

BENTHIC INDICATORS DERIVED FROM THE 2008 DELAWARE ESTUARY BENTHIC INVENTORY (DEBI) SAMPLING

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Delaware Estuary Benthic Inventory (DEBI) Project

With the support of Regional Applied Research Effort (RARE) grants from EPA Regions 2 and 3, the Partnership for the Delaware Estuary, in conjunction with numerous governmental and academic partners, conducted the Delaware Estuary Benthic Inventory (DEBI) project. In the summer of 2008, extensive benthic community, sediment and water-column sampling was conducted at 230 stations throughout the Delaware Estuary.

Project goals:

- Obtain a comprehensive inventory of benthic communities for habitat assessment
- Determine the association of benthic communities with bathymetric and sediment mapping efforts by the Delaware Bay Benthic Mapping Project (DBBMP)
- Obtain sediment and water column data to provide further assessment of the state of benthic communities and ecosystems
- Collect data in ways that allow comparison with recent federal (EPA and NOAA) and historical benthic surveys
- Use multiple sampling methods as needed to sample hard-bottom communities not well sampled by conventional gear (grabs and cores)

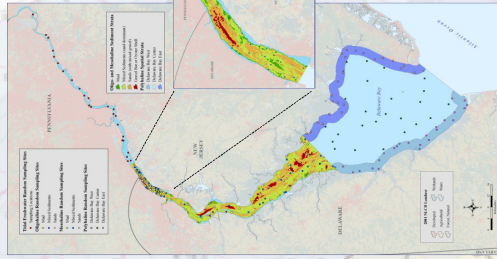
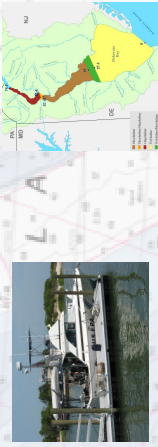
DEBI 2008 Sampling Design

With the assistance of Hal Walker and Charlie Strobel of EPA's Office of Research and Development, Atlantic Ecology Division (Narragansett, RI), we developed a probabilistic sampling design where stations were randomly located within salinity zones and sediment types (where known).

- Salinity: tidal freshwater, oligohaline, mesohaline, and polyhaline
- Sediment: mud (silt and clay), mixed, and sand
- Near-shore (Delaware and New Jersey) and open-bay zones received separate allocations of sites; bottoms near the shoreline of the lower bay had been previously mapped by the DBBMP, while those in the middle of the bay had not
- 250 stations were randomly chosen according to the strata described above

On the Delaware Bay, aboard the RV Lear:

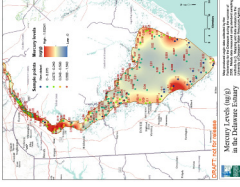
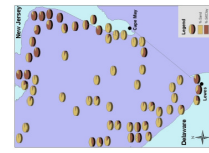
- Two 8" Young grab (0.04 m²) samples were taken at each station
- One for sediments (% silt-clay and TOC), metals, and PCB's (at selected stations)
- One for benthic community analysis: 0.5-mm sieved and preserved in formalin; benthic organisms were identified by Versar, Inc. (Columbia, MD)
- Video camera on grab sampler returned bottom images which were later analyzed
- Water-column salinity, temperature, pH, turbidity and dissolved oxygen profiles were obtained with a YSI Model 6600 V2 sonde
- Hard-bottom sampling by dredge and SCUBA was also conducted in the sloughs of the lower estuary



Sampling Results by the Numbers

From July through September, 2008:

- 36 days on the water
- 30+ staff and volunteers assisted
- 230+ stations sampled as described above
- >460 grabs processed
- Videos reviewed, clips selected and classified; useable imagery from 87 stations
- 1,500 YSI sonde points in water column profiles
- Hard-bottom communities sampled extensively in 2008 (lower bay sloughs) and in 2009 (tidal river)



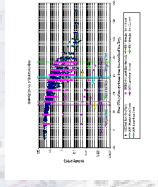
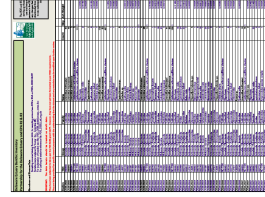
Benthic Abundance and Biomass Data

Metadata, fields and descriptors, and example:

- Station name, DE00-0500 (latitude, longitude and sampling date are in separate file)
- TSN (or Taxonomic Serial Number), 065852
- Higher taxonomic group, Annelida : Polychaeta
- Family, Spionidae
- Species (or lowest identification), *Marenzelleria viridis*
- Number in sample
- Ash-free dry weight, mg

Quick Facts:

- 3290 lines or species-occurrence records from 231 stations
- 244 species (or taxa) and 235 TSN's
- 112 families and 9 phyla (Chordata, Platyhelminthes, Nemertina, Echiurida, Annelida, Mollusca, Arthropoda, Echinodermata, Chordata)
- What was the most diverse site?
- What was the most commonly occurring species?
- What was the most abundant species?
- What species had the highest biomass?



Utility for the Upcoming State of the Estuary Report

These data can be used to inform the first-ever use of benthic indicators in the SOTER report for the Delaware Estuary. A review of nearly two dozen SOTERs revealed that when benthic indicators are used, there is a wide diversity of approaches, ranging from simple species diversity, reference to sediment quality or toxicity from metal or organic contaminants, supplemented with distribution maps of notable or foundation species (e.g., scallops, mussels), to sophisticated indices of biotic integrity (benthic IBI, Weisberg *et al.* 1997 Estuaries 20, 149) in a relatively few cases. Since the validation of biotic indices for the mid Atlantic estuaries (and biogeographic provinces) is ongoing, we propose to use straightforward benthic metrics derived from DEBI community data for PDE report.

B-IBI Pros	B-IBI Cons
• One metric summary of benthic status, 1-5 numerical scale	• Species sensitivity and tolerances reference and required sites in the Delaware Estuary?
• Multi-metric species diversity, abundance, biomass, % pollution response, non-stochastic response to stressors	• Benthic may have multiple responses to stressors
• Index measures benthic condition at single point averaged over component metrics	• Benthic spatial relationships among sites, interpretability with guidance from sediment maps
• Extensively developed over decades, especially in the Chesapeake Bay	• Cost estimate in the figures to develop for Delaware Estuary
• US and international evaluation of benthic indices is ongoing at many agencies, sites and ecological scales	• B-IBI interpretability, assessed by stressors or desirable habitat, ecosystem qualities?

Recommendations:

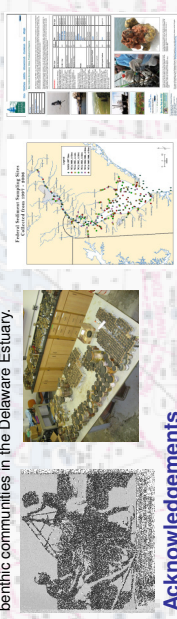
- Number of species, Shannon-Wiener's H'
- Evenness $J = H' / H'_{max}$
- Species accumulation curves
- $N_{sp} = (N_{total})^2 / \sum (N_i^2)$ and $ES = (N_{total})^2 / \sum (N_i^2)$
- Display spatial patterns in biodiversity and biomass correlated with sediment type(s)
- Identify 'biodiversity hotspots' with unique, signature, or foundational species
- Develop Delaware Estuary B-IBI once (1) pollution sensitivity / tolerance is confirmed, (2) reference and 'sites of known stress' are identified for index validation, and (3) work with other, ongoing estuary, regional, and province-level efforts

DEBI Data Access from the Web and Future Work

Over the past year, the DEBI Work Group has strived to geo-reference these data in order to make them FGDC-compliant and to release them to interested users. We are pleased to announce that these data will be made available via the Partnership's web site:

www.delawareestuary.org/science_projects_baybottom_data.asp

In addition, it should also prove possible to compare indicators derived from the 2008 data with similarly formatted and electronically available data from federally funded studies (EMAP, MAIA, NCA) from the 1990's through the 2000's, as well as other past surveys. Thus in addition to benthic habitat status, we hope for the first time to be able to reveal trends in benthic communities in the Delaware Estuary.



Acknowledgements

Support for the Delaware Estuary Benthic Inventory was provided by an EPA RARE grant to the Partnership for the Delaware Estuary. Special thanks to the captain and crew of the RV Lear: Jim Gouvas and Steve Donahue, and to the dozens of PDE, EPA staff and UD CMES/OE students who assisted in fieldwork in 2008 and again in 2009. Bart Wilson of the Delaware Coastal Program's Delaware Bay Benthic Mapping Project (DBBMP) provided sediment maps used in the design of the sampling program as well as valuable ongoing assistance.

Benthic Abundance and Biomass Data

Quick Facts:

- 3290 lines or species-occurrence records from 231 stations
- 244 species (or taxa) and 235 TSN's
- 112 families in 9 phyla: Cnidaria, Platyhelminthes, Nemertina, Echiurida, Annelida, Mollusca, Arthropoda, Echinodermata, Chordata
- Five stations had 40 or more species: NJ08-0558 main channel near Cross Ledge (51 species), DE08-0620 (44), NJ08-0574 (42), DE08-0605 (41), NJ08-0567 (40)
- Mean species diversity, 14 species
- One station, DE08-0558 from near Christina River, had no organisms present
- Most surprisingly, a lone unidentified echiuroid ("spoon worm") was found at station DE08-0626 at Slaughter Beach
- Horseshoe crabs were collected at five Delaware stations

Benthic Abundance and Biomass Data

Benthic Species:

- Five most diverse groups: polychaetes (27 families, 79 species), amphipods (15 families, 35 species), bivalves (17 families, 27 species), and gastropods (15 families, 25 species)
- Ten most common species occurrences: *Cyathura polita*¹ (108 stations), *Oligochaeta*² (100), *Mediomastus ambiseta*³ (96), *Glycinde solitaria*³ (94), *Tubificoides*² spp. (92), *Streblospio benedicti*³ (89), *Marenzelleria viridis*³ (78), *Leucon americanus*⁴ (75), *Acteocina canaliculata*⁵ (73), *Apocorophium lacustre*⁶ (69)
- Highest abundance: 2853 *Gemma gemma*⁷ at NJ08-0551 near Nantuxent Creek (71,000 m⁻²)
- Highest biomass: 7.7 g of *Corbicula fluminea*⁷ at DE08-0504 near Marcus Hook (192 g m⁻²), overall mean total biomass 0.30 g or 7.4 g m⁻²
- Mean abundance 360 per grab, or 9000 m⁻², highest total abundance 5691 or 142,000 m⁻² at NJ08-0567 Egg Island Point (including 2228 *Sabellaria vulgaris*³ and 1575 *Polydora cornuta*³)

¹Isopod, ²Oligochaete, ³Polychaete, ⁴Cumacean, ⁵Gastropod, ⁶Amphipod, ⁷Bivalve