Water Quality Trends in Southwest Florida

Full Article:

Summary

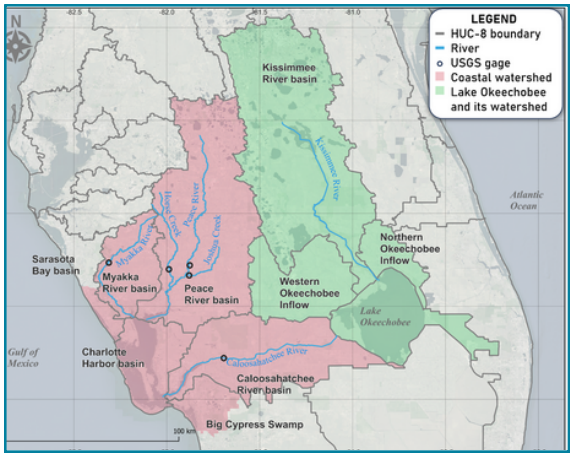
A joint research project was conducted to assess water quality trends from 2000-2021 in Southwest Florida coastal waters and estuaries using a 20+ year dataset collected by the Coastal Charlotte Harbor Monitoring Network, a partnership of sampling organizations including the CHNEP. Annual levels of Nitrogen, Phosphorus, and Chlorophyll-a (Chl-a) were measured against their respective regulatory thresholds and then were assessed over 5-year increments to determine if there were increasing or decreasing trends. That was then compared with seagrass and macroalgae data collected in the same timeframe. The results showed that across the whole area, Nitrogen concentrations have remained near or above their thresholds since 2016 or earlier. Phosphorus concentrations were near or below their thresholds until 2007 but then have been varied in the different areas - with some increasing, stable, or decreasing. Chl-a concentrations were near or below their thresholds until 2017 and since, all have been stable or improving - except the West Wall of Charlotte Harbor. Seagrasses were increasing in southern areas (Caloosahatchee estuaries and Estero Bay) until 2014 but then started to decline - with the exception of Pine Island Sound. Seagrasses in the upper areas (Tidal Peace and Myakka Rivers, Charlotte Harbor) were increasing until 2018 but then started substantially declining. Overall maximum coverage of macroalgae has been increasing from 2017-2021 in most areas throughout the region post Hurricane Irma.

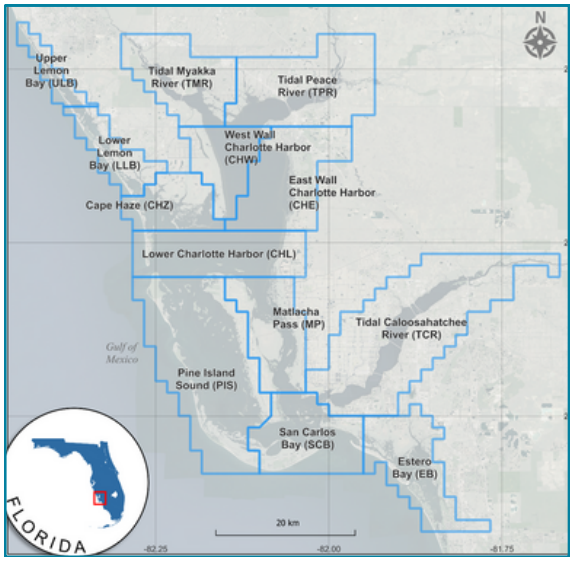
Water Quality Trend Analysis

The project used long-term monitoring data from Lemon Bay south to the Estero Bay watershed in Southwest Florida (Fig 1). These watersheds are further divided into 13 distinct areas with unique characteristics (Fig 2).

Twenty plus years of water quality data, including Nitrogen, Phosphorus, and Chlorophyll-a concentrations were analyzed using a generalized additive model (GAM). First, the monthly mean concentrations of Nitrogen, Phosphorus, and Chlorophyll-a over the full time period (2000–2021) were input into the GAM; then 2) the monthly GAM results were used to estimate annual mean concentrations with 95% confidence intervals; and finally 3) estimate trends of annual means over a sliding, 5-year window (2000–2004, 2001–2005, ending in 2017–2021) were determined, accounting for seasonal variations in data between years.

Annual concentrations for Nitrogen, Phosphorus, and Chlorophyll-a in each of the regions were also compared against regulatory thresholds for those same areas. It is important to note though that the use of thresholds should not be interpreted as a regulatory assessment.





(Right Top) Figure 1. Study area includes mulitple large watersheds that receive flow from several major river systems in Central and Southwest Florida.

(Right Bottom) Figure 2. The watersheds are further broken into 13 distinct sampling areas.

Nitrogen as Major Driver for Seagass Loss

The trend analysis looked at nutrient pollution indicators across the study area and found that Nitrogen concentrations (Total Nitrogen, TN) in the northern Charlotte Harbor areas (Tidal Peace River, Tidal Myakka River, West Wall Charlotte Harbor, East Wall Charlotte Harbor, Cape Haze) were stable from 2000-2010 and then began trending upward in 2012.

Nitrogen concentrations in the southern areas (Lower Charlotte Harbor, Matlacha Pass, Pine Island Sound, San Carlos Bay, and Estero Bay) were more variable from 2000-2021, though also began trending upward in 2014. The Nitrogen conditions in the Tidal Caloosahatchee River have been poor every year - fluctuating in levels from 2000-2011, trending downward between 2012-2016 and then holding steadier after 2016 at levels that are still above the regulatory threshold.

Seagrass coverage was increasing from 1999 to 2018 in the northern Charlotte Harbor areas, then dropped dramatically between 2018 and 2022. Coverage was increasing across the southern estuaries from 1999 to 2014 but then started declining - with the exception of Pine Island Sound.

Nitrogen as a Driver for Macroalgae Growth

Since 2016, across all areas, Nitrogen concentrations were generally elevated above specified regulatory thresholds for water quality defined in the Florida Administrative Code (F.A.C.) 62-302.532, and trending upwards in contrast to other water quality indicators used for this study.

Between 2017 and 2018, macroalgae maximum cover increased at the East Wall, Cape Haze, Lemon Bay, Pine Island Sound, and San Carlos Bay following Hurricane Irma. Subsequently, comparing 2019–2021, macroalgae growth increased in almost the whole region, often substantially (except in Estero Bay where it decreased). The combined seagrass loss and macroalgae growth is a biological response to excess Nitrogen pollution in coastal waters.

Trends by Region for Most Recent 5-Year Window (2017-2021)

	TN	TP	Chl-a	Seagrass	Macroalgae
Tidal Peace River	●	↓	●	↓	↑
Tidal Myakka River	●	↓	●	↓	↑
East Wall Charlotte Harbor	●	●	↓	↓	↑
West Wall Charlotte Harbor	●	●	●	↓	↑
Cape Haze	●	●	↓	↓	●
Lower Charlotte Harbor	●	●	↓	↓	↑
Tidal Caloosahatchee River	●	↓	↓	↓	●
Matlacha Pass	●	●	●	↓	↑
Pine Island Sound	●	●	↓	↑	↑
San Carlos Bay	●	●	↓	↓	●
Estero Bay	●	●	↓	↓	↓

Symbol Legend: Trend Directions
- ↑ Up
- ● None
- ↓ Down

Color Legend: 5-year Mean Concentration Relative to Regulatory Threshold
- Above threshold
- Near threshold
- Below threshold

Seagrass and Macroalgae Conditions Based On Coverage
- Declining
- No Change
- Improving

Management

Tracking and understanding changes in water quality along with bioindicators such as seagrass and algae provides a more complete picture of ecosystem health and is important for managing and restoring coastal ecosystems. These long-term curated data sets will continue to be a foundation for further analysis and assessment of the success of nutrient reduction projects in these watersheds.