

The Effects of Hypoxia on the Marine Ecosystem of Long Island Sound

by
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Long Island Sound is bordered by New York and Connecticut. It is approximately 110 miles long and about 21 miles across at its widest point. The sound is an important natural resource to Connecticut, providing individuals with opportunities for recreation, business, as well as scientific research. Studies commissioned by the Long Island Sound Study estimated that more than \$5 billion is generated annually in the regional economy from boating, commercial and sport fishing, swimming, and beaching. The National Estuary Program, operating under the Environmental Protection Agency, deemed Long Island Sound as one of 28 nationally significant estuaries (Atkin, 1998).

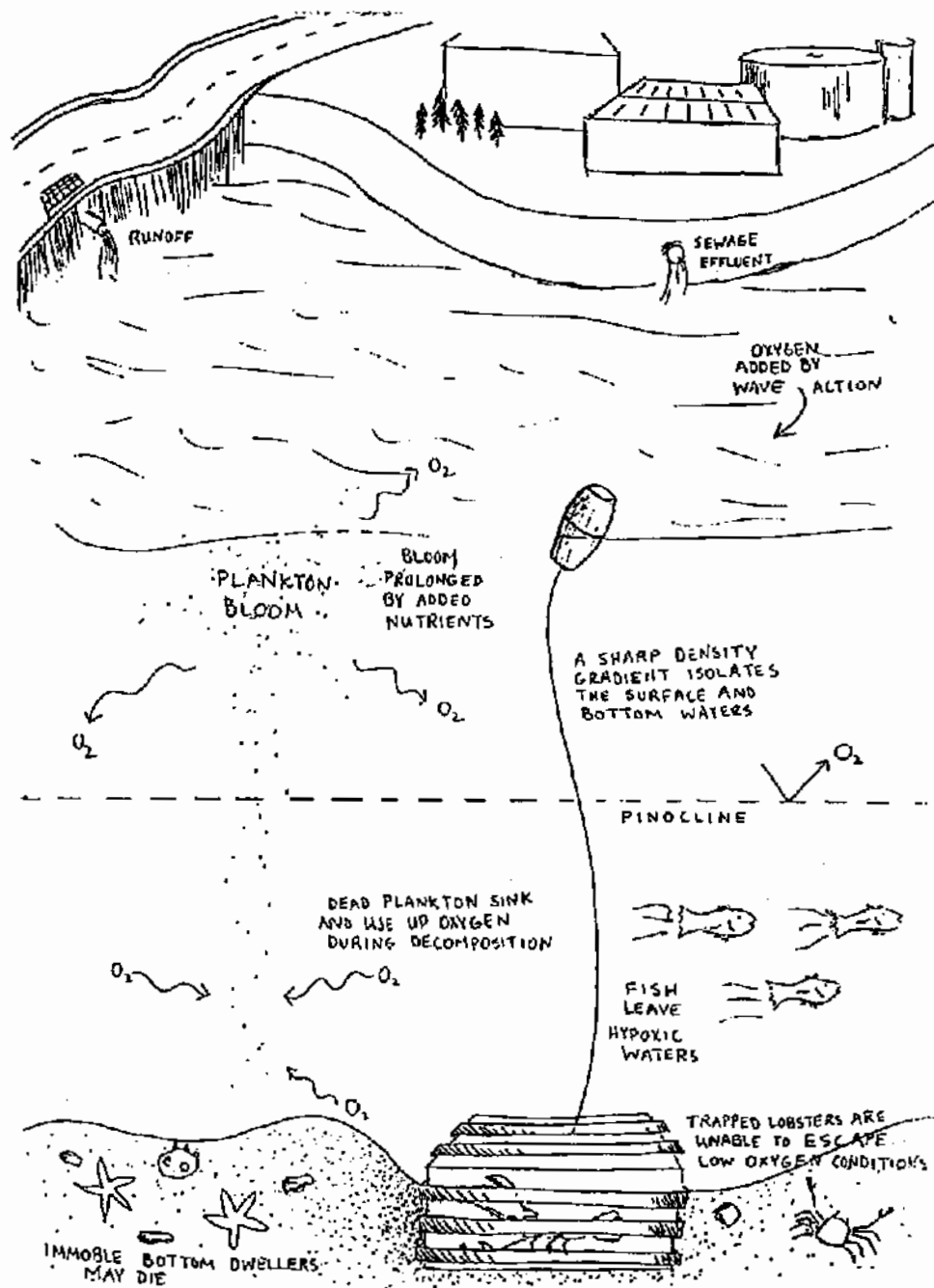
The economic value of Long Island Sound constantly comes into play in the battle for its conservation. Often times, however, its ecological value is, surprisingly, overlooked. As a biological entity, the estuary is an extremely important habitat for many species of fish and wildlife. The many habitats of the estuary include shellfish beds, sea grass meadows, kelp beds, river deltas and channels, tidal flats rocky shores, salt marsh, and open water bays are vital to the health of over 75% of all important commercial fisheries. The estuary as a whole is also an extremely productive ecosystem. It is one of the most productive natural systems on earth, producing more food per acre than even the richest Midwestern farmland (Atkin, 1998). The economic value of Long Island Sound as an estuary has been a primary focus of the heated debate over estuarine habitat restoration. Many legislators wonder if the cost of rebuilding lost habitat area is worth the product.

In recognition of the seemingly bleak future of the Sound, a number of organizations have been formed to combat the destruction of the estuary. Among the more important organizations working to restore the sound and the environment as a whole is the United States Environmental Protection Agency (EPA). In 1990, the EPA adopted a program called the Long Island Sound Study. The top priority of the Long Island Sound Study was originally planning and understanding ways in which Long Island Sound could undergo restoration. Now, however, its focus has shifted to the more active role of conservation management. The primary objective for the group is reducing nitrogen loads which contribute to low levels of dissolved oxygen or hypoxia. Hypoxic water conditions occur in substantial areas of western Long Island Sound in late summer.

Seawater is considered hypoxic when the dissolved oxygen is 3.0 parts per million (ppm) or lower, although at 5.0 ppm signs of stress become noticeable among ecosystem inhabitants (EPA, 94). At a measured level of less than 1.0 ppm, water conditions are considered anoxic, or oxygen-free. The level of dissolved oxygen present in any marine habitat is crucial to the health and survival of all its inhabitants. When this level is altered, either unnaturally or naturally, it becomes potentially deadly for the organisms of the affected community and can ultimately cause an ecosystem collapse. This would constitute a breakdown of the ecosystem in which natural ecological succession would be entirely absent until the hypoxic condition is remedied (EPA, 1994).

There are several causes of this biological phenomenon (see figure below). Not all of the causes of low oxygen water conditions are man-made. In fact, it is quite natural for dissolved oxygen concentrations to drop during a period of one to two months during the summer season. This occurs when warm surface water, heated by the sun, remains "floating" on top of cooler, denser water. This creates the marine ecological condition called a pycnocline where surface water stays relatively fresh by interacting with air and receiving oxygen from photosynthesis while deep water oxygen is consumed by animal respiration and decaying organic matter. The pycnocline prevents the mixing of the two levels creating hypoxic water conditions in the deeper waters. Conditions remain this way as long as the pycnocline stratification exists (EPA, 1994).

There are, however, man-made conditions that contribute to an exacerbation of this phenomenon. Excess nitrogen loads are drained into the Sound by river flow, direct atmospheric deposition, and human activity primarily resulting from sewage treatment plant drainage and storm water runoff. These nitrogen loads excessively nourish algal growth in the Sound leading to algal blooms. These sudden population blooms are too much for higher trophic levels of the ecosystem to consume. Therefore, large amounts of algae die at the end of their life cycle. These massive loads of dead algae sink to the bottom and begin to decay. In their normal process of respiration decomposers, which break down these algal loads, require oxygen. This oxygen cannot be efficiently replaced creating a condition of hypoxia (Atkins, 1998). This condition when caused by unnatural algal blooms can go through deceiving fluctuations. The excess blooms photosynthesize and initially produce excessive



amounts of oxygen. Temporarily, the ecosystem can appear healthy when in fact it is approaching a dire hypoxic circumstance.

This condition of hypoxia and, in some places anoxia, (in 1987, anoxia was first found in a portion of the Western Narrows) causes extreme ecological disorder (EPA, 1994). Most noticeably, the disorder causes a phenomenon known as a "fish kill" which constitutes the sudden deaths of fish. Fish kills have occurred as recently as October 1998 in Long Island Sound as a result of severe hypoxia (Schafer and

O'Keefe, 1998). The phenomenon has also reduced the growth rate of newly settled lobsters and reduces the overall health of habitats (EPA, 1994). Most important, by killing certain species of fish in great numbers, and limiting the growth of others, the delicate balance between estuarine trophic levels can be lost. This can result in the loss of certain fisheries, a significant blow to the current ecological value of the Sound. If circumstances become dire enough, a complete shutdown of the estuarine ecosystem will occur and result in a type of ecological death. The National Marine Fisheries Service (NMFS), a division of the

National Oceanic and Atmospheric Administration (NOAA), as well as local environmental organizations report threats to the health of major fisheries and water quality of Long Island Sound.

Currently, much is being done to remedy the condition of severe seasonal hypoxia. Steps are currently being taken by sewage treatment centers surrounding Long Island Sound to add a tertiary (chemical) treatment facility which would further reduce nitrogen loads in treated waters. This point-source nitrogen reduction would result in a substantial decrease in overall nitrogen deposition throughout the Sound.

The Clean Water Act now prohibits any unauthorized dumping of wastes into the Sound. All parties discharging wastes must obtain a permit from the State of Connecticut EPA. The Connecticut Motor Vehicle Department now offers a Long Island Sound license plate for an added registration fee. A portion of the proceeds from these novelty plates goes to the Long Island Sound conservation effort.

Many environmental organizations such as Save the Sound, Soundwaters, and Project Oceanology are dedicated to informing the public about the health of Long Island Sound. Education programs include camps, classes, and field experiences in which the public may learn what they can do to aid in the effort to preserve this important environmental resource. The Maritime Aquarium and Mystic Aquarium in Norwalk and Mystic, respectively, conduct extensive research programs and offer a wide array of plant and animal attractions, which also serve to educate the public about the ocean and Long Island Sound. Some local coastal municipalities are now working closely with conservation management organizations to make practical reforms to improve water quality.

The *Resource Directory of Agencies and Organizations Focused on the Environment, Long Island Sound and its Coastal Watershed* lists hundreds of other organizations which operate directly to aid in

the conservation efforts in Long Island Sound. Cooperative efforts with experts and local citizens can help to influence protectoral reform. Informed decision-makers can be the most powerful tool for the protection of coastal waters.

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References

Atkin, John and Save the Sound, Inc. 1998. *The Long Island Sound Conservation Blueprint*. Save the Sound, Inc.

Environmental Protection Agency. 1994. *Long Island Sound Study*.

Long Island Sound Councils and Assembly. 1998. *Resource Directory of Agencies and Organizations Focused on the Environment, Long Island Sound, and its Coastal watershed*.

Schaefer, Sara and Jame O'Keefe. 1998. Thousands of fish suffocate in Stamford Harbor. *Stamford Advocate*.

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