

WATER QUALITY MONITORING PROJECT

FLORIDA KEYS NATIONAL MARINE SANCTUARY

Water Quality Is Clearly Important to Marine Ecosystems

Most marine animals and plants go through their entire life cycle completely surrounded by seawater. Healthy marine ecosystems depend on good water quality to maintain their productivity and species diversity. Water quality is an overall evaluation based on a suite of measurements and analyses conducted in the field and laboratory. Water temperature, salt content (salinity) and dissolved oxygen (DO) concentrations are some of the environmental factors measured by scientists. Significant changes in these and other factors can have negative effects on marine life, including increased susceptibility to disease and even death. Marine organisms may become stressed when conditions change beyond what they are able to tolerate.

Water quality has been a high priority for managers of the Florida Keys National Marine Sanctuary and the focus of extensive scientific research since Congress designated the sanctuary in 1990. As part of the sanctuary legislation, Congress directed the U.S. Environmental Protection Agency and the state of Florida to create the Water Quality Protection Program. In 1995, as part of the new program, scientists from Florida International University established the Water Quality Monitoring Project to track and analyze water quality in sanctuary waters.

Land-Based Nutrients Impact Marine Life

Scientists also routinely measure the nutrient content of the water, especially the various chemical forms of two plant nutrients: phosphorus and nitrogen. An excess of nutrients (also called nutrient enrichment or eutrophication) promotes the growth of macroalgae or seaweeds, which compete with coral for living space on the seafloor. In the Keys, nutrients enter nearshore waters from land, through stormwater runoff and groundwater seepage. Groundwater carries sewage from underground septic systems to nearshore waters and canals through the porous limestone that forms the islands of the Keys. Nearshore tidal currents can then move nutrient-rich waters to where they affect coral reefs and seagrass meadows—marine communities that are adapted to low-nutrient waters and can be impacted by nutrient enrichment.

Coral reefs and seagrass meadows thrive best in waters with very little turbidity, or cloudiness. Water turbidity is affected both by sediment stirred up from the bottom and by concentrations of phytoplankton—the collection of microscopic algae and photosynthetic bacteria living in the water. Dense populations or “blooms” of phytoplankton, can cloud the water, turning it green in color. Phytoplankton contain the green pigment chlorophyll-a, allowing them to produce their own food using sunlight and raw materials. Such blooms, which are fed by phosphorus, nitrogen, and other plant-growth nutrients, can increase water turbidity and block sunlight from reaching seagrass on the seafloor. Turbid water is detrimental to most shallow-water corals because they need sunlight to aide their symbiotic algae (called zooxanthellae) in providing essential nutrition. Phytoplankton organisms are not always harmful to marine life. At normal population levels, they are important part of the food web for many species.

Currents Connect All Waters in the Keys

The entire South Florida region, including the Florida Keys, Florida Bay and the Southwest Florida shelf, is connected by water currents. Tidal flows take place daily through the channels between the Keys and the bay and between the bay and the Gulf of Mexico. Two large surface currents, the Florida Current and the Gulf of Mexico Loop Current, along with the inshore currents of the shelf, also sweep across the region. Fresh water from the Everglades flows through Shark River Slough on Florida’s southwest coast and then southward toward Florida Bay. The Florida Keys and adjacent coral reef are at the center of this complex and endent system of water movement. The quality of water affecting the reef is influenced by water flows in and around the Keys themselves, as well as by currents originating outside the region.



Coral reefs thrive in clear, low-nutrient waters.
Photo: FKNMS

<http://floridakeys.noaa.gov/>



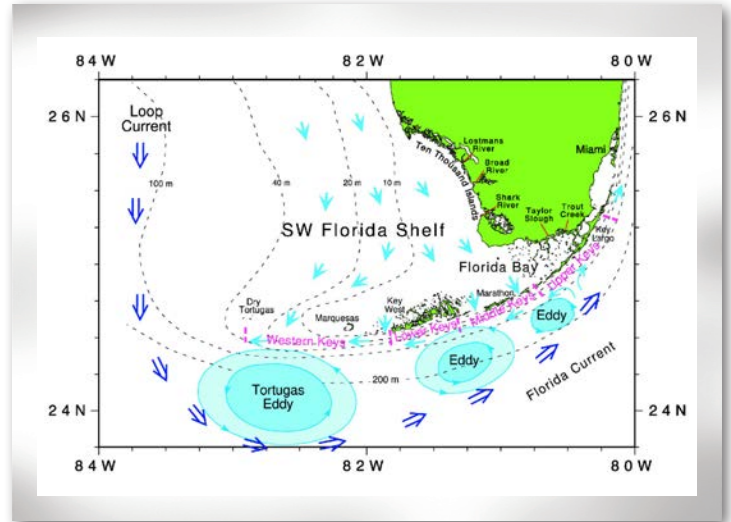
Fifteen Years of Monitoring Yields Results

The Water Quality Monitoring Project has been collecting water quality data from 154 stations since 1995. Program scientists have closely analyzed the period from 1995 to 2010 for trends. Throughout these 15 years, nearshore waters in the Keys exhibited elevated levels of nitrate, an inorganic form of nitrogen found in plant fertilizers and sewage. In contrast, elevated nitrate concentrations were not present at sampling sites in the Tortugas. This distribution pattern suggests that an inshore source of nitrate is being diluted by ocean water. Although upgrades in sewage treatment have been occurring throughout the Keys in recent times, sewage may still be entering nearshore waters through groundwater and may partially account for high nitrate levels near shore. Another source is stormwater runoff.

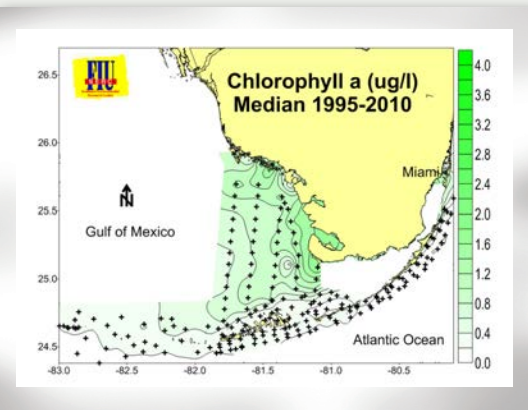
Additionally, the area north of the Lower Keys exhibited high turbidity, chlorophyll-a and phosphorus levels, indicating that phytoplankton populations may be experiencing blooms. Waters flowing from the Southwest Florida shelf are thought to contribute to these conditions. Some of the highest nitrate levels are also observed at a few sampling sites in this same non-populated area. Instead of originating from sewage or fertilizers, these nitrates may be entering the water column when sediment containing nitrates and other organic material is stirred up from the shallow seafloor on windy days.

Geographic Trends Detected in Water Quality Characteristics

Statistical analyses of the data identified two major geographic trends. One trend was apparent from north to south: the highest chlorophyll-a, turbidity and dissolved nutrient levels were found north of the Middle Keys in sites nearest to the Southwest Florida shelf. These levels gradually decreased moving south toward the Marquesas. This decline was probably due to the uptake of nutrients by marine life and by mixing with ocean waters. This north-south pattern is thought to be driven by waters from the Southwest shelf, which are high in phosphorus.



The region is connected by surface currents.
Image Source: Redrawn from Lee *et al.*, 2002



Shelf waters have the highest chlorophyll-a levels.
Image: FIU

The second major trend was evident from inshore waters near the Keys toward offshore waters on the ocean side. Nutrients gradually decreased from inshore stations along the Keys toward the offshore stations at the reef. This inshore-offshore pattern points to a land-based source of nutrients. Stations from the Tortugas, also with the lowest nutrient levels, were similar to reef stations along the Keys.

The highest phytoplankton populations in the region, as indicated by chlorophyll-a levels (left), were found outside of the sanctuary on the Southwest shelf. Chlorophyll-a levels diminished from the north to the south near the Marquesas and Tortugas. A similar trend was observed in total phosphorus, an important nutrient fueling the phytoplankton populations. Most likely, coastal rivers, runoff and Gulf of Mexico waters to the north contributed to the high levels of phosphorus observed in shelf waters.

It's All about the Big Picture

By examining water quality monitoring results from sanctuary waters, along with results collected from nearby waters, scientists and managers have begun to understand the big picture of water quality. Through this regional approach, much has been learned about nutrient sources, the role of surface currents and geographic differences in water quality. In this interconnected system, water quality is affected by sources located within the Keys and as well as those outside of the Keys. Changes in fresh water flows on the mainland planned as part of the Comprehensive Everglades Restoration Program may also affect water quality in the future. By systematically monitoring the system, scientists will continue to provide sanctuary managers with the best available information. To view the many data maps and reports produced as part of the Water Quality Monitoring Project, visit <http://serc.fiu.edu/wqmnetwork>.