MACROALGAE & TOXIC DINOFLAGELLATE BLOOMS

INTRODUCTION

Excess nutrients make the Inland Bays a good home for various nuisance plants and animals. Some large algae, macroalgae, such as sea lettuce, you can see. Others are microscopic, single-celled plants—phytoplankton. When in excessive numbers, the microscopic creatures can be visible as they color the water, giving rise to so-called red or brown tides. This proliferation of phytoplankton is often called a "harmful algal bloom."

DEFINITION

MACROALGAE

Macroalgae are large marine plants, easily visible to the eye, with some, such as our local sea lettuce, reaching lengths in excess of 12 feet. Breaking free from holdfasts on shells or other aquatic structures, macroalgae can form large, drifting masses that eventually drift ashore onto our beaches.

Blooms of macroalgae occur when an overabundance of nutrients (eutrophication) stimulates rapid and disproportionate algae growth. Blooms degrade water quality and impact living resources of the Bays—effects may be local and temporary or widespread and prolonged. Reports from residents and users of the Bays suggest that limited macroalgae blooms have occurred for decades—infrequently, and with minimal impact. In the past decade, however, bloom conditions have led to frequent formidable water quality and environmental impacts raising significant management concerns.

As with fertilizers on land, nutrients in the water stimulate plant growth. Within limits, the more nutrients you add, the more growth and plant production you get—until you burn the plants when the nutrients reach a lethal concentration. With algae in the Bays, however, no upper nutrient limit seems to exist. When high nutrient loads are added to the water, such as in runoff following a rainstorm, plants increase their body weight by rapidly absorbing the nutrients. Studies show that sea lettuce biomass can double every 1.5 to 5 days.

When macroalgae becomes highly concentrated, they shade each other, blocking out the sunlight required for photosynthesis—at which point they *consume* oxygen rather than *produce* it. At this point, due to the large mass of algae and a deficiency of oxygen, the algae dies and decomposition begins. Decomposition also consumes vast quantities of oxygen from the already depleted surrounding aquatic system depleting the local system of oxygen even more thus causing:

- septic conditions
- the release of toxic hydrogen sulfide gases and other toxics
- the relocation or death of oxygen-requiring aquatic life forms
- large fish, crab, and clam kills, and
- tourism concerns about the safety of the air and water.

PHYTOPLANKTON

Phytoplankton are single-celled drifting plants that feed on nutrients and live in the waters of the Inland Bays. When phytoplankton are too numerous, they can also deplete the water of dissolved oxygen (DO) at night and even on cloudy days when respiration rates of the plankton exceed that of photosynthesis (DO production). Low DO levels in the Inland Bays waters have become common events in late summer; they may result in large fish kills. High phytoplankton concentration in the water column prevents light from reaching bottom dwelling plants, thus decreasing species diversity and habitat function and value.

DINOFLAGELLATES

Dinoflagellates are one-celled organisms such as *Pfiesteria piscicida* and the organisms that produce red tide. Many dinoflagellates feed on phytoplankton, so theoretically, their numbers may increase when the quantity of their food source, phytoplankton, increases. Other dinoflagellates are photosynthetic so their numbers grow with increased nutrient supplies. *Pfiesteria* produce toxins that can kill fish and have other harmful effects. *Pfiesteria* has 24 forms (from a large zoospore to a cyst in the sediments) – it can act like a plant or an animal. It has been associated with fish lesions, fish kills and possible human health affects.

MANAGEMENT TECHNIQUES

TMDL

The established TMDL nutrient limits are partially based on living resource habitat requirements for estuarine submerged aquatic vegetation (SAV)—the dominant plant species in healthy, low-nutrient environments. Acceptable nutrient loadings support SAV and a balanced standing stock of macroalgae.

Best Management Practices (BMPs)

Keeping nutrients on land—and preventing their introduction into tributaries and streams—would abate macroalgal buildup during late- winter and spring. Best Management Practices (BMPs) refer to accepted and recommended methods for controlling nonpoint source pollution for surface and ground water, and may include one or more conservation practices.

- ***Agricultural BMPs***—include natural vegetative buffer strips, manure storage sheds, dead bird composters, sediment stabilization and retention techniques, etc.
- ***Urban BMPs***—include natural vegetative buffer strips, stormwater retention and detention systems, centralized sewer systems, advanced alternative septic systems, etc.

Harvesting

Starting in 1997, the State began *harvesting* the rotting macroalgae in the shoreline area. This management approach was never meant to be more than a "band-aid" to relieve the most stressed areas-it addresses the symptoms, but not the cure. Controversy followed the harvesting of the macroalgae over the question of fish and shellfish by-catch. Several years of investigations have indicated that when the decomposing algae reduces the dissolved oxygen in the algal-mat area to below 2ppm (mg/l) DO, the living resources of concern leave the impacted area for more healthy surroundings. At these low DO levels noxious macroalgae mats can be safely harvested and removed without adversely impacting the bays' living resources.

TYPICAL COSTS

The costs of not doing anything about the nutrients feeding the macroalgae and dinoflagellate growth are high. At its worst, the noxious macroalgae outbreak in Dewey Beach had tourists and homeowners up in arms over the noxious conditions:

- Seasonal renters asked for refunds for their rentals
- Homeowners documented paint damage—even inside dwellings
- Large clam kills, possibly impacted local populations and recruitment
- Other animals may have left entire areas of the Bays or died in place
- Tourists, and tourist monies, left—without guarantee of future return.

The outbreak of *Pfiesteria* in Maryland waters had multiple costs. Millions of fish died; many more had lesions. The local seafood industry lost millions of dollars, as people were afraid to buy and consume fish from the Chesapeake Bay. The Governor of Maryland closed the Pocomoke River to recreation as well as fishing. Fishermen also reported memory loss.

It is believed that Delaware experienced a *Pfiesteria* outbreak in 1987 and 1988. It was again discovered in the Bays in 1997-98 through water quality monitoring.

IMPLEMENTATION ISSUES

Unless you see the red or brown tides or smell the decaying macroalgae, the effects of seaweed and microscopic plants and animals may be *mysterious*. The connection between many of the management measures, the costs associated with the harmful algal blooms, and the algae may seem loose at best, but it is known that nutrients feed and drive macroalgae and HAB problems.

Existing bay water quality conditions do not allow for a mid- to late-summer "healthy community" of living resources—as annually- occurring macroalgae and phytoplankton blooms vividly underscore. Midsummer, in warm weather conditions, macroalgae begins to decompose and stresses the Bays' natural resources. Maximum macroalgae growth occurs during late winter and early spring when cold water and spring rains supply runoff-carrying nutrients. Inland Bays flushing rates, exceeding 90 to 100 days—coupled with high spring nutrient runoff—essentially "front load" the Bays with maximum nutrients during the optimal growth period. ***Summer's macroalgae problem stems from conditions during the period extending March to June—the best time to control rampant growth by reducing nutrients.***

Low-nutrient (oligotrophic) waters characterize healthy conditions beyond the influence of urban and agricultural nutrient runoff. Rare in Delaware's Inland Bays today, such low-nutrient waters can be found further south in Maryland and Virginia's coastal bays—bays with sea grasses. Where ***seagrasses (submerged aquatic vegetation-SAV)*** dominate, commercial and recreational fish, crab, and shellfish populations and communities thrive. Thus, ***SAV provides a good indication of the health of bay's livings resources***. A well-balanced estuarine system—composed of SAV, macroalgae, and high water/habitat-quality-demanding indicator species—are the final end point goal of the TMDL nutrient control program for the Inland Bays. Elimination of excessive macroalgae growth problems will be an endpoint against which to measure the success of the nutrient pollution-control program conducted in the Inland Bays.

INLAND BAYS WATERSHED

This fact sheet was prepared by the Delaware Department of Natural Resources and Environmental Control's Whole Basin Team, at the request of the Inland Bays Tributary Action Teams, for citizens and stakeholders interested in one of Delaware's most environmentally and economically attractive areas—the Inland Bays and its surrounding lands, surface and ground waters.

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