covered bridge for photographers, tourists, canoers, kayakers, and handicapped individuals. Below covered bridge, currently no good place to park and view the bridge. This would be a good vantage point for photographers to take pictures of the covered bridge. Shop owners would favor this. Tourist train runs by here, so plenty of people would use access site and use toilets. There is also potential access above the covered bridge for kayakers, who like the rough water under the bridge. Good spot for tishiig due to deep water. High potential for handicap fishing access.	Would need long-term funding source, plus development	Owned by NE Utilities. Currently 15-20 spaces. Could be 50+ spaces. Long term lease, so state could manage it.

001983

SUMMARY OF RESTORATION ALTERNATIVES
HOUSATONIC RIVER WATERSHED

Project/ Action	Description	Location	Quantity and Quality of Resources/Services Provided	Cost	Notes
Historic Bridge Program	Preserve historic bridges along the river.	Throughout Berkshire County			
Urban Renewal (removal of old parking lots/buildings)	Remove old parking lots and buildings; clean up and enhance neglected urban areas.	Pittsfield, other urbanized areas			
Create River Walks	Create public access by constructing trails along the river.	For example: • Great Barrington fair grounds • Between Woods Pond and the Decker Canoe Launch • Holmes Road south to Pittsfield/Lenox line	Improved access to the river for the general public. Enhanced views of the floodplain, especially in the winter. This trail would follow the ridge on the east side of the river through the state forest.		Great Barrington currently has a river walk that goes through the center of town and includes an educational area. Much of the land along this stretch is already publicly owned.

G0019883

SUMMARY OF RESTORATION ALTERNATIVES
HOUSATONIC RIVER WATERSHED

Project/ Action	Description	Location	Quantity and Quality of Resources/Services Provided	cost	Notes
Create **River Walks (cont'd)**		. Northeast Log Home Company			The NE Log Home Co. is contaminated with high levels of wood treating chemicals, so state may not want to use this land.
Build Bike Paths Along River	Create public access by constructing bike paths along the river.		Improved public access to the river.		
Renovate Parks	Stabilize banks. improve parking lot and restrooms, build more restroom facilities, develop a camping area, build bicycle trails, improve waterfront picnic areas.	For example, Burbank Park on Onota Lake. Pittsfield (This lake drains into the southwest branch of the Housatonic.)	Increased use and enjoyment of waterside park.		

SUMMARY OF RESTORATION ALTERNATIVES
HOUSATONIC RIVER WATERSHED

Project/ Action	**Description**	**Location**	Quantity and Quality **of** Resources/Services **Provided**	cost	Notes
Renovate Parks **(cont'd)**	Build a restroom facility, **more** picnic areas, **and** a **retaining** wall for **swimming.**	For example, parks surrounding Pontosuc Lake (also drams into southwest branch of the **Housatonic)**	Better lake facilities, desirable because State has just upgraded Route 7, which **runs** along the **eastern** bank of the lake and will increase USC of lake.		
	Develop nature trail (linear park) along shore of pond; clean **up area;** install benches and observation deck.	For example, **Belair** Pond, Pittsfield, just south of Pontosuc Lake	Increased accessibility and enjoyment of waterside area.		The city owns **the** land around the pond and currently has $5,000 to begin the project.
	Upgrade existing **river** facilities.	**For** example, **Fred** Gamer Park. Pittsfield; Pitt Park, Pittsfield; Lee Parks	Increased accessibility **and** enjoyment of waterside **area.**		
General Beautification *of* River	improve aesthetics of **river.**				

001991

SUMMARY OF RESTORATION ALTERNATIVES
HOUSATONIC RIVER WATERSHED

Project/ Action	Description	Location	Quantity and Quality of Resources/Services Provided	cost	Notes
;ENERAL LAND/ WETLANDS CONSERVATION					
Vetlands Restoration	Undertake actions **to** restore degraded (e.g.. drained) wetlands **in** the watershed.	Various locations **throughout** the watershed.	A variety of services associated with wetlands, **including** improved water quality, flood water, retention, habitat for wildlife, etc.	Cost would **include the** cost to **purchase** any lands that **are** not publicly **owned,** the cost to restore wetlands services (including **planning** costs), and the cost to monitor the progress of **these** projects.	See Land Acquisition table for recommended land **purchases.** Some provision for various possible failure modes should be considered (or performance standards **set for** any projects to be accomplished by the RP.
	Restore parts of the **floodplain** (e.g. farmlands) back lo their original forest habitat.		See above.		

SUMMARY OF RESTORATION **ALTERNATIVES**
HOUSATONIC RIVER WATERSHED

Project/ Action	Description	Location	Quantity and Quality of Resources/Services Provided	Cost.	Notes
Wetlands Preservation	Acquire land.	For example, Brattlebrook wetland, Pittsfield; Jacoby Brook area north of West Street, Pittsfield; Richmond Fern area (the headwaters of the SW branch, near Richmond Pond, a habitat for several endangered species); Agawam Lake and Konkapot Brook wetland areas.	Adjacent wetlands provides important ecological functions, such as sediment traps, groundwater discharge/ discharger functions. nutrient removal/retention, transformation functions. Wetlands provide important wildlife habitat for both resident and migratory wildlife species. Eighty of these wetland acres also support rare and endangered species.		Continued development of the southwest branch watershed is contributing to flooding along its middle reach
Stabilize River Bank	Install stone rip-rap along river, or employ bio-engineering with suitable plantings.		Decreased mobilization of silt due to high flows meandering.		This action will not be effective unless it is done throughout the entire river. It may degrade wildlife habitat and create new meanders due to river "reflection".
Bog Turtle Habitat Protection	Restore wildlife corridors between potential bog turtle habitats.		Bog turtles are an endangered species and can only travel up to four km at one time. They therefore need corridors so they can make stops between habitats.		None of the bog turtle sites are along the main stem of the Housatonic, but one is in the former flood plain and is cut off from the river by Route 7.
Eagle Habitat Protection	Identify eagle habitats and protect.		Eagle habitat and possible additional opportunities to view eagles.		

SUMMARY OF RESTORATION ALTERNATIVES
HOUSATONIC RIVER WATERSHED

Project/ Action	Description	Location	Quantity and Quality of Resources/Services Provided	cost	Notes
OTHER					
Restore **Mink and Otter** Levels	Stock mink and otters and protect them and their habitat.		Mink and otters		Mink and otter populations may be lower than would be expected in this type of habitat without PCBs. However, due to these animals' sensitivity to PCBs, this option may not be viable until PCB levels have decreased.
Restore Levels of **Other Riverine Animals**	Stock and protect such animals as wood turtles, king fishers, b&k swallows, and salamanders and other amphibians.		Riverine animals		
Implement **Educational** Programs	Develop programs to educate the public about the river and its uses.		Increased public respect for the river. which would decrease littering and increase support for cleanup efforts.		
Create Legal/ Administrative Fund to Minimize Future Pollution	Develop ha. to implement pollution prevention programs.		Minimization of future pollution		
Fund Studies	Conduct a creel survey to assess boating and angler usage.		Information would help management of boating and fishing.		May be provided for under FERC relicensing

001993

EXAMPLES OF LAND THAT COULD BE ACQUIRED TO PROVIDE COMPENSATION FOR LOST HABITAT

Property	Location	Quantity and Quality of Resources/Services Provided	Notes
135 acre tract	*Sheffield*	*Preservation of floodplain forest and* restoration of current farmlands to original habitat.	
N/F DeLuca property	near the Canaan/ Cornwall (CT) line	Preservation of river front land.	Tract is 300 acres with at least a mile of river frontage
Carlson Farm	Sherman, CT	Preservation of river front land, as well as provide public access to the Appalachian Trail.	Tract is 289 acres with a mile of river frontage. Naromi Land Trust was trying to preserve this tract.
Farm on Route 44	Route 44, near Salisbury, CT		Previously owned by the Crosby family
Tract owned by the Eastover Resort	Pittsfield	Addition to the Pittsfield Greenway Program.	
DeVos Farm	Across from the Decker boat launch		Contaminated site currently owned by GE
Giroux land	On west side of Woods Pond in Lee. Leads directly down to the water and is surrounded by state land	Access to Woods Pond and complete state acquisition of the area.	
Hale Farm and tract owned by former Senator Fitzpatrick	Near convergence of Hop Brook and the Housatonic, near Hop Brook Wildlife Management area	Because Hale Farm contains rare species, it is already protected from development by an APR. The state would, however, like to actively manage the land and provide public access.	

001995

APPROACH FOR AN ASSESSMENT OF DAMAGES RESULTING FROM INJURY TO GRODNDWATER RESOURCES--- CHAPTER 5,

INTRODUCTION

The purpose of this chapter is to present background and guidance sufficient to permit the trustees to evaluate the potential scale of a damage claim based on groundwater injury, and, if appropriate, to begin to collect the data necessary for such a claim. This information is presented in four parts:

1) A review of the questions that need to be answered to determine whether, and to what extent, groundwater resources have been injured;

2) A review of options for the assessment of damages resulting from groundwater injury, and the issues associated with these options; and

3) Data elements necessary for injury determination and one of 'the assessment options, presented in table format to facilitate future data collection.

4) An example of completed data tables for a hypothetical groundwater injury damage claim scenario.

The attached tables, once completed, would provide the basis for determining whether to proceed with a more detailed assessment, but would not themselves be sufficient to support a claim for natural resource damages.

INJURY DETERMINATION AND QUANTIFICATION

- According to the U.S. Department of the Interior regulations for damage assessment under CERCLA, groundwater injury has occurred if any of the following conditions are met (43 CFR 11.62(c)):

  1) Concentrations of hazardous substances in previously potable water exceed Federal or State drinking water standards.

  2) Concentrations of hazardous substances in groundwater with a committed use as a public water supply exceed water quality criteria established under the Safe Drinking Water Act.

  3) Concentrations of hazardous substances in groundwater with a committed use as a domestic water supply exceed water quality criteria established under the Clean Water Act.

  4) Concentrations of hazardous substances in groundwater are sufficient to cause injury to surface water, air, geologic, or biological resources when exposed to the groundwater.

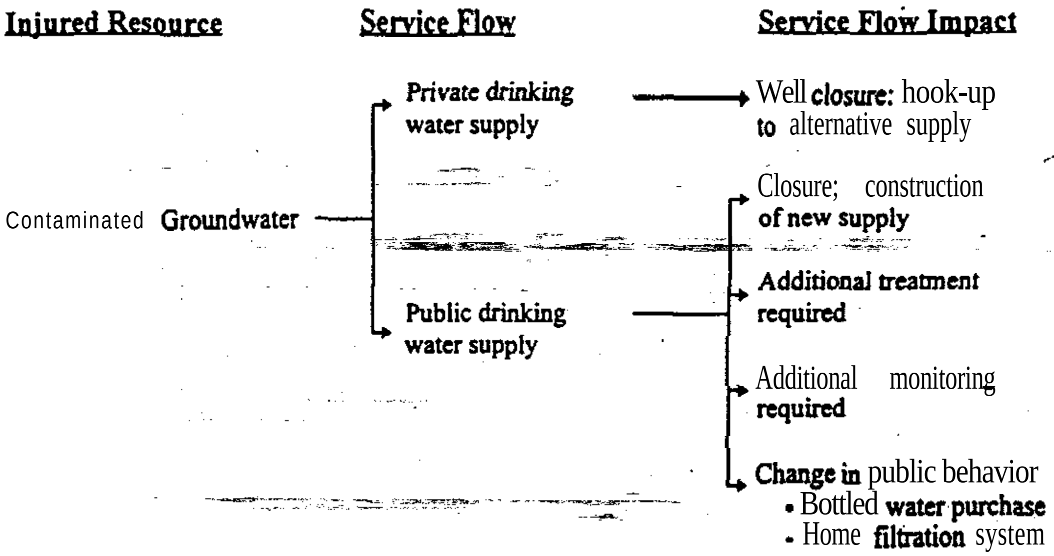
- In order to document injury to groundwater resources, samples of contaminated groundwater must be collected from properly constructed wells, springs and/or seeps that are at least 100 feet apart

- A pathway from the source of the hazardous substance(s) to the groundwater resource should be documented.

- The groundwater injury must be quantified in terms of the areal extent of contamination and the volume of injured groundwater within that. area Volume can be measured as an *in situ volume* of water, a volume pumped from wells, a volume discharged to a surface water body, or any other appropriate measure.

- The baseline condition of the resource (i.e., the condition that would have been expected had the discharge of hazardous substances not occurred) should be determined, either through the use of historical data or through comparison of the assessment area to a suitable control area

- Similarly, the baseline services provided by the resource should be determined. Baseline data is used not only to confirm the extent of injury but also to indicate the appropriate objective of restoration actions. The following is an illustration of some of the service flows potentially affected by groundwater injury.



OPTIONS

- Damages associated with injury to natural resources fall into hvo general categories: 1) costs to restore, rehabilitate, replace and/or acquire equivalent resources, and 2) compensable values, or the amount of money (or additional restoration) that is necessary to compensate the public for lost resource services during the period between the release of hazardous substances and restoration of the resource(s) to their baseline condition.

- A damage claim for injury to groundwater resources will include a restoration component, and may include a compensable value component. Inclusion of compensable values depends largely on the expected magnitude of damages relative to the expected cost of assessment.

- Three options should be considered for the assessment of compensable values:

  1. Calculating the costs incurred by the public to avoid exposure to contaminated groundwater (the focus of the remainder of this chapter);

  2. Estimating decreases in property values that can be attributed to the groundwater contamination; and

  3. Estimating passive use values for the injured groundwater resource.

- Note that when calculating compensable values, only committed uses of the resource or services may be used to measure the change from baseline resulting from injury to a resource (43 CFR 11.84(b)(2)). A committed use is defined as a current public use or a planned public use of a resource for which there was a documented legal, administrative, budgetary, or financial commitment established before the release of the hazardous substance was detected (43 CFR 11.14(h)). The committed use criterion does not apply to the determination of the appropriate level of restoration.

Restoration Costs

- The focus of the restoration costing exercise should be on the cost to implement a plan to restore, rehabilitate, replace and/or acquire the equivalent of the injured resource (referred to jointly as "restoration.") Restoration and rehabilitation are actions taken to return resources to their baseline condition (e.g., pump and treat); replacement and acquisition of the equivalent are actions that substitute the injured resource with resources that provide the same or substantially similar services as those that have been and will be lost due to injury (e.g., purchase of a replacement water supply for a municipality).

- Damages could include the cost of actions already undertaken, as long as those actions are distinct from a *remedial* response (i.e., they go beyond measures that are intended to protect human health and the environment but that do not fully restore the injured resource).

- The actual damage claim is based on an accurate present value accounting of the expected costs of the proposed actions, including both direct and indirect costs. A variety of cost estimating methodologies are available to complete this accounting (as described in the DO1 regulations at 43 CFR 11.83).

001993

Averting Behavior Costs/Added Costs

- The averting behavior cost approach requires documentation of consumer expenditures, made in direct response to groundwater contamination, that result in decreased consumer surplus (the difference between what consumers are willing to pay for a good and the market price of the good).

- In the case of groundwater injury, damages are most obviously reflected in purchases of bottled water or home filtration' systems when those purchases are solely to avoid real or perceived risks associated with groundwater contamination.

- It is important to note that averting behavior, such as the purchase of bottled water, may provide benefits greater than those needed by consumers to feel that they have avoided a real or perceived risk (e.g., improved drinking water taste). Ideally, these added benefits would be quantified and subtracted from the averting behavior costs.

- This approach requires the collection of data on bottled water or filtration system purchases, or a survey of the affected public.

- The added cost approach is another way to measure the cost to the public to avoid exposure. For example, the cost to construct a new water supply as a dii result of groundwater injury, reflected perhaps through a water rate increase, is a measure of lost consumer surplus. However, it would be necessary to determine, and allocate, the portion of the added cost that is associated with the contamination and not with other factors (e.g., a rate increase to support construction of a new primary treatment facility).

- The costs of actions taken in the past may also be compensable (e.g., the costs associated with modifications to a water supply system, such as enhanced monitoring, made in response to a perception of future risk).

- If the incremental cost change (i.e., loss in consumer surplus) associated with any of these scenarios is small relative to typical expenditures in the absence of injury, then it can be assumed that damages are equal to the cost increment. However, if the change is moderate to large relative to typical expenditures, then the elasticity of demand for groundwater would need to be considered, since consumers may reduce consumption (associated with lawn care or backyard pools, for example) in response to cost changes.

Changes in Property Values

- Two options, hedonic price and' repeat sales, are available to measure the effect of an environmental **disamenity,** such as groundwater contamination, on property values.

- The hedonic price method assumes that the value of an environmental service, **such as clean** groundwater, is capitaliid in the value of a property in the same manner as, for example, the property size or number of **bedrooms. Therefore, a change in the environmental service** (i.e., the quality of groundwater under **a** property) should bereflected in the value of the property if all other factors are held constant In order to have **sufficient** explanatory power, this method requites the development of a statistical model that can account for multiple attributes across a large number of property sales.

- **The repeat sales method is similar** to the hedonic **price method in that it** compares property sales and tries to isolate the effect of the environmental **disamenity** on those sales. The key difference, however, is that it is based on the eomparison of multiple sales of the same property over time.

- Among the problems associated with the use **of** property value studies to estimate damages are: the need for the potentially costly gathering of a large amount of **data;** the very real possibility that much of the data needed to construct a sound model may not be available; and the possibility that the real estate market may not be in a condition that is amenable to such studies (e.g., the market may be in a period of **price** instability, or there may be multiple **environmental disamenities** affecting local **property** values, including other disamenities associated with the site).

Passive Use Values

- **Individuals** value natural resources for many reasons other **than** those related to direct use of those resources. The "passive use" **value** of a resource is a compensable value that is properly included in natural resource damage assessments under CERCLA.

- Passive use values may include: the **value** of knowing that the resource is available for use by family, friends, or the general public, the value of protecting the resource for its intrinsic worth, or the value derived from knowing that the resource will be available to future generations.

- The magnitude of passive use values is difficult to assess, since there is no market to evaluate. The primary means by which economists attempt to measure these values is a technique known as contingent valuation (CV), in which members of the public are asked questions designed to elicit their willingness to pay for a particular environmental good (e.g., the injured resource restored to its baseline condition over a specific time period). The total passive use value of a resource is calculated as the average individual (or household) willingness to pay multiplied by the total population (or number of households) expected to share this value.

DATA NEEDS

- The following exhibits outline the data elements necessary for the development of a groundwater damage claim based on the averting behavior cost approach. Exhibit 5-1 summarizes the data elements associated with injury determination and quantification, and follows the guidelines provided in the Department of the Interior's damage assessment regulations at 43 CFR Part 11. We have provided specific references to the regulations whenever possible.

- Exhibit 5-2 summarizes data elements associated with the averting behavior/added cost approach to a compensable damage determination. The table is divided into two parts; the first focuses on damages based on the bottled water/home filtration response to groundwater contamination, while the second focuses on the costs to respond to contamination on a system-wide basis.

- Exhibit 5-3 provides an example using a scenario in which compensation is required for the costs associated with replacing a contaminated municipal water supply. We assume that the replacement costs are passed on to the consumers, and that the change in water prices is not large enough to cause a shift in demand

Exhibit 5-1

Data Elements for a Groundwater Damage Claim

Data Element	Description	source	Comment
Committed use of resource	Describe current or planned future public use		43 CFR 11.84(b)(2)
Date of hazardous substance release	Beginning of time period over which damages will accrue		
Hazardous substance detected in groundwater	List one or more substances		
Max. and/or avg. concentration of hazardous substance	Concentration(s) demonstrating injury to resource		
Standard against which concentration is compared	e.g., MCL, WQC		43 CFR 11.62(c)
Data satisfy regulatory criteria? (Y/N)	Confirm collection of two contaminated samples at least 100' apart		43 CFR 11.62(c)(2)
Pathway from source to groundwater resource	Describe characteristics of unsaturated zone		43 CFR 11.63(c)(3)
Area of contamination	Describe extent of contamination in unsaturated zone		43 CFR 11.71(i)(1)
Volume of injured groundwater	Quantification of lost services formerly provided by resource (e.g., *acre-fact* of ~~potable drinking water~~)		43 CFR 11.71(i)(4)
Baseline concentration	Concentration that was observed, or would have been expected, prior to hazardous substance release		43 CFR 11.72(b)
Baseline service(s) provided by groundwater	If different from volume of injured groundwater		
Natural recovery period	Estimate of years to full recovery without active restoration		43 CFR 11.73(a)(1)

002003

Exhibit 5-2

Data Elements for a Groundwater Damage Claim
Averting Behavior Costs/Added Costs

Data Element	Description	Source	Comments --
Bottled water/home filtration			
Quantity of drinking water consumed per household per month			
Price of tap water			Per unit volume
Price of bottled water/filtration system			Per same unit volume as tap water
Elasticity of demand for drinking water			Measures consumer response relative to price change
Number of households switching to bottled water/filtration system			Requires identification of relevant geographic area
Duration of bottled water purchases/use of filtration			If ongoing, estimate time until purchases are no longer necessary

002004

Exhibit 5-2 (cont.)

Data Elements for a Groundwater Damage Claim
Averting Behavior Costs/Added Costs

Data Element	Description	source	Comments
Municipal supply			
Description of injury and impact on service flow			
Description of action taken in response to injury			
Total cost of response			
Year(s) in which response CON were incurred			used to calculate present value of damages
Additional benefit(s) provided by response action	e.g.,improved taste, enhanced fire suppression capability		Value should be subtracted from damages
Value of added benefit(s)			
Net Damages			

GO2005

Exhibit 5-3

Data Elements for a Groundwater Damage Claim
Averting Behavior Costs/Added Costs
Example

Data Element	Description	Source	Comments
Municipal supply			
Description of injury and impact on service flow	Municipal wellfield closed due to contaminant concentrations in excess of MCLs		
Description of action taken in response to injury	Construction of new wellfield in uncontaminated portion of aquifer; new distribution lines		
Total cost of response	$3 million		
Year(s) in which response costs were incurred	1993		
Additional benefit(s) provided by response action	Sufficient capacity to provide new supply for subdivision that had private wells and needed to address a different contamination problem		
Value of added benefit(s)	$1.5 million		Cost to develop new, independent supply for sub-division
Net Damages	$1.5 million		

APPROACH FOR AN ASSESSMENT OF DAMAGES BASED ON THE ADDED COST OF DEVELOPMENT RESULTING FROM INJURY TO NATURAL RESOURCES

CHAPTER 6

INTRODUCTION

The purpose of this chapter is to present background and guidance sufficient to permit the trustees to evaluate the potential scale of a damage claim based on the added cost of development resulting from injury to natural resources, and, if appropriate, to begin to collect the data necessary for such a claim. This information is presented in three parts:

1. A discussion of the basis for making a claim based on the added costs of development and of the potential issues associated with such a claim;

2. Data elements necessary for a defensible claim, presented in table format, to facilitate future data collection; and

3. An example of a completed data table for a hypothetical added cost damage claim scenario.

This chapter focuses on added costs resulting from injury to soils and sediments. We addressed added costs resulting from injury to groundwater resources in Chapter 5.

BASIS FOR DAMAGE CLAIM

- Damages of this type fall in the category of compensable value, in that they are the amount of money required to make the public whole for lost services that would have been provided by injured resources had the injury not occurred. In this case, the "services" can be defined generally as the provision of clean sediments, soils or other resources sufficient to support infrastructure development projects. Damages would be based on the costs associated with any obstacles to development attributable to the injury.

- Examples of infrastructure development projects that might be affected by natural resource injury include, but are not limited to:

  Road or bridge construction
  Rivet-way recreational site development or maintenance
  POTW construction and/or operation
  Construction or maintenance of public facilities located in a river floodplain
  Navigational channel maintenance dredging
  Construction of public water supply systems

- Added costs can be either the costs (past or future) associated with modifications to a project necessitated by the resource injury (e.g., construction of a TSCA-compliant disposal facility for contaminated dredged sediments), or the difference in cost between a preferred approach and a more expensive approach that must be taken due to the injury (e.g., construction of a surface water reservoir for public water supply instead of constructing a groundwater well field in an area that was, or might become, contaminated).

- A project that is completely abandoned due to the resource injury may also provide a basis for damages if the benefits of the project are foregone or if a less beneficial project is substituted. Projects that fit this description should be assessed on a case-by-case basis to determine whether a damage claim would be appropriate.

- Any economic project for which damages are to be claimed under CERCLA must have been for public, rather than private, benefit. For example, added costs associated with the construction of a public boat lunch are claimable, while those associated with the cost of a private marina probably are not.

- Only committed uses of the resource or services may be used to measure the change from baseline resulting from injury to a resource (43 CFR 11.84(b)(2)). A committed use is defined as a current public use or a planned public use of a resource for which there was a documented legal, administrative, budgetary, or financial commitment established before the release of the hazardous substance was detected (43 CFR 11.14(h)). Thus, added costs associated with planned maintenance dredging, for example, would be compensable, whereas potential added costs associated with the development of a state park that has not been formally established would not be.

- The most diicult part of a damage claim of this kind is documenting that the costs for which compensation is required were incurred solely as a result of the injury and can be disaggregated from other costs of the activity. For example, the costs of additional water supply monitoring (i.e., sample collection and analysis) would be claimable only to the extent that the monitoring is necessitated only by the presence of the hazardous substances attributable to the responsible party, and would not have been conducted in the absence of the hazardous substance (e.g., to address a different contamination probiem).

DATA ELEMENTS

- The data necessary to document an added cost damage claim are summarized in Exhibit 6-l.

- A separate table should be completed for each identified project

- Each data element should be accompanied by a reference to the source of the data to allow for replication of the analysis.

EXAMPLE

- Exhibit 6-2 presents an example of the data that would be required in the hypothetical case in which the costs of a bridge construction project increase due to the presence of PCB-contaminated sediients around the bridge footings.

- Hypothetical details have been provided in order to give a sense of the types of issues that might need to be addressed in conjunction with a damage assessment of this kind.

Exhibit 6-l

DATA ELEMENTS FOR Ah' ADDED COST DAMAGE CLAIM

Data Element	Description	Source	Comment
Project description	Description of project affected by resource injury (e.g., bridge reconstruction)		
Committed use of resource	Document that the project implies a current or planned future public use of the resource		43 CFR 11.84(b)(2)
Injured resource and its impact on project	Specify type of injury and describe how project was altered		
Total project cost	Cost of project as implemented, following injury		
Project element(s)/cost component(s) associated solely with resource injury	Describe specific steps taken in response to injury		
Incremental cost of project element(s) identified above	Cost attributable solely to resource injury		
Year(s) in which incremental cost was/will be incurred			

002010

Exhibit 6-2

DATA ELEMENTS FOR AN ADDED COST DAMAGE CLAIM

Example

Data Element	Description	Source	Comment
Project description	Construction of new bridge span to replace aging span	State DOT road maintenance plan	
Committed use of resource	Project is a specific line item in DOT plan		
Injured resource and its impact on project	PCB-contaminated sediment requiring special management/disposal		Relocation of bridge to avoid contamination considered but rejected as less cost-effective
Total project cost (as undertaken)	$2.5 million		
Project element(s) associated solely with resource injury	1. additional sediment sampling and analysis 2. environmentally-sensitive dredging protocol 3. dewatering and off-site disposal of sediments		Off-site disposal assumed; final disposal determination has not yet been made; provisions for dewatering might add to incremental cost
Incremental cost of project elements identified above	4. $36,000 5. $250,000 6. $100,000		Incremental costs not reported in original planning document; cost estimates generated in concert with DOT project representative (see attached assumptions/calculations)
Year(s) in which incremental cost incurred	7. 1995 8. 1996 9. 1996		

002011

Appendix A: Recreational Fishing in Massachusetts

CALCULATION OF LOST OR DIMINISHED RECREATIONAL FISHING TRIPS IN MASSACHUSETTS

Appendix A: Recreational Fishing in Massachusetts

CALCULATION OF LOST OR DIMINISHED RECREATIONAL FISHING TRIPS IN MASSACHUSETTS

INTRODUCTION

The following analysis estimates the effects of elevated levels of PCBs on recreational fishing on the Housatonic River in the state of Massachusetts. This contamination spreads from the General Electric facility in Pittsfield, Massachusetts, to the Connecticut border. In this analysis we address lost warm water fishing trips on the New Lenox Road/Woods Pond and Sheffield stretches of the river, lost trout fishing trips on the Glendale to Housatonic stretch, and all lost fishing nips on the remaining segments of the river (see Exhibit A-l). We do not estimate the number of. fishing trips with decreased enjoyment due to the PCB contamination because the data necessary for this analysis are not available for the Massachusetts Housatonic. This analysis has been completed for settlement and case management purposes only, and is based on existing data. Our estimates could be refined through primary data collection and analysis designed to examine the specific response of Massachusetts anglers to contamination of the Housatonic River.

Prior to 1976, when the public first became aware of the PCB contamination of the Housatonic, the'main stem of the Housatonic River in Massachusetts was not an actively managed fishery. This situation was primarily due to other sources of pollution in the 'river such as municipal wastewater byproducts. After 1976, however. with the upgrading of the Pittsfield POTW, these sources of pollution diminished dramatically. By the late 1970s and early 1980s the river's water quality had improved and most contaminants other than PCBs had been significantly reduced.' Based on these events, we believe-that after approximately 1980 the state would have considered actively managing the Housatonic River as a fishery if it were not for the persistent and elevated PCB contamination.'

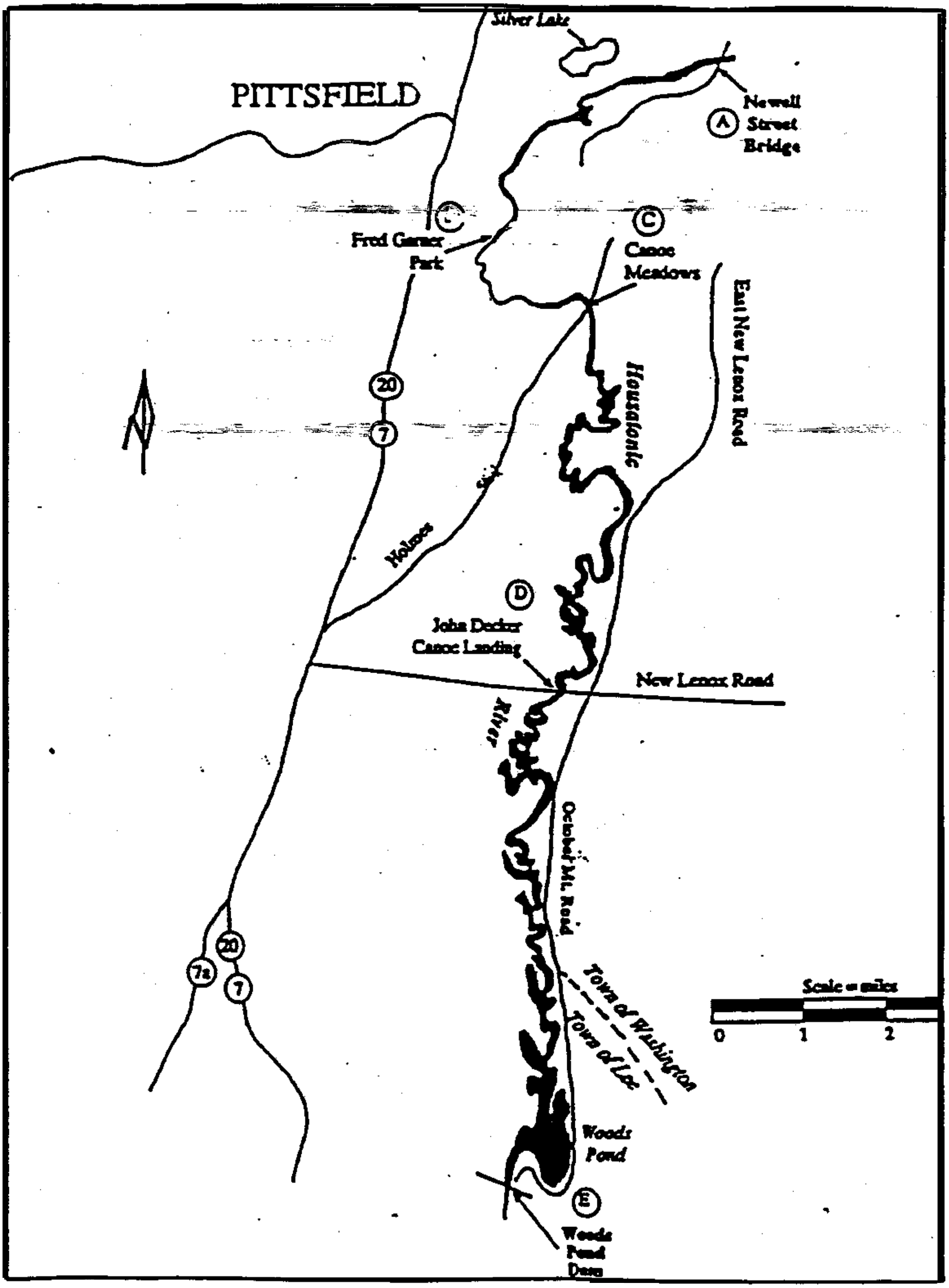
In this analysis we estimate the number of lost fishing trips on the Massachusetts stretch of the Housatonic from 1980 forward. Because of the elevated levels of PCBs present in the Massachusetts stretch of the Housatonic, we assume that without substantial clean-up and source control, PCB contaminant levels in fish will not drop below the Food and Drug Administration's

[1] There is currently a fish consumption advisory for largemouth bass due to mercury contamination in Pontosuc Lake, which drains into the Housatonic. Because bass are not a highly mobile species, however, Tom Keefe, Western Director of the Massachusetts Fisheries and Wildlife Division, believes that these fish do not reach further downstream than Wahconah Park in Pittsfield, which lies upstream of the GE facility. This site therefore does not affect the quality of the Housatonic fishery sooth of the GE Pittsfield facility.

onal communication with Tom Keefe of the Massachusetts Fisheries and Wildlife Division.

Exhibit A-l

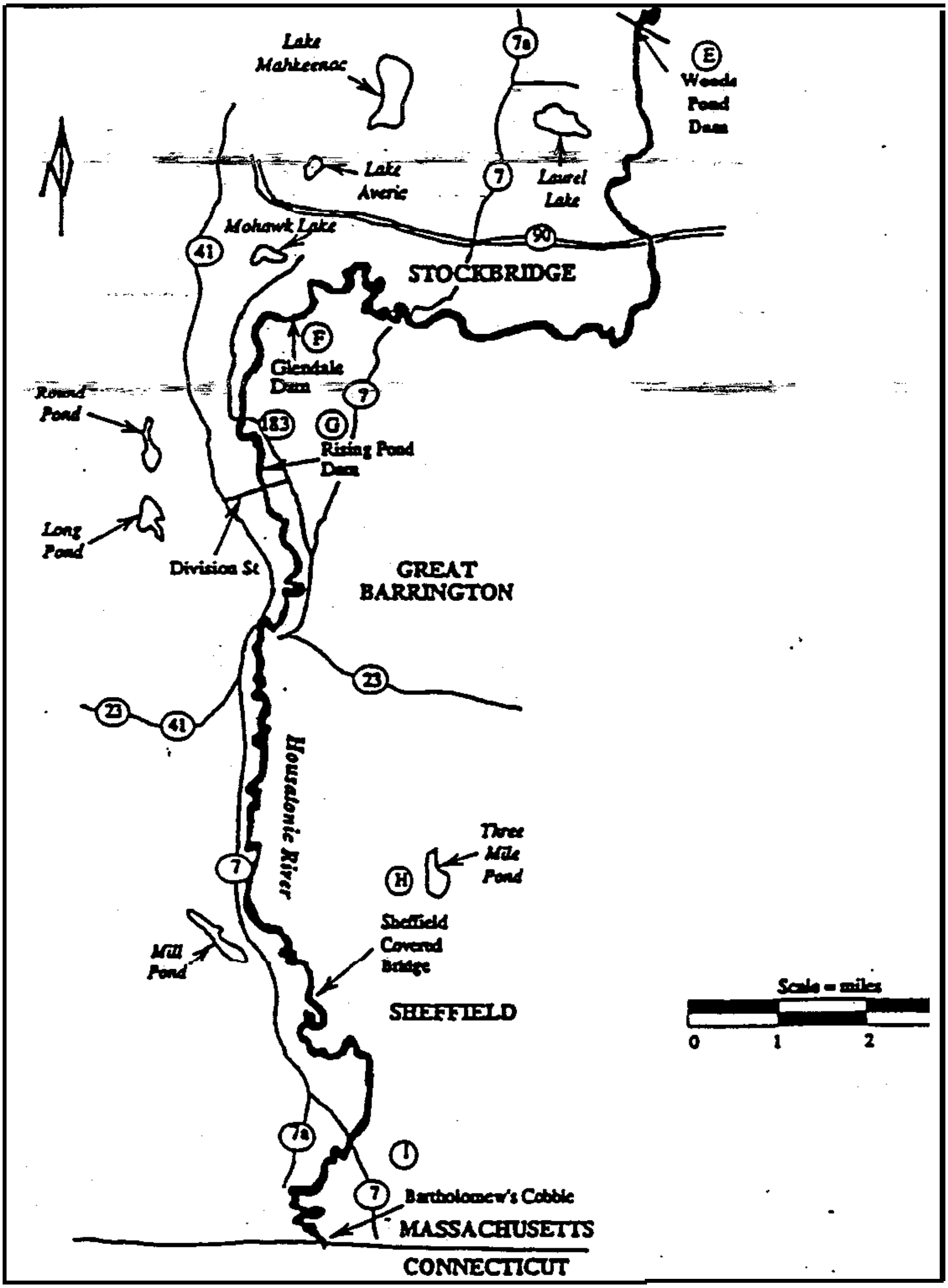
HOUSATONIC **RIVER**
PITTSFIELD TO WOODS POND **DAM**



Source: ChemRisk®, Methodology and Results of the Housatonic River Creel Survey, Portland, ME, 1994.

Exhibit A-l
(Continued)

HOUSATONIC RIVER
WOODS POND DAM TO CONNECTICUT BORDER



Source: ChemRisk®, Methodology and Results of the Housatonic River Creel Survey, Portland, ME, 1994.

action level of two parts per million in the foreseeable future. In order to bound the potential losses associated with PCB contamination of the Massachusetts Housatonic, we consider three scenarios. These include a 20-year recovery scenario, which assumes that the sources of PCBs are controlled and PCB levels in fish decline below the FDA action level; a 50-year recovery period., which assumes that cleanup and source control are less intensive, and thus it takes longer for levels of PCBs in fish to decline below the FDA action level; and no recovery, which assumes no cleanup or source control of PCB contamination in the Housatonic.

Because we lack pre-1976 fishing pressure data for the Housatonic River in Massachusetts,. we use data available for the Connecticut stretch of the Housatonic, as well as for the Deerfield River in Massachusetts and the Farmington River in Connecticut, to model potential fishing pressure on the Massachusetts stretch of the Housatonic. Because the Connecticut stretch, of the Housatonic is also contaminated with PCBs, where applicable we use the Deerfield and Farmington River data to estimate the pressure that would exist on the Housatonic in the absence of public health advisories associated with PCBs. These data are only applicable, however, for purposes of estimating potential fishing rates on Woods Pond and potential put and take trout fishing trips. For the analysis of other warm water stretches and catch and release trout fishing trips, we use the available data for the Connecticut segment of the Housatonic River.

NEW **LENOX** ROAD TO WOODS POND

The stretch of the Housatonic River from the John Decker boat launch at New Lenox Road to the Woods Pond Dam includes slow-moving, warm water with habitat for species such as perch, chain pickerel, northern pike and largemouth bass. Fishing on this stretch is conducted primarily by canoe or pram, while some ice fishing for warm water species also occurs. Boat access includes the Decker boat launch and a launch area in Woods Pond. Although little shore-based fishing occurs, there is access by foot to Woods Pond from October Mountain Road, an unimproved road that runs along the east side of the pond.

Analysis of Lost Fishing Trips

To estimate the number of lost fishing trips on the stretch of the Housatonic from New Lenox Road to the Woods Pond Dam, we first estimate the number of baseline trips (the number of trips that we believe would have taken place in the absence of public health advisories associated with PCBs) and then subtract the number of fishing trips that actually occurred in this stretch.

002016

Potential Fishing Trips

No fishing pressure data exist for this stretch of the river prior to 1976, when the public first became aware of the PCB contamination. Therefore, to estimate potential fishing pressure on this stretch assuming no public health advisory for PCBs, we use 1991 data for the Deerfield River in Massachusetts,[3] and 1985/86 fishing pressure data for the warm water stretches of the Housatonic River in Connecticut[4]

In 1991, New England Power Company conducted a study to estimate recreational use rates, such as fishing pressures; on its Deerfield River sites. One such site provides access to New England Power's No. 2 development impoundment in Massachusetts off of Route 2, a warm water impoundment with carry-in boat access. Be-cause this site is comparable to Woods Pond in terms of fishing type and natural conditions, and because the Deerfield River is not contaminated with PCBs, we use the data available for this site (calculated as fishing rate per acre surface area) to estimate potential fishing rates on Woods Pond.

The Deerfield River site is not, however, comparable to the stretch of the Housatonic from the Decker boat launch at New Lenox Road to Woods Pond. To estimate the potential fishing pressure on this stretch, we use the 1985/86 Connecticut Housatonic River data. Although the Connecticut stretch of the river is also contaminated with PCBs, and although these data do not reflect pre-1976 fishing rates, the contamination levels on the Connecticut stretch are significantly lower than those found in the Woods Pond area. The Connecticut data are therefore more likely to be indicative of potential fishing pressures on a river that is not contaminated with elevated levels of PCBs.

Because of the different data sources used to estimate potential fishing rates on Woods Pond and on the stretch upstream to New Lenox Road, we present the analysis of potential fishing trips for each segment of this stretch separately.

Woods Pond

Available Data

- The 1991 Deerfield study reports 1,485 fishing trips per year on the Deerfield River No. 2 development impoundment.
- Fig on the No. 2 impoundment occurs primarily by small carry-in boat.
- The No. 2 Deerfield River impoundment is approximately 64 acres in size.
- Woods Pond is approximately 50 acres in size.

---

[3] *Application for New License for Major Projects Existing Dams Greater than Five Megawatts, Deerfield River Project. FERC Project Number 2323,* Prepared by New England Power Company.

[4] *An Angler Survey and Economic Study of the Housatonic River Fishery Resource,* Timothy Barry, *State* of Connecticut, Department of Environmental Protection, Bureau of Fisheries, (1988).

Assumptions

- We assume that Woods Pond would have been actively fished after 1980, had the Housatonic not been contaminated with elevated levels of PCBs. We therefore calculate lost trips along this stretch from 1980 forward.

- We assume that the 1991 Deerfield data reflect potential fishing rates from 1980 forward. Based on general fishing trends, we believe that this assumption may lead us to overestimate fishing trips from 1980 to 1990, and underestimate trips from 1992 forward.

Calculations

- Estimated fishing pressure per acre surface area for the Deerfield River No. 2 development impoundment:

  (1,485 fishing trips/year) / (64 acres) = 23.2 fishing trips/acre/year.

- Estimated number of potential fishing trips per year for Woods Pond:

  (23.2 fishing trips/acre/year)(50 acres) = 1,160 potential fishing trips per year.

- Present value of the estimated number of potential fishing trips to Woods Pond, from 1980 forward assuming *(i)* a 20-year recovery period, *(ii)* a SO-year recovery period, and ***(iii) no recovery*** (1996 values):[5, 6]

  (i) 42,501 potential present vahte fishing trips;

  (ii) 55,090 potential present value fishing trips;

  (iii) 63,910 potential present value fishing trips.

Areas of Uncertainty

- We assume that the Deertield River site is comparable to Woods Pond because of its size and the nature of the fishery. The Deerfield site only provides carry-in boat access, however, whereas Woods Pond has a boat launch and boats with electric motors are allowed. Because fishing on the Deertield site is conducted primarily by boat, and because of the greater boat access at Woods Pond. we might expect the fishing rate on Woods Pond to be greater than that seen on the Deertield River impoundment in the absence of elevated levels of PCBs.

---

[5] Throughout this appendix, reported present value fishing trips represent estimates of potential or actual trips over the time period of the scenario (in thii case, 1980-2016 for a 20-year recovery, 1980-2046 for a SO-year recovery. and 1980-on for no recovery).

[6] All present value calculations in thii appendix assume a three percent real discount rate.

- Access to the Deerfield No., 2 impoundment is limited to that available through the New England Power site. We therefore assume that the 1991 estimated fishing value captures' most anglers on this impoundment, If other access points are used, however, our analysis may underestimate the total number of fishing trips taken at this site, and thus underestimate the potential fishing trips on Woods Pond in the absence of elevated levels of PCBs.

New Lenox Road to Woods Pond

In the 1985/86 Connecticut angler survey, the authors subdivided the river into six homogenous sections based on the type of fishery supported. Sections 1 through 3 primarily support trout and smallmouth bass, section 4 supports smallmouth bass and miscellaneous pan and gamefish, and sections 5 and 6 (Lakes Lillinonah and Zoar, respectively) support large and smallmouth bass as well as miscellaneous pan and gamefish.

The 1985/86 study found that warm water fishing pressures were greatest on the downstream lakes. Because the lakes are comparable to the New Lenox Road-Woods Pond stretch in terms of species found and type of fishing conducted (primarily by boat), and because 'we believe that the New Lenox Road - Woods Pond stretch would produce a high quality fishery if not for the PCB contamination, we use data for the downstream lakes to model potential fishing rates for this area.[7]

[7] A 1992 survey, reported in *Methodology and Results* of the *Housatonic River* Creel *Survey*, prepared for the General Electric Company by ChemRisk, a division of McLaren/Hart (March 25, 1994), found that even with the current PCB levels, fishing pressure on the Massachusetts stretch of the Housatonic River is highest on the Woods Pond stretch of the river.

Available Data

- The 1985/86 Connecticut angler survey found the following fishing pressure on Lakes Lillinonab and Zoar:

Exhibit A-2 WARM WATER FISHING PRESSURE: Housatonic River, Connecticut		
River Section	**Fishing Pressure (angler days/year)**	**Surface Area (acres)**
Lake Lillinonah	12,097	1,900
Lake Zoar	6,456	1.018
Total:	18,553	2,918

- The stretch of the Housatonic from New Lenox Road to Woods Pond is approximately 4.5 miles in length, and has an average width of 150 to 200 feet.

Assumptions

- We assume that this area would have been actively fished after 1980, if the Housatonic had not been contaminated with elevated levels of PCBs. We therefore calculate lost trips along this stretch from 1980 forward.

- We assume that the 1985186 Connecticut data, reflect potential fishing rates from 1980 forward. Based on general fishing trends, this assumption may lead us to overestimate fishing trips from 1980 to 1985, and underestimate trips from 1986 to 1996.

Calculations

- To estimate the potential fishing pressure on this stretch, we. first calculate the average 1985/86 fishing pressure per acre surface area per year for Lakes Lillinonah and Zoar:

  (18.553 angler days/year) / (2,9 18 acres) = 6.4 angler days/acre/year.

  To estimate the total surface area of the New Lenox Road - Woods Pond stretch, we multiply the length of the stretch by its average width:

  (4.5 mi)(5,280 ft/mi)(175 feet)(1 acre/43,560 ft^2) = 95.5 acres.

- Estimated number of angler days per year for the New Lenox Road - Woods Pond stretch:

  (6.4 angler days/acre/year)(95.5 acres) = 611 angler days/year.

- Present value of the estimated number of potential fishing trips on the New Lenox Road - Woods Pond stretch, from 1980 forward, assuming *(i)* a 20-year recovery period, (ii) a SO-year recovery period, and (iii) no recovery (in 1996 values):

  (i) 22,386 potential present value fishing trips;

  (ii) 29,017 potential present value fishing trips;

  (iii) 33,663 potential present value fishing trips.

Areas of Uncertainty

- By using fishing pressure data for the Connecticut stretch of the Housatonic to estimate potential trips to the New Lenox Road - Woods Pond stretch (assuming no elevated PCB levels), we are using data from a contaminated river with public health advisories to estimate potential trips assuming no public health advisory. Because the Connecticut data do not capture the angling population that may avoid the river due to the PCBs, this analysis may underestimate the total number of potential fishing trips to the New Lenox Road - Woods Pond stretch of the river.

- Because we lack better data, we use data available for the Connecticut stretch of the Housatonic to model potential fishing pressures on the Massachusetts stretch General fishing rates in Connecticut may not, however, reflect fishing rates in Massachusetts. 'We do not know if this assumption leads us to underestimate or overestimate fishing pressure on the Massachusetts stretch of the Housatonic.

Total Potential Fishing Trips, New Lenox Road to Woods Pond Dam

- Estimated number of potential fishing trips on the New Lenox Road to Woods Pond Dam stretch, from 1980 forward assuming *(i)* a 20-year recovery period, (ii) a 50-year recovery period, and *(iii)* no recovery (1996 values):

  (i) (42,501 present value fishing trips) + (22,386 present value fishing trips = 64,887 potential present value fishing trips;

  (ii) (55,090 present value fishing trips) + (29,017 present value fishing trips) = 84,107 potential present value fishing trips;

  (iii) (63,910 present value fishing trips) + (33,663 present value fishing trips) = 97,573 potential present value fishing trips.

Actual Fishing Trips

To estimate the number of fishing trips lost due to PCBs on the New Lenox Road - Woods Pond stretch of the Housatooic, we must know not only the number of potential trips (if the river had not been contaminated with elevated levels of PCBs), but also the number of trips actually taken to this stretch of the river from 1980 forward.

The only fishing pressure data available for the Massachusetts stretch of the Housatonic were collected in 1992.[1] In this study, the authors subdivided the Massachusetts stretch of the river south of Pittsfield into two sections: the area between the Newell Street Bridge in Pittsfield and Woods Pond Dam (Section 1), and between Woods Pond Dam and the Connecticut border (Section 2). Although this report provides some data specific to Woods Pond, it does not provide data specific to the entire New Lenox Road to Woods Pond stretch To estimate the number of trips taken to this stretch, we therefore use the available Woods Pond data, and extrapolate from there,maining data fishing pressure for the stretch upstream of Woods Pond to the Decker boat launch.

The 1992 study provides the following information:

- In Section 1, the authors found the highest level of-fishing activity on the New Lenox Road-Woods Pond stretch. They also found no fishing activity in the Newell Street Bridge and Fred Garner Park areas.
- The authors estimated a total of 3,300 ± 732 angler hours on Section 1 (approximately 14 miles in length) between May and October of 1992. Of these hours, 926 ± 3 17 were spent on Woods Pond (defined as the area up to one mile upstream of the Woods Pond Dam).
- Based on angler interviews, the authors estimated an average fishing trip length for Section 1 of 2.7 hours.

[1] *Methodology and Results of the Housatonic River Creel Survey*, 1994.

Assumptions

- To estimate fishing pressure on the area not including Woods Pond (approximately 4.5 miles in length), we first subtract from the total number of Section 1 angler hours the number of hours specific to Woods Pond.

- The study reports that no anglers were seen in the Newell Street Bridge and Fred Garner Park areas. Because the authors do not specify the downstream point of the Fred Gamer Park area, we assume only that no fishing occurs between the Newell Street Bridge and Fred Garner Park (approximately 2 miles in length).

- To calculate the full length of Section 1 actively fished (not including Woods Pond), we subtract from the total length the distance between the Newell Street Bridge and Fred Garner Park, and the one mile defined as the Woods Pond area.

- To estimate fishing pressure per river mile for Section 1 (not including Woods Pond), we divide the total number of Section 1 angler hours (not including those specific to Woods Pond), by the number of river miles calculated above.

Calculations

- Estimated length of Section 1 actively fished (not including Woods Pond):

  (Total) - (Newell St. Bridge to Fred Garner Park) - (Woods Pond) =

  (14 miles) - (2 miles) - (1 mile) = 11 miles.

- Estimated number of Section 1 angler hours per year, not including those spent on Woods Pond:

  (3,300 hours/year) - (926 hours/year) = 2,374 angler hours/year.

- Estimated number of fishing trips per year on Section 1, not including those spent on Woods Pond:

  (2,374 fishing hours/year) / (2.7 hours/trip) = 879.3 fishing trips/year.

- Estimated number of fishing trips per year per river mile, Section.1 (not including Wood Pond):

  (879.3 fishing trips/year) / (11 miles) = 79.9 fishing trips/year/mile.

- Estimated number of fishing trips per year for the upper half of the New Lenox Road-Woods Pond stretch (area not including Woods Pond):

(79.9 fishing trips/year/mile)(4.5 miles) = 360 fishing trips/year.

- Estimated number of fishing trips per year on Woods Pond:

  (926 angler hours/year) / (2.7 hours/fishing trip) = 343 fishing trips/year.

- Total number of potential fishing trips per year on the New Lenox Road-Woods Pond stretch:

  (360 trips) + (343 trips) = 703 fishing trips per year.

- Present value of the estimated actual number of fishing trips per year taken to the New Lenox Road - Woods Pond stretch, from 1980 forward assuming *(i)* a 20-year recovery period, *(ii)* a SO-year recovery period, and *(iii)* no recovery (in 1996 values):

  (i) 25,757 actual present value fishing trips;

  (ii) 33,386 actual present value fishing nips;

  (iii) 38,732 actual present value fishing trips.

<u>Areas of Uncertainty</u>

- The only available fishing pressure data for the Massachusetts stretch of the Housatonic were collected in 1992. We therefore use these data to model the number of fishing trips taken to this stretch of the river from 1980 forward We believe, however, that very few fishing nips occurred during the first few years after the public became aware of the contamination, and that the number of trips increased over tune. Using the 1992 data therefore probably leads us to overestimate nips between 1980 and 1991, and may cause us to underestimate trips from 1993 forward.

Lost Fishing Trips

<u>Calculations</u>

- Total lost fishing trips on the New Lenox Road to Woods Pond stretch from 1980 forward (present values):

  (i) 20-year recovery ‘scenario: (64,887 potential fishing trips) - (25,757 actual fishing trips) = 39,130 lost fishing trips;

  (ii) 50-year recovery scenario: (84,107 potential fishing trips) - (33,386 actual fishing trips) = 50,721 lost fishing trips;

(iii) No recovery scenario: (97.573 potential fishing trips) - (38,732 actual fishing trips) = 58,841 lost fishing trips.

Thus, we estimate that a total of 39,000 to 59,000 present value fishing trips have been or will be lost as a result of PCB contamination of this stretch of the river.

Areas of Uncertainty

- Because the 1992 Housatonic River survey was conducted between May and October, the survey did not capture those anglers who fish in the early Spring or late Fall, or those who ice fish on Woods Pond.' While the Deerfield study was also conducted only during the summer, the Connecticut data used to estimate potential trips on the New Lenox Road to Wood Pond stretch were collected year round Because Lakes Liionah and Zoar support ice fishing, these trips were included in the estimated total number of trips per year to these areas. Because our estimate of potential trips captures those fishing year round, whereas our estimate of trips taken does not, we may overestimate the total number of lost trips on this stretch.

GLENDALE-HOUSATONIC STRETCH

The stretch of the river from Glendale (downstream of the Glendale Dam) to Housatonic includes high quality trout habitat that has been favorably compared to the Housatonic Trout Management Area (TMA) in Connecticut This section,' approximately 2.5 miles in length, includes one of the longer cool water stretches downstream of the confluence of the East and Southwest branches in Pittsfield, and currently supports a population of brown trout.[9]

There is currently little fishing on this stretch of the river, despite the available trout population, due to the PCB contamination of the *river.* If the river were not contaminated with PCBs, however, the state believes that it would stock and manage the upper 1.5 miles of this stretch as a catch and release fishery with the potential for a trophy trout fishery.[10, 11]

---

[9] This stretch nuts from the Glendale Dam to a first minor dam (approximately 1.5 miles downstream), and then down to a second dam (another mile downstream).

[10] The state would not stock the lower mile because it affords no access for a hatchery truck.

[11] Personal communication with Tom Keefe and Km Simmons of the Massachusetts Fisheries and Wildlife Division.

Analysis of Lost Fishing Trips

To estimate the number of lost fishing trips on this stretch from 1980 forward, we first estimate the number of baseline trips (i.e.,' trips that would have been taken to the site in the absence of elevated levels of PCBs), and subtract from this value the estimated actual number of trips taken to this stretch.

Potential Fishing Trips

To estimate the number of potential fishing trips on the Glendale to Housatonic stretch of the river, we assume that this stretch would have been managed as a put and take fishery from 1980 till 1987, after which it would have been managed as a catch and release fishery." The analysis of potential fishing trips is therefore divided into two parts, the first an estimate of potential put and take fishing trips from 1980 to 1987, and the second an estimate of potential catch and release fishing trips from 1988 forward.

Put and Take Fishing Trips

To estimate the total number of potential put and take fishing trips from 1980 to 1987 (based on the estimated number of trout stocked per year), we use data available for a 9.5 kilometer put and take stretch of the Farmington River in Connecticut. Below we discuss the available data and assumptions made for this analysis:

- In 1982 through 1984, the CT DEP collected fishing rate data for a 9.5 kilometer stretch of the Farmington River from Collinsville to Unionville, in northwestern Connecticut.[13] This study found the following:

  The CT DEP stocked approximately 261 adult trout per hectare surface area per year on this stretch of the Farmington River between 1982 and 1984.

  This study found an average of approximately 61 fishing trips per day in the spring, approximately 20 trips per day in the summer, and approximately eight trips per day in the fall.

  We estimate the total surface area of this stretch of the Farmington River based on its length (9.5 km) and average width (36 meters).

---

[12] In 1986, the Massachusetts Fisheries and Wildlife Division proposed catch and release areas on several rivers withii the state, many of which were instated after 1987. We therefore assume that without the PCB contamination. thii stretch of the Housatonic would have become a catch and release area in 1988.

[13] *Catch-and-Release Management of a Trout Stream Contaminated with PCBs*, Robert D. Orciari and Gerald H. Leonard, Connecticut Department of Environmental Protection, Inland Fisheries Division, 'North American Journal of Fisheries Management, 10:315-329, (1990).

For the Purposes of this study, spring was measured from the opening day of the fishing season, the third Saturday in April (approximately April 18th) to June 15th (59 days), summer fell from June 16th to Labor Day, (approximately September 5th. 82 days), and the fall fishing season lasted from the day after Labor Day (approximately September 6th) till October 31st (56 days).[14]

- The Massachusetts Fisheries and Wildlife Division stocks on average 500 to 1,000 trout per mile per year for a put and take trout fishery. We therefore assume that the Glendale - Housatonic stretch would have been stocked with 750 trout per year per mile, from 1980 to 1987.

- We assume that fishing pressure per stocked trout would have remained constant from 1980 to 1987 on both the Housatonic and Farmington Rivers.

Calculations

- To estimate the total number of fishing trips per year on the Farmington River stretch between 1982 and 1984, we multiply the number of trips per day per season, by the total number of days in each season:

  Spring: (61 fishing trips/day)(59 days) = 3,599 fishing trips.
  Summer: (20 fishing trips/day)(82 days) = 1,640 fishing trips.
  Fall: (8 fishing trips/day)(56 days) = 448 fishing trips.

  Total annual fishing trips: = 5,687 fishing trips/year.

- To estimate the total number of trout stocked per year on the Farmington River stretch, we first estimate the total surface area of this stretch, and then multiply this value by the stocking rate per surface area:

  (9500 m)(36 m)(1 hectare/10,000 m^2) = 34.2 hectares.

  (261 trout/hectare/year)(34.2 hectares) = 8,926 trout stocked/year.

[14] Personal communication with William Hyatt, Connecticut Department of Environmental Protection, Bureau of Fisheries.

- To estimate the fishing rate per stocked trout on the Farmington, we divide the estimated total number of **fishing** trips per year by the estimated **total** number of trout stocked per year:

(5,687 **fishing trips/year) / (8,926** trout stocked/year)
= 0.637 trips/trout stocked.

- Estimated number of trout that would have been stocked **per** year on the **Glendale - Housatonic stretch:**

(750 trout **stocked/mile/year)(1.5 miles) =** 1,125 trout stocked/year.

- Estimated number of potential put and take **fishing** trips per year on the. Glendale- **Housatonic stretch:**

(1,125 trout stocked/year)(0.637 trips/trout stocked) = 717 fishing trips/year.

- We then calculate the present value of the total number of potential put and take **fishing** trips between **1980** and 1987:

Exhibit A-3

Potential Put and Take Fishing Trips: Glendale to Housatonic, 1980-1987

Year	Trips	Present Value (1996)
1980	717	1,151
1981	717	1,117
1982	717	1,085
1983	717	I.053
1984	717	1,022
1985	717	992
1986	717	964
1987	717	936
Total Present Value:		**8320**

- Total potential put and take fishing trips on the Glendale - Housatonic stretch, 1980-1987 **(1996 values):**

8.3 19 potential present *value* put and take fishing trips.

002023

Areas of Uncertainty

- We assume that the Glendale - Housatonic stretch would have been stocked with 750 trout per mile per year. Ken Simmons, a cold water biologist for the state Fish and Wildlife Division, believes, however, that because of both the potential high quality and short length of this stretch, the annual stocking rate would have been close to 1,000 trout per mile. Thus, by assuming that only 750 trout would have been stocked per year per mile on this stretch, we may underestimate the potential number of put and take fishing trips for this stretch.

- By using Farmington River data we assume that this 9.5 km stretch is comparable to the Glendale - Housatonic stretch based on access, natural beauty, and the quality of trout habitat. This assumption may lead us to overestimate angling pressure on the Glendale - Housatonic stretch if any of these characteristics are of higher quality on the Farmington River stretch.

- Although we use Connecticut data to model potential Massachusetts fishing rates, general fishing trends in Connecticut may not reflect fishing trends in Massachusetts. We do not know if this may lead us to underestimate or overestimate of fishing pressure on the Massachusetts stretch of the Housatonic~

- We assume that fishing pressure per stocked trout would have remained constant from 1980 to 1987 on the Massachusetts stretch of the Housatonic River. We believe that this is a fair assumption based on the fact that Massachusetts fishing license sales have shown an approximately constant level of public interest in fishing throughout this time.

Catch and Release Fishing Trips

Because the Farmington River data only reflect potential put and take fishing rates, to estimate the potentialmunber of catch and release fishing nips on the Glendale/Housatonic stretch from 1988 forward we use the available catch and release fishing pressure data (angler per stocked river mile) for the Housatonic TMA in Connecticut. Below we discuss the available data and necessary assumptions for this analysis:

- The stretch of the TMA stocked with trout is approximately 9.5 kilometers in length (5.9 miles).[15]

- The following table outlines the available fishing pressure data for the Housatonic TMA:

---

[15] *Catch-and-Release Management of a Trout Stream Contaminated with PCBs (1990).*

Exhibit A-4

TROUT FISHING PRESSURE:
Housatonic TMA

Year	Fishing Trips
1981	3,200 ± 800
1982	6,100 ± 900
1983	5,700 ± 900
1984	3,500 ± 700
1985/1986	10,286

Note:

1981 through 1984 data are reported as fishing trips, whereas 1985/86 data. are reported as angler days. For our analysis we assume that these units are equivalent.

Trip estimates for 1981 through 1984 are considered conservative due to a flaw in the study sampling design.

1981 through 1984 data were only collected between the third Saturday in April through October 15th. The 1985/86 data, however, reflect year-round fishing pressure.

Because 1981 survey counts were not conducted on the opening day weekend or October 1st through 15th, the number of actual trips in 1981 was expanded by 12 percent based on extrapolations of the 1982 data.

Because TMA fishing pressure data are only available for 1981 through 1986, we assume that fishing pressures on this stretch remained at 1986 levels from that date forward.[16]

[16] Because fishing pressures are now high on the TMA, and because this pressure is limited by water releases from the upstream Falls River Dam, we assume that fishing pressure on this stretch would not be greater than that presently seen, even if the river were not contaminated with elevated levels of PCBs.

Calculations

- To estimate potential catch and release fishing pressure on the Glendale - Housatonic stretch from 1988 forward, we use the available 1985186 TMA data on stocking rates per mile:

  (10,286 fishing trips/5.9 miles stocked) = 1,743 fishing trips/mile stocked.

- Estimated number of potential catch and release fishing trips per year for the Glendale - Housatonic stretch:

  (1,743 trips/mile stocked/year)(1.5 mile stocked) = 2,615 fishing trips/year.

- Estimated present value number of potential catch and release fishing trips on the Glendale-Housatonic stretch, from 1988 forward, assuming *(i)* a 20-year recovery period, *(ii)* a SO-year recovery period, and *(iii)* no recovery (in 1996 values):

  (i) 65,471 potential present value catch and release fishing trips;'

  (ii) 93,849 potential present value catch and release fishing nips;

  (iii) 113,733 potential present value catch and release fishing nips.

To determine whether this estimate of potential catch and release rates (1,743 trips per river mile) reflects rates seen elsewhere in Massachusetts, we compared this value to observed fishing rates on a catch-and release stretch of the Deerfield River. A 1991 recreational study of the Deerfield River found approximately 1,353 trips per river mile on a 1.6 mile catch and release stretch" Although this value is lower than our estimate of potential fishing pressure on the Glendale - Housatonic stretch, the 1991 study may have underestimated total trips because counts were conducted only for those anglers parking at the access area, whereas some anglers park elsewhere.'* In addition, because the Glendale - Housatonic stretch has good access, and because the 'state fisheries department believes that it could provide higher quality trout fishing than the Deerfield stretch, using the Deerfield data may underestimate potential fishing rates on this stretch of the Housatonic.[19]

---

[17] Fishing data represent angler counts on the 1.6 mile stretch of the Deerfield River below the Fife Brook fishing access, north of Route 2, in Massachusetts.

[18] Personal communication with John Ragonese of the New England Power Company.

[19] Personal communication with Leo Daley of the Massachusetts Fisheries and Wildlife Division.

Areas of Uncertainty

- By using the TMA data to estimate fishing pressure on the Glendale - Housatonic stretch from 1988 forward, we assume that this Massachusetts stretch provides equally high quality trout fishing and access as the Connecticut TMA. This assumption may lead us to overestimate angling pressure on the Glendale - Housatonic stretch both because access is slightly more limited, the quality of trout fishing may be slightly lower, and the Connecticut angling population may, on average, fish more often than the Massachusetts angling population.

- We assume that TMA fishing pressure remained approximately stable from. 1986 forward. This assumption is based on comments from the CT DEP's western fishery manager who believes that current TMA fishing pressures are between 10,000 and 12,000 fishing trips per year.

Actual Fishing Trips

To estimate the number of fishing trips on the Glendale - Housatonic stretch lost from 1980 forward, we must estimate not only the number of potential fishing trips, but also the number of fishing trips actually taken during this period. To estimate the number of fishing trips actually taken to this stretch of the Housatonic from 1980 forward, we use the 1992 fishing pressure data for the Massachusetts stretch of the Housatonic from the Woods Pond Dam to the Connecticut border.

The 1992 Housatonic Creel Survey provides the following data for Section 2 of the river:

- The authors estimate a total of 3,535 ± 769 angler hours for Section 2 (approximately 43 miles in length) for May through October, 1992.[20]

- The authors estimate an average trip length of 3.0 hours.

Assumptions

- Because this source does not provide data specific to the Glendale-Housatonic stretch, we assume a constant fishing pressure along the entire 43 mile length of Section 2 to estimate fishing pressure on the 1.5 mile Glendale/Housatonic stretch.

[20] Of the 44 anglers interviewed on Section 2.22 were specifically targeting trout and Ii were targeting bass. We therefore assume that these anglers represent anglers targeting the natural trout and bass populations on this stretch of the river.

Calculations

- Estimated number of fishing trips per year along Section 2 of the Housatonic River:

  (3,535 angler hours/year) / (3.0 hours/fishing trip) = 1,178 fishing trips/year.

- Estimated number of fishing trips per year per river mile along Section 2:

  (1,178 fishing trips/year) / (43 miles) = 27.4 fishing trips/year/mile.

- Estimated number of fishing trips per year on the Glendale-Housatonic stretch:

  (27.4 fishing trip/year/mile)(1.5 miles) = 41 fishing trips/year.

- Estimated present value actual fishing trips on the Glendale-Housatonic stretch between 1980 to 1986, and from 1987 forward (in 1996 values):

  1980-1987: 476 actual present value fishing trips.

  1988 forward:

  (i) 20-year recovery scenario: 1,026 actual present value fishing trips;

  (ii) 50-year recovery scenario: 1,471 actual present value fishing trips;

  (iii) No recovery scenario: 1,783 actual present value fishing trips.

Areas of Uncertainty

- We believe that current fishing pressure on the Glendale-Housatonic stretch is higher than the estimated value of 41 fishing trips per year. By assuming that the fishing pressure is constant throughout the 43 mile stretch of Section 2, we may underestimate fishing, rates on the Glendale-Housatonic stretch, which we expect to be higher than average due to the quality of trout fishing available. The 1992. survey found, however, that the highest level of activity along Section 2 occurs between the Woods Pond and Glendale Dams, which lie upstream of the Glendale-Housatonic stretch.

Lost Fishing Trips

- Estimated lost fishing trips, 1980 to 1987 (1996 values):

  (8,319 potential trips).- (476 actual trips) = 7,843 lost fishing trips.

- Estimated present value lost fishing trips, 1988 forward (1996 values):

(i) **20-year recovery scenario: (65,471** potential trips) - (1,026 actual trips) = 64,445 lost fishing trips;-

(ii) **50-year** recovery scenario (93,849 potential trips) - (1,471 actual trips) = 92,378 **lost** fishing trips;

(iii) No recovery scenario: (113,733 potential trips) - (1,783 actual trips) = 111,950 lost **fishing** trips.

Thus, we estimate that a total of approximately 72,00Q **to** 120,000 present value fishing trips have been or will be lost as a result of PCB contamination of this stretch of the river.

Areas of Uncertainty

- If the **Housatonic River were not contaminated, the state fisheries** department would assess **the** entire stretch of the river to determine its potential for a seasonal put and take trout fishery.” If other sections of the river were found to provide appropriate conditions, the state might stock more trout, and our estimate of lost trout **fishing** trips would be too low. However, we have only estimated lost trout fishing trips on the Glendale to Housatonic stretch of the river.

SHEFFIELD TO THE CONNECTICIJT BORDER

The stretch of the Housatonic River from Sheffield to the Connecticut border, which includes warm water reaches with constant meanders and **oxbows,** is a relatively popular warm water and ice fishing area. This stretch, which is approximately six miles in length and 225 to 250 feet wide, is accessible **from** both Routes 7 and **7a.**

Analysis of Lost Fishing Trips

Potential **Fishing** Trips

To estimate the number of potential fishing trips on this stretch of the river (if the river had not been contaminated with **PCBs),** we use **1985/86** fishing pressure data per surface area for the warm water stretches of the Connecticut Housatonic. Because this stretch is considered a fairly high quality warm water fishing area, we use data for Lakes Lillmonah and **Zoar** to model potential fishing pressure on this stretch of the river.

---

[21] **Personal** communication **with Ken Simmons of the Massachusetts Fisheries and Wildlife Division.**

In our analysis of lost fishing trips on the New Lenox Road-Woods Pond stretch (see above), we estimate that 6.4 fishing trips are taken per acre per year on Lakes Lillinonah and Zoar. To estimate the number of potential fishing trips per year for the Sheffield area, we must first estimate the total surface area of this stretch, then multiply this value by the Connecticut fishing pressure value per acre.

- We estimate the total surface area of the Sheffield stretch by multiplying its-length by its average width:

  Total Surface Area = (6 mi)(5280 ft/mi)(238 ft) (1 acre/43,560 ft^2) = 173 acres.

- Estimated number of potential fishing trips per year on the Sheffield area:

  (6.4 fishing trips/acre/year)(173 acres) = 1,107 fishing t&s/year.

- Present value potential fishing trips per year on this stretch of the river, from 1980 forward, assuming *(i)* a 20-year recovery scenario, *(ii)* a 50-year recovery scenario, and *(iii)* no recovery (in 1996 values):

  (i) 40,559 potential fishing trips;

  (ii) 52,573 potential fishing trips;

  (iii) 60,990 potential fishing trips.

Actual Fishing Trips

To estimate the number of lost fishing trips on this stretch of the river from 1980 forward, we must estimate not only the number of potential fishing nips, but also the number of trips actually taken to this stretch during this time. To estimate the number of fishing trips taken to the Sheffield-Connecticut border stretch of the river, we use the available 1992 data for Section 2 of the river (Woods Pond Dam to the Connecticut border).

In constructing our estimate of lost fishing trips on the Glendale-Housatonic stretch (see above), we estimate that 27.4 fishing trips occur per river mile per year on Section 2.

- To estimate the number of fishing trips that occur per year on the Sheffield-Connecticut border stretch (approximately 6 miles), we multiply this pressure estimate by the length of this stretch:

  (27.4 fishing trips/year/mile)(6 miles) = 164 fishing trips/year.

002035

- Present value of the estimated total number of fishing trips from 1980 forward (in 1996 values), assuming *(i)* a 20-year recovery scenario, *(ii)* a 50-year recovery scenario, and (iii) a no recovery *scenario:*

  (i) 6,009 actual fishing trips.

  (ii) 7,789 actual fishing trips.

  (iii) 9,036 actual fishing trips.

Lost Fishing Trips

- Total present value number of fishing trips on the Sheffield to Connecticut border stretch lost from 1980 forward (1996 values):

  (i) Assuming 20-year recovery: (40,559 potential fishing trips) - (6,009 actual fishing trips) = 34,550 lost fishing trips;

  (ii) Assuming SO-year recovery (52,573 potential fishing trips - (7,789 actual fishing trips = 44,784 lost fishing trips;

  (iii) Assuming no recovery: (60,999 potential fishing trips) - (9,036 actual fishing trips) = 5 1,953 lost fishing trips.

Thus, we estimate that a total f approximately 34,000 to 52,000 present value fishing trips have been or will be lost as a result of PCB contamination of this stretch of the river.

REMAINING STRETCHES

The remaining stretches of the river from the GE facility in Pittsfield to the Connecticut border include primarily warm, slow-moving water. These stretches include the areas between the Newell Street Bridge in Pittsfield and the Decker boat launch at New Lenox Road (approximately nine miles in length), the Woods Pond Dam to the Glendale Dam (approximately 13 miles in length), and the railroad trestle north of Housatonic to Sheffield (approximately 16 miles in length), a total of approximately 38 river miles. However, a 1992 survey found no fishing activity in the two mile stretch between the Newell Street Bridge and Fred Gamer Park; therefore, our calculations cover *a* distance of appmximately 36 river miles. To estimate the number of potential tips (if the river had not been contaminated with elevated levels of PCBs), we assume that these stretches would have been unstocked, but would support sufficient natural populations of bass and panfish to, generate a moderate level of fishing activity.

Potential Fishing Trips

Because we do not believe that these stretches of the river would provide as high quality warm water fishing as that available in the Woods Pond or Sheffteld area, we do not use fishing pressure data for Lakes Lillinonah and Zoar to estimate potential fishing rates in these areas. Instead, we use data for section 4 (from the Route 341 bridge to New Milford), the only other primarily warm water fishing stretch in Connecticut. The 1985/86 study found an average of 1,890 fishing trips per year on this stretch, which is approximately 27 kilometers in length (16.8. miles).

Calculations

- Estimated fishing pressure per river mile for the Route 341 to New Milford stretch:

  (1,890 fishing nips/year) / (16.8 miles) = 113 fishing trips/year/mile.

- Estimated number of potential fisbing trips per year, remaining stretches of the river:

  (113 fishing trips/year/mile)(36 miles) = 4,068 fishing nips/year.

- Present value estimated potential fishing trips along these stretches of the river, from 1980 forward assuming *(i)* a 20-year recovery scenario, *(ii)* a 50-year recovery scenario, and *(iii)* no, recovery (in 1996 values):

  (i) 149,048 potential fishing trips;

  (ii) 193,195 potential fishing trips;

  (iii) 224,126 potential fishing trips.

Actual Fishing Trips

To estimate the total number of fishing trips taken to these stretches of the river from 1980 forward, we use the available 1992 data. To estimate the actual fishing pressure on the stretch from the Newell Street Bridge to the Decker boat launch we use 1992 Section 1 data, and to estimate fishing pressure for the Woods Pond to Glendale and Housatonic to Sheffield stretches we use the 1992 Section 2 data.

The 1992 survey found no fishing activity between the Newell Street Bridge and Fred Garner Park (approximately two miles in length); therefore we will only estimate fishing trips for the section between Fred Garner Park and the Decker boat launch (approximately seven miles in length).

002037

In our-analysis of lost fishing trips in the Woods Pond area (see above), we estimate that 79.9 fishing trips occur per year per river mile on Section 1 (not including trips spent on Woods Pond): To estimate the total number of fishing trips actually ***taken*** per year on the Fred Garner Park-Decker boat launch stretch, we multiply this value by the length of this stretch:

(79.9 fishing trips/year/mile)(7 miles) = 559 fishing trips/year.

In the analysis of lost fishing 'trips for-the Glendale-Housatonic stretch (see above), we estimate 27.4 fishing trips per year per mile on Section 2 of the river.

- To estimate the number of fishing trips actually taken on the Woods Pond-Glendale stretch (13 miles), and the Housatonic-Sheffield stretch (16 miles), we multiply this fishing pressure value by the total length (29 miles):

  (27.4 fishing trips/year/mile)(29 miles) = 795 fishing trips/year.

- Total number of fishing trips actually taken per year:

  (559 fishing trips/year) + (795 fishing trips/year) = 1,354 fishing trips/year.

- Present value fishing trips actually taken to these stretches, from 1980 forward (in 1996 values), assuming *(i)* a 20-year recovery scenario, *(ii)* a SO-year recovery scenario, and *(iii)* no recovery.

  (i) 49,609 actual fishing trips;

  (ii) 64,303 actual fishing trips;

  (iii) 74,599 actual ***fishing*** trips.

Lost Fishing Trips

- To estimate the number of lost fishing trips on these stretches of the river from 1980 forward, we subtract the number of trips actually taken from the potential number of fishing trips (1996 values):

  (i) **20-year *recovery* scenario:** (149,048 potential fishing trips) - (49,609 actual fishing trips) = 99,439 lost fishing trips;

  (ii) **50-year** recovery scenario: (193,195 potential fishing trips) - ***(64,303*** actual fishing trips) = 128,892 lost fishing trips;

(iii) No recovery scenario: (224,126 potential fishing trips) • (74,599 -a&al fishing trips) = 149,527 lost fishing trips.

Thus, approximately 100,000 to 150,000 present value fishing trips have been or will be lost along this stretch of the river.

Appendix B: Recreational Fishing in Connecticut

CALCULATION OF LOST OR DIMINISHED RECREATIONAL FISHING TRIPS IN CONNECTICUT

Appendix B: Recreational Fishing in Connecticut

CALCULATION OF LOST OR DIMINISHED RECREATIONAL FISHING TRIPS IN CONNECTICUT

INTRODUCTION

The following analysis estimates the effects of elevated levels of PCBs on recreational fishing on the Housatonic River in the state of Connecticut Elevated levels of PCBs are present from the Massachusetts border south to Stevenson Dam at the foot of Lake Zoar (see Exhibit B-1). In this analysis we address lost fishing trips and fishing trips with reduced enjoyment for trout anglers in the Housatonic Trout Management Area (TMA) and anglers on the warm water stretches of the river (south of the Route 341 bridge). We also address lost fishing trips due to the state's decision ~~not~~ to establish a walleye fishery on the New Milford stretch of the Housatonic. For this analysis, we use three scenarios to bound potential future losses due to the PCB contamination. These include a 20-year recovery period (from 1996 forward), which assumes that the sources of PCBs are controlled such that fish consumption advisories related to PCBs are lifted; a SO-year recovery period, which assumes that clean-up and source control are less intensive and a longer period of time is required before advisories can be lifted; and no recovery, which assumes no clean up or source control of the PCB contamination in the Housatonic. This analysis has been completed for settlement and case management purposes only, and is based on existing data. Our analysis could be refined through primary data collection and analysis designed to examine the specific responses of Connecticut anglers to contamination of the Housatonic River.

TROUT MANAGEMENT AREA

Prior to the time when the state became aware of the PCB contamination of the Housatonic River,. the Connecticut Department of Environmental Protection (CT DEP) managed a seven mile stretch of the Housatonic as a put and take fishery, stocking approximately 21,500 trout per year. In the following three years the state reduced and then canceled stocking in response to public health concerns due to the PCBs.[1] In 1981. however, in order to maintain the fishery, the state established a Trout Management Area with catch and release fishing only.

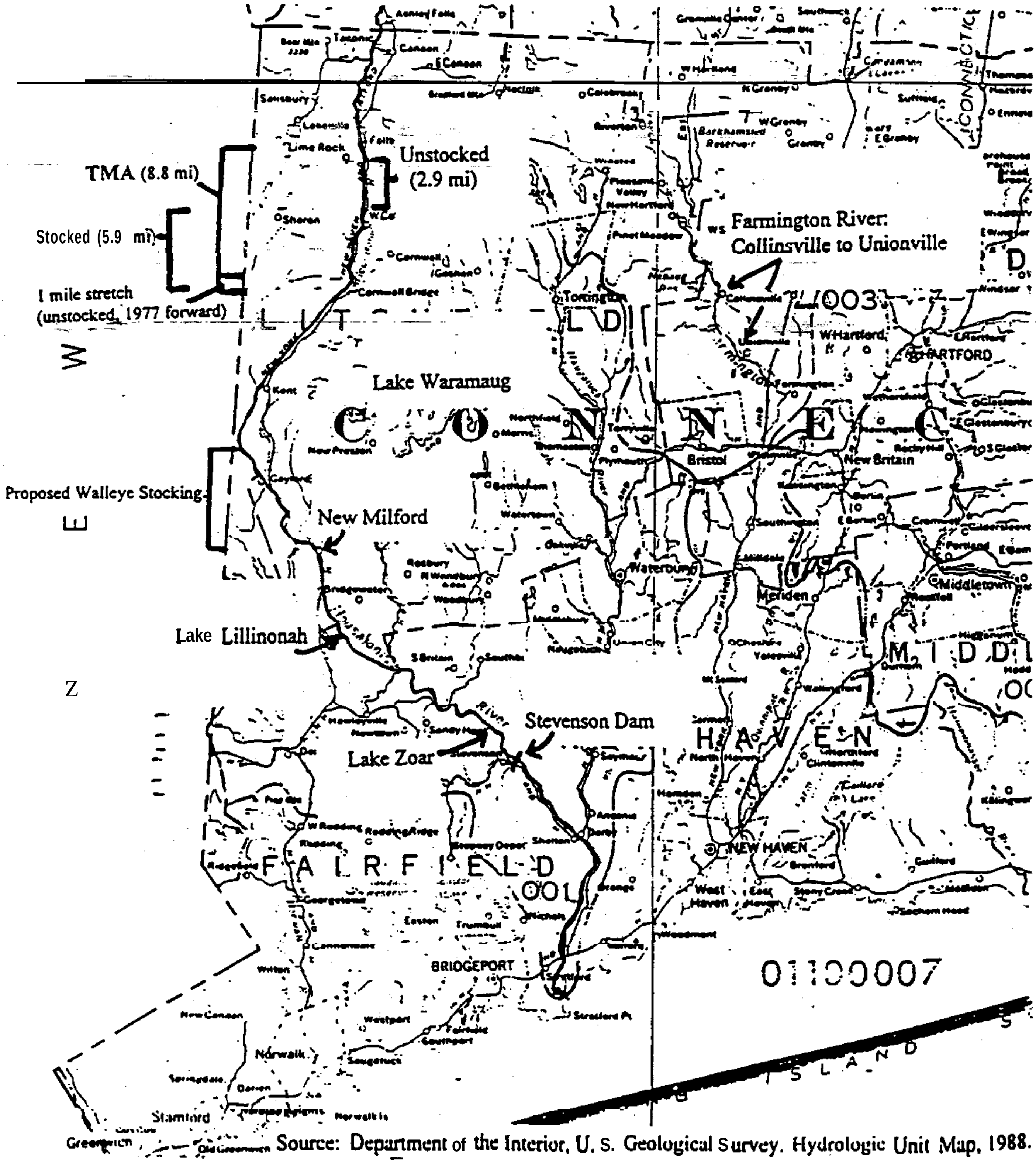
With the establishment of the Housatonic TMA, the nature of the Housatonic trout fishery changed. During the first year of catch and release management, bait fishing was banned and only single hook lures were allowed. Although these restrictions were lifted in 1982, the

[1] *Catch-and-Release Management of a Trout Stream Contaminated with PCBs*, Robert D. Orciari and Gerald H. Leonard, Connecticut Department of Environmental Protection, Inland Fisheries Division, North American Journal of Fisheries *Management*, 10:315-329, (1990).

002041

Exhibit B-l

HOUSATONIC RIVER, CONNECTICUT



Source: Department of the Interior, U. S. Geological Survey. Hydrologic Unit Map, 1988.

002042

number of bait and lure anglers has not recovered to the pm-1981 levels.' This' may be in part because these anglers were intent on keeping and potentially consuming their catch, and that they therefore left the Housatonic for uncontaminated water bodies or put and take trout fisheries.

To assess the effects of the PCB contamination on the Housatonic trout fishery, we estimate the number of fishing nips that we believe would have been taken to this stretch of the river if it had not been contaminated with elevated levels of PCBs, and compare this estimate to the number of trips actually taken to this stretch during this period.

Analysis of Lost Fishing Trips

To estimate the number of lost fishing trips due to the PCB contamination on the seven mi!e stretch of the Housatonic River that had been managed as a put and take fishery, we make the following assumptions concerning the management of the fishery. Assuming that the river had not been contaminated with elevated levels of PCBs, we believe that this stretch would have remained a put and take fishery (with similar stocking levels) until 1987, at which point we believe that it would have become a catch and release fishery? Without the PCB contamination, the state might have established catch and release management only on the -fly fishing area, which makes up the lower three miles of the current TMA.[4] For this analysis, however, we assume that the entire seven mile stretch would have become a catch and release area in 1987. To estimate the number of lost fishing trips on this stretch of the river, we estimate both the number of potential fishing trips, assuming that the river had not been contaminated with elevated levels of PCBs, and the total number of trips actually taken to tbis stretch during this time.

Potential Fishing Trips

To estimate the number of potential fishing trips per year on this seven mile stretch of the Housatonic, we assume that the stretch would have been managed as a put and take fishery until 1987, after which we assume that it would have been managed as a catch and release fishery. Tbis analysis is therefore divided into two sections, the first an estimate of potential put and take fishing trips from 1978 to 1986, and the second an estimate of potential catch and release fishing nips from 1987 forward.

---

[2] Personal communication with Ed Kluck, former president of the Housatonic Fly Fishing Association.

[3] In 1987. the CT DEP established a trout management area on the Farmington River, a similarly popular, but uncontaminated, trout fishery. We therefore assume that the TMA stretch of the Housatonic would have become a catch and release fishery at thii time rather than in 1981, if the river were not contaminated with PCBs.

[4] Personal communication with Robert Orciari and Timothy Barry, CT DEP. Bureau of Fisheries.

Put and Take Fishing Trips

Because we lack fishing pressure data for the TMA of the Housatonic River prior to 1976, the year when the public first became aware of the PCB contamination, we cannot use data specific to the Housatonic to estimate the number of potential put and take fishing trips on this stretch of the river.[5] We instead use put and take fishing pressure data for a stretch of the Farmington River, another popular trout stream in Connecticut, which is not subject to any health advisories.

Below we discuss the data available and assumptions made to estimate potential put and take fishing rates on the Housatonic River between 1978 and 1986, using Farmington River pressure data:

- From 1982 through 1984, the CT DEP collected fishing rate data for a 5.9 mile (9.5 kilometer) stretch of the Farmington River from Colliiville to Unionville, in northwestern Connecticut.[6]

  The CT DEP stocked approximately 261 adult trout per hectare surface area' per year on this stretch of the Farmington River between 1982 and 1984.

  This study found an average of approximately 61 fishing nips per day in the spring, approximately 20 trips per day in the summer, and approximately eight trips per day in the fall.

  We estimate the total surface area of this stretch of the Farmington River based on its length (5.9 miles, 9.5 km) and average width (36 meters).

  For the purposes of this study, spring was measured from the opening day of the fishing season, the third Saturday in April (approximately April 18th) to June 15th (59 days), summer fell from June 16th to Labor Day, (approximately September 5th, 82 days), and the fall fishing season lasted from the day after Labor Day (approximately September 6th) till October 3 1st (56 days).[7]

---

[5] *In 1976,* the CT DEP collected 1975 fishing pressure data for Connecticut licensed anglers; however. data specific to the Housatonic River are not available. In addition, in 1976/77, the CT DEP collected fishing diaries kept by members of the Housatonic Fly Fiibiig Association (HFFA). Although this source provides fishing pressure information, the data are not representative of the general angling population because the HFFA is made up of only fly fishermen and because they are on average both avid and experienced anglers. These data were also collected for years when the public was already aware of the PCB contamination.

'h-and-Release Management of a Trout Stream Contaminated with PCBs, (1990).

[7] Personal communication with William Hyatt, CT DEP Bureau of Fisheries.

G0204

- In 1977, prior to management changes due to the PCB contamination, the CT DEP stocked 21,500 adult trout (10 to 12 inches) in the seven mile stretch of the Housatonic River between Cornwall and West Cornwall.* We assume that stocking rates would have remained at this level until the management change in 1987.

- We assume that fishing pressure per stocked trout would have remained constant from 1978 to 1986 on both the Farmington and Housatonic Rivers.

Calculations

- To estimate the total number of fishing trips per year on the reference stretch of the Farmington River between 1982 and 1984, we multiply the number of trips per day per season by the total number of days in each season:

Spring: (61 fishing trips/day)(59 days) = 3,599 fishing trips.
Summer: (20 fishing trips/day)(82 days) = 1,640 fishing trips.
Fall: (8 fishing trips/day)(56 days) = 448 fishing trips.

Total: 5,687 fishing trips/year.

- To estimate the total number of trout stocked per year on the reference stretch of the Farmington River, we first estimate the total surface area of this stretch, and then multiply this value by the stocking rate per surface area:

(9500 mj(36 m)(l hectare/10,000 m^2) = 34.2 hectares.

(261 trout/hectare/year)(34.2 hectares) = 8,926 trout stocked/year.

- To estimate the fishing rate per stocked trout on the Farmington, we divide the estimated total number of fishing trips per year by the estimated total number of trout stocked per year:

(5,687 fishing trips/year) / (8,926 trout stocked/year)
= 0.637 trips/trout stocked.

[1] *Fisheries Management of the Housatonic River, 1981-1995; Salisbury to Kent, Synopsis*, Prepared for the Upper Housatonic River Working Group, Bob Orciari, Connecticut Department of Environmental Protection, Fisheries Division, 1996.

- Thus, the number of potential put and take fishing trips per year in the Housatonic TMA, assuming that the river had not been contaminated with PCBs, is estimated to he:

  (21,500 trout stocked/year)(0.637 trips/trout stocked)
  = 13,696 fishing trips/year.

- To estimate the total number of present value potential put and take fishing trips on the Housatonic TMA between 1978 and, 1986, we calculate the present value of each year's trips (in 1996 values):

Exhibit E-2

Potential Put and Take Fishing Trips: Housatonic TMA, 19184986

Year	Trips per Year: Trips	Trips per Year: Present Value (1996)
1978	13,696	23,317
1979	13,696	22,637
1980	13,696	21,978
1981	13,696	21,338
1982	13,696	20,716
1983	13,696	20,113
1984	13,696	19,527
1985	13,696	18,958
1986	13,696	18,406
Total Present Value:		186,990

- Total estimated present value number of potential put and take fishing trips for the seven utile stretch of the Housatonic River. **1978-1986 (1996** values): 186,991.

Areas of Uncertainty

- By assuming that the fishing pressure per **stocked trout on the reference** stretch of the Farmington River would be approximately equal to that of the Housatonic TMA (if the Housatonic were not' contaminated with elevated levels of PCBs), we assume that all other characteristics such as water quality, trout habitat, and access are approximately equal for these two stretches. If the Farmington provides better trout conditions and/or

[9] **All present value calculations in thii appendix assume a three percent discount rate.**

access, however, we may be overestimating the potential put and take fishing pressure per stocked trout on the Housatonic TMA, and therefore the number of potential fishing trips.

- We assume that fishing pressure per stocked trout would have remained constant from 1978 to 1986 on both the Farmington and Housatonic Rivers; Because state-wide fishing trends have shown an increased number of anglers and angler days per year over the last twenty years, this assumption may underestimate the total number of baseline trips.

- The fishing pressure data for the Farmington River used in this analysis were collected between 1982 and 1984, after the establishment of the Housatonic TMA in response to the PCB contamination. It is therefore possible that the angling population counted on the Farmington River includes anglers that may have left the Housatonic due to either the PCB contamination or the catch and release management regime. we-may therefore overestimate the potential fishing pressure per stocked trout on the Housatonic TMA in the absence of elevated levels of PCBs.

Catch and Release Fishing Trips

To estimate the number of potential fishing trips to the seven mile stretch of the Housatonic River if the river had not been contaminated with PCBs, we assume that this stretch would have become a catch and release fishery in 1987, based on similar management changes on uncontaminated rivers in the state. When establishing the Housatonic TMA in 1981, however, the CT DEP chose to manage only the stretch of the river between Routes 112 and 4, thereby excluding a one mile stretch (downstream of Route 4) which had -previously been stocked.” The current TMA instead includes 8.8 miles (14 kilometers), of which the upper 2.8 miles (4.5 km) do not provide good trout habitat. Only the lower 5.9 miles (9.5 kilometers) are therefore stocked with trout.”

The CT DEP chose to manage the stretch between Routes 112 and 4 because it is easily defined by the two road crossings. The state reasoned that if they included the one mile stretch downstream of Route 4, the TMA would lack a defined end, and anglers could potentially keep fish and argue that they were unaware that they were fishing in the TMA. Because of public health concerns due to the PCB contamination, the CT DEP decided not to stock this stretch of the river.

---

[10] *Catch-ad-Release Management of a Trout Stream Contaminated with PCBs, (1990).*

[11] Ibid.

002047

To estimate the effect of the PCB contamination on fishing rates on the seven mile stretch of the river, we must assess the effects on both the stretch which became the TMA, and the one mile stretch downstream of the TMA. Because fishing pressures are now high on the TMA, and because this pressure is limited by water releases from the upstream Falls River Dam, we assume that past fishing pressure on tbis stretch would not have been greater than that presently seen, even if the river had not been contaminated with PCBs. For the 5.9 mile stretch of the TMA, therefore, we assume that the resource fully recovered in 1987.

To estimate the number of lost fishing trips on the seven mile stretch of the Housatonic River from 1987 forward, we therefore only evaluate the number of potential trips on the one mile stretch downstream of the TMA. As discussed above, we estimate losses for three scenarios: a 20-year recovery period, a SO-yearrecovery period, and no future resource recovery. Below we list the available data and assumptions used to estimate these values:

- In 1985-86, the CT DEP conducted an economic and creel survey of the Housatonic River from the Massachusetts border to Stevenson Dam.[12] For this study, the river was subdivided into six sections, of which section 2 represents the TMA. Estimates for 1985 and 1986 show 10,286 *angler days* per year on the TMA.

- Although fishing pressure data for the Housatonic TMA have not been collected since 1986, CT DEP fisheries managers believes that the fishing pressure on the TMA has stabilized at a level between 10,000 and 12,000 fishing trips per year.

- We assume that fishing pressures on the one mile stretch downstream of the current TMA from 1987 forward would reflect those seen on the TMA. For this analysis we therefore use the available 1985/86 fishing pressure data (calculated per mile) for the TMA.

Calculations

- To estimate potential catch and release fishing pressure from 1987 forward on the one mile stretch downstream of the TMA, we use the 1985/86 TMA fishing pressure data (expressed as anglers/mile stocked):"

  (10,286 trips/5.9 miles stocked) = 1,743 fishing trips/mile stocked.

---

[12] *An Angler Survey and Economic Study of the Housatonic River Fishery Resource.* Timothy Barry, State of Connecticut, Department of Environmental Protection, Bureau of Fisheries, (1988). [This study will be referred to as the "1985/86 Connecticut economic and creel survey."]

[13] Data in the 1985/86 economic and creel survey of the Housatonic River are reported as angler days rather than fishing trips. Angler days are defined as a fishing trip completed in the morning and/or evening. For this analysis. we will assume that an angler day is equivalent to a fishing tip.

- Estimated number of potential catch and release fishing trips per year on this one mile stretch:

  (1,743 trips/mile stocked)(1 mile stocked/year) = 1,743 fishing trips/year

- Present value estimates of the number of potential fishing trips from 1987 forward, assuming (i) a 20-year recovery period, *(ii) a* 50-year *recovery* period, and (iii) no resource recovery (1996 values):[14]

  (i) 45,913 potential catch and release fishing trips;
  (ii) 64,829 potential catch and release fishing trips;
  (iii) 78,082 potential catch and release fishing trips.

Areas of Uncertainty

- By assuming that the potential fishing pressure on the one mile stretch downstream of the TMA would reflect that seen in the TMA, we assume that the natural quality of, and access to, this stretch is approximately equal to that found in the TMA. This may overestimate potential fishing pressure along this stretch because access is relatively limited.

Actual Fishing Trips

To estimate the number of lost fishing trips in the Housatonic TMA, we must estimate not only the number of potential fishing trips, but also the number of fishing trips taken to this stretch of the river during this time. The following post-1977 data are available for the Housatonic TMA:

- The CT DEP reduced stocking in the seven mile stretch of the Housatonic from the 1977 level (21,500 adult trout) to the following levels between *1978* and 1980:[15]

  1978: 6,000 adult trout
  1979: 12,000 adult trout
  1980: 0 adult trout

---

[14] Throughout this appendix, reported present value fishing trips represent estimates of potential or actual trips over the time period of the scenario (in this case 1987-2016 for a 20-year recovery, 1987-2046 for a 50-year recovery and 1987-on for no recovery).

[15] *Anglers Face Trade-Off on Tainted Stream*, Laurie A. O'Neill, New York Times, February 8, 1981.

- In 1981 -through 1984, the CT DEP conducted an angler survey 'of the Housatonic TMA between the third Saturday in April and October 15th. The results show the following number of fishing trips per year:[16]

  1981: 3,200 ± 800 fishing tips"
  1982: 6,100 ± 900 fishing trips
  1983: 5,700 ± 900 fishing trips
  1984: 3,500 ± 700 fishing trips[18]

- The 1985/86 Connecticut economic and creel survey found 10,286 angler days per year in the TMA.

Assumptions

- We assume that the 5.9 miles of the river that became part of the TMA recovered fully in 1987.

- Because the one mile stretch downstream of the TMA was not stocked from 198 1 forward, we assume that no trips were taken to this stretch after this time.

Calculations

- Because we lack data for the number of trips taken to the Housatonid TMA between 1978 and 1980, we estimate the number of fishing trips using Farmington River fishing pressure estimates and known stocking rates:

  1978: (6,000 trout stocked)(0.637 trips/trout stocked) = 3,822 fishing trips.

  1979: (12,000 trout stocked)(0.637 trips/trout stocked) = 7,644 fishing trips.

  1980: (0 trout stocked)(0.637 trips/trout stocked) = 0 fishing trips.

[16] *Establishment and Evaluation of Two Trout Management Area on the Housatonic and Willimantic Rivers,* Robert Orciari and Charles Phillips, State of Connecticut, Department of Environmental Protection, Bureau of Fisheries, (1986). Trip estimates are considered conservative (i.e., low) due to a flaw in the sampling design.

[17] Because survey counts were not conducted on the opening day weekend or October 1st-15th in 1981, values were expanded by l2 percent based on extrapolations of the 1982 data.

[18] Fiiig rates in 1984 were probably lower than those seen in 1982 and 1983 because of a major flood during late May through June of that year.

- To estimate the total number of actual nips taken to the Housatonic TMA area between 1978 and 1986, we calculate the present value of each years trips (in 1996 values):

Exhibit B-3

Actual Fishing Trips: Housatonic TMA Area, 1978-1984

Year	Trips per Year	
	Trips	Present Value (1996)
1978	3,822*	6,507
1979	7,644*	12,634
1980	0*	0
1981	3,200	4,985
1982	6,100	9,227
1983	5,700	8,371
1984	3,500	4,990
1985	10,286	14,238
1986	10,286	13,824
Total Present Value:		**74,776**

* Estimated values.

- Total estimated number of fishing trips taken to the Housatonic TMA, 1978-1986 (1996 values):

  74,776 actual fishing trips.

Areas of Uncertainty

- When calculating the number of trips taken to the seven mile stretch of the river, we assume that no trips were taken in 1980 because no trout were stocked. However there may have been trips targeted toward holdover trout from previous stockings. We may therefore underestimate the number of trips taken to this stretch in 1980.

Lost Fishing Trips

For 1978 through 1986, we have estimated both the number of potential put and take fishing nips and the number of trips actually taken to this stretch during this time. Because we assume that the 5.9 mile stretch of the TMA recovered in 1987, however, from-1987 forward we assume that only the one mile stretch downstream of the TMA was affected by the PCB contamination, Because no stocking occurredon this stretch during this time, we assume that no nips were taken and that all potential catch and release trips on this stretch were lost. To estimate the total number of lost trips on the seven mile stretch of the Housatonic, we therefore evaluate the number of lost trips from 1978 to 1986 (potential trips minus actual trips), and add this value to the number of lost fishing trips on the one mile stretch from 1987 forward.

Calculations

- Estimated number of present value lost fishing trips on the seven mile stretch of the Housatonic from 1978 to 1986, (1996 values):

  186,991 potential trips - 74,776 actual trips = 112,215 lost fishing trips.

- Estimated number of present value lost catch and release fishing trips on the one mile stretch downstream of the TMA, 1987 forward, assuming.(i) a 20-year recovery period, (ii) a SO-year recovery period, and (iii) no resource recovery (1996 values):

  (i) 45,913 lost catch and release fishing nips;
  (ii) 64,829 lost catch and release fishing trips;
  (iii) 78,082 lost catch and release fishing trips.

- Total number of present value lost trips on the seven mile stretch of the Housatonic, 1978 forward (1996 values):

  (i) 158,128 lost catch and release fishing trips;
  (ii) 177,044 lost catch and release fishing trips;
  (iii) 190,297 lost catch and release fishing nips.

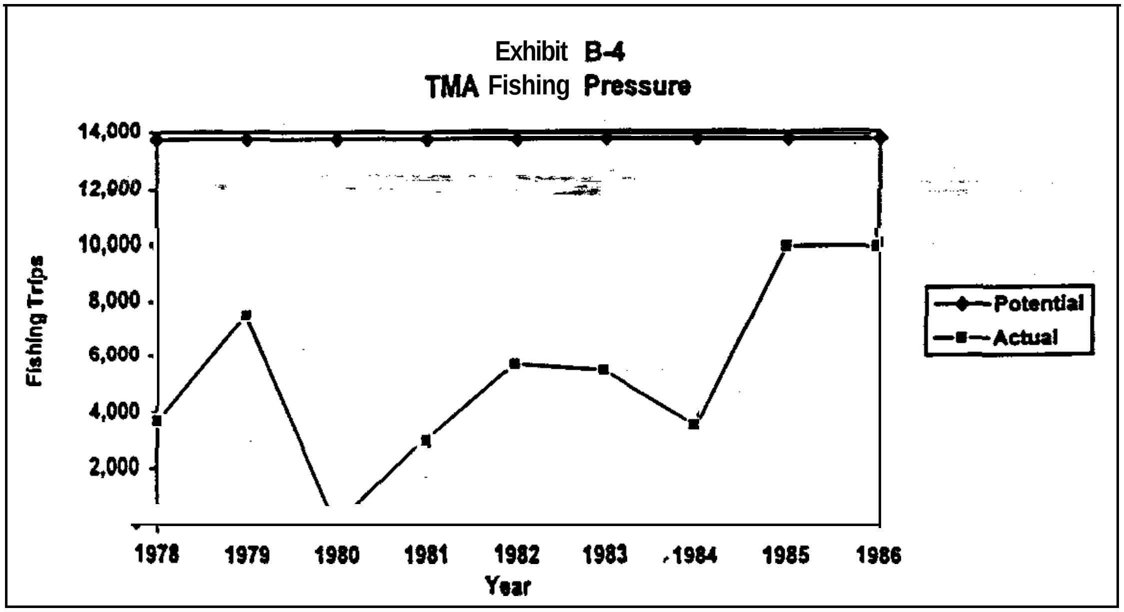
Areas of Uncertainty

- Because this analysis only evaluates lost trout fishing trips in the Housatonic TMA, it does not estimate lost trips among trout anglers on other segments of the river. Because no other areas are stocked with trout, however, trout angling pressure elsewhere is relatively low. We therefore assume that this analysis captures most of the effect on trout anglers on the Housatonic River in Connecticut.

- In this analysis, we assume lost fishing trips on this stretch of the river because stocking rates were reduced due to the PCB contamination. Trout which were not stocked in the Housatonic TMA, however, were stocked elsewhere around the state. The CT DEP fisheries managers believe, however, that the Connecticut angling population still suffered a loss because of the high value of a trip to the Housatonic TMA, due to the natural beauty and high quality trout habitat associated with this area.

They believe that this value is reflected in the willingness of Connecticut anglers to travel to the Housatonic TMA, even though it is located in a fairly remote section of the state.

- From 1981 forward, we assume no fishing trips were taken to the one mile downstream stretch, because this stretch was not stocked. There may, however, have been trips targeted toward trout that migrate out. of the TMA. We may therefore underestimate the number of trips taken, and therefore overestimate the number of trips lost on this stretch of the Housatonic.



Analysis of Diminished Enjoyment for Fishing Trips Taken

To estimate the number of fishing trips to the Housatonic TMA area with reduced enjoyment due to the PCB contamination, we assume that only those anglers who would prefer to consume their catch are affected. Because no data exist on the percentage of anglers on the Housatonic TMA who would prefer to consume their catch, we use the following assumptions to estimate the number of trips with reduced enjoyment in the Housatonic TMA:

002053

- The 1985/86 Connecticut economic and creel survey provides information on the percentage of anglers who consume their catch, based on fishing method and river section fished. This study found the following consumption rates for fly fishermen:[19]

  Section 1:[20] 25% (1 out of 4)
  Section 2: 4%[21]
  Section 3: 33% (2 out of 6)

  The small sample sizes for sections 1 and 3 reflect the scarcity of anglers along the unstocked areas surrounding the TMA.

- Because both trout and fly fishing rates are greater in section 1 than in section 3, we assume that the fish consumption rate in section 1 more closely reflects the potential consumption rate in the TMA. We therefore use the 1985/86 consumption rate data for Section 1 as an estimate of potential rates on the Housatonic TMA.

For this analysis we only estimate losses from 1981 to 1987, the years between the establishment of catch and release regulations on the Housatonic due to the PCB contamination, and the date when we believe that this stretch would have become catch and release without the contamination.

Calculations

- To estimate the number of fishing trips with reduced enjoyment, we first calculate the present value (1996) of the total number of fishing trips taken to the Housatonic TMA between 1981 and 1986:

[19] We use data specific to fly fishermen because the 1981-84 Housatonic TMA angler survey found that approximately 85 percent of all anglers on the Housatonic TMA fly fish. This may lead to an underestimate of consumption rates for TMA anglers, however, because consumption rates are greater among bait and lure fishermen. Note that the sample sizes of these surveys are quite small.

[20] The authors of the 1985/86 study subdivided the Housatonic (from the Massachusetts border to Stevenson Dam) into six homogenous segments based on the type of fishery supported. Section 1 runs from the state border to the Route 7 bridge. section 2 runs from Route 7 to the Route 4 bridge, and section 3 runs from the Route 4 bridge to the Route 341 bridge.

[21] The low consumption rate for section 2 anglers reflects the catch and release management of the TMA.

Exhibit B-5

Total **Fishing** Trips:
Housatonic **TMA,** 1981-1986

Year	Trips per Year	
	Trips	Present Value (1996)
1981	3,200	4,985
1982	6,100	9,227
1983	5,700	8,371
1984	3,500	4,990
1985	10,286	14,238
1986	10,286	13,824
Total Present Value:		**55,635**

- Estimated **number** of present value **fishing trips** to the Housatonic TMA with reduced enjoyment (1996 values):

(55,635 fishing **trips)(25%) =** 13,909 fishing trips.

Areas of Uncertainty

- This analysis assumes that only those anglers who prefer to consume their catch experience reduced enjoyment of their fishing nips due to the PCB contamination. We therefore assume that those anglers who prefer to release their catch place no additional value on fishing in **uncontaminated** waters. **This** assumption probably underestimates the total **number of** nips with reduced enjoyment for **those** anglers fishing the Housatonic **TMA.**

- For this analysis we use Housatonic angler consumption rates to estimate potential consumption rates for TMA anglers (if this segment were neither catch and **release** nor contaminated with **PCBs).** Consumption rates estimated for Housatonic anglers in **1985/86** do not, however, **capture** the percentage of anglers who may have **already** chosen not to consume their catch due to the **PCBs.** Thus, our analysis probably **underestimates** the number of anglers who **would prefer** to consume their catch, and therefore underestimates the total number of trips with reduced enjoyment for those fishing the Housatonic TMA.

- In this analysis, we use Section 1 measured consumption **rates** as an estimate of potential consumption rates among Housatonic **TMA** anglers (if this stretch were neither catch and release nor contaminated). Because of the. small survey sample size for this section (four individuals), however, this value may not be representative of the entire angling population, and we may therefore overestimate the percentage of anglers on the Housatonic who would prefer to consume their catch. A statewide survey on fishing behavior on 67 streams found, however, that on average 29 percent of all trout caught in put and take fisheries are released. Although this value represents the number of trout released and not the number of anglers who release their catch (and therefore do not plan to consume it), this value indicates that the percentage of anglers who do plan to keep and potentially consume their catch may be much higher than 25 percent.[22]

- In this analysis we estimate the number of fishing trips with reduced enjoyment by multiplying the consumption rate (which refers to anglers) with the number of fishing trips (which refers to angler days). We do not know, however, if anglers who consume their catch fish as frequently as the general angling population. Thus, we do not know if this assumption will lead us to over- or underestimate the total number of fishing trips with reduced enjoyment.

WARM WATER FISHING

The lower stretches of the Housatonic River, includii Lakes Lillinonah and Zoar, include slower-moving, warmer water than the upper stretches. Although no stocking occurs on these stretches, the river provides natural habitat for largemouth and smallmouth bass and miscellaneous panfish and gamefish. Since 1977 there has been a fish consumption advisory on all species in the Housatonic River, however, catch and release regulations have not been placed on these stretches of the river.[23] Below we discuss the number of lost fishing trips and the number of fishing trips with reduced enjoyment due to the PCB contamination, on the warm water stretches of the Housatonic.

Analysis of Lost Fishing Trips

To estimate the number of lost fishing trips on, the lower stretches of the river due to the PCB contamination, we must know both the number of trips taken to the river prior to, and after, 1976, the year when the public first became aware of the contamination. There are no data, however, on fishing pressure for these angling populations prior to 1985. In addition, because

[22] *Final Summary Survey Report*, N. T. Hagstrom, M. Humpherys, W. A. Hyatt, Connecticut Department of Environmental Protection, Bureau of Fisheries, in preparation.

[23] In approximately 1990. the consumption advisories were lifted for yellow perch downstream of Bulls Bridge, yellow perch and sunfish from Lakes Lillinonah and Zoar, and white perch from Lake Zoar.

the 1985 data will reflect any shift that may have occurred in fishing behavior due to public awareness of the PCB contamination; we have no means of using these data to model fishing rates prior to 1976.

Because we lack the necessary data for this analysis, we cannot quantitatively estimate the number of lost fishing trips for this angling population. We do, however, have the following information:

- ~~There is currently very little fishing~~ on Lakes Lillinonah and Zoar aside from that which occurs during bass fishing tournaments.[24]

- The two angling populations most greatly impacted by the PCB contamination are residents of the surrounding area and subsistence fishermen (primarily Vietnamese-American and Cambodian-American anglers from the surrounding cities). Fishing rates among lake residents used to be much higher. These subsistence anglers stopped fishing the Housatonic lakes in approximately 1993, when multilingual consumption warnings were posted in this area

Analysis of Diminished Enjoyment for Fishing Trips Taken

To estimate the number of fishing trips on the warm water stretches of the Housatonic with reduced enjoyment due to the PCB contamination, we assume that only those anglers who consume their catch are affected.

Assumptions

- For this analysis we calculate losses from 1977, the first year after the public became aware of the PCB contamination, forward.

- We only estimate losses for sections 4 through 6 of the Housatonic River.[25] The 1985/86 Connecticut economic and creel survey found that, on average, 48 and 50 percent of anglers on these sections target bass and panfish/gamefish, respectively. In addition, 66 and 33 percent use bait and lures, respectively. This population is therefore distinct from that fishing the TMA region, 95 percent of which target trout, and 90 percent of which use flies.

---

[24] Information on fishing trends and effects due to the PCB contamination were supplied by personal communication with Stuart Wilson of the Lake Zoar Authority, August 1, 1996.

[25] As defined in the 1985/86 Connecticut economic and creel survey, section 4 runs from the Route 341 bridge to New Milford, section 5 includes Lake Lillinonah (New Milford to the Shepaug Dam), and section 6 includes Lake Zoar (the Shepaug to the Stevenson Dam).

002057

- 'The only data available for fishing rates on regions of the Housatonic River outside of the TMA are for 1985.and 1986. For this analysis we assume that these data reflect fishing rates for 1977 forward. Based on overall fishing trends, this assumption probably leads us to overestimate fishing rates prior to 1985. and underestimate fishing rates from 1987 forward.

- The 1985/86 creel survey provides the following information on the percentag ;e of anglers consuming their catch, based on the river section fished and the type of fishing conducted:.

Section 4:	55% (bait)	30% (lure)
Section 5:	67% (bait)	22% (lure)
Section 6:	65% (bait)	15% (lure)

Calculations

- To estimate the number of fishing trips with reduced value on sections 4 through 6 of the Housatonic River, we first calculate the total number of fishing trips per year. The 1985/86 economic creel survey provides the following values for annual fishing trips:

Section 4:	1,426 (bait)	373 (lure)
section 5:	6,589 (bait)	5,508 (lure)
Section 6:	4,287 (bait)	2,169 (lure)

- To estimate the number of fishing trips with reduced enjoyment per river section per year, we multiply the total number of trips per section by the percentage of anglers (bait and lure) who consume their catch:

Section 4:

Bait: (1,426 fishing trips)(55% consume) = 784 fishing trips;
Lure: (373 fishing trips)(30% consume) = 112 fishing trips;

Section 5:

Bait: (6,589 fishing trips)(67% consume) = 4,415 fishing trips;
Lure: (5,508 fishing trips)(22% consume) = 1,212 fishing trips;

Section 6:

Bait: (4,287 fishing trips)(65% consume) = 2,787 fishing trips;
Lure: (2,169 fishing trips)(15% consume) = 325 fishing trips;

Total number of fishing trips with reduced enjoyment:

Bait: 7,986 fishing trips.
Lure: 1,649 fishing trips.

- To **estimate** the total number of present **value fishing** trips with reduced enjoyment, we calculate the **present value** of trips from 1977 forward. As discussed above, we estimate future losses under the following **three** recovery estimates: (i) a **20-year** recovery period, (ii) a **50-year** recovery period, and (iii) no resource-recovery (1996 values):

  (i) Bait: 333,398 fishing trips;
  Lure: 68,842 fishing trips;

  (ii) **Bait: 420,065 fishing trips;**
  Lure: 86,738 fishing trips;

  (iii) Bait: 480,787 **fishing** trips.
  Lure: 99,276 **fishing** trips.

<u>Areas of Uncertainty</u>

- Because this analysis only assesses losses to anglers in sections 4 through 6 of the river, we have not addressed losses to warm water **anglers** 'in sections 1 through 3 of the Housatonic. Our analysis therefore probably underestimates the number of trips **with** reduced enjoyment among the **Housatonic** warm water fishing population.

- This analysis **assumes** that only those anglers who consume their catch experience a reduced value in fishing due to the PCB contamination. We therefore assume that those anglers who prefer not to consume their catch place no value on fishing in uncomaminated waters. This assmnption probably underestimates the total reduction in value of fishing trips for those anglers fishing sections 4 through 6 of the Housatonic River.

- In this analysis we estimate the number of fishing trips with reduced enjoyment by multiplying the consumption rate (which refers to anglers) with the number of fishing trips (which refers to angler days). We do not know, however, if anglers who consume their catch fish as frequently as those who do not. Thus, we do not know if this assumption over- or underestimates the total number of angler **trips with** reduced enjoyment.

- To estimate the **number** of fishing trips with reduced enjoyment, we use data on consumption rates among Housatonic River anglers. This does not, however, reflect the number of anglers who have **already** chosen not to consume their catch because of the PCBs. Our method of estimating the number of trips with reduced enjoyment therefore probably underestimates the total number.

In March 1996 Connecticut issued a state-wide mercury warning for all freshwater fish. Under this warning, "high risk" individuals (pregnant women, nursing mothers, children) are advised to limit fish consumption from the-state's waters to one meal per month. Low-risk individuals (the rest of the population) are advised to liiit their consumption to one fish meal per week. These warnings are expected to remain in effect for at least another year. As a result, some individuals who currently do not consume their-catch from the Housatonic due to PCBs might not choose to do so even in the absence of PCBs. This advisory, however, is not as widely known as the PCB advisory, is not as severe, and has been in effect for only one year.

In order to test the sensitivity of our damage estimates to this factor, we calculate the number of present value trips with reduced enjoyment assuming no reduced enjoyment due solely to PCBs after 1995 (i.e., assuming trips with reduced enjoyment from 1977 to 1995). These results are summarized below. Note that we believe that these assumptions will lead us to severely understate the true number of reduced enjoyment trips.

Total number of present value trips with reduced enjoyment, 1977-1995:

Bait: 296,601 fishing nips
Lure: 42,660 fishing trips

WALLEYE FISHERY

In 1992, the Connecticut DEP conducted a scoping analysis to assess potential sites for a managed walleye fishery. The walleye is one of the most popular game fish in North America; however, prior to 1992 the state of Connecticut had no managed populations of this species. The purpose of the 1992 study was to establish four experimental walleye fisheries in Connecticut, with the intent of stocking four to eight more sites throughout the state if the managed walleye populations were found to survive. In their scoping analysis, CT DBP reviewed all potential Connecticut sites to assess which provided appropriate natural habitats and were underutilized.

One site found to be both underutilized and to provide appropriate conditions was the New Milford stretch of the Housatonic River.[26] This stretch of the river is not only underutilii by anglers, but also lies near several population centers and provides extensive shore and canoe access. Because of the attributes of the area, the CT DEP western fisheries manager believes that this site would have been included, not as one of the four initial experimental sites, but as one of the following stocking sites.[27] This is especially true because one of the state's choices for the

---

[26] *A Proposal to Establish and Assess Walleye Fisheries in Connecticut*, Robert D. Orciari, Connecticut Department of Environmental Protection, Bureau of Natural Resources (1992).

[27] Personal communication with Robert Orciari, CT DEP Bureau of Fisheries.

002000

experimental walleye-fisheries was Lake Waramaug, which drains directly into this stretch of the Housatonic. Since some walleye stocked in Lake Waramaug would stray into this stretch of the river, the CT DEP thought that they would probably stock walleye in this stretch of the Housatonic as well.

Given the PCB contamination of the river, however, and the fact that walleye are a taale fish, the state will not choose the Housatonic as a walleye fishery site.[28] Because the state has been limited in its management choices by the PCB contamination of the Housatonic River, we assume that the public lost the recreational opportunities that would. have been associated with a stocked walleye fishery in this stretch of the river.

Analysis of Lost Fishing Trips

In its scoping analysis of potential walleye fishery sites, the CT DEP stated that it was reasonable to expect a walleye fishery to generate greater than 10 angler trips per hectare of river stocked per year. The.CT DEP walleye proposal called for initial experimental stocking in 1993, to produce a catchable walleye population (greater than 15 inches) in 1996. Assuming that a second round of stocking would begin in 1996, and following the same three-year growth rate, we assume losses on tbis stretch of the Housatonic from 1999 forward.

To estimate the number of lost walleye fishing trips per year, we multiply the estimated number of angler trips per hectare, by the surface area of the proposed walleye fishery on the Housatonic River (155 hectares):

(155 hectares/year)(10 trips/hectare) = 1,550 lost trips/year.

Present value estimates of the number of potential walleye fishing trips from 1999 forward, assuming (*i*) a 20-year recovery period, (*ii*) a 50-year recovery period, and (iii) no resource recovery (1996 values):

(*i*) 20,094 potential present value walleye fishing trips;
(*ii*) 36,915 potential present value walleye fishing trips;
(*iii*) 48,700 potential present value walleye fishing trips.

---

[28] The location of hydroelectric dams on the Housatonic was also cited as a hindrance for walleye stocking on thii stretch of tbc river. Robert Orciari of the CT DEP Bureau of Fisheries believes, however. that PCBs were the main obstacle preventing the establishment of a walleye fishery, since hydroelectric dams can be accommodated for in managing a walleye population.

002061

Appendix C: Valuation of Lost and Diminished Trips

VALUATION OF LOST OR DIMINISHED RECREATIONAL FISHING TRIPS IN MASSACHUSETTS AND CONNECTICUT

Appendix C: Valuation of Lost and Diminished Trips

VALUATION OF LOST OR DIMINISHED RECREATIONAL FISHING TRIPS IN MASSACHUSETTS AND CONNECTICUT

Lost use damages reflect the difference in recreational use value of the Housatonic River fishery with and without contamination, measured as the difference in net economic value, or consumer surplus under these two states (Interior, l-387). In the case of the Housatonic River, the lost use value is associated with a reduction in the number of trips due to contamination; the dished use value is associated with a reduction in the value of trips that were taken as a result of the imposition of catch-and-release regulations and consumption advisories. Ideally, the net economic values assigned to these lost or diminished fishing trips would be based on studies of angler behavior at the Housatonic River or other comparable fisheries in the nearby area; however, such studies are beyond&e scope of this preliminary assessment. This analysis has been completed for settlement and case management purposes only, and is solely based on existing data.

While primary data collection and analysis has not been conducted for this case, the existing economic literature on recreational fishing provides a number of estimates of net economic value per fishing day that can be used as proxies for the value of a lost or diminished fishing trip on the Housatonic River. Because fishing management regimes and recreational values differ by species, we reviewed the literature addressing values for trout, warmwater and walleye angling activities. We did not consider studies that estimated the value of fishing tips in the western U.S., due to expected differences in the characteristics of these fishing experiences and the nature of the fishing experience at the Housatonic River. Exhibits C-l, C-2, and C-4 summarize trip values by species from the selected studies. The range in reported trip values reflects differences in such factors as fishing regulations, characteristics of surveyed anglers, availability of alternative sites, quality of the fishing experience, species sought, and methods used to derive these value estimates.

We calculate damages for the Connecticut and Massachusetts sections of the Housatonic River separately. For the Connecticut section of the river, we estimate $60 per lost put-and-take trout trip, $30 per lost catch-and-release trout trip, $30 per trout trip with reduced enjoyment, $15 per warmwater fishing trip with reduced enjoyment, and $75 per lost walleye trip. We apply these values to the estimated number of lost trips to yield total damage estimates ranging from approximately $16 to approximately $22 million, in 1996 dollars, depending on the recovery scenario used. For the Massachusetts section of the river we estimate lost trip values for warmwater species to be $15 per trip, catch-and-release tip values for trout to be $30, and put-and-take trip values for trout to be $60 per trip. We apply these values to the estimated number of lost trips to yield a total damage estimate ranging from approximately $5 million to approximately $8 million, in 1996 dollars, again varying based on the recovery scenario used.

The remainder of this appendix discusses the lost use values for trips to the Housatonic River and presents damage estimates associated with elevated levels of PCBs. First, for the Connecticut portion of the river, we estimate lost use damages associated with trout and walleye fisheries and dished use damages associated with trout and warmwater fisheries. Second, for the Massachusetts segment of the river, we estimate lost use damages associated with warmwater and trout fisheries. In the last section, we summarize the results of our analysis and discuss its liitations.

Connecticut

In the state of Connecticut, elevated levels of PCBs led state resource managers to alter fishery management practices. These management changes resulted in a reduction in the number of fishing trips taken to the Housatonic, and prohibited anglers from keeping their catch. In this section. we first discuss the lost use damages associated with trout and walleye fisheries. We then discuss diminished use damages associated with trout and warmwater fisheries.

Lost Use

Trout Values

We estimate two types of trip values for trout fishing damages at the Housatonic Trout Management Area (TMA). The first values put-and-take trips lost at the TMA due 'to the imposition of catch-and-release management. The second values the catch-and-release trips lost on the one mile stretch downstream from the TMA.

Put-and-Take

-As described in Appendix B, prior to public awareness of elevated levels of PCBs in the Housatonic River, the Connecticut Department of Environmental Protection (CT DEP) managed a seven mile stretch of the Housatonic as a put-and-take fishery. Between 1978 and 1981, the CT DEP reduced its stocking levels in the seven mile stretch of the Housatonic from 1977 levels. Thus, for three years, anglers experienced reduced and canceled trout stocking. In the subsequent six years (1981-1987), regulations restricted anglers from keeping their trout catch. To estimate the damages associated with the loss of the put-and-take fishery, we use the available trout fishing literature in Exhibit C-l to estimate a value of a lost put-and-take fishing trip. We reviewed this literature looking for site-specific trout studies which represent angler behavior at put-and-take fisheries. The studies including Connecticut anglers indicate trout fishing day values of $14 to $57. Of these, we focused on the more recent, high quality studies likely to involve limited fishery management. Recognizing the TMA to be an exceptional trout fishery in this region, we use the literature and professional judgment to estimate a $60 value per put-and-take trip at the TMA.

- This estimate is similar to the recent $57.27 estimate generated by Englin, Lambert, and Shaw (1989).[1] Englin, et al.'s study covers a broad range of sites in seven northeastern states with varying levels of regulation and fishing quality. Since some of the sites surveyed may have regulated catch or consumption, this value represents, at minimum, a value for a pm-and-take fishery.

- It is reasonable to assume this value is a lower bound for the value of a put-and-take trip to the TMA. Not all sites included in the Englii et al. study attain the high quality of the TMA. The Housatonic TMA is noted to be not only a world-class trout fishery, but also one of the five best trout fisheries in the country.[2] Excluding these lower quality sites from the Englin study would produce a trip value greater than the-estimated $57.27 per trip.

Catch-and-Release ~-y&T--

Them exists a one mile stretch of the Housatonic downstream of Route 4 that had been previously, but is no longer, stocked due to public health concerns. To estimate the damages associated with the loss of the catch-and-release fishery on this section, we use the available trout fishing literature in Exhibit C-l to estimate a value for a lost catch-and-release fishing trip. We reviewed this literature looking for site-specific trout studies which incorporate anglers fishing at catch-and-release fisheries. The studies including Connecticut anglers indicate catch-and-release values ranging from $14 to $30. Because this section of the river has the potential for high quality trout fishing, we estimate a $30 per trip value for lost catch-and-release fishing trips.

- This value represents the upper bound of results presented by Barry (1986). In this Housatonic study, Barry provides two estimates of catch-and-release fishing on the Housatonic River. $25.05 using the travel cost methodology and $30.02 using the contingent valuation methodology. We expect Barry's values to underestimate the value of a trout fishing trip on this section since these estimates incorporate a variety of lower-valued species than trout

- Brown and Hay (1987) provide an alternative value of a catch-and-release trout fishing trip. In this study, the authors estimate the value of a trout fishing trip in the state of Connecticut to be $14.48. This study provides a

---

[1] Throughout this analysis, we present per trip value estimates in 1996 dollars using the GDP implicit price deflator.

[2] Boston Globe, "Despite the State's Reputation for being a Densely Populated, Developed Region, There are Still Wild Times to be had on...Connecticut's Off-the-path Glistening Fishing Gems," May 6, 1994. New York Times, "Housatonic (PCBs and All) Wins Fame for Its Trout," April 21, 1991.

value for trout sites of varying quality throughout the state. Again, since this **section** of the river has the potential to provide a high quality trout fishery, this result is likely to underestimate the value of a fishing day in this section.

- Our $30 estimate is similar to that of Walsh et al. (1992) in their review of the outdoor recreation demand literature from 1968 to 1988. Based on 39 estimates of the economic value of a fishing day that they identified from existing studies, Walsh et al. calculated an average coldwater fishing trip value of $40.27. We would expect this estimate to be higher than $30 per trip, since this value accounts for unregulated fisheries.[3]

Walleye Values

For the walleye fishery, we estimate a per trip value for lost trips that potentially could have occurred if a walleye fishery had been established on the Housatonic. Walleye are an especially desirable recreational fish species, and we would expect this value to exceed the value for trips targeting other fish species on the river. Although very little site-specific literature exists to estimate walleye trip values, the available literature shown in Exhibit C-2 indicates reported values ranging from $80 to $101 per trip. We use this information, combined with professional judgment, to generate a conservative estimate of $75 per trip for the lost walleye fishery.

- Feather, Hellerstein and Tomasi (1995) value a walleye trip in Minnesota at $96.

- Charbonneau and Hay (1978) provide two national estimates based on two different methodologies. The authors' contingent valuation model produces a result of $80 per trip, and their travel cost model results in a $101 per trip value.

Our estimate is significantly lower than the $92 per trip average for these three models. We are unable to use the site-specific Barry (1986) estimates, because these values do not incorporate walleye fishing. Neither are we able to compare this to the Walsh et al. (1992) study since walleye is a "cool" water fish

[3] Omitting studies solely addressing recreational fishing in the west, as presented in Walsh et al. (1992), yields an average value of 538.39 in 1996 dollars, still above the value we apply in thii analysis.

002060

Exhibit C-l

VALUES PER FI HING DAY, TROUT FISHING

Study Authors/ Publication Date	Model Type	Source of Data	Scope of Study	Fishing Type	Year	Value (Reported)	Value (1996 $)
Englin, Lambert and Shaw (1996)	TCM	1989 NAPAF Freshwater Recreational User angler survey	NY. NH, VT, ME, CT, MA, RI	Trout	1989, I	$47.00	E57.27
Barry (1986)	CVM	Creel survey of all sections of Housatonic River	Connecticut	All	1986	$22.14	$25.05
Barry (1986)	TCM	Creel survey of all sections of Housatonic River	Connecticut	All	1986	$18.47	530.02
Brown and Hay (1987)	CVM	19.30 National Survey	Connecticut	Trout	1980	$8.00	$14.48
Brown and Hay (1987)	CVM	1980 National Survey	Massachusetts	Trout	1980	$9.00	S16.29
Connelly, Brown. and Knuth (1990)	CVM	NY State Angler Survey	New York	Cold water	1988	$13.42	$17.04
Brown and Hay (1987)	CVM	1980 National Survey	US	Trout	1980	$12.00	521.72
Vaughan and Russell (1982)	TCM	Private Fishing Fee Sites	US	Trout	1979	$19.49	$38.52
Charbonneau and Hay (1978)	CVM	1975 National Survey	US	Trout, Land-locked Salmon	1975	$21.00	s54.39
Charbonneau and Hay (1978)	TCM	1975 National Survey	US	Trout, Land-locked Salmon	1975	$43.00	$111.37
Charbonneau and Hay (1978)	CVM	1975 National Survey	US	Sea-run Salmon, Steelhead Trout	1975	$51.00	$132.09
Charbonneau and Hay (1978)	TCM	1975 National Survey	US	Sea-run Salmon, Steelhead Trout	1975	$63.00	1163.17

002061

Exhibit C-2

VALUES PER FISHING DAY', WALLEYE FISHING

Study Authors/ Publication Date	Model Type	Source of Data	Scope of Study	Fishing Type	Year	Value (Reported)	Value (1996 $)
Feather. Hellerstein and Tomasi (1995)	TCM	Survey of State angling activities	Minnesota	Walleye, Pike	1989	578.45	$95.59
Charbonneau and Hay (1978)	CVM	1975 National Survey	us	Pike; Walleye	1975	$31.00	$80.29
Charbonneau and Hay (1978)	TCM	1975 National Survey	us	Bass, Muskie, Pike, Walleye	1975	$39.00	$101.01

Lost Use Damages

We calculate lost use damages under each recovery scenario by multiplying the economic value per fishing trip by the estimate of lost *fishing* trips for each species and *management* scenario, as shown in Exhibit C-3. We estimate put-and-take trout damages to be $6.7 million, catch-and-release trout damages to range from $1.4 million to $2.3 million; and walleye damages to range from $1.5 million to $3.7 million, depending on the recovery scenario. Thus, total lost use damages for sections of the river in Connecticut range from $9.6 million to $12.7 million, depending on the recovery scenario assumed.

Exhibit C-3

ESTIMATED ECONOMIC DAMAGES FROM LOST USE OF THE HOUSATONIC RIVER FISHERY IN CONNECTICUT DUE TO PCB CONTAMINATION
(millions of 1996 dollars)

Put-and-Take Trout
($60 per trip)

Scenario	Present Value Estimate of Number of Lost Fishing Trips	Estimated Economic Damages
1978 to 1986 losses	112,000	S6.7

Catch-and-Release Trout
($30 per trip)

Scenario	Present Value Estimate of Number of Lost Fishing Trips	Estimated Economic Damages
20 year recovery	46,000	$1.4
50 year recovery	65.000	$2.0
No recovery	78.000	$2.3

Walleye
($75 per trip)

Scenario	Present Value Estimate of Number of Lost Fishing Trips	Estimated Economic Damages
20 year recovery	20,000	$1.5
50 year recovery	37,000	$2.8
No recovery	49,000	$3.7

Total

Scenario	Total Estimated Economic Damages Associated with Lost Use
20 year recovery	59.6
so year recovery	$11.5
No recovery	512.7

Diminished Use

Our approach to valuing reduced enjoyment of trout and warmwater fishing due to the imposition of the catch-and-release restrictions is to value the lost ability to keep any fish that are caught. We estimate this lost value as the difference in value between a put-and-take and catch-and-release trip. We do not include losses that anglers incur through other behavioral modifications such as eating less fish, because we are not able to quantify this marginal value loss. Neither do we include losses associated with substituting other sites for the Housatonic, because we do not have a measure of the number of diverted trips. The Housatonic is likely the premier trout fishery in this region, but some anglers who catch trout for consumption may have substituted other fisheries for the Housatonic during the catch-and-release years of 1981-1987. In particular, the put-and-take trout fishery of the Fannington River provides a stretch that is managed for trout fishing but is located close to a more heavily urbanized area of the state than the Housatonic TMA. Similarly, warmwater anglers may have substituted other warmwater habitats, e.g., Candlewood Reservoir, Saugatuck Reservoirs, and Lake Waramaug, in response to the change in fishing regulations.

Trout Values

We use the literature listed in Exhibit C-l to estimate the reduced value of a trout fishing trip due to the premature imposition of catch-and-release restrictions. We estimate that anglers incur damages at least equal to $30 per trip for the inability to consume trout caught on the. TMA during 1981 to 1987. We calculate this value as the difference between the value of a put-and-take trip and a catch-and-release trip. As previously described, we use the $60 per trip estimate as the value of a trout put-and-take trip and the $30 per trip estimate as the value of a trout catch-and-release trip.

Warmwater Species Values

As mentioned in the previous section, fish consumption advisories on all species posted on the Housatonic have limbed angler activities. We assume warmwater anglers abide by these advisories and do not keep their catch As a result, anglers incur a reduction in value equivalent to the imposition of catch-and-release restrictions on a previously unrestricted put-and-take fishery. We rely on the warmwater species literature listed in Exhibit C-4 to determine catch-and-release and put-and-take values. We estimate that anglers incur damages at least equal to $ 15 per trip resulting from the inability to keep fish caught on warmwater fishing stretches of the Housatonic River. We calculate this value as the difference between the value of a put-and-take and catch-and-release trip.

Catch-and-Release

We reviewed the literature in Exhibit C-4 looking for site-specific warmwater species studies which represent angler behavior at catch-and-release fisheries. The Connecticut studies indicate trip values range from $15 to $30 per trip. Recognizing that the Connecticut studies with higher estimates incorporate highly valued trout fishing, we estimate a lost catch-and-release value at $15 per trip for this section of the Housatonic.

- This estimate is similar to that of Hay (1988) who provides a value for bass fishing in the state of Connecticut during the time of consumption restrictions. In this study, the author estimates the value of a bass fishing trip in the state of Connecticut to be $15.34 per trip. We assume warmwater fishing in the Housatonic would yield an experience of average value since there are a number of available substitute sites as previously mentioned.

- The Housatonic study by Barry (1986) also provides an estimate of the value of a catch-and-release trip on the Housatonic. In this study, Barry provides two estimates for fishing on the Housatonic River: $25.05 using the travel cost methodology and $30.02 using the contingent valuation methodology. We assume these values are the upper bound for warmwater angling, because these results include values for trout fishing.

- Values from other region-specific, warmwater fishing studies (Connelly, Brown and Knuth, 1990; Menz and Wilton, 1983) that are the closest geographically to the Housatonic River provide higher trip value estimates. These studies average $41 per warmwater fishing, trip.

Put-and-Take

Of the literature we found describing warmwater fishing values, we were unable to find a study to allow us to estimate the value of a put-and-take warmwater fishing trip. As Exhibit C-4 shows, the studies we found to measure put-and-take values do not geographically represent the Housatonic River site. Therefore, we use the information we developed from trout fishing trips to estimate a put-and-take value for warmwater fishing.

- In the case of trout, put-and-take values are double the catch-and-release values. If we assume this to be the case for warmwater species in general, the put-and-take value of warmwater fishing is $30 per trip. We use this value to estimate the $15 per trip value for the reduced enjoyment of warmwater fishing activities.

Exhibit C-4

VALUES PER FISHING DAY, WARMWATERSPECIES **FISHING**

Study Authors/ Publication Date	Model Type	Source of Data	Scope of Study	Fishing Type	Year	Value (Reported)	Value (1996 $)
Hay (1988)	CVM	1985 National Survey	Connecticut	Bass	1985	$11.00	$15.34
Hay (1988)	CVM	1985 National Survey	Massachusetts	Bass	1985	$9.00	$12.55
Barry (1986)	CVM	Creel survey of all sections of Housatonic River	Connecticut	All	1986	$22.14	$25.05
Barry (1986)	TCM	Creel survey of all sections of Housatonic River	Connecticut	All	1986	$18.47	$30.02
Connelly, Brown, and Knuth (1990)	CVM	NY State Angler Survey	New York	Warmwater	1988	$14.21	$18.04
Menz and Wilton (1983)	TCM	1976 State Angler Survey	St. Lawrence River (Jefferson County), New York	Bass	1976	$25.99	$63.69
Menz and Wilton (1983)	TCM	1976 State Angler Survey	St. Lawrence River (St. Lawrence County), New York	Bass	1976	$35.22	$86.31
Charbonneau and Hay (1978)	CVM	1975 National Survey	US	Bass	1975	$19.00	$49.21
Charbonneau and Hay (1978)	CVM	1975 National Survey	US	Catfish	1975	$15.00	$38.85
Vaughn and Russell (1982)	TCM	Private Fishing Fee Sites	US	Catfish	1979	$12.48	$24.67
Charbonneau and Hay (1978)	CVM	1975 National Survey	US	Panfish	1975	$19.00	$49.21
Charbonneau and Hay (1978)	TCM	1975 National Survey	US	Freshwater Species	1975	$38.00	$98.42
Miller and Hay (1984)	TCM	1980 National Survey	Maine	Freshwater Species	1980	$23.00	$41.62

Diminishe Use Damages

We calculate dished use damages for each recovery scenario by multiplying the economic value per fishing trip by the estimate of lost trips with reduced enjoyment for each species, as shown in Exhibit C-S. Dhninished use damages range from $3.7 million to $9.1 million, depending on recovery scenario. In addition, we provide an estimate of diminished use damages which reflects a scenario in which dished use damages due solely to PCB contamination end in 1995, the year in which the statewide mercury advisory was issued. Under this alternative scenario, dished use damages are approximately $4.1 million. As noted in Appendii B, however, we believe that this scenario is likely to significantly understate true damages.

Exhibit C-5

ESTIMATED ECONOMIC DAMAGES FROM DIMINISHED USE OF THE HOUSATONIC RIVER FISHERY IN CONNECTICUT DUE TO PCB CONTAMINATION
(millions of 19% dollars)

Trout
($30 per trip)

Scenario	Present Value Estimate of Number of Diminished Fishing Trips	Estimated Economic Damages
1981 to 1986 losses	14,000	so.4

Warmwater Species
($15 per trip)

Scenario	Present Value Estimate of Number of Diminished Fishing Trips	Estimated Economic Damages
LO year recovery	402,000	$6.0
50 year recovery	507,000	$7.6
No recovery	580,000	S8.7
Assuming diminished use value damages due solely to PCBs end in 1995	249,000	s3.7

Total

Scenario	Total Estimated Economic Damages Associated with Diminished Use[4]
20 year recovery	$6.5
50 year recovery	$8.0
No recovery	$9.1
Assuming diminished use value damages due solely to PCBs end in 1995	$4.1

[4] Individual damage estimates may not sum to total due to rounding.

Total Damages

We combine the damage estimates presented in Exhibits C-3 and C-5 to calculate total damages to the Housatonic River in the state of Connecticut. Our total damage estimate ranges from $16 million to $22 million, in 1996 dollars, depending on the recovery scenario used. Note that under the scenario in which diihed use associated solely with PCBs ends in 1995, total damages will range from $13.7 to $16.8 million.

Exhibit C-6

ESTIMATED ECONOMIC DAMAGES FROM DIMINISHED AND LOST USE OF THE HOUSATONIC RIVER FISHERY IN CONNECTICUT DUE TO PCB CONTAMINATION
(millions of 1996 dollars)

Scenario	Estimated Lost Use Damages	Estimated Diminished Use Damages	Total Estimated Lost and Diminished Use Damages
20 year recovery	$9.6	$6.5	$16.1
50 year recovery	$11.5	$8.0	$19.5
No resource recovery	$12.7	$9.1	$21.8

Massachusetts

In the state of Massachusetts, elevated levels of PCBs led the state to alter fishery management practices. We believe that these management shifts resulted in lower numbers of fishing trips taken. In this section, we discuss the lost use damages associated with warmwater and trout fisheries on the Massachusetts section of the Housatonic. We do not e&mate diminished use damages for the Massachusetts section of the Housatonic, as the data necessary for this analysis are not available.

Warmwater Species Values

But for the presence of elevated levels of PCBs, we believe that the state would have actively managed the Housatonic River as a recreational fishery. Currently, anglers either continue to fish the river (presumably following the posted warnings and then not consuming their catch), travel elsewhere to fish, or no longer fish. In the absence of elevated levels of PCBs, anglers could have experienced an undiihed fishing experience on the Housatonic. Exhibit C-4 presents the literature we used to estimate the value of a lost warmwater fishing day on the Housatonic in Massachusetts. We focus on site-specific studies that measure the values for warmwater species under limited management regimes. We found one Massachusetts and two Connecticut studies that provide values ranging from $13 to $30 per trip. Recognizing that the Housatonic-specific studies with higher estimates incorporate highly valued trout fishing, we estimate a $15 per trip value for the loss of warmwater fishing trips on the Massachusetts Housatonic.

- This estimate is similar to that of Hay (1988) who provides a value for bass fishing in the states of Massachusetts and Connecticut during the time of fish consumption advisories. Since the Massachusetts habitat sustained greater contamination than Connecticut, but is likely to have been of the same quality, we use the upper bound of these two estimates to value these warmwater trips. Hay estimates the value of a bass fishing trip in the state of Massachusetts to be $12.55 per trip, and in the state of Connecticut to be $15.34 per trip. The estimates represent lower bound values of an unmanaged warmwater fishing trip in these states, because they average warmwater fishing throughout each, state and include sites under consumption advisories such as the Housatonic.

- The $15 estimate we use is within the bounds of Walsh et al. (1992) in their review of the outdoor recreation demand literature from 1968 to 1988, Based on 23 estimates of the economic value of a fishing day that they identified from existing studies, Walsh et al. calculate an average warmwater fishing trip value of $30.97. We ~~would expect this estimate to be higher than $15 per trip~~ since these studies may include unregulated fisheries not experiencing consumption advisories.

Our review of warmwater-specific studies shows our per trip figure to be a conservative estimate of trip value. Per trip values from all warmwater fishing studies' (Exhibit C-4) across the U.S. range from $13 to $101.

Trout Values

As discussed for Connecticut trout fishing losses, we estimate two types of trip values for trout fishing damages in Massachusetts. We first value lost put-and-take trips due to the PCB contamination in the river. We then value the lost c&h-and-release trips, that would have occurred if the state had implemented a catch-and-release trout fishery.

Put-and-Take

In the absence of elevated levels of PCBs, we assume the high quality trout habitat of the Glendale-Housatonic stretch would have been managed as a put-and-take fishery from 1980 to 1987. Based on the same principles we used to value a trip at the TMA, we rely on the literature listed in Exhibit C-l to estimate a trip value for the Massachusetts section of the river. We consider site-specific trout studies that measure trip values for anglers at a put-and-take fishery. The values for these studies range from $ 16 to 857 per trip. Because this section of the river has the potential to be a trophy trout fishery, similar to the Connecticut TMA, we estimate a $60 per trip value to estimate damages associated with the lost put-and-take fishing trips.

- This estimate is similar to the S57.27 estimate by Englin, Lambert, and Shaw (1989).

- ✦ ✶ **reasonable** ✦□ ✦✦○✦ ✦✦ $60 per trip value is a **lower** bound estimate of the value of a put-and-take trout fishing day in the Massachusetts section of the Housatonic. Other sites included in Englin et al.'s study cover a broad range of sites in seven northeastern states at various levels of regulation and fishing quality. This site has the potential to be a trophy trout fishery and has a habitat closely related to the highly-valued Connecticut TMA.

Catch-and-Release

Assuming the state would have imposed catch-and-release restrictions on the river from 1988 onward, we estimate a value of a catch-and-release trout fishing trip using the same principals as we did for the TMA. The literature in Exhibit C-l shows per trip values from all trout fishing studies range from $14 to $163 per trip. However, we, focus on site-specific literature likely to measure catch-and-ml-ease values. Of these, the ones most closely related to this section of the river are Massachusetts and Connecticut studies with values ranging from $14 to $30 per trip. We estimate a value that we think most closely represents the conditions at this section of the river, and use a $30 per trip value to estimate catch-and-release damages for warmwater fishing.

- This value represents the upper bound of results presented by Barry (1986). In this Housatonic study, Barry provides two estimates for catch-and-release fishing on the Housatonic River: $25.05 using the travel cost methodology and $30.02 using the contingent valuation methodology. We expect Barry's values to underestimate the value of a trout trip on this section since these : estimates incorporate a variety of lower-valued species than trout.

- Brown and Hay (1987) provide a catch-and-release trout fishing trip value for the state of Massachusetts. In this study, the authors estimate a value of $ 16.29 per trip. We would expect this trip value to be an underestimate since the Housatonic has the potential to be a trophy trout fishery.

- The $30 estimate we use is below that of Walsh et al. (1992) in their review of the outdoor recreation demand literature from 1968 to 1988. Based on 39 estimates of the economic value of a fishing day that they identified from existing study, Walsh et al. calculated an average coldwater fishing trip value of 840.27. We would expect this estimate to be higher than $30 per trip since this estimate accounts for put-and-take, catch-and-release, and unregulated fisheries. [5]

[5] Omitting studies solely addressing recreational fishing in the west, as presented in Walsh et al. (1992). yields an average value of $38.39 in 1996 dollars, still above the value we apply in this analysis.

Lost Use Damages

We estimate a range of $5 million to $8 million in lost use damages by multiplying the economic value per fishing trip by the estimate of lost fishing trips.

- We first calculate damages associated with warmwater fishing trips at various locations along the Housatonic, as shown in Exhibit C-7.

Exhibit C-7

ESTIMATED ECONOMIC DAMAGES FROM LOST USE OF THE HOUSATONIC WARMWATER FISHERY IN MASSACHUSETTS DUE TO PCB CONTAMINATION

Warmwater Species
(millions of 1996 dollars)

Site / Scenario	Estimated Number of Lost Trips	Estimated Economic Damages[6] ($15 per trip)
New Lenox Road to Woodls Pond		
20-year recovery	39,000	$0.6
50-year recovery	51,000	$0.8
No recovery	59,000	$0.9
Sheffield to Connecticut Border		
20-year recovery	35,000	$0.5
50-year recovery	45,000	$0.7
No recovery	52,000	$0.8
Remaining Housatonic Stretches		
20-year recovery	99,000	$1.5
50-year recovery	129,000	$1.9
No recovery	150,000	$2.3
Total		
20-year recovery	173,000	$2.6
50-year recovery	225,000	$3.4
No recovery	261,000	$4.0

- We then determine the damages associated with trout fishing in the Glendale-Housatonic stretch, as shown in Exhibit C-8.

[6] Individual damage estimates may not sum to total due to rounding.

Exhibit C-8

ESTIMATED ECONOMIC DAMAGES FROM LOST USE OF THE HOUSATONIC **RIVER** FISHERY IN **MASSACHUSETTS** DUE TO PCB CONTAMINATION .

Trout
(millions of 1996 **dollars)**

Regulatory Regime	Estimated Number of Lost Trips	Estimated Economic Damages
Put-and-Take Trout (1980-1987) ($60 per trip)	8,000	$0.5
Catch-and-Release Trout (1988-) ($30 per trip)		
20-year recovery	64,000	$1.9
50-year recovery	92,000	$2.8
No recovery	112,000	$3.4
Total		
20-year recovery	72,000	$2.4
50-year recovery	100,000	$3.3
No recovery	120,000	$3.9

- Finally, we estimate total damages to the Housatooic River in the state of Massachusetts due to PCB contamination to be between approximately **$5** million and $8 million, in 1996 dollars, as shown in Exhibit C-9.

Exhibit C-9

ESTIMATED ECONOMIC **DAMAGES** FROM LOST USE OF THE HOUSATONIC **RIVER** FISHERY IN **MASSACHUSETTS** DUE TO PCB CONTAMINATION
(millions 1996 dollars)

Scenario/Species Type	Estimated **Lost Use Damages**
20-year recovery	
Warmwater Fishing	S2.6
Trout Fishing	**$2.4**
TOTAL	**$5.0**
50-year recovery	
Warmwater Fishing	s3.4
Trout Fiihii	$3.3
TOTAL	**$6.7**
No Recovery	
Warmwater Fishing	**$4.0**
Trout **Fishing**	s3.9
TOTAL	**$7.9**

Summary and Limitations

We estimate total economic damages from lost and diminished use of the Housatonic River fishery in Connecticut and Massachusetts to be 821.1 million to $29.7 million (1996 dollars), depending on the recovery scenario. The Connecticut damages make up the greater portion of this range at $16.1 million to $21.8 million. We estimate Massachusetts damages to be between $5 million and $8 million.

This damage estimate is based on existing data. A more precise damage estimate could be obtained with additional data gathered specifically for the Housatonic situation. For example, angler surveys and travel cost or contingent valuation studies could be conducted to obtain economic values and use levels that pertain directly to the kinds and quality of fishing available at the Housatonic. In addition, surveys of Housatonic anglers and potential anglers could be used to determine the extent to which the posting of health warnings and curtailment of stocking due to PCB contamination provoked the sharp drop in public use of the fishery that occurred in the 1980s. Whether new estimates based on additional data would be lower or higher than the current estimates can not be determined at this time. There are a number of additional factors that may cause components of this analysis to be either under- or overestimates of the true damages. These factors are summarized below.

- The walleye trip damages may be under- or overestimates of the true damages, because walleye trip values for the state of Connecticut were not available. To the extent that the value of Connecticut walleye trips differ from the estimate we derived from the two national and one state studies, our results will be biased.

- To estimate the reduced value of trips resulting from the imposition of consumption advisories in Connecticut, we used the information we developed from trout fishing trips to estimate a relationship between the value of catch-and-release and put-and-take warmwater fishing trips. To the extent that the true relationship differs from our assumption, we would have biased estimates of the diminished value of these warmwater trips.

- In this analysis we assume Connecticut warmwater anglers abide by fish consumption advisories and do not keep their catch. Our diminished value results for warmwater species may be overestimates of the true damages if anglers ignore this advisory.

- The method we use to calculate diminished use damages is the difference between catch-and-release and put-and-take values. The catch-and-release values may, however, overestimate the true catch-and-release value of the Housatonic fishery. Anglers may have an even smaller value per trip not only because they cannot keep their catch, but also because they are aware of the extensive PCB contamination in the fishery. Also, we do not estimate diminished use damages for the Massachusetts portion of the river because the data necessary for this analysis are not available. For these reasons, our analysis may understate diminished use damages.

REFERENCES FOR APPENDIX C

Barry, Timothy J., "A Creel and Economic Survey of the Housatonic River," State of Connecticut, Department of Environmental Protection, Bureau of Fisheries, State Office Building, Hartford, CT. June 1988.

Brown, Gardner, and Michael J. Hay, "Net Economic Recreation Values for Deer and Waterfowl Hunting and Trout Fishing," Division of Policy and Directives Management, U.S. Fish and Wildlife Service, Washington, DC, March 1987.

Charbonneau, J. John, and Michael J. Hay, "Human Diiensions in Wildlife Management," Wildlife Management Institute: 43rd North American Wildlife and Natural Resources Conference. U.S. Fish and Wildlife Service, Washington, D.C.

Connelly, Nancy A, Tommy L. Brown, and Barbara A. Knuth, "New York Statewide Angler Survey," New York State Department of Environmental Conservation. Bureau of Fisheries. 1988.

Englin, Jeffrey, David Lambert, and W. Douglass Shaw, "A Structural Equations Approach to Modeling Consumptive Recreation Demand," Working Paper, Department of Applied Economics and Statistics/204, University of Nevada-Reno, July 1996.

Feather, Peter, Hellerstein, Daniel, and Tomasi, Theodore, "A Discrete-Count Model of Recreational Demand," *Journal of Environmental Economics and Management,* Vol. 29, pp. 214-227, 1995.

Hay, Michael, J., "Analysis of the 1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: Net Economic Recreation Values for Deer, Elk and Waterfowl Hunting and Bass Fishing" U.S. Department of the Interior, Fish and Wildlife Service, Report 85-1, July, 1988.

Menz, Fredric C., and Donald P. Wilton, "Alternative Ways to Measure Recreation Values by the Travel *Cost* Method," *American Journal of Agricultural Economics,* Vol. 65, May 1983.

Miller, John R, and Michael J. Hay, "Estimating Substate Values of Fishing and Hunting," Conference Proceedings from Transactions of the North American Wildlife and Natural Resources Conference 49, pp. 345-355, 1984.

U.S. Department of the Interior (Interior). Type B Technical Information Document: Techniques to Measure Damages to Natural Resources. Washington, DC. 1987.

REFERENCES FOR APPENDIX C
(continued)

Vaughan, William J., and Clifford S. Russell, "Valuing 'a Fishing Day: An Application of a Systematic Varying Parameter *Model,*" ***Land Economics***, Vol. 58, No. 4, November 1982.

Walsh, Richard G., Donn M. J&son, and John R McKean, "Benefit Transfer of Outdoor Recreation Demand Studies, 1968-1988," ***Water** Resources Research,* Vol. *28,* No. *3, pp.* 707-713, March 1992.

Appendix D: Recreational Boating

CALCULATION AND VALUATION OF LOST BOATING TRIPS IN MASSACHUSETTS AND CONNECTICUT

Appendix D: Recreational Boating

CALCULATION AND VALUATION OF LOST BOATING TRIPS IN MASSACHUSETTS AND CONNECTICUT

INTRODUCTION

The following analysis estimates the effects of elevated levels of PCBs on recreational boating on the Housatonic Rivet in Connecticut and Massachusetts. The Connecticut stretch of the Housatonic River provides recreational boating opportunities for two distinct populations. The upstream area, which includes fairly fast moving, cold water, including some rapids, includes a ten mile stretch popular among whitewater boaters (i.e., canoers and kayakers). In contrast, the downstream lakes, Lakes Lillinonah and Zoar, provide boating opportunities for power boats and water skiers. The Massachusetts stretch of the Housatonic River includes primarily flat; slow-moving warm water, sections of which provide unique experiences due to. the available solitude, the rural character and aesthetic beauty of the land, and opportunities to view wildlife.

We believe that the high current level of use on the whitewatet stretch of the Housatonic in Connecticut indicates that boating rates on this stretch are not currently affected by the presence of elevated levels of PCBs. Because we lack data for boating rates on the downstream lakes in Connecticut, we are unable to assess the effects of the PCB contamination on this recreational resource. In this analysis, therefore, we only assess tecteational boating losses on the Massachusetts stretch of the Housatonic River.

This analysis has been completed for settlement and case management purposes only, and is based on existing data. Our estimates could be refined through primary data collection and analysis designed to examine the specific response of Massachusetts and Cormecticut boaters to contamination of the Housatonic River.

MASSACHUSETTS

The Massachusetts stretch of the Housatonic River includes primarily flat, slow-moving warm watet meandering through Berkshire County to the Connecticut border. Two stretches of this rivet popular among boaters are the stretch from the John Decker boat launch at New Lenox Road to Woods Pond, and the stretch from Ashley Falls past Bartholomew's Cobble to the Falls Rivet Dam in Connecticut. Both of these stretches provide unique experiences due to the available solitude, the rural character and aesthetic beauty of the land, and opportunities to view wildlife.

To estimate the effects of PCB contamination in the Housatonic River on boating rates along the Massachusetts stretch of the river, one could compare boating rates on the river prior to 1976, the year when the public first became aware of the contamination, with rates after 1976. The Massachusetts stretch of the Housatonic was not, however, heavily boated prior to 1976, due

002084

to other water quality issues and the lower overall popularity of boating during that period. We therefore assess the effects of the PCB contamination on boating rates on the Housatonic River by comparing current boating use of the two popular stretches of the Massachusetts Housatonic to our estimate of the potential boating rates on these stretches, (i.e., the estimated rate of use had the river not been contaminated with elevated levels of PCBs). Because of the high levels of PCBs present in the Massachusetts stretch of the Housatonic, and the &responding negative public attitude towards recreational uses of the river, we assume that without substantial clean-up and contaminant source control, boating levels will continue to be depressed. In estimating lost boating opportunities for the Massachusetts stretch of the river, we calculate losses under two scenarios, the first assuming the return of boating rates to baseline conditions within 20 years, and the second assuming losses co&n&g in perpetuity.

Analysis of Lost Boating Days

To estimate the total number of lost boating days on the Massachusetts stretch of the Housatonic River, we compare the number of potential boating trips (assuming that the river did not contain elevated levels of PCBs), with the number of boating trips actually taken to a popular stretch of the river in Connecticut. We define a boating trip as a one-day trip on the river by an individual.

'Potential Boating Rates

One measure of the annual number of potential boating trips on the Massachusetts stretch of the Housatonic River would be actual boating rates on an uncontaminated river with comparable natural and regional demographic characteristics. No recreational boating data exist, however, for such a river in Massachusetts. To model potential boating use of the Massachusetts stretch, we therefore use boating data for a popular ten mile stretch of the Housatonic River in comlecticut.

The ten mile stretch of the Housatonic River from below the Falls River Dam to the Housatonic Meadows State Park in Connecticut is a popular canoeing and kayaking area. This stretch is made up of two stretches, the first from the Falls River Dam to the covered bridge in West Cornwall (six miles in length), and the second from the covered bridge to the Housatonic Meadows State Park (four miles in length). The entire stretch winds through a beautiful rural area of northeastern Connecticut. Aside from a brief stretch of whitewater just below the dam, the first six mile stretch includes primarily flat water. The second stretch, from the covered bridge to Housatonic Meadows, however, includes Class I and II whitewater rapids.[1] Because the characteristics of the upper six mile stretch of the river in Connecticut are more comparable to the Massachusetts stretch of the Housatonic, we estimate potential boating rates on the Massachusetts Housatonic using estimated boating rates for this stretch of the river.

[1] Whitewater rapids range in difficulty from Class I to Class VI. with the latter the more difficult.

Available Data

No studies have been conducted to measure boating rates on the Connecticut Housatonic. To construct an estimate, we contacted the two main boating outfitters that provide rental equipment for this stretch of the river.[2] Both outfitters provide transportation to and from the put-in and take-out locations along this stretch. Phone interviews with these outfitters provided the following information:[3]

- Clarke Outdoors outfits approximately 150 boaters each weekend day from mid April to mid October (27 weekends).
- Clarke Outdoors outfits apprqximately 30 to 50 people per week&y during the summer (from Memorial Day to Labor Day, 70 weekdays total).
- River Running Expeditions conducts approximately the same level of business as Clarke Outdoors.
- Approximately rive percent of all boaters who rent equipment from Clarke Outdoors boat only the six mile stretch from the Falls River Dam to the covered bridge in West Cornwall (i.e., the lower portion of this section is far more popular than the upper stretch).

To estimate the total number of potential boating trips on the Massachusetts stretch of the river from 1976 forward, we assume that current boating rates reflect trends from 1990 forward.' To be conservative, we. estimate the number of potential boating trips on the Massachusetts stretch by assuming that no trips would have occurred along the river prior to 1990 in the absence of elevated levels of PCBs, even though the water quality of the Massachusetts stretch improved dramatically from 1980 forward.[5]

[2] Clarke Outdoors, in Cornwall (contact, Jennifer Clarke), and River Running Expeditions, in Falls Village (contact, Joan Manasse).

[3] Because Joan Manasse of River Running Expeditions was unwilling to provide boating rate information, we obtained information for both outfitters from Jennifer Clarke of Clarke Outdoors.

[4] 1990 is the first year for which reliable boating data are available.

[5] Personal communication with Tom Keefe of the Massachusetts Fisheries and Wildlife Division.

Calculations

- The number of individuals renting boats per year on weekend days from Clarke Outdoors:

  (150 people/weekend day)(2 days/weekend)(27 weekends/year) = 8,100 boaters/year.

- The number of individuals renting boats per year on weekdays from Clarke Outdoors, assuming an average of 40 People per weekday:

  (40 people/weekday)(70 weekdays/year) = 2,800 boaters/year.

- The number of individuals renting boats per year from Clarke Outdoors:

  (8,100 weekend boaters) + (2.800 weekday boaters) = 10,900 total boaters/year.

- The number of individuals renting boats per year from both Clarke Outdoors and River Running Expeditions, assuming that rental rates at River Running Expeditions are approximately equal to those seen at Clarke Outdoors:

  (10,900 boaters/year)(2) = 21,800 total boaters/year = 21,800 total boating trips/year.

- The number of boating trips per year targeted toward the upper six mile stretch from the Falls River Dam to the covered bridge at West Cornwall:

  (21,800 boating trips/year)(5%) = 1,090 boating trips/year.

- The number of boating nips per year on each of the two popular stretches of the Housatonic River in Massachusetts assuming the river had not been contaminated with PCBs.

  1,090 boating trips per year.

- Present value potential boating trips on each of the popular stretches of the Massachusetts Housatonic, from 1990 forward (1996 values)?

  44,685 potential present value boating trips per stretch.

---

[6] **All present value calculations in this Appendix use a three percent real discount rate.**

Thus, based on the assumptions described above, we estimate that approximately 45,000 boating trips would have been taken along each of the two popular stretches of the Housatonic River in Massachusetts, in the absence of elevated PCB contamination.

Actual Boating Rates

No studies have been conducted on boating rates on either of the two pop&r Massachusetts stretches of the Housatonic River. To estimate the number of actual boating trips per year on these stretches; we use commercial data collected from outfitters whd provide equipment and/or who conduct. guided tours of these two stretches of the river.[7] The two stretches along which boat tours are conducted include the stretch from the Decker boat launch at New Lenox Road to Woods Pond, and the stretch from Ashley Falls, past Bartholomew's Cobble, to the Falls River Dam in Connecticut.

Phone interviews with commercial outfitters and tour groups provided the following information:

- The Massachusetts Audubon Society conducts guided nature tours of the Housatonic River from the Decker boat launch to Woods Pond From 1990 to 1995, an average of 77 families participated per year.
- Canyon Ranch Spa takes, at most, 90 to 110 boaters on the Decker boat launch/Woods Pond stretch of the river per year.
- Main Street Sport and Leisure (Lenox, Massachusetts) conducts boating tours of the Decker to Woods Pond stretch of the Housatonic. We estimate that approximately 300 boaters participate in these trips per year.*
- Berkshire Hiking Holidays conducts guided tours both of the Decker boat launch/Woods Pond stretch and the Ashley Falls/Bartholomew's Cobble stretch. Approximately 50 boaters participate in these trips per year.

---

[7] These outfitters/tour groups include: the Massachusetts Audubon Society, the Canyon Ranch Spa, Main Street Sport and Leisure, Berkshire Hikiig Holidays, the Trustees of the Reservation (Bartholomew's Cobble), and Gaffer's Outdoors.

[8] Personal communication with Richard Woller of Berkshire Hiking Holidays.

- The Trustees of the Reservation conducts guided tours of the stretch from Ashley Falls past Bartholomew's Cobble to the Falls Village Dam. Until 1995, the number of participants was approximately 50 to 100 per year. Since 1995, the number has increased to approximately 200 boaters per year.[9]

- We have not been able to contact Mike Gaffer of Gaffer's Outdoors.

All outfitters responded that they inform those renting boats and those participating in guided tours that the river contains elevated levels of PCBs.

To use the data described above to estimate actual boating rates on the two stretches of the Massachusetts Housatonic, we make the following assumptions:

- To estimate the total number of boaters participating in the Massachusetts Audubon nature tours, we assume that the average boating group size is approximately 2.5 individuals.[10]

- We assume that the number of boaters participating in Berkshire Hiking Holiday tours is distributed approximately evenly between the two popular stretches of the Massachusetts Housatonic.

- Because we lack data for Gaffer's Outdoors, we use the average number of individual boaters for all other outfitters to estimate the number of individuals outfitted by Gaffer's Outdoors. In addition, we assume that these trips are equally divided between the two popular stretches of the river.

When estimating the number of actual trips taken to the Massachusetts stretch of the Housatonic, we separately evaluate boating use of the two popular stretches of tbe Housatonic River, To estimate the total number of trips taken, we use the available data in the following manner:

[9] The number of participants on these trips increased in 1995 because the Trustees of the Reservation purchased more canoes.

[10] Thii estimate is based on the value reported for the average size of non-motorized boating parties for those boating on the Deerfield River in Massachusetts.

- To estimate the number of actual trips from 1990 forward on the Decker launch/Woods Pond stretch, we use the available Massachusetts Audubon Society data for 1990 forward, the current data for the Canyon Ranch Spa, Main Street Sport and Leisure, Berkshire Hiking Holidays, and the estimated data for Gaffer's Outdoors.

- To estimate the-number of annual trips from 1990 to 1995 for the Ashley Falls/Falls Village stretch, we use the pm-1995 data for the Trustees of the Reservation, current data for Berkshire Hiking Holidays, and estimated data for Gaffer's Outdoors.

- To estimate the number of annual trips from 1995 forward for the Ashley' Falls/Falls Village stretch, we use the 1995 data for the Trustees of the Reservation, current data for Berkshire Hiking Holidays, and estimated data for Gaffer's Outdoors.

The results of this analysis are summarized in Exhibit D-l. The calculations we performed are detailed below.

Exhibit D-l

ESTIMATED CURRENT BOATING RATES
MASSACHUSETTS STRETCH OF THE HOUSATONIC RIVER

River Stretch	Years	Estimated Use (boating trips per year)
Decker Launch to Woods Pond	1990 forward	689
Ashley Falls to Falls Village, CT	1990 - 1994	184
	1995 forward	309

Calculations

- Estimated number of boaters per year participating in the Massachusetts Audubon Society nature tours, 1990 to 1995:

  (76.7 parties/year)(2.5 individuals/party) = 192 individual boaters per year.

- Total number of current trips on both stretches of the Massachusetts Housatonic River:

002090

Ashley Falls to Falls Village Dam:

- Estimated number of Berkshire Hiking Holiday boaters on the Ashley Falls/Falls Village Dam stretch of the river:

  (50 boaters/year)*(0.5) = 25 boaters/year.

- Estimated number of Gaffer Outdoors' boaters on the Ashley Falls/Falls Village Dam stretch of the river:

  (168 boaters/year)*(0.5) = 84 boaters/year.

- Total estimated number of 'boaters per year on the Ashley Falls/Falls Village Dam stretch of the Massachusetts Housatonic, 1990 to 1994:

Berkshire Hiking Holidays:	25 boaters/year.
Trustees of the Reservation:	75 boaters/year.
Gaffer's Outdoors (estimated):	84 boaters/year.
Total (using available data):	184 boaters/year.

- Total estimated number of boaters per year on the Ashley Falls/Falls Village Dam stretch of the Massachusetts Housatonic, 1995 forward:

Berkshire Hiking Holidays:	25 boaters/year.
Trustees of the Reservation:	200 boaters/year.
Gaffer's Outdoors (estimated):	84 boaters/year.
Total (using available data):	309 boaters/year.

- present value estimated number of actual boaters on the Ashley Falls/Falls Village Dam stretch of the Massachusetts Housatonic, 1990 to 1994 (1996 values):

  1,036 actual boating trips, 1990-1994.

- present value estimated number of actual boaters on the Ashley Falls/Falls Village Dam stretch of the Massachusetts Housatonic, 1995 forward (1996 values):

  Assuming resource use recovers to baseline within 20 years (i.e., 184 boaters/year, 1990-1994, 309 boaters/year 1995-2015, 1.090 boaters/year, 20 16 on): 25,774

  Assuming no recovery of resource use to baseline: 10,927.

- Total present value of the estimated number of actual boating trips to the Ashley Falls/Falls Village Dam stretch of the Housatonic, 1990 forward (1996 values):

  Assuming 20 year recovery of resource use to baseline: (1,036 actual trips) + (10,927 actual trips) = 11,963 actual trips.

  Assuming no recovery of resource use to baseline: (1,036 actual trips) + (25,774 actual trips) = 26,810 actual trips.

Lost Boating Trips

Based on the Connecticut Housatonic data, we assume that each of the two popular stretches of the Massachusetts Housatonic would support approximately '1,090 boating trips per year. To estimate the total number of lost boating trips on each stretch, we subtract from the potential number of trips the number of trips actually taken to the river.

- Estimated present value lost boating trips on the Decker Launch/Woods Pond stretch, 1990 forward (1996 values):

  Assuming recovery of resource use to baseline in 20 years: (44,685 potential boating trips) - (36,133 actual boating trips) = 8,552 lost boating trips.

  Assuming no recovery of resource use to baseline: (44,685' potential boating trips) - (28,738 actual boating trips) = 15,947 lost boating trips.

- Estimated present value lost boating trips on the Ashley Falls/Falls Village Dam stretch, 1990 forward (1996 values):

  Assuming recovery of resource use to baseline in 20 years: (44,685 potential boating trips) - (26,810 actual boating trips) = 17,875 lost boating trips.

  Assuming no recovery of resource use to baseline: (44,685 potential boating hips) - (11,963 actual boating trips) = 32,722 lost boating trips.

Thus, based on this analysis we estimate losses of 8,000 to 16,000 boating opportunities on the Decker launch/Wood Pond stretch, and losses of 18,000 to 33,000 boating opportunities on the Ashley Falls stretch These ranges reflect differing assumptions regarding the likely recovery period for the resource. These lost use estimates are based on estimated yearly potential use of approximately 1,100 trips per year on each stretch, versus an estimated current yearly use of approximately 700 and 300 trips on the Woods Pond and Ashley Falls stretches, respectively.

Areas of Uncertainty

- The characteristics of the Massachusetts stretch of the Housatonic River are most closely reflected by the six mile Connecticut stretch from the Falls River Dam to the covered bridge in West Cornwall. The Connecticut stretch does, however, include a short stretch of whitewater. Because whitewater boating is generally more of an attraction than flat water -- boating, our analysis may overestimate potential boating rates on each of the popular stretches of the Massachusetts Housatonic by modeling boating rates based on the estimated rates for the upper six mile stretch of the Connecticut Housatonic.

- The boating rates calculated above for the six mile stretch of the Connecticut Housatonic reflect data only for boaters who use commercial services; however, the river is also popular among individual boaters. Total boating rates for this stretch of the river have not been evaluated, therefore only commercial data are available. Because our estimate of the number of annual potential boating trips does not include individual boaters, this factor may lead us to underestimate the total number of potential boating trips on the two Massachusetts stretches of the river.

- Because we lack data for one of the two major boating outtitters on the Connecticut stretch of the river, we estimate total commercial boating rates based on only one primary outfitter. This estimate may not, however, reflect actual commercial boating rates for this stretch. We do not know whether this factor causes us to over- or underestimate actual commercial boating rates.

- Because we assume that current trends reflect boating use from only 1990 forward, and because we lack earlier boating data, we only estimate the annual number of potential boating trips on the Massachusetts Housatonic from 1990 forward. We believe that boating trips would have been taken prior to 1990 if the river were not contaminated; as a result, this factor likely leads us to underestimate the number of lost boating opportunities.

- All data used to estimate commercial boating use of the two popular stretches of the Housatonic River are approximate values provided by the commercial outfitters and/or tour groups interviewed. If these numbers do not accurately reflect commercial use of the river, our estimate may not reflect actual commercial use of the river.

002094

- For this analysis we attempted to contact all outfitters and tour groups that produce boating trips on the Massachusetts stretch of the river. Because we were not able to gain direct information for Gaffer's Outdoors or Main Street Sport and Leisure, and because we may not have learned of all outfitters/tour groups in the area, our estimate of total commercial use may not be accurate.

VALUATION OF LOST BOATING TRIPS

No existing studies were identified that provide estimates of the value of a recreational boating nip on the Housatonic River. Thus, for purposes of this preliminary damage assessment we rely on value estimates drawn from the broader literature, as described below.

Walsh et al. (1992) calculate an average boating trip value of $64 based on 11 estimates of the economic value of a-boating day that they identified from existing studies." This value may under-or over-estimate the value of a boating trip on the Housatonic for a number of reasons:

- Because of the small number of studies considered in developing this estimate, the robustness of this value is questionable; More studies would help provide a value estimate insensitive to model misspecification.

- This estimate represents an average value. that does not take into account the value of specific characteristics of a site. The authors calculate a mean per nip estimate by averaging across user population characteristics, site characteristics and estimation techniques. To the degree that the Housatonic boating population differs from the average population, the Walsh et al. value may over-or underestimate, the true value of a boating day on the Housatonic.

Bergstrom and Cordell (1991) conduct an analysis of the value of outdoor recreational activities in the U.S., including canoeing/kayaking. The authors sample U.S. counties and apply a multi-community, multi-site travel cost model to estimate a value of $27 per canoe/kayak trip. This is an average value which may not accurately represent the value of a boating nip on the Housatonic. To the degree that boating at the Housatonic is of higher quality than at other U.S. sites, this value could underestimate the true value of a trip to the Housatonic.

Considering that both these estimates represent nationwide boating activity, and using best professional judgment, we apply a value of $40 per trip to our analysis of boating on the Housatonic. A more precise damage estimate could be obtained with additional data gathered specifically for the Housatonic. For example, boater surveys and travel cost or contingent

---

[11] In this analysis, we present per nip value estimates. converted to 1996 dollars using the GDP implicit price deflator where necessary.

valuation studies could be conducted to obtain economic values and use levels that pertain directly to the boating opportunities provided by the Housatonic. In addition, surveys of Housatonic boaters and potential boaters could be used to determine the extent to which the posting of health warnings due to PCB contamination provoked the sharp drop in public use of the river that began in the 1980s. Whether new value estimates based on primary (i.e., site specific) data would be lower or higher than the current average estimate can not be determined at this time.

RESULTS

Exhibit D-2 provides a summary of our estimates of present value recreational boating damages for the Massachusetts Housatonic River site. As shown, damages are estimated to fall in the range of one to two million dollars. This range reflects uncertainty in the likely recovery period for this resource.

Exhibit D-2

PRELIMINARY ESTIMATE OF RECREATIONAL BOATING DAMAGES

Scenario/River Stretch	Value Per Trip (1996 $)	Approximate Number of Present Value Lost Trips	Damages (1996 $)
Assuming 20 year recovery of use to baseline:			
Decker boat launch to Woods Pond	$40	8,000	$320,000
Ashley Falls to Falls River Dam	$40	18,000	$720,000
Total:			$1,040,000
Assuming no recovery of use to baseline:			
Decker boat launch to Woods Pond	$40	16,000	$640,000
Ashley Falls to Falls River Dam	$40	33,000	$1,320,000
Total:			$1,960,000