

Green Bay NRDA: Why No HEA?

NOAA-ARD, Monthly Meeting

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Agenda

- Why so much historical “injury” work in GB?
- How the NRDA added to and synthesized the injury information
- Why no service-based HEA?
- How the NRDA scaled injury information to restoration

Fox River/Green Bay Site



Why so much historical “injury” work in GB?



Organo-chlorines discovered early

- 1962-1965: U.S. FWS, National Contaminant Biomonitoring Program (Patuxent)
- Highest O-Cs from entire U.S. program found in herring gull eggs from Sister Island in Green Bay
- Unable to discern which O-Cs, unable to tell source – complete surprise



Deformities discovered in birds

- 1970s: Major banding efforts, particularly for double-crested cormorants in upper Green Bay (Michigan and Wisconsin islands)
- Deformities (crossed bills) widespread
 - Severe (bills often twist in opposite directions, or around head)
 - Long lasting (continued at least until the 1990s)
 - Extremely high rates (approx. 5% on Hat Island, WI in 1994)



Lamprey control surprisingly ineffective

- 1950s: lake trout population crash, mostly attributable to sea lamprey invasion
- 1950s: Massive and successful lamprey program control launched
- 1960s and 1970s: Lake Michigan lake trout recovery unsustainable even with large stocking efforts (Why?)



Contaminants Research

- 1960s-1970s: the O-C are dominated by PCBs
- 1970s-1980s: high concentrations of PCBs in all Green Bay biota
 - 25 species of birds
 - Many dozens of fish species (FCAs issued on almost all sport fish)
 - PCBs in sediment, water, biota throughout WI & MI waters of GB



Contaminants Research (cont.)

- 1980s: the Bay becomes a focus of multiple lines of PCB research
 - Aroclor & congener patterns by media
 - Attempts to link biological effects with PCBs or particular congeners
 - Attempts to determine PCB sources



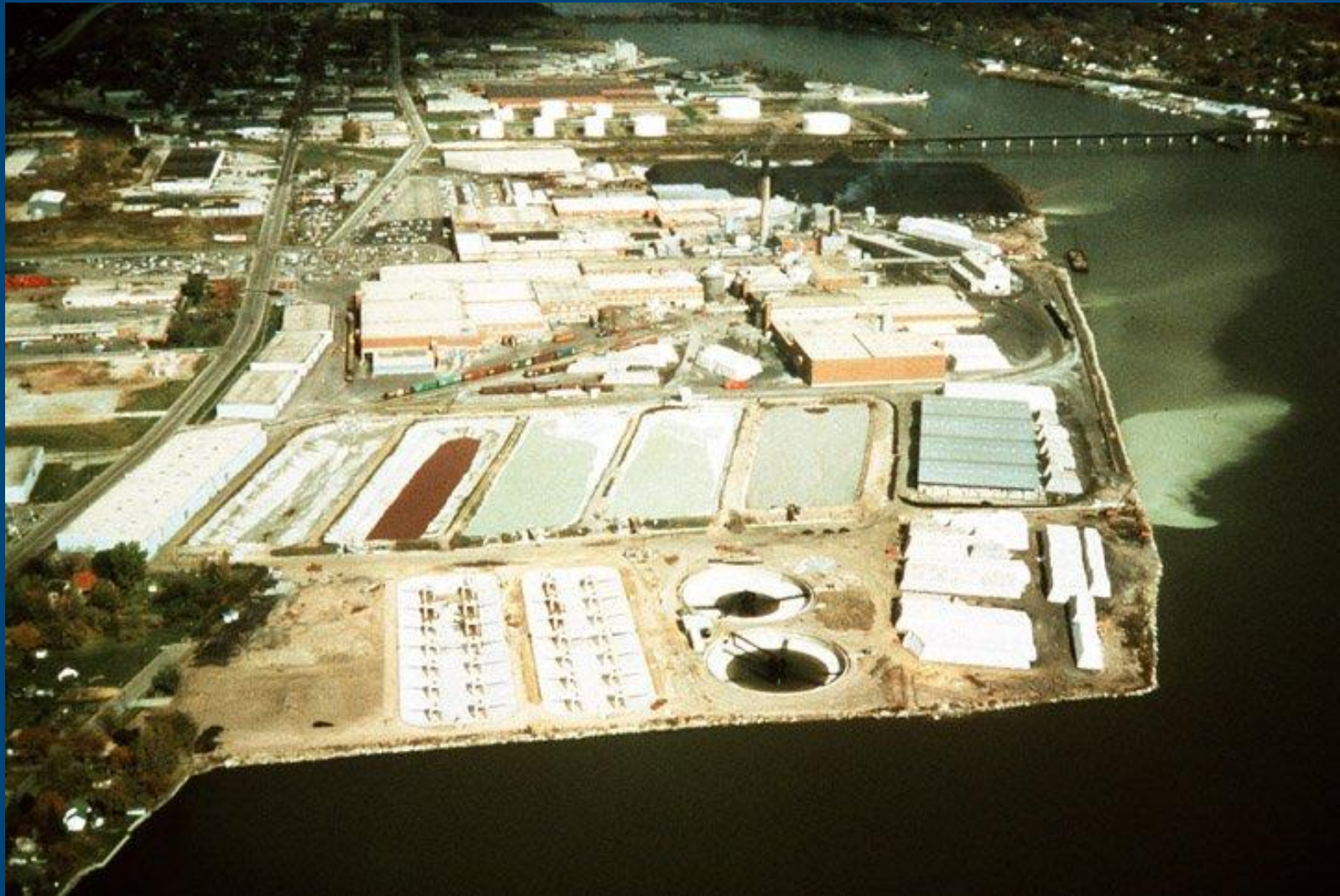
Contaminants Research (cont.)

- 1990s: controversies and answers
 - The double-crested cormorant wars: PCBs the cause of deformities (etc.) or not?
 - The Green Bay Mass Balance Study: is the Fox River the dominant source or not?
 - What's wrong with the lake trout: PCBs or not?



How the NRDA added to and synthesized the injury information

Fox River/Green Bay NRDA Site



Fox River/Green Bay NRDA Site (cont.)



Fox River/Green Bay NRDA Site (cont.)



Fox River/Green Bay NRDA Site (cont.)



Fox River/Green Bay NRDA Site (cont.)



Injury Assessment

Original NRDA studies:

- Game fish pathway (field): confirmation of GBMBS
- Walleye injury (field): injury discovered
- Lake trout injury (lab & field): injury ruled out
- Waterfowl injury (field): consumption advisory triggers confirmed; direct injuries ruled out
- Double-crested cormorant injury (lab & field): mixed results
- Tree swallow injury (field): injury ruled out
- Forster's and common tern injury (lab & field): injury confirmed

Injury Assessment (cont.)

- Synthesis of site-specific information via formal determinations by Authorized Official
 - Pathway [6 rounds of CERCLA 104(e); existing literature; original analysis of FRMBS & GBMBS data]
 - Surface water injury (existing data)
 - Fish consumption advisories (existing data)
 - Fish toxicological injuries (existing and new studies)
 - Avian injuries (existing and new studies; original analysis of PCBs, DDx, and bald eagle reproduction)

Restoration and Compensation Determination Plan (RCDP)

Lower Fox River/Green Bay Natural Resource Damage Assessment

October 25, 2000

Prepared for:

U.S. Fish and Wildlife Service
U.S. Department of the Interior
U.S. Department of Justice
Oneida Tribe of Indians of Wisconsin
Menominee Indian Tribe of Wisconsin
National Oceanic and Atmospheric
Administration
Little Traverse Bay Bands
of Odawa Indians
Michigan Attorney General

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Pathway: Approach

- PCB release history from paper company facilities
- Water circulation and sediment transport patterns
- Spatial and temporal distribution of PCBs in sediment, water, and biota
- Evaluation of PCB congener patterns in sediment
- Application of the Green Bay Mass Balance Study to pathway determination

Pathway: Conclusions

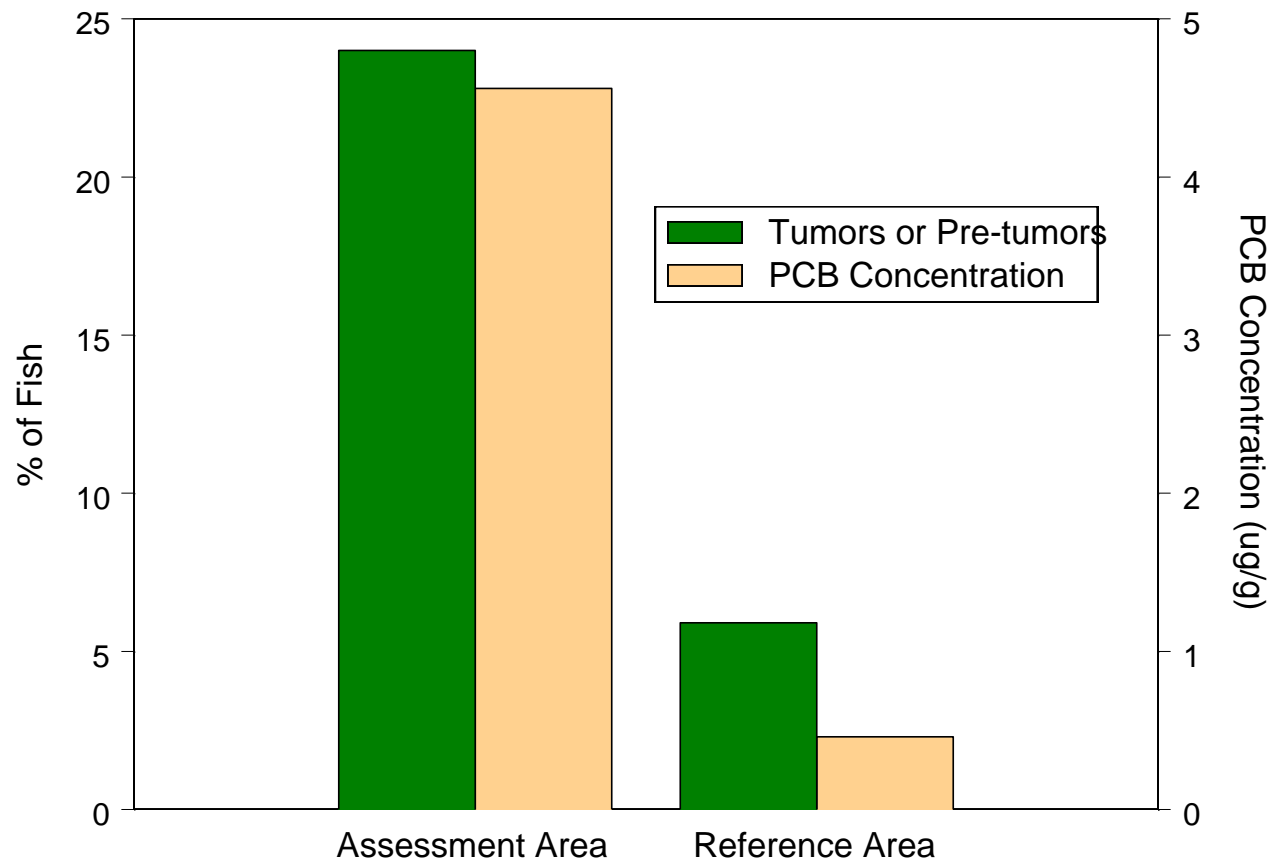
- Fox River dominant source of PCBs to Green Bay
- Surface water is the primary pathway by which PCBs are transported within the system
- Fox River PCBs transported throughout Green Bay
- Green Bay PCBs have declined since 1970s, but remain elevated
- PCBs transported from Green Bay to Lake Michigan



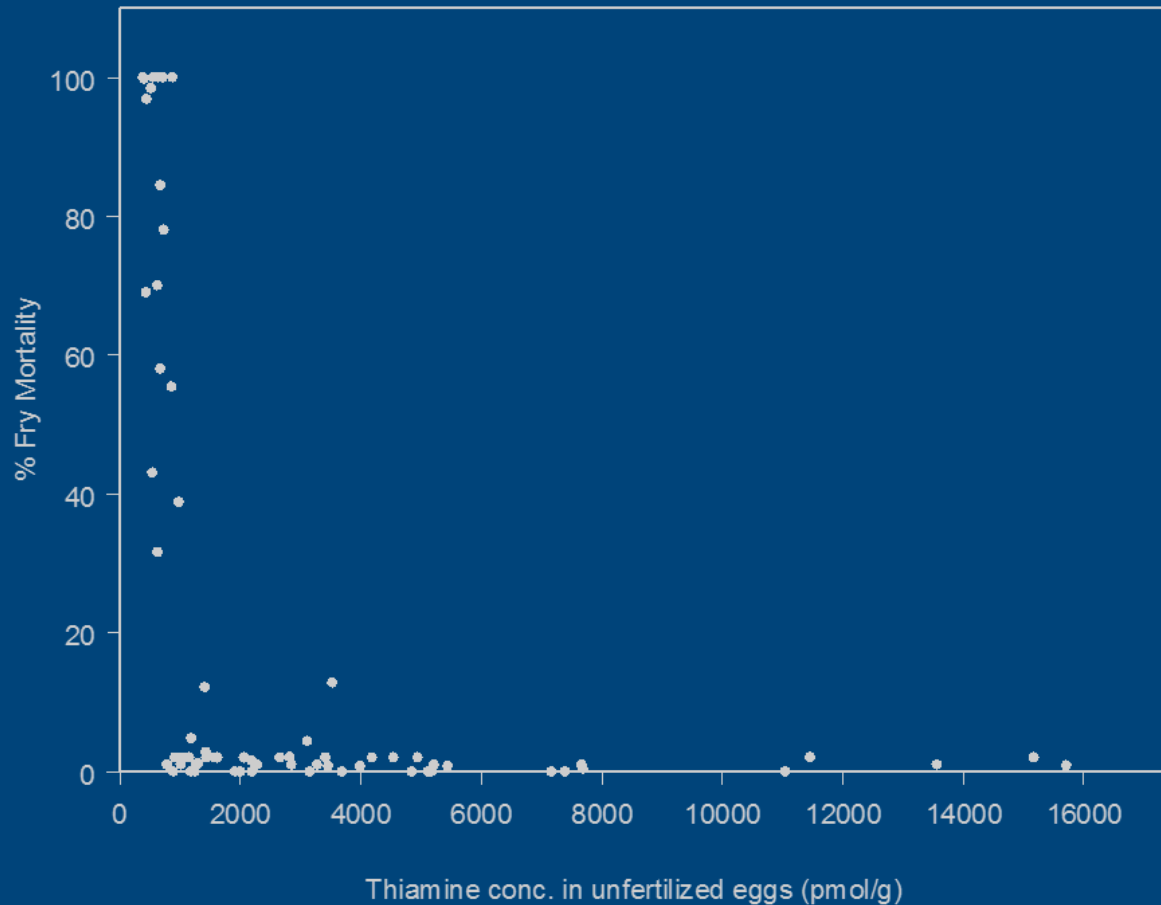
Injury: Surface Water

- Surface water throughout Lower Fox River and Green Bay contaminated with PCBs
- Fish are exposed to PCBs in the surface water
- PCBs in surface water greatly exceed criteria and standards for protection of biota

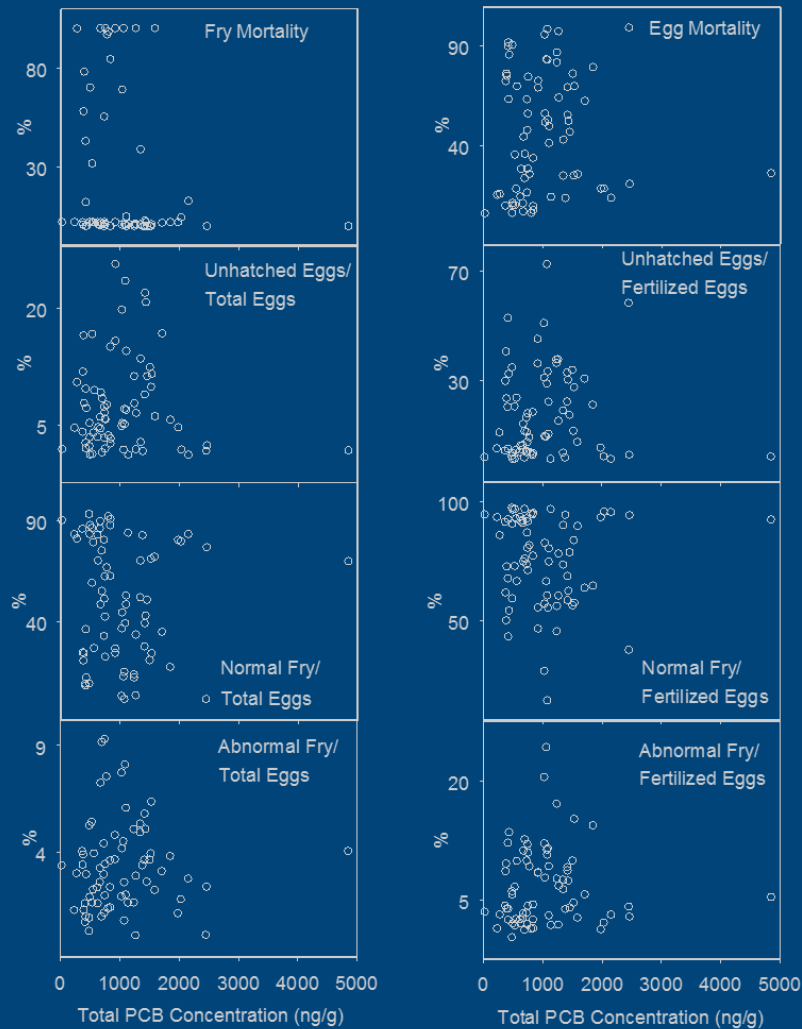
Injury: Walleye (Liver Tumors)



Injury: Lake Trout (Reproduction) Thiamine Deficiency



Injury: Lake Trout (Reproduction) PCBs

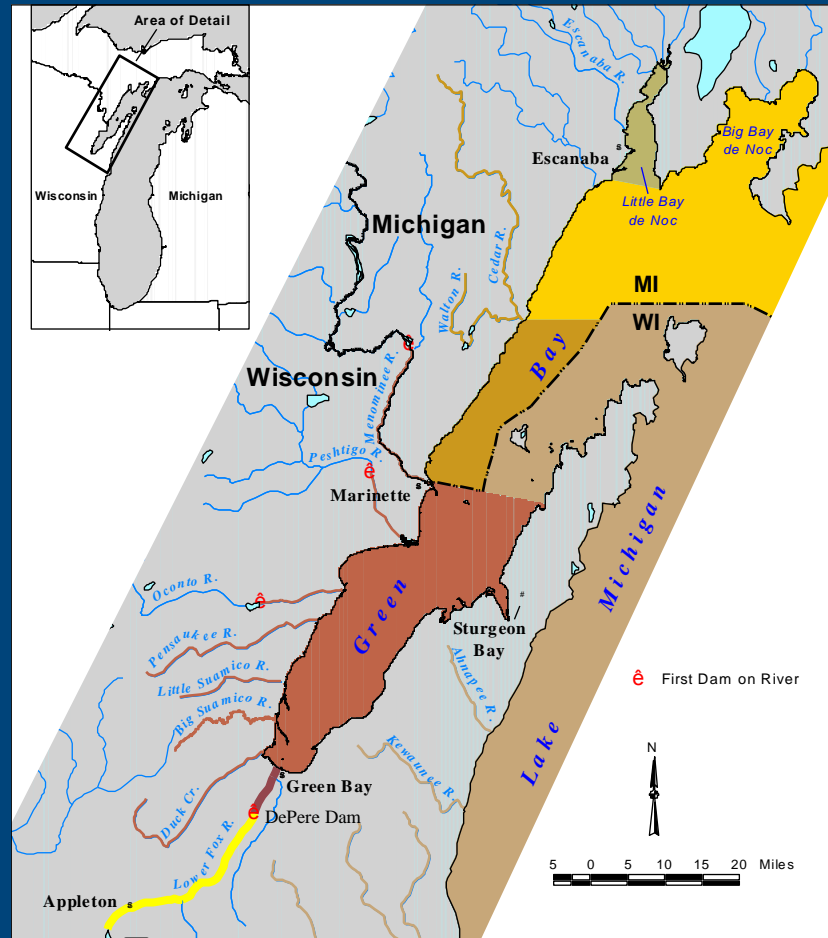




Injury: Fish Species With Advisories

- Black crappie; bluegill; brook trout; brown trout; burbot; carp; channel catfish; chinook salmon; chubs; coho salmon; lake trout; longnose sucker; northern pike; rainbow trout; rock bass; sheepshead; smallmouth bass; smelt; splake; sturgeon; walleye; white bass; whitefish; white perch; white sucker; yellow perch

Injury: Spatial Extent of Advisories

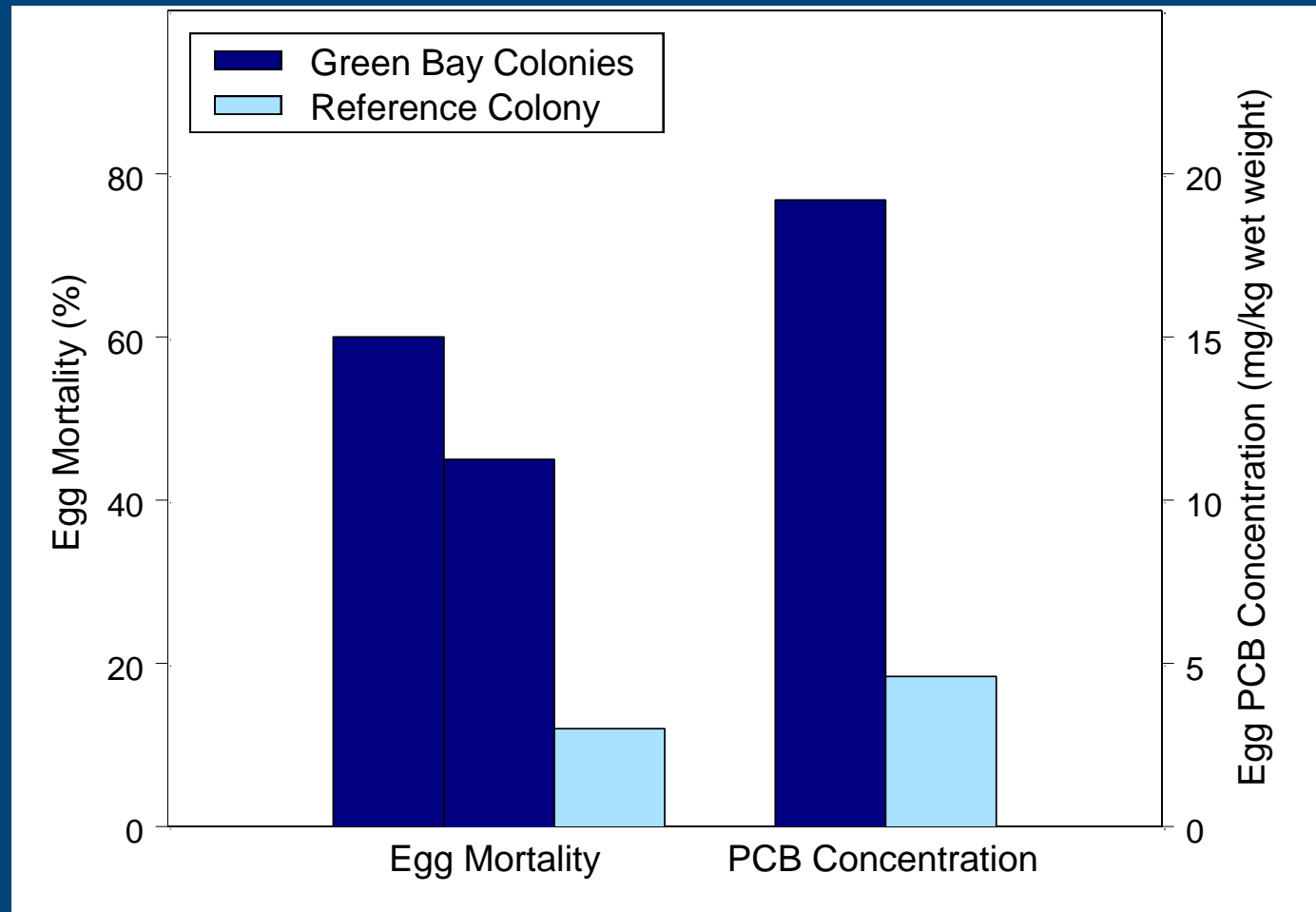


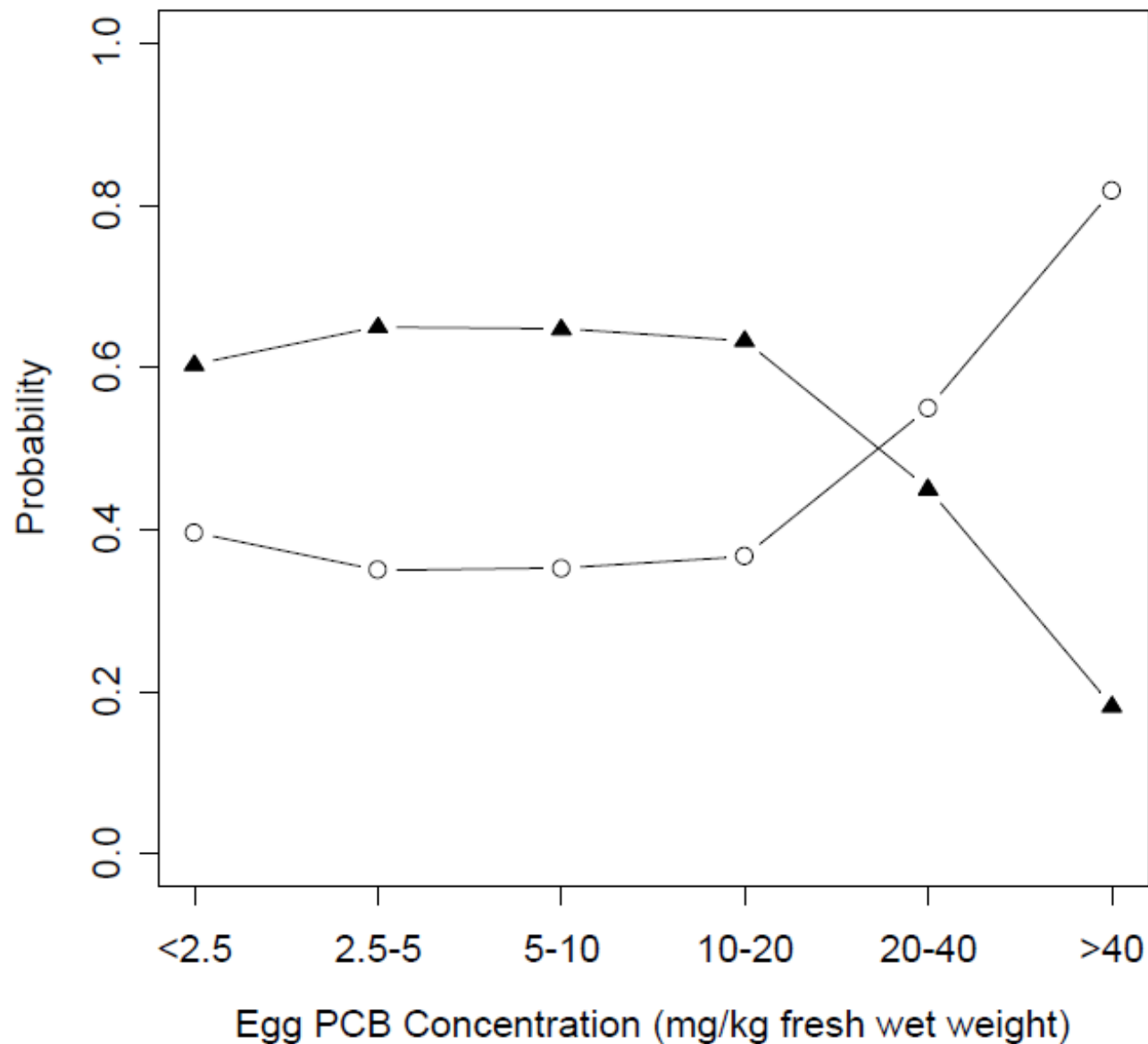


Injuries: Birds

- Waterfowl also have PCB consumption advisories
- Forster's terns, common terns, and bald eagles have decreased reproduction, maybe also double-crested cormorants
- Common terns have increased deformities

Injuries: Forster's Tern (Reproduction)





~fiegprob.ssc

Figure 5-13. Probability of bald eagles in inland Michigan and Wisconsin and Green Bay producing no young (open circles) or one or more young (triangles) in relation to egg PCB concentrations.

Injury: Conclusions

- WQS to protect aquatic life & wildlife greatly exceeded
- Severe fish consumptive advisories
- Waterfowl consumption advisories
- Walleye liver tumors (no obvious population effects)
- About 1/5 of avian species tested showed injuries (reduced reproduction and deformities but without obvious population effects)



Injury: Conclusions (cont.)

- Late trout reproductive failure (including obvious population effects) not linked to PCBs after 1970s
- Dramatic deformities in double-crested cormorants not linked to PCBs

Why No Service-based HEA?



HEA Issues for Green Bay

- All of Green Bay has PCBs and injuries (100+ miles x ~20 miles)
- Green Bay habitats are mostly distinct from both Lake Michigan habitats and inland habitats
- Restoration to improve habitat quality within Green Bay would probably also increase measurable injuries
- Many of the best restoration opportunities are inland



HEA Issues for Green Bay (cont.)

- Injury levels subtle, but over very large areas for very long time
- Needed methods to trade dissimilar resources and habitats between debit and credit
- Needed methods that did not rely on numbers of organisms lost & gained
- Needed methods that did not require ecological conversions from subtle injuries to habitat acreage



HEA Issues for Green Bay

- Needed methods that would prevail against hostile PRPs (and State)
- High stakes with pronounced “grossly disproportionate” issues
- PED
 - ~\$ ¾ billion cost for sediment restoration (cleanup authorities explicitly excluded at beginning)
 - ~\$ ¾ billion for residual compensatory value
- Needed to know relationship of values and costs for realistic restoration options

How the NRDA scaled injury information to restoration

Original Recreational Fishing Study

- Wisconsin and Michigan waters of Green Bay
- Addresses only anglers from nearby counties who currently fish in Green Bay
- Addresses only impacts of FCAs
- Conjoint analysis of original SP data (boat ramp fees, catch rate, FCA level)
- About \$100 million (about 2/3 in past)



All the Rest

- Biological and ecological losses not addressed by recreational fishing study
- General public not included in the recreational fishing study

All the Rest (cont.)

- How much restoration to address:
 - Subtle PCB injuries for decades (past and future) over thousands of square miles
 - PCB cleanup should speed recovery but cannot address most of the PCBs (>\$100 billion to clean up Green Bay)
 - Restoration beyond cleanup should improve environmental quality of the Fox River and Green Bay to compensate for PCB injuries



Restoration

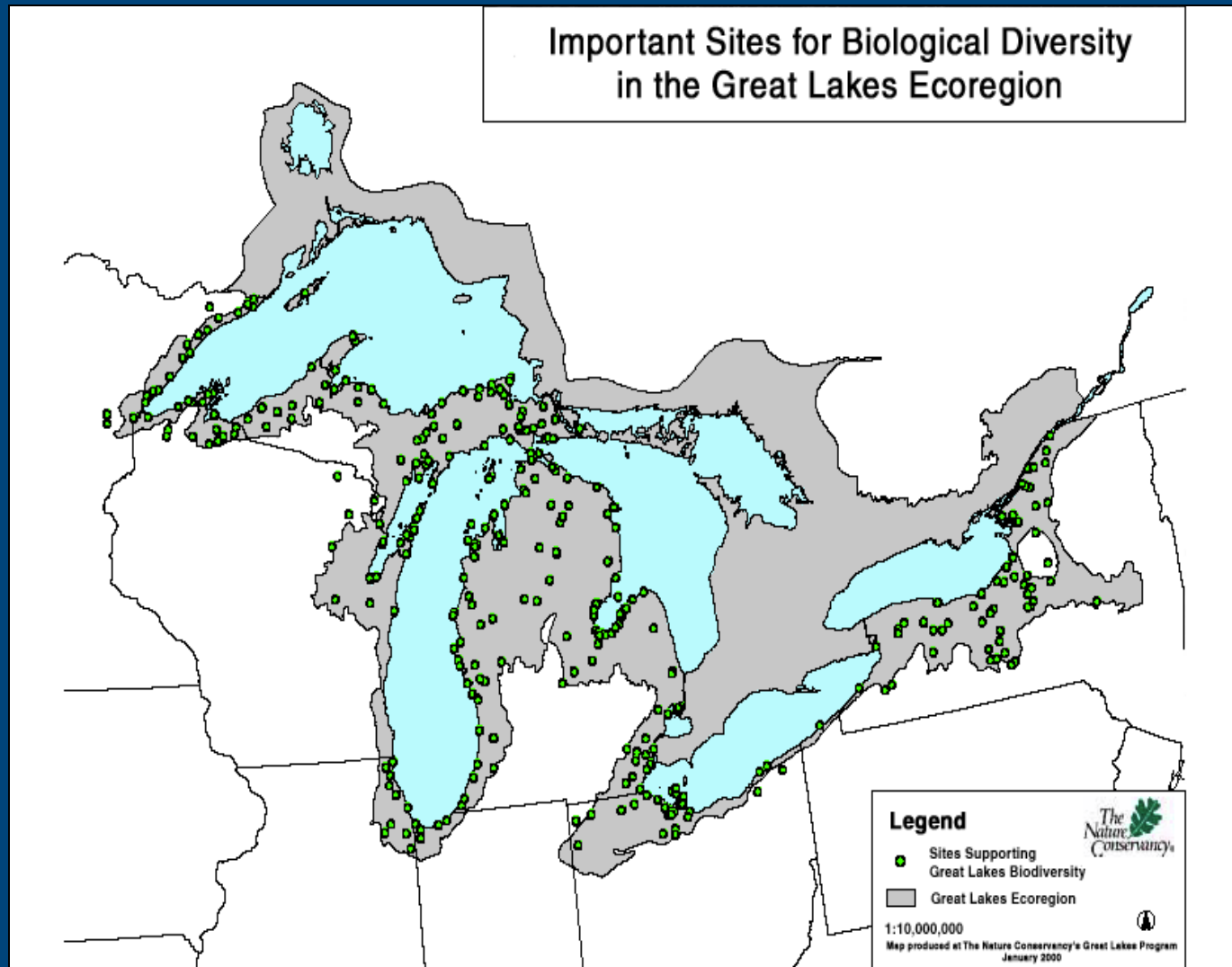
- Formal criteria developed first
- Project selection
 - 621 projects compiled
 - 564 projects after NRDA criteria
 - Categorize and rank
 - Select projects
 - Develop strategy for implementation



Restoration (cont.)

- Preferred alternatives
 - Wetland preservation
 - Wetland restoration
 - Reduce agricultural runoff into Green Bay
 - Stream buffer strips
 - Conservation tillage on cropland
 - Improve recreational opportunities
 - Less important, but part of the mix

Restoration: Preservation





Restoration: Scaling

- How much is enough?
- How should the different project types be combined into an overall approach?
- What are the public's preferences and attitudes?
- How do values compare to costs?

Restoration: Scaling

- “HEA” with the value terms measured
 - Original SP data with conjoint analysis (“total value equivalency”): “VEA?”
 - Value to public gained from environmental quality through restoration is balanced against the value lost from continuing PCB injuries
 - Determines “how much is enough,” with the flexibility to consider different project mixes
 - Empirical measurement of the value terms for different restoration types and injuries, rather than modeled ecological service losses & gains



Restoration: Scaling (cont.)

- Written survey, conducted in 10 counties in Green Bay area
- Conducted using rigorous survey and economic methods
- Designed to quantify how the public balances ongoing PCB injuries against improved environmental quality via restoration

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If you had to choose, would you prefer Alternative A or Alternative B? *Check one box at the bottom.*

| | Alternative A ▼ | Alternative B ▼ |
|---|------------------------------------|-------------------------------------|
| Wetlands Acres | 58,000 acres (current) | 58,000 acres (current) |
| PCBs Years until safe for nearly all fish and wildlife | 100+ years until safe (current) | 40 years until safe (60% faster) |
| Outdoor Recreation Facilities at existing parks | 10% more | 0% more |
| Acres in new parks | 0 acres (current) | 0 acres (current) |
| Runoff Average water clarity in the southern Bay | 34 inches (70% deeper) | 20 inches (current) |
| Excess algae days in lower Bay . | 40 days or less (50% fewer) | 80 days or less (current) |
| Added cost to your household Each year for 10 years | \$50 more | \$50 more |

Check (✓) the box for the
alternative you prefer →



Restoration: Scaling (cont.)

| Action | Mean Importance Ranking |
|---|-------------------------|
| Reduce PCB risks to wildlife | 4.3 |
| Remove PCB consumption advisories | 4.3 |
| Reduce runoff to improve water clarity | 4.0 |
| Increase wetland habitat for wildlife | 3.9 |
| Reduce runoff to reduce algae blooms | 3.8 |
| Improve existing parks | 3.6 |
| Add new parks | 3.3 |
| 1 = not at all important, 5 = very important. | |

Restoration: Scaling (cont.)

- Economic model constructed from survey results
- Various mixes of restoration types can compensate for ongoing PCB injuries
 - Wetland preservation and restoration
 - Nonpoint source runoff control
 - Park improvements
 - Not adding new parks
- Under scenarios of less PCB remediation, more restoration is required

Restoration: Scaling (cont.)

| PCB cleanup scenario | Wetlands | | Increase in bay water clarity from runoff control | Improvement in existing parks |
|--|-----------------|----------------|---|-------------------------------|
| | Acres preserved | Acres restored | | |
| Intensive (injuries gone in 20 years) | 8,700 | 2,900 | +2" | 10% |
| | 6,900 | 2,300 | +6" | 5% |
| Intermediate (injuries gone in 40 years) | 9,900 | 3,300 | +4" | 10% |
| | 8,700 | 2,900 | +8" | 10% |



Restoration: Cost

- Reasonable cost estimates for the preferred restoration alternative
 - Standard cost estimating methods
 - Detailed analysis of land costs
 - Information on distribution of different restoration opportunities in the area
 - Experiences of other agencies/programs doing similar work
 - Modeling of the relationship between restoration, runoff, and water clarity



Restoration: Cost

- Final claim follows selection of PCB remedy
- Final claim includes:
 - Value of past recreational fishing losses
 - Cost of restoration to address future PCB injuries
 - Assessment costs
- Total \$200-\$300 million
 - Depends on cleanup
 - Depends on exact project mix and locations

Gross Disproportionality

| <u>Cost > Value</u> | <u>Cost \cong Value</u> | <u>Cost < Value</u> |
|---------------------------------------|--------------------------------------|-----------------------------------|
| Sediment removal in GB by trustees | Habitat restoration (trustees) | Recreational facilities (PRPs) |
| Cost \$111 <u>b</u> illion | Cost \$111-268 million | Cost \$7 million |
| Value \$610 <u>m</u> illion | Value \$254-610 million | Value \$55 million |



Gross Disproportionality (cont.)

- In theory
 - Trustees could seek \$111 billion to restore sediments of Green Bay (but less authority than cleanup, and cost = 180x value)
 - Popular park could be cheap and valuable (but merry-go-rounds are not NR)
- Therefore: cost-effective, relevant NR restoration, fairly and accurately valued