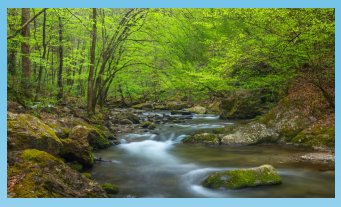
Norman Bird Sanctuary
Water Quality Monitoring & Restoration Program



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This slide presentation is part of the training for participants in the Norman Bird Sanctuary's .....WATER QUALITY MONITORING & RESTORATION Program.

PART 1 covers the
ECOLOGY OF AQUATIC ECOSYSTEMS

PART 2 covers the SIGNIFICANCE of each
WATER QUALITY PARAMETERS to be monitored.

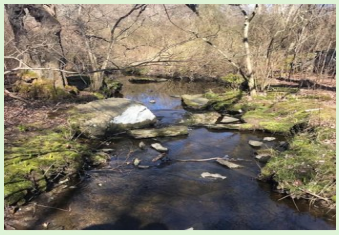
The program's MISSION STATEMENT is posted on the website.

The main objective of the program is to monitor the "ecological health" of aquatic ecosystems in and around the Norman Bird Sanctuary.

NORMAN BIRD SANCTUARY

Water Quality Monitoring & Restoration Program

PART 1: Ecology of Aquatic Ecosystems



Part 1: ECOLOGY OF AQUATIC ECOSYSTEMS

Earth's Water Resources

71% of Earth's surface

Kings Beach, Newport RI

87% open ocean
10% coastal habitats
(bays, coral reefs, estuaries, rocky & sandy shores, salt marshes, mangrove swamps, etc.)

Walden Pond, Concord MA

*****[0.03%]*****

AVAILABLE: lakes, streams, soil moisture, atmospheric vapor, surface runoff, etc.

[2.97%]

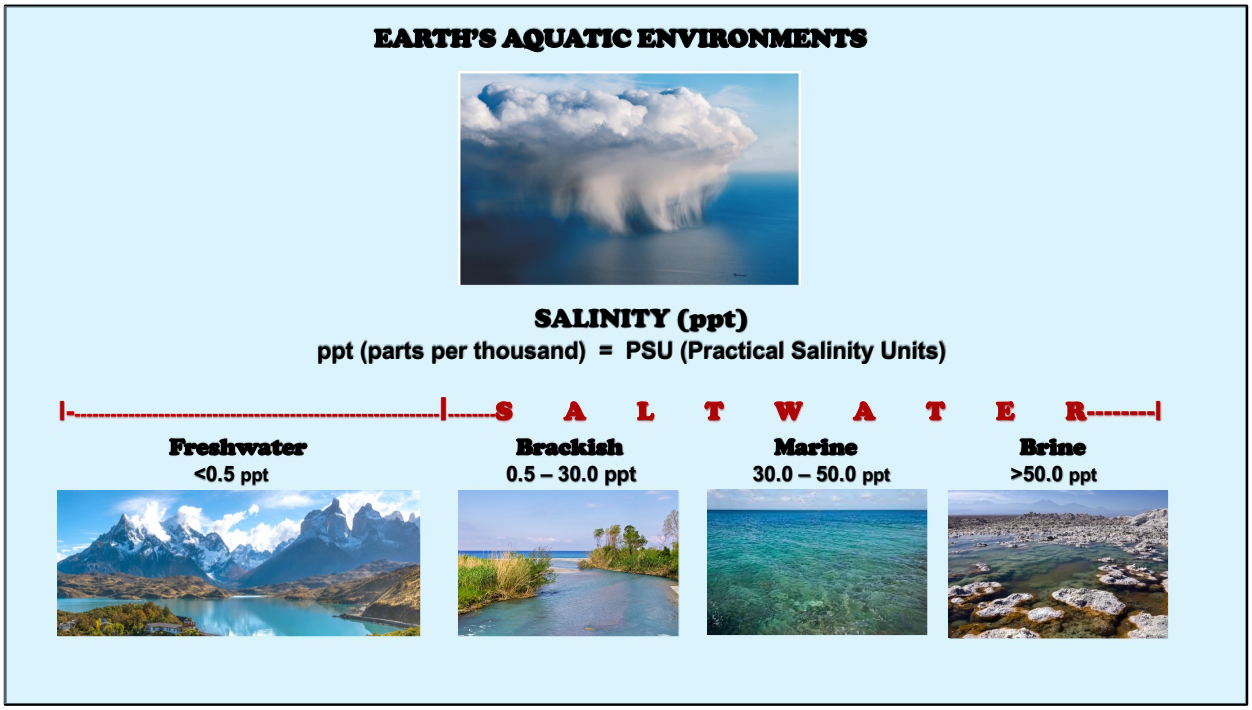
UNAVAILABLE: ice caps, glaciers, & deep below Earth's surface.

A look at the EARTH'S WATER RESOURCES... reveals that the overwhelming percentage of it is SALT WATER....and 87% of that is open ocean.

Of the 3% that is FRESHWATER..... only .03% is available for use by life on Earth.

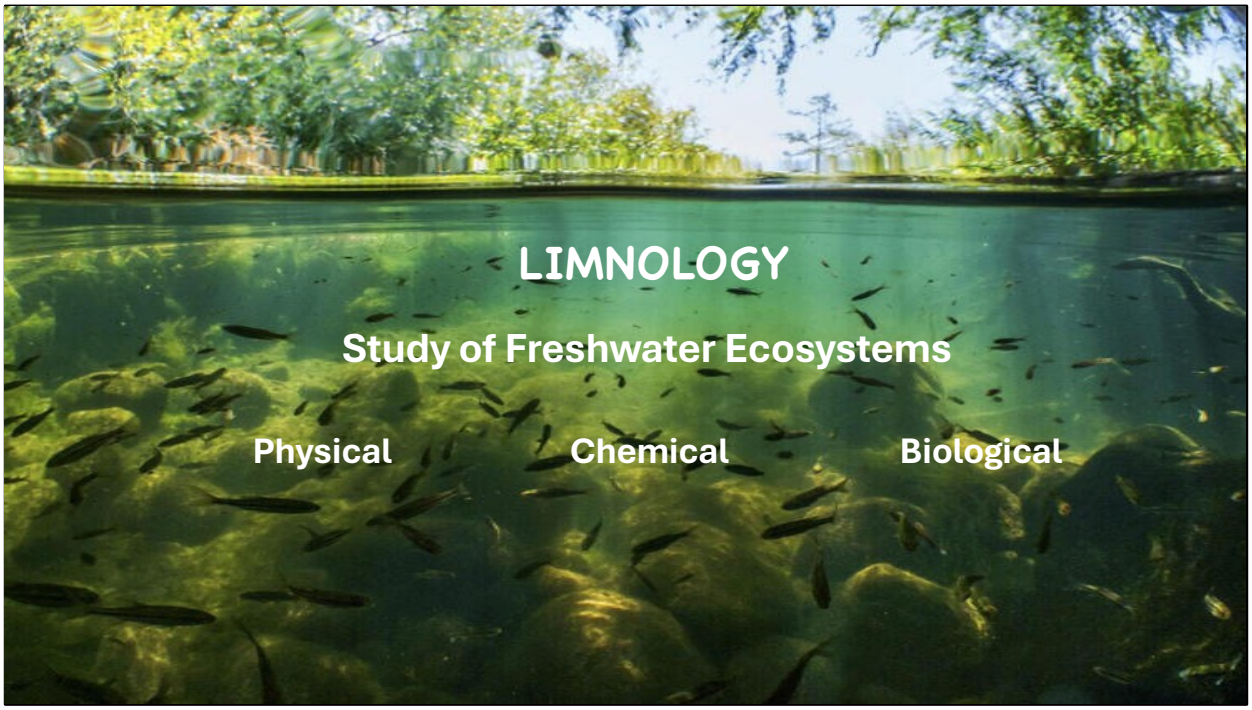
....the other 2.97% is UNAVAILABLE freshwater....since it is stored in the Earth's ice & deep below the surface.

So....our FRESHWATER is a "precious resource"



Aquatic environments are classified according to levels of SALINITY....or "salt content", which is measured in ppt, or Parts Per Thousand, or PSU.....Practical Salinity Units.

Freshwater is less than 0.5 parts per thousand....
...and the BRACKISH, MARINE and BRINE categories of SALTWATER range from
0.5 to over 50.0 ppt.



LIMNOLOGY is the formal study of physical, chemical & biological aspects of FRESHWATER HABITATS.

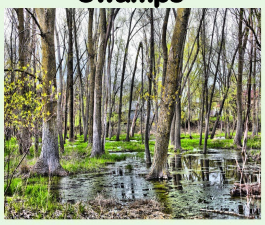
Lentic Ecosystems

(still waters)

Lakes

Ponds

Swamps



Marshes

Bogs

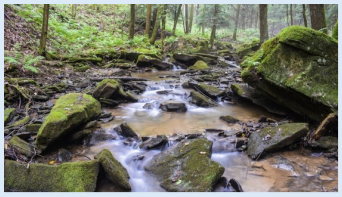
Still bodies of water, such as lakes, ponds, swamps, marshes & bogs are called LENTIC ECOSYSTEMS.

Lotic Ecosystems

(flowing waters)

Rivers

Streams



Brooks

LOTIC ECOSYSTEMS consist of flowing waters, such as rivers, streams & brooks.

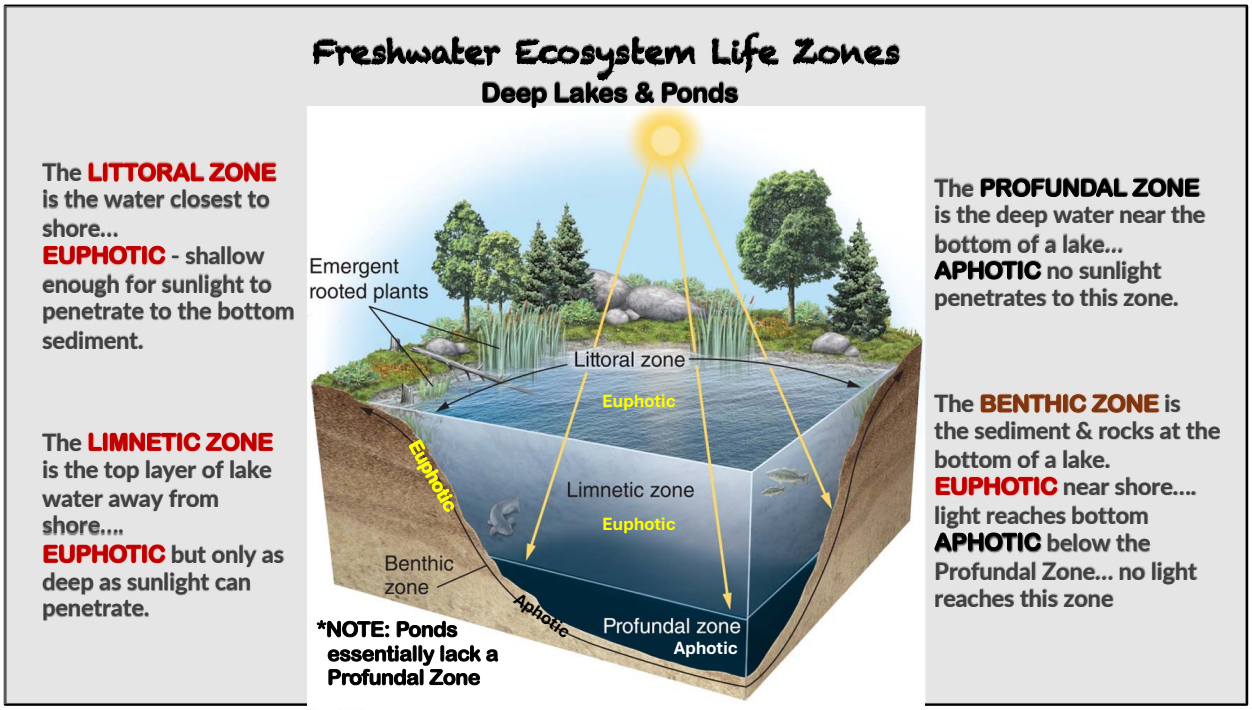


Figure 13.3
Friedland, *Environmental Science for AP®*, 2e, © 2015 W.H. Freeman and Company

LIFE ZONES in deep lakes and ponds include:

The LITTORAL ZONE, which is closest to shore, is EUPHOTIC....where light penetrates to the bottom.

The LIMNETIC ZONE is the upper layer of open water away from shore...and is EUPHOTIC to a certain depth.

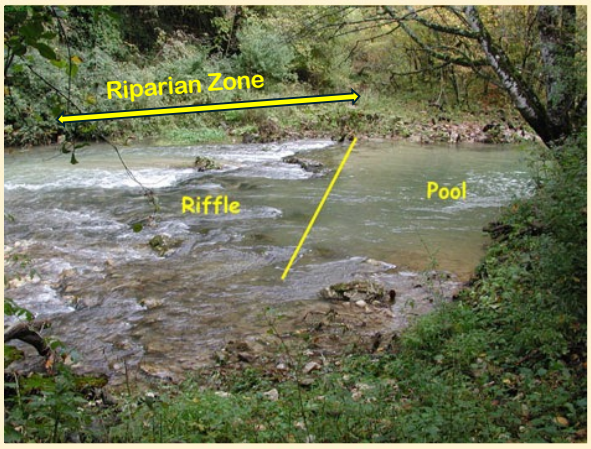
The PROFUNDAL ZONE is the deep APHOTIC region near the bottom....below the limnetic zone,..... where no light penetrates.

The BENTHIC ZONE is the bottom layer where light penetrates near shore, but is aphotic in deep areas.

Streams & Rivers

Light penetrates to the bottom throughout, except is deep rivers.

RIFFLES
rocky sections where water is aerated.... provides dissolved oxygen to stream organisms.



POOLS
calm sections with fine sediments ...mud & sand algae/phytoplankton produce oxygen.

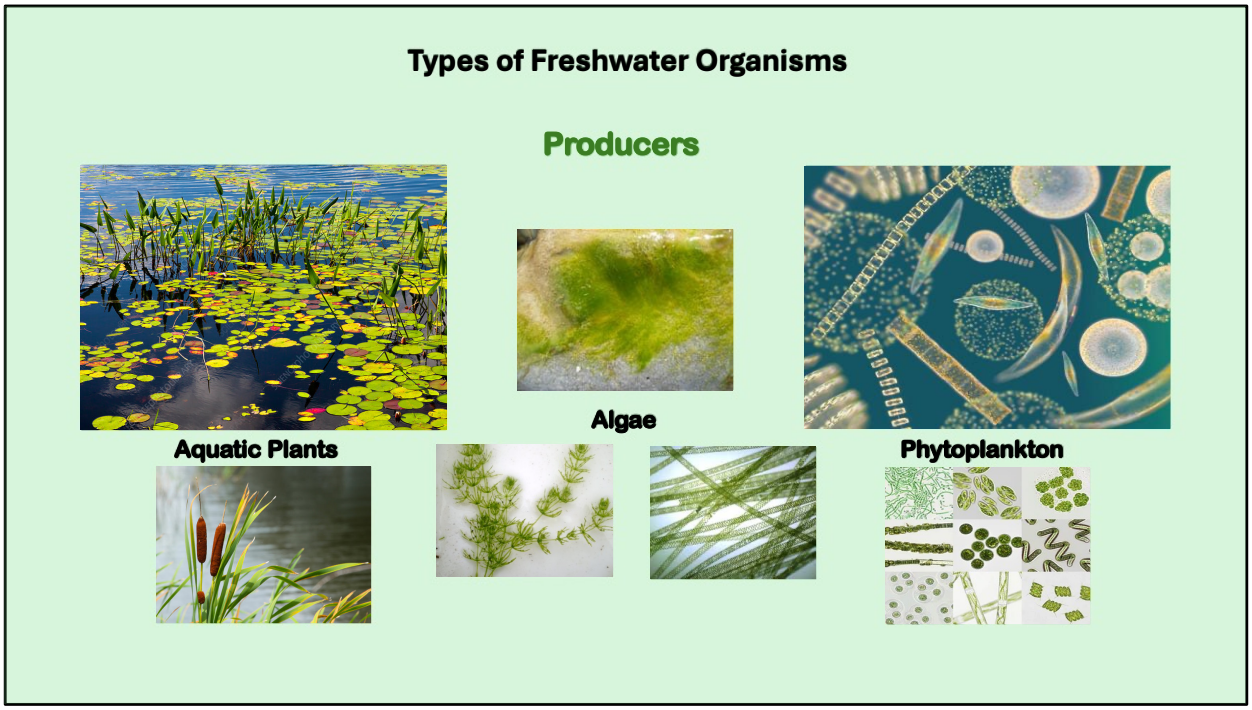
RIPARIAN ZONE
Land area along the edges of streams.
Protects stream from excessive runoff & provides shade to keep water cool.
Plant debris adds organic nutrients for stream organisms.

Life zones in LOTIC systems are less complicated.

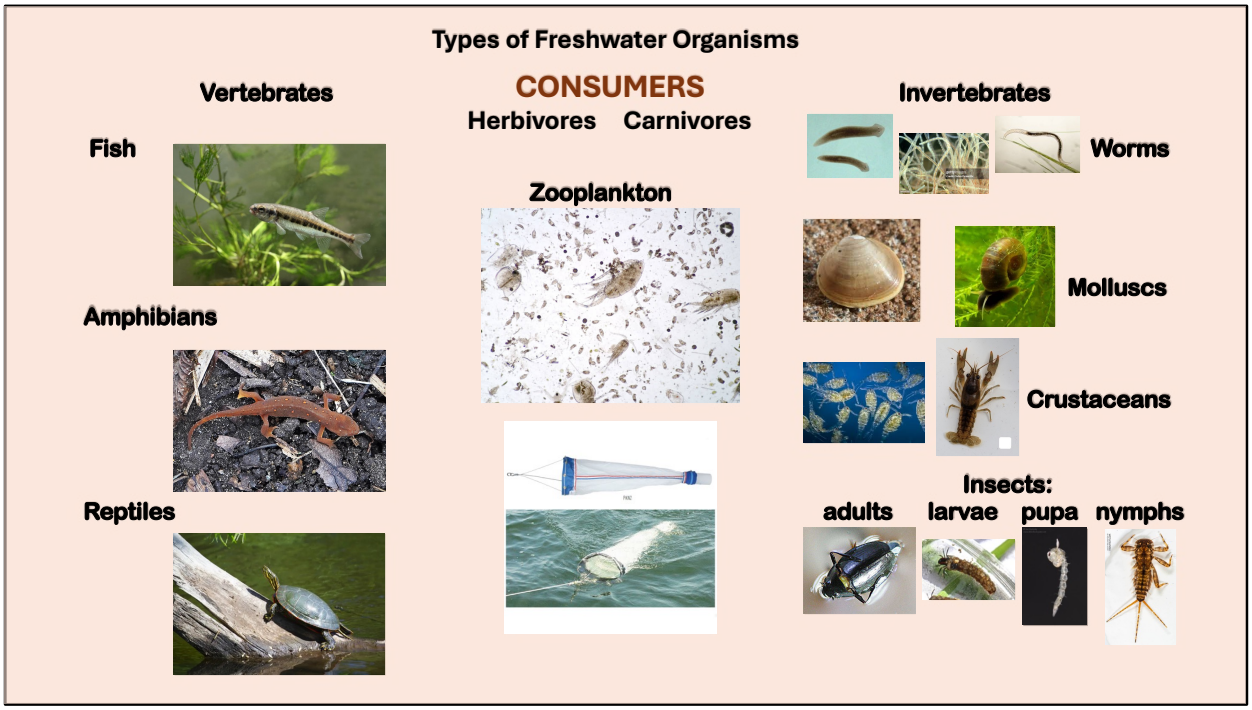
A typical river or stream has rocky,..... well-aerated RIFFLE areas.... which provides dissolved oxygen to organisms inhabiting the system.

POOLS are calm areas of sand and mud sediments, & usually have a lower dissolved oxygen level.

The land along the shoreline of lotic systems is referred to as the RIPARIAN ZONE, & has a major influence on the water quality of the stream.
.....including protection from harmful runoff & providing shade & plant debris nutrients for aquatic organisms.



Freshwater organisms include primary PRODUCERS, such as aquatic plants, algae
& phytoplankton..... all of which carry on the vital process of PHOTOSYNTHESIS in the ecosystem.



CONSUMERS in freshwater include various types of HERBIVORES & CARNIVORES.....
including VERTEBRATES, ZOOPLANKTON & INVERTEBRATES.

DECOMPOSERS

[recycling of essential nutrients]

Break down all organic matter…dead organisms & waste products from live organisms.

Fungi

Release NITROGEN & PHOSPHORUS for reuse by producers (aquatic plants, algae & phytoplankton).

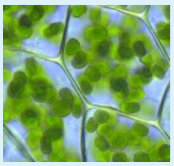
Protozoa

Bacteria

BACTERIA, FUNGI and certain kinds of PROTOZOANS make up the DECOMPOSERS
……. that breakdown dead organic matter & the waste products from live consumers.

They perform a vital function in the recycling of matter & energy in all terrestrial and aquatic ecosystems on Earth.

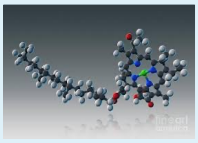
Major Biochemical Processes in Aquatic Ecosystems



PHOTOSYNTHESIS

[OCCURS ONLY DURING DAYTIME]

PRODUCER Organisms / Cells Contain CHLOROPHYLL
Use SOLAR ENERGY + CARBON DIOXIDE (CO_2) + WATER (H_2O)
to manufacture food /CARBOHYDRATES & release OXYGEN (O_2)



$\rightarrow$ chlorophyll + CO_2 + H_2O $\rightarrow$ $C_6H_{12}O_6$ + O_2
glucose

CELL RESPIRATION

[OCCURS DAY AND NIGHT]

in PRODUCERS, CONSUMERS & DECOMPOSERS
Obtain food by consuming Producers & other Consumers.
Use ENERGY from CARBOHYDRATES ($C_6H_{12}O_6$)
Use OXYGEN & produce CARBON DIOXIDE (CO_2) & WATER (H_2O)

$C_6H_{12}O_6$ + O_2 $\rightarrow$ CO_2 + H_2O + ENERGY

Two major processes are at play in aquatic ecosystems:
PHOTOSYNTHESIS is performed by chlorophyll-bearing PRODUCER organisms. Using SOLAR ENERGY, they manufacture GLUCOSE sugar & OXYGEN from CARBON DIOXIDE & WATER. This process ONLY occurs during daylight hours.

CELLULAR RESPIRATION is performed by CONSUMERS, DECOMPOSERS .....& "PRODUCERS" both day & night.
Using GLUCOSE & OXYGEN, these organisms produce CARBON DIOXIDE & WATER.....& release ENERGY for other cell activities.

So, PHOTOSYNTHESIS is only a food-making process in producer organisms ..... like ALGAE, AQUATIC PLANTS & PHYTOPLANKTON.....
otherwise they essentially "live and breathe" like all consumers.

BIOMASS (protein) SYNTHESIS

PRIMARY PRODUCTION
in PRODUCER Organisms
(green plants & all chlorophyll-bearing organisms.....plants, algae, Cyanobacteria, etc.)

* **[a basic mechanism by which life on Earth operates.]**

1.3E6 kcal Solar Energy + 106 CO_2 + 90 H_2O + 16 NO_3 + 1 PO_4 + Mineral Elements

yields → 1.3E4 kcal energy stored in 3258 g. of living BIOMASS + 815 g. Mineral Ash + 154 O_2 + 1.287E6 kcal HEAT energy dispersed to atmospheric & aquatic ... "ENVIRONMENTAL SINKS"

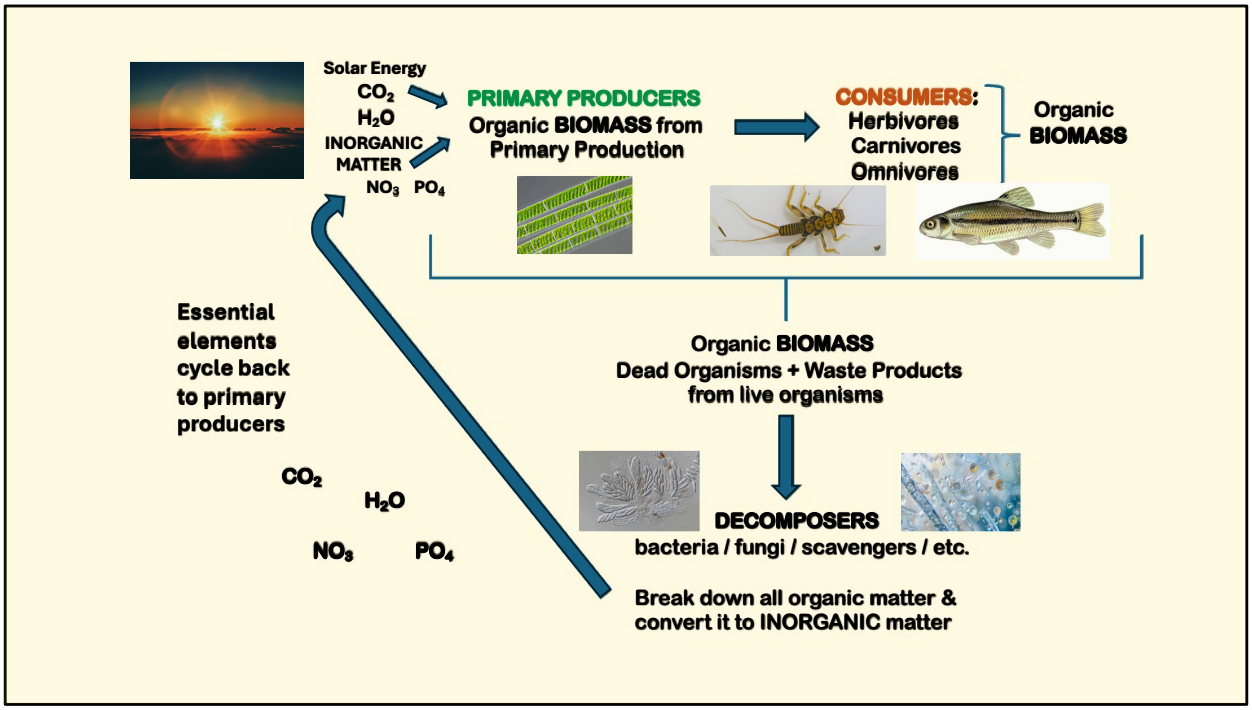
***NOTE: a 99% loss of energy from the initial solar input.**

PRIMARY PRODUCTION is the core process sustaining life on Earth.

This generalized equation depicts the processes occurring in PRODUCERS which includes PHOTOSYNTHESIS, RESPIRATION & the manufacturing of new BIOMASS.

Solar energy is first stored in GLUCOSE in PRODUCER organisms..... through PHOTOSYNTHESIS.

During BIOMASS production (or protein synthesis), these organisms use the energy stored in the glucose to combine NITRATE & PHOSPHATE and CARBON, HYDROGEN & OXYGEN to produce new living matter.
.....99% of the matter in living organisms consist of 5 elements .....
Carbon, Hydrogen, Oxygen, Nitrogen & Phosphorus



In simpler terms..... the BIOMASS manufactured by producers, during primary production, is then used by consumer organisms..... in the FOOD CHAIN.

Eventually.....all organic matter in the BIOMASS of dead organisms.....and in the waste products of live organisms, is broken down by fungi & bacteria.

These DECOMPOSERS convert the complex organic matter into simpler INORGANIC matter.....which is then cycled back to the primary producers.

Water Quality

Physical, Chemical & Biological characteristics of a body of water, that determine its suitability for a specific use...

Types of Water Use
HUMAN (Anthropogenic)

RESIDENTIAL - Drinking / Lawn & Garden Care
RECREATIONAL - Swimming / Boating
AGRICULTURAL - Irrigation / Animals
INDUSTRIAL - Cooling, Processing, Washing
& COMMERCIAL Product production & operations

So how can we check on whether an aquatic habitat is "ecologically healthy"..... and that the processes of photosynthesis, respiration, biomass production & decomposition are working properly?

This is the main objective of WATER QUALITY MONITORING.....during which we examine the physical, chemical & biological aspects of a body of water, ...that determine whether it is suitable for a specific use.

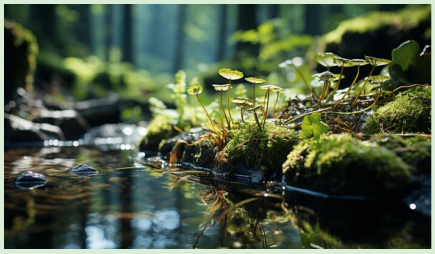
This is much like blood & urine tests on humans ....to determine if all is working well!

The major categories of the HUMAN....or ANTHROPOGENIC, uses of aquatic systems are: RESIDENTIAL
RECREATIONAL
AGRICULTURAL
INDUSTRIAL
COMMERCIAL

Water Use

NATURAL ECOSYSTEMS
To support healthy natural populations of aquatic life.

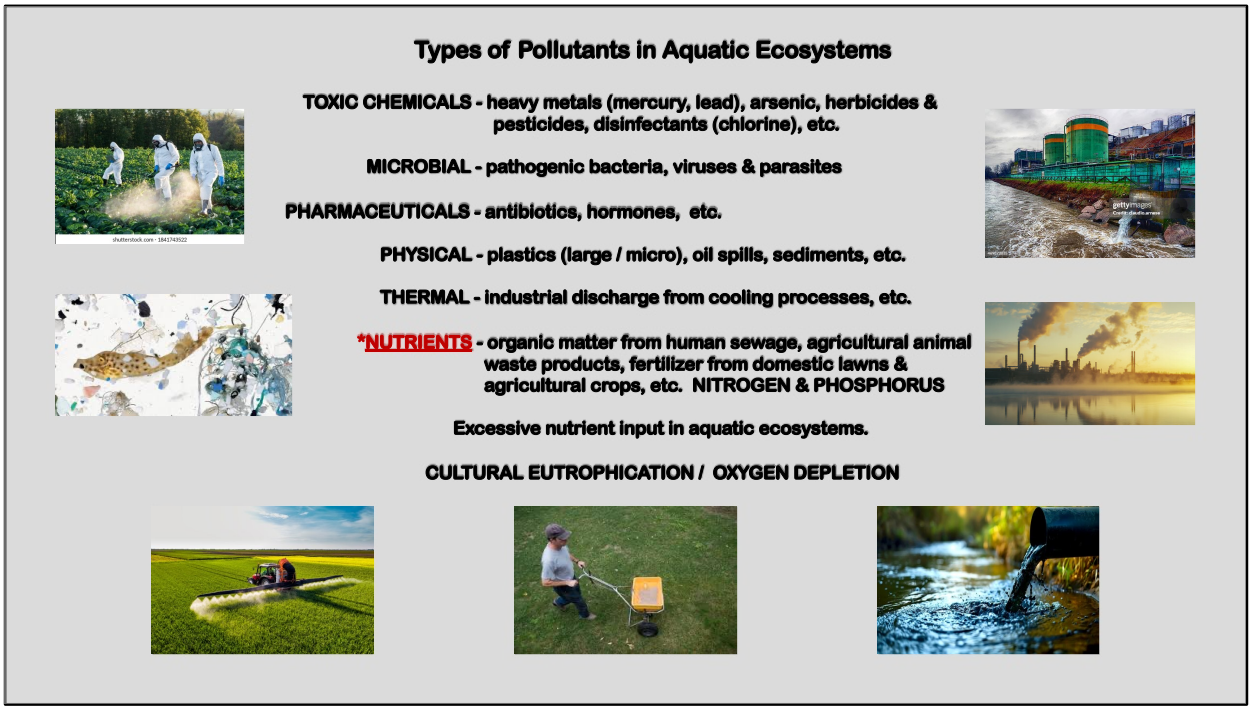
***main objective of NBA WQM&RP**






The main objective of the our WATER QUALITY MONITORING Program is to determine, whether natural processes operating in the freshwater streams and ponds, in and around the Norman Bird Sanctuary, are in an "ecologically-healthy" state.....

and if not ..... try and identify the source
of pollution .....& coordinate our efforts with the community, & local and state agencies,
to restore the ecological integrity of any impaired aquatic habitats.

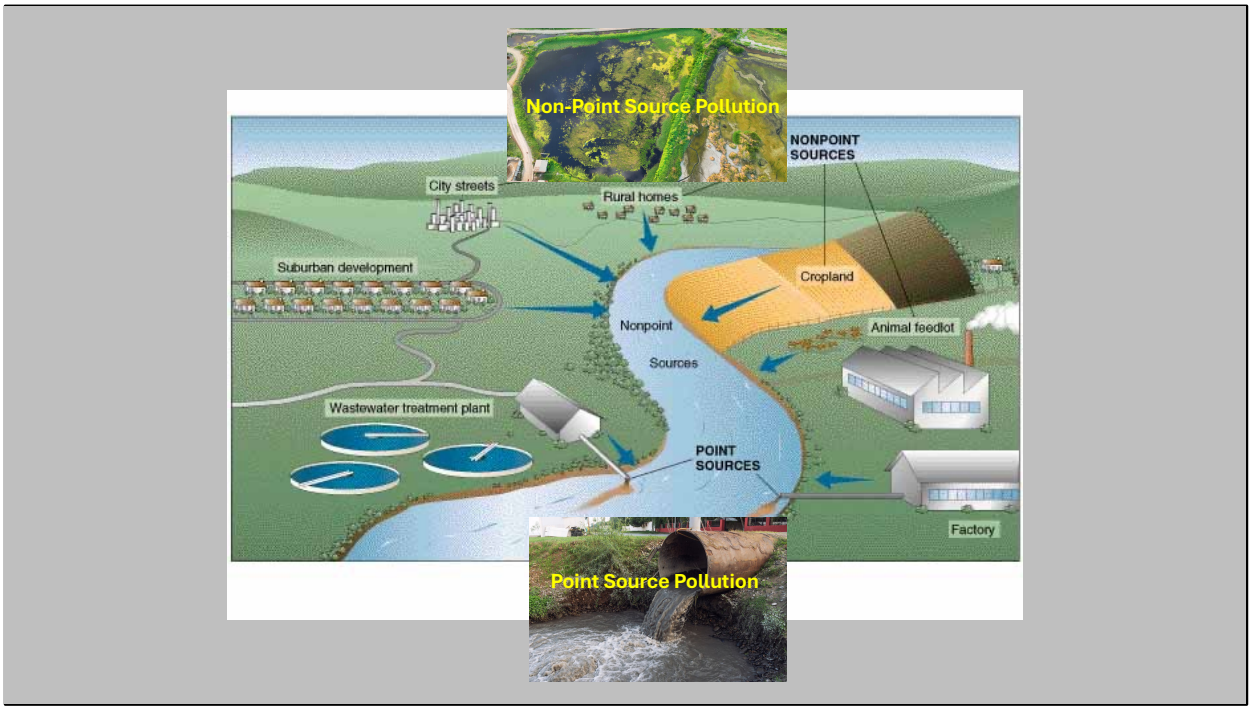


The degradation of aquatic ecosystems comes in a variety of forms.....

The types of pollutants include:

TOXIC CHEMICALS
MICROBIAL
PHYSICAL
THERMAL

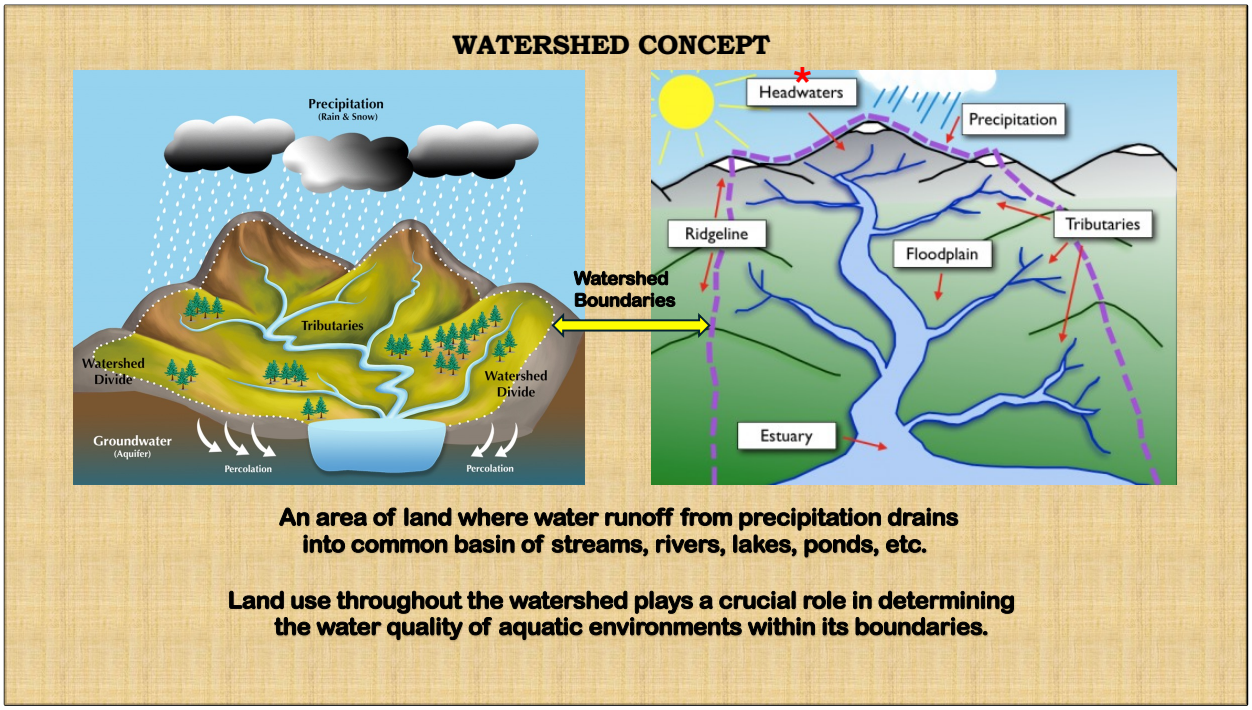
and.....an excessive input of organic matter....
containing Nitrogen & Phosphorus NUTRIENTS.....which can ultimately lead to OXYGEN DEPLETION in a body of water.



Water pollution can come from either POINT or NON-POINT sources.....

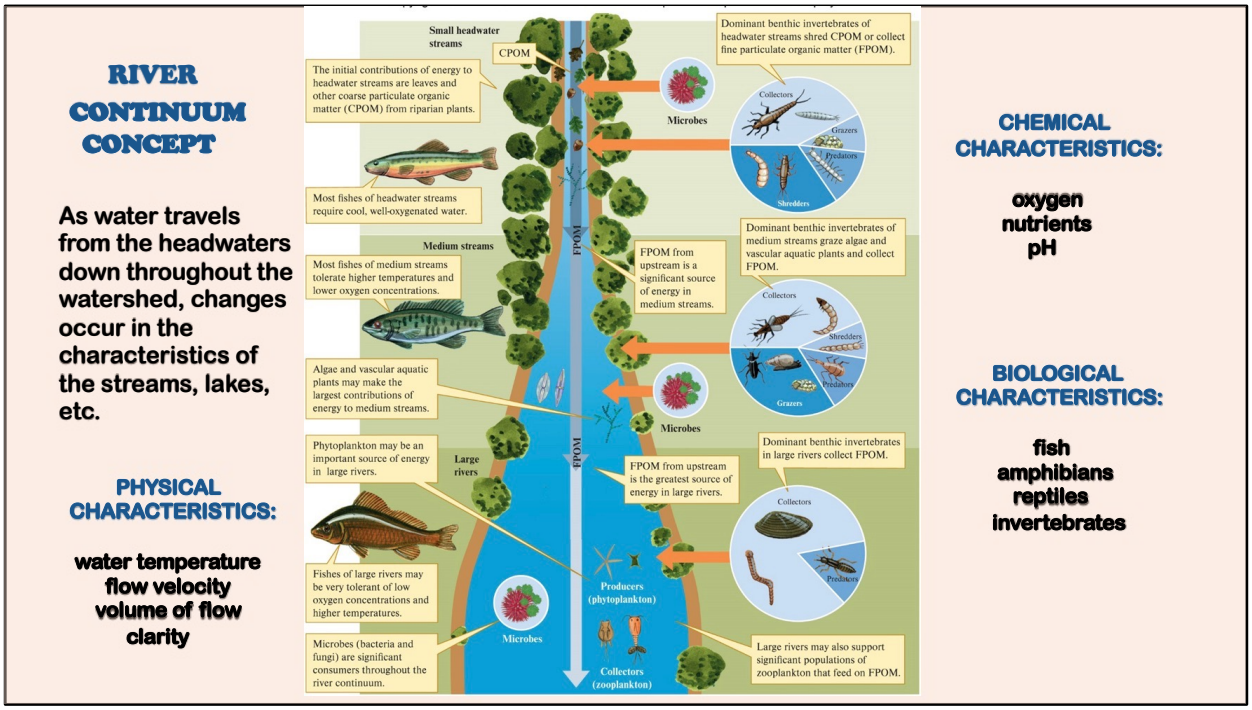
NON-POINT SOURCE POLLUTION comes from unspecified locations in a watershed.... like domestic lawn care & agricultural runoff.

POINT SOURCE POLLUTION comes from a
specific location.... like discharge from a factory, or sewage treatment plant.



A WATERSHED is an area of land where rainfall runoff drains into a series of streams, that flow into a common basin.

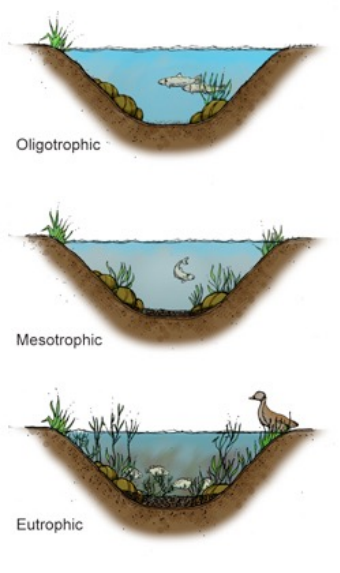
So land use in the watershed influences the water quality of the aquatic ecosystems.



The RIVER CONTINUUM CONCEPT.....

....depicts the PHYSICAL, CHEMICAL & BIOLOGICAL changes occurring in a river or stream..... from its headwaters to its final destination in a lake, or eventually the sea.

TROPHIC STATE in Aquatic Ecosystems



Level of PRODUCTIVITY …how much biodiversity it can support.

DEPTH	TEMPERATURE	NUTRIENTS	BIODIVERSITY
deep	cold	low	low
moderate	warmer	medium	moderate
shallow	warm	high	high

The TROPHIC STATE of a body of water refers to changes in DEPTH, TEMP, NUTRIENTS & BIODIVERSITY..... as it ages over time.

Early stages of deep, cold water, low concentrations of nutrients & little variety of life forms..... are called OLIGOTROPHIC....

In the MESOTROPHIC STATE....water gets more shallow & a little warmer. Nutrients & biodiversity increase.

A EUTROPHIC lake is shallow and warm....
with high nutrient levels & diversity of life forms.

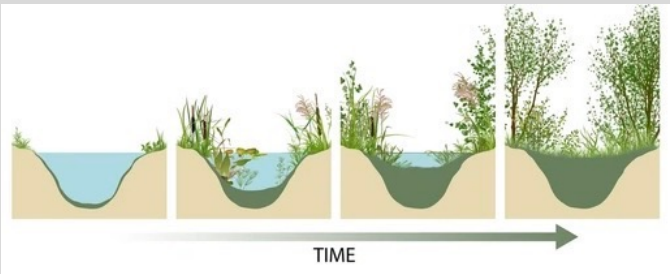
EUTROPHICATION

Natural process of physical, chemical & biological changes in aquatic ecosystems, as they age over time .....

***accumulation of N & P nutrient organic matter**

***increase in biomass production**

***increase in amount of aquatic life / species diversity**



OLIGOTROPHIC ----------EUTROPHIC

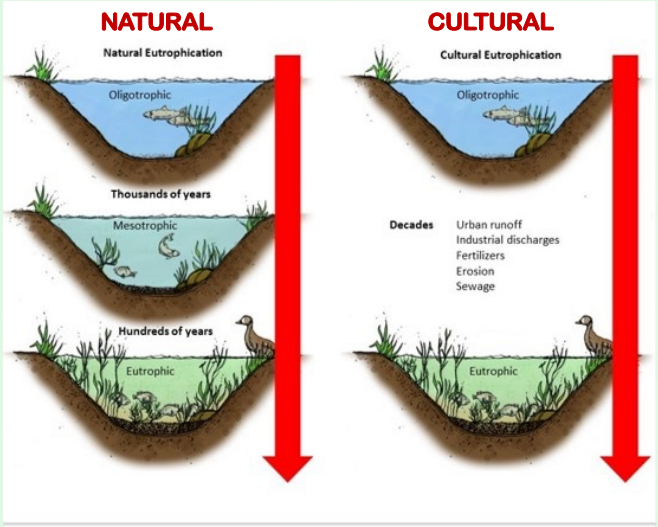
EUTROPHICATION is essentially a natural process involving the "aging" of a body of water from an OLIGOTROPHIC state to a EUTROPHIC one.

EUTROPHICATION

NATURAL INPUT→

Normal amounts of nitrogen & phosphorus from natural decay of dead plants and animals, & waste products from live animals.

***ages slowly over hundreds & thousands of years.**



← HUMAN INPUT (anthropogenic)

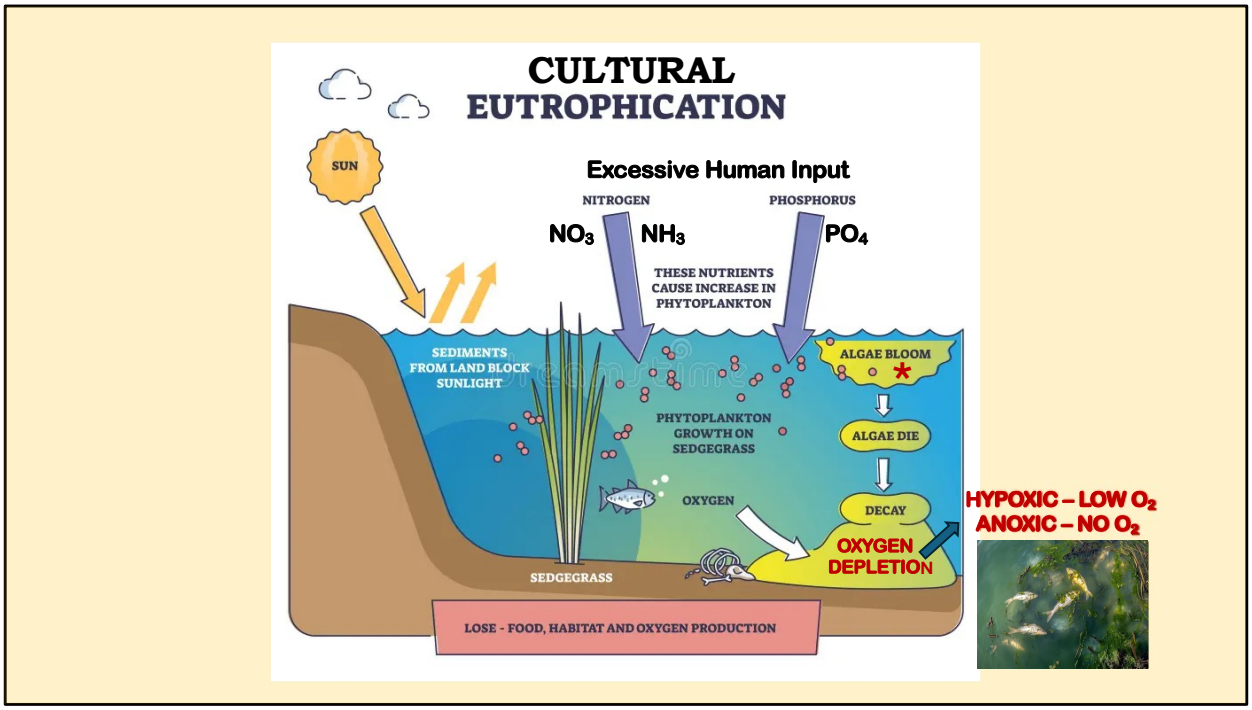
Excessive amounts of nitrogen & phosphorus from agricultural & domestic sources.

***ages quickly over years/decades**

The process of EUTROPHICATION can be either "natural" or "cultural"

NATURAL EUTROPHICATION occurs over long periods of time..... hundreds or thousands of years.

When humans add excess nitrogen & phosphorus nutrients, the aquatic ecosystem ages rapidly.... over years or decades.



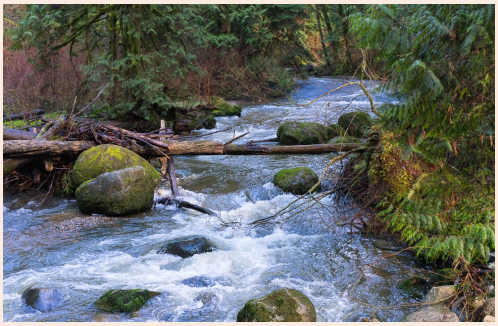
and……this rapid aging can lead to ALGAL BLOOMS, when the excess population of the algae dies, & the decomposition process depletes the oxygen near the bottom.

This results in either HYPOXIC, or low oxygen conditions, ……or ANOXIC zero-oxygen conditions.

These conditions are either stressful or lethal to populations of organisms inhabiting the aquatic environment.

Effects of Anthropogenic (Human) Input in Aquatic Ecosystems

Ecologically Healthy Stream



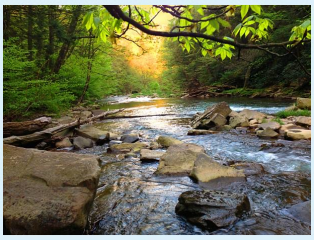
Organic Overload in a Stream
Cultural Eutrophication

The effects of human ...or ANTHROPOGENIC... nutrient input can seriously impair an ecologically healthy stream or lake.... in a short period of time.

WATER QUALITY MONITORING

Basic Test Parameters
for determining ecological health of aquatic habitats

WATER QUALITY PARAMETERS for Determining the Ecological Health of FRESHWATER ECOSYSTEMS



GENERAL INFORMATION:

- *Observer
- *Date
- *Time of Day
- *Weather: Current
  Past 24-48hrs
- *Name of Aquatic Ecosystem
- *Freshwater / Marine
- *Location (Description)
- *Latitude/Longitude/Elevation

ABIOTIC PARAMETERS:

Physical Factors:

- *AIR TEMPERATURE (°C)
- *WATER TEMPERATURE (°C)
- *VOLUME OF FLOW (m^3/sec)
  - -Avg Width
  - -Avg Depth
  - -Avg Velocity
  - -Bottom Type (.8 or .9)

Chemical Factors:

- *pH (acid/base 0.0-14.0)
- *ALKALINITY (mg/L $CaCO_3$)
- *Ca/Mg HARDNESS (mg/L)
- *DISSOLVED OXYGEN (DO mg/L)
- *OXYGEN SATURATION (%)
- *NITRATE NITROGEN (mg/L NO_3-N)
- *AMMONIA NITROGEN (mg/L NH_3-N)
- *TOTAL AMMONIA NITROGEN (mg/L NH_3-N & NH_4+)
- *PHOSPHATE (mg/L PO_4 - orthrophosphate)
- *CHLORINE (mg/L Free & Total)
- *CHLORIDE (mg/L Na & Ca salts)
- *SALINITY (ppt-Parts Per Thousand / PSU-Practical Salinity Units)
- *ELECTRICAL CONDUCTIVITY (EC) (µS/cm) – micro/milli Siemens per centimeter
- *OXIDATION REDUCTION POTENTIAL (ORP) mV - millivolts

BIOTIC COMMUNITY: (Indicator/Index Species)

Macroinvertebrates:

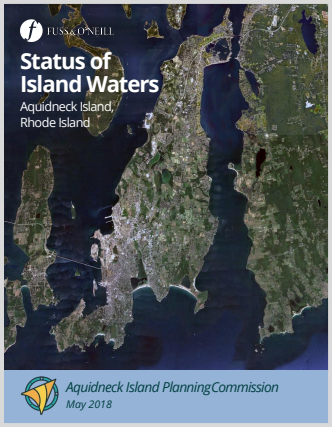
- *Hilsenhoff Biotic Index (HBI)
- *EPT Index: Ephemeroptera (mayfly nymphs)
  Plecoptera (stonefly nymphs)
  Trichoptera (caddisfly larvae/ pupa)

Besides the influencing effects of current weather, time of day & season of the year...
a series of PHYSICAL, CHEMICAL & BIOLOGICAL test Parameters are used to determine the health of an aquatic ecosystem.

WATER QUALITY CRITERIA / STANDARDS
for all major factors used to determine the ecological health of aquatic ecosystems.

Set by LOCAL, STATE & FEDERAL ENVIRONMENTAL AGENCIES

D·E·M Rhode Island Department of Environmental Management

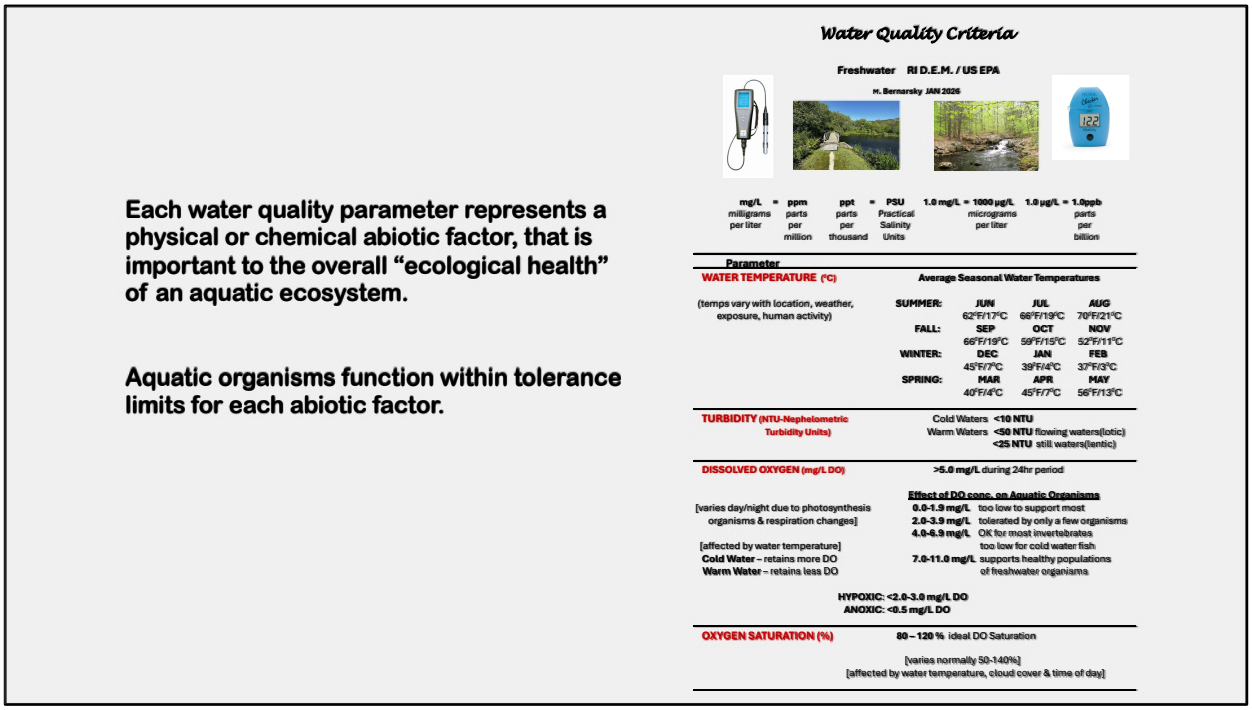


UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Water Quality Criteria, or Standards……for each major parameter are set by local, state & federal agencies……

Each water quality parameter represents a physical or chemical abiotic factor, that is important to the overall "ecological health" of an aquatic ecosystem.

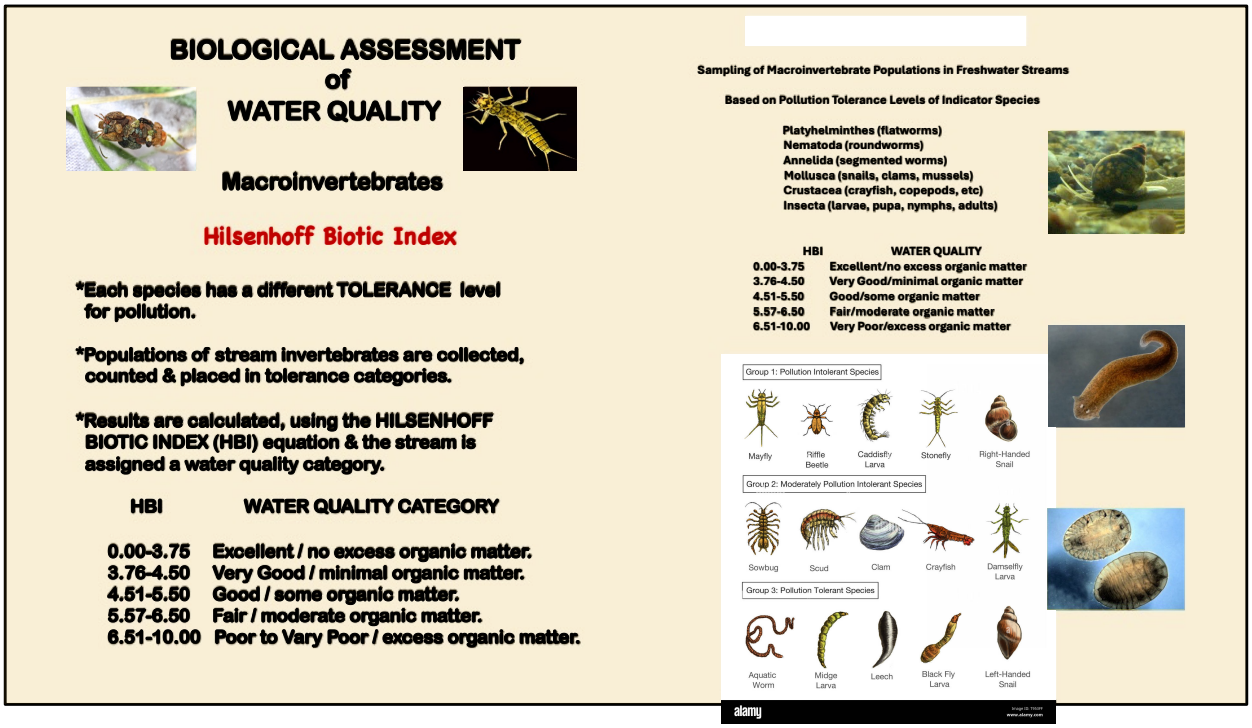
Aquatic organisms function within tolerance limits for each abiotic factor.



Each parameter has an acceptable range ....
within which aquatic organisms can tolerate & survive.

Some of the commonly used parameters include.....

TEMPERATURE
TURBIDITY
&
DISSOLVED OXYGEN



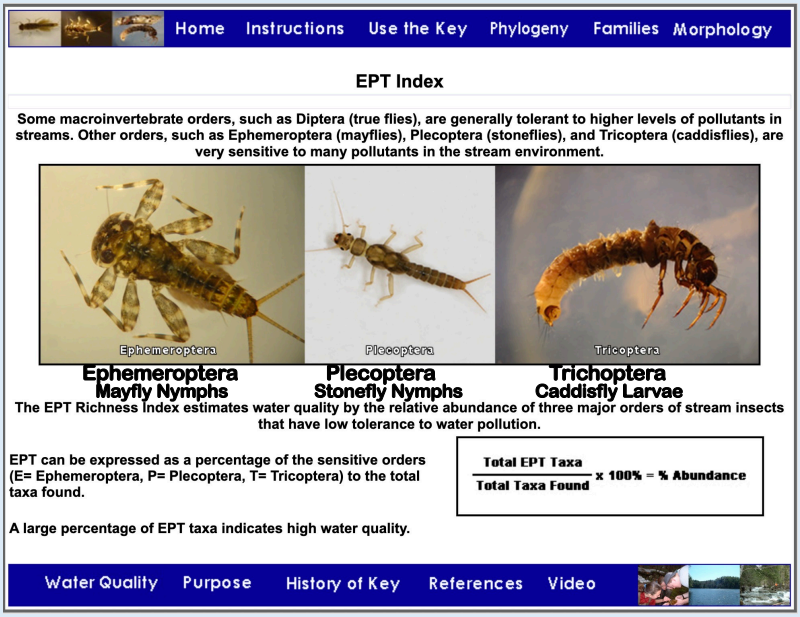
BIOLOGICAL ASSESSMENTS are also used to monitor water quality.....

The HILSENHOFF BIOTIC INDEX identifies & counts populations of aquatic macroinvertebrates..... which are mostly the larval & nymph stages of insects.

Each species of organism has a RANGE OF TOLERANCE for each physical and chemical factor in their aquatic habitat.

The numerical results are on a scale from
.....0.0 - 10.0

EPT Biotic Index for Freshwater Stream Water Quality



% of MAYFLY NYMPHS, STONEFLY NYMPHS & CADDIS FLY LARVAE compared to the total number of macroinvertebrates in a stream sample:

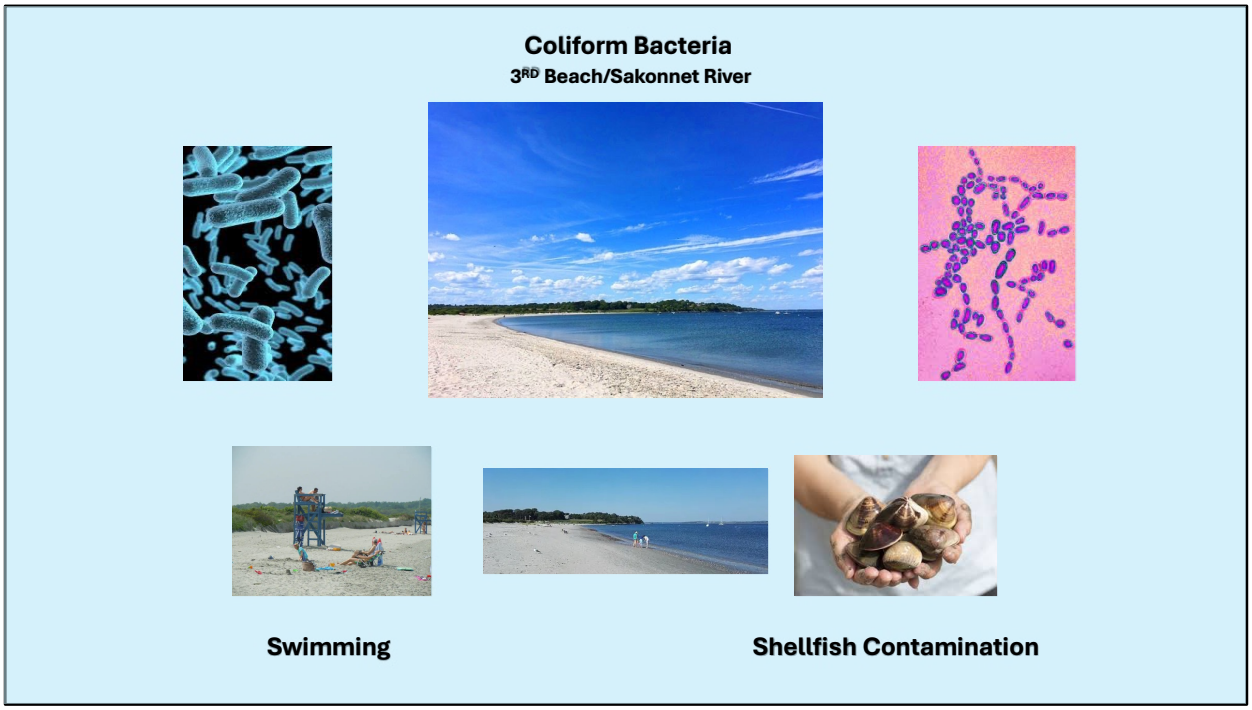
EPT Water Quality Scale:

>27%	Excellent
21-26%	Good
14-20%	Good-Fair
7-13%	Fair
0-6%	Poor

A similar biological assessment of water quality uses the EPT Biotic Index, where 3 major groups of "pollution intolerant species" are counted ..... Mayfly & stonefly nymphs... & caddisfly larvae.

& are compared to all other species present.

.....the results are placed on a scale from
0.0 to greater than 27%



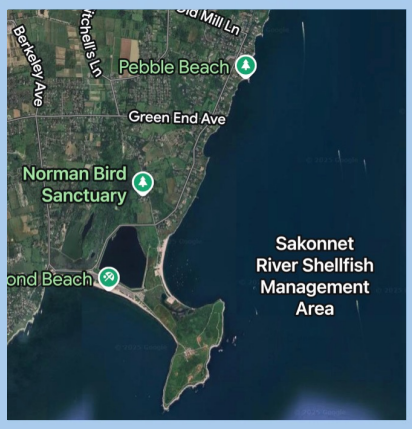
During the summer season, samples of seawater will be taken for coliform bacteria analysis at Salve Regina University's environmental lab.

The source of the bacteria is fecal waste products from humans & other animals. High levels of coliform can result in intestinal issues, eye/ear infections & rashes. It can also indicate possible contamination of shellfish populations.

Sakonnet River Shellfish Management Area
[RI D.E.M. - Division of Marine Fisheries]

Ocean Acidification !! **Plankton & Oxygen Production** **Nutrient Pollution!!**

Mg:Ca **pH** **$CaCO_3$** **SiO_2** **NO_3** **PO_4**

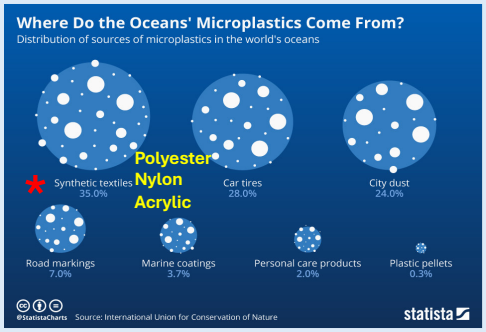


The long term ecological health of the Sakonnet River Shellfish Management Area depends on normal levels of water quality factors, that are important to the survival of the shellfish, plankton & other marine organisms.

Changing pH levels can effect the ability of marine organisms to construct bones & shells.

Silica is necessary for shell production in diatoms and other plankton life, that produce most of the oxygen for Planet Earth.

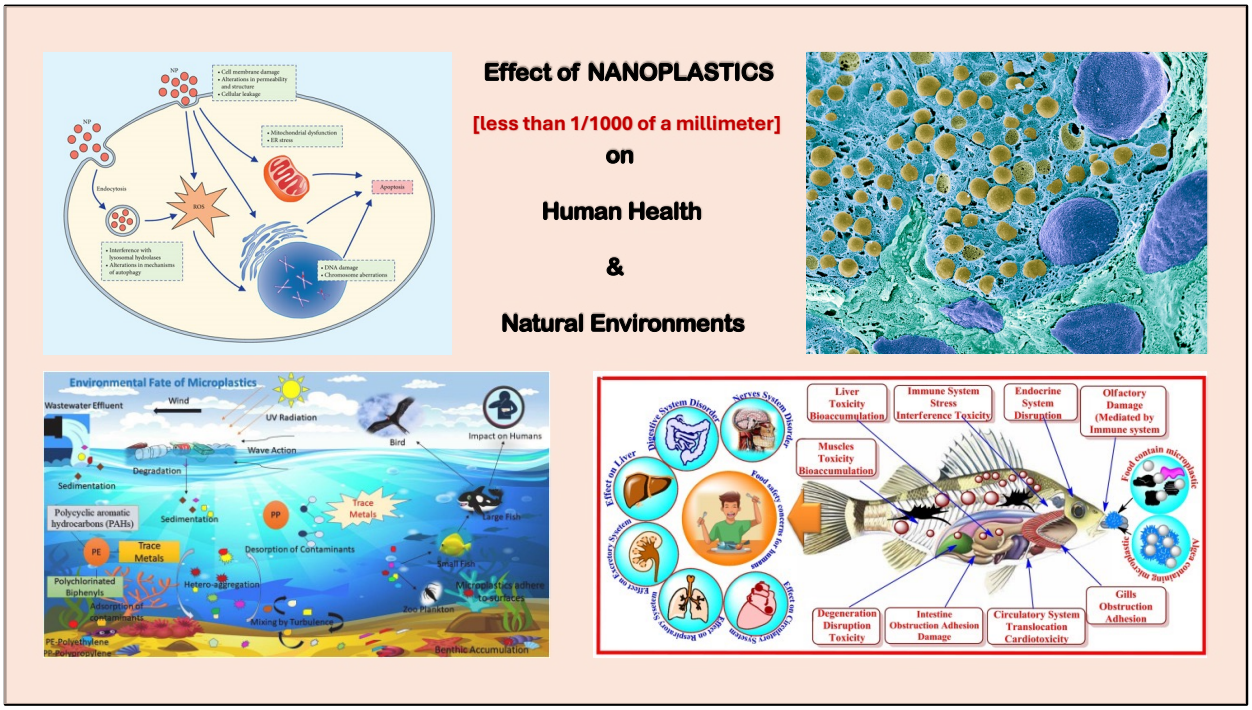
Excess nitrogen & phosphorus can lead to oxygen depletion in the habitat of sea floor
organisms.



Current size categories	Size range	Proposed size categories	Size Range	Organism of equivalent size
Nanoplastic	0.001-1 µm	Femto-size plastics	0.02-0.2 µm	Virus
Microplastic	1-1000 µm	Pico-size plastics	0.2-2 µm	Bacteria
		Nano-size plastics	2-20 µm	Flagellates
		Micro-size plastics	20-200 µm	Diatoms, dinoflagellates, ciliates, daphnids
		Meso-size plastics	200-2000 µm	Amphipods, appendicularians, chetognatos, copepods, thaliaceans
Mesoplastic	1-10 mm	Macro-size plastic	0.2-20 cm	Euphausiids, heteropods, jellyfish, larval fish, mysids, pteropods, solitary salps
Macroplastic	> 1 cm	Mega-size plastic	20-200 cm	Jellyfish, colonial salps

During the past decade or so, MICROPLASTICS have have become a human health concern, as well as the effects it might be having on all life in the world's ecosystems.

They are sized in 4 major categories from greater than 1 centimeter in diameter..... to NANOPLASTICS,... the size of a virus!!!

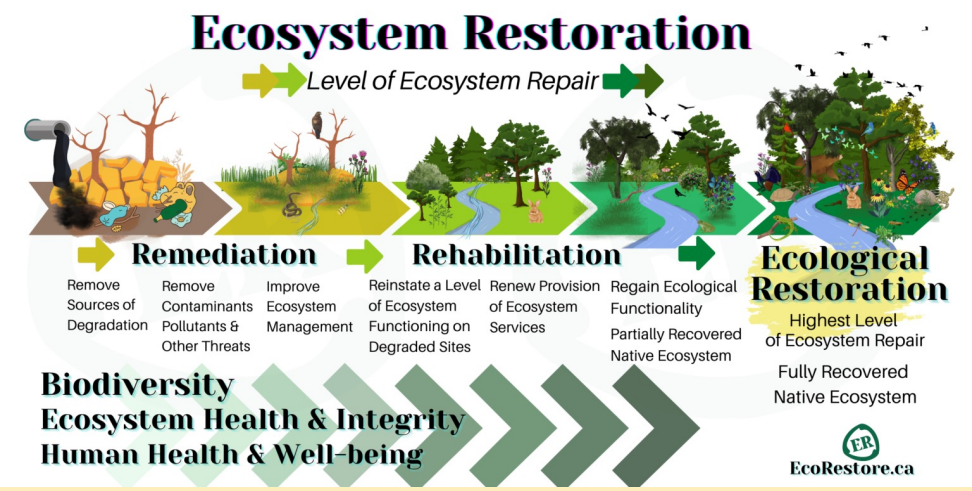


Nanoplastics can enter the cells of living organisms .....& interrupt liver, muscle, breathing, & other vital animal functions.

Immune & endocrine systems can also be compromised.....

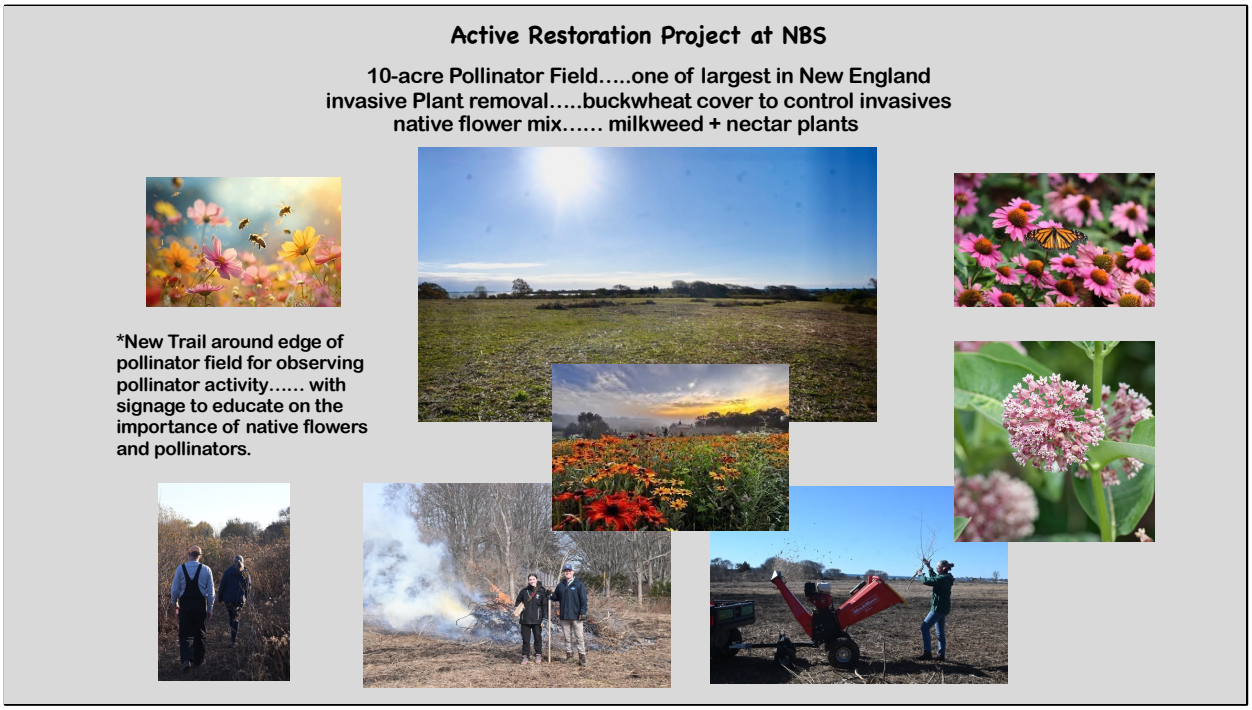
So we're also looking into possibility of monitoring MICROPLASTICS in our local freshwater & marine habitats.

Ecological Restoration .....process of assisting the recovery of an ecosystem, that has been degraded, damaged, destroyed or transformed from its original natural state.



The Norman Bird Sanctuary volunteer program also includes ECOSYSTEM RESTORATION, as we work to REMEDIATE & REHABILITATE impaired habitats, & even create new habitats to benefit wildlife species.

One of these projects involves stabilizing
sand dunes with plantings of Beach Rose, Bayberry & Dune Grass.



Another project underway is the establishment of a 10-acre POLLINATOR field, which will be one of the largest in the northeast US.

This habitat will benefit Monarch Butterflies on their migratory journey, along the eastern half of North America, to their wintering grounds in the mountains of Mexico.

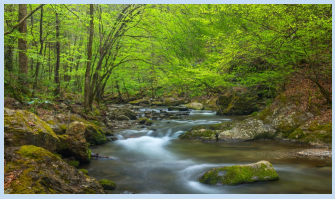
This project will also increase the diversity of other butterfly species, birds & pollinating bees.

Future Restoration Project at NBS

Native Bee Hotels !!! .....NOT AT NEWPORT PRICES!!!!

And to entice the native bees to take up residence at the Sanctuary, we plan to construct an "upscale" bee hotel..... and we will not be charging "Newport prices"!!

Norman Bird Sanctuary
Water Quality Monitoring & Restoration Program



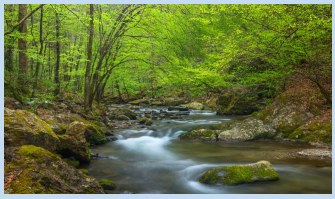
NORMAN BIRD SANCTUARY

END PART 1

This concludes PART 1 of our WATER QUALITY MONITORING TRAINING.....

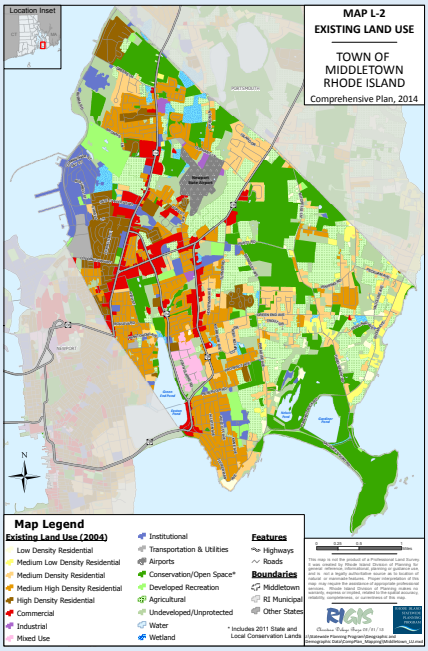
...any questions????

Norman Bird Sanctuary
Water Quality Monitoring & Restoration Program



NORMAN BIRD SANCTUARY

This presentation will cover details about each of the major water quality PARAMETERS, that volunteers will be monitoring throughout the year.



BASIC INFORMATION ABOUT THE WATERSHED:

***Size (sq. mi.) of the Watershed / Map / Major streams, lakes, etc.**

***Land Use % - Residential, Agricultural, Industrial, Recreational, etc.**

***Location of Headwaters / Source of water for stream, lake, etc. being monitored.**

INFORMATION DURING TESTING:

***OBSERVER conducting tests.**

***DATE & TIME OF DAY**

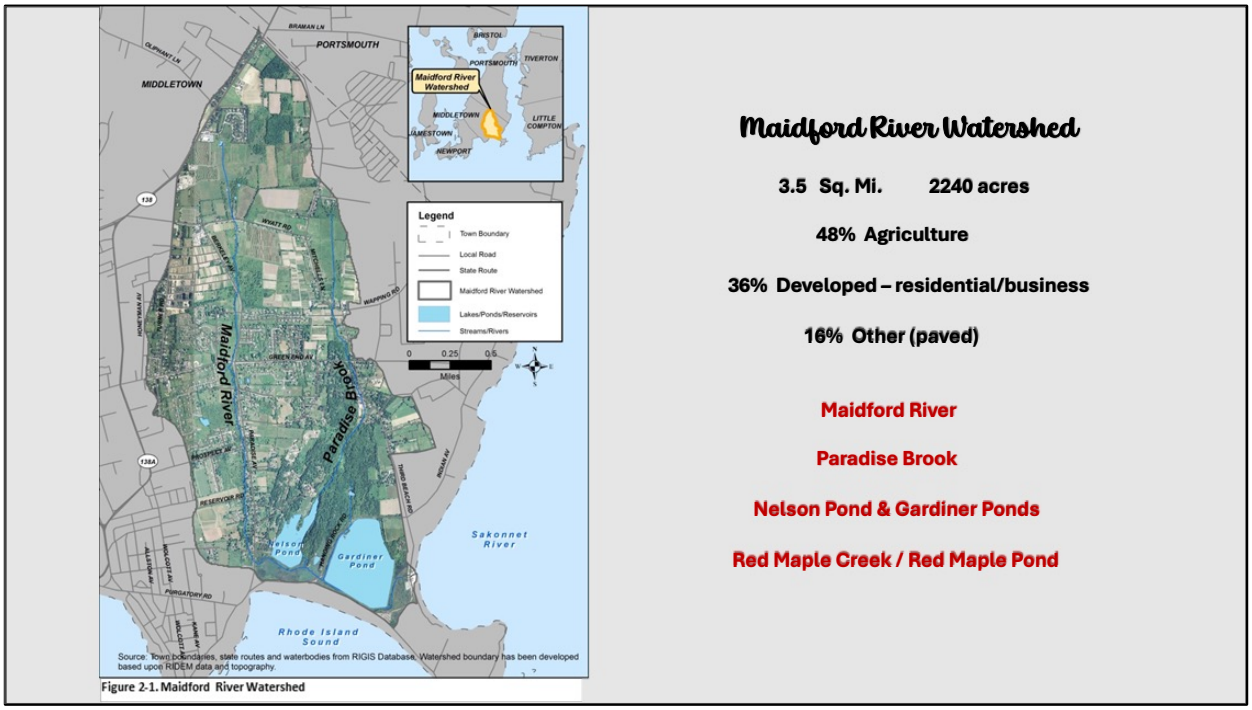
***WEATHER: Current & Past 24-48 hrs.**

The first requirement of a water quality program is an understanding of the entire watershed, that surrounds the aquatic ecosystems to be monitored.

This includes the size of the drainage area, major bodies of water, sources of the water & types of land use in the region.

An understanding of long-term weather patterns in the region is also important, since it may influence the water testing results.

Time of year, time of day, & weather conditions on the days before, & the day of testing are also essential.



The aquatic ecosystems we will be monitoring are within the 3.5 square mile MAIDFORD WATERSHED.

Land Use in the region is:

48% AGRICULTURE
36% DEVELOPED
16% OTHER (mostly paved surfaces)

The major bodies of water in the watershed include:

Maidford River
Paradise Brook
Red Maple Creek & Pond
Nelson & Gardiner Ponds

The the headwaters of the Maidford River
are located at Newport Vineyards in Middletown, & runs for about 4.0 miles to a tidal marsh area near Third Beach.

Paradise Brook headwaters are at Fayal & Mitchell Lanes in Middletown, & flows through the Norman Bird Sanctuary into Nelson Pond.

The Red Maple Creek water source is woodland springs withing the Sanctuary's property. It flows into Red Maple Pond, & joins the Maidford River near the intersection of Hanging Rock & Sachuest Point Roads.

The water from Nelson Pond flows through an underground pipe into Gardiner Pond. Both ponds are managed by the city of Newport as public drinking water.

Water Quality Parameters to be monitored:

Weather Conditions: (influencing factors)

*** Air Temp (^{0}C)**

*** Cloud Cover (% estimate)**

*** Precipitation: Current & Past 48 hours**
light...moderate.....heavy

ABIOTIC FACTORS: Physical / Chemical

Conducted at monitoring site:

- **Water Temperature (^{0}C)**
- **Dissolved Oxygen (mg/L)** milligrams per liter
- **DO % Saturation**
- **pH**
- **Electric Conductivity EC (µS/cm)** MicroSeimens /Centimeter
- **Salinity (ppt)** parts per thousand or **(PSU)** Practical Salinity Units
- **ORP** (Oxidation Reduction Potential) **(mV)** milliVolts

---

Conducted on samples returned to lab:

- **Turbidity (NTU)** Nephelometric Turbidity Units
- **Alkalinity (mg/L $CaCO_3$)**
- **Ammonia LR (low range))** mg/L Free Ammonia NH_3 [un-ionized]
- **Nitrate (mg/L NO_3-N) –nitrate nitrogen [x 4.43 = NO_3 nitrate]**
- **Phosphate (mg/L ortho Phosphate)**
- **Chloride (mg/L Cl-) * only in winter during roadway salting.**

At each monitoring site, weather factors of air temperature, cloud cover & precipitation are recorded.

Water tests at each site include: [READ FROM LIST)

Water samples taken at each site are tested in the lab for: [READ FROM LIST]

Abiotic Physical Parameters

Stream Velocity/Volume of Flow

AVG DEPTH (m) x AVG WIDTH (m) x AVG VELOCITY (m/sec)
x .8 (rocky bottom) or .9 (sand/mud bottom)
= VOLUME OF FLOW (m^3/sec)

STREAM VOLUME OF FLOW MEASUREMENT

DATE:_____ TIME:_____ LOCATION:_____

WEATHER CONDITIONS:
Precipitation: Current_____ Lat: ____.____ Lon:____.____
Past 48 Hrs._____ Elevation:_____ft

Stream Width	Measurement (meters)	Depths (meters) 1	2	3	4	5	TOTAL	AVERAGE
#1								
#2								
#3								
#4								
#5								
TOTAL:							TOTAL:	

AVERAGE: WIDTH (m) _____ AVERAGE: DEPTH (m) _____

Stream Velocity (_____ meter distance)
Time (seconds)
Trial #1: _____
Trial #2: _____ _____Meters ÷ _____
Trial #3: _____ Average Seconds
TOTAL: _____
AVERAGE: SECONDS _____ = _____ AVERAGE VELOCITY (m/sec)

Type of Stream Bottom: (friction value)	STREAM VOLUME OF FLOW	=	average WIDTH	X	average DEPTH	X	average VELOCITY	X	Bottom Type Value
0.8____Rubble 0.9____Smooth CHECK ONE		=	_____	x	_____	x	_____	x	_____

= _____ m^3/sec

*[cubic meters per second (m^3/sec) x 35.315 = cubic feet per second (ft^3/sec)]

= _____ ft^3/sec

Pond/Lake Depth & Acreage

AVG DEPTH (m) / Contour Mapping
AREA = m^2

It is import to measure the VOLUME OF FLOW in streams, & approximate DEPTH & AREA COVERED by ponds or lakes being monitored.

Stream flow is usually measured in cubic ft or meters per second.

The volume & movement of water in an aquatic habitat can influence other factors being monitored.

Abiotic Physical Parameters

WATER TEMPERATURE

*Dissolved Oxygen Concentration - Colder water retains more O_2
- Warmer water…less oxygen.

*Rate of Metabolic Processes: Photosynthesis Respiration
Decomposition Biomass Production

*Release of Nutrients during Decomposition of Organic Matter

*Effect of Toxins on Aquatic Life

*Tolerance of species to temperature levels & temperature change

*WATER TEMPERATURE
[temps may vary due to location, weather & human activity]

- coldest month
@ - warmest month

Average Seasonal Water Temperatures

SUMMER:	JUN	JUL	AUG @
	62°F/17°C	66°F/19°C	70°F/21°C
FALL:	SEP	OCT	NOV
	66°F/19°C	59°F/15°C	52°F/11°C
WINTER:	DEC	JAN	FEB #
	45°F/7°C	39°F/4°C	37°F/3°C
SPRING:	MAR	APR	APR
	40°F/4°C	450°F/7°C	56°F/13°C

The first Parameter important to effective water quality monitoring is WATER TEMPERATURE.

Temperature effects many key processes operating in an aquatic ecosystem:

[READ THE 5 WITH RED STAR]

There are "normal" seasonal averages for water temperature by month.....
FEB being the coldest, & AUG the warmest.

Abiotic Physical Parameters

NTU = Nephelometric Turbidity Units

TURBIDITY (NTU)

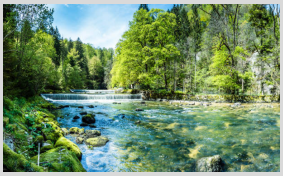
A measure of water clarity, due to suspended particles that may have a negative impact on aquatic life.

***Reduction of light penetration for photosynthesis.**

***Clogging of fish & macroinvertebrate gills.**

***May indicate excessive N & P…leading to accelerated eutrophication & oxygen depletion.**

Standard: <10 NTU cold waters
<50 NTU warm waters / flowing
<25 NTU warm waters / still



TURBIDITY is a physical factor that measures how clear the water is, in terms of the presence of suspended particles, or chemical color substances, that can effect the normal functioning of aquatic life including:

[READ THE 3 EFFECTS WITH RED STAR]

Turbidity is measured in NTU's, or Nephelometric Turbidity Units.

Abiotic Chemical Parameters

mg/L = milligrams per liter
ppm = parts per million
1.0 mg/L = 1.0 ppm

DISSOLVED OXYGEN (mg/L DO)

ATMOSPHERE 21% WATER <1%

* Dissolved Oxygen is O_2 molecules in water, NOT the oxygen on H_2O molecules.

H_2O H_2O H_2O → O_2 O_2 H_2O H_2O H_2O

Varies day/night due to photosynthesis & respiration.

Affected by % cloud cover & available light for photosynthesis, during daytime.

*PHOTOSYNTHESIS - Producers / chlorophyll-bearing aquatic life (algae, phytoplankton, aquatic plants) add O_2 to water.

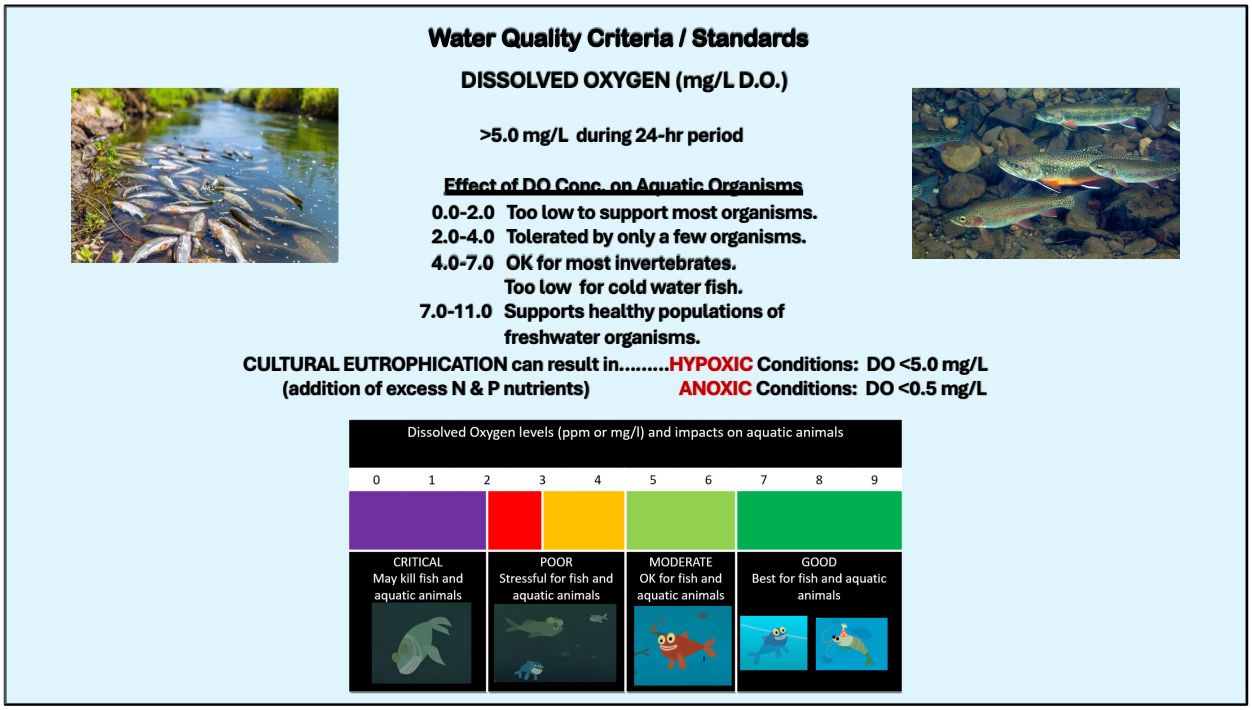
*Physical Aeration, in rocky/riffle areas of streams & wave action or wind on the water surface adds O_2 to water.

*RESPIRATION - Consumers & Decomposers remove O_2 from water.

Dissolved oxygen, or DO, is a major factor important to the ecological health of aquatic ecosystems. While the atmosphere consists of 21% oxygen, water has less than 1%.....& therefore can be a major limiting factor to the survival of aquatic life.
The dissolved oxygen molecule, that is produced & used in aquatic systems, is NOT the oxygen atom on the water molecule.

DO varies throughout the day & night due to changes in Photosynthesis & Respiration.
Oxygen is added to water biologically through PHOTOSYNTHESIS, & physically by AERATION & ABSORPTION in rocky streams, or by surface wind and wave action.

Oxygen is removed from water biologically through RESPIRATION by aquatic Consumers & Decomposers. ....& by increased temperatures.
Time of day & cloud cover also affect DO levels.



The water quality standard for Dissolved Oxygen greater than 5.0 mg/L during a 24hr period.

0-2.0 mg/L is too low for most aquatic organisms to survive. A few organisms can tolerate 2.0-4.0. 4.0-7.0 is OK for most, except cold water fish.....& 7.0-11.0 supports a healthy aquatic ecosystem.

Cultural Eutrophication & oxygen depletion from too many nutrients, can lead to:

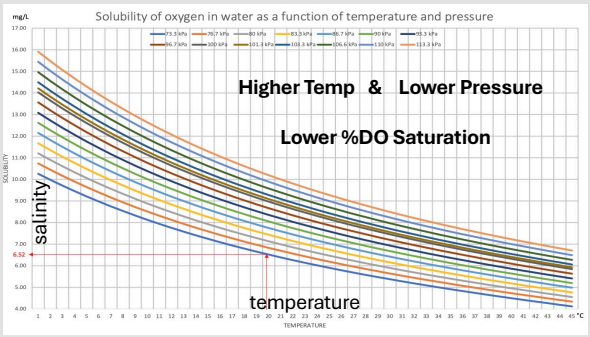
HYPOXIC conditions under 5.0 mg/L
and
ANOXIC conditions under 0.5 mg/L

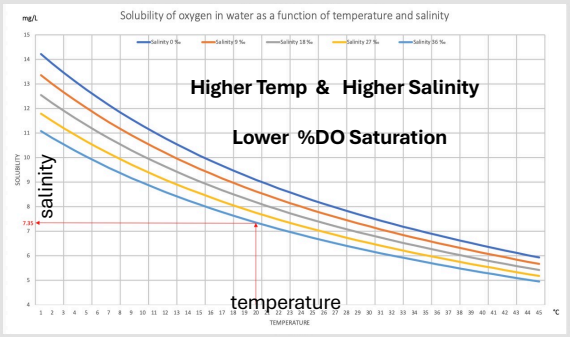
Dissolved Oxygen Saturation (% DO)

Maximum concentration of DO, that water can hold at a given:

TEMPERATURE, SALINITY LEVEL & BAROMETRIC PRESSURE

Water Quality Standard
[at sea level, avg. temp. freshwater]
80 – 120 %
varies from 50 – 140 %



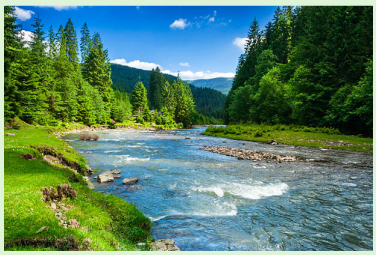


DO Saturation refers to the % of oxygen water can hold at a certain temperature, salinity & pressure.

Higher temps & low pressure lowers the solubility of oxygen in water.....

& higher salinity levels also lower DO Saturation.

The ideal DO saturation range is 80 - 120%

Stream A		Stream B
		
DO = 8.5 mg/L Water Temp = 4.8 ^{0}C	salinity & pressure same for both	DO = 8.5 mg/L Water Temp = 18.9 ^{0}C
DO Saturation = 66.23 %	Recommended 80 – 120 %DO	DO Saturation = 91.41 %

Here's an example of the importance of conducting both DO in mg/L, & %DO Saturation in water quality monitoring:

Stream A & Stream B both have a DO of 8.5 mg/L, but due to water temperature differences, Stream B is in better ecological condition.... with 91% DO Saturation ...and is within the water quality range of 80-120%. Where Stream A DO Saturation falls well below the range at 66%.

Abiotic Chemical Parameters

STANDARD: 6.5 – 8.5 recommended
(5.0 – 9.5 range in freshwaters)

***NOTE:** Values can change throughout day & night, due to changes in concentrations of carbon dioxide, during photosynthesis by aquatic plants, algae, etc., & respiration by fish, invertebrates, bacteria, etc.

pH

(Std. pH Units 0.0-14.0)

***A measure of the acid/base (alkaline) conditions in water.**

***Affects the overall balance of biochemical processes in aquatic ecosystems….photosynthesis, respiration, etc.**

***Reproductive success of aquatic life…eggs, larvae, etc.**

***Oxygen – Carbon Dioxide exchange in fish gills.**

***Increases toxicity of heavy metals & other pollutants.**

***Industrial discharges, agricultural runoff, etc. → pH changes.**

***Geology of the watershed influences pH… limestone, etc.**

***Carbon Dioxide (CO_2) affects pH levels in water.**

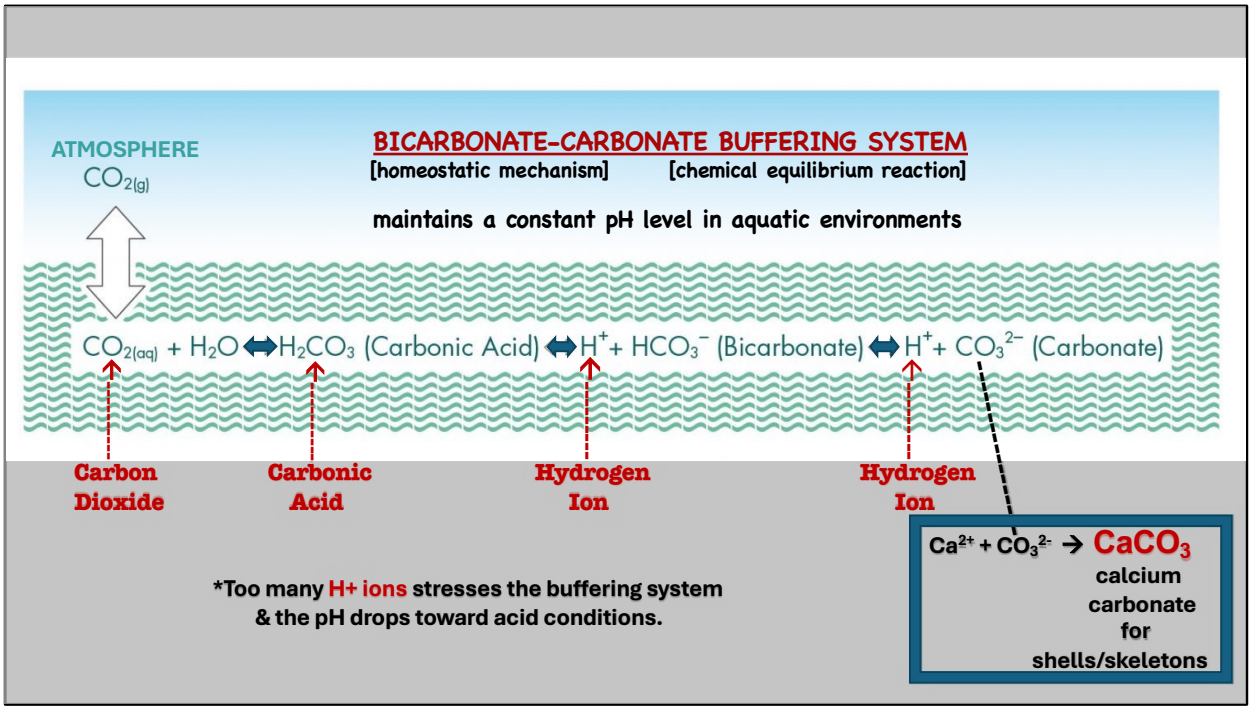
CO_2 (Carbon Dioxide) + H_2O (Water) → H_2CO_3 (Carbonic Acid)

pH is a measure of acid/base conditions in water, & has a profound effect on the balance of biochemical processes, reproduction, gill respiration, the effects of toxins on aquatic organisms, etc. Changes in pH can be the result of agricultural, domestic & industrial runoff…….as well as climate change.

Photosynthesis and respiration throughout a 24-hr period affects the concentrations of CARBON DIOXIDE in aquatic environments.

And….. the amount of CO2 in the water determines the concentration of CARBONIC ACID …..which then affects the pH. The ideal pH range for aquatic organisms is 6.5 - 8.5.

The presence of limestone in the geology of a region influences the ability of aquatic ecosystems to maintain pH levels.



All marine & freshwater environments on Earth have a chemical BUFFER SYSTEM, that prevents pH levels from becoming too acidic. As you can see from this chemical equation, Carbon Dioxide entering water becomes CARBONIC ACID.
...which then dissociates into HYDROGEN & BICARBONATE Ions. The bicarbonate further dissociates into another a HYDROGEN ION & a CARBONATE Ion.

Too many Hydrogen Ions stresses the buffer system.....& the pH drops toward acidic conditions.

CALCIUM in the water reacts with the carbonate ion to form CALCIUM CARBONATE.....the main ingredient in shells & bones of aquatic organisms.

CALCIUM CARBONATE acts as a major player in buffering pH levels in aquatic ecosystems.

$CaCO_3$ + H_2CO_3 → Ca^{2+} + 2 $H_2CO_3^-$

Shells Bones Limestone	carbonic acid	calcium ion	bicarbonate ion

***Excess H^+ Ions are neutralized.....pH is kept in check.**

Calcium available to the buffer system is influenced by the amount of limestone in the watershed.

Calcium carbonate in aquatic ecosystems
assists in the buffering of pH levels.....by incorporating the Hydrogens from carbonic acid into bicarbonate ions.

Abiotic Chemical Parameters

Ca/Mg Hardness (mg/L $CaCO_3$)

***Amount of Ca (calcium) & Mg (magnesium) salts in the water availability to the pH Buffering System.**

***Levels are influenced by Limestone geology in watershed.**

Hardness Levels:
0-60 Soft Water
61-120 Moderately Hard Water
121-180 Hard Water
>180 Very Hard Water

Standard:
5.0 – 120 mg/L ($CaCO_3$) normal range.
>500.0 mg/L toxic to freshwater life.

A Calcium/Magnesium Hardness test will indicate the availability of Calcium Carbonate for the buffer system.

The amount of LIMESTONE in the watershed influences concentration of Calcium Carbonate in the water.

Abiotic Chemical Parameters

ALKALINITY (mg/L $CaCO_3$)

*Measures water's capacity to neutralize, or buffer, acid conditions.

*Influenced by geology of the watershed....

Runoff from Limestone deposits in the watershed add Calcium Carbonate to the water, which increases $CaCO_3$ concentration & the Alkalinity Buffering Capacity.

STANDARD:	
Very Low	10 mg/L
Low	11-50 mg/L
Moderate	51-150 mg/L
High	151-300 mg/L
Very High	>300 mg/L

80 – 120 mg/L	optimal for normal functioning of freshwater ecosystems.
< 20.0 mg/L	stressful for aquatic. organisms.
< 10.0 mg/L	poorly buffered/harmful affects on aquatic organisms.

An ALKALINITY test is essentially a check on whether the Buffer System is working.

80-120 mg/L Calcium Carbonate Alkalinity is ideal for maintaining pH stability in aquatic habitats.

Abiotic Chemical Parameters

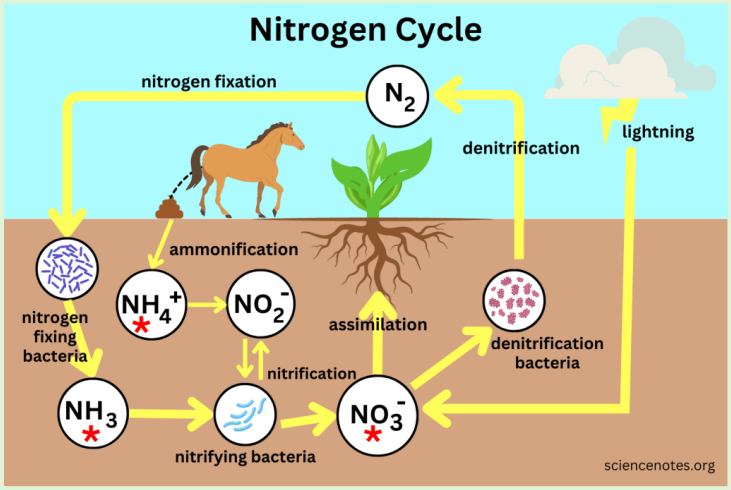
NITROGEN

***One of the 2 essential nutrients in terrestrial & aquatic ecosystems. (phosphorus is other essential nutrient)**

***Essential to biomass synthesis. (new living organisms)**

***5 forms of nitrogen:**

- N_2 - nitrogen gas (atmosphere)
- NH_3 - ammonia nitrogen
- NH_4^+ - ammonium ion
- NO_2 - nitrite
- NO_3^- - nitrate



* - Water Quality Tests

Two major nutrients important to chlorophyll-bearing, producer organisms, such as algae, phytoplankton & aquatic plants are NITROGEN & PHOSPHORUS.

Keep in mind the 5 main elements that make up 99% of living organisms: C H O N & P.

Nitrogen comes in 5 forms in the Nitrogen Cycle on Earth:

Nitrogen Gas - N2
Ammonia Nitrogen - NH3
(free ammonia)
Ammonium Ion - NH4+
Nitrite - NO2
Nitrate - NO3

The ammonia, ammonium & nitrate forms of Nitrogen are the main focus in water analysis.

Abiotic Chemical Parameters

AMMONIA NITROGEN LR mg/L
(NH_3-N)

Low Range
mg/L NH_3-N

***Normal part of the nitrogen cycle.**

N_2 (nitrogen gas) atmosphere → **"lightning" / "nitrogen fixation" bacteria in water/soil** → **NH_3 (ammonia nitrogen) water/soil**

***Certain algae & Cyanobacteria ("blue-green algae") & can use NH_3-N directly as a nutrient for synthesis of proteins, etc. (new biomass).**

***Toxic to aquatic life in high concentrations:**
-damages gills
-impairs reproduction
-affects nervous systems

***Excess NH_3 (agricultural fertilizer runoff/septic & water treatment discharge) can lead to eutrophication & "algal blooms"..... and high populations of phytoplankton.... blocks light penetration in water.**

[Higher water temp & pH increases the amount of NH_3 in water.]

***Algal populations die & are decomposed at the bottom of the aquatic ecosystem by bacteria.....**
"oxygen depletion" / "dead zones". / "fish kills"

HYPOXIC Condition - very low dissolved oxygen levels
ANOXIC Condition - NO dissolved oxygen

Atmospheric Nitrogen is converted to AMMONIA (NH3) by lightning and biological nitrogen fixation. Some algae & cyanobacteria can use NH3 directly as a nutrient for biomass production.

But, excess ammonia from agriculture & septic systems can lead to "algal blooms", & as excess algal populations die.....bacterial decomposition depletes the oxygen, leading to Hypoxic or Anoxic dissolved oxygen conditions.

Too much of this "free ammonia" can be directly toxic to aquatic life..... damaging gills, & affecting reproductive & nervous systems of aquatic life.

Abiotic Chemical Parameters

High Range
mg/L NH_4^+

AMMONIUM NITROGEN HR mg/L
(NH_4^+-N)

***Formed when NH_3 dissolves in water / most abundant form of ammonia nitrogen in aquatic ecosystems.**

$NH_3 + H^+ \rightarrow NH_4^+$ (ammonium ion)

***Less toxic to aquatic life in higher concentrations than NH_3**

***Conversion to Nitrate:**

NH_4+ ammonium → NO_2 nitrite → NO_3 nitrate

***Excess amounts can lead to eutrophication. - algal blooms, oxygen depletion, etc.**

Nitrogen in the form of the AMMONIUM ION....NH4+, is not as toxic to organisms, but it can still cause cultural eutrophication if excessive amounts enter the waters.

AMMONIA – NITROGEN

STANDARDS:

***AMMONIA NITROGEN LR** (mg/L NH_3-N) <0.10 mg/L recommended
Toxic to aquatic organisms. <0.02 mg/L for healthy fish pop.
High pH/temp. increases NH_3

***AMMONIA NITROGEN HR** [NH_4+(ammonium)] 0.10 – 1.00 mg/L
Generally non-toxic to aquatic
ACUTE Effect (1-hr avg.) 17.0 mg/L life accept in high conc.
CHRONIC Effect (30-day avg.) 1.9 mg/L



The EPA and RI DEM Standards recommend less than 0.1 mg/L for Ammonia,
…… & 0.1 to 1.00 mg/L for Ammonium.

There are also short-term ACUTE and long-term CHRONIC levels set for ammonia in freshwater ecosystems.

Abiotic Chemical Parameters

STANDARD:

<1.0 mg/L	recommended
> 2.0 mg/L	triggers eutrophication
< 4.0 mg/L	acceptable
> 10.0 mg/L	affects fish, amphibians & macroinvertebrates.

0.3 – 0.5 mg/L ideal range

NITRATE NITROGEN
NO_3-N

NH_3 (ammonia) → (bacteria) NO_3 (nitrate)

NH_4 (ammonium) → (bacteria) NO_2 (nitrite) → NO_3 (nitrate)

*Most used form of NITROGEN by producer organisms (algae, phytoplankton, etc.)

*Essential for growth of producer organisms.....biomass/protein synthesis.

*Excess amounts from agricultural fertilizer & animal waste runoff, septic systems, wastewater treatment discharge, etc. can result in

CULTURAL EUTROPHICATION

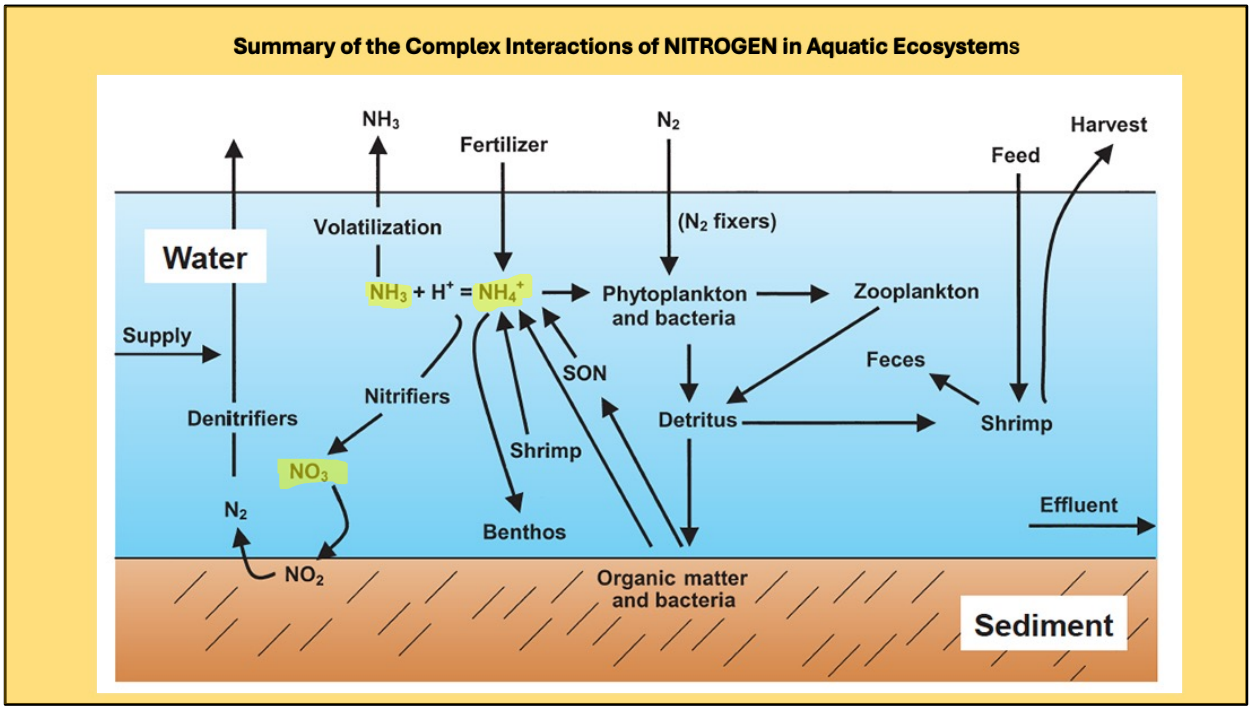
algal blooms.....oxygen depletion.....stress/death of aquatic life

HYPOXIC or ANOXIC Conditions

NITRATE NITROGEN ...NO3....is the most utilized form of nitrogen as a nutrient for producer organisms.

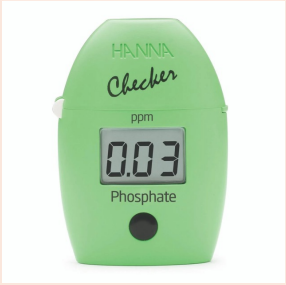
Once again, the major sources of Nitrogen pollution is agricultural, domestic & septic runoff in the watershed.

.....less than 1.0 mg/L NO3 is recommended ...& the ideal range is 0.3 - 0.5 mg/L



Thus, Nitrogen in freshwater habitats involves complex biochemical processes & interactions, ...and is an important parameter in water quality monitoring.

Abiotic Chemical Parameters

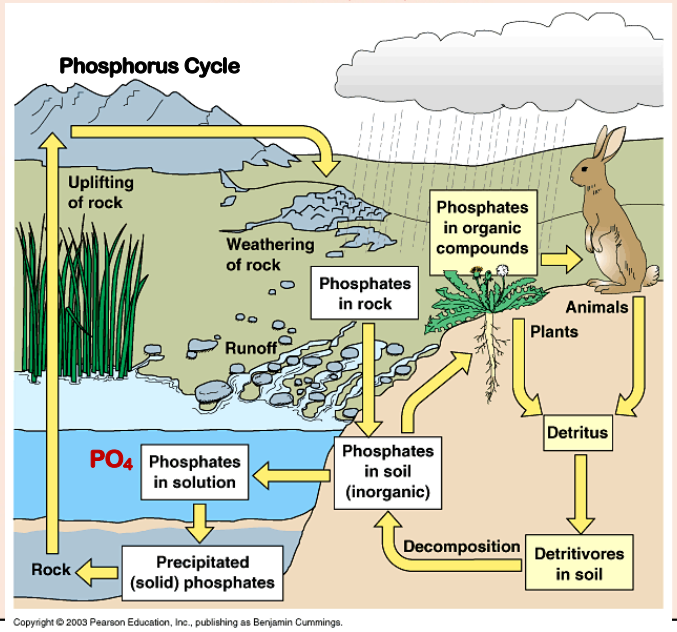


***Essential nutrient for aquatic organisms … Producers (algae, phytoplankton, etc.),Consumers, & Decomposers.**

-DNA, ATP (energy storage)
-Biomass/protein synthesis

***Major LIMITING FACTOR in aquatic ecosystems…**
Ratio 16 N : 1 P

PHOSPHORUS
[PO_4 –orthophosphate]



The other essential nutrient is ….PHOSPHORUS…. in the form of ORTHOPHOSPHATE …PO4… & is a major LIMITING FACTOR in aquatic ecosystems.

Since the normal ratio of nitrogen to phosphorus is 16 N to 1 P…… even small increases in phosphorus can quickly accelerate eutrophication, & seriously impair water quality in freshwater environments.

Phosphorus (cont.)

***Excess phosphate from agricultural fertilizer/animal waste runoff, water treatment facilities, septic systems, etc.**

CULTURAL EUTROPHICATION

Agal Blooms .....Oxygen Depletion.....suffocation of aquatic organisms

Hypoxic / Anoxic
Low DO 0.0 DO
Conditions

PO_4

orthophosphate

STANDARD	mg/L
Unpolluted lakes and streams:	0.01-0.03
Stimulates aquatic plant/algae growth:	0.25-0.10
MAX level before eutrophication:	0.10
Accelerated eutrophication: /oxygen depletion	>0.10

0.05 mg/L streams entering lakes
<0.10 mg/L streams not entering lakes
<0.025 mg/L lakes & reservoirs
NOTE: Ideal Ratio for phosphorus & nitrogen nutrients:
16 NO_3 : 1 PO_4

As with nitrogen, major sources of excess phosphorus is agricultural & septic waste runoff.

Healthy lakes and streams have phosphorus levels between 0.01 & 0.03 mg/L

During the higher temperatures of the growing season, eutrophication is accelerated, once phosphate concentrations reach 0.10 mg/L .

ELECTRICAL CONDUCTIVITY (EC)
µS/cm (micro Siemens per cemtimeter)
mS/cm (milli Siemens per centimeter)

***Indirect measurement of dissolved substances…..**
potential nutrients, salinity, pH/alkalinity, etc.

cations	anions
Na^+	Cl^-
K^+	SO_4^{2-}
Ca^{2+}	HCO_3^-
Mg^{2+}	NO_3^-
NH_4^+	PO_4^{3-}
	CO_3^{2-}

STANDARD:

mS/cm	TROPHIC STATE
<0.078	Nutrient Poor/OLIGOTROPHIC
0.078-0.156	Low nutrients/MESOTROPHIC
0.156-0.313	Nutrient Rich/EUTROPHIC
>0.313	Excess nutrients ADVANCED EUTROPHIC

NOTE: EC x 0.64 = TDS (total dissolved solids)

ELECTRICAL CONDUCTIVITY, or EC is measured in Siemens per centimeter.

It is an indirect measurement of dissolved ionic substances in the water…..which may be influencing nutrient levels, salinity, pH & alkalinity, etc.

EC values can also be used to assess the
TROPHIC STATE of a freshwater system.

…from NUTRIENT POOR at <0.078 milli Siemens…. to ADVANCED EUTROPHIC above .313 milli Siemens.

OXIDATION REDUCTION POTENTIAL (ORP mV - milliVolts)

***Measure of overall health & balance of biochemical processes operating in an aquatic ecosystem.**

SCALE: -1000 mV to +1000 mV

***Specifically....the ability of water to break down waste products & other contaminants.**

+ORP values - healthy, well-oxygenated water, with adequate waste removal.
–ORP values - poor oxygen levels, with inadequate waste removal.
Scale: -1000 mV to +1000 mV

Water Quality Standard

+ 300 – 340 mV ideal range

Oxidation Reduction Potential, or ORP, is a measure of the state of certain biochemical processes in an aquatic system.

It is measured in milli VOLTS in a range from minus 1000 to plus 1000.

It is an especially important indicator of the ability of the system to rid the water of waste products & other contaminants.

PLUS values indicate adequate OXIDATION of waste products, &.....
MINUS values indicate processes, like anaerobic respiration, are at play....& wastes and contaminants are not being processed.

The ideal range in a healthy aquatic ecosystem is +300 to 340.

SALINITY (ppt or PSU)

***Measurements are usually conducted on saltwater environments:**

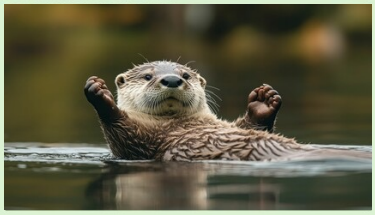
S A L I N I T Y

BRACKISH	MARINE	BRINE
0.5 – 30.0 ppt	30.0-50.0 ppt	>50.0 ppt

FRESHWATER ECOSYSTEMS
(streams / rivers / lakes / ponds / etc.)

SALINITY = < 0.5 ppt

NOTE: Salinity measurements may be used to check on salts from roadways during winter, & sea spray during storms in coastal areas.



The concentration of salt, in parts per thousand in aquatic ecosystems is used to classify them as Freshwater, Brackish, Marine or Brine environments.

It is also used in freshwater habitats to determine, whether there has been saltwater intrusion from roadway salting in winter, & salt spray during stormy conditions near the ocean.

Freshwater habitats contain less than 0.5 parts per thousand salinity.

Abiotic Chemical Parameters

STANDARD:

< 100 mg/L normal
860 mg/L ACUTE EXPOSURE (1-hr)
230mg/L CHRONIC EXPOSURE (30-day)

CHLORIDE (Cl-)

***A "stable" ION of Chlorine - (Cl^-)**

***Common in natural waters as…KCl, NaCl, $CaCl_2$**

***Essential for biochemical processes.**

***Helps maintain pH levels & nerve impulse transmission.**

Sources:
- **-natural weathering of rock/soil**
- **-"ocean spray"**
- **-road deicing in winter**
- **-wastewater treatment discharge**
- **-agricultural runoff (fertilizer – Potash potassium chloride KCl)**

Chloride is common in natural freshwater environments….as Potassium, Sodium & Calcium compounds.

In normal concentrations, it plays a significant role in aquatic biochemistry…. such as nerve impulse transmission in aquatic organisms.

Problems occur when too much chloride enters freshwater……..from road deicing or wastewater treatment discharge.

Another significant contributor to chloride pollution is potassium chloride fertilizer, or potash (potassium ash), runoff in agricultural areas.

Less than 100 mg/L is the preferred level in freshwater habitats.

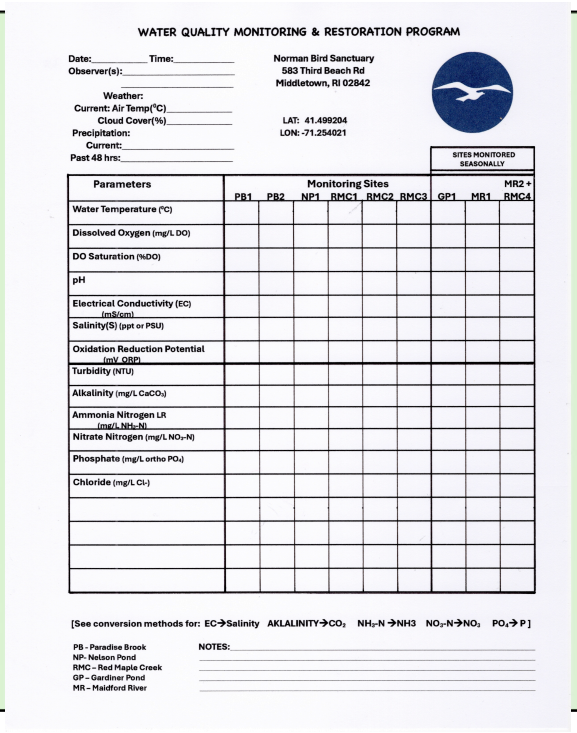
The water quality monitoring program will be conducting regular testing at a variety of sites,
..... in and around the Norman Bird Sanctuary.
The main focus is the 5 sites marked in RED on this aerial map..... along the Paradise Brook and Red Maple Creek withing the Sanctuary property. The Maidford River, Nelson & Gardiner Pond sites, labeled in BLUE, will be tested seasonally.

During the summer season, samples will be collected at the GREEN labeled sties at Third Beach..... & sent to the Salve Regina University Environmental Lab for assessing bacterial contamination at the Beach.

The seawater, at the SR1 site in YELLOW, will be monitored for OCEAN ACIDIFICATION, SILICA LEVELS, & EXCESS NUTRIENT issues, that might affect the Sakonnet River Shellfish Management Area.

DATA FORM

.....for recording test results in the field at monitoring sites, & in the lab on samples brought back from sites.



WATER QUALITY MONITORING & RESTORATION PROGRAM

Date:_____ Time:_____
Observer(s):_____
_____
Weather:
Current: Air Temp(°C)_____
Cloud Cover(%)_____
Precipitation:
Current:_____
Past 48 hrs:_____

Norman Bird Sanctuary
583 Third Beach Rd
Middletown, RI 02842

LAT: 41.499204
LON: -71.254021

SITES MONITORED SEASONALLY

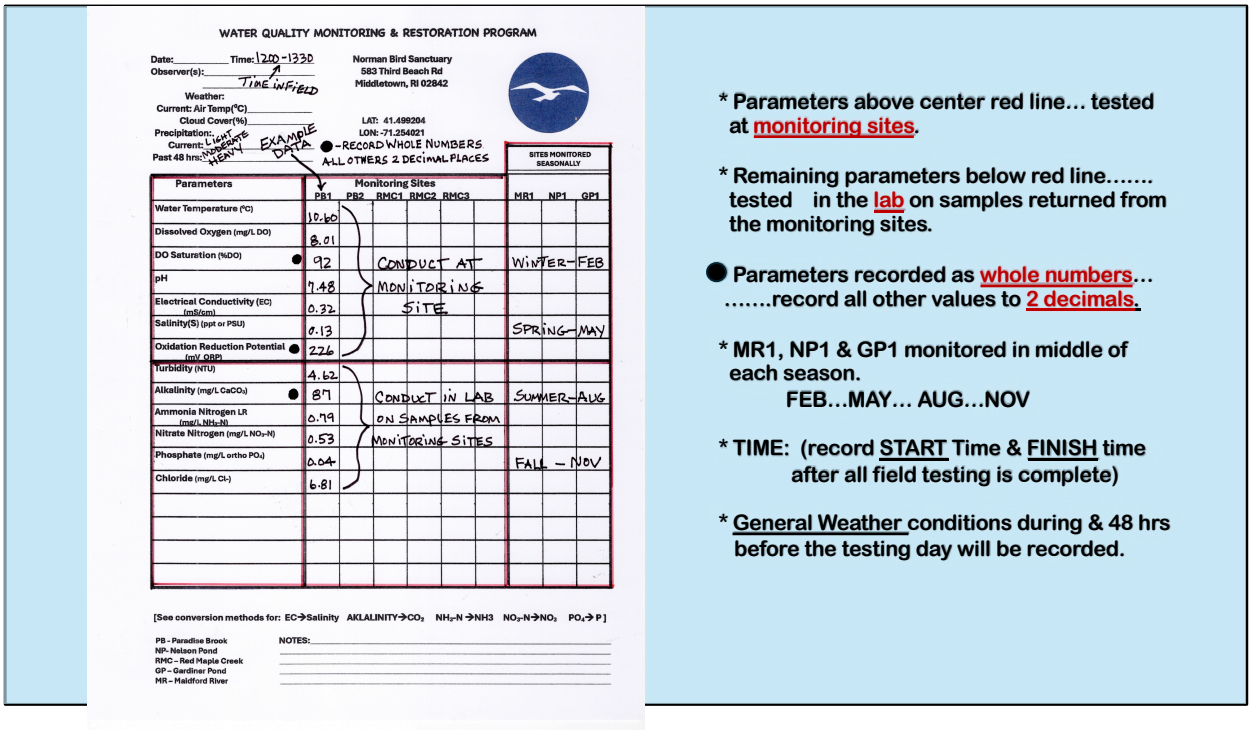
Parameters	Monitoring Sites								MR2 +
	PB1	PB2	NP1	RMC1	RMC2	RMC3	GP1	MR1	RMC4
Water Temperature (°C)									
Dissolved Oxygen (mg/L DO)									
DO Saturation (%DO)									
pH									
Electrical Conductivity (EC) (mS/cm)									
Salinity(S) (ppt or PSU)									
Oxidation Reduction Potential (mV ORP)									
Turbidity (NTU)									
Alkalinity (mg/L $CaCO_3$)									
Ammonia Nitrogen LR (mg/L NH_3-N)									
Nitrate Nitrogen (mg/L NO_3-N)									
Phosphate (mg/L ortho PO_4)									
Chloride (mg/L Cl_2)									

[See conversion methods for: EC→Salinity AKLALINITY→CO_3 NH_3-N →NH3 NO_3-N→NO_3 PO_4→ P]

PB - Paradise Brook
NP- Nelson Pond
RMC – Red Maple Creek
GP – Gardiner Pond
MR – Maidford River

NOTES:_____

This is the official data form for recording the basic physical & chemical factors, that are important to assessing water quality.



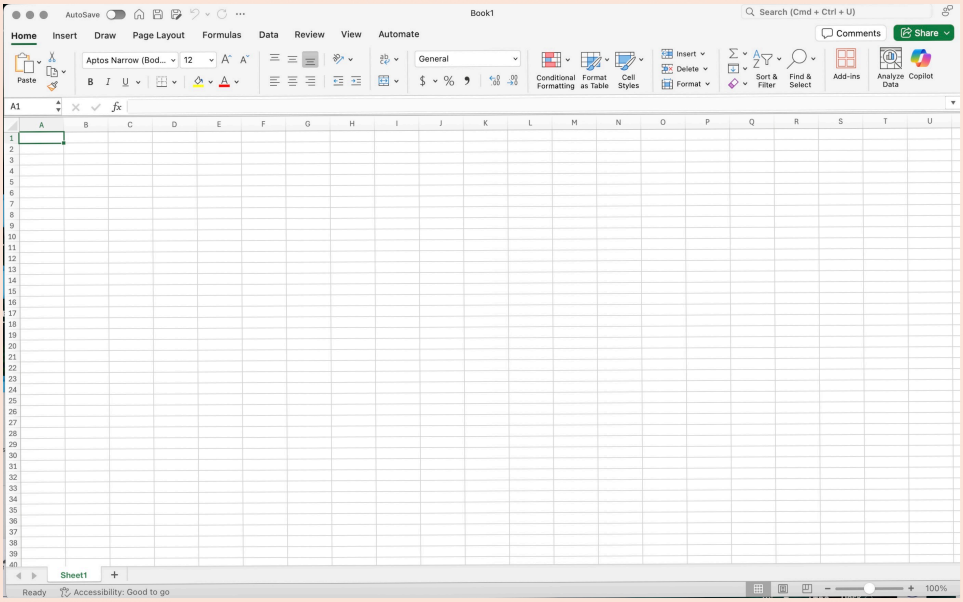
Test results AT the monitoring site are recorded above the red line....
from WATER TEMP thru ORP. Test results on samples brought back to lab are recorded below the line.

The black circles indicate results recorded as WHOLE NUMBERS. ..... & all other values to 2 DECIMALS....

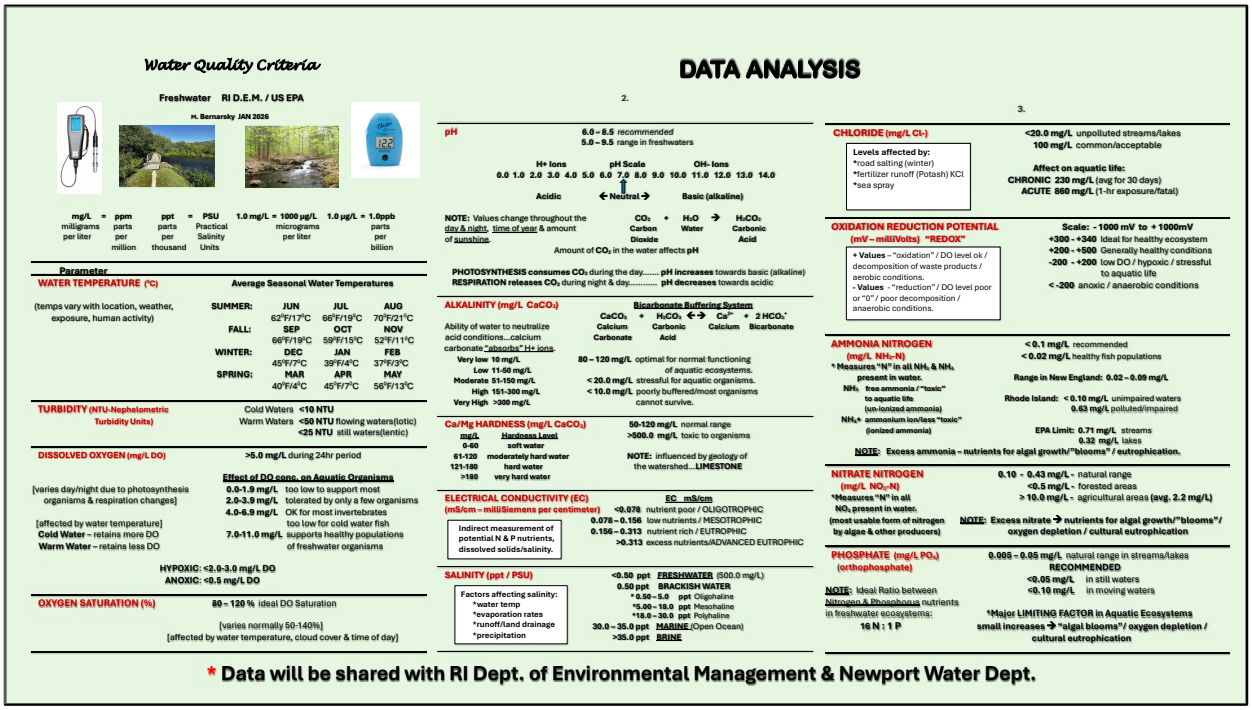
Seasonal monitoring test results will be recorded, during FEB...MAY...AUG...& NOV, in the righthand column.

The starting and finishing times, & general weather conditions, while at the monitoring sites, will also be recorded.

All data will be saved to EXCEL spreadsheets.
GRAPHS of all parameters over time will be created.

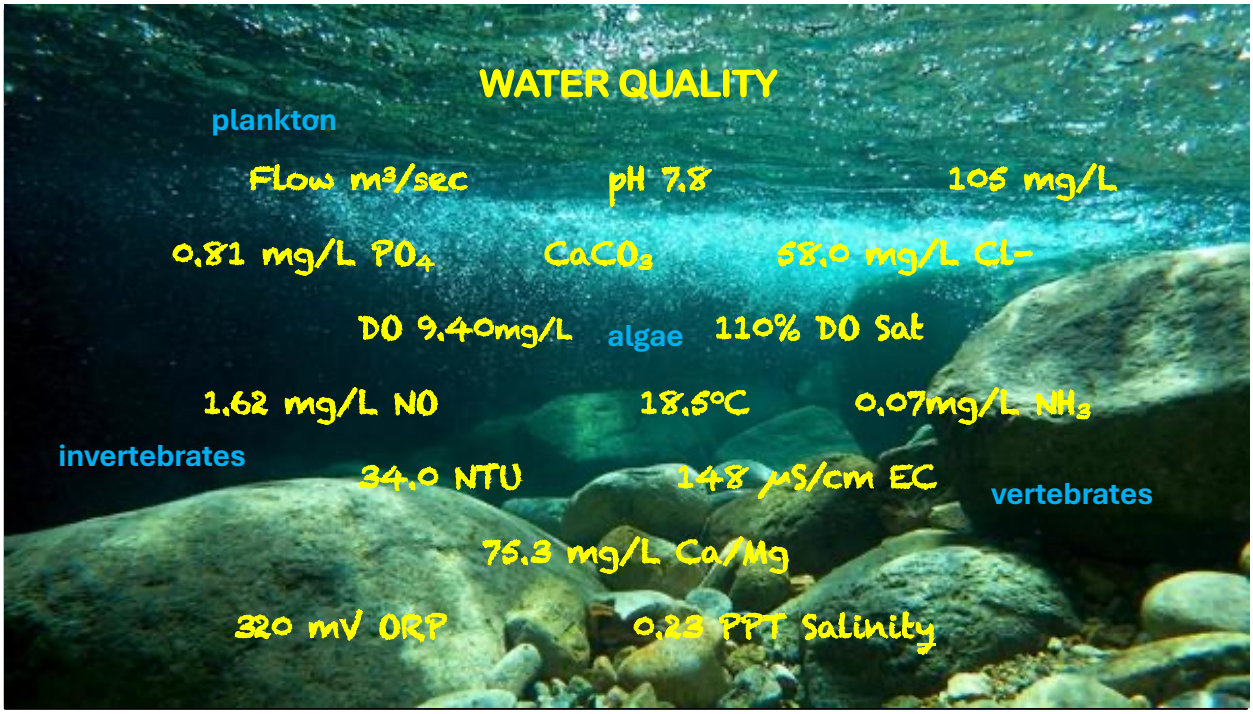


All test results will be stored on EXCEL spreadsheets....and used to create graphs for each parameter..... to show trends throughout the year.

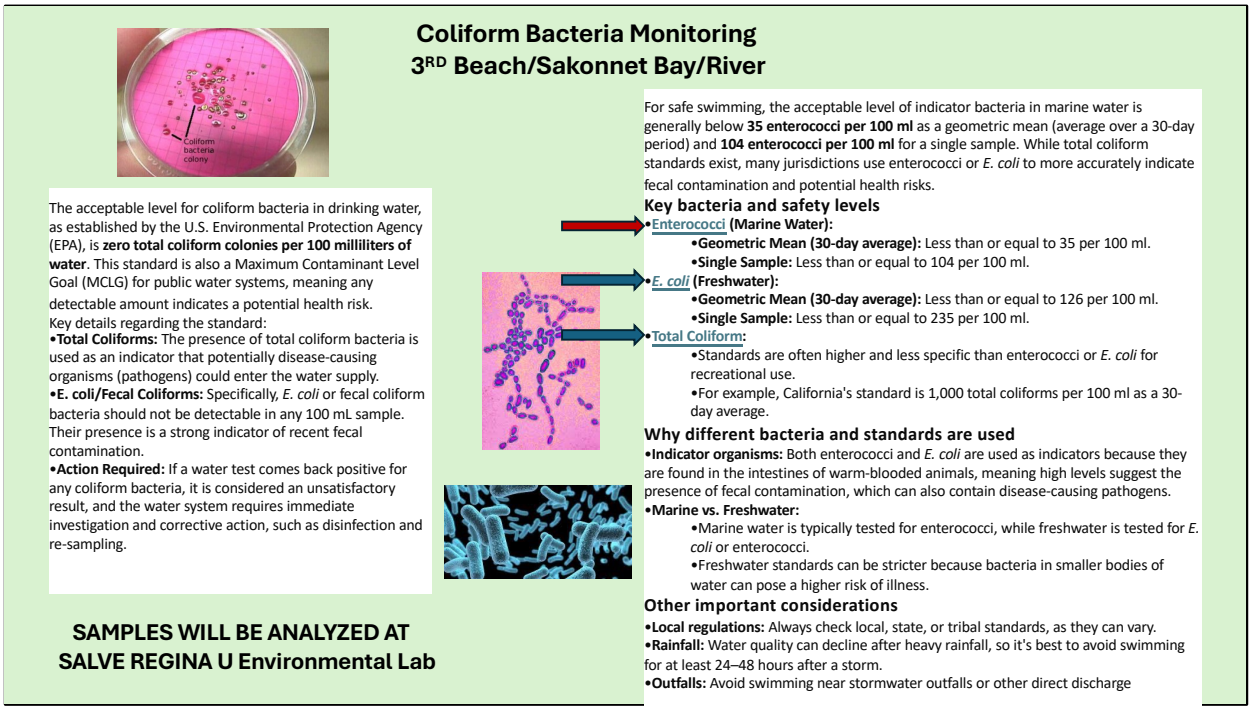


Each parameter will be compared to WATER QUALITY CRITERIA ....and a yearly report will be generated on the ecological health of the monitored aquatic ecosystems.

We will be sharing our results with the public,
Rhode Island DEM, & Newport Water Department.



Water quality dynamics involves complex interactions between physical & chemical abiotic factors....& the biotic community of organisms in aquatic ecosystems.



COLIFORM BACTERIA sampling is another form of water quality monitoring ..... associated with human drinking water, swimming safety, & possible shellfish contamination..

Different types of coliform are monitored in freshwater and marine environments.

The presence of coliform bacteria indicates fecal contamination of the water from humans & animals. It can cause skin, ear & throat infections, but more importantly it indicates the possible presence of other pathogens.... such as typhoid fever, hepatitis, gastroenteritis & dysentery.

Marine Water Quality Monitoring
Third Beach, Middletown RI

Sakonnet River Shellfish Management Area
RI Department of Environmental Management (RIDEM)

General Factors
WATER TEMP. DO / %DO
ALKALINITY. ORP
CO2 PH

Calcifying Organisms
(shells / bones)
MAGNESIUM
CALCIUM
Mg:Ca Ratio

Diatoms & Plankton
SILICA

Nutrient Levels
AMMONIA
NITRATE
PHOSPHATE

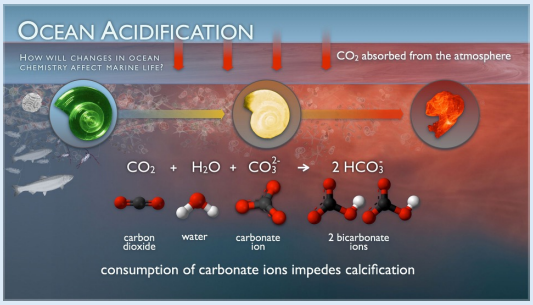
The purpose of marine ecosystem monitoring at Third Beach is associated with the health of calcifying & plankton organisms,..... and nutrient levels, as they relate to oxygen concentration in the Sakonnet River.

Ocean Acidification Monitoring

3RD Beach, Middletown RI

Seawater Parameters to be Monitored at or near Solar Noon

Water Temperature
Dissolved Oxygen
pH
Alkalinity
ORP
Salinity
Ammonia
Nitrate
Phosphate
Magnesium
Calcium
Mg : Ca Ratio

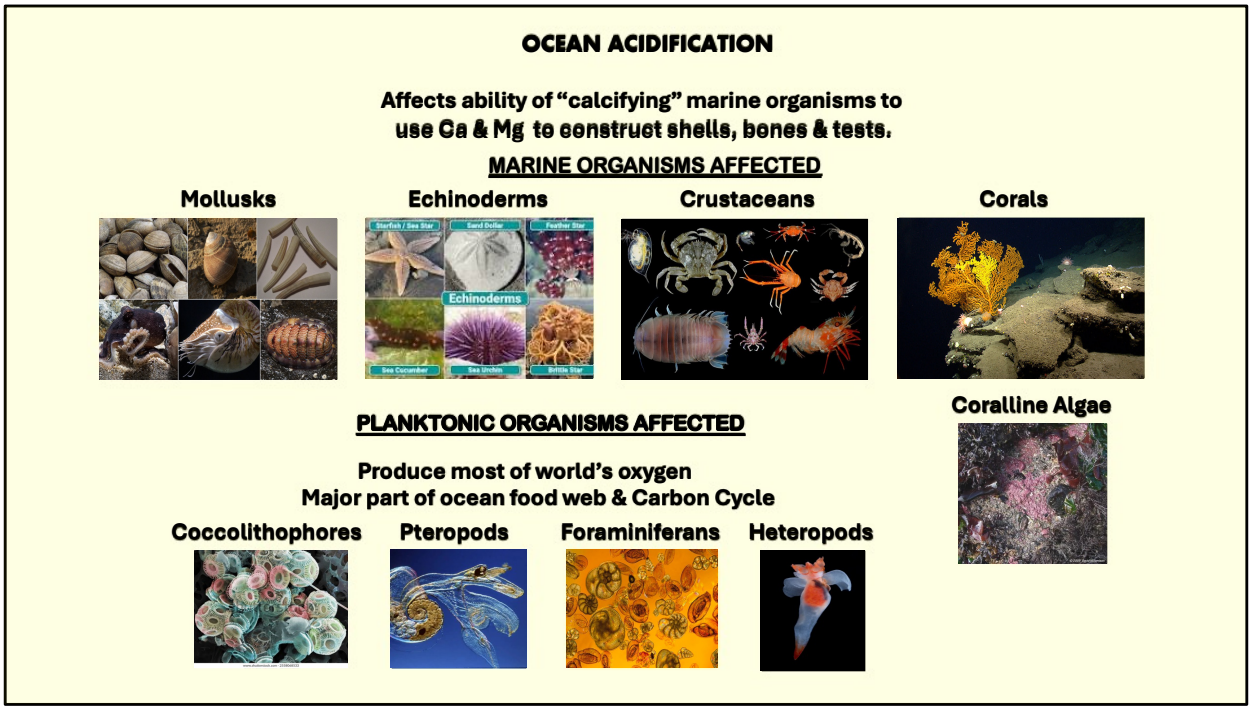


Key factors related to the ability of the water to maintain pH levels important to the ecological health of marine organisms.... & their ability to manufacture bones, shells, sponge & coral material.

PH, ALKALINITY, MAGNESIUM & CALCIUM are especially important to the health of certain groups of marine organisms.

Monitoring these factors is a check on the environmental issue OCEAN ACIDIFICATION.

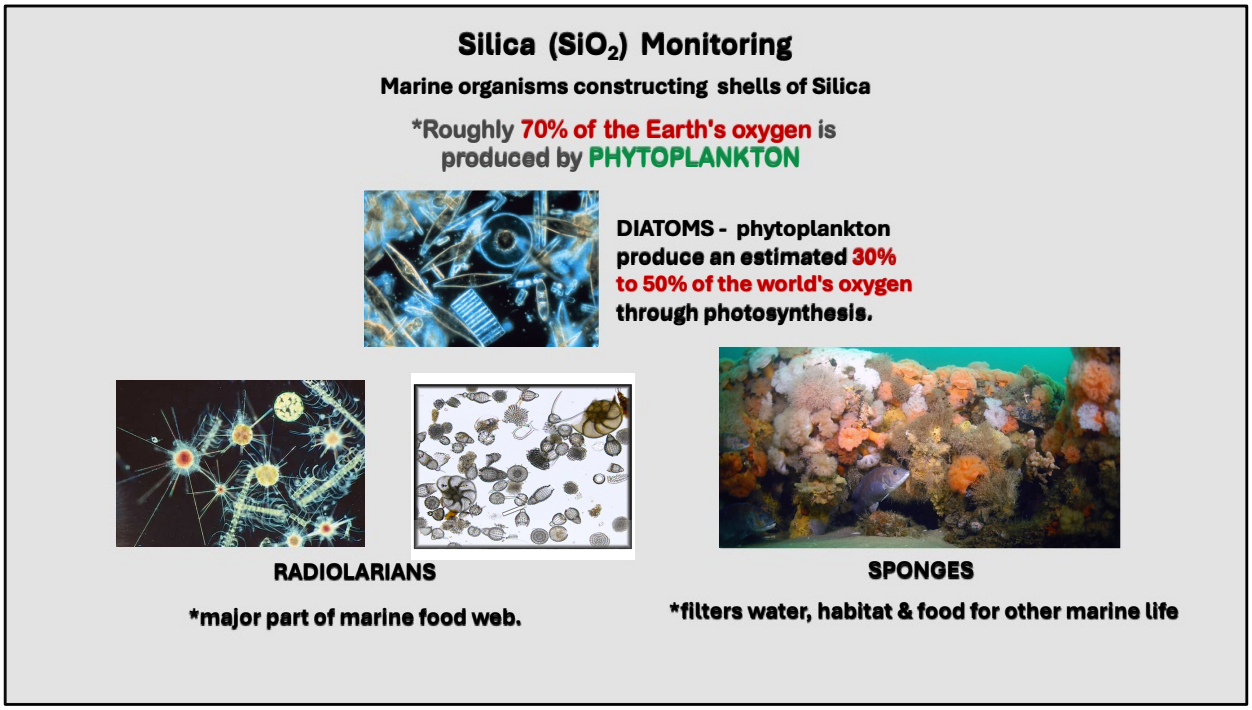
The lowering of normal pH levels, due to excess CO2 in the water, can affect the ability of these organisms to utilize Calcium & Magnesium..... by interrupting the MAGNESIUM to CALCIUM Ratio.



The types of marine organisms affected by this acidification include.....

MOLLUSKS
ECHINODERMS
CRUSTACEANS
CORALS

....& PLANKTON ....which not only produce most of the OXYGEN on Earth..... they also play a crucial role in the OCEAN FOOD WEB & the Earth's CARBON CYCLE.



Monitoring SILICA in the Sakonnet is
is important to silicon shell production for 3 other important groups of marine organisms....

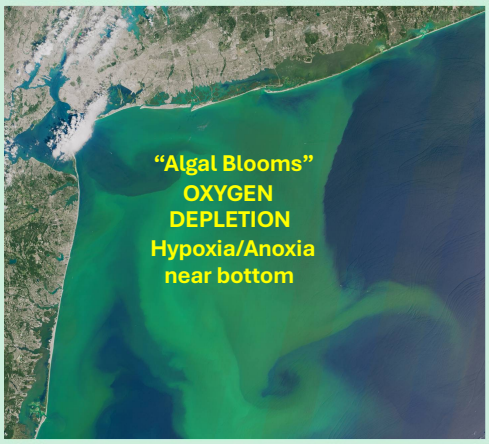
DIATOMS are responsible for most of the 70% of Earth's oxygen produced by PHYTOPLANKTON !!!

Silica is also required by RARIOLARIANS...
that are a large part of the marine food web.

SPONGES play a role in filtering seawater
.....as well as providing food & habitat for other marine life..... & they also require silica for their skeletal structures.

Nutrient Pollution ---------> Cultural Eutrophication

Agricultural / Septic Waste



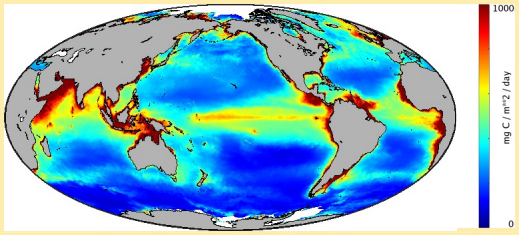
Water Temperature
Dissolved Oxygen
pH
Alkalinity
ORP
Salinity
Ammonia
Nitrate
Phosphate
Magnesium
Calcium
Mg : Ca Ratio

It's also important to monitor NITROGEN & PHOSPHORUS levels in marine ecosystems.
These essential nutrients are used by chlorophyll-bearing organisms to manufacture BIOMASS....

....Along coastal areas during the warm seasons, high concentrations of these nutrients may result in high populations of algae & phytoplankton. When these organisms die, decomposers deplete the oxygen..... resulting in oxygen "dead zones" near the bottom of the water column, which is the habitat of shellfish & other marine life.

Other Parameters monitored at 3rd Beach:

Water Temperature
Dissolved Oxygen
pH
Alkalinity
ORP
Salinity
Ammonia
Nitrate
Phosphate
Magnesium
Calcium
Mg : Ca Ratio



PRIMARY PRODUCTIVITY

BIOCHEMICAL PROCESSES

Photosynthesis **Respiration** **Biomass Synthesis** **Decomposition**

CHEMICAL& PHYSICAL ACTIVITY IN SEAWATER

Temperature, Dissolved Oxygen, ORP (Oxidation Reduction Potential), & Salinity will also be monitored at 3RD Beach.

All of these factors are important to maintaining primary productivity in the Sakonnet River, & in the Earth's marine environment & atmosphere.

Marine Environment Parameters

The complex interactions between marine life & their saltwater environment..... have evolved during the past 4.0 billion years since the origin of the oceans.

[READ WORDS ON SLIDE]