10/21/98

Housatonic River

Evaluation of Natural Resource Damages

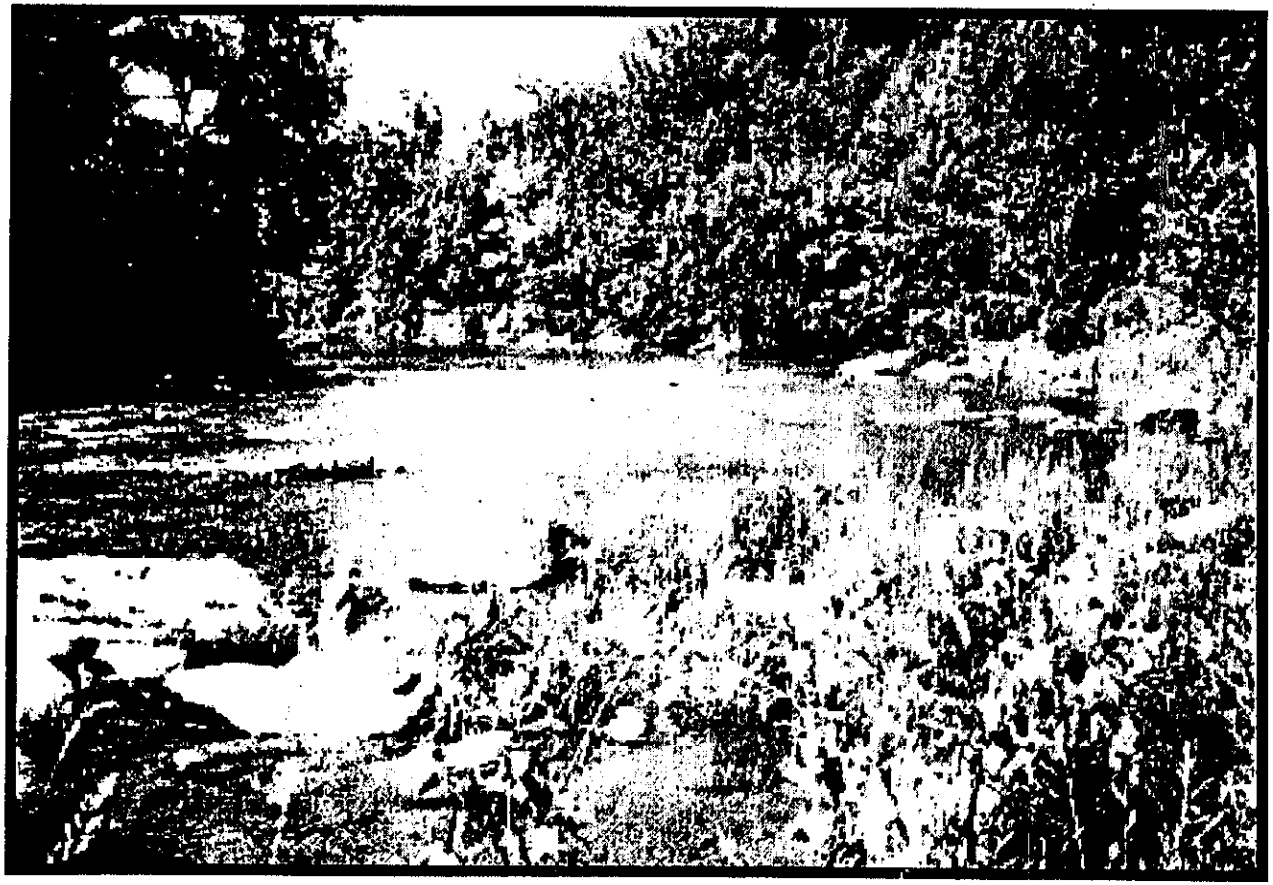

EXHIBIT 10

NATURAL RESOURCE DAMAGES
"NRD"

- Fundamental Purpose of NRD is to ***Restore Injured Natural Resources*** and the Services They Provide to the Greatest Extent Practicable

- Response Actions at Hazardous Waste Sites are Distinct but Integral Components of NRD

- Response Actions Stop or Control Harm and Risk to Human Health and the Environment and Also Serve as the Primary Component of NRD, or ***"Primary Restoration"*** -- Response Actions are Administered by Response Agencies Such as the EPA, MA/DEP or CT/DEP

- NRD Also Compensates the! Public for Injury to the Environment and 'Lost Use of the Environment Before, During and After Response Actions, or ***"Compensatory Restoration'/*** -- Compensatory Restoration Projects are Administered by Natural Resource Trustee Agencies such as MA/EOEA, CT/DEP-BNR, DOI and NOAA

- ***Compensatory Restoration Projects may Restore, Replace, Rehabilitate or Acquire the Equivalent of the Injured Natural Resources*** and can be implemented in conjunction with or separate-from Response Actions

- ***Primary Restoration + Compensatory Restoration = NRD***

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NATURAL RESOURCE DAMAGES
Legal Framework

- General Model for NRD Actions Come From NRD Sections of CERCLA (Hazardous Waste) and OPA (Oil)
- Designated Natural Resource Trustees under CERCLA and OPA Action Behalf of the Public:
  - Massachusetts Executive Office of Environmental Affairs
  - Connecticut DEP - Bureau of Natural Resources
  - U.S. Department of the Interior - U.S. Fish & Wildlife Service
  - National Oceanic and Atmospheric Administration (NOAA)
- Trustees May Assess Damages, Bring a Court Claim to Recover 8, or Settle with a Responsible Party for $ and/or Restoration
- Trustees Must Prove "Causation" of Injury (Court Claim) and Must Develop a Restoration Plan with Public Input (Settlement & Court Claim) before expending recovered $ (CERCLA §11 l(i))

NATURAL RESOURCE DAMAGES
Natural Resource Damages Assessment F'rocess

General Approach

Preassessment Screen	NRDA Plan	NRDA Implementation	NRDA Claim	Restoration Planning	Restoration
→→→1 Year →→→→	*→→→1 - 3 Years →→*	*→→→→→2 - 5 Years →→→→→*	*→→→→→2 -10 Years →→→→→*	*→→→2 - 5 Years →→→*	*→1 - 10 Years →→*

• Establish Trustee Council
• Review documented existing information
• Is NRDA Warranted?
	• Design Detailed Injury, Pathway, Qualification, Economic Studies
	• Scope out Potential Restoration Options
	• Coordinate NRDA Plan With Response Actions
	• Public, Response Agency & PRP Input
		• Implement Studies in NRDA Plan
		• Coordinate NRDA With Response Actions
		• Qualify Injuries & Service Interruptions
		• Determine What Needs to be Restored
		• Value ($) Damages/ Scale Potential Restoration Options
		• Public, Response Agency & PRP Input
			• Seek compensation from Potentially Responsible Parties (PRPs)
			• Negotiate: 2 *Years*
			  ▪ Settlement
			  ▪ Consent Decree (CD)
			  ▪ Public Comment
			  ▪ CD Becomes Effective
			or
			• Litigate: *2-10* Years
				• Refine & Develop Restoration Options Identified and Scaled in NRDA
				• Coordinate Restoration Planning With Response Actions
				• Public & Response Agency Input
				• Develop Restoration Plan
					Implement Restoration Plan
					Public &Response Agency Input

→→→→→→→→→→→→→ 9 - 34 Years →→→→→→→→→→→→→					

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NATURAL RESOURCE DAMAGES

NRD Process Used For the Housatonic River - GE Pitsfield Site

Housatonic River Approach

Preassessment Screen	NRD Evaluation & Settlement Position	Global Negotiations	Consent Decree	Restoration Planning	Restoration
→→→1995 →→→	→→→→→1996 - 1997 →→→→→	→1997 - 1998→	→1998 - 1999 →	→→→ 1998 →→→	→→ 1999 →→
• Reviewed Existing Information • **Draft** PAS • NRDA **Warrantec**	• Use Existing Information and Literature to Evaluate and Estimate NRD • Test Evaluation and Estimates With Selective Data Collection and Modeling • Scope out Potential Restoration Options • Coordinate NRD Evaluation With Response Actions	• **Agreement** in Principle on Remediation, Restoration and Redevelopment Announced September, 1998			

→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→5 - 20 Years →→→→→→→→→→→→→→→→→→→→→→→→→→→→→

Completed | Future Activities

General Approach

Preassessment Screen	NRDA Plan	NRDA Implementation	NRDA Claim	Restoration Planning	Restoration
→→→1 Year →→→→	→→→1 - 3 Years →→→	→→→→→2 - 5 Years →→→→→	→→→→→2 - 10 Years →→→→→	→→→2 - 5 Years →→→	→1 - 10 Years →→

→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→ 9 - 34 Years →→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→→

NATURAL RESOURCE DAMAGES
NRD Process Used For the Housatonic River - GE Pittsfield Site

Preassessment Screen	NRD Evaluation & Settlement Position	Global Negotiations	Consent Decree	Restoration Planning	Restoration
1995	1996 - 1997	1997 - 1998	1998 - 1999	1998 +	1999 +
• Reviewed Existing Information • Draft PAS • NRDA Warranted	• Use Existing Information and Literature to Evaluate and Estimate NRD • Test Evaluation and Estimates With Selective Data Collection and Modeling • Scope out Potential Restoration Options • Coordinate NRD Evaluation With Response Actions	• Agreement in Principle on Remediation, Restoration and Redevelopment Announced September, 1998	• Negotiate NRD Sections of Consent Decree (CD) • Lodge CD in Federal Court and Receive Public Comment • Respond to Public Comments , • Enter CD as Final Settlement in Federal Court	• Establish Trustee Council • Develop Restoration Options • Develop Restoration Plan with Public and Response Agency Input • Coordinate Restoration Planning with Response Actions • Publish Restoration Plan(s) for Public Comment • Finalize Restoration Plan	• Implement Restoration Plan • Coordinate Implementation with Response Actions • Coordinate Implementation with Public Input
5			20 Years		

Completed Future Activities

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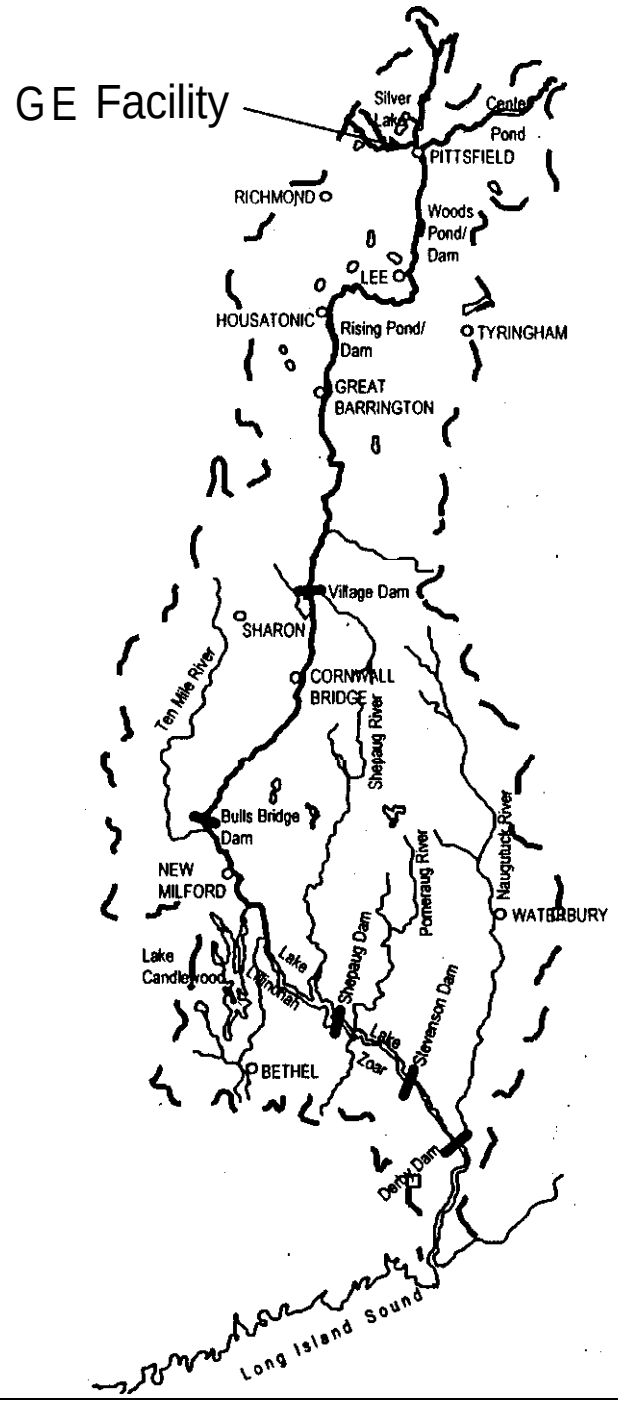
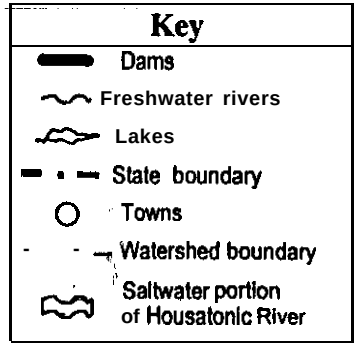
Housatonic River NRD Evaluation

Overview

- Trustees evaluated three categories of natural resource damages:
  - Damages associated with ecological injuries.
  - Damages associated with recreational use impacts.
  - Damages associated with passive use values.
- Based on the results of these evaluations the trustees developed an inventory of appropriate restoration alternatives.
- Results of this effort were used by the trustees to develop the NRD component of the Governments' comprehensive NRD, remediation, and redevelopment settlement with GE.

Housatonic River Watershed





Ecological *Service Loss*

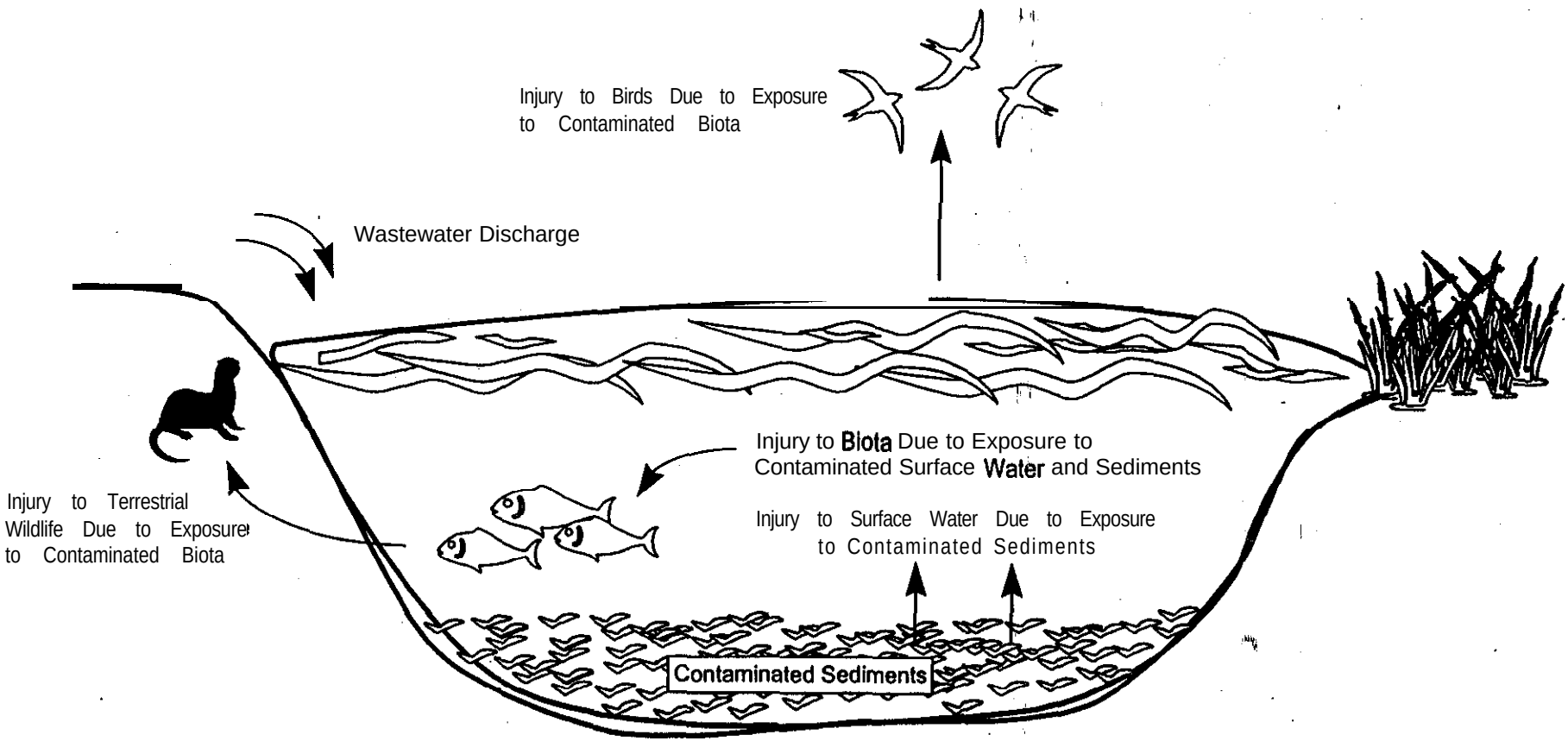
Goal

Evaluate the loss of ecological services provided by the Housatonic River and floodplain resulting from PCB contamination by determining:

1. The geographic areas in which services have been diminished.
2. The degree to which these services have been diminished.
3. The time period during which services have been diminished.
4. The appropriate level of compensation.

Ecological Service Loss

General Ecological Injury Pathways

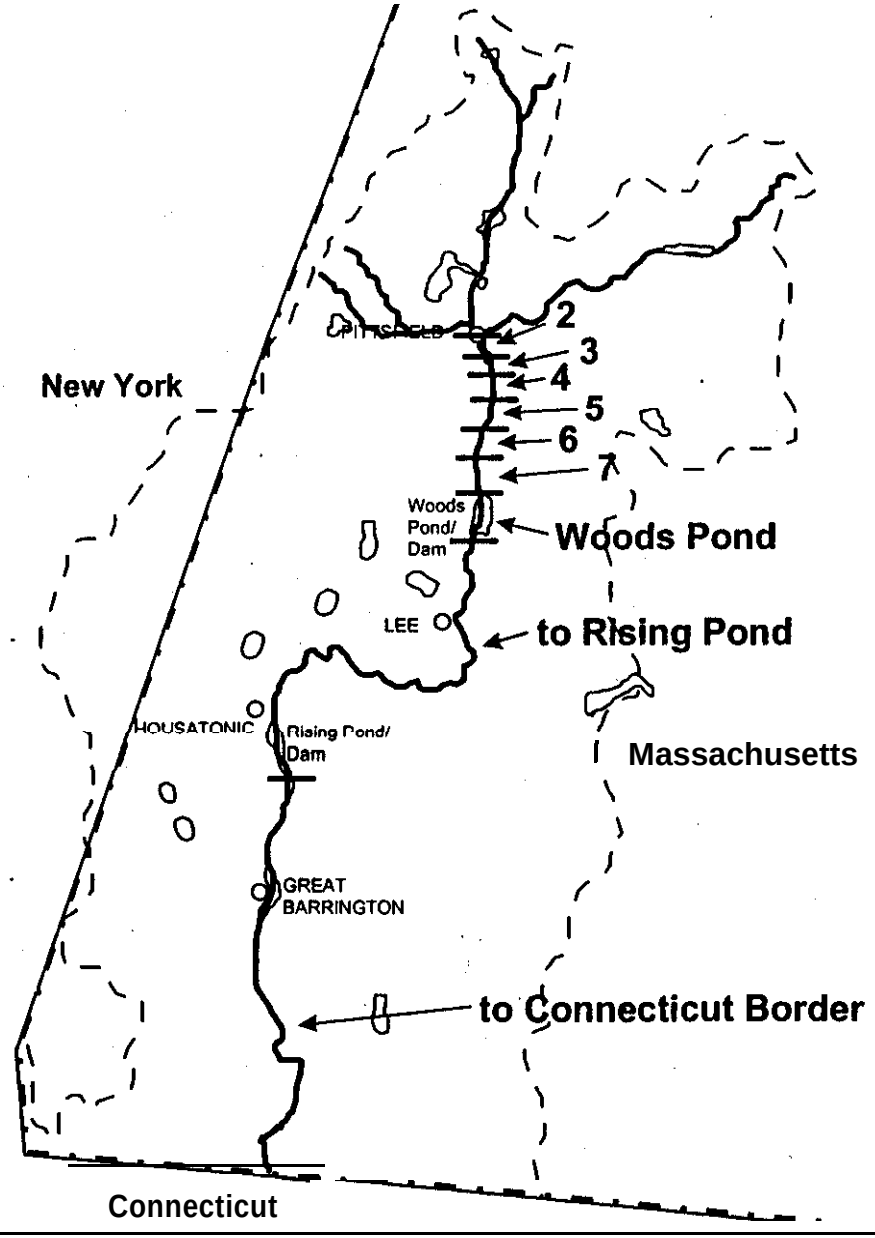


Ecological, Service Loss

General Methodology

- For each identified river and floodplain segment, relying on existing *data and* the *body* of available literature, the trustees:
  - Characterized PCB exposure using indicator species at multiple trophic levels.
  - Compared PCB concentrations to specific toxicity referetice values.
  - Estimated the degree of ecological service reductions.
  - Estimated a percentage of ecological service reduction for that segment.
- This analysis was repeated for each, river and floodplain segment.
- The trustees used the results as input to a Habitat Equivalency Analysis.

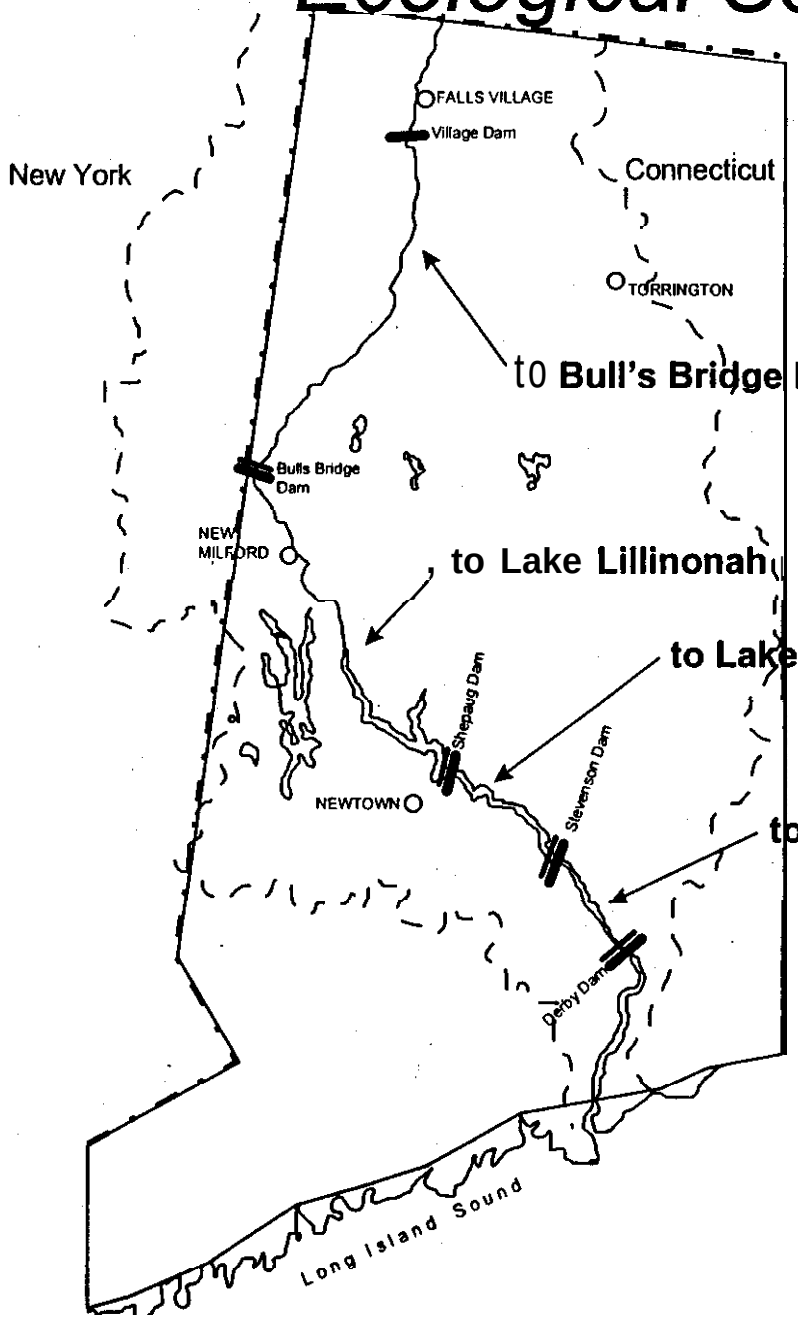
Ecological Service Loss



Housa tonic River Watershed in Massachusetts

River Segments

Ecological Service Loss



Hausatonic River Watershed in Connecticut

River Segments

Ecological Service Loss

Habitat Equivalency Analysis (HEA)

- HEA is the use of modeling and non-monetary damage metrics to evaluate and quantify ecological service losses and to scale appropriate compensation.:,!;
- In this case, the metric is lost "acre years."
- HEA modeling requires the use of actual: data and a variety of assumptions (e.g., periods of past and future impact, discount rate).
- HEA model results reflect consideration of the time period of loss, and the time period in which compensation is provided.

Ecological Service Loss

HEA Results

- Through HEA modeling, the trustees concluded that ecological services have been diminished due to PCB contamination in each of the 14 river segments between Pittsfield and Long Island Sound and in each of the 4 floodplain segments between Pittsfield and the Massachusetts/ Connecticut border.

- The HEA modeling estimated that 12,000 acres of' comparable habitat, provided within 20 years, would be appropriate compensation for the diminished ecological services.

Human' Use Service Loss - Direct Use

Recreational Anglers and Boaters

Goal

Apply existing information, supplemented by focus group results, to estimate the magnitude of loss associated with human health advisories issued for anglers and boaters using the Housatonic.

Human Use Service Loss - Direct Use

Recreational Anglers and Boaters

- Why is it important to evaluate lost recreational use?
  - Fishing and boating represent significant use categories..
  - Human contact with PCBs through fishing and boating (directly or through fish consumption) poses an actual or perceived health risk.
  - This risk leads to the establishment of use advisories and public concern.
  - **Advisories and public concern cause changes in behavior (lost or diminished use opportunities).**

Human Use Service Loss - Direct Use

Recreational Anglers and Boaters

Methodology

- Interviewed resource managers and ‘other relevant parties

- Reviewed available information on fishing behavior on the Housatonic, as well as other rivers and lakes in Massachusetts and Connecticut. ,

- Estimated the number of lost or diminished trips by river segment, over time, ‘associated’with the PCB-related health advisories.

Human Use Service Loss - Direct Use

Recreational Anglers and Boaters

Methodological Considerations

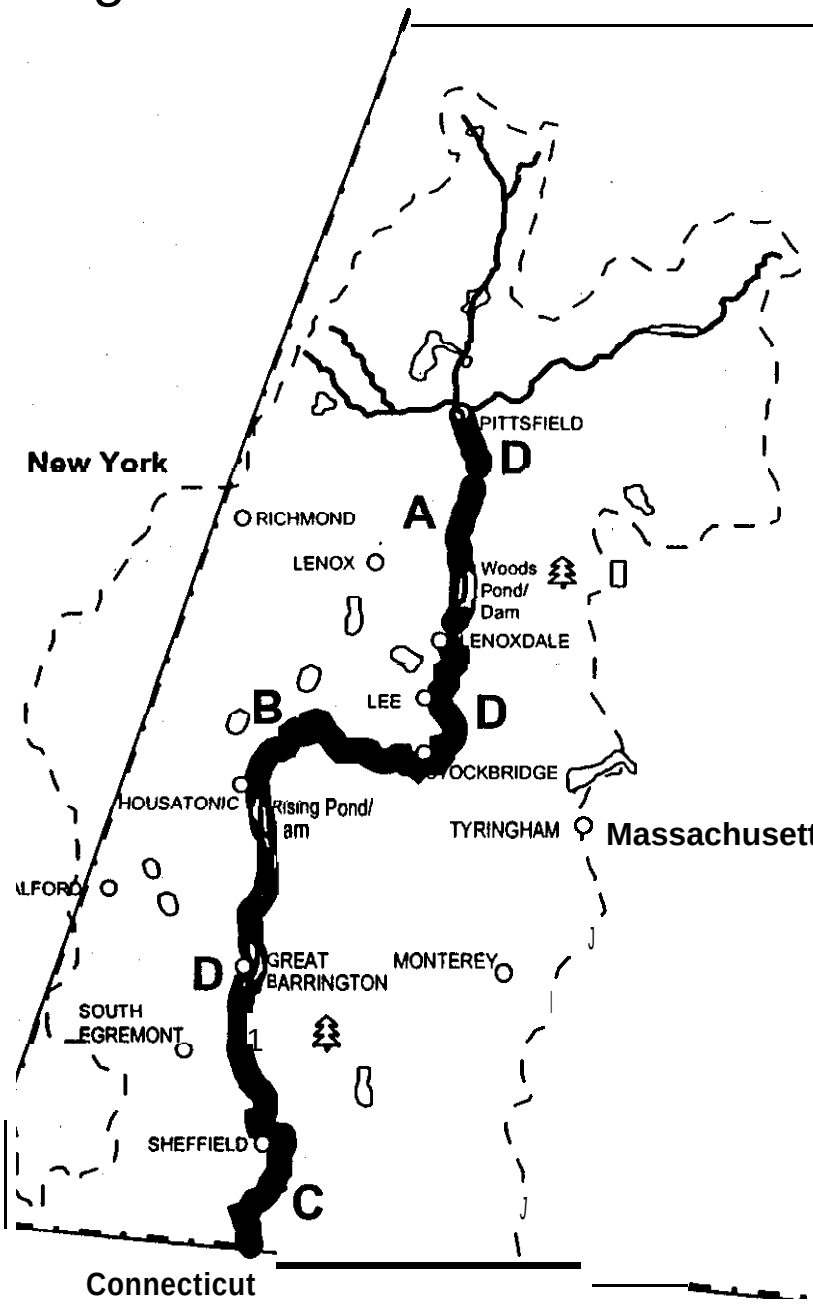
- The nature of the river and the approach to fisheries management varies widely from Pittsfield to the Stevenson Dam in Connecticut.
- Ideally, trustees would compare fishing pressure prior to the public health advisories with pressure after the advisories in order to estimate the number of trips lost.
- However, data on fishing pressure prior to the public health advisories generally do not exist, and overall water quality has improved over time.

Hu'man Use Service Loss - Direct Use

Recreational Anglers and Boaters

T'ne Advisories

Segments Defined for Recreational Fishing and Boating Analysis

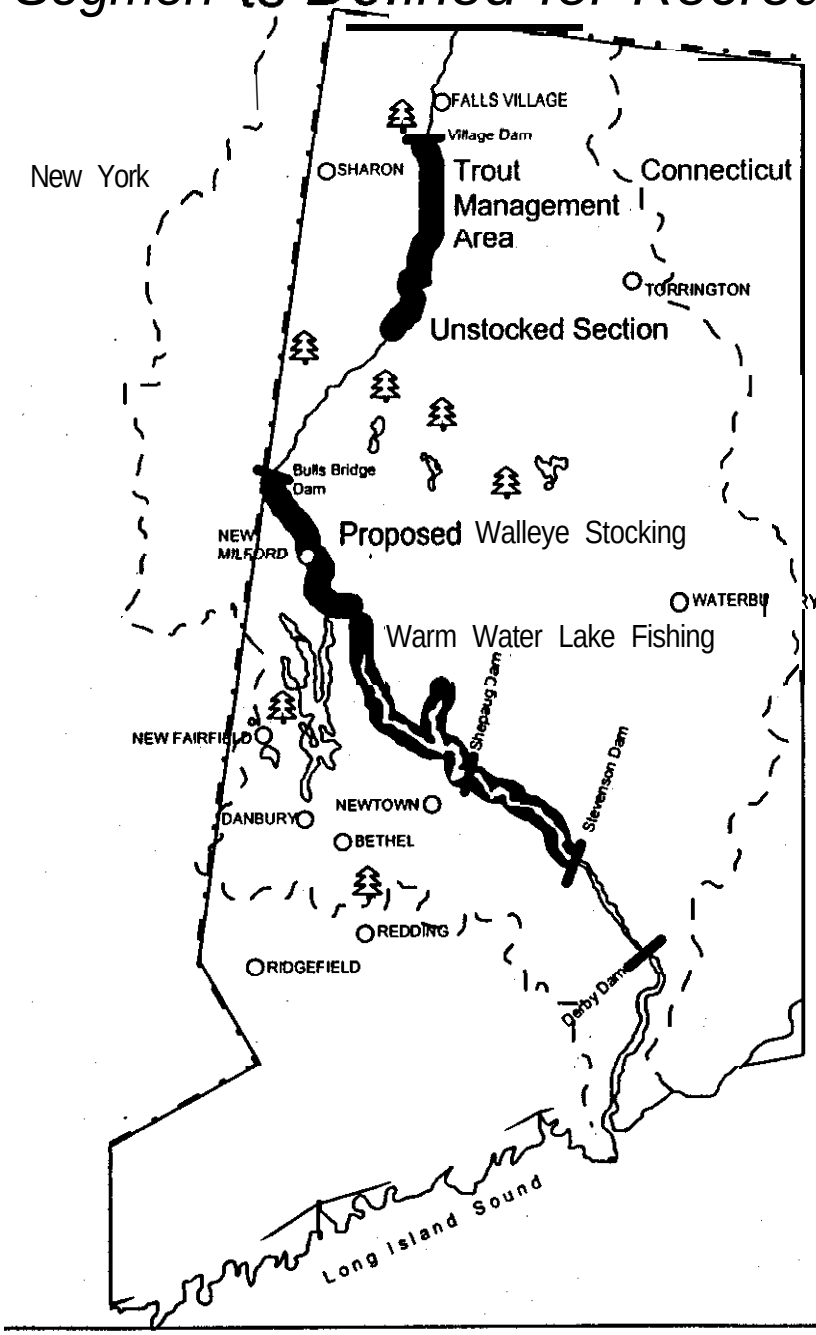


Housatonic River Watershed in Massachusetts

Segment	Description	Time Period	# of Lost Trips/ Year	# of Dimin. Trips/ Year
A New Lenox Rd - Woods	Pond warm water, lost trips	1981-	1,000	NA
B Glendale - Housatonic	trout. lost trips	1981-	700-2,600	NA
C Sheffield - Connecticut Border	warm water. lost trips	1981-	1,000	NA
D Remaining Stretches	warm water. lost trips	1981-	2.700	NA
Boating	canoeing	1990-	900-1,000	NA

NA = Not Assessed

Segments Defined for Recreational Fishing and Boating Analysis



Housatonic River Watershed. in Connecticut

Segment	Description	Time Period	# of Lost Trips/ Year	#of Dimin. Trips/ Year
Trout Management Area	put-and-take trout catch-and-r&lease walleye	1981-1988	8,000	1,600
Warm Water Lake Fishing	warm water	1987-	1,700	0
Proposed Walleye Stocking	walleye	1999-	1,550	--
Boating	--	--	no current effect	

NA = Not Assessed

Human Use Service Loss - Passive Use

Goal

Apply existing information, supplemented by focus group results, to estimate: the magnitude of passive use losses associated with PCB contamination in the Housatonic.

Human Use Service Loss - Passive Use

- The passive use value of a resource reflects the value placed on the resource for reasons other than its direct use (e.g., "existence" value, "bequest" value).

- Trustees employ a variety of methods to evaluate passive use value:
  - Review of "willingness to pay" values derived for comparable sites.
  - Focus groups to test willingness to pay assumptions.
  - Formal "contingent valuation" (CV) surveys.

- In this case, the trustees used the first two methods to complete an evaluation of the values that a high quality CV instrument could be expected to demonstrate.

Human Use Service Loss - Passive Use

- Two factors determine the total willingness to pay: (1) the size of the "market" area for the Housatonic River environment, and (2) the willingness to pay per household within that market area.

- The trustees attempted to define the relevant market area for the Housatonic River environment through:

  - A review of articles on the river in the popular press.
  - Consideration of membership in organizations associated with the river
  - Interviews with representatives of state tourism bureaus, non-profit organizations and other informed parties
  - Focus groups in. Massachusetts and Connecticut.

- The trustees used'data from existing literature as welt as focus. group results to estimate household willingness to pay.

Human Use Service Loss - Passive Use

Mention of Housatonic River/PC& in Newpapers/Magazines

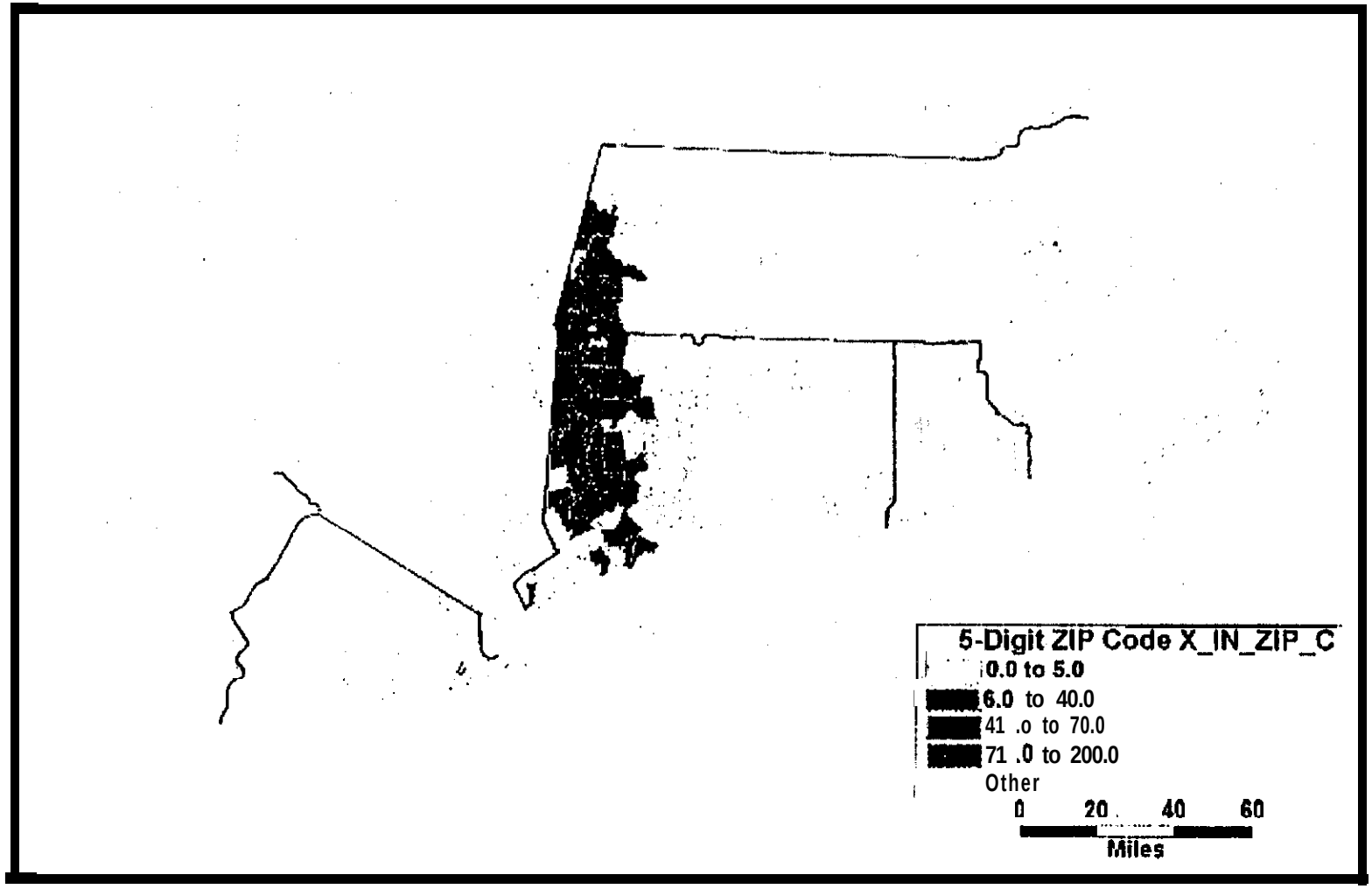
Newspaper (years available on-line)	Article Topic				
	PCBs	Recreation/Travel (Discuss PCBs)	Other Environmental Issues (Discuss PCBs)	Eagles (Shepaug Dam area)	Total (Discuss PCBs)
Hartford Courant (1991-1996)	0	6[1] (2)	5	0	11 (2)
Boston Globe (1980-1996)	7	4	9 (4)	2	22 (11)
Boston Herald (1994-1996)	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.*

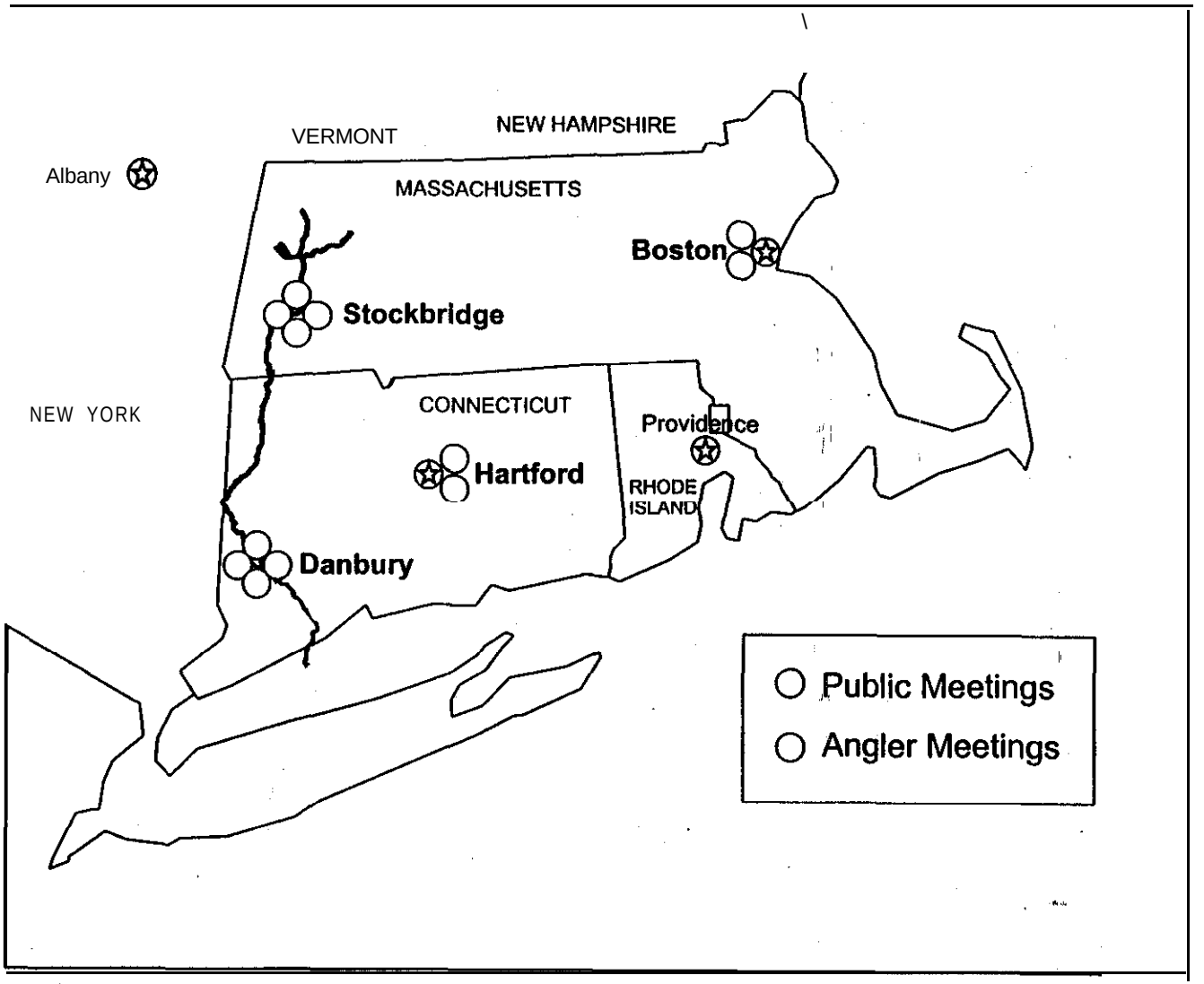
Human Use Service Loss - Passive Use

Housatonic, Valley Association Members, by Zip Code



Humanr Use Service Loss - Passive Use

Focus Group Locations



Human Use Service Loss - Passive Use

Discussion Sequence: General Public Focus Groups

Dis ussion Topics

Opening Statement

Two or three most important problems facing the state

Does state face important environmental problems? If so, which?

Do you use state's freshwater bodies for any recreational experience this year?

Description of state's major rivers

Description of the PCB and mercury advisories for the major rivers

Description of PCBs and their effects on wildlife

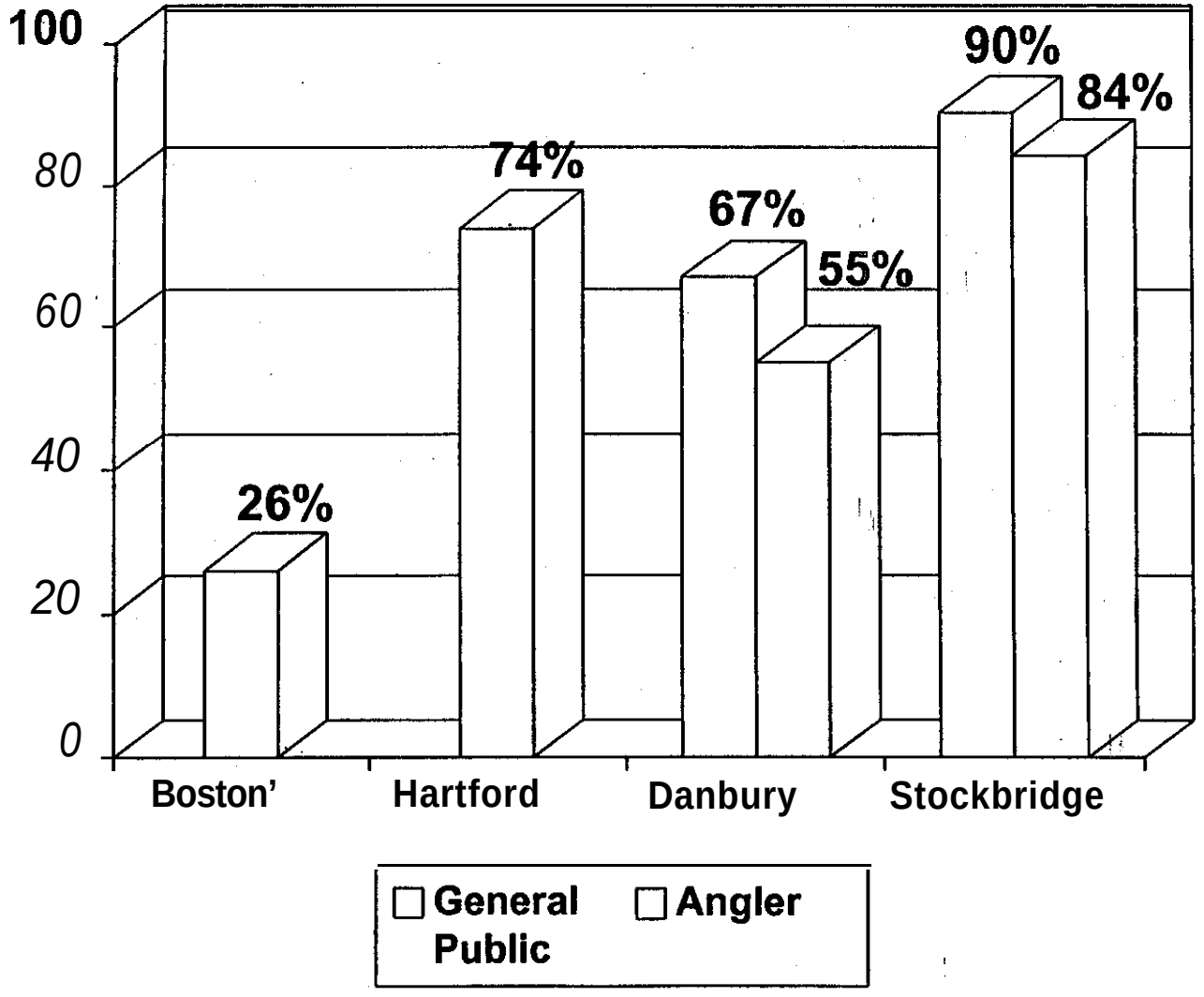
Issue: Should the public pay for a program to cleanup the PCBs in the state's portion of the Housatonic? Description of what the program would do and would not do and how it would be done.

Why they voted the way they did

(Filled out short questionnaire before departing)

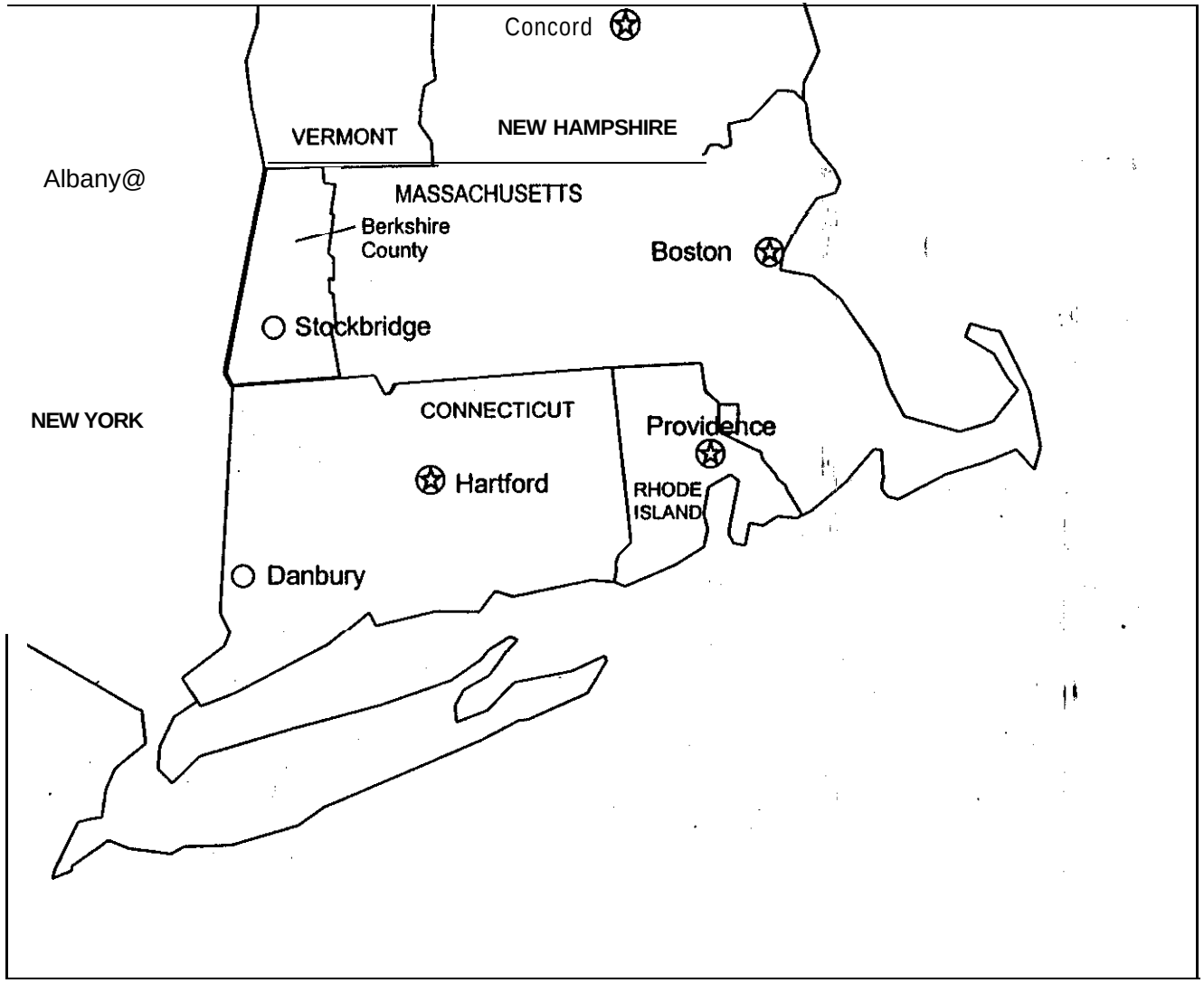
Human Use Service Loss - Passive Use

Summary of Willingness to Pay Responses (% of "Yes Votes)*



Human Use Service Loss - Passive Use

Assumed Markef Area for Housatonic River



‘Restoration

Overview

- Based’on the evaluation of past and future service interruptions (i.e., ecological habitat, recreational use, passive. use) . . .
- . . . and an inventory of projects evaluated on the basis of factors such as stakeholder priorities, relationship to resource and service losses, and implementability . . .
- The trustees constructed a set of projects that would provide appropriate compensation for the identified ecological and human use losses.

Restoration

Project Categories

- Resource-based
- Access-based
- Maintenarice-based

Restoration

Resource-based Projects

- Acquisition of key habitats and sensitive environments. within the Housatonic River watershed in Massachusetts and Connecticut.
- Riparian and instream habitat improvements in key segments of the river in both Massachusetts and Connecticut.
- Targeted fishery enhancements in Connecticut.
- This combination of projects would address habitat losses, improve the quality and quantity of recreational opportunities, and address passive use losses.

Restoration

Access-based Projects

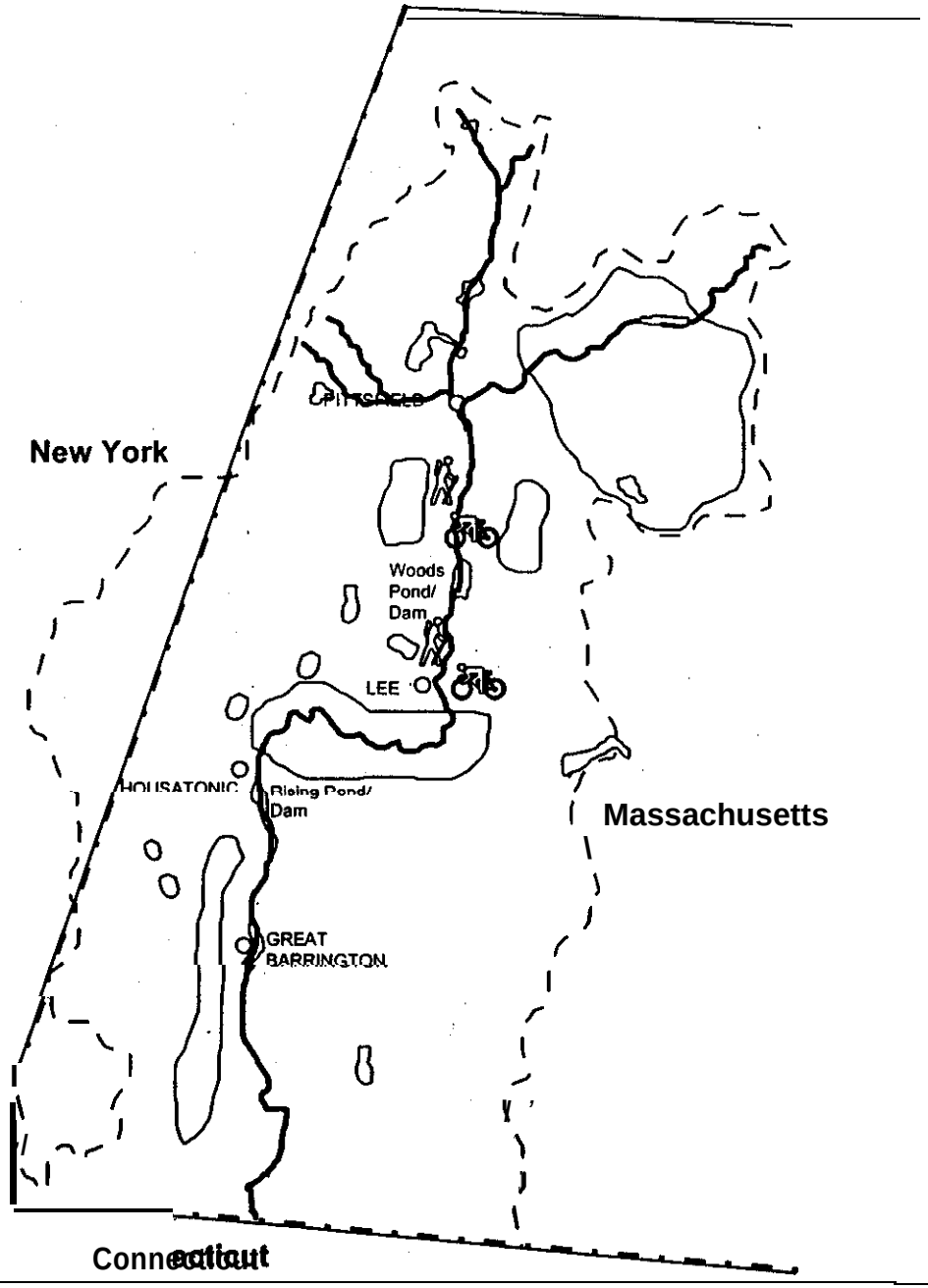
- Construct riverbank trails.
- Upgrade existing river facilities.
- Provide additional access to the river.
- This combination of projects helps to ensure that the public will have the ability to utilize this valuable natural resource.

Restoration

Maintenance-based Projects

- River Steward program.
- Operations and maintenance programs ‘For acquired lands in Massachusetts and Connecticut.
- Fisheries management program in Connecticut.
- This combination of projects ensures that the public’s use of the river will be protected into the future.

Examples of Potential Housa tonic River Restoration Projects



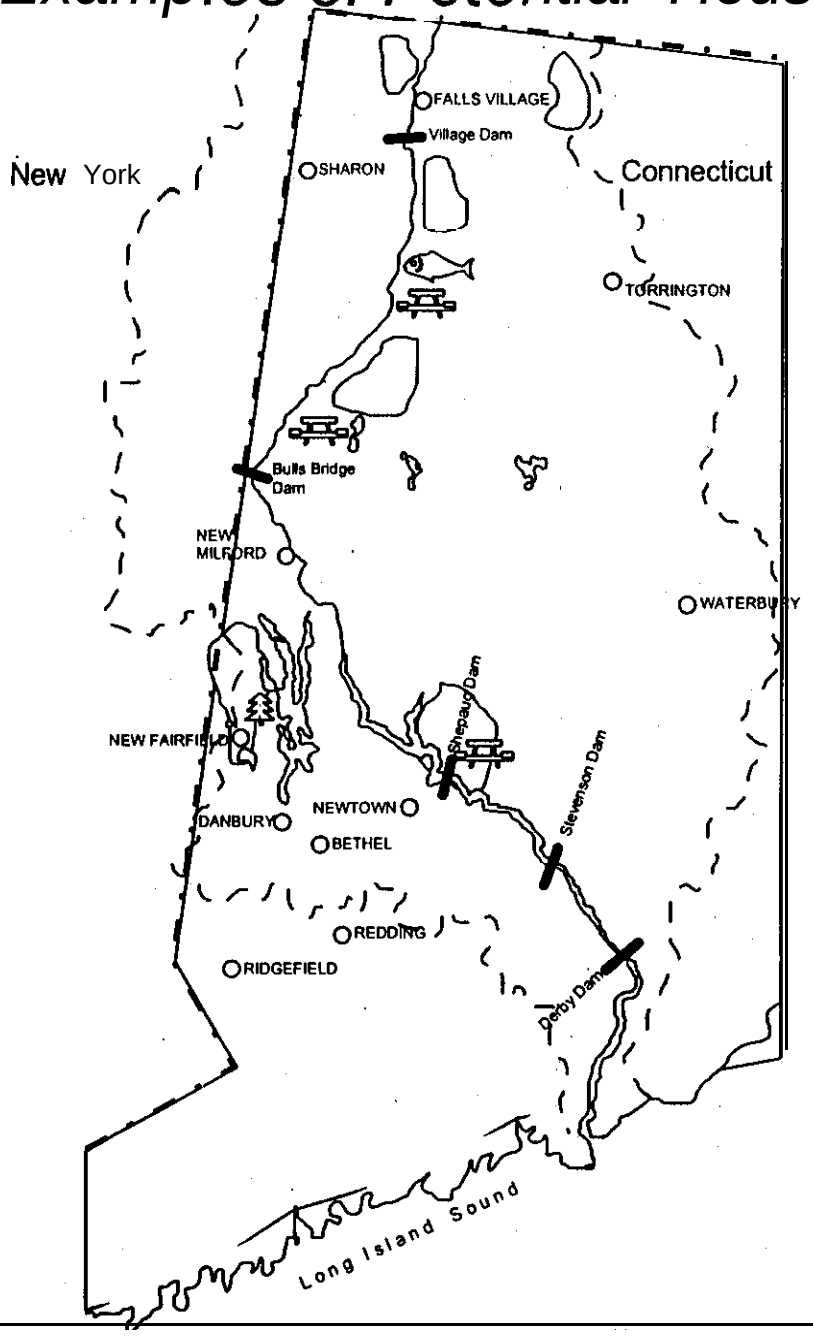
Housa tonic River Watershed in Massachusetts

Key

Land Acquisition and O&M

Riverbank Trails

Examples of Potential Housatonic River: Restoration Projects



Housatonic River Watershed in Connecticut

Key

Land Acquisition and O&M

Fish Management Program

Existing Facilities Upgrade

NATURAL RESOURCE DAMAGES
NRD Settlement for the Housatonic River - GE Pittsfield Site

RESTORATION OF NATURAL RESOURCES

Primary Restoration

Primary restoration will be composed of the response actions agreed upon for the Housatonic River, Silver Lake, Unkamet Brook and associated wetlands and floodplains. The Settlement provides for the Trustees' participation in the development of the Response Actions.

Compensatory Restoration

1. GE will pay $15 million, to be administered by the natural resource trustees (NOAA, DOI, MA EOEA, CT DEP/BNR), with appropriate public input, for natural resource restoration and enhancement projects in the Housatonic River environment.

2. The Pittstield Economic Development Authority (PEDA) will establish a revenue-sharing arrangement linking the anticipated success of the economic redevelopment in Pittstield with $4 million in additional natural resource damage compensation. The $4 million will be administered by the natural resource trustees, with appropriate public input, for natural resource restoration and enhancement projects in the Housatonic River environment.

3. GE will perform or fund the following restoration/ enhancement projects in connection with the cleanup:

   a. Habitat enhancements in the first ½ mile river reach (pool/riffle structure in riverbed, enhancement of vegetation on banks) in conjunction with response action performed by GE.

   b. Habitat improvements in the next I ½ mile reach (pool/riffle structure in riverbed, enhancement of vegetation on banks), to be performed by EPA in conjunction with response action performed by EPA and to be financed as part of the I ½ mile cleanup. (see I.C.8.d.)

   c. Habitat and recreational enhancements at Silver Lake.

   d. Unkamet Brook rerouting and habitat improvement.

   e. At the GE Plant Site south of East Street. enhance stormwater drainage and create vegetated buffer by pavement; emoval in 200 foot wide strip between Newell Street and facility boundary and replacement with clean soil and vegetation.

   f. Habitat improvements at former Oxbow A and C (approximately 15 acres) to encourage long term increased wildlife use.

   g. Installation ofvegetated caps and other habitat enhancements at some former GE landfills and GE-owned parking lots.

   h. Protection of IO acres of wetland on GE Plant Site east of Unkamet Brook through a conservation easement.

   i. Payment by GE of $600.000 for wetlands mitigation.

4. GE will coordinate with the Trustees and EPA in the design. implementation and maintenance plans for the projects.

5. GE will discuss with the Trustees and the City at a later time, greenway/walkway projects in the vicinity of the River near the GE facility.

6. Habitat enhancement, revegetation and recreational enhancements associated with brownfields redevelopment.

HOUSATONIC RIVER

EVALUATION OF NATURAL RESOURCE DAMAGES

ECOLOGICAL SERVICE LOSSES

- Materials describing injury assessment methodology
- Data summaries associated with injury assessment
- Habitat equivalency analysis output

Housatonic River Injury Assessment: Objectives

- Determine the spatial and temporal extent of ecological, injuries to aquatic and terrestrial species associated directly with the Housatonic River.

- Identify the degree of injuries in impacted species.

Housa tonic River Injury Assessment: Introduction

- Study Site: Housatonic River and associated flood plain -- Pittsfield to Long island, Sound.

- Compound Released: Predominantly (9599%) Aroclor 1260 (Hexa-nona chlorinated biphenyls make up 89% of product mixture).

- Distribution of PCBs in the environment
  - -- << w a t e r
  - -- sediment
  - -- biota
- Interspecies PCB transport pathways
  - -- sediment biological interactions
  - -- trophic transfer of PCBs

Housa tonic River Injury Assessment: Methods

- Species exposure.
- Duration of exposure.
- Identification of relevant toxicity reference values.
- Loss of ecological services from exposure.
- Habitat Equivalency Analysis

Housatonic River Injury Assessment: Methods (continued)

Species Exposure

- No new data collected.

- . Injury assessment based upon:
  -- previously conducted studies in the Housatonic (species/ environment exposure data collected)
  -- previously published and unpublished toxicity literature (toxicity reference values and PCB degradation data)

- Species chosen for injury assessment (selection criteria):
  -- resident in Housatonic River in significant populations
  -- PCB data available for multiple locations'
  -- species representative of various riverine environment'trophic, levels

Housa tonic River Injury Assessment: Methods (continued)

Species Exposure (continued)

- Species chosen for injury assessment include:
  - -- Yellow Perch
  - -- Largemouth Bass
  - -- Earthworm
  - -- Snapping Turtle
  - -- Mink
  - -- Pumpkinseed/Bluegill
  - -- Bullfrog
  - -- Kingfisher
  - -- Robin
  - -- Otter
- Actual species tissue contamination data used where available
- Where not available, species tissue PCB concentration data derived from Housatonic River biological sediment accumulation factors and published biological accumulation factors

Housa tonic River Injury Assessment: Methods (continued)

Species Exposure (continued)

- PCB concentrations in indicator organisms were observed or calculated for the following locations:
  - -- Reaches 2-7 of upper Housatonic River
  - -- Woods Pond
  - -- Rising Pond
  - -- Connecticut Border'
  - -- Cornwall
  - -- Bulls Bridge
  - -- Lake Lillinonah
  - -- Lake Zoar
  - -- Lake Housatonic

- Main stem riverbed sediment PCBs concentration data currently available.

- Flood plain PCB concentration data (MA only) used in terrestrial ecosystem assessment.

Housa tonic River Injury Assessment: Methods (continued)

Duration of Exposure

- **Past:** Assessment assumption: due to release of PCBs into Housatonic river from 1930s-1970s, PCB concentrations have been elevated in the river. Due to slow degradation rates (see below) concentrations of PCBs from 1981-present were at least as high as present PCB levels.

- **Present:** Observed and calculated PCB concentrations in fish and wildlife are presented elsewhere in this presentation.

Housa tonic River Injury Assessment: Methods (continued)

Duration.of Exposure (continued)

- **Future:** Based upon data presented in Van Dort et al. (1997) only approximately 23% of hexa-nona chlorinated biphenyls have degraded in Woods Pond in the last 50 years, making the half-life for this portion of Aroclor 1260 (89% of total mixture makeup) 115.5 years.

Housa tonic River Injury Assessment - Loss of Ecological Services from Exposure

- Decrease in level of ecological services provided is related to:
  - spatial extent and degree of PCB concentration
  - temporal extent and degree of PCB contamination
  - degree of toxic impacts to resident biota

- An indicator species/environment is used for major trophic levels in th Housatonic River environment:

Riverine/Aquatic Food Chain
- Sediments (macroinvertebrate)
- Housatonic River fish
  - Pumkinseed/Bluegill
  - Yellow perch
  - Largemouth bass
- Bullfrog
- Snapping turtle
- Kingfisher
- Mammals
  - Mink and Otter

Flood Plain/Food Chain
- Sediments
- Worms
- Robin

Housatonic River Injury Assessment - Loss of Ecological Services from Exposure

(continue@)

- Toxic impacts to these indicator species will result in a reduction in ecological services provided by the represented trophic level. For example:

  [PCB] $\geq$ NOEL (O-IO% service reduction)
  [PCB] $\geq$ LOEL (IO-40% service reduction)
  [PCB] $\geq$ $EC_{,,}$ (25-50% service reduction)
  [PCB] $\geq$ LC_{50} (75100% service reduction)
  [PCB] $\geq$ 'Mortality (100% service reduction)

Housa tonic River Injury Assessment - Methods

Identification of relevant Toxicity Reference Values (TRVs)

- Identify relevant (related) species/sediments
- Use TRVs derived under similar conditions to those observed in Houstonic River environment
- Use TRVs derived for similar PCB products
- Use TRVs which distinguish degree of toxicity for species of concern - e.g.:
  - NOEL/NOAEL (no effects level/no adverse effects level)
  - EC,, (Effect concentration @ 50% of tested organisms)
  - LC,, (Lethal concentration @ 50% of tested organisms)

Housa tonic River Injury Assessment - Methods (continued)

Identification of relevant Toxicity Reference Values (TRVs) (continued)

- Sediment benchmark (Addresses benthic macroinvertebrates):
  No effect level: 20 ppb
  Threshold effect level: 34.1 ppb
  Probable effect' level: 277 ppb

- Fish
  Reduced hatchability: 0.31 ppm (Lake trout)
  LOEL (adult): 4.5 ppm (Trout)
  58% mortality (adult): 32.8 ppm (*Fundulus*)

Housa tonic River Injury Assessment - Methods (continued)

Identification of relevant Toxicity Reference Values (TRVs) (continued)

- Birds
  NOEL: 7 ppm (Forsters tern/pisciverous dird)
  LOAEL: 8-25 ppm (Terns, eagles, doves, cormorants).
  Lethality: 75-300 ppm (Cormorants, gulls, passerines, pheasants)

- Mink
  LOEC 0.4-5 ppm (Reduced reproduction)
  EC,, 1.2 ppm (Litter size)
  Mortality 31 ppm

- Otter
  LOEC 3.5 ppm (females)
  EC_{50} 16 ppm

Housa tonic River Injury Assessment: Habitat Equivalency Analysis (HEA) Introduction

- Method for identifying appropriate levels of compensation for past and future ecological service losses through provision of additional similar services in the future.

- These services are in addition to those required to restore the resource. to, baseline conditions.

. Accordingly, the level of services indicated by the HEA method addresses interim losses.

Housa tonic River Injury Assessment: Habitat Equivalency Analysis Assumptions

- Same general level of losses occurred: 19814997
- Remedial activities occurring: 1998-2002
- Sediment remediation level is 9ppm
- Recovery of remediated areas: 2003-2007
- Ecological services lost due to residual, post-remediation contamination-: 2008-2017
- Discount rate: 3%’

Housa tonic River Injury Assessment: Habitat Equivalency Analysis: Results

- Number of compensatory,acres required for past losses.
- Number of compensatory acres required for future losses
- Based on analysis of percent service reduction, weighted values for acres lost.
- Total number of compensatory acres required.

HOUSATONIC RIVER INJURY ASSESSMENT

TABLE OF CONTENTS FOR INJURY ASSESSMENT CALCULATIONS

DOCUMENT 1

Observed Average PCB Concentrations (parts per million) in Housatonic Riverbed Sediment/Macroinvertebrates [1]		Toxic Reference Values (ppm)[1]		Estimated Average Service Reduction due to PCB Conlamination in Housatonic River Sediment'				
Reach	Average w/Backwaters			NOEL	Average w/Backwaters PEL	SEL	Sediment/ Macroinvertebrate % serv. reduc.	
each 2	0.83	NOEL [a]	'0.02	10	50	100	100	
each 3	17.08	PEL [b]	0.277	10	50	100	100	
each 4	47.53:	SEL [c]	0.34	10	50	100	100	
each 5	37.57			10	50	100	100	
each 6	18.06			10	50	100	100	
each 7	26.65			10	50	100	100	
'oods Pond	29			10	50	100	100	
ising Pond				10	50	100	100	
T Border	I			10	50	100	100	
ornwall	0.15			10	0	0	10	
ills's Bridge	0.30			10	10	0	10	
ake Lillinonah	0.59			10	50	50	50	
ake Zoar	0.26			10	0	0	10	
tke Hottsatonic	Data not available							

otes:

[PCB] are observed sediment concentrations. Benthic invertebrate toxicity reference values were used to develop sediment quality guidelines. (Smith et al. 1996, and MENVIQ 1992. Persuad et al. 1991)

Rules for estimation of percent service reduction:

[PCB] > NOEL (O-IO% service reduction)

[PCB] > PEL (IO-50% service reduction)

[PCB] > SEL (50-100% service reduction)

If sediment/species [PCB] is greater than 2 times the action level, % service reduction is the high end of the service reduction range.

If sediment species (PCB] is between I and 2 times the action level, % service reduction is the low end of the service reduction range.

If sediment species (PCB] is less than the action level, % service reduction is 0.

DOCUMENT 2

Total Suspended Solids (milligrams per liter) in the Housatonic River
1979- 1992

River mile fmm LIS	CT Border 84.6	Cornwall 70	Bull's Bridge 52	Lake Lillinonah 30	Lake Zoar 21	Lake Housatonic
Means - -		66	45.5	29.9	9	
		139.7		20.9	is.3	
		27.6		16.8		
Average of means		77.8	45.5	22.5	12.15	Data not available

Calculated PCB Concentration (parts per million) in the Total Suspended So

River mile from LIS	CT Border 84.t	Cornwall 70				
			0.14	0.11	0.07	
				0.09	0.08	
				0.08		
			0.14	0.10	0.07	0.0
Means		0.19				0M
		0.34		0.09	0.08	
		0.11		0.08		
Average of means		0.21	0.14	0.10	0.07	0.0

Notes:

1. PCB concentrations were calculated from TSS concentrations using the following equation, assuming flow is greater than 750 cubic feet per second:

PCB = 0.048 + 0.0021 x TSS

The equation is found in "PCB Fate and Transport Model: Additional Monitoring and Model Verification" for the Housatonic River, Connecticut, November, 1994, by General Electric.

2. PCB concentration in the Lake Housatonic reach was extrapolated from a best tit line on a graph of PCB concentration versus river mile.

DOCUMENT 4

Housatonic River Species of Concern: Organism PCB Concentrations (parts per million) by Riverbed Reach Based upon 1984-1996 Sampling Efforts

		Yellow Perch (yoy) [1-4]	Pumpkinseed/ Bluegill (yoy) [1-4]	Largemouth Bass (yoy) [1-4]	Kingfisher [5]	Mink [6]	otter [7]
Reach 2	avg	1.9[B]	1.9[B]	1.9[B]	3.6-7.1[B]	0.7-30.2[B]	26.6[B]
	high	13.5[B]	13.5[B]	13.5[B]	25.9-50.8[B]	5.0-214.7[B]	189[B]
Reach 3	avg	38.4'	38.4'	38.4'	73.7-144.4[B]	14.2-610.6[B]	538[B]
	high	83.3'	83.3[B]	83.3'	160.0-313.2[B]	30.8-1323.5[B]	1166.2'
Reach 4	avg	106.9"	106.9'	106.9'	205.2-402.0[B]	39.6-1700.0[B]	1496.6'
	high	1372.5'	1372.5'	1372.5'	2635.2-5160.6	507.8-21822.8[B]	1921.5[B]
Reach 5	avg	26[A]	27"	29.5"	52.8-103.4[B]	10.2-437.3[B]	385.0'
	high	27"	29"	31[A]	55.7-109.0[B]	10.7-461.1[B]	406[B]
Reach 6	avg	40.6'	40.6"	40.6'	78.0-152.7[B]	15.0-645.5[B]	568.4'
	high	180[B]	180[B]	180[B]	345.6-676.8[B]	66.6-2862.0[B]	2520[B]
Reach 7	avg	60.0[B]	60.0'	60.0'	115.2-225.6[B]	22.2-954.0[B]	840[B]
	high	495[B]	495[B]	495[B]	950.4-1861.2[B]	183.2-7870.5[B]	6930[B]
Reach 7-1W	avg	33.5"	19.5"	22.5[A]	48.3-94.6[B]	9.3-400.1[B]	352.3'
(Woods Pond)	high	38[A]	22"	23[A]	53.2-104.2[B]	10.2-440.4[B]	387.8'
Rising Pond	avg	6.1[A]	5.4[B]	16[A]	17.6-34.5[B]	3.4-145.8[B]	128.4'
	high	6.1[A]	49.5[B]	16[A]	45.9-89.9[B]	8.8-380.0[B]	334.6'
CT Border	avg	3.9"	2.5"	3.9[A]	6.6-12.9[B]	1.3-54.5[B]	48.02'
	high	4.5"	3.5[A]	4.3[A]	7.9-15.4[B]	1.3-65.2[B]	57.4[B]
Cornwall	avg	3.94[A1]	5.88[A1]	2.98	8.1-15.9[B]	1.3-67.4[B]	59.4[B]
	high	3.94"'	5.88[A1]	2.9[B]	7-13.7[B]	1.3-67.4[B]	59.4[B]
Bulls Bridge	avg	1.6[A1]	1.9[A1]	4.18"'	4.9-9.6[B]	0.8-40.7[B]	35.8'
	high	2.28[A1]	3.7[A1]	4.18"'	6.5-12.7[B]	1.0-53.8[B]	47.4[B]
Lake Lillinonah	avg	0.82[A1]	0.82[A1]	1.4[A1]	1.9-3.8[B]	0.3-16.1[B]	14.2[B]
	high	0.82[A1]	1.22"'	2.3[A1]	2.8-5.4[B]	0.4-23.0[B]	20.3'
Lake Zoar	avg	0.68[A1]	0.6[A1]	1.0[A1]	1.5-5.9[B]	0.2-12.1[B]	10.6[B]
	high	0.68[A1]	0.6[A1]	2.3"'	2.3-4.5[B]	0.4-19.0[B]	16.7[B]
Lake Housatonic	avg	0.44"'	0.39"'	0.6[B]	0.9-1.8[B]	0.1-7.6[B]	6.7[B]
	high	0.44"'	0.39"'	0.6[B]	0.9-1.8[B]	0.1-7.6[B]	6.7'

DOCUMENT 5

Housatonic River Species of Concern: Averaged Organism PCB Concentrations (parts per million) by Riverbed Reach
Based upon 1984-1996 Sampling Efforts

	Yellow Perch (yoy)[1,2]	Pumpkieed/ Bluegil (yoy)[1,]	Largemouth Bass (yoy)[1,]	Kingfisher[3]			Mink[4]			Otter[5]
				low	high	avg	low	high	avg	
Reach 2	1.9	1.9	1.9	3.6	7.1	5.4	0.7	30.2	15.5	26.6
Reach 3	38.4	38.4	38.4	73.1	144.4	109.1	14.2	610.6	312.4	537.6
Reach 4	106.9	106.9	106.9	205.2	402	303.6	39.6	1700	869.8	1496.6
Reach 5	26	27	29.5	52.8	103.4	78.1	10.2	437.3	223.8	385.0
Reach 6	40.6	40.6.	40.6	78	152.7	115.4	15.02	645.5	330.3	568.4
Reach 1	60.0	80.d	60.6	115.2	225.6	170.4	22.2	954	488.1	839.4
Woods Pond	33.5	19.5	22.5	48.3	94.6	71.5	9.3	400.1	204.7	352.3
Rising Pond	6.1	5.4	16	17.6	34.5	26.1	3.4	145.8	74.6	128.3
CT Border	3.9	2.5	3.9	6.6	12.9	9.8	1.3	54.5	27.9	48.1
Cornwall	3.94	5.88	2.9	8.1	15.9	12.0	1.3	55.7	28.5	59.4
Bulls Bridge	1.6	1.9	4.18	4.9	8.6	6.8	0.8	40.7	20.7	35.8
Lake Lillinonal	0.82	0.82	1.4	1.9	3.8	2.9	0.3	23.9	12.1	14.2
Lake Zoar	0.68	0.6		1.5	2.9	2.2	0.2	13.2	6.7	10.6
Lake Housatonic	0.44	0.39	0.6	0.7	1.3	1.0	0.1	7.6	3.9,	6.1

Estimated Average Percent Loss in Services of Indicator Species due lo PCB Contamination in the Housatonic River [6]

	Kingfisher				Mink		Otter	
	NOEC	LOEL	Mortality	LOEL	EC50	Mortality	LOEL	EC50
Reach 2	0	0	0	40	50	0	40	25
Reach 3	10	40	100	40	50	100	40	50
Reach 4	10	40	100	40	50	100	40	50
Reach 5	10	40	100	40	50	100	40	50
Reach 6	10	40	100	40	50	100	40	50
Reach 7	10	40	100	40	iii	100	40	50
woods Pond	10	40	0	40	50	100	40	50
Rising Pond	10	25	0	40	50	100	40	50
CI' Border	0	IO	0	40	50	0	40	50
Cornwall	0	IO	0	40	50	0	40	50
Bulls Bridge	0	0	0	40	50	6	40	50
Lake Lillinonah	0	0	0	40	50	0	40	0
Lake Zoar	0	0	0	40	50	0	25	0
Lake Housatonic	0	0	0	40	50	0	IO	0

Estimated Average Loss of Services in Trophic Levels due to PCB Contamination in the Housatonic River [6]

	Sediment avg. % serv reduc'	Fish avg % serv. reduc. [n]	Bird avg % serv. reduc. [n]	Mammal avg. % serv reduc. [o]	Total sys % serv. reduc
Rleach 2	100	40	0	45	46.3
Rleach 3	100	75	100	75	87.5
Rleach 4	100	100	100	75	93.8
Rleach 5	100	40	100	75	78.8
Rleach 6	100	75	100	75	87.5
Reach 7	100	is	100	75	87.5
W'oods Pond	100	51.7	40	75	66.7
Rilsing Pond	100	40	is	75	60.0
CT Border	100	40	IO	50	50.0
Cornwall	IO	40	10	50	27.5
Bulls Bridge ,	IO	40	0	50	25.0
Lake Lillinonah'	50	30	0	45	31.3
Lake Zoar	10	20	0	37.5	16.9
Lake Housatonic	0	IO	0	30	10.0

DOCUMENT 6

Housatonic River Species of Concern: Average Organism PCB Concentrations (parts Per million) by Riverbed Reach Based upon 19X4-1996 Sampling Efforts and Modelling, Assuming Sediment Remedialion to 5 ppm

	Yellow Perch (yoy)[1,2]	Pumpkin eed/ Bluegill (yoy)[1,2]	Largemouth Bass (yoy)[1]	Kingfisher[3]			Mink[4]			Otter[5]
				low	high	avg	low	high	avg	
Reach 2	1.9	1.9	1.9	3.6	7.1	5.4	0.7	30.2	15.5	26.6
Reach 3	11.3	11.3	11.3	21.7	42.5	32.1	4.2	179.7	92.0	157.5
Reach 4	11.3	11.3	11.3	21.7	42.5	32.1	4.2	179.7	92.0	157.5
Reach 5	11.3	11.3	11.3	21.7	42.5	32.1	4.2	179.7	92.0	157.5
Reach 6	11.3	11.3	11.3	21.7	42.5	32.1	4.2	179.7	92.0	157.5
Reach 1	11.3	11.3	11.3	21.7	42.5	32.1	4.2	179.7	92.0	157.5
Reach 7-1 W	11.3	11.3	11.3	21.7			4.1	179.7	92.0	157.5
Rising Pond	6.1	5.4	16	17.6	26.1	21.9	3.4	145.8	74.6	128.3
CT Border	3.9	2.5	3.9	6.6	9.8	8.2	1.3	54.5	27.9	48.1
Cornwall	3.94	5.88	1.9	8.1	10.0	9.1	1.3	55.7	28.5	59.4
Bulls Bridge	1.6	1.9	4.18	4.9	6.5	5.7	0.8	40.1	20.7	35.8
Lake Lillinonah	0.82	0.82	1.4	1.9	4.1	3.0	0.3	23.9	12.1	14.2
Lake Zoar	6.68	0.6	1	1.5	2.3	1.9	0.2	13.2	6.7	10.6
Lake Housatonic	0.44	0.39	0.6	0.7	1.0	0.8	0.1	7.6	3.9	6.7

Estimated Average Percent Loss' in Services of Indicator Species due to PCB Contamination in the Housatonic River, Assuming Sediment Remediation to 5 ppm

	Kingfisher			Mink		Otter		
	NOEC	LOEL	Mortality	LOEL	EC50	Mortality	LOEL	EC50
Reach 2	0	0	0	40	50	0	40	25
Reach 3	10	40	0	40	50	100	40	50
Reach 4	10	40	0	40	50	100	40	50
Reach 5	10	40	0	40	50	100	40	50
Reach 6	10	40	0	40	50	100	40	50
Reach 1	10	40	0	40	50	100	40	50
Woods Pond	10	40	0	40	50	100	40	50
Rising Pond	10	25	0	40	50	100	40	50
CT Border	0	10	0	40	50	0	40	50
Cornwall	0	10	0	40	50	0	40	50
Bulls Bridge	0	0	0	40	50	0	40	50
Lake Lillinonah	0	0	0	40	50	0	40	0
Lake Zoar	0	0	0	40	50	0	25	0
Lake Housatonic	0	0	0	40	50	0	10	0

Estimated Average Loss[6] of Services in Trophic Levels due lo PCB Contamination in the Housatonic River, Assuming Sediment Remediation lo 5 ppm

	Sediment avg. % serv. reduc'	Fish avg % serv. reduc. [m]	Bird avg. % serv. reduc. [n]	Mammal ng. % serv. reduc. [o]	Total sys % serv. reduc
Reach 2	100	40	0	45	46.3
Reach 3	100	40	40	75	63.8
Reach 4	100	40	40	75	63.0
Reach 5	100	40	40	75	63.8
Reach 6	100	40	40	75	63.8
Reach 7	100	40	40	75	63.8
Woods Pond	100	40	40	75	63.8
Using Pond	100	40	25	75	60.0
CT Border	100	40	IO	50	50.0
Cornwall	10	40	IO	50	21.5
Bulls Bridge	I O	40	0	45	23.8
Lake	50	30	0	ji.5	29.4
Lake Zoar	10	20	0	37.5	16.9
Lake Housatonic	0	IO	0	30	10.0

DOCUMENT 7

Average PCB Concentration (parts per million) in Housatonic River Floodplain Indicator Species [1,2]			Toxicity Reference Values (ppm)			Estimated Average Percent Service Reduction of indicator Species in the Housatonic River Floodplain Due to PCB Contamination [3]					
Reach	Earthworms	American Robin	Earthworms Birds				Earthworm LOEL	NOEC	American Robin LOEL	Lethality	% Service Reduction: Floodplain Species Averag
2 to 5	78.4	9285.9				2 to 5	IO	10	4 0	100	55
5 lo Woods Pond	63.7	7559. I	NOEC		7	5 to Woods Pond	0	IO	40	100	50
Woods Pond to Rising Pond	5.39	706	LOEL	76	8	Woods Pond to Rising Pond	0	10	40	100	50
Rising Pond to CT Border	I .42	238.2	Mortality		75	Rising Pond to CT Border	0	IO	40	100	50

Notes:

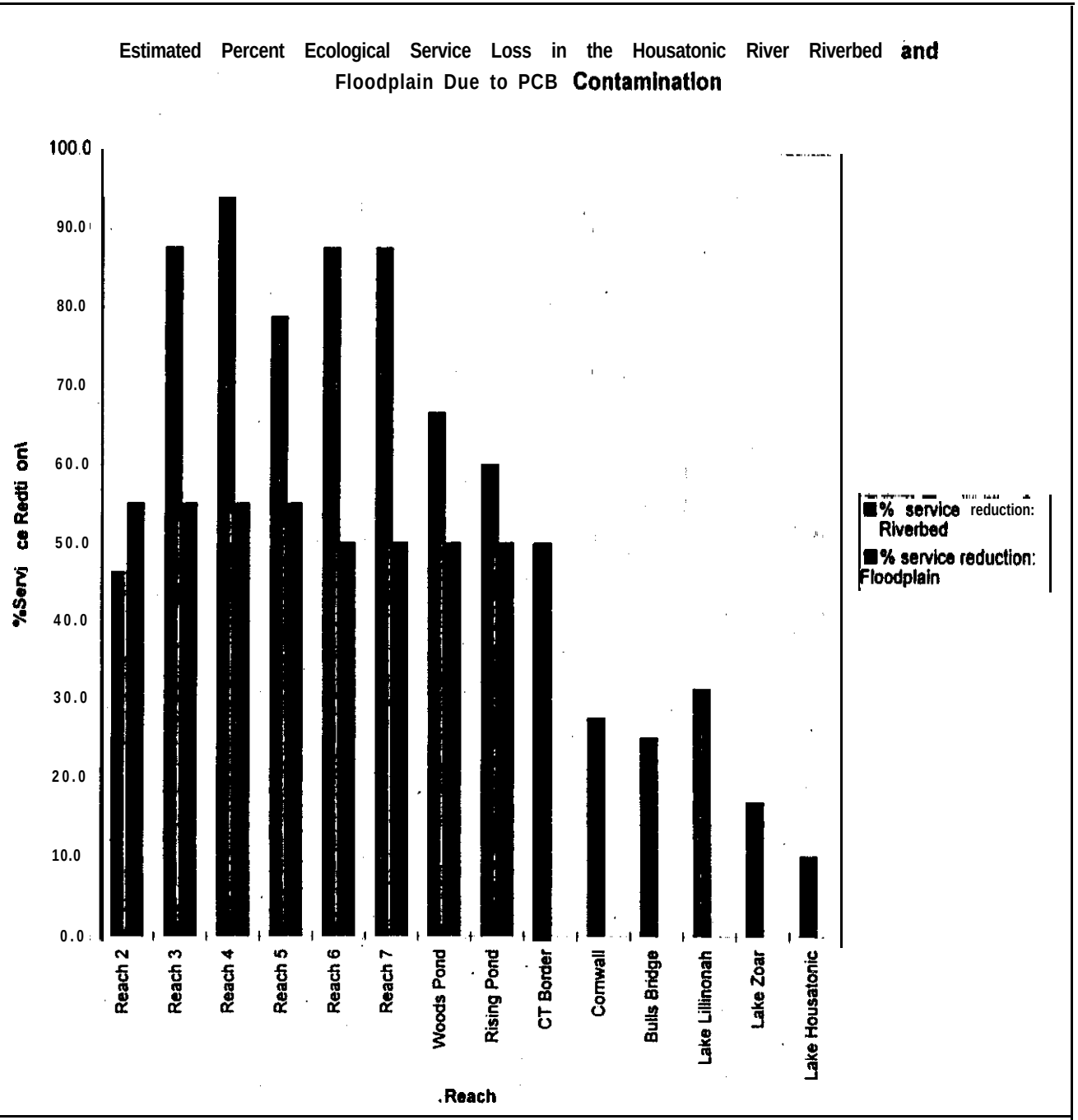
1. Earthworm [PCB] were calculated using a BSAF of4.9 (USFW 1985).
2. American Robin [PCB] were calculated using the following equations:
   Biological Half Life. (BHL) of PCBs = ln 2/first order elimination rate constant = ln 2/0.0024 = 288.75 days (Subramanian, et al. 1987, Nichols,et al. 1997).
   Daily Intake (DI) of PCBs = [(Ci x Fi)+(Cw x Fw)+(Cp x Fp)] x IR x AF x FS x FY x 1/BW (Henning. et al. 1997).
   Body Burden of PCBs = (DI x BHL)/ln 2 (GE Work Plan Protocol B 1997).
3. Roles for estimation of percent service reduction:

a) [PCB] > NOEC (0-10% service reduction)'
b) [PCB] > LOEL (IO-40% service reduction)
c) [PCB] > Lethality (100% service reduction)
d) If species (PCB] is greater than 2 times the action level, % service reduction is the high end of the service reduction range.
e) If species [PCB] is behveen I and 2 limes the action level, % service reduction is the low end of the service reduction range.
f) If species (PCB] is less than the action level, % service reduction is 0.
g) For the LOEL, if species [PCB] is greater than 4 times the action level, % service reduction is 40; ifspecies [PCB] is between 2 and 4 times the action level, % service reduction is 25; if species [PCB] is between I and 2 times the action level, % service reduction is IO.

DOCUMENT 9

Percent Service Loss and Acreage per Riverbed Reach of the Housatonic River from Pittsfield, MA to Long Island Sound							Percent Service Loss and Acreage per Floodplain Reach of the Housatonic River from Pittsfield, MA to the CT Border			
		1981-2007 No Action			2008-2017 Sediment Remediation: 5ppm		No Action			
Riverbed Reach	acres	% service reduction	lost acres	acres	% service reduction	lost acres	Floodplain Reach	% service reduction	acres	lost acres
2	13.8	46.3	6.4	13.8	46.25	6.4	2 to 5	55	642.42	353.33
3	47.7	87.5	41.7	47.7	63.75	30.4	5 to Woods Pond	50	570.74	285.3
4	14.7	93.8	13.8	14.7	63.75	9.4	W.P. to Rising Pond	50	2011.4	1005
5	46.5	78.8	36.6	46.5	63.75	29.6	R.P. to CT Border	50	2980.1	1490.(
6	31.4	87.5	27.5	31.4	63.75	20.0				
7	106.2	87.5	92.9	106.2	63.75	67.7				
Woods Pond	266.9	66.7	178.0	266.9	63.75	170.1				
Rising Pond	397.8	60.0	238.7	397.8	60.0	238.7				
CT Border	369.73	50.0	184.9	369.73	50.0	184.9				
Cornwall	364.2	27.5	100.2	364.2	27.5	100.2				
Bull's Bridge Dam	1631.3	25.0	407.8	1631.3	23.8	387.4				
Lake Lillinonah	919.8	31.3	287.4	919.8	29.4	270.2				
Lake Zoar	1360.4	16.9	229.6	1360.4	16.9	229.6				
Lake Housatonic	424.2	10.0	42.4	424.2	10.0	42.4				
Total	5994.5		1887.8	5994.5		1786.9	Total		6204.66	3124.46

	% service reduction: Riverbed	% service reduction: Floodplain
each 2	46.3	55
Reach 3	87.5	55
Reach 4	93.1	55
Reach 5	78.8	55
Reach 6	87.5	so
Reach 7	87.5	so
Woods Pond	66.7	50
Rising Pond	60.0	so
CT Border	50.0	
Cornwall	27.5	
Bulls Bridge	25.0	
Lake Lillinonah	31.3	
Lake Zoar	16.4	
Lake Housatonic	10.0	



2009	4.47	21.32	6.58	20.77	14.03	47.48	119.34	167.41	129.66	70.25	271.74	189.51	161.01	29.1
2010	4.34	20.70	6.39	20.17	13.62	46.10	115.86	162.53	125.88	68.21	263.82	183.99	156.32	28.8
2011	4.21	20.10	6.21	19.58	13.22	44.76	112.49	157.80	122.22	66.22	256.14	178.63	151.77	28.0,
2012	4.09	19.52	6.03	19.01	12.84	43.46	109.21	153.20	118.66	64.29	248.68	173.43	147.35	27.2,
2013	3.97	18.95	5.85	18.46	12.46	42.19	106.03	148.74	115.20	62.42	241.43	168.37	143.05	26.4
2014	3.86	18.39	5.68	17.92	12.10	40.96	102.94	144.41	III.85	60.60	234.40	163.47	138.89	25.6
2015	3.74	17.86	5.51	17.40	ii.75	39.77	99.94	140.20	108.59	58.84	227.58	158.71	134.84	24.9
2016	3.64	17.34	5.35	16.89	II.41	38.61	97.03	136.12	105.43	57.12	220.95	154.09	130.91	24.1
2017	3.53	16.83	5.20	16.40	11.07	37.49	94.21	132.15	102.36	55.46	214.51	149.60	127.10	23.4
Total/year total	233.54	1412.33	460.30	1268.74	929.15	3144.94	6439.73	8745.01	6773.28	3669.99	14732.25	10353.84	8410.83	1554.1
	68128.06													
annuity factor, **20 year, 3%**														
discount rate	14.88													
Compensatory **acreage, 20 years**	4579.28													

2011	233.59	188.66	664.89	985.10	
2012	226.79	183.17	645.52	956.4 I	
2013	220.18	177.83	626.72	928.55	
2014	213.77	172.65	608.47	90 I .50	
2015	ioj.54	167.62	590.74	875.25	
2016	201.50	162.74	573.54	849.75	
2017	195.63	158.00	556.83	825.00	Comp. acres, perp
Total/year	12945.72	10455.69	36847.91	54594.04	114843.35
				annuity rate, 20 yrs	14.88
				Comp. acres, 20yrs	7717.97

Riverbed	4579.3
Floodplain	7718.0
Total	12297.2

Conclusion of Ecological Injury Assessment:

herefore, 12,297 acres are required for compensation of injury to the Housatonic River environment due t PCB contamination.

DOCUMENT 10

Literature References for Toxicity Reference Values for Housatonic River Injury Assessment indicator Species

Species	Toxicity Reference Action Level	Toxicity Reference Value (ppm)	TRV Literature Reference	Percent Service Reduction
Sediment/Macroinvertebrates	NOEL	0.02	EC and MENVIQ 1992	0-10%
	PEL	0.277	Smith. et al. 1996	IO-50%
	SEL	0.34	Persuad, et al. 1991	50-100%
Earthworms	LOEL	76	Rodriguez-Grau, et al. 1989	IO-40%
Fish	NOEL (adult)	4.5	Mac and Seeley 198 I	0-10%
	LOEL (eggs)	0.3 I	Mac and Edsall 1991	10-40%
	58% Mortality	32.8	Black 1995	75-100%
Birds	NOEL	7	Harris, et al. 1993	0-10%
	L O E L	8	Hoffman, et al. 1996	10-40%
	Mortality	75	Hoffman, et al. 1996	100%
Mink	LOEL	0.4	Foley, et al. 1988	10-40%
	EC50	1.2	Leonards, et al. 1995	25-50%
	Mortality	31	Aulerich, et al. 1986	100%
Otter	LOEL	3.5	Henney, et al. 1981	10-40%
	EC50	16	Mason and MacDonald 1994	25-50%

DOCUMENT 11

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HOUSATONIC RIVER

EVALUATION OF NATURAL RESOURCE DAMAGES

RECREATIONAL FISHING AND BOATING SERVICE LOSSES

- Recreational fishing damages - results summary
- Data used to assess recreational fishing and boating damages

RECREATIONAL FISHING DAMAGES DUE TO PCB CONTAMINATION OF THE HOUSATONIC RIVER BASED ON A 20 YEAR RECOVERY (Post-1980)

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 (1997-2017)	Present Value Total Number of Trips Lost or Diminished (1996)	Total Present Value Damages (millions 1996$)
Massachusetts								
New Lenox Road (IDecker) to Woods Pond Dam	Warm Water	1981-	Lost Trips	1,000	22,000	16,000	38,000	$0.6
Glendale to Housatonic	Trout	1981-	Lost Trips	700-2,600	33,000	40,000	73,000	$2.4
Sheffield to Connecticut Border	Warm Water	1981-	Lost Trips	1,000	19,000	15,000	34,000	$0.5
Remaining Stretches	Warm Water	1981-	Lost Trips	2,700	55,000	42,000	97,000	$1.5
All Stretches	Warm Water/ Trout	1981-	Diminished Enjoyment	Not Assessed*	Not Assessed*	Not Assessed*	Not Assessed*	Not Assessed*
Connecticut								
		1981-1986	Lost Put-and-Take Trips	7,000	63,000		63,000	$3.8
TMA	Trout	1987-	Lost Catch and Release	1,700	20,000	27,000	47,000	$1.4
		1981-1986	Diminished Enjoyment	1.600	14,000		14,000	$0.4
Lower Stretches (Lakes Lillinonah and Zoar)	Warm Water	1981-	Diminished Enjoyment	10,000	194,000	149,000	343,000	$5.1
New Milford Walleye Fishery	Stocked Walleye	1999-	Lost Trips	1.550		21,000	21,000	$1.0
TOTAL								$16.7

* Data necessary for this analysis are not available

VALUES PER FISHING DAY, TROUT FISHING

Study Authors/ Publication Date	Model Type	Source Of Data	scope Of Study	Fishing Type	Year	Value Unit*	Value (Reported)	Value (1996 $)
Englin, Lambert and Shaw (1996)	TCM	1989 NAPAP Freshwater Recreational User angler survey	NY, NH, VT, ME, CT, MA. RI	'Trout	1989	per trip	$48.00	$58.70
Barry (1986)	CVM	1986 Creel survey of all sections of Housatonic River	Connecticut	All	1986	per trip	$22.14	$30.28
Barry (1986)	TCM	1986 Creel survey of all sections of Housatonic River	Connecticut	All	1986	per trip.	$18.47	$25.26
Brown and Hay (1987)	CVM	1980 National Survey	Connecticut	Trout	1980	per day	$8.00	$14.53
Brown and Hay (1987)	CVM	1980 National Survey	Massachusetts	Trout	1980	per day	$9.00	$16.35
Connelly, Brown. and Knuth (1990)	CVM	1989 NY State Angler Survey	New York	Cold water	1988	per day	$13.42	$17.10
Parsons and Hauber (1995)	TCM	1989 PNL Aquatic-Based Recreation Survey	Maine	Trout, Salmon, Bass, Brook Trout, Brown Trout, Lake Trout	1989	per trip	$158.55	$193.90
Mullen and Menz	TCM	1976 NY State Department of Environmental Conservation Survey	New York	Trout, Salmon	1976	per day	$12.67	$31.16
Brown and Hay (I 987)	CVM	1980 National Survey	US	Trout	1980	per day	$12.00	$21.90
Vaughan and Russell (1982)	TCM	1979 Private Fishing Fee Sites	US	Trout	1979	per day	$19.49	$38.66
Charbonneau and Hay (I 978)	CVM	1975 National Survey	US	Trout, Land-locked Salmon	1978	per day	$21.00	$45.17
Charbonneau and Hay (1978)	TCM	1975 National Survey	US	Trout, Land-locked Salmon	1978	per day	$43.00	$92.49
Charbonneau and Hay (1978)	CVM	1975 National Survey	US	Sea-run Salmon, Steelhead Trout	1978	per day	$5 I .oo	5109.70
Charbonneau and Hay (1978)	TCM	1975 National Survey	US	Sea-run Salmon, Steelhead Trout	1978	per day	$63.00	$135.51

* In this preliminary assessment, we assume a day of fishing at the Housatonic River constitutes a fishing trip. The site-specific studies providing per-trip values are to regions that likely involve a single day of fishing. As a result we assume the length of these trips is similar to that of the Housatonic River.

VALUES PER FISHING DAY, WARMWATER SPECIES FISHING

Study Authors/ Publication Date	Model Type	Source of Data	Scope of Study	Fishing Type	Year	Value Unit*	Value (Reported)	Value (1996 $)
Hay (1988)	CVM	1985 National Survey	Connecticut	Bass	1985	per day	$11.00	$15.39
Hay (1988)	CVM	1985 National Survey	Massachusetts	Bass	1985	per day	$9.00	$12.59
Barry (1986)	CVM	1986 Creel survey of all sections of Housatonic River	Connecticut	All	1986	per trip	$22.14	$30.28
Barry (1986)	TCM	1986 Creel survey of all sections of Housalonic River	Connecticut	All	1986	per trip	$18.47	$25.26
Connelly, Brown, and Knuth (1990)	CVM	1989 NY State Angler Survey	New York	Warmwater	1988	per day	$14.21	$18.10
Menz and Wilton (1983)	TCM	1976 State Angler Survey	St. Lawrence River (Jefferson County), New York	Bass	1976	per day	$25.99	$63.93
Menz and Wilton (1983)	TCM	1976 State Angler Survey	St. Lawrence River (St. Lawrence County), New York	Bass	1976	per day	$35.22	$86.63
Parsons and Hauber (1995)	TCM	1989 PNL Aquatic-Based Survey	Maine	Trout, Salmon, Bass, Brook Trout, Brown Trout, Lake Trout	1989	per trip	158.55	193.90
Charbonneau and Hay (1978)	CVM	1975 National Survey	US	Bass	1978	per day	$19.00	$40.87
Charbonneau and Hay (1978)	CVM	1975 National Survey	US	Catfish	1978	per day	$15.00	$32.26
Vaughn and Russell (1982)	TCM	1979 Private Fishing Fee Sites	US	Catfish	1979	per day	$12.48	$24.76
Charbonneau and Hay (1978)	CVM	1975 National Survey	US	Panfish	1978	per day	$19.00	$40.87
Charbonneau and Hay (I 978)	TCM	1975 National Survey	US	Freshwater Species	1978	per day	$38.00	$81.74
Miller and Hay (1984)	TCM	1980 National Survey	Maine	Freshwater Species	1980	per day	$21.17	$38.44

* In this preliminary assessment, we assume, similar to the Housalonic. a day of fishing to the sites valued in the literature constitutes a fishing trip.

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Evaluation of Economic Losses Due to Lost or Diminished Recreational Angling and Boating Trips

	Lost Trips	Diminished Trips
Massachusetts		
Warm water	$15	--
Put-and-Take Trout	$60	--
Catch-and-Release Trout	$30	--
Canoeing	$40	--
Connecticut		
Put-and-Take Trout	$60	$30
Catch-and-Release Trout	$30	--
Walleye	$50	--
Warm water	--	$15

FISHING PRESSURE ESTIMATES BASED ON STOCKED FISH TO TRIP RELATIONSHIPS			
River Segment	**Basis for Estimate**	**Fishing Pressure Estimate**	**Source of Estimate**
Massachusetts			
Glendale to Housatonic I	Put and Take: 750 trout stocked/mile/year	Put and Take: 0.637 trips/trout stocked	1982-84 data for the Farmington River in CT
	Catch and Release: 10,286 trips/5.9 miles stocked	Catch and Release: 1,743 fishing trips/mile stocked	1985-86 data for the Housatonic TMA in CT
Connecticut			
Trout Management Area (TMA)	Put and Take: 8,926 trout stocked/yea	Put and Take: 0.637 trips/trout stocked	1982-84 data for the Farmington River in CT
	Catch and Release: 10,286 trips/5.9 miles stocked	Catch and Release: 1,743 fishing trips/mile stocked	1985-86 data for the Housatonic TMA in CT
Walleye Fishery	155 hectares stocked/year	10 trips/stocked hectare	1992 scoping analysis of proposed walleye fishery

VALUATION OF LOST PRESENT VALUE BOATING TRIPS

The following analysis estimates the effects of elevated levels of PCBs on recreational boating on the Housatonic River in Massachusetts. The Massachusetts stretch of the Housatonic River includes primarily flat, slow-moving warm water meandering through Berkshire County to the Connecticut border. Two stretches of this river popular among boaters are the stretch from the John Decker boat launch at New Lenox Road to Woods Pond, and the stretch from Ashley Fells past Bartholomew's Cobble to the Fells River Dam in Connecticut. Both of these stretches provide unique experiences due to the available solitude, the rural character end aesthetic beauty of the land, and opportunities to view wildlife.

Based on actual Connecticut Housatonic boating data, we assume that each of the two popular stretches of the Massachusetts Housatonic would support approximately 1,090 boating trips per year (i.e., in the absence of PCBs, boating pressure in Massachusetts would be similar to existing boating pressure in Connecticut). To estimate the total number of lost present value 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 present value boating trips) - (36,133 actual present value boating trips) = 8,552 lost present value 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 present value boating trips) - (26,810 actual present value boating nips) = 17,875 lost present value boating trips.

Thus, based on this analysis we estimate losses of approximately 8,000 present value boating opportunities on the Decker Launch/Woods Pond stretch, and losses of approximately 18,000 present value boating opportunities on the Ashley Falls stretch. These lost use estimates are based on estimated yearly potential use of approximately 1,100 trips per year on each stretch, versus an estimated c-t yearly use of approximately 700 and 300 trips on the Woods Pond and Ashley Falls stretches. respectively.

RECREATIONAL BOATING DAMAGES

Scenario/River Stretch	Value Per Trip (1996 $)[1]	Approximate Number of Present Value Lost Trips[2]	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**

Notes: [1] Based on estimates by Walsh et al. (1992) and Bergstrom and Cordell (1991), and best professional judgment.

[2] Assumes a three percent real discount rate.