USGS Monitoring and Research in the Barnegat Bay Watershed

New Jersey Department of Environmental Protection
Barnegat Bay Stakeholder Meeting
Ocean County College
May 5, 2010

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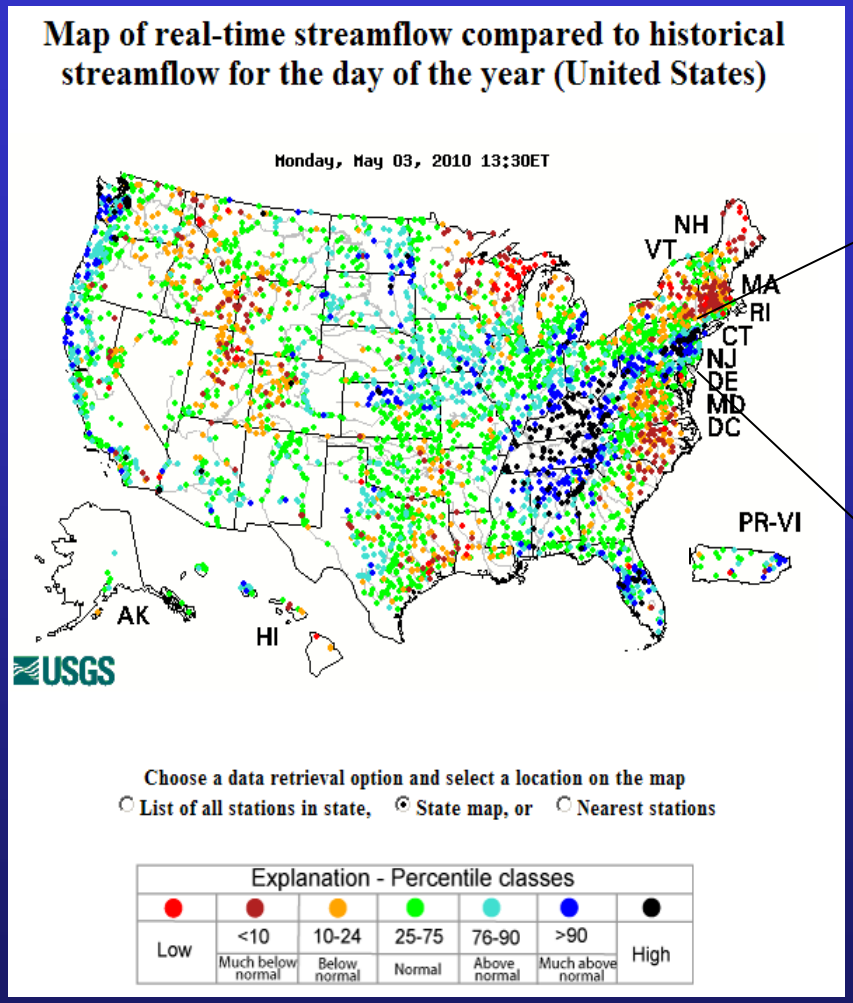
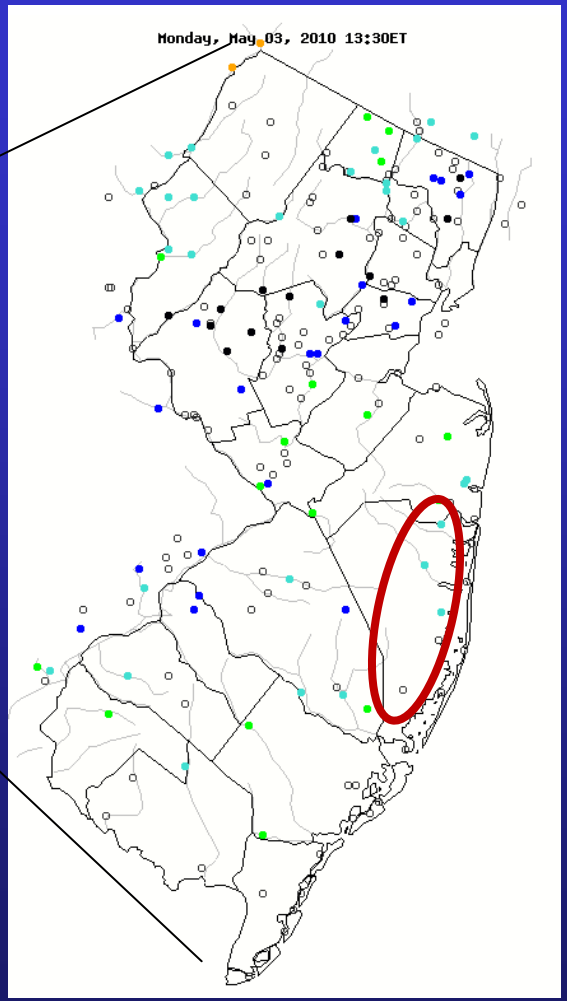
USGS STREAMFLOW MONITORING NETWORK





- 114 Continuous Record Discharge Gages / 4 in BBLEH
- 181 Partial Record discharge sites / 15 in BBLEH
- 99 Crest Stage Gages / 5 in BBLEH

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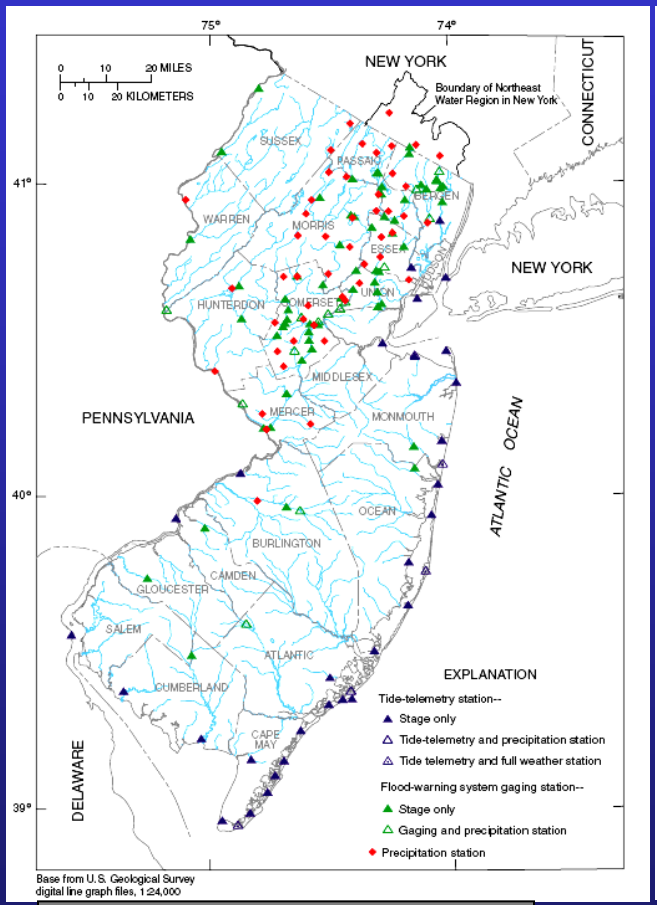
Surface-Water Monitoring Networks

Funded cooperatively with various agencies

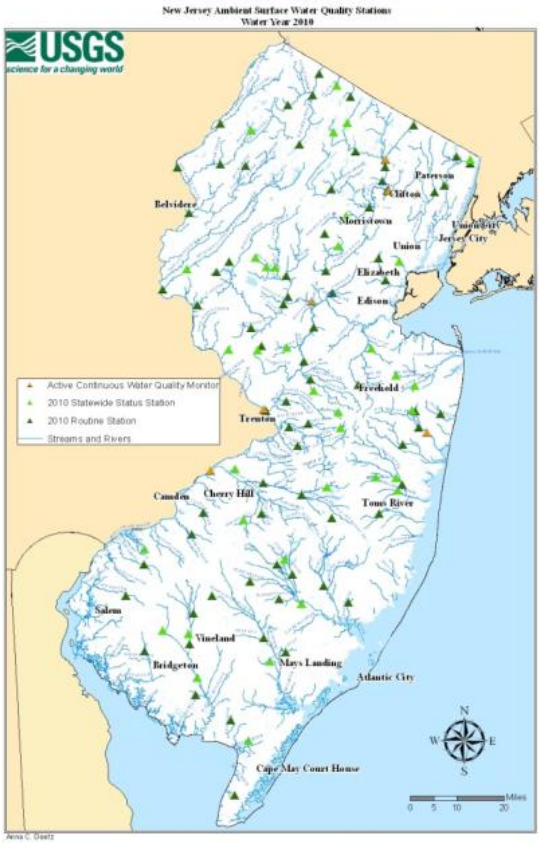
Flood/Tide Warning



NJ Coastal Tide gages w/ NJOHSP
- 25 Continuous tide gages / 5 in BBLEH
- 33 crest stage gages/ 3 in BBLEH
- 5 weather stations / 1 in BBLEH

Flood Warning Networks with 5 Counties & USACE
- 45 stage-only gages /1 in BBLEH
- 36 precipitation gages
- 13 continuous-discharge gages

Water Quality Monitoring



115 Water-quality sites w/ NJDEP
- 7 Background
- 42 Statewide status sites /3 in BBLEH
- 23 Watershed integrator sites / 1 in BBLEH
- 43 Land use indicator sites / 1 in BBLEH
- Sampled seasonally (4 per year)

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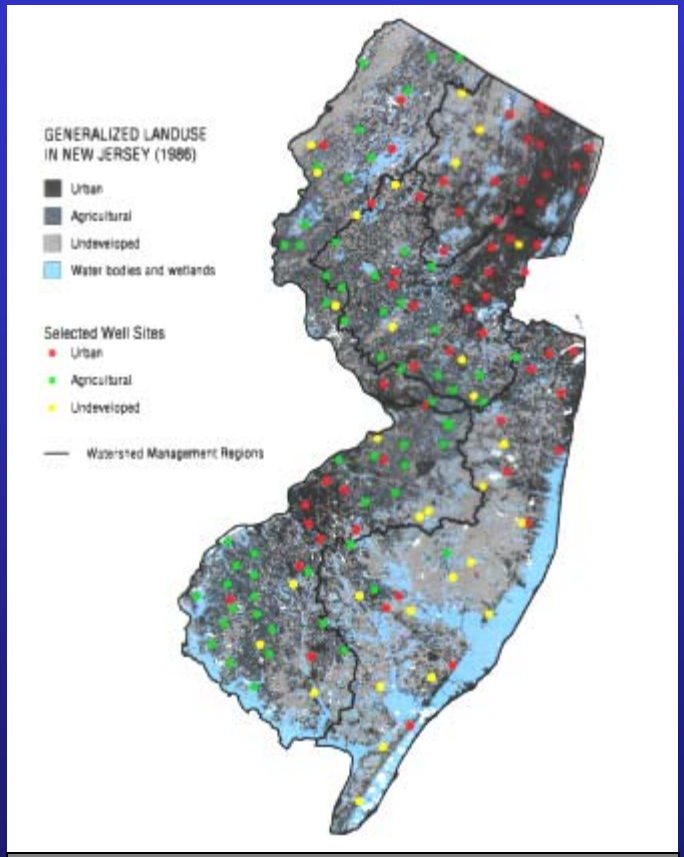
Ground-Water Network

Funded cooperatively with NJDEP

Ground-Water Levels

189 Sites total / 24 in BBLEH

Ground-Water Quality



- **150 random shallow wells / 11 in BBLEH**
- **Land-use stratification (Urban, Ag, Undevel).**
- **30 wells sampled annually (USGS & NJGS)**

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FRESHWATER INPUTS

590 million gallons per day (average)

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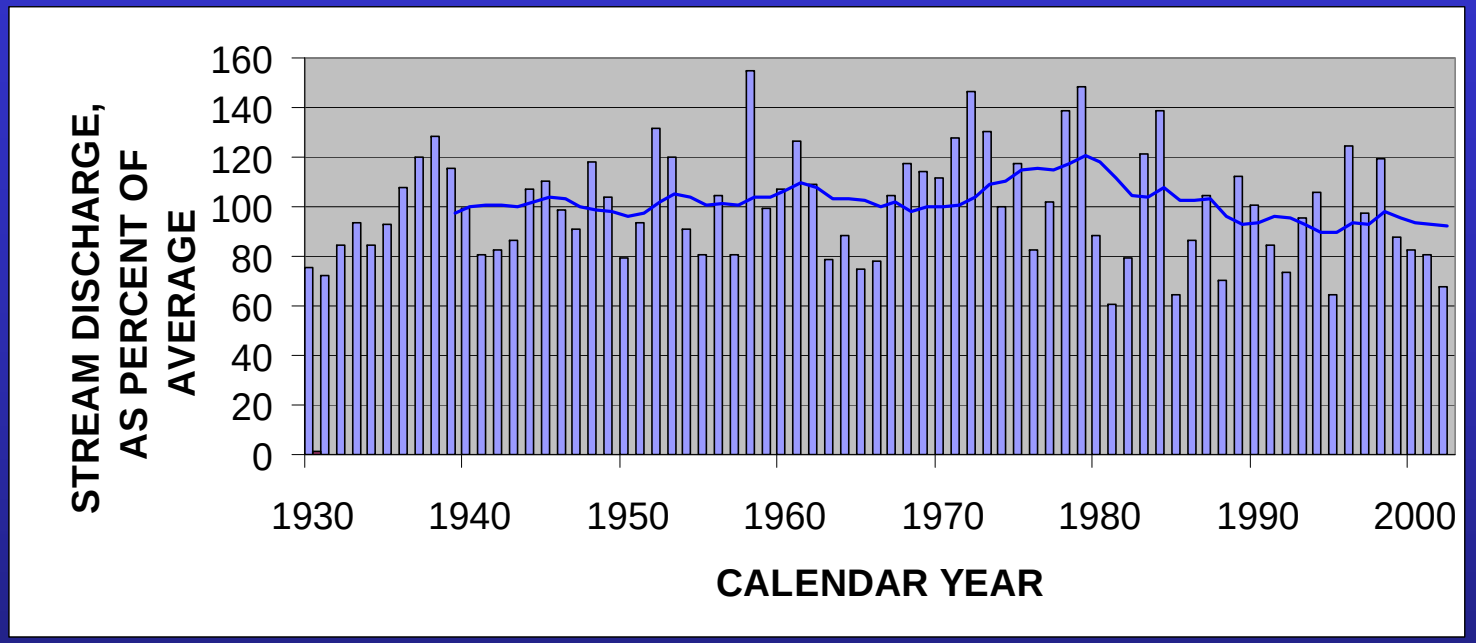
FRESHWATER INPUTS

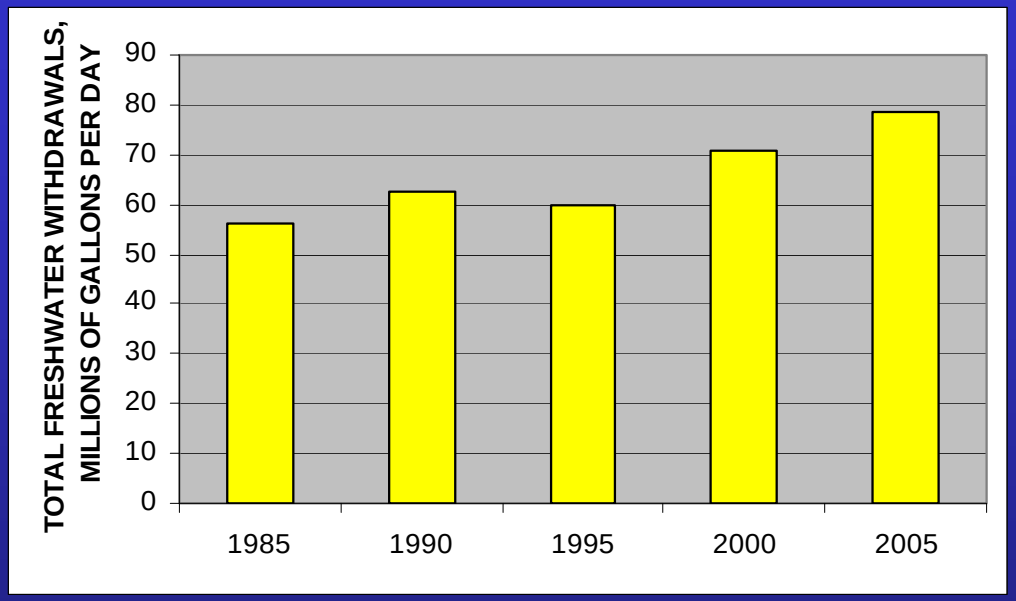
Toms River Streamflow 1929-2002



1929

2000

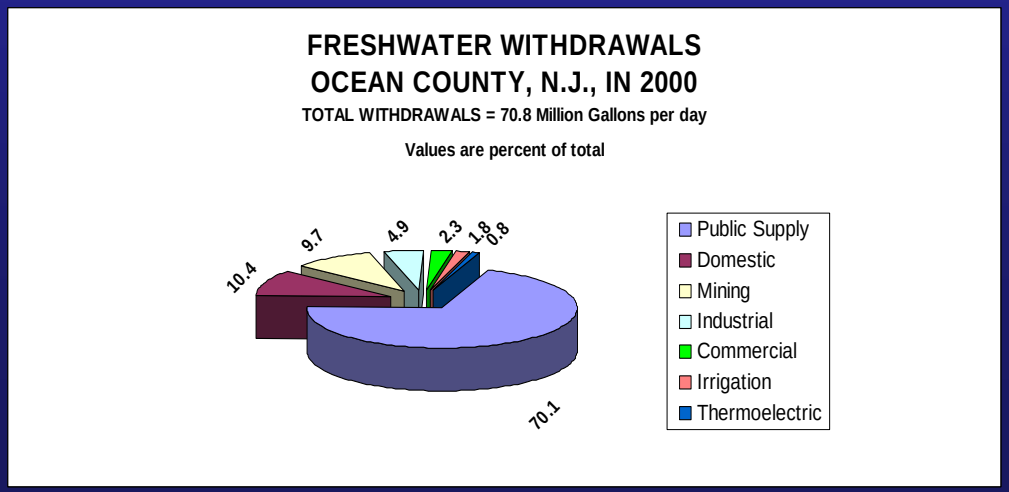
FRESHWATER INPUTS



FRESHWATER WITHDRAWALS

Ocean County

1985 - 2005



Nitrogen

Importance -- Biological productivity in coastal waters is normally limited by the availability of nitrogen, with secondary P limitation (demonstrated in Barnegat Bay by Seitzinger, et al, 2001)

Common forms

- Organic nitrogen
- Inorganic forms: NO_3^-, NO_2^-, NH_3, NH_4^+

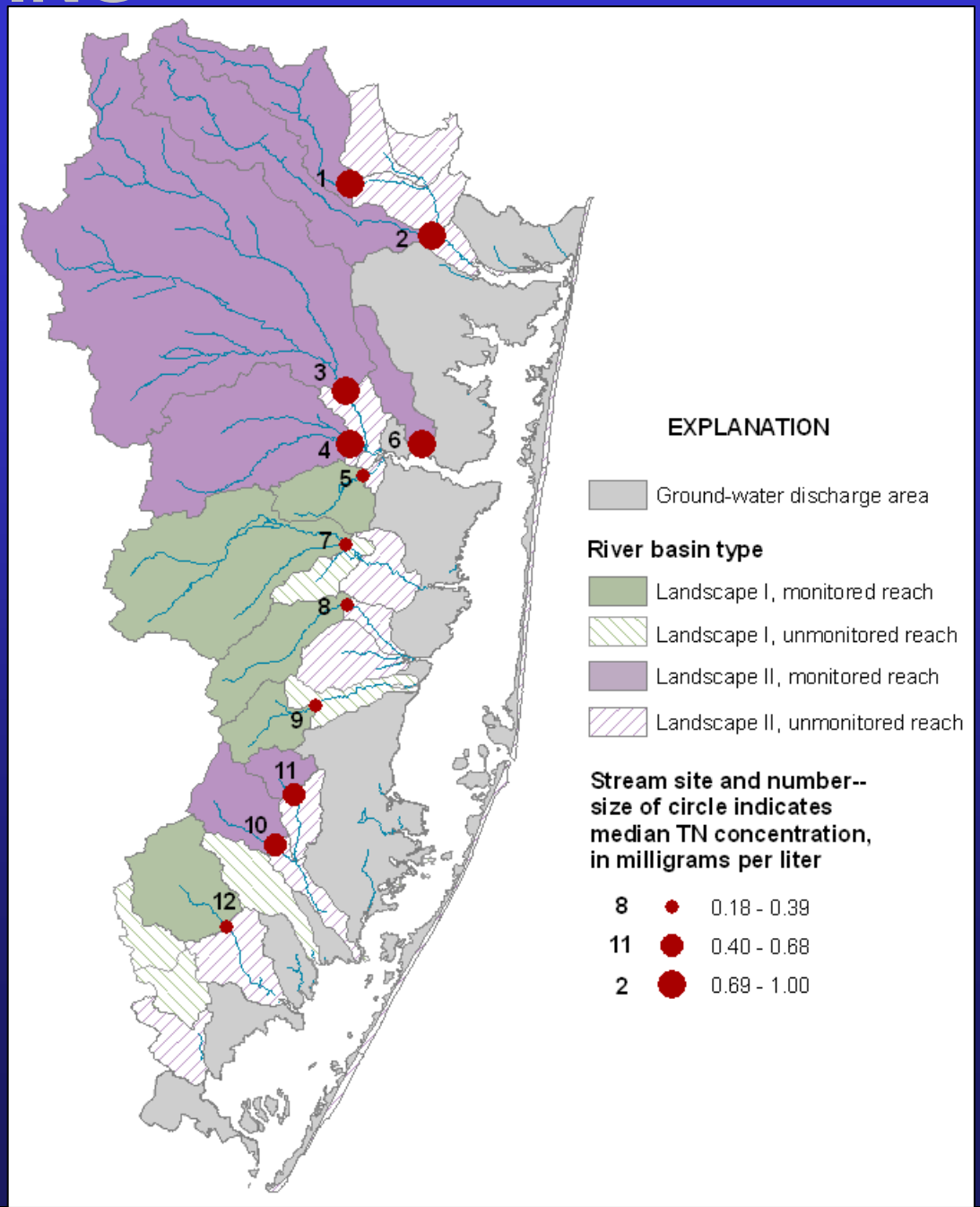
Common sources

- Residential and commercial areas
  - Lawn fertilizer, septic system waste, leaky sewer pipes, industrial discharge
- Agricultural areas
  - Crop fertilizer, animal manure, septic system waste
- Atmosphere
  - Automobile emissions, industrial emissions, natural N-fixation processes, emissions from agricultural sources

NITROGEN LOADING

Total Nitrogen Concentrations in Streams

Median concentrations of total nitrogen (TN) at 12 stream sites in the Barnegat Bay–Little Egg Harbor watershed, 1987–2008



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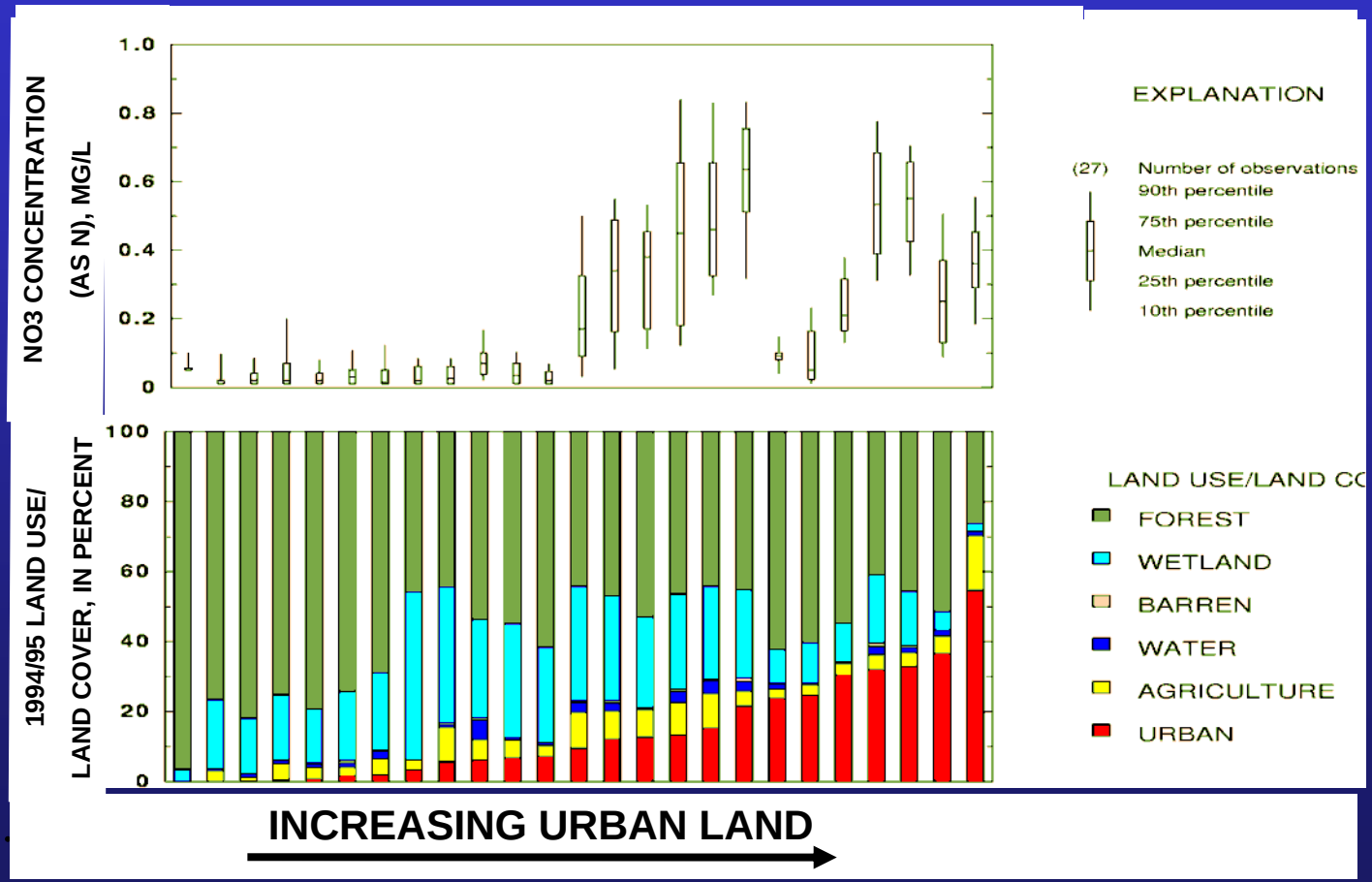
NITROGEN LOADING

RELATION BETWEEN WATER QUALITY AND LAND USE/LAND COVER



Source: Hunchak-Kariouk and Nicholson, 2001

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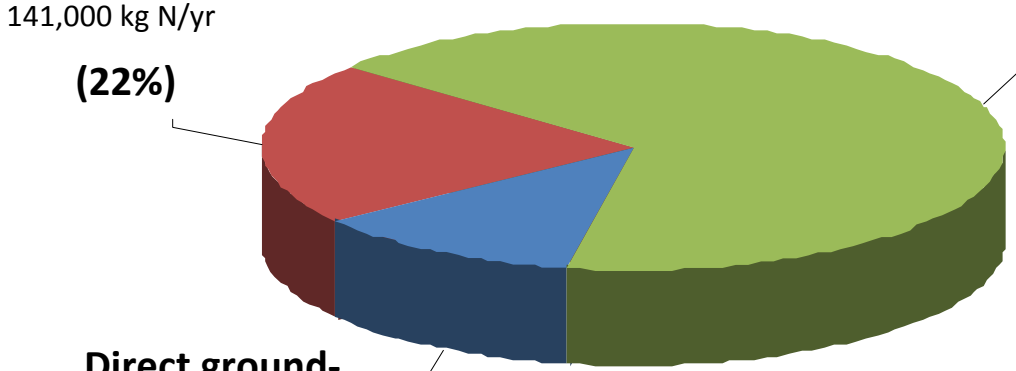
NITROGEN LOADING

Updated (2009) Estimate of Delivered Load



Direct atmospheric deposition
141,000 kg N/yr
(22%)

Surface water
(includes storm water and N in ground-water discharge as baseflow)
431,000 kg N/yr
(66%)

Direct ground-water discharge to the estuary
78,000 kg N/yr
(12%)

Total load = 650,000 kg N/yr

Wieben and Baker (2009)

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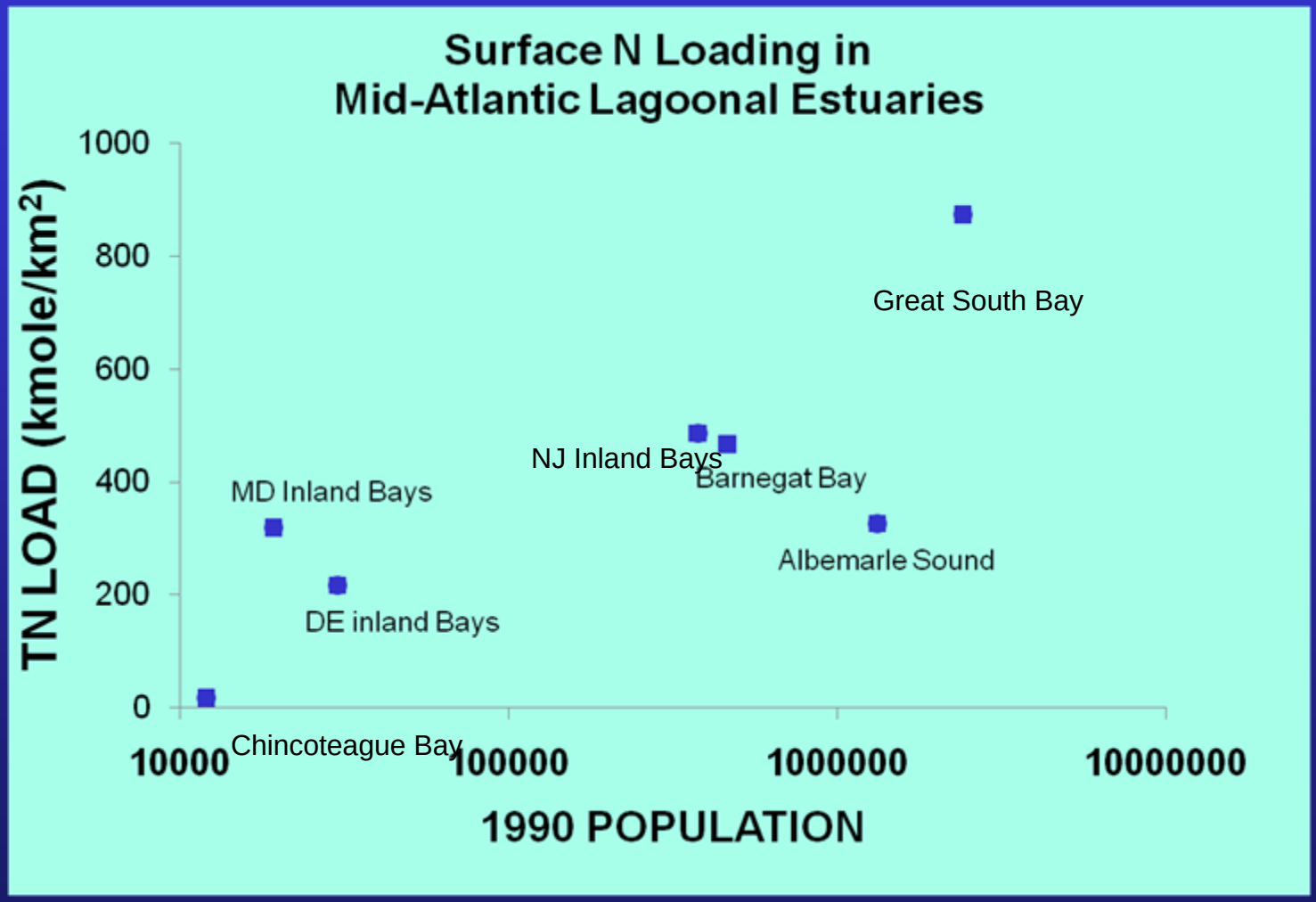
NITROGEN LOADING



Source: NOAA Estuarine Typology Database (Smith and others, 2003)

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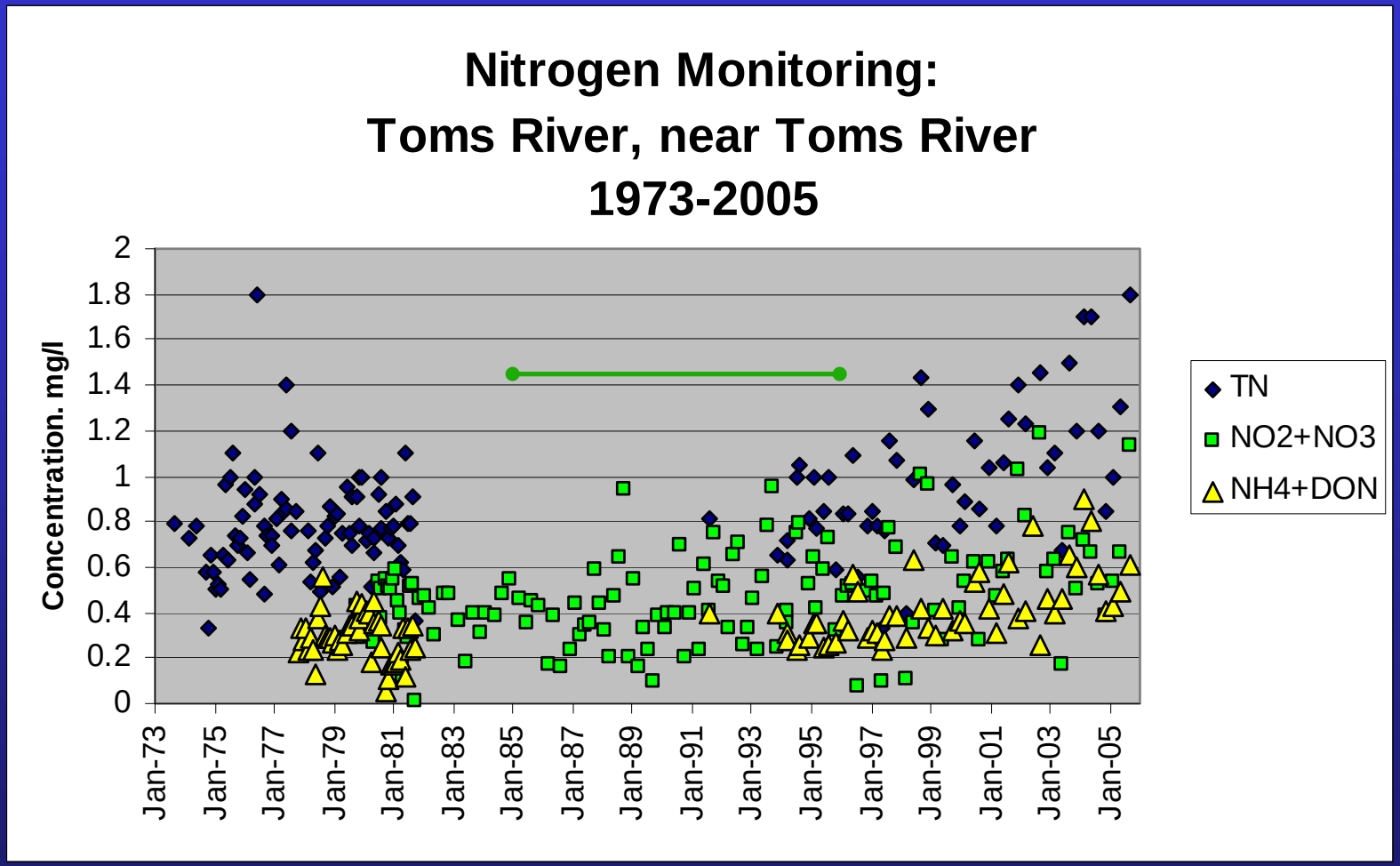
NITROGEN LOADING



Source: USGS/NJDEP Cooperative Ambient Stream Monitoring Network

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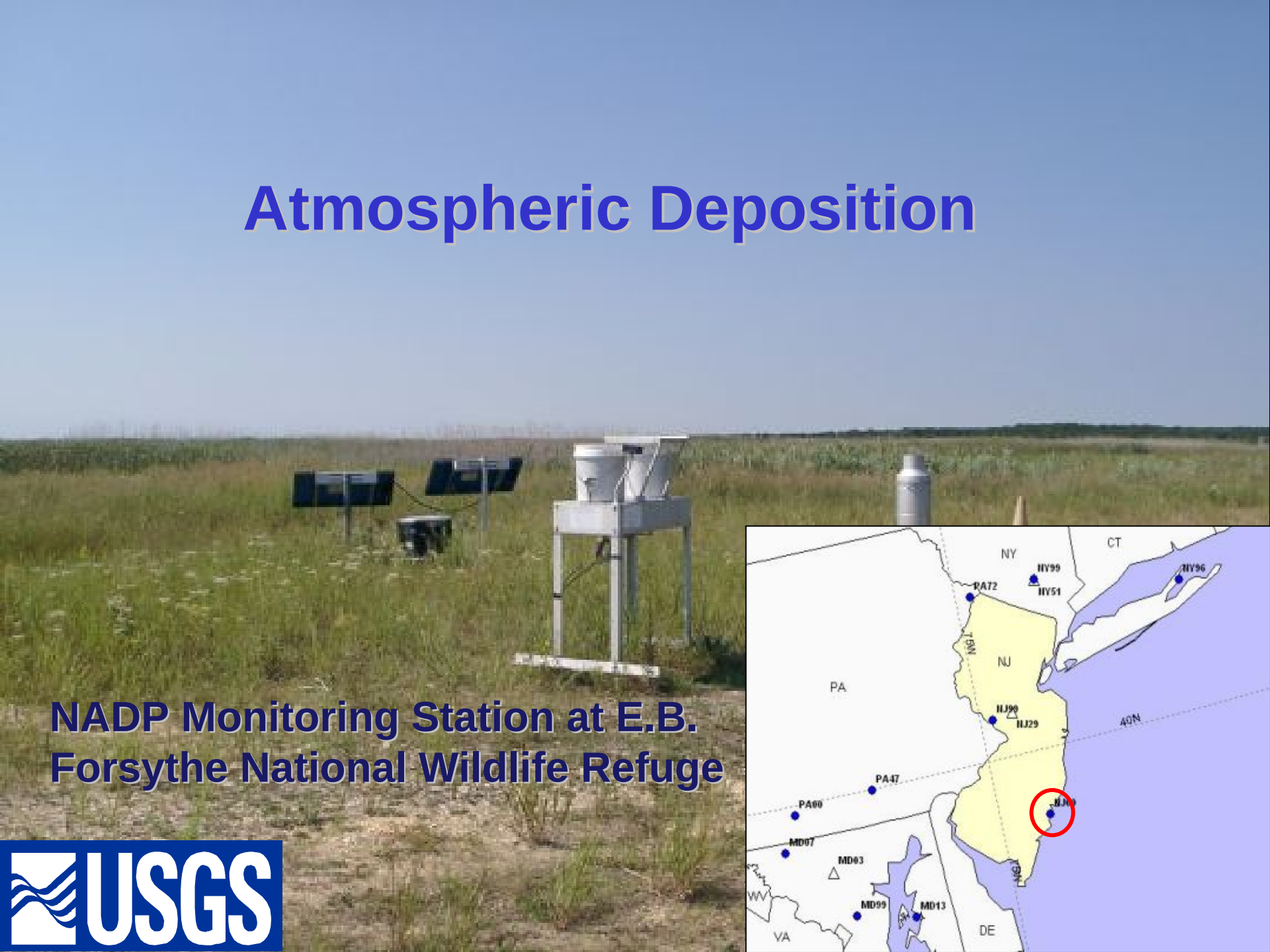
Increasing trend in NO2+NO3 during 1985-95 is statistically significant (p = 0.10)
(Hickman and Barringer, 1999)

Atmospheric Deposition



NADP Monitoring Station at E.B. Forsythe National Wildlife Refuge

SOURCES

Sources of N in atmospheric deposition:
Primarily local and regional combustion of fossil fuels

Local NOx emissions

Barnegat Bay NOx Airshed (NOAA-ARL and USEPA-NERL, 2001)

Regional sources: N may be transported over long distances before deposition

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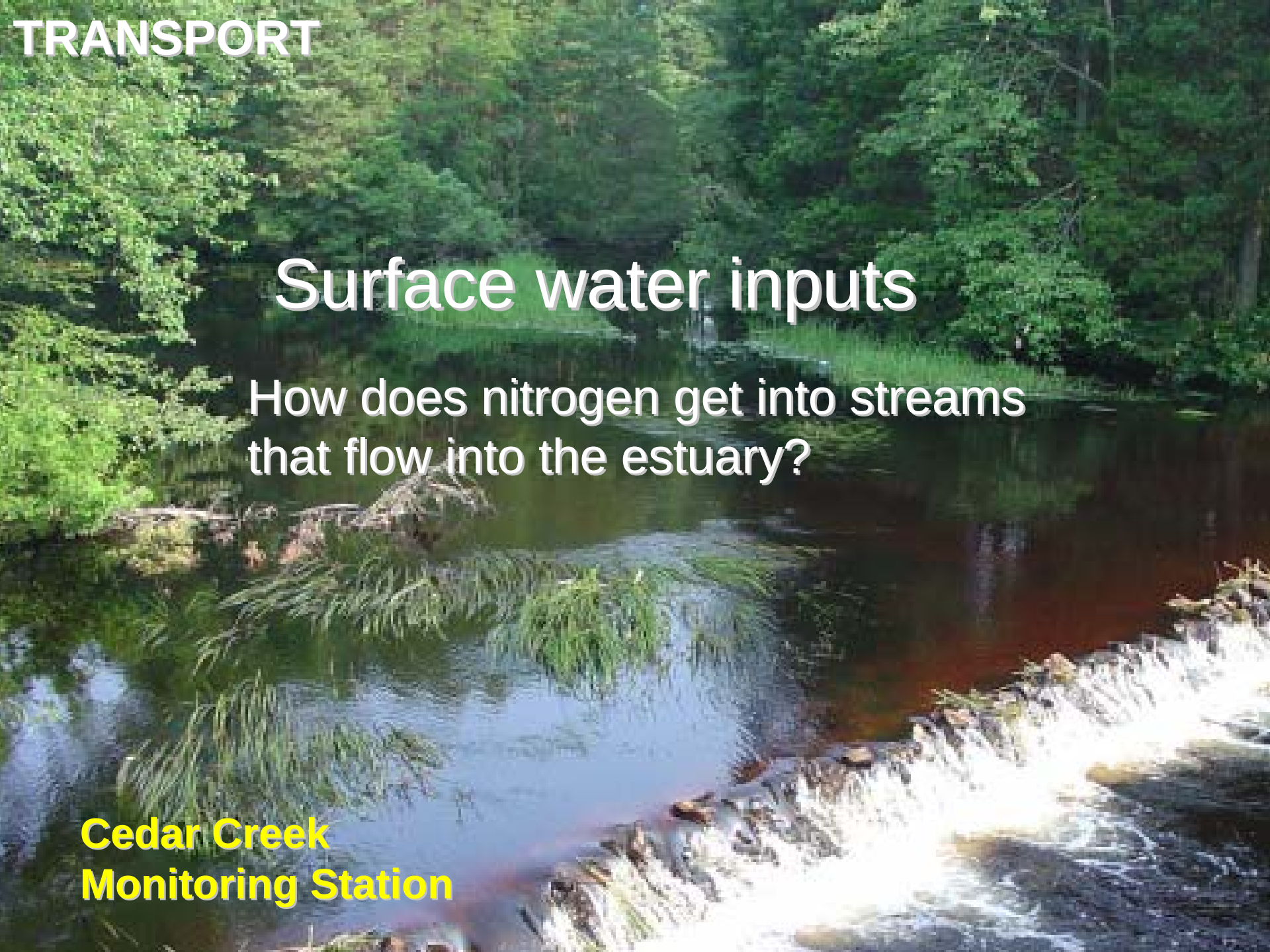

Surface water inputs

How does nitrogen get into streams that flow into the estuary?

Cedar Creek Monitoring Station

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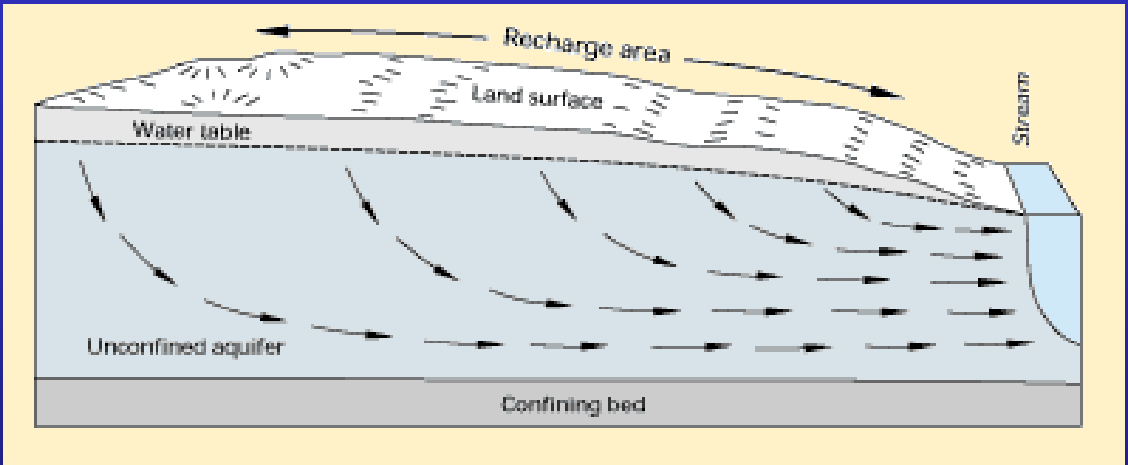
GROUNDWATER FLOW TO STREAMS



How much of the nitrogen load in streams comes from groundwater?

Baseflow sustains flow during dry periods

In southern New Jersey, 80% of streamflow is baseflow (comes from groundwater discharge)

Nearly all baseflow originates as aquifer recharge

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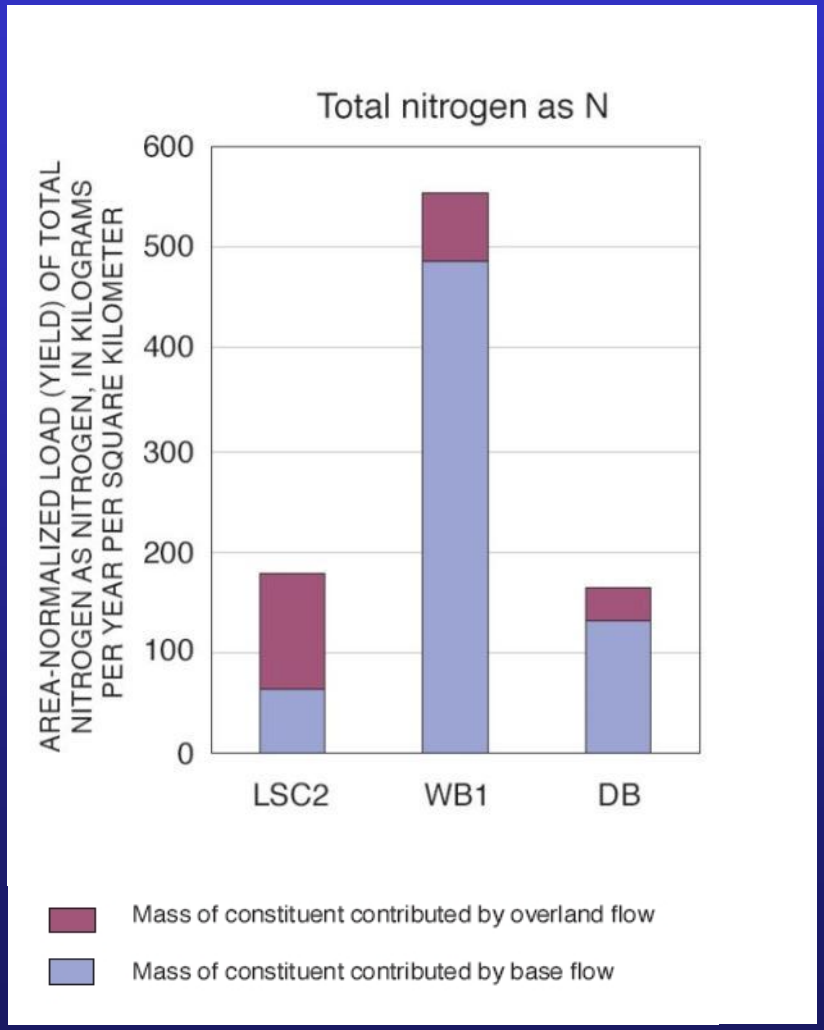
Relative Loads from Stormwater and Baseflow

USGS/NJDEP Toms River study (2006)

R. Baker and K. Hunchak-Kariouk (2006, USGS)

Connell and Schuster (NJDEP, 1999)

- Base flow contributed more of the N load than overland flow in 2 of 3 tributaries
- Groundwater is an important nitrogen transport pathway



Source: Baker and Hunchak-Kariouk, 2006

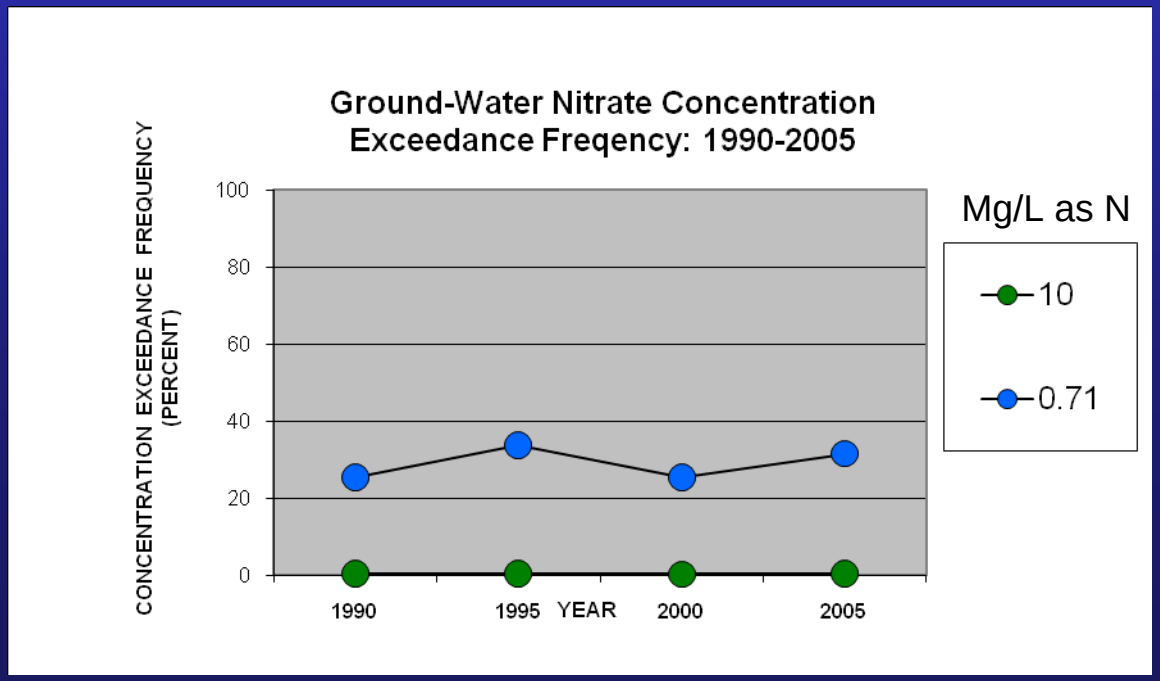
TRANSPORT

Using N in Groundwater as an Indicator of Potential Load

C. Wieben, USGS (2007)

1,700+ Ocean County ground-water sample results for 1990-2005

26-34% of ground-water sample concentrations were above proposed 0.71 mg/l N criteria for rivers and streams in Nutrient Ecoregion XIV (Atlantic Coast).



Data Source: Wieben, 2007

Ongoing USGS Research

- Simulation of nitrogen transport in groundwater
- Quantifying sources of Nitrogen
- Exploring linkage between nutrient loads and biotic responses

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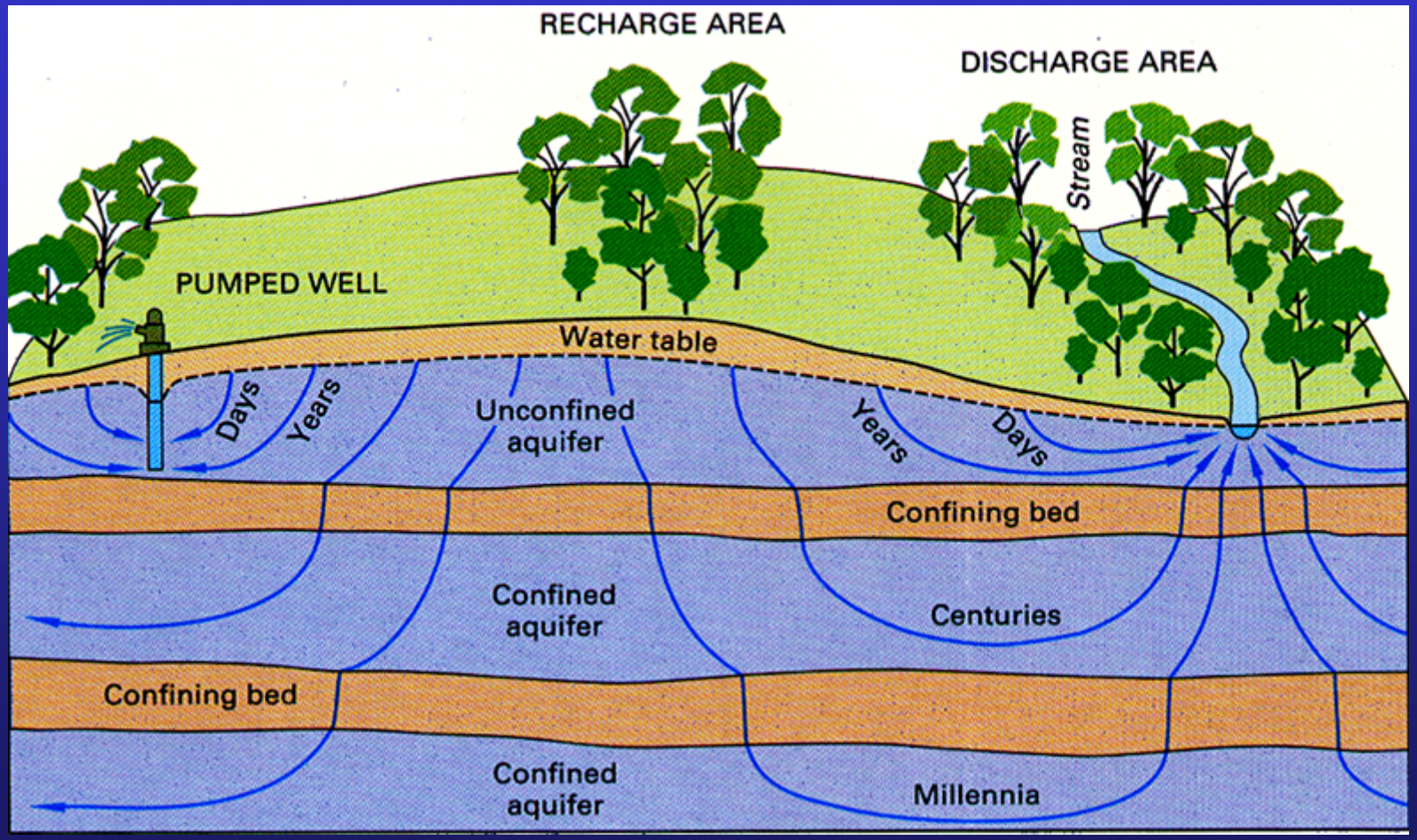
Transport

GROUNDWATER INPUTS



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Transport

Groundwater Flowpath Analysis

S. Cauller and L. Voronin, USGS (ongoing)

- Exploring the link between historical land use and nutrient loads
- Utilizing existing groundwater-flow model developed for water-supply analysis

- Objectives:

  - Determine if observed trends in base flow nutrient loads can be predicted from historical land use

  - Predict loads under alternative management strategies

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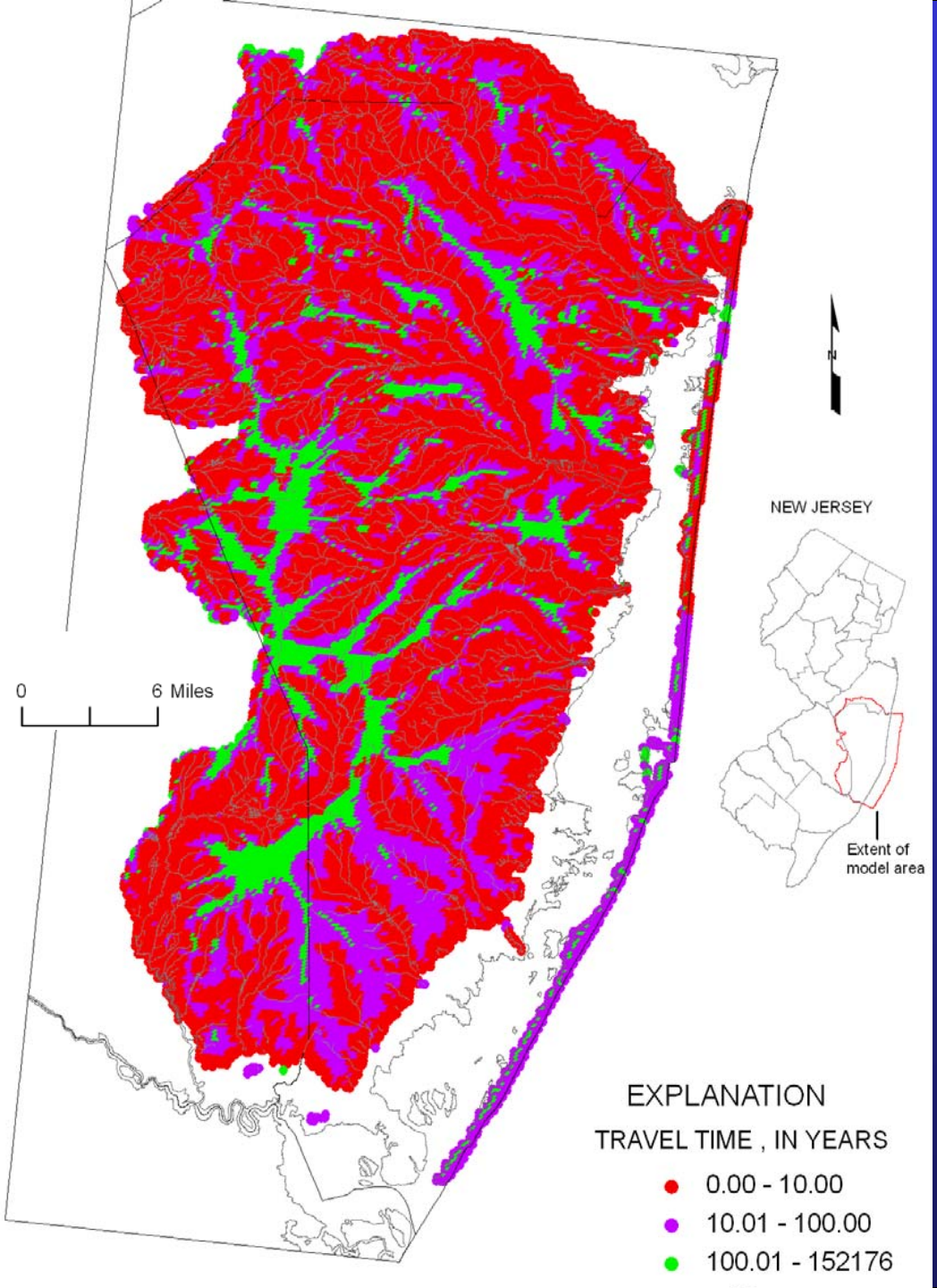
Preliminary simulated groundwater travel time from recharge to discharge area



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SOURCES

QUANTIFYING SOURCES OF NUTRIENT INPUTS TO THE BARNEGAT BAY-LITTLE EGG HARBOR ESTUARY

R. Baker and C. Wieben, USGS (ongoing)

Objectives:

- Improve current understanding of nutrient (N + P) sources

  (Using N and O isotope analysis)
- Quantify loading to previously unmonitored streams.
- Improve estimates of direct and indirect ground-water nutrient loading.

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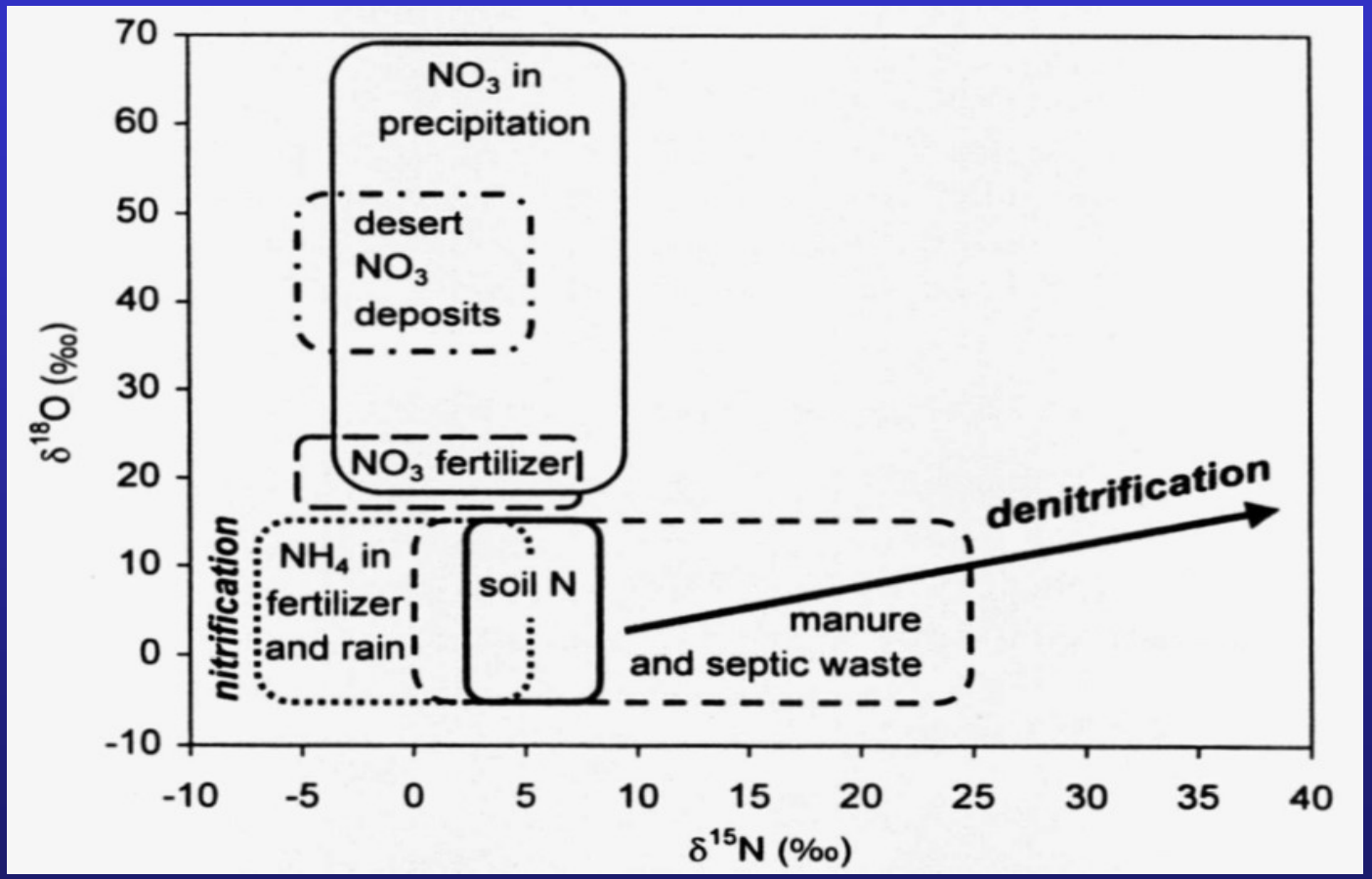
SOURCES

Using Isotopes to identify nitrogen sources



From OHTE and others, 2008

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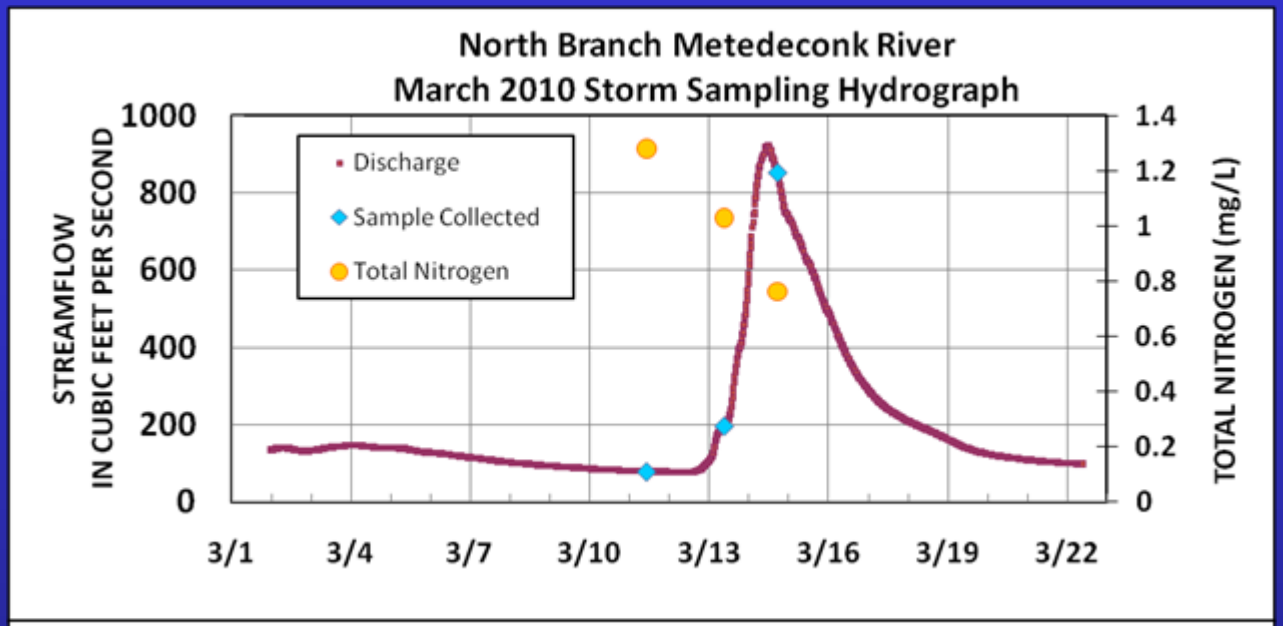
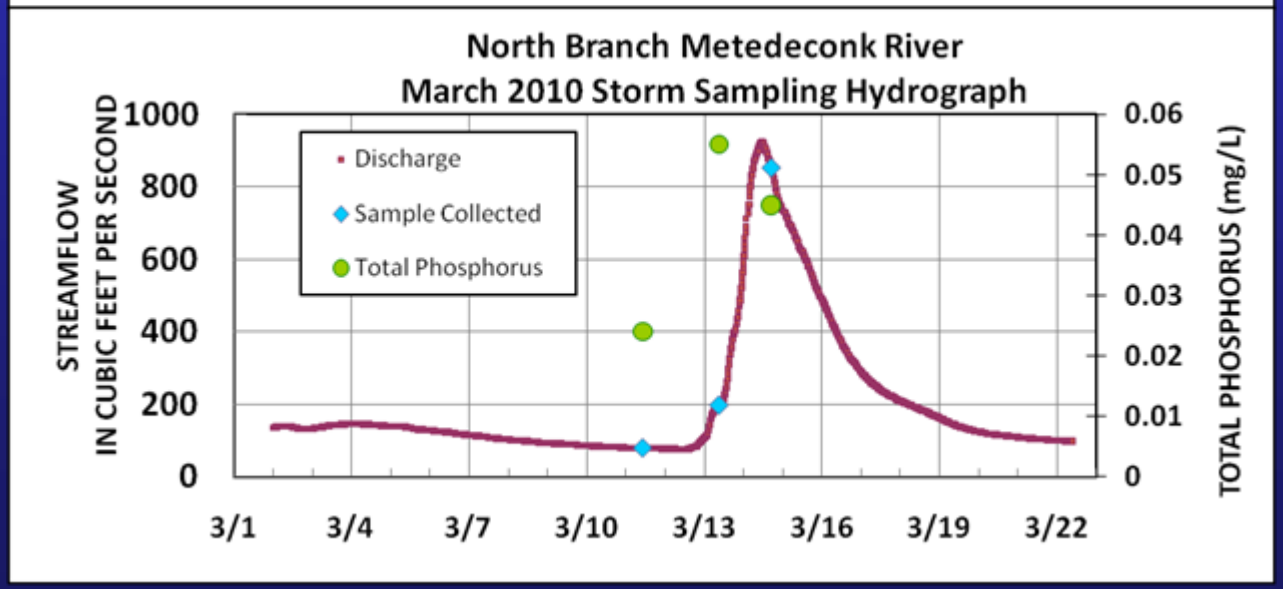
SOURCES

2010 STREAM SAMPLING BEFORE AND DURING STORM EVENTS





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ECOLOGICAL CONSEQUENCES

ASSESSMENT OF NUTRIENT LOADING AND BIOTIC RESPONSE IN SUPPORT OF NUTRIENT MANAGEMENT PLANNING

M. Kennish, R. Lathrop, S. Haag (Rutgers University/CRSSA/JCNERR)
R. Baker, C. Wieben (USGS) -- Ongoing: 2009-2012

- Joint project -- Rutgers University and USGS
- EPA funding through NEIWPCC
- One Objective: Determine spatial and temporal relations between nutrient loadings and biotic conditions in Barnegat Bay

NITROGEN LOAD SUMMARY

What we have learned:

- Primary nutrient delivery pathway is probably surface water
- Nutrient loads from surface water are related to land use
- Groundwater contribution to surface water N load is substantial; large reservoir of N in shallow GW
- Potentially long lag time from release to GW to delivery
- Atmospheric N input is substantial

USGS

USGS Contributors

Ron Baker
Stephen Cauller
Robert Nicholson
Lois Voronin
Christine Wieben

USGS

Selected References on Nutrient Inputs to Barnegat Bay
Robert S. Nicholson, US Geological Survey , New Jersey Water Science Center
NJDEP Barnegat Bay Stakeholders Meeting, Ocean County College, May 5, 2010

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11. Weiben, C., and Baker, R., 2009, ☝□■♦❒♓♌◆♦♓□■⬧ □♐ ☠♓♦❒□♑♏■ ♦□ ♦♒♏ ☜♋❒■♏♑♋♦ ☜♋♎♧☹♓♦♦●♏ ☚♑♑ ☟♋❒♌□❒ ☚⬧♦◆♋❒♎💻 ✝□♎♋♦♏♎ ☹□♋♎♓■♑ ☚⬧♦♓❍♋♦♏⬧ ♧ ☜♋❒■♏♑♋♦ ☜♋♎ ☚♋❒♦■♏❒⬧♒♓□♧ http://www.bbep.org/studies.html

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