

# Lake Waukewan and Winona Water Quality Trends and Management

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NHDES VLAP Program Coordinator



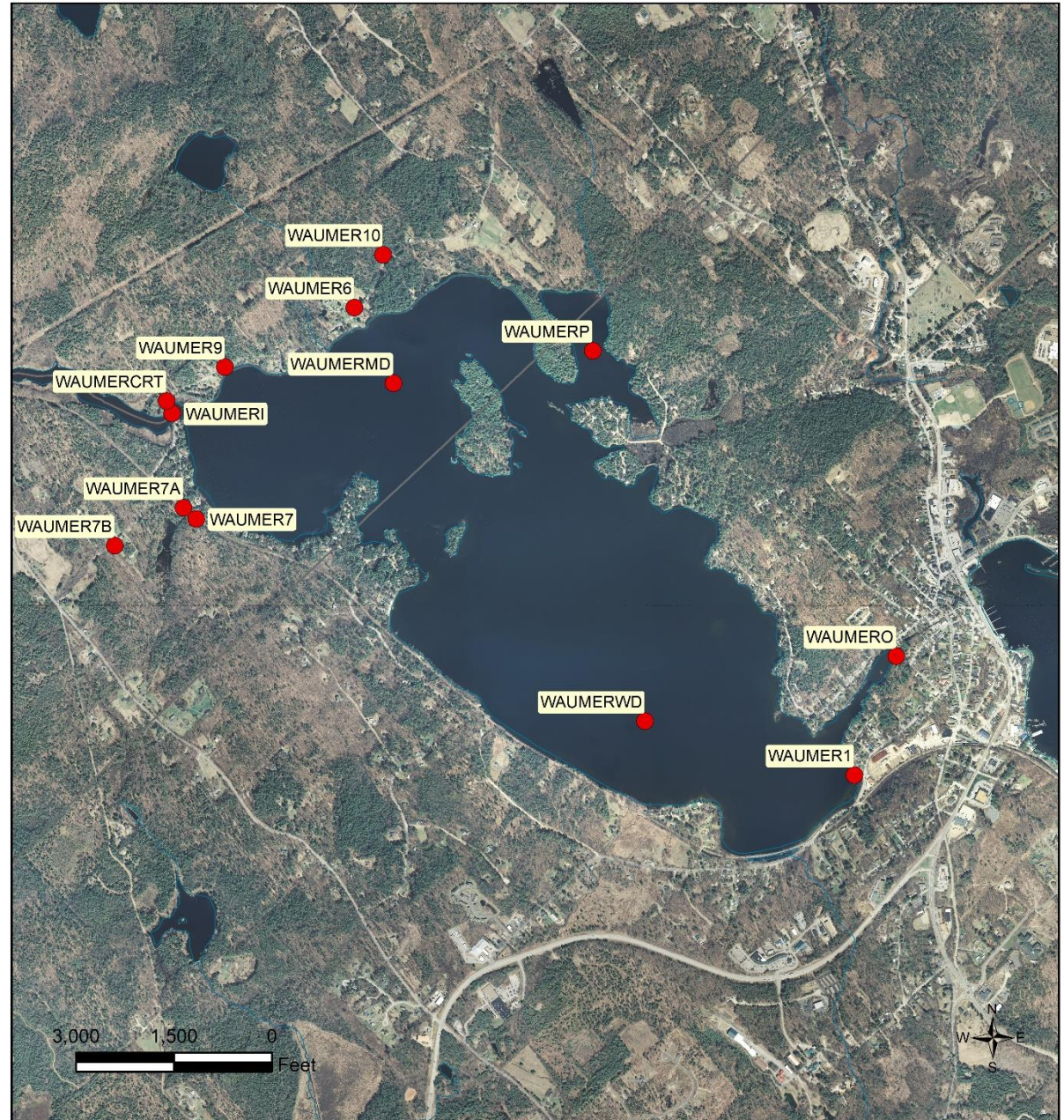


# Presentation

- Waukewan and Winona Water Quality Parameters and Trends
- VLAP Reports and Recommendations

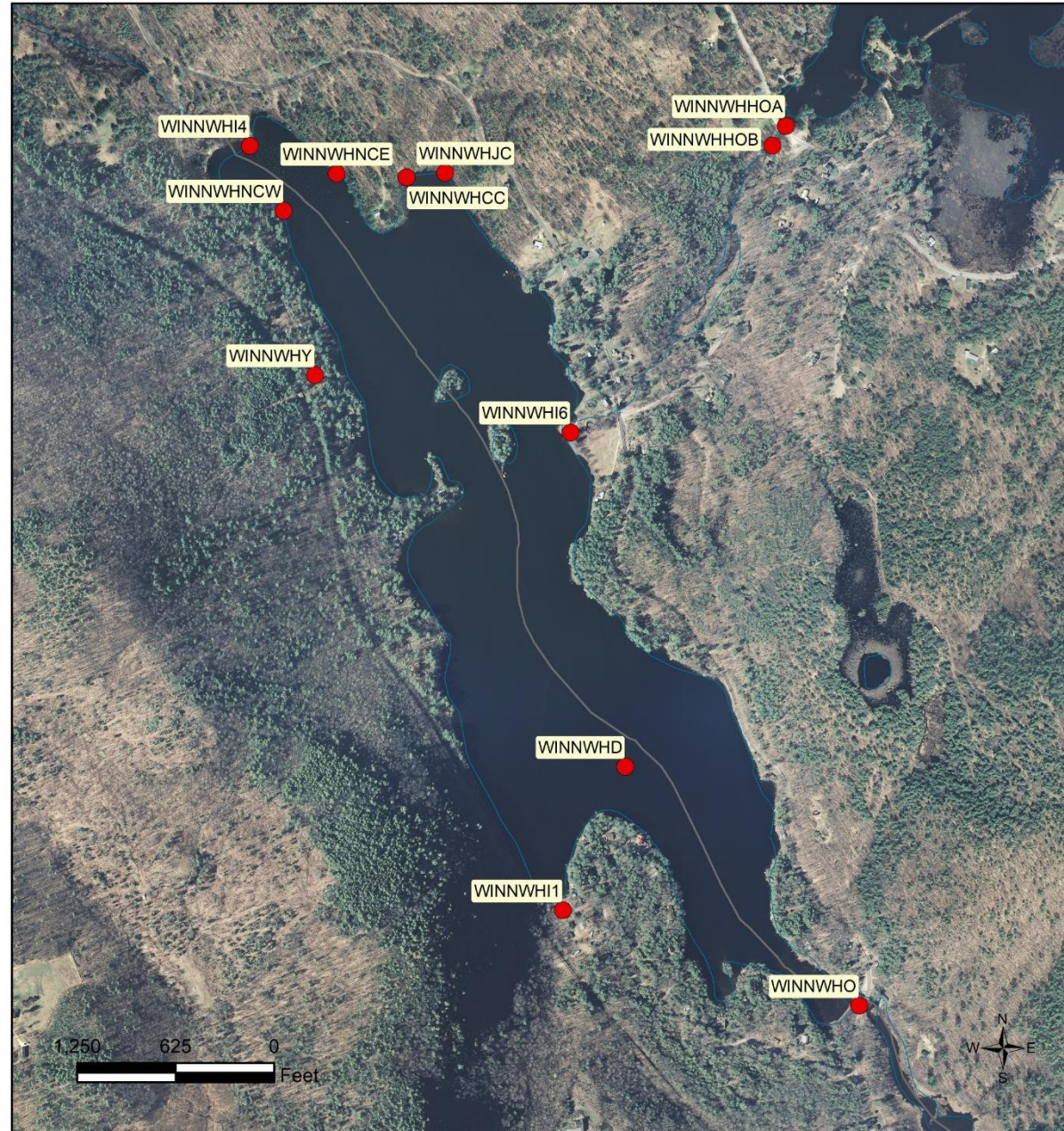


# Lake Waukewan Sample Locations

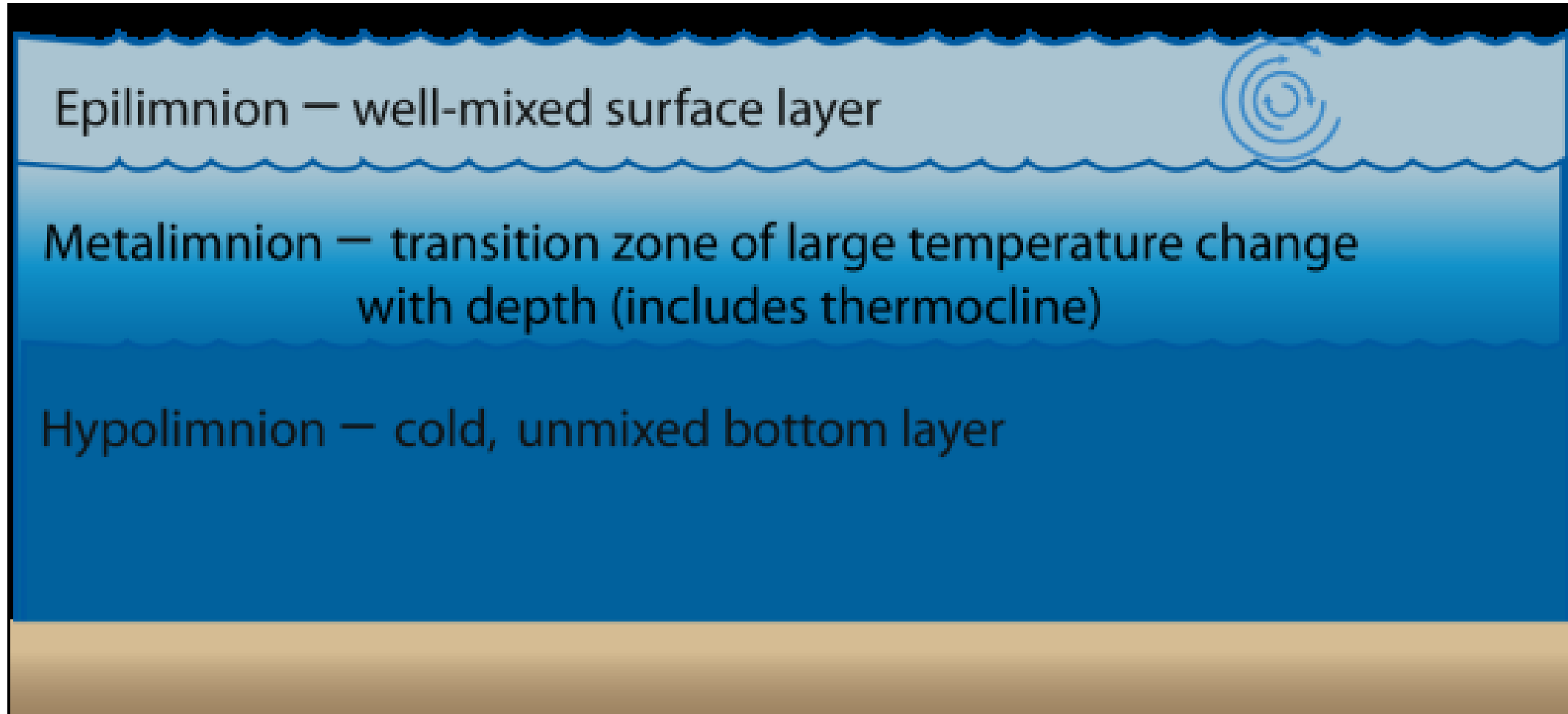




# Lake Winona Sample Locations



# VLAP Monitoring







# VLAP Monitoring

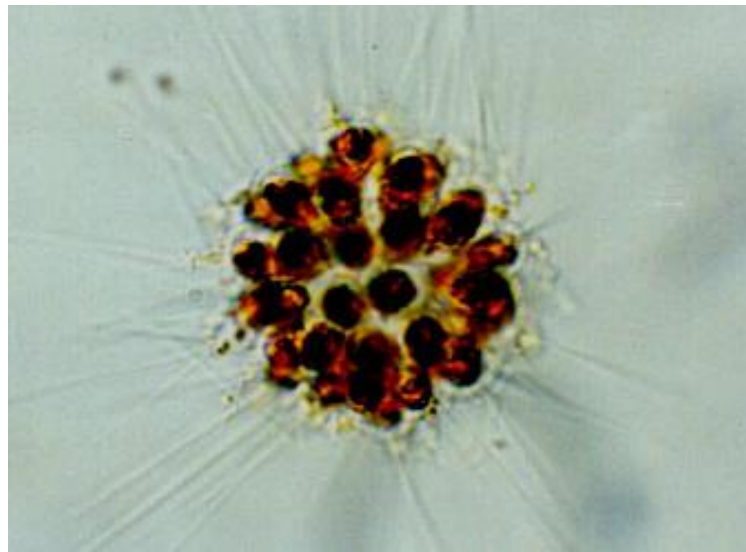
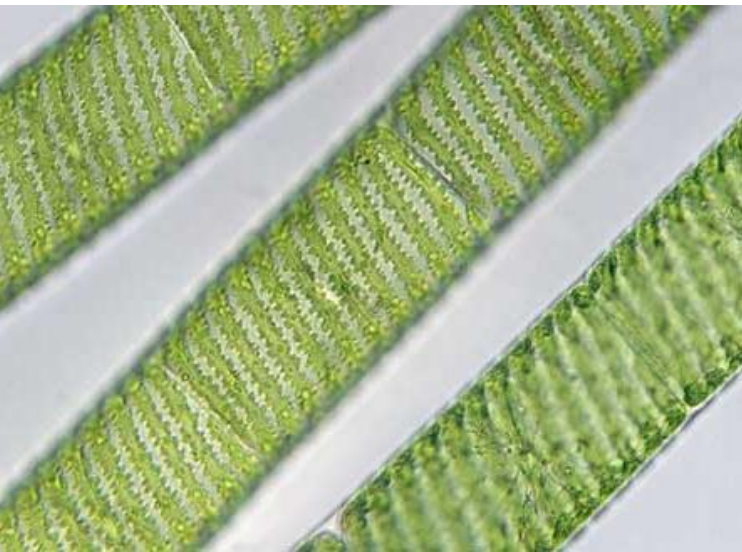
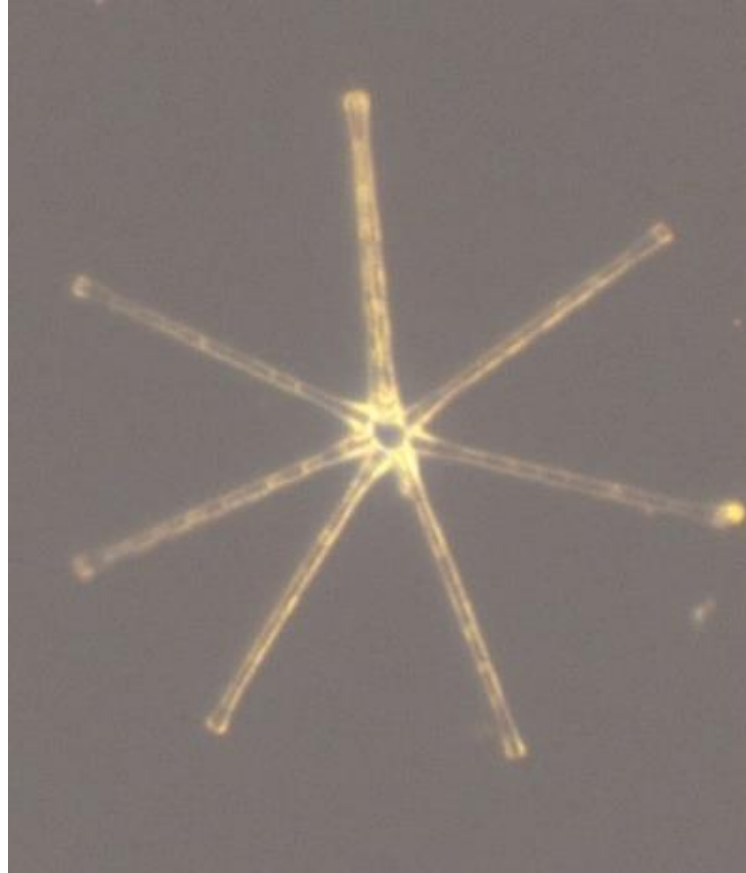
- Samples analyzed for variety of parameters
- Indicators of lake health:
  - Chlorophyll-a
  - Transparency
  - Total Phosphorus
  - Conductivity/chloride
- Can you swim and recreate?
- Can aquatic life thrive?

# Water Analyses

## Chlorophyll-a:

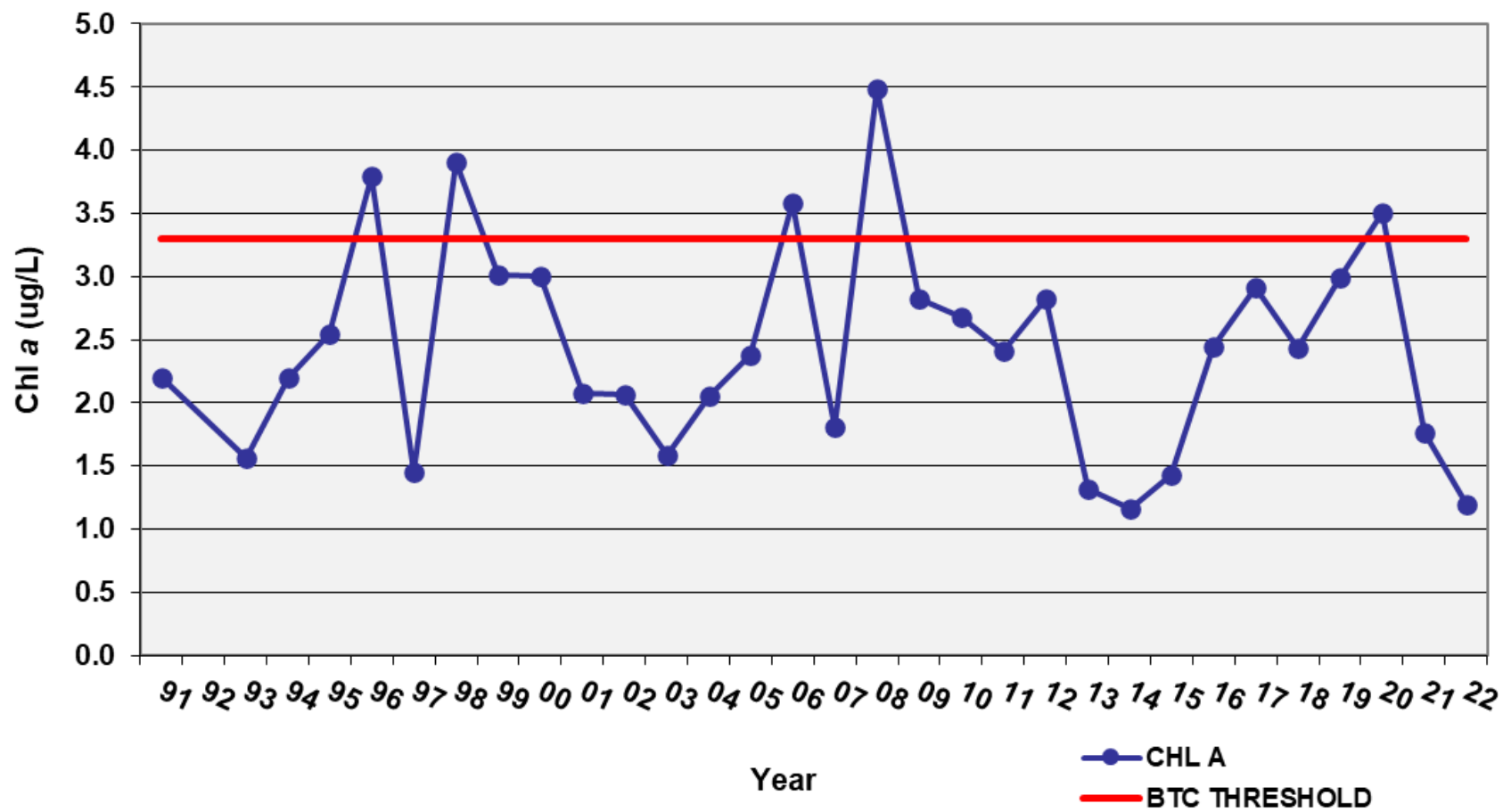
Photosynthetic pigment in plants, algae and cyanobacteria.

- Provides general indication of algal or cyanobacteria abundance.
- High Chl-a concentrations can indicate algal blooms caused by too many nutrients.



# Waukewan Lake, Mayo Deep Spot

Average Chlorophyll a values at Lake Waukewan, Mayo Stn., Meredith  
(1991-2022)



## Water Quality Trends

**Range:**  
1.16 to 4.49 ug/L

**Median:**  
2.41 ug/L

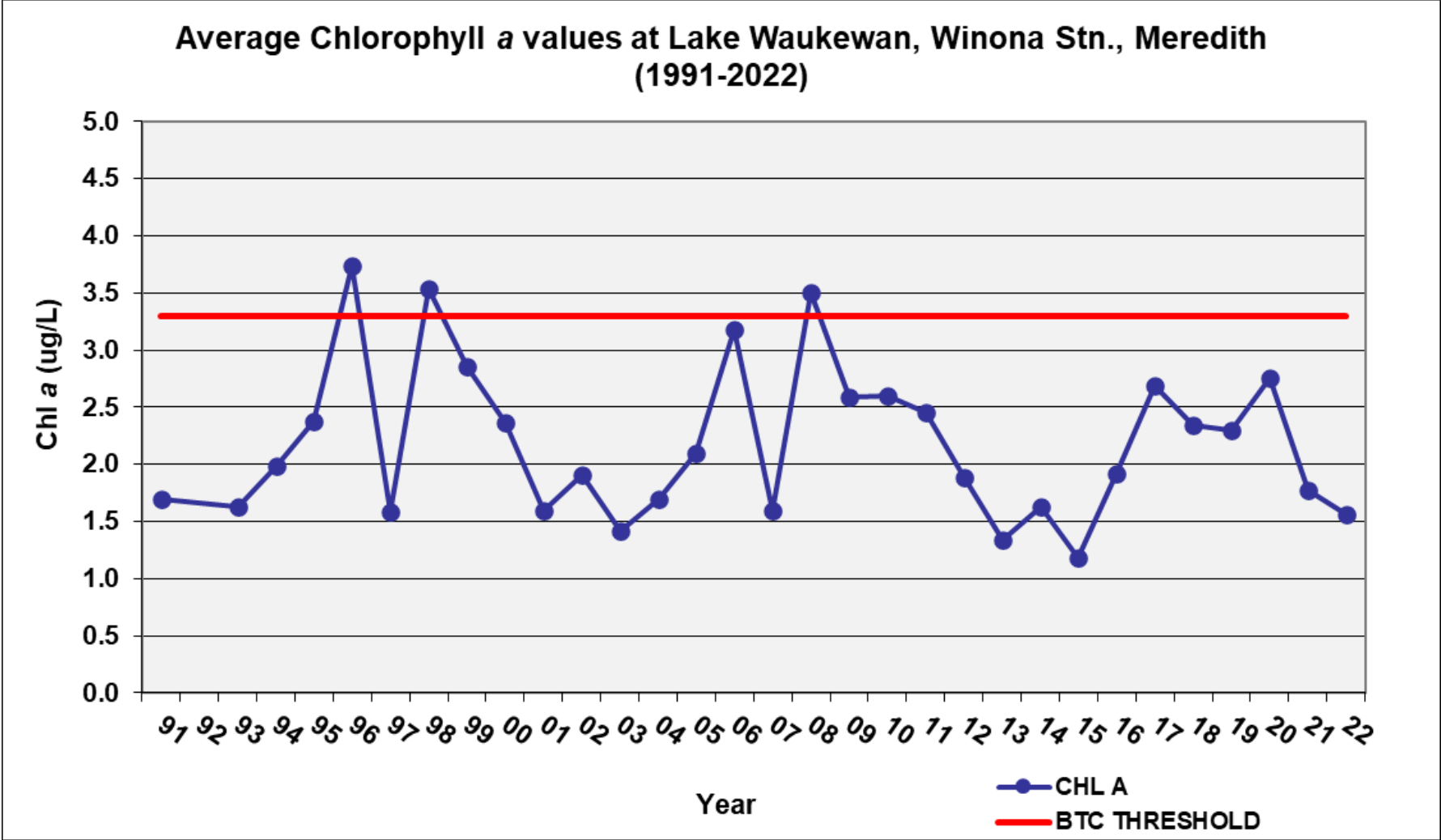
**BTC Threshold:**  
3.3 ug/L

**Good Range:**  
0.0 – 5.0 ug/L

**Algal blooms:**  
> 15.0 ug/L



# Waukewan Lake, Winona Deep Spot



## Water Quality Trends

**Range:**  
1.18 and 3.74 ug/L

**Median:**  
2.19 ug/L

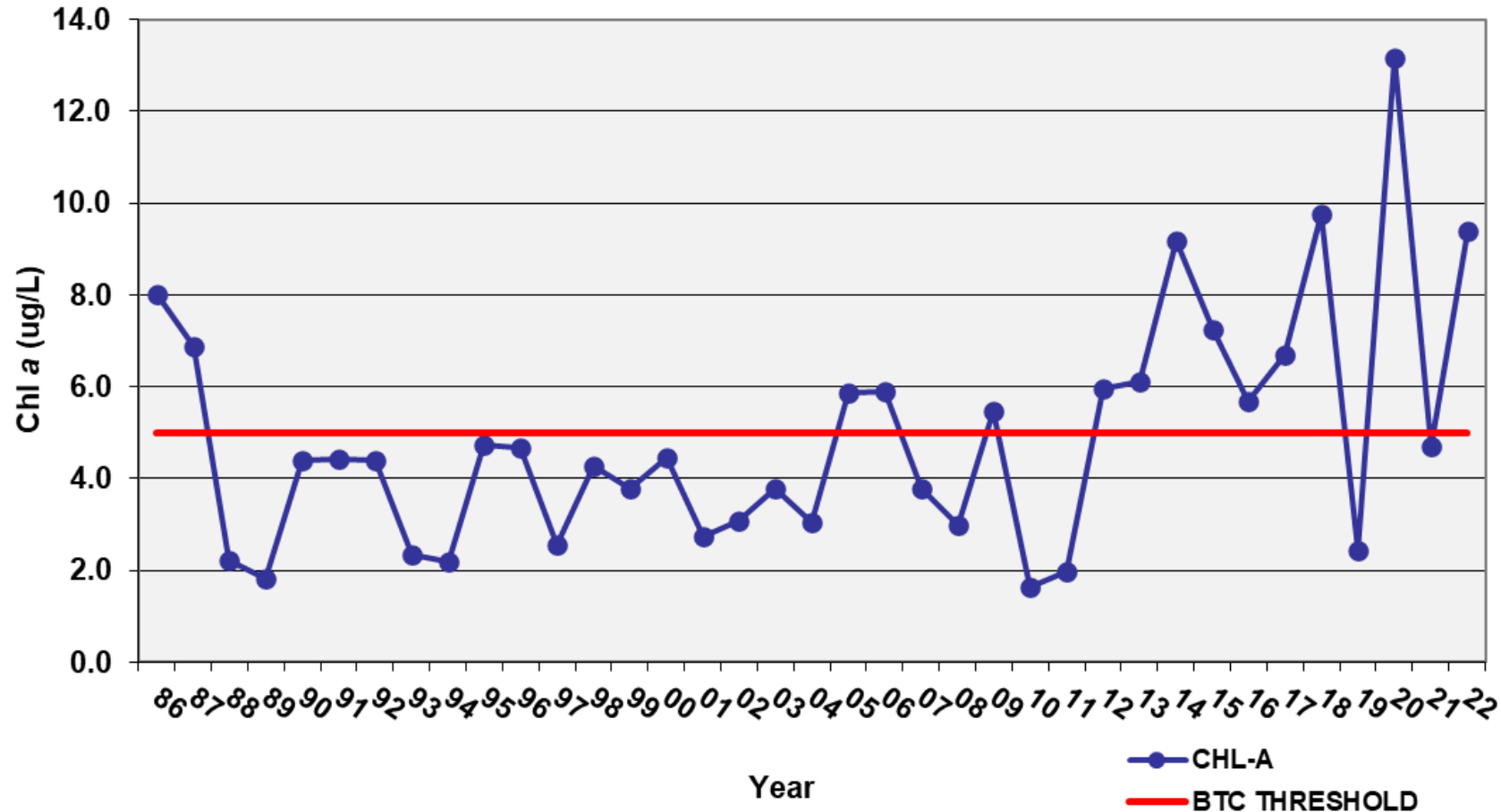
**BTC Threshold:**  
3.3 ug/L

**Good Range:**  
0.0 – 5.0 ug/L

**Algal blooms:**  
> 15.0 ug/L

# Lake Winona, New Hampton

Average Chlorophyll a values at Lake Winona, New Hampton  
(1986-2022)



## Water Quality Trends

**Range:**  
1.65 and 13.17 ug/L

**Median:**  
4.44 ug/L

**BTC Threshold:**  
5.0 ug/L

**Good Range:**  
0.0 – 5.0 ug/L

**Algal blooms:**  
15.0 ug/L

**Trend:**  
Worsening



# Water Analyses

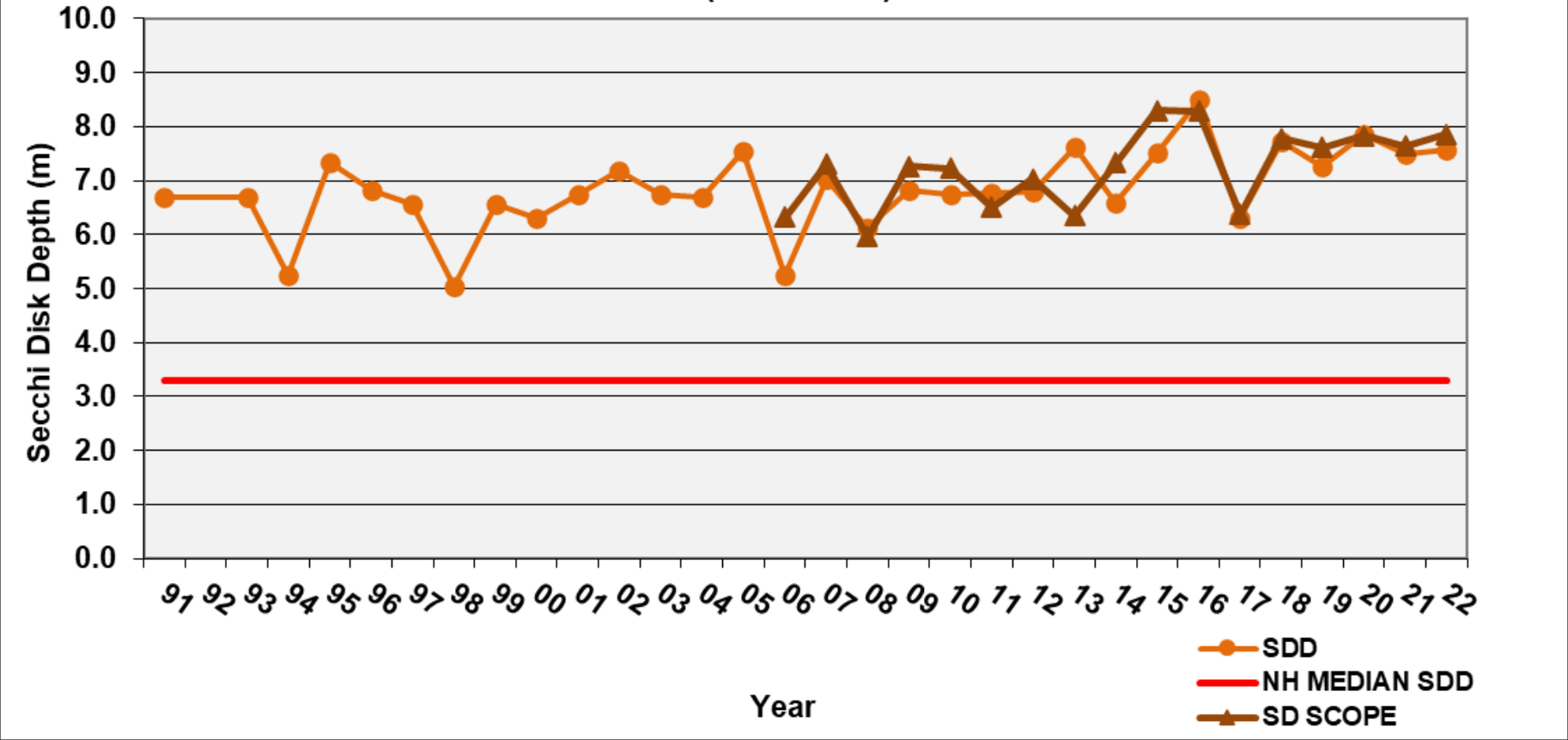
**Transparency:** measure of water clarity

- **Measured using a Secchi Disk**
- **Influenced by:**
  - Water color
  - Turbidity: sediments, fine particulate matter, algae
  - Surface conditions



# Lake Waukewan, Mayo Deep Spot

Average Secchi Disk values at Lake Waukewan, Mayo Stn., Meredith  
(1991-2022)



## Water Quality Trends

**Range:**  
5.03 - 8.5 meters

**Median:**  
6.77 meters

**NH Median:**  
3.3 meters

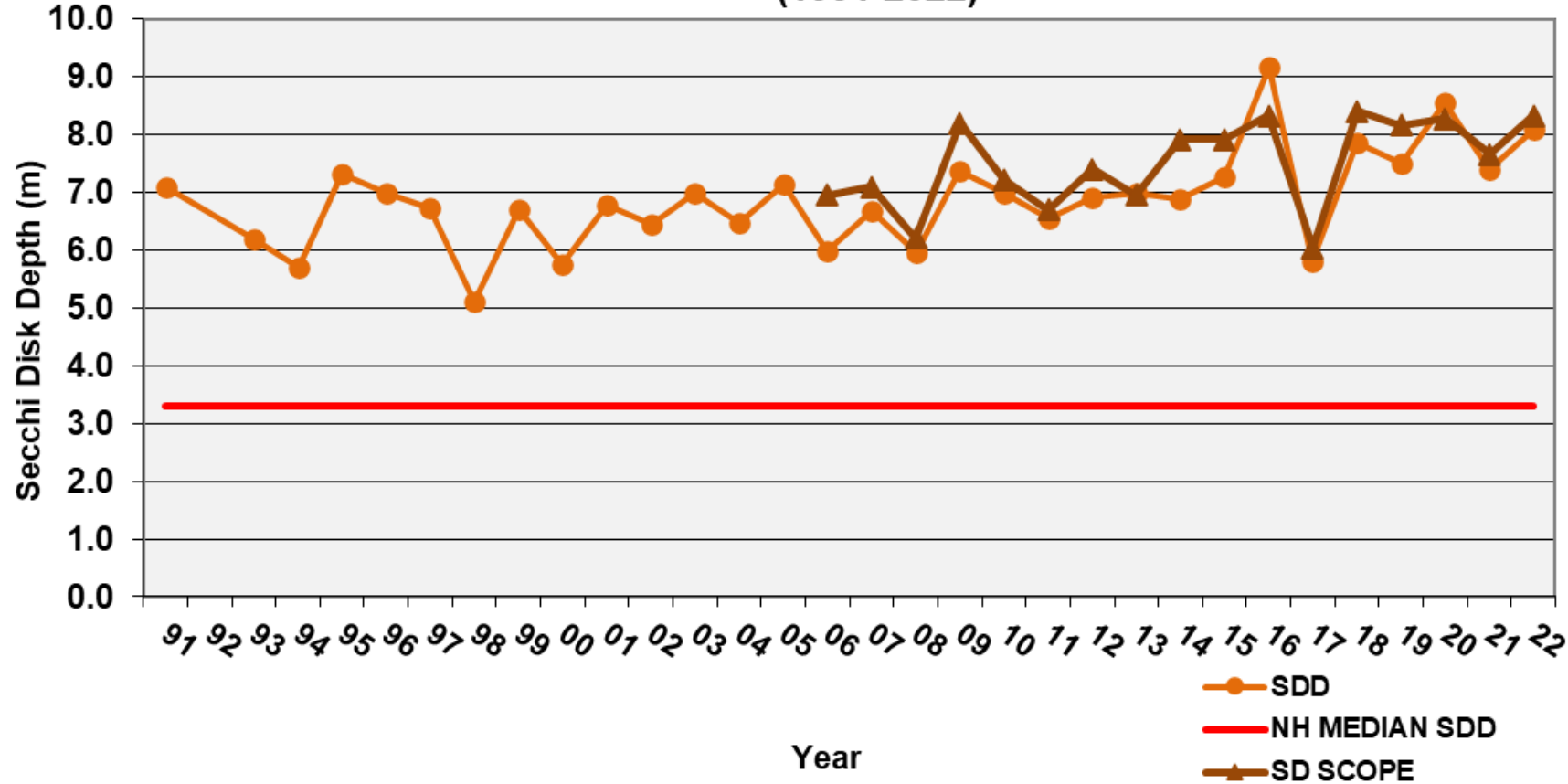
**Good Range:**  
2.0 – 4.5 meters

**Trend:**  
Improving



# Lake Waukewan, Winona Deep Spot

Average Secchi Disk values at Lake Waukewan, Winona Stn., Meredith  
(1991-2022)



## Water Quality Trends

**Range:**  
5.10 – 9.17 meters

**Median:**  
6.90 meters

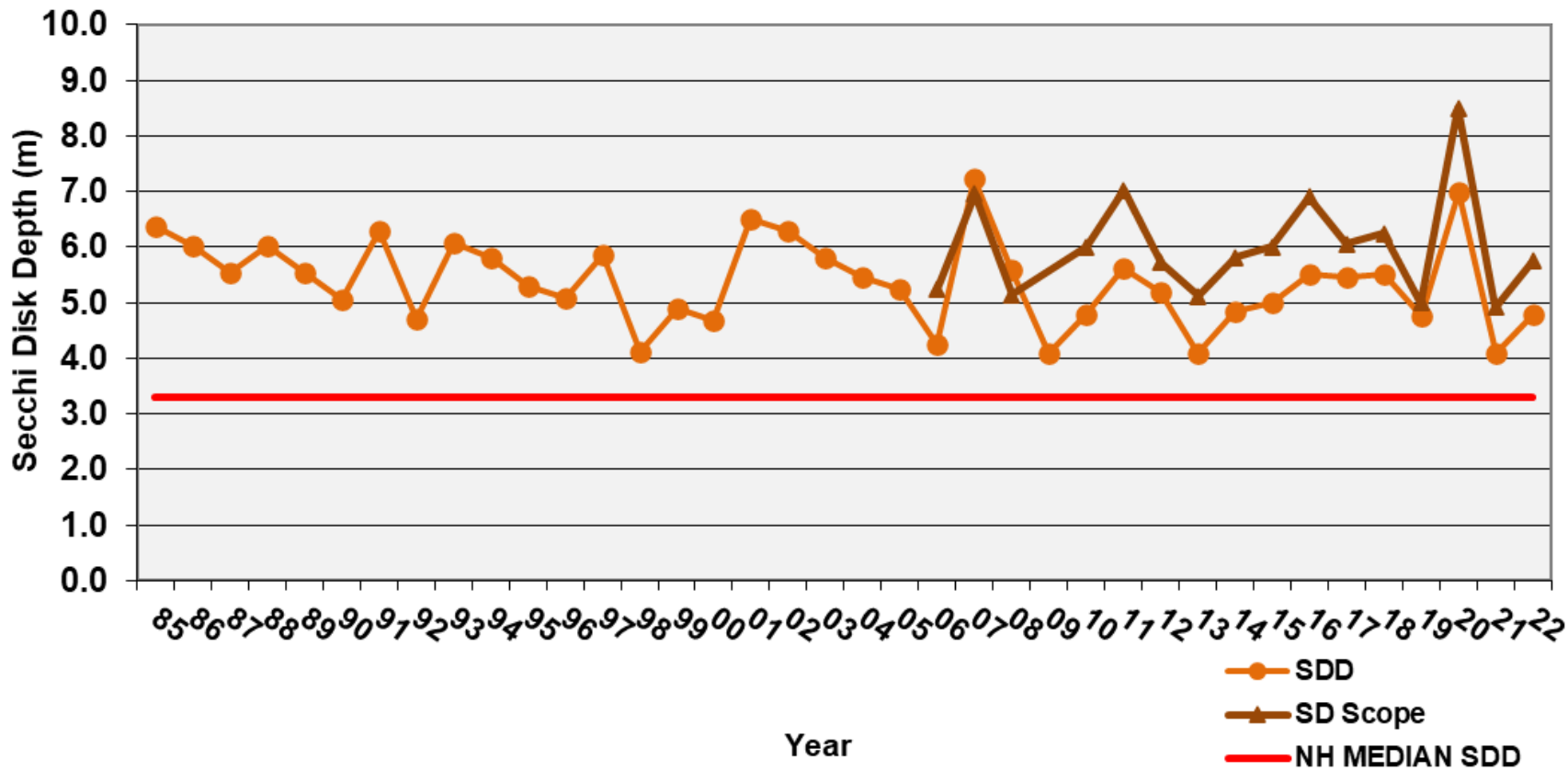
**NH Median:**  
3.3 meters

**Good Range:**  
2.0 – 4.5 meters

**Trend:**  
Improving

# Lake Winona, New Hampton Deep Spot

Average Secchi Disk values at Lake Winona, New Hampton  
(1985-2022)



## Water Quality Trends

**Range:**  
4.09 – 7.22 meters

**Median:**  
5.45 meters

**NH Median:**  
3.3 meters

**Good Range:**  
2.0 – 4.5 meters

**Trend:**  
Stable



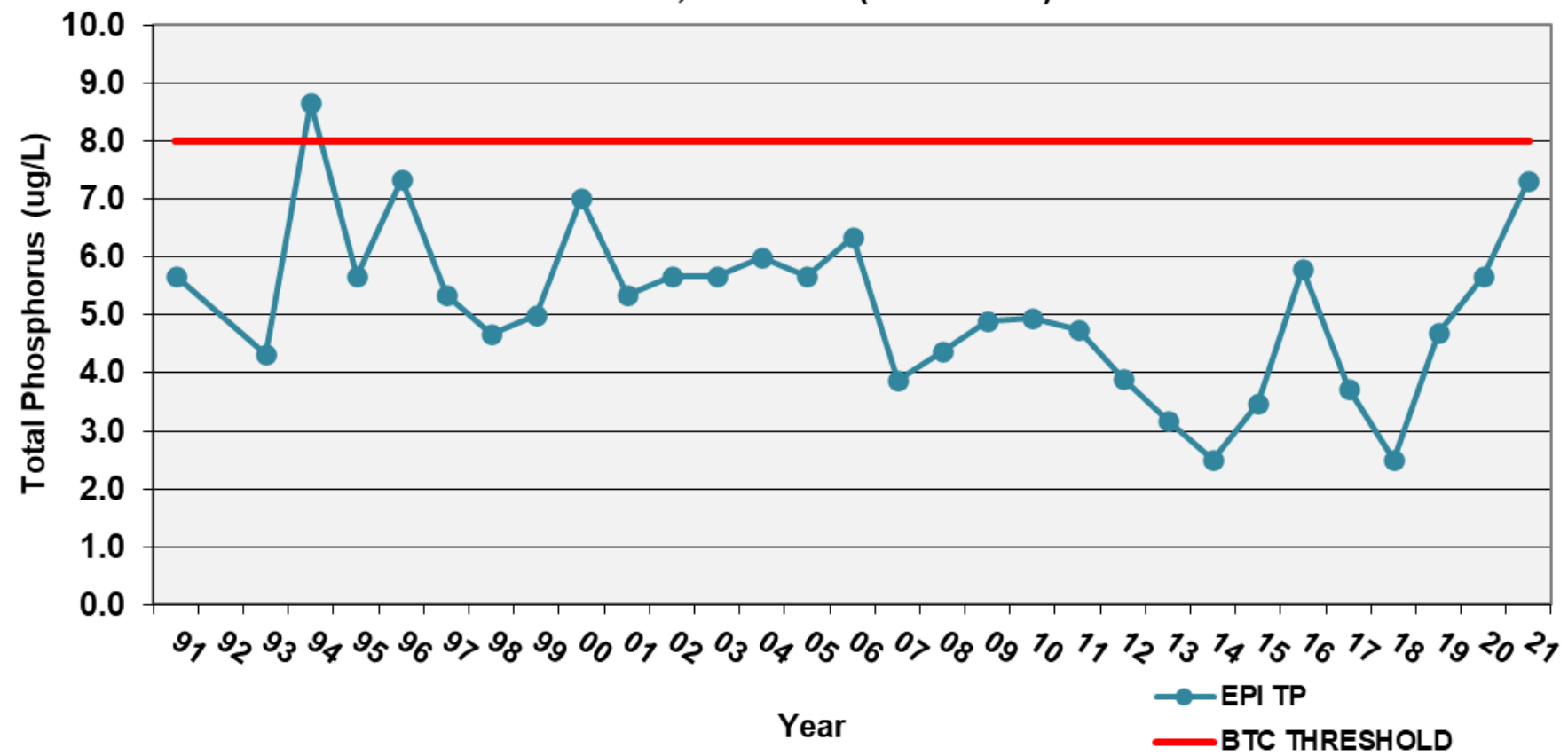


## Water Analyses

**Total Phosphorus:** nutrient that promotes plant and algal growth

# Lake Waukewan, Mayo Deep Spot

Average Epilimnetic Total Phosphorus Values at Lake Waukewan, Mayo Stn., Meredith (1991-2021)



## Water Quality Trends

**Range:**  
3 – 9 ug/L

**Median:**  
5 ug/L

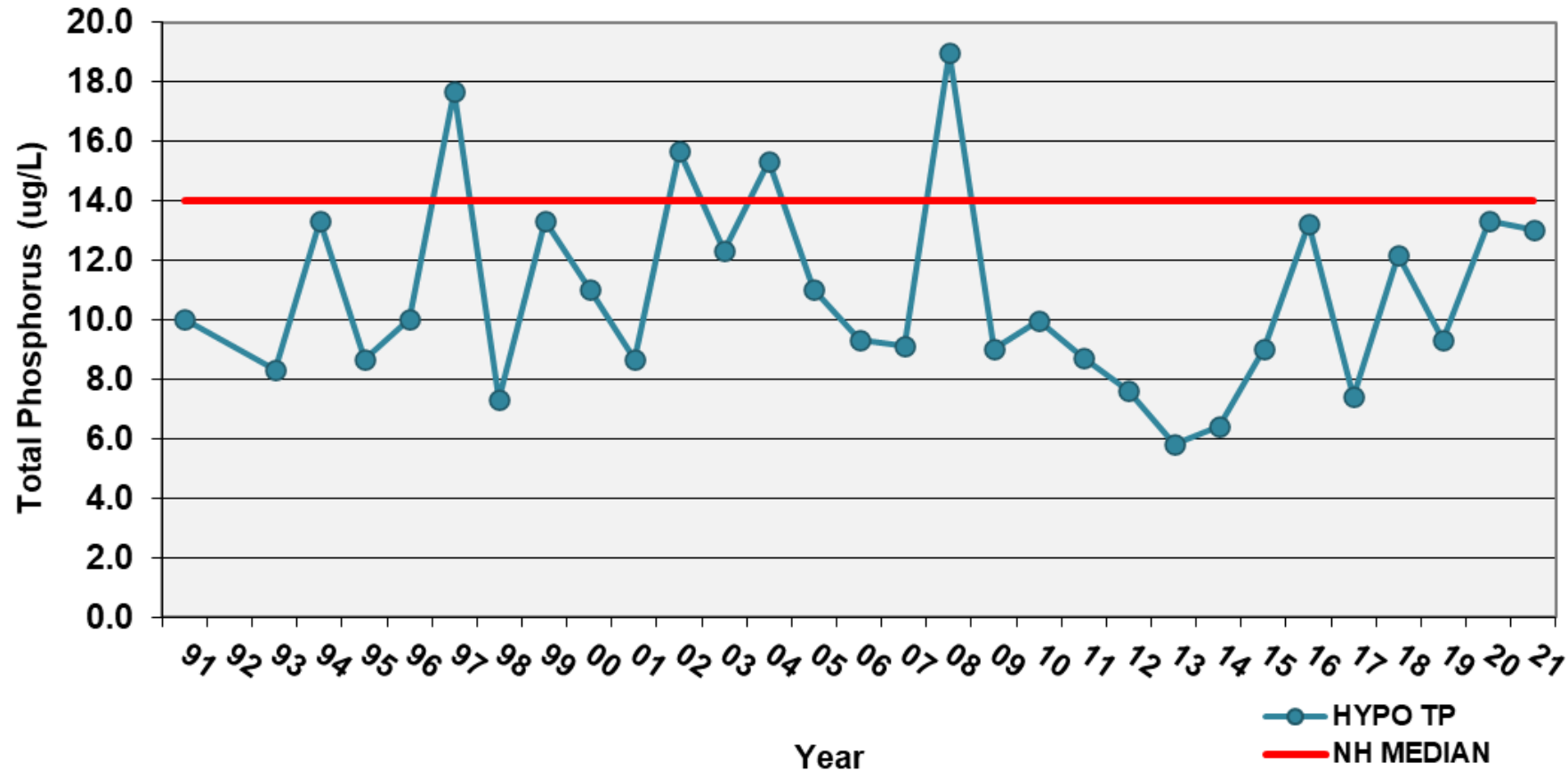
**BTC Threshold:**  
8 ug/L

**Good Range:**  
1 – 12 ug/L

**Trend:**  
Stable

# Lake Waukewan, Mayo Deep Spot

Average Hypolimnetic Total Phosphorus Values at Lake Waukewan, Mayo  
Stn., Meredith (1991-2021)



## Water Quality Trends

**Range:**  
6 – 19 ug/L

**Median:**  
10 ug/L

**NH Median:**  
14 ug/L

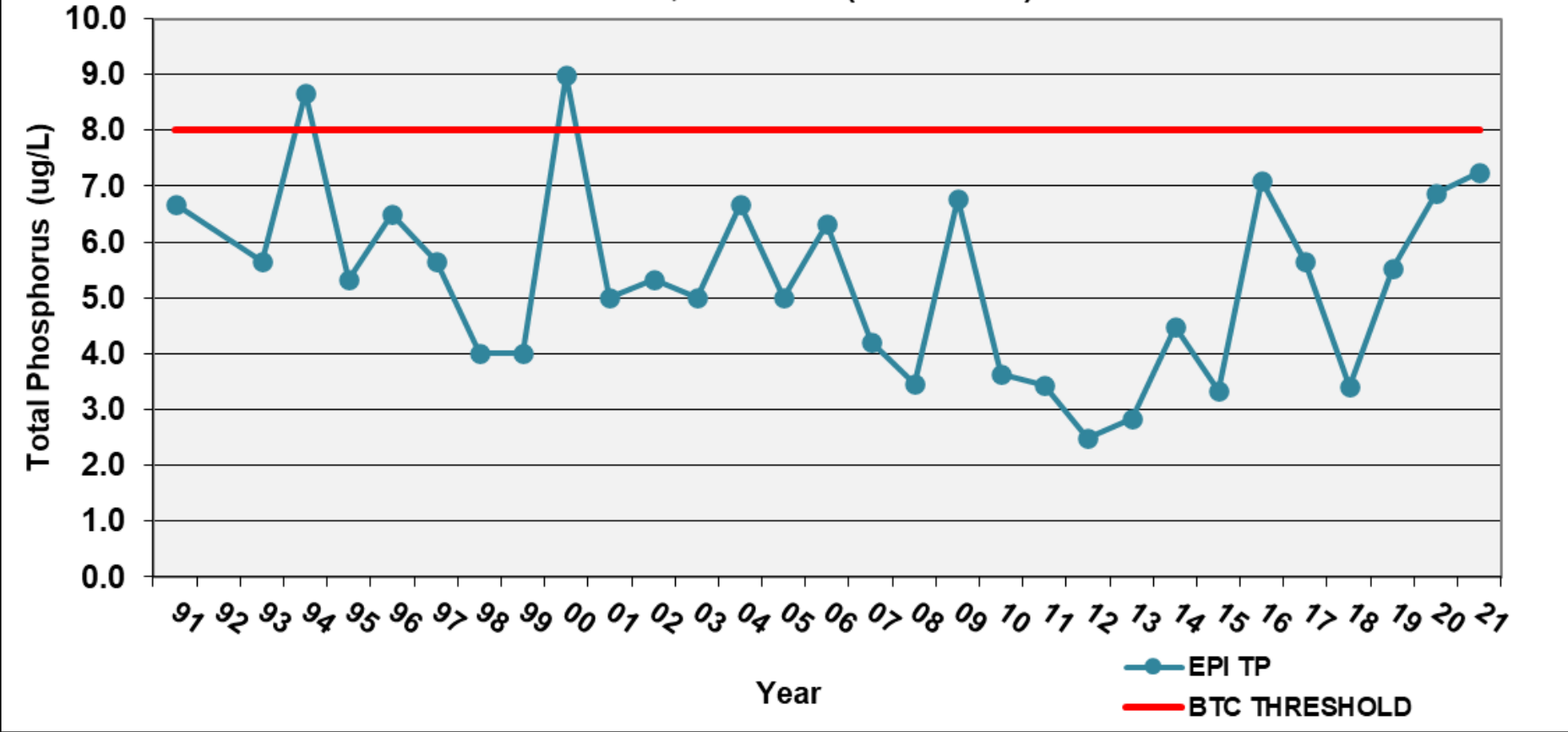
**Good Range:**  
1 – 12 ug/L

**Trend:**  
Stable



# Lake Waukewan, Winona Deep Spot

Average Epilimnetic Total Phosphorus Values at Lake Waukewan, Winona Stn., Meredith (1991-2021)



## Water Quality Trends

**Range:**  
3 – 9 ug/L

**Median:**  
5 ug/L

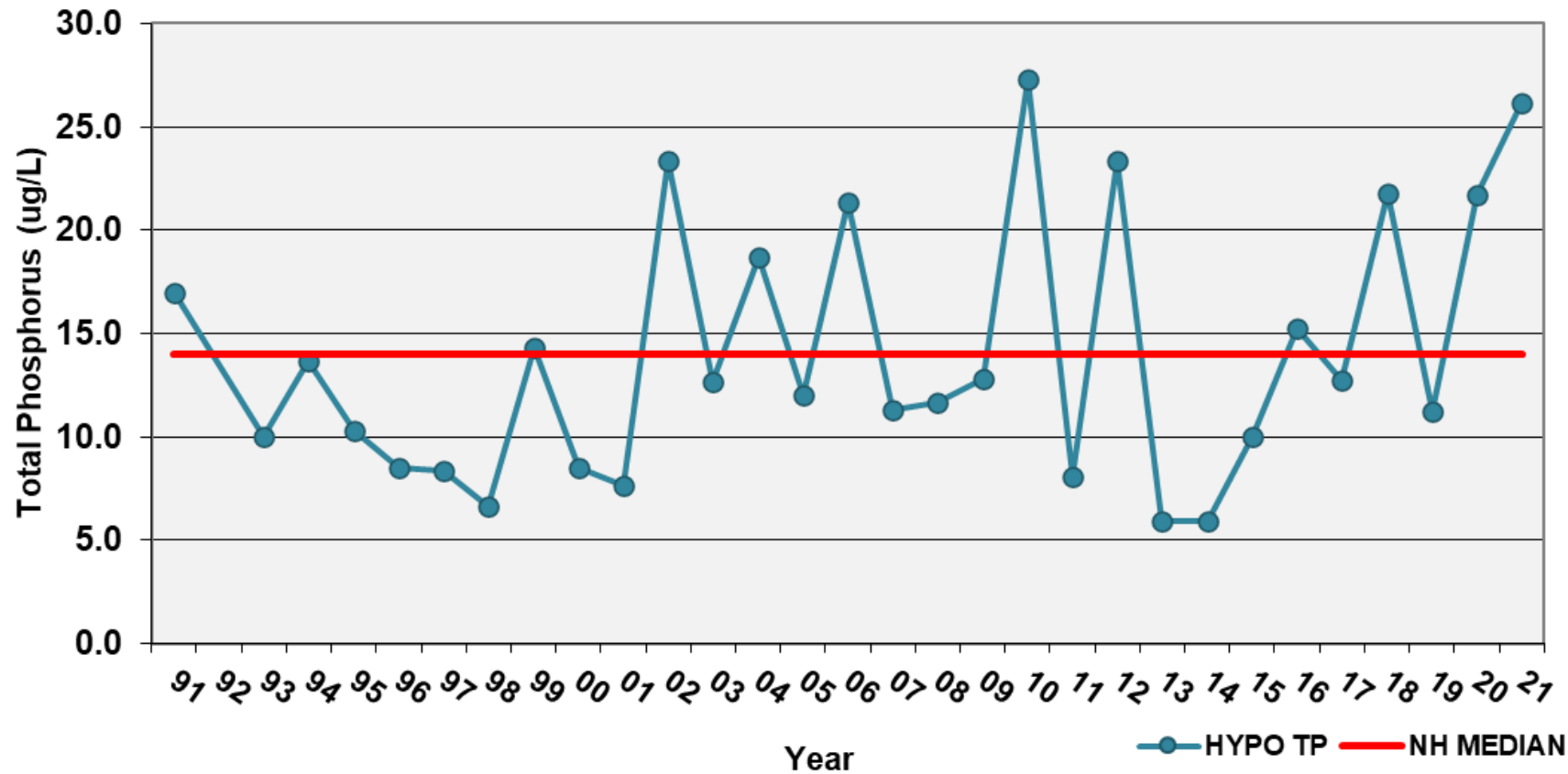
**BTC Threshold:**  
8 ug/L

**Good Range:**  
1 – 12 ug/L

**Trend:**  
Stable

# Lake Waukewan, Winona Deep Spot

Average Hypolimnetic Total Phosphorus Values at Lake Waukewan,  
Winona Stn., Meredith (1991-2021)



## Water Quality Trends

**Range:**  
6 – 27 ug/L

**Median:**  
12 ug/L

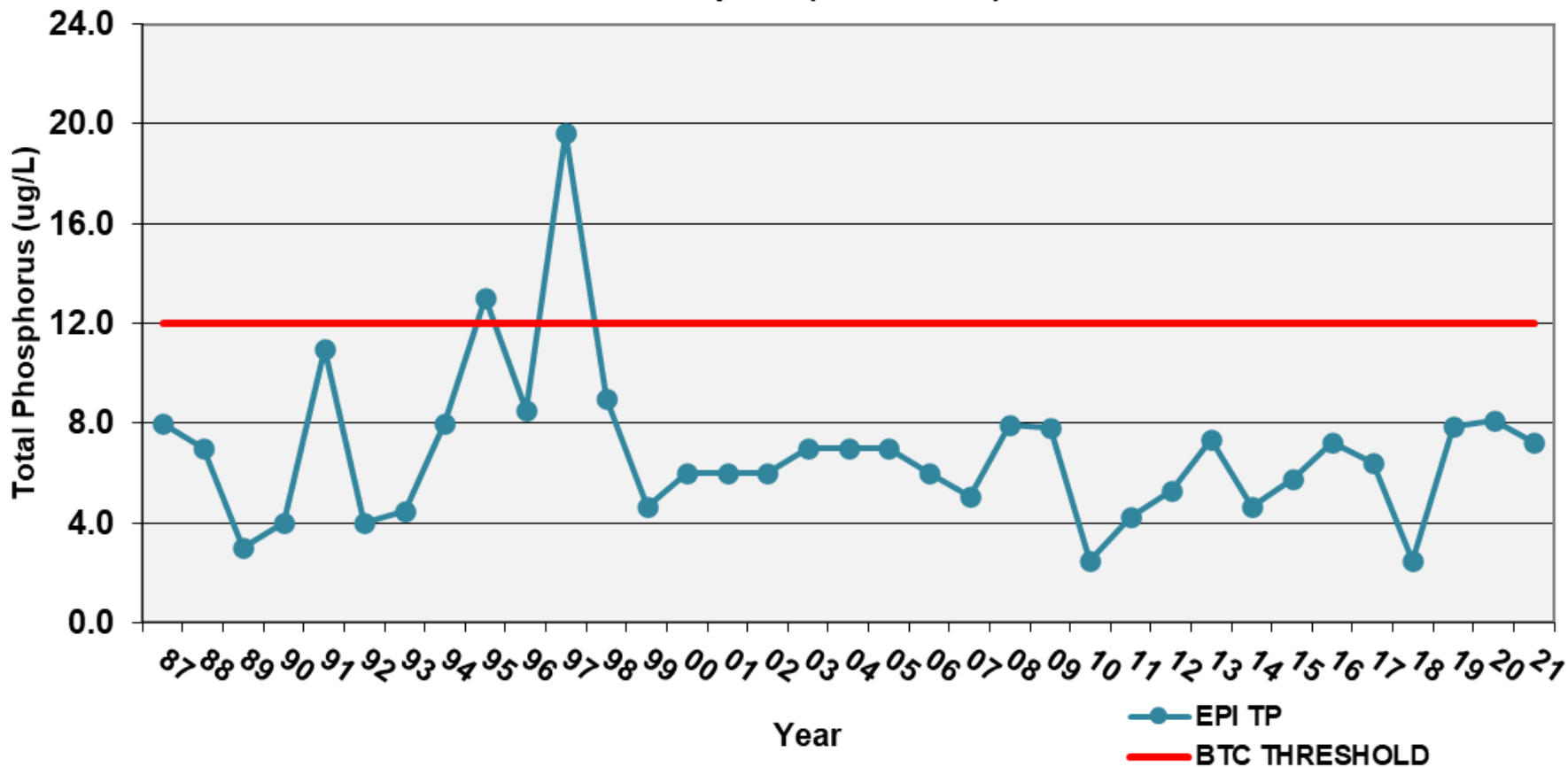
**NH Median:**  
14 ug/L

**Good Range:**  
1 – 12 ug/L

**Trend:**  
Stable

# Lake Winona Deep Spot

Average Epilimnetic Total Phosphorus Values at Lake Winona, New Hampton (1987-2021)



## Water Quality Trends

**Range:**  
3 – 20 ug/L

**Median:**  
7 ug/L

**BTC Threshold:**  
12 ug/L

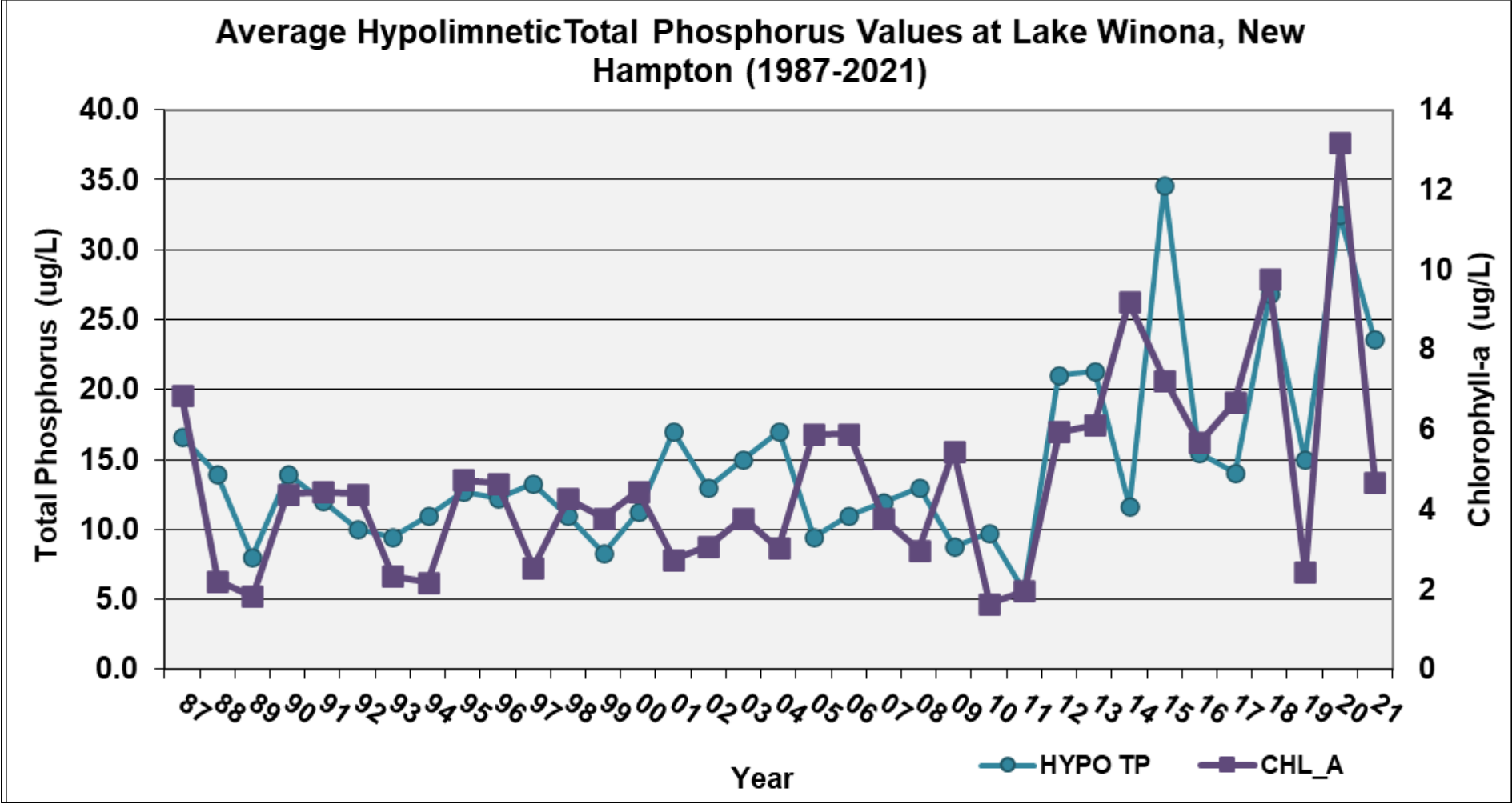
**Good Range:**  
1 – 12 ug/L

**Trend:**  
Stable



# Lake Winona Deep Spot

Average Hypolimnetic Total Phosphorus Values at Lake Winona, New Hampton (1987-2021)



## Water Quality Trends

**Range:**  
6 – 35 ug/L

**Median:**  
13 ug/L

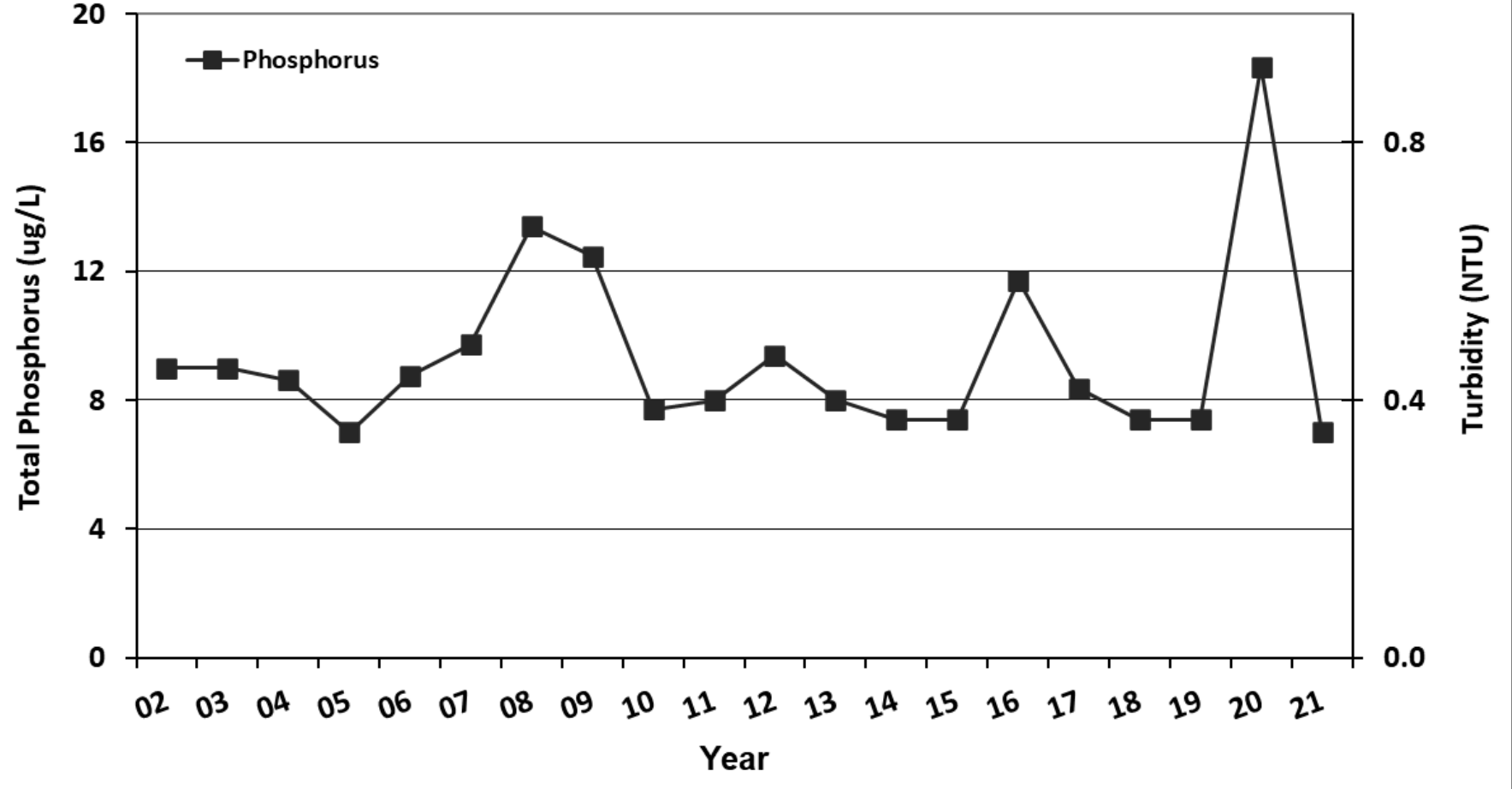
**NH Median:**  
14 ug/L

**Good Range:**  
1 – 12 ug/L

**Trend:**  
Worsening

# Snake River

Average Annual Total Phosphorus and Turbidity of Snake River



## Water Quality Trends

**Range:**  
5 – 29 ug/L

**Median:**  
8 ug/L

**Good Range:**  
1 – 12 ug/L

**Trend:**  
Stable

# Nutrients : Algae : Clarity Relationships

Increases in nutrients



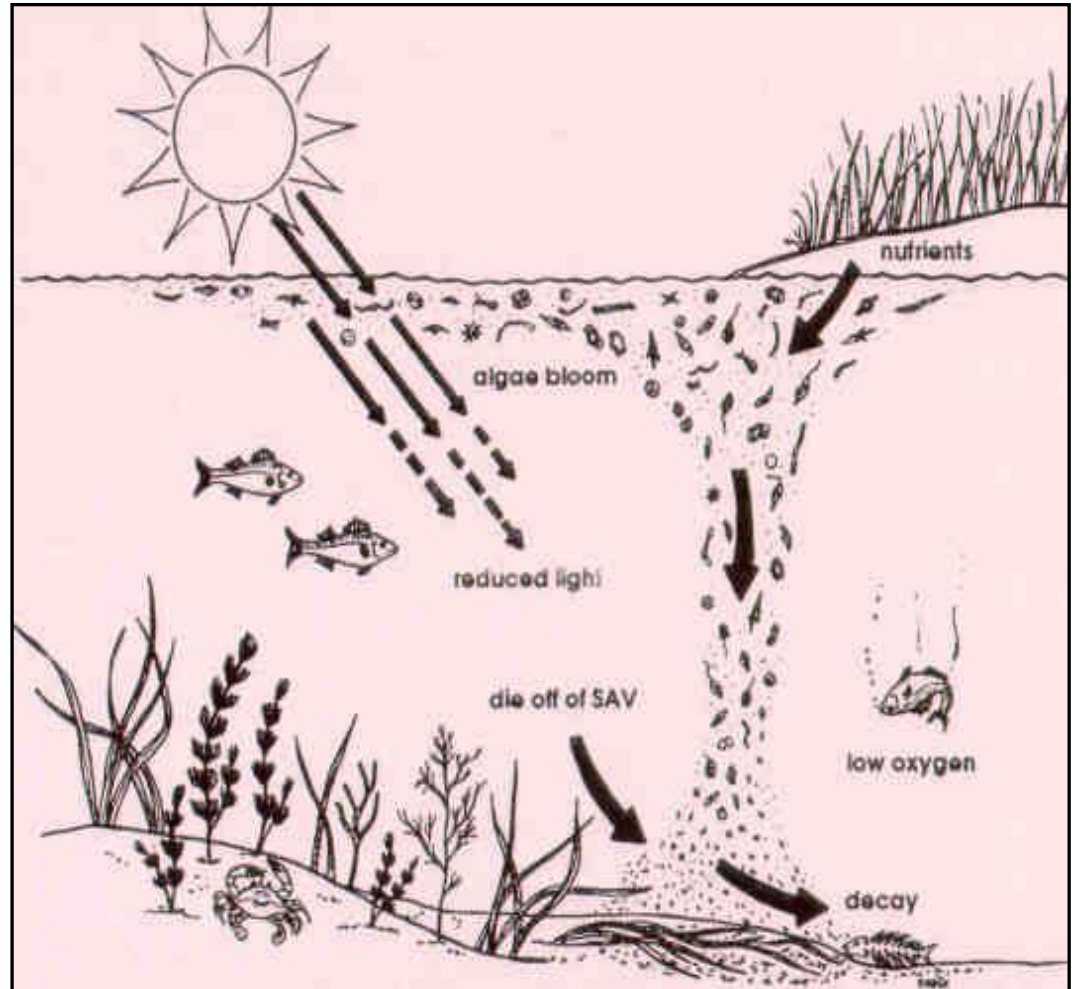
Increases in algae



Decreases in lake clarity



Decreases in property values!





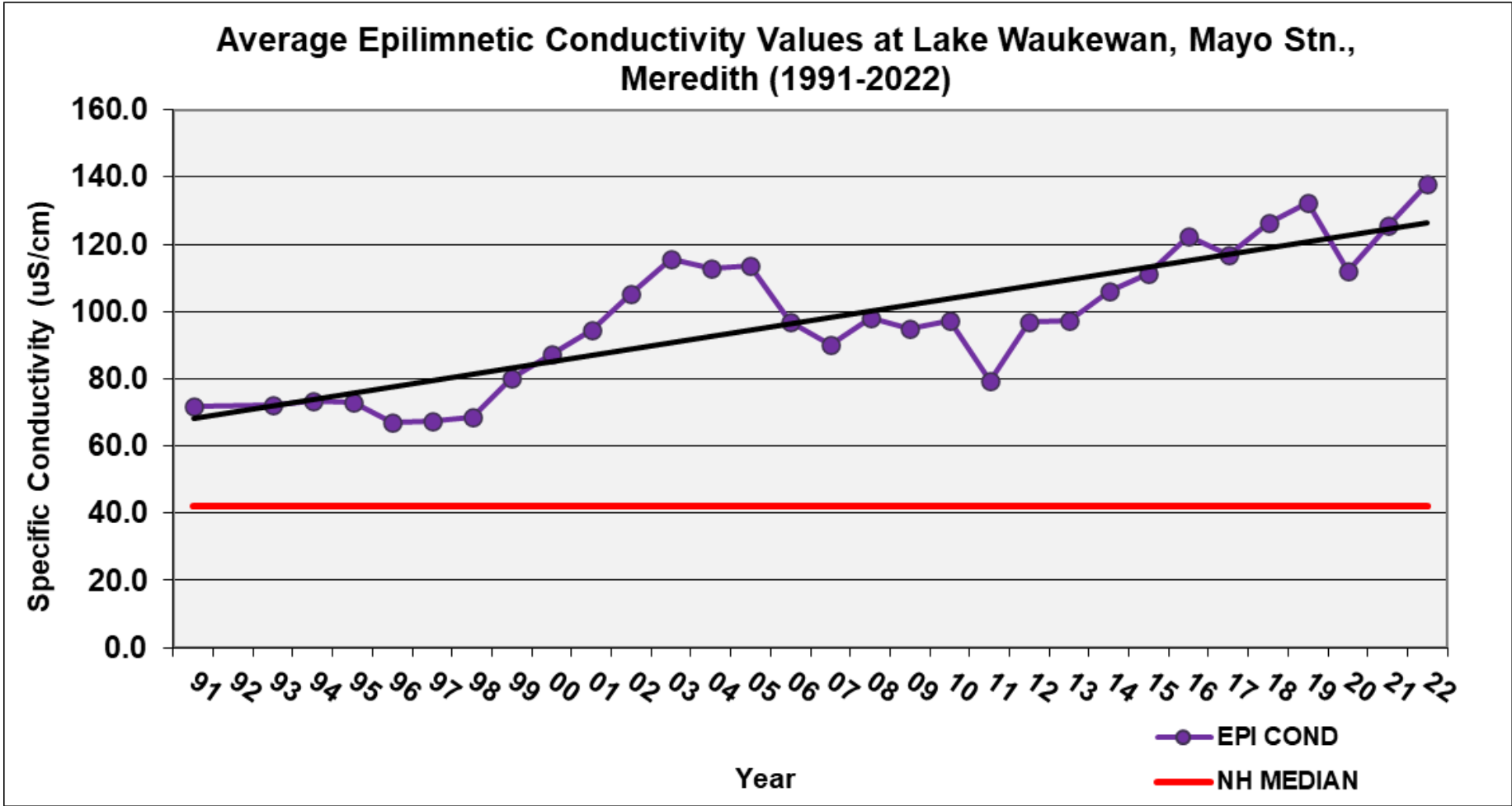
# Water Analyses

**Conductivity:** Ability of water to conduct electrical current.

- Salts and minerals
- Natural occurring
- Human influences



# Lake Waukewan, Mayo Deep Spot



## Water Quality Trends

**Range:**

67.1 uS/cm -  
137.9 uS/cm

**Median:**

97.1 uS/cm

**NH Median:**

42.3 uS/cm

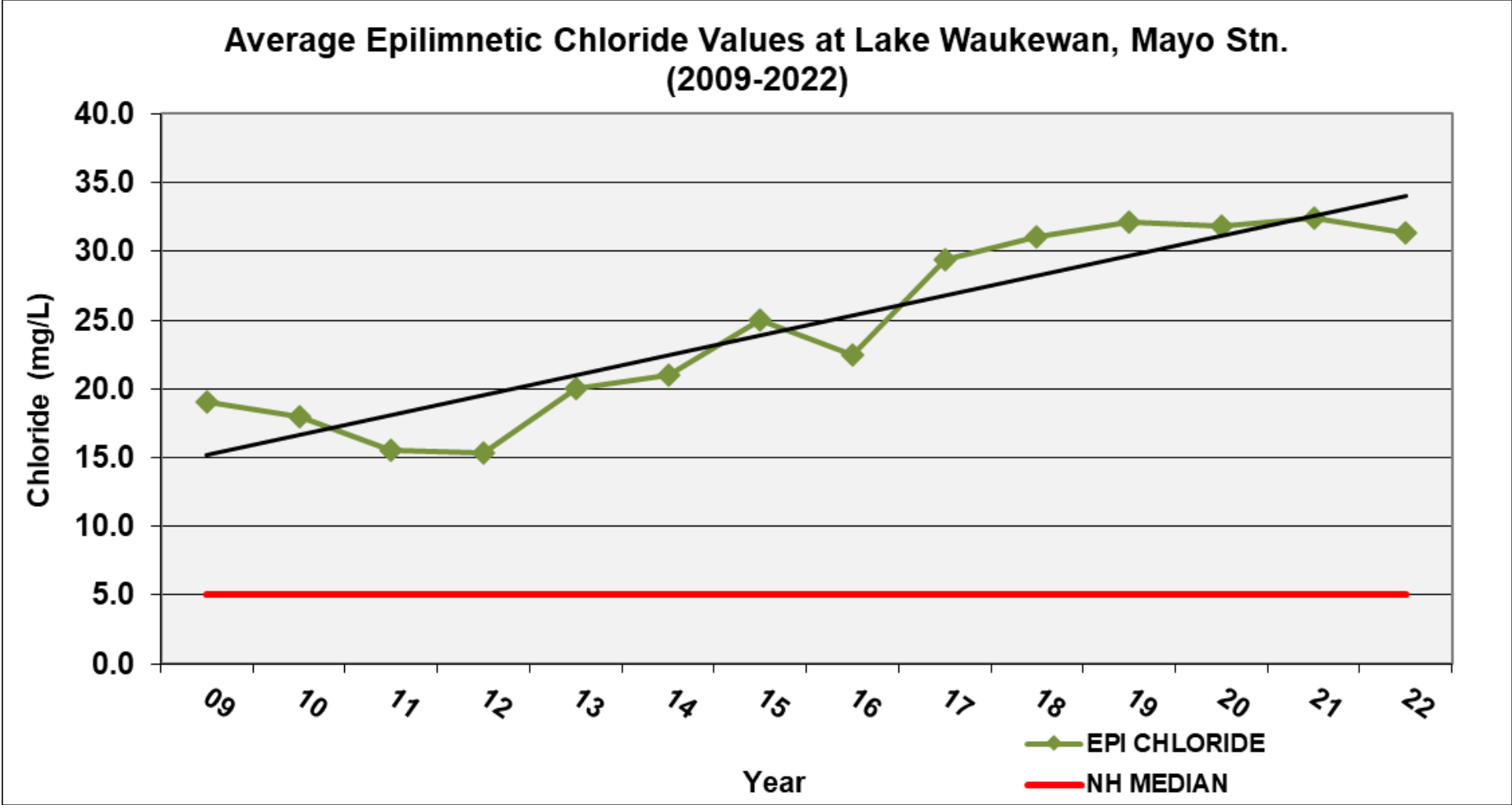
**Good Range:**

< 100 uS/cm

**Trend:**

Worsening

# Lake Waukewan, Mayo Deep Spot



## Water Quality Trends

**Range:**  
15.3 mg/L – 32.4 mg/L

**Median:**  
23.7 mg/L

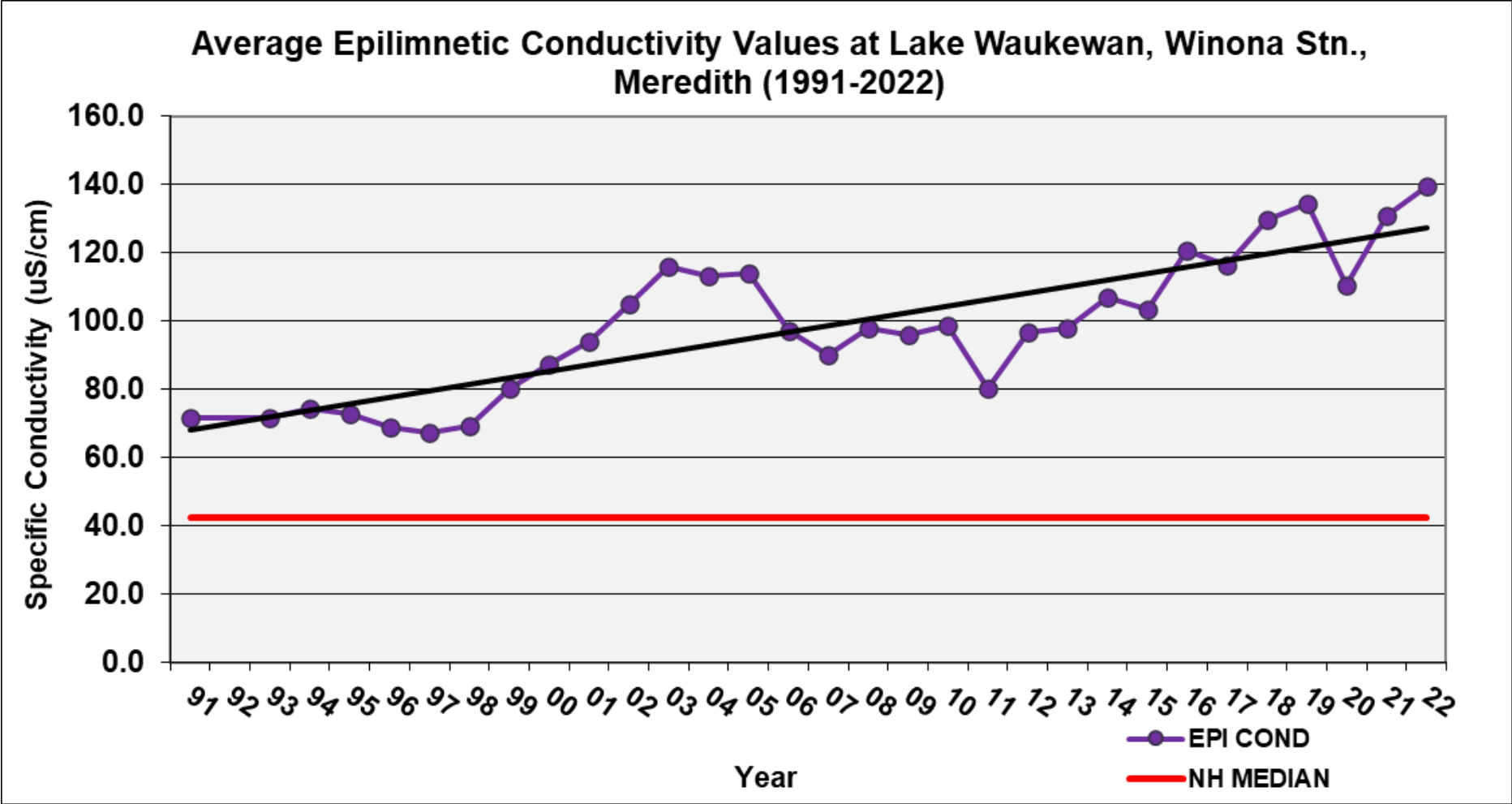
**NH Median:**  
5 mg/L

**Good Range:**  
< 230 mg/L

**Trend:**  
Worsening



# Lake Waukewan, Winona Deep Spot



## Water Quality Trends

**Range:**

67.5 uS/cm -  
139.4 uS/cm

**Median:**

97.9 uS/cm

**NH Median:**

42.3 uS/cm

**Good Range:**

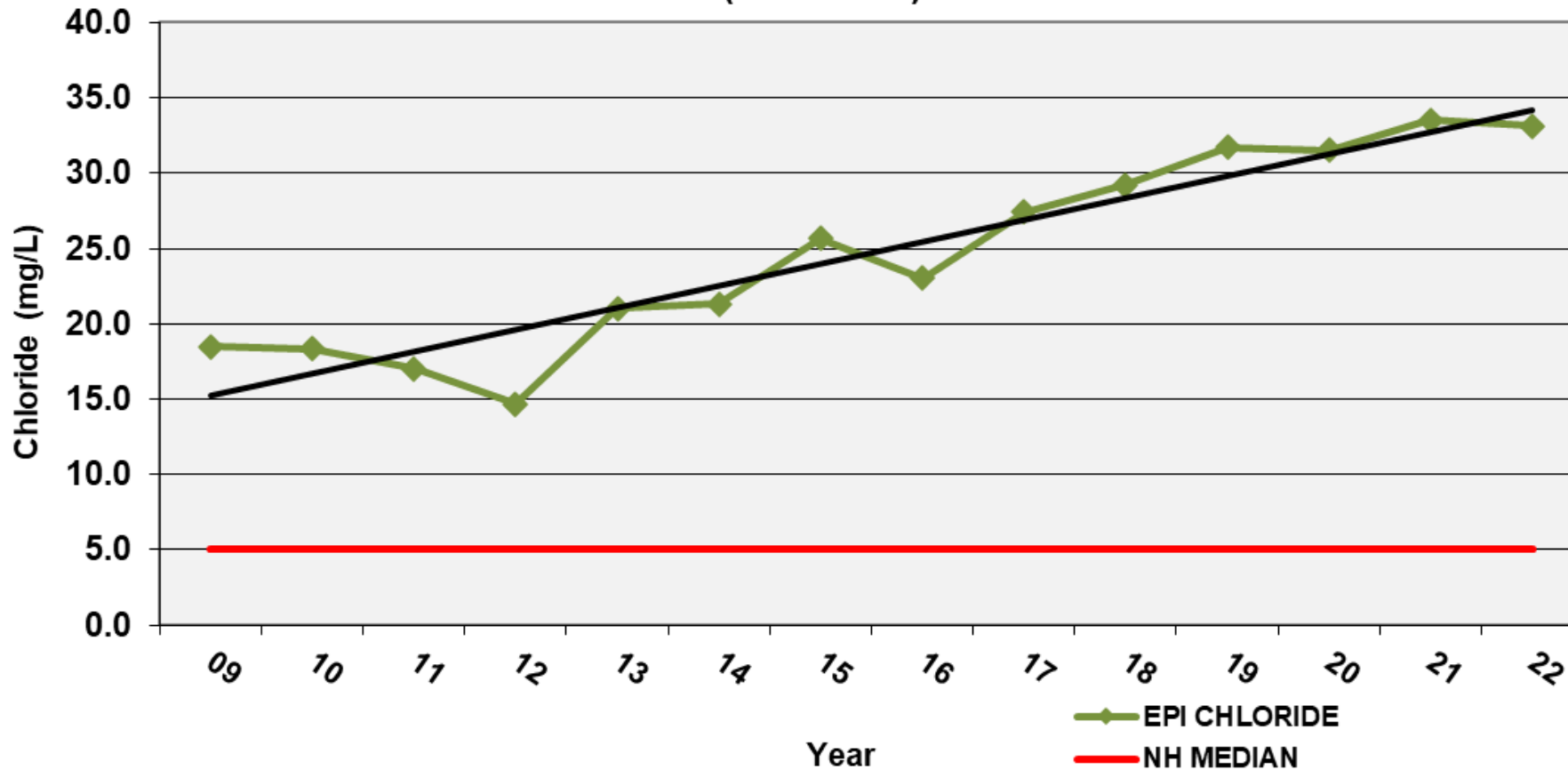
< 100 uS/cm

**Trend:**

Worsening

# Lake Waukewan, Winona Deep Spot

Average Epilimnetic Chloride Values at Lake Waukewan, Winona Stn.,  
(2009-2022)



## Water Quality Trends

### Range:

14.6 mg/L – 33.5 mg/L

### Median:

24.3 mg/L

### NH Median:

5 mg/L

### Good Range:

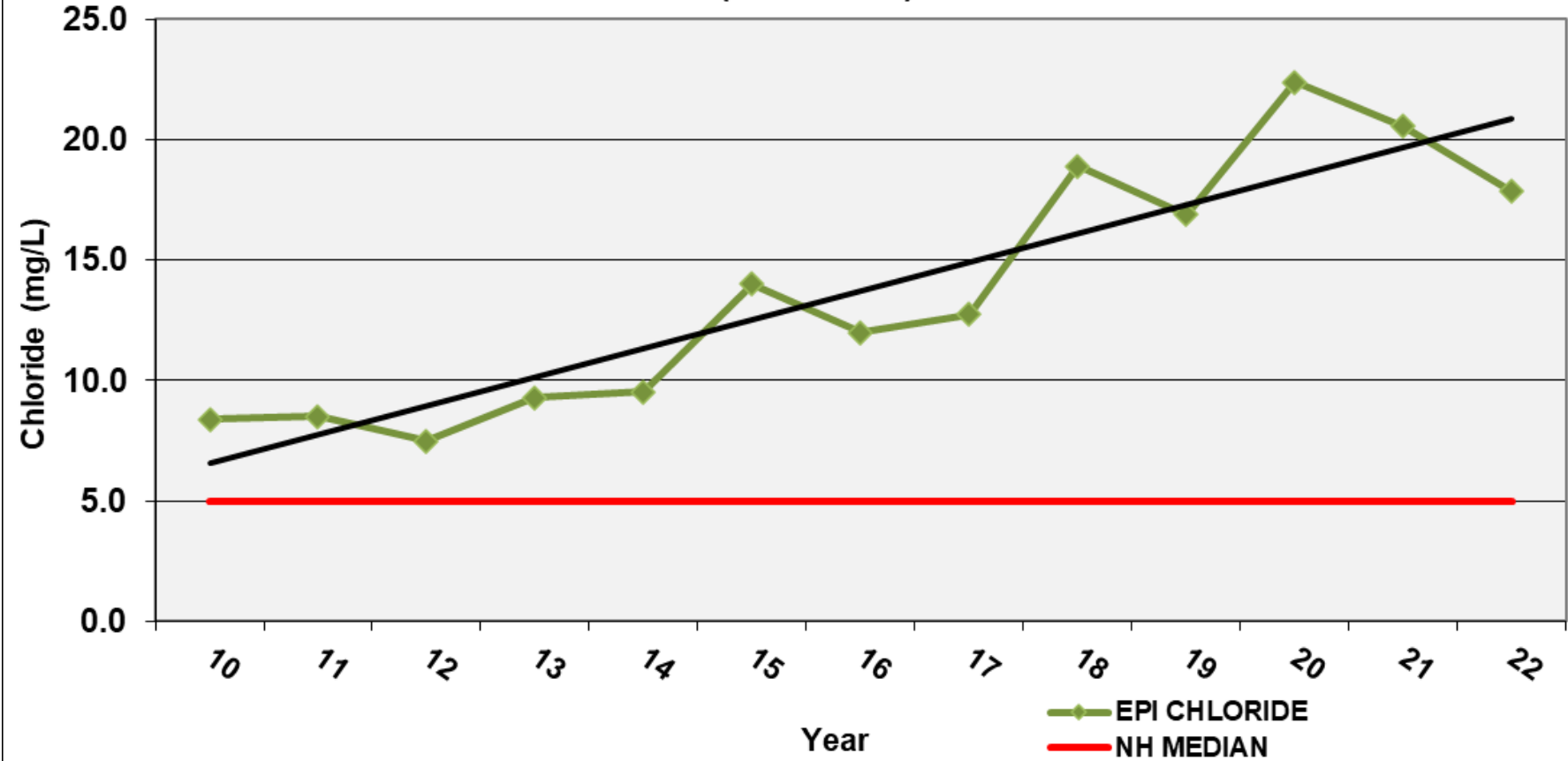
< 230 mg/L

### Trend:

Worsening

# Lake Winona Deep Spot

Average Epilimnetic Chloride Values at Lake Winona, New Hampton  
(2010-2022)



## Water Quality Trends

**Range:**  
42.8 uS/cm - 88.12 uS/cm

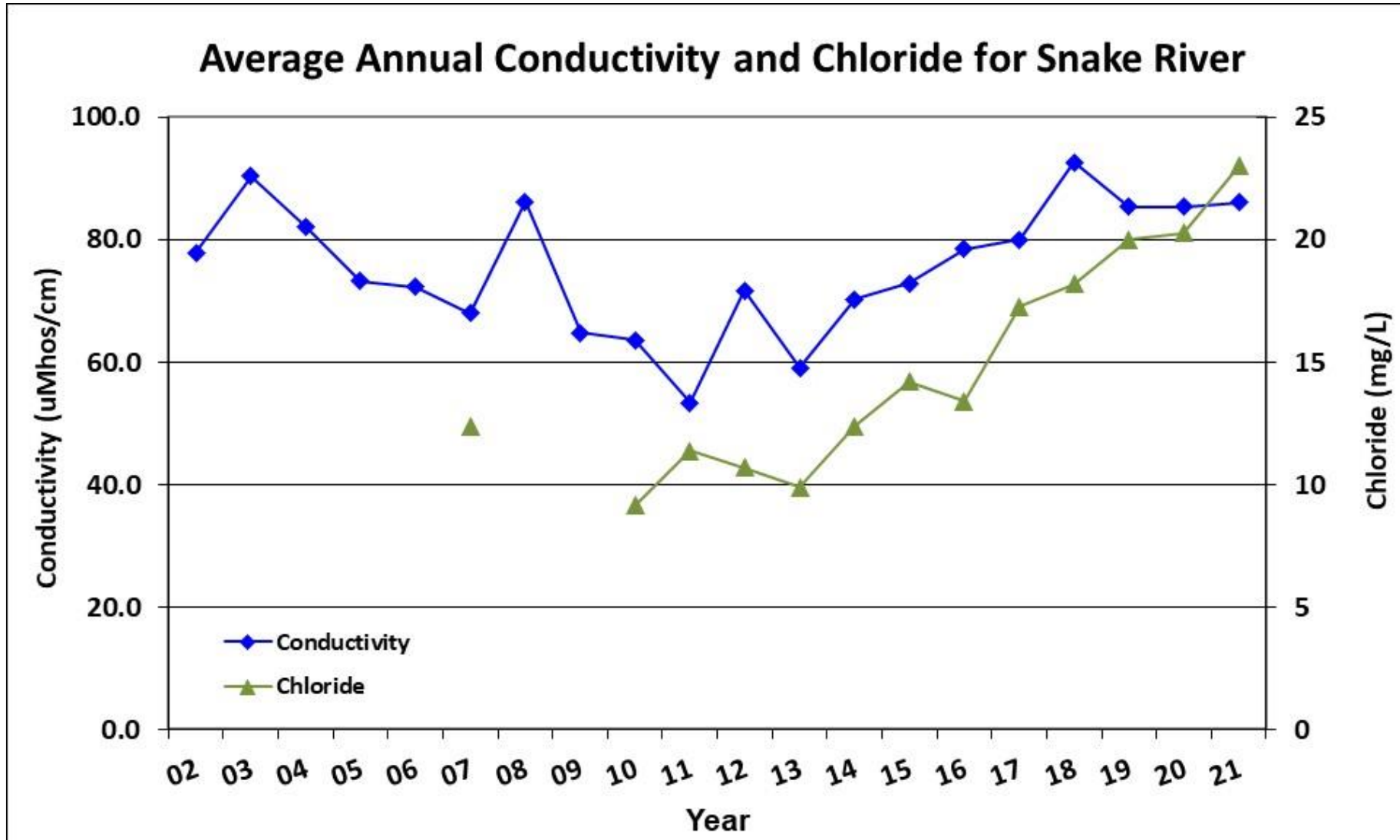
**Median:**  
59.8 uS/cm

**NH Median:**  
42.3 uS/cm

**Good Range:**  
< 100 uS/cm

**Trend:**  
Worsening

# Snake River





# Lake Waukewan Tributaries



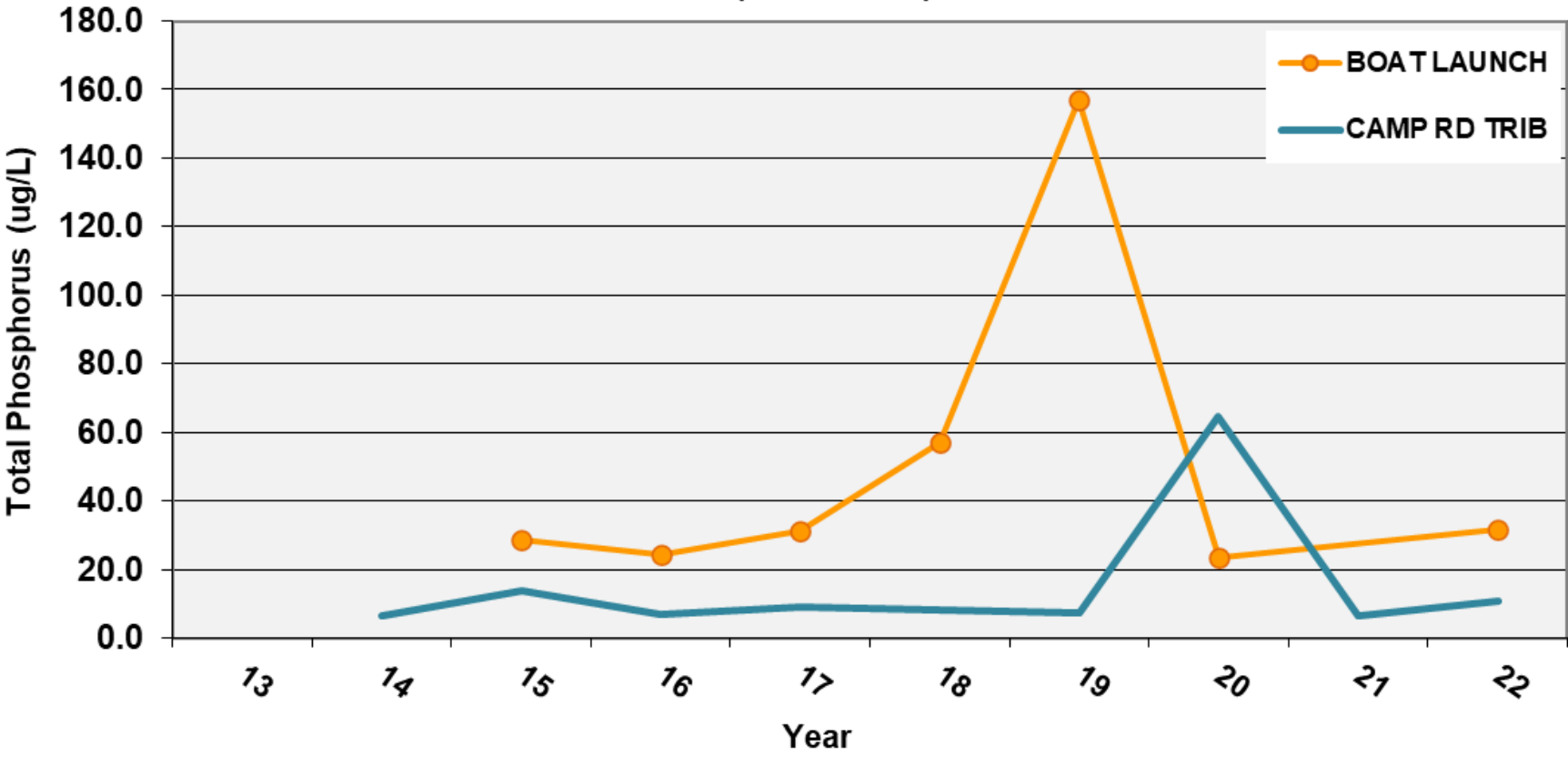
## LAKE WAUKEWAN MEREDITH

### VOLUNTEER LAKE ASSESSMENT PROGRAM

STATIONID	STATION NAME
WAUMER0	OUTLET
WAUMERP	PERKINS COVE
WAUMERWD	WINONA STATION S
WAUMER1	INLET
WAUMERMD	MAYO STATION N
WAUMER7	SAYWARD BK
WAUMER9	EE BROOK
WAUMER6	MAYO FARM BK
WAUMER10	BROOKSIDE LANE STREAM
WAUMER1	BOAT LAUNCH
WAUMERCRT	CAMP RD TRIB
WAUMER7A	SAYWARD BK UPPER
WAUMER7B	SAYWARD BK AT ROCK RIDGE

# Lake Waukewan Tributaries

Average Total Phosphorus Values at Lake Waukewan Tributaries  
(2013-2022)



## Water Quality Trends Boat Launch

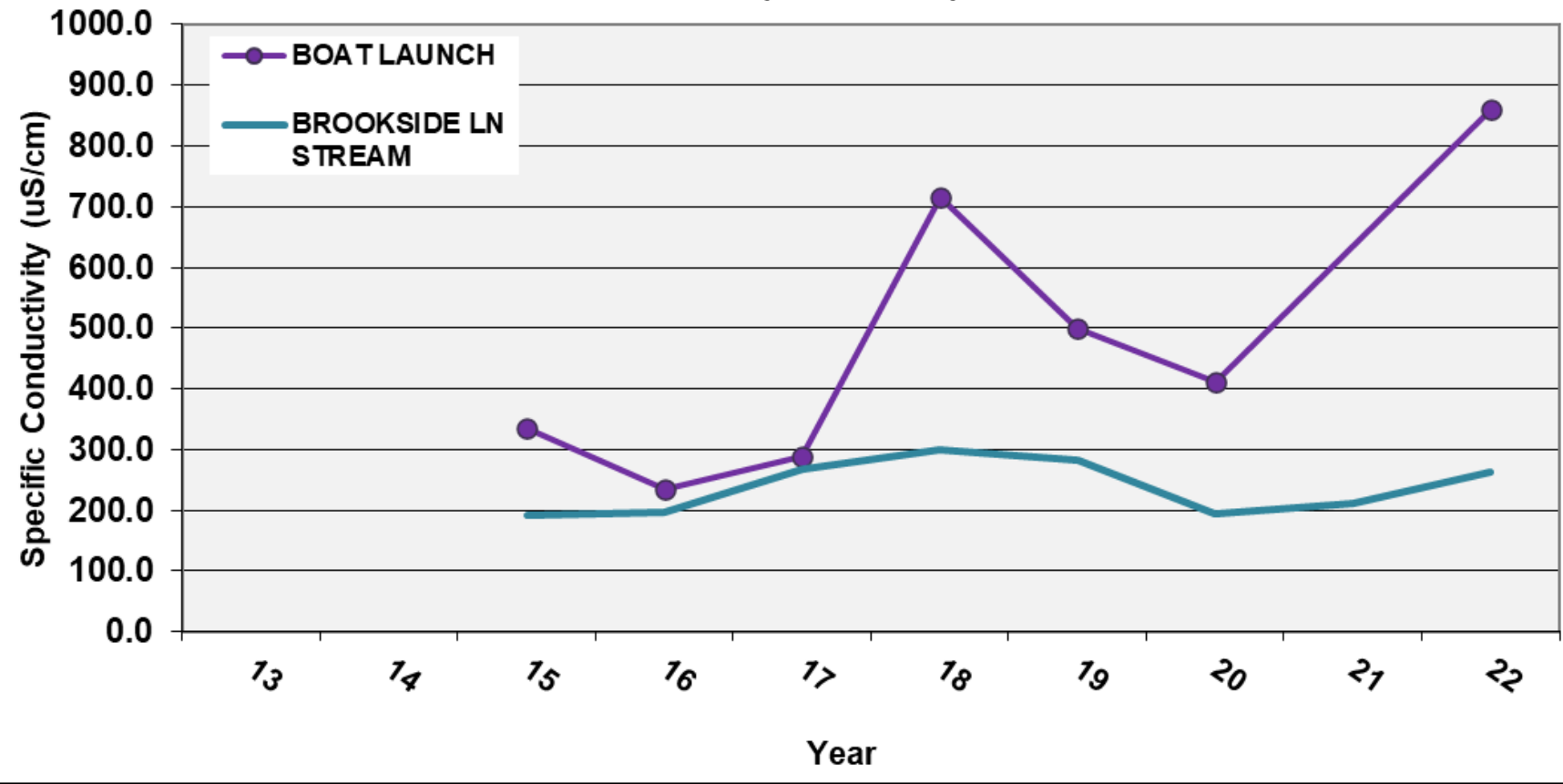
**Range:**  
23-157 ug/L

**Median:**  
31 ug/L

**Trend:**  
N/A

# Lake Waukewan Tributaries

Average Conductivity Values at Lake Waukewan Tributaries  
(2013-2022)



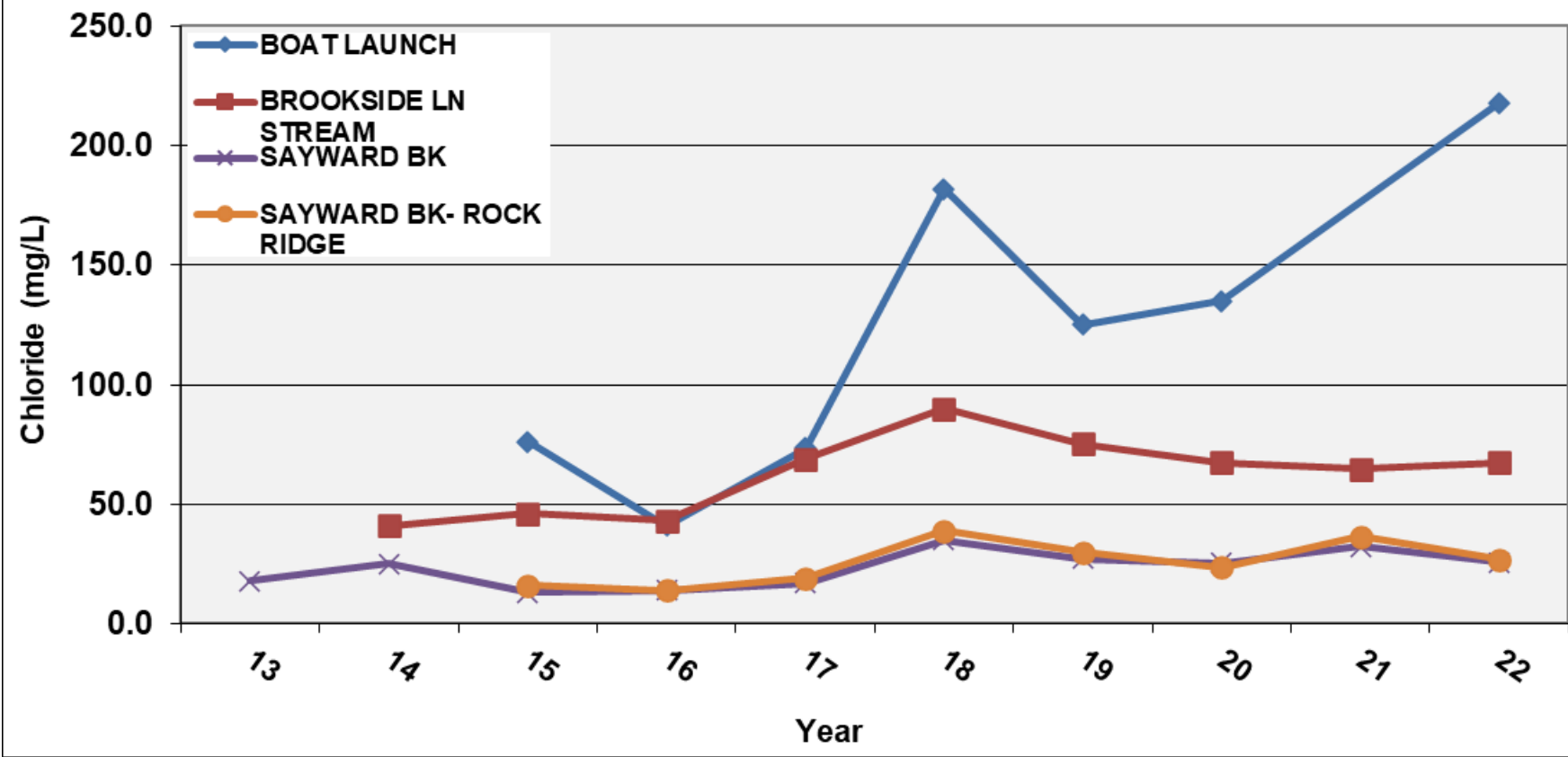
## Water Quality Trends

**Range:**  
192.1 – 860.0  
uS/cm

**Median:**  
324.0 uS/cm

# Lake Waukewan Tributaries

Average Chloride Values at Lake Waukewan Tributaries  
(2013-2022)



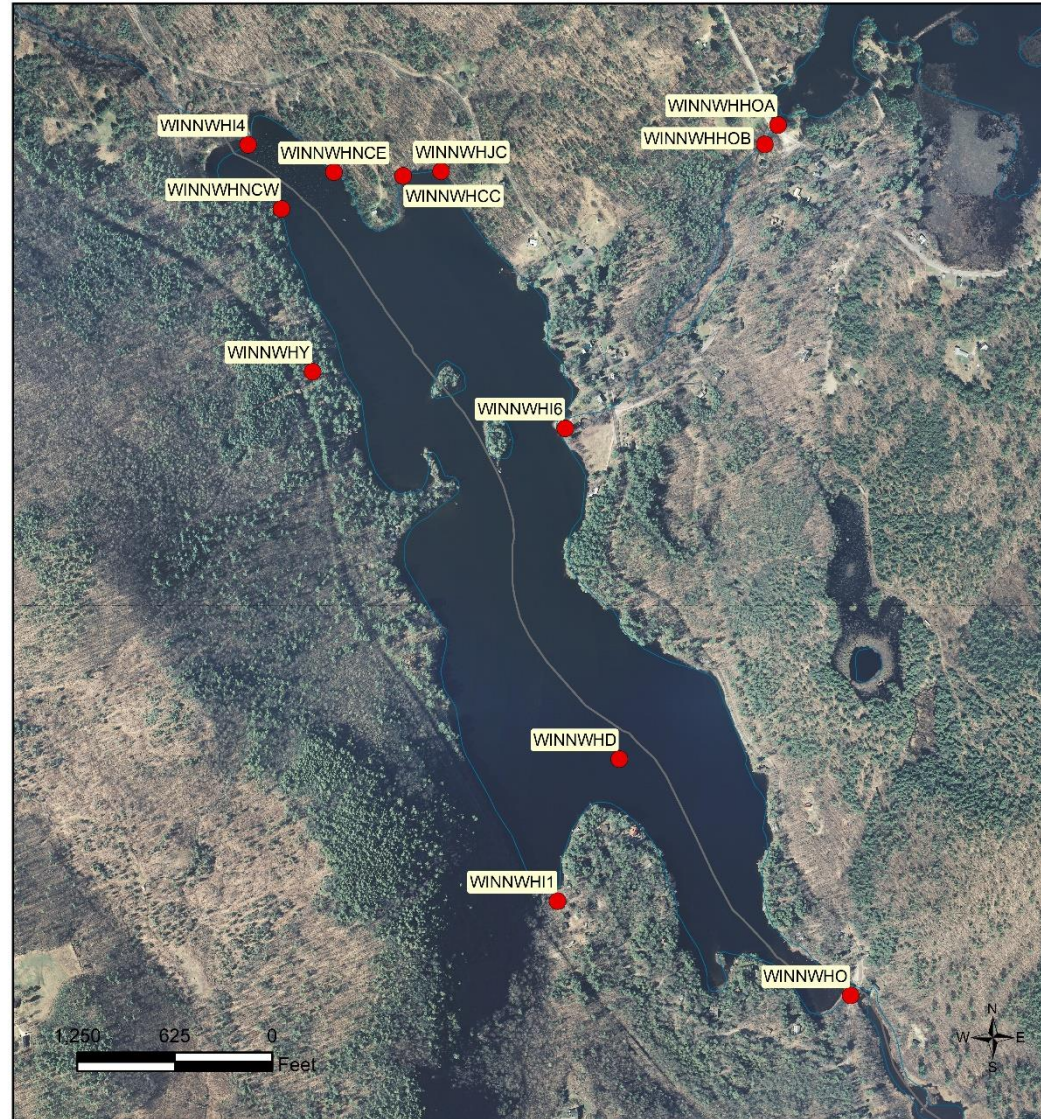
## Water Quality Trends

Range:

34.0 mg/L – 218 mg/L



# Lake Winona Tributaries



LAKE WINONA  
NEW HAMPTON  
VOLUNTEER LAKE ASSESSMENT PROGRAM

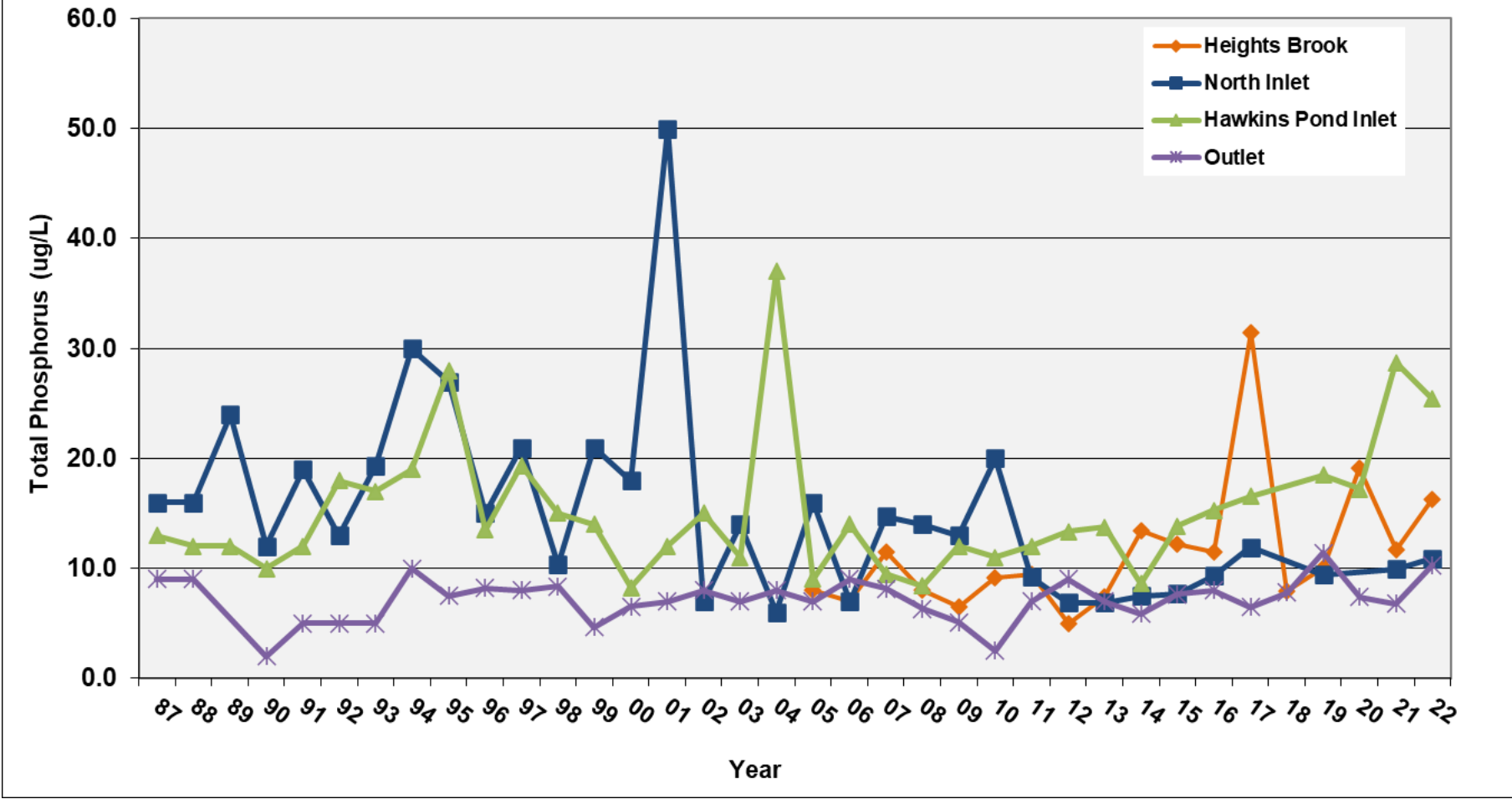
STATIONID	STATION NAME
WINNWHI4	NORTH INLET
WINNWHI6	HAWKINS POND INLET
WINNWHHD	DEEP SPOT
WINNWHI1	HEIGHTS BROOK INLET
WINNWHO	OUTLET
WINNWHOA	HAWKINS OUTLET ABOVE
WINNWHOB	HAWKINS OUTLET BELOW
WINNWHCC	CHUTES COVE
WINNWHNCW	NORTH COVE WEST SIDE
WINNWHNCE	NORTH COVE EAST SIDE
WINNWHY	YORK BROOK
WINNWHJC	JEAN CHUTES

Source: The data layers are derived from NHDES data and are under constant revision. NHDES is not responsible for the use or interpretation of this information. Not intended for legal use NHDES Watershed Management Bureau Date: 2/17/2021



# Lake Winona Tributaries

Average Total Phosphorus Values at Lake Winona Tributaries (1987-2022)

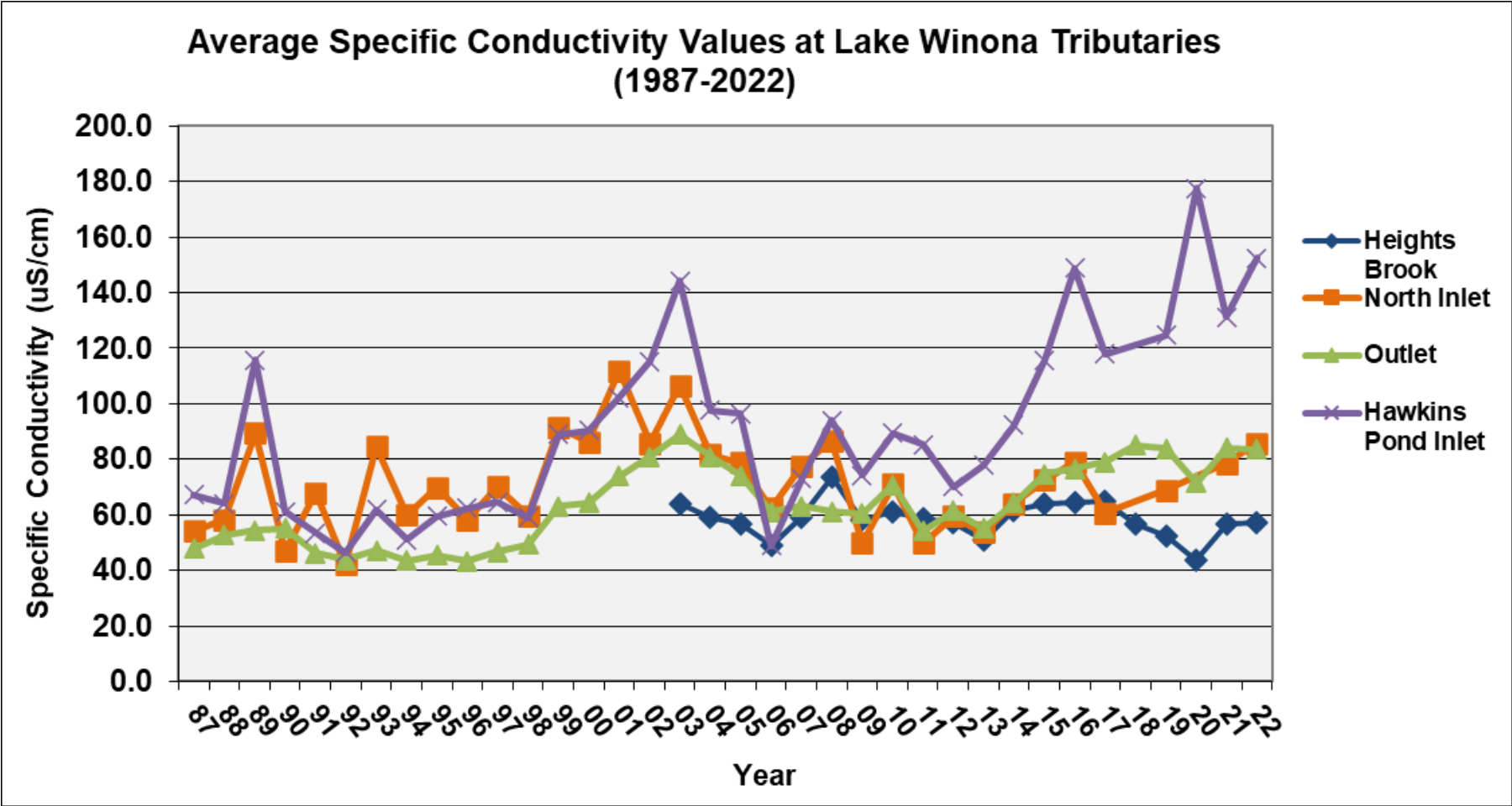


## Water Quality Trends

**Range:**  
5 ug/L – 20 ug/L

**Median:**  
12 ug/L

# Lake Winona Tributaries

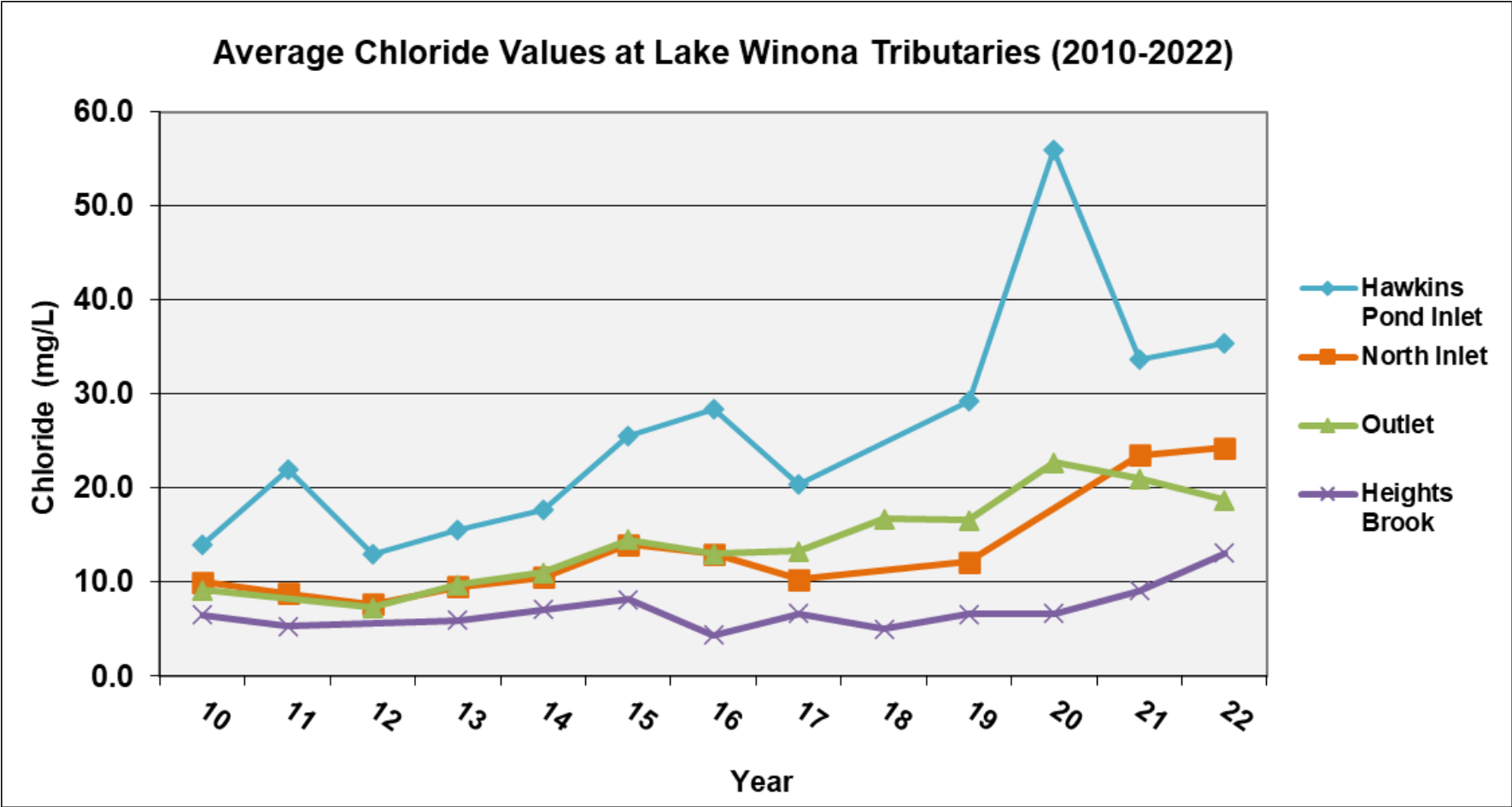


## Water Quality Trends

**Range:**  
42.0 – 177.5  
uS/cm

**Median:**  
66.2 uS/cm

# Lake Winona Tributaries



## Water Quality Trends

**Range:**  
4 – 55.9 mg/L

**Median:**  
12.2 mg/L



# VLAP Annual Reports

## Lake Information Mapper

<http://tinyurl.com/NH-LakeMapper>

NHDES Publications

### Lake Information Mapper

This interactive map allows the user to access water quality information of individual waterbodies around New Hampshire. By zooming in and clicking on a waterbody of interest, the user has access to historic and current Lake Trophic Survey reports, the most recent Volunteer Lake Assessment Program (VLAP) reports, Total Maximum Daily Load (TMDL) reports, ice cover history, cyanobacteria bloom history, Watershed Based Plans, Diagnostic Feasibility Studies, and information on known invasive aquatic species.



For additional information or if you have problems accessing particular content, please contact [Kirsten Hugger](#) or dial (603) 271-1152 for accommodation.

Note: If the Mapper is not loading, please try clearing your browser history and reloading the Mapper.

OK

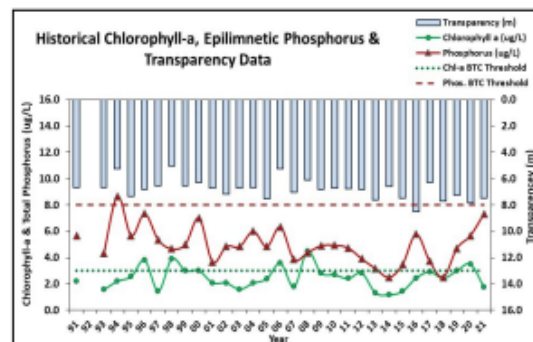
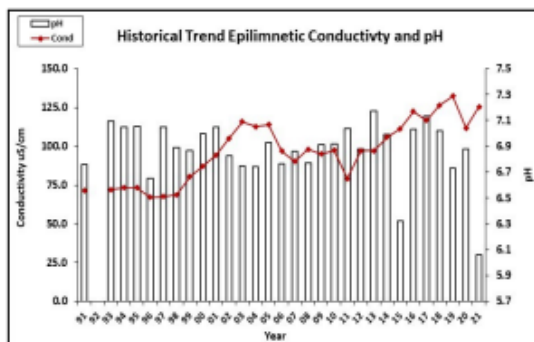


# VOLUNTEER ASSESSMENT PROGRAM INDIVIDUAL LAKE REPORTS LAKE WAUKEWAN, MAYO STN., MEREDITH 2021 DATA SUMMARY

**RECOMMENDED ACTIONS:** Great job sampling in 2021! Lake quality remained representative of oligotrophic, or high quality conditions, however Epilimnetic (upper water layer) phosphorus (nutrient) levels have increased steadily since 2018 and were the highest measured since 1996. Nutrient levels were generally elevated in June following spring snowmelt and runoff. Clean up roadside ditches and culverts of any leftover sand/salt mixtures applied to roads during winter months. Continue watershed management efforts to reduce nutrient loads and stormwater run-off. Monitor the increasing conductivity and chloride trends as chloride can negatively impact drinking water and aquatic life. Encourage local and private winter maintenance companies to obtain Green SnowPro Certification. Continue efforts to monitor water quality in spring, fall and winter to better understand nutrient dynamics and affects on cyanobacteria growth. Keep up the great work!

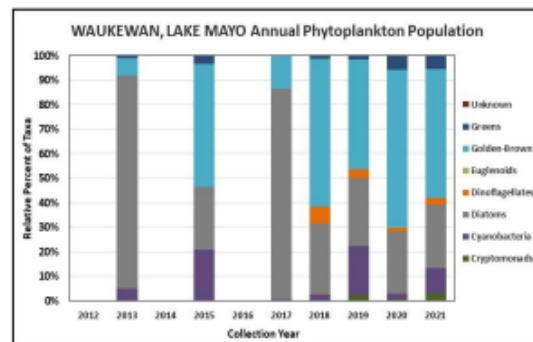
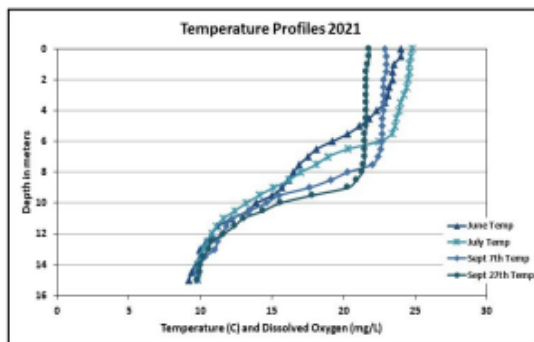
## HISTORICAL WATER QUALITY TREND ANALYSIS

Parameter	Trend	Parameter	Trend
Conductivity	Worsening	Chlorophyll-a	Stable
pH (epilimnion)	Stable	Transparency	Improving
		Phosphorus (epilimnion)	Stable



## DISSOLVED OXYGEN AND PHYTOPLANKTON

(Note: Information may not be collected annually)



# VLAP Reports

**OBSERVATIONS** (Refer to Table 1 and Historical Deep Spot Data Graphics)

- **CHLOROPHYLL-A:** Chlorophyll level was low in June, increased in July but remained within a low range, decreased in early September and remained stable through late September. Average chlorophyll level decreased from 2020 and was less than the state median and the threshold for oligotrophic lakes. Historical trend analysis indicates relatively stable chlorophyll levels since monitoring began.
- **CONDUCTIVITY/CHLORIDE:** Epilimnetic (upper water layer), Metalimnetic (middle water layer) and Hypolimnetic (lower water layer) conductivity levels remained slightly elevated and greater than the state median. Epilimnetic chloride level was also greater than the state median, yet less than the state chronic chloride standard. Historical trend analysis indicates significantly increasing (worsening) epilimnetic conductivity levels since monitoring began. Brookside Lane Stream conductivity and chloride levels were elevated and much greater than the state medians.
- **COLOR:** Epilimnetic color data indicates the water was borderline clear to lightly tea colored, or light brown and was darkest in June.
- **TOTAL PHOSPHORUS:** Epilimnetic phosphorus level was within a low range in June, decreased slightly in July, increased slightly in early September and remained stable through late September. Average epilimnetic phosphorus level remained stable with 2020 and was less than the state median and the threshold for oligotrophic lakes. Historical trend analysis indicates relatively stable epilimnetic phosphorus levels since monitoring began. Metalimnetic phosphorus level was slightly elevated in June and July. Hypolimnetic phosphorus level was elevated, particularly in September, likely indicating release of phosphorus from bottom sediments under anoxic (no dissolved oxygen) conditions. Brookside Lane Stream phosphorus level was elevated for that station.
- **TRANSPARENCY:** Transparency measured with (VS) and without (NVS) the viewscope was above average (good) in June, decreased (worsened) slightly in July but remained above average, decreased to below average range in early September, and then increased (improved) in late September. Average NVS transparency decreased slightly from 2020 but remained much higher (better) than the state median. Historical trend analysis indicates significantly increasing (improving) NVS transparency since monitoring began.
- **TURBIDITY:** Epilimnetic turbidity and Metalimnetic turbidity levels fluctuated within a low range. Hypolimnetic turbidity level was slightly elevated, particularly in late September and lab data noted an abundance of zooplankton in the sample. Brookside Lane Stream turbidity level was within a very low range.
- **pH:** Epilimnetic, Hypolimnetic and Brookside Lane Stream pH levels fluctuated within a slightly acidic range and were less than desirable 6.5-8.0 units. Historical trend analysis indicates stable epilimnetic pH levels since monitoring began. Metalimnetic pH level fluctuated around the low end of the desirable range.

Station Name	Table 1. 2021 Average Water Quality Data for LAKE WAUKEWAN - WINONA STN.									
	Alk. (mg/L)	Chlor-a (ug/L)	Chloride (mg/L)	Color (pcu)	Cond. (us/cm)	Total P (ug/L)	Trans. (m)		Turb. (ntu)	pH
							NVS	VS		
Epilimnion	8.3	1.77	34	22	130.9	7	7.39	7.66	0.38	6.16
Metalimnion					131.8	9			0.56	6.64
Hypolimnion					135.4	26			2.08	6.16
Brookside Lane Stream			65		212.0	16			0.18	6.35

**NH Median Values**

Median values generated from historic lake monitoring data.

Alkalinity: 4.5 mg/L Chlorophyll-a: 4.39 ug/L  
 Conductivity: 42.3 uS/cm Chloride: 5 mg/L  
 Total Phosphorus: 11 ug/L Transparency: 3.3 m  
 pH: 6.6

**NH Water Quality Standards**

Numeric criteria for specific parameters. Water quality violation if thresholds exceeded.

Chloride: > 230 mg/L (chronic) Turbidity: > 10 NTU above natural  
 E. coli: > 88 cts/100 mL (beach)  
 E. coli: > 406 cts/100 mL (surface waters)  
 pH: between 6.5-8.0 (unless naturally occurring)

# VLAP Reports





# THANK YOU!

**Sara Steiner**  
**VLAP Coordinator**  
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**[sara.e.steiner@des.nh.gov](mailto:sara.e.steiner@des.nh.gov)**