More Precise Assessment of Benthic Conditions in Delaware Bay Using Probability Survey Data, Targeted Sampling and Acoustic Habitat Maps.

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Combining information from benthic mapping and probability surveys

Talk Outline:

- (1) Delaware Bay Benthic Mapping Project (DBBMP)
- (2) National Coastal Assessment – Measurements

- PCBs in Delaware River fish
  - Trends in body burdens (info from Delaware DNREC)
  - Some PCB Diagnostics / Forensics based on NCA data

- Diagnostics related to sediment contamination (Zinc).
  - Estuarine Comparisons for the Northeast
  - Probability of Benthic Impairment

- Next Steps:
  - Combining information from probability surveys, and DBBMP maps
  - Using DBBMP maps, for stratified random sampling in 2008.

Delaware River Estuary:

NMN Pilot Study

Watershed Characteristics / Multiple Uses

- One of the longest un-dammed rivers in the U.S.
- Tributaries within NY, PA, DE, and NJ
- 15 Million people use the water for drinking
- Worlds largest freshwater port complex
- One of the Nation's largest oil/container ports
- Valued: Finfish, Shellfish, Horseshoe Crabs (largest breeding population)
- Internationally Migrating Shore Birds
- High N loading, and high estuarine productivity

Benthic habitat mapping.

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Also acknowledge work of John Madsen, Univ of Delaware

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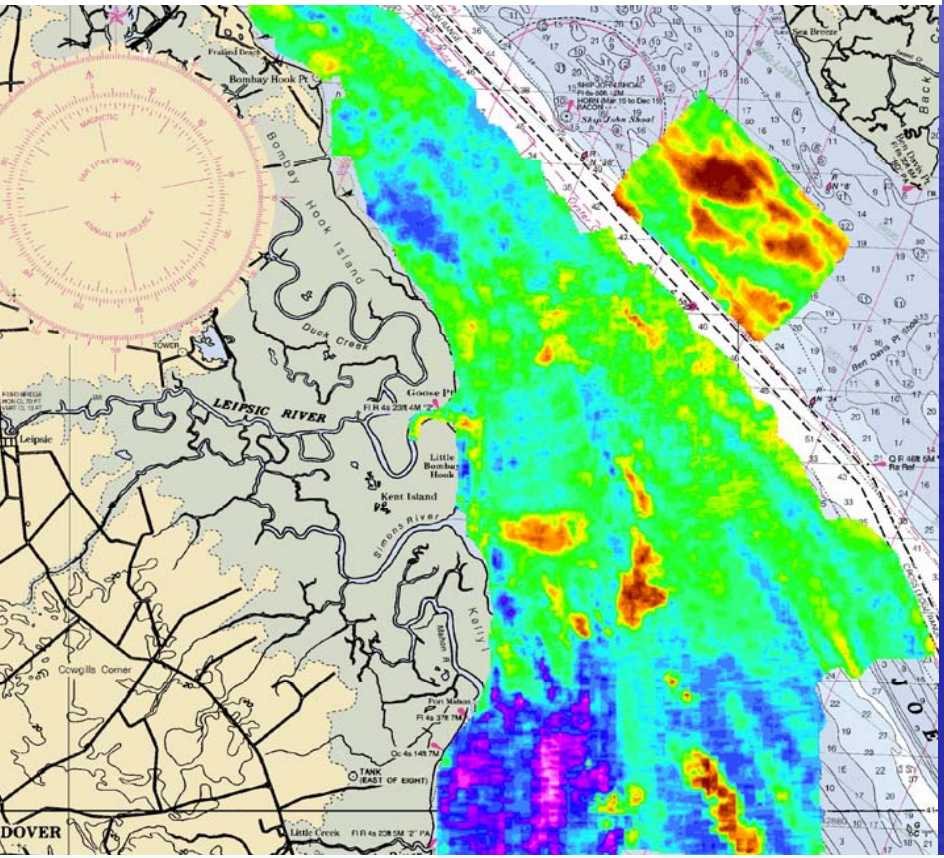
Benthic habitat maps:

Example applications: (1) useful for management efforts to restore oyster reefs (market value exceeds $1.5 million annually), and (2) identify and protect many other valued benthic habitat features



Legend

Bottom Sediment Distribution

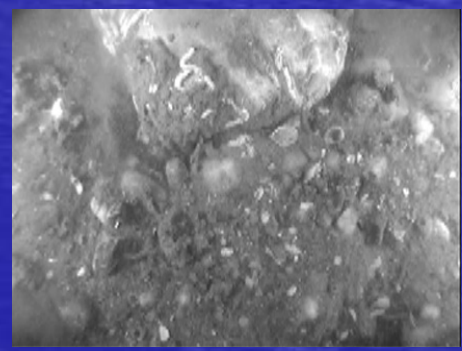
- Peat
- Peaty Clay
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silts, with shell
- Fine Sand
- Silty Fine to Medium Sand
- Silty Medium Sand
- Fine to Medium Sand
- Fine to Medium Sand, with abundant shell material and/or pebbles
- Medium to Coarse Sand
- Coarse Sand
- Coarse Sand, with varying amounts of pebbles and/or shell
- Moderate Shell Material
- Abundant Shell Material
- Dense Oyster Shell

Needs For Habitat Maps

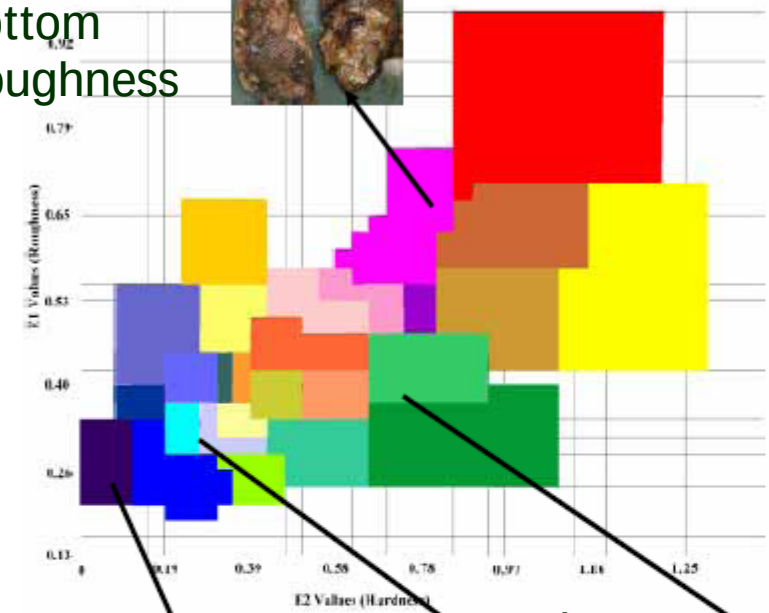
Improve understanding (research & education)
Restoration
Assessments
Dredging Permits
CWA 303d listing and delisting decisions
Marine Protection Areas

Using acoustic technology to collect bathymetric and sediment classification data

- RoxAnn Seabed Classification
  - Single beam 200 kHz, collects info on roughness and hardness every second in depths 1-50 meters.
- Chirp Sub-bottom Profiler
- Multibeam bathymetry system
- Field verification (sediment and biology)

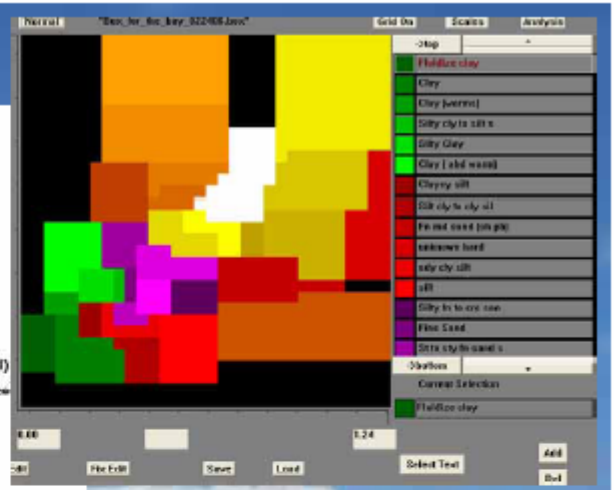


Bottom Roughness



Bottom Hardness

- Fluidized clay
- Clay
- Clay (with random worm tubes)
- Clay (with abundant worm tubes)
- Clayey silt
- Silty clay (with random shells fragments)
- Silty clay to Clayey silty sand
- Firm Silty clay to Clayey silt
- Silt
- Sandy clayey silt
- Dense Sandy silt (with moderate shell material)
- Silt to Silty fine sand (with moderate shell mate
- Fine sand
- Silty fine to medium sand
- Silty medium sand
- Silty fine to coarse sand
- Fine to medium sand
- Medium to coarse sand (with coarse pebbles)
- Fine to medium sand (with moderate amount of shell material and pebbles)
- Course sand (with random pebbles)
- Very Coarse sand
- Medium sand (with moderate to abundant pebbles); or Dense Shell Material (Oyster) with Matrix
- Sandy granule pebbles (with a coarse sand matrix); or Abundant Shell Material (Oyster Shell) with matrix
- Gravel (mix of pebbles and cobbles; with coarse sand matrix); or Dense Shell Material (Oysters)
- Gravel (dense mix of pebbles and cobbles); or Outcropping of Compacted Pre-Holocene Sediments
- Gravel (dense mix of pebbles and cobbles); or Outcropping of Compacted Pre-Holocene Sediments

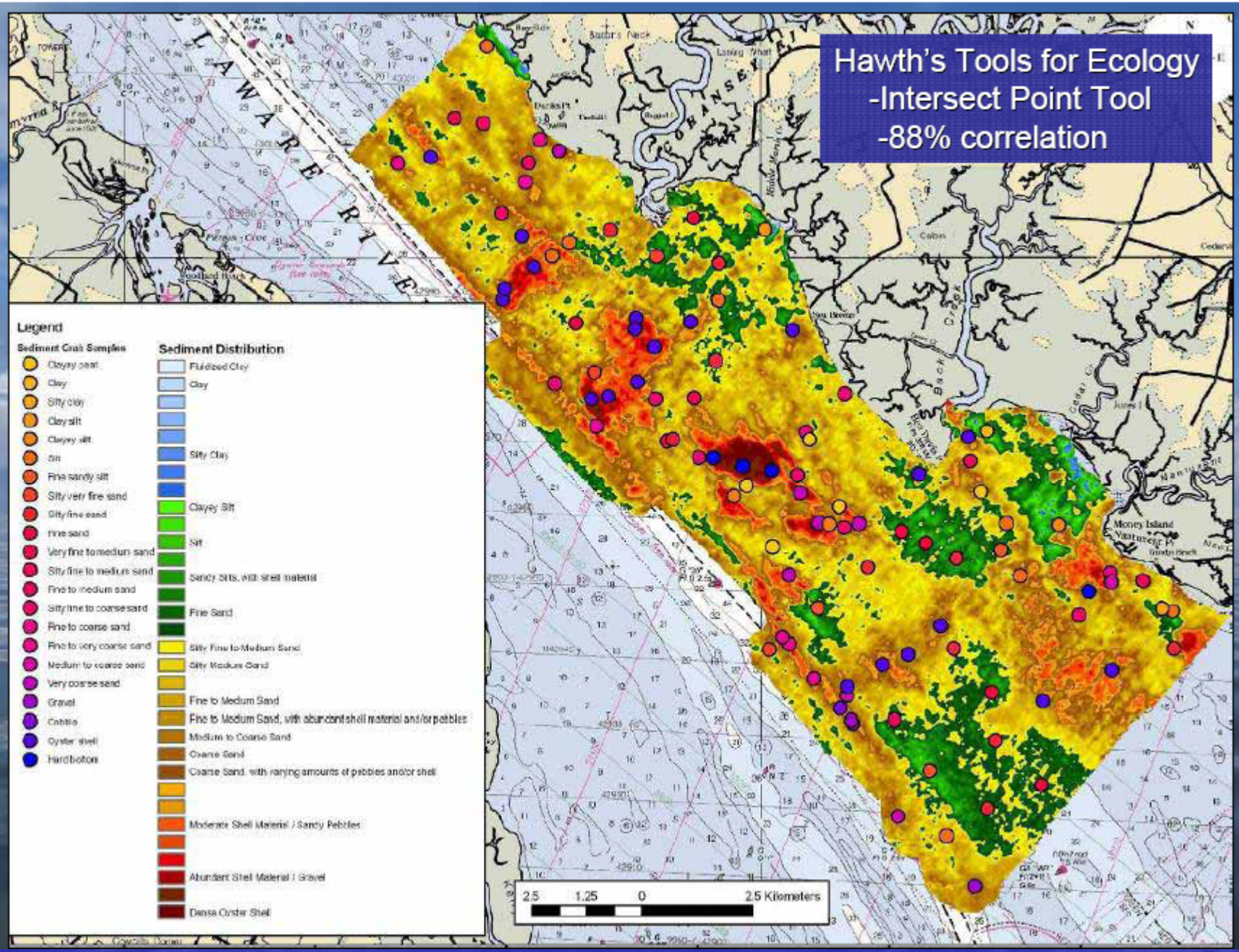


91% Correlation on Hardness and Roughness values of grab samples

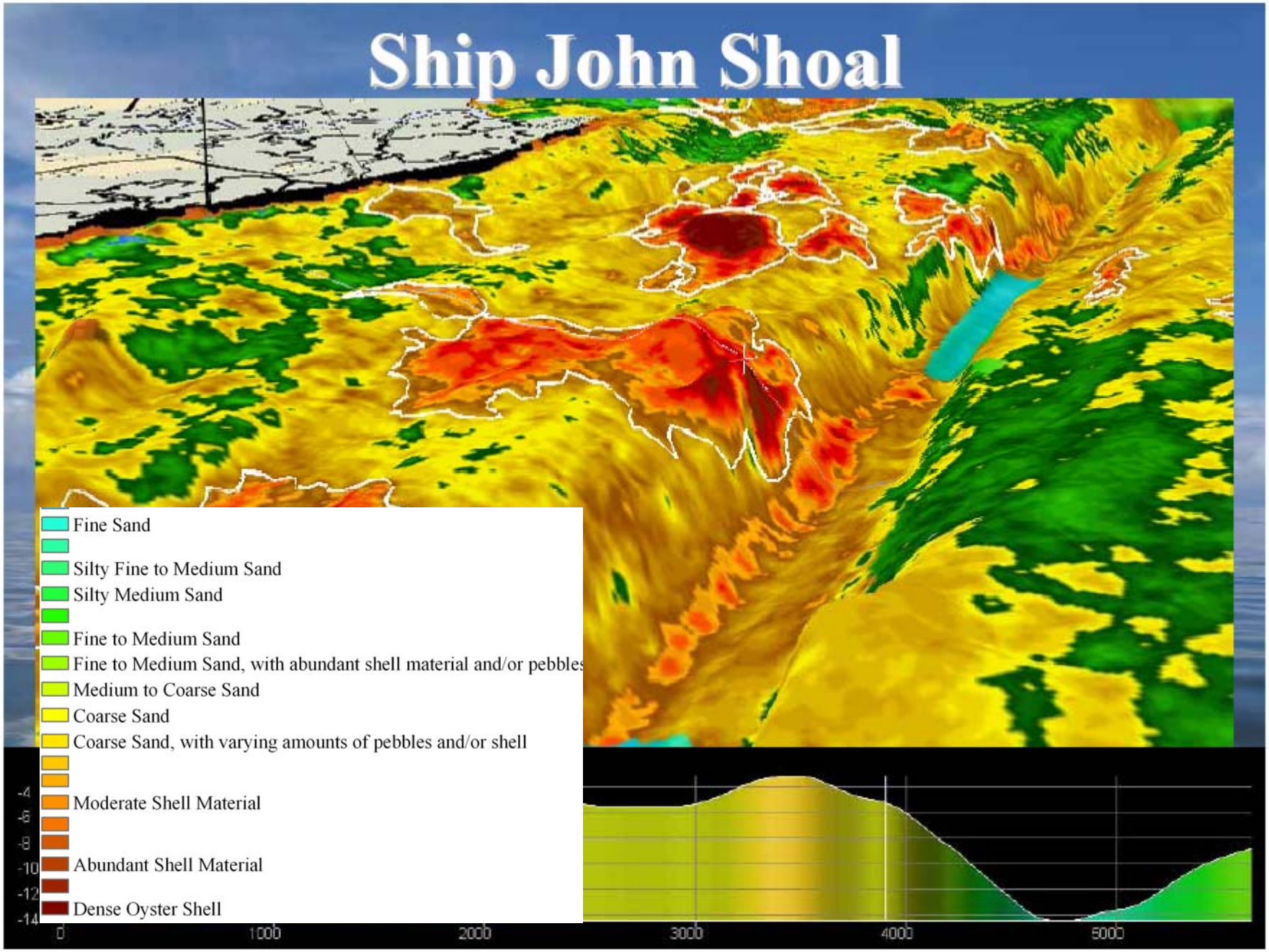
database - Notepad

File Edit Format View Help

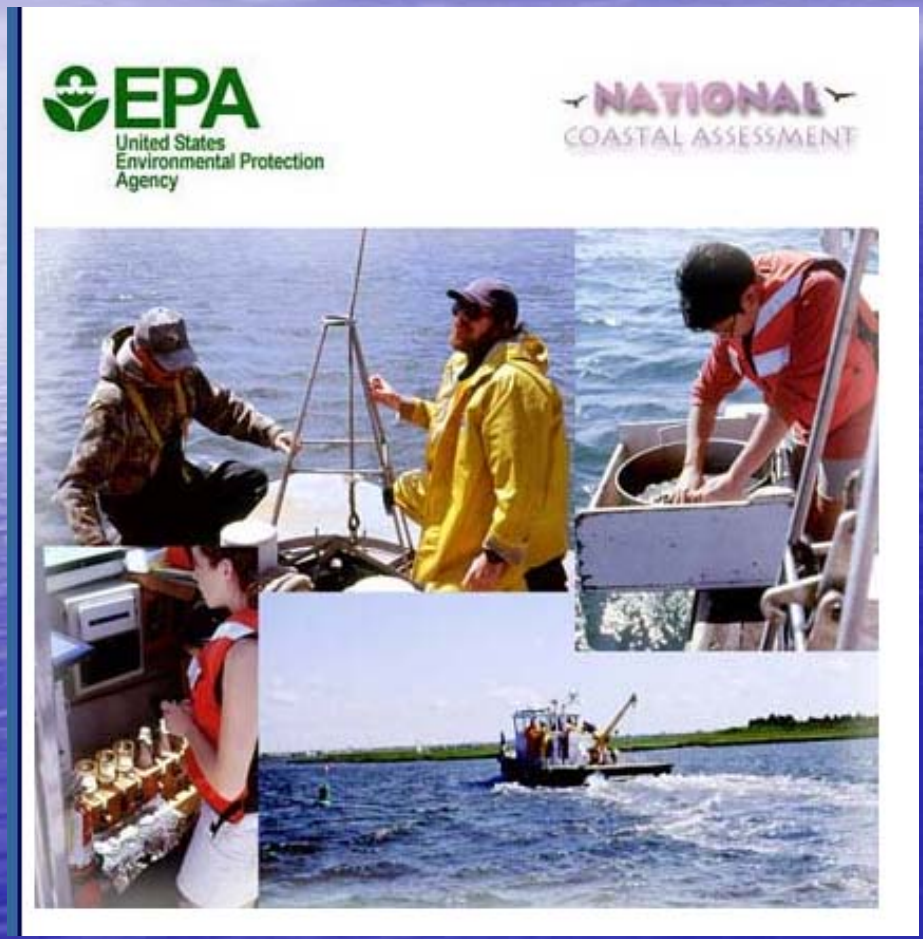
9	39.4566086	-75.5663083	-9.06	0.250	1.27
9	39.4566050	-75.5663016	-9.15	0.244	1.22
19	39.4566033	-75.5662966	-9.15	0.226	1.13
19	39.4565983	-75.5662916	-9.15	0.222	1.12
19	39.4565966	-75.5662849	-9.06	0.218	1.15
9	39.4565933	-75.5662800	-9.06	0.217	1.20
19	39.4565916	-75.5662766	-9.15	0.194	1.02
20	39.4565883	-75.5662716	-9.06	0.370	0.94
19	39.4565849	-75.5662666	-9.15	0.251	1.12
19	39.4565816	-75.5662633	-9.06	0.248	1.03
19	39.4565800	-75.5662600	-9.15	0.255	1.09
9	39.4565766	-75.5662566	-9.15	0.256	1.44
19	39.4565750	-75.5662533	-9.15	0.227	1.09
9	39.4565700	-75.5662500	-9.15	0.255	1.19
19	39.4565683	-75.5662466	-9.06	0.262	1.13
19	39.4565650	-75.5662410	-9.06	0.243	1.07
19	39.4565616	-75.5662433	-9.15	0.245	1.04
9	39.4565600	-75.5662399	-9.15	0.260	1.19
19	39.4565150	-75.5662383	-9.15	0.267	1.15


Hawth's Tools for Ecology
-Intersect Point Tool
-88% correlation
Legend
Sediment Grab Samples
Clayey peat
Clay
Silty clay
Clay silt
Clayey silt
Silt
Fine sandy silt
Silty very fine sand
Silty fine sand
Fine sand
Very fine to medium sand
Silty fine to medium sand
Fine to medium sand
Silty fine to coarse sand
Fine to coarse sand
Fine to very coarse sand
Medium to coarse sand
Very coarse sand
Gravel
Cobble
Oyster shell
Hardbottom
Sediment Distribution
Fluidized Clay
Clay
Silty Clay
Clayey Silt
Silt
Sandy Silts, with shell material
Fine Sand
Silty Fine to Medium Sand
Silty Medium Sand
Fine to Medium Sand
Fine to Medium Sand, with abundant shell material and/or pebbles
Medium to Coarse Sand
Coarse Sand
Coarse Sand, with varying amounts of pebbles and/or shell
Moderate Shell Material / Sandy Pebbles
Abundant Shell Material / Gravel
Dense Oyster Shell
2.5 1.25 0 2.5 Kilometers

Ship John Shoal



National Coastal Assessment use of probability survey sampling at randomly chosen locations.



- Blind Sampling by design
- Advantages:
  - Comparable method for unbiased cross-system comparisons
  - Look at sediment triad : sediment chemistry, benthic biology and sediment toxicity.

National Coastal Assessment (NCA)

NCA / Assessment Endpoints
- Water column condition
- Sediment conditions
- Benthic community measures
- Contaminants in Fish

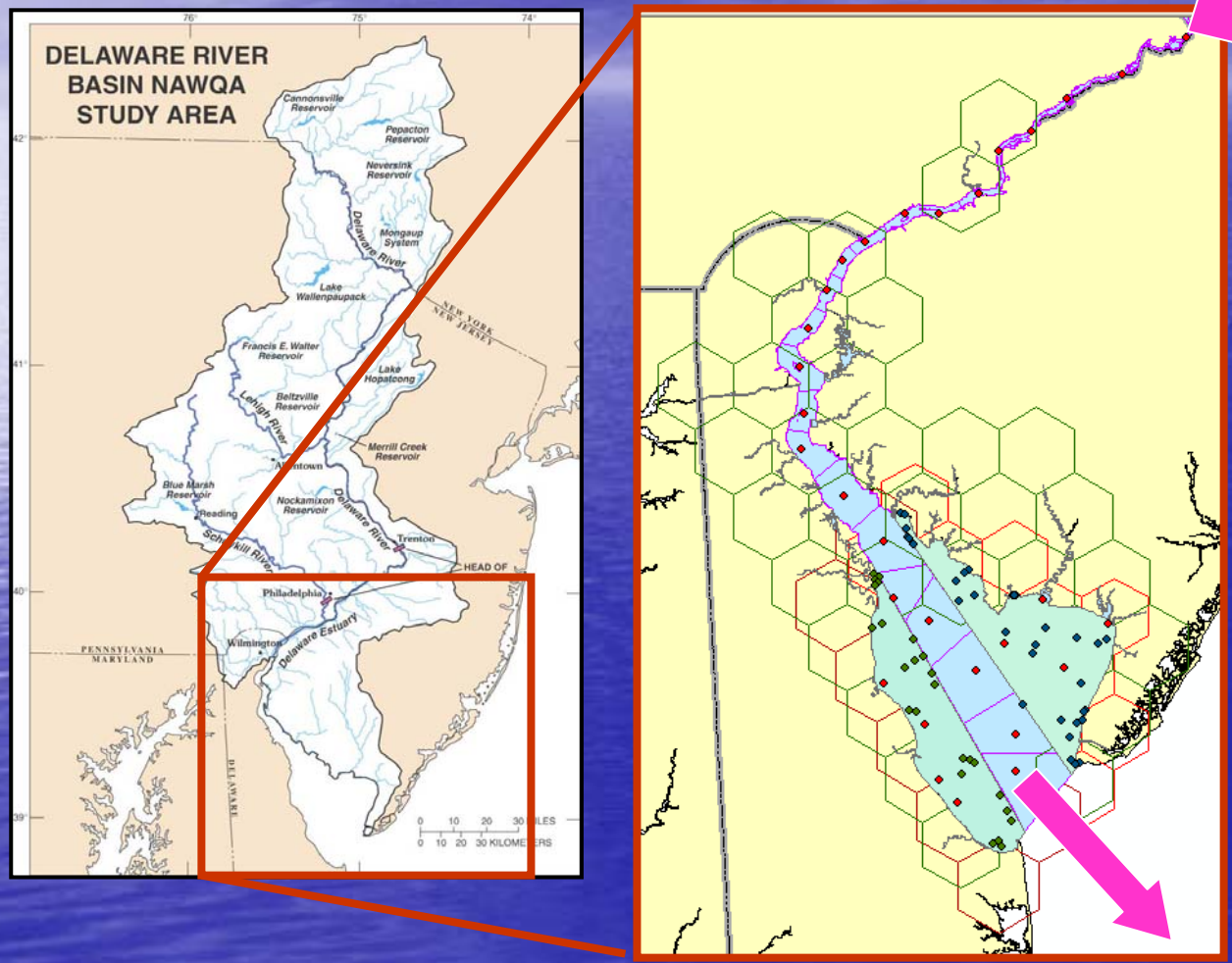
NCA: Measurement Endpoints
- Numerous

NCA Indices:
- Water Quality
- Sediment Quality
- Benthic Index
- Fish Tissue Contaminants

Assessments of Condition

Management Decisions

Some of the basics related to the probability survey design.



Boat Run Stations

Sampling design for 2000-2001 includes:

(1) Boat Run stations,

(2) Delaware Bay, and

(3) Minor tributaries

Additional Info from earlier EMAP Virginia Province, MAIA, and subsequent NCA surveys thru 2006.

How does sediment contamination in Delaware Bay compare to other National Estuary Program estuaries?

- **ERL (Effect Range Low)**

  Determined values for each chemical as the 10th percentile in a database of ascending concentrations associated with adverse biological effects.

- **ERM: (Effects Range Median)**

  Determined for each chemical as the 50th percentile (median) in a database of ascending concentrations associated with adverse biological effects.

- **Good:**

  No ERM concentrations exceeded, and less than 5 ERL concentrations exceeded

- **Fair:**

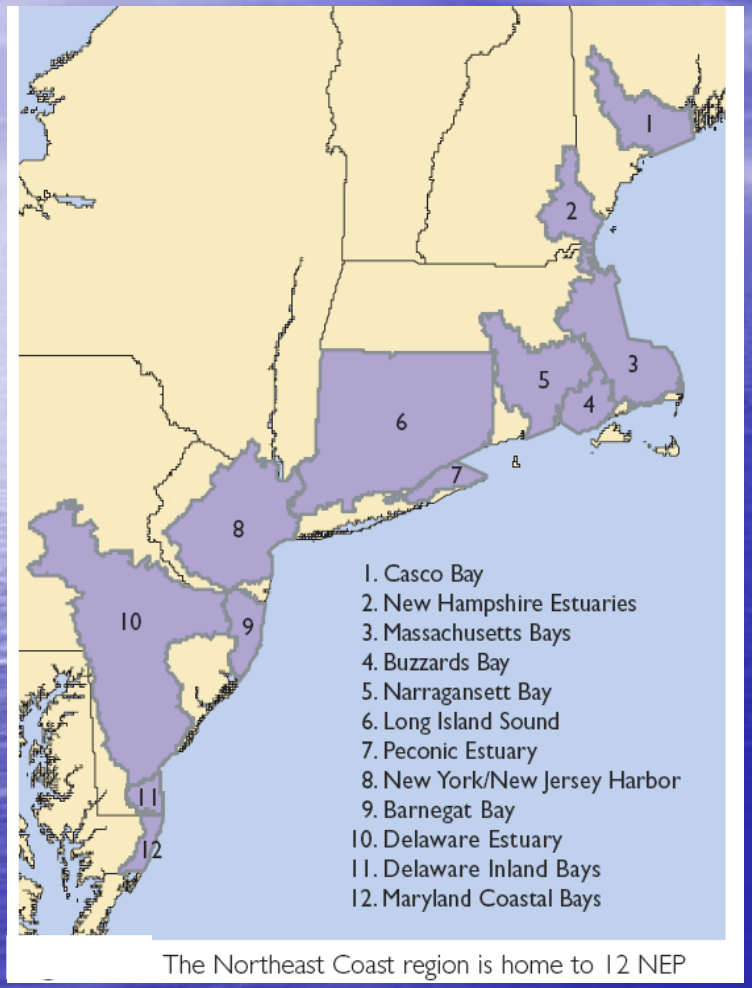
  No ERM concentrations exceeded, and 5 or more ERL concentrations are exceeded

- **Poor:**

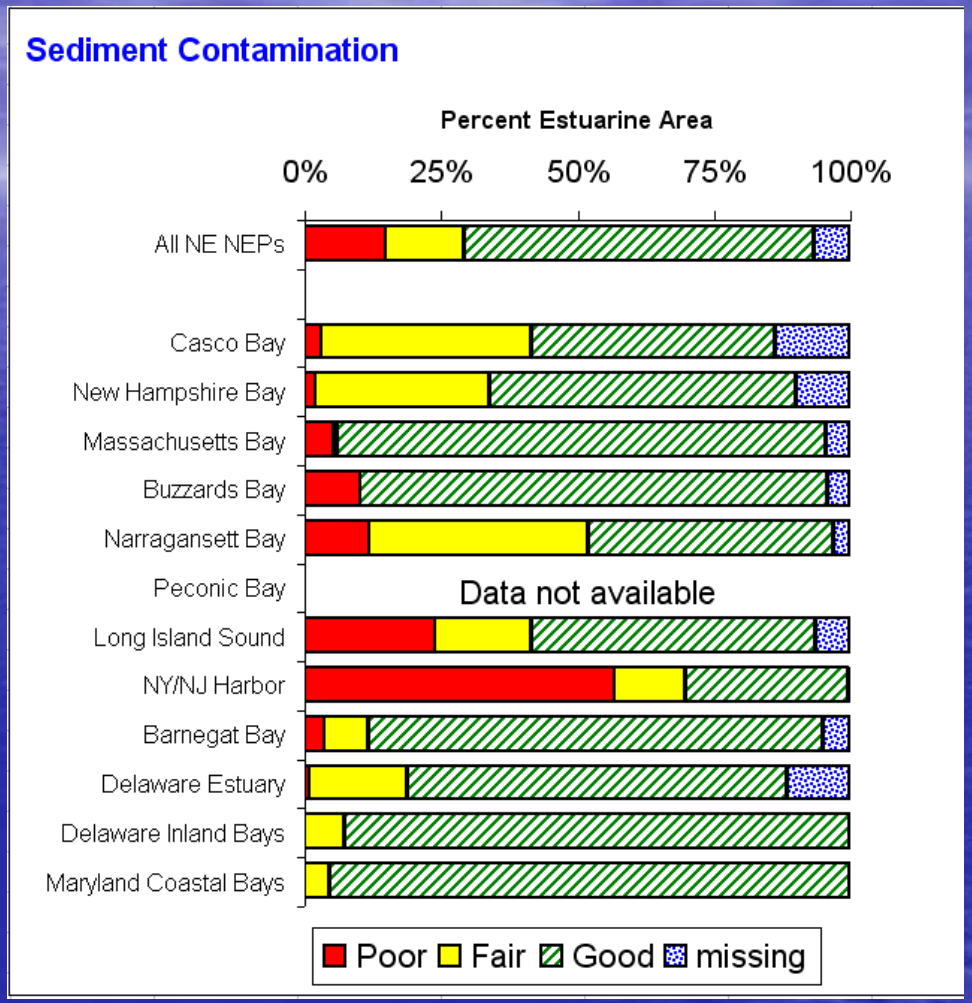
  An ERM is exceeded for 1 or more contaminants

O'Connor and Paul: 41% of ERM exceedances were toxic & 5% on non-exceedances were toxic

How does sediment contamination in Delaware Bay compare to other National Estuary Program estuaries?



The Northeast Coast region is home to 12 NEP



Delaware Bay is a relatively clean estuary on a % area basis !

National Estuary Program Coastal Condition Report Assessment for the Delaware River Estuary (data from 2000, 2001)

About 60 % of the fish have contaminant concentrations based on whole fish analysis that exceed FDA consumption advisories, primarily due to PCB & DDT

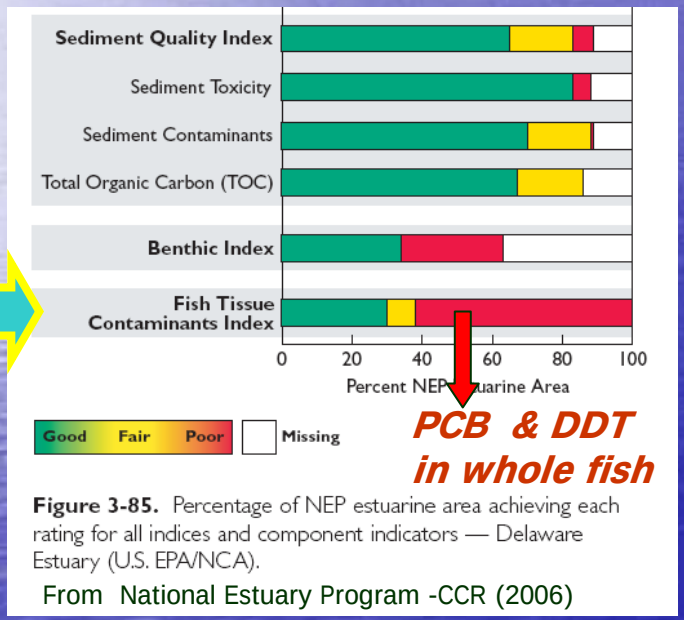
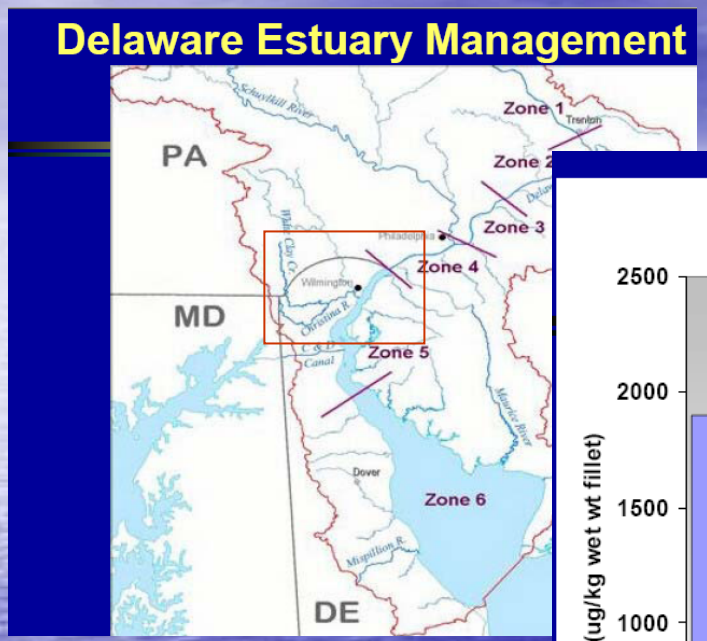


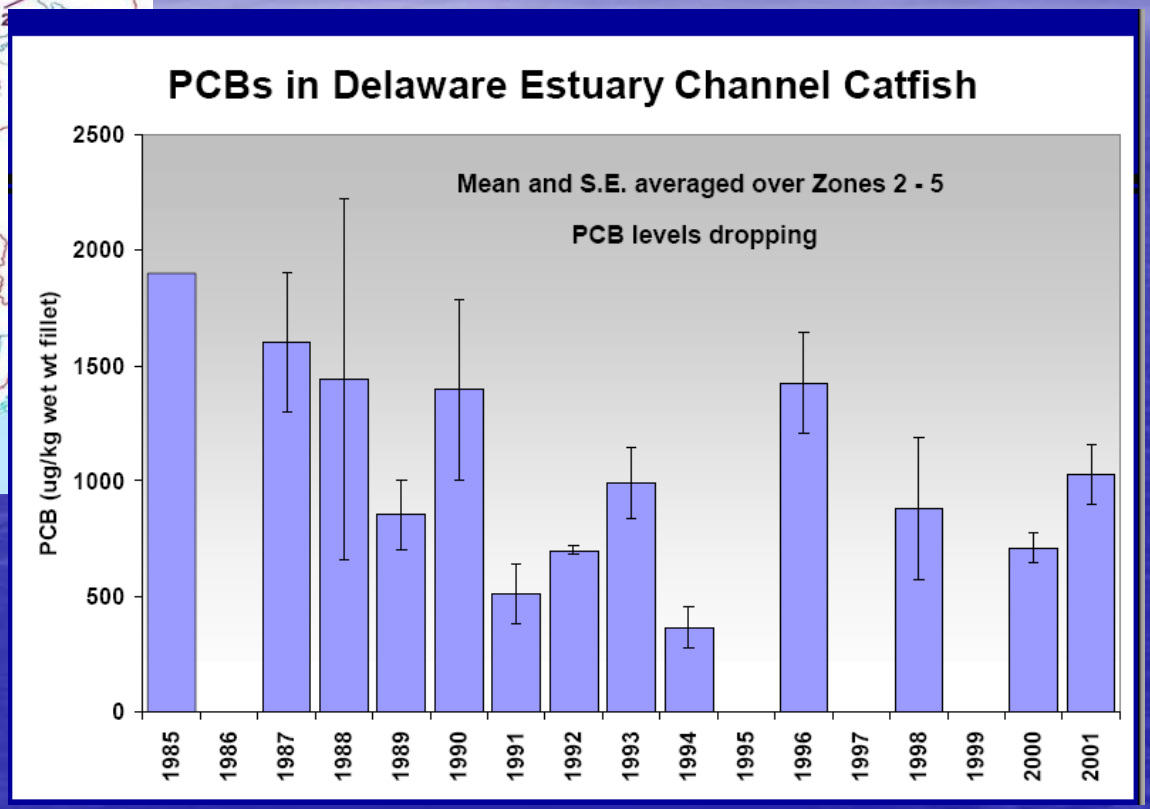
Figure 3-85. Percentage of NEP estuarine area achieving each rating for all indices and component indicators — Delaware Estuary (U.S. EPA/NCA).

From National Estuary Program -CCR (2006)

- Species Caught in Bottom Trawls associated with bottom feeding:
  - Channel Catfish
  - White Perch
  - Weakfish
  - Blue Crab
  - Summer Flounder
- What are the trends in PCBs in fish?
- Can high concentratios of PCBs and DDT be detected in NCA sediment samples?
- Are there other contaminant signatures at sites with high PCB?

PCB Levels have fallen for a number of species,

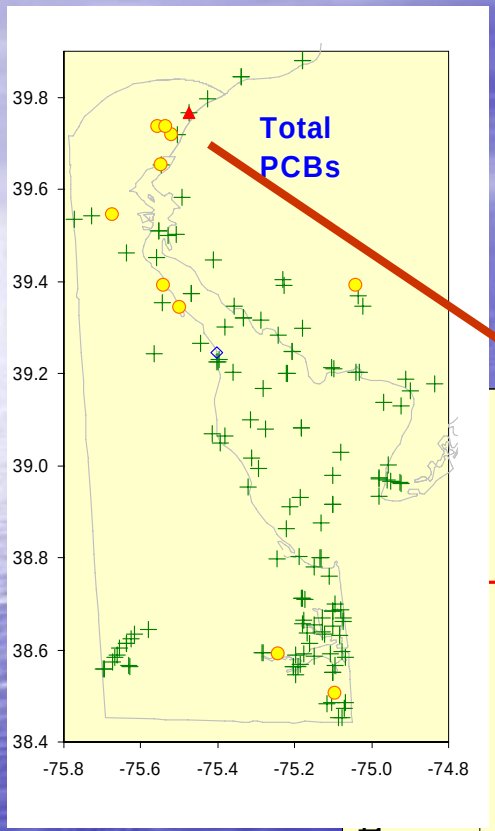




but rate of decline is slowing.

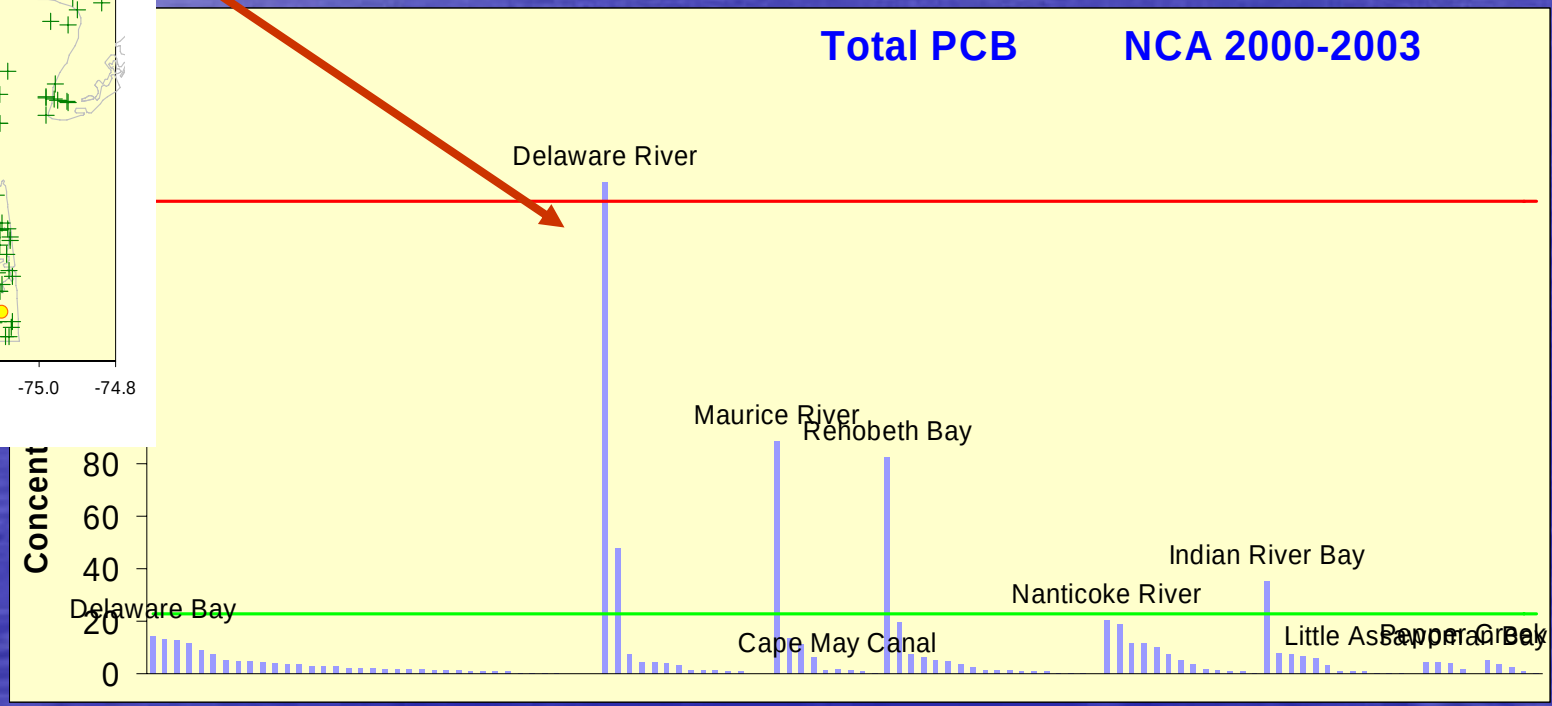
From Rick Greene, Delaware DNREC April 5, 2007

DE00-0047 Delaware River 2000 Long -75.47 Lat 39.767



A significant source of PCBs at the AMTRAK Former Refueling Facility, and a remedial investigation study in in process.

Another source is the DuPont Edge Moor TiO2 plant with a unique byproduct (IUPAC 209 deca-PCB)



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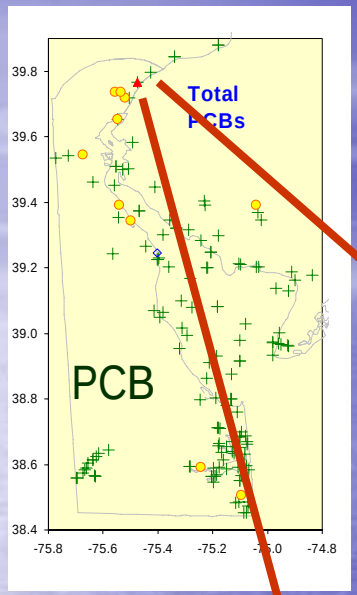
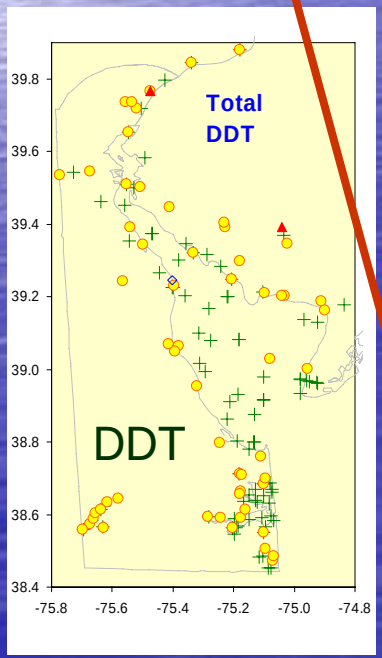
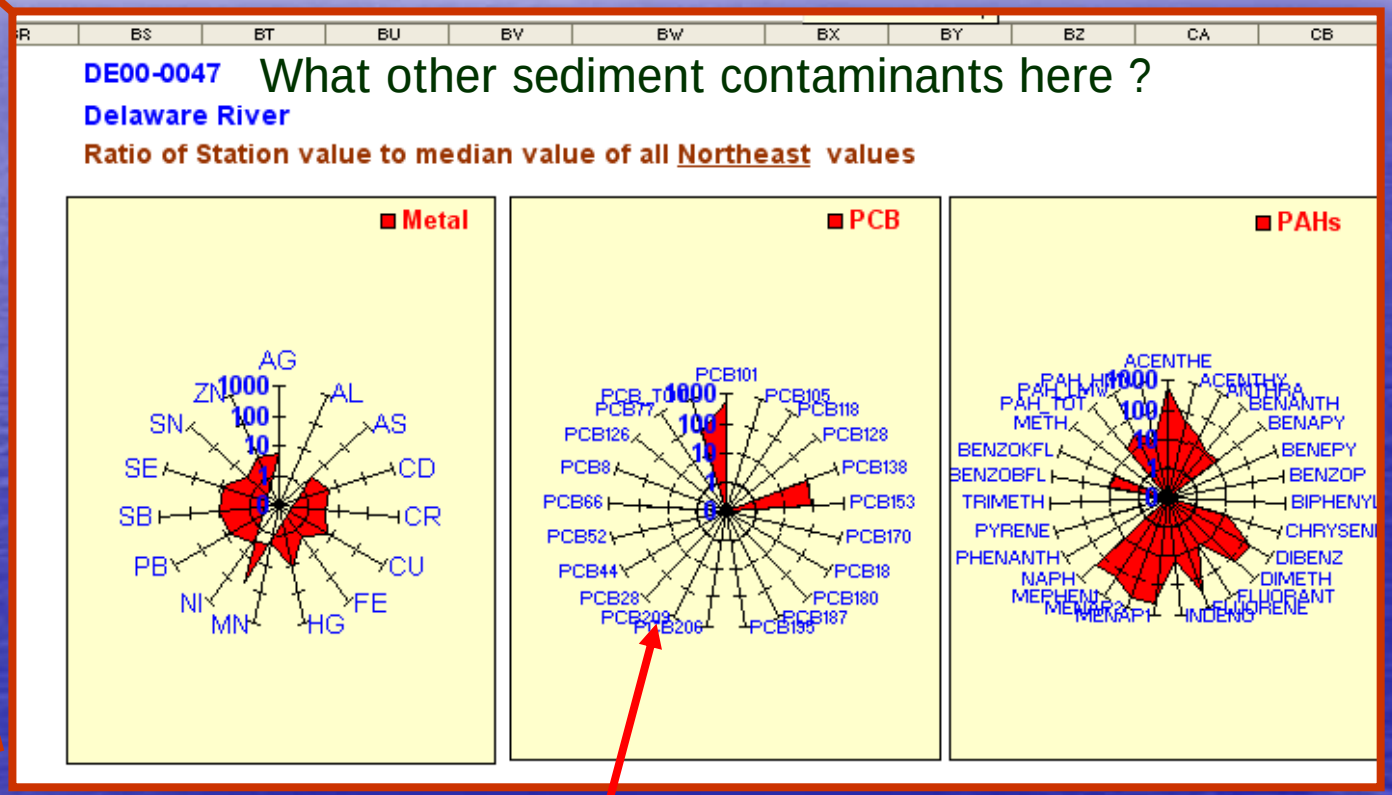




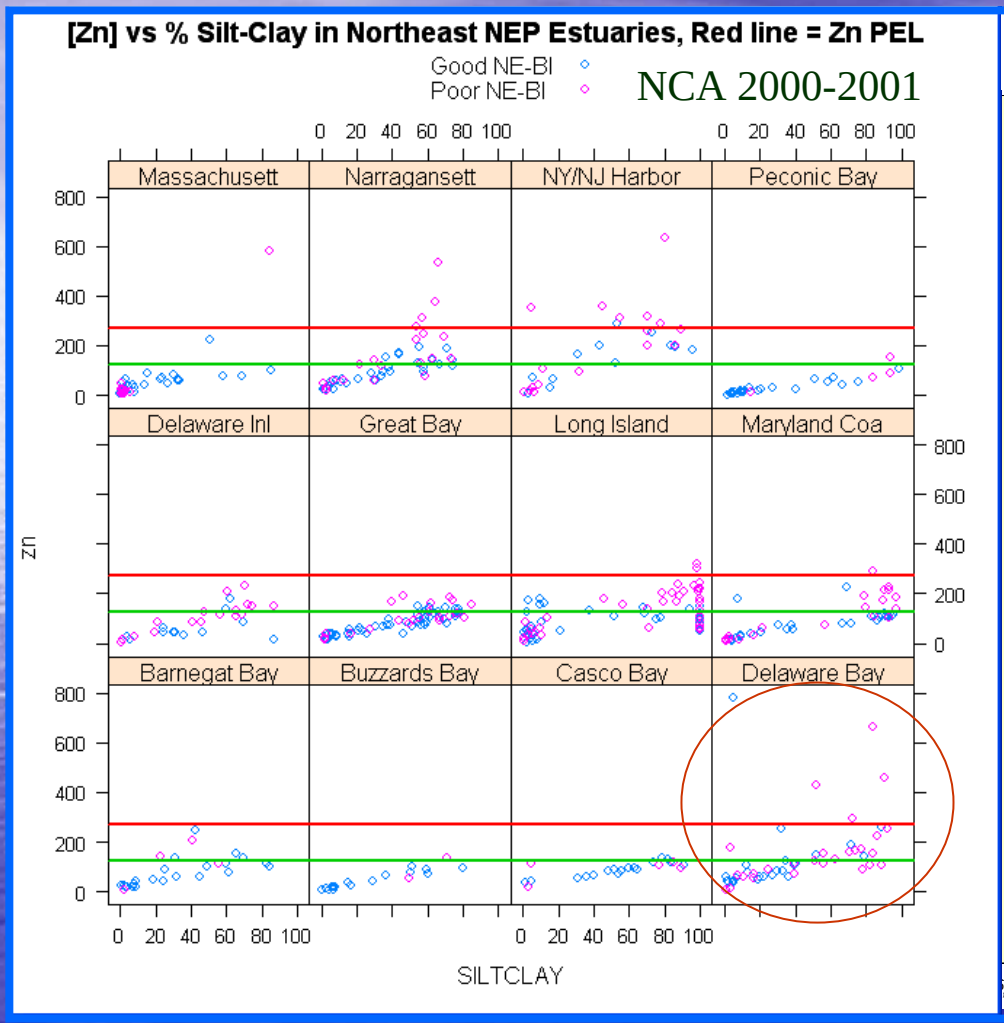
A significant source of PCBs at the AMTRAK Former Refuling Facility, and a remedial investigation study in in process.

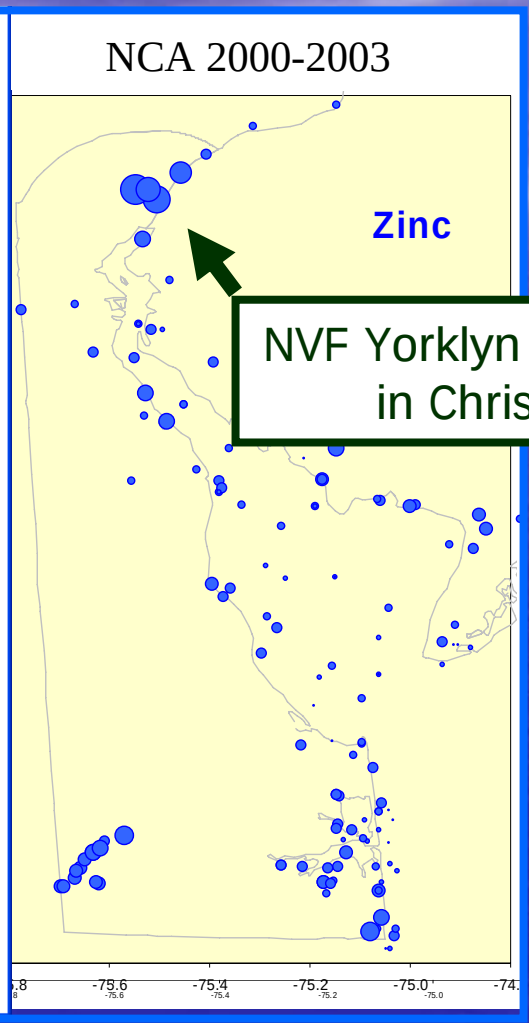
Another source is the DuPont Edge Moor TiO2 plant (IUPAC 209 deca-PCB) found some of the NCA fish samples.



However, enrichment of 209 – deca-PCB does not show up in this sediment sample.

National Estuary Program Estuaries in the Northeast. Delaware Bay has some areas with high [Zinc]





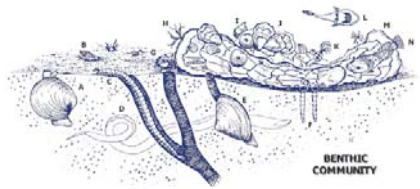
In Delaware [Zn] > TEL ~ 9 % of area, and > 1.2% area > PEL.

What is the likelihood of encountering a poor benthic index in NCA data in relation to concentration of Zinc in sediments?

Conditional Probability that the VP Benthic Index (BI) is "Poor" in relation to [Zinc] in Sediments

Look at this probability for entire data set:

Then recalculate prob(BI = poor) for data subsets with increasing concentrations of zinc.



Probability of Poor Benthic Index

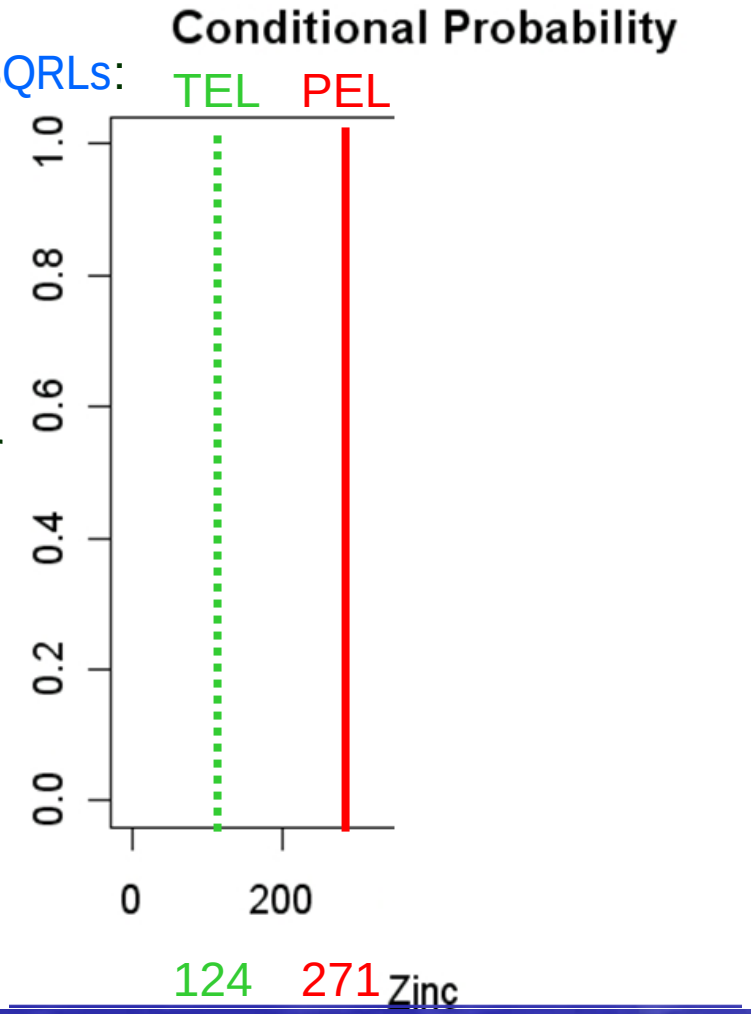
ERM = 410

PEL = 271

ERL = 150

TEL = 124

NOAA SQRLs:

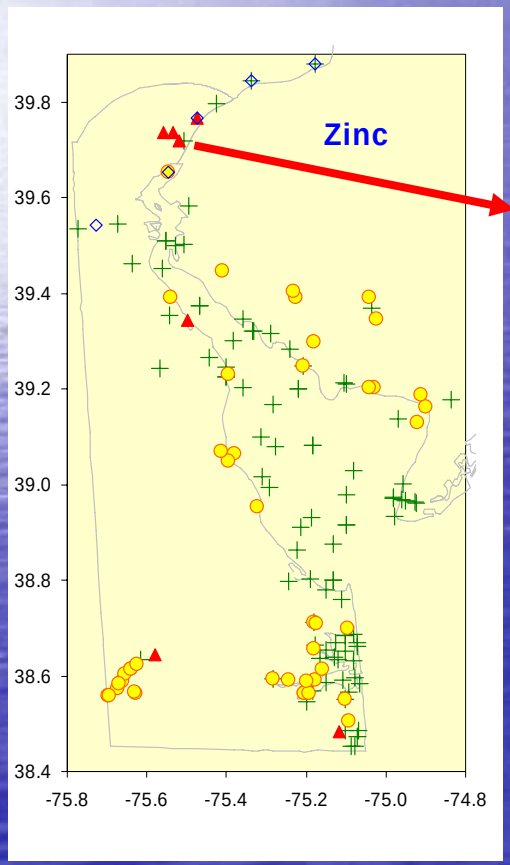


NOAA Screening Quick Reference Tables (SQuiRTs) for [Zn] in marine sediments

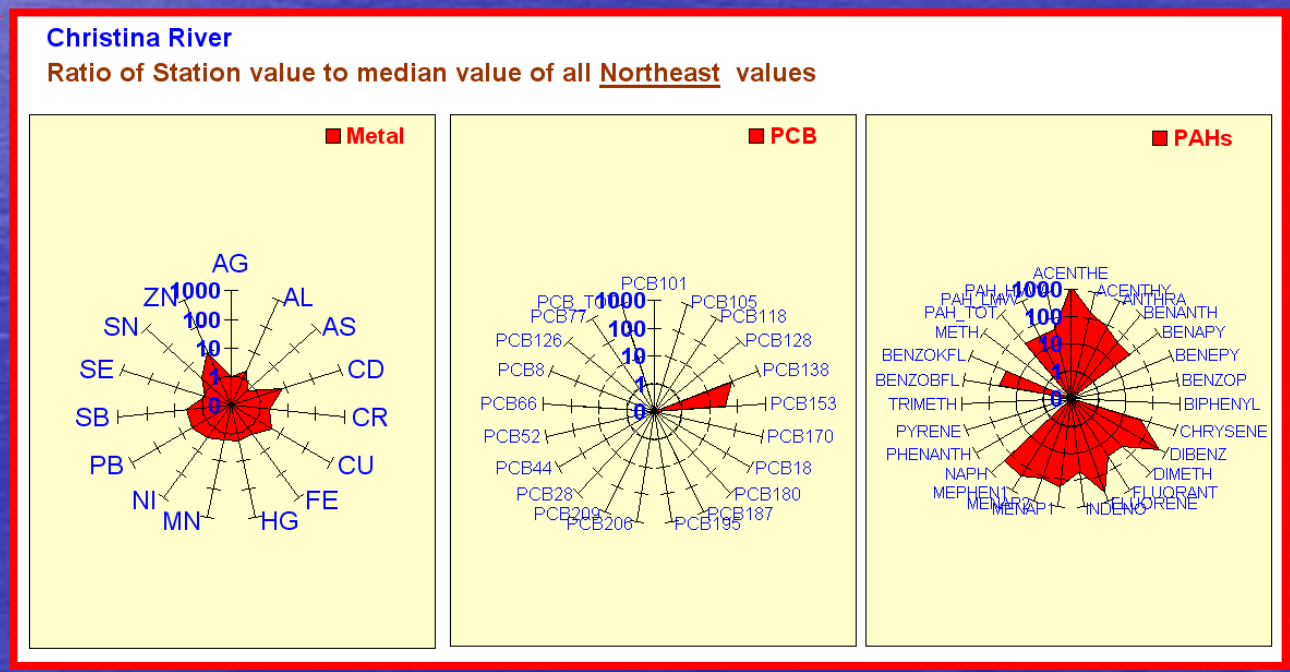
NCA Data from Virginian Province (2000-2001)

How extensive is the Zinc contamination in Delaware?

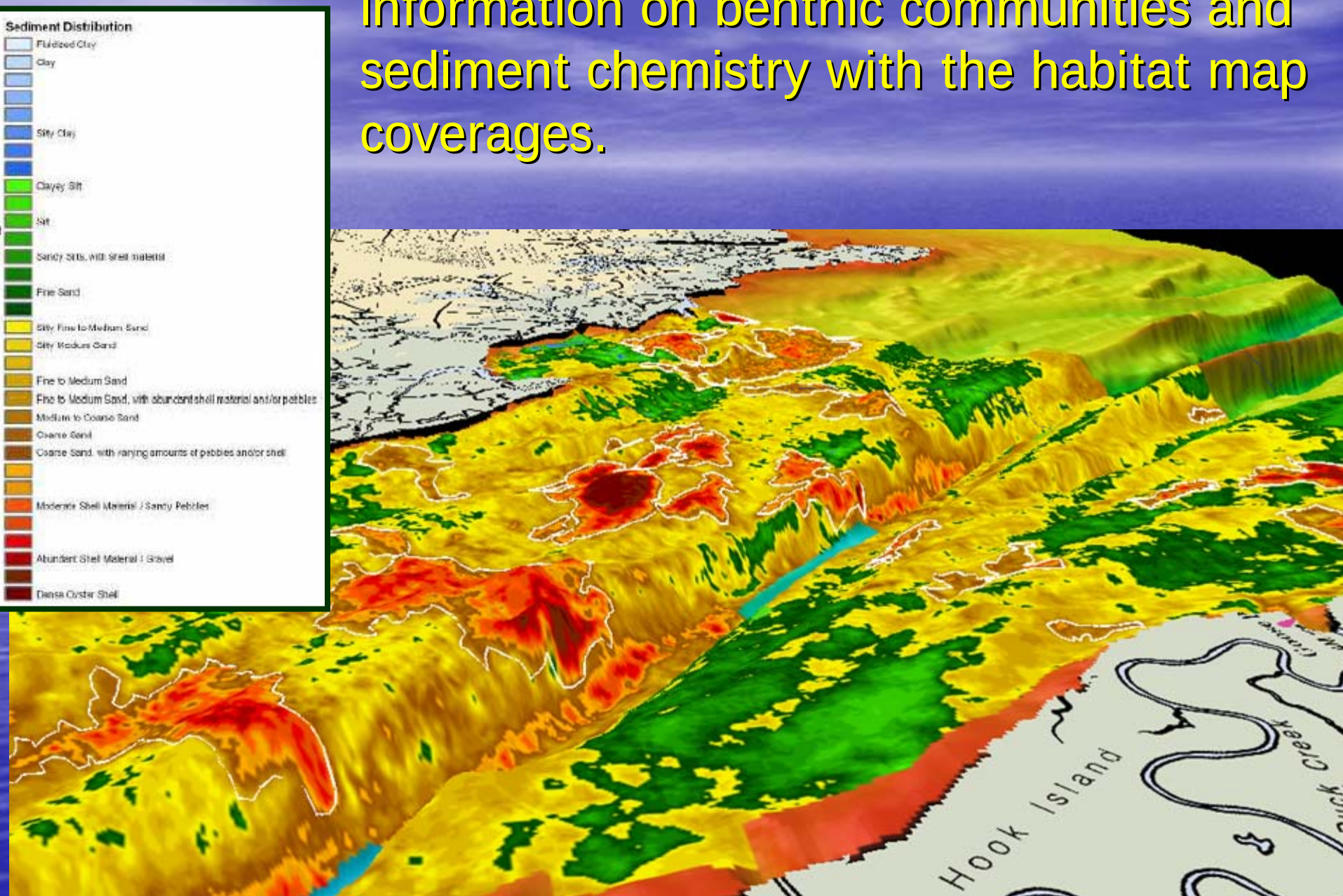
In Delaware estuarine waters,
~ 0.8% of the area has [Zn] > PEL &
~ 14.8 % of area with TEC < [Zn] < PEL



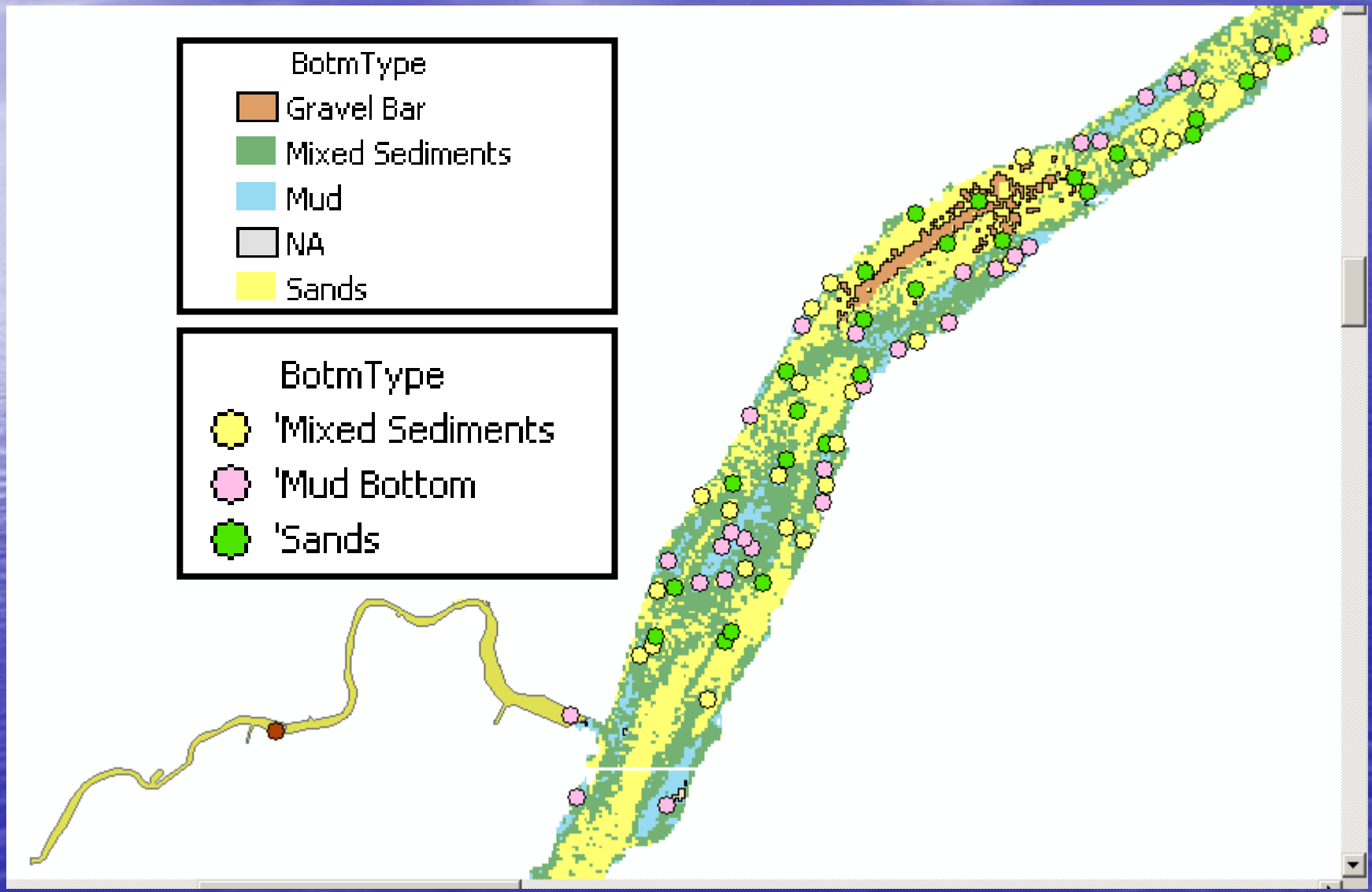
What else is going on at the "hot spot" for Zn?



In the year ahead, we will be combining information on benthic communities and sediment chemistry with the habitat map coverages.



In summer 2008, sampling will make use of DBBMP sediment types, for stratified random sampling.



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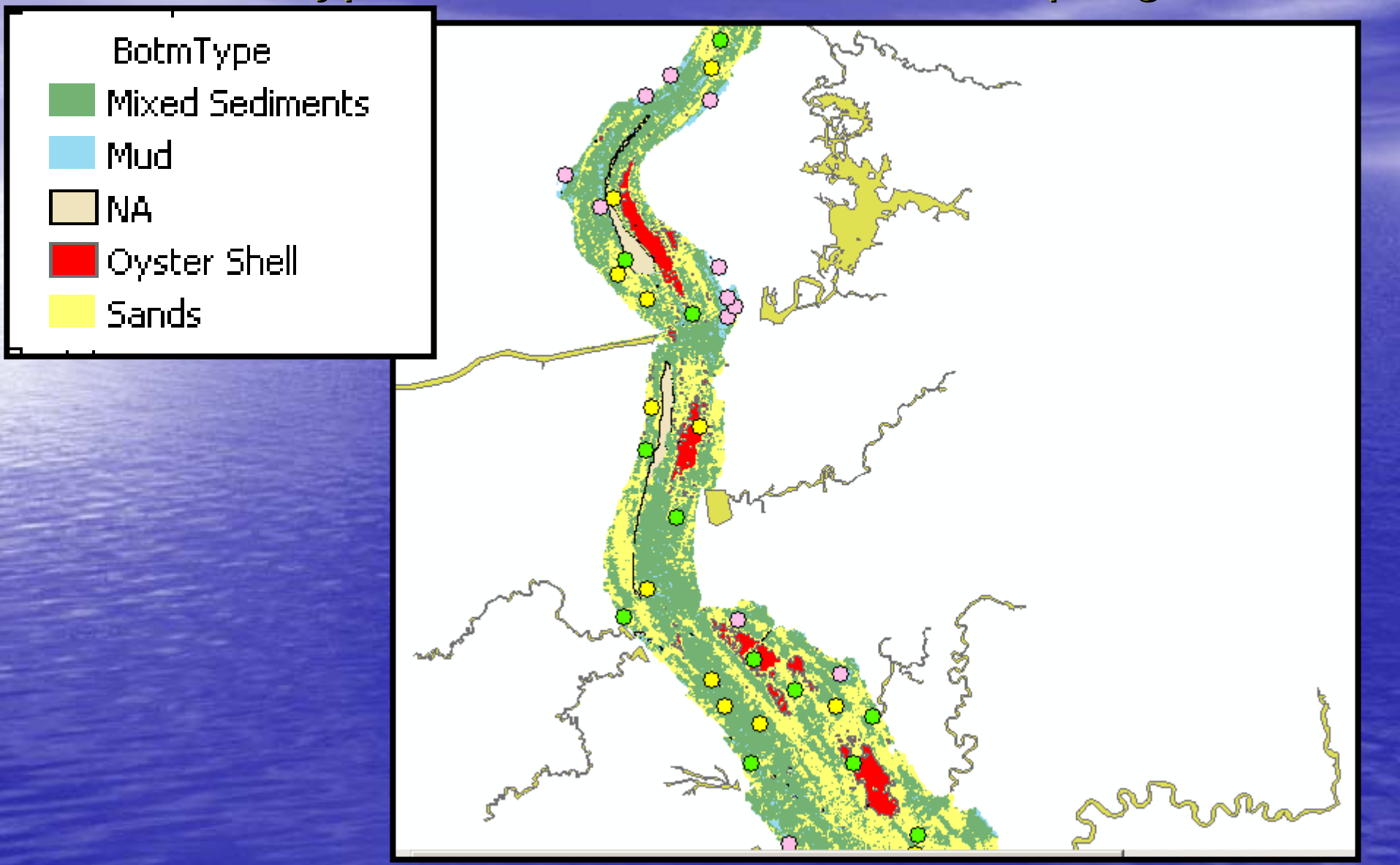
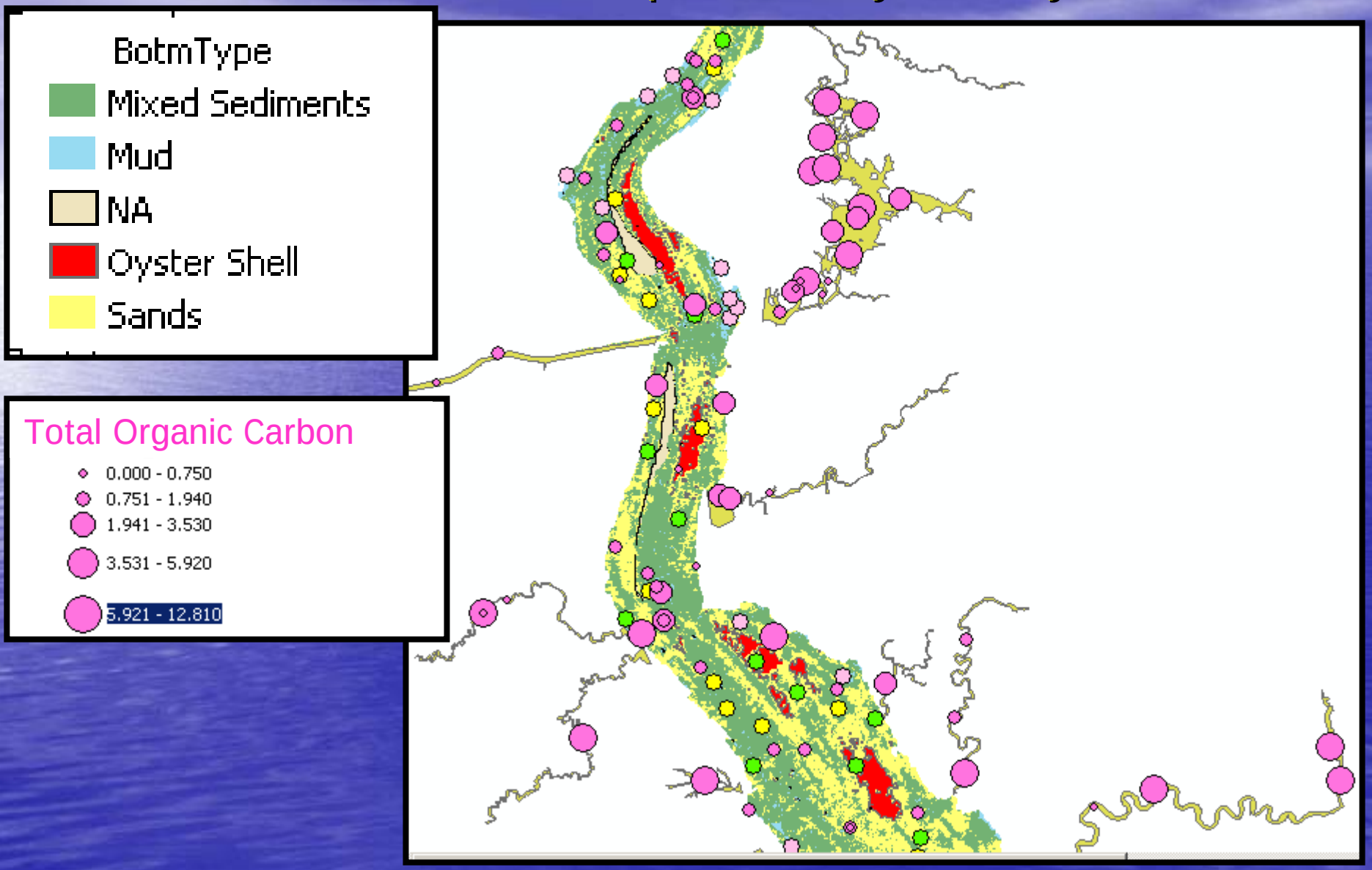


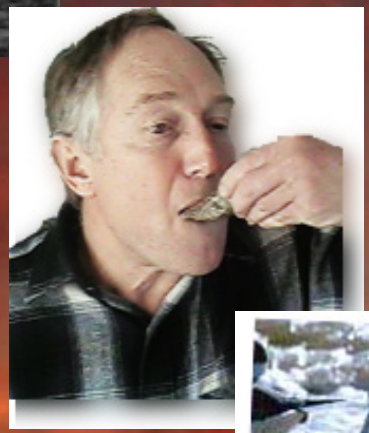
Combining information from DBBMP, 2008 sampling and earlier EMAP / NCA probability surveys



Conclusions:

- (1) Detailed benthic habitat maps valuable for spatially explicit natural resource management
- (2) Probability based sampling can help provide estimates of overall condition
  - % area statistics, simple graphical calculators, radar plots can use for valuable forensics & diagnostics, and support management decisions
- Information from both approaches can be combined for multiple-use management decisions

Questions ?



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PARTNERSHIP FOR THE DELAWARE ESTUARY INC.

DCMP
DELAWARE COASTAL MANAGEMENT PROGRAM

Coastal Management Program

DNREC Online

Delaware River Basin Commission

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

UNIVERSITY OF DELAWARE

newjersey nidep department of environmental protection