Environmental Management of Nutrients for Turf & Landscape

Nutrient Management Program Manager
DCR Nutrient Management Program

Environmental Management of Nutrients
Knowledge Areas

- Effects of nutrients in ground and surface waters
- Factors causing decline of Chesapeake Bay
- Hydrologic cycle
- Nutrient loss mechanisms to ground and surface waters
- Identification and management of environmentally sensitive sites
- Seasonal nutrient loss patterns
- Use of cropping systems to reduce nutrient loss

Water Resources

- Water covers 70% of earth’s surface
- Only 3% of all water is fresh water!
- Two thirds of all fresh water is locked up in glaciers and ice caps.
- Lakes, rivers, and streams contain 0.5% of all freshwater worldwide.
- 30% of all freshwater on the planet is “Groundwater”

Water Resources

- Most groundwater is too deep to be economical to reach.
- Some aquifers have been so heavily pumped that their water levels have dropped too low for people to tap as a source.
- Quantity is not the only concern, the quality is also under constant assault from a variety of sources.

Water Resources

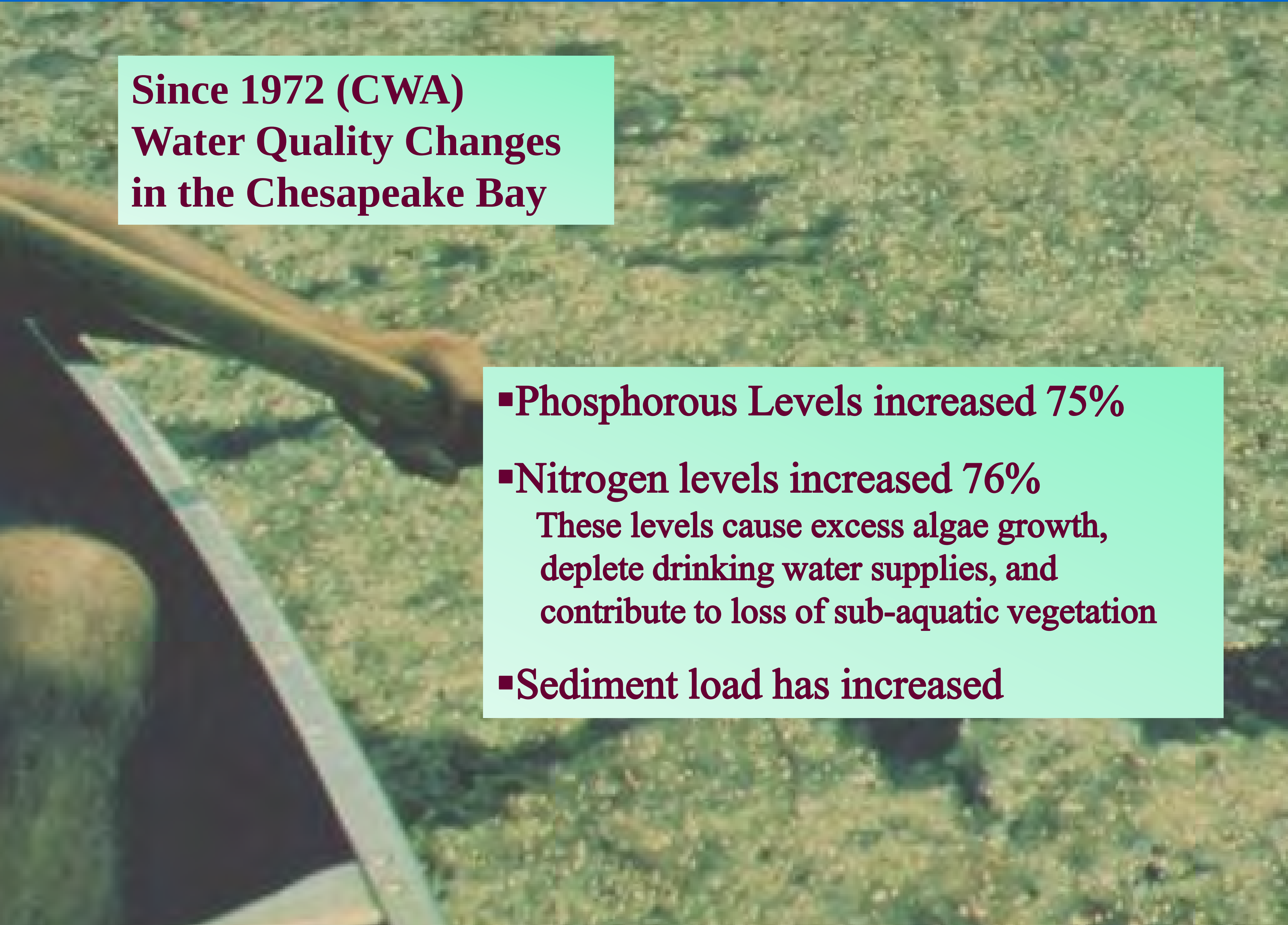
- Humans pose the biggest threat to many aquifers and to the people who drink from them.
- Nonpoint source pollution accounts for 65 to 75 % of the nation’s most polluted waters
- Cities and farms are not the only groundwater polluters, natural gas drilling, mining, military bases, and saltwater intrusion, highway road banks, and construction sites.

Scope of Nitrogen and Phosphrous Pollution

- 16,00 waters in US are impaired by nutrient related pollution. Every state effected.
  - 101,461 miles of rivers and streams
  - 2.5 million acres of lakes and reservoirs
  - 833 sq. mi. of bays and estuaries
  - 47% of all US streams have medium to high levels of P
  - 53% of all streams have high level of N
  - 78% of all coastal waters exhibit eutrophication
  - Nitrate Drinking Water Violations have doubled in 8 yrs.

Nutrient Impacts in Surface Waters

Eutrophication- an excess of nutrients which may cause ecological problems and can harm aquatic life.



Since 1972 (CWA) Water Quality Changes in the Chesapeake Bay

- Phosphorous Levels increased 75%
- Nitrogen levels increased 76%

  These levels cause excess algae growth, deplete drinking water supplies, and contribute to loss of sub-aquatic vegetation
- Sediment load has increased

Sedimentation

- Occurs when water carrying eroded soil particles slows long enough for soil particles to settle out.
- Effects water quality physically, chemically and biologically
- Destroys fish spawning beds, reduces useful storage volume in reservoirs, clogs streams, and make expensive filtration necessary for municipal water supplies.

Sediment

- Carries organic matter, animal or industrial wastes, nutrients, and chemicals.
- Most troublesome is phosphorous from fertilizers, organic matter and animal manure.
- May carry pesticides such as herbicides and insecticides that are toxic to plants & animals.
- Urban Stormwater is biggest contribution
  - 80% of US population is concentrated on 10% of the land

Household Waste Disposal

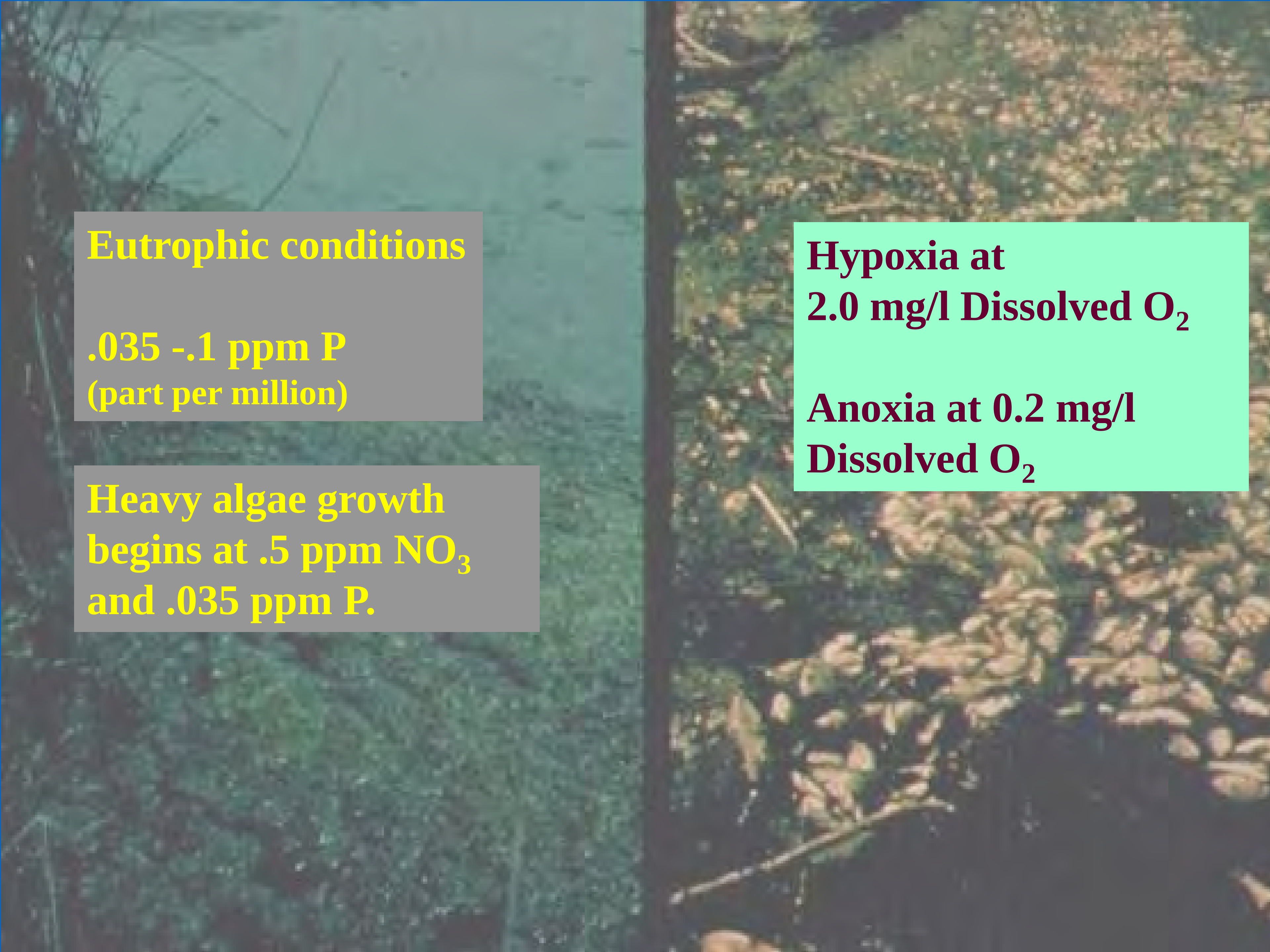
- One half of all houses in Virginia depend on septic systems (soil adsorption) for treatment and disposal of household wastes.
- Over 1 million houses in Virginia use on-site sewage systems. 25,000 new septic systems are installed each year.
- More than100 million gallons of septic effluent is discharged into the soils of Virginia each day!

Nitrogen and Phosphorus
Surface Water Concerns

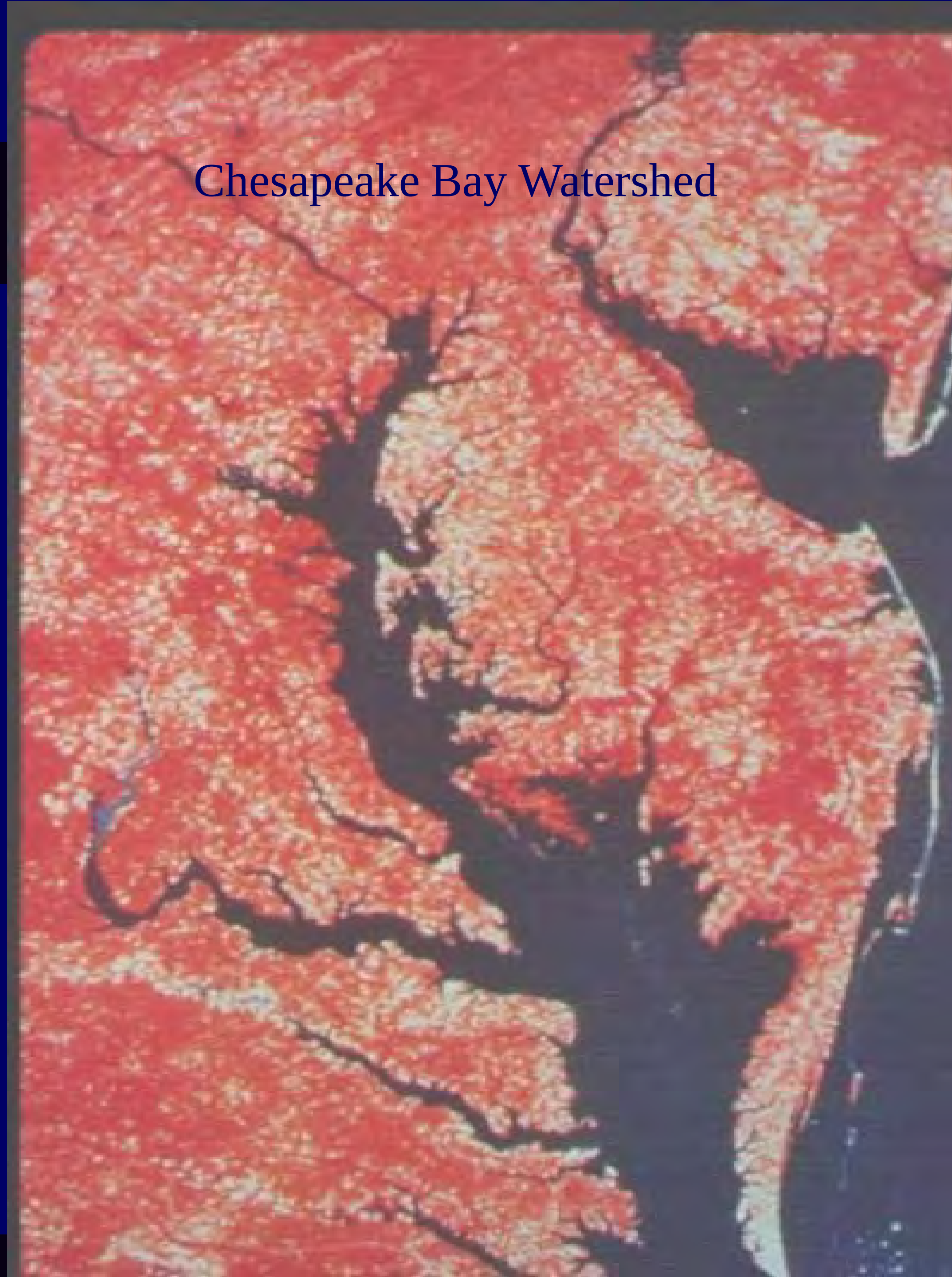
- Algae growth fertilized by nutrients esp. Phosphorous
- As algae die, decomposition process depletes dissolved oxygen needed by fish and other aquatic life
- Extreme cases cause fish kills
- Algae can cause taste and odor problems in drinking water and increased treatment costs
- Excessive phytoplankton (algae) growth in Chesapeake Bay cuts out light needed by bottom grasses (S.A.V.)

DECOMPOSITION :

* Depletes the Oxygen Supply
* Releases Plant Nutrients


Eutrophic conditions
.035 -.1 ppm P
(part per million)
Heavy algae growth begins at .5 ppm NO_3 and .035 ppm P.
Hypoxia at 2.0 mg/l Dissolved O_2
Anoxia at 0.2 mg/l Dissolved O_2

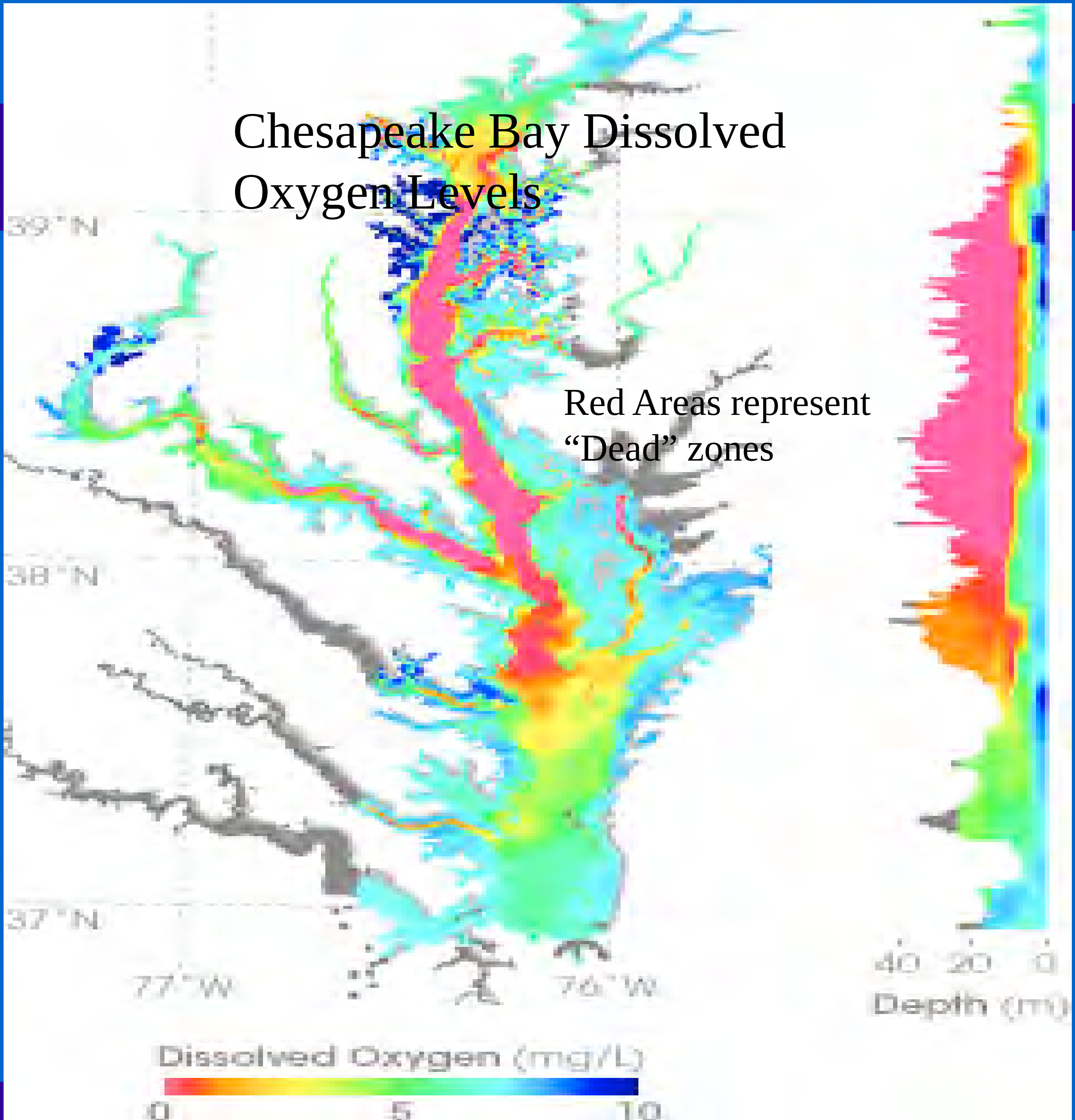
Chesapeake Bay Watershed



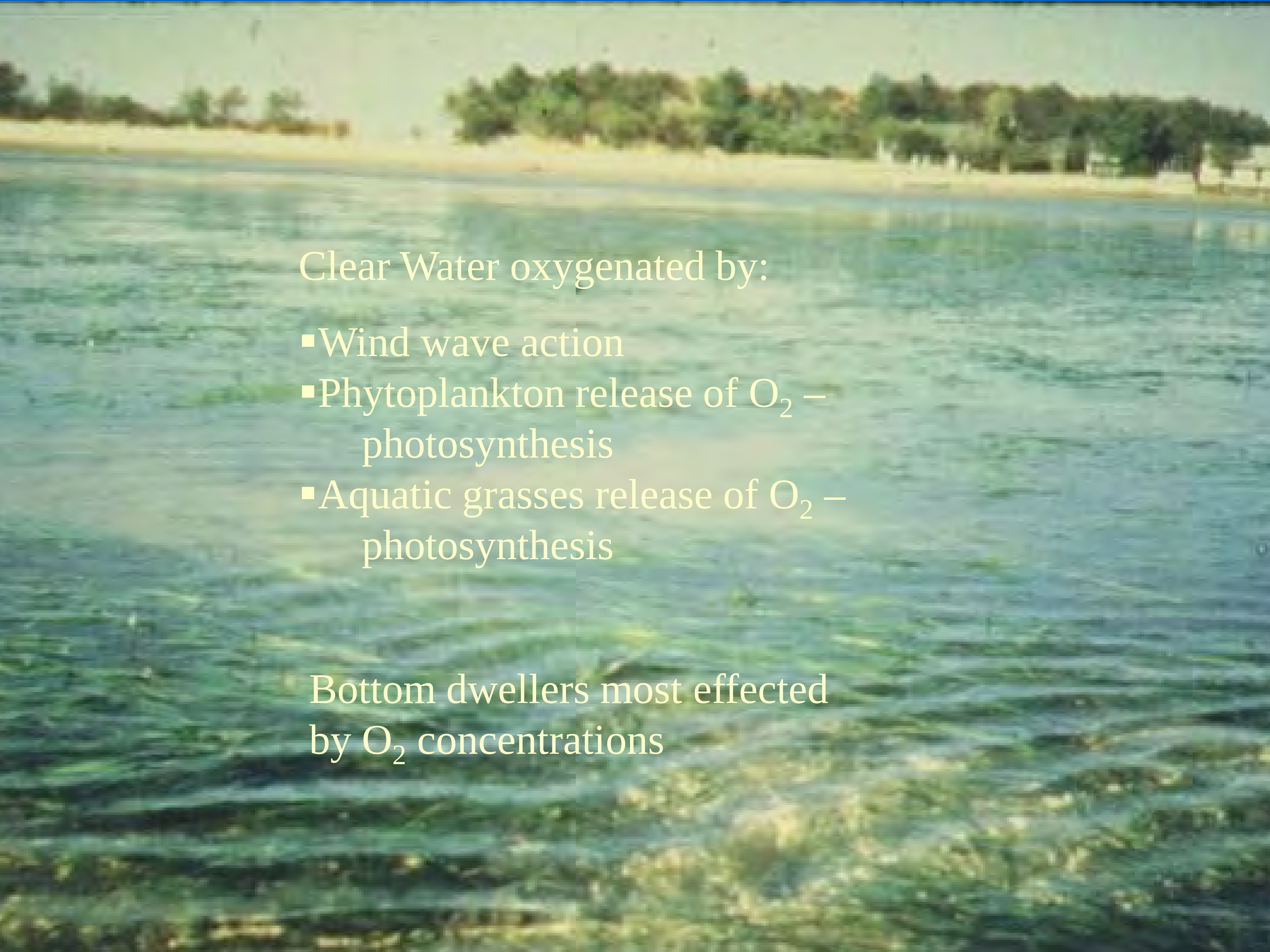
Chesapeake Bay

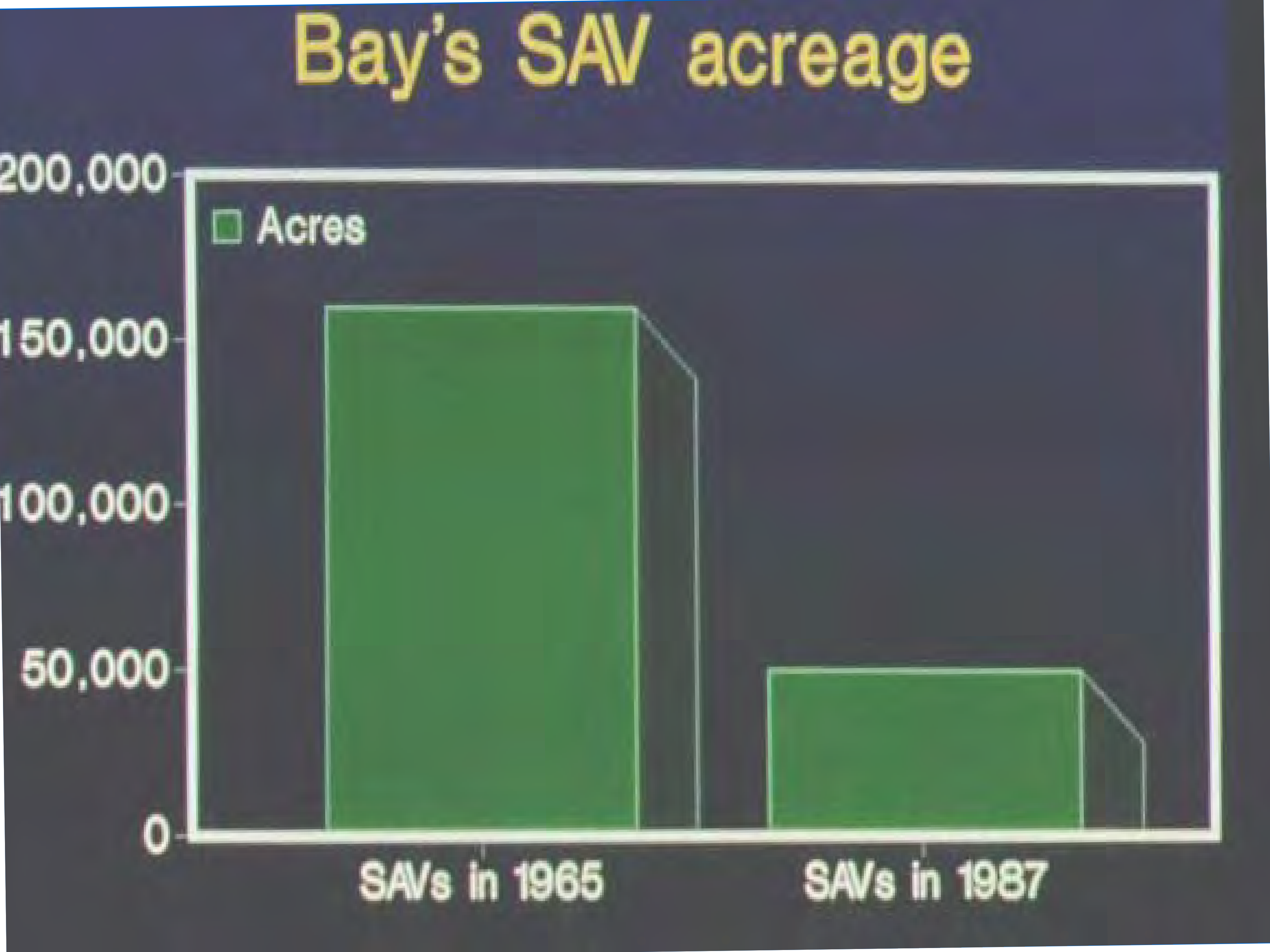
- Congressional appropriation of $27 million for six year EPA study to determine the reasons for the decline of the Chesapeake Bay
- Final report printed in 1982 found three major problems:
- Nitrogen and phosphorus levels causing excess algae growth
- Sediment from ag and urban soil erosion. Urban impacts from stormwater runoff are tremendous
- Toxic compounds (Ag pesticides not found to be a major problem)

Chesapeake Bay Dissolved Oxygen Levels



Red Areas represent "Dead" zones

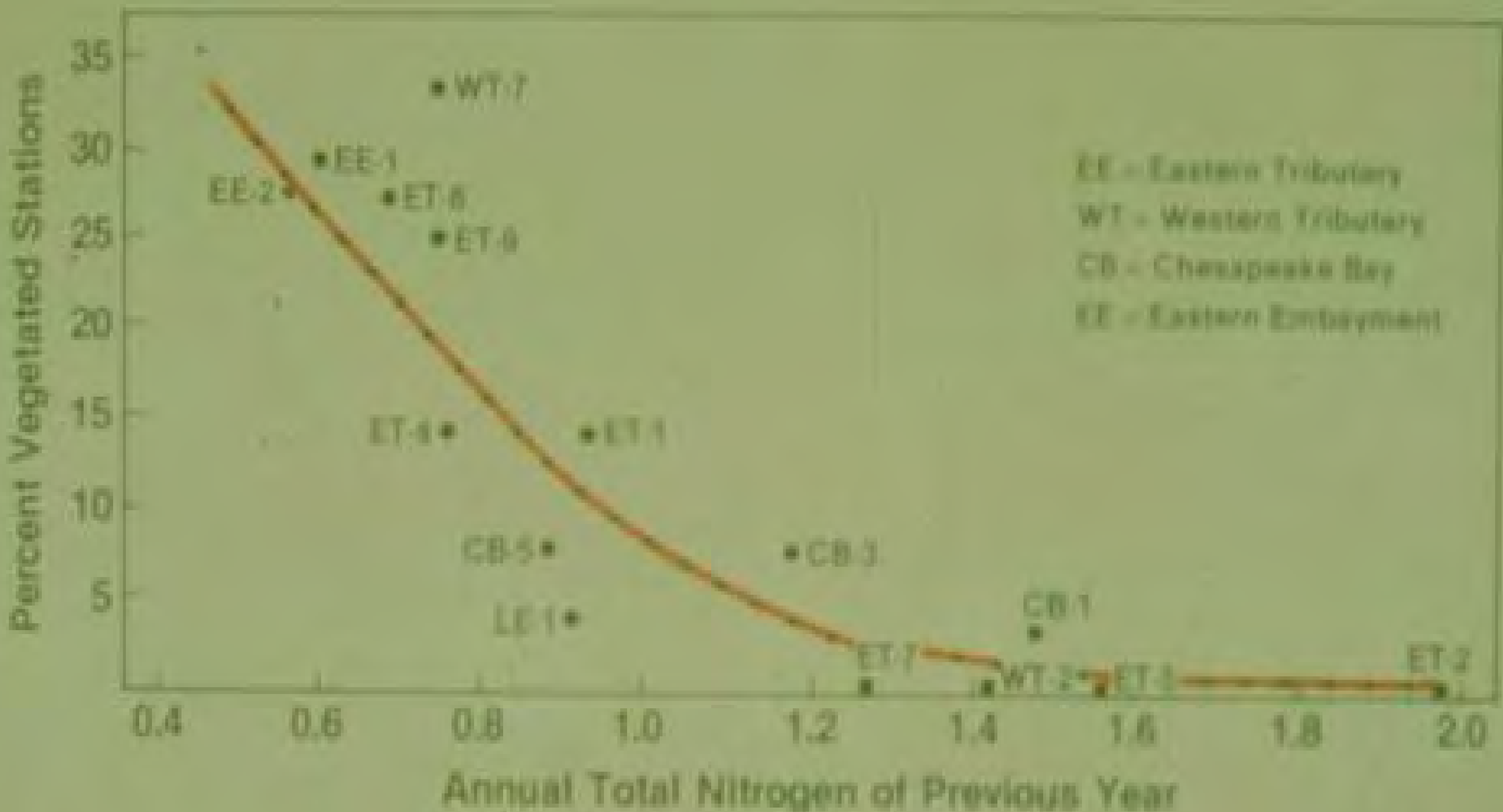

Clear Water oxygenated by:
▪Wind wave action
▪Phytoplankton release of O_2 – photosynthesis
▪Aquatic grasses release of O_2 – photosynthesis
Bottom dwellers most effected by O_2 concentrations


Bay's SAV acreage
200,000
150,000
100,000
50,000
0
Acres
SAVs in 1965
SAVs in 1987

Populations of bay creatures
have drastically decreased

What is good for the Bay is also good for the stream going by YOUR house.

SAV and Nutrients



Increases in nutrients correlate with decreases in SAV. Areas of the Bay that are highly enriched with nutrients have the greatest SAV losses.

Groundwater


Private Irrigation Wells for home lawns are increasing dramatically
•PUMPS
•SERVICE
DRILLING

Key Factors about Turf

- 75% of all turf is residential lawns
- 15% of turf in low maintenance parks
- 10% turf in athletic fields and golf courses
- 70% of all turf in the Bay is on home lawns
  - Half is maintained as high input turf.

  30% is public turf areas 33% is thought to be high input turf

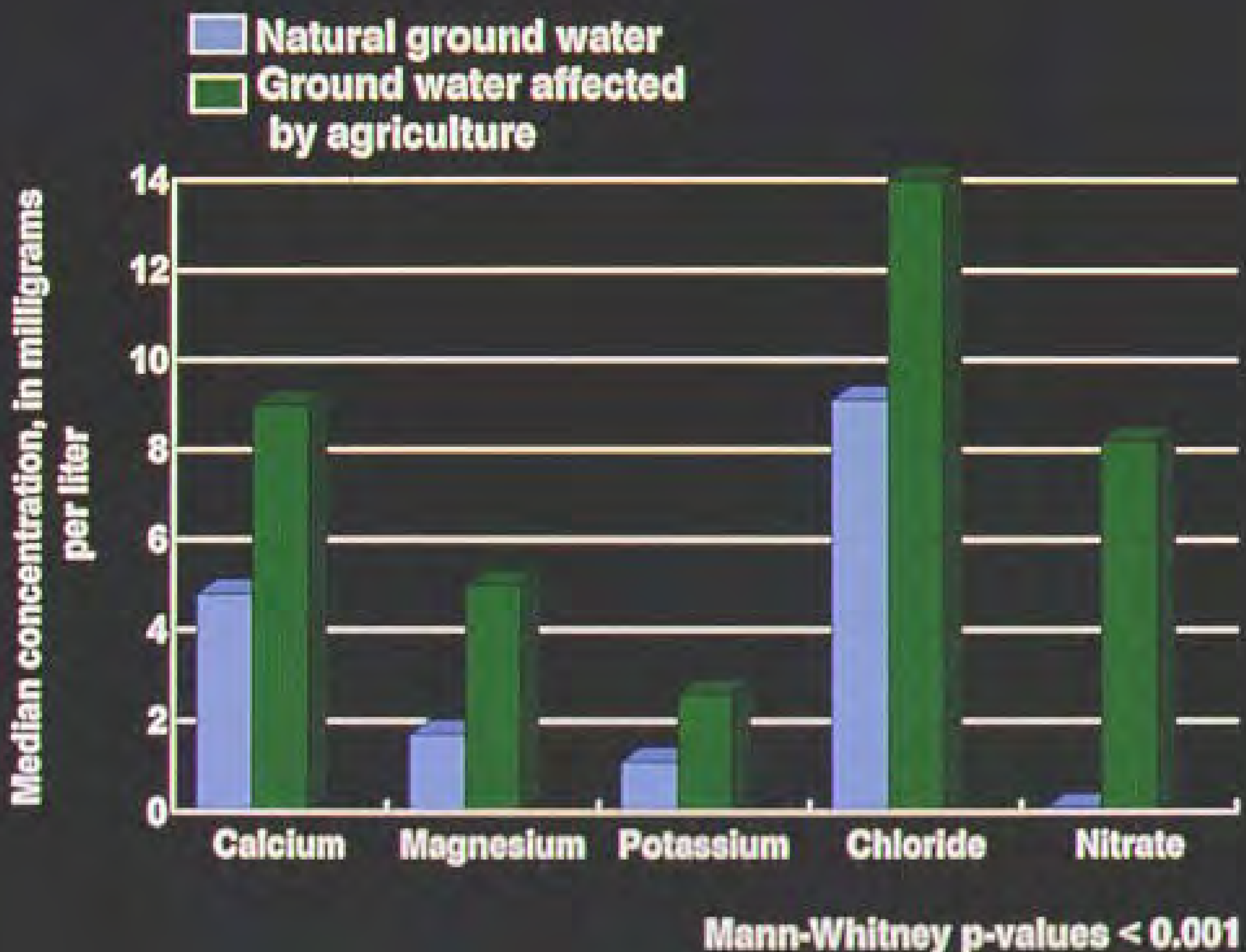
Nitrogen
Groundwater Concerns

- Nitrate-nitrogen is mobile in the soil
- Can leach to groundwater
- Nitrate form most problematic
- 10.0 ppm nitrate + nitrite nitrogen EPA drinking water standard
  - Violations to the Nitrate Drinking Water Std have doubled in last 8 yrs.
- Consumption of high nitrate water by infants potentially dangerous
- "Blue Baby Syndrome" is a lack of oxygen transport to brain.
  - There have been reported cases of Blue Baby Syndrome in Va.
- Some evidence of livestock reproductive problems

Runoff and Leaching

- Dissolved nutrients and pesticides can reach groundwater by moving down through the soil. Nitrogen moves this way.
- Certain pesticides are highly mobile and have been detected in groundwater. Aldicarb (Temik), alachlor (Lasso), and triazines (Atrazine) are just a few.

USGS Delmarva Study 1992



Degree of Nitrate Leaching

- Precipitation amounts and timing
- Physical properties of soil
- Nitrate levels in soil

USGS Delmarva Study 1992

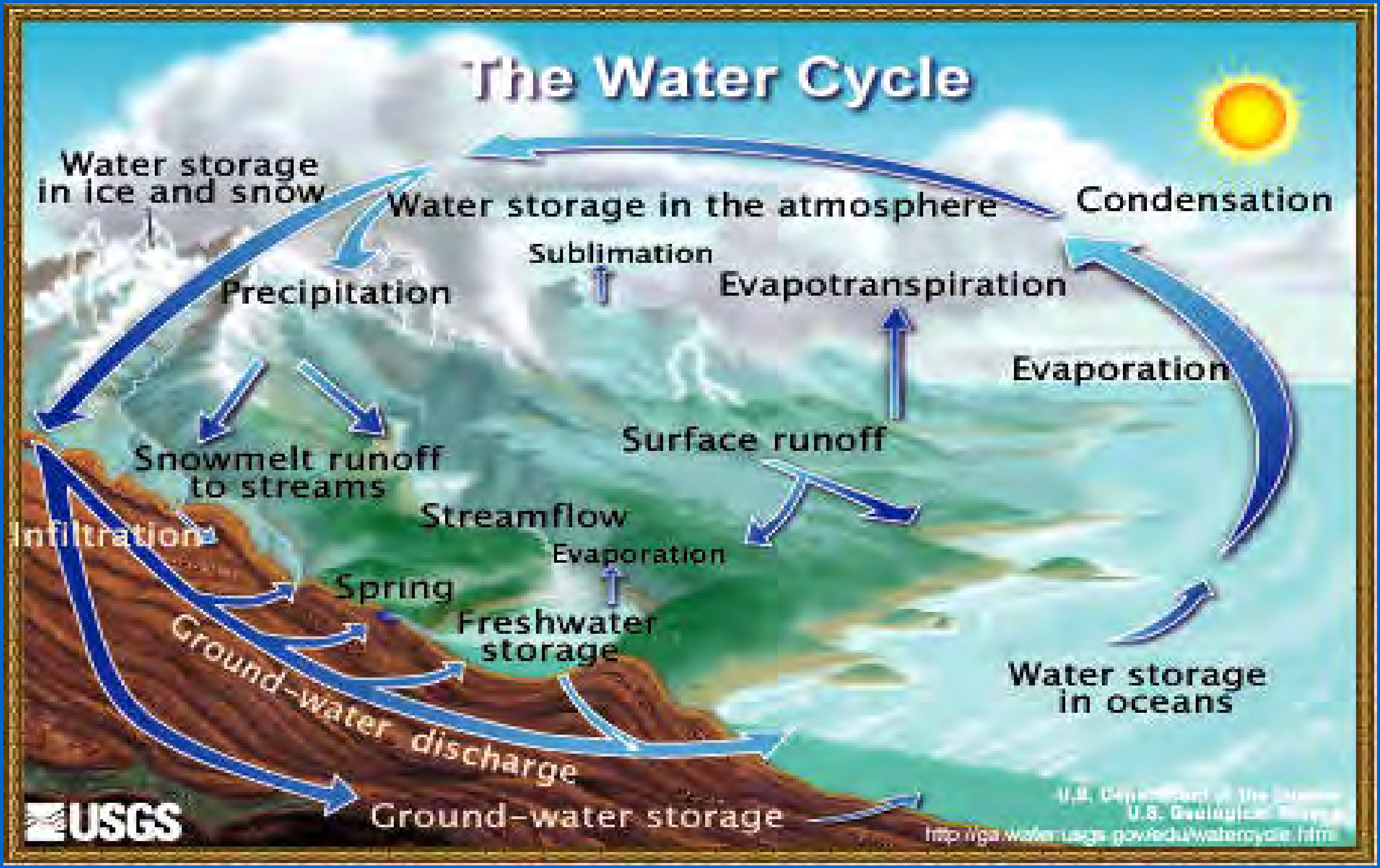
More Nitrate Facts…………

Range: 0.46 to 48mg/l N concentrations found in groundwater.

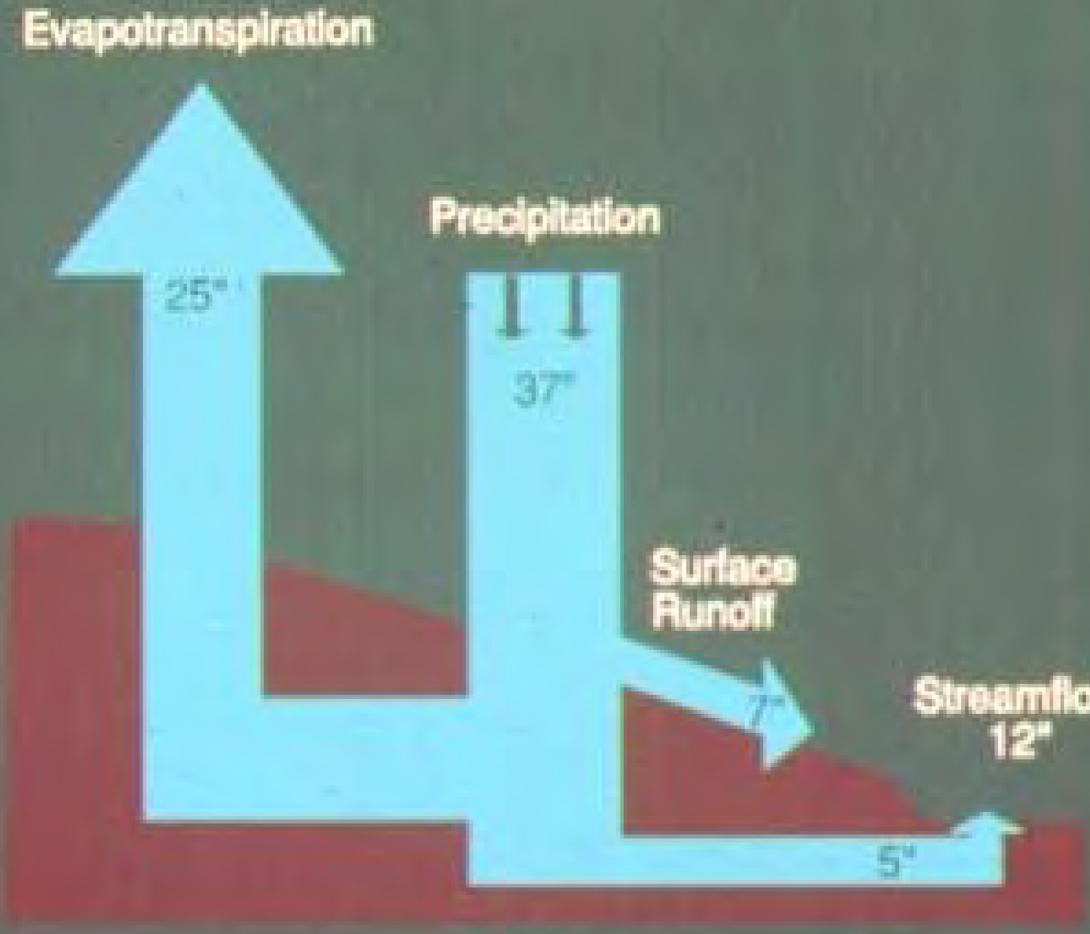
Groundwater in 26 percent of all wells tested exceed EPA drinking water standard of 10.0 mg/l as N

Highest Nitrate concentrations commonly found at the base of the aquifer.

Hydrologic Cycle



General Water Budget
Upper South Fork Shenandoah River Subarea



State Water Control Board, 1991

Groundwater Surface Water Interactions

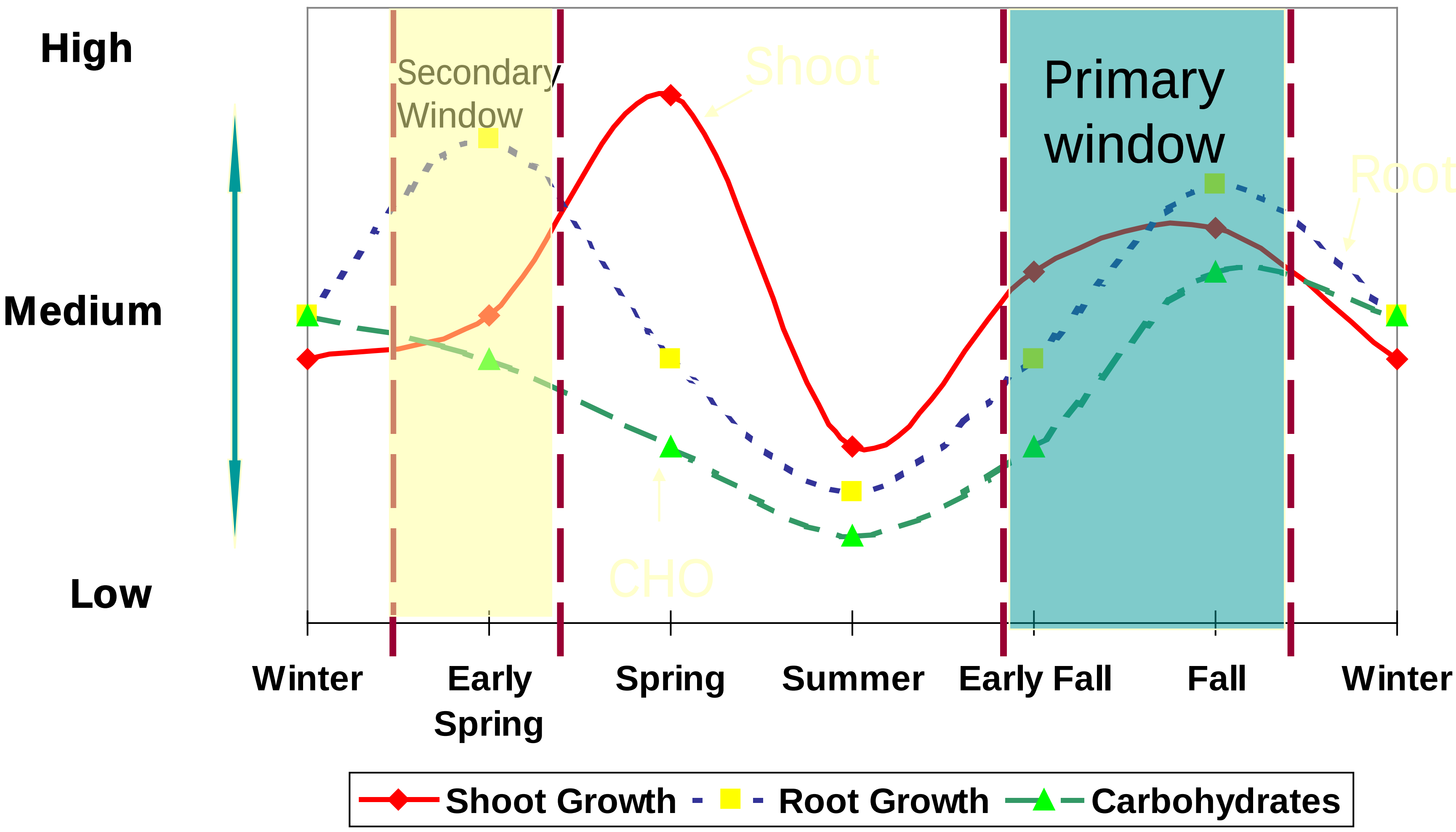
- Base flow index for rivers & streams in the Valley region of Virginia originating from ground water is 48 to 92 percent. Higher numbers from carbonate rock formations.
- Blue Ridge areas where alluvium and colluvium deposits are large have greater than 75 % stream base flow from groundwater.
  - Source US Geological Survey

Seasons of Greatest Leaching

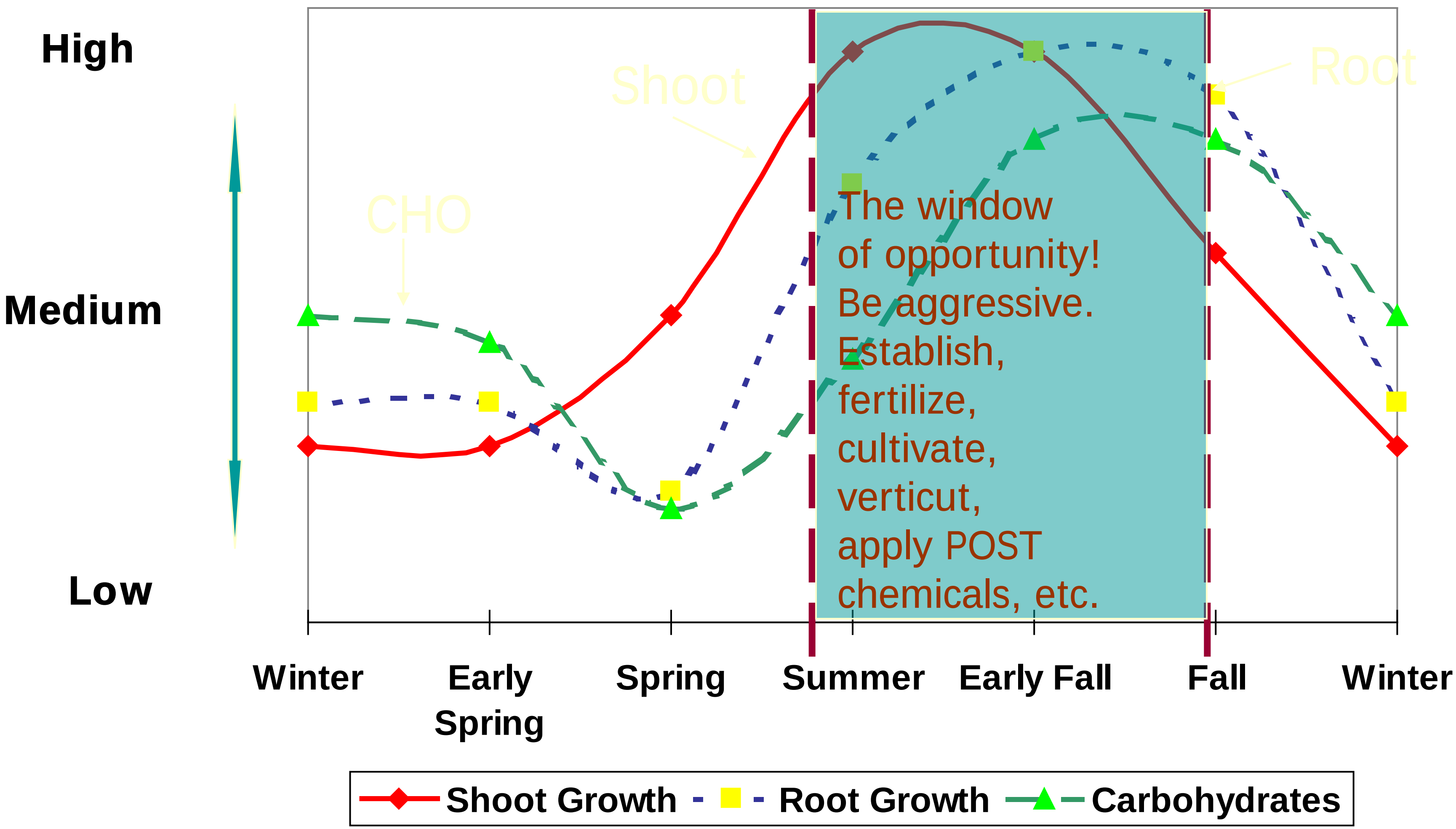
- Leaching potential increases during times of low evapotranspiration and little plant growth & uptake

- Late fall
- Winter
- Early spring

Seasonal Growth Patterns: Cool-Season Turfgrasses



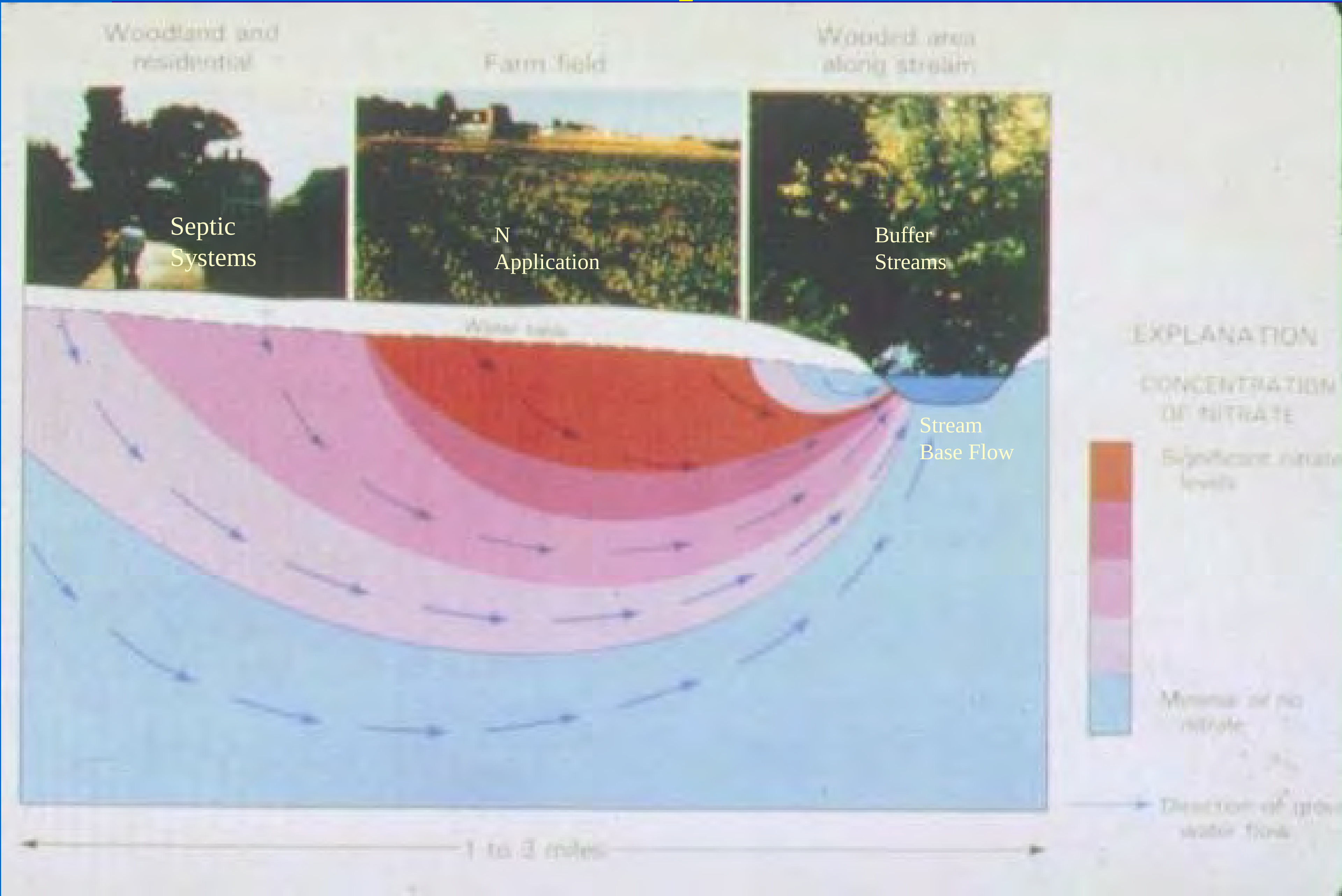
Seasonal Growth Patterns: Warm-Season Turfgrasses



Ground and Surface Water Connections

- Springs
- Seeps
- Drain tile outlets
- Some stream or river beds act as recharge to aquifer system by cutting overbearing confining layer
- Sinkholes
- Wetlands and marshes
- Which way is the net flow ?

How Groundwater and Nitrate Moves Below Ground to Impact Surface Waters



Nitrogen Loss Forms & Pathways

- NH_4^+ bound to eroding sediment or organic matter. NH_3 (ammonia gas from feed lots or other organic sources) concentrations that produce fish kills are only 0.08 to 1.09 ppm
- Organic N suspended in runoff water
- Soluble NO_3^- in runoff water
- NO_3^- leaching to groundwater

Nutrient Practices to Reduce Nitrogen Pollution Potential

- Rate of application
- Timing of application
- Placement of nutrients
- Cover crops (Trap crops) such as ryegrass over Bermuda

Timing of Applications

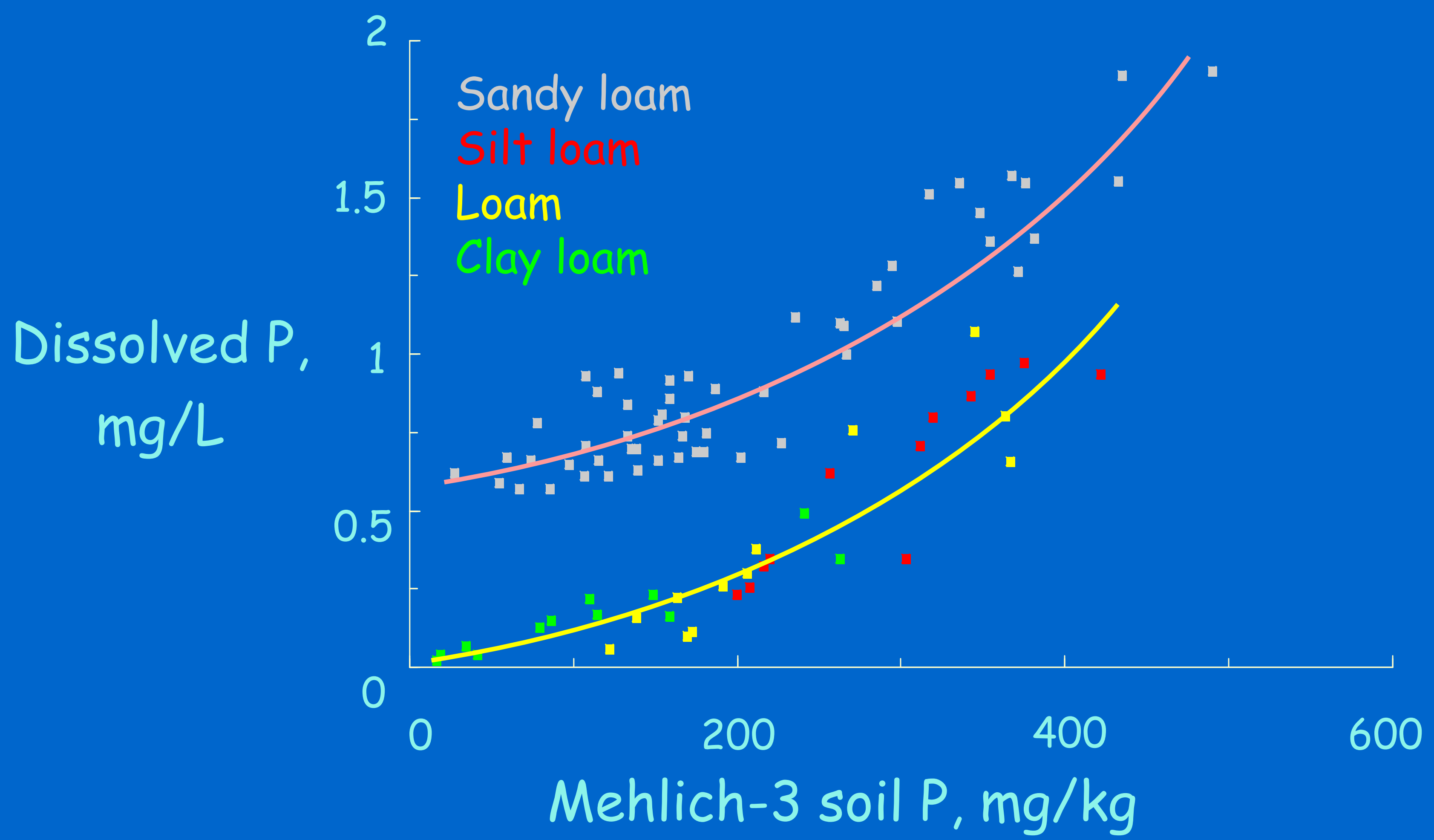
When is the best time to apply nutrients to turf or ornamentals?

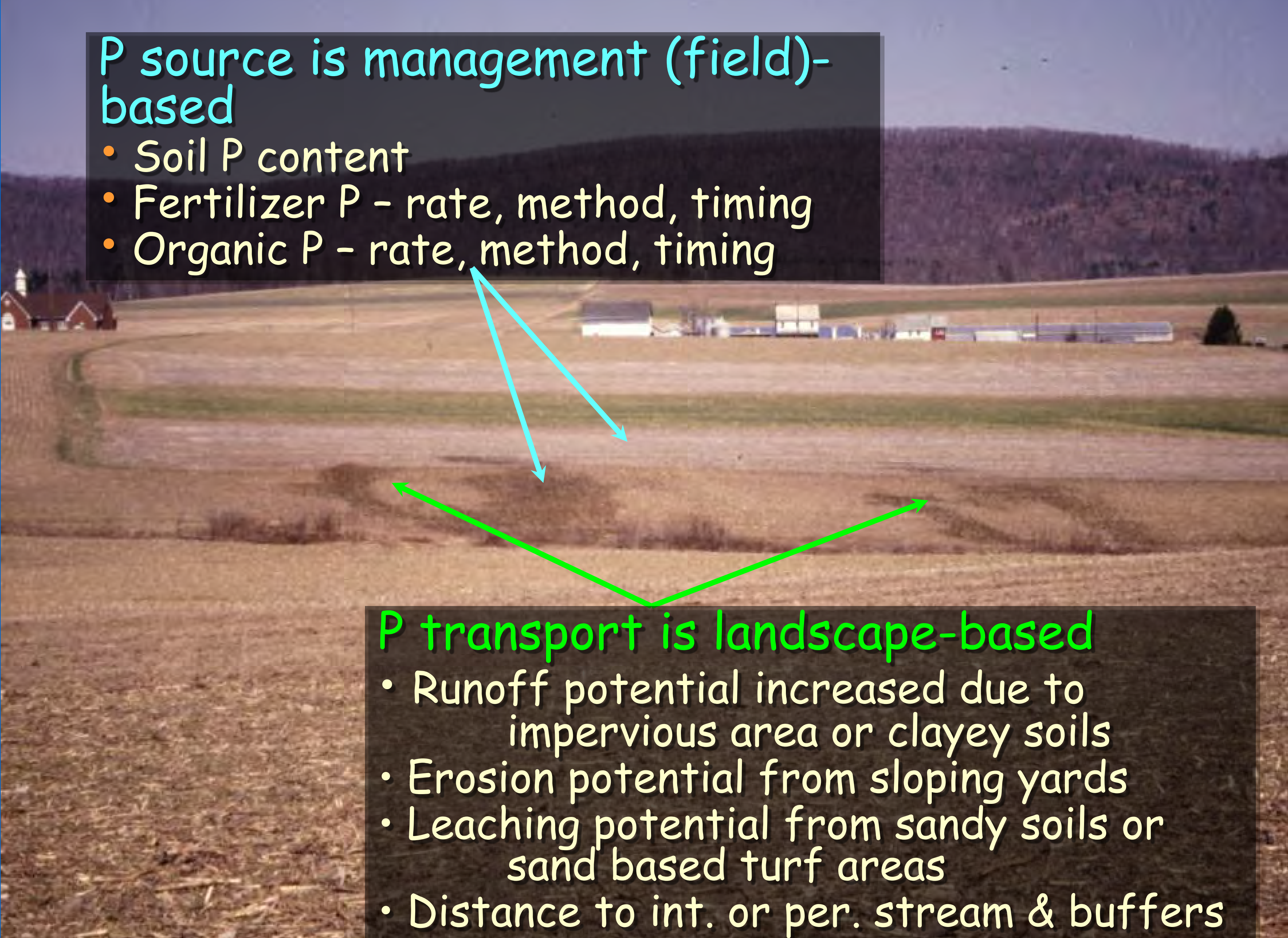
Phosphorus Management

Phosphorus Loss Forms & Pathways

- Particulate P complexes eroded from soil with sediment. The smaller the particle, the longer it stays in suspension.
- Organic P suspended in runoff water
- Soluble HPO_4^{-2} or $H_2PO_4^{-}$ in runoff water
- Soluble P in subsurface flow and tile drains (mainly course textured poorly drained soils)

Relating Soil P to Runoff P





P source is management (field)-based

- Soil P content
- Fertilizer P – rate, method, timing
- Organic P – rate, method, timing

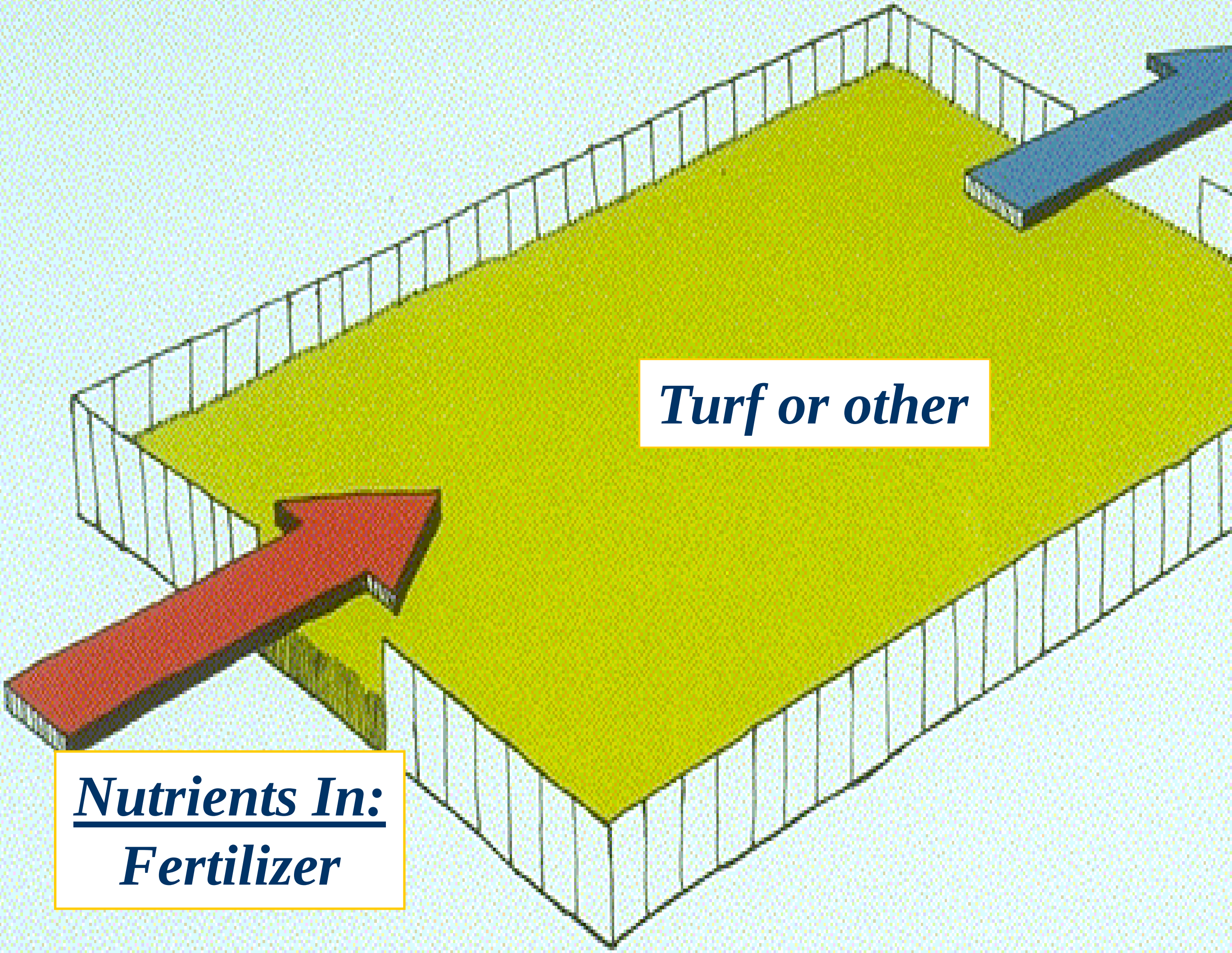
P transport is landscape-based

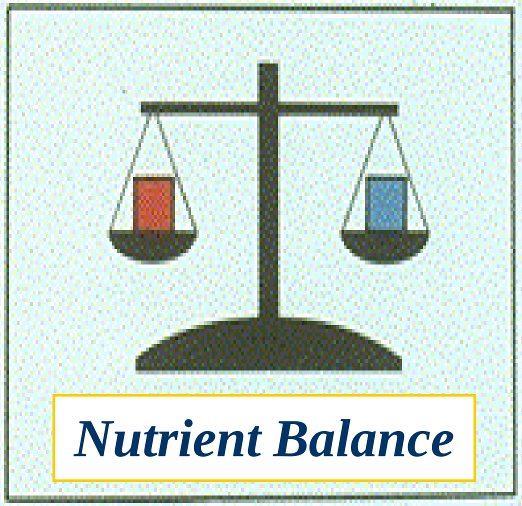
- Runoff potential increased due to impervious area or clayey soils
- Erosion potential from sloping yards
- Leaching potential from sandy soils or sand based turf areas
- Distance to int. or per. stream & buffers

Nutrient Practices to Reduce Phosphorus Pollution Potential

- Keep Soil Surface P Saturation Levels Below Environmentally Critical Levels
- Reduce Soil Erosion on Land With High Levels of Soil Test P and on Highly Erodible or Highly Leachable Land
- Keep P Applications Below Plant Removal Rates in High Risk Situations

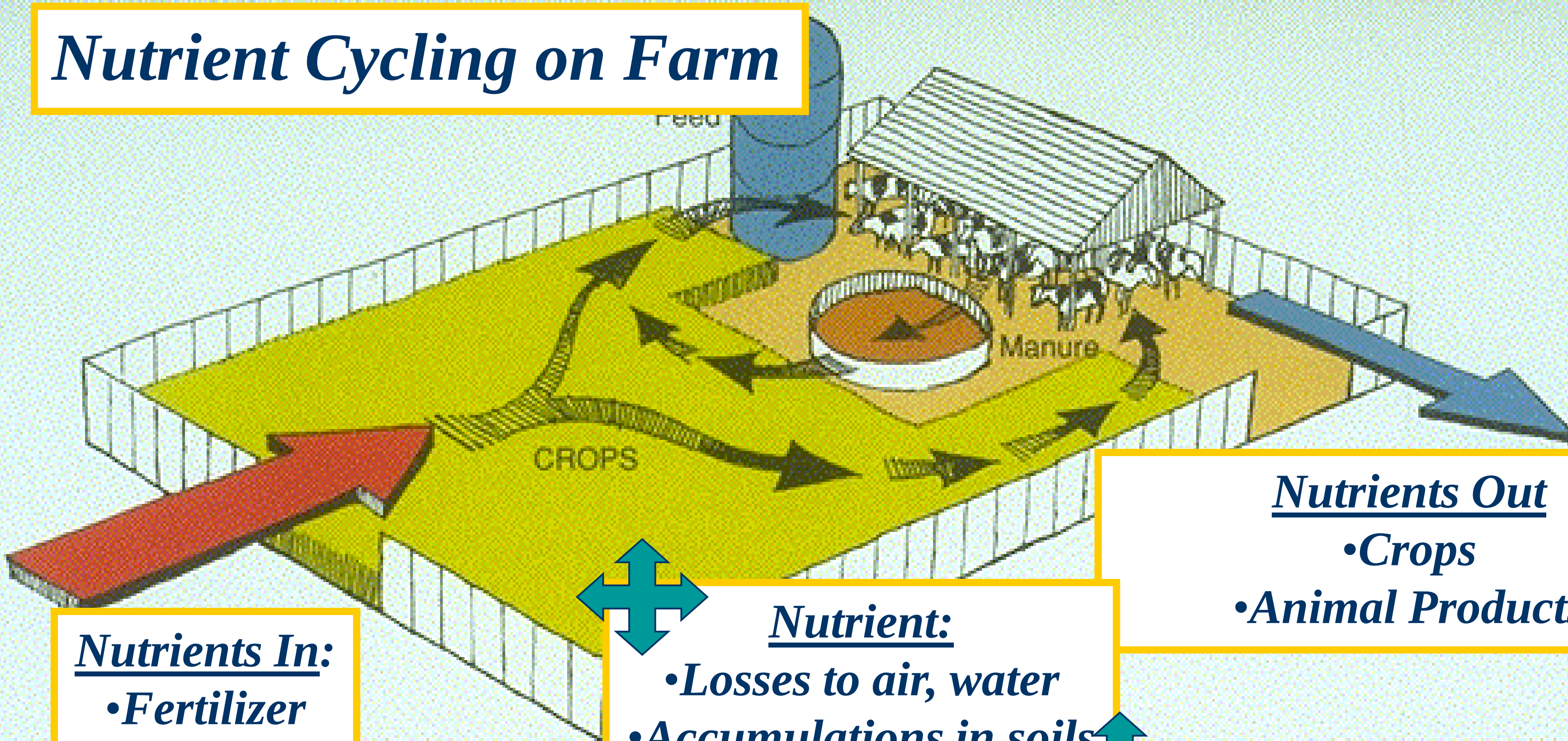
Nutrient Cycling in Turf & Landscaped Areas





…and follow nutrient recommendations

Nutrient Cycling on Farm

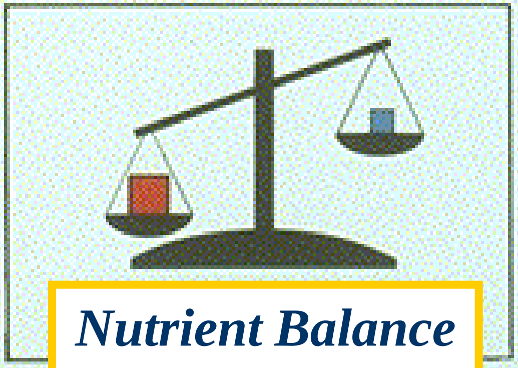


***Nutrients In*:**
•Fertilizer
•Feed

Nutrient:
•Losses to air, water
•Accumulations in soils

Nutrients Out
•Crops
•Animal Products

" A livestock farm is much more complex.
We often cannot balance inputs of
feed and fertilizers with outputs.
This results in excess nutrients that can
be lost to air or water or build up in soils.



Nutrient Balance

Everything in Balance?

Environmentally Sensitive Sites

Field contains or drains to sinkholes OR

Any area, yard or field containing 33% or more:

- Soils with a high potential for leaching
- Soils shallow to rock < 40”
- Poorly drained with coarse textured soils or tile drained
- Frequently flooded soils
- Slope > 15%

Environmentally Sensitive Site – pg 2

Environmentally sensitive site" means any field which is particularly susceptible to nutrient loss to groundwater or surface water since it contains, or drains to areas which contain, *sinkholes, or where at least 33% of the area in a specific field contains one or* any *combination* of the following features:

1. Soils with *high potential for leaching based on soil texture or excessive drainage*;
2. Shallow soils less than 41 inches deep likely to be located over fractured rock or limestone bedrock;
3. Subsurface tile drains;
4. *Soils with high potential for subsurface lateral flow based on soil texture and/or poor drainage;*
5. Floodplains as identified by soils prone to frequent flooding in county soil surveys; or
6. Lands with slopes greater than 15%.

Karst Topography

- Underlying limestone formations which may be characterized by solution cavities or “sinkholes” which form a direct connection between surface and groundwater due to collapse of the soil profile into the cavity.
- Pollution sources can be some distance away


< Sinkholes
Rock Outcrop >

Determining Environmentally Sensitive Sites

Use site visit and soil survey - Do areas of the field have one or more sinkholes or does part of the field drain to a sinkhole?

Or does at least 33% of the field have any combination of the following:

From Table 1-4 Standards and Criteria pages 28- 36

- soils with a “H” for environmental sensitivity

a. Leaching

b. Shallow soils

c. Drainage - Soils with high potential for subsurface lateral flow

(continued on next slide)

Determining Environmentally Sensitive Sites - Continued

From site visit –

d. Subsurface tile drains

e. Soils with very slow permeability rates/high run off potential

From soil survey –

f. Floodplains - soils prone to “frequent” flooding - (usually in soil and water features table)

g. Lands with slopes greater than 15%

- “E” slope or greater in Coastal Plain

- “D” slope or greater in other regions

Table 1-4 (page 28)

Nitrogen Loss Risk and Environmental Sensitivity Ratings for Virginia Soils & Soil Series Associated With Environmentally Sensitive Sites

Soil Series	Environmental Sensitivity	Category
Abell	L	
Ackwater	L	
Acredale	L	
Aden	L	
Airmont	L	
Alaga	H	Leaching
Alamance	H	Leaching
Alanthus	M	Leaching
Albano	L	
Albemarle	M	Leaching
Alderflats	L	
Aldino	L	
Allegheny	H	Shallow
Alonemill	H	Leaching
Alonzville	M	Leaching
Altavista	L	
Altavista variant	L	
Alticrest	H	Shallow
Angie	L	
Appling	L	
Appling gritty	L	
Appomattox	L	
Aqualfs	L	
Aquents	H	Drainage

Nitrogen vs Phosphorous Management Strategies

- Nitrogen
  - Rate- based upon Turf Needs
  - Timing- when plants most need
  - Placement- in root zone
  - Cover crops- ex. Overseeding bermuda with ryegrass to scavenge residual N from previous crop
- Phosphorous
  - Erosion Control- particulate P- Target
  - Manage runoff -organic P + Plant Avail P
    - Over-seeding - Terraces
  - Concentrations of soil test P – Source
    - Reduce P applications – Use “Zero P” fertilizers
    - Return grass clippings

Importance of Good Soil Management

- Reduce soil erosion by matching technology to situation
- Narrow landscape beds to interrupt slopes, contouring landscapes, filter strips are beneficial and economical
- Grassed waterways and bedding terraces may be required
- Careful use of fertilizers, & pesticides

Conclusion

- Many agricultural and turfgrass practices practices can threaten OUR water quality if soil properties are poorly understood or ignored. These threats are serious, but are manageable. Water quality can be improved while protecting the productivity and value of the soil for all uses.
- We can have both healthy soil and clean water by applying Good Soil & Nutrient Management Practices!

- Nutrient Management Program Manager
- Virginia Department of Conservation and Recreation, Division of Stormwater Management

DCR

Virginia Department of Conservation & Recreation

Rye Scavenger Crop Effect on Leachate During January 1991

Treatment	Leachate NO3-N
Spring Applied Poultry Litter No Rye Cover	42 ppm
Spring Applied Poultry Litter Rye Cover	13 ppm
No Poultry Litter No Rye Cover	19 ppm
No Poultry Litter Rye Cover	2 ppm

Source: Wye Research Center (Unpublished Data)

Phosphorus Based Nutrient Management

- Poultry Waste Management Act prescribes no further build-up of P in from poultry waste in soils already high or very high in P
- Phosphorus criteria for other NMPs is under review

Environmentally Sensitive Site – Regs pg 2

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From site visit –

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From soil survey –

e. Floodplains - soils prone to “frequent” flooding - (usually in soil and water features table)

f. Lands with slopes greater than 15%

- <u>“E” slope</u> or greater in Coastal Plain

- “D” slope or greater in other regions

Soil Nitrate Leaching Index

- Potential susceptibility to leaching of soluble nutrients below the root zone

- Influenced by:
  - Permeability of soil series
  - Expected annual precipitation

Environmentally Sensitive Sites

- Soils with a leaching index of 10 or greater
- Fields including or draining to sinkholes
- Shallow soils <41 inches deep over fractured rock or limestone bedrock
- Subsurface tile drained areas
- Floodplains prone to annual flooding
- Fields with slopes >15%


JCB

Table I-6
Soil Series Associated With Environmentally Sensitive Sites

Shallow Soils Limestone Bedrock	Very Shallow Soils (<20") Over Fractured Bedrock	Shallow Soils (20-40") Over Fractured Bedrock
Bland	Beech Grove	Alleghany
Carbo	Bugley	Alticrest
Chilhowie	Cataska	Ararat
Faywood	Chiswell	Berks
Opequon	Corydon	Berks Variant
Rock Outcrop	Craggey	Blairton
Westmoreland	Dandridge	Brookwood
Wurno	Drypond	Brushy
	Klinesville	Calvin Cobbly
	M	Caneyville
	Newbern	Catoctin
	Ramsey	Clearbrook
	Rock Land	Clifton
	Sylvatus	Cowee
	Urbanland	Gainsboro
	Weikert	Gilpin
	Wekert	Gunstock
		Hazel Channery
		Hazelton
		Junaluska
		Koannarock
		Konnarock
		Lily
		Lily Variant
		Litz
		Massanutten
		Meadows
		Peaks
		Pigeon Roost
		Rubble Land
		Schaffenaker
		Sequoia
		Sylco
		Talladega
		Trappist
		Wallen
		Webbtown

It is important for shallow soils associated with environmentally sensitive sites to receive split applications of nitrogen on corn and other non-legume summer annuals, and split spring nitrogen on small grains. These identified shallow soils should also be a high priority for timely fall-planted winter cereal grains to trap available soil nitrogen.