



USGS LAKE STUDIES – CASE STUDY: SILVER LAKE (OCEANA COUNTY, MI)

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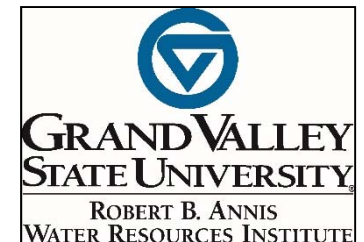
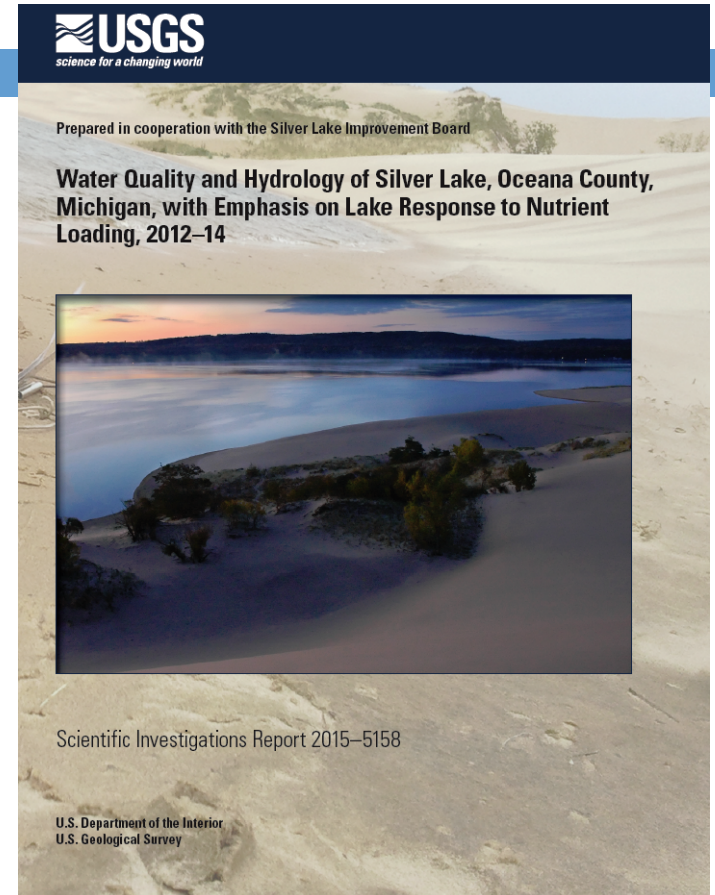
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USGS Inland lake studies in Michigan (since 1990's)

- Water quality and hydrology of Silver Lake, Oceana County, Michigan, with emphasis on lake response to nutrient loading (2016)
- Estimation of a Trophic State Index for selected inland lakes in Michigan, 1999–2013
- Water-quality characteristics of Michigan's inland lakes, 2001-10
- Predicting lake trophic state by relating Secchi-disk transparency measurements to Landsat-satellite imagery for Michigan inland lakes, 2003-05 and 2007-08
- State and regional water-quality characteristics and trophic conditions of Michigan's inland lakes, 2001-2005
- Predicting water quality by relating Secchi-disk transparency and chlorophyll a measurements to satellite imagery for Michigan Inland Lakes, August 2002
- Effects of residential development on the water quality of Higgins Lake, Michigan 1995-99

Silver Lake Nutrient Loading Study

- “Water Quality and Hydrology of Silver Lake, Oceana County, Michigan, with Emphasis on Lake Response to Nutrient Loading, 2012-14”
 - ▣ USGS Scientific Investigations Report 2015-5158
<https://pubs.er.usgs.gov/publication/sir20155158>
- Prepared in cooperation with the Silver Lake Improvement Board
- Authors: Angela K. Brennan, Christopher J. Hoard, Joseph W. Duris (USGS); and Mary E. Ogdahl, and Alan D. Steinman (Grand Valley State University – Annis Water Resources Institute (GVSU-AWRI))



Project Problem

- In 2011, Progressive AE published the “Silver Lake 2011 Water Quality Monitoring Report”

Study results indicated Silver Lake appeared to be undergoing more accelerated eutrophication and if the trend continued, that there would be more frequent and prolonged algal blooms, reduced transparency, and a decline in overall water quality.

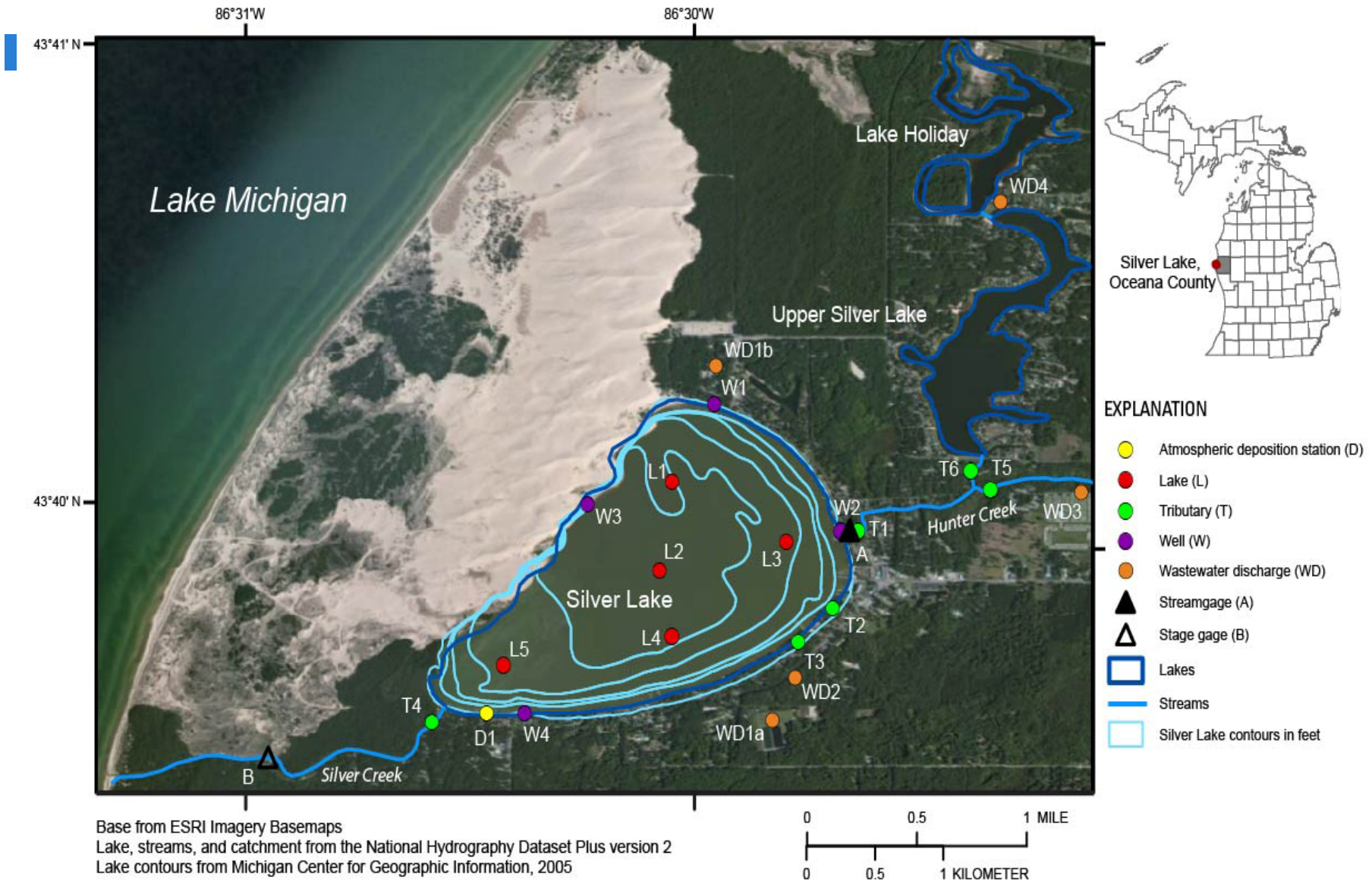


Project Objectives

- Describe current water quality in the lake, groundwater, tributaries, and atmosphere;
- Quantify the water and nutrient budgets for Silver Lake and estimate the contribution of septic systems;
- Identify the nutrient(s) limiting algal growth in Silver Lake;
- Present model scenarios of future lake conditions in response to changes in nutrient loading inputs



Silver Lake, Oceana County, MI



Approach

- Monitor surface water flow & establish a water budget
- Water chemistry:
 - Monitoring lake and stream chemistry 4 times per year for 2 years, plus 2-3 storm events (annually)
- 5 monitoring locations on lake
 - Water temp, DO, Conductivity, pH
 - Secchi disc transparency
 - Chlorophyll-*a*, phytoplankton, N, P (surface & bottom)



Approach cont...

- Monitor groundwater influence:
 - 4 wells, measure water levels & nutrient chemistry for 2 years
 - Observe groundwater flow by installing seepage meters
 - Sample drainage tiles for N & P (38 tiles)



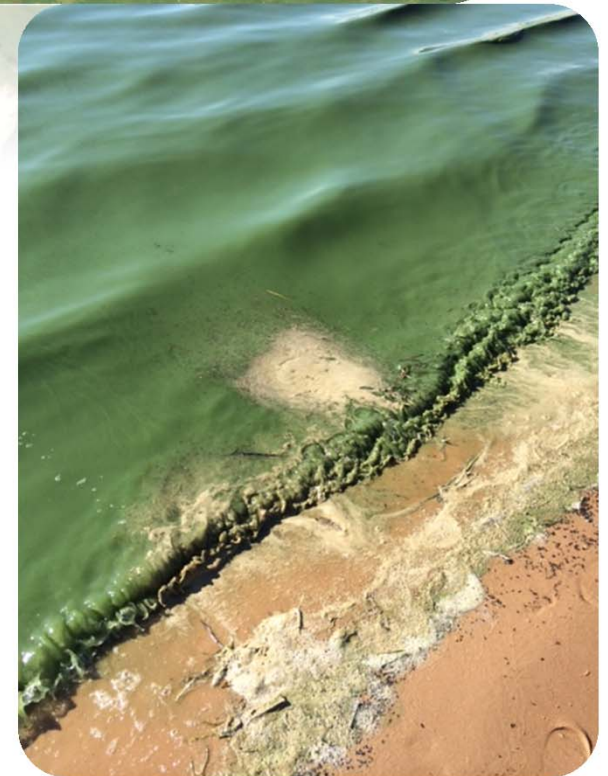
Approach cont...

- Precipitation
 - Wet (rain and snow) & dry (several days following no precip) samples to determine nutrient deposition (N and P)
- Nutrient inputs from lawn runoff and waterfowl
 - Estimated from literature values

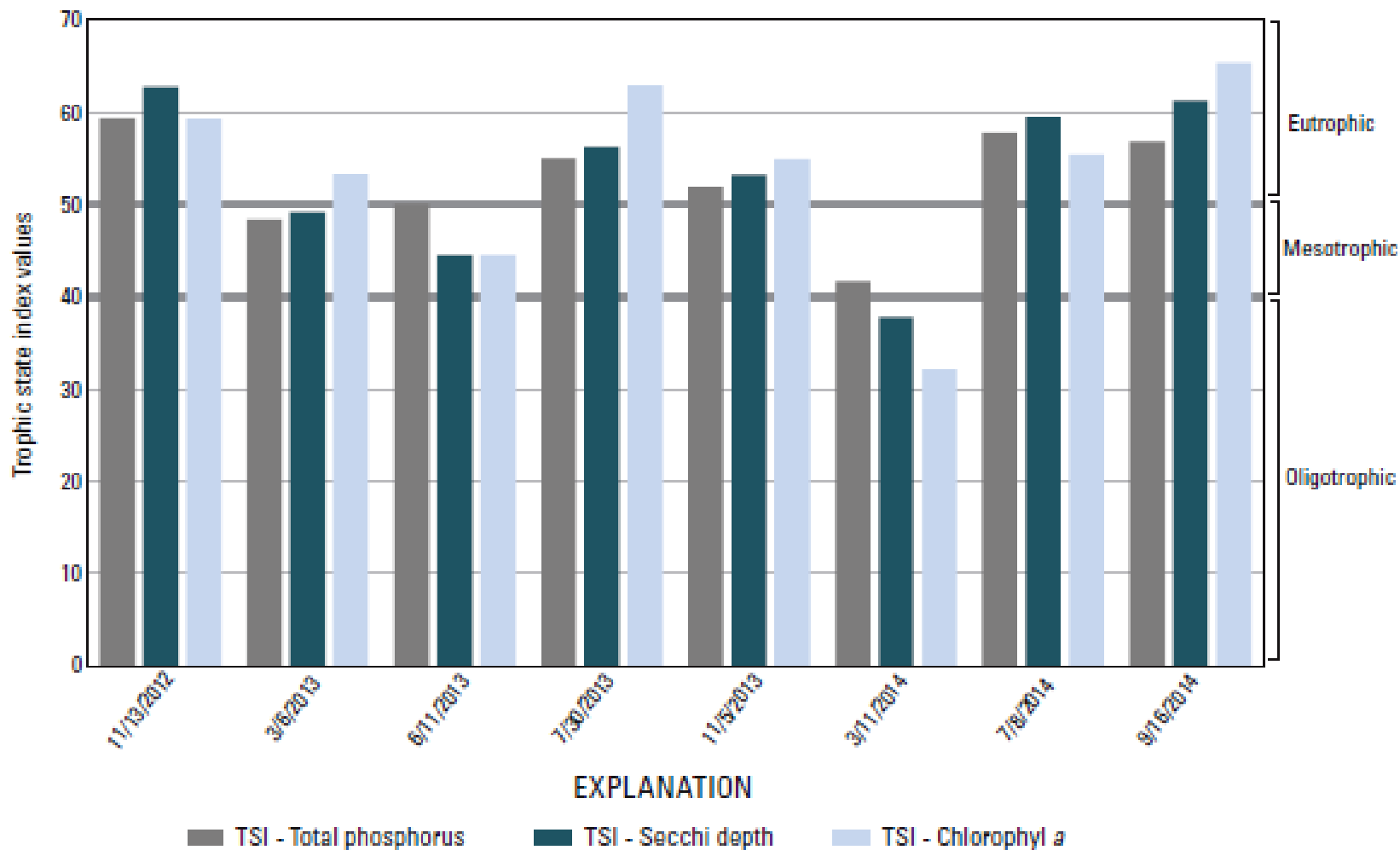


Approach cont...

- Identify nutrient controlling algal blooms (Annis Water Resources Institute (AWRI)
 - Nutrient bioassay, algal ID (cyanotoxins)
- Internal nutrient loading estimates (AWRI), determine flux of P & N from sediments
 - 2 sites, oxic & anoxic treatments



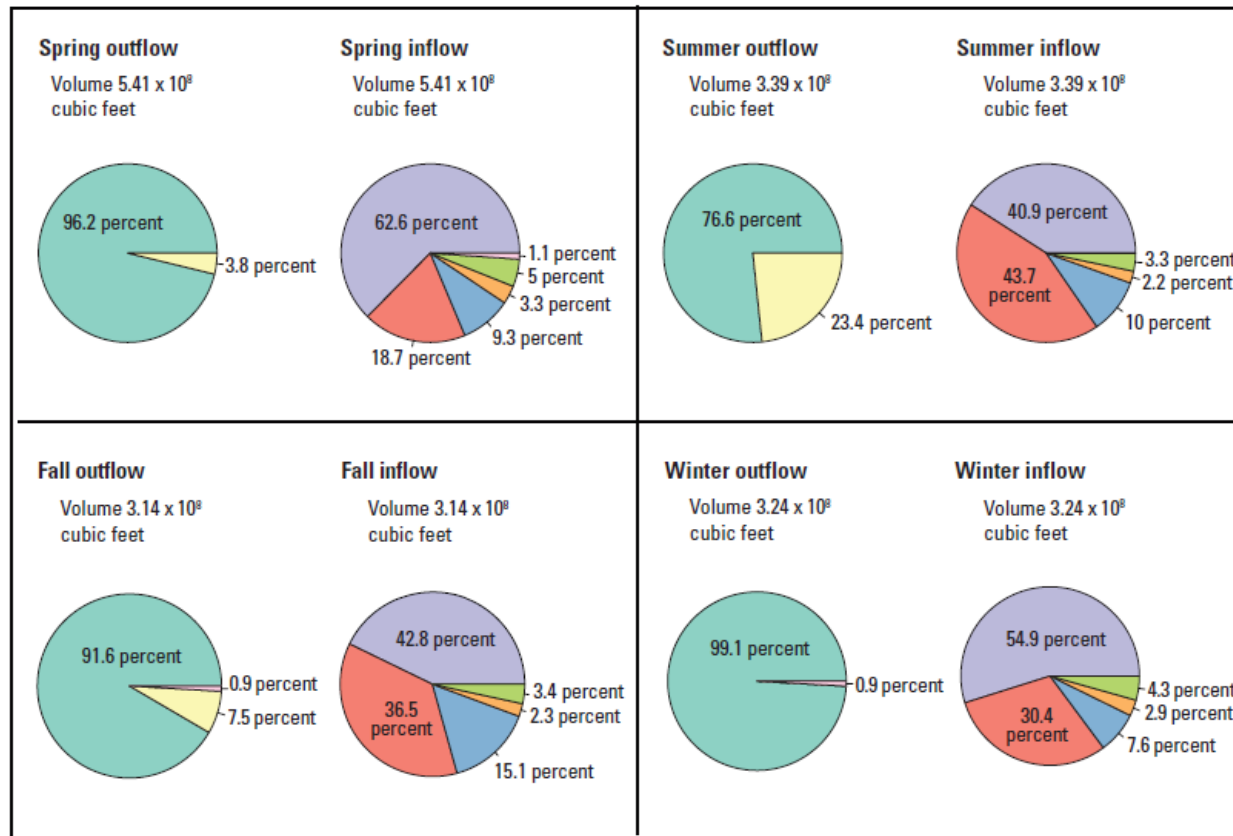
Project results – Trophic Status



Trophic status of Silver Lake, Oceana County, Michigan, based on Carlson's Trophic State Index. (TSI, trophic state index; less than 40 represents oligotrophic conditions, 40-50 mesotrophic, greater than 50 represents eutrophic conditions).



Project results – Water budget

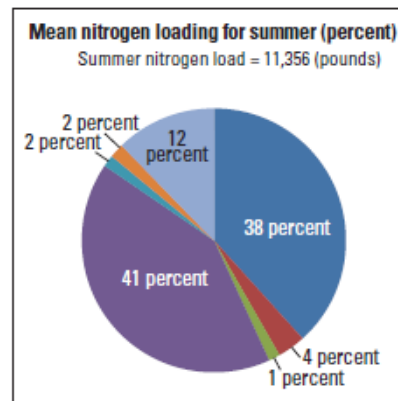
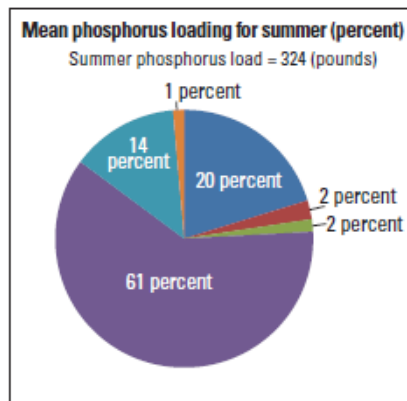
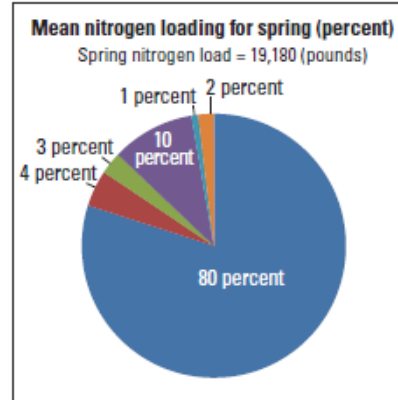
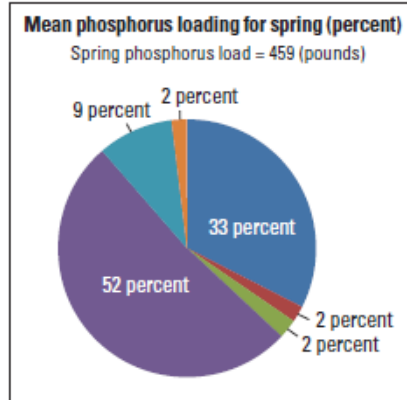
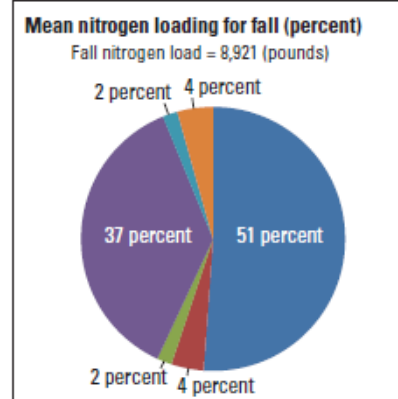
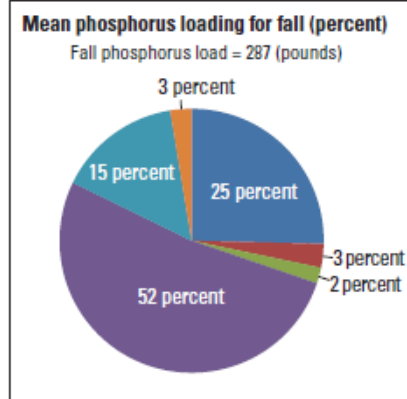


EXPLANATION

- Surface outflow
- Evaporation
- Hunter Creek
- Groundwater
- Precipitation
- Tributary at North Shore Drive
- Tributary at State Park
- Change in storage

Figure 13. Water budget, by season, for Sliver Lake, Oceana County, Michigan.

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EXPLANATION

- Hunter Creek
- Tributary at State Park
- Tributary at North Shore Drive
- Groundwater
- Lawn runoff
- Atmospheric deposition

Figure 14. Mean nutrient loading, by season, to Silver Lake, Oceana County, Michigan. (Internal load of phosphorus and nitrogen was measured only during the summer and assumed to be negligible during the remainder of the year. Internal phosphorus loading during the summer was less than 1 percent of the total phosphorus load.)

Project results

- Concluded that internal loading is not a major source of P to Silver Lake
- Algal growth appears to be co-limited by P and N
- Cyanotoxin levels are not an issue to date



Project results -Predicting future lake conditions

- Nutrient adjustment scenarios of phosphorus and nitrogen to Silver Lake were processed using the BATHTUB model.

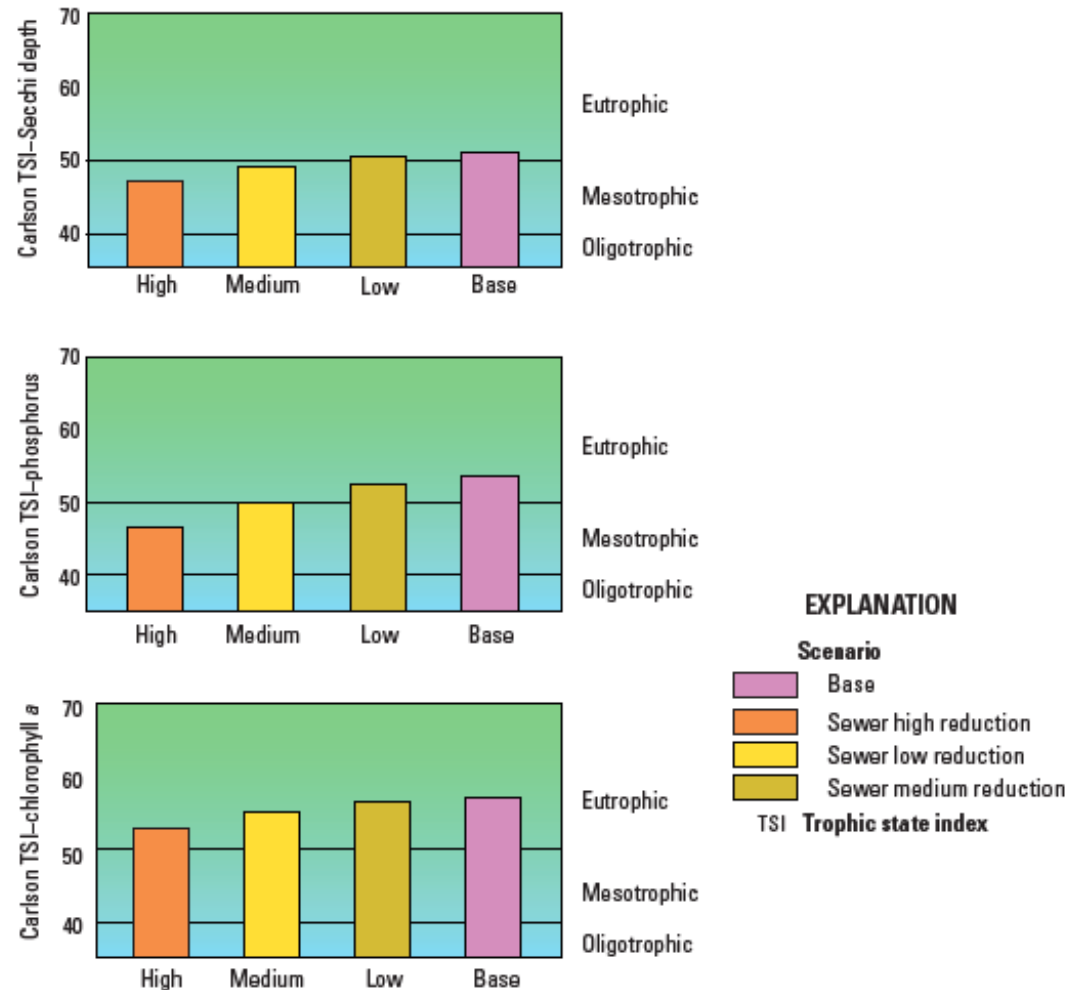


Figure 21. Simulated effect of conversion from onsite septic-waste treatment (within 200 feet of shoreline) to central sewer system using BATHTUB. (Based on Carlson's Trophic State Index (TSI) values, less than 40 represents oligotrophic conditions, 40-50 mesotrophic, and greater than 50 represents eutrophic conditions.)

Study costs

- USGS cooperative water funds, subject to federal appropriation, but can sometimes fund typically up to 25% of project to help offset costs
- Also, this was for a comprehensive study of the water and nutrient budgets for Silver Lake
- All data are available in perpetuity through the USGS National Water Information System (NWIS) database
- 2-years of monitoring, 1 year to publish final report = 3-year study
 - ▣ Costs can vary for a project like this, depending on objectives of the project and USGS coop fund availability to help offset costs

Key Points



- Important to fully understand what questions you want answered
- Important to understand what you are getting at the end of the project (your final product)
- Helps to have someone (watershed manager, environmental consultant, or resource consultant) who can take the study results and provide recommendations based on the project results

THANK YOU


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