What The HABs is Going On?

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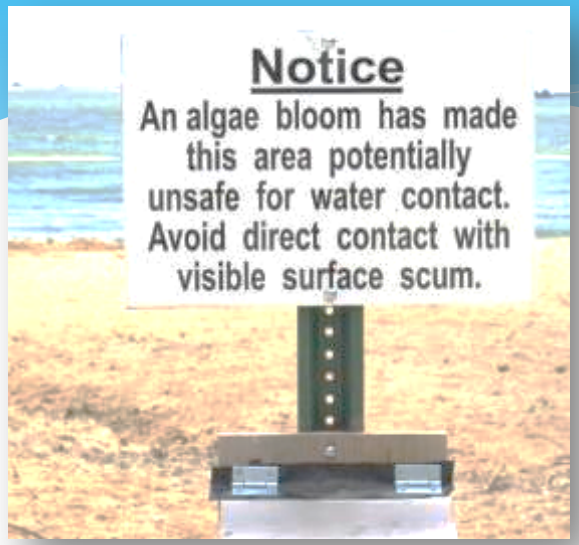
Thanks To

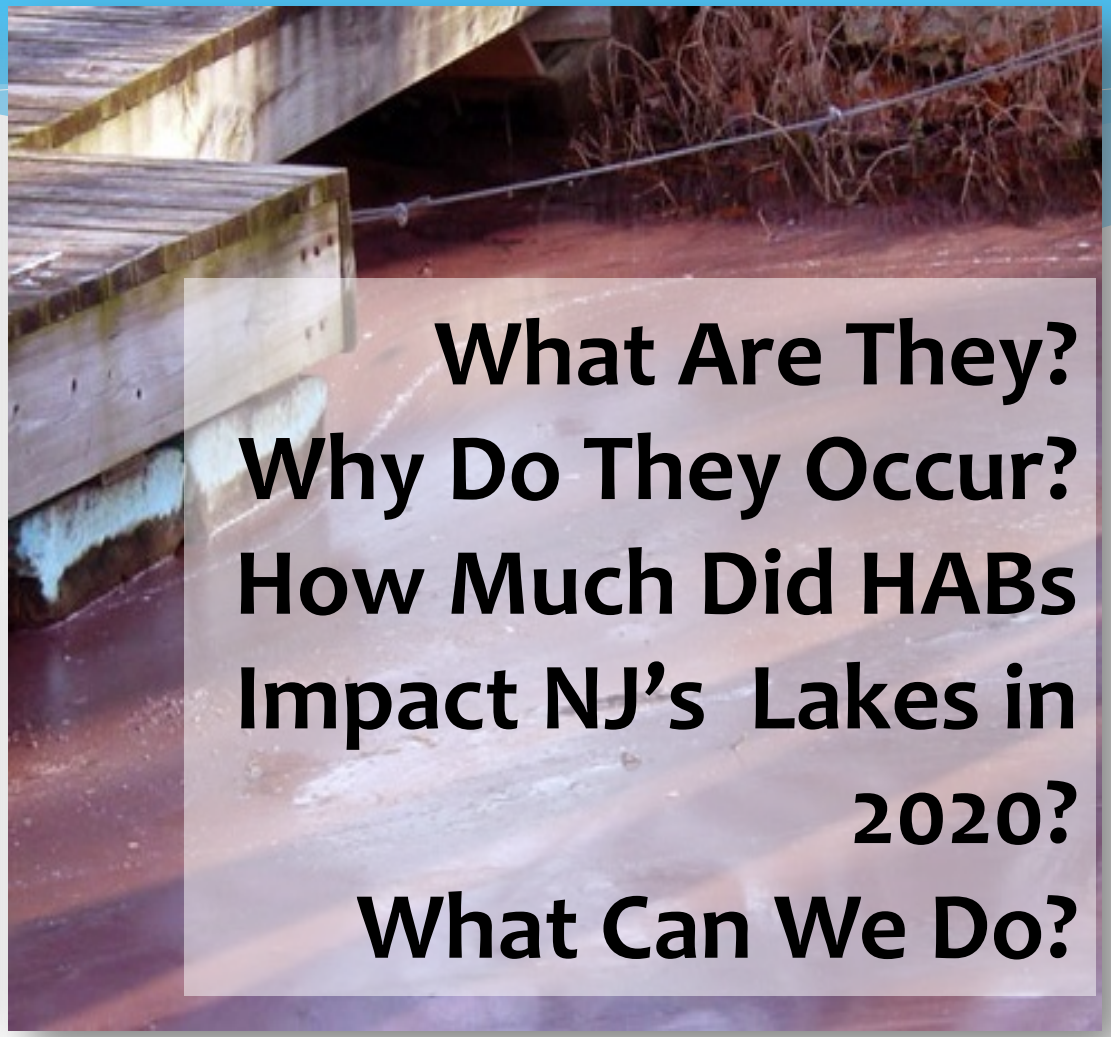
NEW JERSEY HIGHLANDS COALITION

NW NJ | Rivers CONFERENCE

CWC

What We Will Be Covering





What's A HAB

Harmful Algae Blooms

- Impact the recreational use, ecology and water quality of lakes.
- Intense cyanobacteria (bluegreen algae) blooms that generate very high concentrations of cyanotoxins.
- High concentrations of cyanotoxins can impact the health of humans, pets, and livestock.

Tell me More About Cyanobacteria!

- They are prokaryotes…not eukaryotes (such as algae)…lack membrane encased organelles or mitochondria.
- However, they can photosynthesize.
- Thus share properties of both bacteria and algae.

What Makes Them So Unique?

- Many can assimilate atmospheric nitrogen… providing an unlimited source of N.
- Biologically adept at assimilating organic phosphorus, better than "good algae".
- Many can regulate positon in water column.
- Many do well in low light conditions.
- Selectively rejected as food source by filter feeders and zooplankton.
- Some produce cyanotoxins.

Cyanotoxins

- Not produced to directly harm humans, pets and livestock.
- Cyanotoxins create a competitive advantage over “good algae”.
- Some toxins “ooze” out of healthy cyanobacteria.
- But large amounts are released when cyanobacteria die.
- Once released, relatively stable and slow to biodegrade.

The “Bad Guys”

- Microcystis
- Planktothrix
- Anabaena
- Aphanizomenon
- Anacapsa
- Lyngbya
- Gloeotrichia

Tell Me More About Cyanotoxins!

- Different types of cyanotoxins
  - Microcystin-LR
  - Cylindrospermopsin
  - Anatoxin -a
  - Saxitoxins
  - Anatoxin-a(S)

These forms of greatest interest and concern in freshwater ecosystems (including reservoirs)

One of 60 + congeners

Tell Me More About Cyanotoxins!

- Cyanotoxins released into environment by both living and dead cyanobacteria.
- Major water quality problems typically occur upon the death of the bluegreens when large amounts of toxins rapidly released into the environment.
- Once in the environment, extremely stable, and decompose slowly.

Exposure to Cyanotoxins

- Drinking or contact recreational activities, dogs licking their fur (indirect ingestion).
- Even at low concentrations, recreational contact may cause skin rashes (even for dogs and livestock), ear/throat infections and gastrointestinal distress.
- Increased attention being given to possible links between cyanotoxins and neurodegenerative diseases (Parkinson's, ALS, and Alzheimer's).

They Will Make You Sick!!

Cyanotoxin	Health Effects in Humans	Cyanobacteria that can produce the toxin
Microcystin-LR	Abdominal pain, headache, sore throat, nausea and vomiting, dry cough, diarrhea, blistering around the mouth, pneumonia, liver toxicity.	*Microcystis*, *Anabaena*, *Nodularia*, *Planktothrix*, *Fischerella*, *Nostoc*, *Oscillatoria*, and *Gloeotrichia*
Cylindrospermopsin	Fever, headache, vomiting, bloody diarrhea, liver and kidney toxicity	*Cylindrospermopsis raciborskii*, *Aphanizomenon flos-aquae*, *Aphanizomenon gracile*, *Aphanizomenon ovalisporum*, *Umezakia natans*, *Anabaena bergii*, *Anabaena lapponica*, *Anabaena planctonica*, *Lyngbya wollei*, *Rhaphidiopsis curvata*, and *Rhaphidiopsis mediterranea*
Anatoxin-a group	Tingling, burning, numbness, drowsiness, incoherent speech, salivation, respiratory paralysis leading to death, neurotoxin.	*Chrysosporum (Aphanizomenon) ovalisporum*, *Cuspidothrix*, *Cylindrospermopsis*, *Cylindrospermum*, *Dolichospermum*, *Microcystis*, *Oscillatoria*, *Planktothrix*, *Phormidium*, *Anabaena flos-aquae*, *A. lemmermannii Raphidiopsis mediterranea* (strain of *Cylindrospermopsis raciborskii*), *Tychonema* and *Woronichinia*

https://www.state.nj.us/dep/wms/bfbm/download/TechnicalFactSheet.pdf

How Does NJDEP Define A HAB?

- Cyanobacteria cell count (cells/ml)
- Concentration of toxin
- More information - https://www.nj.gov/dep/hab/

NJDEP's Toxin Guidance

- Microcystin (total including –LR) - 3 µg/L
- Cylindrospermopsin - 8 µg/L

As per DEP –

"These concentrations are intended to be protective during short-term exposures, such as multiple days of swimming during the swimming season, for the more sensitive sub-population of children".

"The values are probably highly conservative (i.e., protective) for the degree of exposure most likely to occur."

Five Tier Action Protocol

- **Watch** – Visual evidence of possible HAB **or** 20,000-40,000 cells/ml **and** toxins levels below
- **Alert** - 40,000-80,000 cells/ml **and** toxin levels **below** thresholds
- **Advisory** – Moderate Risk; > 80,000 cells/ml or toxins levels **above** thresholds (microcystin > 3 µg/L)
- **Warning** – High Risk; elevated toxins (microcystin 20-20,000 µg/L **and/or** evidence of expanding bloom
- **Danger** – Very High Risk; elevated toxins (microcystin >20,000 µg/L **and/or** evidence of

HAB ALERT LEVEL	CRITERIA	RECOMMENDATIONS
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WATCH *Suspected or confirmed HAB with potential for allergenic and irritative health effects*	Suspected HAB based on visual assessment or screening test OR Lab confirmed cell counts between 20k – 40k cells/mL AND No known toxins above public health thresholds	Public Bathing Beaches Open (dependent upon local health authority evaluation and assessment) Waterbody Accessible: ➢ Use caution during primary contact (e.g. swimming) and secondary (e.g. non-contact boating) recreational activities Do not ingest water (people/pets/livestock) Do not consume fish
ALERT *Confirmed HAB that requires greater observation due to increasing potential for toxin production* **PUBLIC BATHING BEACHES INCREASE MONITORING**	Lab confirmed cell counts between 40k – 80k cells/mL AND No known toxins above public health threshold	**WATCH remains in effect.** **Public Bathing Beaches Open (dependent upon local health authority evaluation and assessment) and should observe and report changing bloom conditions** Waterbody Accessible: ➢ Use caution during primary contact (e.g. swimming) and secondary (e.g. non-contact boating) recreational activities Do not ingest water (people/pets/livestock) Do not consume fish
ADVISORY *Confirmed HAB with **moderate risk** of adverse health effects and increased potential for toxins above public health thresholds*	Lab testing for toxins exceeds public health thresholds OR Lab confirmed cell counts above 80K cells/mL OR Field measurement evidence indicating HAB present and above guidance thresholds (e.g. phycocyanin readings)	Public Bathing Beaches Closed Waterbody Remains Accessible: ➢ Avoid primary contact recreation (e.g. swimming) ➢ Use caution for secondary contact recreation (e.g. boating without water contact) Do not ingest water (people/pets/livestock) Do not consume fish
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DANGER *Confirmed HAB with **very high risk** of adverse health effects due to very high toxin levels*	Toxin (microcystin) > 2000 µg/l AND/OR Additional evidence, including, expanding bloom, increasing toxin levels (i.e. duration, spatial extent or negative human or animal health impacts) indicates that additional recommendations are warranted	Closure of Public Bathing Beaches Possible closure of all or portions of waterbody and possible restrictions access to shoreline. Avoid primary contact recreation (e.g. swimming) May recommend against secondary contact recreation with additional evidence Do not ingest water (people/pets/livestock) Do not consume fish

Why Do HABs Occur?

This Is Nothing New

- Cyanobacteria blooms are not a new phenomena, been occurring for millennia.
- But public becoming better educated and more aware of the WQ problems and health risks they pose.

"Typical" Conditions That "Usually" Trigger A Bloom

- Excessive phosphorus loading...may originate from internal and/or external sources.
- High in-lake phosphorus concentrations.
- Warm water temperatures.
- Plenty of sunlight for photosynthesis.
- Relatively stable water column.

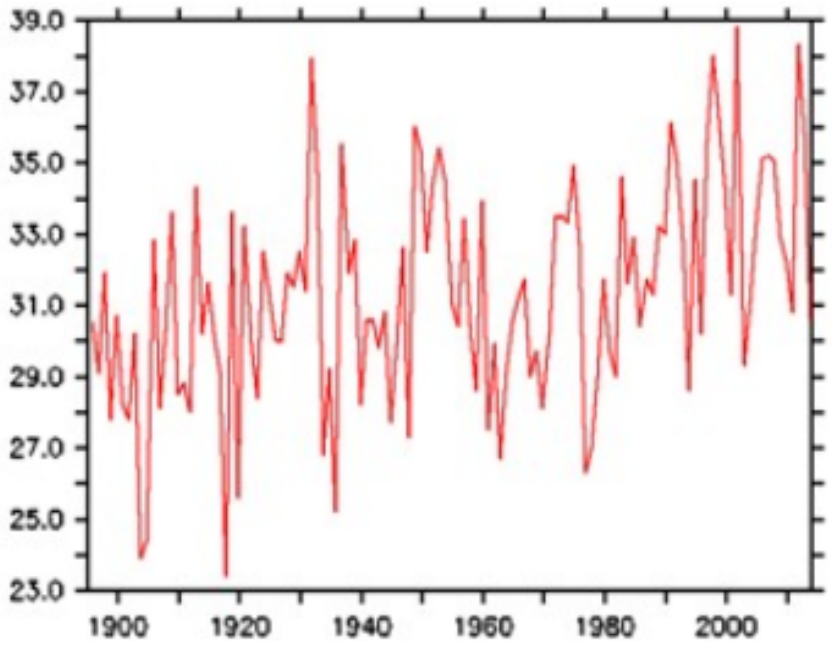
Not As Simple As It Sounds

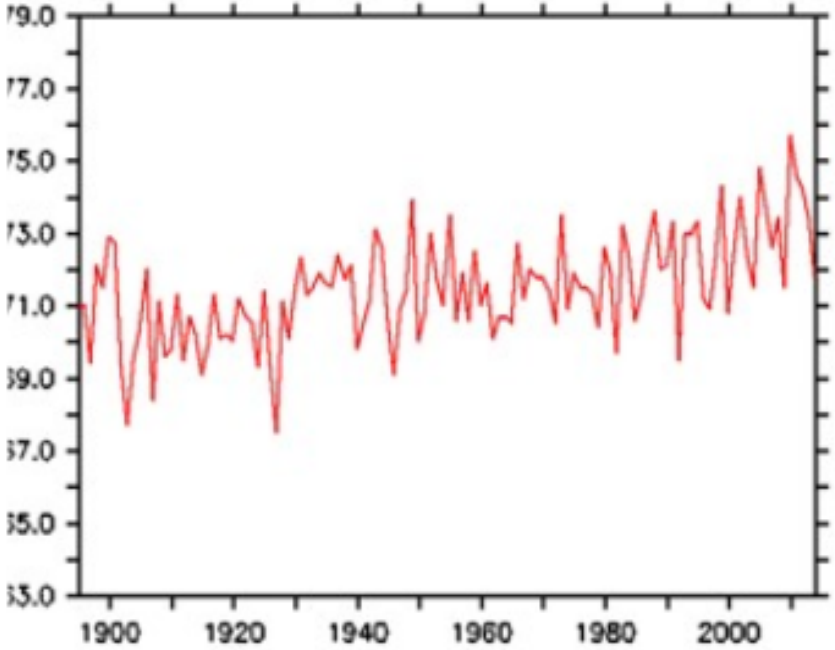
- "Typical conditions" don't always lead to bloom...and blooms/ high cyanotoxin levels may occur under sub-optimal environmental conditions.
- Not all cyanobacteria cause HABs.
- Not all cyanobacteria produce cyanotoxins.
- Cyanotoxin producers may not always produce cyanotoxins even during bloom conditions.

Is There a Link to Climate Change?

- Frequency, intensity and duration shows links of more HABs to climate change.
- Warmer winters, earlier ice out and earlier onset of “growing season”.
- More Phos loading due to increased intensity and frequency of storms.
- Warmer summers increase opportunity for thermal stratification and DO depletion leading to more internal P loading.

Trends In NJ
Winter and Summer Temperatures

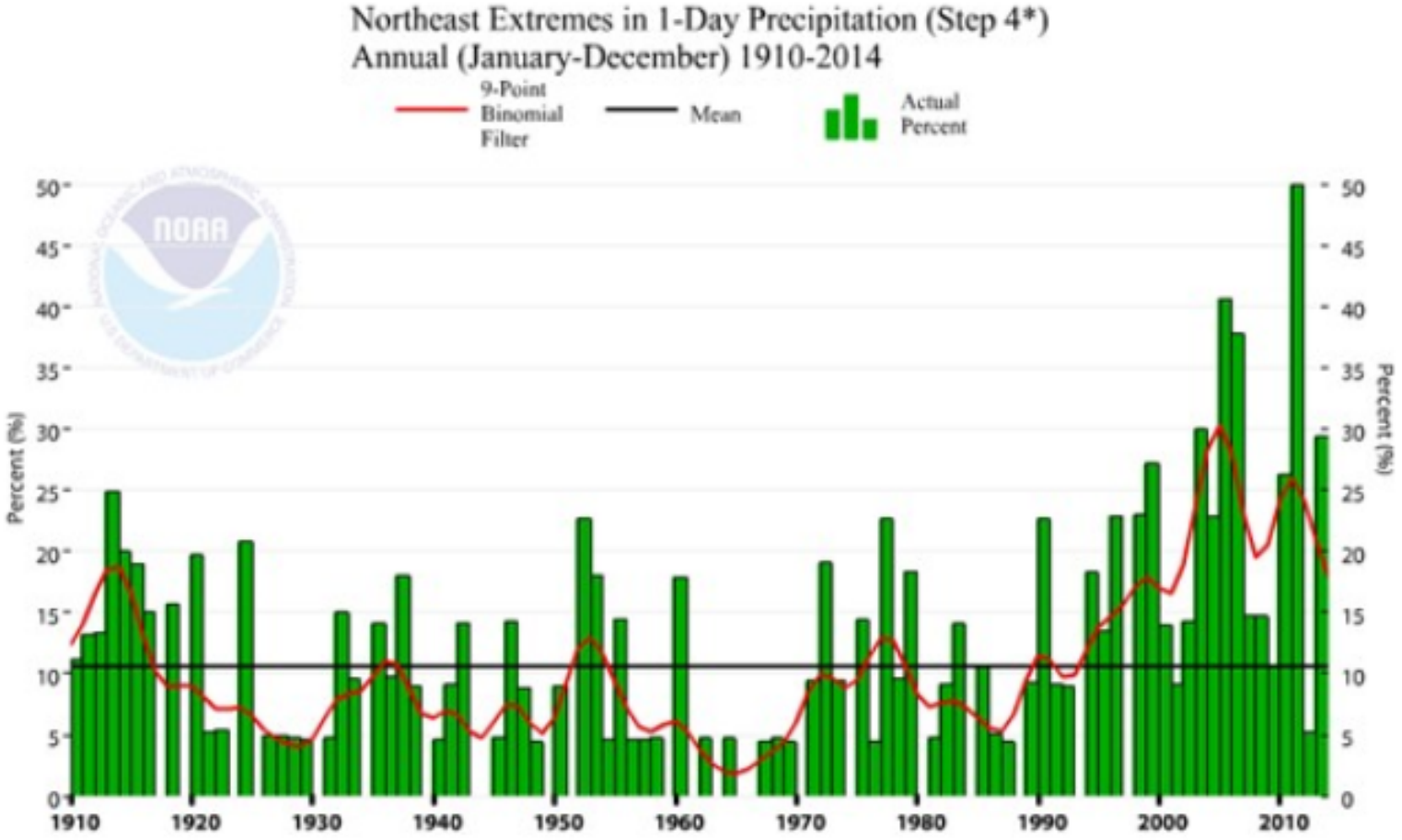




- Larger warming trend in winter (3.7°F/100 yrs) than in summer (2.4°F/100 yrs)
- Year-to-year temperature variability is much larger in winter, which can mask long-term trends
- The three warmest summers have occurred since 2005

Source - Dr. Anthony Broccoli

Fraction of Precipitation Falling in Extreme 1-Day Precipitation Events



Source - Dr. Anthony Broccoli/National Climatic Data Center

The Common Denominator

- Excessive phosphorus loading.
- More phosphorus leads to more productivity; the production of organic carbon.
- For lakes, this means more algae…including cyanobacteria.

Ok, but how much is "excessive"?

Phosphorus – The Primary Driver of Eutrophication

- For the lakes, ponds and reservoirs of NJ, phosphorus is typically the "limiting nutrient" or "nutrient of concern".
- Add more phosphorus...get more productivity.
- Only need a little phosphorus to stimulate "too much" productivity...0.04 mg/L
- 1lb phosphorus can create 1,000 lbs of algae!

Eutrophic Lake - “A”

Not Too Bad

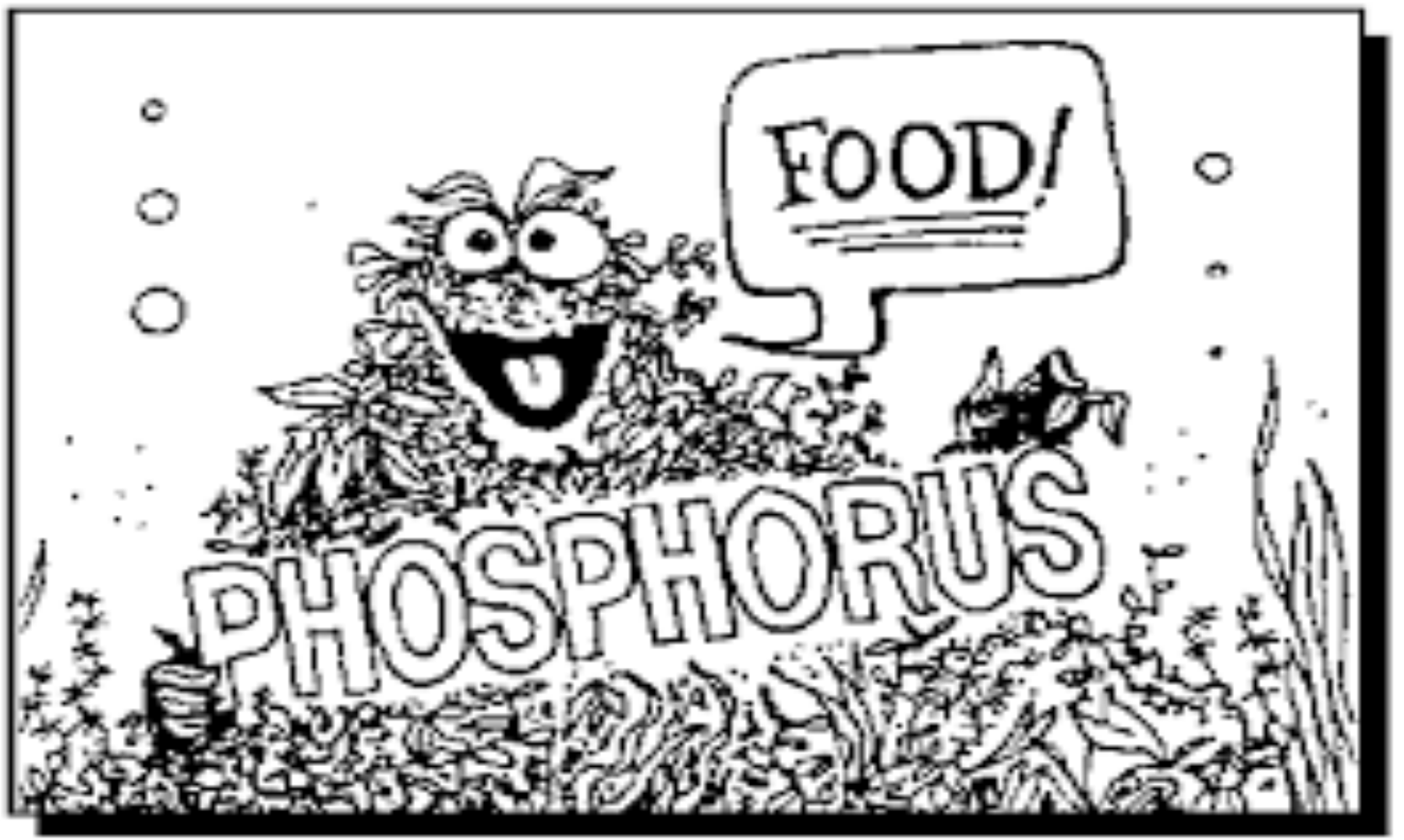
Eutrophic Lake - “B”

Not Too Good

Controlling HABs


Don't Just Treat or React to The Symptom....
Identify and Correct the Cause

If Phosphorus Is The Problem…Where Is It Coming From?



Eutrophic Lakes Are Not Dead Lakes

Rather They Are Lakes That Needs to Go On a Phosphorus Diet

The bad news…most of NJ's lakes are eutrophic and most are susceptible to a HAB

A Lake is a Lake is a Lake… Well, NO…That's Not The Case

- Although phosphorus loading and availability may be the driver of eutrophication, a number of other factors work in concert to determine if a HAB will occur.
- Lakes are complex living "organisms" with their water quality defined by various internal biological, physical, chemical and hydrologic interactions.
- Understanding these interactions not only provide insight relative to HAB development, but can be used to control eutrophication and prevent a HAB.

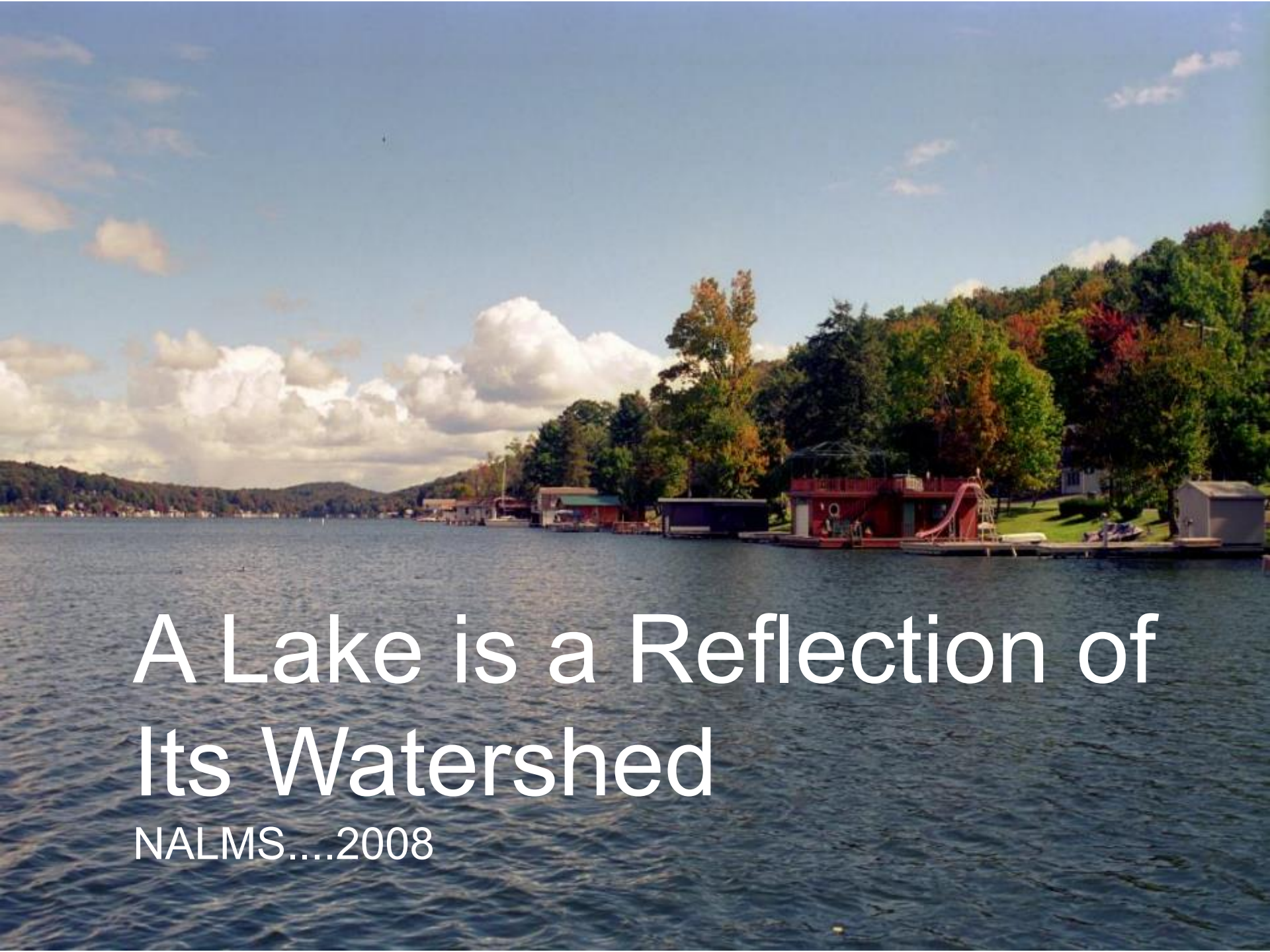
Phosphorus Sources

Phosphorus inputs vary seasonally and may originate from both internal and external sources.

- In-lake (internal)
  - Sediment release and recycling
  - Decomposition of organic material (algae, weeds, fish, etc.)
- External (watershed)
  - Stormwater runoff (direct and indirect)
  - Septic systems and wastewater
  - Rainfall
  - Waterfowl

Stormwater Runoff

- For the majority (80%) of lakes, stormwater management is fundamental to controlling HABs
- Addresses main source of phosphorus loading and root cause of most eutrophication problems and HABs.



A Lake is a Reflection of Its Watershed

NALMS....2008

You Wouldn't Build A House Without A Plan

Controlling Eutrophication and HABs

- Identify what's causing the lake's eutrophication and/or HAB.
- Examine the lake's biological, chemical, hydrologic and physical interactions...all of which affect HAB development.
- Accurately identify and quantify sources and timing of phosphorus loading.
- Use data to direct and prioritize management efforts.

HAB Management Plan

- **Root Cause, Watershed Management Action Measures -** Actions to decrease phosphorus loading and prevent HAB.
- **Proactive and In-Lake Measures -** Actions to prevent HAB or its lessen severity or duration.
- **Reactive Management Measures -** Actions taken if a HAB occurs.

Root Cause Strategies

- Source Control: Preventative Management
  - No-P Fertilizer
  - Septic management
  - Alternative lawn cover / Shoreline buffers
  - Waterfowl, pet waste, yard waste controls
- Delivery Control: Responsive Management
  - Stormwater Mgmt – Single lot to regional BMPs
- In-Lake Control: Reactive/Corrective Management
  - Aeration
  - Nutrient Inactivation
  - Other proven techniques

The Stormwater Connection

- Directly affects the amount and timing of phosphorus loading.
- Indirectly affects lake's thermal properties, water column stability and mixing dynamics.
- Source of legacy loads tied to internal loading.
- Indirectly affects septic loading due to effect on groundwater elevation.
- **Successful lake management and HAB prevention/ control must involve systematic stormwater management that emphasizes phosphorus load reduction.**

Turn Down The Volume!!!

- Green infrastructure reduces the volume of runoff leaving a site.
- Results in lower flow rates, lower runoff quantities, and less pollutants discharged offsite.
- Less nutrient loading = Less HABs

"Stormwater is A Resource Not a Waste"

Rather than trying to "get rid" of stormwater as quickly as possible; treat it as a valuable resource…embrace and contain it on site

- Retain
- Reuse
- Recharge
- Preserve existing hydrology and hydrologic properties of site

"Sweat The Big Storms… But Control The Small Storms"

- Majority of chronic stormwater problems (eutrophication, localized flooding, erosion) more a function of the smaller, commonly re-occurring events than the large extreme events.
- By fully managing all the runoff produced by 1-year event (2.75" /24), can effectively decrease 93% of stormwater impacts.
- "Think small to achieve big results"… design for ≤1-year storm and first-flush of larger storms.

CWC

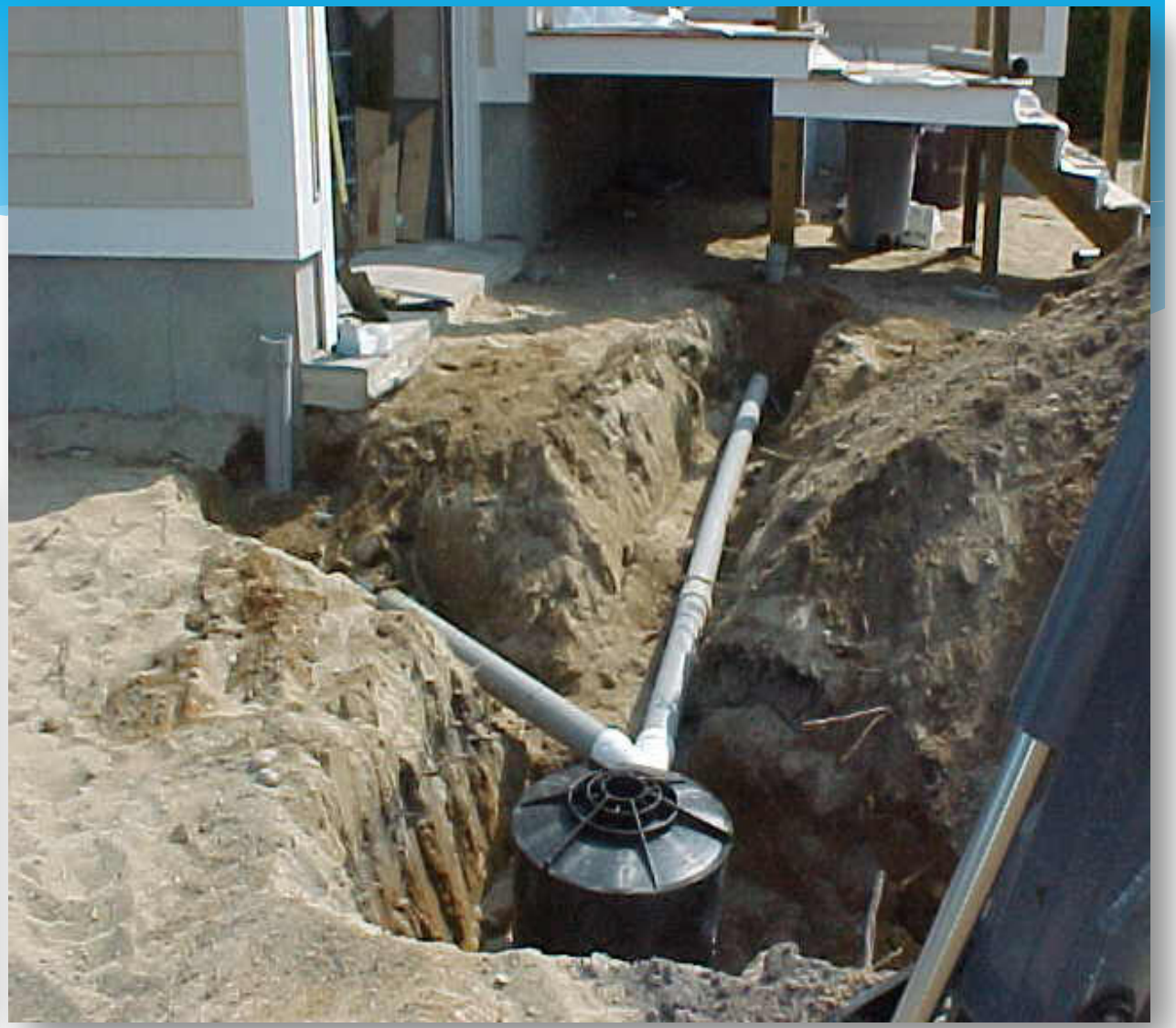
1-year storm also referred to as "water quality storm"

Single Lot Solutions

Single-Lot, "Pocket" BMPs

Harvesting Rain Water

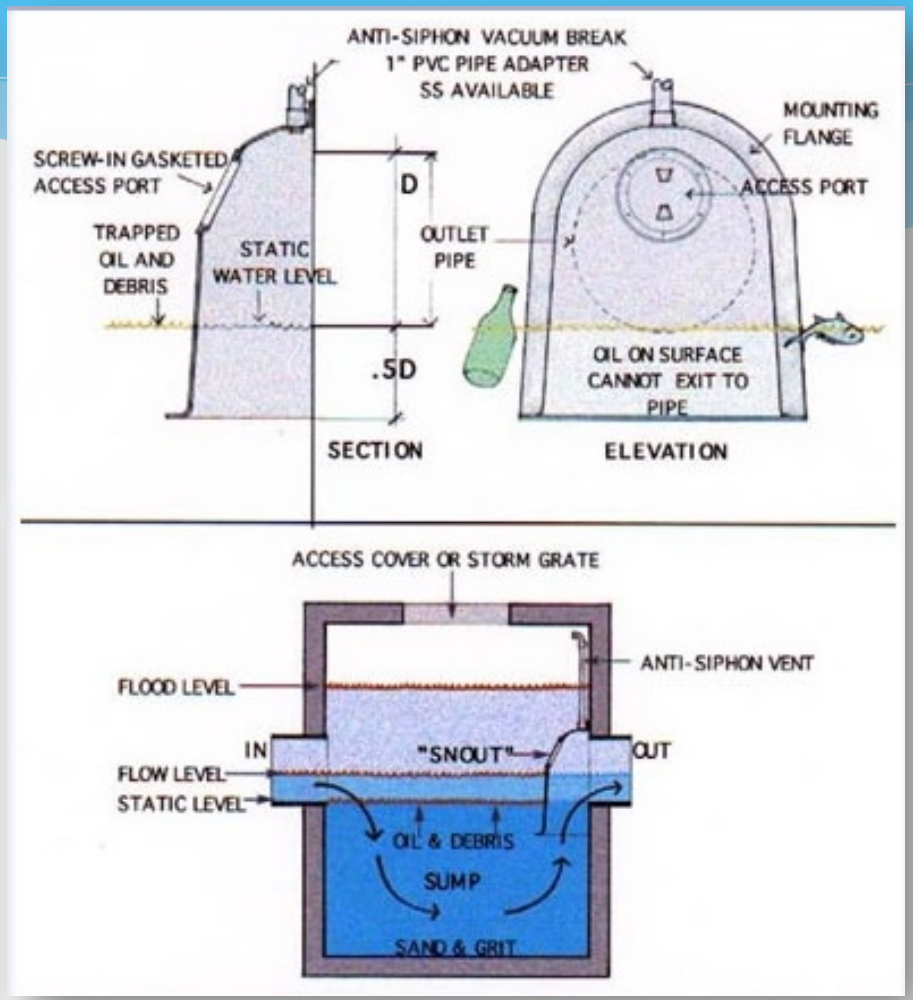
Drywells



Rain Gardens

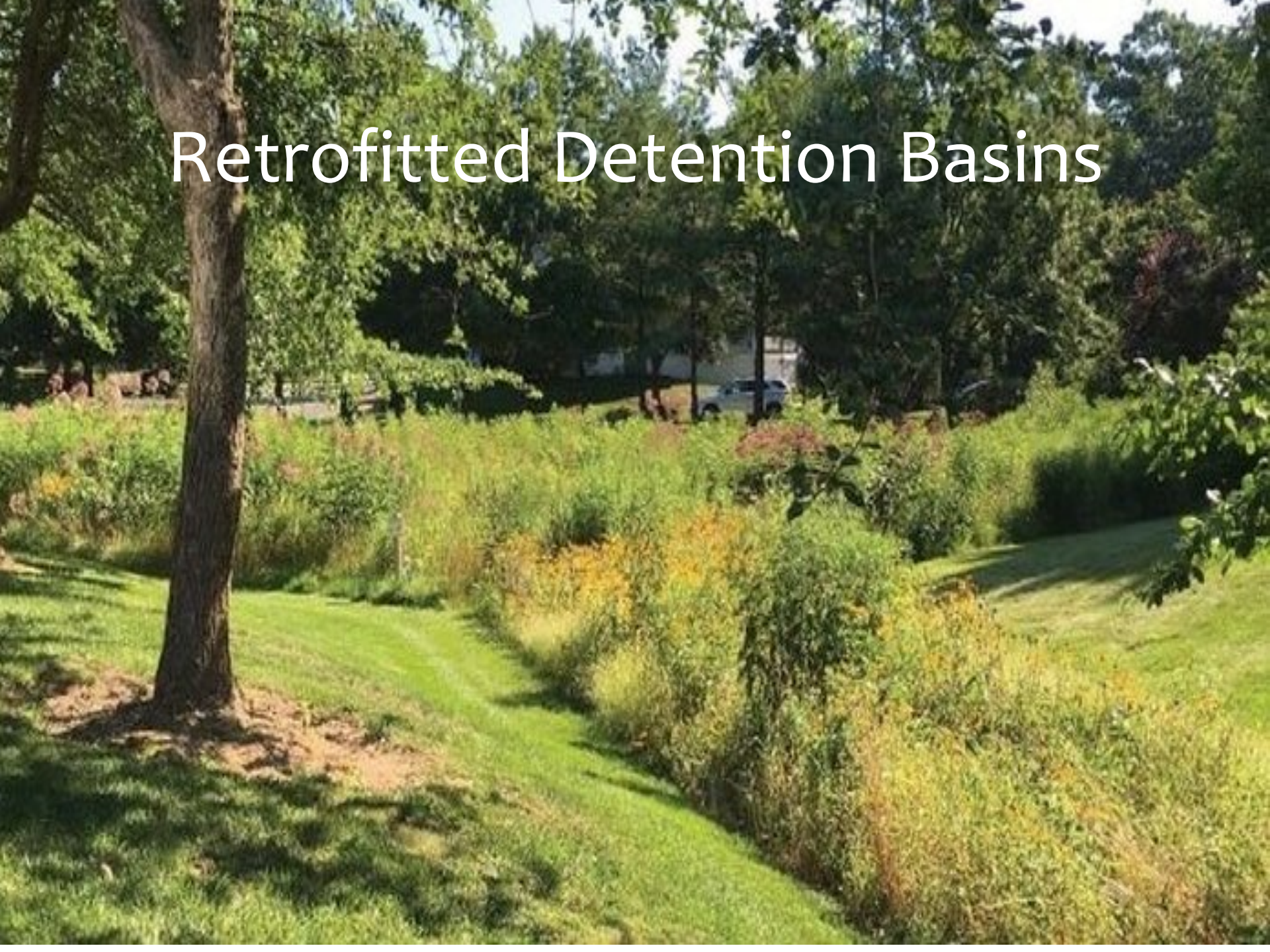

Community Solutions

Catch Basin Retrofit

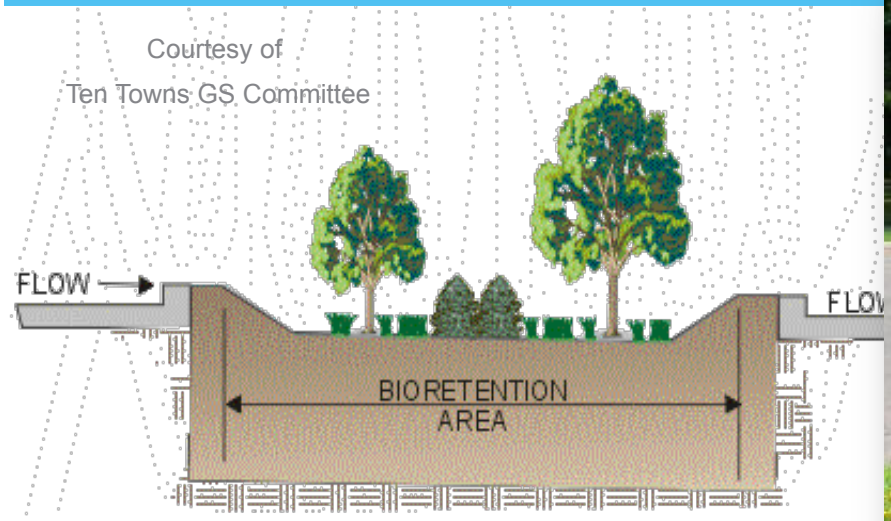


Curb-Side Bio-Retention

Retrofitted Detention Basins



Bioretention Parking Lot Swale



Bioretention Application in a Non-Residential Setting

Greenwood Lake Commission Green/Gray Infrastructure Retrofit

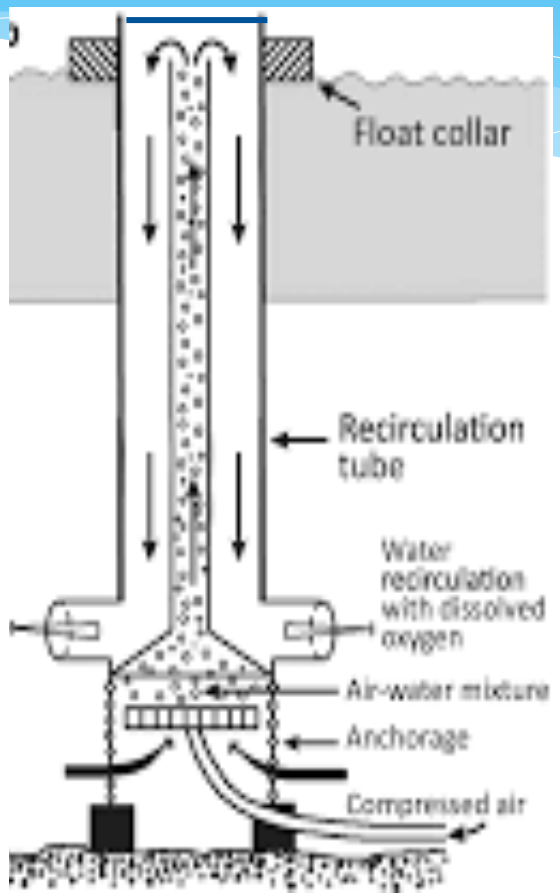
In-Lake Proactive Controls

- Aeration
- Alum and other nutrient inactivants
- Biomanipulation
- Selective water release
- Floating wetland islands
- Sonic devices

The applicability and success of these strategies requires a comprehensive understanding of the interactions that define your lake and what triggers a HAB

Aeration / Circulation

Destratification



Pure Oxygen

Hypolimnetic and Layer Air™


Nutrient Inactivation
Alum
Polyaluminum Chloride (PAC)
PhosLock™

In-Lake Reactive Actions

Things to do if a bloom occurs to lessen its intensity, duration, ecological impacts and socio-economic impacts:

- Careful use of copper sulfate
- Oxidizing agents (non-copper algaecides)
- Filtration

Why Not Just Bomb Bloom With Copper Sulfate?

The Paradox of Copper Sulfate Treatments

- Copper based algaecide treatments can be part of a HAB management strategy.
- But should not be the "go to" solution.
- Reliance on $CuSO_4$ only creates an environment that much more conducive for more cyanobacteria growth...blooms returns often that much more intense.

The Paradox of Copper Sulfate Treatments

- May temporarily relieve bloom conditions but can actually exacerbate problem.
- Largescale algaecide treatments lead to the rapid release of large amounts of cyanotoxins and organic phosphorus.
- Treatments also kill off “good algae” and zooplankton, rapid die off can depress oxygen levels leading to a fish kill.

Voodoo Science

- There is no magic or "one size fits all" remedy
- Nutrient management is key to preventing HABs
- Understand cause/effect
- Use data to guide management decisions
- Avoid easy fixes and fixes lacking scientifically corroborated data

How Did NJ Lake's Do This Year?

2019 - The "Perfect Storm" or The "New Normal"

- In 2019, warm winter, early ice out set stage for early start of "growing season".
- Exceptionally wet winter / spring resulted in a large amount of phosphorus loading at onset of growing season.
- Saturated soils increased septic loading and decreased runoff retention and infiltration.
- Intermittent/extreme rainfall in July resulted in more phosphorus loading and warm water temps promoted cyanobacteria growth and HAB formation.

Rainfall/Temps 2019 vs. 2020

- Spring - July 2019 one of warmest and wettest on record…
  - Warmer temps = earlier growing season
  - More rainfall = more loading
  - More rainfall = saturated soils, impacts septic system functionality
- Spring 2020 – July 2020 much drier compared to 2019
  - Jan – June monthly rainfall 0.5”-1.5” below average
  - Less rainfall = less loading
  - Drier spring = unsaturated soils, septic system function better and more infiltration of runoff.

Thank You NJDEP

- In spring of 2020 NJDEP launched multi-tier approach to evaluating a HAB
- Quantitative – based on escalating cell counts and cyanotoxin threshold concentrations
- Improved ability to objectively gauge severity of a HAB and associated health risks

HAB ALERT LEVEL	CRITERIA	RECOMMENDATIONS
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Five Tier Action Protocol

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- **Danger** – Very High Risk; elevated toxins (microcystin >20,000 µg/L **and/or** evidence of expanding bloom

Even though NJDEP definitions of a HAB among strictness, their 2020 Action Protocol prevented unnecessary lake closures while at same time protecting health of lake users.

In Summary

In Summary….HABs

- HABs are not a new thing.
- But…frequency and severity of HABs is increasing.
- At very high densities, cyanobacteria negatively affect health of humans, pets and livestock.

In Summary….HABs

- NJ's lakes are phosphorus rich and therefore susceptible to HABs...Key to preventing HABs is reduce the amount of phosphorus loading.
- For most NJ lakes, the majority of the annual phosphorus load (direct and indirect) is the result of stormwater runoff.

In Summary….HABs

- Proper stormwater management is key to controlling lake eutrophication and preventing HABs.
- Green infrastructure especially effective in decreasing volume and rate of runoff, and pollutant (phosphorus) load.
- GI SW Management can be implemented at lot-specific, local and regional scales.

Our Goal

For More Information on HABs

- NJDEP -

https://www.state.nj.us/dep/wms/HABS.html

https://www.state.nj.us/dep/wms/bfbm/download/NJHABResponseStrategy.pdf

- NALMS.org

https://www.nalms.org/home/nalms-inland-hab-program/

- NYSDEC –

https://www.dec.ny.gov/chemical/77118.html

https://www.dec.ny.gov/docs/water_pdf/habsbrochure.pdf

For More Information on HABs

EPA and Others…

- https://www.epa.gov/nutrientpollution/harmful-algal-blooms
- http://oceanservice.noaa.gov/hazards/hab/
- http://www.cdc.gov/nceh/hsb/hab/
- http://www2.epa.gov/nutrientpollution/harmful-algal-blooms
- https://www.health.state.mn.us/diseases/hab/hab.pdf

Thank You
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