Where Has the Grass Gone?

Factors Impacting Submerged Aquatic Vegetation Bring Together Partners at Mattamuskeet National Wildlife Refuge

By Doug Howell & Michelle Moorman

The grass has all but disappeared from Lake Mattamuskeet, the centerpiece of the U.S. Fish and Wildlife Service’s (USFWS) Mattamuskeet National Wildlife Refuge (Refuge). The “grass,” often referred to as submerged aquatic vegetation (SAV), includes beds of aquatic plants like wild celery, redhead grass, sago pondweed, southern naiad, eurasian milfoil, muskgrass and nitella.

Located on the Albemarle-Pamlico Peninsula in eastern North Carolina, the Refuge was established to promote and maintain wetlands for migratory bird populations, specifically wintering waterfowl, as well as habitat for other wetland-dependent wildlife. Many of the Refuge wildlife and habitat conservation goals, outlined in its Comprehensive Conservation Plan, are supported by having grasses in the lake, as well as emergent vegetation around the lake shore. This vegetation provides key food resources for migratory birds, particularly waterfowl, as well as habitat for fish, crabs and other aquatic organisms.

Just how important is Lake Mattamuskeet and the Refuge to wintering waterfowl? Its strategic location along the Atlantic Flyway makes it a vitally important annual stopover site for hundreds of thousands of wintering ducks, geese and swans. Sportsmen and wildlife viewers alike, from all parts of the state and country, visit the Refuge and local area each year to hunt, fish, and observe wildlife — activities that provide a vital economy to the region.

Why is the grass disappearing? The sudden decline of SAV on the east side of the lake, and the potential impact these declines could have, particularly to waterfowl, fish, and crabs, has alarmed natural resource managers from the USFWS and the North Carolina Wildlife Resources Commission (NCWRC).

In 2014, a memorandum of understanding was signed by the USFWS and NCWRC to create the Mattamuskeet Collaboration Team for the purpose of co-managing more than a dozen projects aimed at addressing the health of Lake Mattamuskeet’s ecosystem, identifying and prioritizing monitoring and research needs and opportunities for habitat restoration, as well as projects designed to increase the recreational value of the lake,” said USFWS Southeast Region Director Cindy Dohner.

Since establishing the collaborative agreement, USFWS, NCWRC and other partner agencies and researchers have been studying the ecology of Lake Mattamuskeet in order to better understand why SAV has declined.

“This collaborative agreement has allowed the two agencies to leverage more resources and accomplish much more than they could if they were addressing this difficult conservation challenge of restoring Lake Mattamuskeet alone,” NCWRC Executive Director Gordon Myers said.

As part of the Mattamuskeet Collaboration Team, the Mattamuskeet Technical Working Group was formed and tasked with ensuring that the best available science is used for habitat restoration on the lake and surrounding watershed. The Mattamuskeet Technical Working Group is a multi-disciplinary team consisting of members from USFWS and NCWRC who have specific and extensive expertise in wildlife and fisheries management, water quality and environmental contaminants.

Based on results from an assessment of water-quality trends, we have concluded that significant increases in nutrients and suspended sediments in the lake since the 1980s have caused an increase in harmful phytoplankton and a reduction in water clarity (eutrophication). As a result, the grass has declined from the deepest to the shallowest areas of the lake. Many of the last beds of SAV are currently located in the calmer waters along the shallow, southern shores of Lake Mattamuskeet.

Lake Mattamuskeet is the largest naturally formed lake in North Carolina, with a surface area of approximately 40,000 acres. It is also very shallow, with an average depth of just 2 feet. It is not the only shallow lake that has lost its grasses; other large, shallow lakes share similar histories. In theory, shallow lakes generally have two ecosystem states — one where phytoplankton is dominant or one where macrophytes dominate.

Fighting Phytoplankton

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Phytoplankton are mostly microscopic, single-celled photosynthetic organisms that live suspended in the water, and include algae, diatoms and cyanobacteria. Macrophytes are aquatic plants (that include SAV) and grow in or near or near water and are either emergent, submerged or floating. Phytoplankton and macrophytes are considered primary producers because they use the process of photosynthesis to produce their own food while serving quality habitat for animals further up the food chain. Whether a lake is dominated by phytoplankton or SAV is important to resource managers because it has implications for what can occur. Dense communities of phytoplankton often result when there is too much sediment and too many nutrients like nitrogen and phosphorus in a water body. The combination of excess sediment and phytoplankton reduces water clarity, which reduces the amount of light in the water column available to SAV for photosynthesis. This causes the health and abundance of SAV to decline to the point where it is not able to support the rich wildlife and recreational users if the concentration of toxins in the lake increases. An assessment of water-quality data by the N.C. Division of Water Resources has determined that Lake Mattamuskeet is currently not meeting state water-quality standards, and beginning in 2016, the lake will appear on the U.S. Environmental Protection Agency’s list of impaired waters.

![Maps below show the estimated proportion of submerged aquatic vegetation (SAV) coverage in Lake Mattamuskeet for the years 1991, 2004, 2016 and 2020. An x-axis on the left side of the lake shows the locations where SAV coverage was estimated.](https://example.com/maps)

<table>
<thead>
<tr>
<th>Year</th>
<th>SAV Coverage</th>
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<tbody>
<tr>
<td>1991</td>
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<td>2004</td>
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<tr>
<td>2016</td>
<td>0.0</td>
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<tr>
<td>2020</td>
<td>0.0</td>
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This isn’t the first time in the history of the Refuge that SAV hasn’t been present in Lake Mattamuskeet. The lake was refilled and established as Mattamuskeet National Wildlife Refuge in 1934 following a failed agricultural project that drained the lake three times in the early 1900s. At this time, no SAV was present and the lake had poor water clarity. Turbid water conditions prevailed in the lake until the 1950s, attributed to the large number of carp present, which tend to stir up bottom sediments. It was presumed that the turbid water conditions prevented growth and survival of SAV. Refuge managers began transplanting SAV and removing carp at this time. Between 1945 and 1960, SAV restoration in Lake Mattamuskeet began to have success with the removal of 2.3 million pounds of carp, 230,000 pounds of catfish and 150,000 pounds of gar, bowfin, gizzard shad and muskellunge. As SAV began to take hold, water quality became healthier and SAV further promoted the establishment, spread and survival of the grasses during this time. Since the 1960s, the lake has been viewed as an important part of the Lake Mattamuskeet ecosystem. The grass on the west side of Lake Mattamuskeet began to decline during the 1990s, while grass on the east side continued to flourish. In 2009, concerns over those declines sparked research to more fully understand the apparent changes that were occurring. By extracting and examining cores of the lake sediment, researchers concluded that the construction of the Highway 94 causeway in 1946 resulted in a unique shallow lake ecosystem at Lake Mattamuskeet. Highway 94, which bisects the lake from north to south, effectively resulted in two distinct basins, which were only connected by a few culverts underneath the causeway. The west basin of the lake was dominated by phytoplankton while the east basin of the lake had better water quality and supported dense beds of grasses. This unique two-state system maintained itself until recently, when the state of the lake changed again.

Monitoring data collected since 2012 indicates that there is presently no difference in water quality between the east and west sides of the lake, and rapid declines in SAV have occurred since 2013. Additionally, increasing levels of harmful cyanobacteria in the water are producing toxins that could potentially harm wildlife and recreational users if the concentration of toxins in the lake increases. An assessment of water-quality data by the N.C. Division of Water Resources has determined that Lake Mattamuskeet is currently not meeting state water-quality standards, and beginning in 2016, the lake will appear on the U.S. Environmental Protection Agency’s list of impaired waters.

GROWING CONCERN

There are likely many sources of increased sediment and nutrients that have resulted in eutrophication in Lake Mattamuskeet, including: runoff from the surrounding farmland, and waterfowl impoundments draining to the lake, waterfowl feces and atmospheric deposition of nutrients. The Refuge currently affects the rate of water outflow from Lake Mattamuskeet to a very limited extent, through flap gates on each of the four canals leading to Pamlico Sound. One-way flap gates were installed in 1991 to control water levels in the lake higher than those in Pamlico Sound. When the flap gates are open, winds can accelerate the process of pushing lake water to Pamlico Sound, depending on direction. The flap gates to close as Lake Mattamuskeet and Pamlico Sound reach the same level, and completely shut when the water level in the lake drops below that of the Sound, preventing salt water from entering the lake.

Once the flap gates close, water levels are increasing in the Pamlico Sound at a rate of 2.5 millimeters per year and that water levels in the Pamlico Sound have increased 9 inches since the early 1900s. This is important because it could impact the rate at which water leaves the lake, increasing the amount of time that it takes excess nutrients and sediments to be “flushed” from the system. Changes in water levels in the Pamlico Sound may play an important role in eutrophication of Lake Mattamuskeet, since even a small rise in sea level directly impacts the amount of time nutrients and sediments reside in the lake. As a result, climate change could increase nutrient and sediment inputs to Lake Mattamuskeet and increase the likelihood that they are recycled and resuspended in the water column by wind and wave action, and digging fish such as striped bass.

SAV is being used as the indicator for the health of Lake Mattamuskeet to guide current and future monitoring and research efforts led by the USFWS and NCWRC. These efforts will provide the baseline information needed for managers to begin targeting potential strategies that can reduce harmful algal blooms and promote the growth of SAV in the lake, and to develop a long-term restoration plan to improve SAV coverage and overall health of the lake.

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Doug Howell is the waterfowl biologist for the North Carolina Wildlife Resources Commission and co-chair of the Mattamuskeet Technical Working Group. Dr. Michelle Moorman is a biologist for the U.S. Fish and Wildlife Service and co-chair of the Mattamuskeet Technical Working Group.