Water Chemistry

Overall Assessment
Trend: Not Assessed/Undetermined
Rationale: Impractical to assess these parameters basin wide. The composition of each lake is unique to that lake.

Lake-by-Lake Assessment
Lake Superior
Specific Conductance
Trend: Increasing
Rationale: Spring lake-wide median values from 1992 through 2008 exhibited a statistically significant ($P<0.05$, $\rho = 0.57$) positive Spearman's Rank Correlation. The median rate of change was 0.10 $\mu mhos \cdot cm^{-1} \cdot yr^{-1}$.

Total Chloride
Trend: No Change
Rationale: Spring lake-wide median values from 1992 through 2008 did not exhibit a statistically significant ($P>0.05$, $\rho = -0.10$) negative Spearman's Rank Correlation.

pH
Trend: No Change
Rationale: Spring lake-wide median values from 1992 through 2008 did not exhibit a statistically significant ($P>0.05$, $\rho = 0.13$) positive Spearman's Rank Correlation.

Total Alkalinity
Trend: No Change
Rationale: Spring lake-wide median values from 1992 through 2008 did not exhibit a statistically significant ($P>0.05$, $\rho = 0.43$) positive Spearman's Rank Correlation.

Turbidity
Trend: Increasing
Rationale:Spring lake-wide median values from 1992 through 2008 exhibited a statistically significant ($P<0.001$, $\rho = 0.76$) positive Spearman's Rank Correlation. The median rate of change was 0.013 $NTU \cdot yr^{-1}$.

Lake Michigan
Specific Conductance
Trend: Increasing
Rationale: Spring lake-wide median values from 1983 through 2008 exhibited a statistically significant ($P<0.0001$, $\rho = 0.85$) positive Spearman's Rank Correlation. The median rate of change was of 0.67 $\mu mhos \cdot cm^{-1} \cdot yr^{-1}$.

Total Chloride
Trend: Increasing
Rationale: Spring lake-wide median values from 1983 through 2008 exhibited a statistically significant ($P<0.0001$, $\rho = 0.99$) positive Spearman's Rank Correlation. The median rate of change was 0.14 $mg\ Cl \cdot yr^{-1}$.

pH
Trend: No Change
Rationale: Spring lake-wide median values from 1983 through 2008 did not exhibit a statistically significant ($P>0.05$, $\rho=0.02$) positive Spearman’s Rank Correlation.

Total Alkalinity
Trend: Decreasing
Rationale: Spring lake-wide median values from 1983 through 2008 exhibited a statistically significant ($P<0.01$, $\rho=-0.46$) negative Spearman’s Rank Correlation. The median rate of change was -0.065 mg $CaCO_3 \cdot yr^{-1}$.

Turbidity
Trend: No Change
Rationale: Spring lake-wide median values from 1983 through 2008 did not exhibit a statistically significant ($P>0.05$, $\rho=-0.27$) negative Spearman’s Rank Correlation.

Lake Huron
Specific Conductance
Trend: Increasing
Rationale: Spring lake-wide median values from 1983 through 2008 exhibited a statistically significant ($P<0.001$, $\rho=0.66$) positive Spearman’s Rank Correlation. The median rate of change was 0.28 $\mu mhos \cdot cm^{-1} \cdot yr^{-1}$.

Total Chloride
Trend: Increasing
Rationale: Spring lake-wide median values from 1983 through 2008 exhibited a statistically significant ($P<0.0001$, $\rho=0.94$) positive Spearman’s Rank Correlation. The median rate of change was 0.064 mg $Cl \cdot yr^{-1}$.

pH
Trend: No Change
Rationale: Spring lake-wide median values from 1983 through 2008 did not exhibit a statistically significant ($P>0.05$, $\rho=0.33$) positive Spearman’s Rank Correlation.

Total Alkalinity
Trend: No Change
Rationale: Spring lake-wide median values from 1983 through 2008 did not exhibit a statistically significant ($P>0.05$, $\rho=-0.05$) negative Spearman’s Rank Correlation.

Turbidity
Trend: Decreasing at a median rate of -0.0088 $NTU \cdot yr^{-1}$.
Rationale: Spring lake-wide median values from 1983 through 2008 exhibited a statistically significant ($P<0.001$, $\rho=-0.67$) negative Spearman’s Rank Correlation. The median rate of change was -0.0088 $NTU \cdot yr^{-1}$.

Lake Erie
Trend: Not Assessed
Rationale: Spring lake-wide median values from 1983 through 2008 are not assessed for Lake Erie as a whole lake, but rather by the three bathymetrically determined basins.

Lake Ontario

Specific Conductance

Trend: Decreasing at a median rate of -0.72 μmhos·cm^{-1}·yr^{-1}.

Rationale: Spring lake-wide median values from 1986 through 2008 exhibited a statistically significant ($P<0.001$, ρ =-0.68) negative Spearman's Rank Correlation. The median rate of change was -0.72 μmhos·cm^{-1}·yr^{-1}.

Total Chloride

Trend: No Change

Rationale: Spring lake-wide median values from 1986 through 2008 did not exhibit a statistically significant ($P>0.05$, ρ =-0.20) negative Spearman's Rank Correlation.

pH

Trend: No Change

Rationale: Spring lake-wide median values from 1986 through 2008 did not exhibit a statistically significant ($P>0.05$, ρ =0.27) positive Spearman's Rank Correlation.

Total Alkalinity

Trend: Decreasing

Rationale: Spring lake-wide median values from 1986 through 2008 exhibited a statistically significant ($P<0.001$, ρ =-0.83) negative Spearman's Rank Correlation. The median rate of change was -0.40 mg $CaCO_3$·yr^{-1}.

Turbidity

Trend: Decreasing

Rationale: Spring lake-wide median values from 1986 through 2008 exhibited a statistically significant ($P<0.05$, ρ =-0.51) negative Spearman's Rank Correlation. The median rate of change was -0.0075 NTU·yr^{-1}.

Other Spatial Scales

Lake Erie Western Basin

Specific Conductance

Trend: No Change

Rationale: Spring basin-wide median values from 1983 through 2008 did not exhibit a statistically significant ($P>0.05$, ρ =0.30) positive Spearman's Rank Correlation.

Total Chloride

Trend: No Change

Rationale: Spring basin-wide median values from 1983 through 2008 did not exhibit a statistically significant ($P>0.05$, ρ =0.33) positive Spearman's Rank Correlation.

pH

Trend: Decreasing at a median rate of -0.0045 pH units ·yr^{-1}.

Rationale: Spring basin-wide median values from 1983 through 2008 exhibited a statistically significant ($P<0.05$, ρ =-0.36) negative Spearman's Rank Correlation. The median rate of change was -0.0045 pH units ·yr^{-1}.

Total Alkalinity

Trend: No Change

Rationale: Spring basin-wide median values from 1983 through 2008 did not exhibit a statistically significant

(P>0.05, ρ =-0.21) negative Spearman's Rank Correlation.

Turbidity
Trend: No Change
Rationale: Spring basin-wide median values from 1983 through 2008 did not exhibit a statistically significant (P>0.05, ρ =0.25) positive Spearman's Rank Correlation.

Lake Erie Central Basin
Specific Conductance
Trend: No Change
Rationale: Spring basin-wide median values from 1983 through 2008 did not exhibit a statistically significant (P>0.05, ρ =0.29) positive Spearman's Rank Correlation.

Total Chloride
Trend: Increasing
Rationale: Spring basin-wide median values from 1983 through 2008 exhibited a statistically significant (P<0.0001, ρ =0.72) positive Spearman's Rank Correlation. The median rate of change was of 0.095 mg $Cl \cdot yr^{-1}$.

pH
Trend: No Change
Rationale: Spring basin-wide median values from 1983 through 2008 did not exhibit a statistically significant (P>0.05, ρ =0.24) positive Spearman's Rank Correlation.

Total Alkalinity
Trend: Decreasing
Rationale: Spring basin-wide median values from 1983 through 2008 exhibited a statistically significant (P<0.05, ρ =-0.51) negative Spearman's Rank Correlation. The median rate of change was -0.12 mg $CaCO_3 \cdot yr^{-1}$.

Turbidity
Trend: Increasing
Rationale: Spring basin-wide median values from 1983 through 2008 exhibited a statistically significant (P<0.01, ρ =0.52) positive Spearman's Rank Correlation. The median rate of change was 0.072 $NTU \cdot yr^{-1}$.

Lake Erie Eastern Basin
Specific Conductance
Trend: No Change
Rationale: Spring basin-wide median values from 1983 through 2008 did not exhibit a statistically significant (P>0.05, ρ =0.04) positive Spearman's Rank Correlation.

Total Chloride
Trend: Increasing
Rationale: Spring basin-wide median values from 1983 through 2008 exhibited a statistically significant (P<0.0001, ρ =0.71) positive Spearman's Rank Correlation. The median rate of change was 0.12 mg $Cl \cdot yr^{-1}$.

pH
Trend: Increasing

Rationale: Spring basin-wide median values from 1983 through 2008 exhibited a statistically significant ($P<0.05$, ρ =0.48) positive Spearman's Rank Correlation. The median rate of change was 0.005 pH units $\cdot yr^{-1}$.

Total Alkalinity
Trend: Decreasing
Rationale: Spring basin-wide median values from 1983 through 2008 exhibited a statistically significant ($P<0.01$, ρ =-0.54) negative Spearman's Rank Correlation. The median rate of change was -0.24 mg $CaCO_3 \cdot yr^{-1}$.

Turbidity
Trend: Decreasing
Rationale: Spring basin-wide median values from 1983 through 2008 exhibited a statistically significant ($P<0.001$, ρ =-0.62) negative Spearman's Rank Correlation. The median rate of change was 0.072 NTU$\cdot yr^{-1}$.

Purpose

- Monitor the water quality of the Great Lakes
- To assess water quality in the Great Lakes
- To support the evaluation of long term trends and changes in the water quality of the Great Lakes

Ecosystem Objective

The ecosystem objective is to monitor changes in the water quality of the Great Lakes.

Ecological Condition

Measure

To assess the long-term trends in water quality in the open waters of the Great Lakes, offshore Spring sampling stations are averaged over the entire depth of the water column.

Status

The water quality in the Great Lakes is monitored by the Canadian and United States federal governments. Both Environment Canada (EC) and the United States Environmental Protection Agency (USEPA) Great Lakes National Program Office (GLNPO) conduct ship-based cruises to collect water quality samples on the lakes. Methods for EC's Great Lakes Surveillance Program are described in Dove et al. (2009). Sampling and analytical procedures for GLNPO's Open Lake Water Quality Surveys is provided in GLNPO (2010). Briefly, EC conducts monitoring in each of the Great Lakes except Lake Michigan, which is located entirely within the United States. Each lake is generally monitored every second year, with several cruises conducted during that year. All regions (nearshore, offshore, and major embayments) are monitored for the EC program. USEPA conducts one spring and one summer cruise on all waters except Georgian Bay, with stations located more along the central axis of each lake. Here, we provide an update with respect to long-term trends in specific conductance, total chloride, pH, alkalinity and turbidity in each of the Great Lakes.

For the purpose of presenting long-term trends in this report only GLNPO data set were analyzed. The data are restricted to spring sampling periods at offshore locations when and where the water column is well mixed, with the exception of Lake Erie, which is relatively shallow and is therefore divided instead into three basins. The period analyzed for long-term trends was from 1983 through 2008 for Lake Michigan, Lake Huron and Lake Erie. Lake Ontario was monitored from 1986 through 2008 and Lake Superior began in 1992. The analyte values are averaged for each offshore location over the entire water column. The annual lake-wide and basin-wide median values were determined by calculating the median value of the station averages for each lake and basin over the period monitored.

The presentation of data is on a lake-by-lake basis, except Lake Erie, which is divided into three basins. The statistical analyses used to determine long-term trends in the data are, for the most part, non-parametric, or distribution-free statistical methods used to avoid transformations of the data, which would vary among lakes and parameters.

There are two non-parametric methods used to determine the existence, magnitude and significance of trends in the data by lake and by parameter. These are Spearman Rank Correlation (Siegel 1956) and the Sen (or Thiel-Sen) regression estimator (Sen 1968).

The ordering and ranking of the values allows the Spearman rank correlation coefficient to be equivalent to the Pearson product moment coefficient (Sen, 1968). It is not sensitive to the distribution of the data, or to very high or low values that bias the parametric alternative. The strength of the Spearman rank correlation determines the reported statistical significance of all long-term trends. The calculation of the Spearman rank correlation coefficients used the annual lake-wide and basin-wide medians to minimize Type I errors.

The Sen Regression estimator calculates the slopes of regression lines, where significant correlations exist. The Sen technique determines the median rate of change (slope) by choosing m to be the median among the n(n-1)/2 slopes of lines determined by pairs of data points. By using the Sen regression estimator (m) along with the median y (analyte) and x (year) values to determine b (y-intercept) the Kendall-Theil Robust Line (KTRLine) is determined (USGS, 2006). All slopes or rates of change reported in this report are Sen Slopes.

The results of offshore water quality values are shown in Figures 1-5 for the upper Great Lakes (lakes Superior, Huron and Michigan) and Figures 6-10 for the lower Great Lakes (lakes Erie and Ontario). The Graphical data presentation of the station averages are in the form of box plots. The box plots (also called box-and-whisker plots) are an easy way to summarize data and to assess and compare sample distributions. The top of the box is the third quartile (Q3), where 75% of the data values are less than or equal to this value. The line inside the box is the median (half of the observations are less than or equal to the median). The bottom of the box is the first quartile (Q1), where 25% of the data values are less than or equal to this value. The upper whisker extends to the highest data value within the upper limit, defined as Q3 + 1.5 (Q3–Q1). Similarly, the lower whisker extends to the lower limit of Q1 – 1.5 (Q3–Q1). Values that appear as asterisks on the plots are outside the upper or lower limits and considered outliers. The plotting of the KTRLine in the box plots occurs when a statistically significant correlation exists.

Lake Superior

The specific conductance in the open waters of Lake Superior has increased significantly ($P<0.05$, ρ =0.57) at a rate of 0.10 μmhos$\cdot$cm$^{-1}\cdot$yr^{-1}. The lowest lake-wide median of 97 μmhos$\cdot$cm^{-1} occurred in 1992 with the highest lake-wide median of 100 μmhos$\cdot$cm^{-1} occurred in 2002. However, a review of the quality assurance data for specific conductance indicates that the trend may be a result of systematic instrument error (LIMNO). The turbidity has increased significantly ($P<0.001$, ρ =0.76) at a rate of 0.013 FTU$\cdot$yr^{-1}. Turbidity values decreased from 1992 to 1996 followed by increases from 1997 to 2008 with minor inter-annual fluctuations. There were no significant trends in the total chloride, pH and alkalinity in the open waters of Lake Superior. The average annual lake-wide median chloride concentration, pH and alkalinity were 1.3 mg Cl$\cdot$L^{-1}, 7.81 and 41.6 mg $CaCO_3\cdot L^{-1}$ respectively.

Lake Michigan

The specific conductance in the open waters of Lake Michigan has increased significantly ($P<0.0001$, ρ =0.85) at a rate of 0.67 μmhos$\cdot$cm$^{-1}\cdot$yr^{-1}. The lowest lake-wide median of 279 μmhos$\cdot$cm^{-1} occurred in 1983 with the highest lake-wide median of 296 μmhos$\cdot$cm^{-1} occurred in 2004. Specific conductance values increased consistently from 1983 to 2004 followed by a decrease from 2005 through 2008 with an increase overall. Total chloride has increased

($P<0.0001$, ρ =0.99) at a rate of 0.14 mg $Cl \cdot L^{-1} \cdot yr^{-1}$. The lowest lake-wide median of 8.7 mg $Cl \cdot L^{-1}$ occurred in 1983 with the highest lake-wide median of 11.8 mg $Cl \cdot L^{-1}$ occurred in 2007. Chloride concentrations were stable from 1983 to 1987 followed by a steady increase from 1998 to 2008. Total Alkalinity has decreased significantly ($P<0.01$, ρ =-0.46) at a rate of -0.065 mg $CaCO_3 \cdot L^{-1} \cdot yr^{-1}$. The lowest lake-wide median of 105 mg $CaCO_3 \cdot L^{-1}$ occurred in 1999 with the highest lake-wide median of 112 mg $Cl \cdot L^{-1}$ occurred in 1989. Alkalinity values fluctuated inter-annually over 2-3 year periods of increases and decreases with an overall decrease. There were no significant trends in the pH and turbidity in the open waters of Lake Michigan. The average annual lake-wide median pH and total alkalinity were 8.01 and 77.9 mg $CaCO_3 \cdot L^{-1}$ respectively.

Lake Huron

The specific conductance in the open waters of Lake Huron has increased significantly ($P<0.001$, ρ =0.66) at a rate of 0.28 $\mu mhos \cdot cm^{-1} \cdot yr^{-1}$. The lowest lake-wide median of 203 $\mu mhos \cdot cm^{-1}$ occurred in 1985 with the highest lake-wide median of 213 $\mu mhos \cdot cm^{-1}$ occurred in 2002. Specific conductance values increased from 1985 to 1993 and 1998 to 2002 followed by decreases from 1998 to 2002 and inter-annual fluctuations through 2008. Total chloride has increased ($P<0.0001$, ρ =0.94) at a rate of 0.064 mg $Cl \cdot L^{-1} \cdot yr^{-1}$. The lowest lake-wide median of 5.4 mg $Cl \cdot L^{-1}$ occurred in 1985 with the highest lake-wide median of 7.0 mg $Cl \cdot L^{-1}$ occurred in 2007. Chloride concentrations, unlike specific conductance, continually increased from 1988 to 2008. Turbidity has decreased significantly ($P<0.001$, ρ =-0.67) at a rate of -0.0088 $FTU \cdot yr^{-1}$. The lowest lake-wide median of 0.25 FTU occurred in 2005 with the highest lake-wide median of 0.62 FTU occurred in 1983. Turbidity values decreased overall with inter-annual fluctuations over 3-5 year periods from 1983 to 2005. After 2005, the turbidity values were relatively stable and low. There were no significant trends in the pH and total alkalinity in the open waters of Lake Huron. The average annual lake-wide median pH and turbidity were 8.12 and 0.4 FTU respectively.

Lake Ontario

The specific conductance in the open waters of Lake Ontario has decreased significantly ($P<0.001$, ρ =-0.68) at a rate of -0.72 $\mu mhos \cdot cm^{-1} \cdot yr^{-1}$. The lowest lake-wide median of 297 $\mu mhos \cdot cm^{-1}$ occurred in 2003 with the highest lake-wide median of 320 $\mu mhos \cdot cm^{-1}$ occurred in 1986. Specific conductance declined from 1986 to 1999, followed by increases from 1999 to 2005 and reached a plateau with an average of 308 $\mu mhos \cdot cm^{-1}$ for the remainder of the monitored period. Total alkalinity has decreased ($P<0.0001$, ρ =-0.83) at a rate of -0.40 mg $CaCO_3 \cdot L^{-1} \cdot yr^{-1}$. The lowest lake-wide median of 88.2 mg $CaCO_3 \cdot L^{-1}$ occurred in 2003 with the highest lake-wide median of 97.0 mg $CaCO_3 \cdot L^{-1}$ occurred in 1990. Total alkalinity values were stable from 1986 to 1990 followed by a steady decline through 2002. From 2003 through 2007, the alkalinity increased followed by a decline in the median value in 2008. Turbidity has decreased significantly ($P<0.05$, ρ =-0.51) at a rate of -0.0075 $FTU \cdot yr^{-1}$. The lowest lake-wide median of 0.09 FTU occurred in 2002 with the highest lake-wide median of 0.55 FTU occurred in 1990. Turbidity values increased from 1986 to 1990 followed by a decrease from 1990 to 1999. Turbidity increased in 2000 and 2001 followed by a stabilized period from 2003 to 2008 with a median of 0.25 FTU. There were no significant trends in the total chloride and pH in the open waters of Lake Ontario. The average annual lake-wide median total chloride and pH were 22 mg $Cl \cdot L^{-1}$ and 8.06 respectively.

Western Basin Lake Erie

The pH in the western basin of Lake Erie has decreased significantly ($P<0.05$, ρ =-0.36) at a rate of -0.005 pH $units \cdot yr^{-1}$. The lowest lake-wide median of 7.75 occurred in 2007 with the highest lake-wide median of 8.25 occurred in 1986. Annual pH values fluctuated from year to year with an overall decrease. There were no significant trends in the specific conductance, total chloride, alkalinity and turbidity in the western basin of Lake Erie. The average annual lake-wide median specific conductance, total chloride, total alkalinity and turbidity were 260 $\mu mhos \cdot cm^{-1}$, 14.2 mg $Cl \cdot L^{-1}$, 86.6 mg $CaCO_3 \cdot L^{-1}$ and 9.74 FTU respectively.

Central Basin Lake Erie

The total chloride in the central basin of Lake Erie has increased significantly ($P<0.0001$, $\rho=0.72$) at a rate of 0.095 mg $Cl \cdot L^{-1} \cdot yr^{-1}$. The lowest lake-wide median of 14.1 mg $Cl \cdot L^{-1}$ occurred in 1988 with the highest lake-wide median of 17.9 mg $Cl \cdot L^{-1}$ occurred in 2006. Chloride concentrations decreased from 1983 to 1988 followed by a plateau from 1989 to 1998 after which values increased from 1997 through 2006. Total alkalinity has decreased significantly ($P<0.01$, $\rho=-0.51$) at a rate of -0.12 mg $CaCO_3 \cdot L^{-1} \cdot yr^{-1}$. The lowest lake-wide median of 85.7 mg $CaCO_3 \cdot L^{-1}$ occurred in 1998 with the highest lake-wide median of 96.3 mg $CaCO_3 \cdot L^{-1}$ occurred in 1986. There were two distinct periods of change in the alkalinity. The first was a period of decline from 1985 to 1996. The second was an increasing period from 1996 to 2008 with the last four years stabilizing at 91.2 mg $CaCO_3 \cdot L^{-1}$. The overall trend analysis masks the later increasing period occurring from 1996 to 2004. Turbidity has increased significantly ($P<0.01$, $\rho=0.52$) at a rate of 0.072 $FTU \cdot yr^{-1}$. The lowest lake-wide median of 0.78 FTU occurred in 1986 with the highest lake-wide median of 7.82 FTU occurred in 2002. There were no observable patterns in the data; the turbidity of the central basin fluctuated from year to year with the highest annual variability observed in 2002, 2003 and 2007. There were no significant trends in the specific conductance and pH in the central basin of Lake Erie. The average annual lake-wide median specific conductance and pH were 276 $\mu mhos \cdot cm^{-1}$ and 2.08 FTU respectively.

Eastern Basin Lake Erie

The total chloride in the eastern basin of Lake Erie has increased significantly ($P<0.0001$, $\rho=0.71$) at a rate of 0.12 mg $Cl \cdot L^{-1} \cdot yr^{-1}$. The lowest lake-wide median of 14.5 mg $Cl \cdot L^{-1}$ occurred in 1988 with the highest lake-wide median of 18.4 mg $Cl \cdot L^{-1}$ occurred in 2006. Chloride concentrations were stable form 1984 to 1996. Concentrations steadily increased from 1996 to 2007, and then decreased in 2008. The pH has increased significantly ($P<0.05$, $\rho=0.48$) at a rate of 0.005 pH $units \cdot yr^{-1}$. The lowest lake-wide median of 7.91 occurred in 1988 with the highest lake-wide median of 8.35 occurred in 2000. The pH fluctuated over a 3-5 year cycle of increasing and decreasing values form 1983 to 2002. After 2002, pH values remained stable with minimal inter-annual variations. Total alkalinity has decreased significantly ($P<0.01$, $\rho=-0.54$) at a rate of -0.24 mg $CaCO_3 \cdot L^{-1} \cdot yr^{-1}$. The lowest lake-wide median of 85.3 mg $CaCO_3 \cdot L^{-1}$ occurred in 1996 with the highest lake-wide median of 97.0 mg $CaCO_3 \cdot L^{-1}$ occurred in 1983 Alkalinity values were stable from 1983 to 1990, after which the values declined until 1996. Values gradually increased until 2003, after which values remained relatively stable through 2008. Turbidity has decreased significantly ($P<0.001$, $\rho=-0.62$) at a rate of -0.074 $FTU \cdot yr^{-1}$. The lowest lake-wide median of 0.20 FTU occurred in 2000 with the highest lake-wide median of 3.29 FTU occurred in 1984. Turbidity steadily declined from 1983 to 2000 and exhibited inter-annual variability. After 2000, turbidity values increased slightly and remained stable through 20008, with 2007 exhibiting the greatest annual variation in values. There were no significant trends in the specific conductance in the eastern basin of Lake Erie. The average annual lake-wide median specific conductance was 279 $\mu mhos \cdot cm^{-1}$.

Assessing Data Quality

Insert "x" under the statement that best corresponds with each data characteristic

Data Characteristics	Strongly Agree	Agree	Neutral or Unknown	Disagree	Strongly Disagree	Not Applicable
1. Data are documented, validated, or quality-assured by a recognized agency or organization	X					
2. Data are traceable to original sources	X					
3. The source of the data is a known, reliable and respected generator of data	X					

4. Geographic coverage and scale of data are appropriate to the Great Lakes basin		X				
5. Data obtained from sources within the U.S. are comparable to those from Canada			X			
6. Uncertainty and variability in the data are documented and within acceptable limits for this indicator report	X					
Clarifying Notes: Only USEPA GLNPO Spring Water Quality Survey Data Was used in determining these trends.						

Acknowledgments

Authors: Eric Osantowski, Chemist, Great Lakes National Program Office, USEPA.

Information Sources

United States data from Great Lakes National Program Office, United States Environmental Protection Agency, Chicago, Illinois.

List of Figures

Last Updated

State of the Lakes Ecosystem Conference (SOLEC) 2011

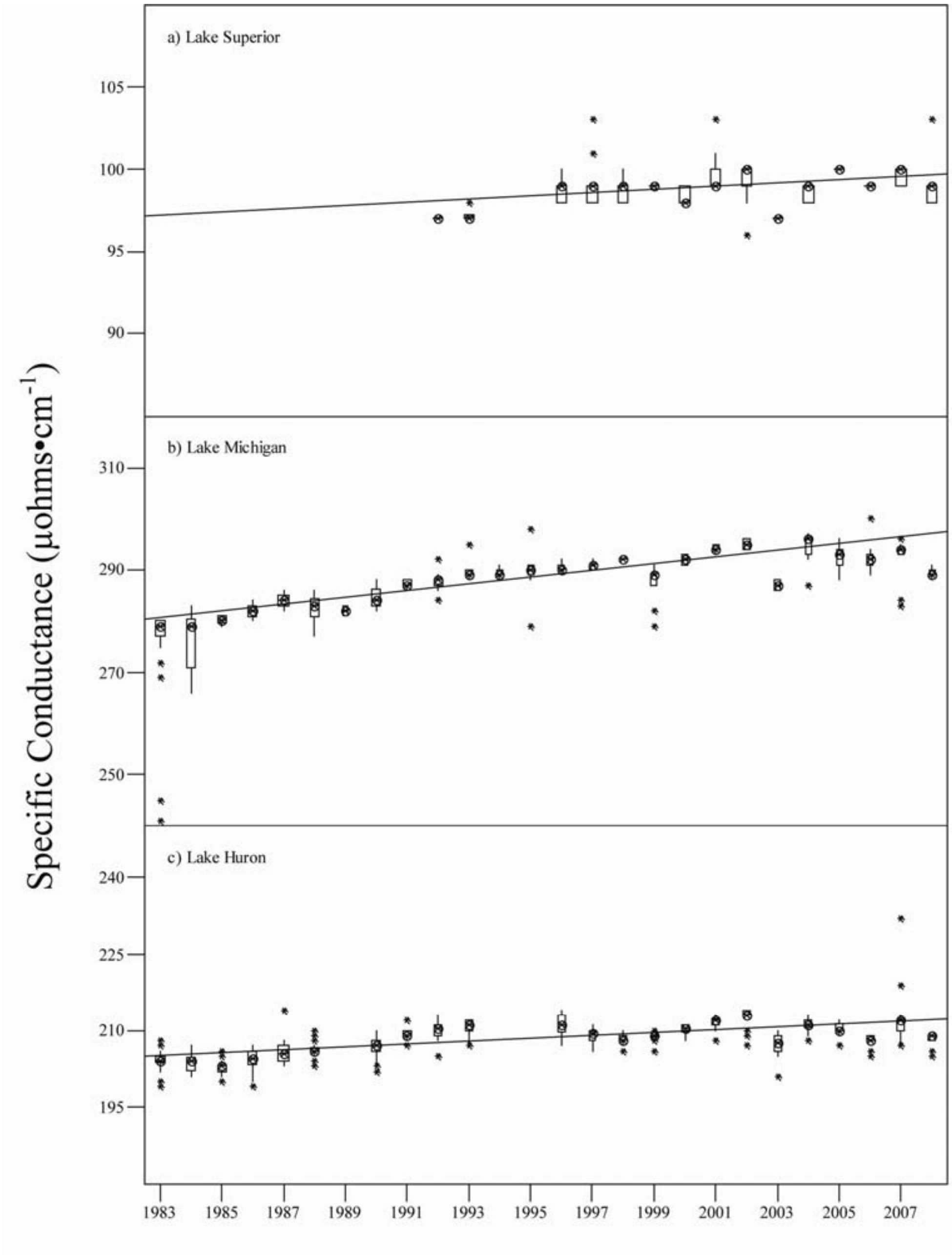

Figure 2. Long-term Trend of Specific Conductance in the Upper Great Lakes
Source: U.S. Environmental Protection Agency, GLNPO

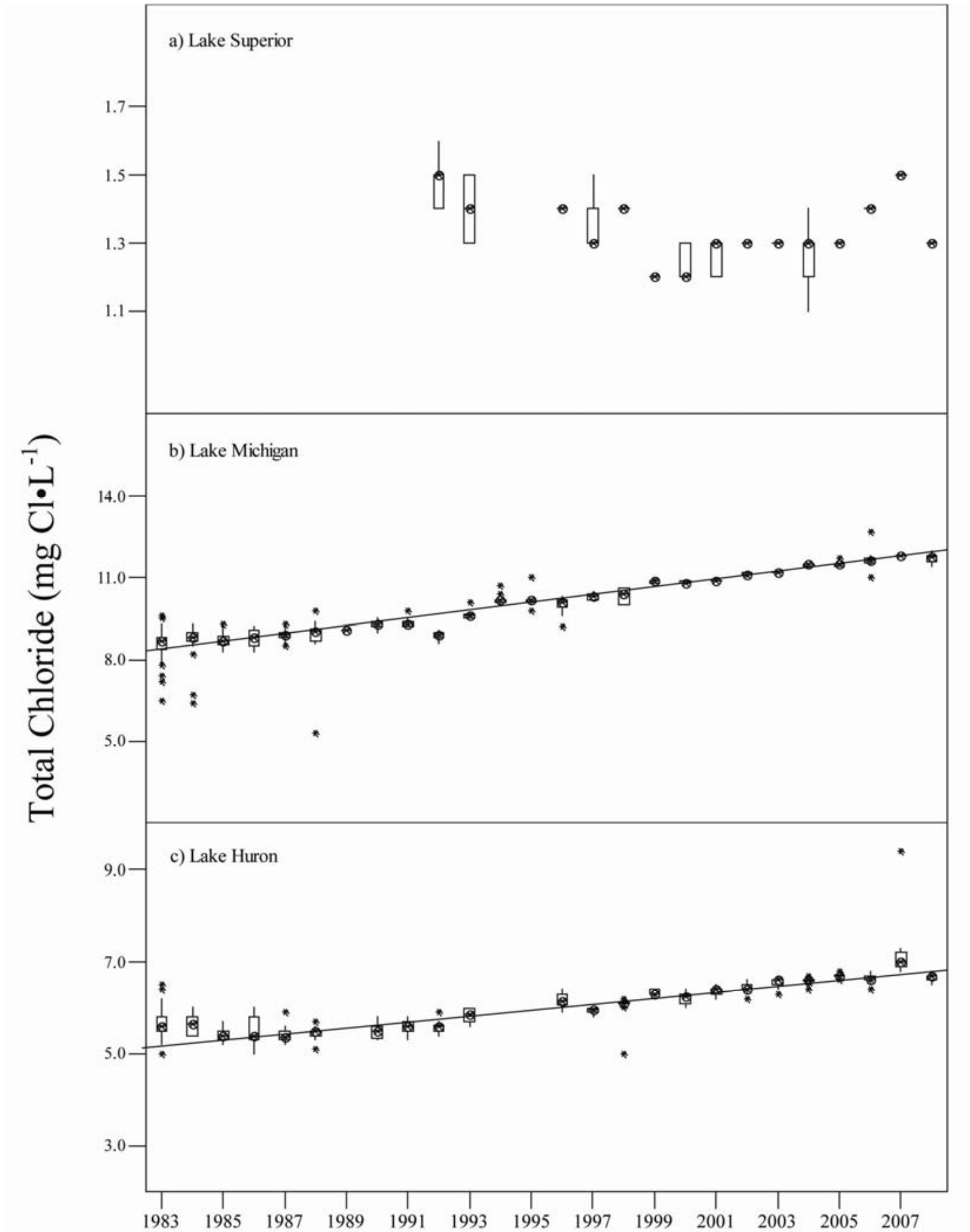

Figure 2. Long-term Trend of Total Chloride in the Upper Great Lakes
Source: U.S. Environmental Protection Agency, GLNPO

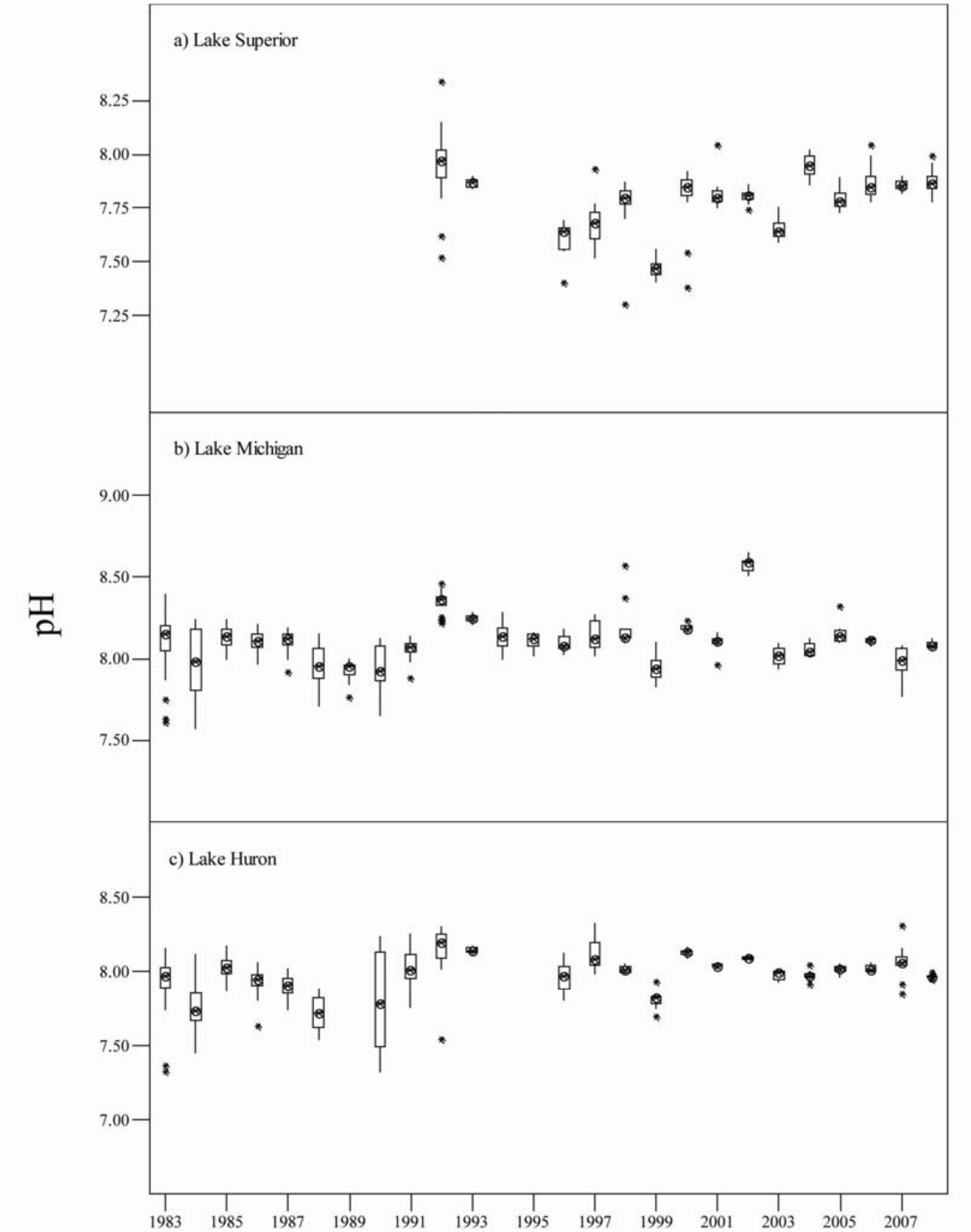

Figure 3. Long-term Trend of pH in the Upper Great Lakes
Source: U.S. Environmental Protection Agency, GLNPO

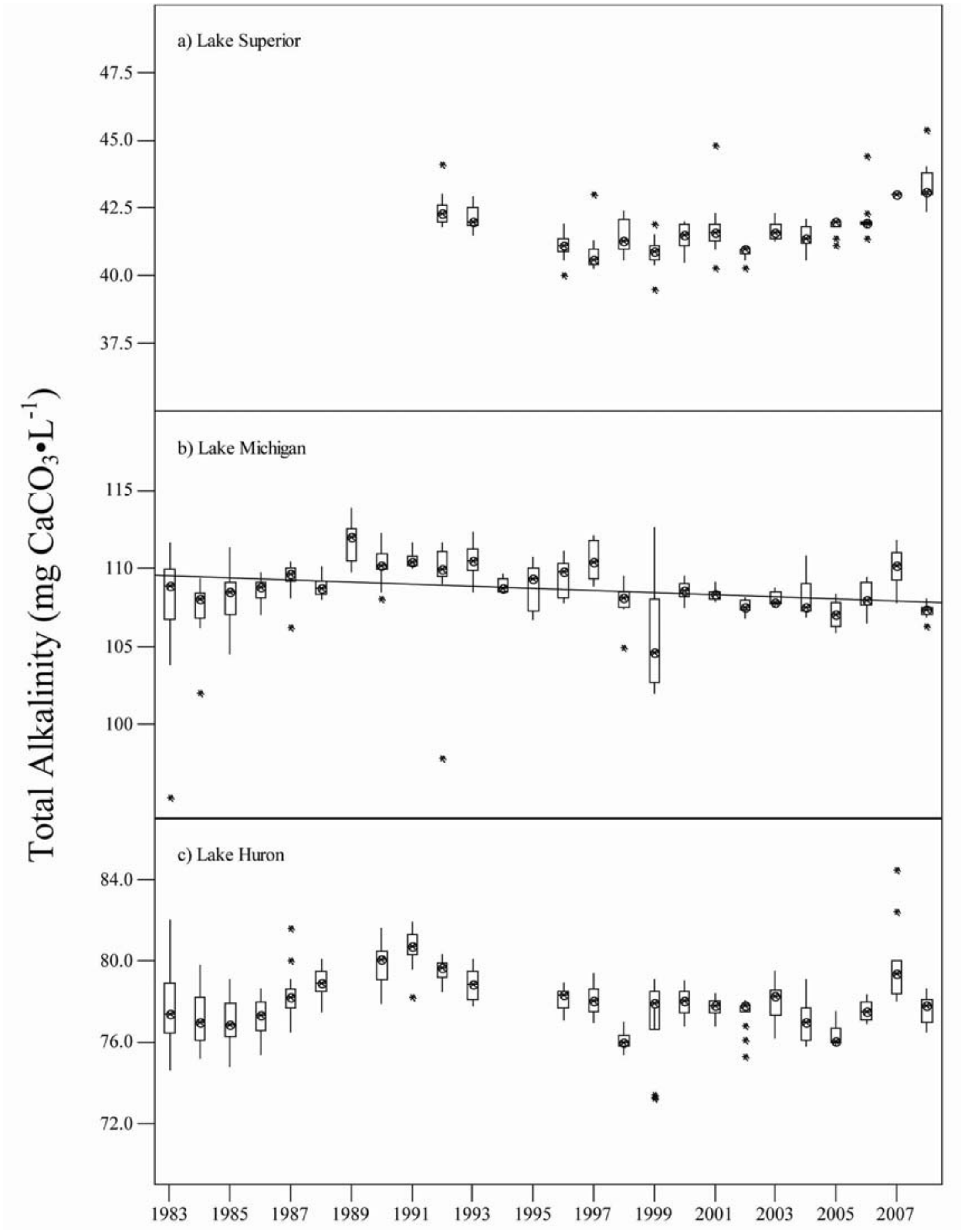

Figure 4. Long-term Trend of Total Alkalinity in the Upper Great Lakes
Source: U.S. Environmental Protection Agency, GLNPO

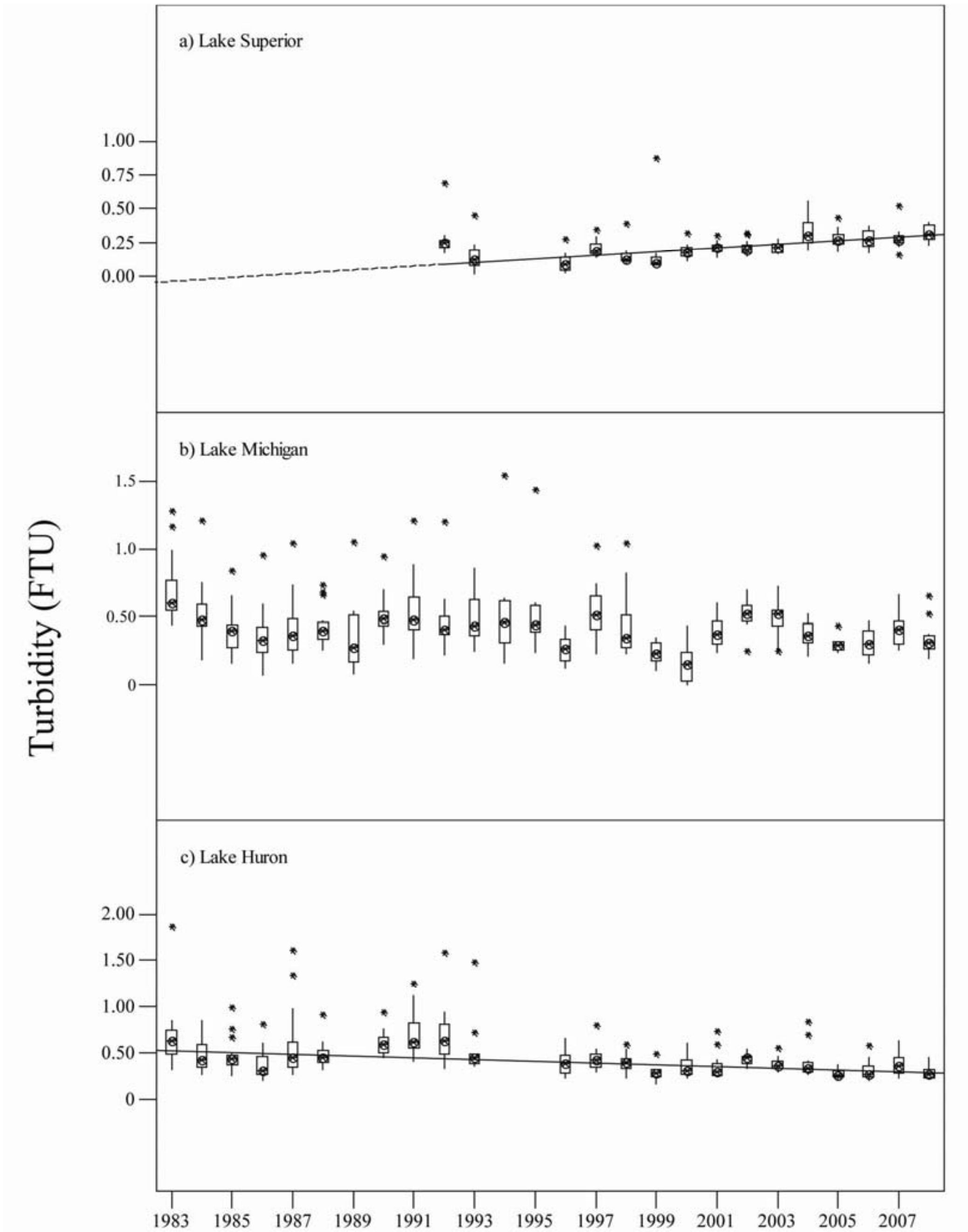

Figure 5. Long-term Trend of Turbidity in the Upper Great Lakes
Source: U.S. Environmental Protection Agency, GLNPO

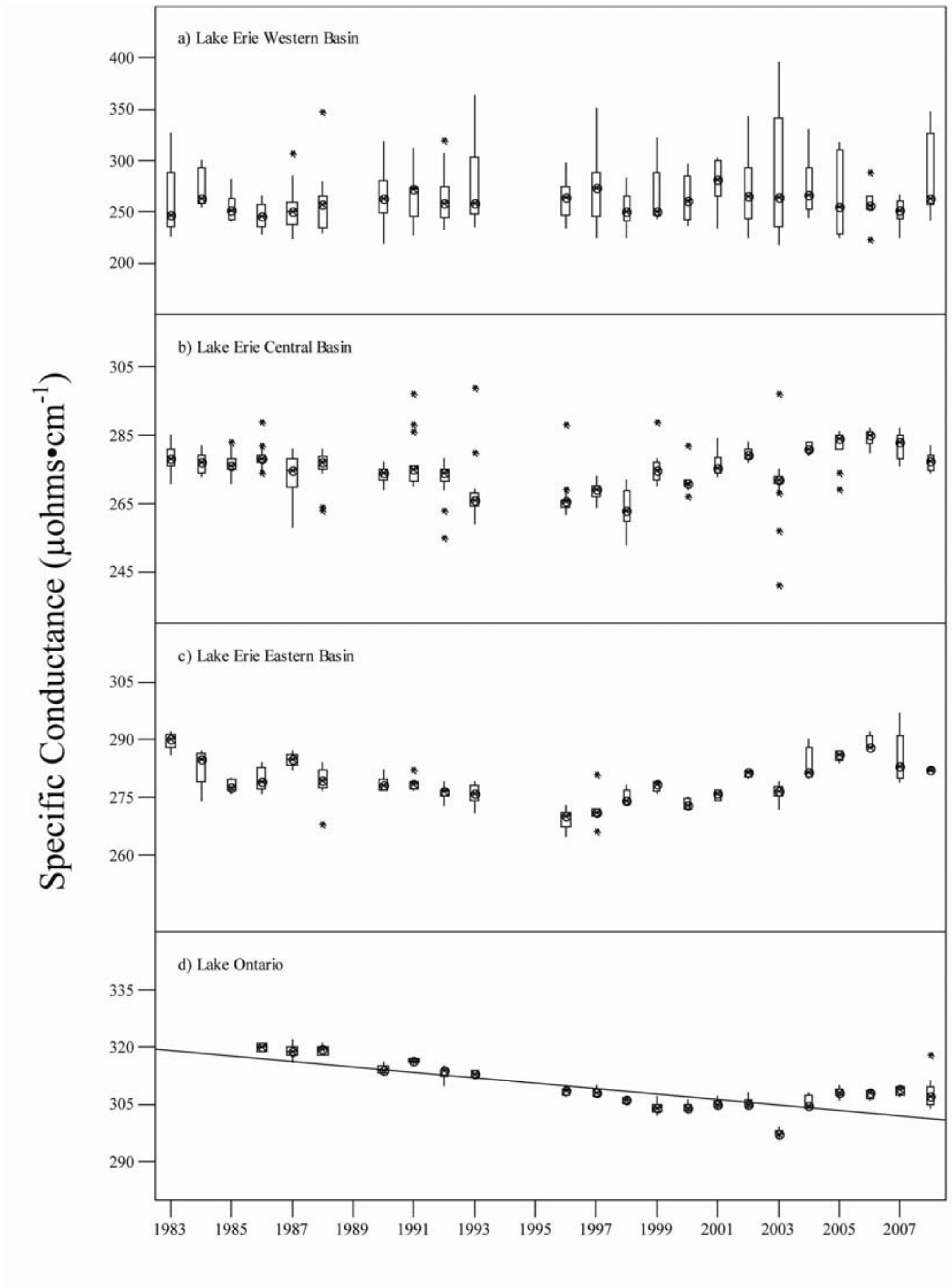

Figure 6. Long-term Trend of Specific Conductance in the Lower Great Lakes
Source: U.S. Environmental Protection Agency, GLNPO

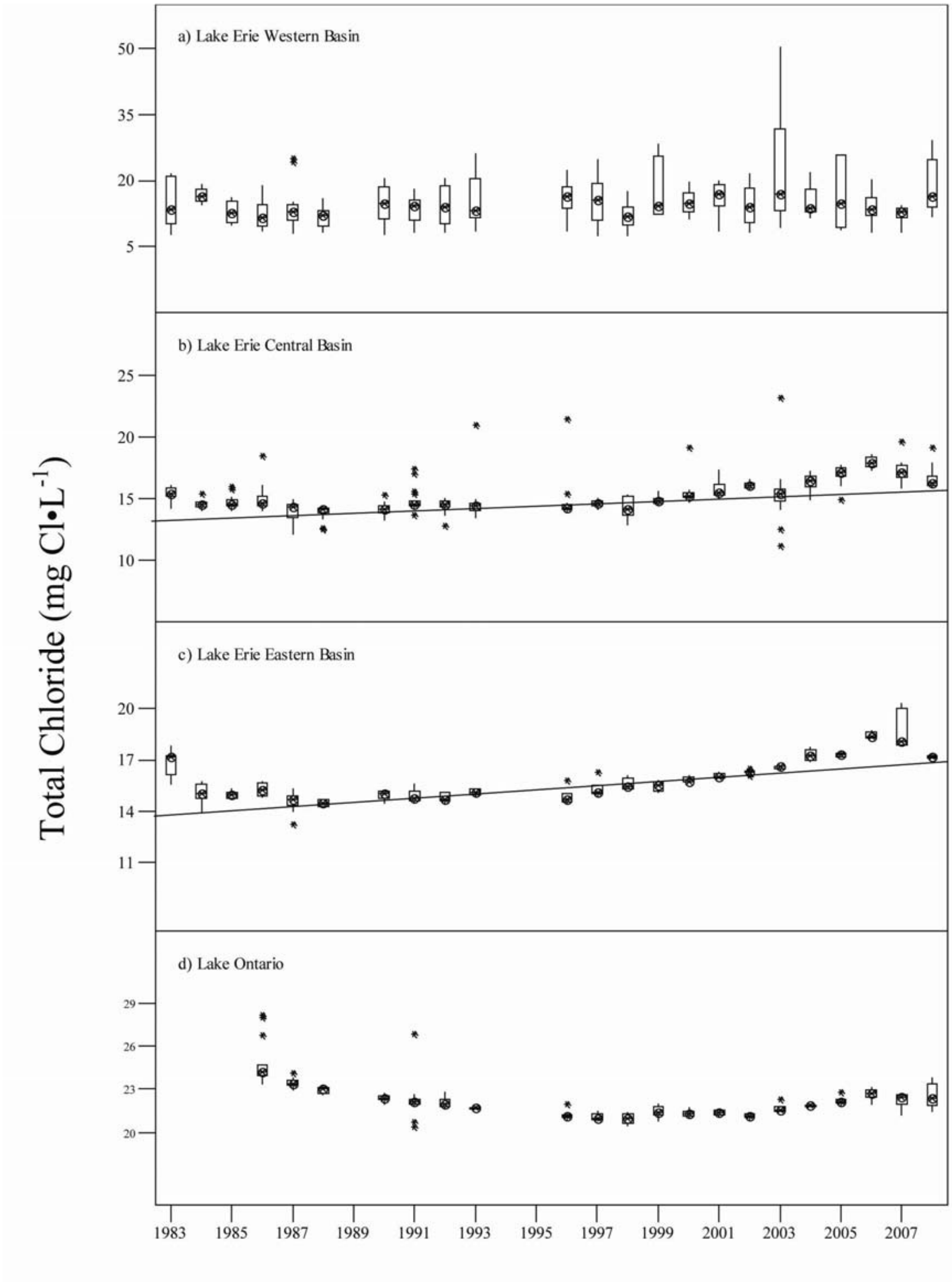

Figure 7. Long-term Trend of Total Chloride in the Lower Great Lakes
Source: U.S. Environmental Protection Agency, GLNPO

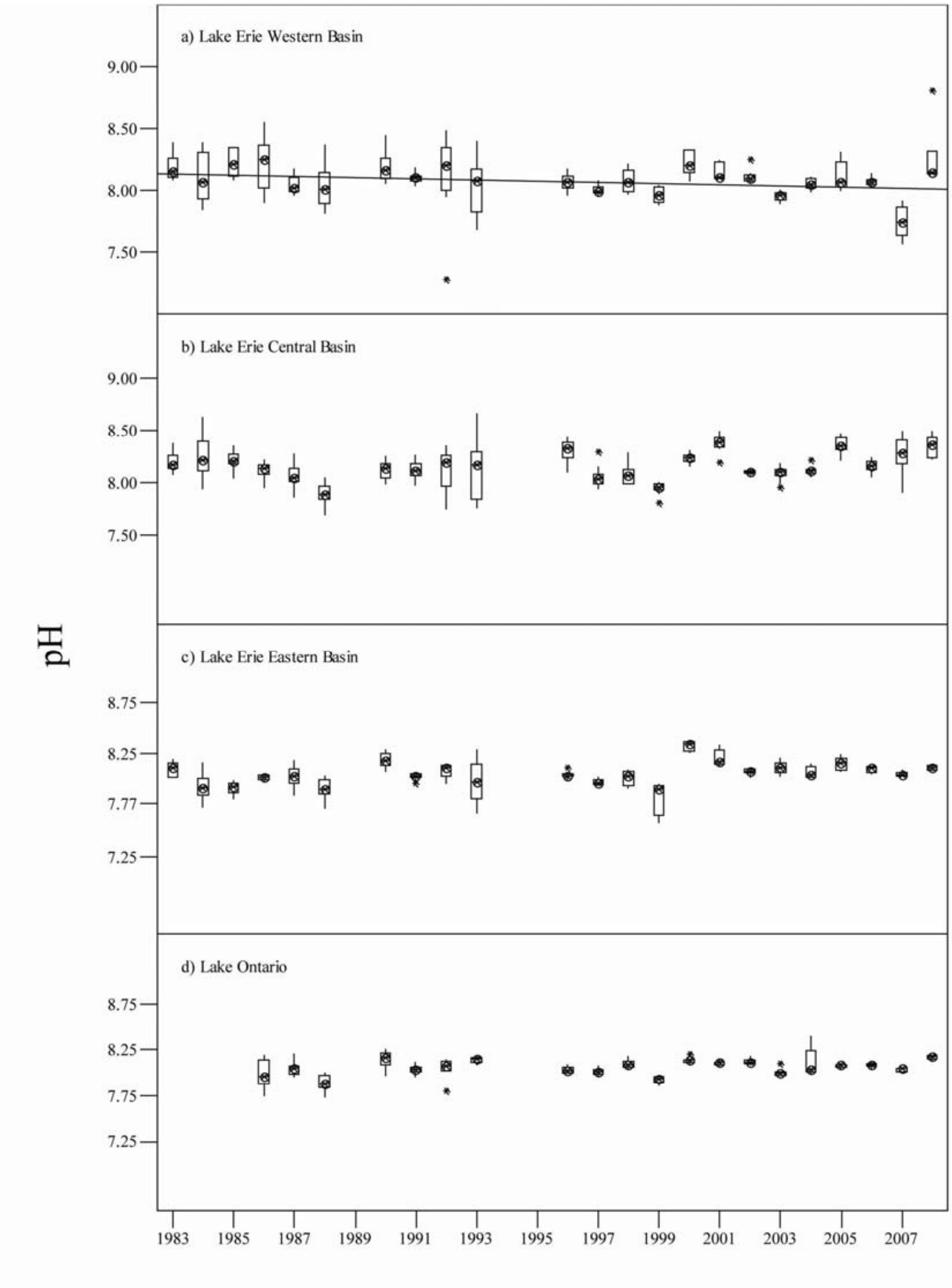

Figure 8. Long-term Trend of pH in the Lower Great Lakes
Source: U.S. Environmental Protection Agency, GLNPO

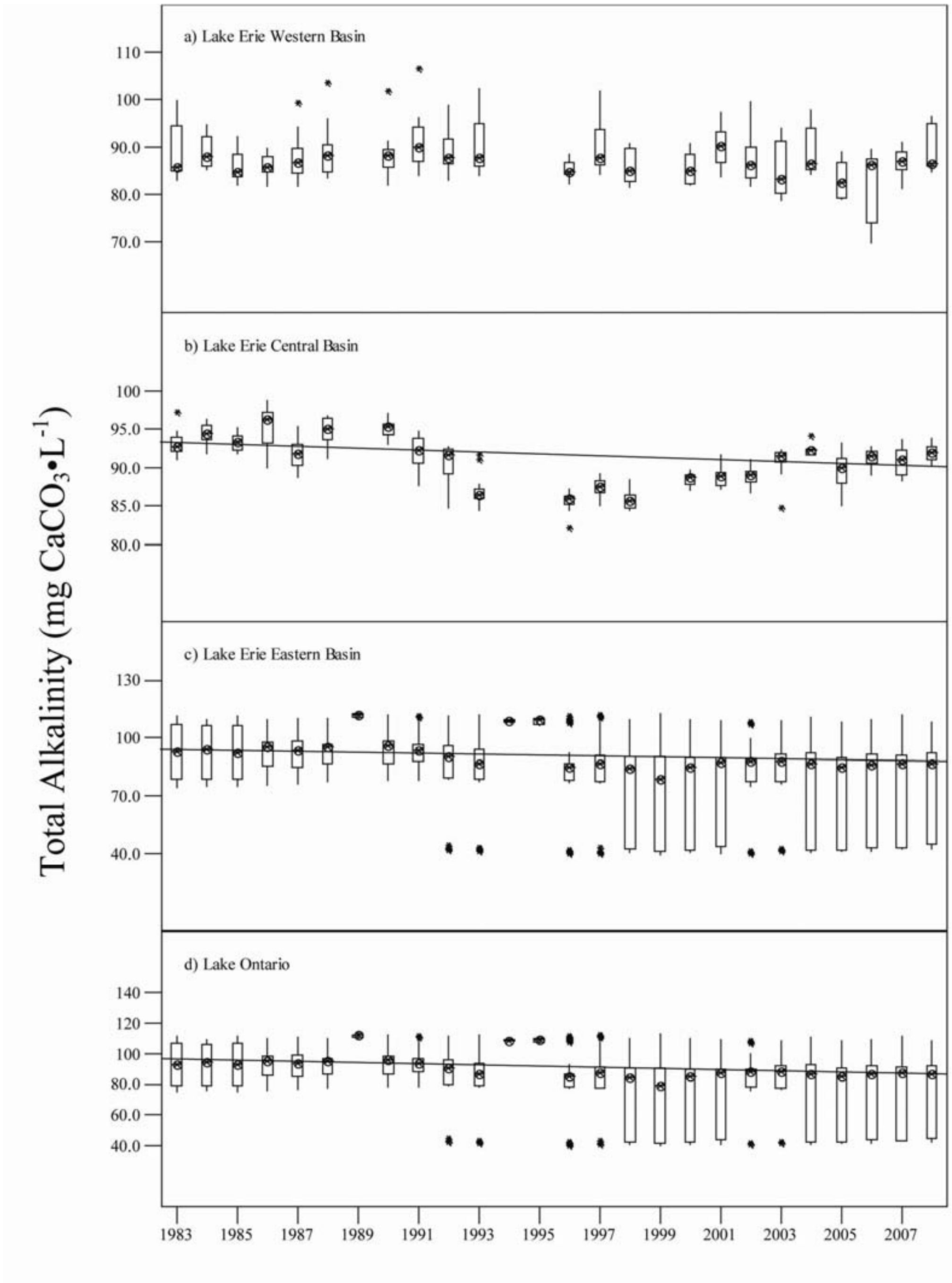

Figure 9. Long-term Trend of Total Alkalinity in the Lower Great Lakes
Source: U.S. Environmental Protection Agency, GLNPO

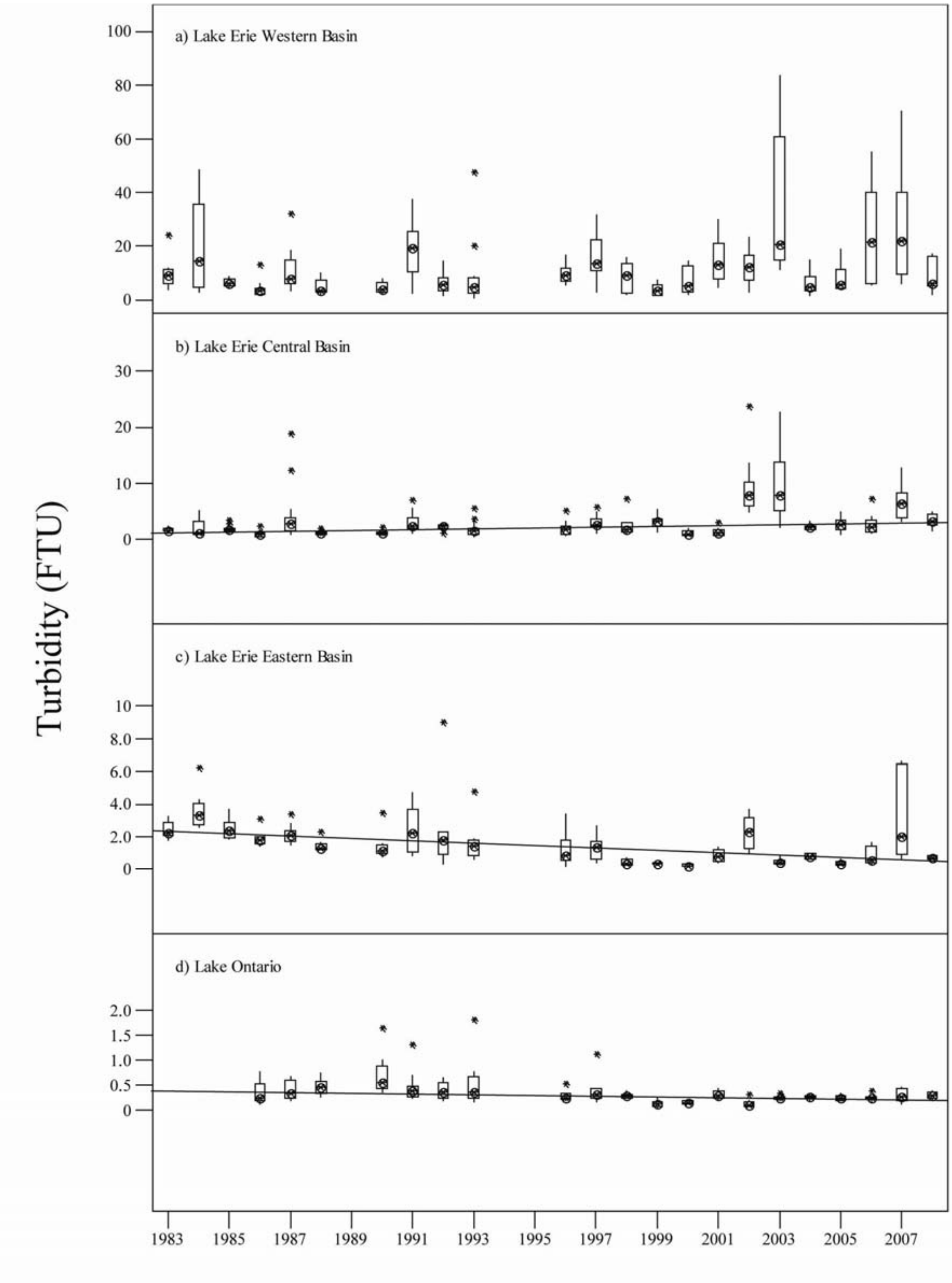

Figure 10. Long-term Trend of Turbidity in the Lower Great Lakes
Source: U.S. Environmental Protection Agency, GLNPO