USGS Monitoring and Research in the Barnegat Bay Watershed

New Jersey Department of Environmental Protection
Barnegat Bay Stakeholder Meeting
Ocean County College
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Map of real-time streamflow compared to historical streamflow for the day of the year (United States)

Choose a data retrieval option and select a location on the map:
- List of all stations in state,
- State map,
- Nearest stations

<table>
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<th>Explanation - Percentile classes</th>
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<tr>
<td>Low</td>
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<td>&lt;10</td>
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- 114 Continuous Record Discharge Gages / 4 in BBLEH
- 181 Partial Record discharge sites / 15 in BBLEH
- 99 Crest Stage Gages / 5 in BBLEH
Surface-Water Monitoring Networks

Flood/Tide Warning

- 25 Continuous tide gages / 5 in BBLEH
- 33 crest stage gages / 3 in BBLEH
- 5 weather stations / 1 in BBLEH

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

Water Quality Monitoring

- 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)

Funded cooperatively with various agencies
Ground-Water Network

**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)

Funded cooperatively with NJDEP
FRESHWATER INPUTS

590 million gallons per day (average)
FRESHWATER INPUTS

Toms River Streamflow 1929-2002

STREAM DISCHARGE, AS PERCENT OF AVERAGE

CALENDAR YEAR

1929

2000
FRESHWATER WITHDRAWALS
Ocean County
1985 - 2005

TOTAL FRESHWATER WITHDRAWALS, MILLIONS OF GALLONS PER DAY

FRESHWATER WITHDRAWALS
OCEAN COUNTY, N.J., IN 2000
TOTAL WITHDRAWALS = 70.8 Million Gallons per day
Values are percent of total

- Public Supply
- Domestic
- Mining
- Industrial
- Commercial
- Irrigation
- Thermoelectric
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: $\text{NO}_3^-$, $\text{NO}_2^-$, $\text{NH}_3$, $\text{NH}_4^+$

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
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
RELATION BETWEEN WATER QUALITY AND LAND USE/LAND COVER

Source: Hunchak-Kariouk and Nicholson, 2001
Updated (2009) Estimate of Delivered Load

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

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

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

Total load = 650,000 kg N/yr

Wieben and Baker (2009)
NITROGEN LOADING

Surface N Loading in Mid-Atlantic Lagoonal Estuaries

Source: NOAA Estuarine Typology Database
(Smith and others, 2003)
Nitrogen Monitoring:
Toms River, near Toms River
1973-2005

Concentration, mg/l

Source: USGS/NJDEP Cooperative Ambient Stream Monitoring Network

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

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

Local NOx emissions

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

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

Cedar Creek Monitoring Station
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.

How much of the nitrogen load in streams comes from groundwater?
Relative Loads from Stormwater and Baseflow

**USGS/NJDEP Toms River study (2006)**


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
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).
Ongoing USGS Research

- Simulation of nitrogen transport in groundwater
- Quantifying sources of Nitrogen
- Exploring linkage between nutrient loads and biotic responses
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
Preliminary simulated groundwater travel time from recharge to discharge area
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 groundwater nutrient loading.
Using Isotopes to identify nitrogen sources

From OHTE and others, 2008
2010 STREAM SAMPLING BEFORE AND DURING STORM EVENTS
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)  

- 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
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 nitrogen 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
Selected References on Nutrient Inputs to Barnegat Bay  
NJDEP Barnegat Bay Stakeholders Meeting, Ocean County College, May 5, 2010


