

ENVIRONMENT

Research targets nitrogen pollution

By Rich Eldred
reldred@cnc.com

It's not a toxic chemical, heavy metal or poison that's fouling our inlets and bays but an essential nutrient to life.

Nitrogen is now the largest pollution problem in the coastal United States with two-thirds of the estuaries degraded," said Marine Biological Laboratory senior scientist Anne Giblin during the MBL's coffee and conversation series at the Swope Center in Woods Hole last week.

Giblin was presenting a review of recent work she did with colleagues at MBL on tracking the life of nitrogen molecules as they cycle through the groundwater, ocean, plants, algae and air.

Fortunately or unfortunately, Cape Cod provides a handy nearby lab with some systems, such as Waquoit Bay in Mashpee seriously impaired due to high nitrogen inflows and low levels of flushing.

The Massachusetts Estuaries Project, based primarily at UMass Dartmouth, has been producing reports on recommended (soon to be mandatory) levels of nitrogen inflows for various local coves and bays. Giblin and others are providing much of the theoretical framework for these studies.

"We want to see if we can use the nitrogen cycling process that works in the environment to predict how much nitrogen we have to remove to get the [bay] system to function better," she explained.

Nitrogen output has doubled

The increasing amount of carbon dioxide in the atmosphere, which has reached the highest levels in the last 200,000 years, is much in the news as the prime greenhouse gas.

Far less attention has been paid to nitrogen. That's not sur-

prising considering that air is 79 percent nitrogen gas. Increases are hard to measure against that huge background number, but we've doubled our output of nitrogen, much of it from automobile exhaust. The increase in chemical fertilization and planting of nitrogen fixing crops has also increased the amount of available nitrogen in circulation. It was just under 100 years ago scientists discovered how to mix air and water to produce ammonia (NH₃) to produce chemical fertilizer.

The ammonia is converted to nitrate (NO₃) and taken up by plants. Today, 20 pounds of nitrogen is deposited on each hectare from the atmosphere alone. In Massachusetts, three times that amount is added from sewerage and freshwater. On Cape Cod, the contribution from wastewater is even greater.

"It does the same thing in the ocean it does on the land; it makes plants grow," Giblin noted. "It causes problems not because it grows plants per se, but because they die and go to the bottom and have to be decomposed."

The decomposing plants suck up the oxygen, killing fish. All the algal growth creates shade, killing bottom-growing vegetation such as eelgrass. Waquoit Bay lost nearly all its eelgrass between 1951 and 1971 due to high nitrogen levels. The bay is now clogged with macro-algae (seaweed).

When the eelgrass disappeared, so did the scallops along with many other fish species. More alarming, the process was abrupt.

Ideally, ammonia from sewerage is converted to nitrate and bacteria denitrify, releasing the nitrogen as a gas back to the air. If it reaches the seawater as a nitrate, algae will use it. In the Baltic Sea, 80 percent to 90 percent of the nitrogen is released as a gas. In Boston

Harbor that number falls to 16 percent.

We've only recently figured out how to explain why there is such a wide range of effective denitrification. Incubator chambers, which are used at MBL, can measure small amounts of nitrogen isotopes and make it possible to trace the path through the soil into the bay.

West Falmouth Harbor has a nearby sewerage treatment plant, built in 1986, so Giblin and her coworkers sank deep wells near the plant and near the shore and collected samples of water to analyze.

"What you see is that plume of nitrogen spreading out from there [the plant] and breaking out to the surface," she explained. "Combined with the time information, that gives us an estimate of travel time for

the water from the sewer plant to reach the shore of the harbor, of 10 to 12 years. And there was little evidence of denitrification taking place in the groundwater."

There is bacteria living in soil, and the nitrogen was in the proper form of nitrate to be turned into gas, but it wasn't happening.

"The nitrate was there, but the bacteria don't use it in the presence of oxygen," Giblin explained. "So the water going into the aquifer essentially continues to West Falmouth Harbor without change."

Once it hit the harbor, the plants and plankton took up the nitrogen and decomposed giving off ammonia. The bacteria that convert ammonia to nitrate need oxygen. Oxygen levels are low as water quality declines and nitrates continue

to flow into the harbor.

"You really need the bacteria to step up to the plate, but they become overwhelmed and they switch to a pathway that actually consumes nitrogen gas," Giblin said. "So the system goes along pretty steady, then at some point it gets a little worse, and a little worse, then crashes quickly. That also means it's more difficult backwards just how much you have to reduce nitrogen to bring it back."

The good news

The good news is that septic treatment plants (including West Falmouth) which used to focus on removing solids, toxic chemicals and other substances now target nitrogen. The plants utilize both anaerobic and aerobic bacteria to convert the ammonia into nitrogen gas long

before it gets into the water table.

"By 2012 to 2015 [when the last of the plume runs out] you should see a reduction of nitrogen in West Falmouth Harbor," Giblin said. "At the plant they have to monitor the microbes. The bacteria are sensitive, so they are worried about what goes into the sewer system."

Runoff and the air will still contribute nitrogen to the estuaries; that's where half of it in Waquoit Bay comes from.

Better auto emission standards would help; so would catch basins to control runoff and lower levels of fertilizer use in the watershed.

"For Cape Cod, the biggest challenge is that we have to deal with a lot of different sources. We're not dealing with 50 to 60 percent of it," Giblin said.