THE SILENT PREDATOR OF THE DEEP BLUE

HYPOXIA

WHAT IS HYPOXIA?

***Hypoxia** is the chemical reaction that occurs when natural waters have a low concentration of oxygen and mostly impacts aquatic life and coastal regions*

Low oxygen levels dramatically alter the ecosystems of water bodies. Some marine life such as fish and mobile invertebrates migrate to escape the hypoxic areas.

Plants and slow moving animals that cannot escape the hazardous hypoxic waters eventually perish, ultimately causing a dramatic decline in the amount of life in the affected areas.

The loss of life in these waters affects fishermen who rely on these resources for their livelihood. In addition, the algae growth that is associated with hypoxia is unattractive to tourists and can cause local businesses to suffer due to the lack of tourism.

O_2 + CO_2 =

↓O_2 + ↑CO_2 =

THE SCIENCE OF HYPOXIA

***Hypoxia** is mainly caused by the convergence of several factors including the physical environment, nutrient enrichment, and...*

Nitrogen and Phosphorus

Nitrogen and phosphorus are essential for plant growth, but an overabundance of these nutrients is called eutrophication and can result in algae bloom. The excessive algae growth then depletes the water of oxygen causing hypoxia.

WHERE HAS IT HIT US HARDEST?

CHESAPEAKE BAY
28% HYPOXIC

Less dense fresh water does not mix with saline Bay waters causing stratification. This causes the oxygen in the bottom water to become limited, leading to hypoxic conditions.

The Bay includes the entire District of Columbia and parts of New York, Pennsylvania, Delaware, Virginia, West Virginia and Maryland.

Nutrients are carried into the Bay by the Potomac, James, and Susquehanna Rivers with the latter carrying the most.

PUT INTO PERSPECTIVE

It's about the size of...

4.5 MILLION OLYMPIC-SIZED POOLS

GULF OF MEXICO
22% HYPOXIC

Less dense fresh water does not mix with saline Gulf waters causing stratification. This causes the oxygen in the bottom water to become limited, leading to hypoxic conditions.

It's the largest human-made hypoxic zone in the US.

Nutrients are carried into the Gulf by the Mississippi River, which drains nearly 41% of the continental US.

PUT INTO PERSPECTIVE

It's about the size of...

THE STATE OF NEW JERSEY

THE SOURCE?

While nutrients come from a variety of sources, the most common ways nutrients enter waterways is by...

- RUN OFF FROM AGRICULTURE
- EROSION OF NUTRIENT RICH SOIL
- DISCHARGE FROM SEWAGE TREATMENT PLANTS
- DEPOSITION OF NITROGEN IN THE ATMOSPHERE

THE HYPOXIA-NUTRIENT CONNECTION

Let's introduce the main nutrients correlated with hypoxia, with a little background on them...

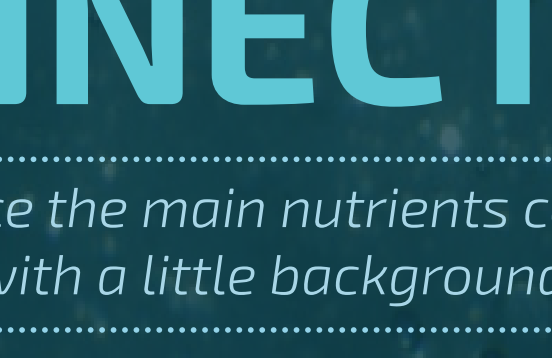
Ammonia-Nitrogen

Ammonia-Nitrogen is a nutrient that contains nitrogen and hydrogen

When aquatic plants and animals die, bacteria break down protein molecules, comprising of nitrogen, into ammonia

Ammonia-Nitrogen has toxic effects on aquatic life, and is much more toxic when water contains very little dissolved oxygen

Ammonia-Nitrogen most commonly enters surface waters through fertilizer run off and through discharges from wastewater sources

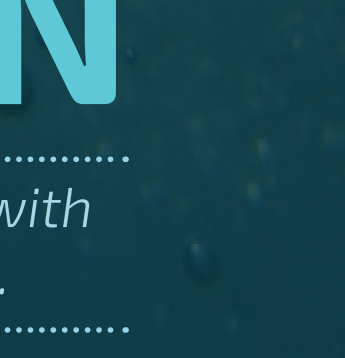


Kjeldahl Nitrogen

The total Kjeldahl Nitrogen is the sum of organic nitrogen, ammonia, and ammonium

The total Kjeldahl Nitrogen is used as an indicator for wastewater treatment performance

The total Kjeldahl Nitrogen analysis is important because it assesses the impact of organic nitrogen and ammonia-nitrogen in wastewater facilities and in waterways



Nitrate as N

Nitrate is a soluble compound that contains nitrogen and oxygen

The bulk of nitrate that enters the Gulf of Mexico and the Chesapeake Bay comes from fertilizer run off from agricultural areas

Main sources for nitrate contamination include septic systems, fertilizers, manure, and decaying plant matter

Since nitrate is extremely soluble, it is easily transported when contaminated sources come into contact with moving water

LEVELS OVER THE YEARS

CHESAPEAKE BAY INFORMATION

GULF OF MEXICO INFORMATION

GULF OF MEXICO

Nitrate as N (2001-2014)

There is a **moderate** correlation between the size of the hypoxic zone and the amount of Nitrate as N by year.

Ammonia-Nitrogen (2001-2014)

There is a **moderate** correlation between the size of the hypoxic zone and the amount of Ammonia-Nitrogen by year.

Kjeldahl Nitrogen (2001-2014)

There is a **moderate** correlation between the size of the hypoxic zone and the amount of Kjeldahl Nitrogen by year.

CHESAPEAKE BAY

Nitrate as N (2001-2013)

There is a **moderate** correlation between the size of the hypoxic zone and the amount of Nitrate as N by year.

Ammonia-Nitrogen (2001-2013)

There is a **strong** correlation between the size of the hypoxic zone and the amount of Ammonia-Nitrogen by year.

Kjeldahl Nitrogen (2001-2013)

There is a **moderate** correlation between the size of the hypoxic zone and the amount of Kjeldahl Nitrogen by year.

WHAT IF WE REDUCE NUTRIENT LEVELS?

***Reduction** of nutrients into the waterways will take a great deal of time but the rewards will be grand. Based on the data, these are the predictions...*

CHESAPEAKE BAY

Nitrate as N

IF ▼30% DECREASE IN NITRATE LEVELS → THEN ▼6% DECREASE IN HYPOXIC ZONE

If the average Nitrate as N is reduced by 30% the predicted size of the hypoxic zone will be approximately 6% smaller*

Ammonia-Nitrogen

IF ▼30% DECREASE IN AMMONIA-NITROGEN LEVELS → THEN ▼15% DECREASE IN HYPOXIC ZONE

If the average Ammonia-Nitrogen is reduced by 30% the predicted size of the hypoxic zone will be approximately 15% smaller*

Kjeldahl Nitrogen

IF ▼20% DECREASE IN KJELDAHL-NITROGEN LEVELS → THEN ▼14% DECREASE IN HYPOXIC ZONE

If the average Kjeldahl Nitrogen is reduced by 20% the predicted size of the hypoxic zone will be approximately 14% smaller*

Total

▼30% DECREASE IN TOTAL NUTRIENT LEVELS → ▼8% DECREASE IN HYPOXIC ZONE

If the average amount of total nutrients is reduced by 30% the predicted size of the hypoxic zone will be approximately 8% smaller*

**based on a 6 year average*

GULF OF MEXICO

Nitrate as N

IF ▼30% DECREASE IN NITRATE LEVELS → THEN ▼8% DECREASE IN HYPOXIC ZONE

If the average of Nitrate as N is reduced by 30% the predicted size of the hypoxic zone will be approximately 8% smaller*

Ammonia-Nitrogen

IF ▼30% DECREASE IN AMMONIA-NITROGEN LEVELS → THEN ▼9% DECREASE IN HYPOXIC ZONE

If the average Ammonia-Nitrogen is reduced by 30% the predicted size of the hypoxic zone will be approximately 9% smaller*

Kjeldahl Nitrogen

IF ▼20% DECREASE IN KJELDAHL-NITROGEN LEVELS → THEN ▲33% DECREASE IN HYPOXIC ZONE

If the average Kjeldahl Nitrogen is reduced by 20% the predicted size of the hypoxic zone will be approximately 33% smaller*

Total

▼30% DECREASE IN TOTAL NUTRIENT LEVELS → ▼9% DECREASE IN HYPOXIC ZONE

If the average amount of total nutrients is reduced by 30% the predicted size of the hypoxic zone will be approximately 9% smaller*

**based on a 6 year average*

WHAT SHOULD BE DONE?

Here are some simple actions to consider when thinking about or attempting to making a difference

- PROPERLY MAINTAIN SEPTIC SYSTEMS
- USE COMPOST PILES
- USE SAFE, NON-TOXIC ALTERNATIVES FOR CLEANING AND PEST CONTROL
- LIMIT FERTILIZER USAGE AND FOLLOW APPLICATION INSTRUCTIONS
- PREVENT SOIL EROSION
- BUILD WINDBREAKS SUCH AS PLANTING TREES BETWEEN FIELDS
- PRACTICE CROP ROTATION
- PRACTICE CONTOUR PLANTING SUCH AS PLANTING ACROSS A HILLSIDE
- BUILD ARTIFICIAL WETLANDS TO HELP FILTER NITRATES OUT
- PROTECT WETLANDS AND STREAM-SIDE VEGETATION
- USE WATER TREATMENT PLANTS TO REDUCE NUTRIENT LEVELS IN WATER
- PRACTICE CLEAN BOATING WITH BOATS WITH LOW EMISSION RATES
- CONSERVE WATER AT HOME
- REDUCE EMISSIONS BY CARPOOLING OR USING MASS TRANSIT
- PICK UP AFTER YOUR PET TO REDUCE NUTRIENT RUN-OFF
- ENCOURAGE LAWMAKERS TO TAKE ACTION; CONTACT THEM
- CONTINUE RESEARCH AND MEASUREMENTS IN HYPOXIC AREAS