



FROM GREENS ...

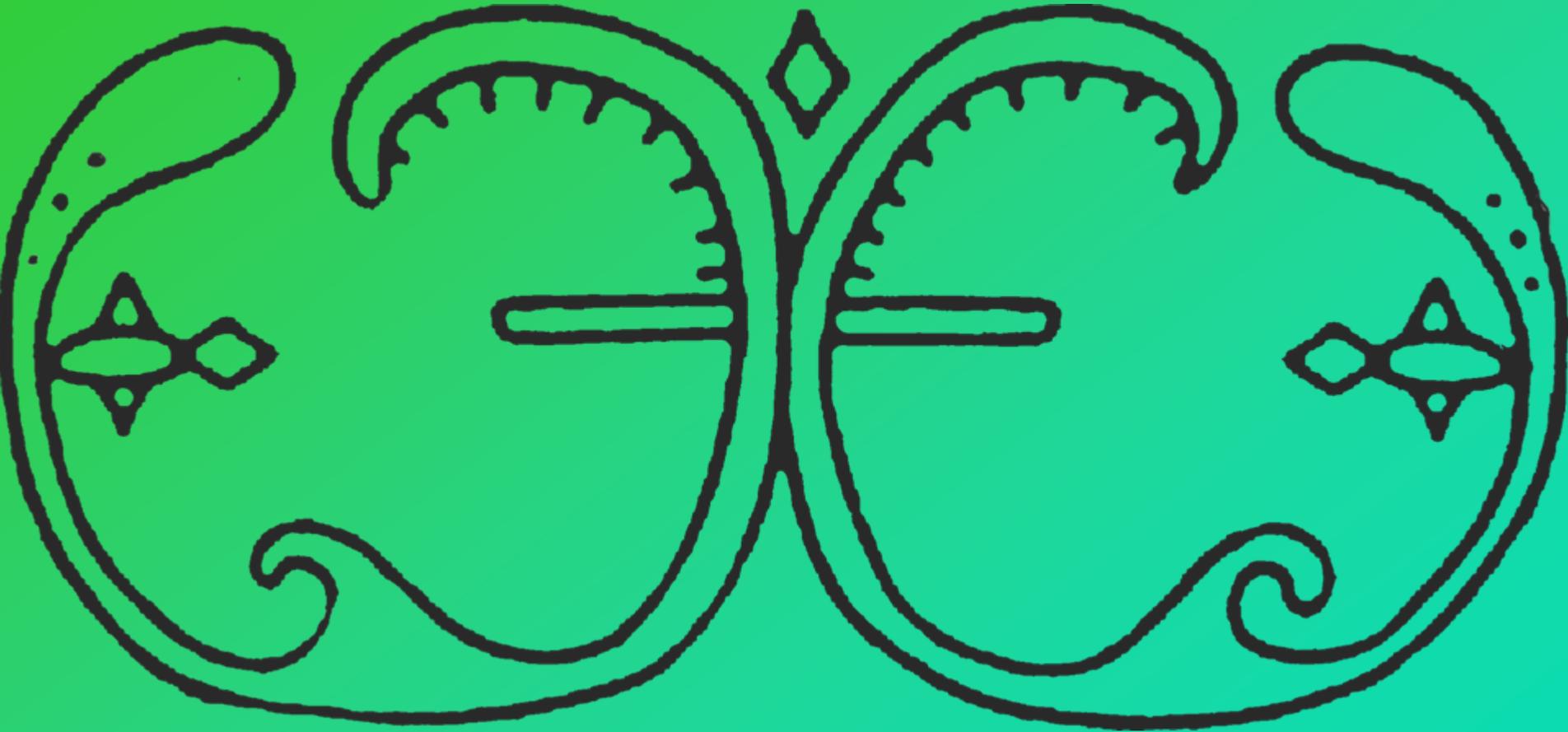
... TO BLUE-GREENS:

**WHAT MIGHT
HAPPEN NEXT IN
THE PENOBSCOT
RIVER?**

National Tribal Forum on Environmental Science

September 27, 2006

Daniel Kusnierz
Penobscot Indian Nation



12 Wabanaki Way, Indian Island, ME 04468
(207)817-7361
pinwater@penobscotnation.org



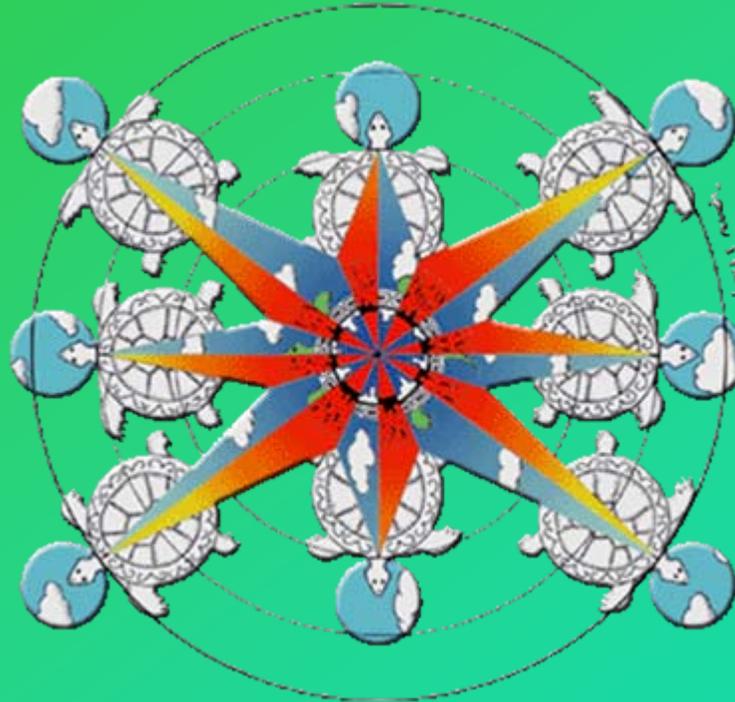
*Penobscot
Indian Nation
Water Resources
Program*

www.penobscotnation.org/DNR/Water/wrhome.html

Presentation Overview

**Are We
Missing
Something?**

**What's
Happening**

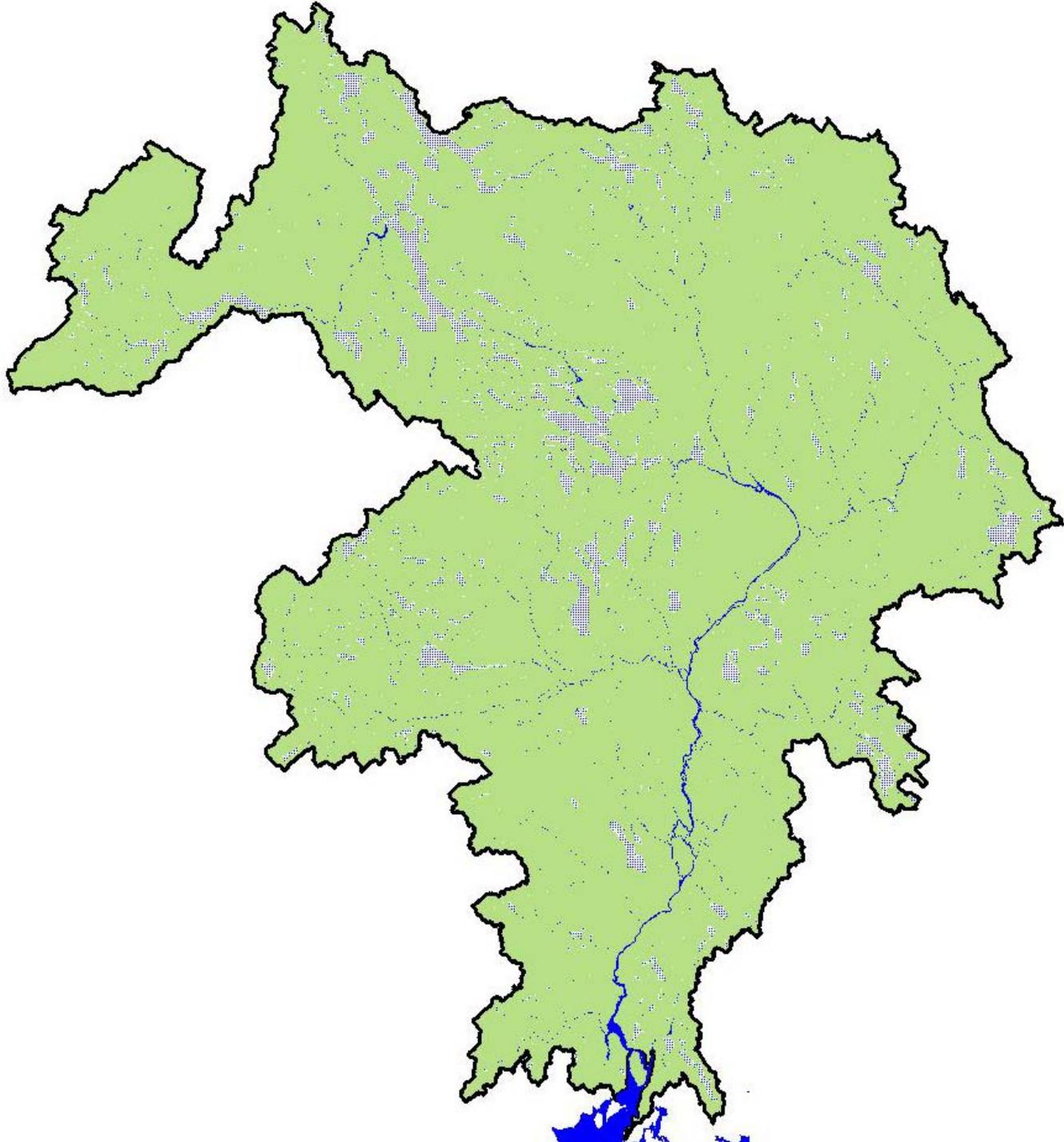


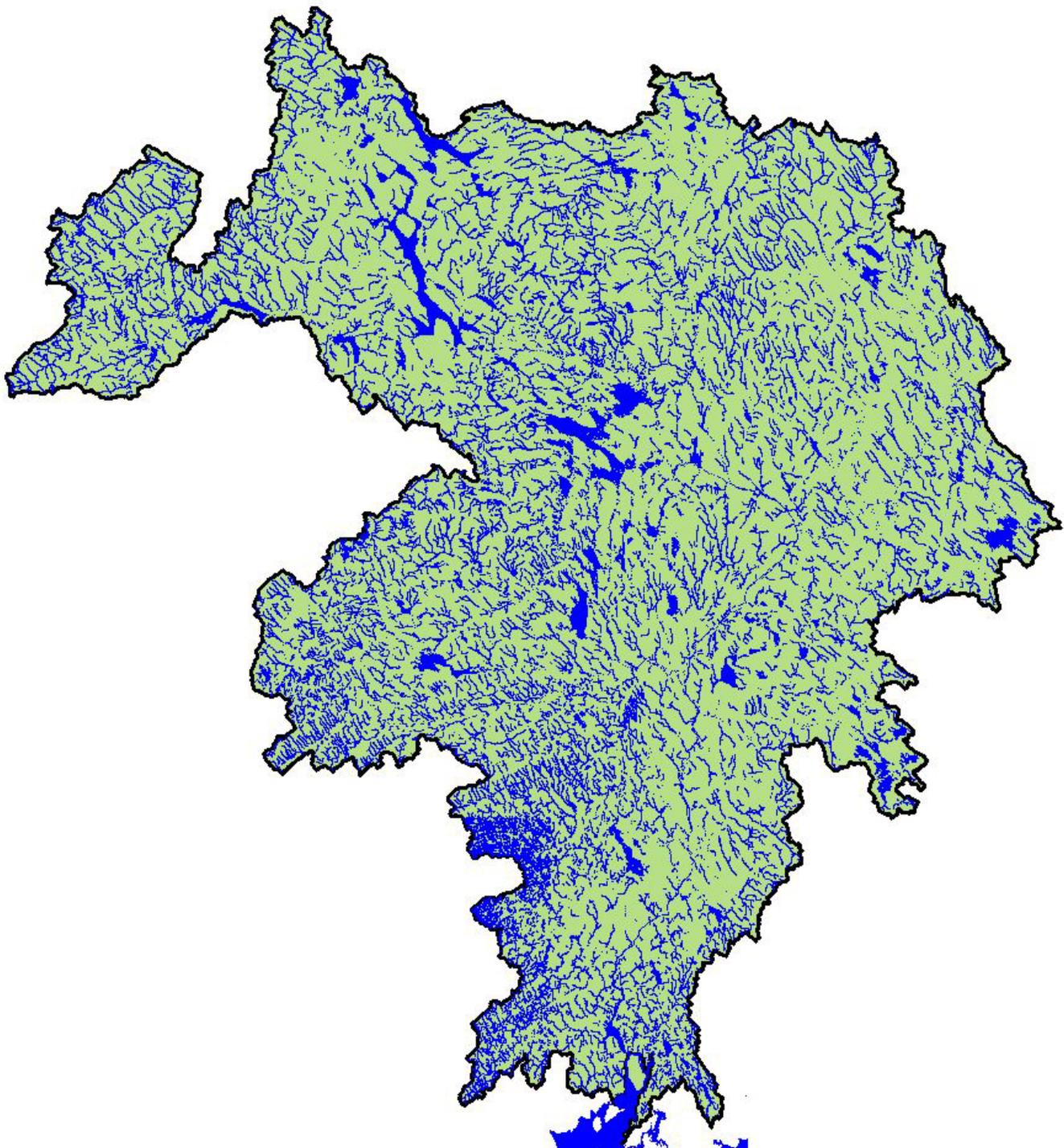
**Is That
Enough?**

**What's Being
Done About It**

The
panawahpskek
River
Watershed



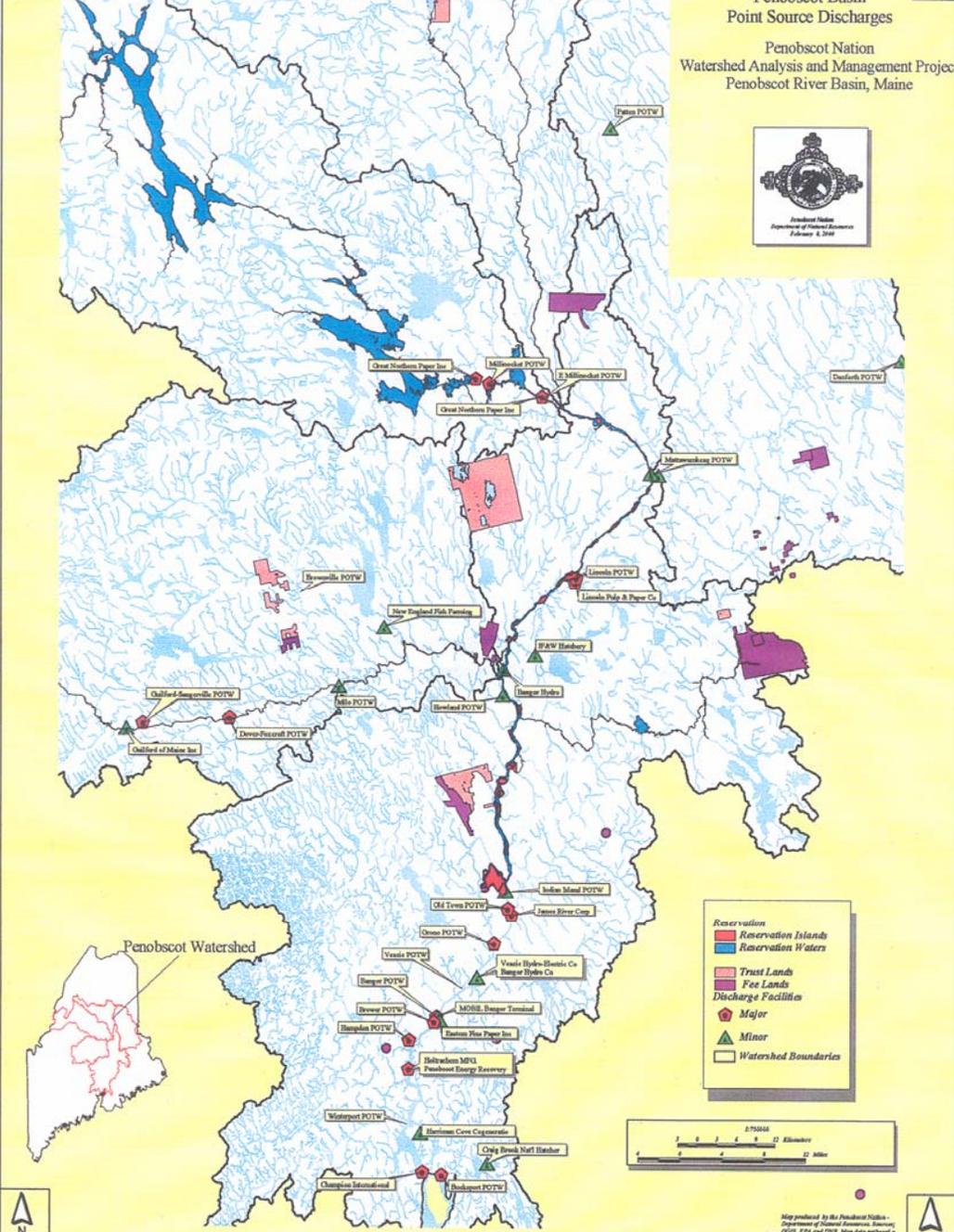






Penobscot Basin
Point Source Discharges

Penobscot Nation
Watershed Analysis and Management Project
Penobscot River Basin, Maine



Baseline Water Quality Monitoring (Penobscot River Watershed)



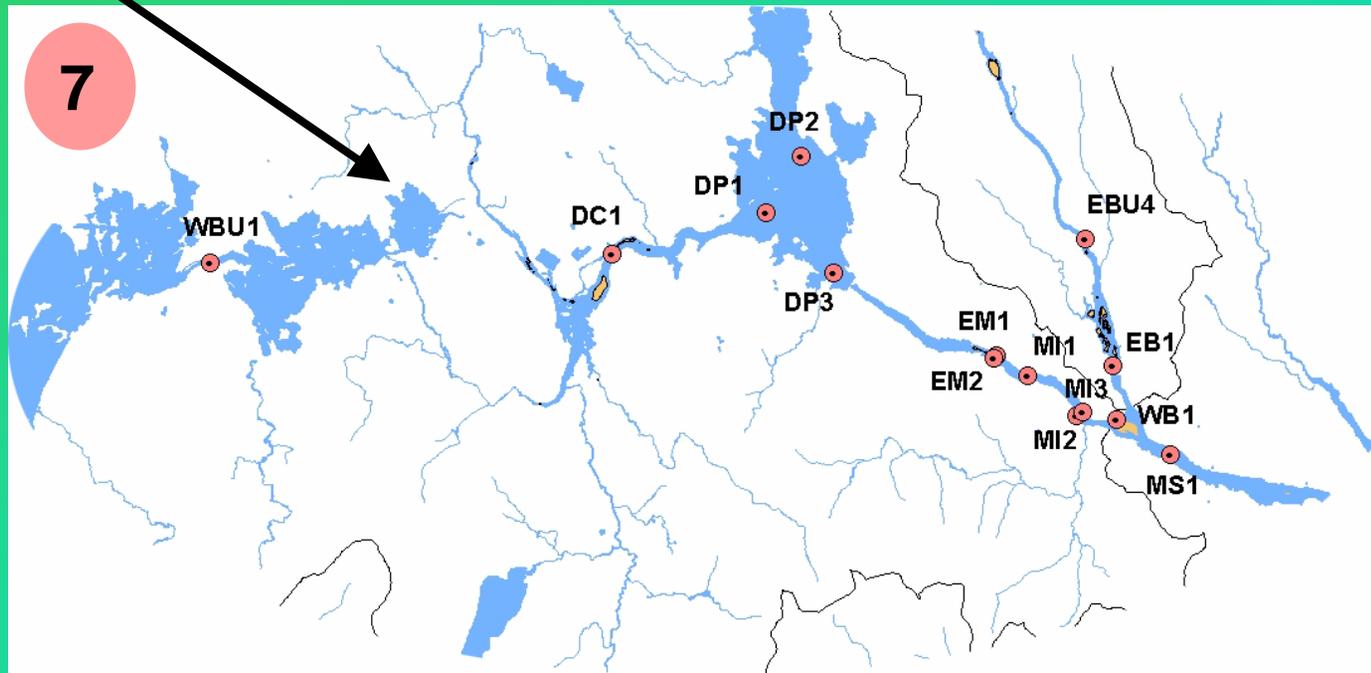
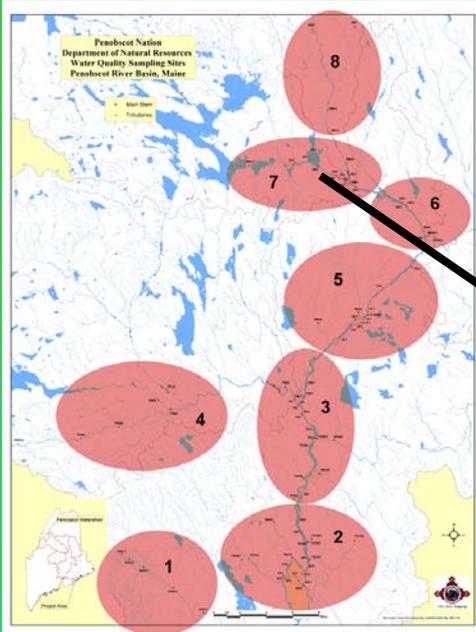
- Mid-May to early October
- More than 85 river and tributary sites
- Sampled weekly
- Sites selected include:
 - Industrial and municipal dischargers
 - Dam impoundments
 - Non-point source

An aerial photograph of a river winding through a dense forest. The water is a milky green color, indicating an algal bloom. The surrounding trees are lush green.

PENOBSCOT RIVER BLOOMS

- **PIN began monitoring blooms in the mid-‘90s**
- **Originate in lower W. Branch Penobscot; not found upstream or in tributaries**
- **Species composition was diverse and not dominated by any one in particular**
- **No toxin producers**

West Branch Penobscot / Dolby Pond Segment

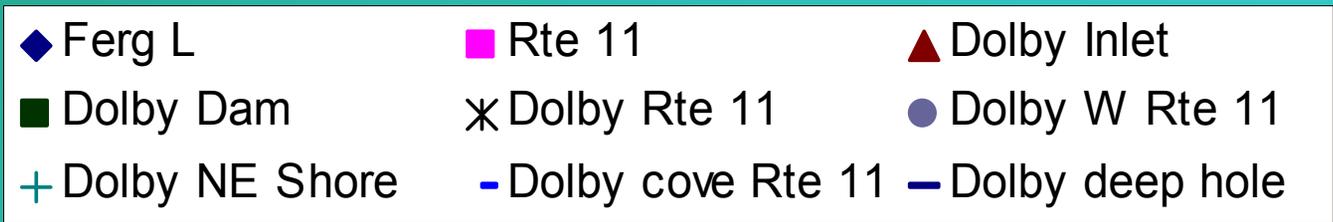
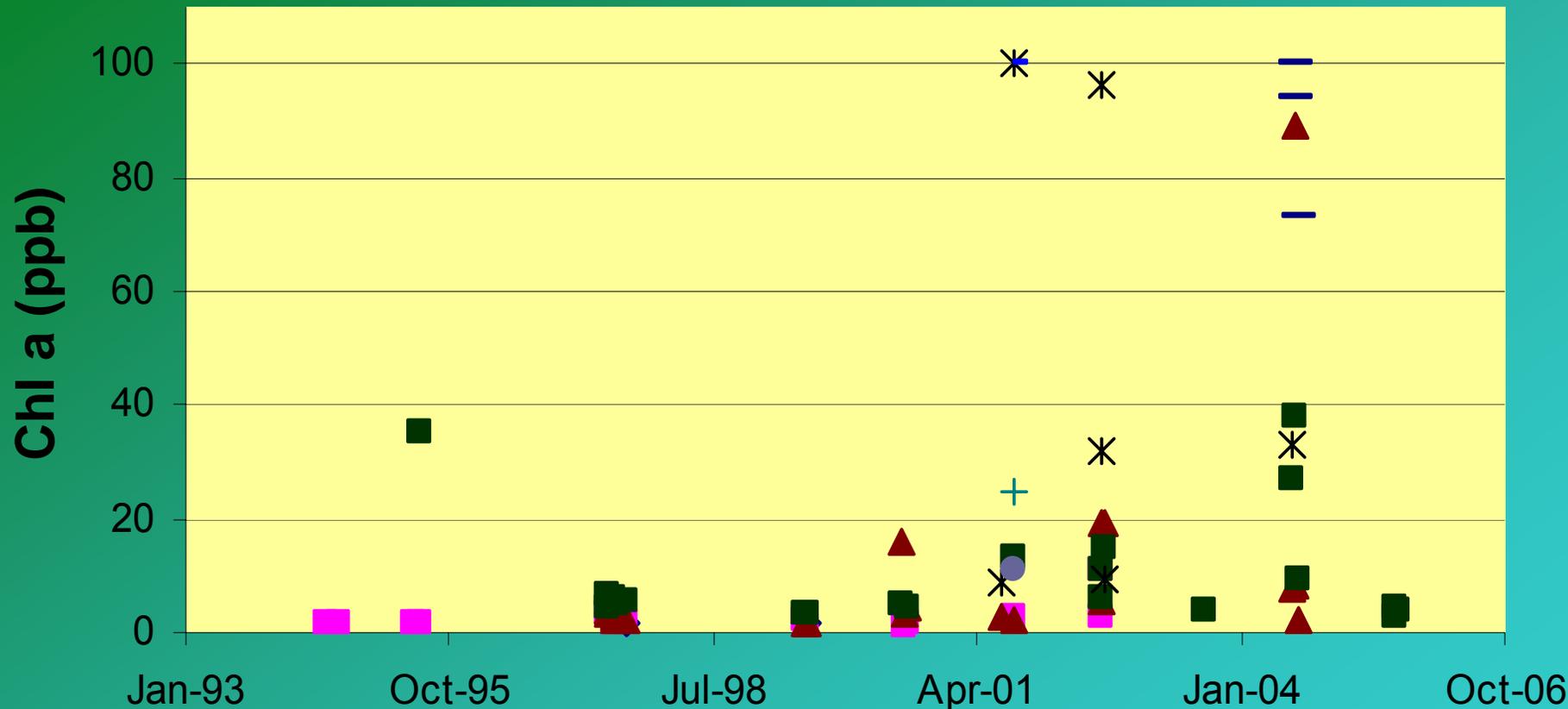


West Branch Penobscot Chlorophyll-a Data

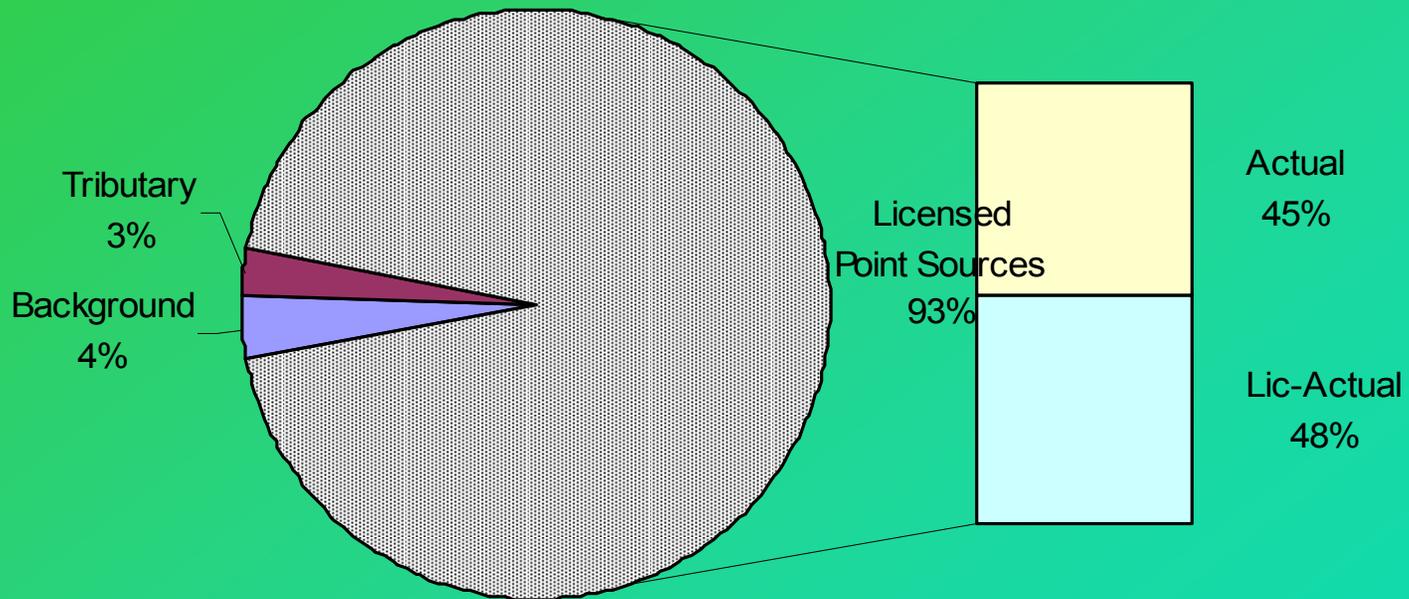


Chlorophyll-a Values 1994 - 2005

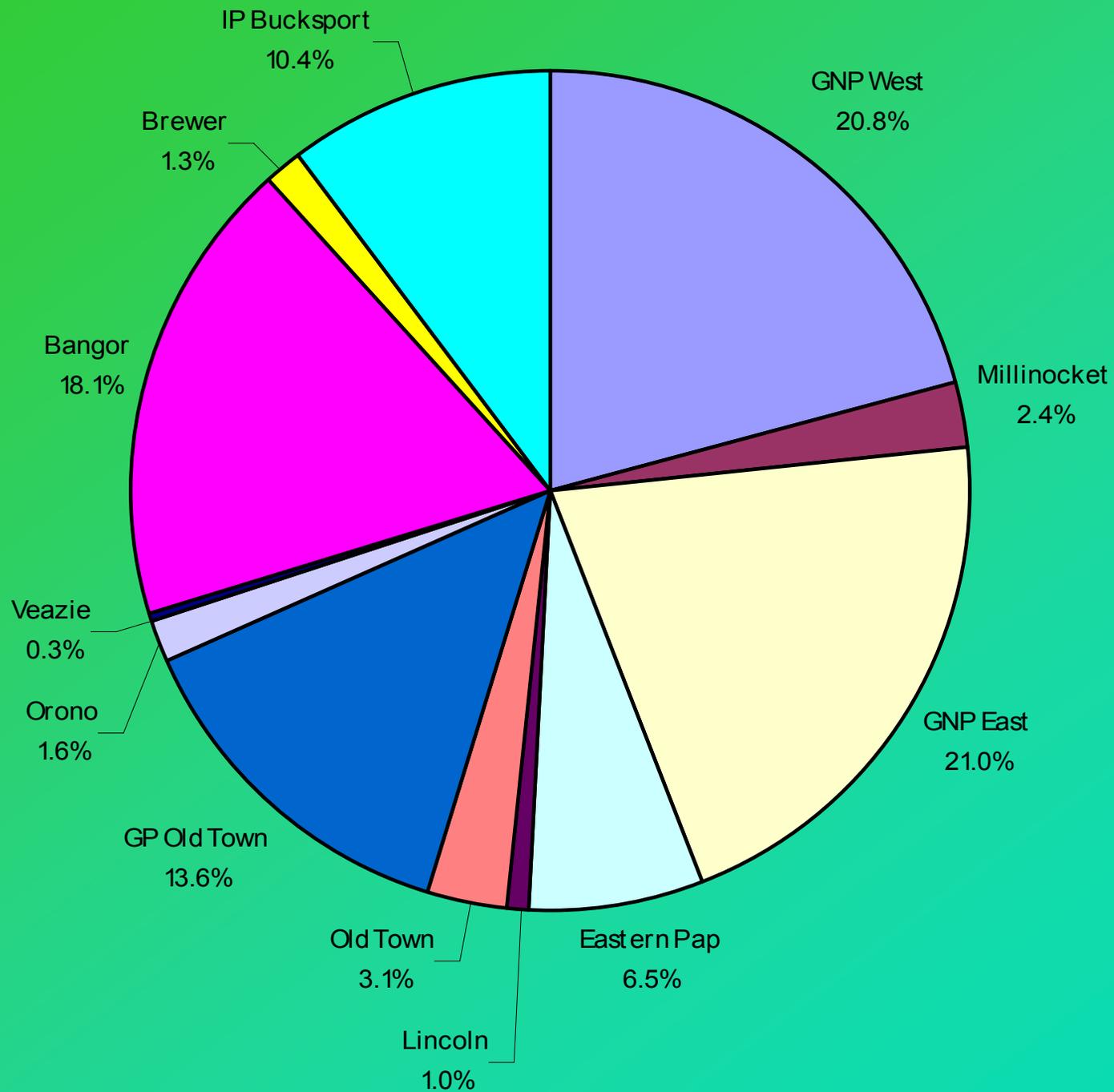
Dolby Pond



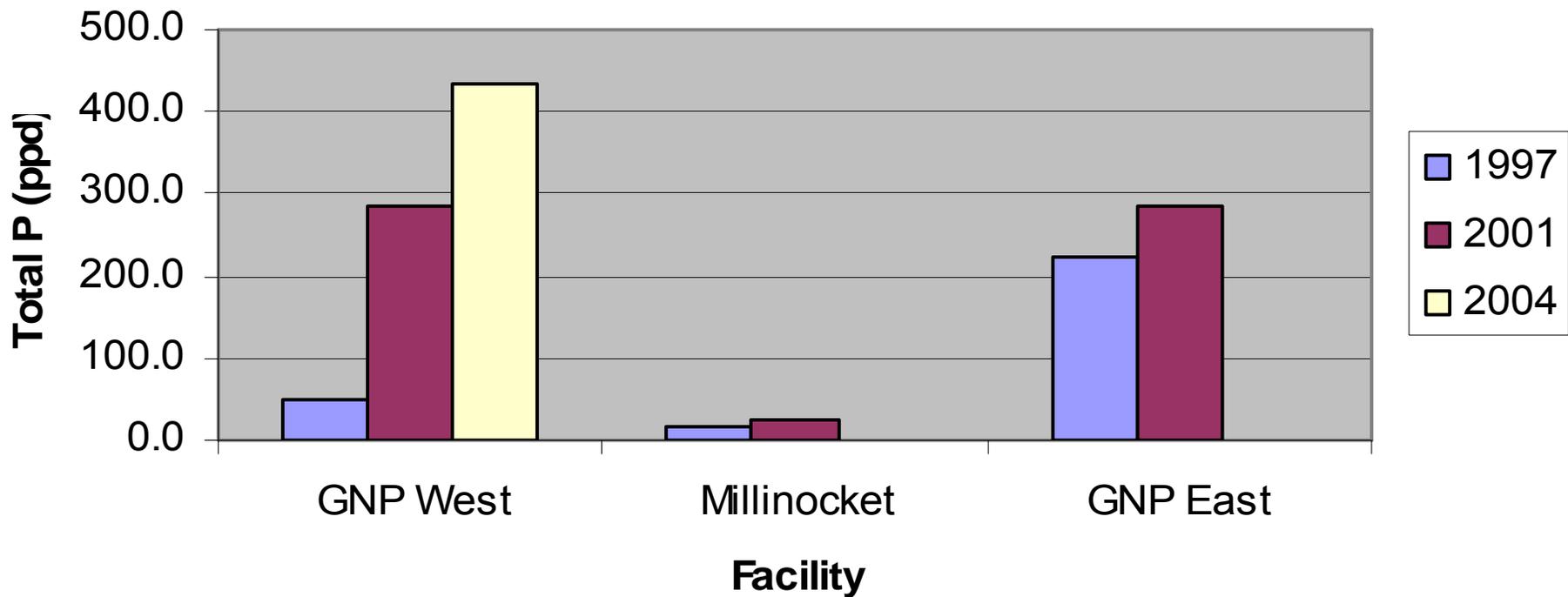
Total Phosphorus



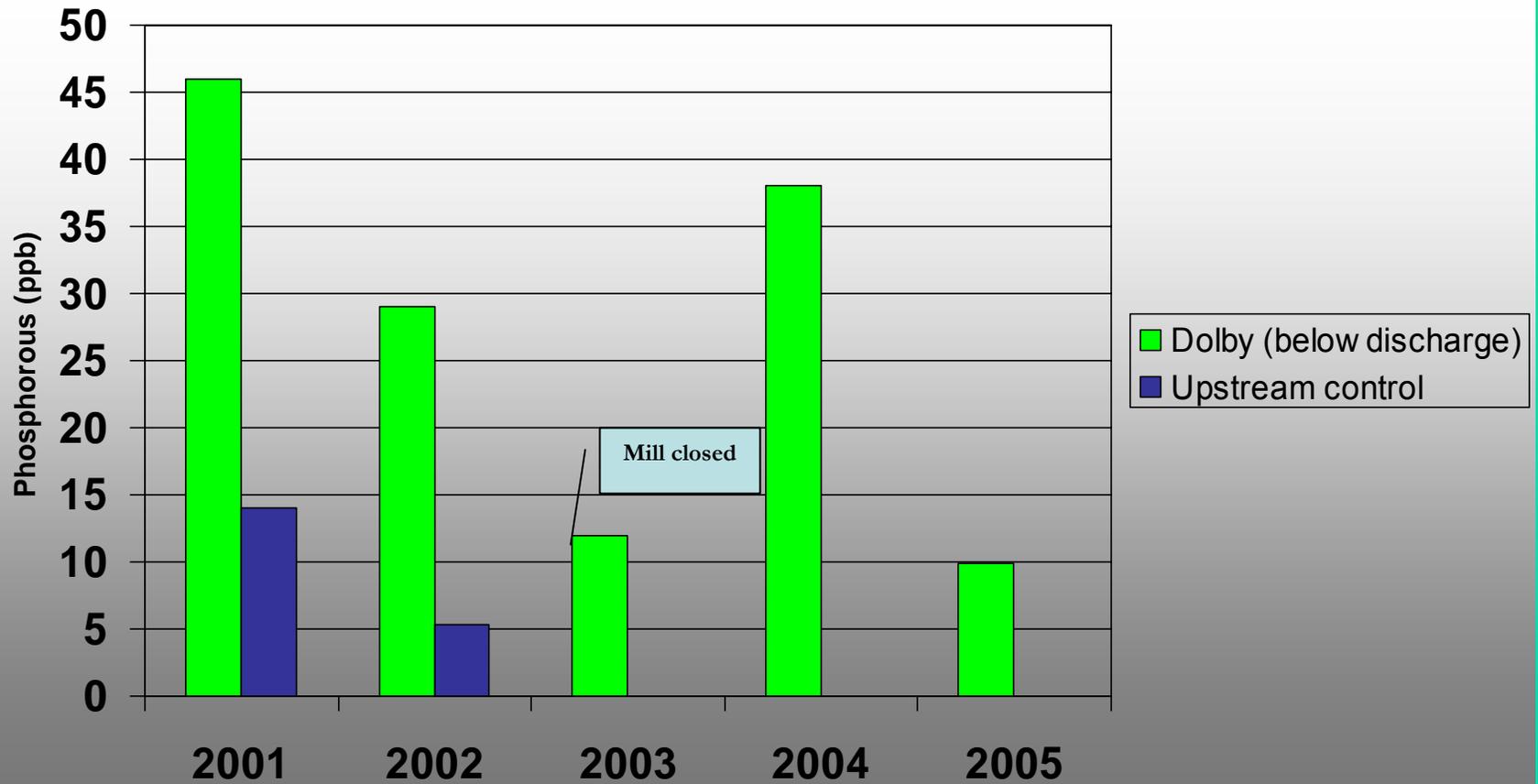
Point source discharges currently have no phosphorus restrictions. The phosphorus for point sources are based upon concentrations measured during the 97 and 01 surveys and WWTP licensed and actual flows.



Total P Loading to W. Branch Penobscot



Instream Total Phosphorous Levels



PENOBSCOT RIVER BLOOMS



- Worst bloom seen in 2004
- Now dominated by cyanobacteria:
 - *Anabaena macrospora*
 - *Anabaena spiroides*
 - *Microcystis aeruginosa*
 - *Microcystis flos-aquae*
- All known toxin producers - anatoxin-a and microcystin

PENOBSCOT RIVER BLOOMS



- Only some cyanobacteria contain hepatotoxins or neurotoxins
- All of them contain lipopolysaccharides (LPS) in their cell wall, which may be the cause of irritations of the:
 - skin
 - digestive tract
 - respiratory membranes
 - eyes
 - ears

Toxic Cyanobacteria in Water: A Guide to Their Public Health Consequences, Monitoring and Management. World Health Organization, E&FN Spon, Routledge, London, 1999.



PENOBSCOT RIVER BLOOMS

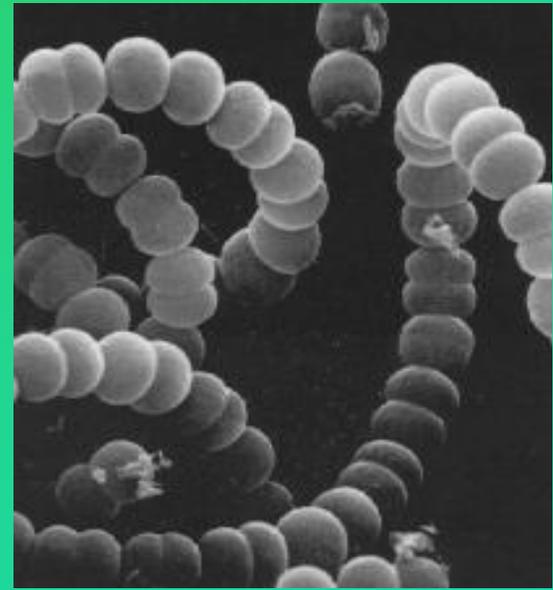
The implications of the present state of knowledge for surveillance and management are that any mass development of cyanobacteria may be a potential health hazard.

If the cyanobacterial cells contain hepatotoxic microcystins, cause for concern may be higher because of the chronic effects of this potent toxin.

Toxic Cyanobacteria in Water: A Guide to Their Public Health Consequences, Monitoring and Management. World Health Organization, E&FN Spon, Routledge, London, 1999.

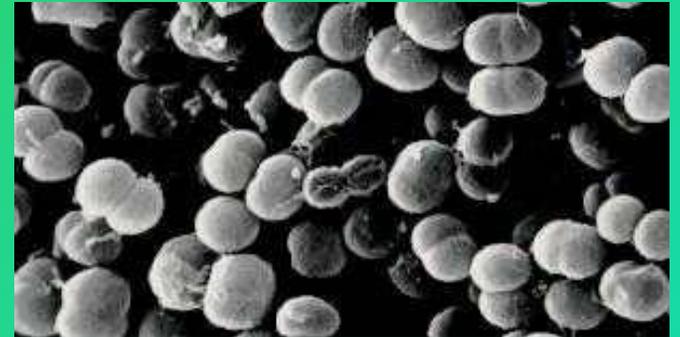
PENOBSCOT RIVER BLOOMS

- Although *Anabaena* was clearly the dominant species (90% of biomass in sample), they were not producing detectable levels of anatoxin-a (neurotoxin)



PENOBSCOT RIVER BLOOMS

- Although *Microcystis* was present in low levels (10% of biomass in sample), they were producing detectable levels of microcystin (*hepatotoxin*) at $0.20\mu\text{g/L}$



PENOBSCOT RIVER BLOOMS



- 0.20 μ g/L of microcystin present
- **What does this mean for ingestion risk?**
 - Microcystin levels were below WHO levels for finished drinking water (1.0 μ g/L) Toxic Cyanobacteria in Water: A Guide to Their Public Health Consequences, Monitoring and Management. World Health Organization, E&FN Spon, Routledge, London, 1999.
- **What does this mean for contact risk?**
 - Moderate risk = 20 ug/L microcystin in the top 4 meters of surface waters Monitoring Bathing Waters, edited by Jamie Bartram and Gareth Rees published by E&FN Spon. for WHO and the EPA in 2000.

PENOBSCOT RIVER BLOOMS

Level of risk ¹	Health risks	Recommended actions
20,000 cells cyanobacteria per ml or 10 µg l ⁻¹ chlorophyll a with a dominance of cyanobacteria	Short-term adverse health outcomes (e.g. skin irritations and gastro-intestinal illness, probably at low frequency)	Post on-site risk advisory signs Inform relevant authorities
10 ⁵ cells cyanobacteria per ml or 50 µg l ⁻¹ chlorophyll a with a dominance of cyanobacteria	Potential for long-term illness with some species Short-term adverse health outcomes (e.g. skin irritations and gastro-intestinal illness)	Watch for scums Restrict bathing and further investigate hazard Post on-site risk advisory signs Inform relevant authorities
Cyanobacterial scum formation in bathing areas	Potential for lethal acute poisoning Potential for long-term illness with some species Short-term adverse health outcomes (e.g. skin irritations and gastro-intestinal illness)	Immediate action to prevent contact with scums; possible prohibition of swimming and other water-contact activities Public health follow-up investigation Inform relevant authorities

¹ Expressed in relation to cyanobacterial density and given in order of increasing risk

PENOBSCOT RIVER BLOOMS



Australian Government

National Health and Medical Research Council

GUIDELINES FOR MANAGING RISKS IN RECREATIONAL WATER

www.nhmrc.gov.au/publications/synopses/eh38.htm

Child = 10 $\mu\text{g/L}$ total microcystins OR 50,000 cells/mL

Adult = 44 $\mu\text{g/L}$ total microcystins OR 220,000 cells/mL



Paskehtek^wok

Joining of the Branches

from Main Square

Pennabetsch Indian Nation
Department of Natural Resources

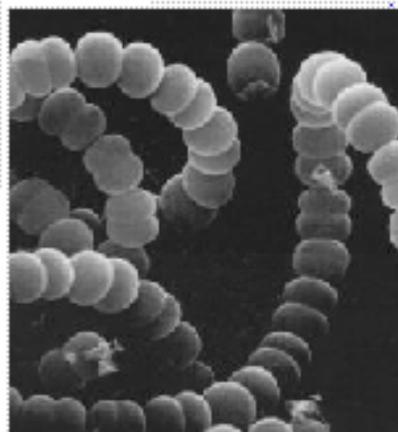
Summer 2004 - Issue 3

Phone Extensions	
Air Technician	7340
David Akonag, Forest	7335
Technician	
Ross, Ross, Forest Technician	7326
John Banks, DNR Director	7330
Rhonda Daigh, Water Quality Monitoring Program	7326
Coordinator	
Clara Jay, Fisheries	7362
Manager	
Yvonne "Cookie" Frantz,	7331
Administrative Assistant	
Tim Gould, Game Warden	7395
Subervisor	
Don Fuchartz, Water	7361
Resources Program Manager	
Frank Loring, Game Warden	7392
Warden	
Jack Loomis, Game Warden	7393
Jason Mitchell, Water	7381
Resources Field Coordinator	
Eric Nicolas, Air Quality	7336
Manager	
Jim Parfilla, Game Warden	7397
Ed Paul, Game Warden	7397
Jim Paul, Water Resources	7382
Field and Lab Technician	
Angie Reed, Water	7360
Resources Planner	
Russ Roy, Forest Manager	7339
Dennis Stevens, Forester	7337
Arlene Wine, GIS Specialist	7341
Water Resources Technician	7363

What Is That Smell?

If you have noticed an earthy or musty smell coming from the river in the past few weeks here is the explanation: we are experiencing what is called a "bloom" of a particular kind of cyanobacteria named *Anabaena*. A bloom is the commonly used word to describe times of high concentrations of these organisms in the water—sometimes forming thick layers or scum on the surface. The highest concentrations are up in Doby Pond in Millinocket and at Waikou Dam. However our aerial surveys and water quality monitoring show that it extends well past Indian Island. While you may not have seen the river around Indian Island turn an

intense blue-green color, it is down here. The water resources staff are working hard on sampling and analyzing many aspects of this bloom! Some species of cyanobacteria produce toxins - but preliminary results have shown maximo one we have in the river is not one of them. However, we are continuing to collect samples and work with the Wright State University laboratory to get a confirmed identification of each



Greatly magnified photo of *Anabaena* species from the web site of Dr. Wayne Corns' lab

species present and determine whether there are any toxins in the water. We should have more results this week. For more information about cyanobacteria, read on!

CYANOBACTERIA DEFINITION

But what are cyanobacteria? If you ask: well cyanobacteria are members of a group known as eubacteria or true bacteria. They also have the distinction of being the oldest known fossils—

(Continued on next page)

CAUTION ~ CAUTION

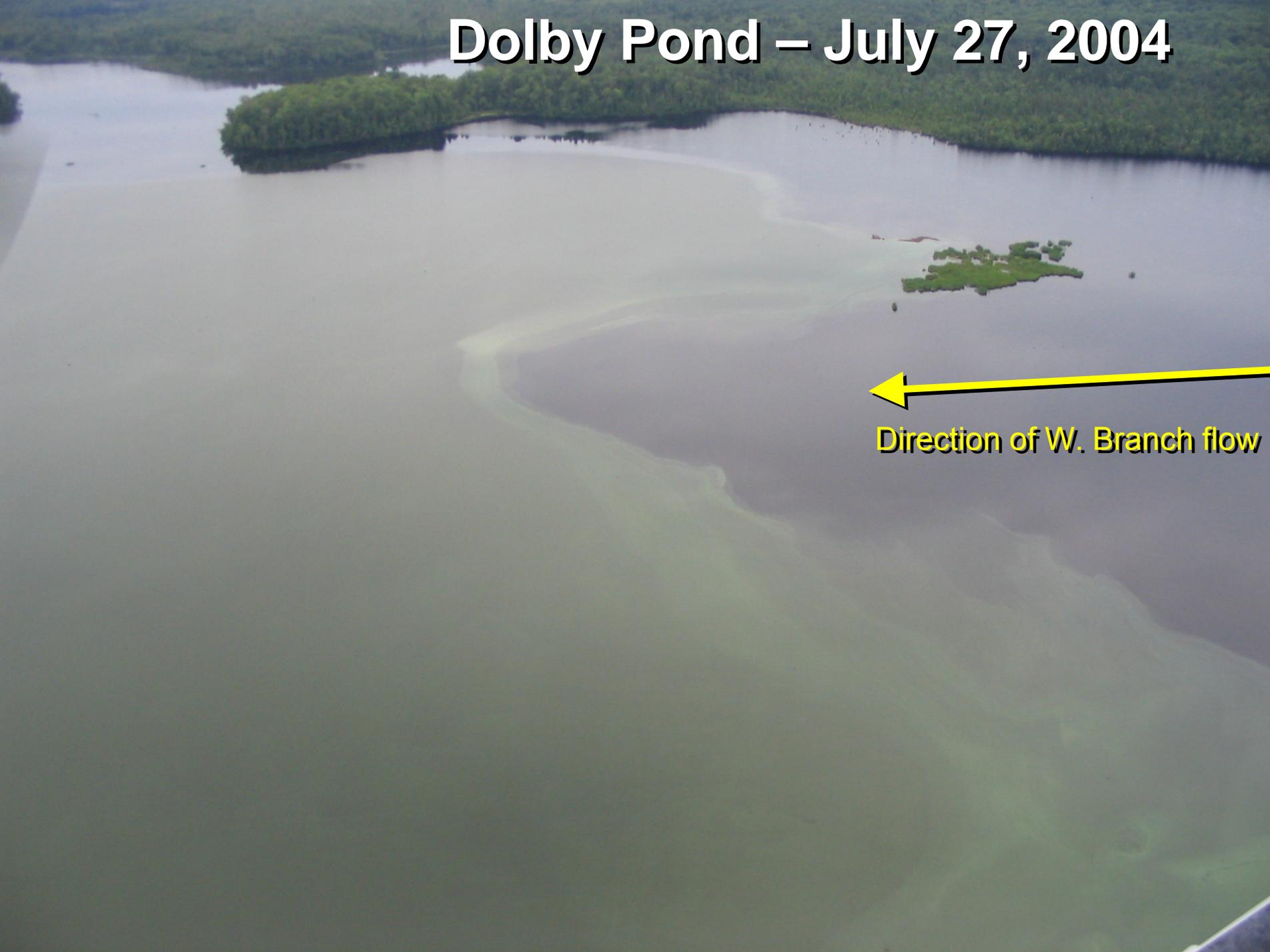
As a precaution, we recommend that you and your pets **DO NOT** ingest any river water at this time - especially near or in areas of large accumulations that look very blue-green in color.



PENOBSCOT RIVER BLOOMS

- **Main stem extent in late July 2004: at least below the Mattawamkeag River**
- **By mid Aug 2004 the bloom extended down the coast to Lincolnville – over 75 miles downriver**
- **Less visually intense below dams but higher chl a levels**
- **Dams potentially breaking up filaments and increasing growth?**

Dolby Pond – July 27, 2004



Direction of W. Branch flow



Dolby Pond edges – July 27, 2004





**Penobscot-Mattawamkeag confluence –
July 27, 2004**

Rockabema Dam – July 27, 2004





PENOBSCOT RIVER BLOOMS

Additional work/ data gaps:

- **Definition of a bloom**
- **Determination of onset and severity of blooms (esp. relative to other years) - possibly using data sondes**
- **Factors affecting blue-green blooms**
- **Taxonomy and community composition**
- **P sampling**
- **Role of dams as “cookers”**
- **Impact of tailrace or turbines on bloom dynamics**

PENOBSCOT RIVER BLOOMS

An aerial photograph of a river bend, likely the Penobscot River, showing a significant green algal bloom in the water. The surrounding area is densely forested with green trees.

The discharger(s) have decreased P and ME DEP is proposing to develop P criteria. The big question...

- **Have we seen a permanent species shift?**
- **Will other factors contribute to or trigger a bloom?**
 - **Weather**
 - **N:P ratio**

An aerial photograph of a river winding through a dense forest. The water is covered in a thick, green, fuzzy layer of algae blooms, which are reflected in the water's surface. The surrounding trees are lush green.

PENOBSCOT RIVER BLOOMS

Effects on tribe:

- **Tribal members cannot carry out sustenance fishing rights due to toxics including dioxins, PCBs, and Hg. These blooms further impair tribe's ability to carry out cultural and traditional practices including**
 - **Sweat lodges**
 - **Canoeing**
 - **Gathering plants for food and medicine**
 - **Swimming**

