



Eastern Research Group, Inc.

April 5, 2000

Communications

Dear Reviewers:

Data, Information,  
and Knowledge  
Management

The following is a recap of what was presented at the Informational Meeting for the Peer Review of Hudson River PCBs Ecological & Human Health Risk Assessment. This meeting took place March 22 and 23, 2000 at the Sheraton Saratoga Springs in Saratoga Springs, NY.

Economic and  
Statistical Support

Please refer to the enclosed agenda, which specifies the presentations and their corresponding numbered packet.

Emissions Inventory  
and Exposure  
Assessment

You will also find two videos that were taken at the briefing. There is an error on the labels on the videos. The videos correspond with the following dates:

Engineering

Tape #1: Currently labeled 03/24; is actually 03/22; Day 1

Tape #2: Correctly labeled; 03/23/00

Environmental Health

Environmental  
Management Systems

If you have any questions or concerns, please do not hesitate to contact any of us here at ERG.

Environmental  
Measurements

Thank you.

Sincerely,

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Eastern Research Group (ERG)  
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Lexington, MA 02421  
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# Informational Meeting for the Peer Review of Hudson River PCBs Ecological & Human Health Risk Assessment

Sheraton Saratoga Springs  
Saratoga Springs, New York  
March 22-23, 2000

## Agenda

Meeting Facilitator: Jan Connery, Eastern Research Group, Inc.

### WEDNESDAY, MARCH 22, 2000

- |          |   |                        |
|----------|---|------------------------|
| 8:00AM   | <b>Registration/Check-in</b>  |                        |
| 8:30AM   | <b>Welcome Remarks</b><br><i>Jan Connery, Eastern Research Group, Inc.</i>  |                        |
| 8:45AM   | <b>Presentation on Site Background</b><br><i>Alison Hess, U.S. Environmental Protection Agency</i>                | <b>SLIDE PACKET #1</b> |
| 10:00AM  | <b>B R E A K</b>  |                        |
| 10:15AM  | <b>Presentation on Findings from Previous Reports</b><br><i>Alison Hess, U.S. Environmental Protection Agency</i> | <b>SLIDE PACKET #1</b> |
| 11:00 AM | <b>Adjourn for Site Tour</b>  |                        |
| 11:30AM  | <b>Board Bus for Site Tour</b>  |                        |
| 12:00AM  | <b>L U N C H</b> (on own, bus will stop at local restaurant)  |                        |
| 5:00PM   | <b>End of Site Tour/Return to Hotel</b>   |                        |

### THURSDAY, MARCH 23, 2000

- |         |   |                        |
|---------|---|------------------------|
| 8:30AM  | <b>Presentations on Ecological Risk Assessment</b><br><i>Ed Garvey, TAMS Consultants, Inc.</i>  | <b>SLIDE PACKET #2</b> |
|         | <i>Helen Chernoff, TAMS Consultants, Inc.</i>   |                        |
|         | <i>Katherine von Stackelberg, Menzie-Cura &amp; Associates, Inc.</i>  | <b>SLIDE PACKET #3</b> |
| 10:30AM | <b>B R E A K</b>  |                        |
| 10:45AM | <b>Review the Charge to Reviewers on the Ecological Risk Assessment</b><br><i>Damien Hughes, U.S. Environmental Protection Agency</i> |                        |

11:45AM LUNCH (on own)

**THURSDAY, MARCH 23, 2000 (CONTINUED)**

1:00PM **Presentations on Human Health Risk Assessment**  
*Marian Olsen, U.S. Environmental Protection Agency*  
*David Merrill, Gradient Corp.* **SLIDE PACKET #4**

3:00PM **BREAK**

3:15PM **Review the Charge to Reviewers on the Human Health Risk Assessment**  
*Damien Hughes, U.S. Environmental Protection Agency*

4:15PM **Adjourn**

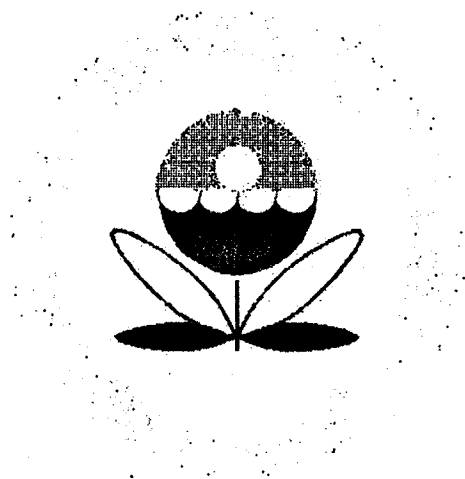
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**ERG**

# **Hudson River PCBs Site Reassessment**



## **Risk Assessment Peer Review**

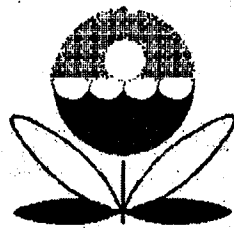
**March 22, 2000**

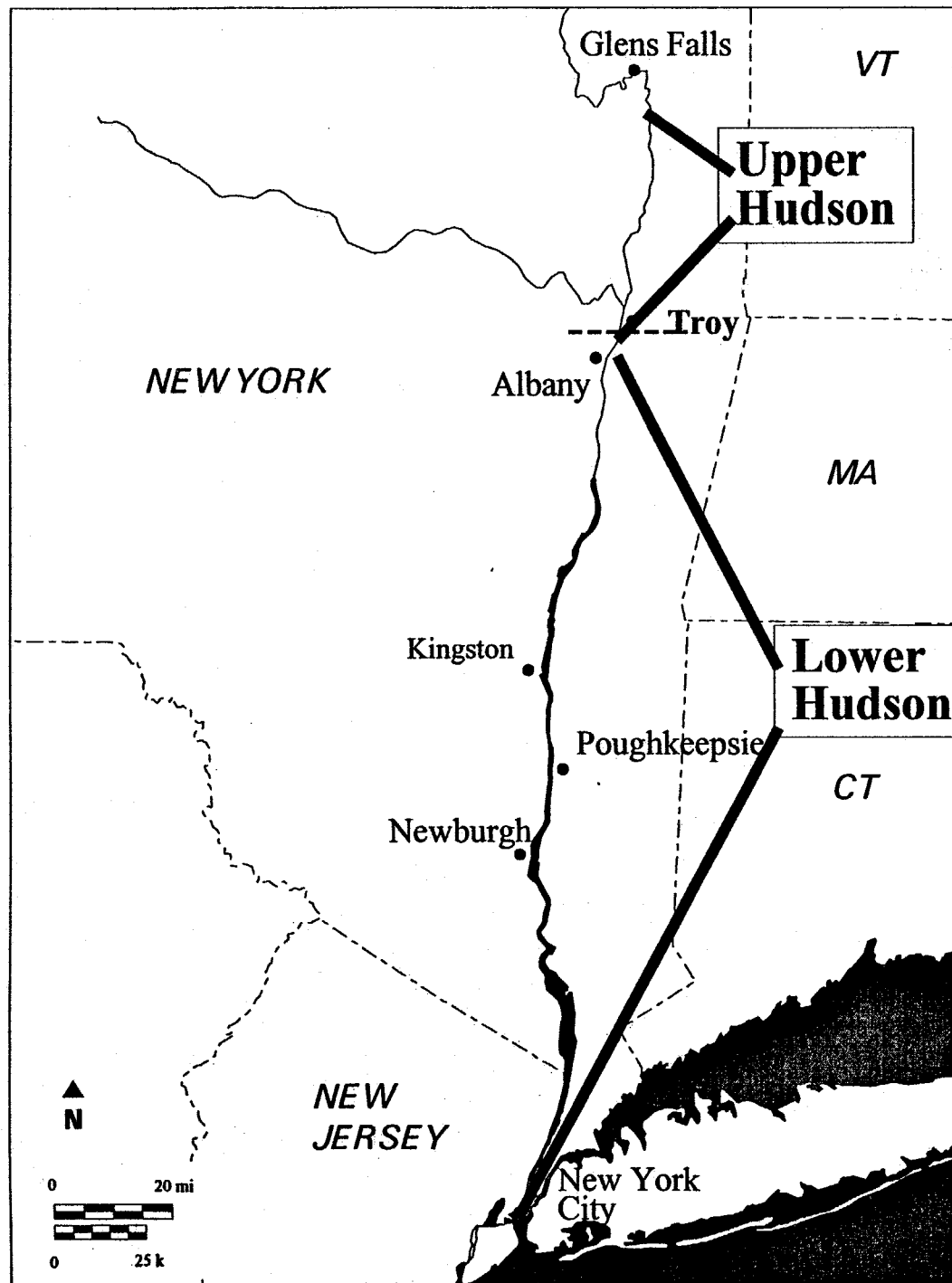
**Alison A. Hess, CPG  
USEPA - Region 2**



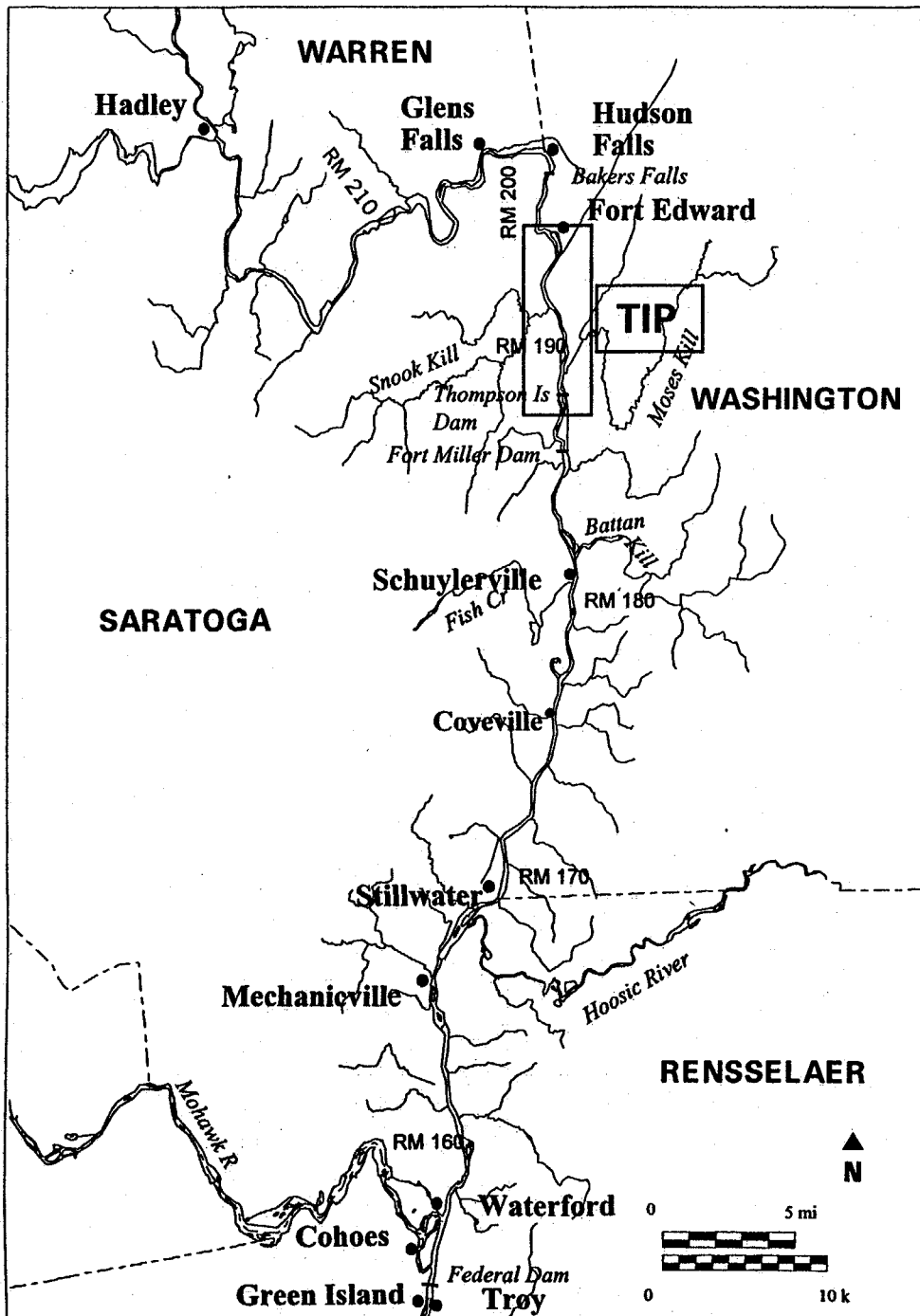
# Hudson River PCBs Site Reassessment

- Site Background
- Findings from Previous Reports
- Feasibility Study



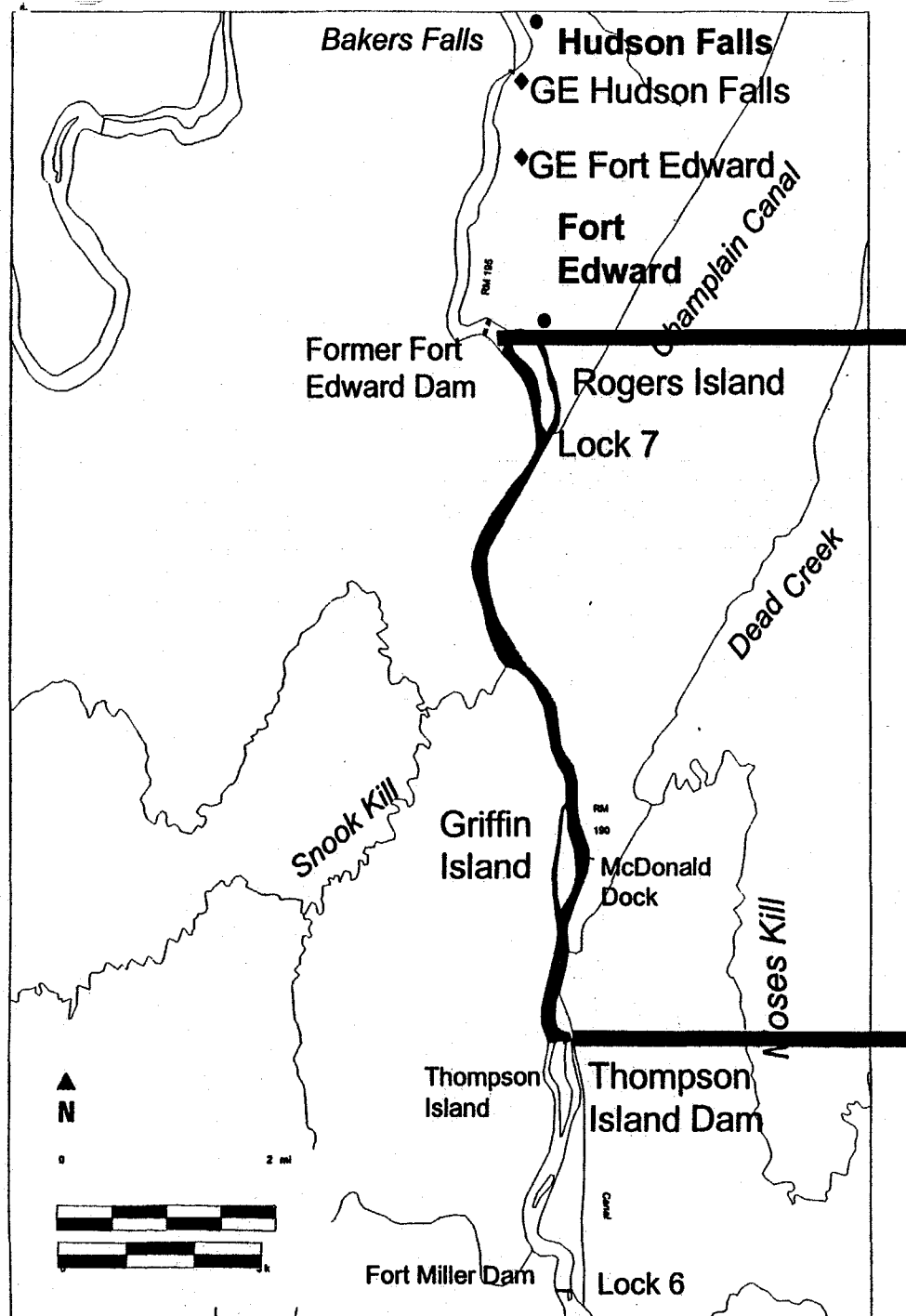


## Upper and Lower Hudson River



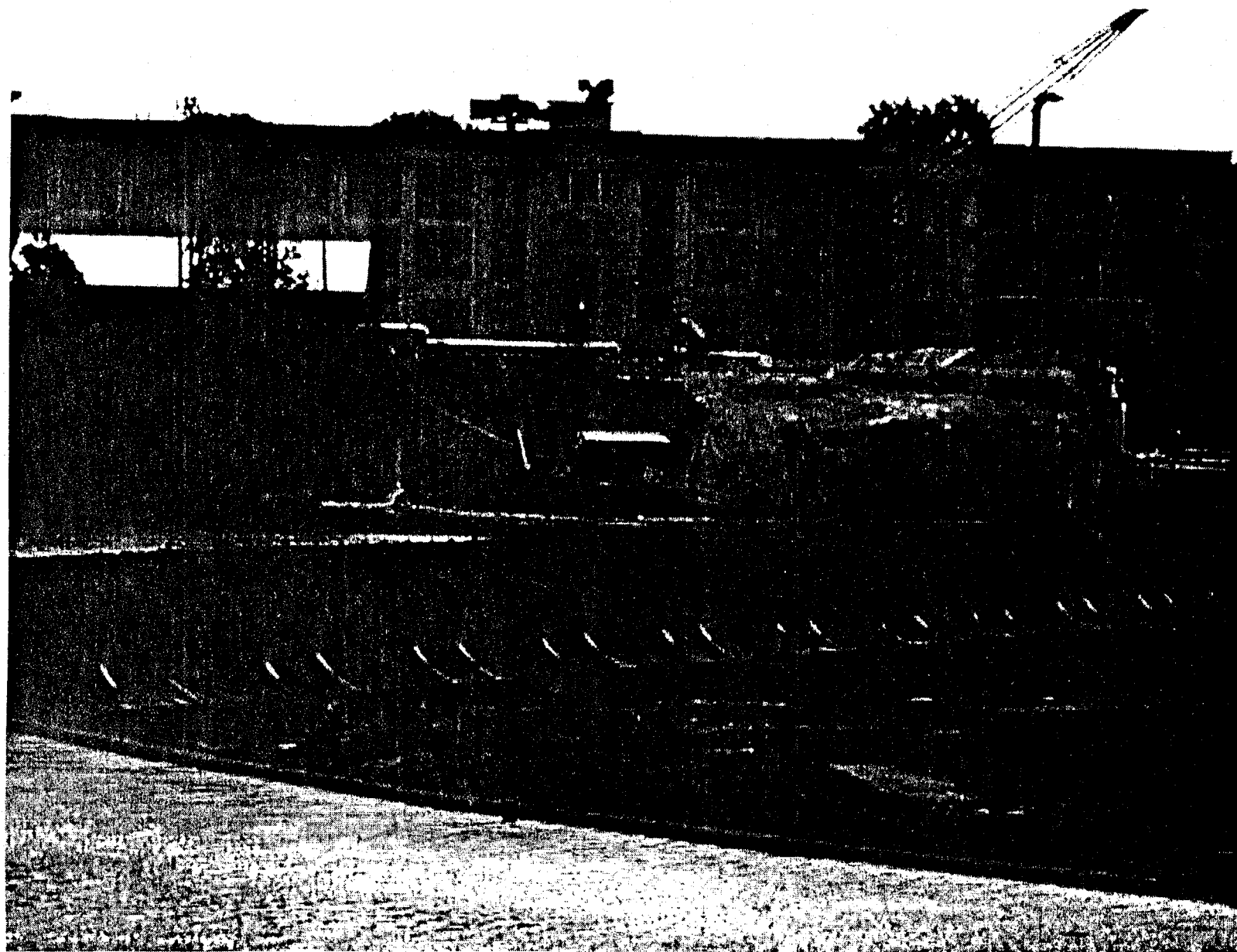
# Upper Hudson River

# Thompson Island Pool

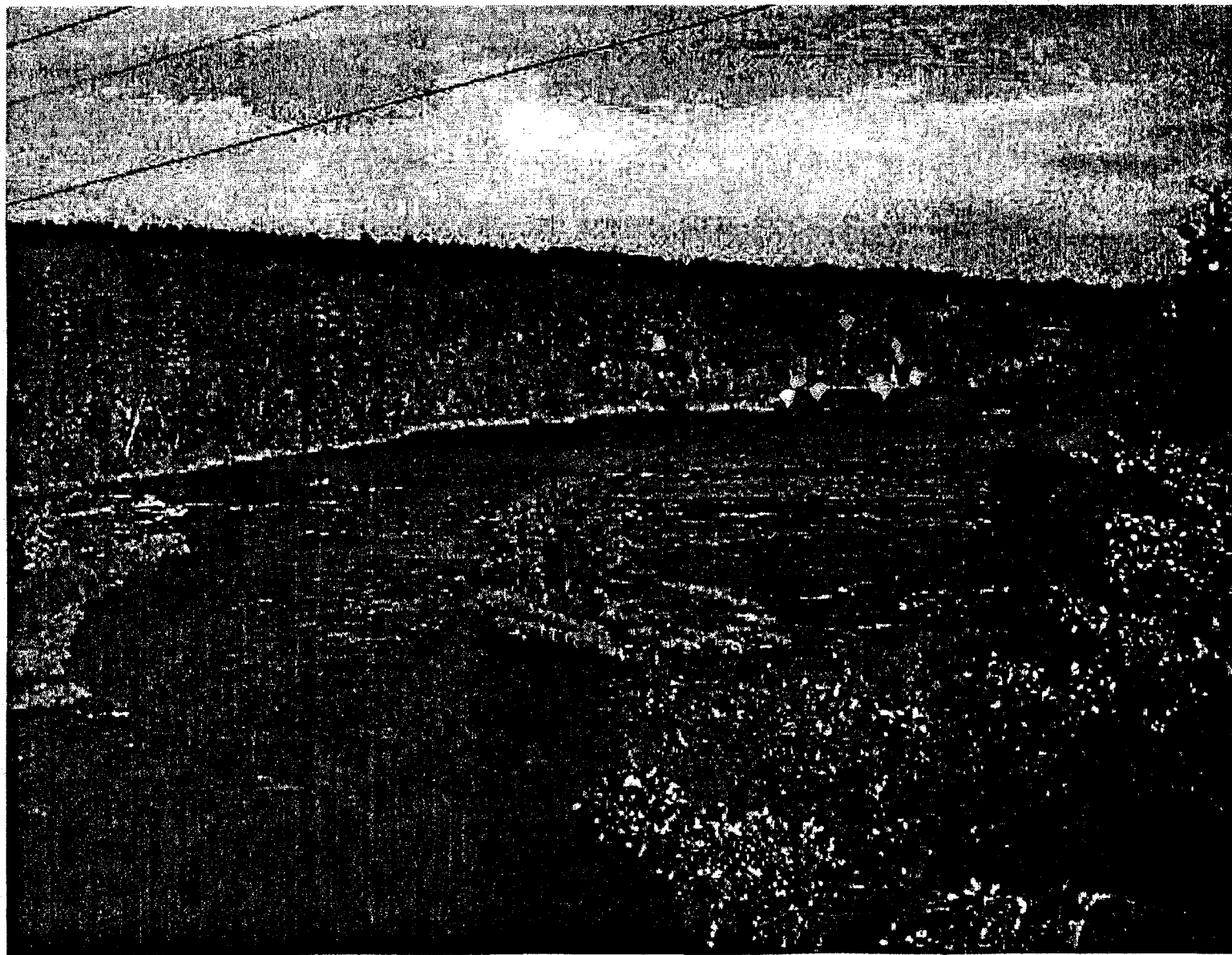




# GE Hudson Falls Plant Site - Bakers Falls Dam



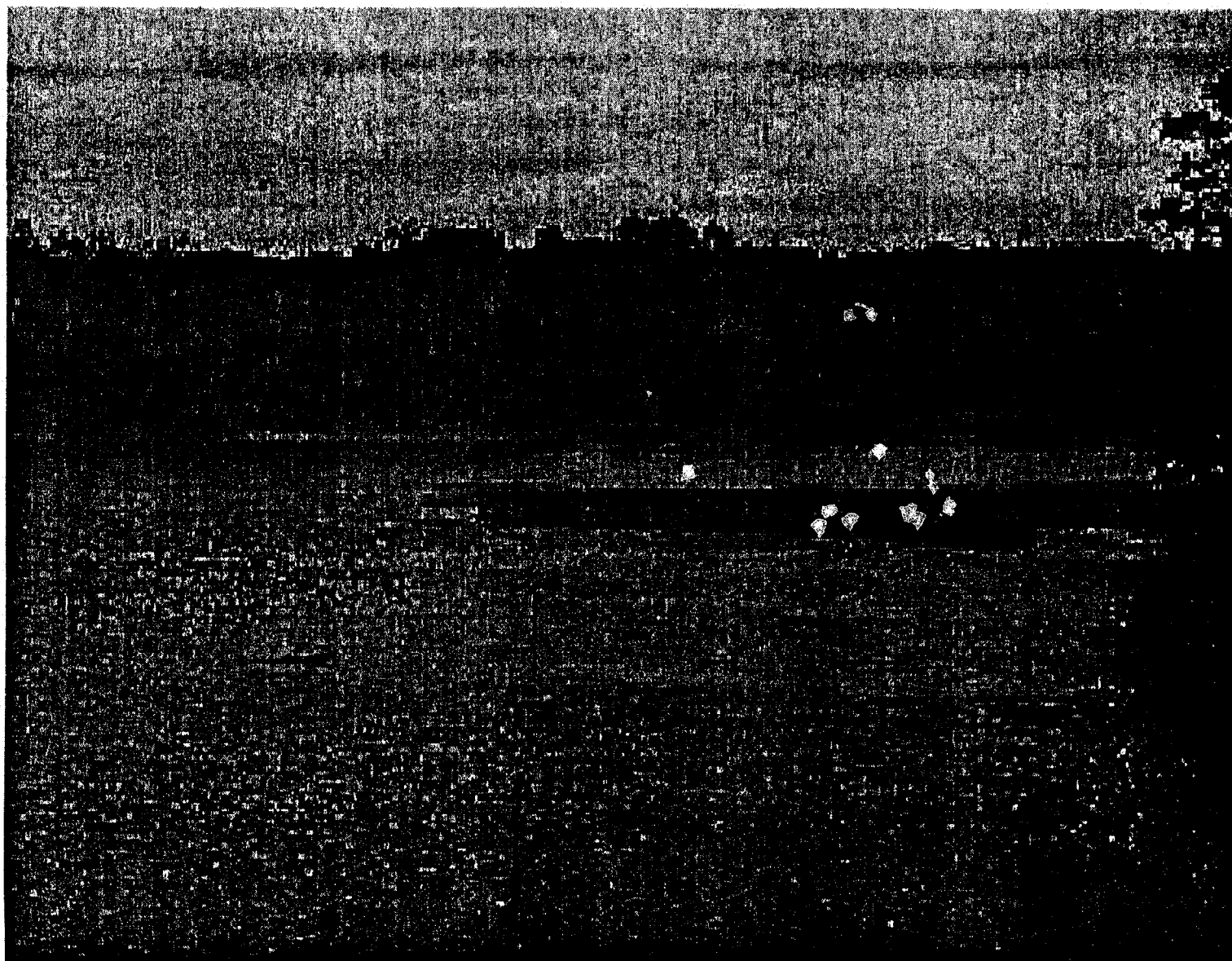
## Upper Hudson River - Looking Upstream from Fort Edward



## Remnant Deposit 5 and Location of Former Ft. Edward Dam

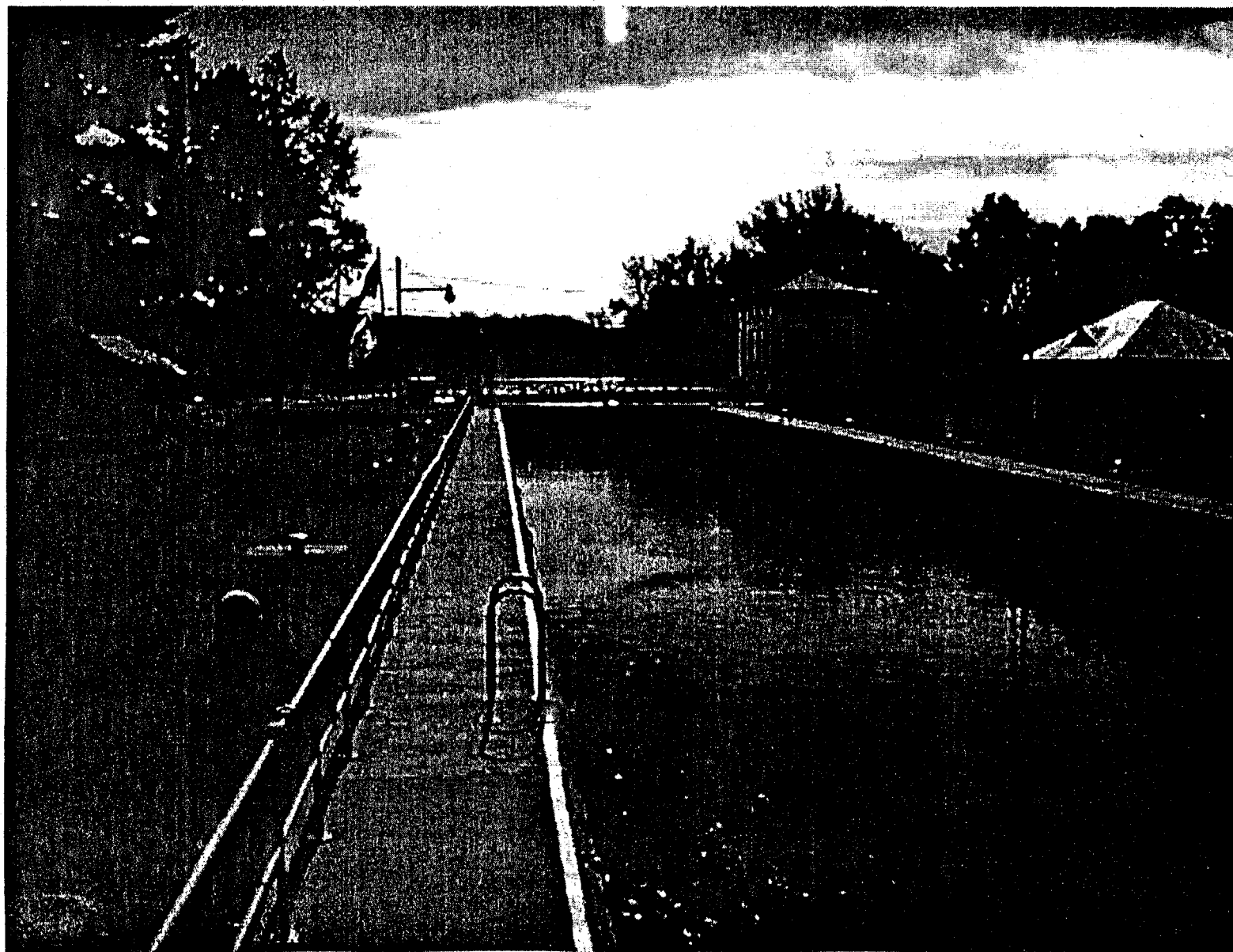


# Upper Hudson River -Thompson Island Pool





# Upper Hudson River /Champlain Canal



## **Hudson River PCBs Site Timeline**

1947 GE used PCBs in manufacturing capacitors  
-1976

1973 Ft. Edward Dam removed

1976 Fishing ban and consumption advisories

1980 Clean Water Act - Section 116

1983 Site proposed for Superfund NPL

1984 Record of Decision

# **Hudson River PCBs Site**

## **1984 Record of Decision**

- Cap Remnant Deposits
- Treatability Study for Waterford
- Interim "No-Action" for  
PCB-contaminated sediments

# **Decision to Conduct the Reassessment**

- Re-opener in 1984 ROD
- Requested by NYSDEC
- EPA requirement for 5-Year Reviews

**Reassessment Announced  
December 1989**



## **Purpose of the Reassessment**

To evaluate whether any action is required to address the PCB-contaminated sediments in the Upper Hudson River in order to be protective of human health and the environment.

## Principal Reassessment Questions

1. When will PCB levels in fish meet human health and ecological risk criteria under continued No Action?
2. Can remedies other than No Action significantly shorten the time required to achieve acceptable risk levels?
3. Could a flood scour sediments, exposing and redistributing buried contamination?

## **Hudson River PCBs Site Reassessment**

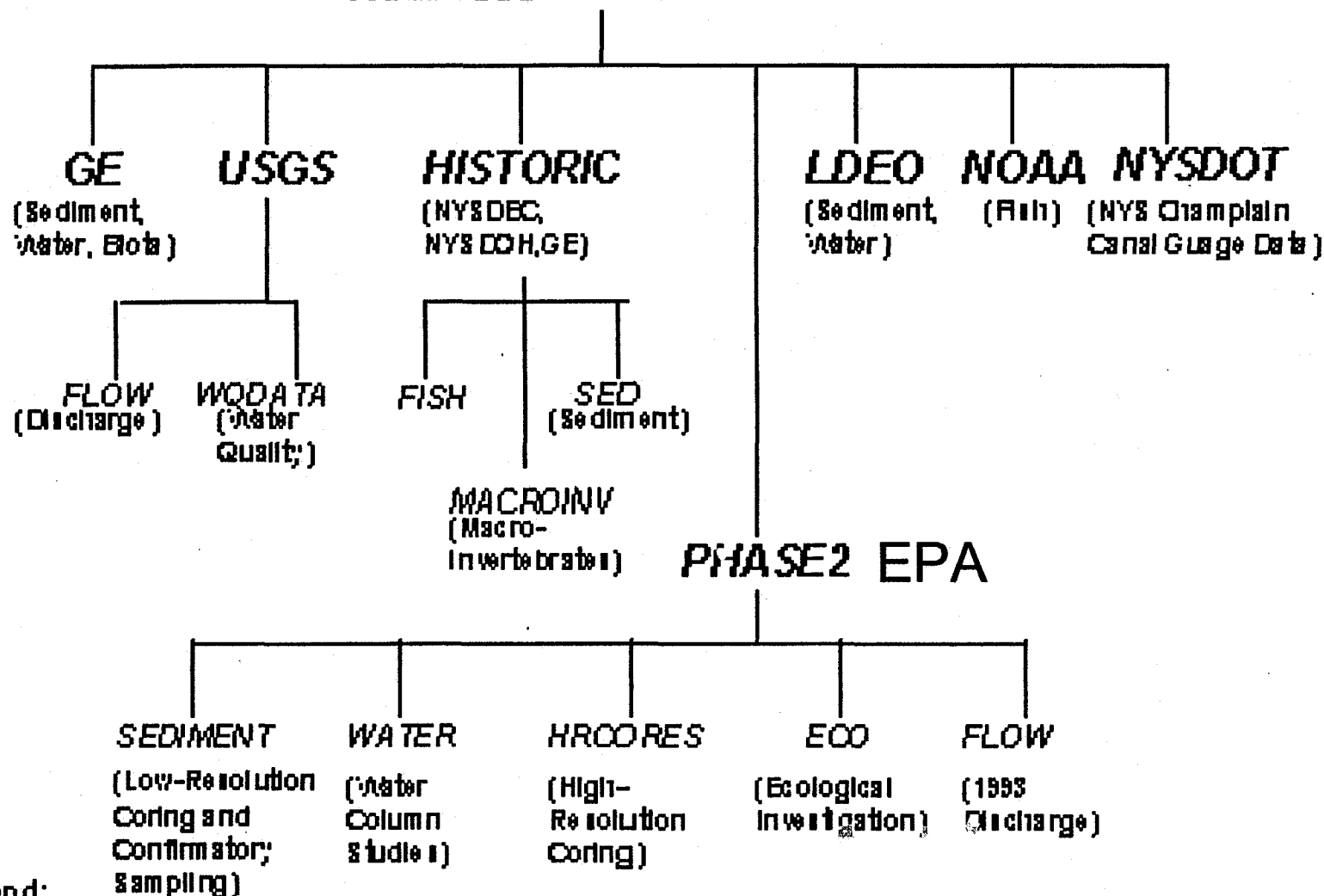
- 1989 Decision to conduct the Reassessment
- 1990 Reassessment Scope of Work issued
- 1991 Remnant Deposit capping completed  
Event at GE Hudson Falls Plant Site
- 1992 EPA Phase 2 sampling and analysis  
- 1994
- 1995 Data validation
- 1996 Release of Phase 2 Reports  
- 2000

## Hudson River PCBs Reassessment Reports

Phase 1 Report	Aug 1991
Phase 2 Reports (Remedial Investigation)	
1. Database Report	Nov 1995
2. Preliminary Model Calibration Report	Oct 1996
3. Data Evaluation and Interpretation Report	Feb 1997
3A. Low Resolution Sediment Coring Report	July 1998
4. Baseline Modeling Report	May 1999
5. Ecological Risk Assessment	Aug 1999
6. Human Health Risk Assessment	Aug 1999
Phase 3 Report (Feasibility Study)	Dec 2000



# Reassessment Database

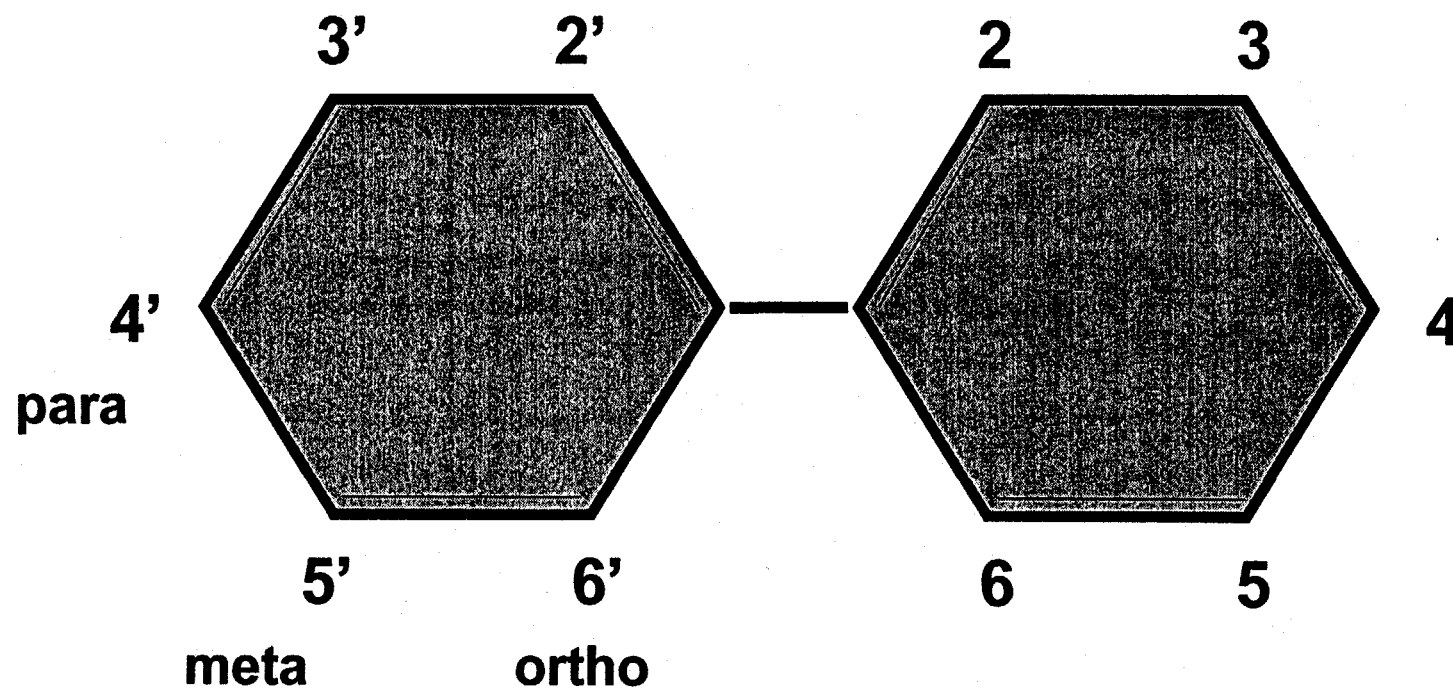


**USGS** - Main Directory

**WQDATA** - Subdirectory

(NYS DEC, NYS DOH, GE) - directory contents description

# Polychlorinated Biphenyl



209 congeners

## **Tri+ PCBs**

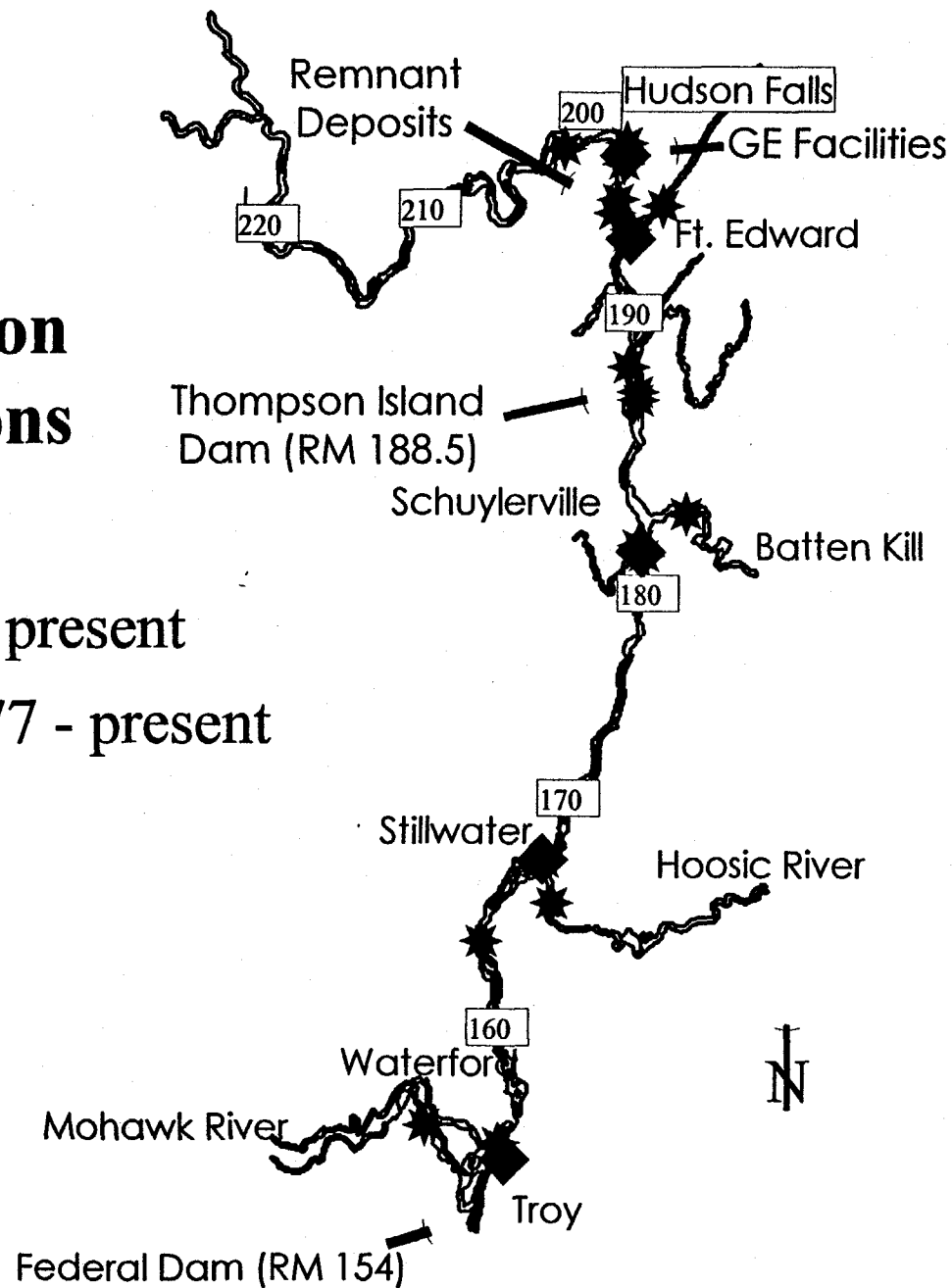
- Sum of congeners with three or more chlorines per molecule
- Provides a consistent basis for the comparison of various analytical techniques for the entire historic record

# **EPA Phase 2 Sampling Programs**

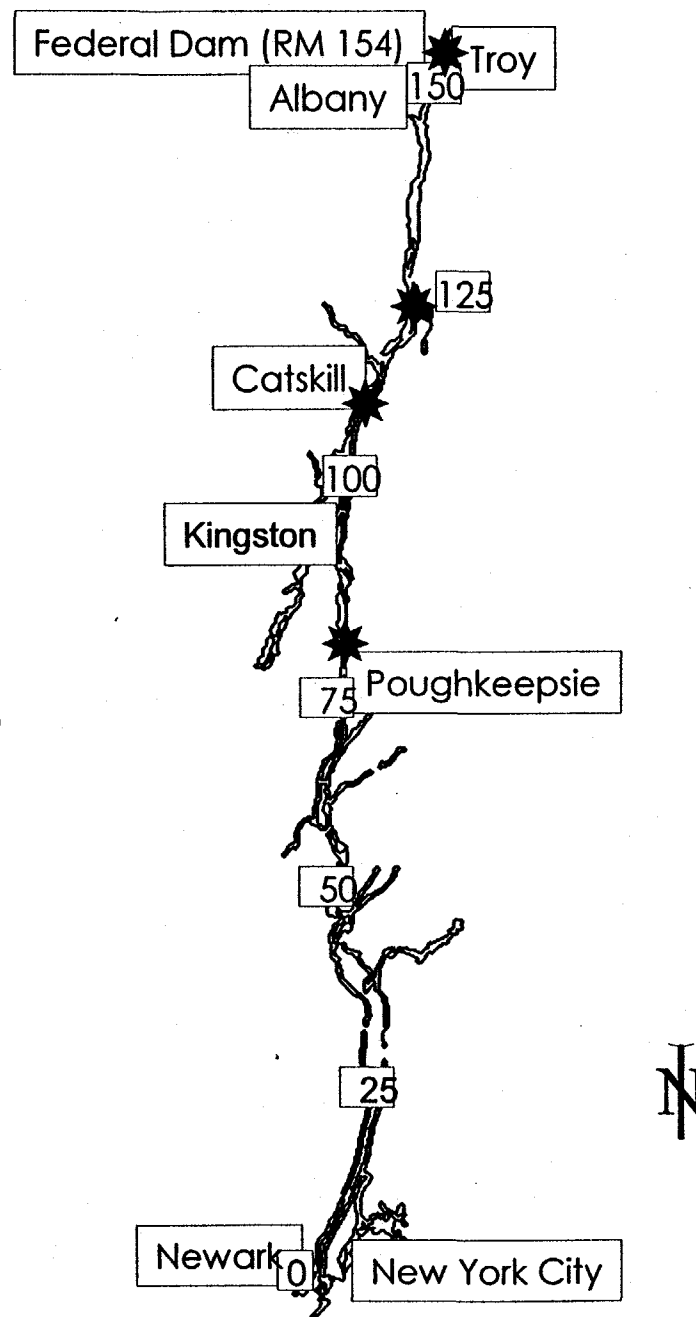
- Water-Column Sampling
- Sediment Sampling
- Geophysical Investigation
- Ecological Investigations

## Upper Hudson Water Stations

- ★ EPA 1993
- ★ GE 1991 - present
- ◆ USGS 1977 - present



# Lower Hudson Water Stations EPA (1993)



## **High Resolution Sediment Investigation**

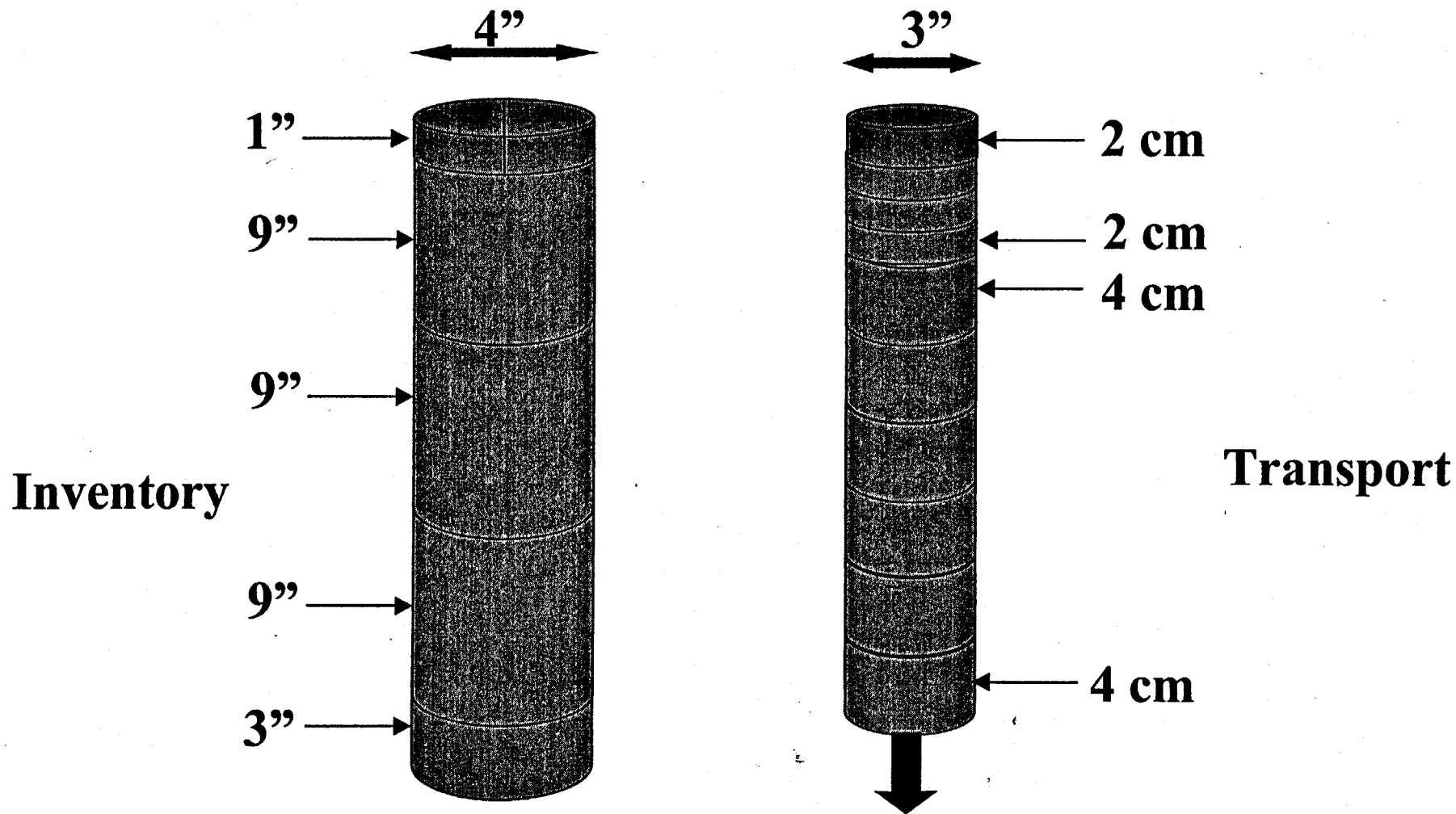
- High resolution sediment cores were obtained from 28 locations from the Upper and Lower Hudson
- Sediment cores were sliced into thin layers to examine historical PCB transport as recorded by the sediments

## **Low Resolution Sediment Coring Program**

- Obtain new sediment PCB inventories to compare with 1984 estimates at selected locations in the TI Pool.
- Refine PCB mass estimates at selected hot spots below the TI Dam to compare with 1976 estimates.



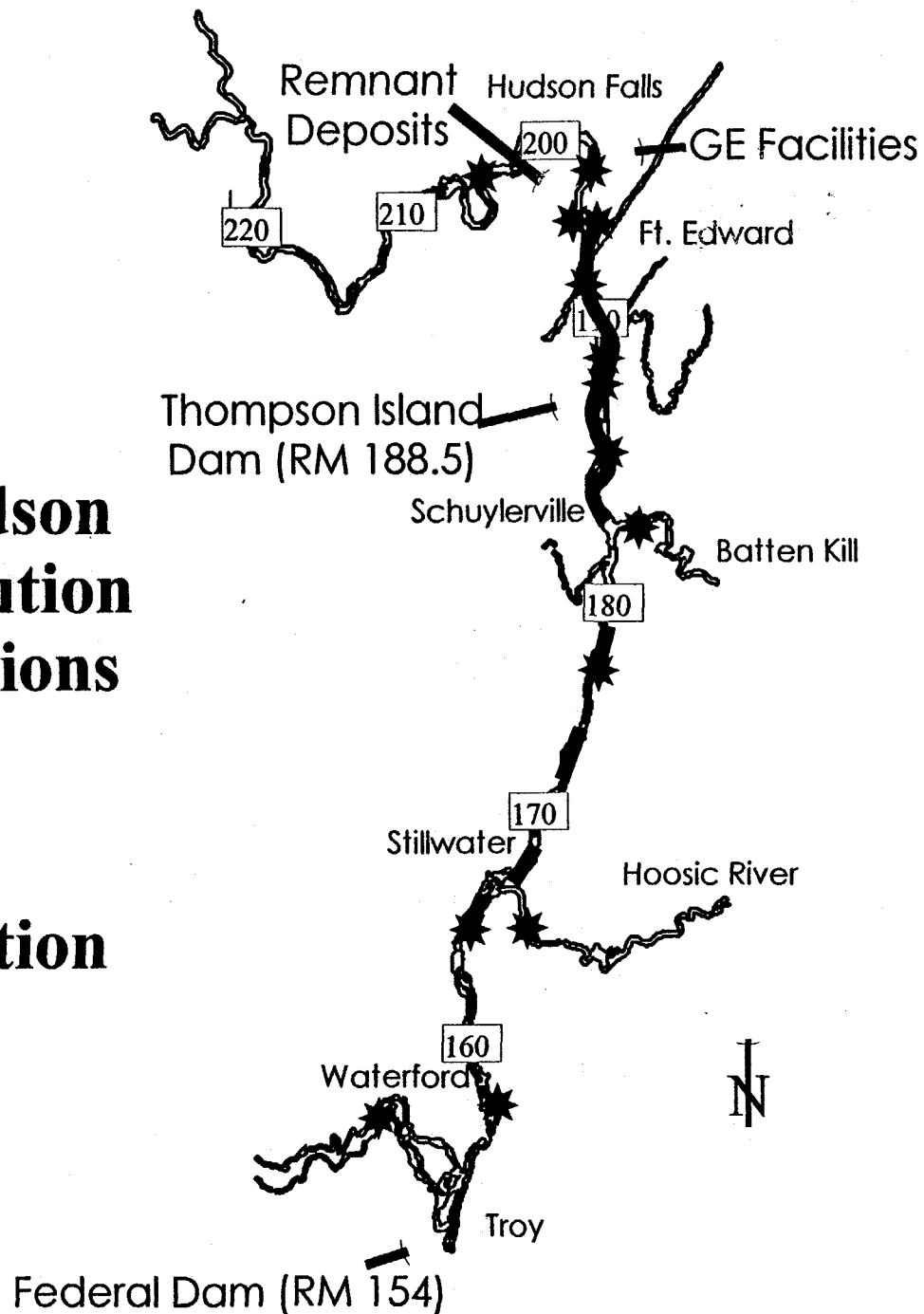
## Low Resolution v. High Resolution



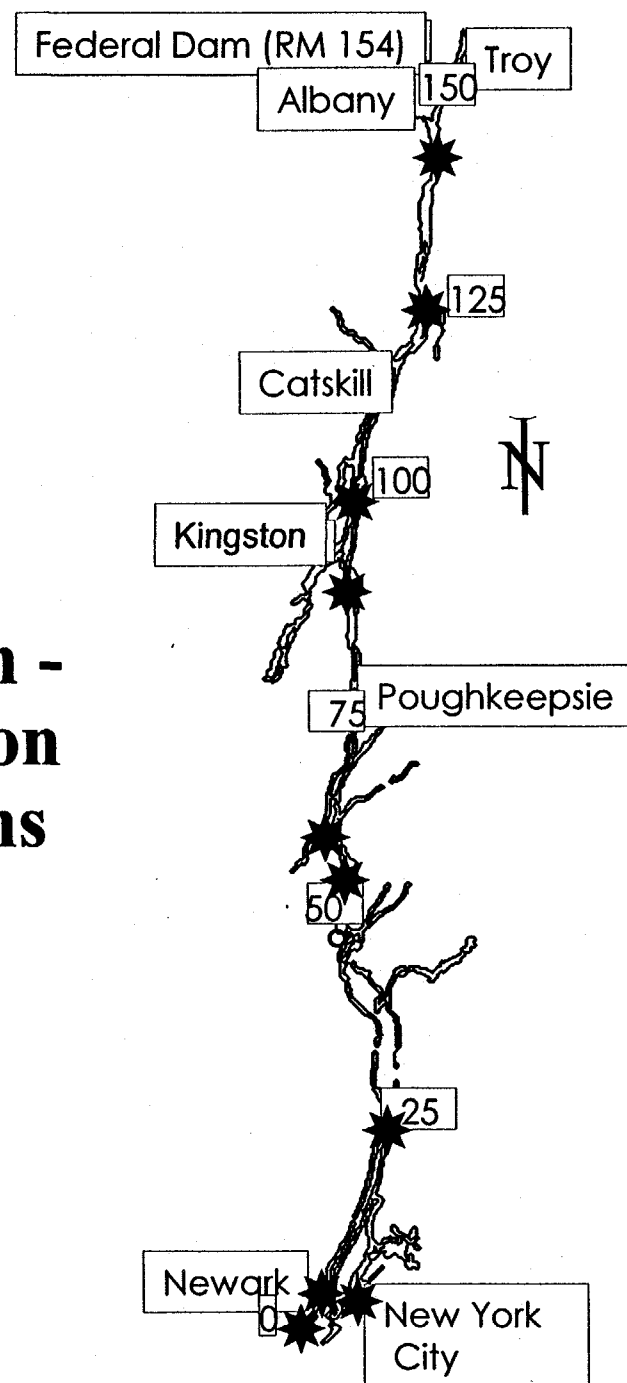
# Upper Hudson High Resolution Core Locations



## Low Resolution Core Area



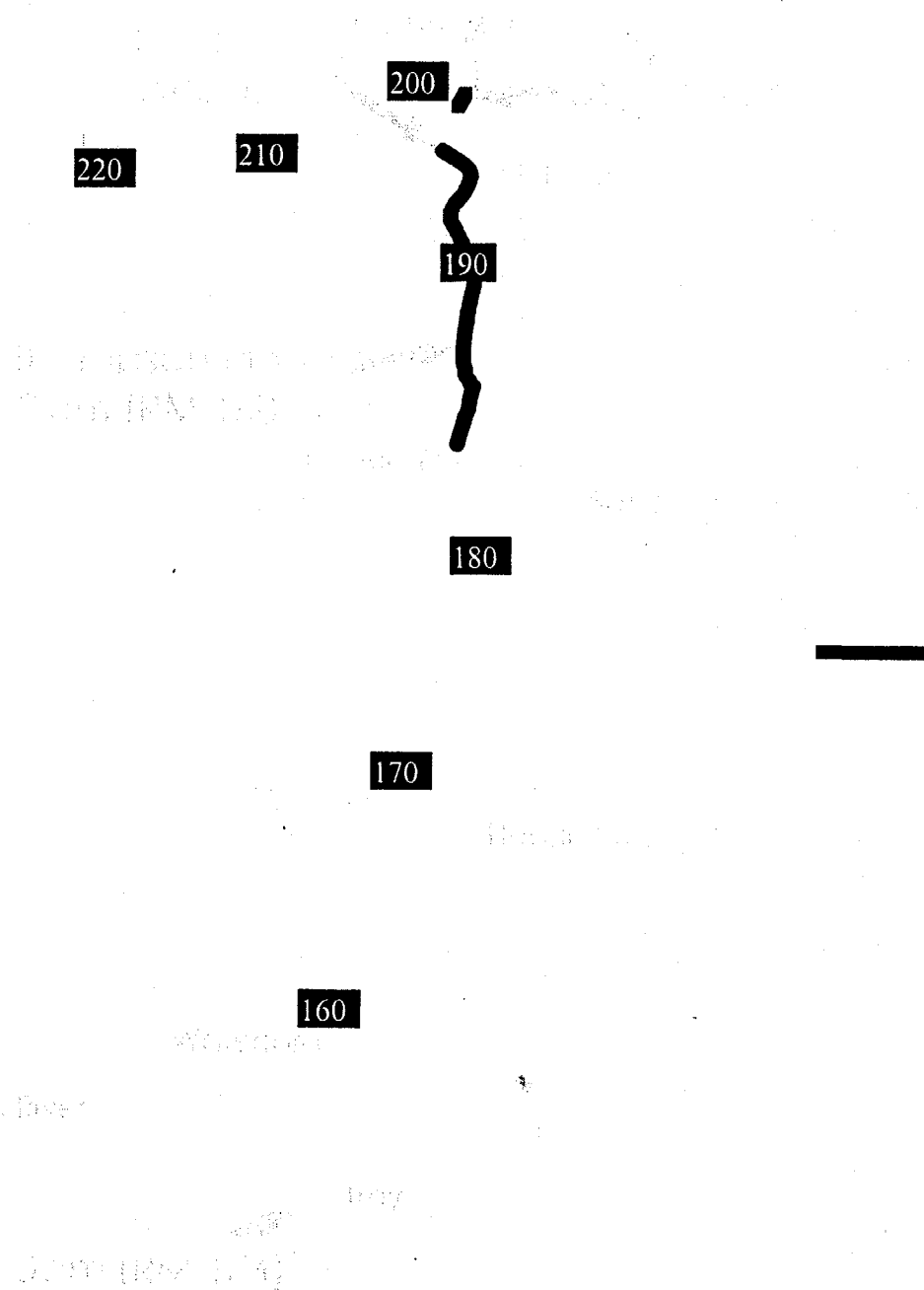
## Lower Hudson - High Resolution Core Locations



# Geophysical Investigation

- Acoustic signals provide information on sediment texture, bathymetry and layering
  - Side-scan sonar images provide “photographs” of the river bottom
- Confirmatory samples provide confirmation of the sediment classes identified via acoustic signals

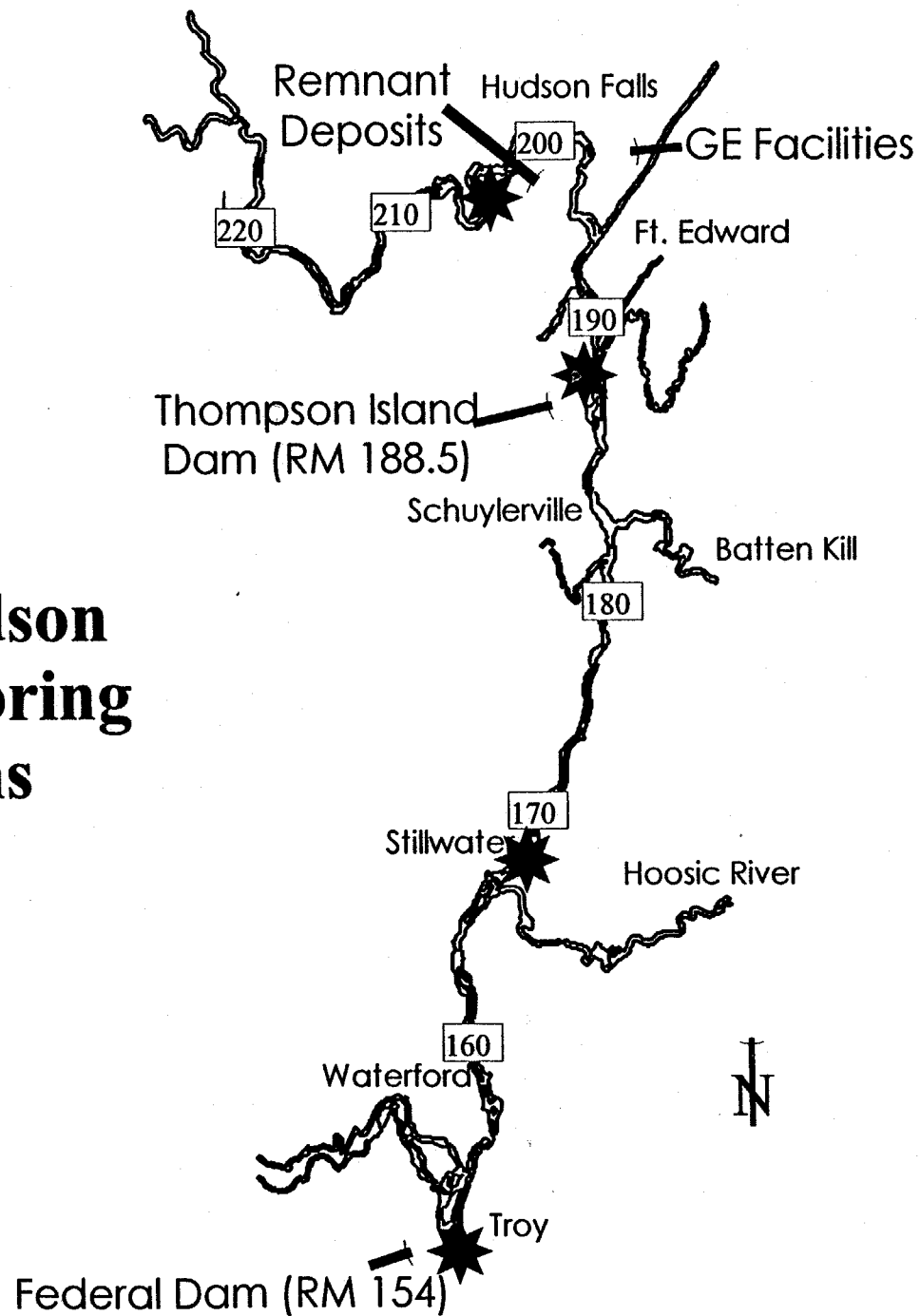
# Geophysical Survey Area



# **Ecological Investigations**

- EPA Phase 2 (1993)
  - Sediment sampling
  - Benthic invertebrates
  - Fish
- NYSDEC Fish Monitoring
- NOAA/NYSDEC Fish (1993 and 1995)
- USF&W Tree Swallow Study
- NYSDOH Multiplate Sampling

# Upper Hudson Fish Monitoring Locations



# Summary

## Upper Hudson River

### Thompson Island Pool

- Upper 6 miles
- 1 dam
- 40% of PCB mass
- Higher sediment concentrations

### Reaches Below TI Dam

- Lower 34 miles
- 6 dams
- 60% of PCB mass
- Lower sediment concentrations

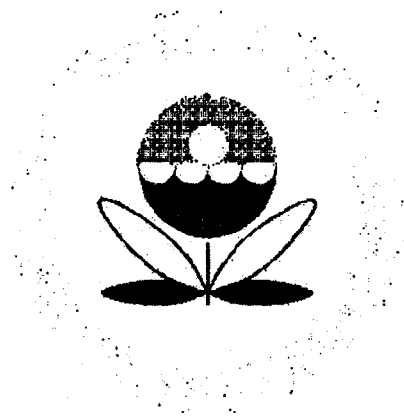
## Lower Hudson River

**153 miles, no dams, tidal, large PCB mass inventory at low concentrations**



# **Hudson River PCBs Reassessment**

## **Findings from Previous Reports**



## **Geochemistry**

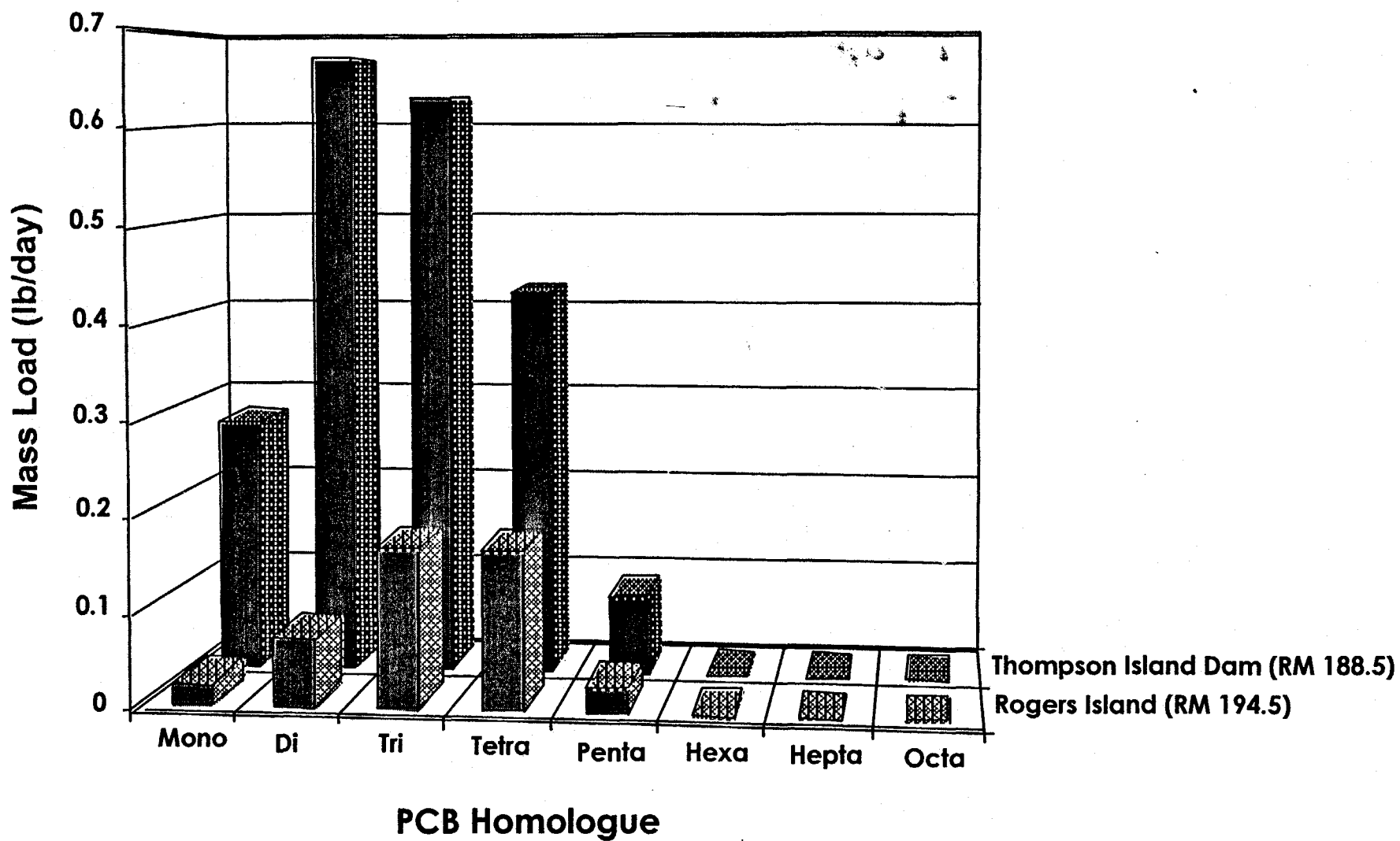
Data Evaluation and Interpretation Report (DEIR)  
Low Resolution Sediment Coring Report (LRC)

- water-column transport
- dechlorination
- burial
- sediment inventory

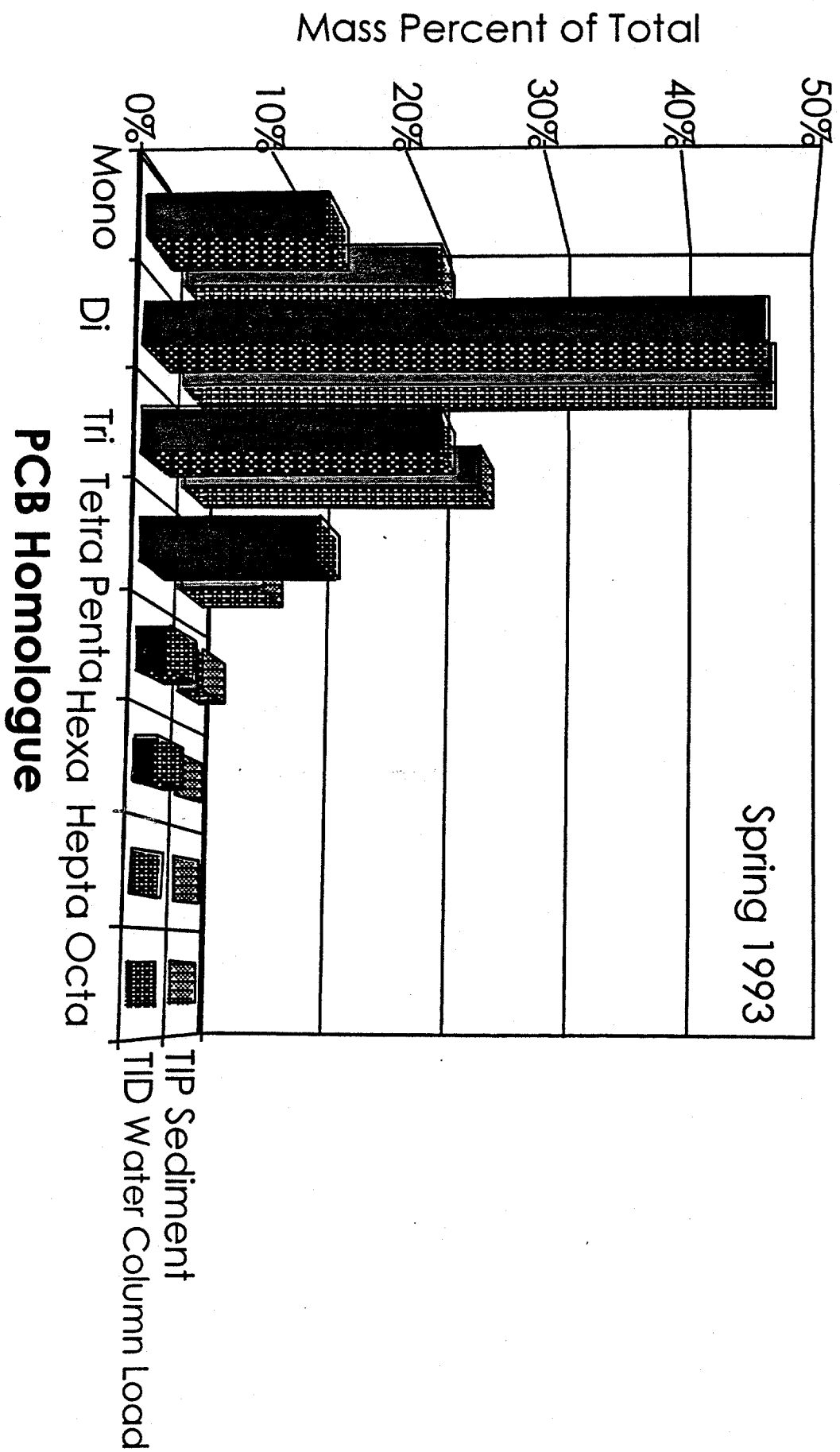
## **Water-Column Transport**

- The increased PCB load across the Thompson Island Pool (TIP) has a readily identifiable homologue pattern which originates from the sediments within the pool.
- The Thompson Island Pool load dominates the water-column load in the freshwater Hudson during low-flow conditions (10 months of the year).

The Thompson Island Pool sediments  
are a major source of PCBs to the  
freshwater Hudson.



Phase 2 Mean Summer Water Column PCB Loads (1993)

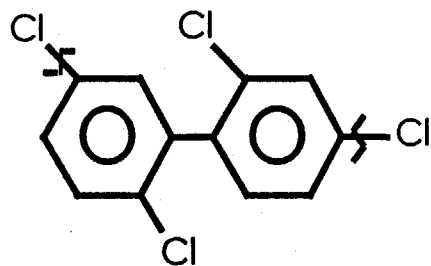


The PCB load from the Thompson Island Pool originates from the sediments within the Pool.

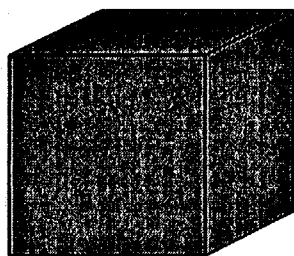
## **Dechlorination**

- The extent of dechlorination is limited in the sediments, resulting in probably less than 10 percent mass loss from the original concentrations.
- Extent of dechlorination controlled by concentration, not time.
- Dechlorination occurs relatively quickly (several years), then rate becomes negligible.
- Even with “extensive” dechlorination, fish are still bioaccumulating Aroclor 1248-like PCBs (with 3, 4 and 5 chlorine atoms).

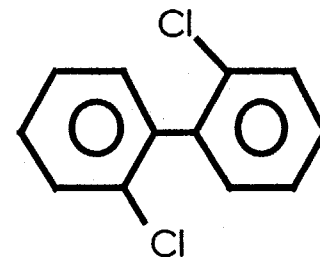
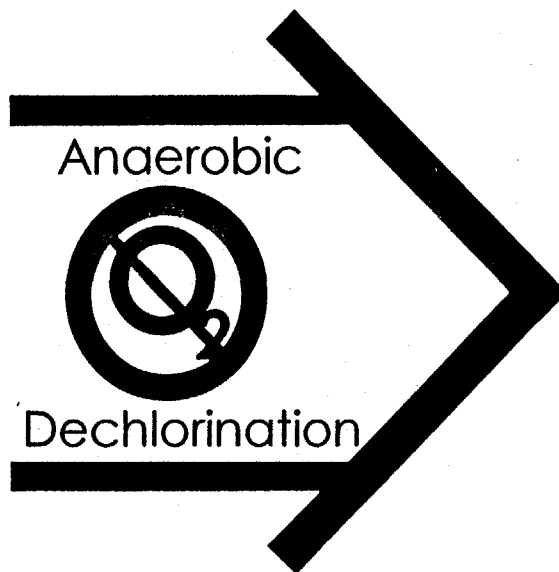
Sediment inventories will not  
be naturally "remediated" via  
dechlorination.



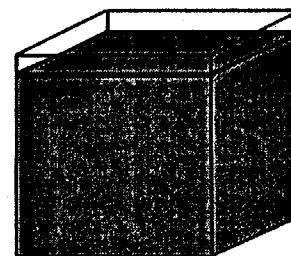
2,2',4,5'-Tetrachlorobiphenyl  
(BZ#49)



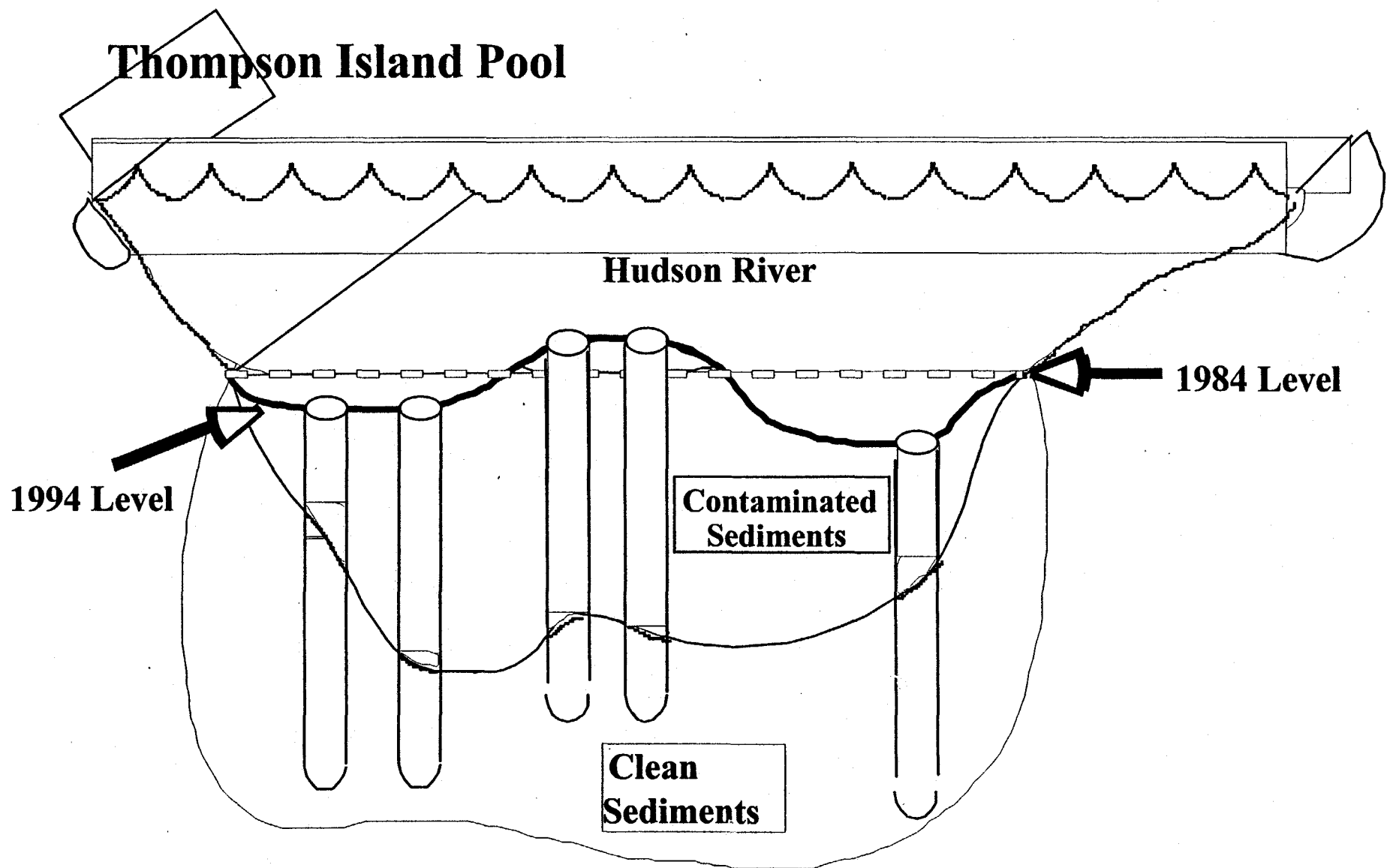
Mass Before  
Dechlorination



2,2'-Dichlorobiphenyl  
(BZ#4)



Mass After  
Dechlorination



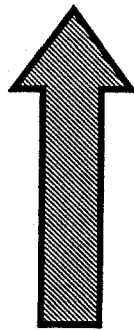
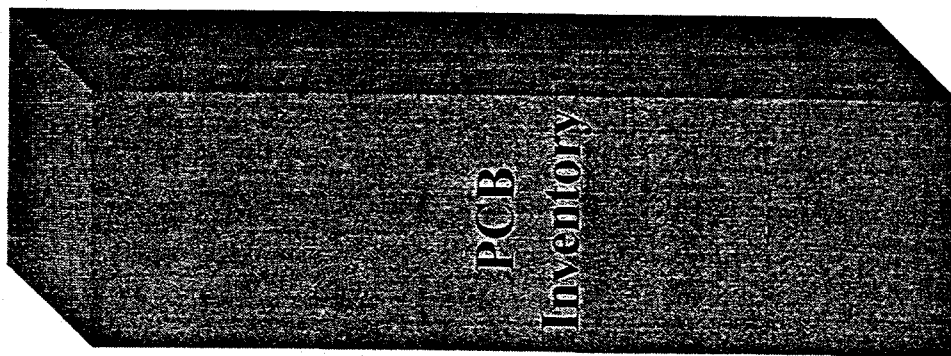


## Sediment Inventory of PCBs

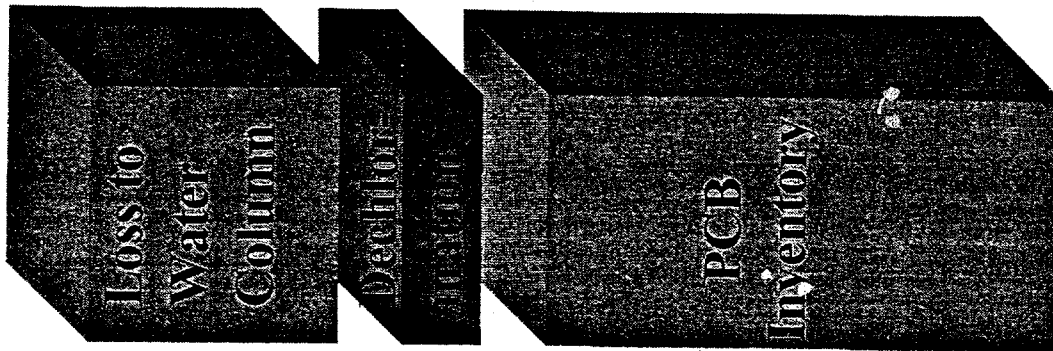
- From 1984 to 1994, there has been a statistically significant loss of PCB inventory (between 4 and 59 percent) from highly-contaminated sediments in the Thompson Island Pool ( $>10 \text{ g/m}^2$ ).

PCBs in the most highly contaminated areas are being redistributed within the river.

1984



1994



~43%  
(4 - 59%)

45%  
(+/-)

~5%

55%  
(+/-)

## **Modeling Findings**

- Revised Baseline Modeling Report  
(January 2000)
  - Supercedes Baseline Modeling Report (May 1999)
- Responsiveness Summary to Baseline  
Modeling Report issued February 2000
- Peer Review underway--to be completed  
March 28

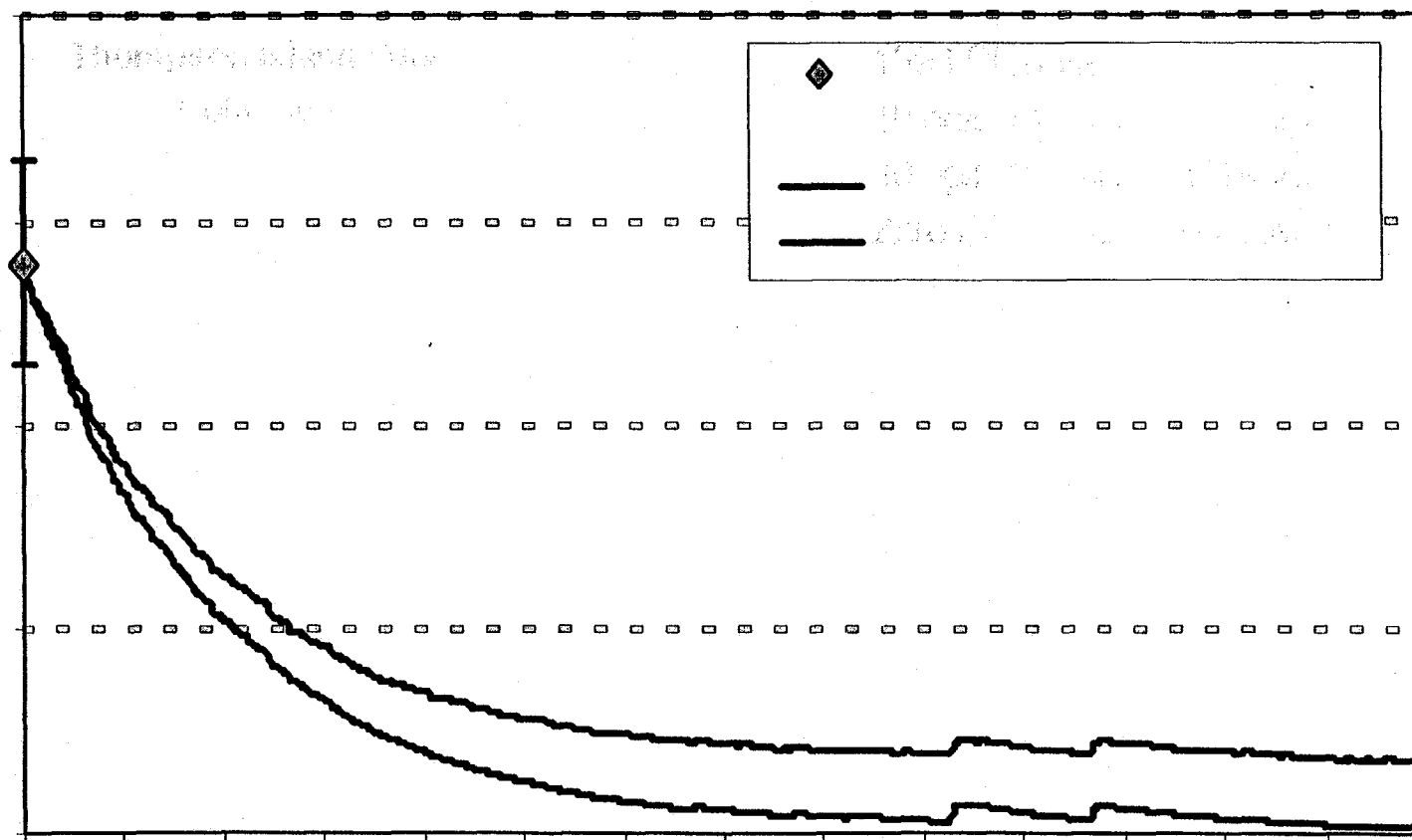
## Modeling - Source Contribution

For the first two to three decades of the model forecast, depending on location, the in-place PCB (Tri+) reservoir in the sediments and sediment-water transfer processes control responses of surface sediment concentrations.

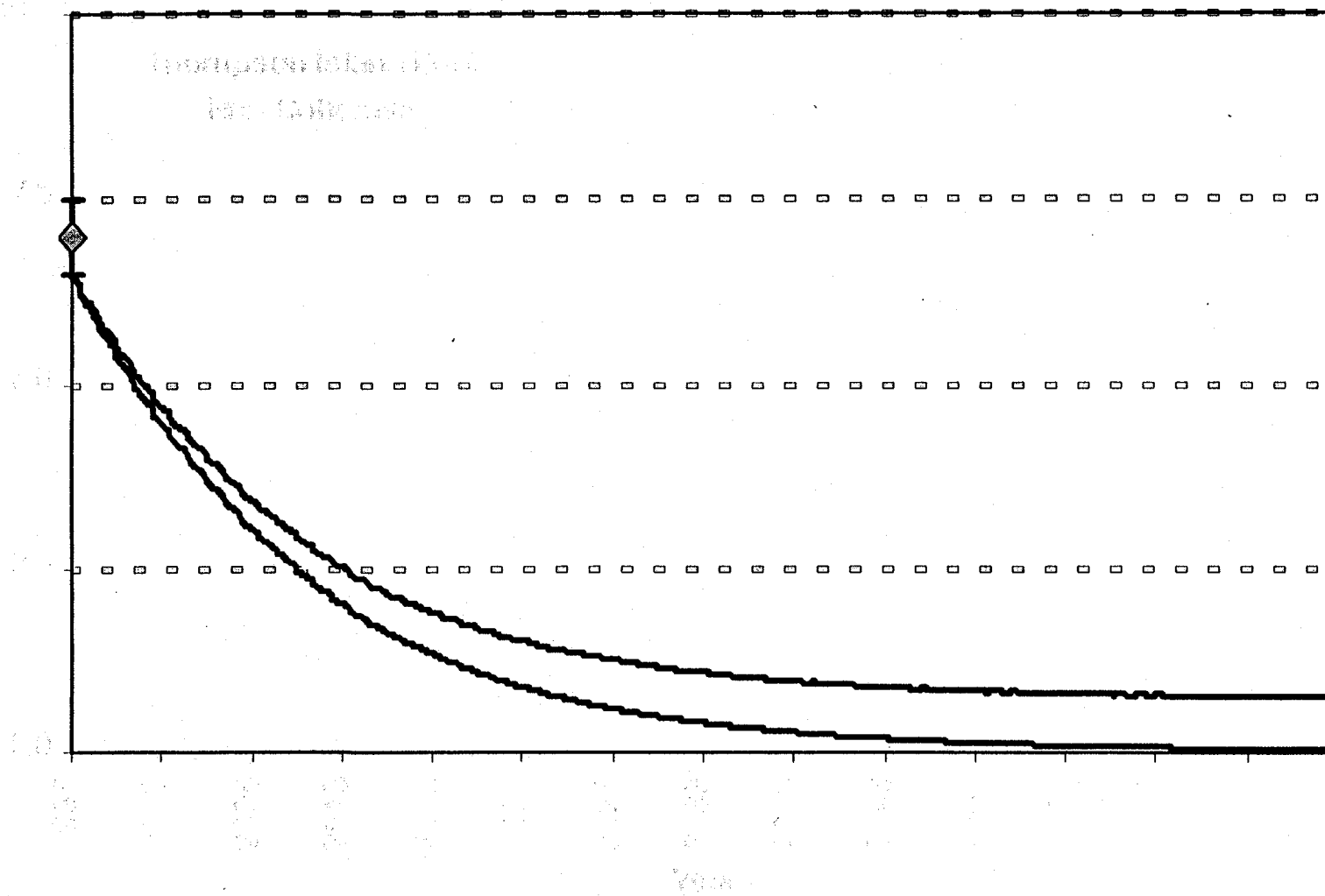
PCB (Tri+) loads from upstream of the model boundary at Fort Edward (*e.g.*, GE Hudson Falls Plant site) control the long-term responses of PCB (Tri+) concentrations in the water column and surface sediments, and accordingly, body burdens in fish.

Upstream loads control the long-term rate of recovery in the river.

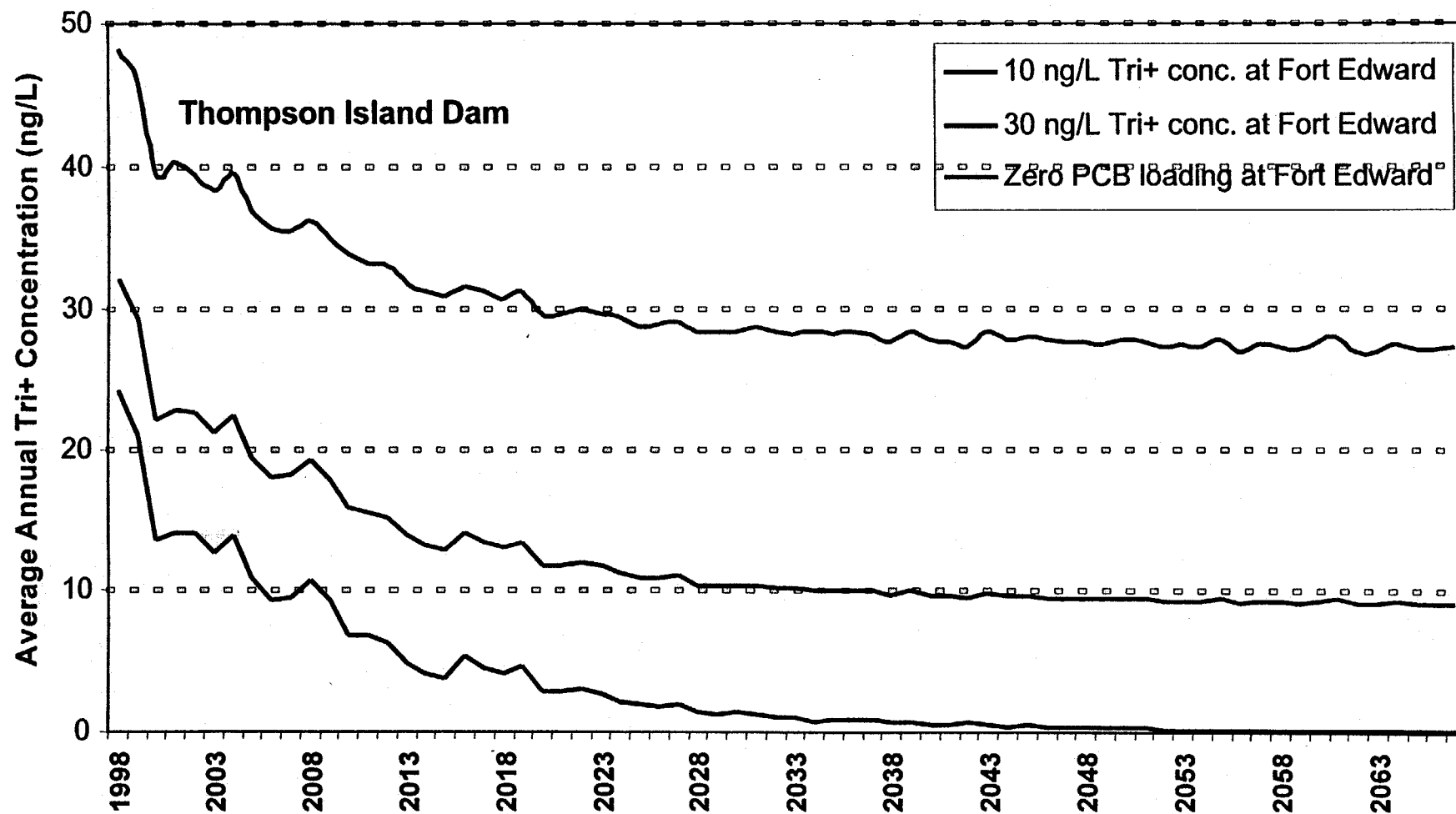
# **Forecast Surface Sediment Tri+ Concentrations for Thompson Island Pool (Cohesive)**



## Forecast Surface Sediment Tri+ Concentrations for Thompson Island Pool (non-cohesive)



# Forecast Annual Average Water-Column Tri+ Concentrations at Thompson Island Dam



## Modeling - Major Floods

A 100-year flood would not yield substantial impacts on the PCB levels in the Upper Hudson River.

- 60 lbs of PCBs lost from Thompson Island Pool
- Impact of flood on water-column PCB levels is minimal after one year.

100-year flood scenario  
not a critical factor.





## Modeling - Burial (Sequestering)

Thompson Island Pool: net deposition of sediment, but losses of PCBs from the sediment

- From 1984 - 1994, the model estimated that ~2000 kg of PCBs (Tri+) were lost from the Thompson Island Pool sediments, while at the same time ~2 cm of net sediment deposition occurred across the pool.

Burial does not isolate  
PCBs in the sediments.

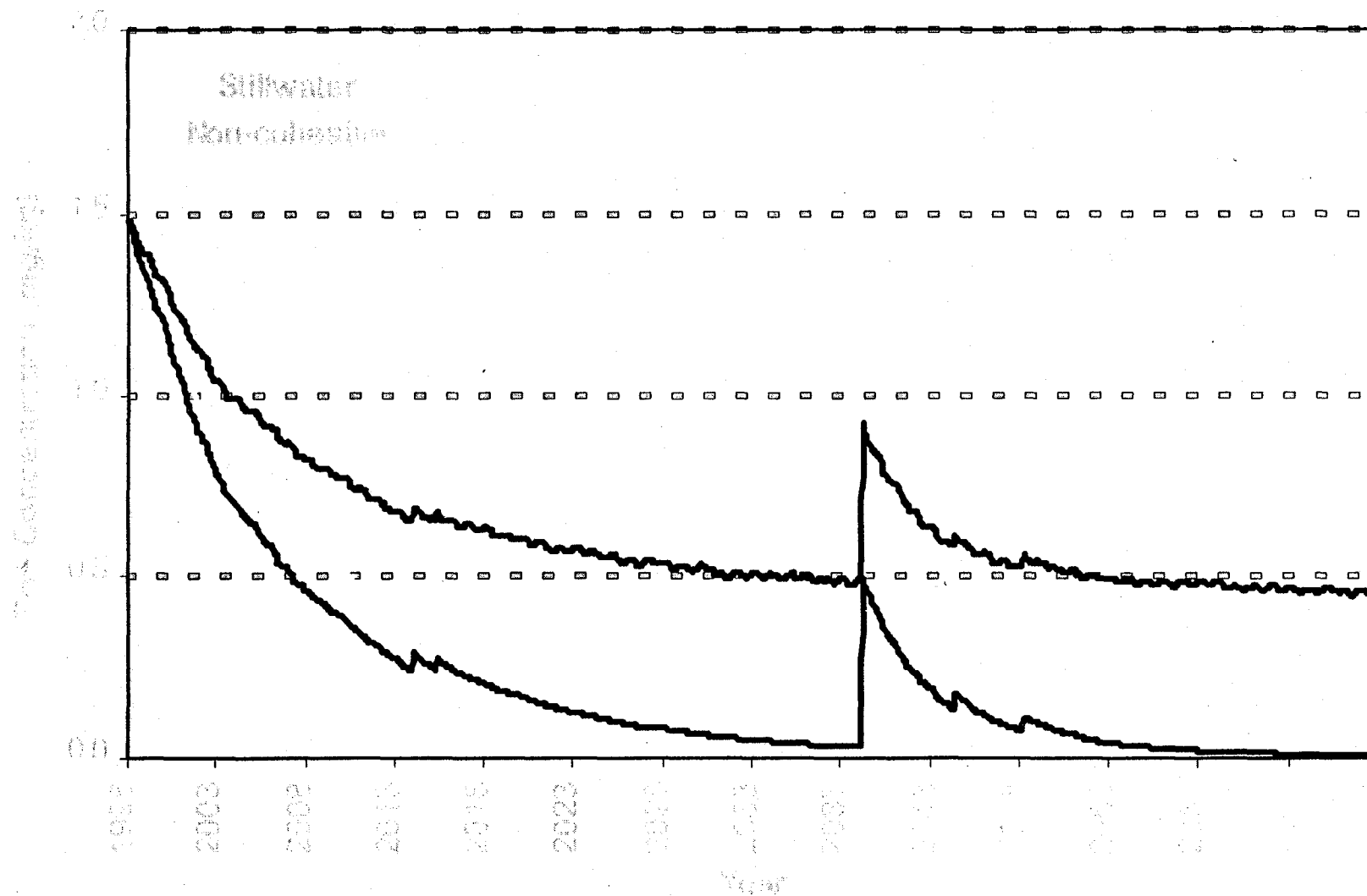
## **Modeling - Sediment Erosion**

Forecasts show that relatively small annual erosion rates eventually, over an extended length of time, expose PCB concentrations in localized areas that were previously at depth.

- The occurrence, magnitude and timing of these computed increases are dependent on forecast assumptions.
- It is reasonable to assume that localized erosion occurs within the river, but at scales smaller than the spatial scale of the model. Therefore, the model may not accurately reflect the areal extent of such erosion or its timing.

Localized erosion can occur even if  
the river reach is net depositional

## Forecast Surface Sediment Tri+ Concentrations for Stillwater Reach



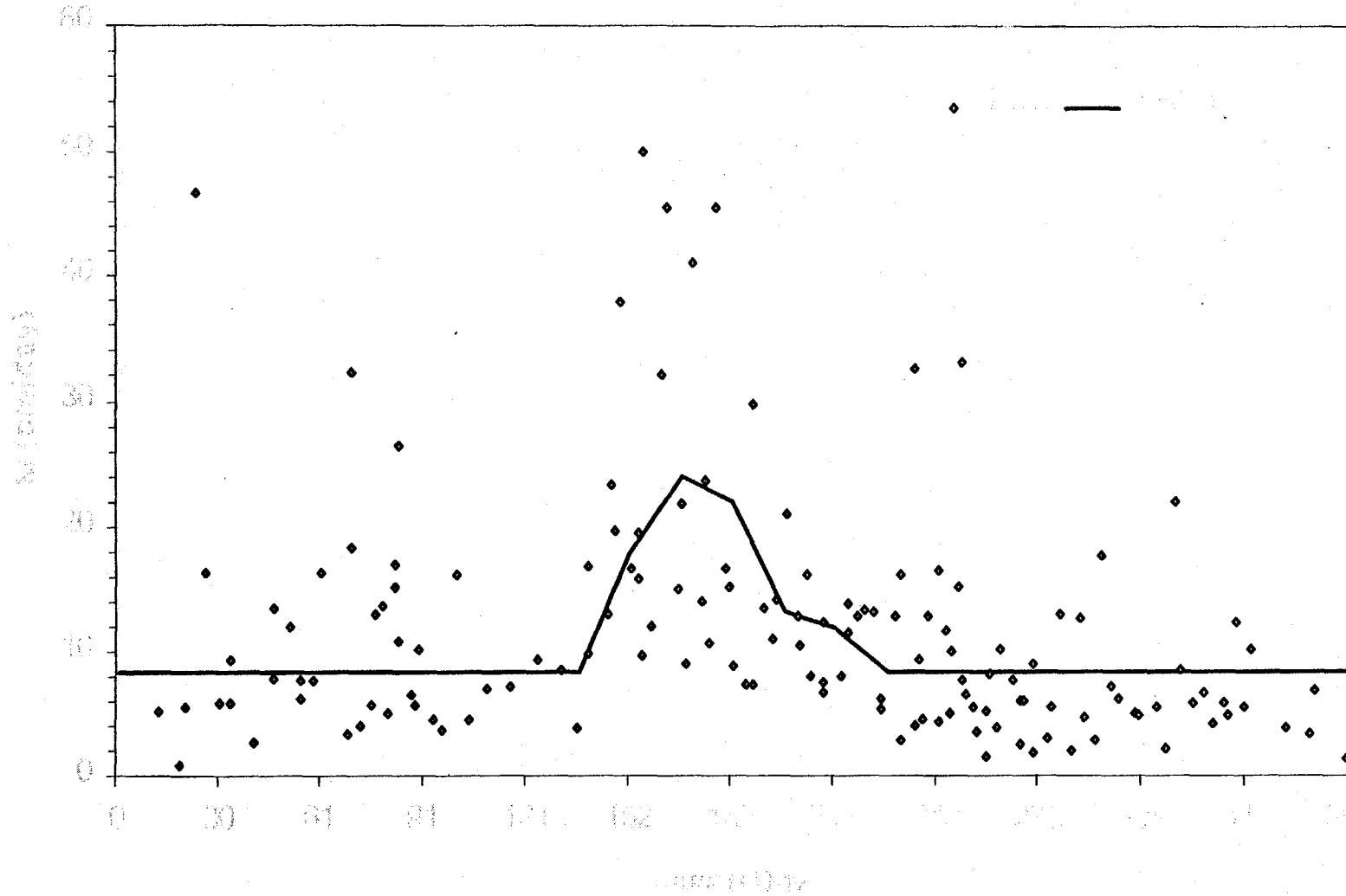
## **Modeling - Uncertainty**

There is a substantial contribution of PCBs from the sediment that is not dependent on the flow of the river.

- The mechanism for non-flow dependent transfer is not fully understood and had to be estimated empirically.
- The empirical PCB sediment-water transfer is approximately 50 percent of the PCB loading to the water column in the Thompson Island Pool.

Sediment-water  
exchange of PCBs is  
not fully understood.

# Data Based Sediment-Water Mass Transfer Rate in Thompson Island Pool, 1993-1997



## **Modeling - Forecasts of Fish Tissue Concentrations**

- Small differences in target levels can make decadal changes in the time it takes to reach target levels
- Appropriate target levels will be identified in the Feasibility Study

Time to reach target level is  
dependent on target level selected.

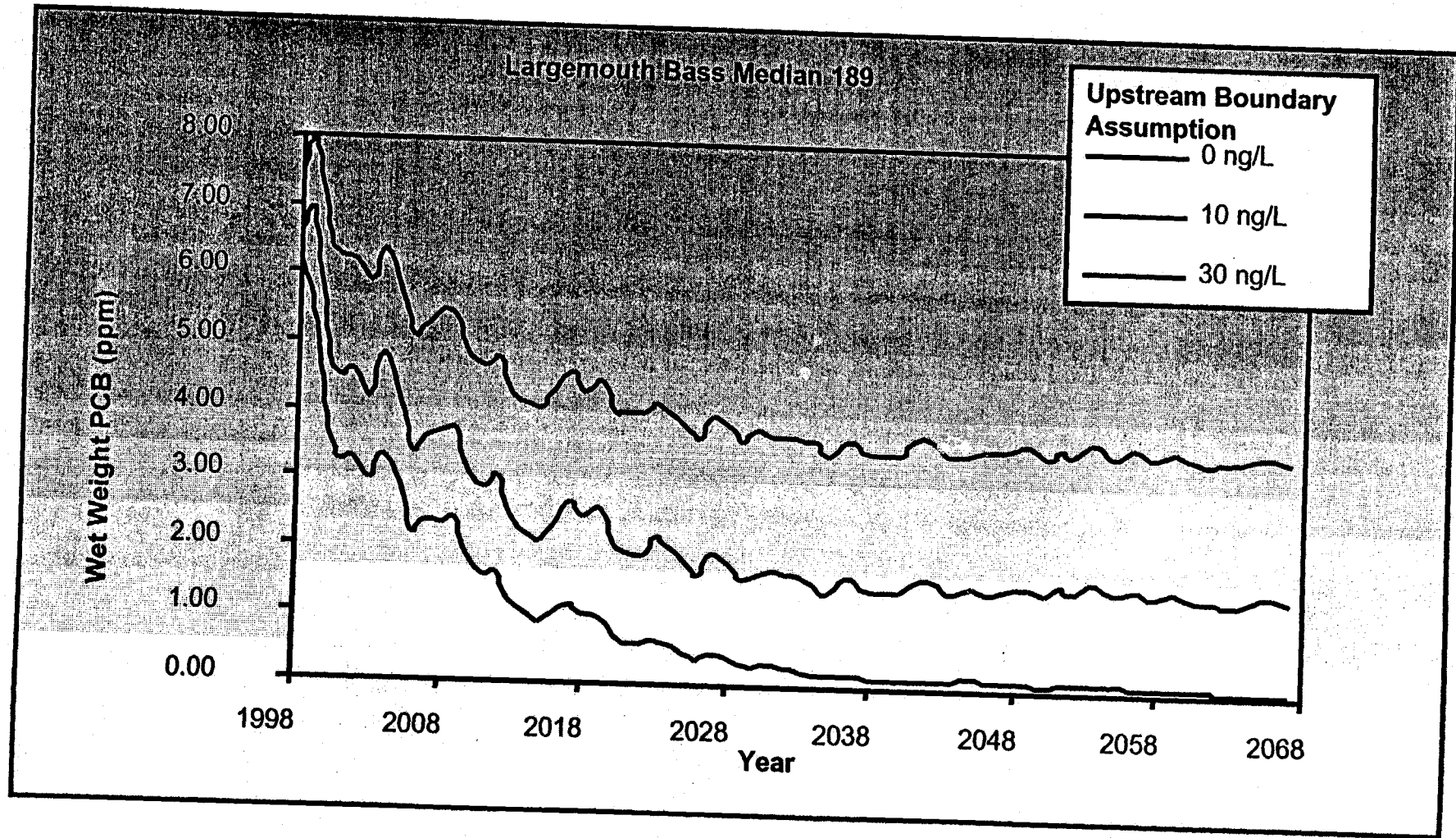
## Relative Importance of Sediment and Water

	Brown Bullhead	Largemouth Bass	Pumpkinseed
Elasticities			
Dissolved Water (ng/l)	0.05	0.27	0.77
Sediment (mg/kg)	0.95	0.73	0.23

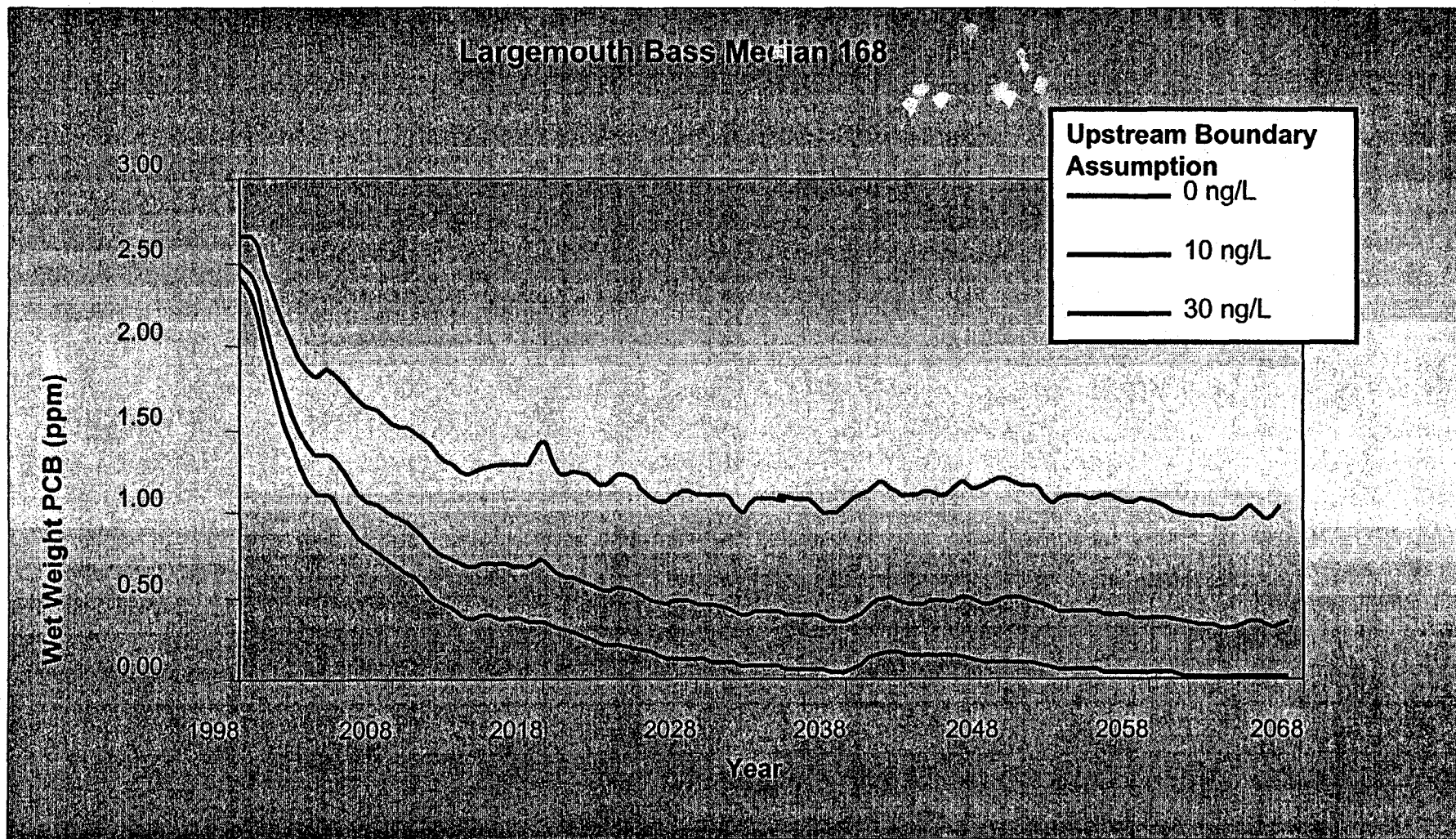
(Coefficients obtained using average-based  
steady-state model results in linear regression)



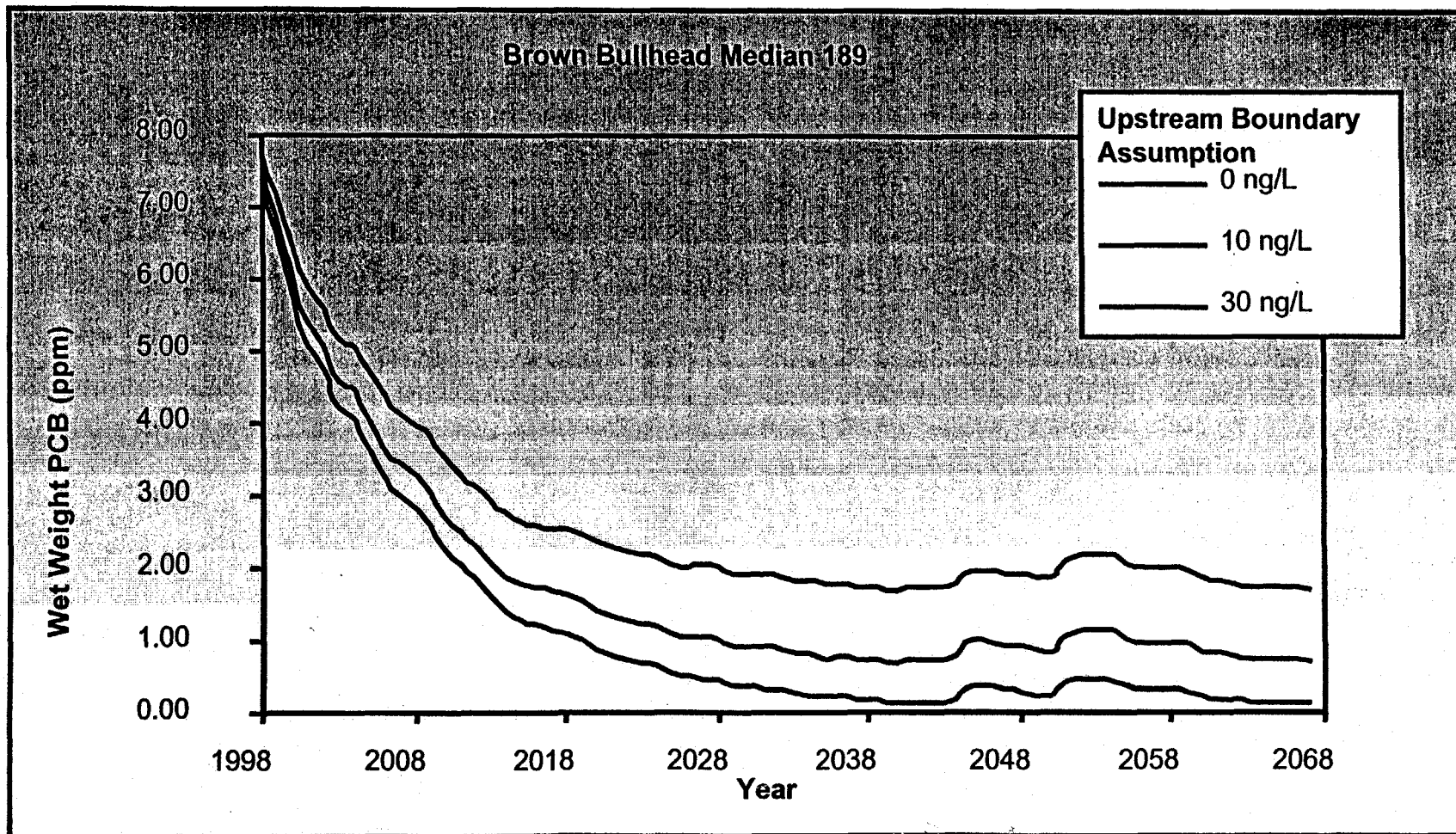
# FISHRAND Forecasts 1998 - 2067 for RM 189 (TIP)



# FISHRAND Forecasts 1998 - 2067 for RM 168 (Stillwater)

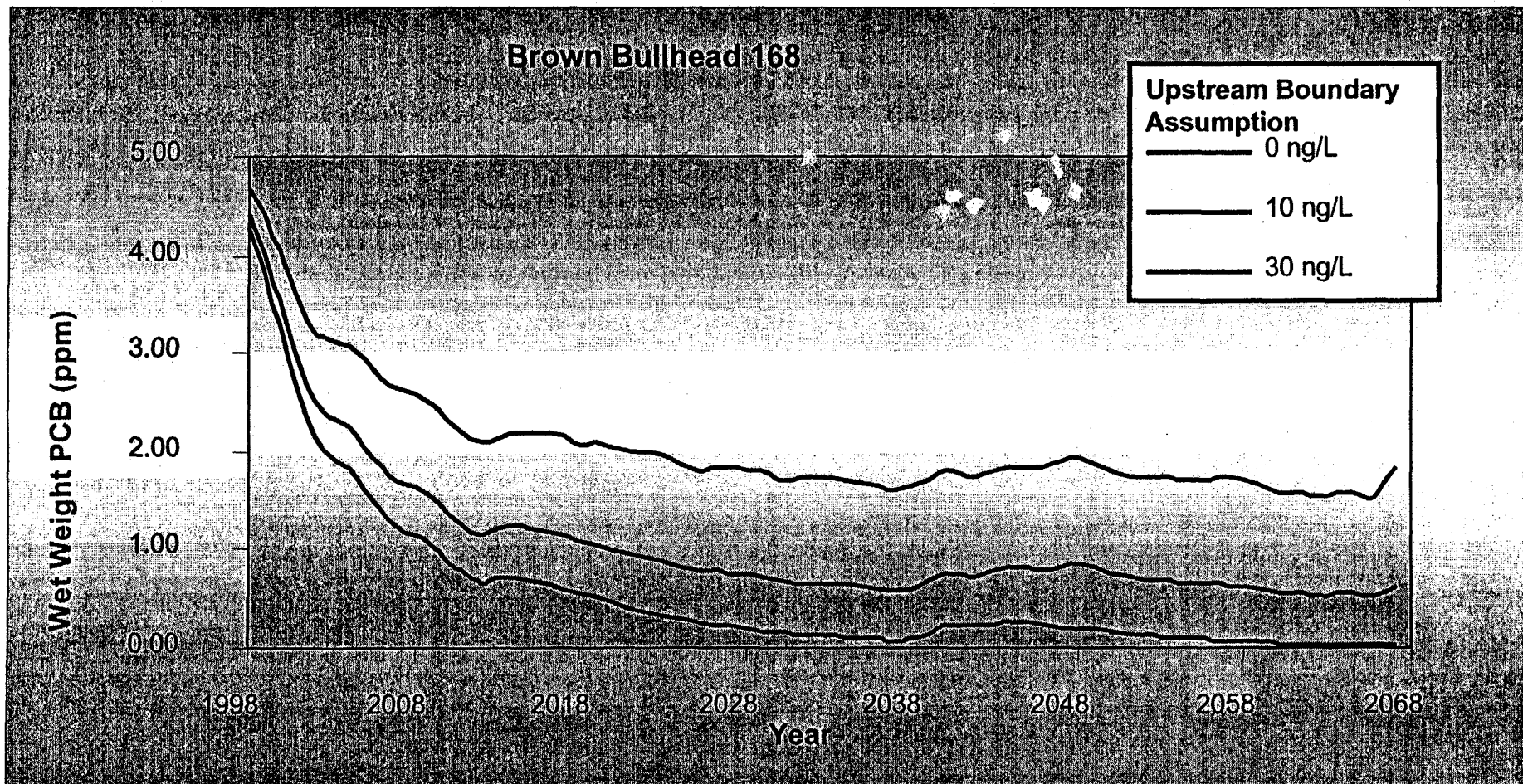


# FISHRAND Forecasts 1998 - 2067 for RM 189 (TIP)





# FISHRAND Forecasts 1998 - 2067 for RM 168 (Stillwater)



## **Summary of Findings**

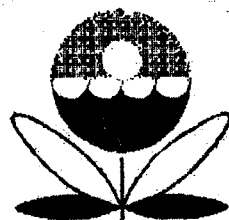
- TIP sediment is the major source of PCBs to the water column
- Dechlorination is not sufficient
- Burial does not isolate PCBs in sediment
- If unabated, PCB loads from upstream of the Thompson Island Pool control the long-term response of the system

# **Hudson River PCBs Reassessment**

## **Human Health Risk Assessment**

**Upper Hudson - August 1999**

**Mid-Hudson - December 1999**

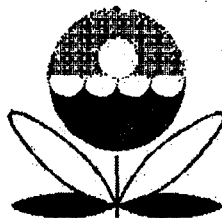


# **Hudson River PCBs Reassessment**

## **Ecological Risk Assessment**

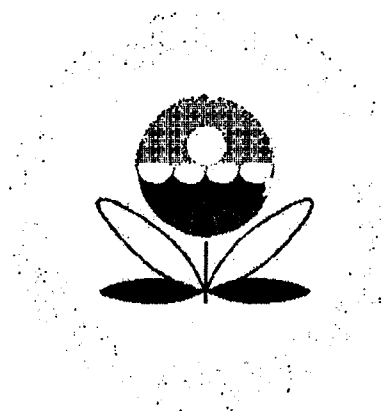
**Upper Hudson - August 1999**

**Lower Hudson Future - December 1999**

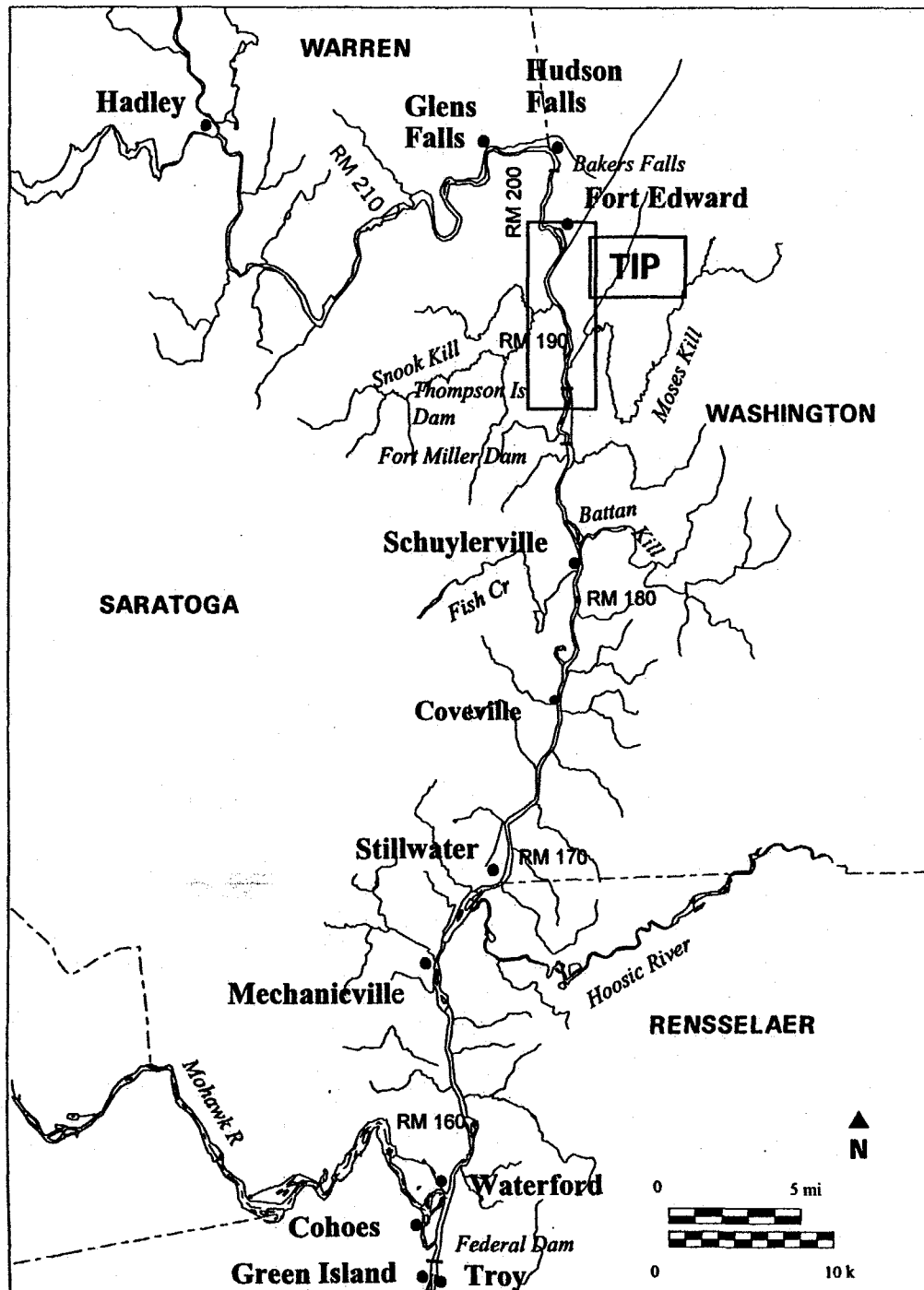


# **Hudson River PCBs Reassessment**

## **Phase 3 Report - Feasibility Study**







## Purpose of FS

Evaluate options to address the PCB-contaminated sediments in the Upper Hudson River to protect human health and the environment.

- SOW 9/98
- Resp Sum 4/99

## Remedial Action Objectives

Developed as part of Feasibility Study

Specify:

- Contaminants (PCBs) and media of interest
- Exposure pathways (*e.g.*, consumption of fish)
- Preliminary remediation goals (*e.g.*, target conc. in fish)

Permits a range of  
alternatives to be developed

## General Response Actions

- No-action
- Monitored natural attenuation
- Containment (capping)
- *In-situ* treatment
- Dredging (+/- treatment) and disposal

## **No-Action**

- required by law
- provides basis for comparison of alternatives
- establishes baseline condition

No need for remediation  
Monitoring is allowed

# **Monitored Natural Attenuation**

- baseline condition presents risk or exceeds applicable standards
- expect to achieve remediation goals in reasonable time frame compared to active alternatives
- may include institutional controls
- may be used in conjunction with other alternatives

**No active remediation  
Monitoring is necessary**

# **NCP Nine Criteria**

## **Threshold Factors**

- 1) Overall Protection of Human Health and Environment
- 2) Compliance with Other Environmental Laws

## **Primary Balancing Factors**

- 3) Long-term Effectiveness and Permanence
- 4) Reduction of Toxicity, Mobility or Volume
- 5) Short-term Effectiveness
- 6) Implementability
- 7) Cost

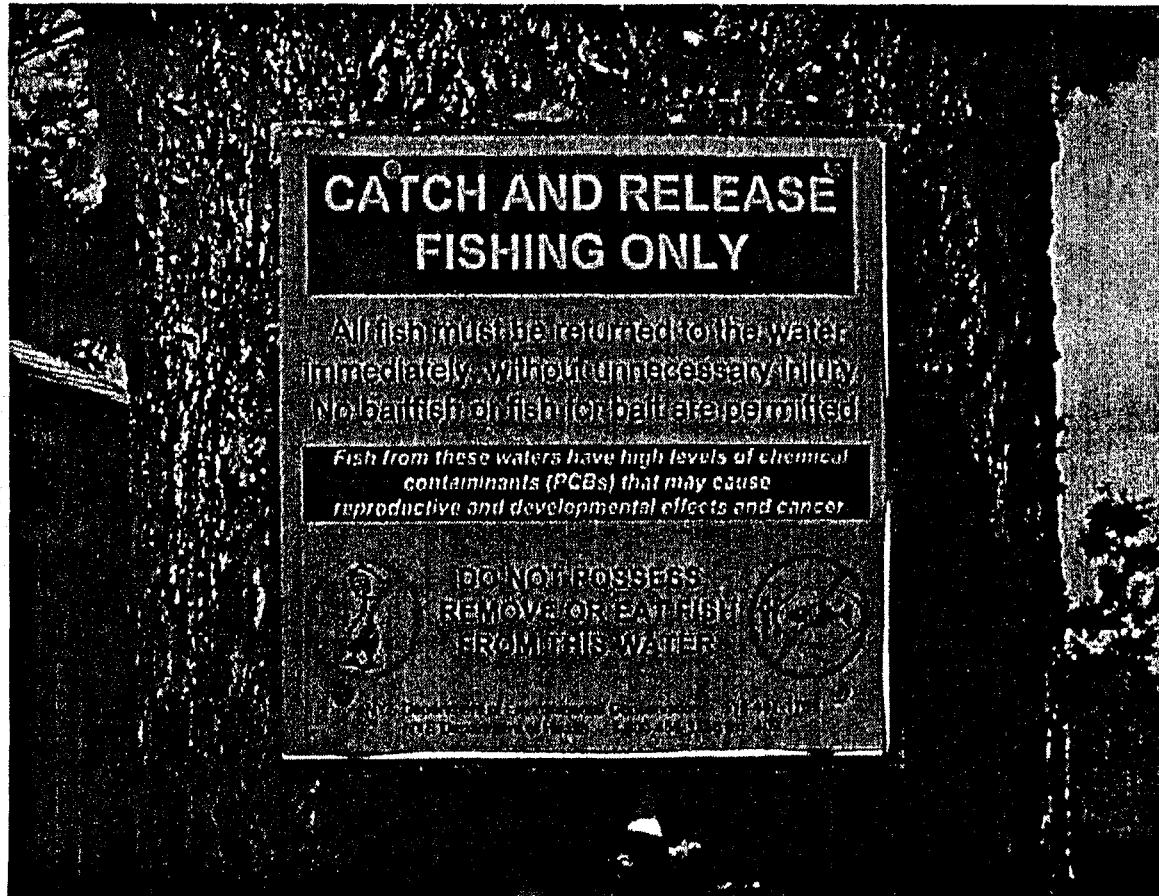
## **Modifying Criteria**

- 8) State Acceptance
- 9) Community Acceptance

## **Proposed Plan - Record of Decision**

- Proposed Plan identifies preferred alternative
  - Public comment (assess community acceptance)
- Record of Decision
  - Responsiveness Summary

# Hudson River PCBs Reassessment



[www.epa.gov/hudson](http://www.epa.gov/hudson)



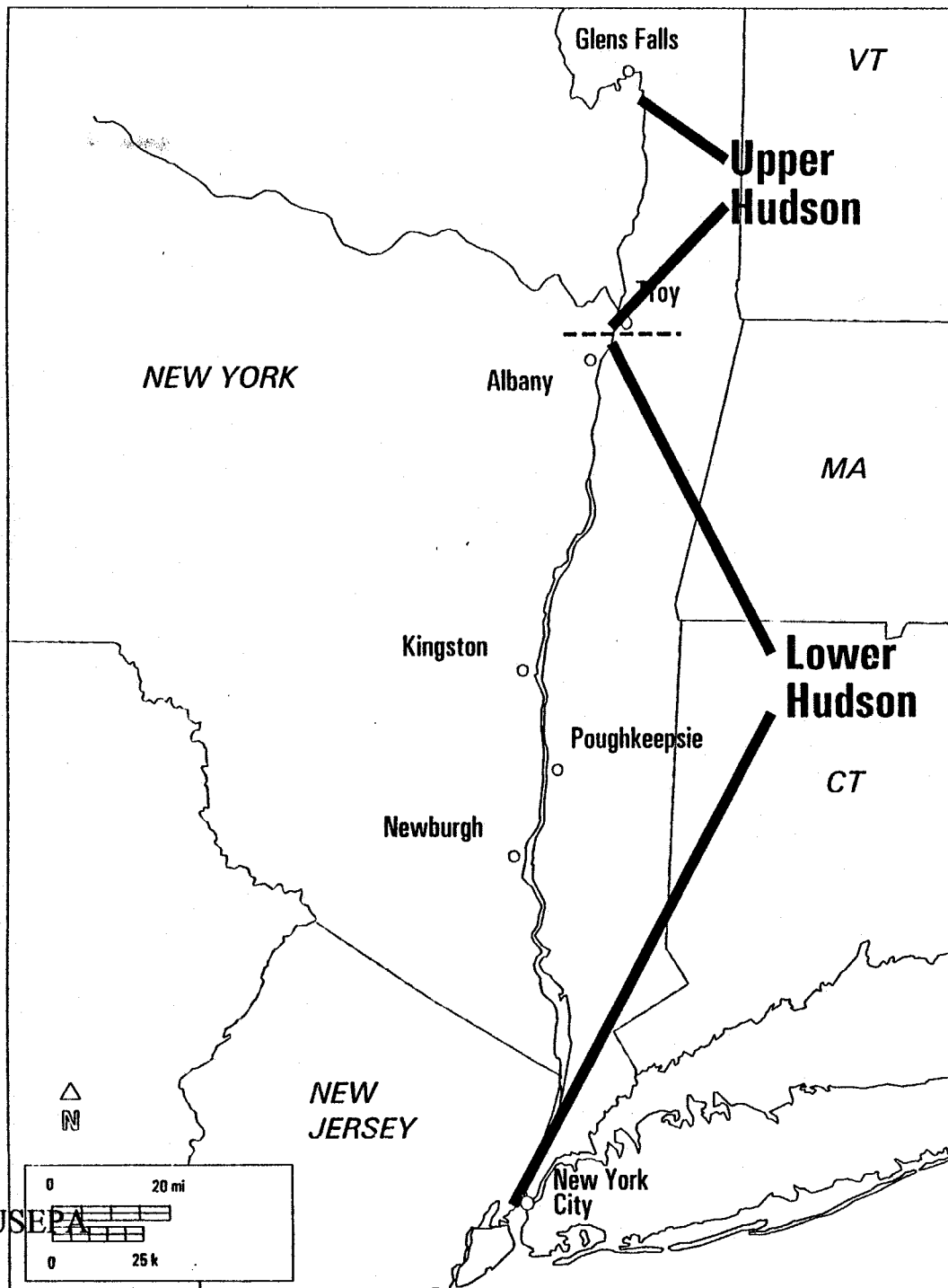
# Examination of Exposure Pathways Based on Congener Patterns

## Relationships Among Fish Body Burdens and Exposure Media

Edward A. Garvey, Ph.D.

# Outline of Presentation

- Sampling Program
- Examination of Homologue Patterns in Biota
- Comparison Among Stations and Species
- Initial Principal Components Analysis
- Selected Congener Ratios
- Summary



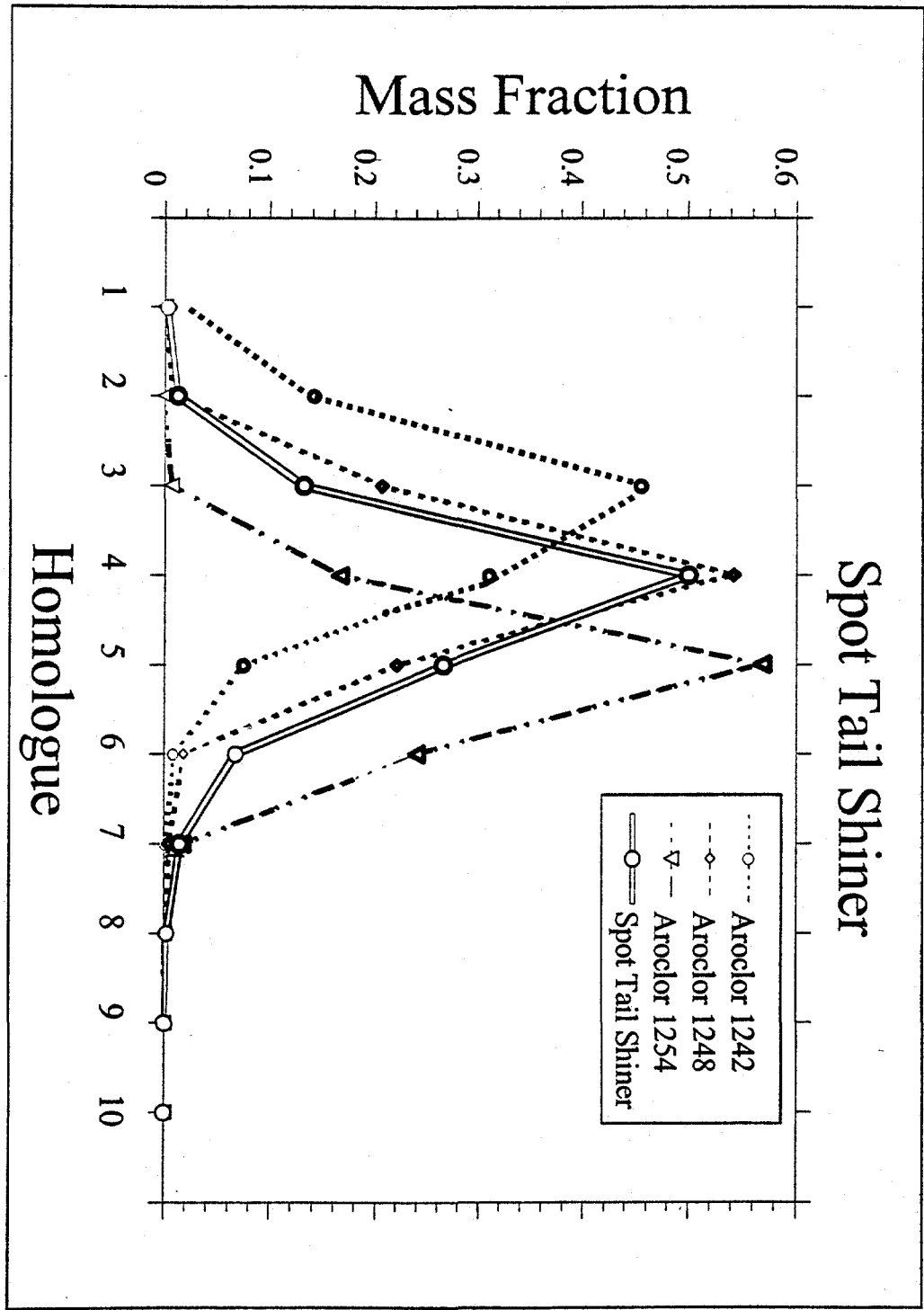
## Scope of Ecological Risk Assessment

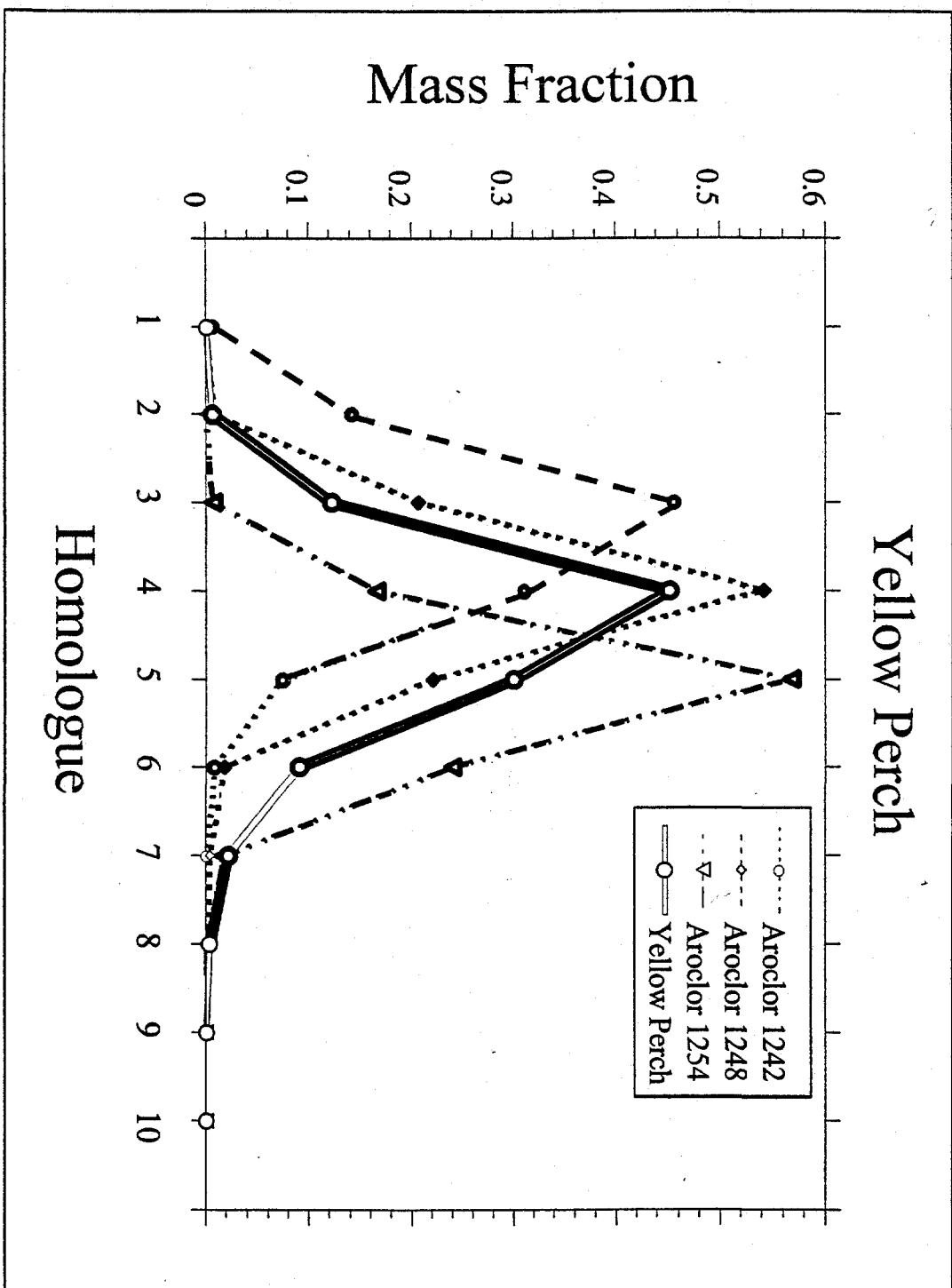
USEPA

TAMS/MCA

# Ecological Sampling Program

- 19 ecological sampling stations throughout Hudson
- Co-located samples
  - Sediments (0-5 cm)
  - Benthic Invertebrates
  - Fish
- Coincident water column sampling (Aug & Sept 93)
- High resolution cores
  - Spanning 200 river miles
- Low resolution cores
  - RM 194 to 168 only



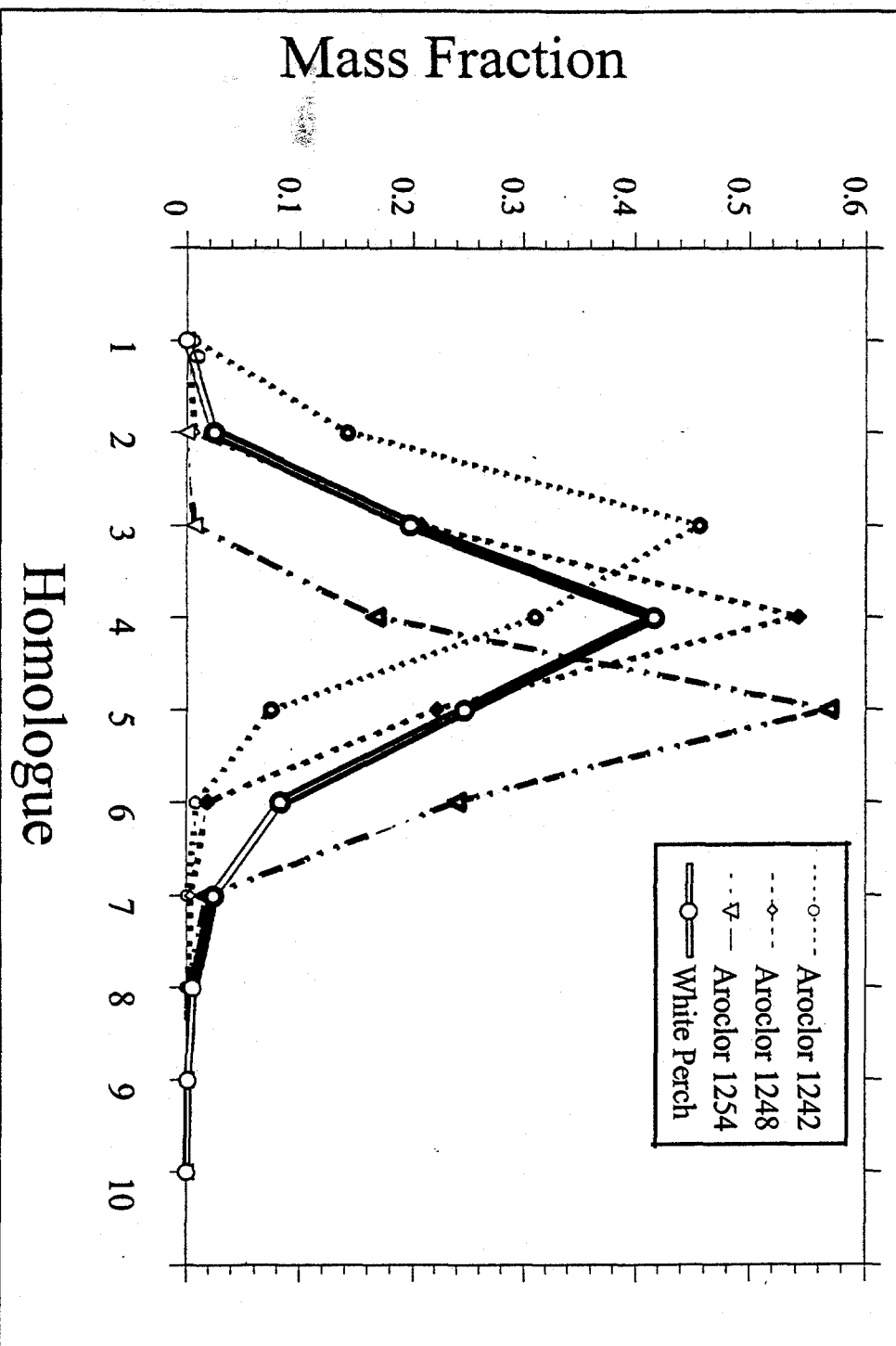


A Comparison of Homologue Patterns in Aroclors and Fish  
RM 175 to 156

USEPA

TAMS/MCA

# White Perch



Homologue

Mass Fraction

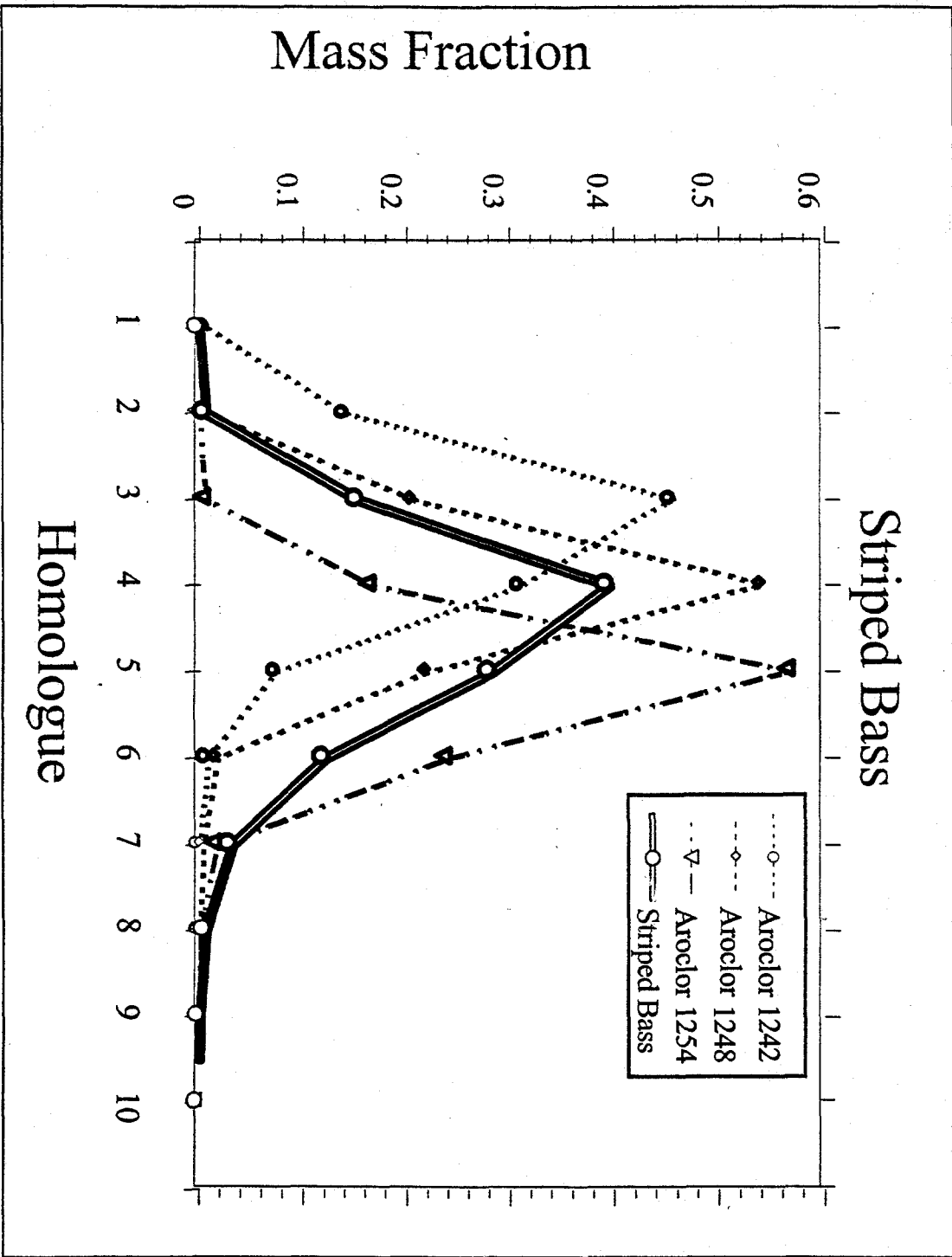
---○--- Aroclor 1242  
 ---◇--- Aroclor 1248  
 -·-·-△-·- Aroclor 1254  
 —○— White Perch

A Comparison of Homologue Patterns in Aroclors and Fish

USEPA

RM 156 to 100

TAMSMCA



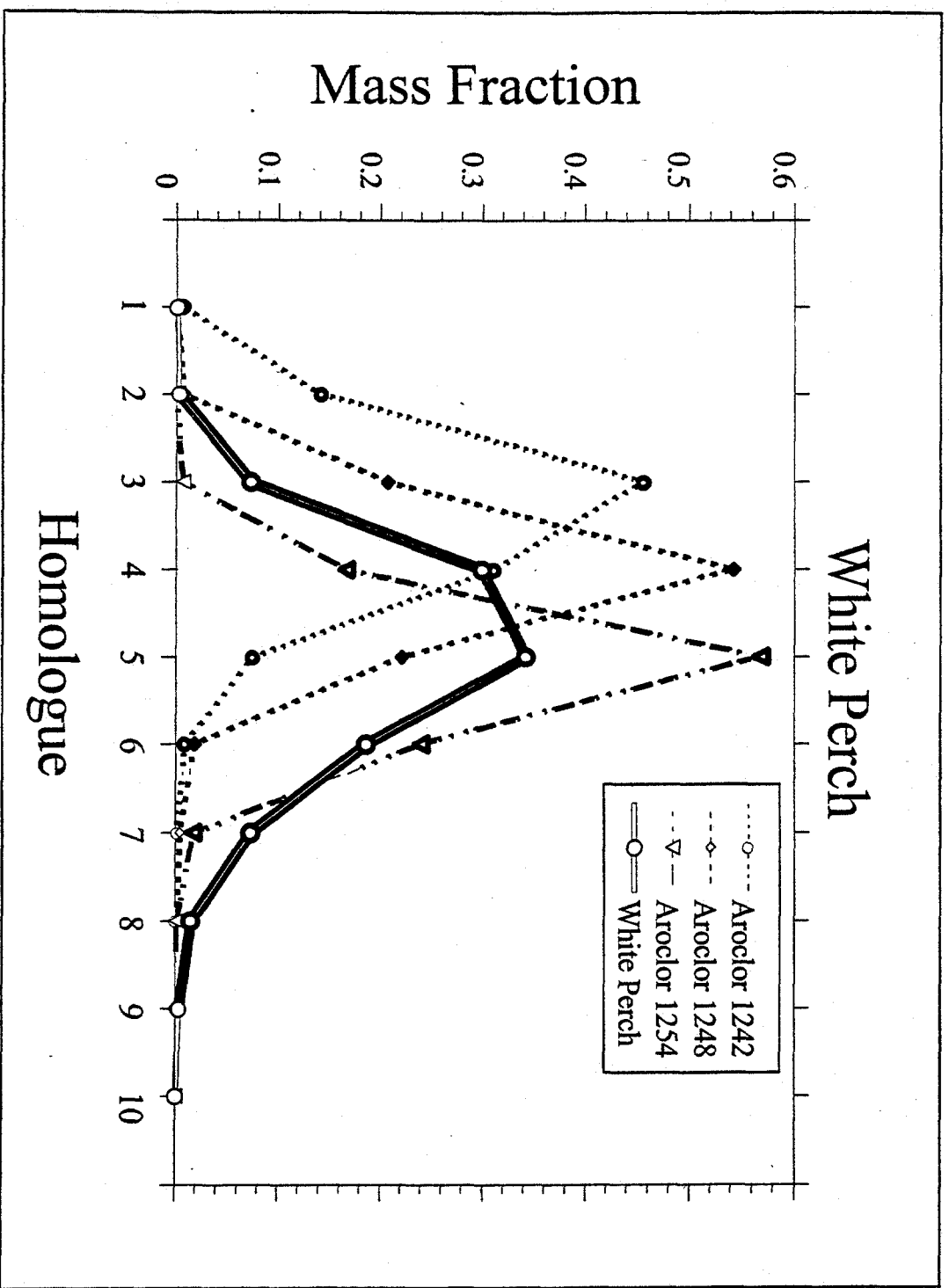
# A Comparison of Homologue Patterns in Aroclors and Fish

USEPA

RM 100 to 60

TAMS/MCA





# A Comparison of Homologue Patterns in Aroclors and Fish

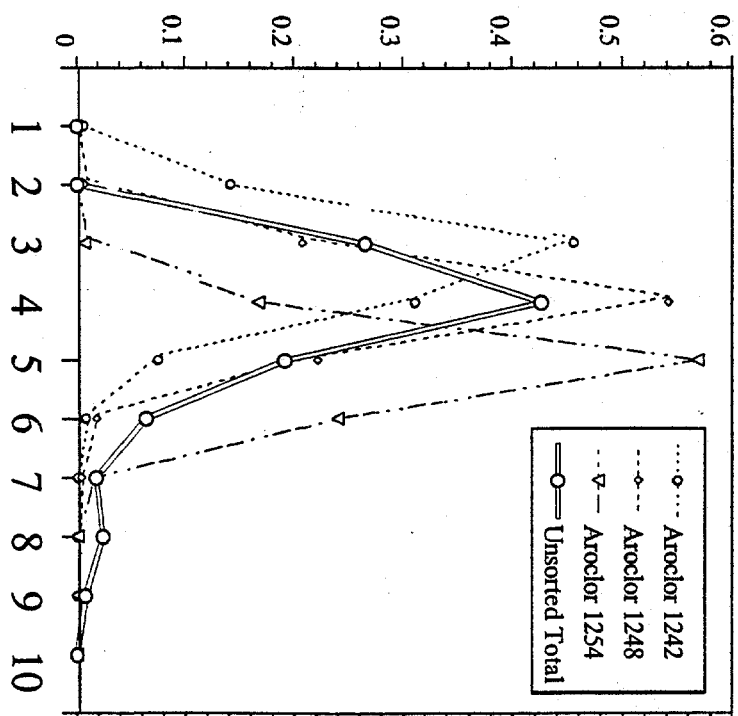
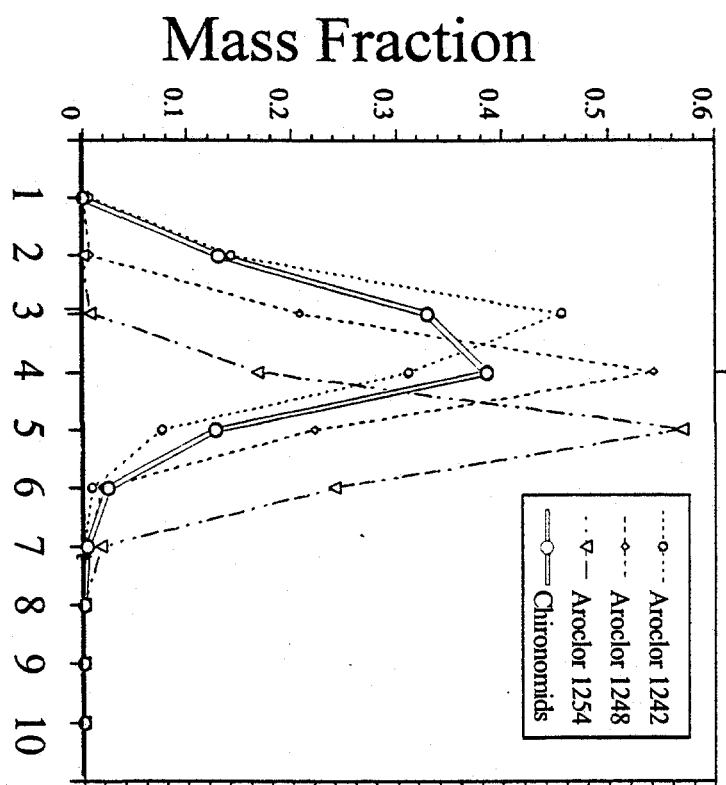
USEPA

RM 60 to 0

TAMS/MCA

## TI Pool RM 190

## Lower Hudson RM 156-100



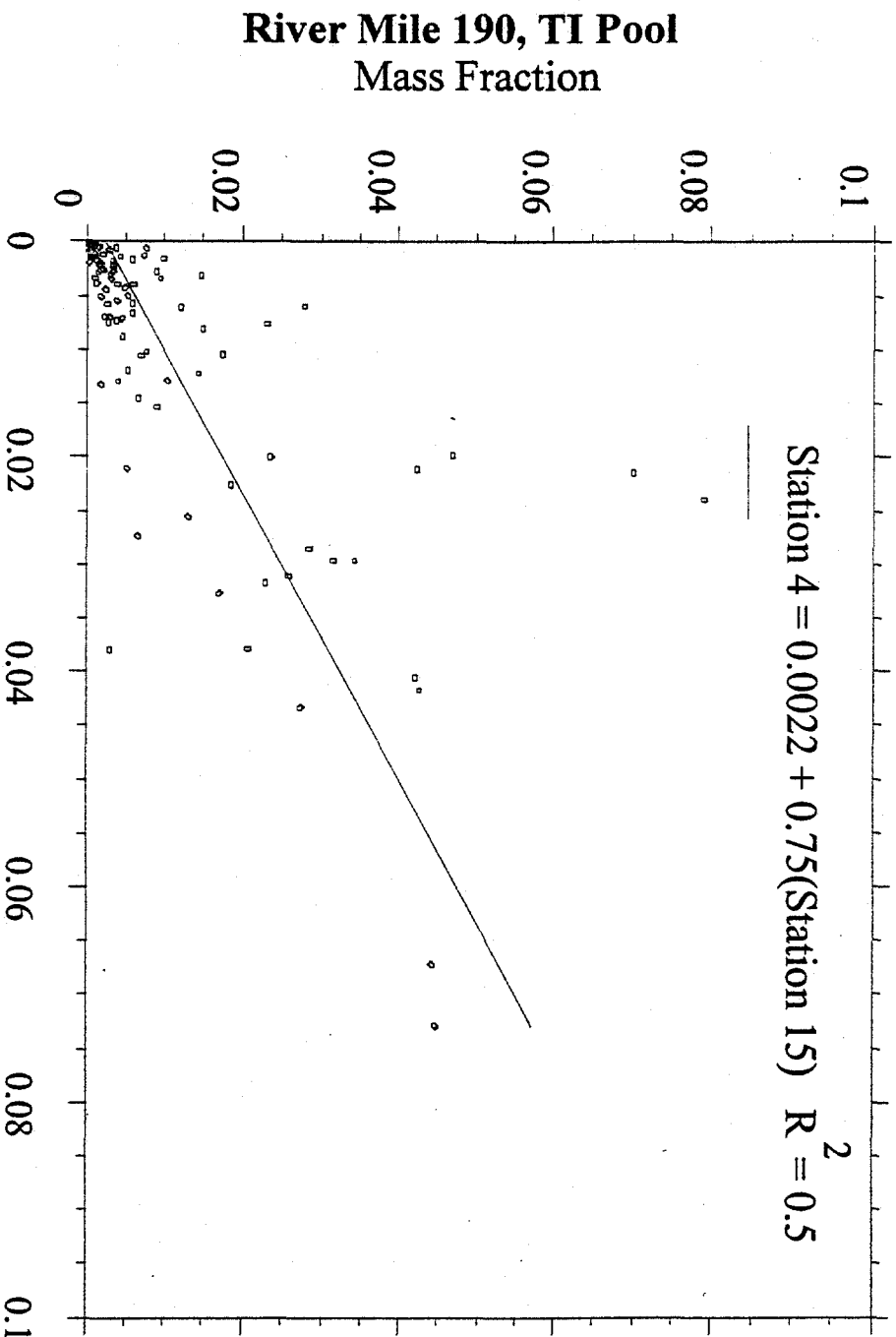
## Homologue

## A Comparison of Homologue Patterns in Aroclors and Invertebrates

USEPA

TAMSMCA

## Largemouth Bass

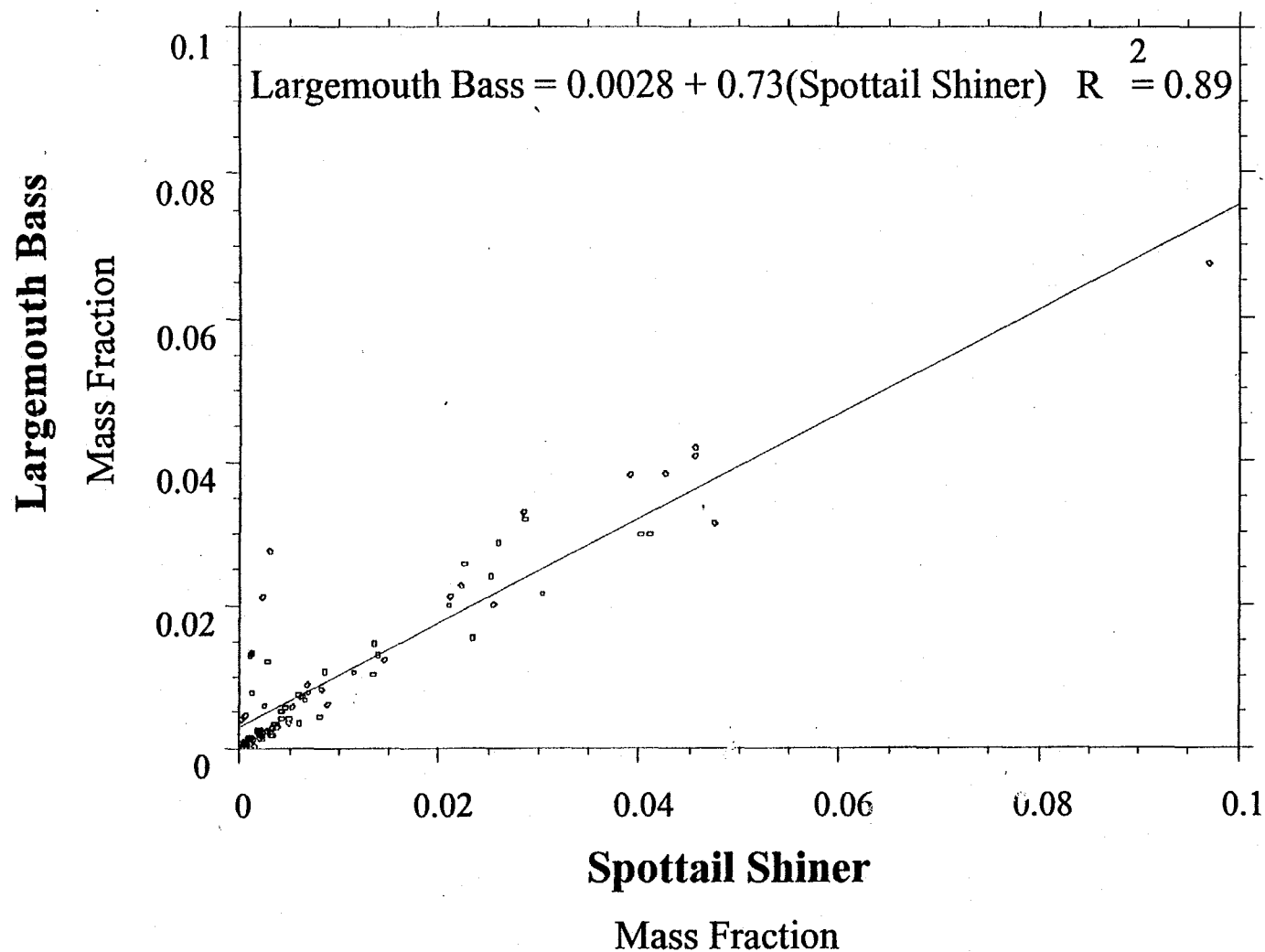


## Comparisons of Congener Mass Fraction Between Stations

USEPA

TAMS/MCA

# River Mile 89.4, Freshwater Lower Hudson



## Comparisons of Congener Mass Fraction Between Species

USEPA

TAMS/MCA

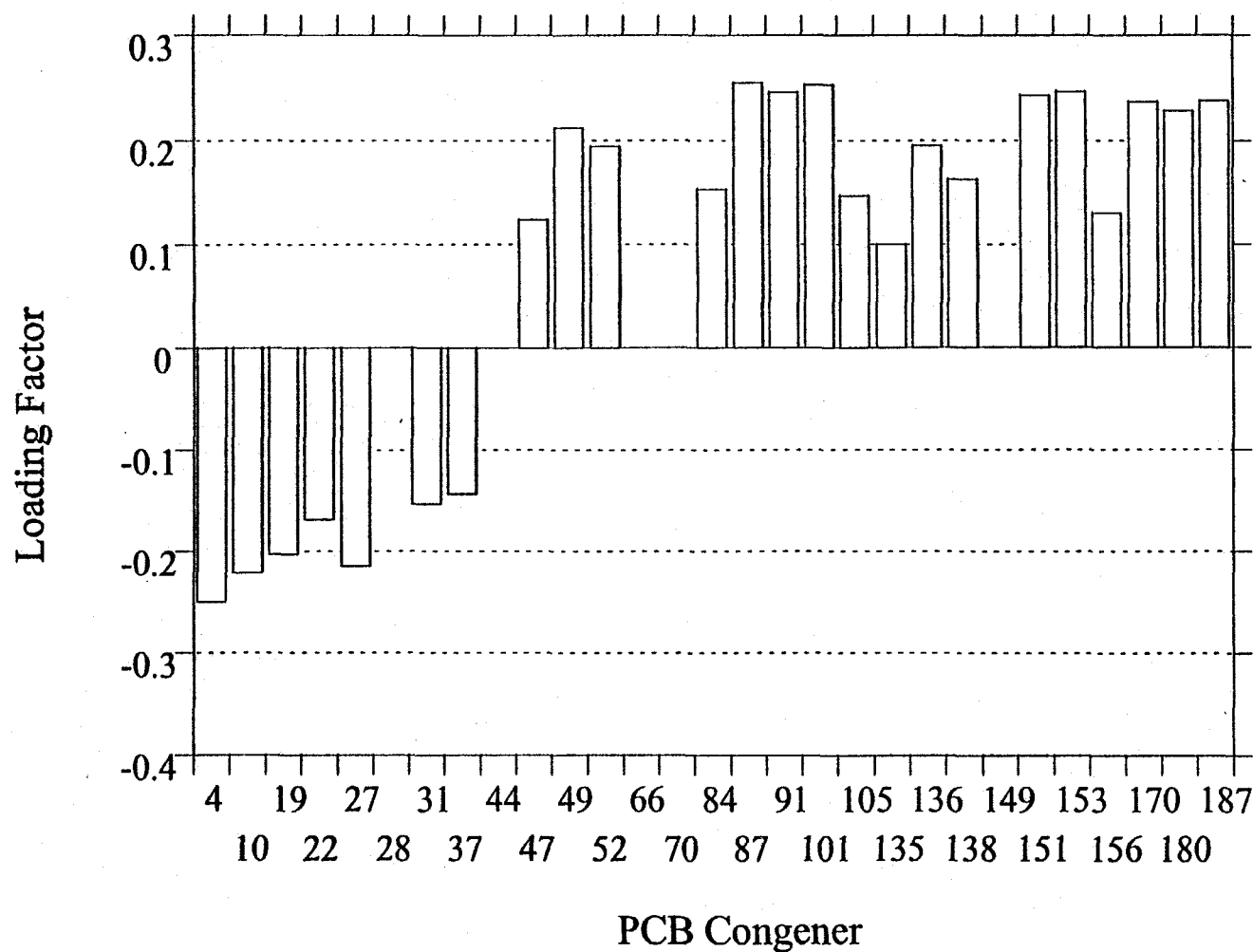
# Homologue Patterns

- Patterns show dominance by tetrachloro homologue in the freshwater Hudson
- Patterns resemble Aroclor 1248
- Pattern below salt front shows impact of NYC metro sources

# Principal Components Analyses

- Three separate analyses performed
- Initial (primary) analysis based on 29 congeners selected via optimization
- Analysis shows ability to separate data by media and location
- Principal components are easily interpreted from geochemical perspective

## Loadings on Principal Component 1



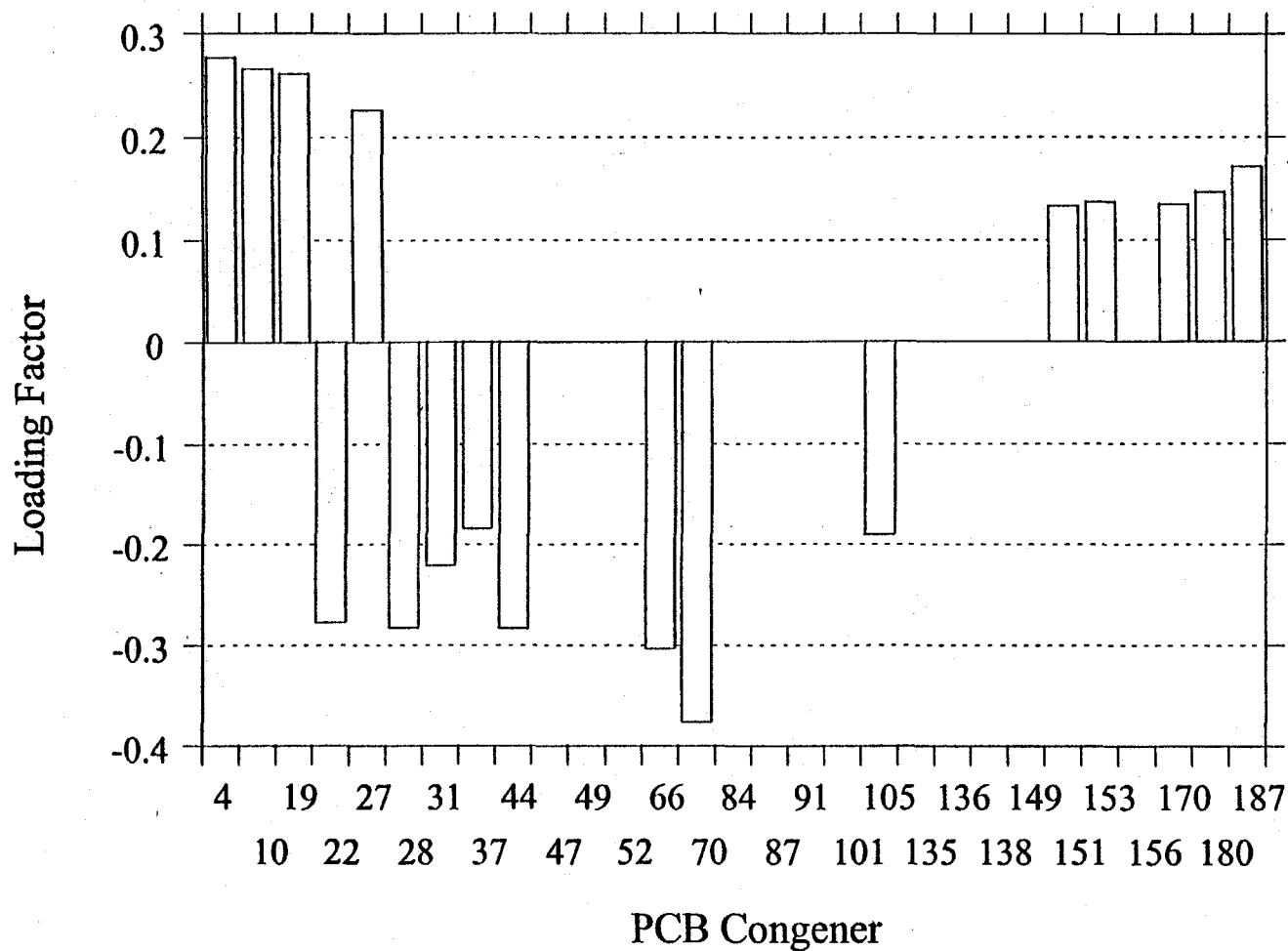
## Congener Loadings for Principal Components 1

1993 USEPA and NOAA Data for Sediments, Water, Fish and Benthic Invertebrates

USEPA

TAMS/MCA

## Loadings on Principal Component 2



## Congener Loadings for Principal Components 2

1993 USEPA and NOAA Data for Sediments, Water, Fish and Benthic Invertebrates

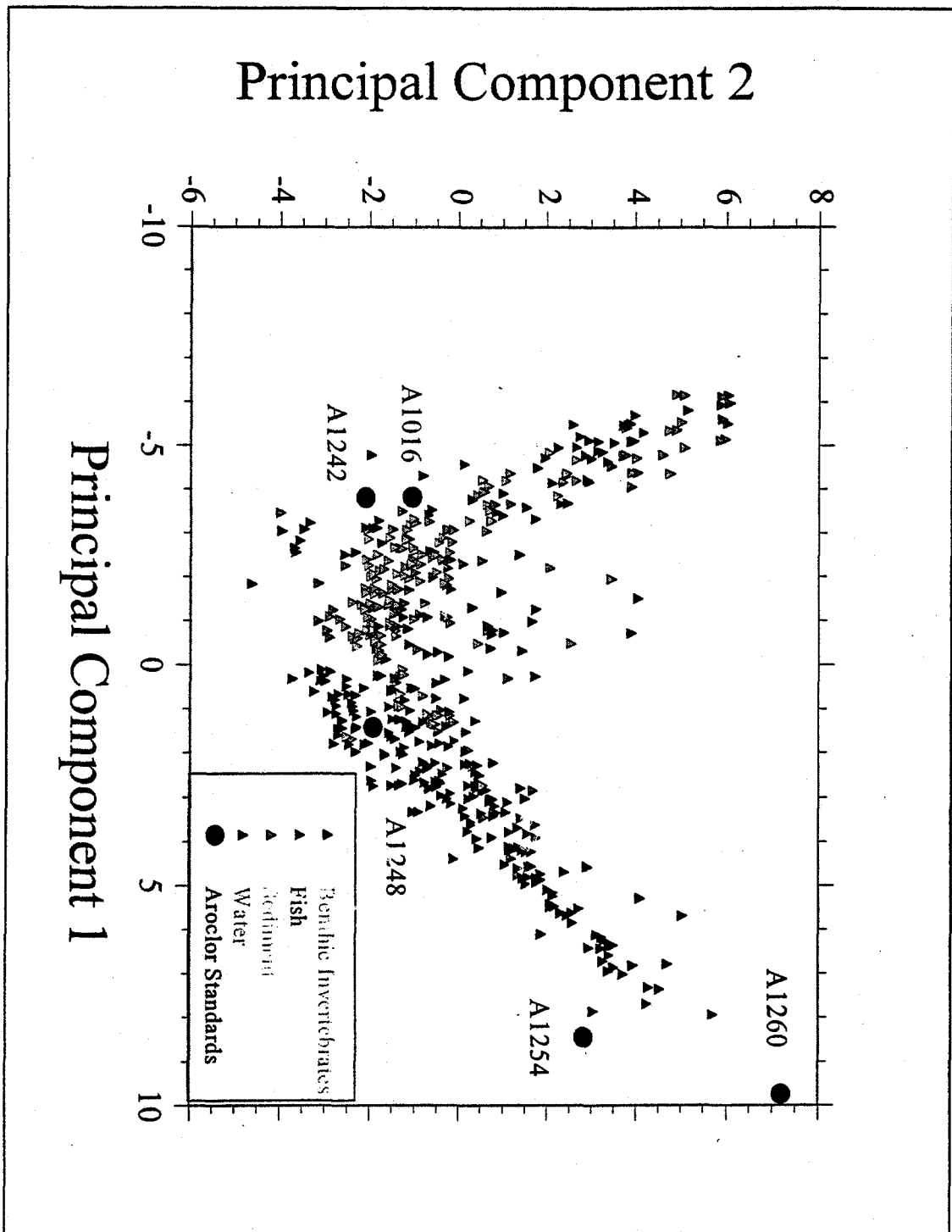
USEPA

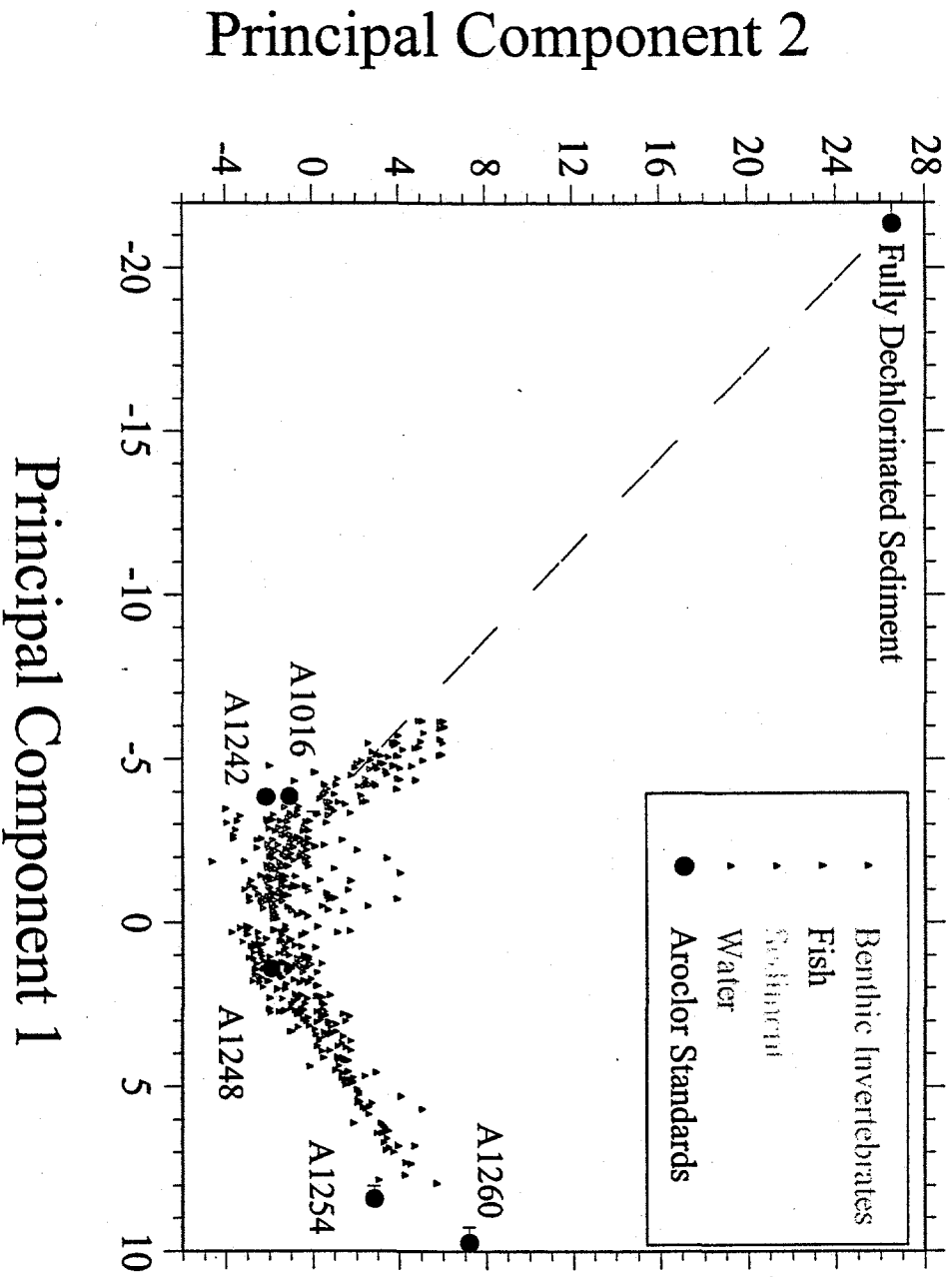
TAMS/MCA



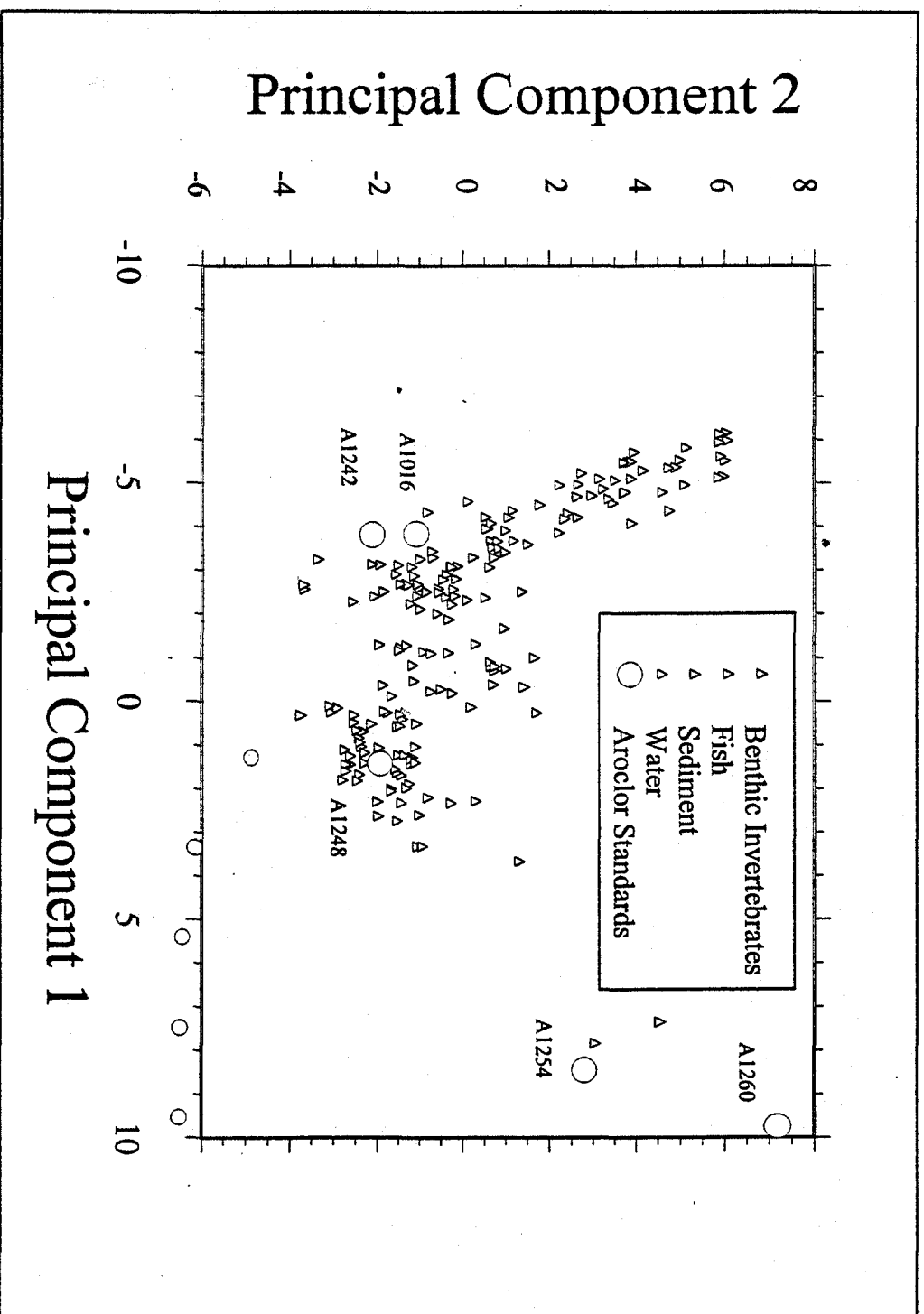
USEPA

# Principal Component Results for Phase 2 Samples Relationship Among Mainstem Hudson Samples TAMMS/MCA





USEPA  
Principal Component Results for Phase 2 Sample  
Fully Dechlorinated Sediment vs. Mainstem Samples  
TAMS/MCA

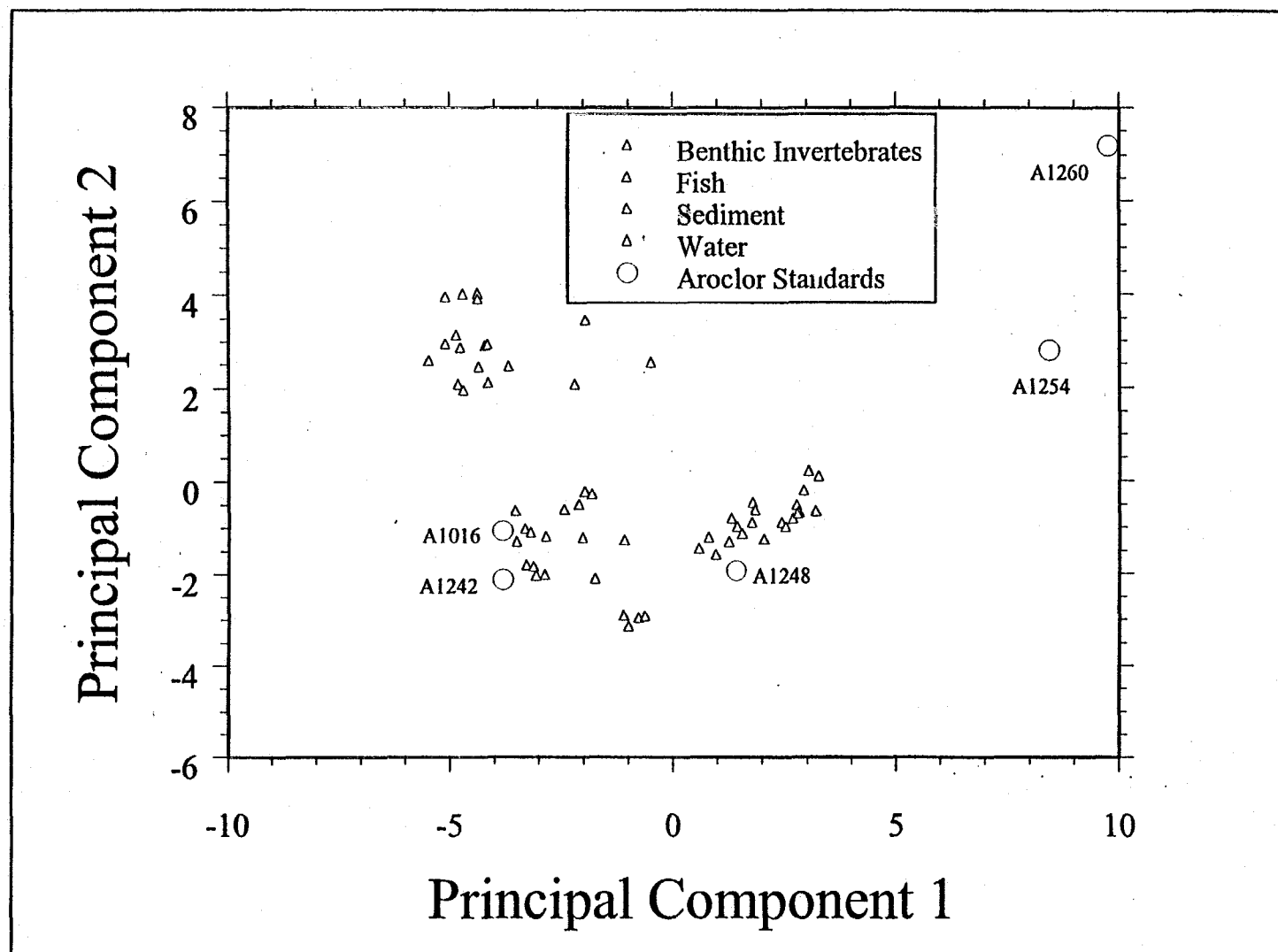


## Principal Component Results for Hudson River Media

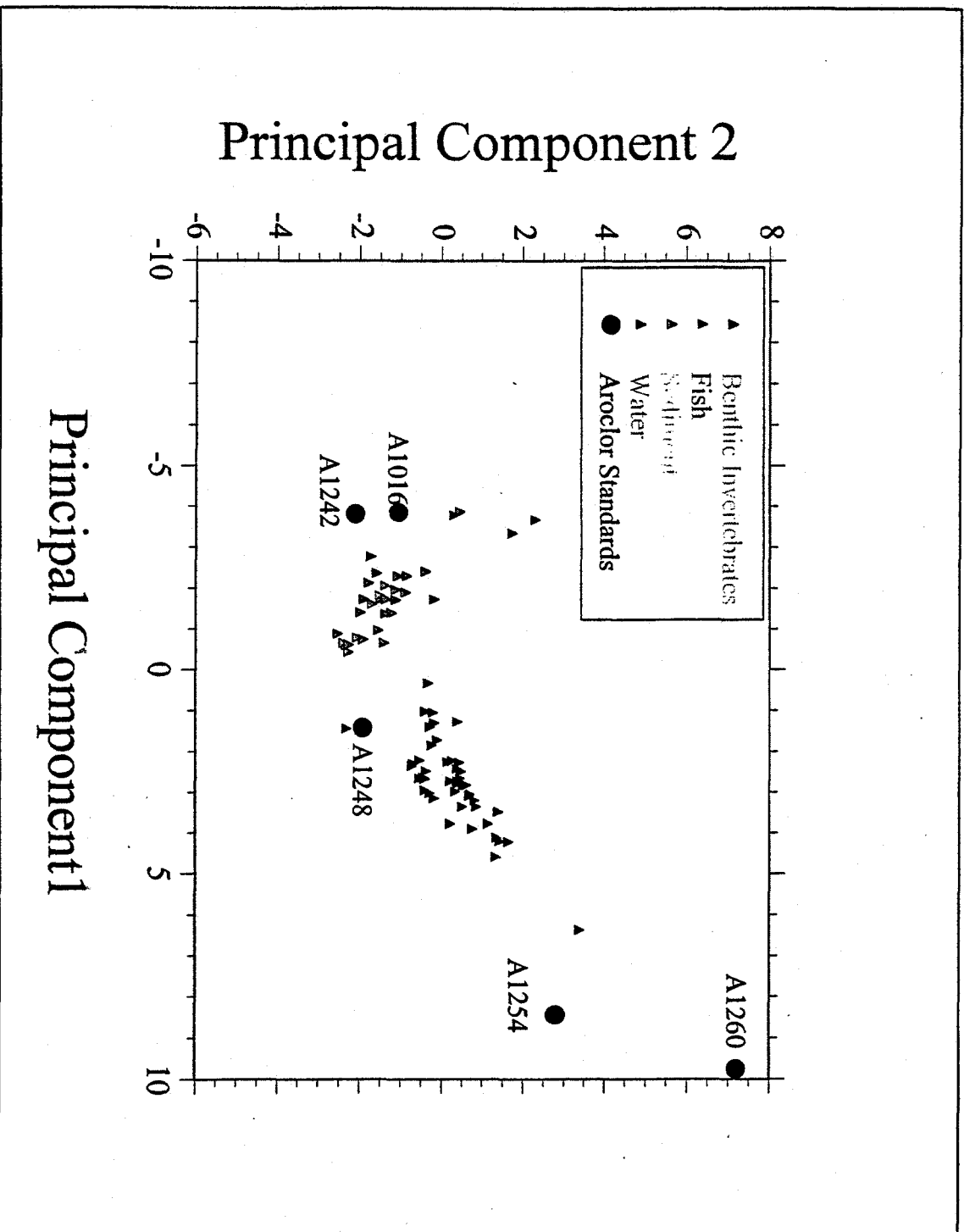
USEPA

RM 195 to 175

TAMS/MCA



Principal Component Results for Hudson River Media  
RM 175 to 156

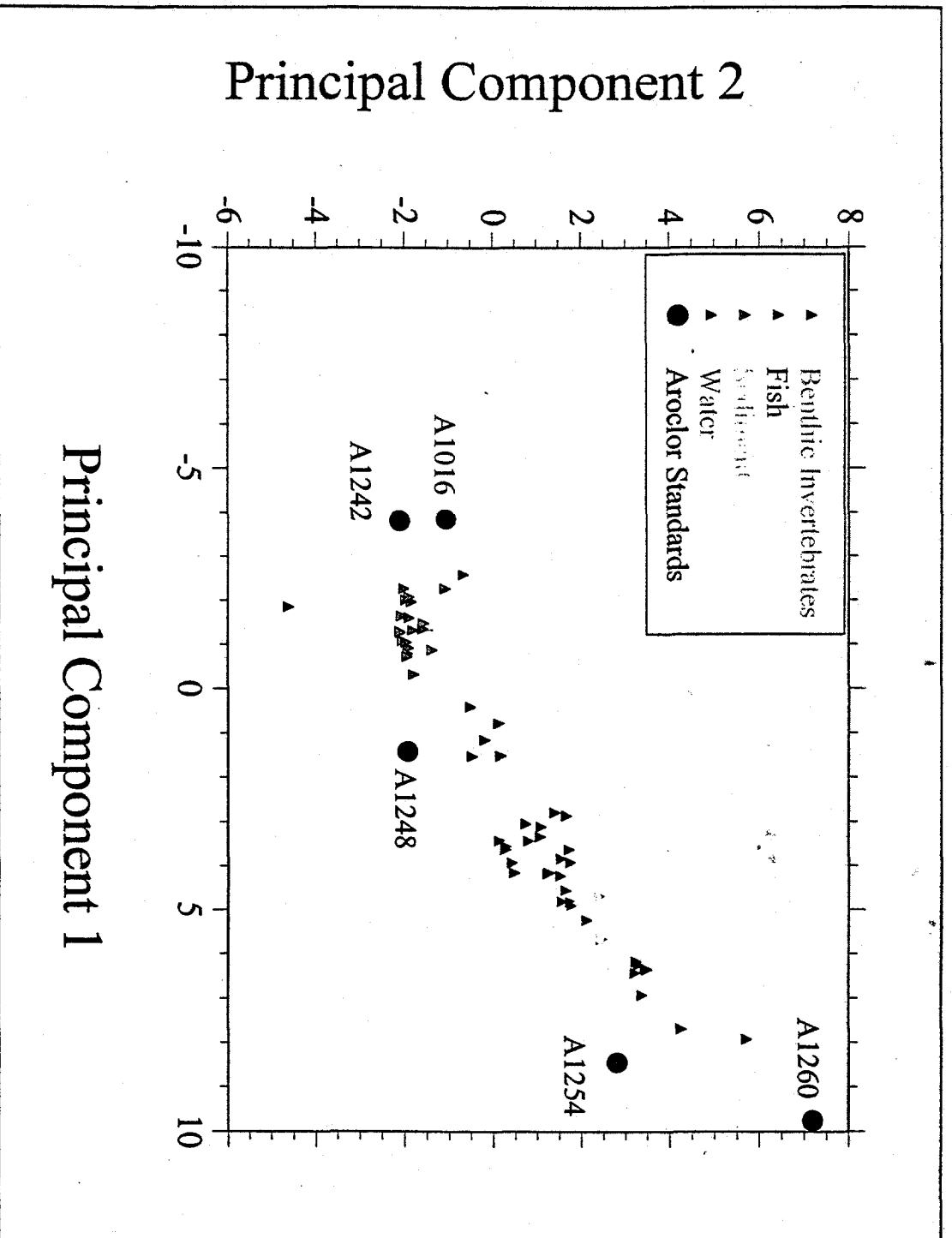


# Principal Component Results for Hudson River Media

USEPA

RM 156 to 100

TAMS/MCA



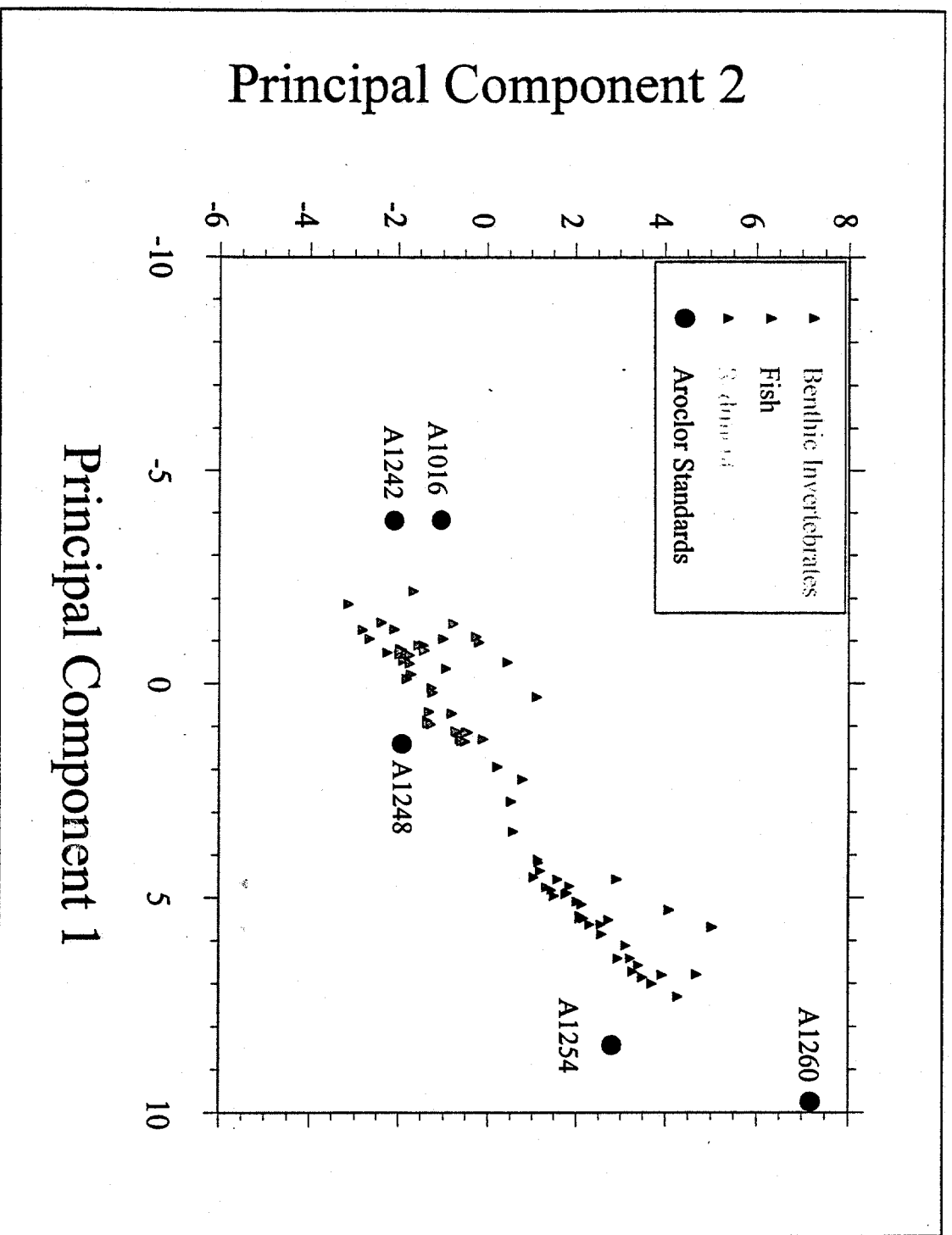
Principal Component 1

## Principal Component Results for Hudson River Media

USEPA

RM 100 to 60

TAMS/MCA



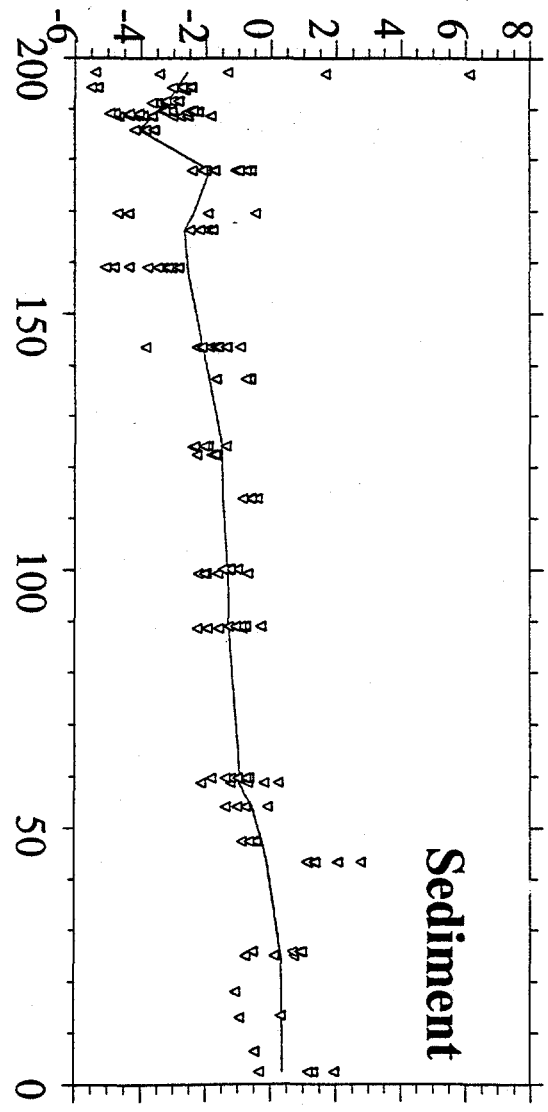
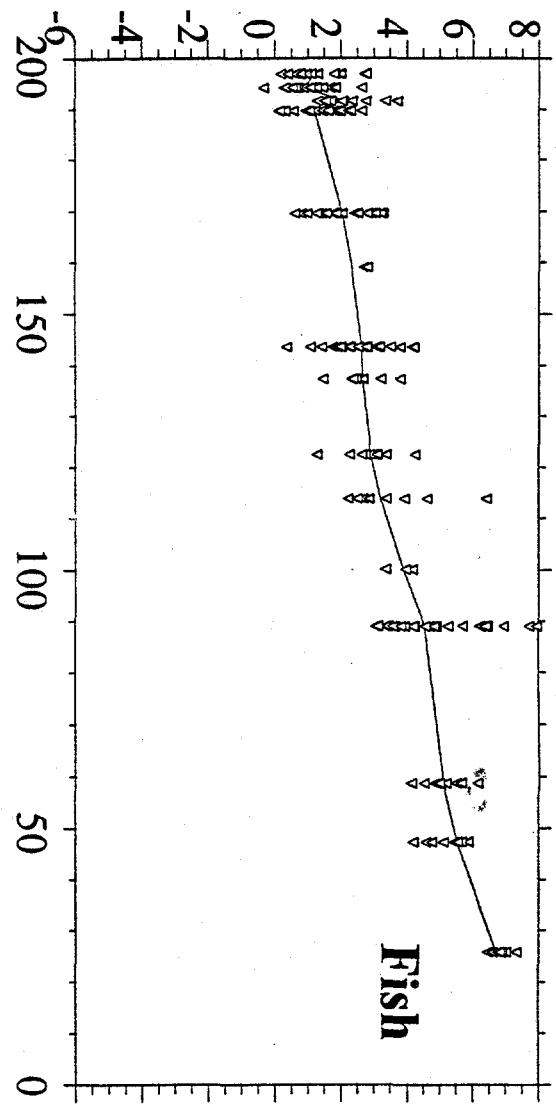
# Principal Component Results for Hudson River Media

USEPA

RM 60 to 0

TAMS/MCA

# Principal Component 1



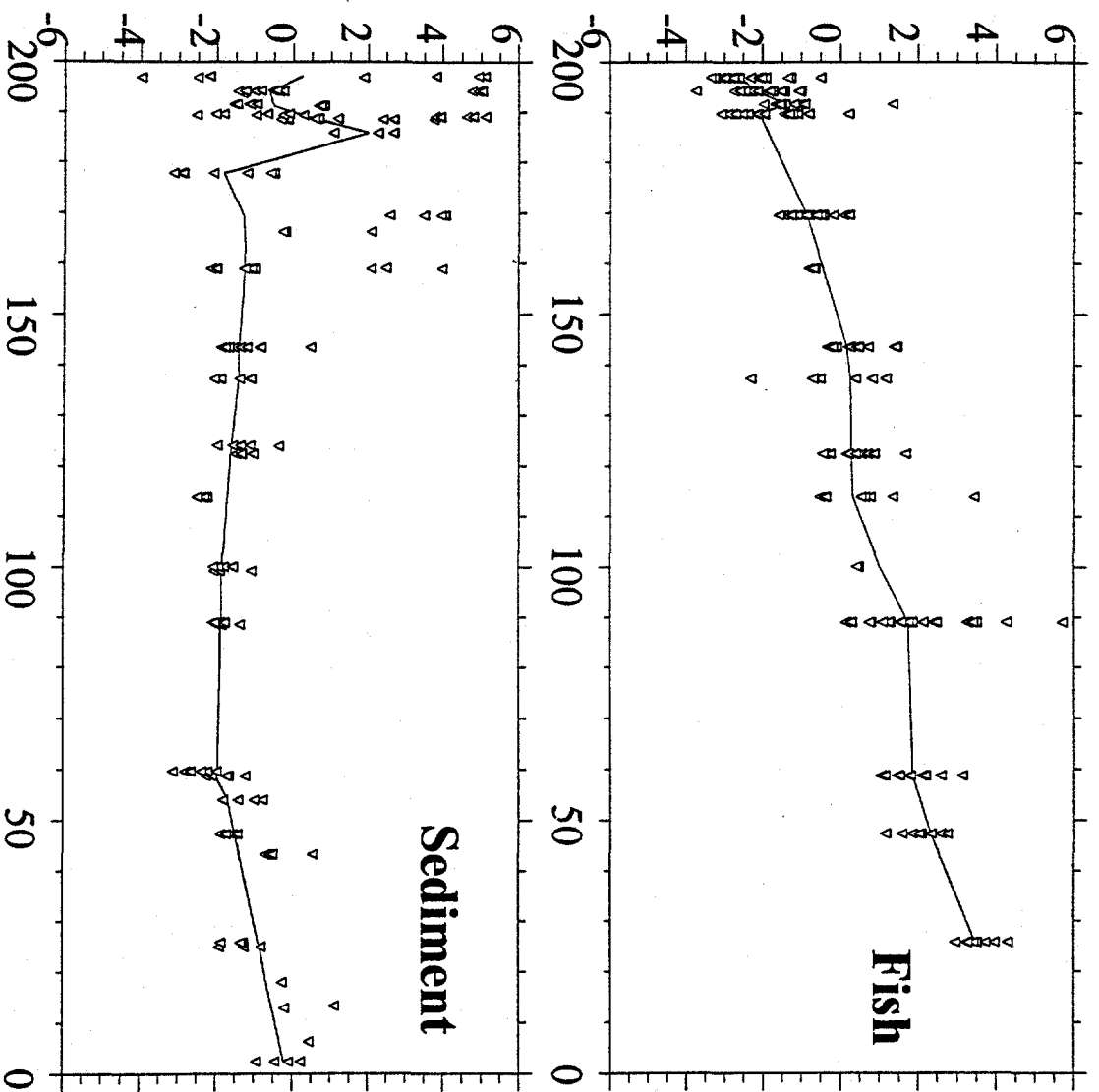
River Mile

## Variation of Principal Component 1 with River Mile in Fish and Sediment

USEPA

TAMS/MCA



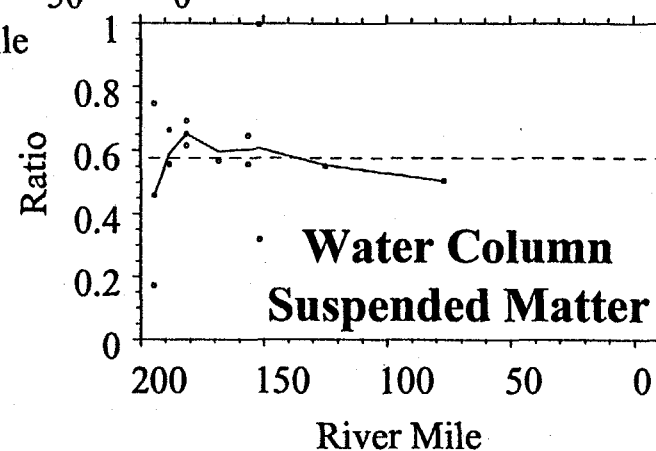
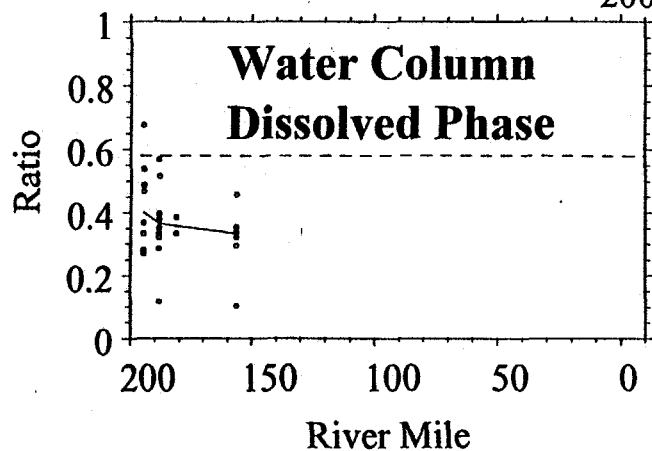
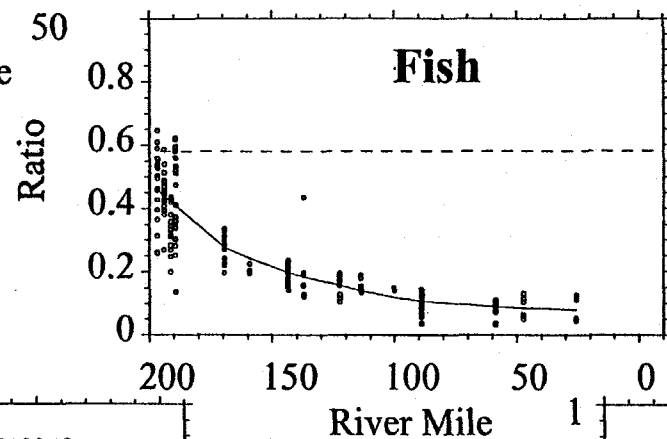
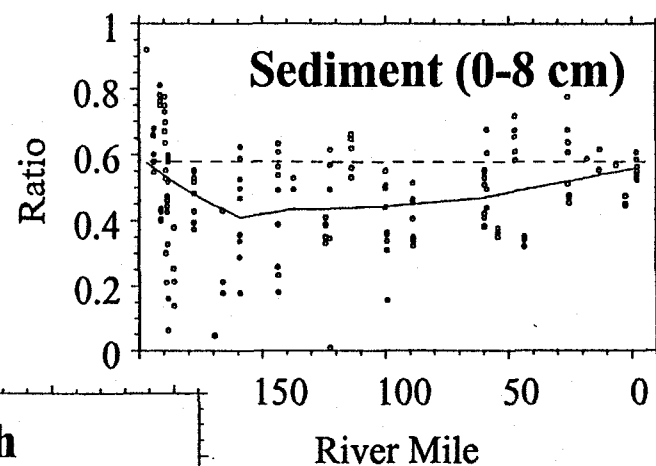
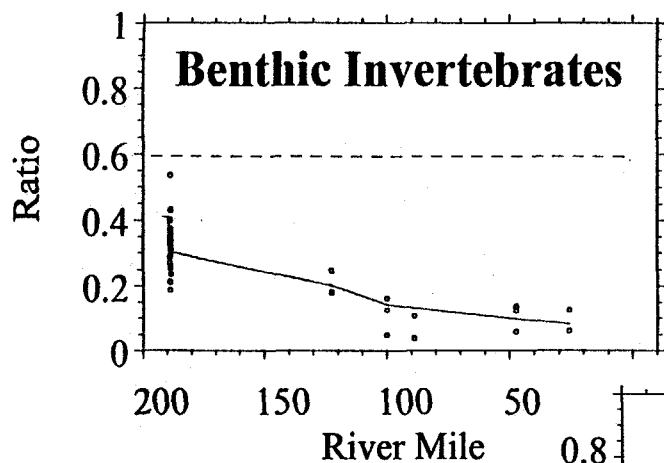


River Mile

# **Variation of Principal Component 2 with River Mile in Fish and Sediment**

# Examination of Congener Ratios

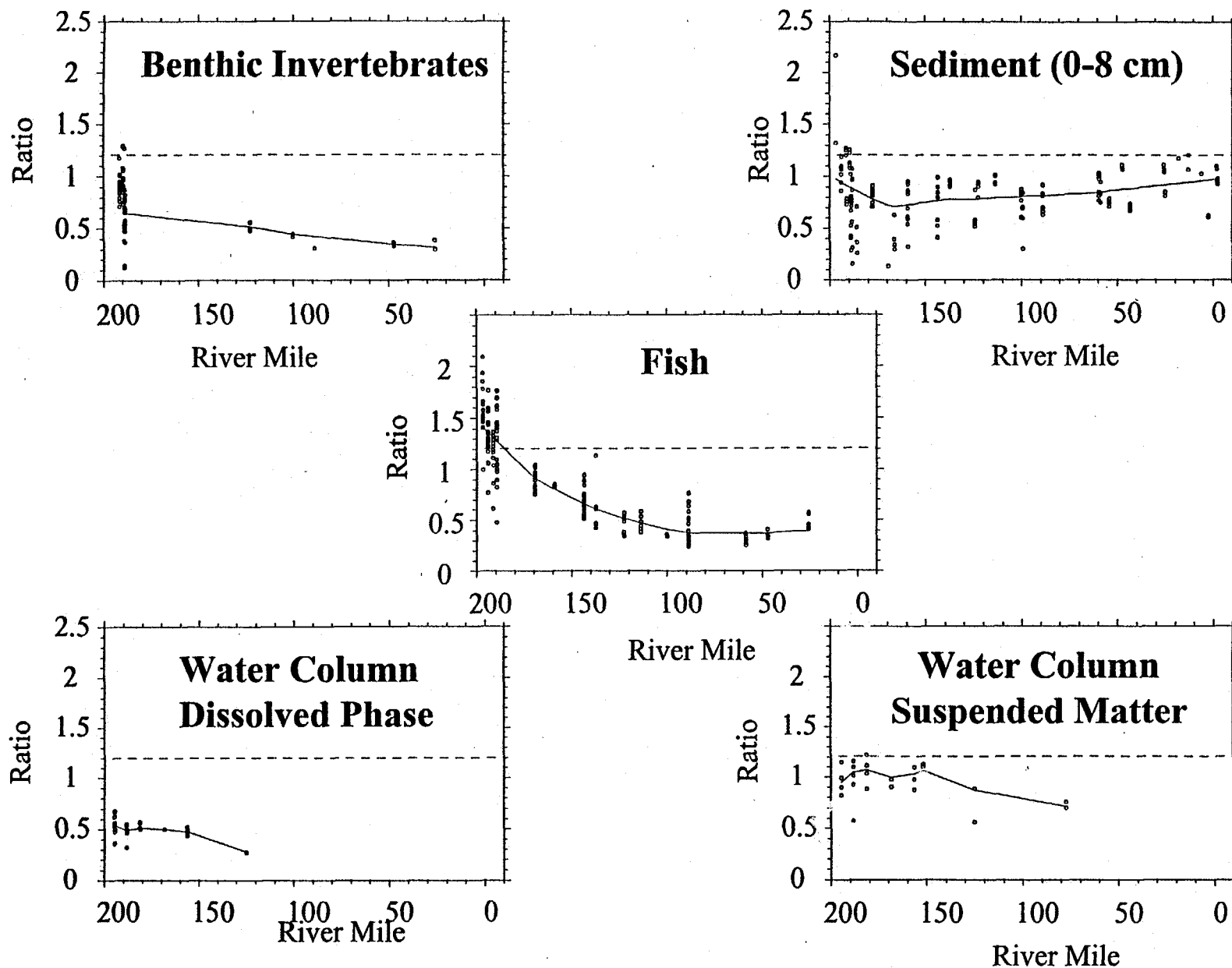
- Several congener ratios have been proposed as tracers for PCB sources
- Four separate congener ratios were examined in the ERA
- Ratio variations in fish do not follow those in exposure media



**A Comparison of Congener Ratio 56/49 for 1993  
Hudson River Samples  
1993 USEPA and NOAA Data**

USEPA

TAMS/MCA



### A Comparison of Congener Ratio 66/49 for 1993

**Hudson River Samples  
1993 USEPA and NOAA Data**

USEPA

TAMS/MCA

# Summary

- Fish body burdens most closely resemble Aroclor 1248 in molecular weight although they are clearly derived from other Aroclors.
- Body burdens for benthic invertebrates are heavier than the sediments to which they are exposed but lighter than the fish that prey on them.
- Fish patterns were more similar within stations than within species, indicating control by local conditions and not trophic level.
- Fish congener patterns gradually shift to heavier congeners downstream of the GE facilities.

## Summary (continued)

- Individual congener ratios do not permit the tracing of fish body burdens to their sources. This may be due to alteration of the congener mixture by metabolic processes within the fish themselves.
- PCBs in fish do not reflect the congener patterns of the exposure concentrations. Rather, it would appear that processes internal to the fish serve to shift the original pattern toward a more chlorinated mixture.

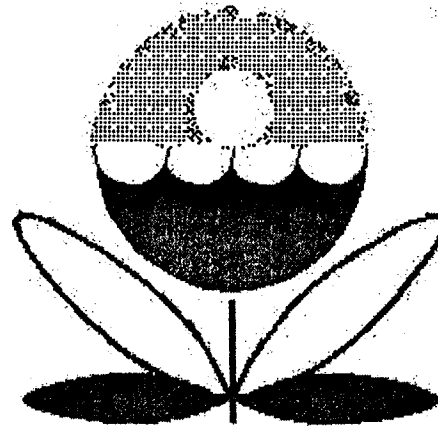
# Hudson River Ecological Risk Assessment

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Helen Chernoff, TAMS  
Consultants, Inc.

Katherine von  
Stackelberg, Menzie-  
Cura & Associates, Inc.

March 23, 2000

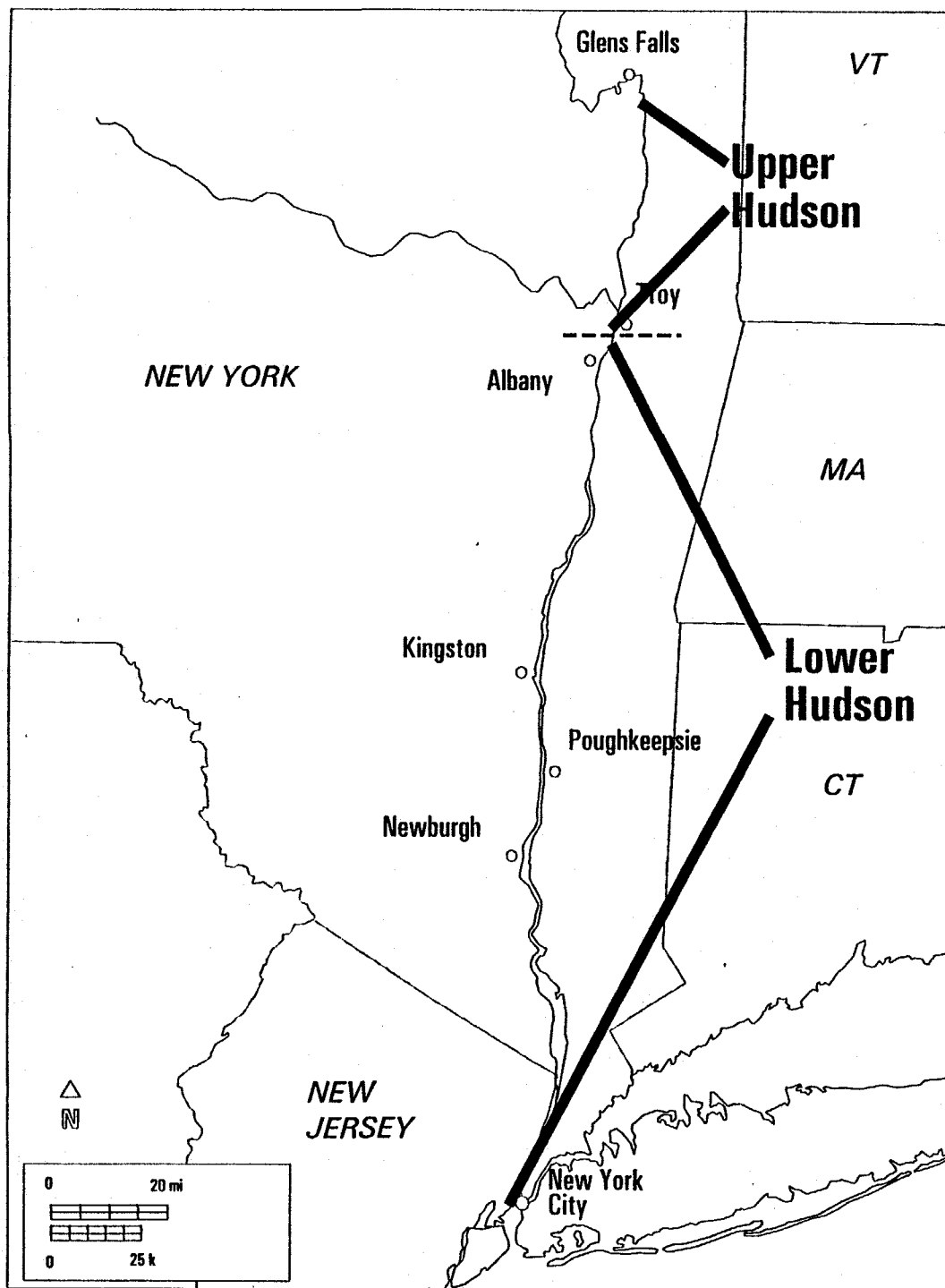


# Overview of Presentation

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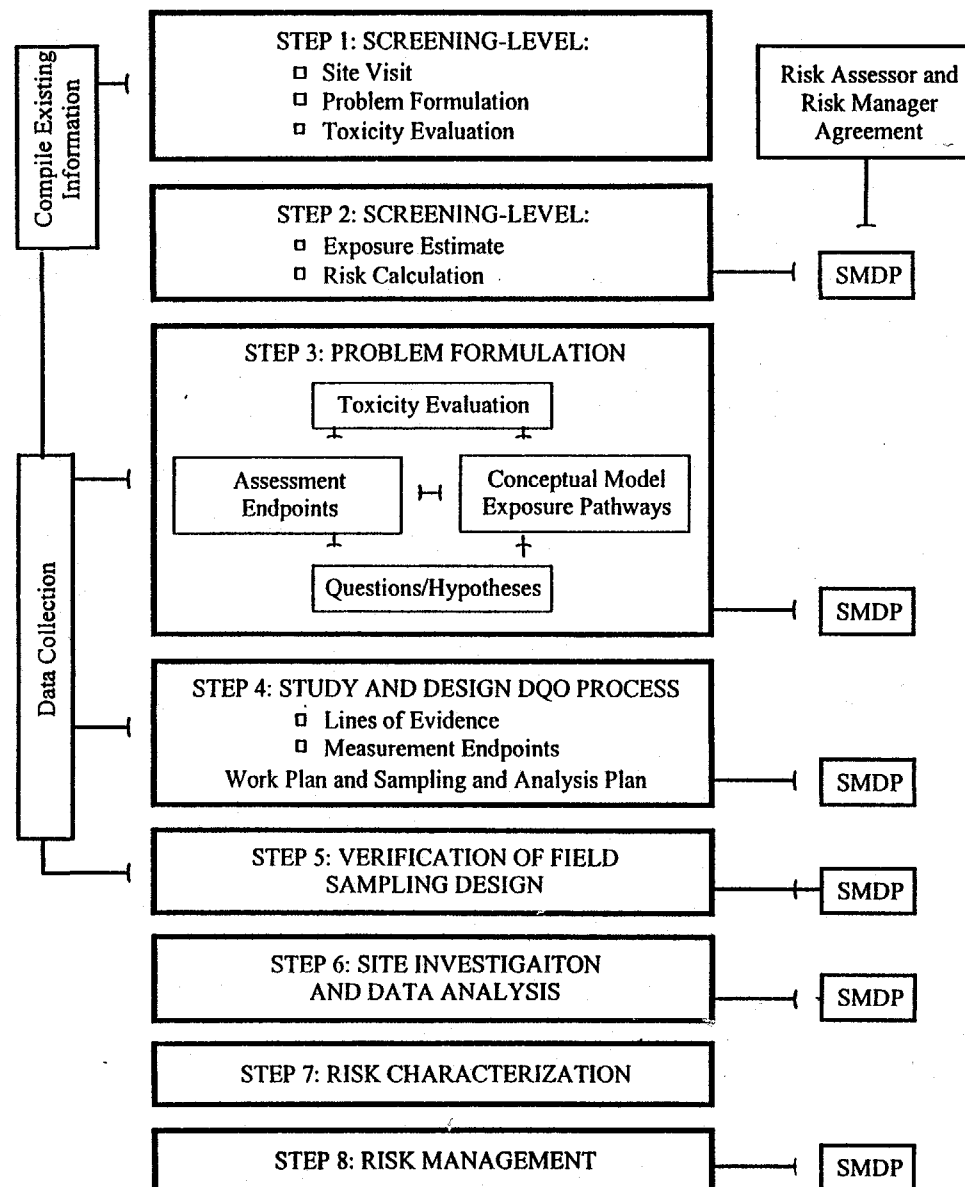
- ◆ Walk through steps of ecological risk assessment process
  - ◆ USEPA, ERAGS, 1997
- ◆ Conclusions of baseline ecological risk assessment
  - ◆ August, 1999 report
  - ◆ March, 2000 Responsiveness Summary





## Scope of Ecological Risk Assessment

# Eight-Step Ecological Risk Assessment Process for Superfund



# Ecological Risk Assessment Process

---

- ◆ Problem Formulation
- ◆ Analysis
  - ◆ Characterization of Exposure
  - ◆ Characterization of Ecological Effects
- ◆ Risk Characterization
  - ◆ Uncertainty Analysis

# Problem Formulation

---

- ◆ Site Characterization
- ◆ Contaminant of Concern (PCBs)
- ◆ Conceptual Model
  - ◆ Exposure pathways
- ◆ Assessment Endpoints
- ◆ Measurement Endpoints
- ◆ Receptors of Concern

# Site Characterization

---

- ◆ Upper Hudson River

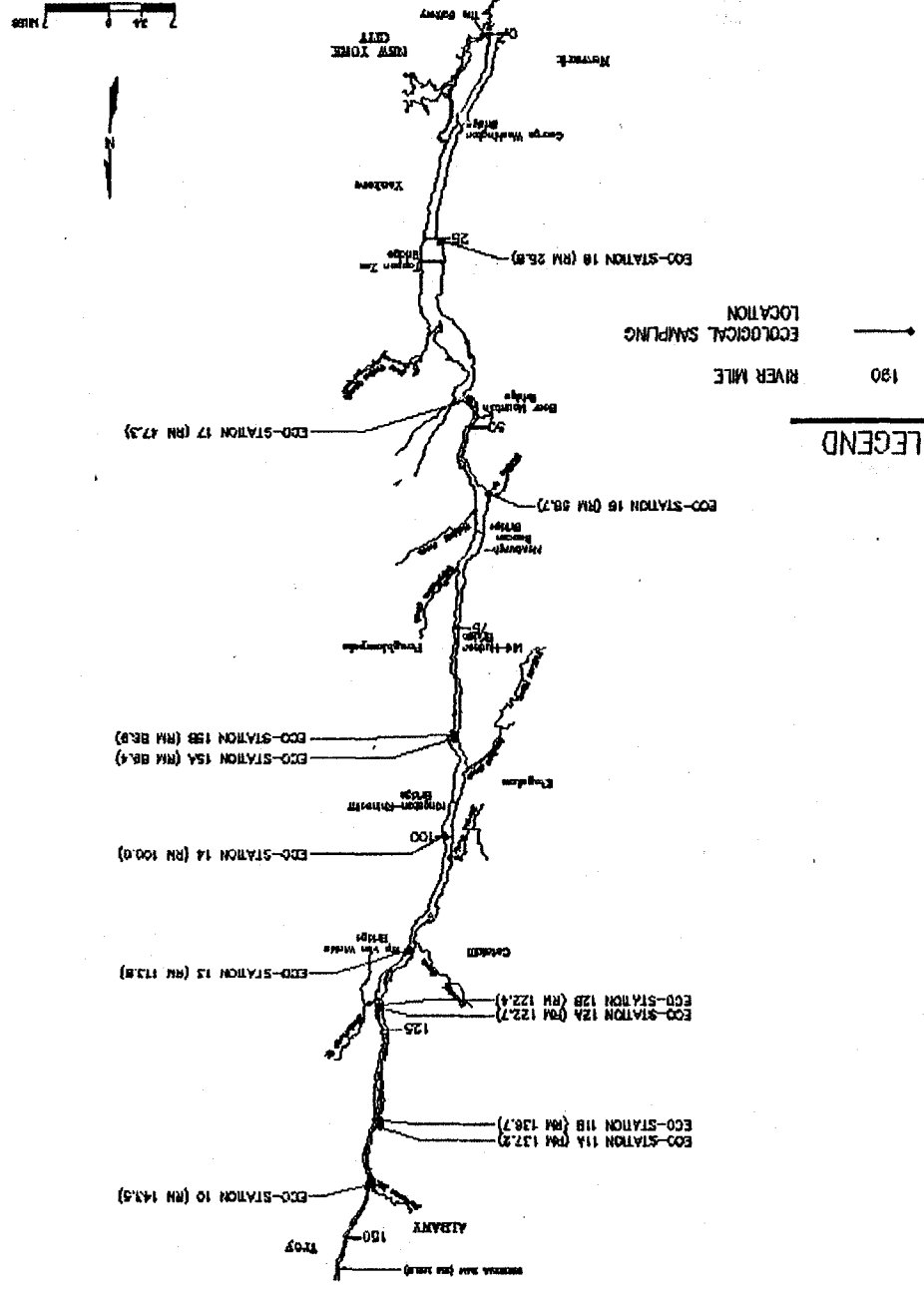
- ◆ Current (field sampling program: 1993)

- ◆ Future (1993 - 2018)

- ◆ Lower Hudson River

- ◆ Current (field sampling program: 1993)

# Upper Hudson River Ecological Sampling Locations



# Contaminant of Concern: PCBs

---

- ◆ Total PCBs as Tri+
  - ◆ Concordance with historical Aroclors
  - ◆ Tri+ roughly equivalent to total in fish
- ◆ Dioxin equivalents (12)
  - ◆ Van den Berg et al., 1998 (WHO)
  - ◆ Data quality issues (BZ#81, BZ#126)
  - ◆ USFWS samples
  - ◆ Phase 2 data

# Average Proportion of Fish-Based TEQ Congeners

	BZ#77	BZ#81	BZ#105	BZ#118	BZ#126
Upper River Mean	0.28		0.06	0.11	0.52
Lower River Mean	0.05		0.02	0.05	0.85
Whole River Mean	0.15		0.03	0.07	0.71
Egg Mean	0.32	0.11	0.04	0.07	0.40
Chick Mean	0.38	0.13	0.04	0.08	0.33
Odonate Mean	0.34	0.05	0.03	0.05	0.49
Insect Mean	0.34	0.11	0.04	0.05	0.42

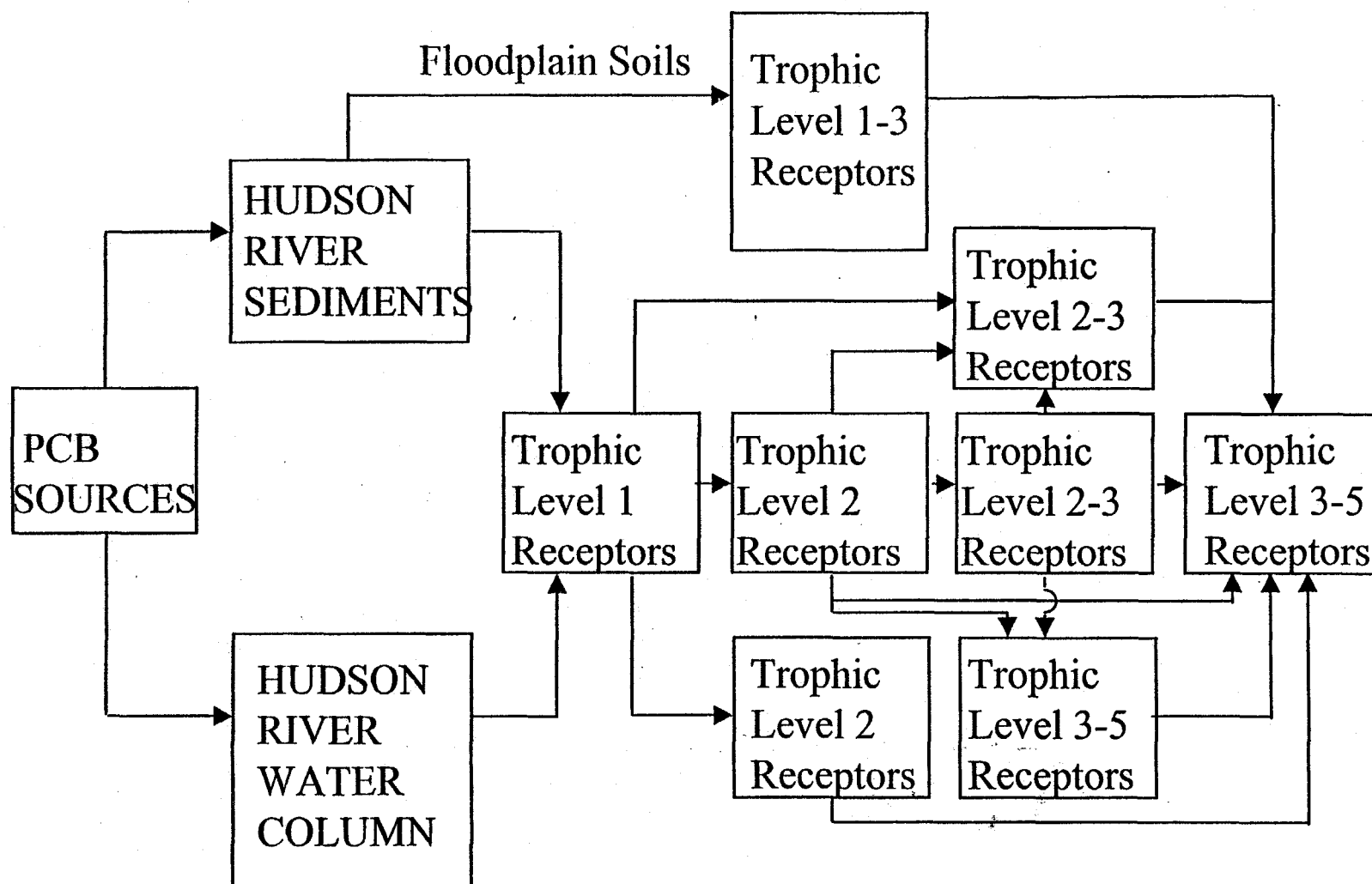


# Conceptual Model

---

- ◆ Exposure Pathways
  - ◆ Aquatic exposure pathways
  - ◆ Terrestrial (nearshore) exposure pathways
- ◆ Ecosystems of the Hudson River

# Conceptual Model Diagram



# Exposure Pathways

---

- ◆ How receptors come into contact with PCBs:

- ◆ Ingestion of water

- ◆ Ingestion of food (e.g., fish, insects)

- ◆ Incidental ingestion of sediment

- ◆ Expressed as:

- ◆ Dietary dose (mammal, bird)

- ◆ Egg concentration (bird, fish)

- ◆ Body burden (fish)

# Ecosystems of the Hudson River

---

- ◆ Upper Hudson River
  - ◆ Non-tidal freshwater - above Federal Dam (RM 153)
- ◆ Lower Hudson River
  - ◆ Tidal freshwater - Federal Dam to Newburgh (RM 153 to RM 60)
  - ◆ Estuarine - Newburgh to Manhattan (RM 60 to RM 0)
  - ◆ Marine - New York Harbor and beyond

# Assessment Endpoints

---

- ◆ Explicit expression of the environmental value that is to be protected
- ◆ Based on:
  - ◆ Mechanisms of toxicity
  - ◆ Receptor groups that are sensitive or highly exposed to PCBs
  - ◆ Potentially complete exposure pathways

# Assessment Endpoints

---

- ◆ Benthic community as source of prey
- ◆ Protection and maintenance (survival, growth, and reproduction) of populations of:
  - ◆ local fish (forage, omnivorous, and piscivorous)
  - ◆ local birds (insectivorous, waterfowl, and piscivorous)
  - ◆ local wildlife (insectivorous, omnivorous, piscivorous)
- ◆ Protection of threatened and endangered species
- ◆ Protection of significant habitats

# Measurement Endpoints

---

- ◆ Actual measurements used to evaluate ecological risk (lines of evidence)
  - ◆ Benthic community indices
  - ◆ Measured and modeled:
    - PCB body burdens in fish (wet weight, lipid-normalized)
    - PCB dietary doses to wildlife
    - PCB concentrations in bird eggs
    - PCB concentrations in sediment and surface water
- ◆ Water Quality Criteria and Sediment Guidelines
- ◆ Field observations

# Receptors of Concern

---

- ◆ Representative of wildlife species using Hudson River
- ◆ Represent different trophic levels, feeding strategies, habitat preferences
- ◆ Receptors include:
  - ◆ macroinvertebrate communities
  - ◆ fish
  - ◆ birds
  - ◆ mammals



## Ecological Receptors of Potential Concern in the Hudson River

### Fish



**Spottail Shiner**



**Pumpkinseed**



**Brown Bullhead**



**White Perch**



**Yellow Perch**



**Largemouth Bass**



**Striped Bass**



**Shortnose Sturgeon**

### Birds



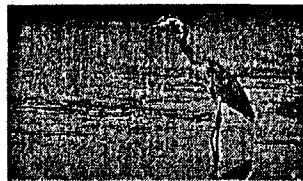
**Tree Swallow**



**Mallard**



**Belted Kingfisher**



**Great Blue Heron**



**Bald Eagle**

### Mammals



**Little Brown Bat**



**Raccoon**



**Mink**



**River Otter**

# NYS and Federal Threatened and Endangered Species

---

- ◆ Invertebrates - Karner blue butterfly
- ◆ Fish - shortnose sturgeon
- ◆ Herpetofauna - northern cricket frog, bog turtle, Blanding's turtle, timber rattlesnake
- ◆ Birds - peregrine falcon, bald eagle, osprey, northern harrier, red-shouldered hawk
- ◆ Mammals - Indiana bat, eastern woodrat

# Significant Habitats

---

- ◆ 34 Sites Designated as Significant Coastal Fish and Wildlife Habitats
- ◆ 5 Additional Sites Containing Important Plant and Animal Communities
- ◆ 4 Sites Comprise the Hudson River National Estuarine Research Reserve

# Exposure Assessment

---

- ◆ Sediment and water concentrations
  - ◆ measured: 1993 USEPA dataset
  - ◆ modeled: HUDTOX model
- ◆ Phytoplankton (mallard)
  - ◆ dissolved water \*  $K_{ow}$  \* lipid
- ◆ Invertebrate and fish
  - ◆ measured: 1993 USEPA dataset
  - ◆ modeled: FISHRAND model

# Exposure Models

---

## 💧 Avian receptors

### 💧 dietary dose

- 1993 data
- HUDTOX, FISHRAND models

### 💧 egg concentration (biomagnification factor)

## 💧 Mammalian receptors

### 💧 dietary dose

- 1993 data
- HUDTOX, FISHRAND models

# Upper Hudson River Sediment & Water Modeling

---

## ◆ HUDTOX model

◆ Tri+ as exposure for fish

◆ Total PCB for:

- comparison to water quality criteria
- comparison to sediment guidelines
- incidental sediment ingestion
- water ingestion

# The FISHRAND Model

---

- ◆ Phytoplankton
  - ◆ dissolved water \*  $K_{ow}$  \* lipid
- ◆ Benthic invertebrates
  - ◆ BSAF
- ◆ Fish species
  - ◆ Gobas modeling framework
  - ◆ Revised Baseline Modeling Report

# Exposure Parameters

---

- ◆ Site-specific data if possible
- ◆ US EPA Wildlife Exposure Factors Handbook
- ◆ Peer-reviewed literature



# Sample Receptor Parameters

## EXPOSURE PARAMETERS FOR BALD EAGLE

	Exposure Parameters	
	Female	Male
Sex (M/F)		
Age (Adult/Juvenile)		
Male/Female Body Weight (kg)	5.10	3.20
Total Daily Dietary Ingestion (kg/day wet wt.)	0.65	0.46
Total Daily Dietary Ingestion (kg/day dry wt.)	-	-
General Dietary Characterization	Opportunistic Piscivore	
Percent Diet Composition (% wet wt.)		
Fish (Total Component)	100%	
Aquatic Invertebrates (Total Component)	0%	
Non-river Related Diet Sources	0%	
Water Consumption Rate (L/day)	0.175	0.129
Percent Incidental Sediment Ingestion in Diet	0.00%	

# Ecological Effects

---

- ◆ PCBs shown to exhibit chronic toxicity
  - ◆ Reproductive
  - ◆ Developmental
  - ◆ Neurological
  - ◆ Immunological
  - ◆ Biochemical
- ◆ Focus on effects with most direct relevance to population

# Effects Assessment

---

- ◆ Toxicity Reference Values (TRVs)
  - ◆ Laboratory studies
    - No observed adverse effect levels (NOAELS)
    - Lowest observed adverse effect levels (LOAELS)
  - ◆ Field studies
    - No observed adverse effect levels (NOAELS)
- ◆ Uncertainty factor approach
  - ◆ Great Lakes
  - ◆ Oak Ridge National Laboratories

# Procedure to Select TRVs

---

- ◆ Done individually for each receptor
- ◆ Compile laboratory studies
  - ◆ same family: no uncertainty factor
- ◆ Compile field studies
  - ◆ only used for NOAEL due to co-occurrence of other contaminants
- ◆ At most, factor of 10 uncertainty
  - ◆ subchronic to chronic (avian)
  - ◆ interspecies (fish, mammal)

# Risk Characterization

---

- ◆ Integrates the exposure and effects assessments
- ◆ Discussion of uncertainty
- ◆ Present risk results

# Toxicity Quotient (TQ)

---

- ◆ Comparison of measured and/or modeled doses or concentrations in the receptors of concern to the toxicity reference values
- ◆ Toxicity quotients equal to or greater than one ( $TQ > 1$ ) typically considered to indicate potential risk to ecological receptors

# Weight of Evidence

---

- ◆ Weight of evidence approach
  - ◆ Multiple measurement endpoints evaluated for each assessment endpoint
  - ◆ Each measurement endpoint is a line of evidence

## Risks to local benthic invertebrate communities were examined using three lines of evidence:

---

- 1) examination of benthic community structure;
- 2) comparison of measured and modeled water column concentrations of PCBs to criteria; and
- 3) comparisons of measured and modeled sediment concentrations to guidelines.



## Risks to local fish populations were examined using five lines of evidence:

---

- ◆ 1) comparison of measured and modeled total PCB fish body burdens to TRVs;
- ◆ 2) comparison of measured and modeled TEQ fish body burdens to TRVs;
- ◆ 3) comparison of measured and modeled water column concentrations of PCBs to criteria;
- ◆ 4) comparisons of measured and modeled sediment concentrations to guidelines; and
- ◆ 5) field-based observations.

10.2714

## Risks to local bird populations were examined using six lines of evidence:

---

- 1) comparison of measured and modeled total PCB dietary doses to TRVs;
- 2) comparison of measured and modeled TEQ dietary doses to TRVs;
- 3) comparison of measured and modeled total PCB egg concentrations to TRVs;
- 4) comparison of modeled and modeled TEQ egg concentrations to TRVs;
- 5) comparison of measured and modeled water column concentrations of PCBs to criteria; and
- 6) field-based observations.

## Risks to local mammal populations were examined using four lines of evidence:

---

- ◆ 1) comparison of measured and modeled total PCB dietary doses to TRVs;
- ◆ 2) comparison of measured and modeled TEQ dietary doses to TRVs;
- ◆ 3) comparison of measured and modeled water column concentrations of PCBs to criteria; and
- ◆ 4) field-based observations.

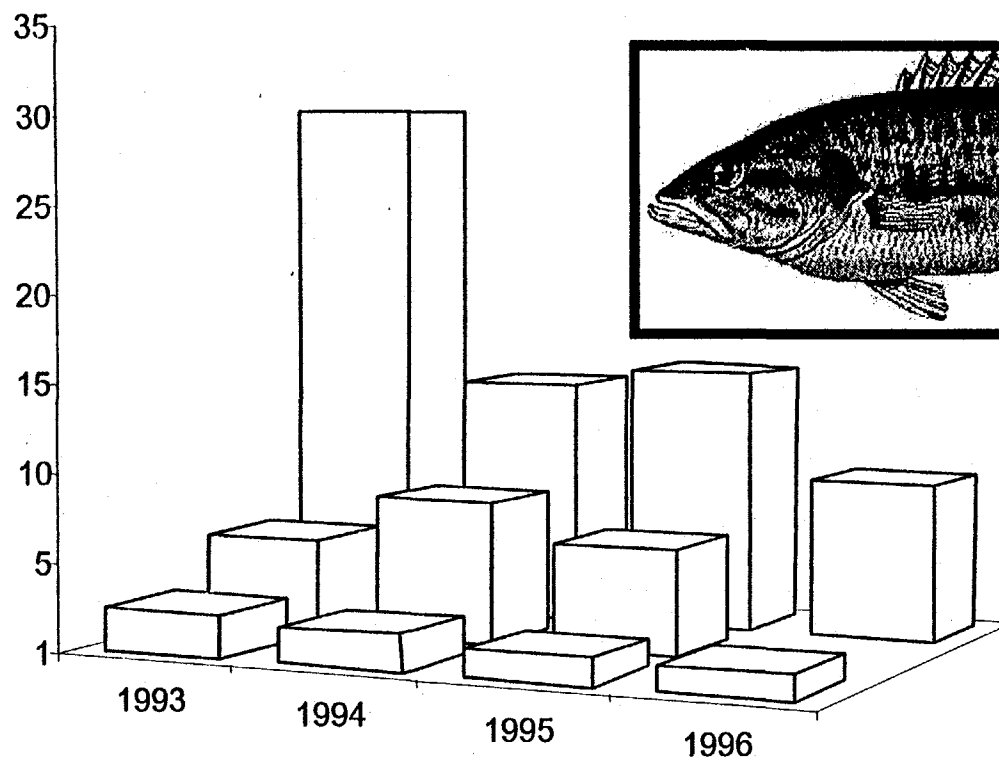
## Risks to significant habitats were examined using two lines of evidence:

---

- ◆ 1) comparison of measured and modeled water column concentrations of PCBs to criteria; and
- ◆ 2) comparisons of measured and modeled sediment concentrations to guidelines.

# NOAEL-based Toxicity Quotient

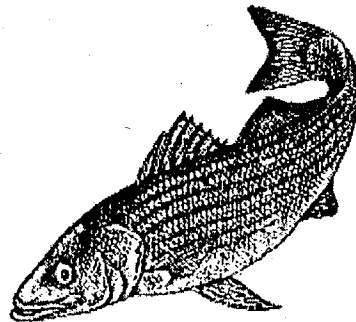
- Catskill
- Stillwater
- Thompson Island Pool



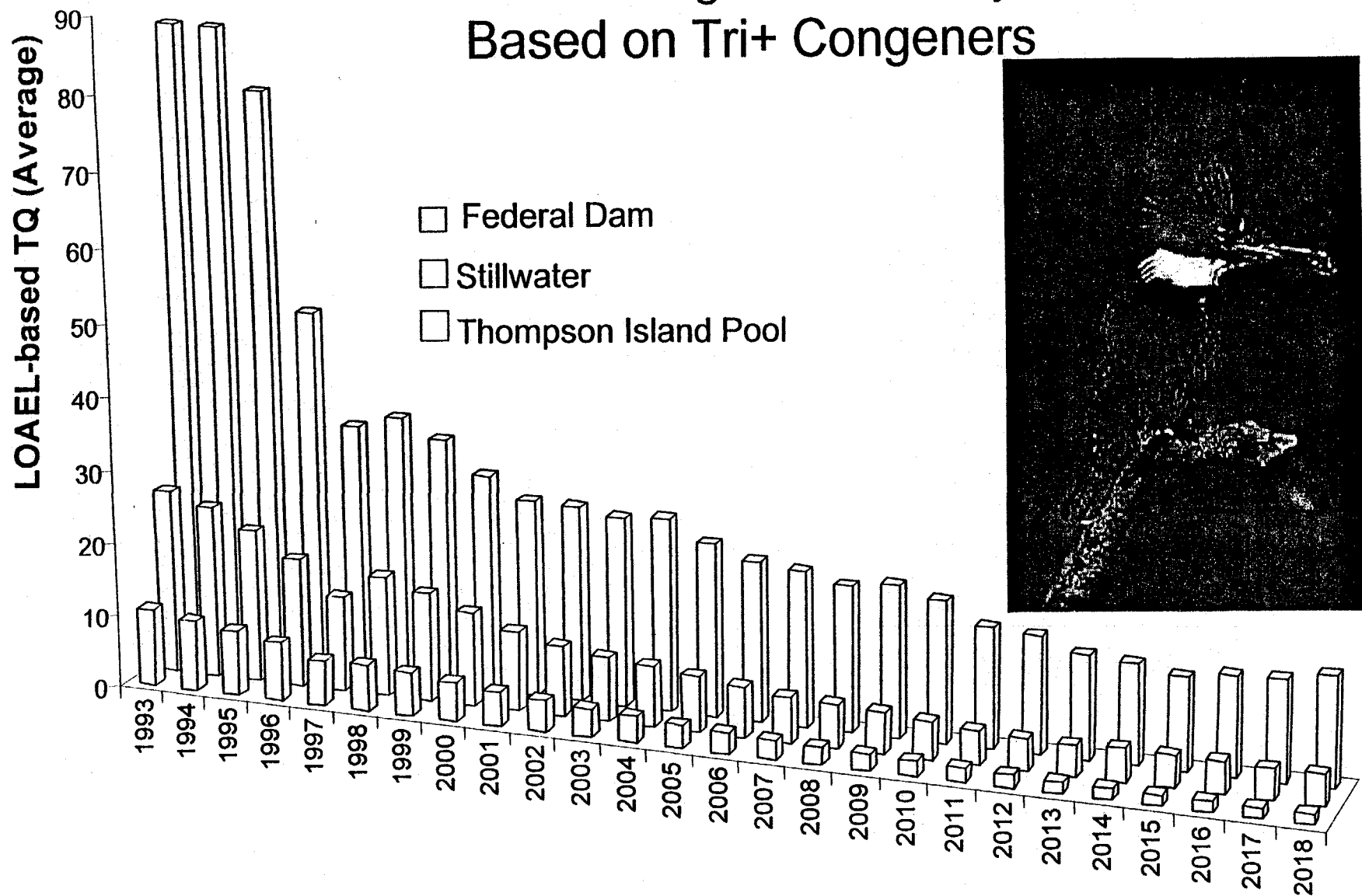
Largemouth Bass Risk Based on TEQs

# Striped Bass Toxicity Quotients

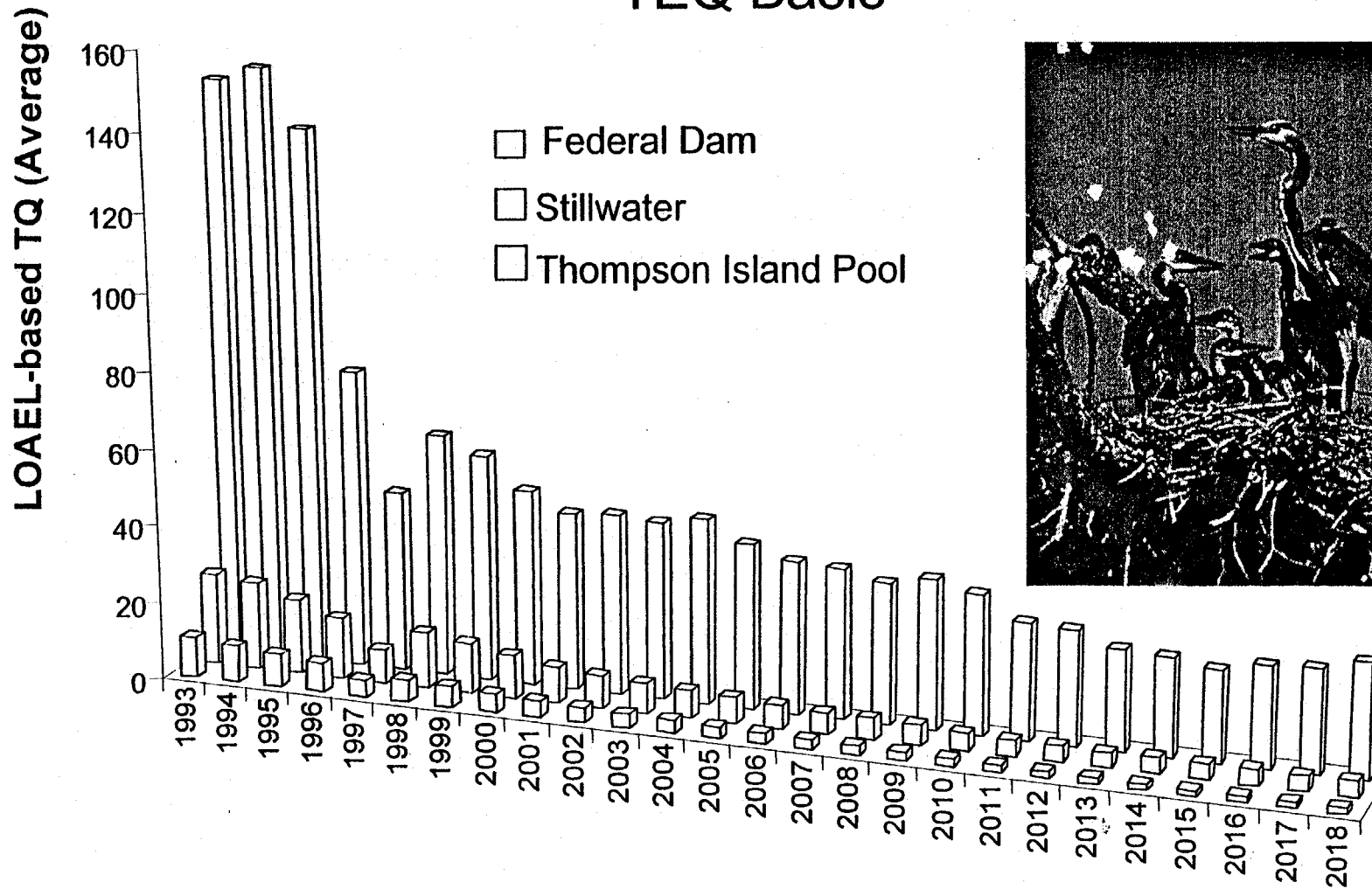
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# Belted Kingfisher Dietary Risk Based on Tri+ Congeners

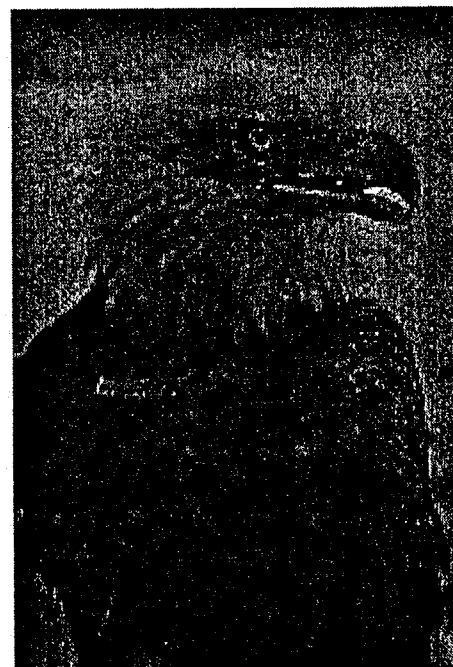
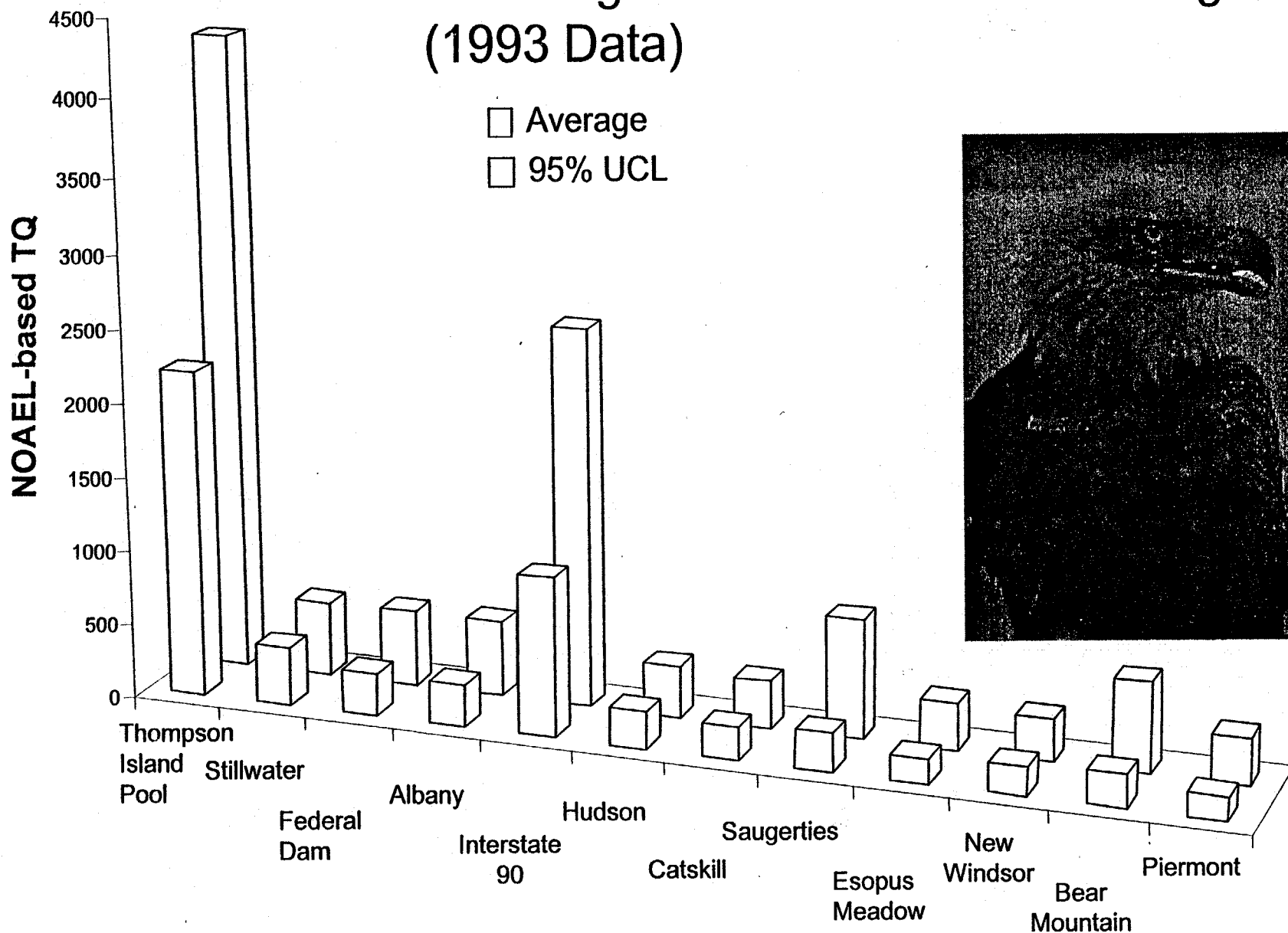


## Great Blue Heron Egg Risk on a TEQ Basis

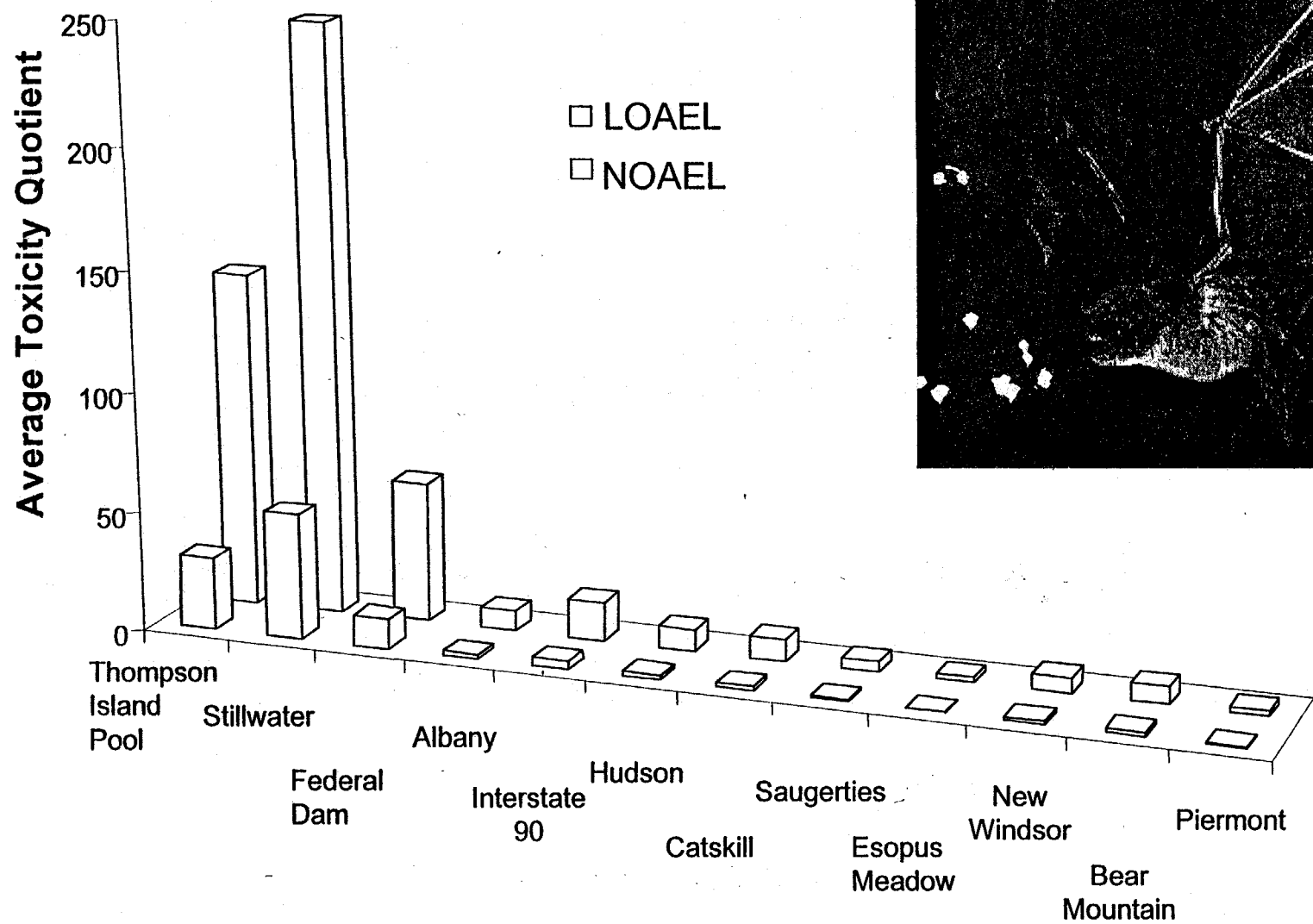




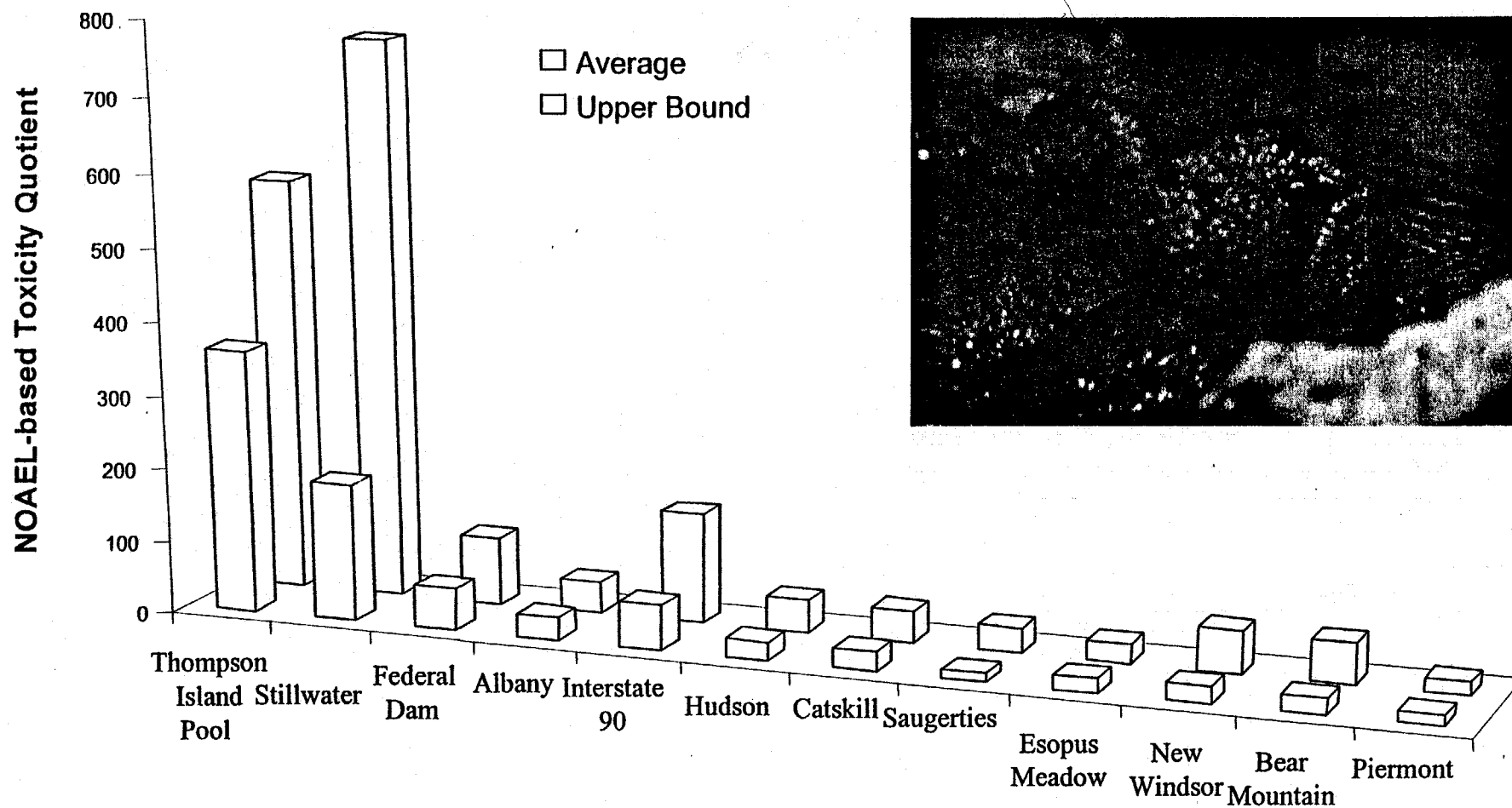
# Bald Eagle Risk Based on Tri+ Congeners (1993 Data)



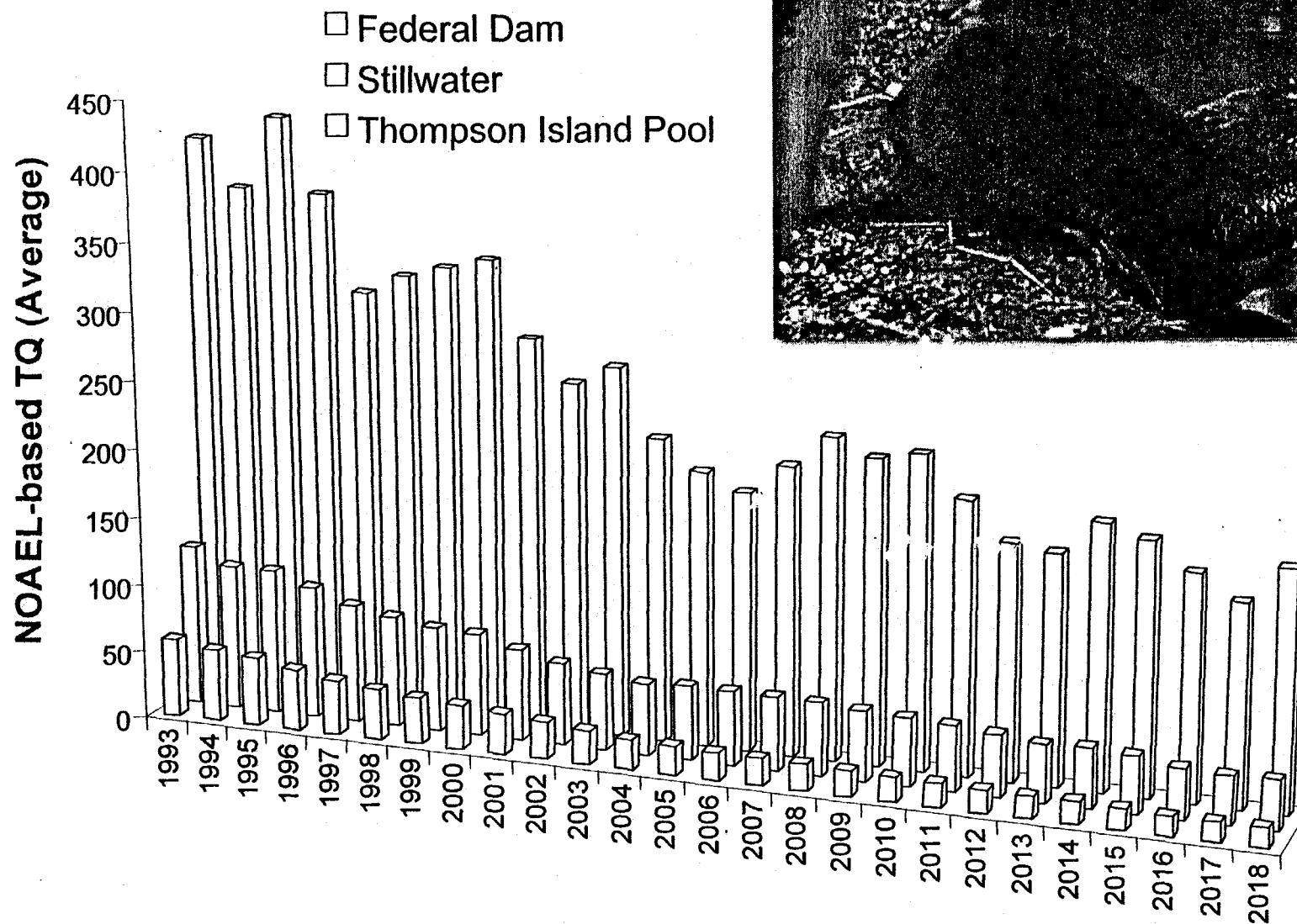
## Little Brown Bat Dietary Risk Based on Tri+ Congeners (1993 Data)



# Mink Dietary Risk Based on Tri+ Congeners (1993 Data)



## River Otter Risk Based on Tri+ Congeners



# Field Studies

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- ◆ Ongoing studies for mammals and birds

- ◆ Mammals

  - ◆ Trapping records

  - ◆ No organized surveys

- ◆ Avian

  - ◆ NYSDEC tagging program for eagles

  - ◆ USFWS

- ◆ Fish

  - ◆ Sampling for contaminants

  - ◆ Power plant abundance surveys

# Uncertainty Analysis

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- ◆ Exposure assessment
  - ◆ Conceptual model
  - ◆ Quantitative exposure parameters
  - ◆ PCB concentrations
- ◆ Effects assessment
  - ◆ Interspecies
  - ◆ Acute to chronic
- ◆ Magnitude of TQs

# Conclusions of the Ecological Risk Assessment

---

- ◆ Toxicity quotients for upper trophic level birds and mammals exceed regulatory levels of concern
- ◆ PCBs may impair but not *prevent* reproduction

PCBs may adversely affect the  
survival, growth and  
reproduction of these animals

# Conclusions of the Ecological Risk Assessment

---

- ◆ Toxicity quotients for birds and mammals consuming emergent aquatic insects and/or plants (bat, mallard, tree swallow) exceed regulatory levels of concern
- ◆ PCBs may impair but not *prevent* reproduction

PCBs may adversely affect the  
survival, growth and  
reproduction of these animals



# Conclusions of the Ecological Risk Assessment

---

- ◆ Toxicity quotients for fish at the top of the food chain (such as largemouth bass, striped bass) exceed regulatory levels of concern
- ◆ PCBs may impair but not *prevent* reproduction and recruitment

PCBs may adversely affect fish  
survival, growth and  
reproduction

# Conclusions of the Ecological Risk Assessment

---

- Threatened and endangered species, represented by the bald eagle and shortnose sturgeon, are at risk due to exposure to PCBs

Threatened and endangered  
species face reproductive  
risks from PCBs

# Conclusions of the Ecological Risk Assessment

---

- PCB concentrations in water and sediments in the Hudson River generally exceed protective criteria and guidelines

Significant habitats and the animals that use them face risks from PCBs

# Conclusions of the Ecological Risk Assessment

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- ◆ Risks to fish and wildlife:
  - ◆ Greatest in the Upper Hudson River
  - ◆ Generally decrease moving down river
  - ◆ Greatest for top level predators
  - ◆ Under baseline conditions many species face considerable risk through the entire forecast period (modeled to 2018)

# Upper Hudson River Human Health Risk Assessment

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## Hudson River PCBs Reassessment



MARIAN OLSEN - USEPA

DAVE MERRILL - GRADIENT CORP

Peer Review Meeting March 23, 2000

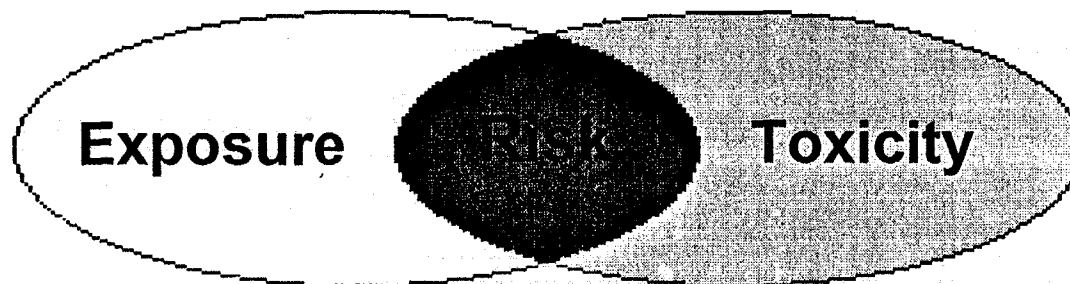
## Outline of Discussion

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- ◆ **Summary of risk results (brief)**
- ◆ **PCB toxicity issues**
- ◆ **Exposure pathways**
  - fish, water, sediment, air
  - Project-specific exposure factors
- ◆ **Monte Carlo (probabilistic) approach**
  - Uncertainty/Sensitivity Analysis
- ◆ **Revised Upper-Hudson results based on revised BMR**

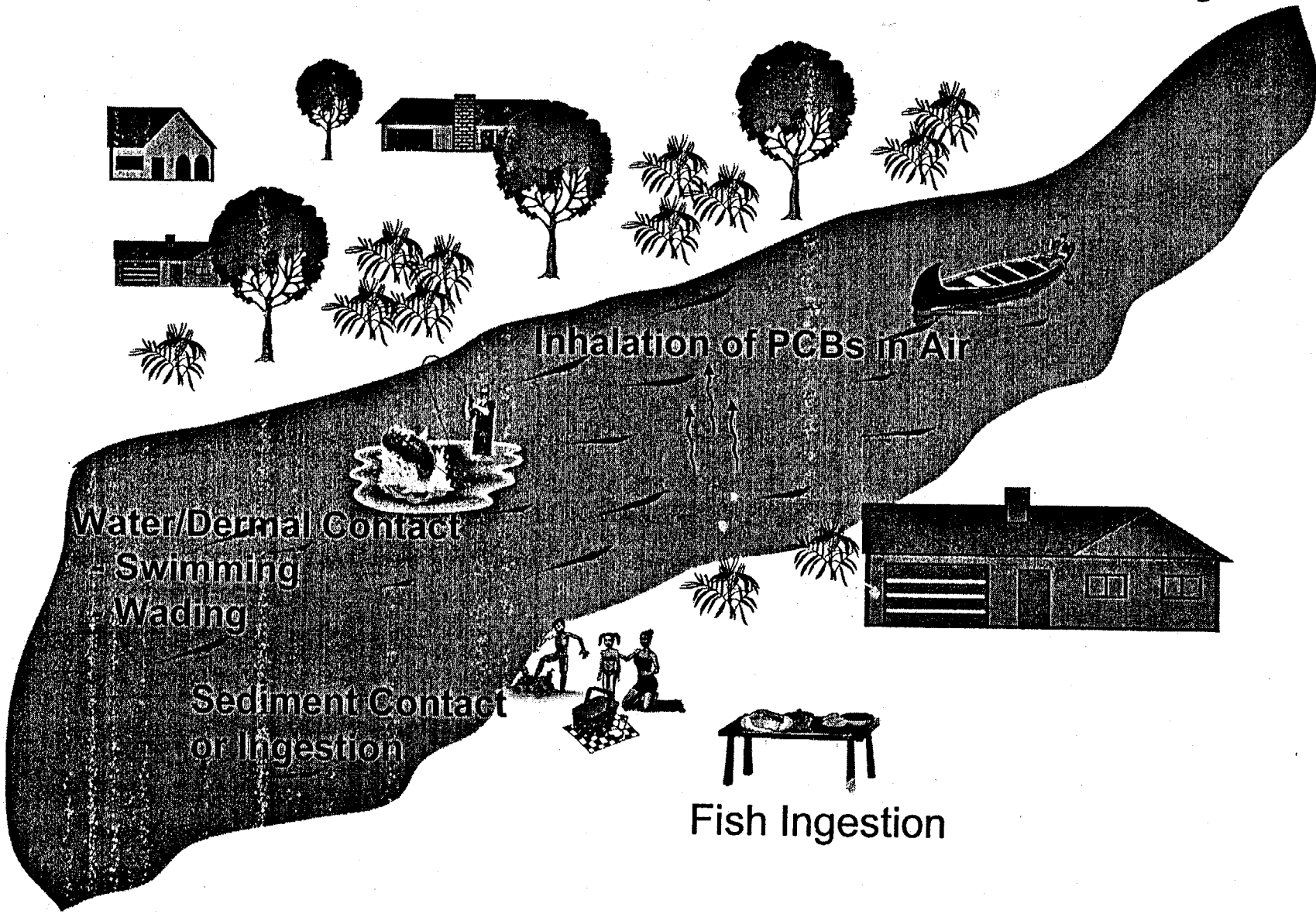
# U.S. EPA Superfund Risk Assessment

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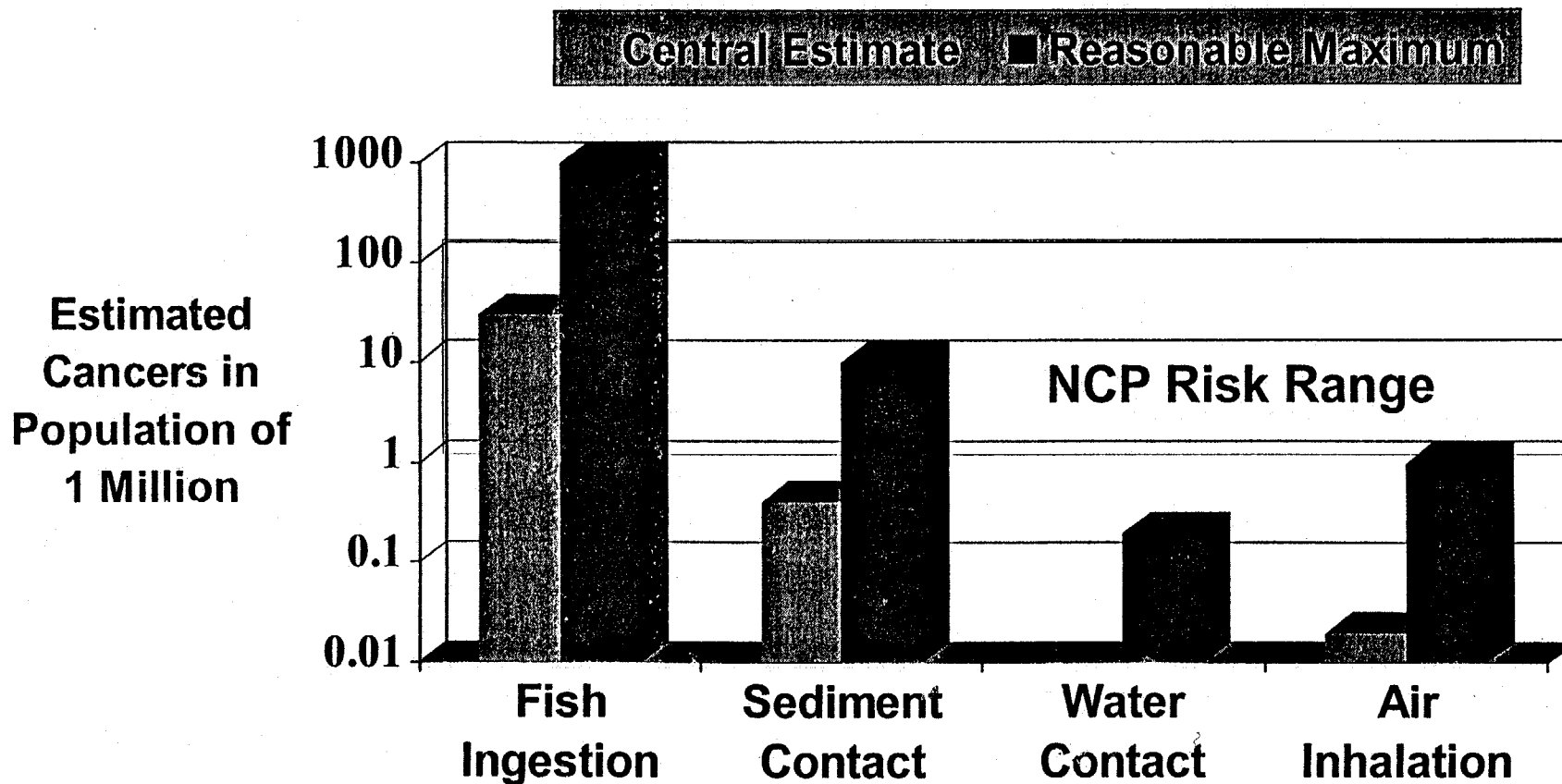
- ◆ Evaluated under current (baseline) and future conditions
- ◆ Baseline conditions evaluated in the absence of institutional or other controls
- ◆ Goal is health protection under reasonable maximum exposures

# Upper Hudson River Exposure Pathways



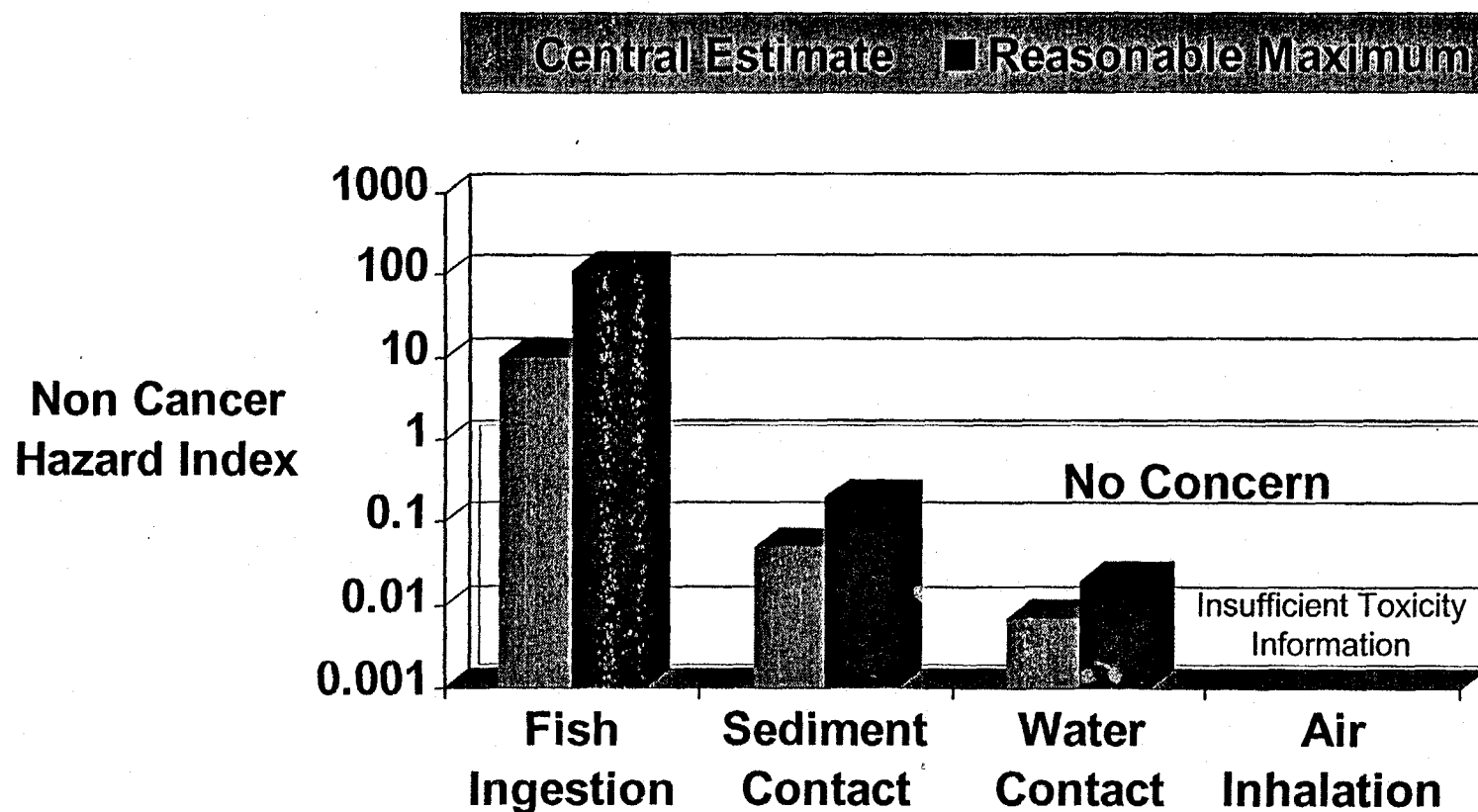


# Cancer Risk Summary



August 1999 Report Values

# Non-Cancer Hazard Index Summary



August 1999 Report Values

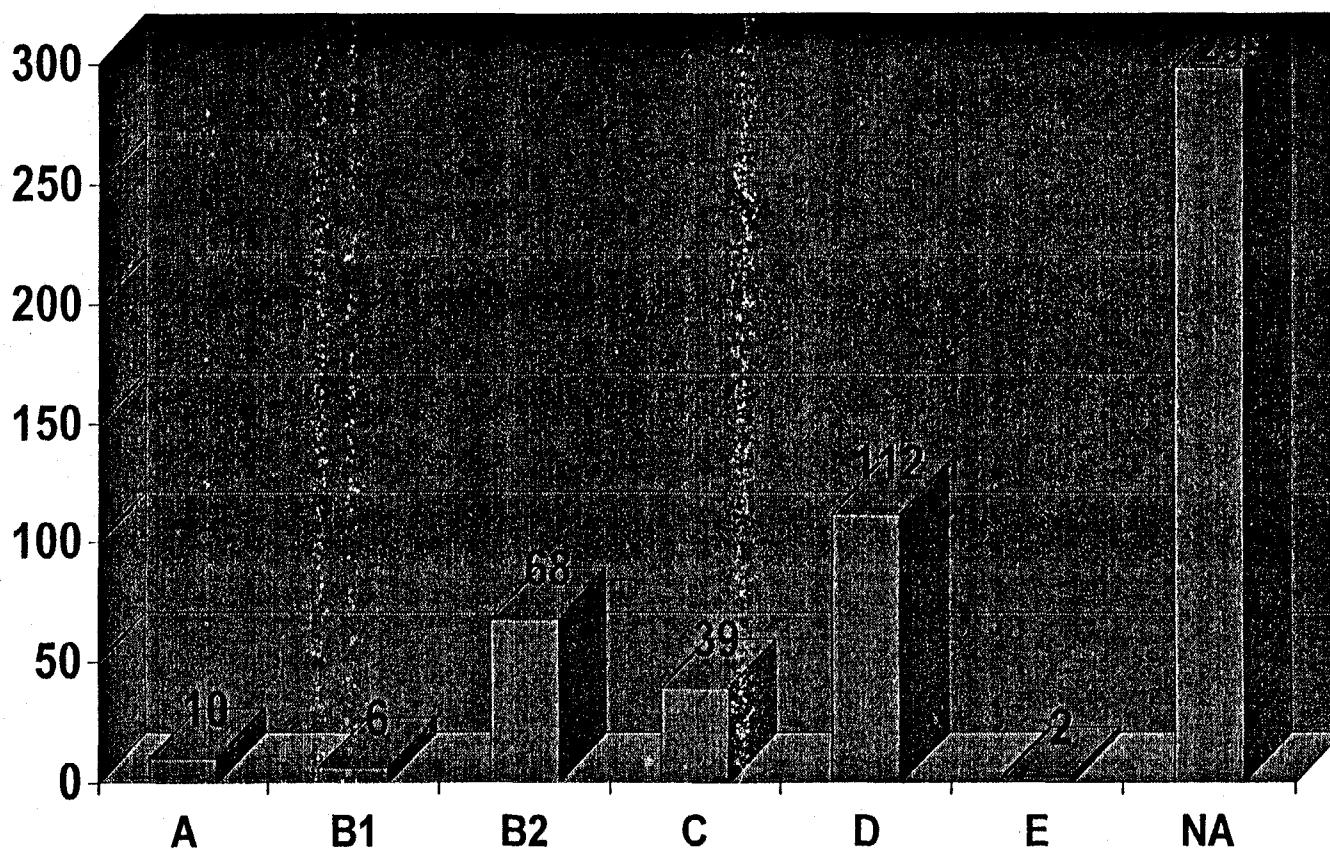
# Process for Chemical Listing in IRIS

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- ◆ Identify chemical in Federal Register listing
- ◆ EPA chemical manager develops toxicological file
- ◆ Draft chemical file reviewed by EPA
- ◆ File submitted for external review
- ◆ Internal (EPA) consensus review
- ◆ File is posted on IRIS

## Carcinogens Classified in IRIS

Number of  
Chemicals  
(536 Total)



Note: As of September 1999

# Carcinogenicity of PCBs (IRIS)

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## ◆ Classified as probable human carcinogen

- Evidence from occupational studies is inadequate but suggestive

## ◆ Sufficient evidence from animal laboratory studies

- Rats exposed to Aroclors 1260, 1254, 1242 and 1016 exhibited liver tumors (1996 study)
- Males had increased numbers of thyroid tumors for all Aroclors
- Commercial Arcolor mixtures cover range of congeners found in environment

## Cancer Slope Factors for PCBs CSF in $\text{mg/kg-day}^{-1}$ (IRIS)

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- ◆ **High Risk & Persistence** (soil, sediment, fish)
  - Upper-bound CSF = 2
  - Central Tendency CSF = 1
- ◆ **Low Risk & Persistence** (air, water)
  - Upper-bound CSF = 0.4
  - Central Tendency CSF = 0.3
- ◆ **Lowest Risk & Persistence** (PCBs with  $\leq 4$  chlorines)
  - Upper bound CSF = 0.07
  - Central tendency CSF = 0.04

## Non-Cancer PCB Toxicity Factors (IRIS)

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- ◆ **Reference Dose (RfD):** *chemical intake likely to be without an appreciable risk of adverse effects to humans during a lifetime.*
- ◆ **RfD is based on feeding studies with rhesus monkeys**
- ◆ **Example adverse effects observed in animals:**
  - Reduced birthweight (1016)
  - immune system impairment (1254)
  - eye toxicity (1254)
- ◆ **PCBs have among the lowest reference doses (high toxicity) in IRIS**

## IRIS Non-Cancer Toxicity Factors (RfDs) for PCBs

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- ◆ **Aroclor 1254 - RfD =  $2 \times 10^{-5}$  mg/kg-day**
  - LOAEL based on various clinical & immunologic effects
  
- ◆ **Aroclor 1016 - RfD =  $7 \times 10^{-5}$  mg/kg-day**
  - NOAEL based on reduced birth weight



# Averaging Time Considerations

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- ◆ **Due to PCB concentrations decline over time, average concentration declines as averaging duration increases.**
- ◆ **Non-cancer**
  - RME concentration averaged over 7 years
  - 7-year period is based on definition of “chronic” exposure
  - Central tendency concentration averaged over  $\approx 12$  years
- ◆ **Cancer**
  - Averaged over RME ( $\approx 40$  years) and central tendency ( $\approx 12$  years) exposure durations

## Risks to Children

---

### ◆ Fish Ingestion

- Point Estimate
  - meal portion  $\approx$  1/3 of adult portion
  - RME cancer risk  $\approx$  1.2-fold lower than adult (revised values)
  - RME Hazard Index  $\approx$  2.3-fold greater than adult (revised values)
- Monte Carlo
  - Simulated ages from  $\geq 10$  up to 70 years
  - No specific break-out of risks by age group

### ◆ Sediment, Water & Air

- Included children, adolescents, and adults for all exposures

# Exposure Pathways Evaluated

---

## ◆ Fish Ingestion

- anglers who catch fish in Hudson in absence of advisories

## ◆ Drinking water (*de minimis* -- Phase 1)

## ◆ Water (recreational contact)

- Dermal Contact

## ◆ Sediment (recreational contact)

- Dermal contact
- Ingestion

## ◆ Air

- Recreators and residents along the river

## Point Estimate & Probability Analyses

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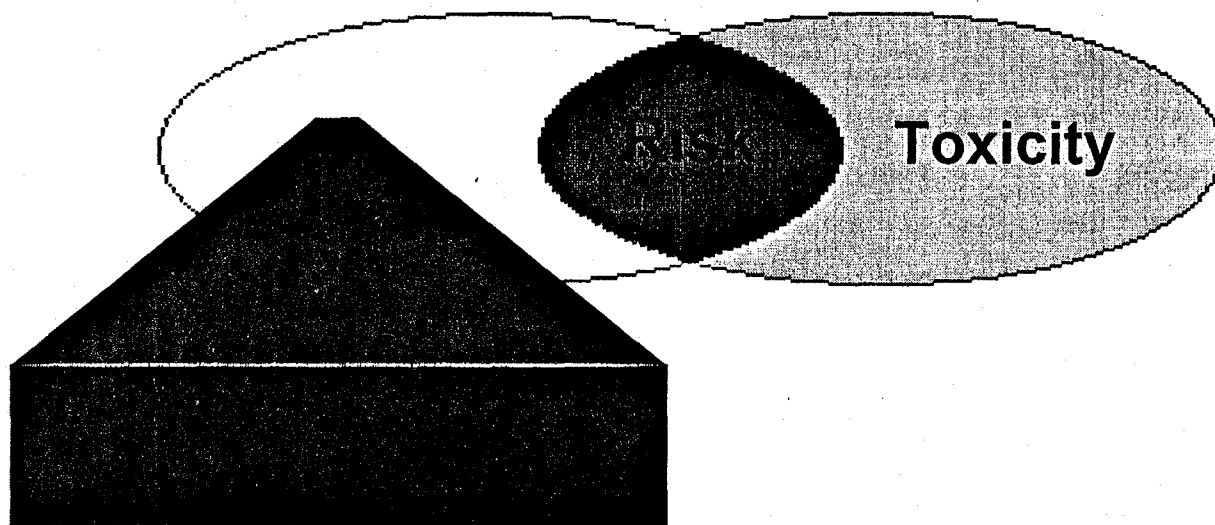
- ◆ For all exposure pathways “point estimate” exposure and risk calculations were performed:
  - Central Tendency estimate of average risk
  - Reasonable Maximum Exposure (RME) risk
- ◆ Monte Carlo analysis performed for fish ingestion

# Summary of Important Exposure Factors

Exposure Factor	Central Estimate	Reasonable Maximum (RME)
<b><u>Fish Ingestion</u></b>		
Consumption (meals/year)	≈6	51
Exposure Duration (years)	12	40
PCBs Lost in Cooking	20%	0%
<b><u>Exposure to Water/Sediment</u></b>		
Adult/Child Recreation (Summer)	50% of RME	1 day per week
Adolescent Recreation (Summer)	50% of RME	3 days per week
Residence Duration (years)	11	41
<b><u>Air Inhalation</u></b>		
Residence Duration (years)	11	41

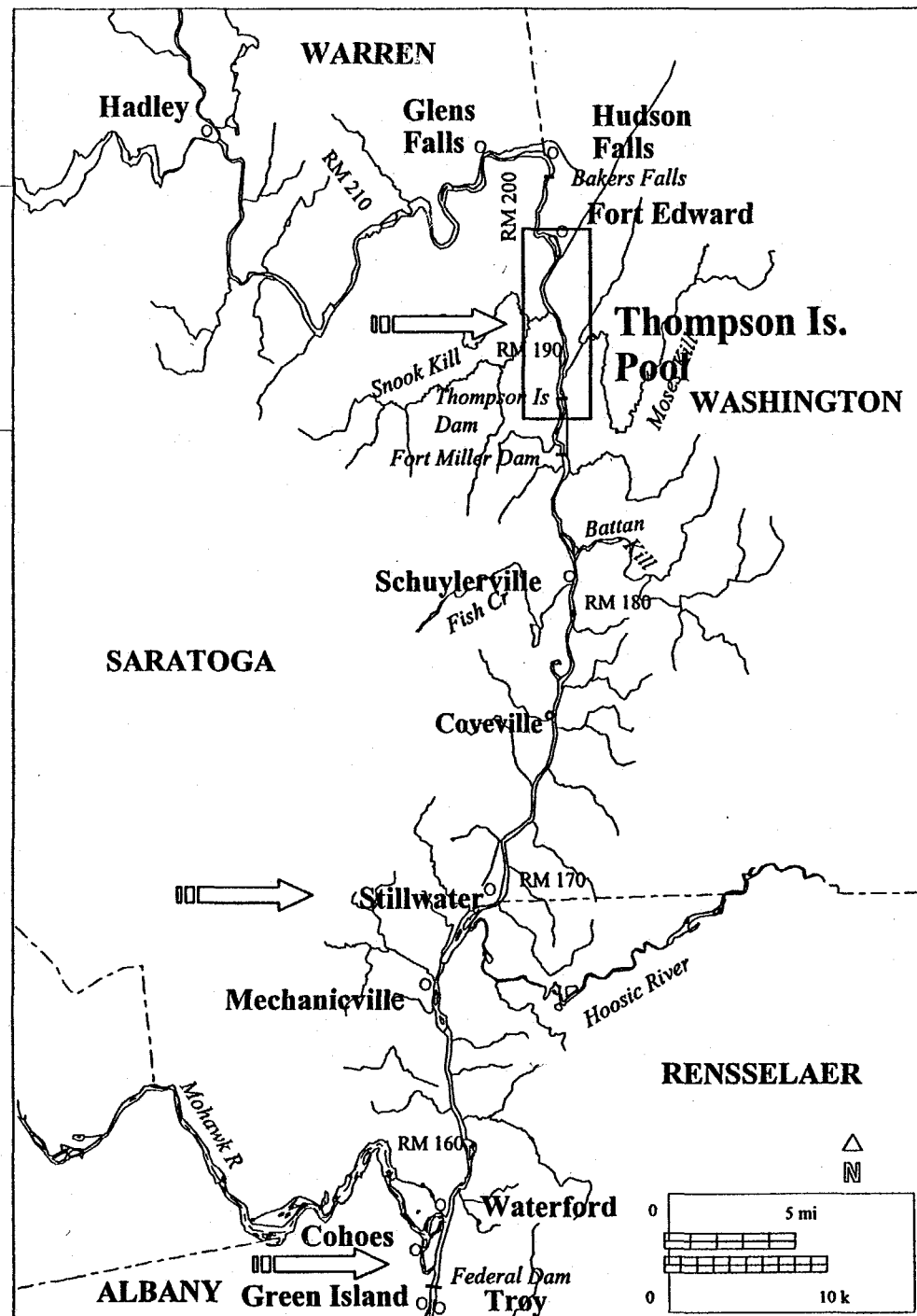
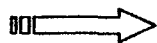
# Discussion of Exposure Factors

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# Scope of Upper Hudson Human Health Risk Assessment

Locations of modeled PCB  
bioaccumulation in Fish



# Exposure Point Concentrations (EPC)

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## ◆ Water & Sediment

- Baseline modeling report 20 year simulations (revised BMR 70 years)

## ◆ Air (2 screening level estimation methods)

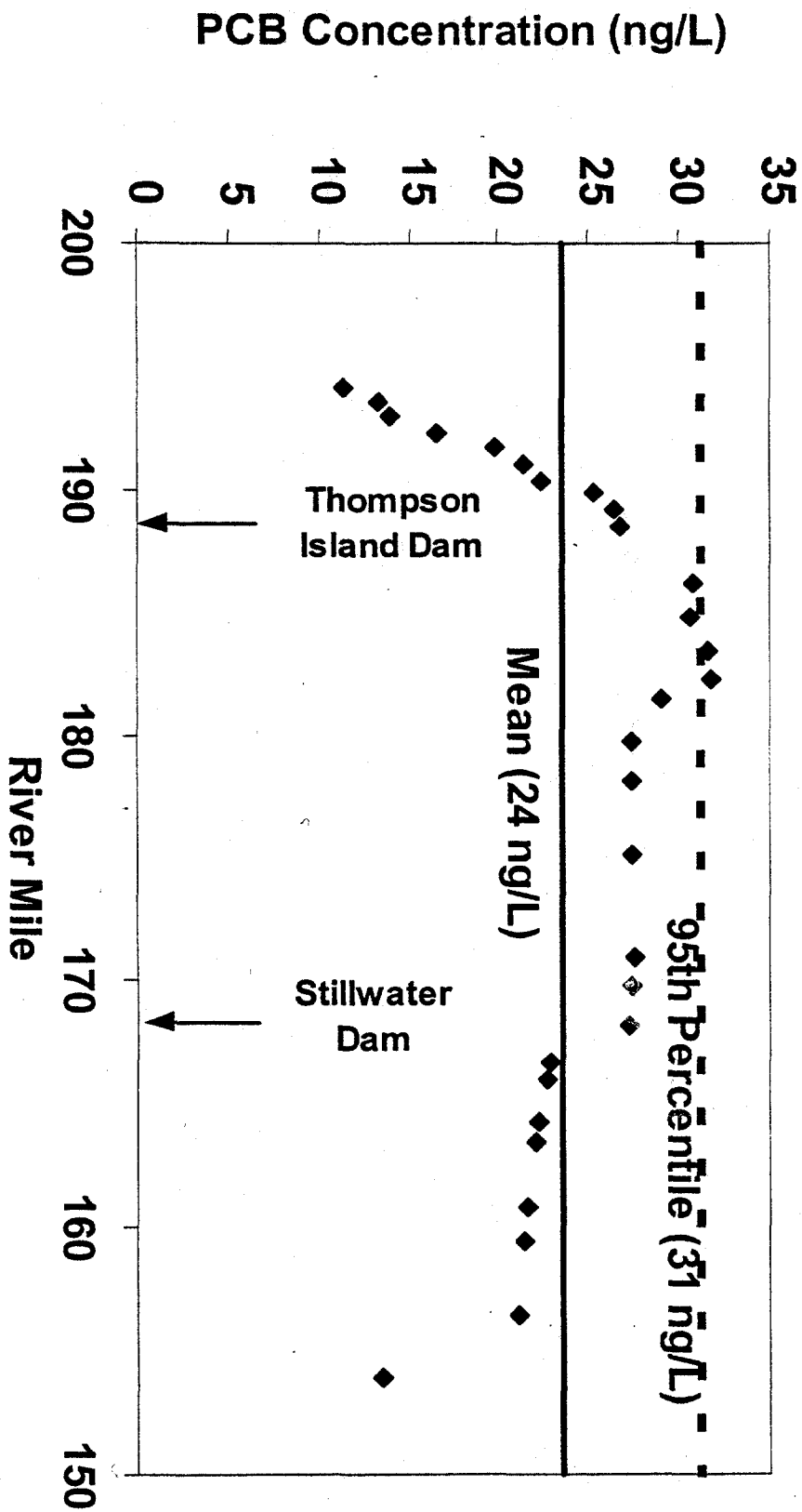
- Empirical transfer coefficient based on 1991 remnant monitoring and coincident river water monitoring
- Mathematical diffusion & air dispersion modeling with field measured diffusion coefficients for Tri- and Tetra-CB

## ◆ Fish

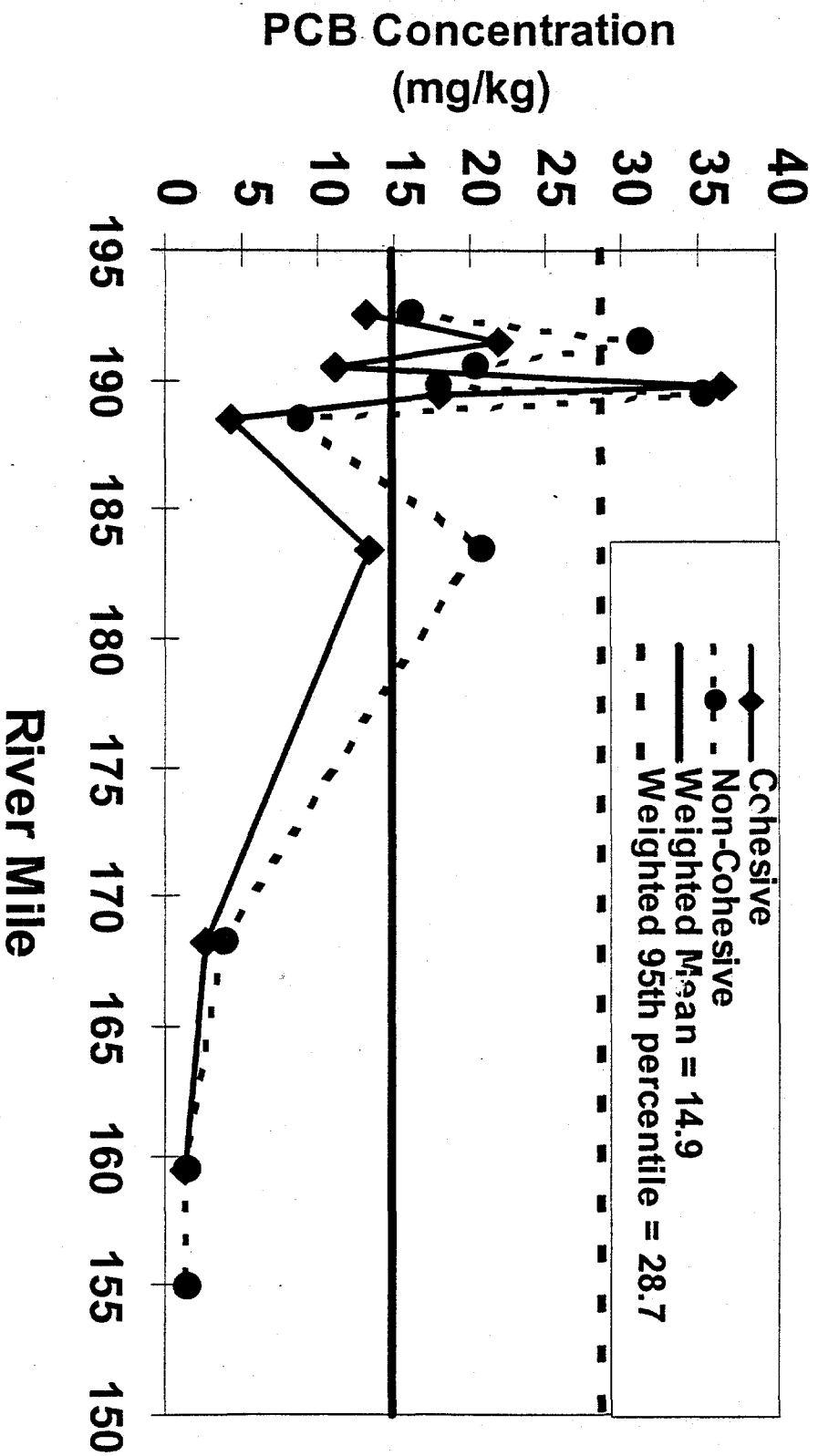
- Extrapolation of 20 year modeling results -- 3 species for 3 locations (revised BMR 70 years)



**Figure 2-12a**  
**Water Column PCB Concentration**  
 20 Year Segment Averaged Values Constant Source



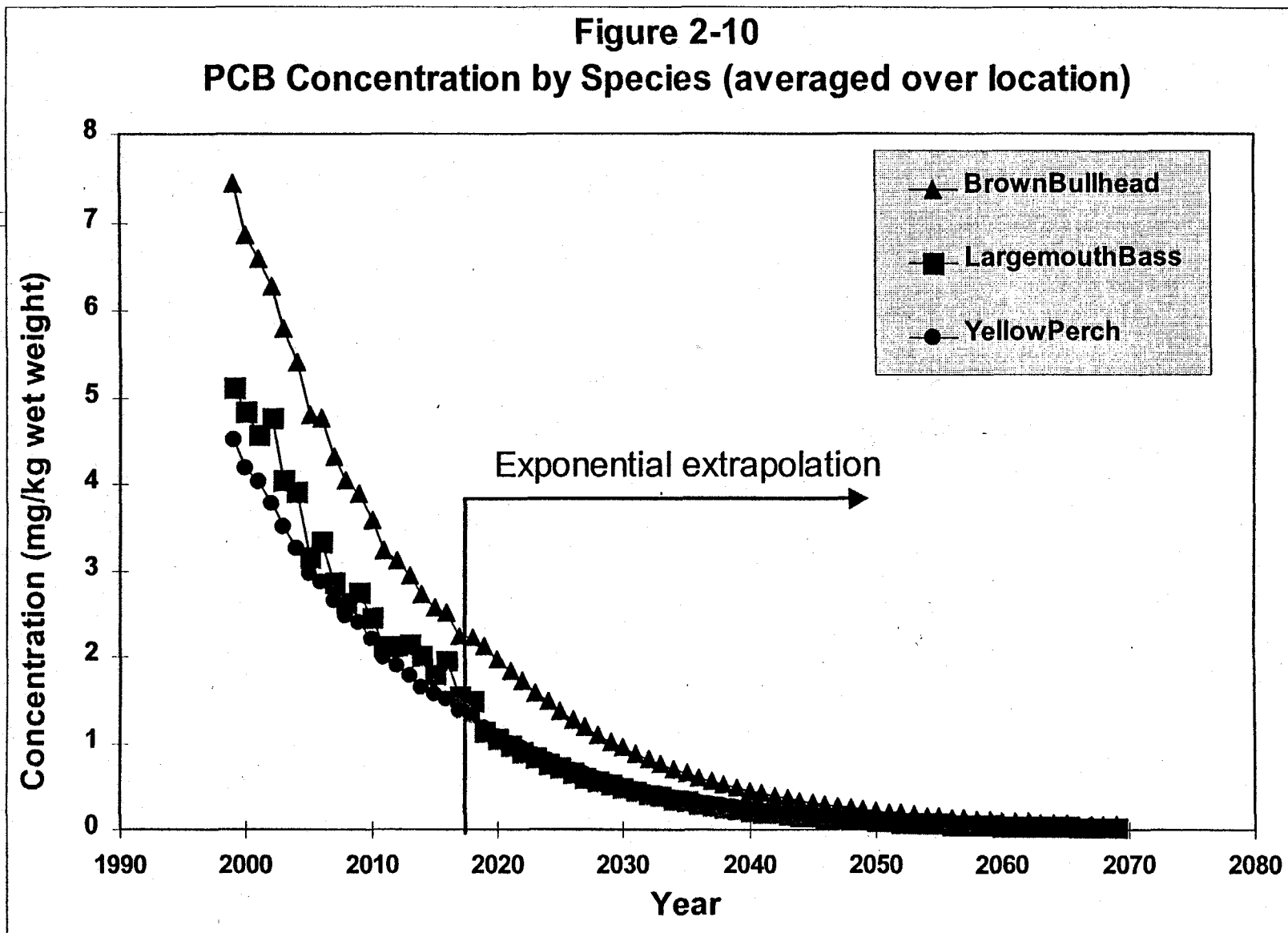
**Figure 2-11b**  
**Total PCB Concentration in Sediment (1999 - 2018)**  
**20 Year Segment Averages -- Constant Source**



# PCB Concentration in Fish

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- ◆ **3 Modeled species -- bass, bullhead, perch**
- ◆ **Species consumption frequency reported in 1991 NY Angler survey for:**
  - bass, walleye, bullhead, carp, eel, perch (U. Hudson species)
  - salmon, trout, other (not typical U. Hudson)
- ◆ **Species ingestion fractions for 3 modeled species used as weighting factors for concentration term**
- ◆ **August 1999 Report extrapolated 20-year model forecast to cover up to 70 years exposure duration**
  - No extrapolation for revised BMR



August 1999 Report Example

# Summary of PCB Concentration Term in Fish Used in Risk Calculations

---

- ◆ **Point estimate adopted average concentration over 3 model locations**
  - 40 year average = 2.2 mg/kg (1.4 mg/kg revised)
  - 12 year average = 4.4 mg/kg (2.4 mg/kg revised)
- ◆ **PCB concentration variability was addressed:**
  - Variations among species consumed
  - Variation in concentration between upstream and downstream locations (Monte Carlo sensitivity analysis)

# Angler Population Exposure Duration

---

- ◆ **Exposure defined as the minimum of:**
  - Residence duration in 5 counties bordering Upper Hudson
  - Fishing duration
- ◆ **Residence duration estimated from 1990 Census data**
- ◆ **Fishing duration based on analysis of 1991 NY Angler Survey data**
- ◆ **Results:**
  - 50<sup>th</sup> percentile = 12 years
  - 95<sup>th</sup> percentile = 40 years

# Variability/Uncertainty Analysis Evaluated Wide Range of Exposure Factors

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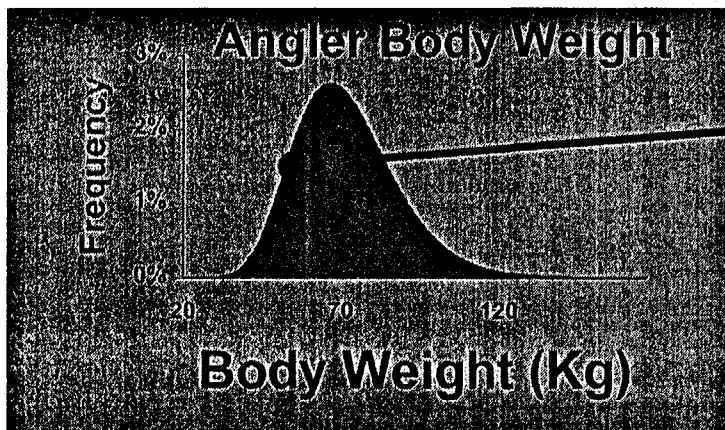
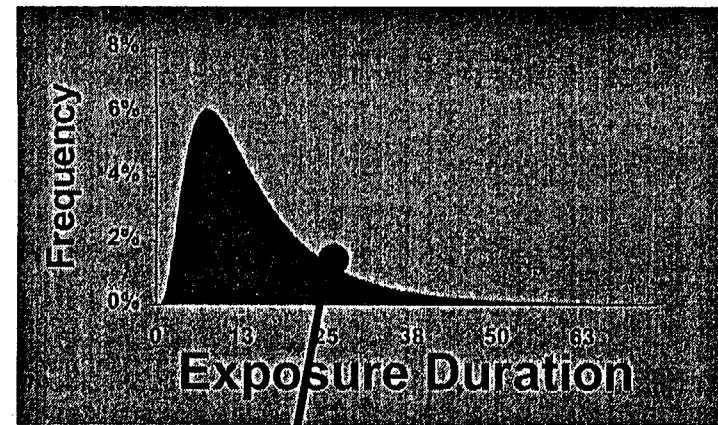
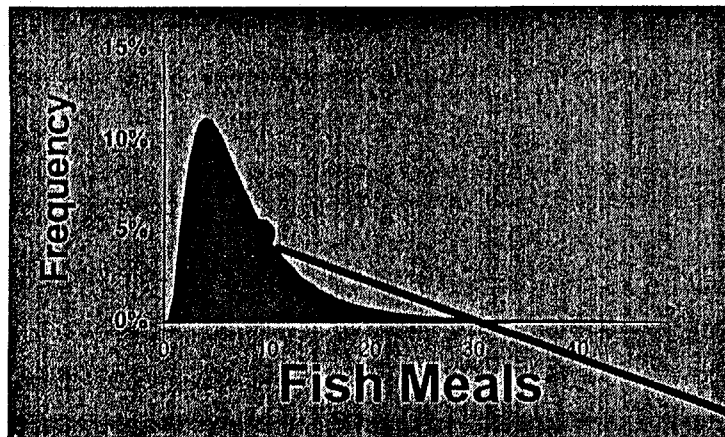
## ◆ Point estimates

- Central tendency and reasonable maximum exposure (RME)
- Intent is to assess exposures  $\geq 90^{\text{th}}$  percentile
- RME is combination of average and  $90^{\text{th}}$  or  $95^{\text{th}}$  percentile values for individual exposure factors

## ◆ Probability methods (Monte Carlo Analyses)

- Developed distribution of fish consumption rates, species ingestion patterns, exposure duration
- Sensitivity of input distributions and discrete estimates

# Schematic of Monte Carlo Exposure to PCBs via Fish Consumption

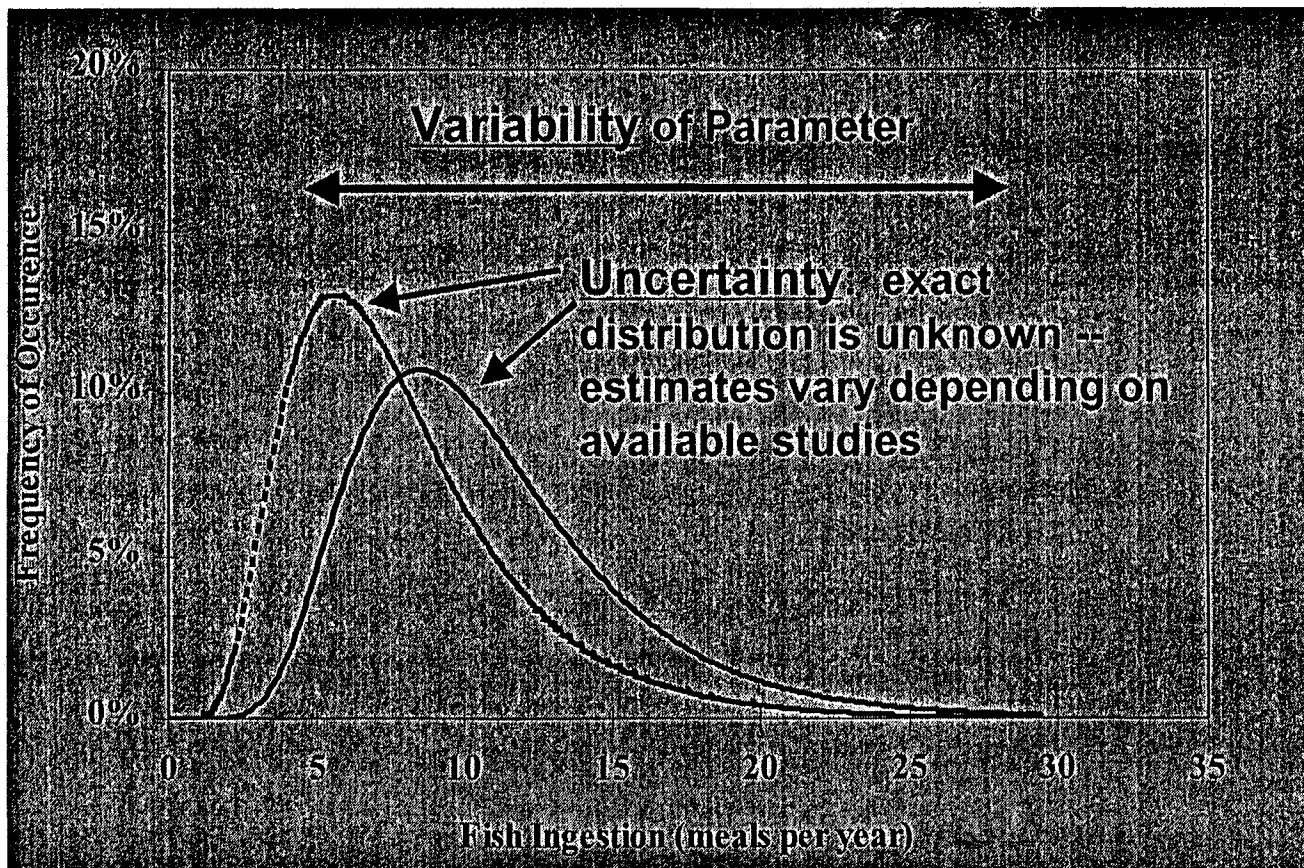


Sample Exposure  
Values From  
Possible Range

Calculate Risk  
(10,000 Anglers x 72 combinations)



# Exposure Factors Exhibit a Combination of Variability and Uncertainty



## Full 2-D Monte Carlo Was Not Feasible

---

- ◆ **Insufficient data to characterize probability distributions for uncertainty**
- ◆ **Sensitivity analysis performed as alternative to 2-D**
- ◆ **Examined uncertainty using a range of possible inputs (72 combinations)**

# Monte Carlo Analyses

## 10,000 Anglers x 72 Combinations

---

Exposure Factor	Base Case	Sensitivity Analysis
Fish Consumption	1991 NY Angler Survey	Maine Survey Michigan Survey L. Ontario Survey
Exposure Duration	Minimum of Fishing and Residence Duration	Residence Duration only
PCBs Lost in Cooking	20% (midpoint)	0% high end 40% low end
Fishing Location (concentration)	Average Thompson Is. Pool, Stillwater, Troy/Albany	Thompson Is. Pool (high) Troy/Albany (low)

# Angler Surveys Used for Sensitivity Analysis

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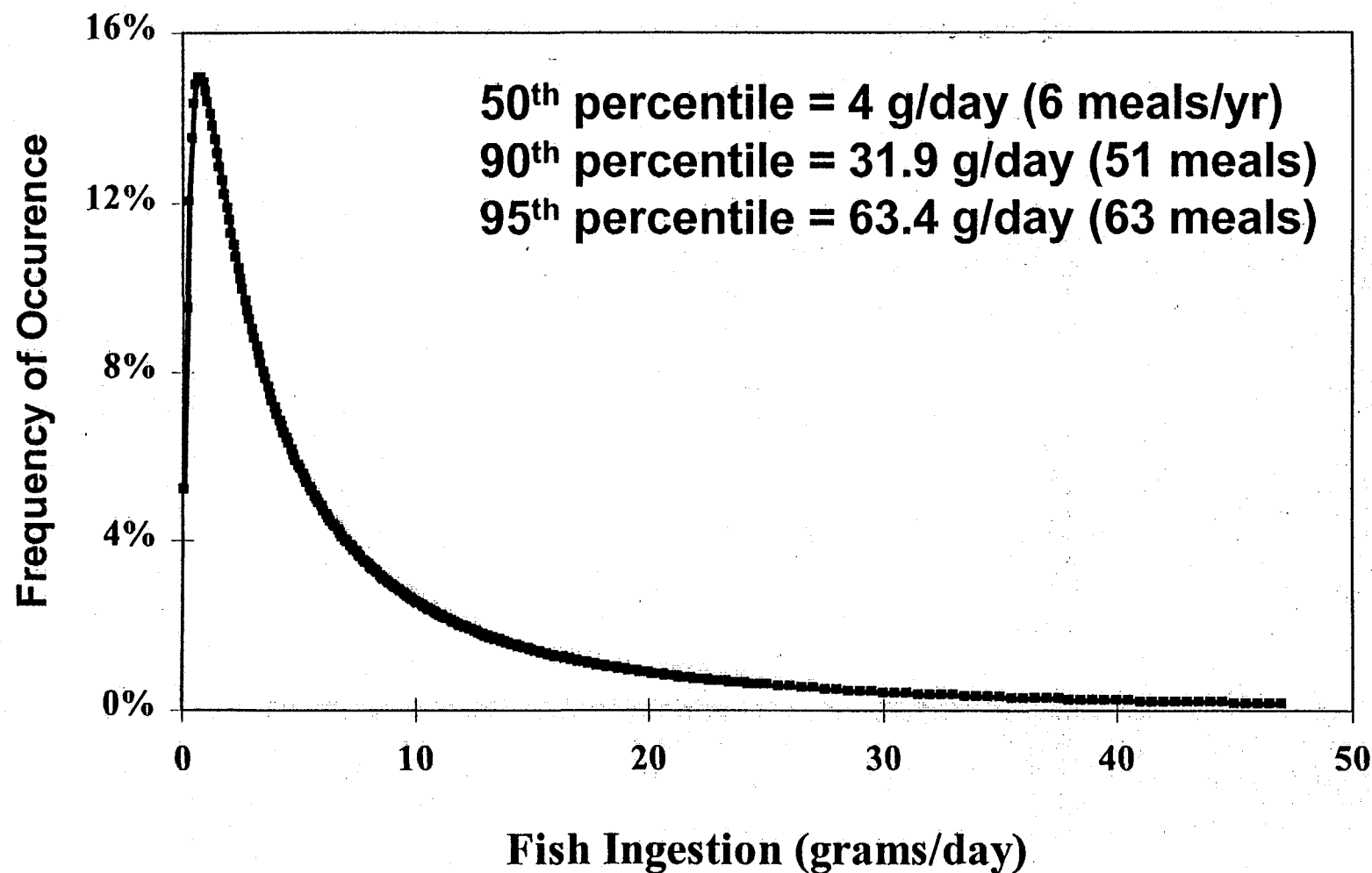
- ◆ **1991 NY Angler Survey (Connelly et al., 1992)**
  - Mail survey of licensed anglers -- 1,030 responses
  - Reported water body, fish catch, consumption, species, distance traveled, awareness of advisories
  
- ◆ **1992 L. Ontario Study (Connelly et al., 1996)**
  - 12-month diary survey -- 516 responses
  - respondents recorded fish consumption & fishing trips for a 1-year period

## **Angler Surveys Used (cont.)**

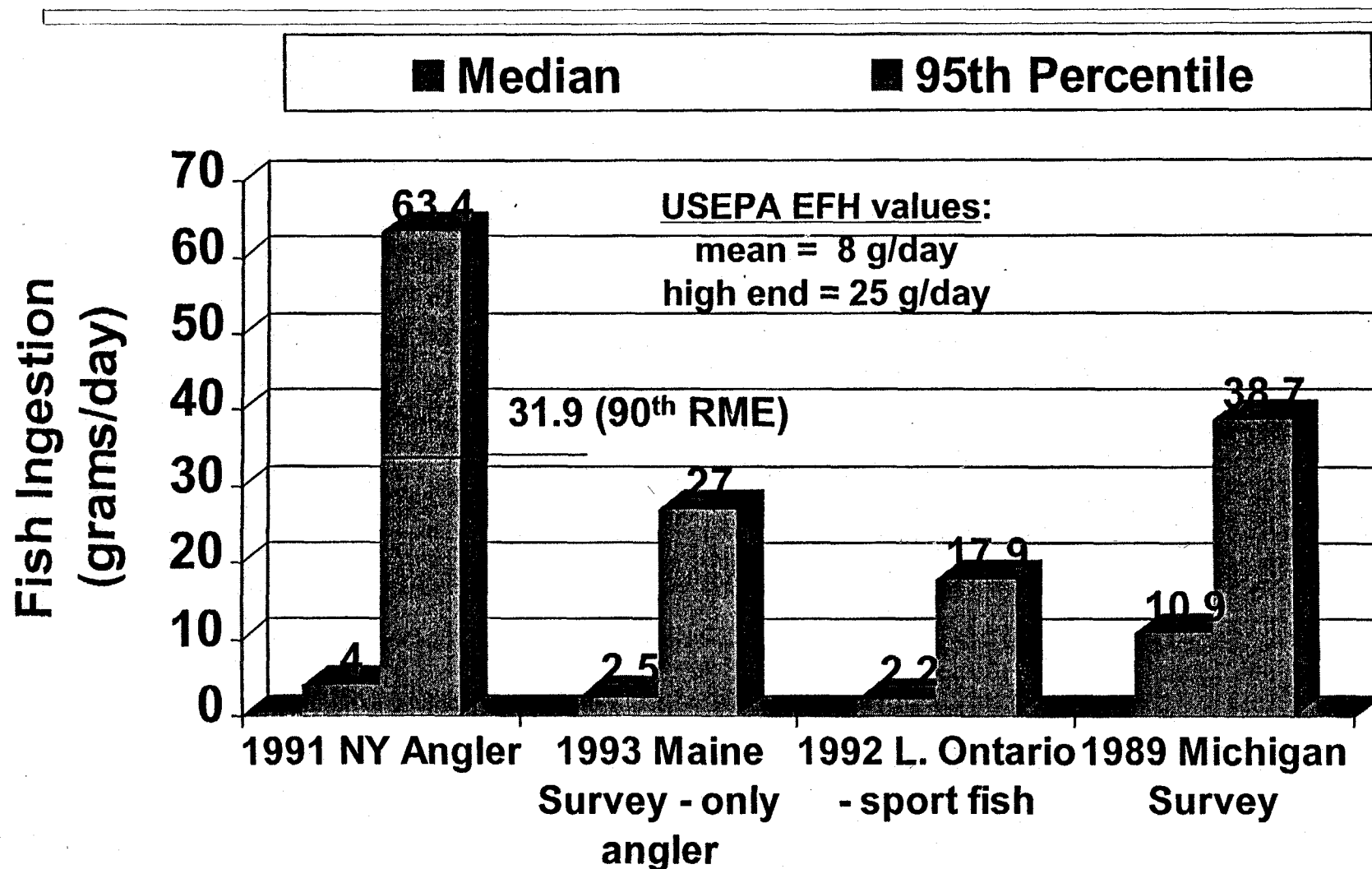
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- ◆ **1993 Maine Angler (Ebert et al., 1993)**
  - Mail survey of licensed anglers
  - 1,612 returned surveys
  - Freshwater fish catch & consumption rates
  
- ◆ **1989 Michigan Sport Anglers (West et al., 1989)**
  - Mail survey of licensed anglers over 5 month period
  - 1,104 responses
  - Fish consumption (self-caught and other), serving size (8 oz. most typical)
  
- ◆ **Hudson-specific surveys considered but not adopted**

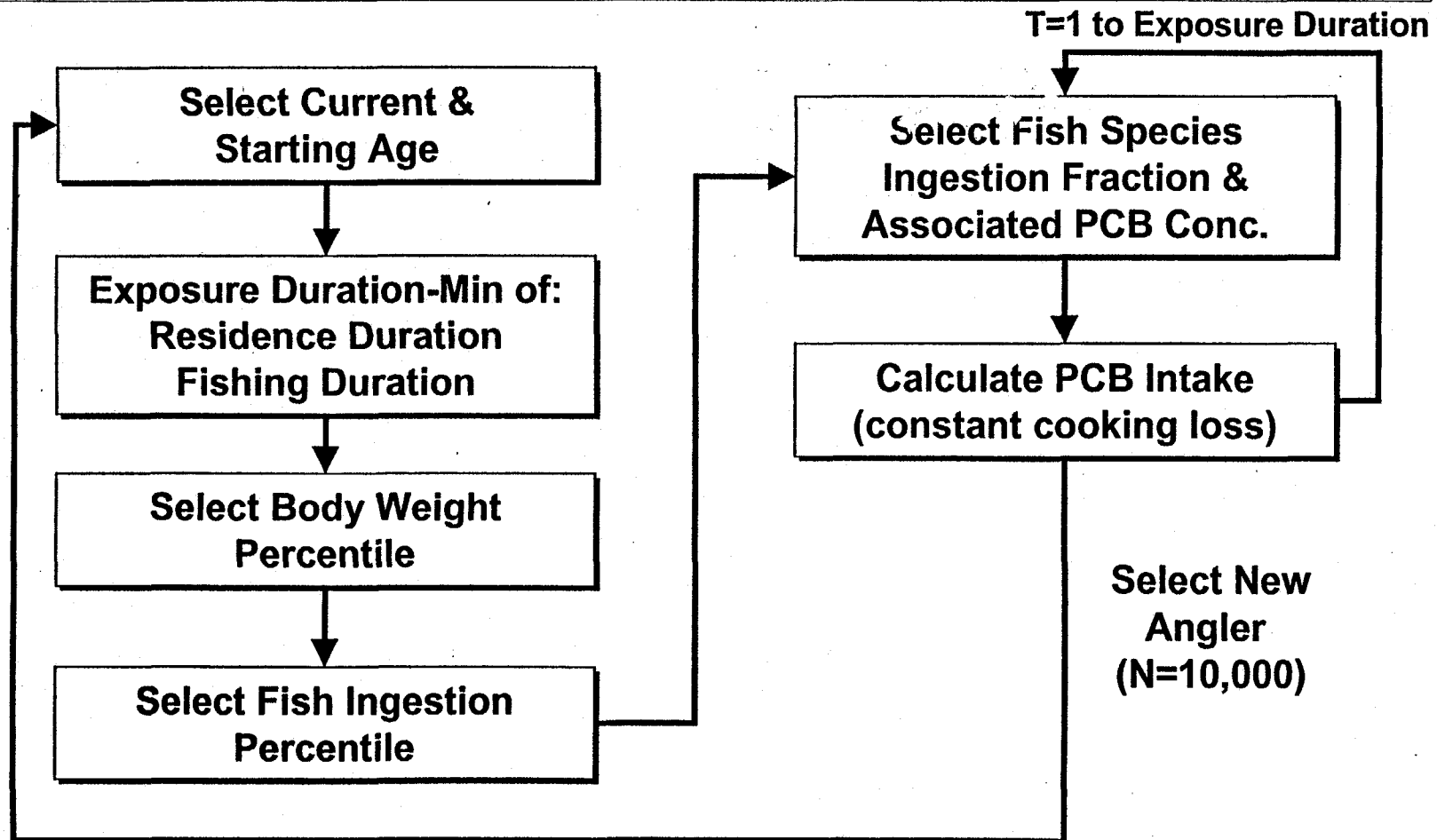
**1991 New York Angler Survey Fish Ingestion Rate  
Empirical Distribution Used  
(Responses < 1,000 Meals/yr)**



# Comparison of Fish Ingestion Studies



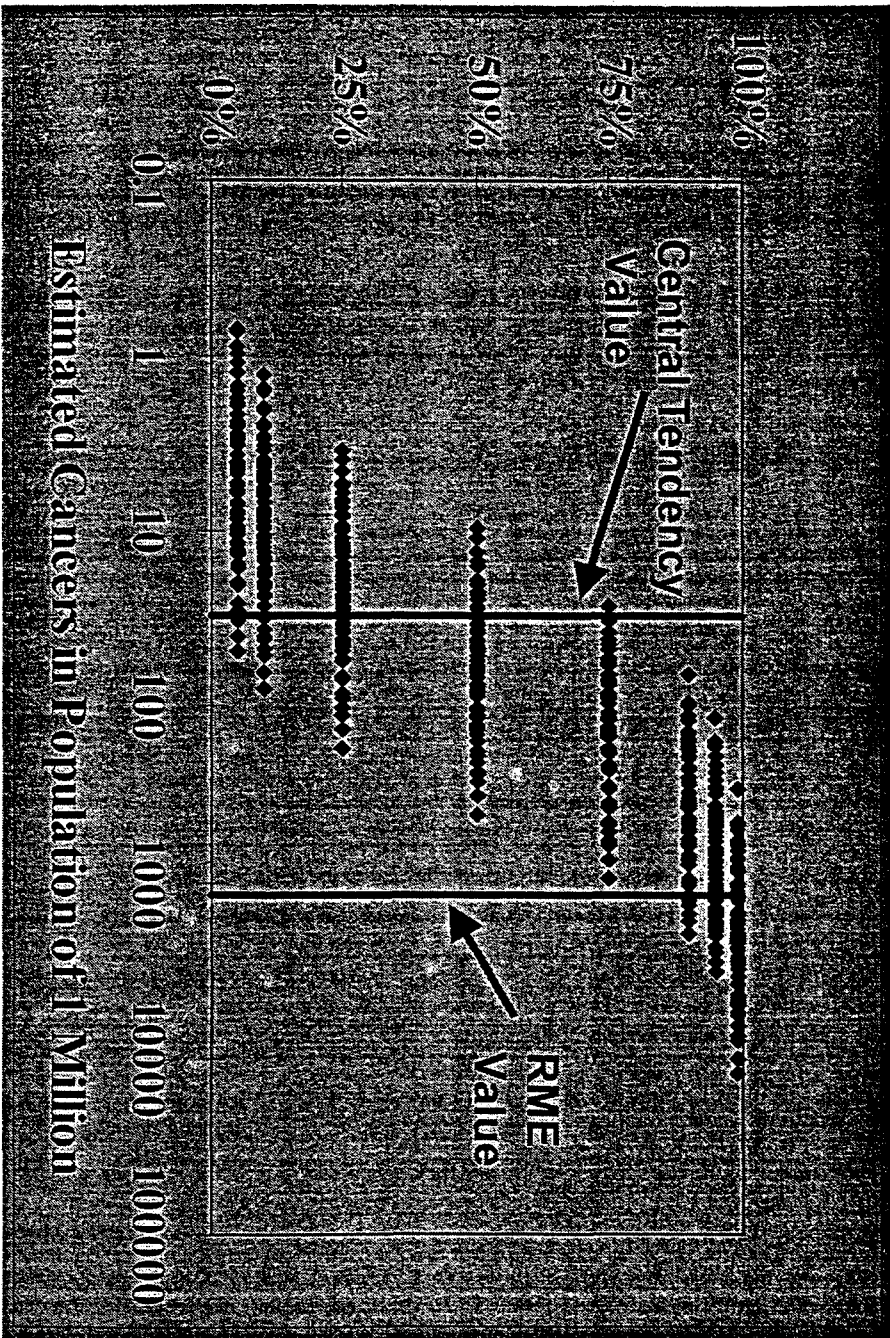
# Monte Carlo Simulation Approach





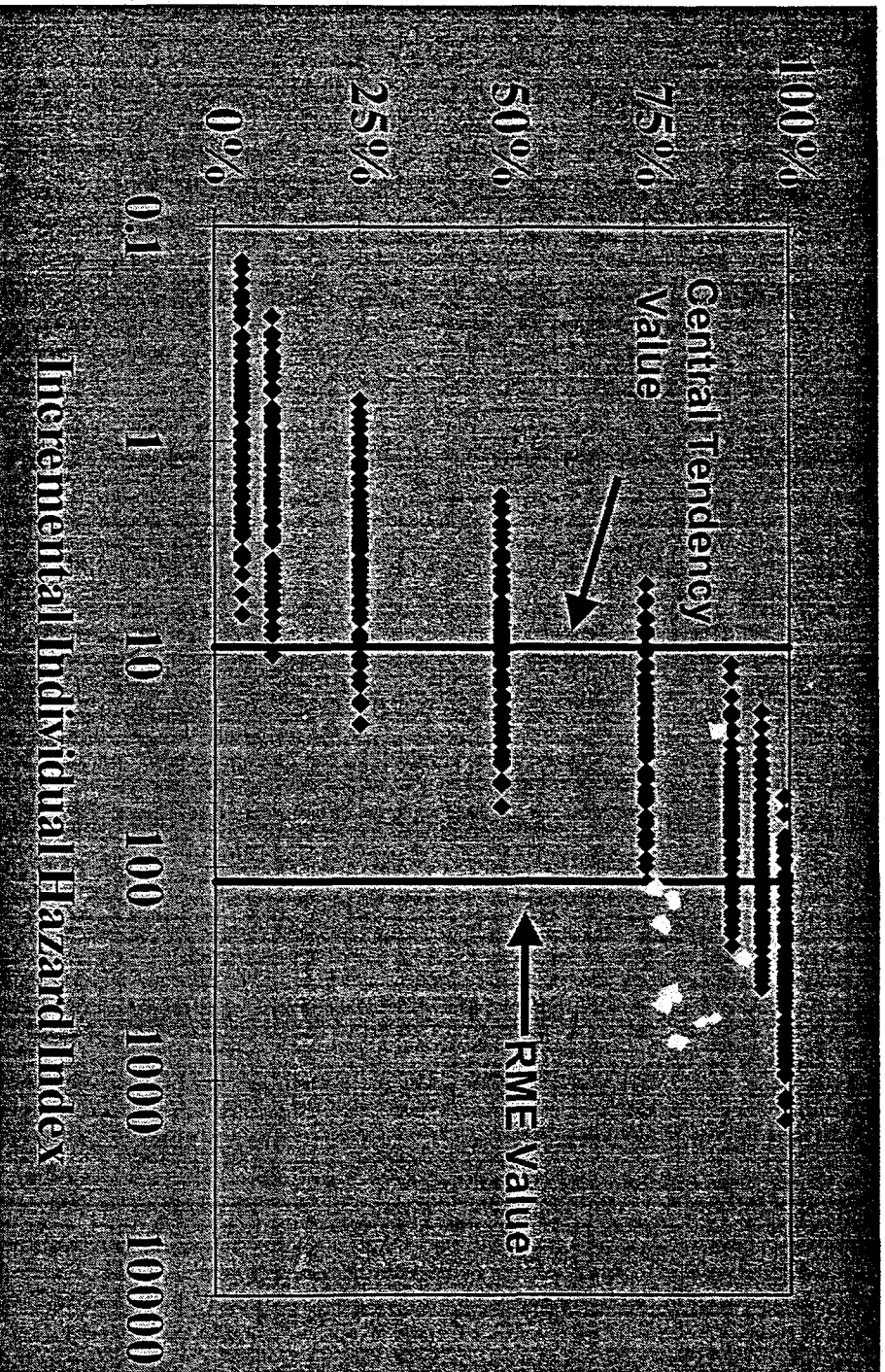
# Range of Cancer Risk Estimates for Fish Ingestion

Fraction of Anglers with  
Risk  $\leq$  than Indicated Value



# Range of Non-Cancer Hazard Index (HI) Estimates for Fish Ingestion

Fraction of Anglers with  
HI  $\leq$  Indicated Value

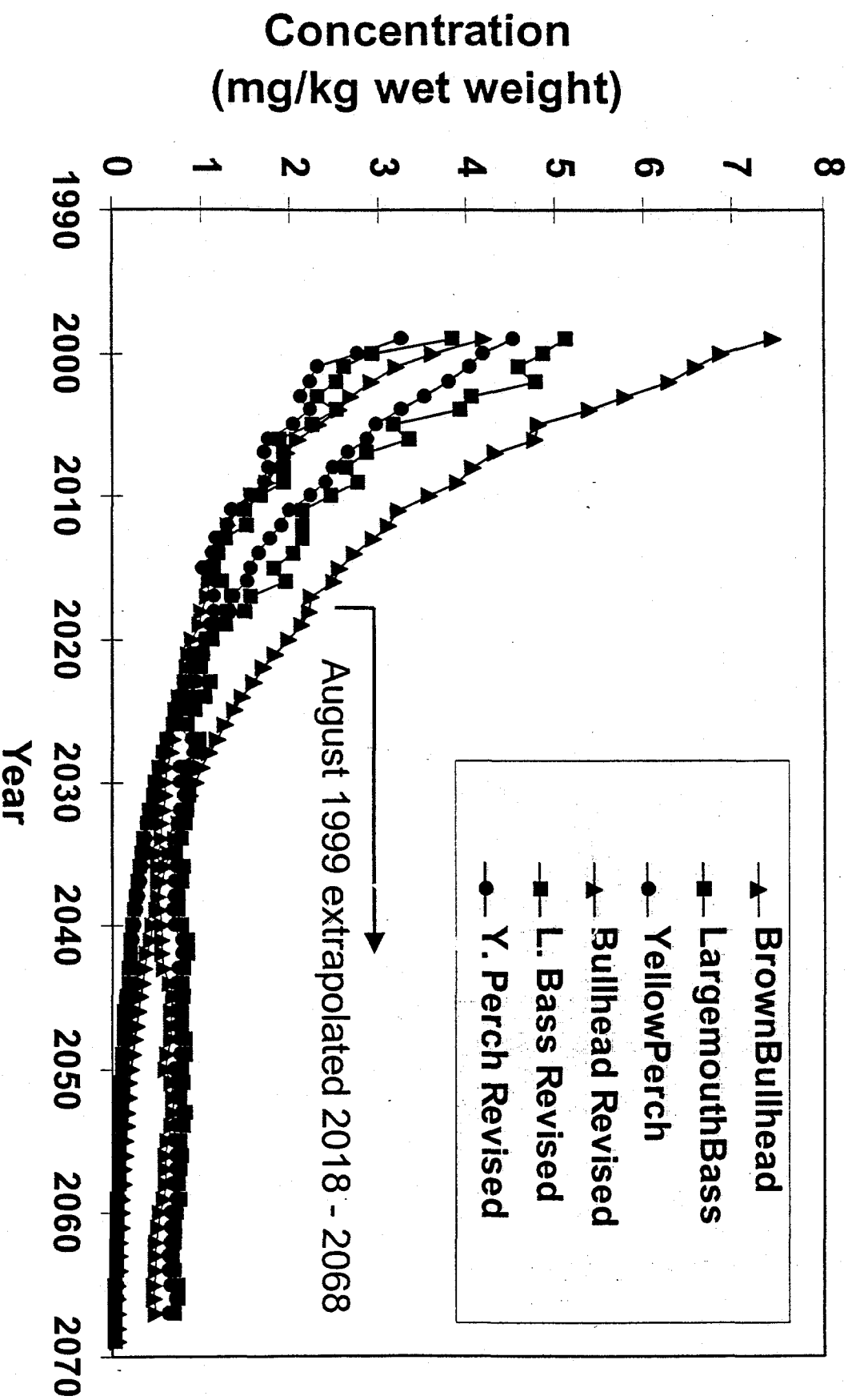


# **Impact of Revised BMR Results on August 1999 Upper Hudson Risk Assessment**

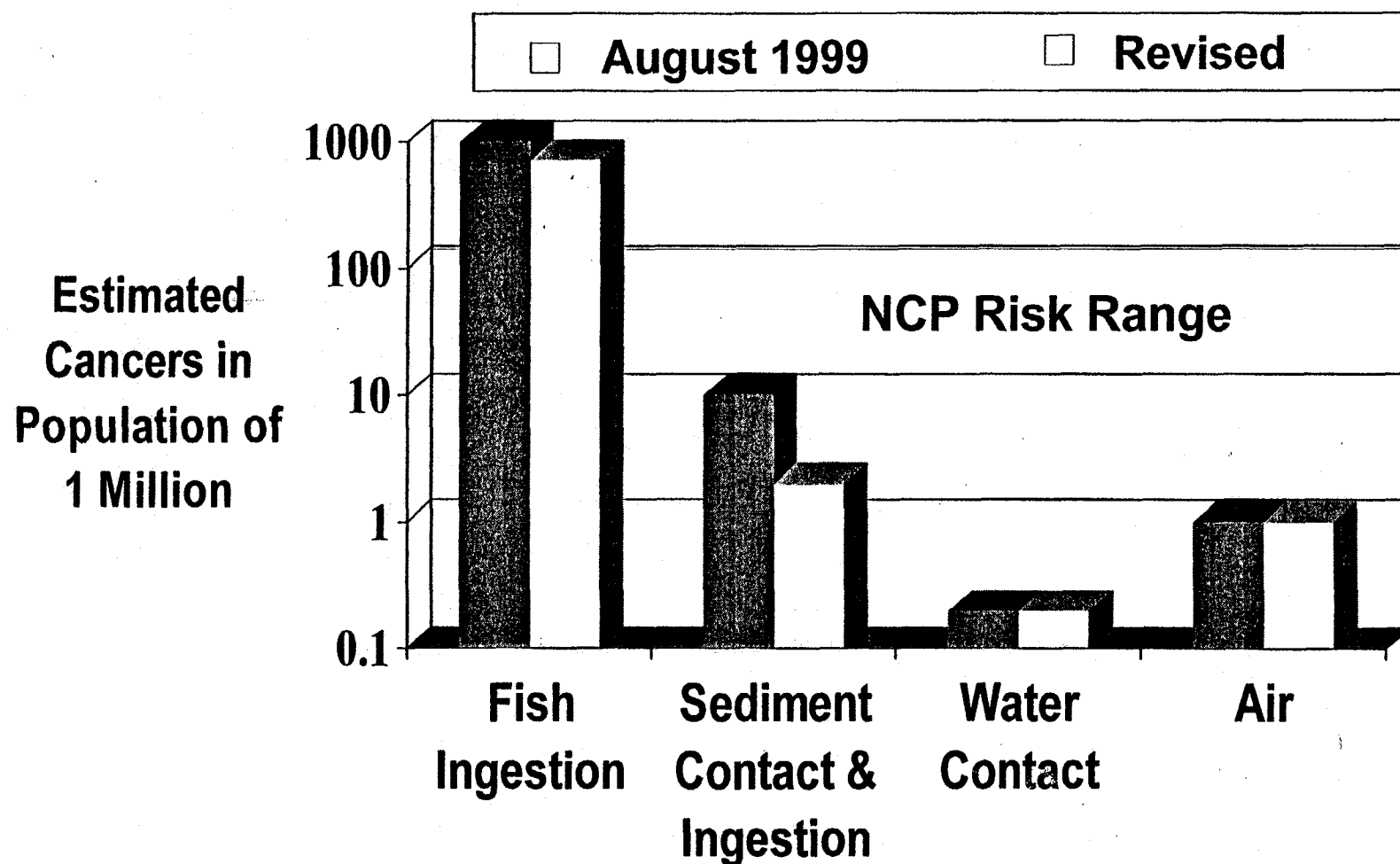
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- ◆ **Revised BMR forecast period = 70 years (vs. 20)**
- ◆ **Modeled average concentration in fish declined by  $\approx$ 2-fold or less depending on species.**
- ◆ **Concentrations in water and sediment averaged over central tendency and RME exposure duration for child, adolescent, adult exposures (not limited to 20 year model period).**
- ◆ **Point estimate adult RME fish ingestion results:**
  - **Cancer risks decline by approximately 30%**
  - **Non-cancer hazards decline by 44%**

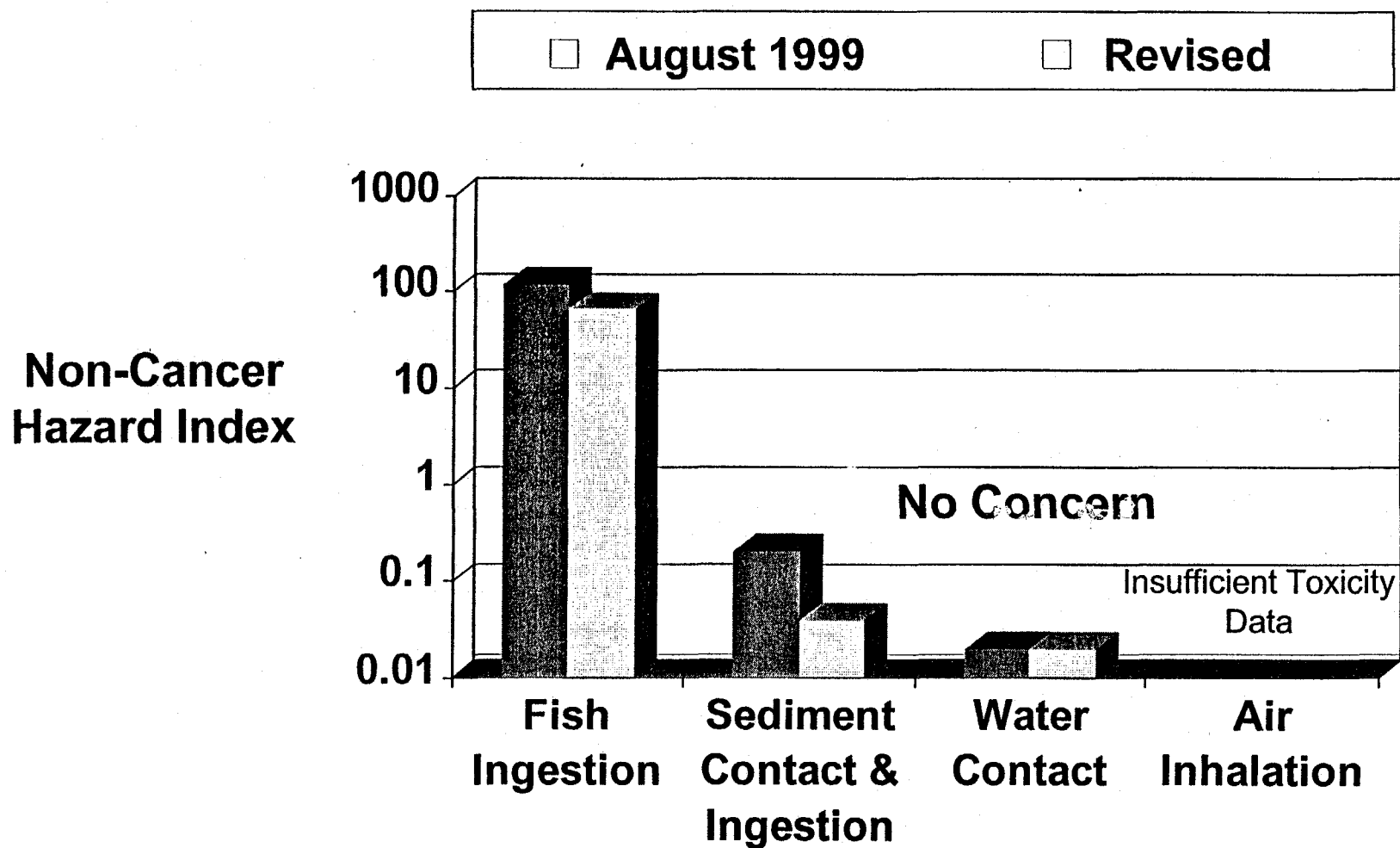
## Comparison of August 1999 and Revised BMR Fish Modeling Results



## Revised BMR Results -- Cancer RME



## Revised BMR -- Non-Cancer RME



# Summary

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- ◆ **Fish ingestion RME cancer risks and non-cancer hazards exceed levels of USEPA concern**
- ◆ **Other exposure pathways are at or below levels of USEPA concern**
- ◆ **Revised BMR results do not significantly alter the risk assessment results**
- ◆ **Monte Carlo Analysis indicates RME fish ingestion:**
  - **at or above 75<sup>th</sup> percentile for all combinations of exposure factor scenarios examined (cancer and non-cancer)**