Water Quality Monitoring and Sampling

Watershed Academy
Clemson's Baruch Institute of Coastal Ecology and Forest Science
Georgetown, SC
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Water Quality Monitoring and Sampling

- Categories and sources of water pollutants
- Water quality parameters and monitoring
- Water quality sampling and analyses
- Sampling and monitoring can be complex!

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Categories of Water Pollution

- Organic Matter
- Nutrients
- Pathogens
- Sediment
- Toxic Contaminants
- Debris
- Thermal Stress

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Types of Pollutants

➔ **Organic Matter**

Nutrients
Pathogens
Sediment
Toxic Contaminants
Debris
Thermal Stress

Sources: yard waste, food waste, animal waste, septic systems, wastewater

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Types of Pollutants

Organic Matter

➔ **Nutrients**

Pathogens
Sediment
Toxic Contaminants
Debris
Thermal Stress

Sources: fertilizers, septic systems, animal waste, wastewater

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Types of Pollutants

Organic Matter
Nutrients

➔ **Pathogens**

Sediment
Toxic Contaminants
Debris
Thermal Stress

Sources: septic systems, animal and pet waste, wastewater

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Types of Pollutants

Organic Matter
Nutrients
Pathogens
➔ **Sediment**
Toxic Contaminants
Debris
Thermal Stress

Sources: construction sites, agricultural fields, timber harvesting, disturbed areas

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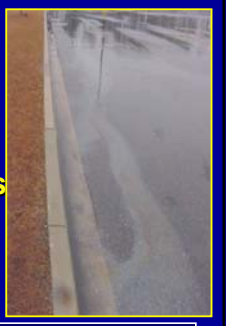
Types of Pollutants

Organic Matter
Nutrients
Pathogens
Sediment
➔ **Toxic Contaminants**
Debris
Thermal Stress



Sources: auto emissions, industrial, commercial, household and agricultural chemicals

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Types of Pollutants

Organic Matter
Nutrients
Pathogens
Sediment
Toxic Contaminants
➔ **Debris**
Thermal Stress

Sources: street litter, boating waste, organic (yard) waste

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Types of Pollutants

Organic Matter
Nutrients
Pathogens
Sediment
Toxic Contaminants
Debris
➔ **Thermal Stress**

Sources: runoff from heat-absorbing impervious surfaces, removal of natural vegetative buffers, shallow water impoundments, decreased base flow

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Impaired Waters – Section 303(d) List

- Impairments listed by EPA or state water quality regulatory agencies – standards exceedance
- Based on designated uses: recreational, aquatic life, fishing, drinking, shellfish harvesting
- Low dissolved oxygen, fecal coliforms, nutrients, metals
- Total Maximum Daily Loads (TMDLs)

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Impaired Waters – Section 303(d) List

Action to alleviate:

"Impairment will be addressed by implementing a locally developed plan that includes the remedial actions necessary for problem resolution."

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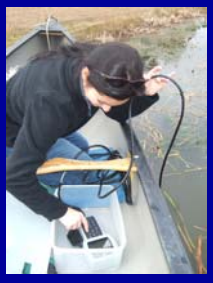
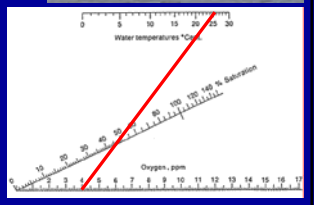
Water Quality Parameters – In situ Monitoring

- Temperature
- Dissolved oxygen
- pH
- Specific conductance
- Redox potential (ORP)
- Turbidity
- Chl A



Dissolved oxygen

- *Units* = mg/L (ppm) or percent saturation
- *Natural* versus *anthropogenic* causes
- Membrane probe or optical measurement
- Procedural considerations
- *Temperature*-dependent



Water Quality Parameters – Sampling

- Organic matter
- Solids
- Nutrients
- Fecal coliforms
- Metals
- PAHs
- Pesticides

Bottom photo credit: Bill Hunt, NCSU

Sampling

- Grab vs. automated
- Composite or sequenced
- Timed vs. event-based
- Procedural considerations
- Safety concerns

Lab Analyses

- Biochemical oxygen demand (BOD)
- Solids
- Nutrients
- Fecal coliforms
- Metals
- Polycyclic aromatic hydrocarbons (PAHs)
- Pesticides

Organic Matter

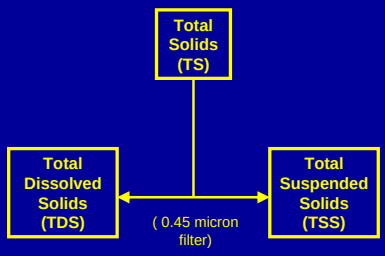
- *Sources*: many!
- Direct versus indirect measures:
- Biochemical oxygen demand (BOD) – 5-day
- Chemical oxygen demand
- Total organic carbon(TOC)

5-day BOD analysis

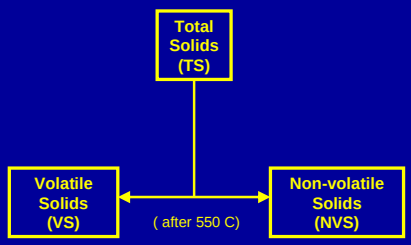
Solids

- All units = mg/L
- *Total solids (TS)* = all dry weight (> 105 C) solids per unit volume
- *Total suspended solids (TSS)* = an indicator of sediment
- *Volatile solids (VS)* = an indicator of organic solid fraction

Filterable Solids



Volatile Solids



Nutrients

- *Units* = mg/L (ppm)
- *Sources* = fertilizer, wastewater, septic
- Nitrogen and phosphorus, but also others
- Organic versus inorganic
- Various forms

Nutrients

- *Nitrogen:*

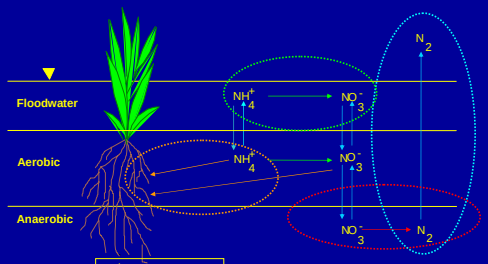
  Ammonium-Nitrogen
  Nitrate-Nitrogen
  Total Kjeldahl Nitrogen (TKN)

- *Phosphorus:*

  Orthophosphate
  Total Phosphorus (TP)

TRAACS ® 2000 for nutrient analyses

Nutrient Dynamics (Inorganic Nitrogen): Nitrification – Denitrification – Plant Uptake

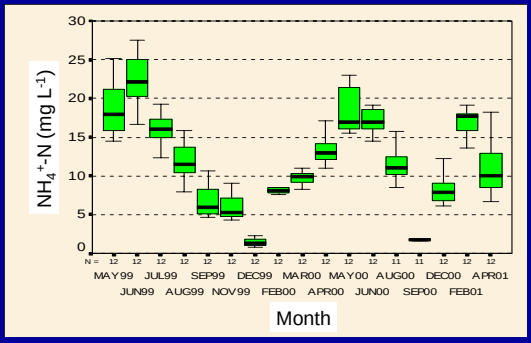


Modified from Reddy and Graetz, 1988

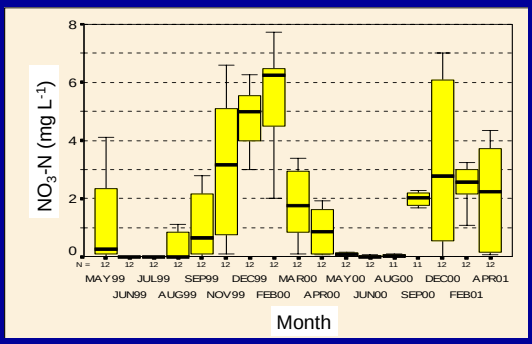
NH_4^+ = Ammonium
NO_3^- = Nitrate
N_2 = Nitrogen gas

1. Nitrification
2. Denitrification/release to air
3. Plant Uptake

Wetland Ammonium-Nitrogen Concentrations by Month

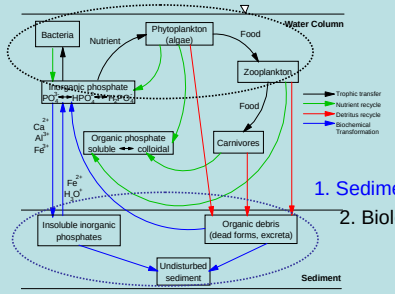


Wetland Nitrate-Nitrogen Concentrations by Month



Phosphorus Dynamics in Wetland and Aquatic Systems

(Modified from Emsley, 1980 and Vymazal, 1995)



1. Sediment adsorption
2. Biological uptake

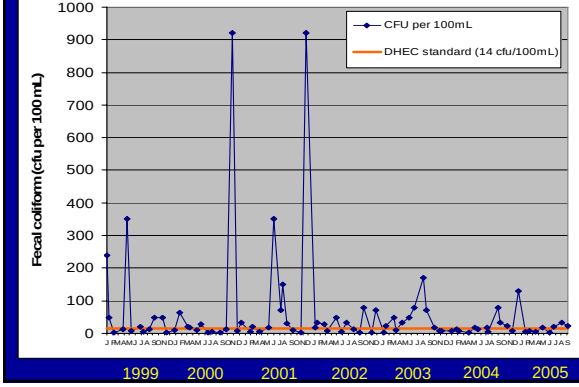
Correlation Coefficients for Nutrient Concentrations and Water Quality Parameters

	Temperature	Dissolved Oxygen	Redox Potential	Total Solids
NH_4 - N	**0.6**	**	**- 0.4**	**
NO_3 - N	**- 0.7**	**0.5**	**0.7**	**
TKN	**	**	**	**0.8**
Ortho - P	**	**	**	**0.8**
TP	**	**	**	**0.7**

Fecal coliforms

- *Units* = colony forming units (cfu) / 100 mL
- Indicator of pathogenic bacteria
- *Human* versus *pet* versus *wildlife*
- Presence/absence test
- Membrane filtration
- Idexx Quantitray™ method
- Time-sensitive sampling (< 6 hr)

Fecal coliforms (cfu per 100 mL) at Boat Basin in Debidue Creek (downstream of Debordieu Colony)



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