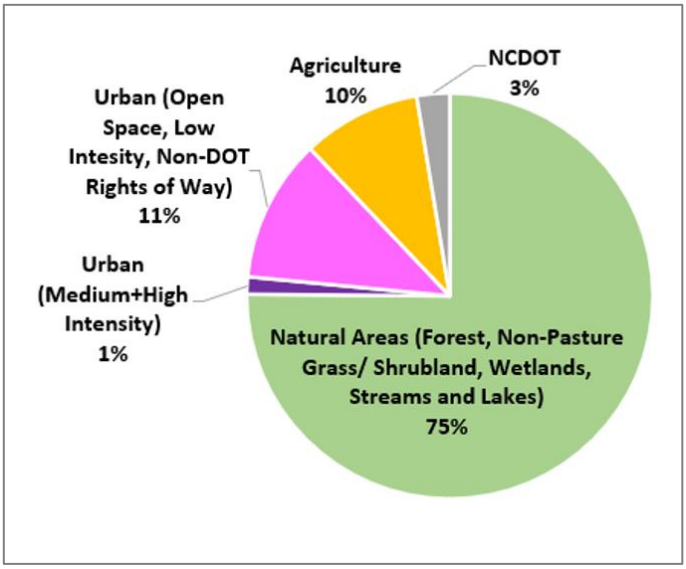
Historic Trends in Nutrient Loading to Falls Lake

Nutrient loading to Falls Lake comes from the watershed, atmosphere, and lake sediments. Loading from the watershed can be estimated from stream flow and water quality data collected since the 1980s. This component of the load comprises the majority of the load to the lake. Most of the watershed load enters the system at the upstream end of the lake. This part of the load includes atmospheric deposition to the watershed, including natural areas.

Seventy-five percent of the watershed is in an unmanaged or natural state (like forests and wetlands). Land use changes have occurred over the past several decades. The area of land in agricultural production (10%) has declined by nearly one-half since 2006 (the tracking year for the 2011 Falls Lake Rules). These lands have either been developed or are no longer in production and transitioning to grassland or forests. Urban development in the watershed has increased and comprises approximately 12% of the watershed area. Most of the urban land is low intensity development, local road rights of way, and developed open space. Just over 1% of the urban areas are medium or high intensity development.



Nutrients are also deposited directly to the surface of Falls Lake from the atmosphere. This deposition can fall with precipitation or settle like dust. Due to improvements in air quality, atmospheric deposition to the watershed and the lake surface has decreased by 20% to 25% since 2006. Air quality and rainfall chemistry data are available to estimate loads deposited from the atmosphere.

Nutrients can also be recycled from the lake sediments. This load is often called “internal.” The UNRBA, US Environmental Protection Agency, and NC Collaboratory have conducted sediment studies in Falls Lake to estimate the amount of loading from the sediments to the lake water. Sufficient data is not available to estimate how this source of loading has changed with time. Because it is a relatively small source compared to the watershed load, seasonal loads predicted by UNRBA lake models provide these estimates. The UNRBA lake models were developed using the data collected in Falls Lake and are a reasonable approximation of internal loading.

Nutrient loading to Falls Lake has decreased significantly since the 1980s. Most of the variability in loading in the recent years is due to rainfall. For example, rainfall in 2017 was average (45 inches). Rainfall in 2018 was 60 inches (30 percent higher than average). As a result, nutrient loading in 2018 was significantly higher than 2017. For comparison, 2007 had only 38 inches of rain and occurred during a historic drought for the area. Even though 2017 had higher rainfall than 2017, the total nitrogen loads to Falls Lake were similar. The total phosphorus loads to Falls Lake in 2017 were much lower than 2007.

Reductions in nutrient loading due to improvements in the watershed kept nutrient loads in 2017 lower than they would have otherwise been. The summary figures show how nutrient loading to Falls Lake has changed since the 1980s.

Total nitrogen loads to Falls Lake have declined since the 1980s.

The 2011 Falls Lake Rules track reductions relative to year 2006. Between 2006 and 2018, the following total nitrogen reductions have been achieved:

- Atmospheric deposition to land and water surfaces (~25 percent)
- Wastewater treatment plant improvements (~40 percent)
- Nutrient application on farmland (~40 percent)
- Nearly 400 stormwater retrofits have been constructed

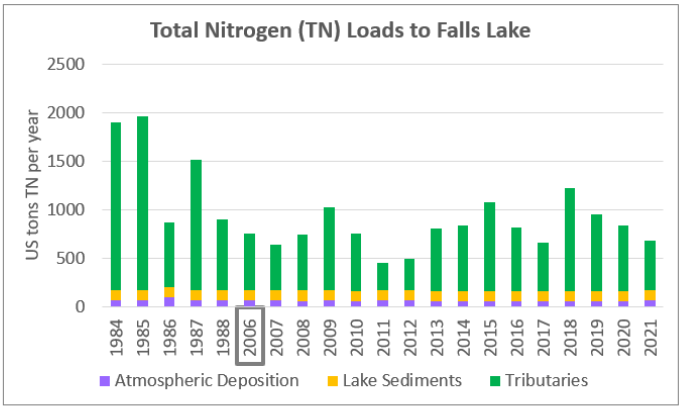


Figure notes: Load is a function of stream flow and concentration.
Atmospheric deposition directly to the lake surface is a minor contributor of the total nitrogen load to Falls Lake. Atmospheric deposition to the watershed is included in the tributary loading.
Total nitrogen loads released from lake sediments are based on modeled years (2014 to 2018).
Missing years indicate a lack of tributary monitoring data.

Total phosphorus loads to Falls Lake have declined since the 1980s.

The 2011 Falls Lake Rules track reductions relative to year 2006. Between 2006 and 2018, the following total phosphorus reductions have been achieved:

- Wastewater treatment plant improvements (~80 percent)
- Nutrient application on farmland (~40 percent)
- Nearly 400 stormwater retrofits or streambank erosion projects have been constructed

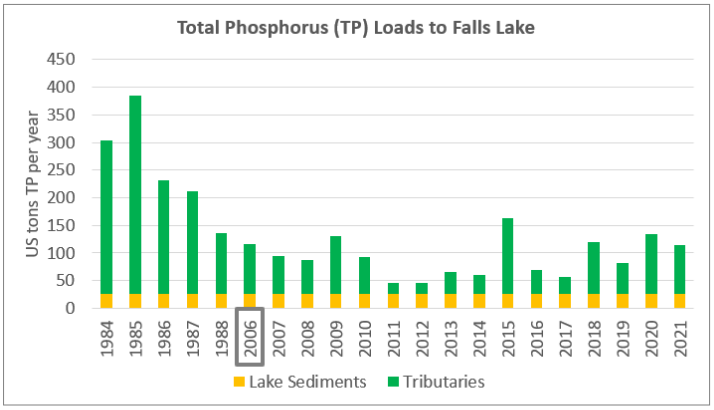


Figure notes: Load is a function of stream flow and concentration.
Atmospheric deposition directly to the lake surface is a minor contributor of the total phosphorus load to Falls Lake. Atmospheric deposition to the watershed is included in the tributary loading.
Total phosphorus loads released from lake sediments are based on modeled years (2014 to 2018).
Missing years indicate a lack of tributary monitoring data.

Annual nutrient loads can be “weighted” by the amount of precipitation that fell that year for a clear view of reduced nutrient loading to Falls Lake. Regulated entities complying with air and water quality requirements have achieved significant reductions in loading since the 1980’s.

The timing of rainfall events also affects delivered load. The same amount of annual rainfall occurring over several large storm events will deliver more load than if the rain occurs as smaller storms throughout the year. Back-to-back large storms saturate soils and result in higher stream flows. In their 2021 status report for Falls Lake, the North Carolina Division of Water Resources (DWR) developed flow-weighted estimates of loading back to 2006. These values divide the delivered load by the stream flow volume. DWR reports that total nitrogen loads from 2006 to 2019 **decreased by 20 percent**, and the total phosphorus loads **decreased by 50 percent**.

When total nitrogen loads to Falls Lake are divided by the annual precipitation at Raleigh-Durham International Airport, significant reductions in loading from the 1980s are evident.

Regulated entities complying with clean air and water quality regulations have achieved significant reductions in loading:

- 1999 Neuse River Rules
- 2002 Clean Smokestacks Act
- 2011 Falls Lake Rules

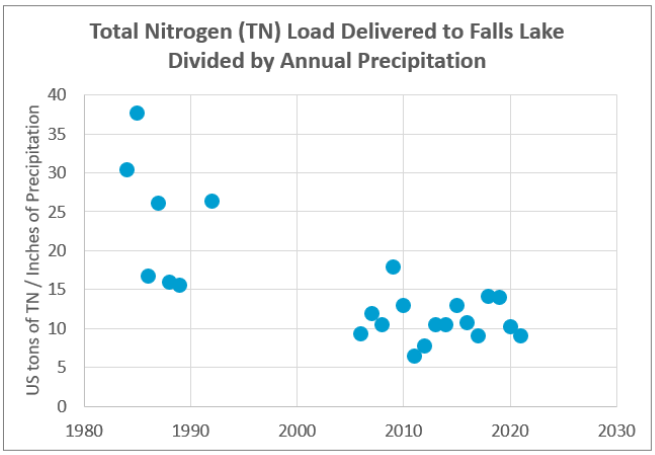


Figure notes: Load is a function of stream flow and concentration.
Missing years indicate a lack of tributary monitoring data.

When total phosphorus loads to Falls Lake are divided by the annual precipitation at Raleigh-Durham International Airport, significant reductions in loading from the 1980s are evident.

Regulated entities complying with clean air and water quality regulations have achieved significant reductions in loading:

- 1988 NC Phosphate Detergent Ban
- 2011 Falls Lake Rules

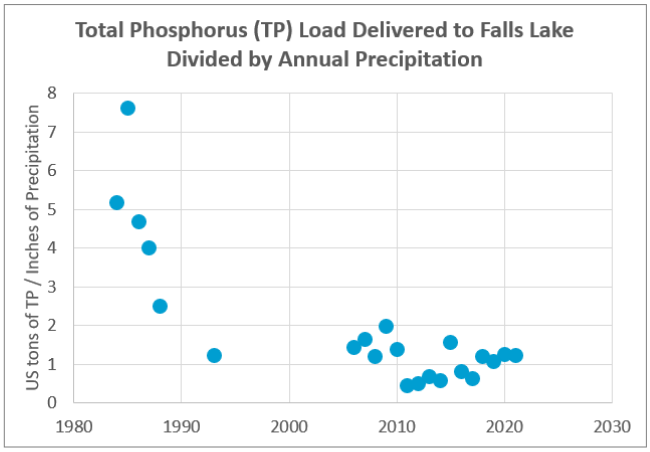


Figure notes: Load is a function of stream flow and concentration.
Missing years indicate a lack of tributary monitoring data.