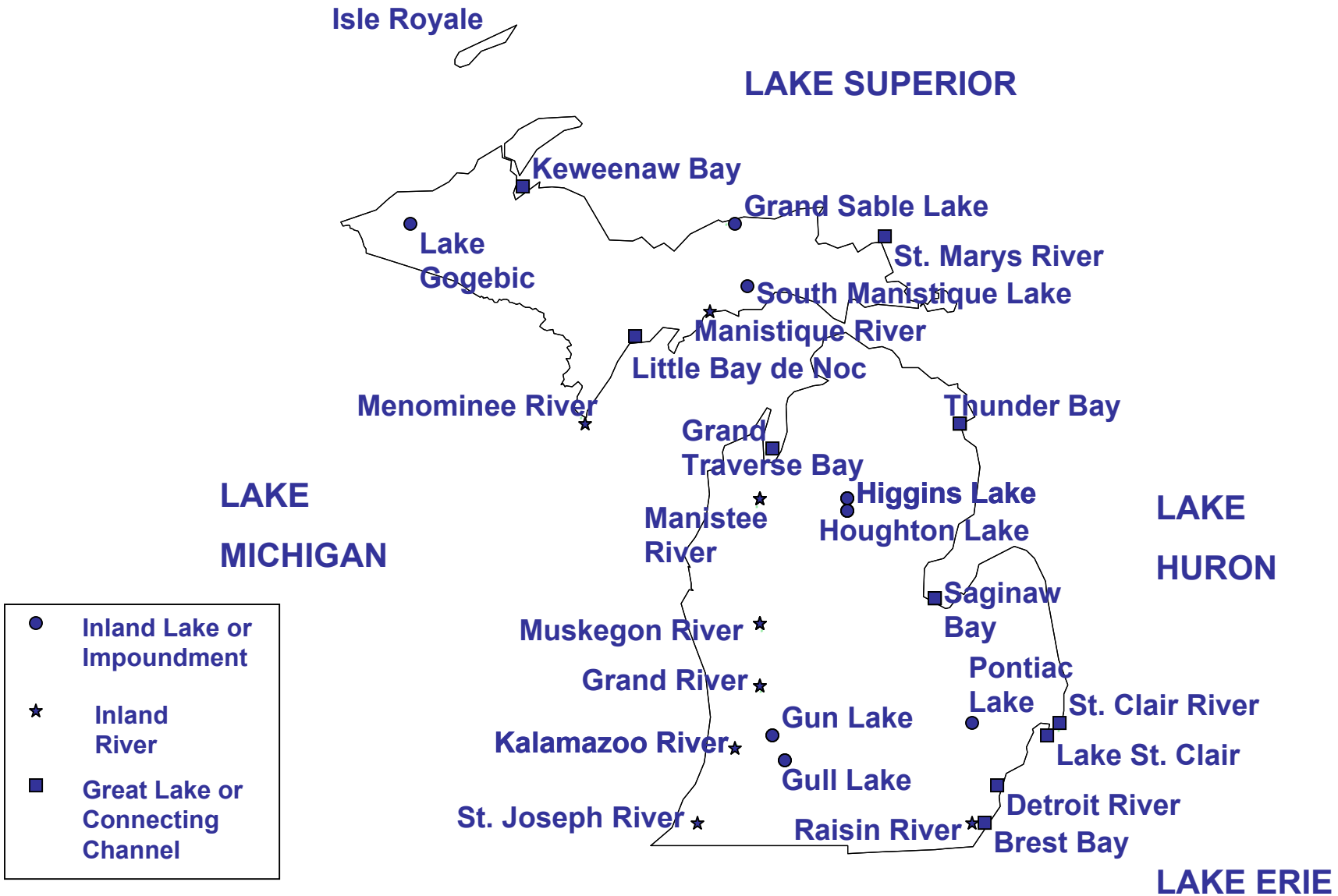
Peer Review of Michigan's Whole Fish Trend Monitoring Program

Gary Kohlhepp, MDEQ-Water Division

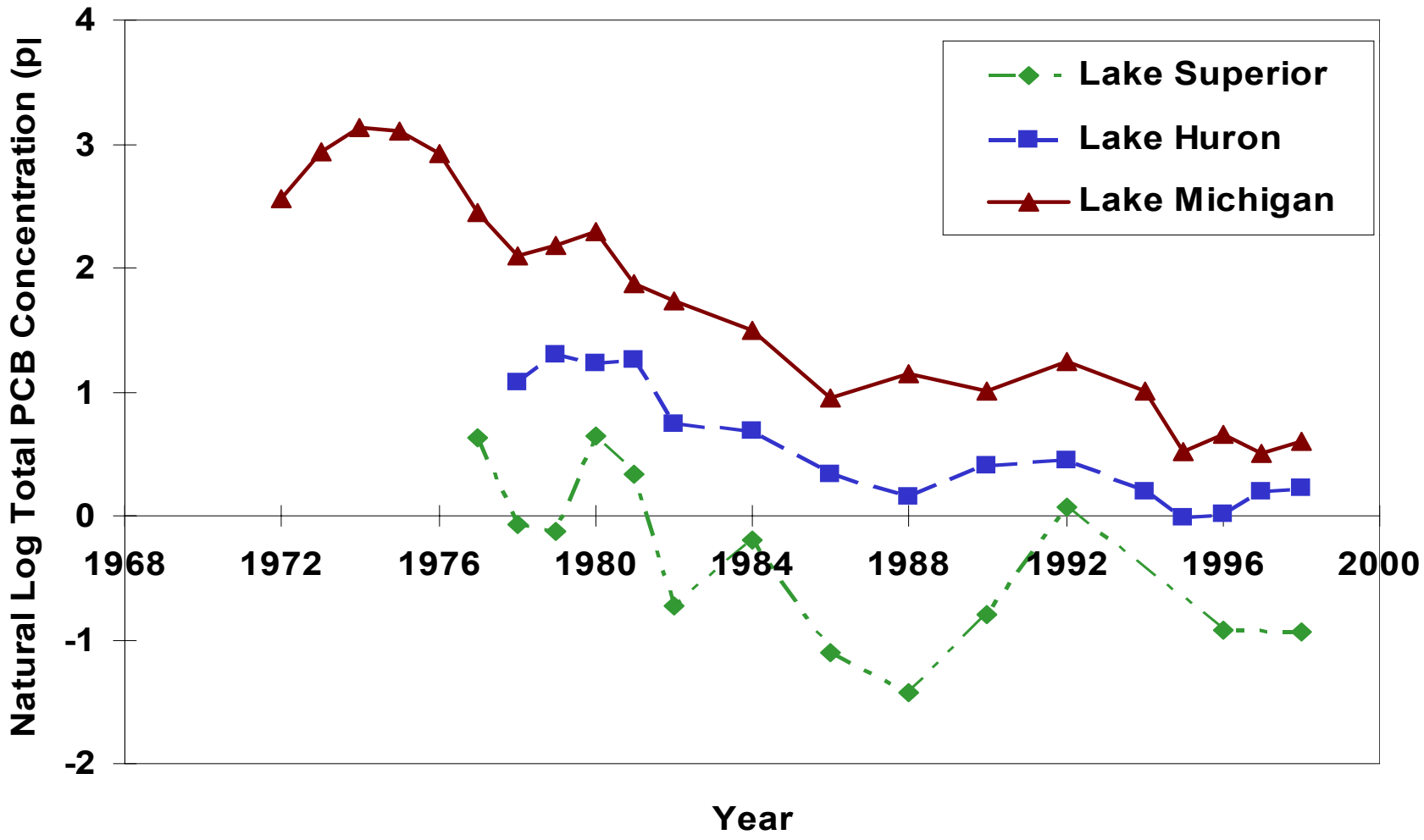
Whole-Fish Trend Monitoring Sites



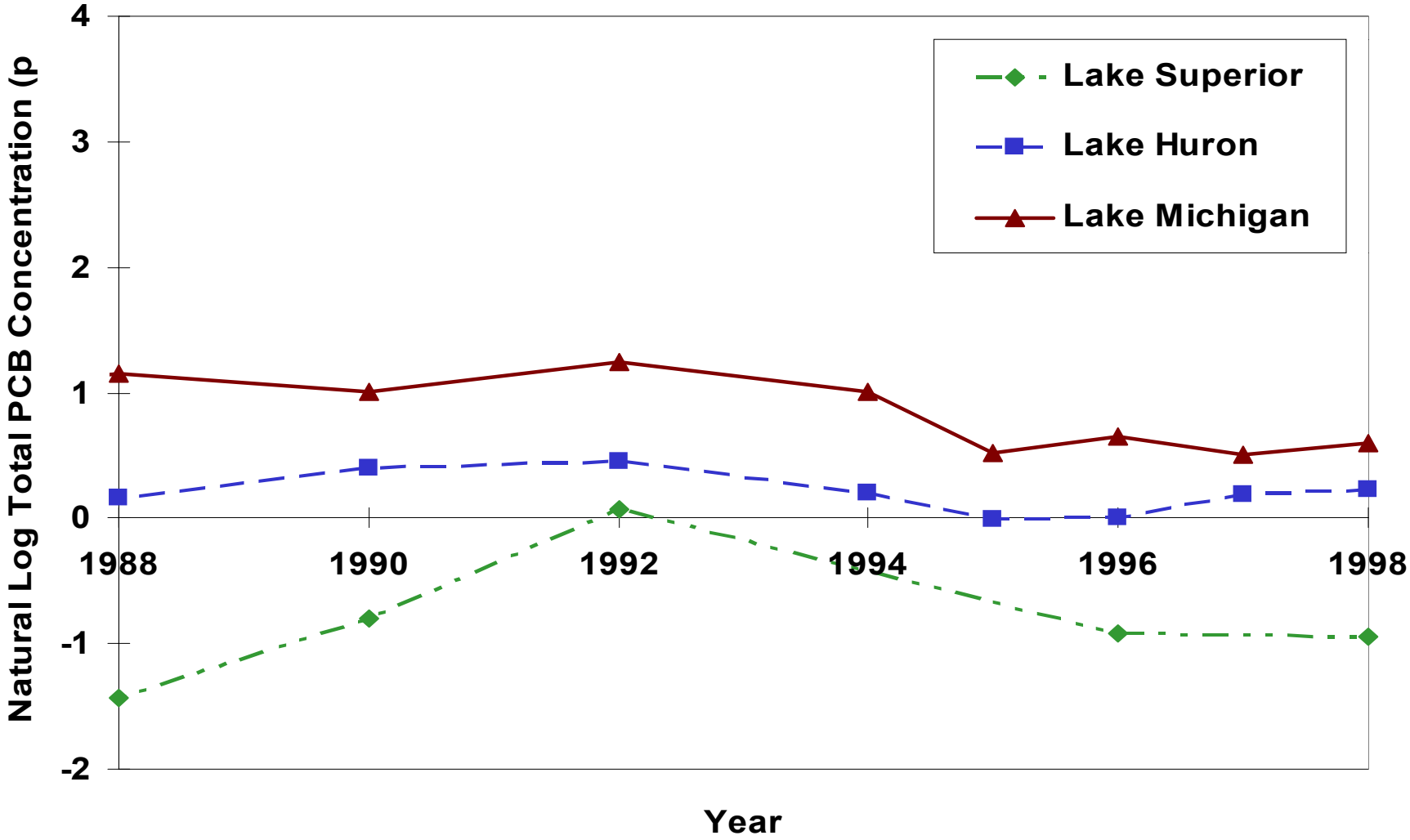
Whole Fish Trends 1990-2000

Contaminant	Total # of Data Sets	Total # of Increasing Trends	Total # of Decreasing Trends	No Trend
Mercury	33	4	5	24
Total PCBs	33	3	2	28
Total Chlordane	33	3	7	23
Total DDT	33	2	4	27
Dioxin TEQ	5	1	0	4

Natural Log of average total PCB concentrations in whole Lake Trout from the Great Lakes, 1970-1998



Natural Log of average total PCB concentrations, 1988-1998



Was the design of MDEQ's trend monitoring program sufficient to detect trends?

- What was the statistical power of the design?
- What improvements could be made to the design to control variability?

Some questions about the original design:

- Unable to estimate age of each fish. How important is age in fish contaminant trend analyses?
- Unable to consistently collect narrow size ranges of fish from each site. Is it better to collect large range of size and control variability with *post hoc* statistical analyses?
- How should fish movement be controlled? Should MDEQ collect young of year fish (YOY) to control fish movement?
- Fish were often collected during different times of the year. Should fish be collected during the same season (e.g. all fish collected in the fall)?

Exponent's review included:

- Literature Review
- Survey
- Data Retrieval
- Peer Review Workshop

Endogenous Factors Affecting Observed Levels of Bioaccumulation & Detection of Trends

- Growth Rates/Growth Efficiency
- Lipid Concentrations
- General Metabolism-Degradation & Absorption of Chemicals
- Age & Size (Length & Weight)
- Gender
- Species
- Tissue Type
- Recent Migratory Behavior

Exogenous Factors Affecting Bioaccumulation & Detection of Trends

- Food Chain Effects-Trophic Level & Prey Concentrations
- Limnological Factors Affecting Mercury Bioaccumulation
- Limnological Factors Affecting Bioaccumulation of Hydrophobic Substances
- Degree of Steady-State with External Loading
- Season of Sampling
- Analytical Precision, Quantification & Extraction Method, Analysts, & Lab Effects
- Sampling Location

Recommendations for Endogenous Factors

Should hydrophobic contaminant concentrations be lipid normalized?

Lipids should not be considered in trends analyses unless lipids change over time. In these cases lipids could be used as a covariate in multiple regression or ANCOVA models.

Recommendations for Endogenous Factors (Cont.)

Should analysts control for age rather than, or in addition to, length/weight?

Age vs. contaminant relationships could be relatively strong in young fish and relatively weak in older fish of some species. However, participants agreed that the MDEQ should collect age information. Also, a range of sizes should be collected and age assessed to provide enough variability to establish effect.

Recommendations for Endogenous Factors (Cont.)

Should gender be considered in sampling or statistical analyses?

Gender should be noted and used in trends analyses, particularly with species that exhibit differential growth rates or behavior between sexes.

Recommendations for Endogenous Factors (Cont.)

Should fish sampling be stratified by size or should size be considered in post hoc statistical analyses?

A large range of sizes should be collected and statistical methods used to account for the influence of size on contaminant concentration.

Recommendations for Endogenous Factors (Cont.)

Can edible-portion samples (with appropriate correction factors) be used to supplement whole fish trend-monitoring data?

MDEQ should not combine tissue types given the variability associated with correction factors. Most believe that it would be better to conduct separate analyses on two different data sets and compare results.

Recommendations for Exogenous Factors

Should a fixed station design be used or should sites be selected randomly?

Some type of randomized design was necessary to obtain a conclusion that could be extrapolated regionally or statewide with known confidence. However, many participants expressed concern that between site variability associated with randomized approaches (primarily in inland waters) overwhelms analysts' ability to detect trends.

Recommendations for Exogenous Factors (Cont.)

Should sampling be stratified by season?

Seasonal variability could be significant and MDEQ should make an effort to control this variability by collecting samples during the same time of year at each site.

Recommendations for Exogenous Factors (Cont.)

Should changes to the food chain be monitored directly or indirectly?

Changes in the food chain over time and space are potentially the most important confounding effects not controlled by current sampling or statistical analyses of trends in Great Lakes fish.

MDEQ should continue to use multi-fish tissue analyses and multi-chemical analyses to identify short term “bumps” or “dips” in long term trends.

Delta nitrogen and delta carbon analyses could be used to identify changes in the food chain. However, changes in delta nitrogen or delta carbon may not explain “bumps” if corresponding diet and forage contaminant data are not available.

Recommendations for Exogenous Factors (Cont.)

Should limnological factors such as pH, temperature, oxygen concentration, and productivity be considered as part of the trend monitoring design and/or post hoc statistics?

Collecting water chemistry data at inland lakes would be useful given that some limnological factors are often closely related to mercury concentrations in fish tissue.

Recommendations for Exogenous Factors (Cont.)

Should YOY fish be monitored to control variability associated with fish movement?

Many participants warned against developing a YOY fish trend monitoring program because of the high inter-year contaminant variability due to factors such as weather, food chain effects, time of collection, and size. While some suggested that YOY monitoring was a useful spatial trend monitoring tool, none of the participants suggest that the DEQ develop a YOY temporal trend program.

Changes to the whole fish trend monitoring program following the peer review:

- Nearly 300 archived spines, scales, or otoliths, from trend samples were located and sent to a contractor for analyses.
- Fish collectors are being asked to collect a large range of sizes at some trend sites.
- Multiple regression is used to evaluate the influence of lipids rather than the ratio method.
- Fish gender is being noted at all sites and will be considered in trends analyses at some sites.

Additional changes still being considered:

- The use of a randomized strategy to select mercury trend sites in inland lakes.
- The use of delta nitrogen and delta carbon to account for changes to the food web
- Collection of water chemistry data at inland lake sites.
- Collection of fish tissue samples during the same season.

Minimum Detectable Trends

- The existing design was sufficient to either detect statistically significant trends or estimate minimum detectable trends of less than +/-5% per year in 70% of the trends analyses conducted.

- The existing design was sufficient to either detect statistically significant trends or estimate minimum detectable trends of less than +/- 10% per year in 96% of the trends analyses conducted.

Contact & Literature Info

- Contact: Bob Day
  - 517-335-3314
  - dayrm@michigan.gov

- Literature:
  - FCMP Review & Recommendation Report
  - Michigan Fish Contaminant Trend Monitoring Strategy; Peer Review Workshop

- To access these documents on-line, follow the outlined path;
  - Start at www.michigan.gov/deq
  - (click) WATER
  - (click) Water Quality Monitoring
  - (click) Assessment of Michigan's Waters
  - Scroll down to Fish Contaminants (click)
  - Scroll down to Related Links