LAKE LILY, Cape May County, New Jersey

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It has been said of the aquarium hobby that fishkeepers do not keep fish, they keep water; the fish keep themselves when the water is right. This bit of popular wisdom illustrates what we do with our tanks. On a larger scale it is a metaphor for our relationship to our environment at large.

The Delaware County (Pa.) Aquarium Society was invited to visit Lake Lily in Cape May Point, New Jersey in August, 1993, and collect fish for the purpose of assessing the lake's health. The community is concerned that the lake has deteriorated, and is poised to act. Longtime residents recall a different lake--lush with water lilies, jumping with sunnies and bass. Migratory birds would pause by its shore. Some, like herons and Ospreys, would stay all summer, encouraged by the abundance of food. The water was clean. Bathers would wash off the salt from their bodies before returning home from the beach.

Now the namesake lilies have been replaced by thick mats of algae. The herons and ospreys have not returned, but have been supplanted by tame ducks and swans that beg food from well-meaning nature-lovers. There are signs posted to discourage the practice, but there is a tradition of kindness to birds in this town.

We were intrigued when we learned that Lake Lily has been flooded with sea water several times in the recent past, and we were eager to discover how big a role this type of event has played in the natural history of the lake.

Many lakes and ponds that mark the great South Jersey aquifer are tinted with the acidic tannin of decaying vegetation. The peat softens the water--known colloquially as "cedar water." Such waters are home to scores of fish up and down the food chain. Aquarists are always keen on the smaller fishes, and the species coveted most is the Blackbanded Sunfish (*Enneacanthus chaetodon*), a North American native perfectly suited by size and demeanor to the home aquarium. Many of us in the club hoped to find it in Lake Lily.

The pond that greeted us was not encouraging. Lake Lily is a classic case of eutrophication--that is, a concentration of nutrients favorable to the growth of algae. Algae consumes oxygen at night (as all photosynthesizers do). Then when the algae dies, it feeds bacteria which consume the lake's oxygen. In the oxygen-depleted water, anaerobic decay processes take over and produce noxious waste products detrimental to the fish life. This is a recipe for disaster in the summertime. Since warm water holds less dissolved

oxygen than cool water, a heat wave can tilt the precarious balance long enough to kill the large fishes that consume the most oxygen. The odds for survival are stacked in favor of the small fishes and those adapted to life in stagnant water. By all accounts, this is exactly what is happening at Lake Lily.

Upon testing the water, it was found to be extremely alkaline (pH 8.7 to 9.0) and hard (carbonate hardness 6 to 8 degrees, total hardness 30 to 33 degrees German). These values, though counterintuitive, did suggest a connection with the Atlantic which was well documented. A hydrometer confirmed, however, that this was fresh water, with a reading below 1.017, the threshold of brackish. Though "fresh," the water is hard enough to walk on and strong enough to burn the gills and membranes in many fishes (alkalosis). Water temperatures were in the mid-80s, lowering the dissolved-oxygen level, but this could not be confirmed by testing. Tests for phosphate and nitrate should have been performed as well, but they weren't available at the time. When present, these pollutants have a tendency to drive the pH down into the acid range. Why the lake would "look" acid yet test alkaline was the topic of the day's discussions.

When we deployed the nets, we found that the lake was not dead as feared, but was teeming with a few species of tough fishes. Mosquitofish (*Gambusia affinis* or *holbrooki*), the tenacious, hell-raising livebearer, were thriving in this water. The proximity and influence of the ocean was borne out by the presence of Silversides (*Menidia beryllina*), Sheepshead Minnows (*Cyprinodon variegatus*), Mummichogs or Bait Killies (*Fundulus heteroclitus*), and Striped or Longnose Killies (*Fundulus majalis*), all of which tolerate a broad range of salinities from fresh all the way up to brine saltier than the sea itself. Striped Killies, particularly, are rarely found out of fairly salty water. If we had not tested Lake Lily's water, we would have sworn that it was salt water!

One pleasant surprise was catching a fish we had not seen before in our trips to Delaware, Pennsylvania, or New Jersey. A substantial number of Rainwater Killies (*Lucania parva*) of all sizes were caught. Though smaller than the common Bait Killie, there is a resemblance, and identifying juveniles can be difficult. Rainwater Killies are more slender and delicate, with a cross-hatched pattern highlighting the scale margins. They have a pretty spot on the anterior dorsal, and possess gentle hues of yellow and orange in the belly region, darkening outwards through the pelvic fins. Larger specimens seemed intolerant of handling and were the first to whirl about with stress. They also seemed prone to parasites, as only these fish had leeches attached. The Rainwater Killies make fine aquarium animals, and, like the Sheepsheads, were prized by our group.

Although our collectors found the lake rich in forage fishes, larger predators were notably absent. Certainly we should have caught sunfish if any were about, but such was not the case. No fingerling bass or pickerel either. The mice were clearly at play!

But without the spectre of predation looming around the corner, this cannot be a picture of natural health. As one resident put it, "How can we fix this lake?" At the time, we were not sure it was "broke," but without the egret and the bass to put things in perspective, it was not right either.

As the town struggles with defining the place the lake holds in its future, there is true sentiment for preserving this resource. The waterfowl are clearly choking the lake by the copious amounts of waste they produce. Yet the community relishes their presence. Will the community be willing to accept a dying lake as a casualty of this tradition? Probably not for long. Education may be the best tool in illuminating this consequence to the public, but so far the signs warning against feeding the birds have been largely ignored. What other action can be politically palatable and yet effective?

Other sources of nutrification need to be identified and corrected. The lake is purportedly fed by springs. These should be located and tested to determine if pollutants are entering by this avenue. The Delaware County Aquarium Society is bush-league when it comes to this, but our water tests in the area of the springs indicate higher pH and slightly lower hardness. Without further testing, we can only speculate what else may be pouring into the lake via those springs. Run-off from storms and roads and septic systems also are known contributors of undesirable contaminants, and cannot be ignored.

In the 1940s, there was a factory in the locality which produced magnesite (magnesium carbonate) for the war effort. The substance was extracted from seawater and used to make the bricks that lined the furnaces of the steel industry. Residents tell of the white dust, flying everywhere at that time, that killed the pines and started on the oaks before the plant was mothballed. We wondered if this could be contributing to the hardness and/or alkalinity. Since the magnesite is a carbonate, and our tests for carbonate hardness revealed only moderate buffering capability (a desirable trait), it is unlikely in our judgment that this is an offending substance. The culprit behind the high general hardness of 33 degrees (almost 600 ppm) is something other than carbonate.

Sea salt can increase the general hardness, but only moderately. Using the same kit on tap water and on tap water saturated with salt, the general hardness increased from 8

degrees to only 13 degrees. This is a far cry from the 33 degrees of Lake Lily, where the water was not even brackish. Obviously something other than sodium chloride is in the water.

Cape May Point, on the southernmost tip of New Jersey, has been battling a beach-erosion problem that is eroding the town. As the sea creeps closer, groundwater wells turn salty and storms wash seawater into the freshwater lakes. Who can tell what consequences such cataclysmic events can have on the lake's fragile system. And how long they have been going on?

We were told of a massive fish kill two years ago when fall and winter storms washed hundreds of large carp (and some sea bass) onto the lawns of the residents. That summer, the heat and algae took its toll on the remaining large fish. The gulls feasted. Then the scrub vegetation on the island in the lake perished--possibly an indicator of salt influx, which kills roots. In short, nothing is the same with Lake Lily anymore. Are these "natural" events from which the lake has recovered in centuries past, or has the sea crept too close this time?

Lake Lily is fertile ground for theory and experimentation. Like a gigantic aquarium gone awry, we can speculate on what were the causes and what can be done. As for the individual aquarist, the remedies will be tempered by real-world budgetary concerns. By careful science and responsible action, the nut may be cracked and the lake returned to its former glory. Or it could be that the lake is evolving, forced by nature into a new role. It will be interesting to follow Lake Lily as it takes a turn into the Twenty-first Century, and discover what we do not know today.

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