



ILLINOIS

Illinois State Water Survey

PRAIRIE RESEARCH INSTITUTE

Water Quality Trend Analysis for Fox River Watershed: Stratton Dam to the Illinois River

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OUTLINE

- Introduction
- Exploratory Data Analysis (**EDA**)
- Water Quality Trend Analysis
 - Seasonal Kendall Test (**SKT**) for Trend
 - Weighted Regression on Time, Discharge and Season (**WRTDS**)
- Results of Trend Analysis
- Summary

INTRODUCTION

- Water Quality (WQ) data for Fox River Watershed collected by different agencies (i.e., FRSG, IEPA, FRMWR, USGS, FRWRD, ISWS and others) stored in ***FoxDB***
- 18 stations were identified (Fox River and its tributaries) met minimum data requirements for trend analysis
- Number of parameters available at stations ranged from 2 to 10.
- In total, 141 WQ parameters across all stations.
- *Objective*: Identify presence or absence of trends in a number nutrient-related water quality data; *determining causes and milestones was not in the scope of this study.*

EXPLORATORY DATA ANALYSIS (EDA)

- Uncover the underlying water quality data structure such as seasonality, trends, step-changes, gap & outliers;
- Statistics indicating its central tendency, spread, skewness, etc.
- Nutrient-related parameters:
 - *Nitrate-nitrogen (NO₃-N)*
 - *Total Kjeldahl Nitrogen (TKN)*
 - *Organic nitrogen (Org-N)*
 - *Ammonia nitrogen (NH₃-N)*
 - *Total phosphorus (TP)*
 - *Dissolved phosphorus (DP)*
 - *Total suspended solids (TSS)*
 - *Dissolved oxygen (DO)*
 - *Chlorophyll-A (CHL-A)*
 - *pH*

EXPLORATORY DATA... (cont'd.)

- Water Quality Parameters by [monitoring station](#)

Station ID	Station name	Total number of water quality parameters by Station
236	<i>Nippersink Cr at Spring Grove</i>	7 (NH ₃ -N, TKN, TP, DP, DO, TSS, pH)
1	<i>Nippersink Cr above Wonder Lake</i>	2 (TP, DP)
184	Fox River at Johnsburg	9 (Org-N, NH ₃ -N, NO ₃ -N, TKN, TP, DP, DO, CHL-A, pH)
23	Fox River at Rt 176	8 (NH ₃ -N, NO ₃ -N, TKN, TP, DP, DO, TSS, pH)
258	Fox River at Oakwood Hills	9 (Org-N, NH ₃ -N, NO ₃ -N, TKN, TP, DP, DO, CHL-A, pH)
4	<i>Flint Cr at Kelsey Rd-Lk Barrington</i>	4 (NH ₃ -N, TKN, TP, DP)
271	<i>Crystal Cr at Rt 31</i>	9 (Org-N, NH ₃ -N, NO ₃ -N, TKN, TP, DP, DO, CHL-A, pH)
24	Fox River at Algonquin	10 (Org-N, NH ₃ -N, NO ₃ -N, TKN, TP, DP, DO, TSS, CHL-A, pH)
268	<i>Tyler Cr at Rt. 31-Elgin</i>	9 (Org-N, NH ₃ -N, NO ₃ -N, TKN, TP, DP, DO, CHL-A, pH)
25	<i>Poplar Cr near Mouth-Elgin</i>	7 (NH ₃ -N, TKN, TP, DP, DO, TSS, pH)
26	Fox River at South Elgin	10 (Org-N, NH ₃ -N, NO ₃ -N, TKN, TP, DP, DO, TSS, CHL-A, pH)
14	<i>Ferson Cr at Rt 34</i>	4 (NH ₃ -N, TKN, TP, DP)
79	<i>Ferson Cr near Mouth-Elgin</i>	9 (Org-N, NH ₃ -N, NO ₃ -N, TKN, TP, DP, DO, CHL-A, pH)
40	Fox River at Geneva	9 (Org-N, NH ₃ -N, NO ₃ -N, TKN, TP, DP, DO, CHL-A, pH)
27	Fox River at Montgomery	10 (Org-N, NH ₃ -N, NO ₃ -N, TKN, TP, DP, DO, TSS, CHL-A, pH)
34	Fox River at Yorkville	9 (Org-N, NH ₃ -N, NO ₃ -N, TKN, TP, DP, DO, CHL-A, pH)
28	<i>Blackberry Cr at Rt 47</i>	7 (NH ₃ -N, TKN, TP, DP, DO, TSS, pH)
287	<i>Blackberry Cr near Mouth</i>	9 (Org-N, NH ₃ -N, NO ₃ -N, TKN, TP, DP, DO, CHL-A, pH)

Upstream

Downstream

Note: Stations are in upstream-to-downstream order.

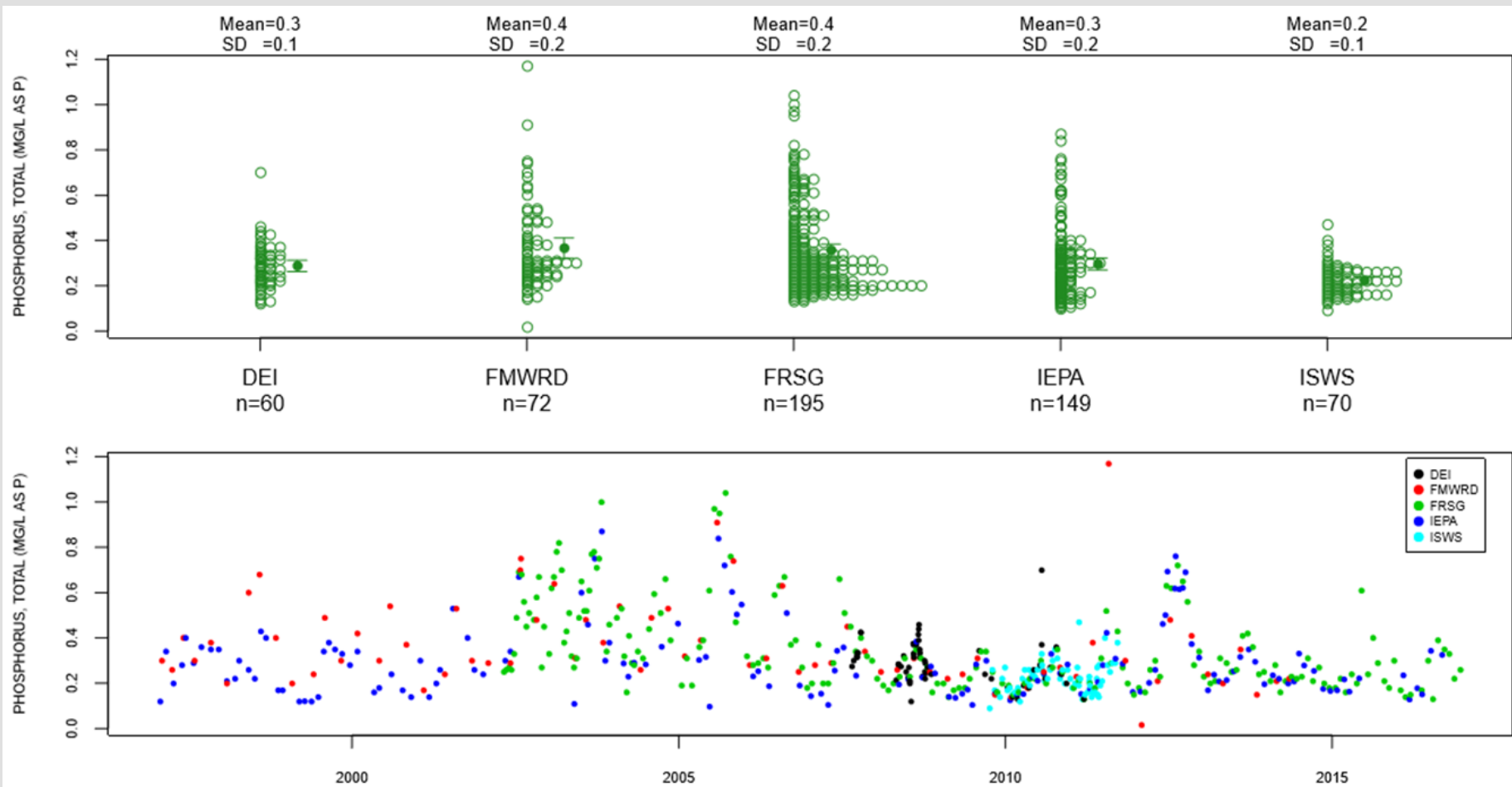
EXPLORATORY DATA... (cont'd.)

- Periods of data records ranged 5 to 20 years usually between 1997 & 2016
- WQ parameter by station varies between 2 and 10

Station ID	Station Name	Org-N	NH3-N	NO3-N	TKN	TP	DP	DO	TSS	CHL-A	pH
236	<i>Nippersink Cr at Spring Grove</i>	-	1997-2016	-	1997-2016	1997-2016	1997-2016	1997-2015	2003-2016	-	1999-2015
1	<i>Nippersink Cr above Wonder Lake</i>	-	-	-	-	1997-2009	1997-2001	-	-	-	-
184	Fox River at Johnsburg	2002-2016	1997-2016	1997-2016	2002-2016	1997-2016	2002-2016	1997-2016	-	2002-2016	2002-2016
23	Fox River at Rt 176	-	1997-2016	1997-2011	1997-2016	1997-2016	1997-2016	1997-2015	2003-2016	-	1999-2015
258	Fox River at Oakwood Hills	2003-2016	1997-2016	1997-2016	2003-2016	1997-2016	2003-2016	1997-2016	-	2003-2016	2003-2016
4	<i>Flint Cr at Kelsey Rd-Lk Barrington</i>	-	2002-2011	-	2000-2011	2000-2011	2000-2011	-	-	-	-
271	<i>Crystal Cr at Rt 31</i>	2003-2016	2003-2016	2003-2016	2003-2016	2003-2016	2003-2016	2003-2016	-	2003-2016	2003-2016
24	Fox River at Algonquin	2002-2016	1997-2016	1997-2016	1997-2016	1997-2016	1997-2016	1997-2012	2003-2016	2002-2016	1999-2016
268	<i>Tyler Cr at Rt. 31-Elgin</i>	2002-2012	1997-2012	1998-2012	1998-2012	1997-2012	2003-2012	1997-2012	-	2003-2012	2003-2012
25	<i>Poplar Cr near Mouth-Elgin</i>	-	1997-2011	-	1997-2016	1997-2016	1997-2016	1997-2015	2003-2016	-	1999-2015
26	Fox River at South Elgin	1998-2016	1997-2016	1998-2016	1997-2016	1997-2016	1997-2016	1997-2016	2003-2016	2001-2016	1999-2016
14	<i>Ferson Cr at Rt 34</i>	-	2000-2011	-	2000-2012	2000-2012	2000-2012	-	-	-	-
79	<i>Ferson Cr near Mouth-Elgin</i>	2003-2016	2003-2016	2003-2016	2003-2016	2003-2016	2003-2016	2003-2016	-	2003-2016	2003-2016
40	Fox River at Geneva	2002-2016	2002-2016	2002-2016	2002-2016	2002-2016	2002-2016	2002-2016	-	2002-2016	2002-2016
27	Fox River at Montgomery	2002-2016	1997-2016	1997-2016	1997-2016	1997-2016	1997-2016	1997-2016	2003-2016	2002-2016	1997-2016
34	Fox River at Yorkville	2002-2016	1997-2016	2002-2016	2002-2016	2002-2016	2002-2016	1997-2016	-	2002-2016	1997-2016
28	<i>Blackberry Cr at Rt 47</i>	-	1997-2016	-	1997-2016	1997-2016	1997-2016	1997-2015	2003-2016	-	1999-2015
287	<i>Blackberry Cr near Mouth</i>	2004-2016	2004-2016	2004-2016	2004-2016	2004-2016	2004-2016	2004-2016	-	2004-2016	2004-2016

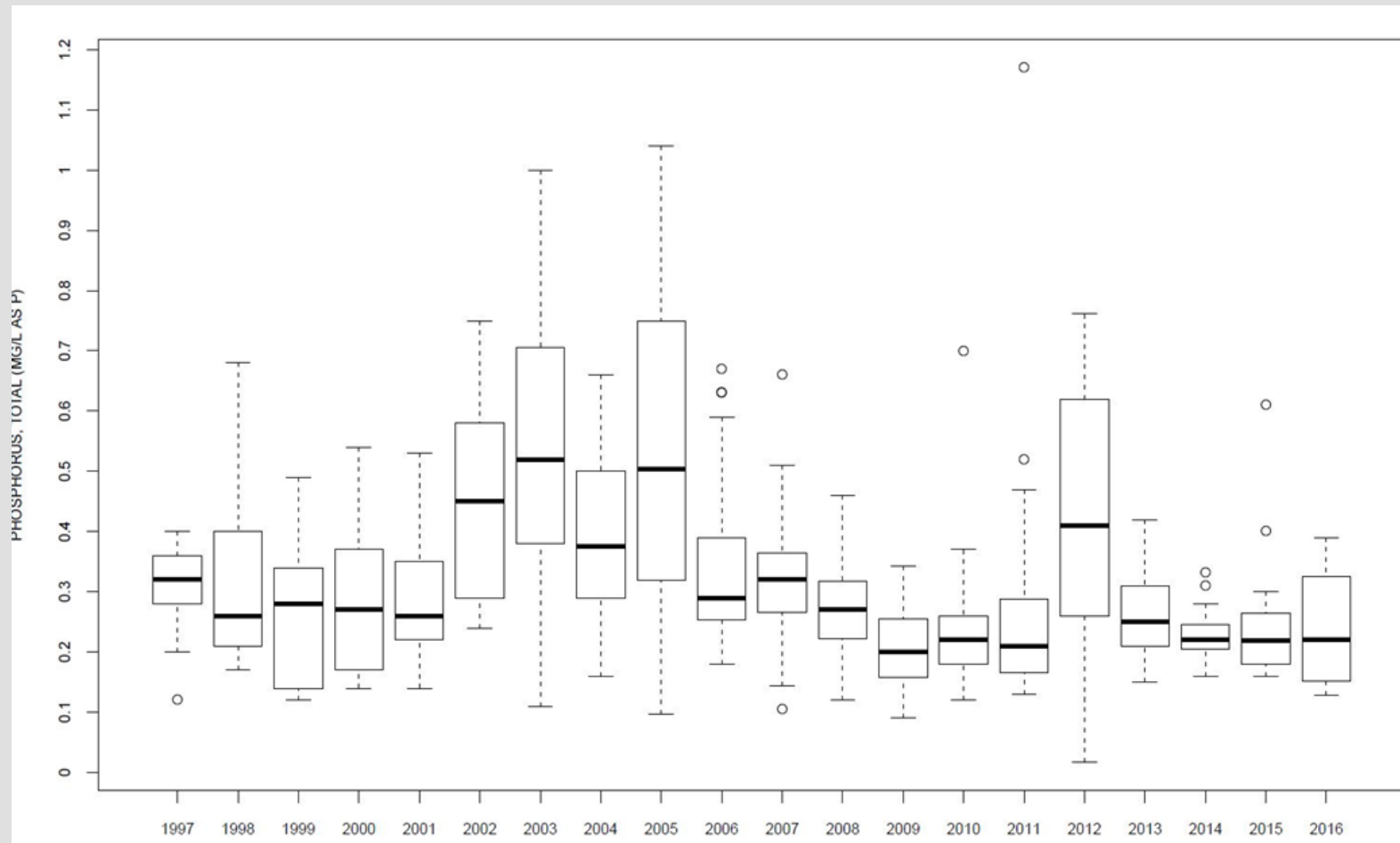
EXPLORATORY DATA... (cont'd.)

■ Total P (mg/L) at Fox River at Montgomery



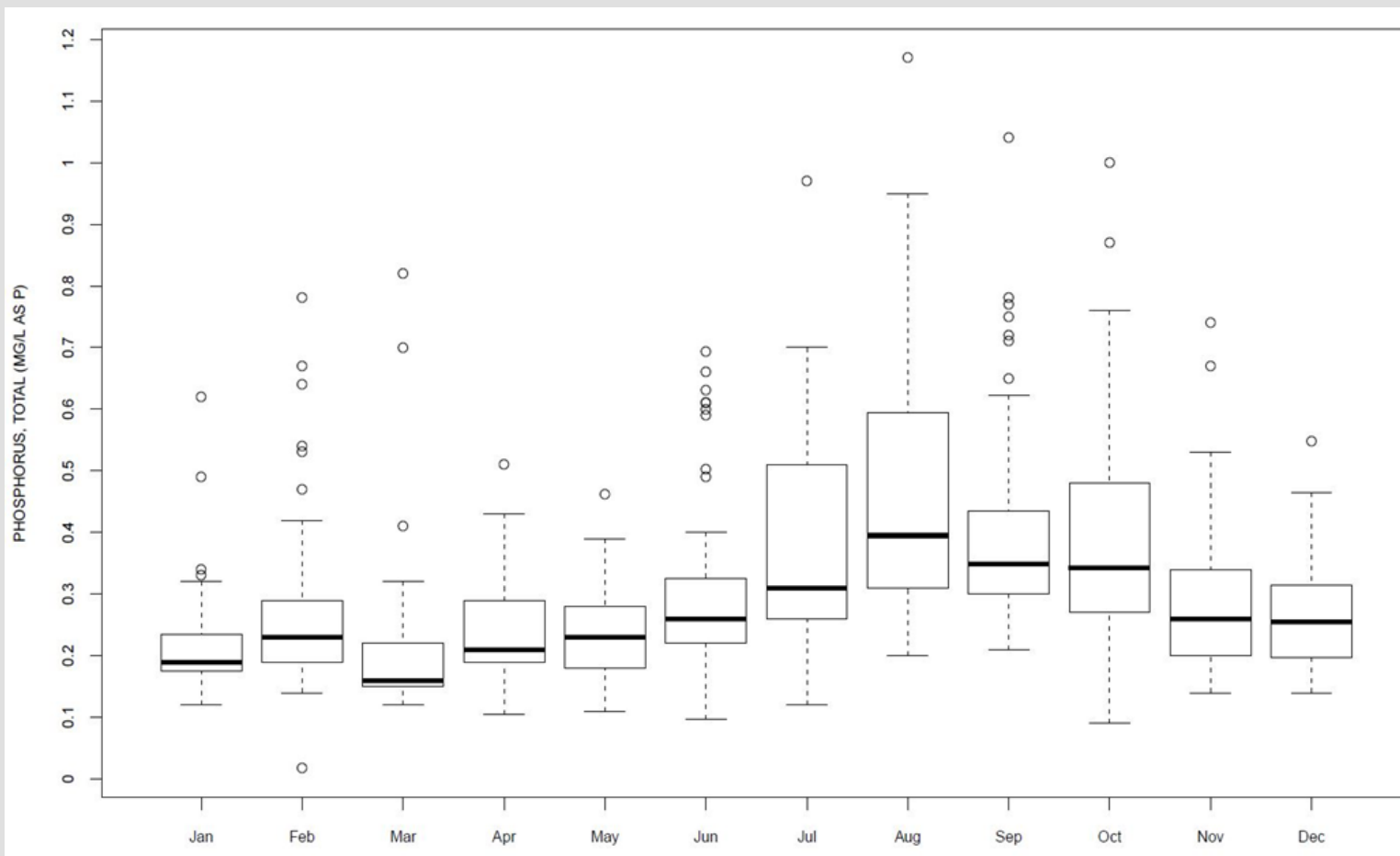
EXPLORATORY DATA... (cont'd.)

- Yearly boxplots of Total P (mg/L)



EXPLORATORY DATA... (cont'd.)

- Total P (mg/L) boxplots by month



Water Quality Trend Analysis

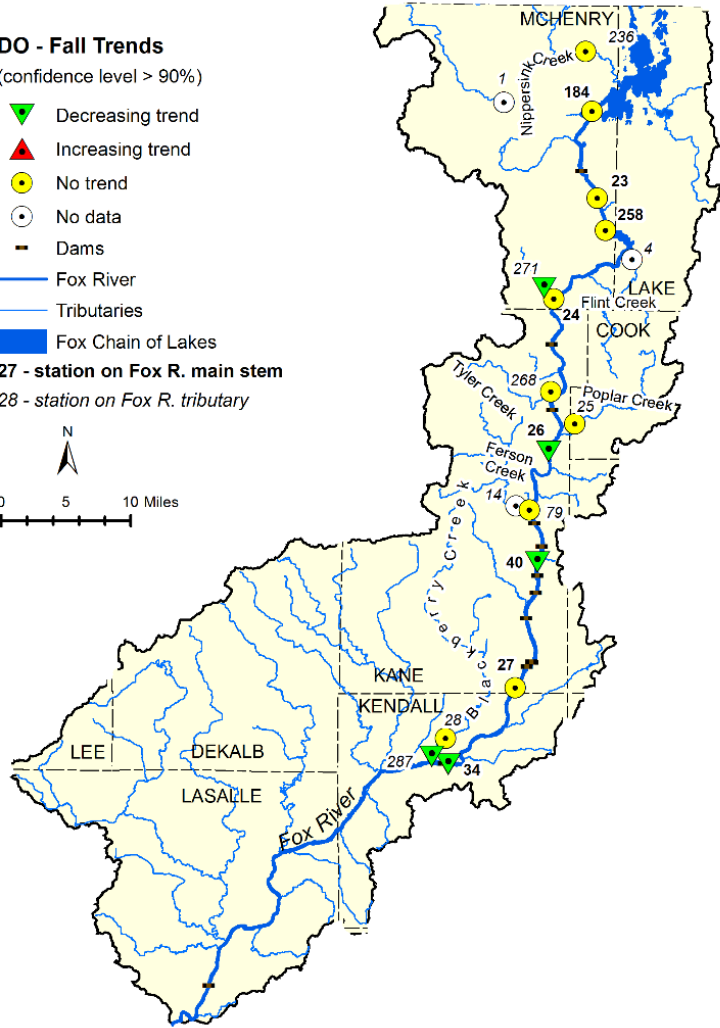
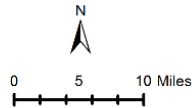
- Identify the presence or absence of trends in the WQ parameters, and
 - if trends exist, estimate the change
- **Seasonal Kendall Test (SKT)**: test for monotonic trend (increasing/decreasing, no trend)
 - core method of trend analysis used in this study
 - requires at least 5 years of concentration data
- SKT analysis used monthly time series data for each WQ parameter at each station

Water Quality Trend... (cont'd.)

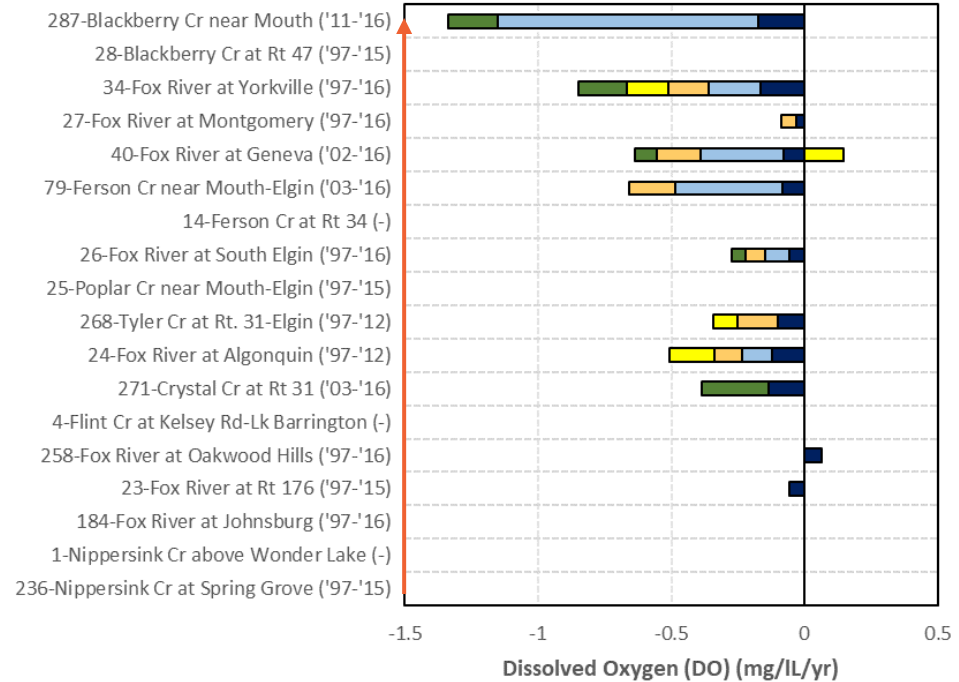
- DO concentration trends and estimated rates of change

DO - Fall Trends (confidence level > 90%)

- Decreasing trend
- Increasing trend
- No trend
- No data
- Dams
- Fox River
- Tributaries
- Fox Chain of Lakes
- 27 - station on Fox R. main stem
- 28 - station on Fox R. tributary



■ Annual ■ Winter ■ Spring ■ Summer ■ Fall



Water Quality Trend... (cont'd.)

- Annual water quality trends

Station ID	Station Name	Org-N	NH ₃ -N	NO ₃ -N	TKN	TP	DP	DO	TSS	CHL-A	pH
236	<i>Nippersink Cr at Spring Grove</i>	-	Decreasing	-	No Trend	No Trend	Decreasing	No Trend	No Trend	-	No Trend
1	<i>Nippersink Cr above Wonder Lake</i>	-	-	-	-	No Trend	No Trend	-	-	-	-
184	Fox River at Johnsburg	Decreasing	Decreasing	Decreasing	Decreasing	No Trend	Increasing	No Trend	-	Decreasing	Increasing
23	Fox River at Rt 176	-	No Trend	Increasing	No Trend	Increasing	Increasing	Decreasing	No Trend	-	No Trend
258	Fox River at Oakwood Hills	No Trend	Decreasing	Decreasing	No Trend	Decreasing	No Trend	Increasing	-	Decreasing	No Trend
4	<i>Flint Cr at Kelsey Rd-Lk Barrington</i>	-	No Trend	-	No Trend	No Trend	No Trend	-	-	-	-
271	<i>Crystal Cr at Rt 31</i>	No Trend	No Trend	Increasing	No Trend	Decreasing	Decreasing	Decreasing	-	No Trend	Decreasing
24	Fox River at Algonquin	No Trend	No Trend	Decreasing	No Trend	No Trend	Increasing	Decreasing	No Trend	Decreasing	No Trend
268	<i>Tyler Cr at Rt. 31-Elgin</i>	No Trend	No Trend	No Trend	No Trend	Decreasing	Decreasing	Decreasing	-	No Trend	Increasing
25	<i>Poplar Cr near Mouth-Elgin</i>	-	No Trend	-	Increasing	Increasing	Increasing	No Trend	No Trend	-	No Trend
26	Fox River at South Elgin	Decreasing	Decreasing	No Trend	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	No Trend
14	<i>Ferson Cr at Rt 34</i>	-	No Trend	-	No Trend	No Trend	No Trend	-	-	-	-
79	<i>Ferson Cr near Mouth-Elgin</i>	No Trend	Decreasing	Decreasing	No Trend	No Trend	Increasing	Decreasing	-	No Trend	Increasing
40	Fox River at Geneva	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	-	Decreasing	No Trend
27	Fox River at Montgomery	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing
34	Fox River at Yorkville	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	-	Decreasing	Decreasing
28	<i>Blackberry Cr at Rt 47</i>	-	No Trend	-	No Trend	No Trend	Decreasing	No Trend	No Trend	-	Decreasing
287	<i>Blackberry Cr near Mouth</i>	No Trend	Decreasing	No Trend	No Trend	No Trend	No Trend	Decreasing	-	No Trend	Decreasing

Water Quality Trend... (cont'd.)

- Winter water quality trends

Station ID	Station Name	Org-N	NH ₃ -N	NO ₃ -N	TKN	TP	DP	DO	TSS	CHL-A	pH
236	<i>Nippersink Cr at Spring Grove</i>	-	No Trend	-	No Trend	No Trend	No Trend	No Trend	No Trend	-	No Trend
1	<i>Nippersink Cr above Wonder Lake</i>	-	-	-	-	No Trend	Decreasing	-	-	-	-
184	Fox River at Johnsburg	No Trend	No Trend	No Trend	No Trend	Decreasing	No Trend	-	-	No Trend	No Trend
23	Fox River at Rt 176	-	No Trend	Increasing	No Trend	Increasing	Increasing	No Trend	-	-	No Trend
258	Fox River at Oakwood Hills	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	-	-	No Trend	-
4	<i>Flint Cr at Kelsey Rd-Lk Barrington</i>	-	No Trend	-	No Trend	No Trend	No Trend	-	-	-	-
271	<i>Crystal Cr at Rt 31</i>	No Trend	No Trend	No Trend	No Trend	Decreasing	Decreasing	No Trend	-	No Trend	-
24	Fox River at Algonquin	No Trend	No Trend	No Trend	No Trend	No Trend	Increasing	Decreasing	No Trend	Decreasing	No Trend
268	<i>Tyler Cr at Rt. 31-Elgin</i>	Decreasing	No Trend	Decreasing	No Trend	Decreasing	Decreasing	No Trend	-	No Trend	-
25	<i>Poplar Cr near Mouth-Elgin</i>	-	No Trend	-	Increasing	Increasing	No Trend	No Trend	Increasing	-	No Trend
26	Fox River at South Elgin	No Trend	Decreasing	No Trend	Decreasing	Decreasing	Decreasing	Decreasing	No Trend	Decreasing	No Trend
14	<i>Ferson Cr at Rt 34</i>	-	No Trend	-	No Trend	No Trend	No Trend	-	-	-	-
79	<i>Ferson Cr near Mouth-Elgin</i>	No Trend	No Trend	Decreasing	No Trend	No Trend	No Trend	Decreasing	-	Increasing	Increasing
40	Fox River at Geneva	No Trend	Decreasing	No Trend	No Trend	Decreasing	No Trend	Decreasing	-	No Trend	No Trend
27	Fox River at Montgomery	No Trend	Decreasing	No Trend	Decreasing	Decreasing	No Trend	No Trend	No Trend	No Trend	Decreasing
34	Fox River at Yorkville	No Trend	Decreasing	No Trend	No Trend	Decreasing	Decreasing	Decreasing	-	Decreasing	Decreasing
28	<i>Blackberry Cr at Rt 47</i>	-	No Trend	-	No Trend	No Trend	Decreasing	No Trend	No Trend	-	No Trend
287	<i>Blackberry Cr near Mouth</i>	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	Decreasing	-	Increasing	-

Water Quality Trend... (cont'd.)

- Spring water quality trends

Station ID	Station Name	Org-N	NH ₃ -N	NO ₃ -N	TKN	TP	DP	DO	TSS	CHL-A	pH
236	<i>Nippersink Cr at Spring Grove</i>	-	Decreasing	-	No Trend	No Trend	Decreasing	No Trend	No Trend	-	No Trend
1	<i>Nippersink Cr above Wonder Lake</i>	-	-	-	-	No Trend	No Trend	-	-	-	-
184	Fox River at Johnsburg	No Trend	No Trend	No Trend	Decreasing	No Trend	Increasing	No Trend	-	Decreasing	No Trend
23	Fox River at Rt 176	-	No Trend	Increasing	No Trend	No Trend	Increasing	No Trend	No Trend	-	No Trend
258	Fox River at Oakwood Hills	No Trend	No Trend	No Trend	No Trend	No Trend	Increasing	No Trend	-	Decreasing	No Trend
4	<i>Flint Cr at Kelsey Rd-Lk Barrington</i>	-	No Trend	-	No Trend	No Trend	No Trend	-	-	-	-
271	<i>Crystal Cr at Rt 31</i>	No Trend	No Trend	No Trend	No Trend	Decreasing	Decreasing	No Trend	-	No Trend	No Trend
24	Fox River at Algonquin	No Trend	No Trend	No Trend	No Trend	No Trend	Increasing	Decreasing	No Trend	Decreasing	No Trend
268	<i>Tyler Cr at Rt. 31-Elgin</i>	No Trend	No Trend	Decreasing	No Trend	No Trend	No Trend	Decreasing	-	No Trend	No Trend
25	<i>Poplar Cr near Mouth-Elgin</i>	-	No Trend	-	No Trend	Increasing	Increasing	No Trend	No Trend	-	No Trend
26	Fox River at South Elgin	Decreasing	No Trend	No Trend	Decreasing	Decreasing	No Trend	Decreasing	No Trend	Decreasing	No Trend
14	<i>Ferson Cr at Rt 34</i>	-	No Trend	-	No Trend	No Trend	No Trend	-	-	-	-
79	<i>Ferson Cr near Mouth-Elgin</i>	No Trend	No Trend	Decreasing	No Trend	No Trend	Increasing	Decreasing	-	No Trend	No Trend
40	Fox River at Geneva	Decreasing	No Trend	No Trend	Decreasing	Decreasing	Decreasing	Decreasing	-	Decreasing	No Trend
27	Fox River at Montgomery	Decreasing	Decreasing	No Trend	No Trend	Decreasing	No Trend	Decreasing	No Trend	Decreasing	Decreasing
34	Fox River at Yorkville	Decreasing	Decreasing	No Trend	Decreasing	Decreasing	Decreasing	Decreasing	-	Decreasing	Decreasing
28	<i>Blackberry Cr at Rt 47</i>	-	Increasing	-	No Trend	No Trend	No Trend	No Trend	No Trend	-	Decreasing
287	<i>Blackberry Cr near Mouth</i>	No Trend	No Trend	No Trend	Decreasing	No Trend	No Trend	No Trend	-	No Trend	Decreasing

Water Quality Trend... (cont'd.)

- Summer water quality trends

Station ID	Station Name	Org-N	NH ₃ -N	NO ₃ -N	TKN	TP	DP	DO	TSS	CHL-A	pH
236	<i>Nippersink Cr at Spring Grove</i>	-	No Trend	-	No Trend	No Trend	No Trend	No Trend	No Trend	-	No Trend
1	<i>Nippersink Cr above Wonder Lake</i>	-	-	-	-	No Trend	No Trend	-	-	-	-
184	Fox River at Johnsburg	No Trend	No Trend	Decreasing	No Trend	No Trend	Increasing	No Trend	-	No Trend	No Trend
23	Fox River at Rt 176	-	No Trend	No Trend	No Trend	No Trend	Increasing	No Trend	No Trend	-	No Trend
258	Fox River at Oakwood Hills	No Trend	No Trend	Decreasing	No Trend	No Trend	No Trend	No Trend	-	No Trend	No Trend
4	<i>Flint Cr at Kelsey Rd-Lk Barrington</i>	-	No Trend	-	No Trend	No Trend	No Trend	-	-	-	-
271	<i>Crystal Cr at Rt 31</i>	No Trend	No Trend	No Trend	No Trend	Decreasing	Decreasing	No Trend	-	No Trend	No Trend
24	Fox River at Algonquin	No Trend	No Trend	Decreasing	No Trend	No Trend	Increasing	Decreasing	No Trend	No Trend	No Trend
268	<i>Tyler Cr at Rt. 31-Elgin</i>	Increasing	No Trend	No Trend	Increasing	No Trend	No Trend	Decreasing	-	No Trend	No Trend
25	<i>Poplar Cr near Mouth-Elgin</i>	-	No Trend	-	No Trend	No Trend	Increasing	No Trend	Decreasing	-	Decreasing
26	Fox River at South Elgin	Decreasing	No Trend	No Trend	Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend
14	<i>Ferson Cr at Rt 34</i>	-	No Trend	-	No Trend	No Trend	-	-	-	-	-
79	<i>Ferson Cr near Mouth-Elgin</i>	No Trend	Decreasing	Decreasing	No Trend	No Trend	Increasing	No Trend	-	No Trend	No Trend
40	Fox River at Geneva	Decreasing	Decreasing	No Trend	Decreasing	Decreasing	Decreasing	Increasing	-	No Trend	No Trend
27	Fox River at Montgomery	Decreasing	Decreasing	Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend	No Trend
34	Fox River at Yorkville	Decreasing	Decreasing	No Trend	Decreasing	Decreasing	Decreasing	Decreasing	-	No Trend	Decreasing
28	<i>Blackberry Cr at Rt 47</i>	-	Decreasing	-	No Trend	Decreasing	No Trend	No Trend	Increasing	-	No Trend
287	<i>Blackberry Cr near Mouth</i>	Decreasing	Decreasing	Increasing	Decreasing	No Trend	No Trend	No Trend	-	No Trend	No Trend

Water Quality Trend... (cont'd.)

- Fall water quality trends

Station ID	Station Name	Org-N	NH ₃ -N	NO ₃ -N	TKN	TP	DP	DO	TSS	CHL-A	pH
236	<i>Nippersink Cr at Spring Grove</i>	-	No Trend	-	No Trend	No Trend	No Trend	No Trend	No Trend	-	No Trend
1	<i>Nippersink Cr above Wonder Lake</i>	-	-	-	-	No Trend	No Trend	-	-	-	-
184	Fox River at Johnsburg	Decreasing	No Trend	No Trend	Decreasing	Decreasing	No Trend	No Trend	-	Decreasing	Increasing
23	Fox River at Rt 176	-	No Trend	Increasing	No Trend	No Trend	No Trend	No Trend	No Trend	-	No Trend
258	Fox River at Oakwood Hills	No Trend	Decreasing	Decreasing	No Trend	Decreasing	No Trend	No Trend	-	No Trend	No Trend
4	<i>Flint Cr at Kelsey Rd-Lk Barrington</i>	-	No Trend	-	No Trend	No Trend	No Trend	-	-	-	-
271	<i>Crystal Cr at Rt 31</i>	No Trend	No Trend	No Trend	No Trend	Decreasing	Decreasing	Decreasing	-	No Trend	No Trend
24	Fox River at Algonquin	No Trend	Decreasing	Decreasing	No Trend	No Trend	No Trend	No Trend	No Trend	Decreasing	No Trend
268	<i>Tyler Cr at Rt. 31-Elgin</i>	No Trend	Increasing	No Trend	No Trend	No Trend	No Trend	No Trend	-	No Trend	No Trend
25	<i>Poplar Cr near Mouth-Elgin</i>	-	No Trend	-	Increasing	Increasing	No Trend	No Trend	No Trend	-	No Trend
26	Fox River at South Elgin	Decreasing	Decreasing	No Trend	Decreasing	No Trend	Decreasing	Decreasing	No Trend	No Trend	No Trend
14	<i>Ferson Cr at Rt 34</i>	-	No Trend	-	No Trend	No Trend	No Trend	-	-	-	-
79	<i>Ferson Cr near Mouth-Elgin</i>	No Trend	Decreasing	Decreasing	No Trend	No Trend	Increasing	No Trend	-	No Trend	Increasing
40	Fox River at Geneva	Decreasing	Decreasing	No Trend	Decreasing	Decreasing	Decreasing	Decreasing	-	Decreasing	No Trend
27	Fox River at Montgomery	Decreasing	Decreasing	Decreasing	No Trend	Decreasing	No Trend	No Trend	Decreasing	Decreasing	No Trend
34	Fox River at Yorkville	Decreasing	Decreasing	No Trend	Decreasing	Decreasing	Decreasing	Decreasing	-	Decreasing	Decreasing
28	<i>Blackberry Cr at Rt 47</i>	-	No Trend	-	No Trend	No Trend	No Trend	No Trend	No Trend	-	No Trend
287	<i>Blackberry Cr near Mouth</i>	No Trend	Decreasing	No Trend	No Trend	No Trend	No Trend	Decreasing	-	No Trend	Decreasing

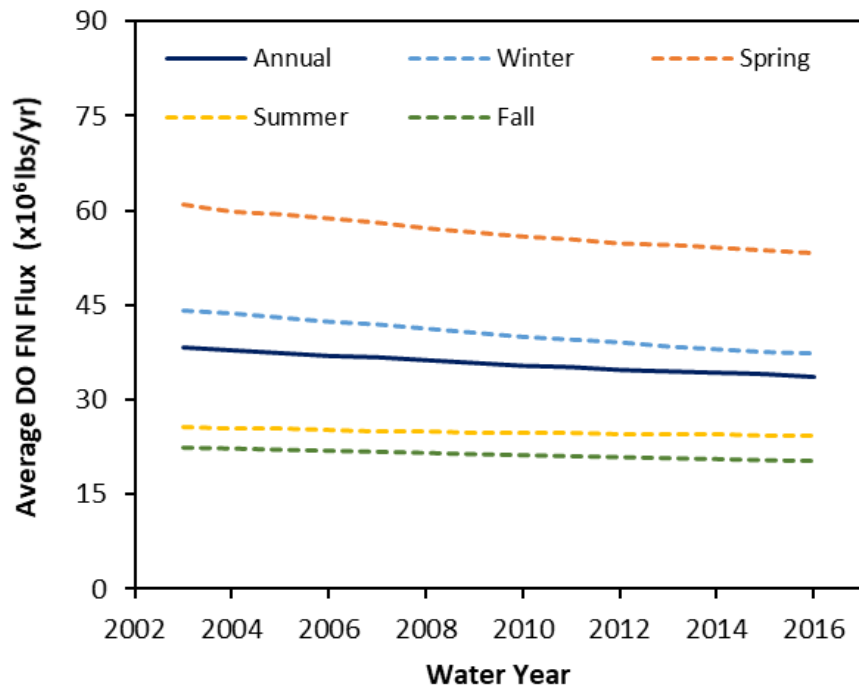
Trend Analysis on WQ Fluxes (loads)

- **Weighted Regression on Time, Discharge and Season (WRTDS)**: method to characterize trends in WQ fluxes
 - Requires long-term continuous discharge (streamflow) data, in addition to concentration data
- Applied to 3 stations with discharge data resulting in 19 WQ parameters analyzed:
 - Fox River at Montgomery, Blackberry Creek at Rt. 47 (Yorkville) and Poplar Creek at Elgin
- WQ Trends were estimated as changes in flow-normalized WQ fluxes computed the WRTDS models
 - Flow-normalized WQ fluxes eliminate the influence of year-to-year flow variation on the WQ parameter of interest

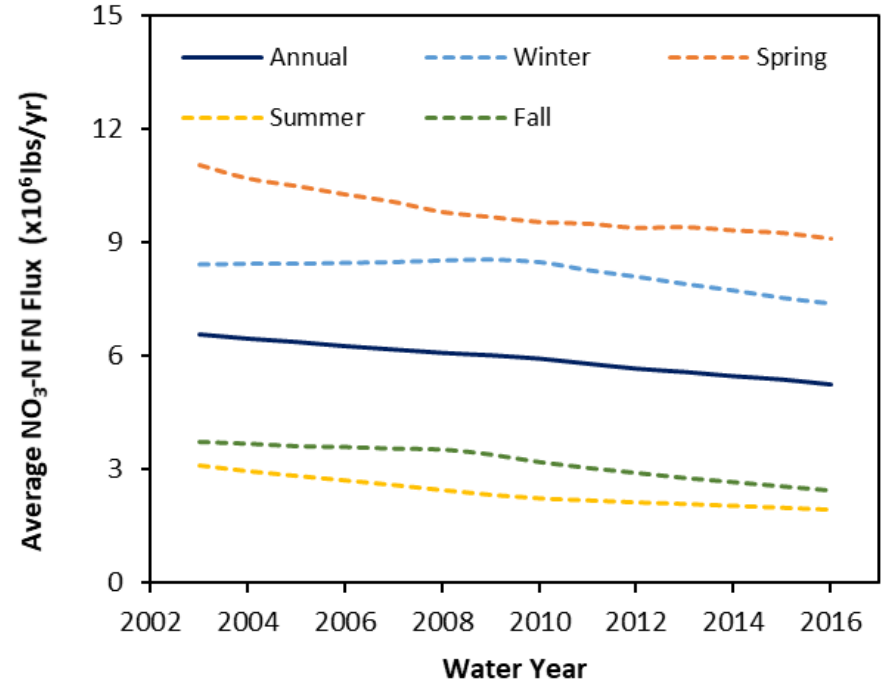
Trend Analysis ... (Cont'd)

- Trends in flow normalized (FN) fluxes for Fox River at Montgomery:

Dissolved Oxygen (lbs/yr)



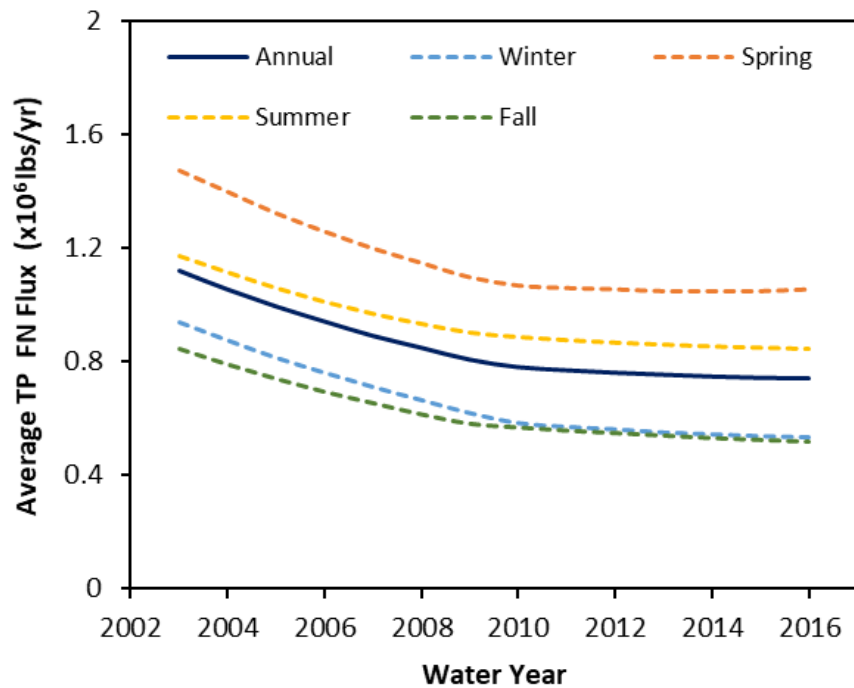
Nitrate-N (lbs/yr)



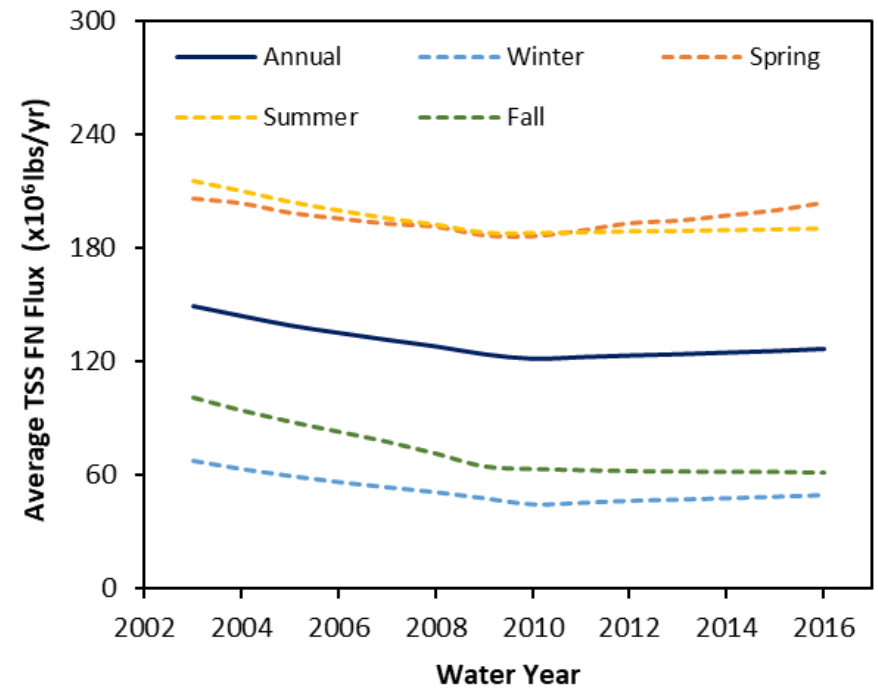
Trend Analysis ... (Cont'd)

- Trends in flow normalized (FN) fluxes for Fox River at Montgomery:

Total Phosphorus (lbs/yr)



Total Susp Solids (lbs/yr)



Water Quality Trend... (cont'd.)

- Trends in flow-normalized fluxes from 2006 to 2016 (%)

Station ID	Station Name		Org-N	NH ₃ -N	NO ₃ -N	TKN	TP	DP	DO	TSS	CHL-A
28	Blackberry Creek near Yorkville:	Annual	-	163.0	-	-15.0	43.0	46.0	-0.6	-	-
		Winter	-	108.0	-	-0.04	92.0	68.0	1.1	-	-
		Spring	-	190.0	-	-20.0	48.0	57.0	-5.2	-	-
		Summer	-	277.0	-	-26.0	4.8	13.0	-0.6	-	-
		Fall	-	198.0	-	2.7	37.0	32.0	9.2	-	-
27	Fox River at Montgomery:	Annual	-11.0	-14.0	-16.0	-7.8	-21.0	-25.0	-8.9	-6.3	-8.8
		Winter	-8.2	-22.0	-13.0	-14.0	-30.0	-21.0	-12.0	-13.0	-21.0
		Spring	-15.0	0.1	-11.0	-6.4	-16.0	-20.0	-9.3	4.2	-20.0
		Summer	-11.0	-12.0	-28.0	-4.0	-16.0	-31.0	-3.6	-4.7	6.7
		Fall	-3.5	-2.9	-32.0	-8.7	-25.0	-29.0	0.0	-26.0	-8.7
25	Poplar Creek at Elgin:	Annual	-	21.0	-	52.0	51.0	-35.0	3.8	-	-
		Winter	-	22.0	-	110.0	105.0	-29.0	4.4	-	-
		Spring	-	12.0	-	22.0	13.0	-41.0	4.5	-	-
		Summer	-	46.0	-	11.0	16.0	-36.0	2.0	-	-
		Fall	-	19.0	-	99.0	118.0	-30.0	2.7	-	-

Summary

- Exploratory Data Analysis followed by trend analysis using SKT method was conducted for a total of 141 WQ parameters (concentrations, pH) across 18 stations in the Fox River watershed.
 - Trend analyses results can only indicated either increasing, decreasing or no trend over the available period of record.
 - SKT generally indicate that WQ is either improving or stable across most stations with some exceptions.

Summary (concluded)

- Additional opportunity to conduct flow-normalized flux (load) trend analyses on 3 stations that also had discharge data.
 - 19 WQ fluxes across 3 of the 18 stations were completed by developing WRTDS models for each available WQ parameter.
 - Fox River at Montgomery, most of the WQ parameters showed improvement across all seasons from 2006 to 2016 (as evidenced by flow-normalized WQ fluxes.
 - Blackberry Creek at Rt. 47 (Yorkville) and Poplar Creek at Elgin show mostly increasing trends.

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