Subaqueous Soils Workshop

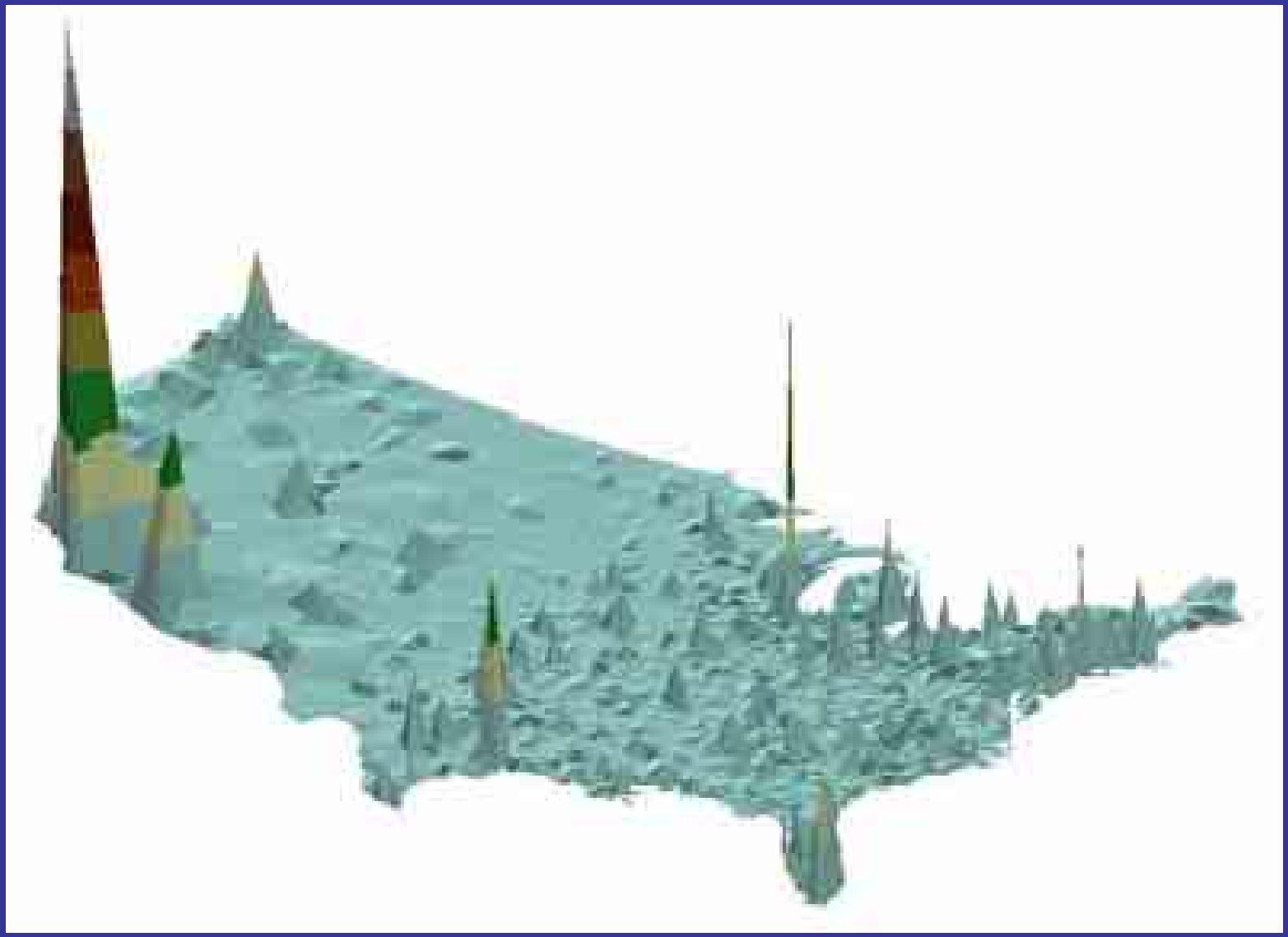
Delaware's Inland Bays

14-18 July 2003

Estuarine Ecology

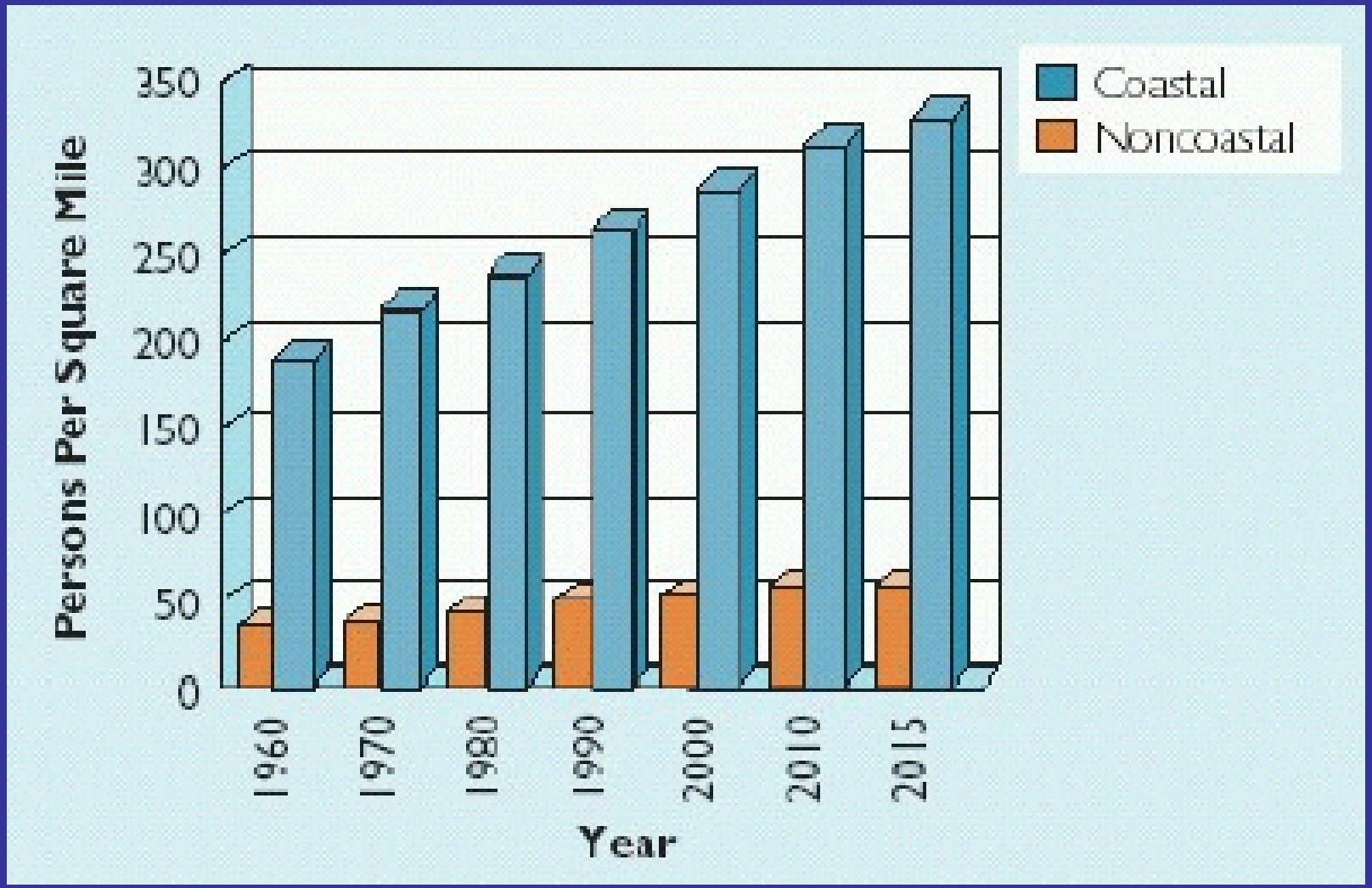
- Basin Characteristics
- General Benthic Ecology
- SAV
- Regional Status

US Census Population Centers



2000 Census

Coastal Population Dynamics



County/Watershed Growth

- Population-156,638; 38% decade growth
- Building Permits-2001 to 2002, 26%
- Winter traffic #s = summer from 20 yrs ago
- Weekend summer population computed by toilet flushes
- Bays' Nutrients supplied by Point and Non-Point sources

Northern Delmarva Peninsula

Southern Delmarva Peninsula

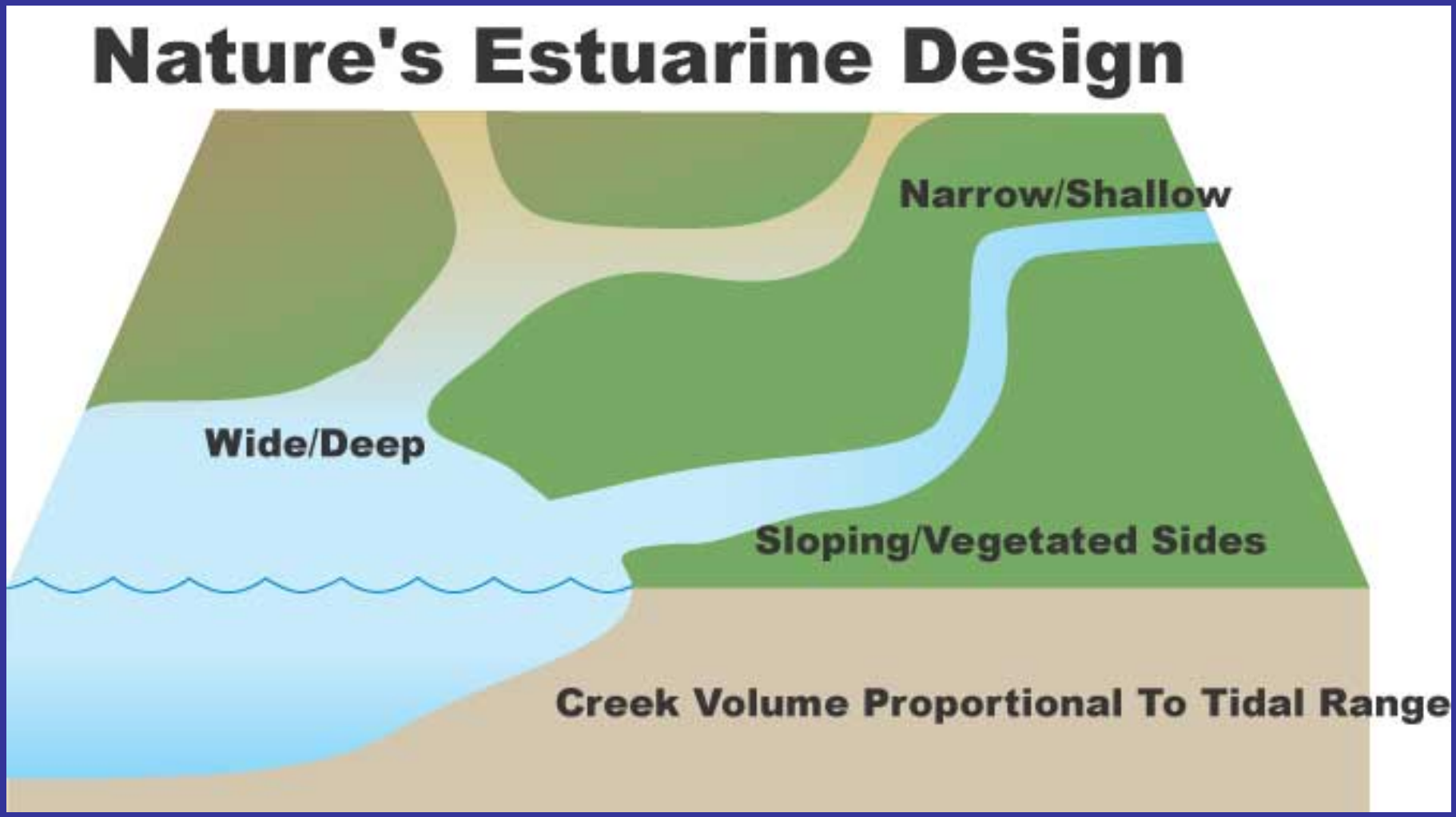
Inland Bays Watershed

Factors affecting benthic diversity and distribution

- Water Column Parameters
- Sediment Parameters
- System Fluid Dynamics

Water Column Parameters

- Salinity-ppt (0/00) vs. psu
  - Ex. 1.5% = 15ppt (psu)
- Dissolved oxygen- mg/l vs. ppm
- Nutrients
  - Dissolved inorganic nitrogen (DIN)
  - Dissolved inorganic phosphorus (DIP)
- Various contaminants (natural or anthropogenic)
- Total Dissolved Sediments
  - Biological-ex. Phytoplankton
  - Physical – sediments (clays or silts)



Estuaries-Mixing of fresh water with seawater

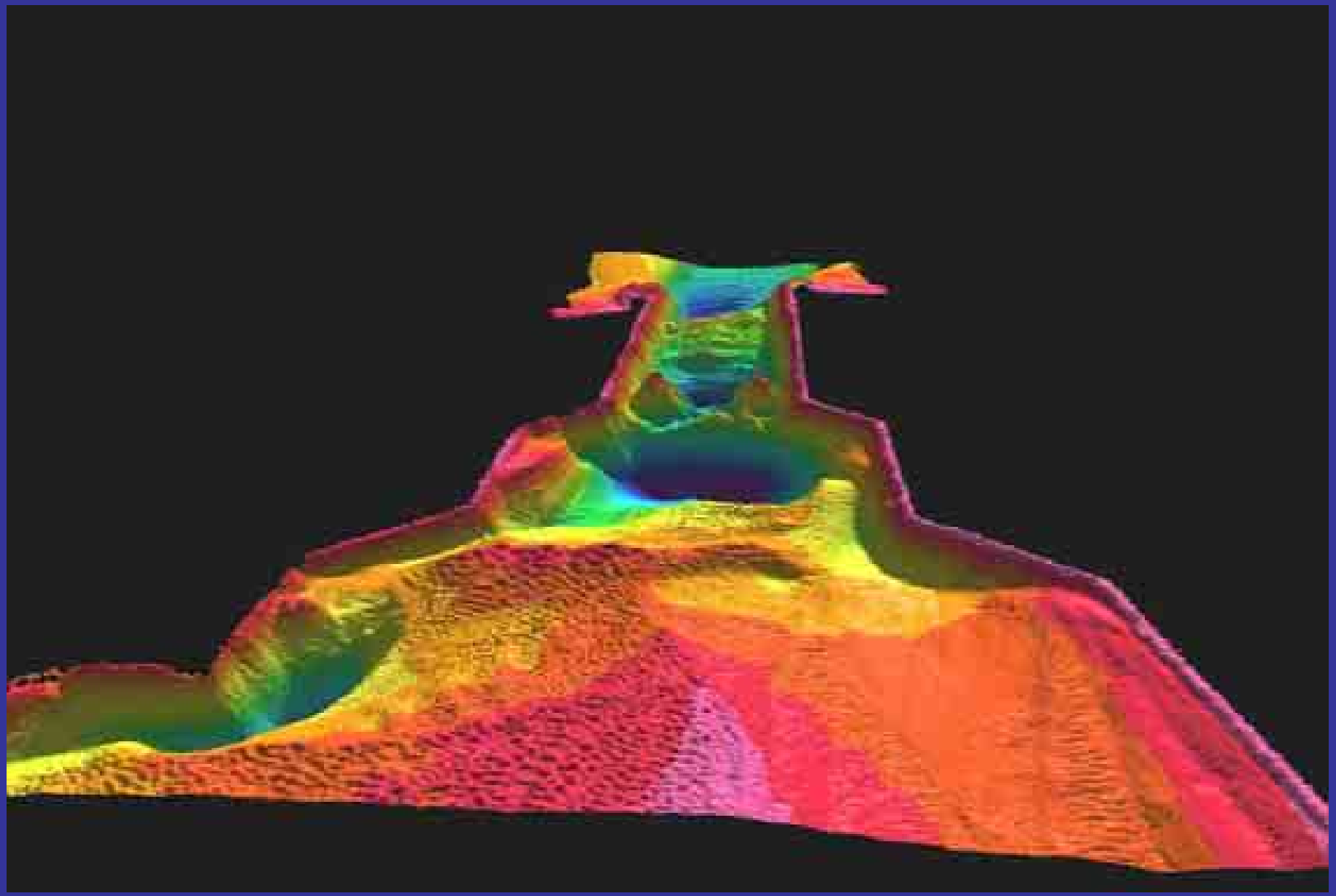
Sediments

- Grain size
- Total organic carbon
- Contaminants
- Sediment salinity (interstitial salinity)
- Redox zone
- Stratigraphy

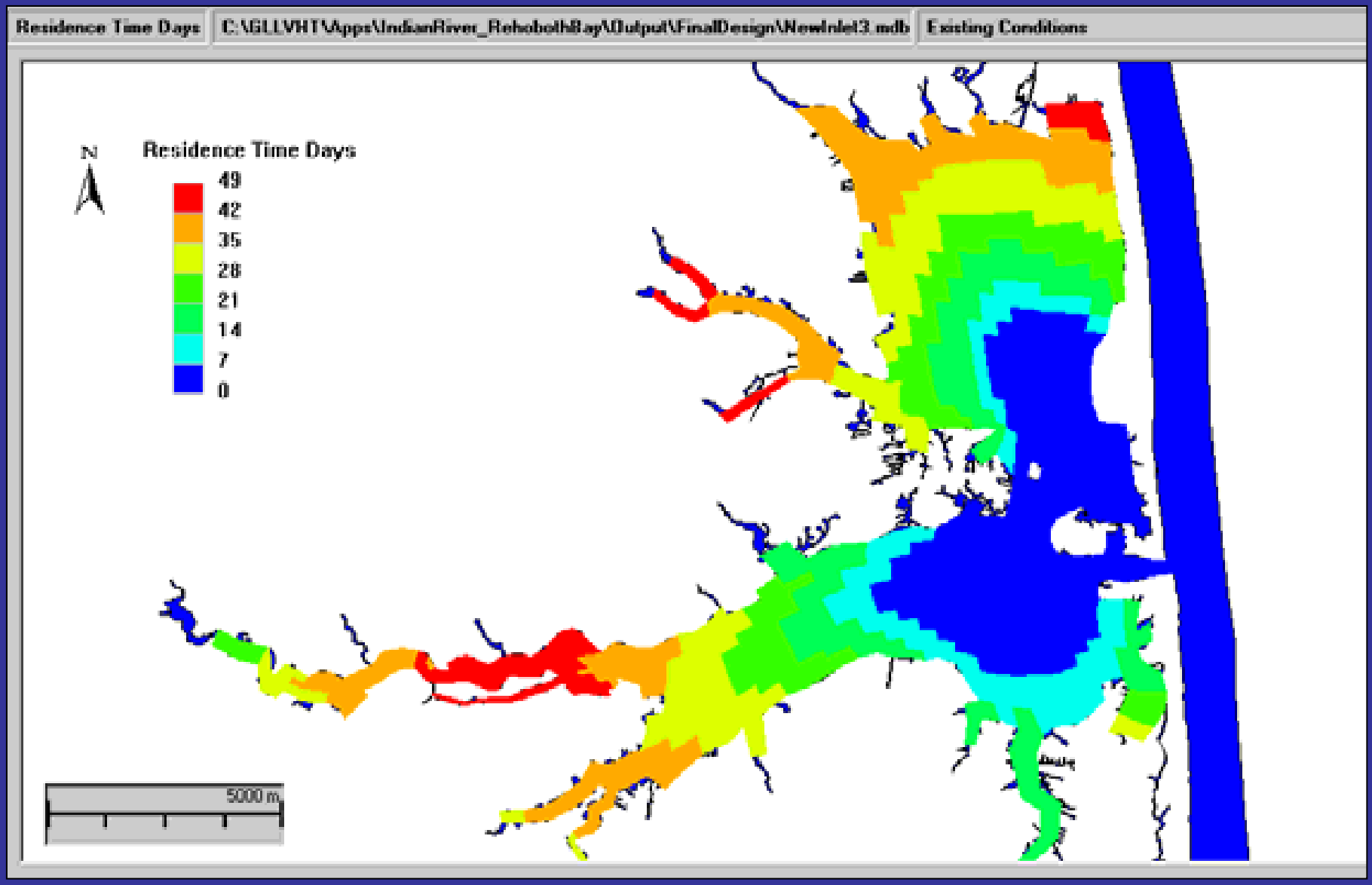
Estuarine System Fluid Dynamics

- Flushing-exchange of water from outside the system to within
- Circulation-exchange of water within the system-dispersion-large scale
- Diffusion-vertical movement of water-small scale
  - Stratification-layering of water column into discrete units (salinity and/or temperature)
  - Diffuse, uniform or homogenous
- Seasonal variability of water column-climatic events
- Meteorological impacts to water column- **episodic events** -storms, rainfall, hurricanes, etc.

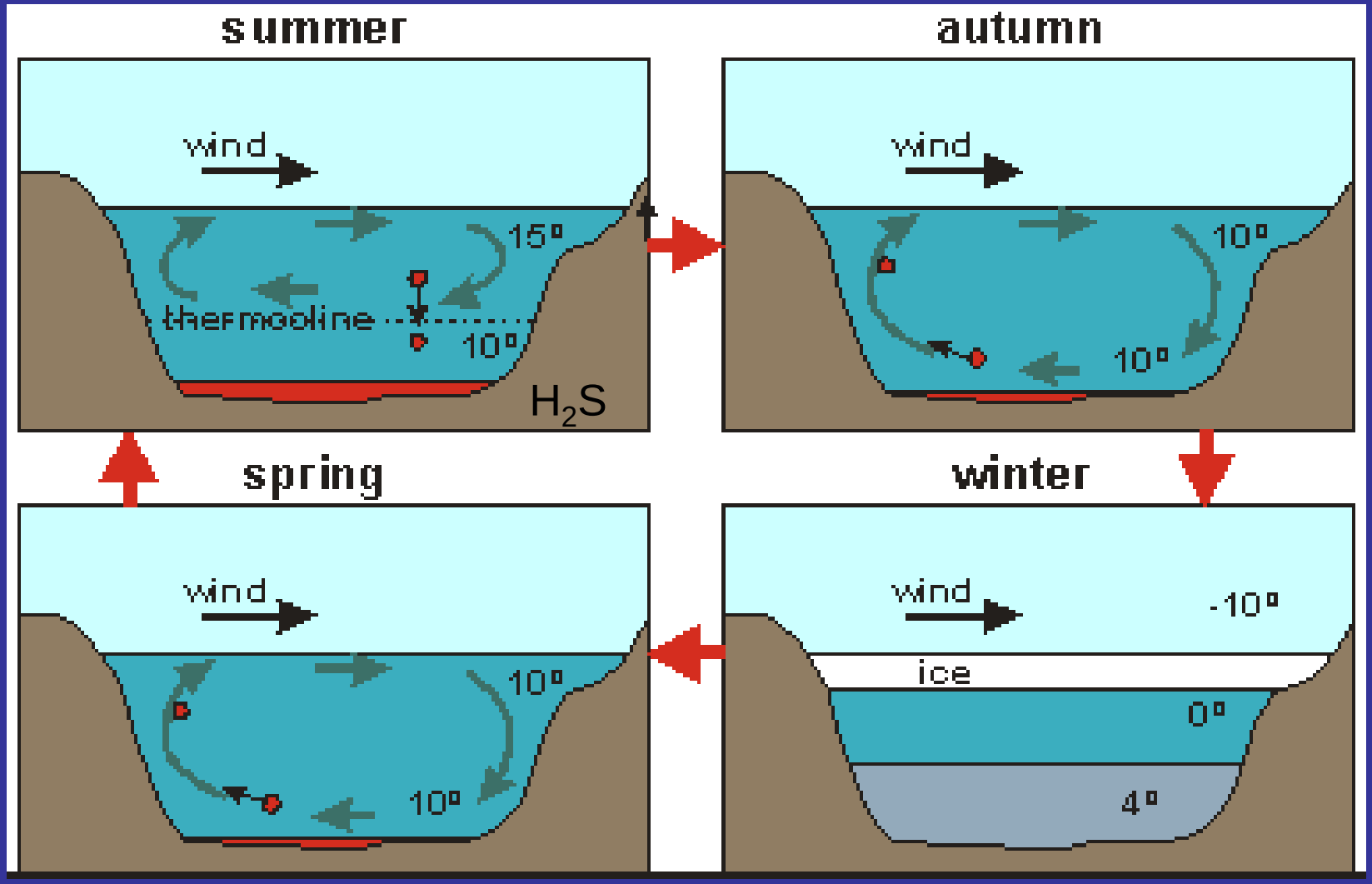
Indian River Inlet Bathymetry



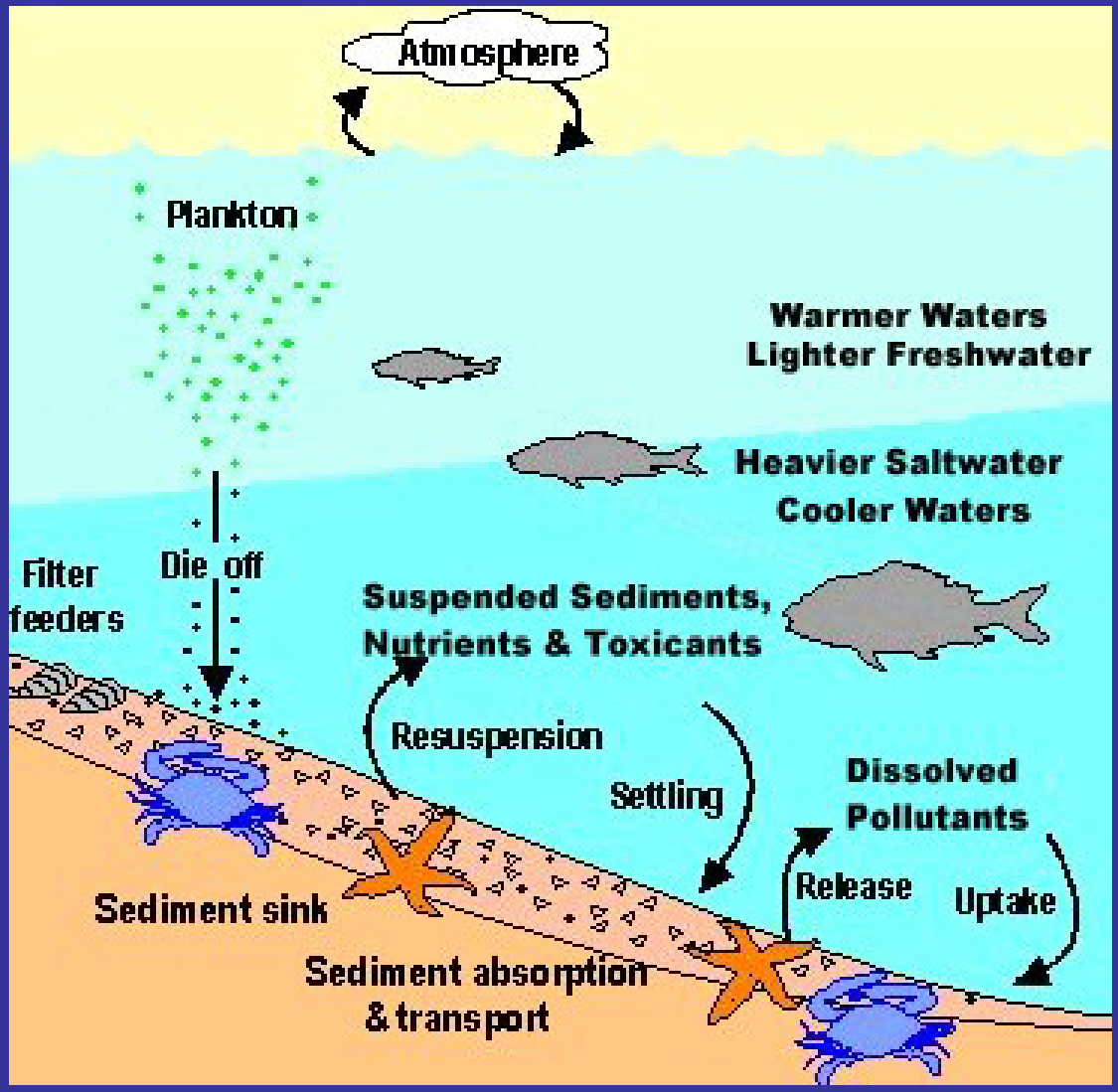
Inland Bays Residence Time



Season Stratification



Stratification



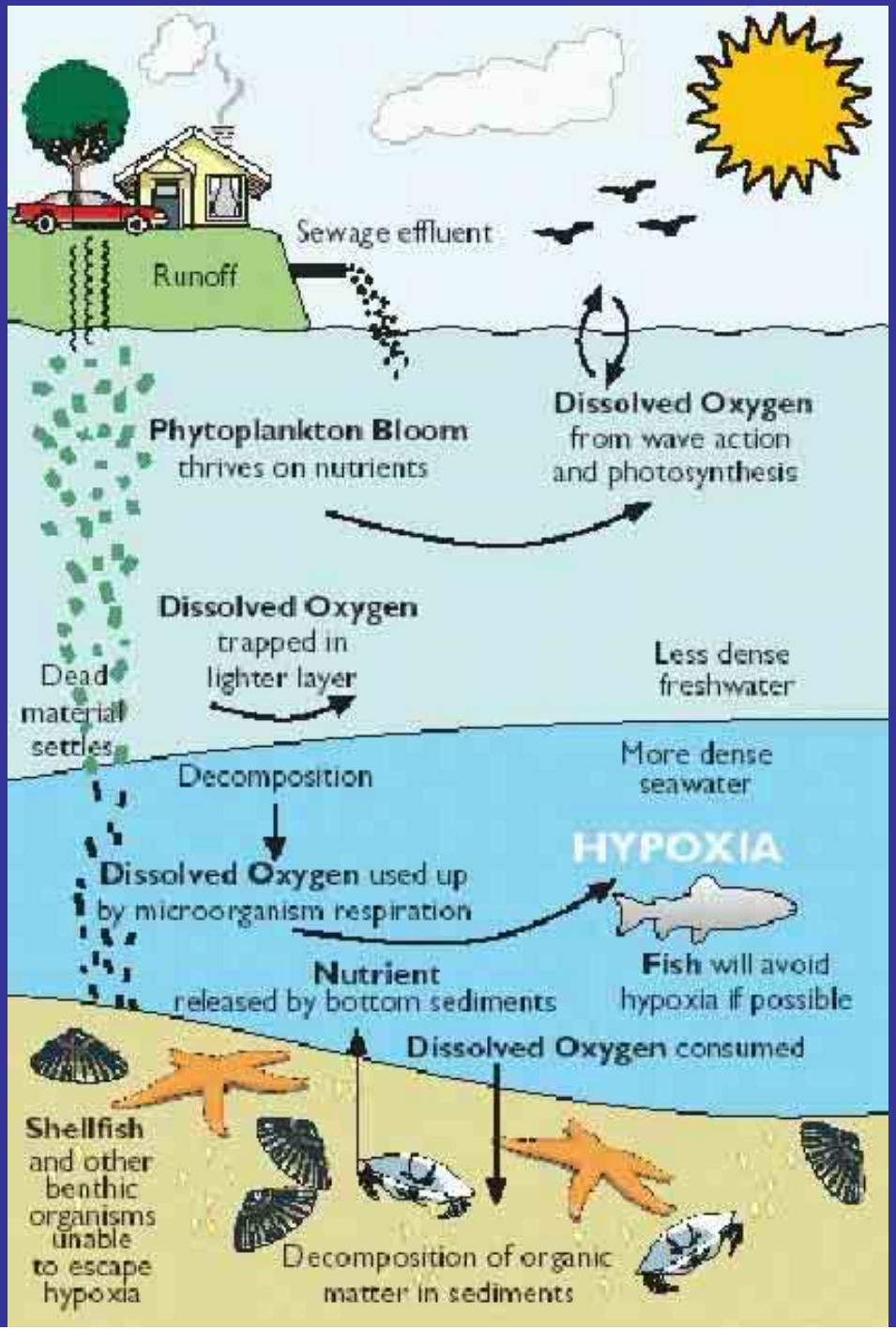
Eutrophication

when available nutrient concentrations increase beyond normal acceptable levels

Nutrients of Concern

Dissolved Inorganic Nitrogen (DIN)

Dissolved Inorganic Phosphorus (DIP)

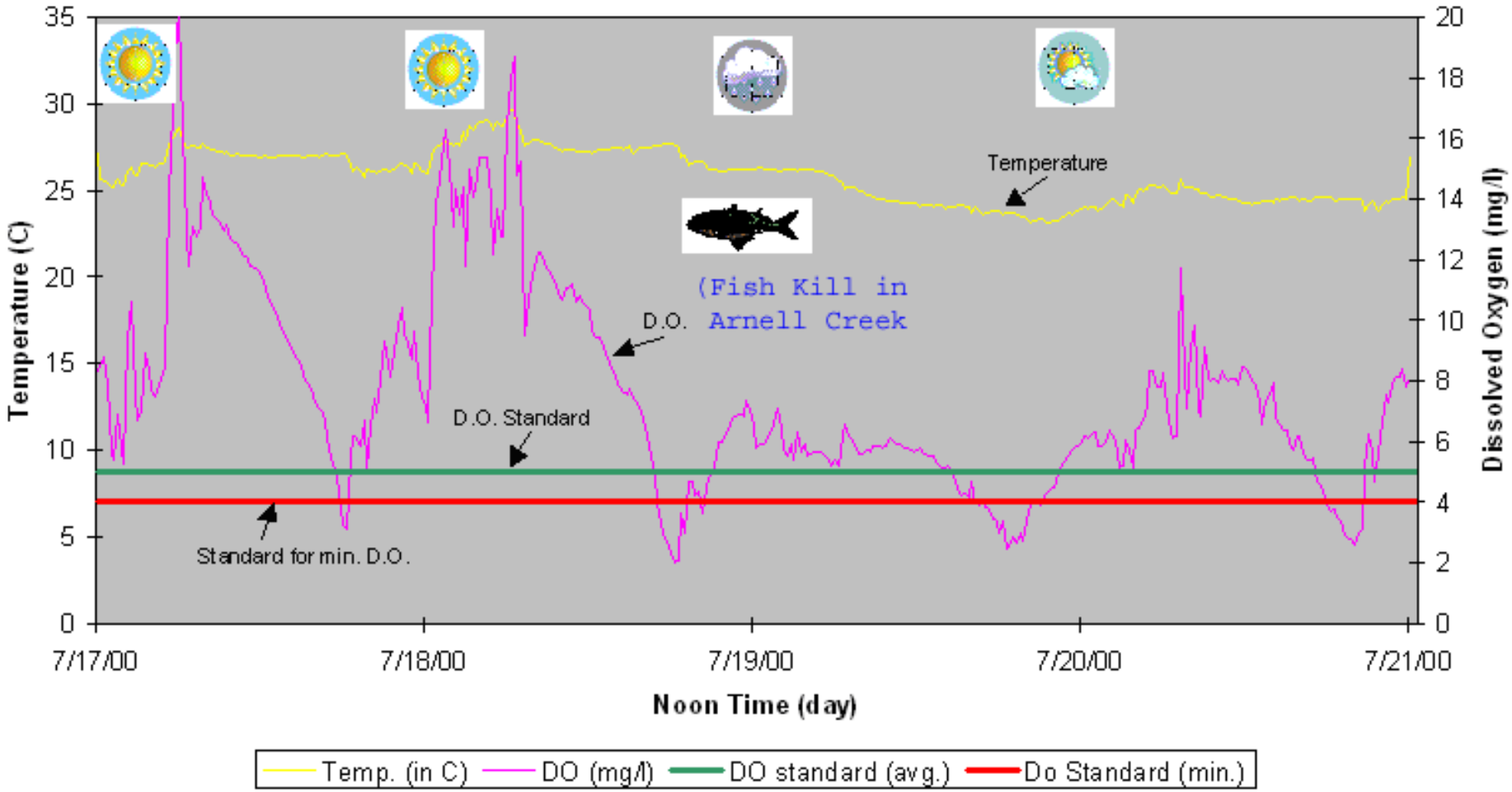


Summer 2000 Fish Kills

- High Number of Fish Kills-20+
- Exceptional YOY Menhaden Population
- High Temperatures
- Long Duration Overcast Skies-Low DO
- Rain with Nutrient Runoff-Fueled Algae Blooms/Crashes
- HABs in Dead-end Canals-*Chattonella*
- Hydrogen Sulfide Releases

Menhaden Fishkill-Aug 2000

Weather Impacts on Dissolved Oxygen Pepper Creek-July 2000



Macroalgae Harvesting

Chaetomorpha

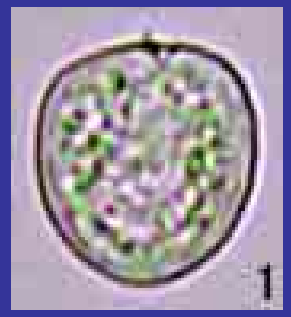
What is a "H.A.B." ?

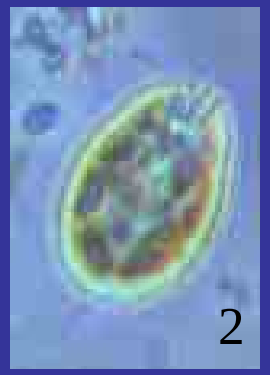
H.A.B. = "Harmful Algae Bloom".
This term is used to describe the proliferation, or "bloom", of single-celled algae (microalgae) or phytoplankton.

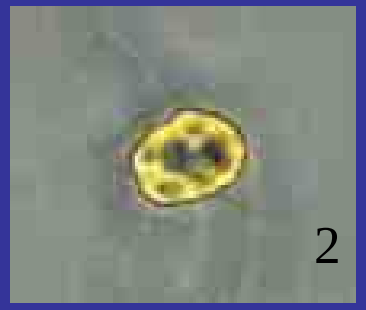
Most phytoplankton are beneficial since they serve as the base of the food chain.

Blooms can be harmful because:

- A small number of algae produce toxins that can harm organisms or concentrate in the food chain.
- Blooms can cause low dissolved oxygen in the water.
- Blooms can reduce light penetration, harming desirable organisms, such as those found within Eelgrass communities.

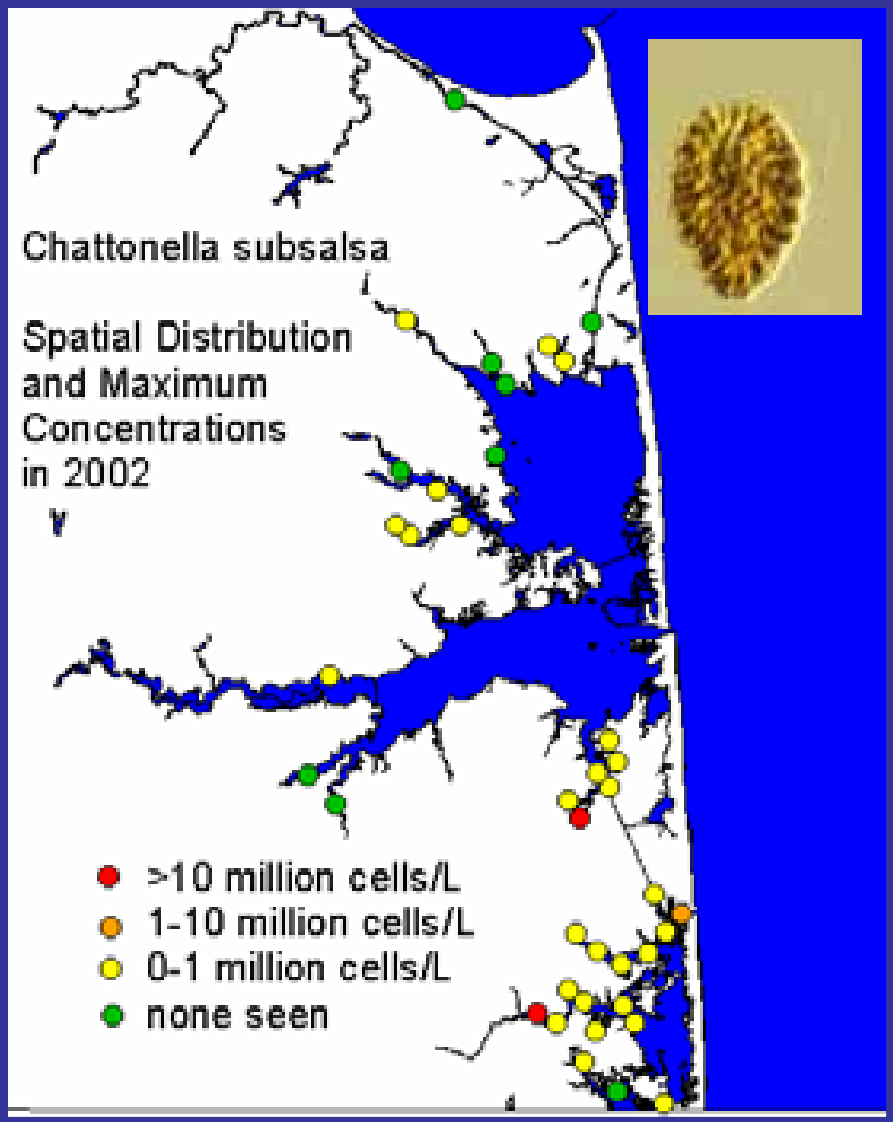


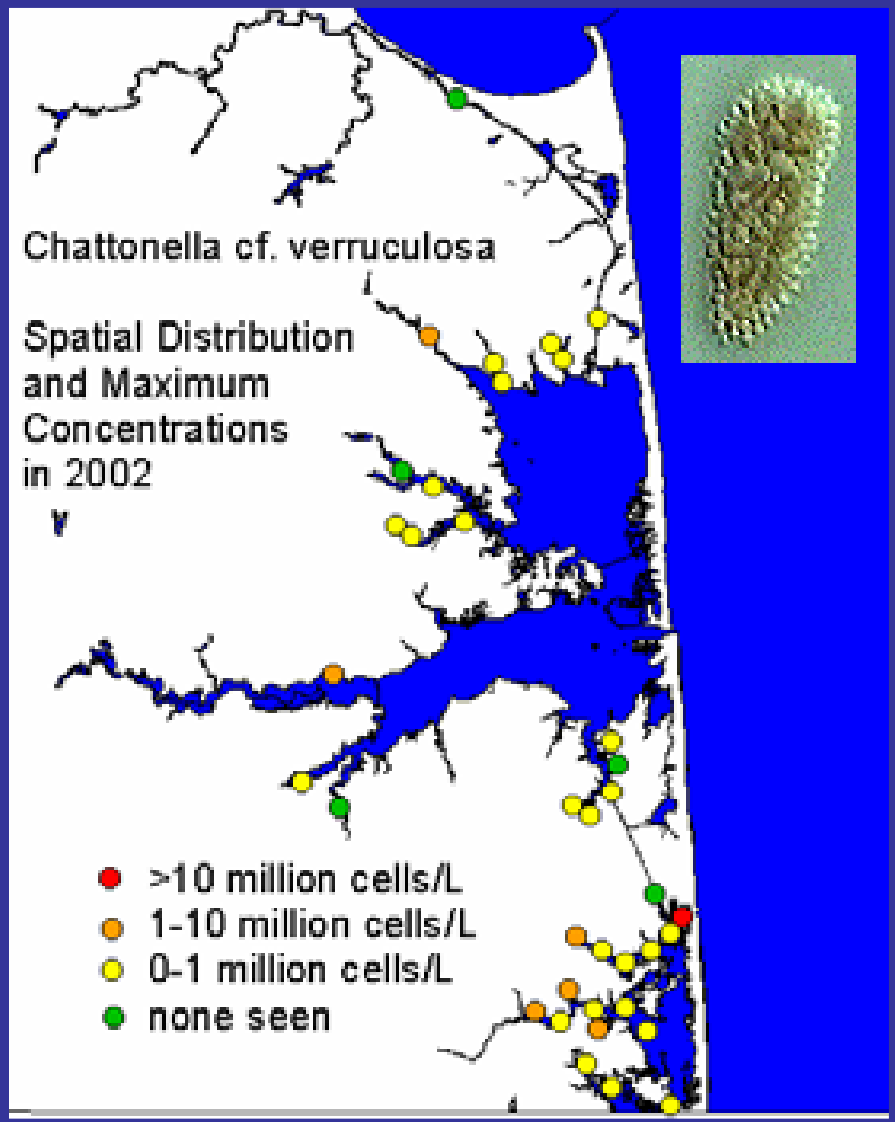




Photos: 1-Univ. of Tokyo, 2-MDDNR

Chattonella -2002



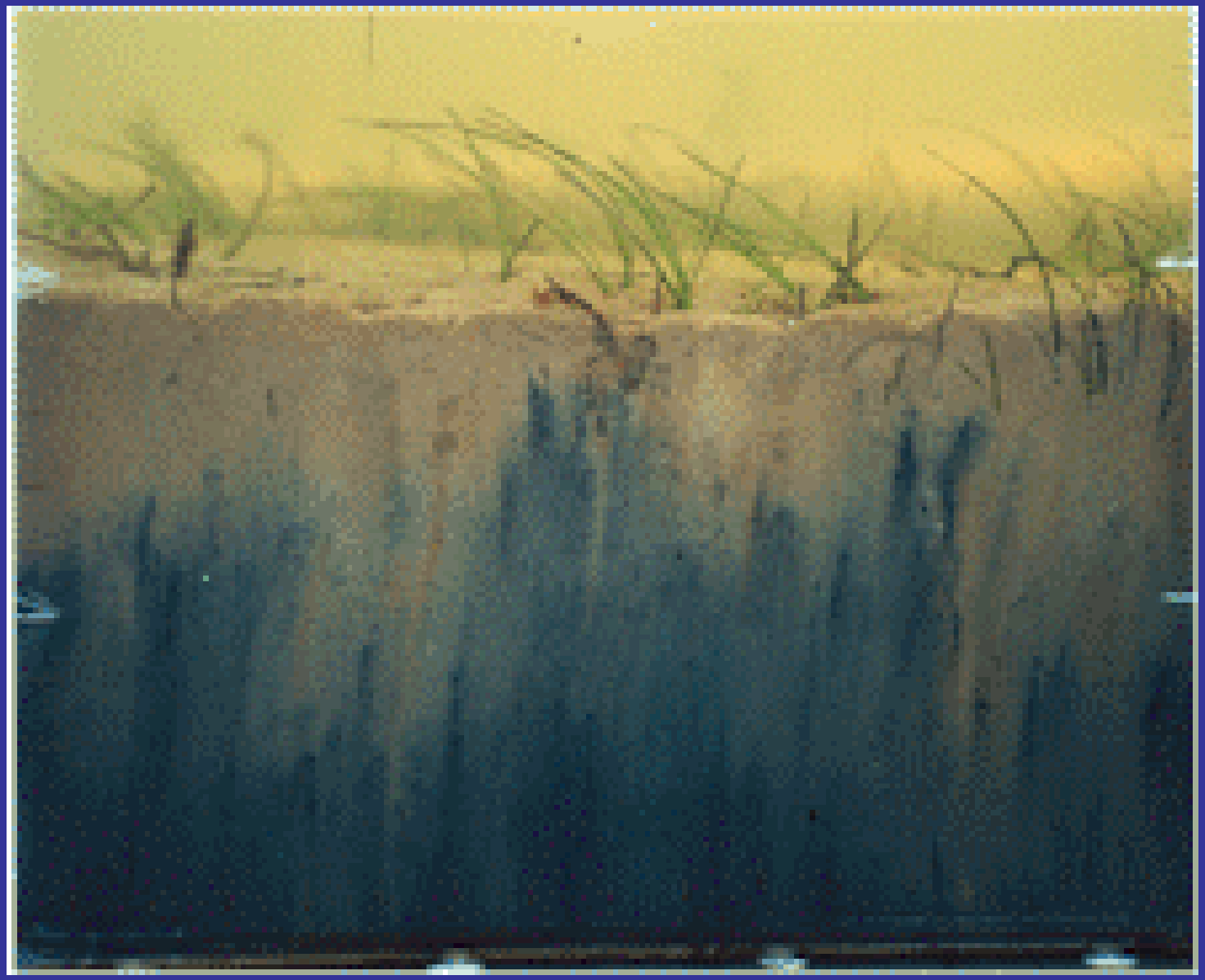


Bob Diaz with Sediment Profile Camera

Benthic Sediment Profile Camera

Active Benthic Sediment Profile

Sediment Profile Under Eelgrass



Sediment Plow Profile Camera

Sediment Plow Profile Camera Output

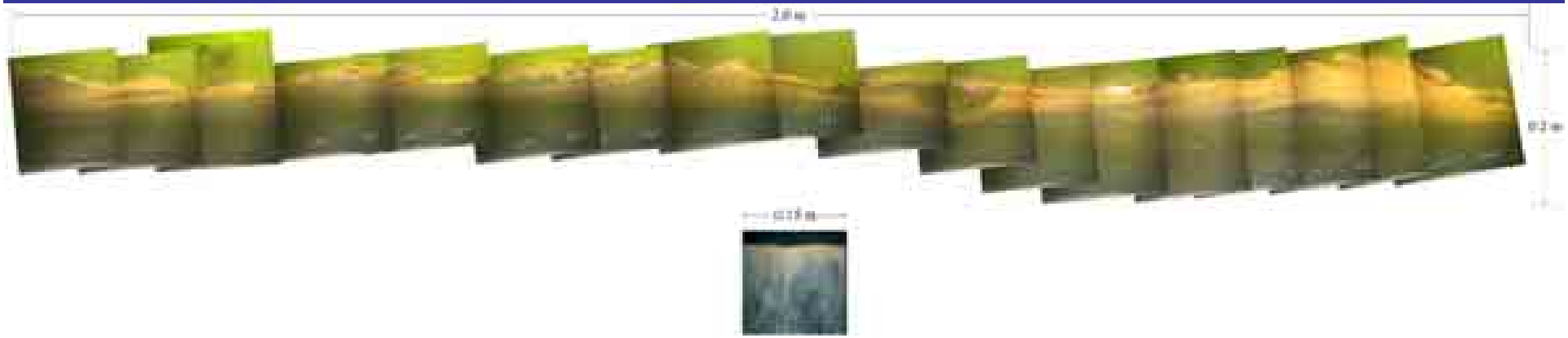
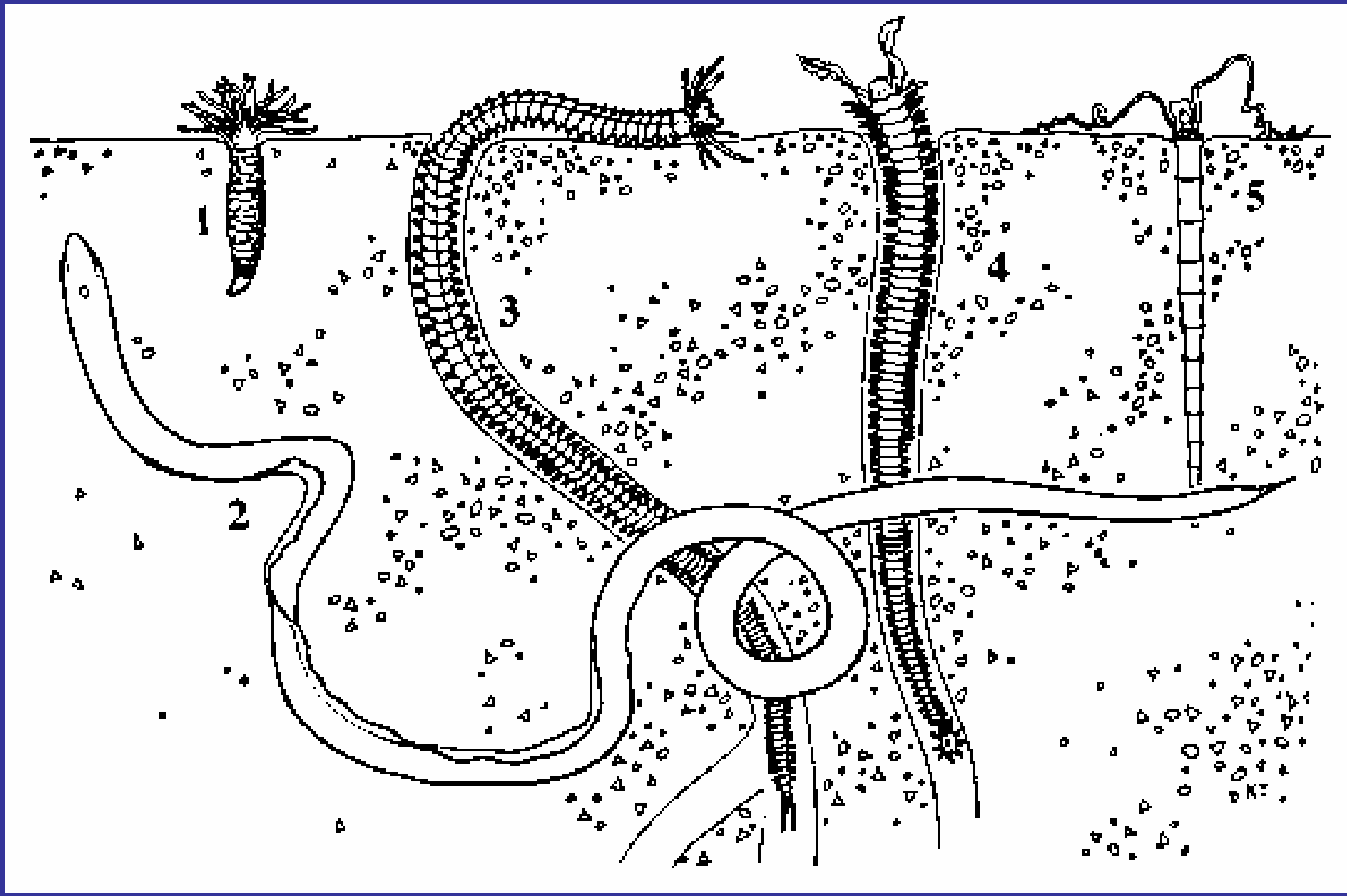
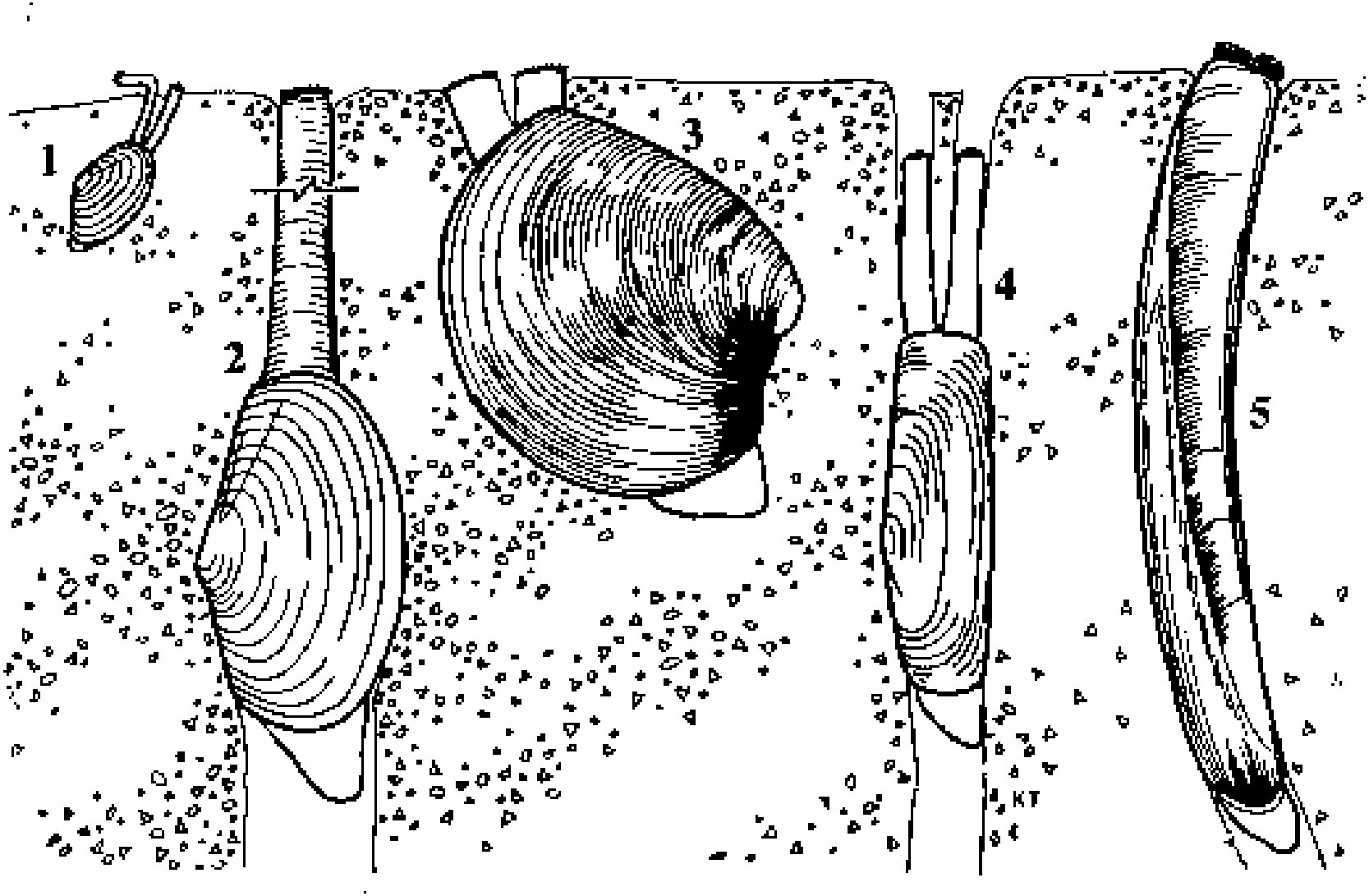


Figure . Plowing profile camera image mosaic (2 m wide) above, and standard profile camera image (0.15 m wide) below.

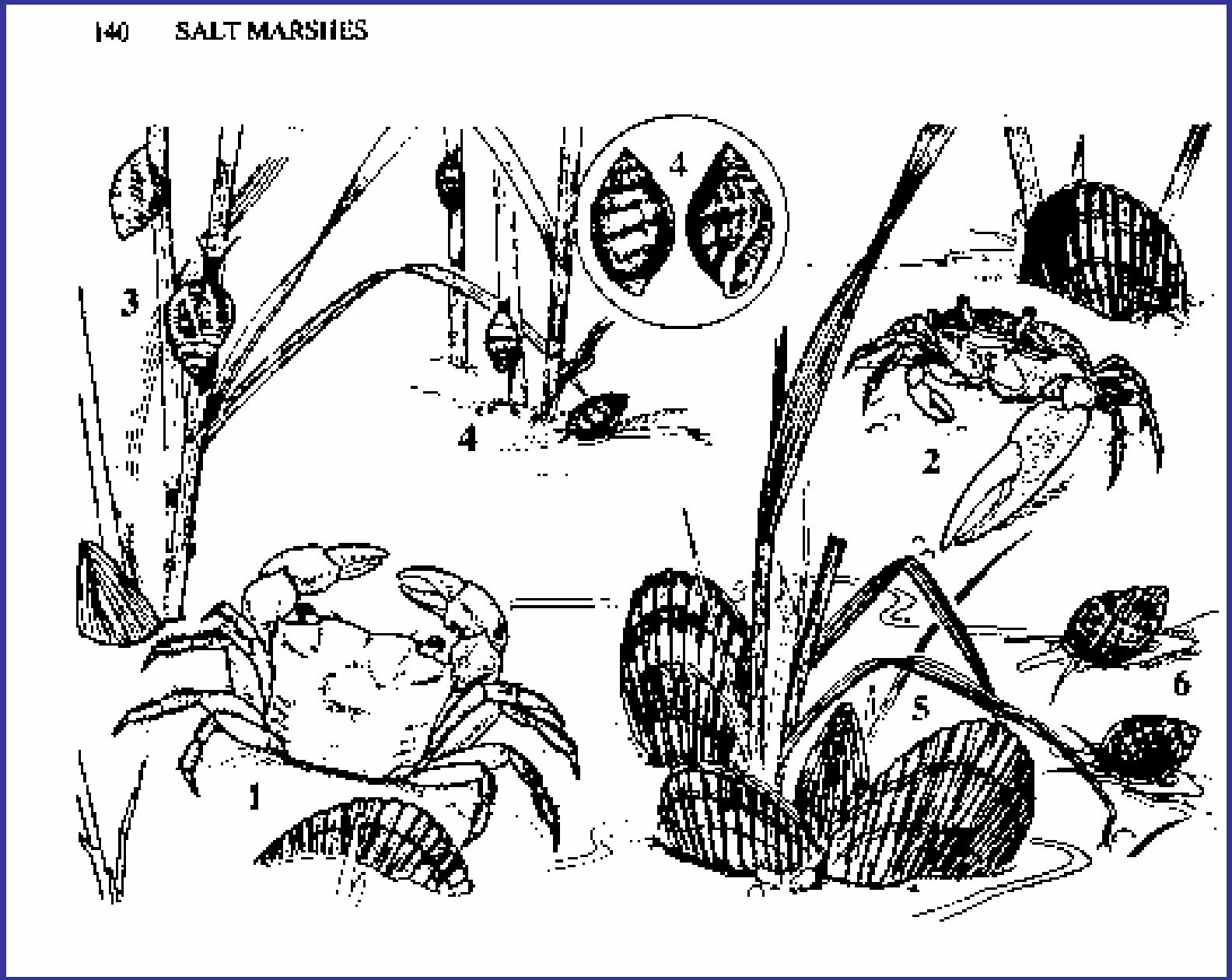
Benthic Annelids



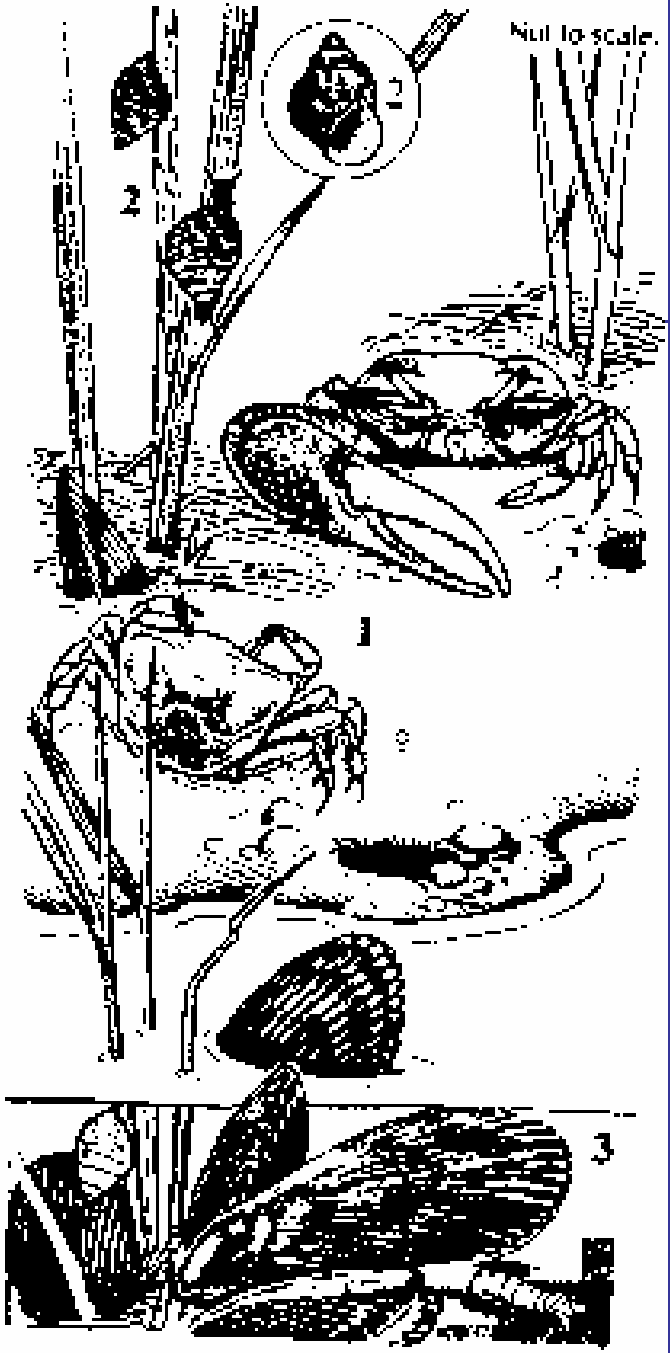
Benthic Bivalves



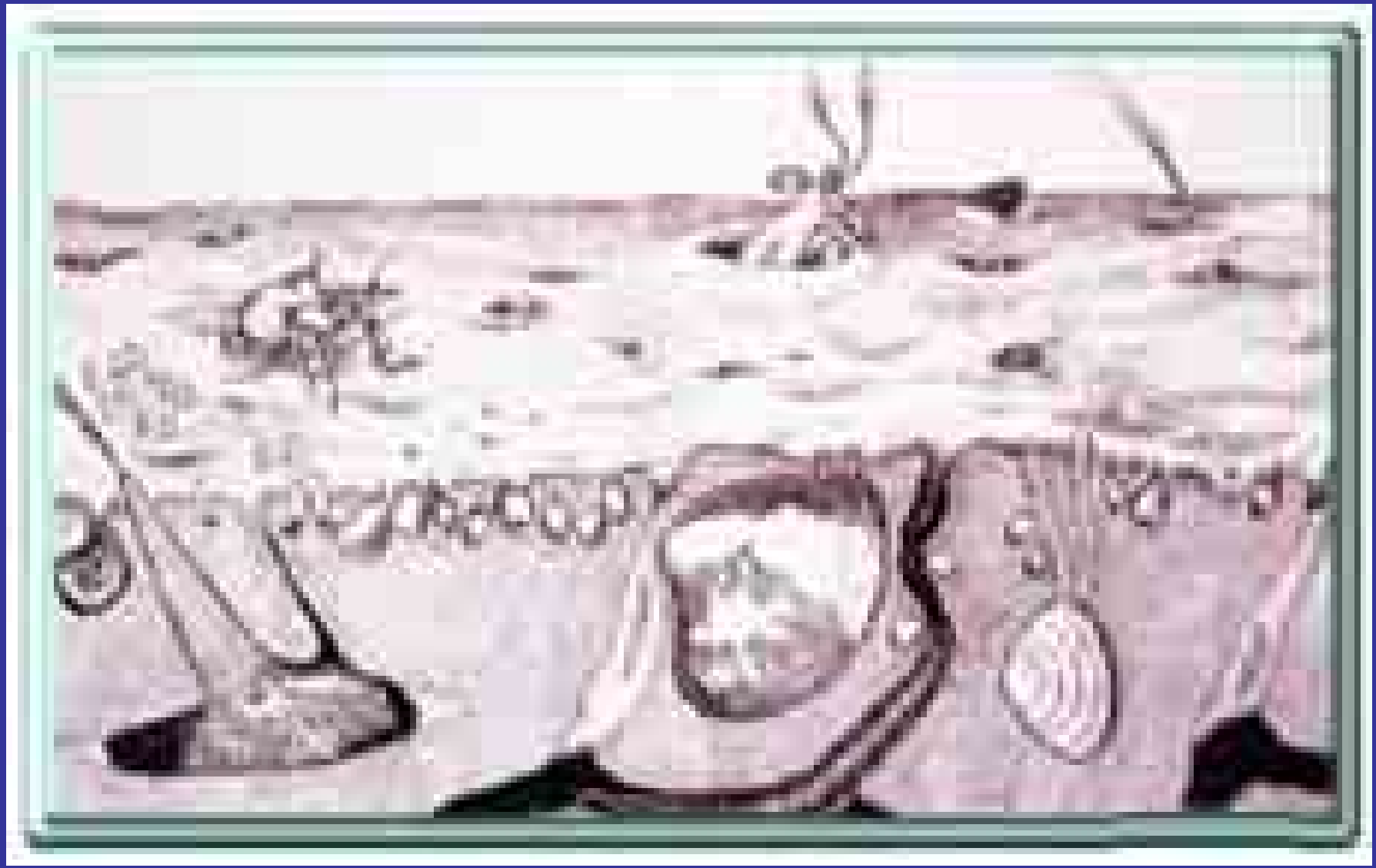
Marsh Invertebrates



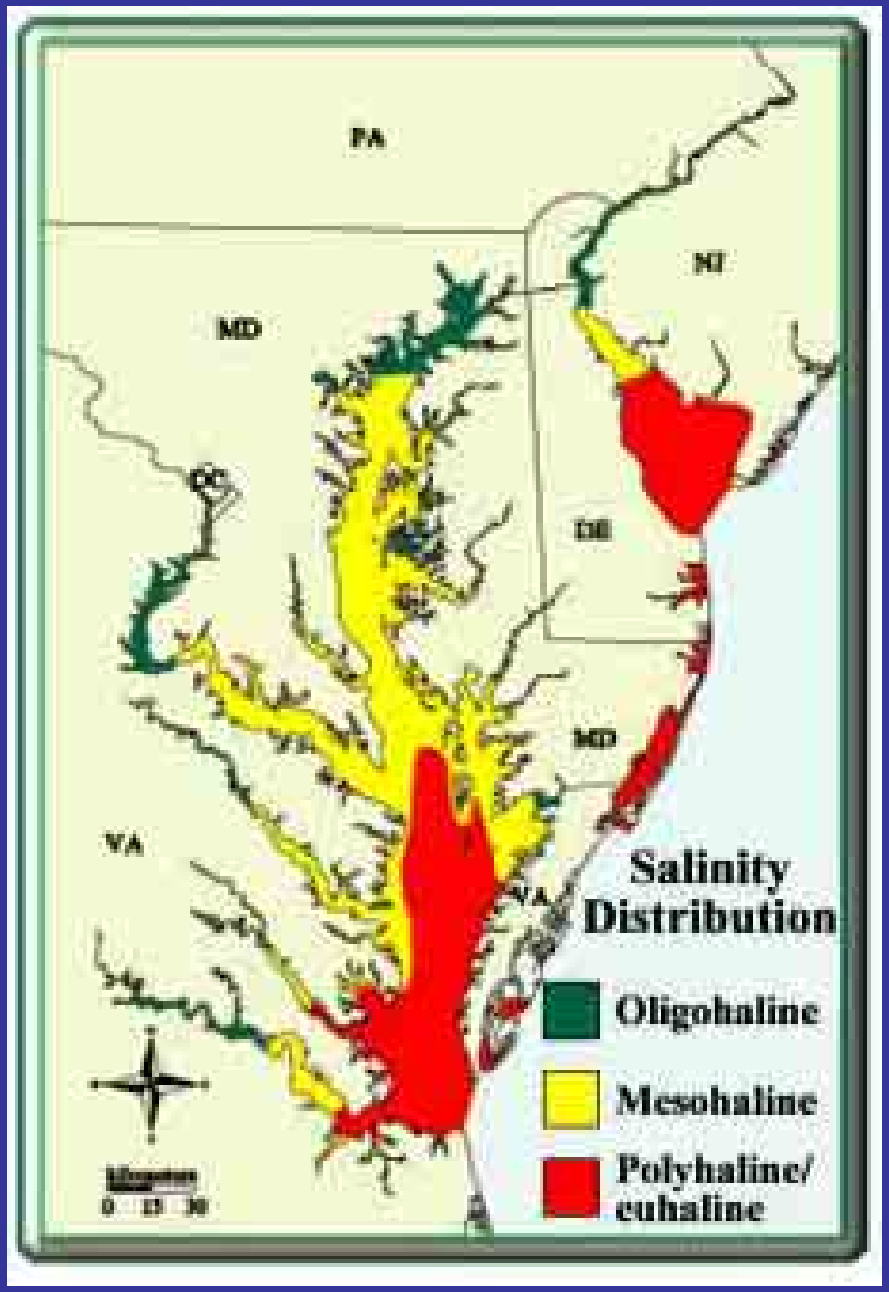
Marsh Invertebrates



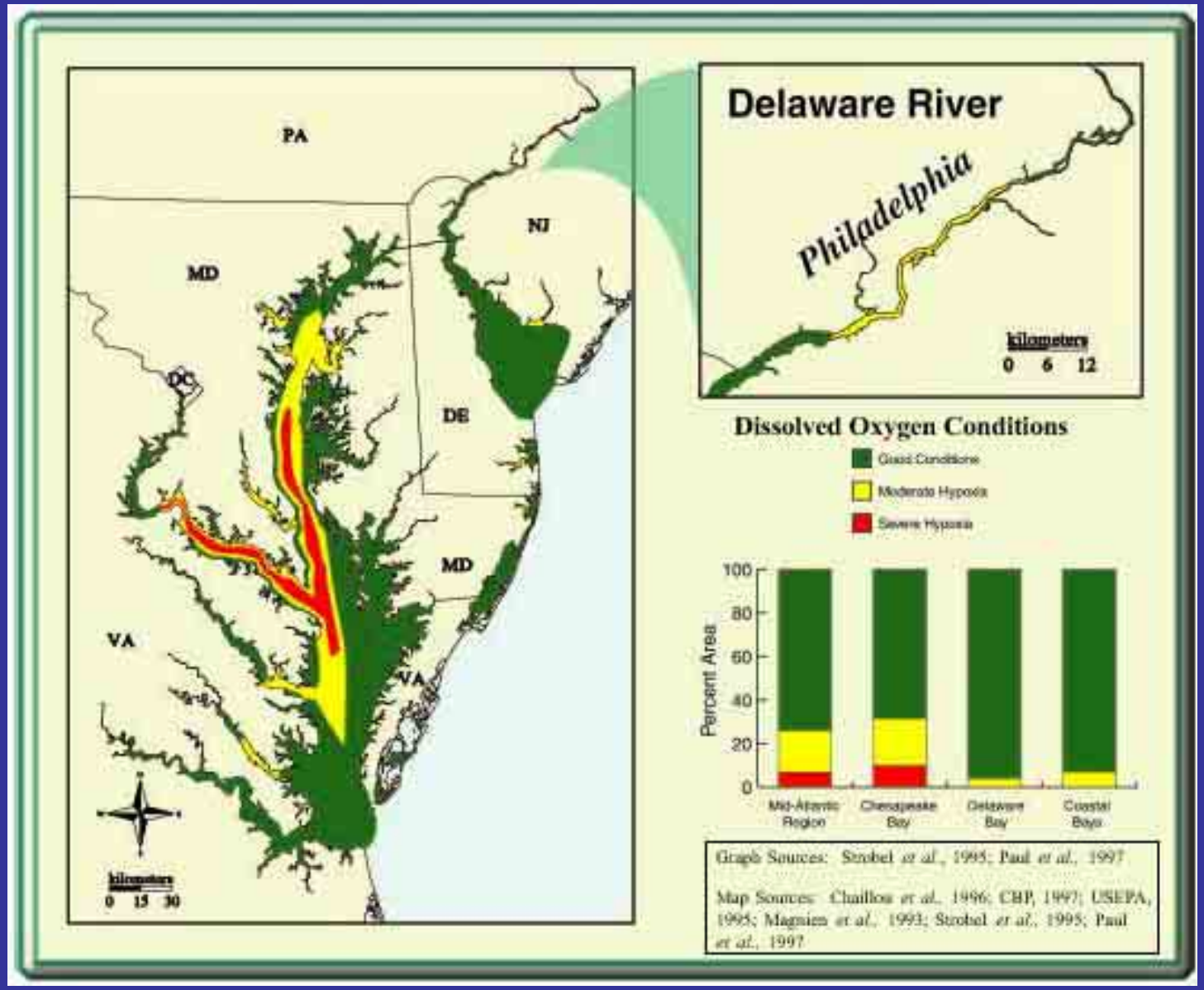
Typical Infauna



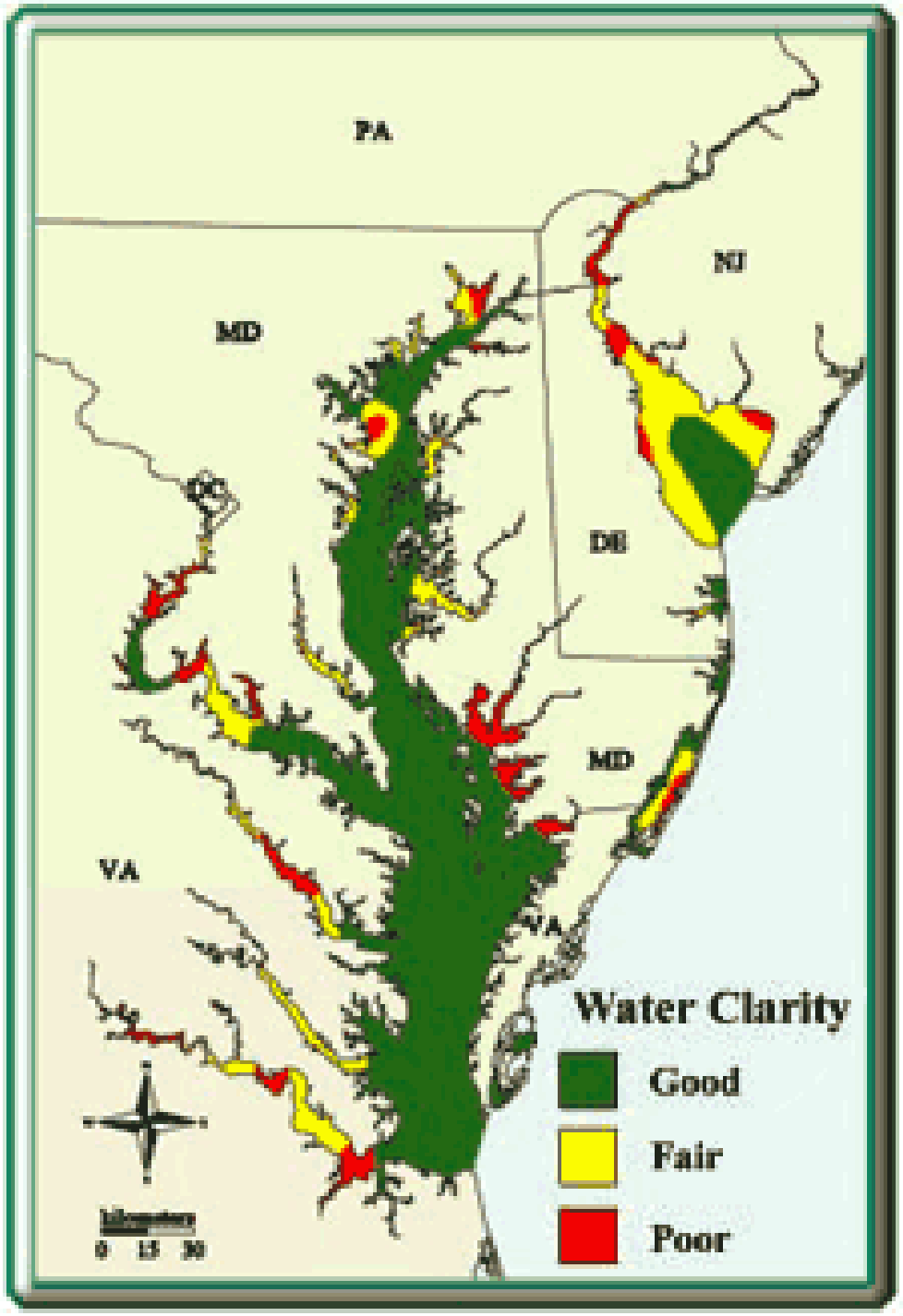
General Salinity Distribution



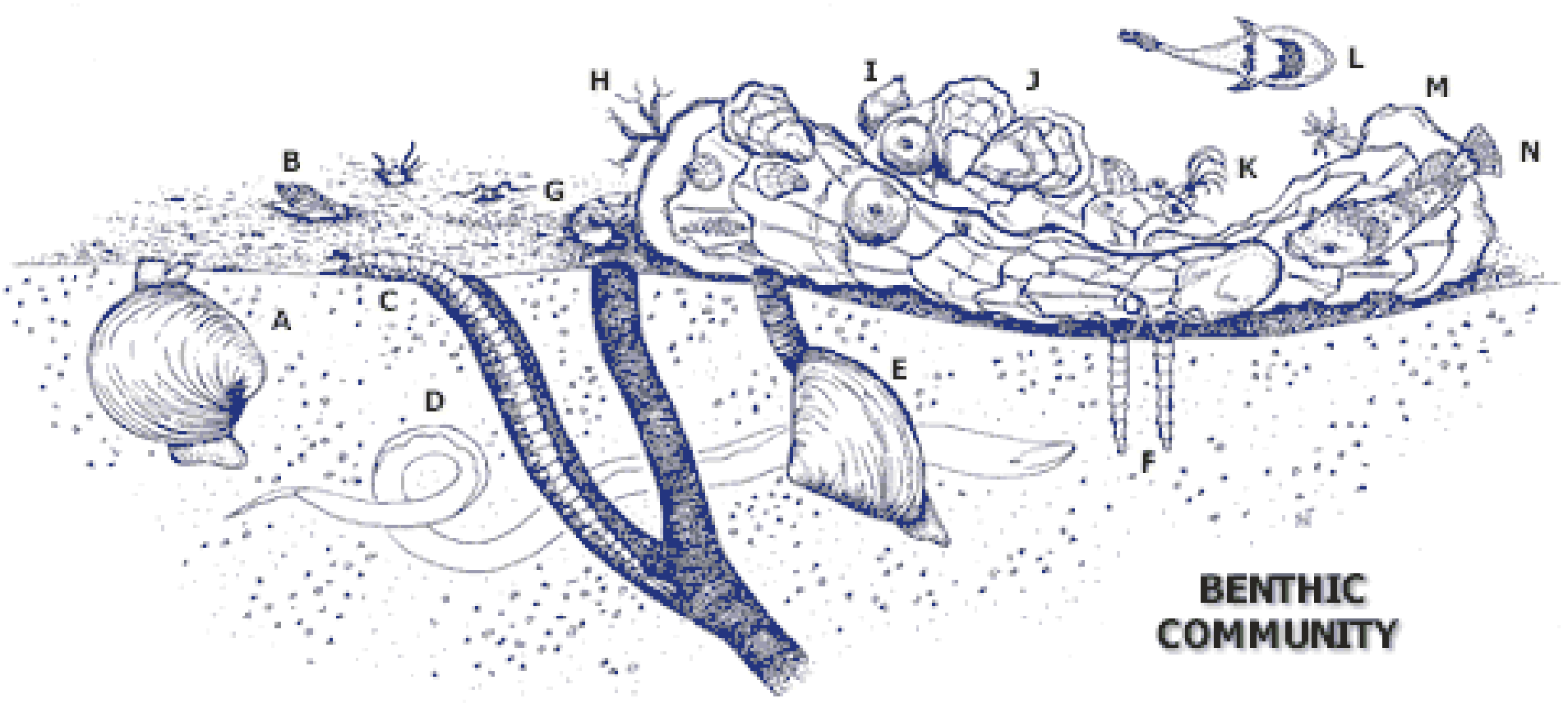
General Dissolved Oxygen Range



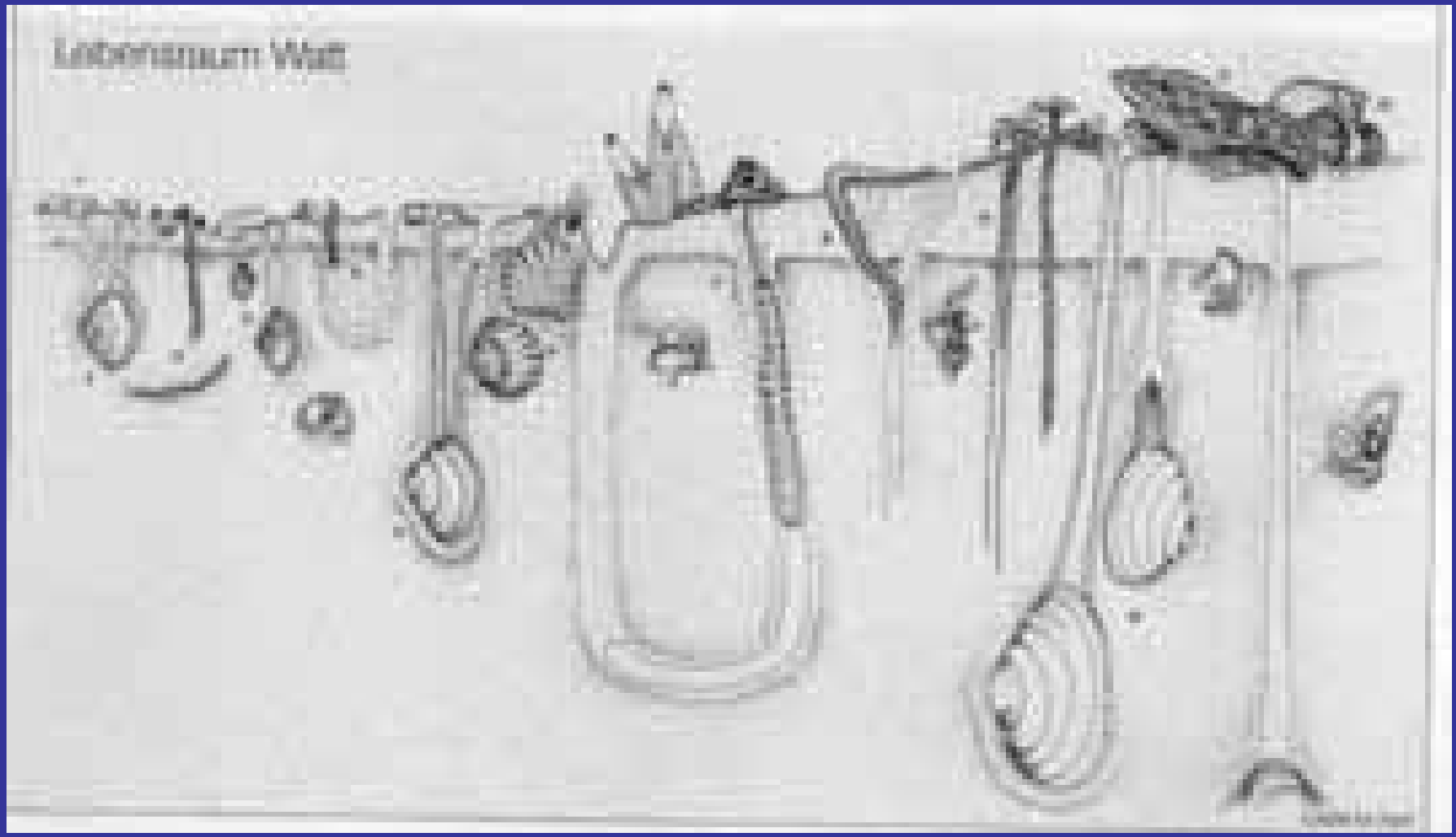
General Water Clarity Conditions



Typical Benthic Community



Burrowing Variations



Underwater View of an Eelgrass Bed

SAV Living Resource Habitat Requirements- Water Quality

Dissolved Inorganic Nitrogen (DIN)	**<0.15 mg/l**
Dissolved Inorganic Phosphorus (DIP)	**<0.01 mg/l***
Total Suspended Solids (mg/l)	**<15 mg/l**
Chlorophyll *a* (ug/l)	**<15 ug/l**
Light Attenuation Coefficient (Kd; m-1)	**<1.5**
Secchi Depth (m)	**>1.0 m**

Critical Life Period-- March - May, September-November

SAV Based TMDL PROCESS

1992 Water Quality Standards-SAV Basis

Inland Bays Estuary Program Model

Hydrodynamic & Water Quality Modeling

Developed TMDL Nutrient Limits

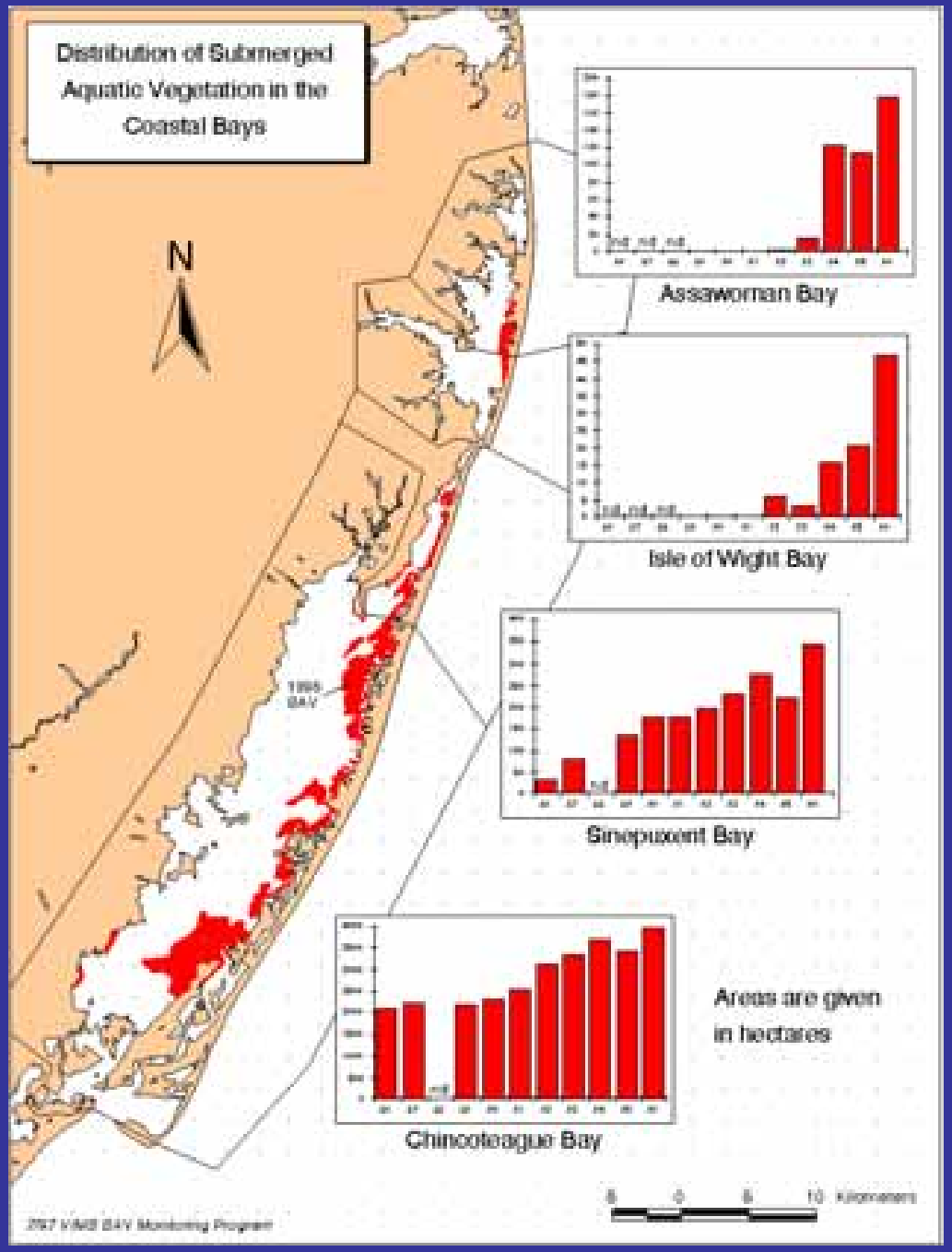
Eliminate All Point Source Discharges-

Nitrogen Load Reductions by 40% or 85%

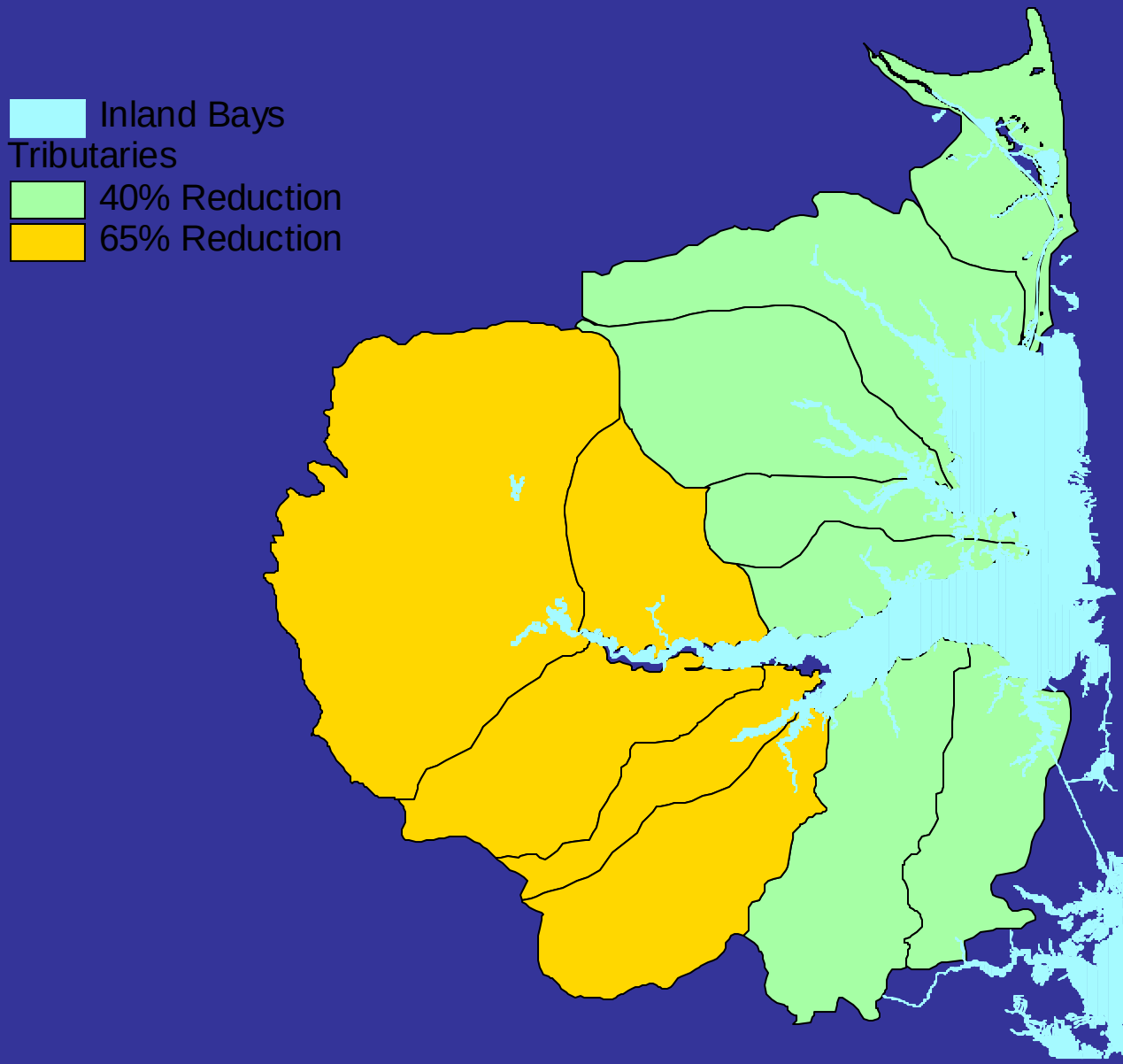
Phosphorous Load Reductions by 40% or 65%

SAV Recovery in the Coastal Bays of Maryland and Virginia

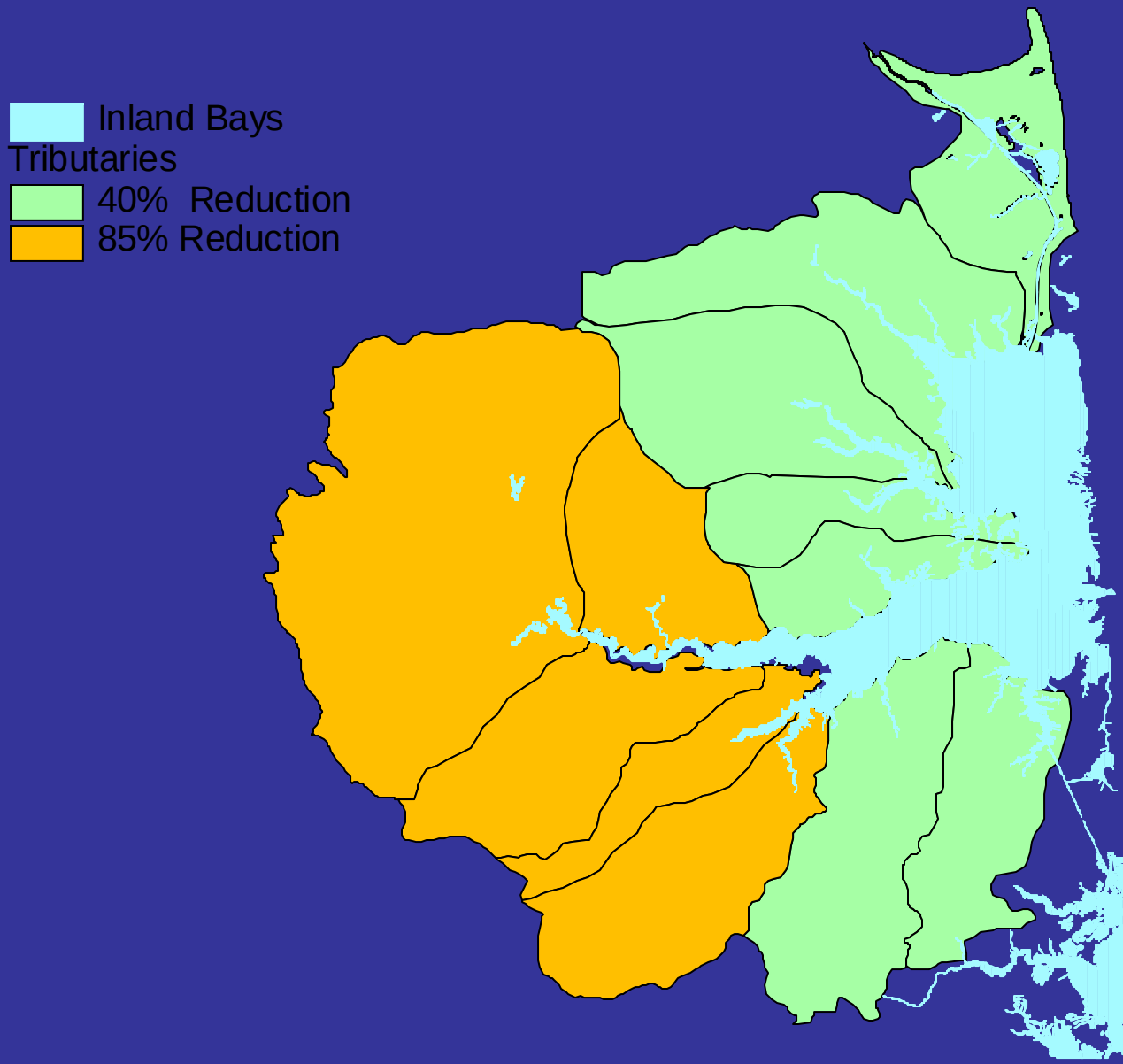
1987-1997



TMDL Phosphorous Load Reduction



TMDL Nitrogen Load Reduction



Excess Nutrients leads to Epiphytes

PROJECT DESIGN CRITERIA

- Site Selection
  - Site History-Previous SAV Growth
  - Hydrology
    - Depth
    - Tidal Range
    - Current Flow Velocity
    - Wave Energy/Exposure
  - Sediment Characteristics
    - Grain Size-fine to medium
    - Organic Carbon <5% dry wt.

SAV Map Examples 2001

Eelgrass Planting Bundle

Eelgrass Harvested from Beds

1999 Crew and Gear

Shoots and Roots

Potted Shoots and Roots

Eelgrass Potting Unit

Potting Units Stacked in Trays

2 Meter/25 Point Planting Grid

Freshly Planted Eelgrass

Crabby Intruder

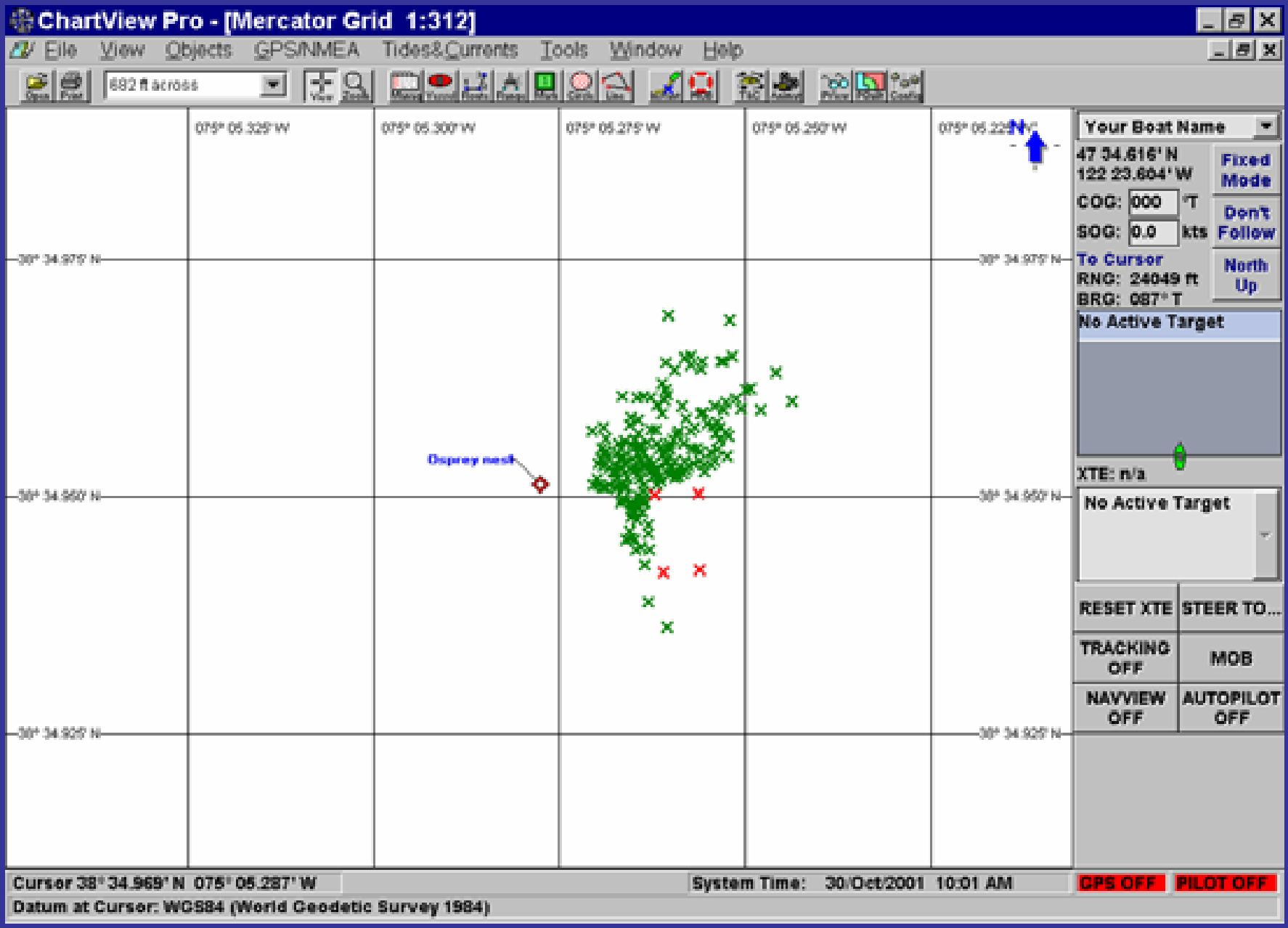
First Year Shoots from Seeds

Rhizome spread

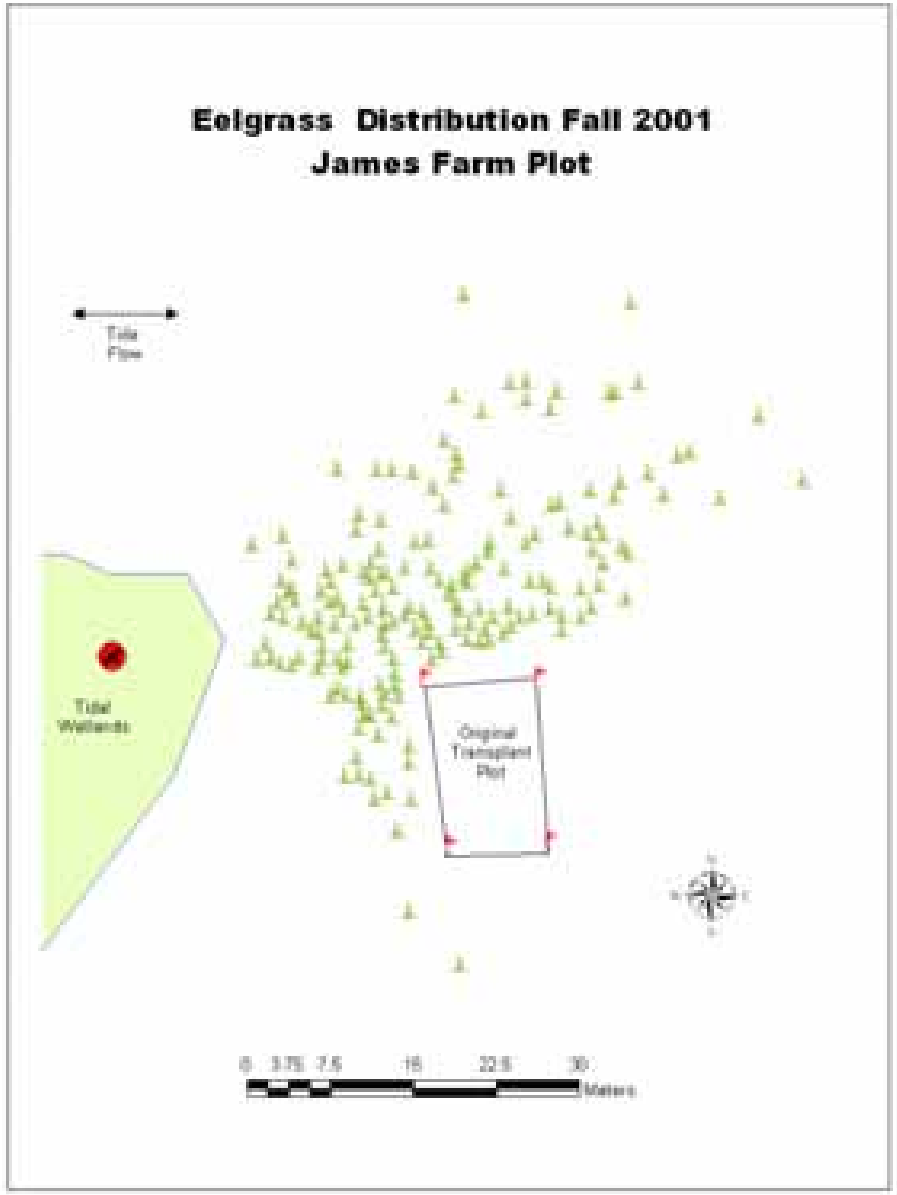
Enhanced Differential GPS Unit

Improved GPS Accuracy

James Farm Eelgrass Seed Distribution

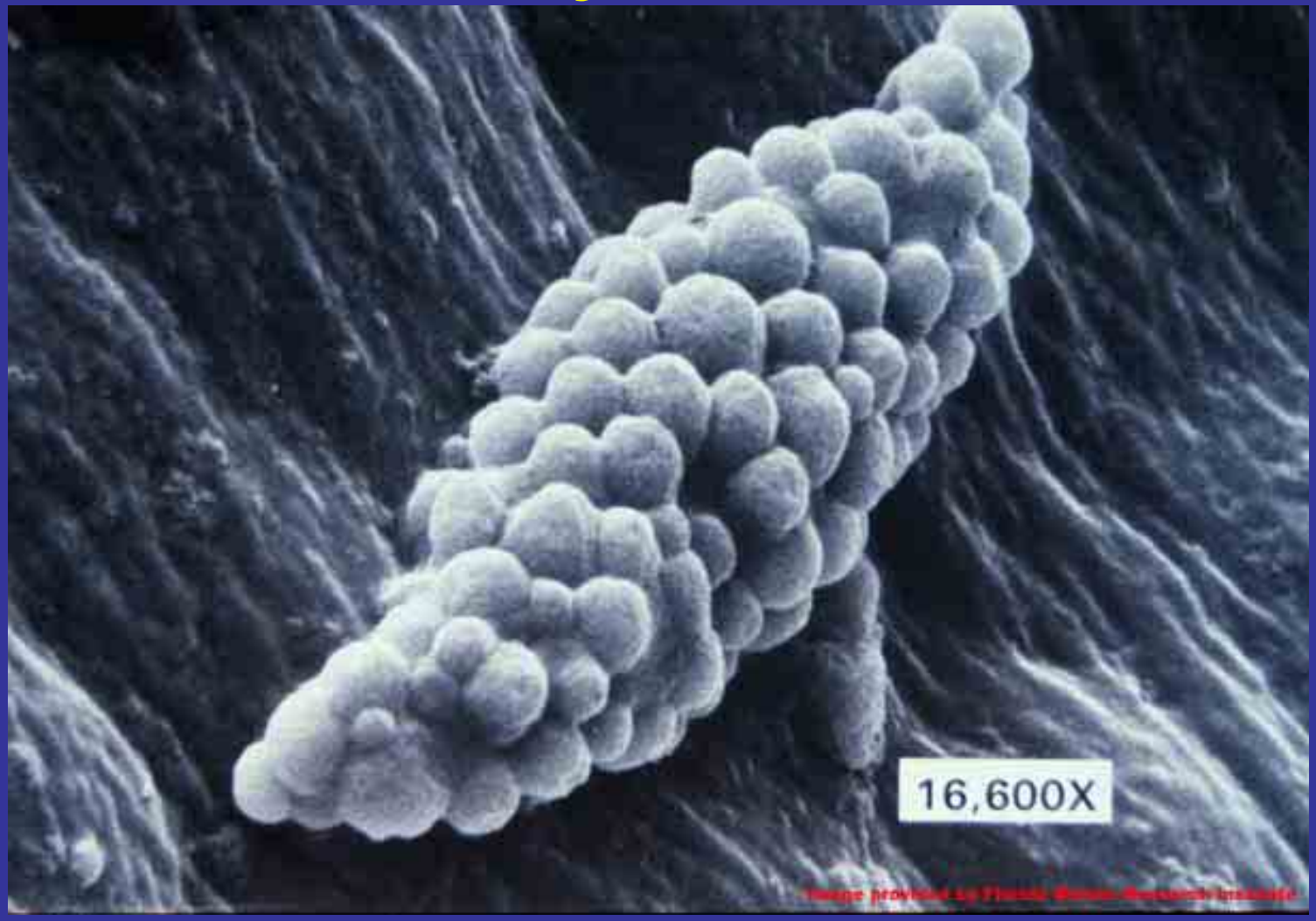


Seed distribution around initial planting site



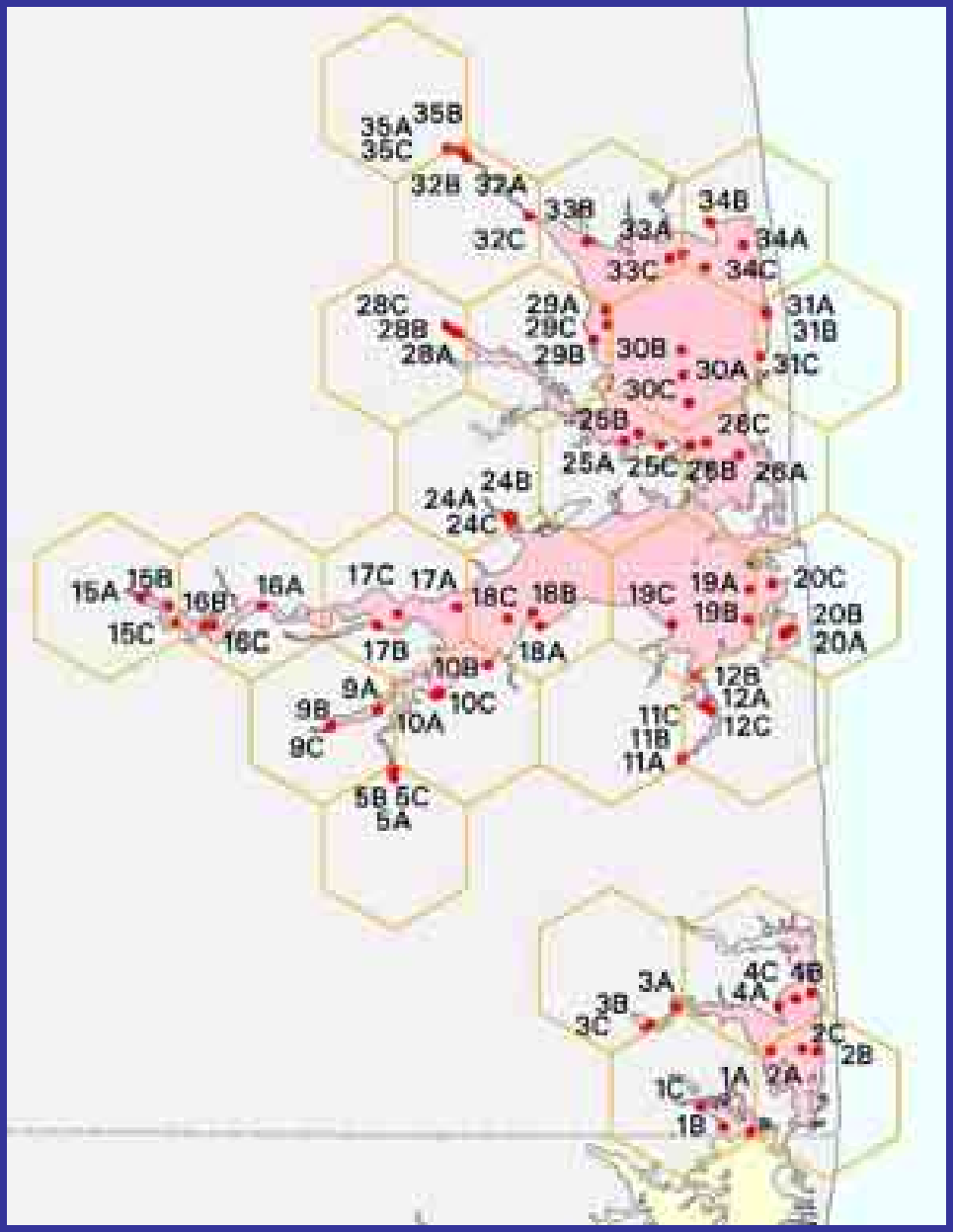
Seahorse on Eelgrass

Eelgrass Wasting Disease- *Labyrinthula*



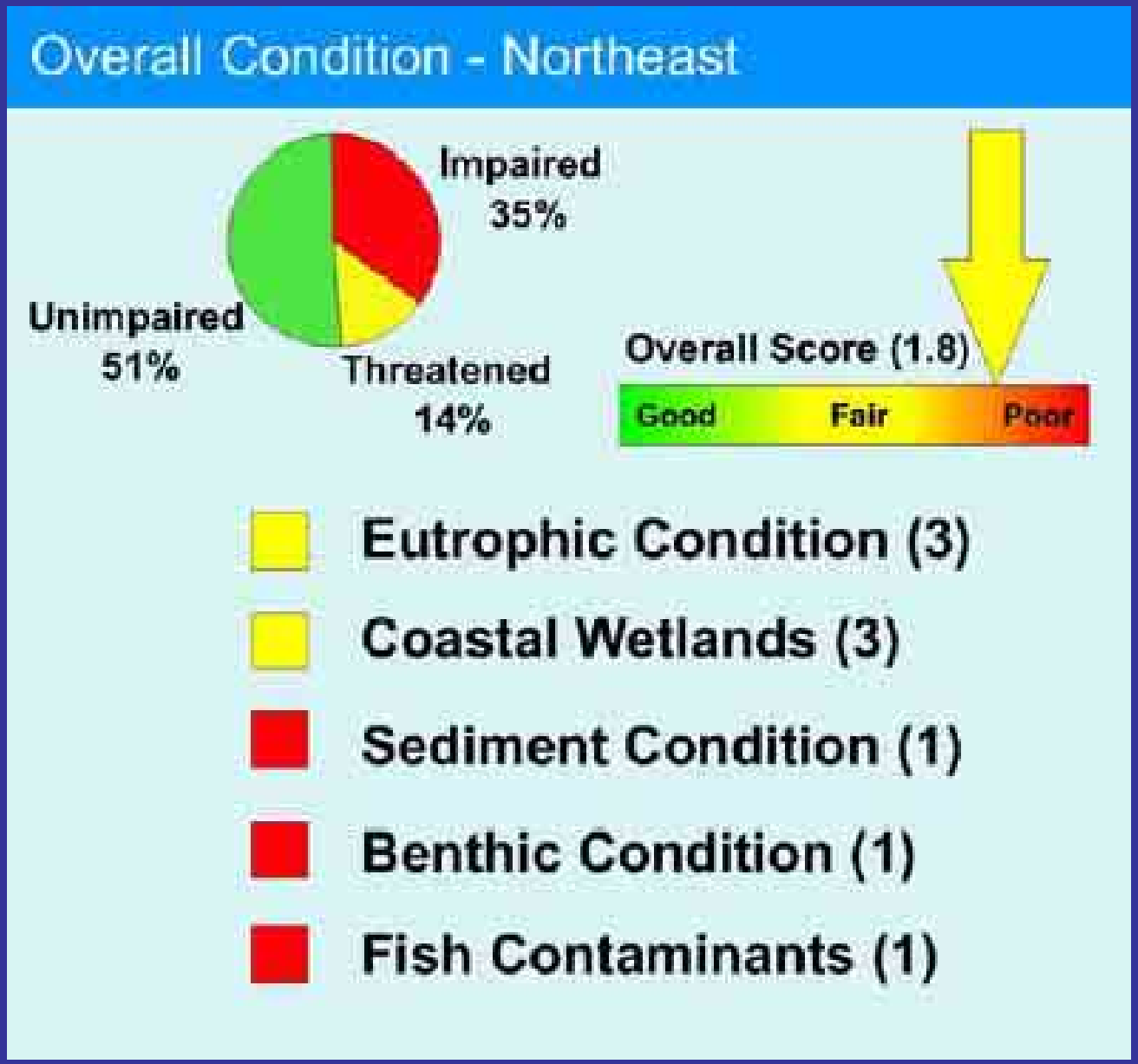
National Coastal Assessment Program

- Probabilistic Monitoring Design-
  - Status by % Area
- National, Regional, State & Watershed level
- Multimedia
  - Water Quality
  - Benthic Biometrics
  - Sediment Chemistry
  - Sediment Toxicity
  - Fish Tissue Toxicity



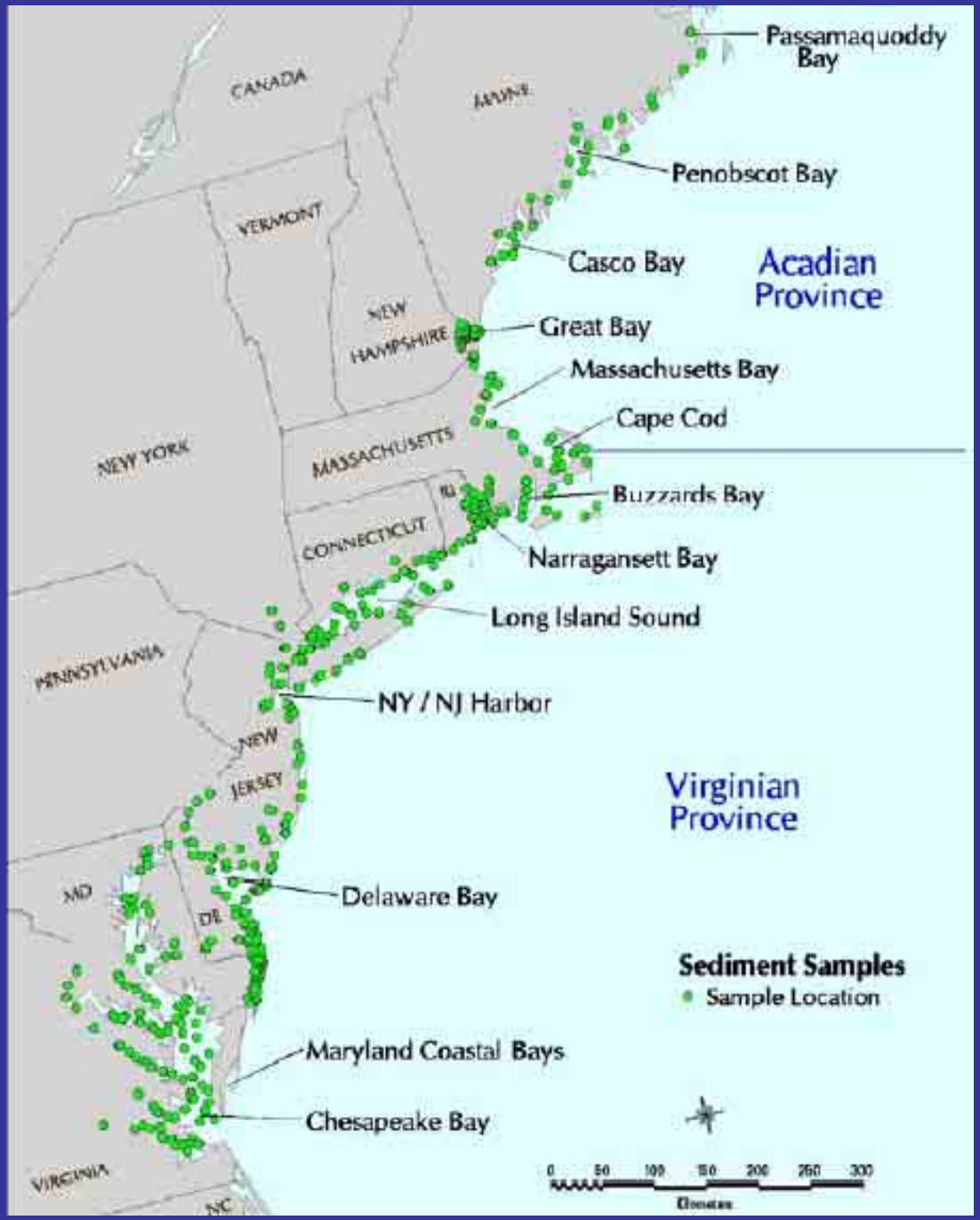
National Coastal Assessment Report Card

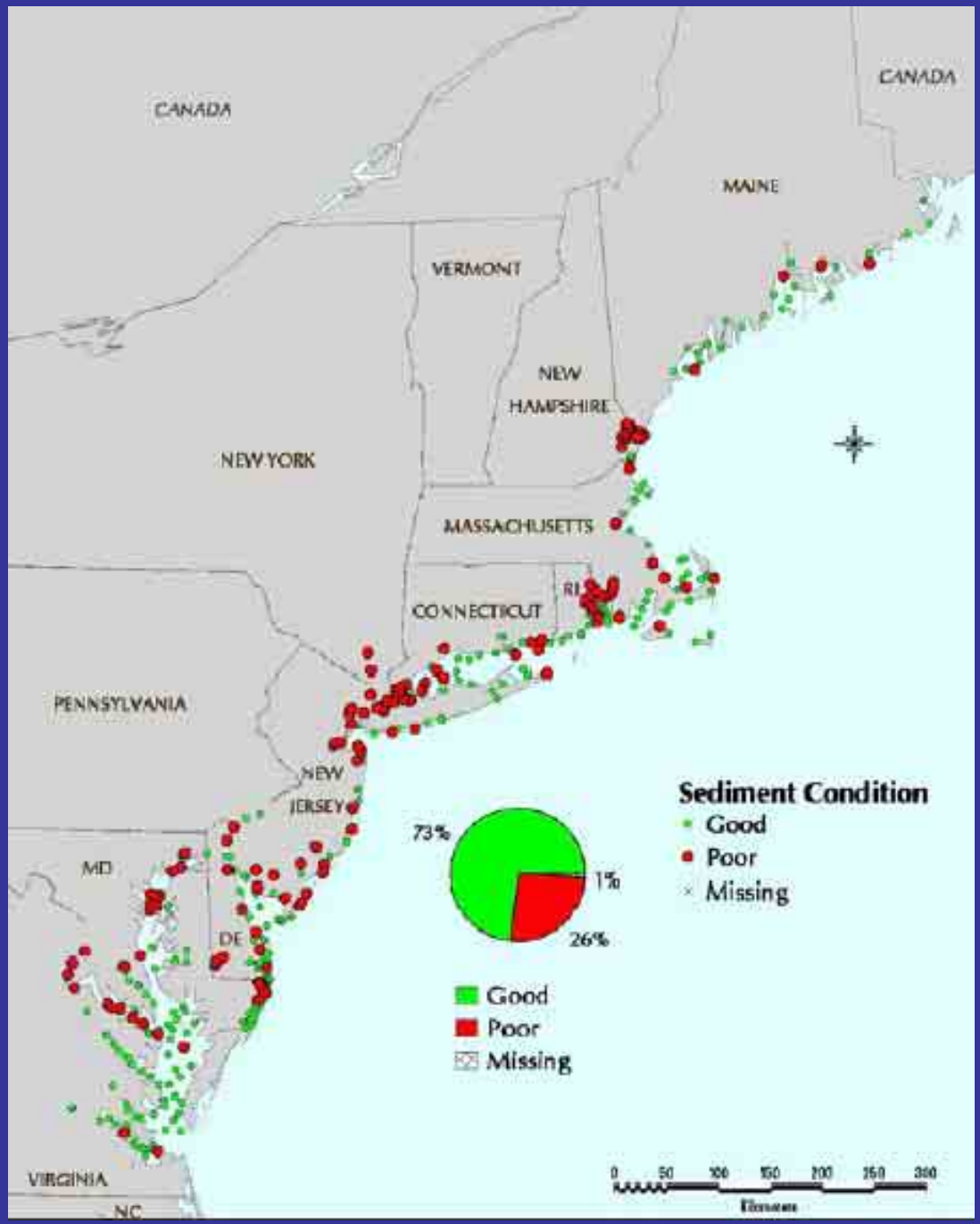
5=Good
1=Bad



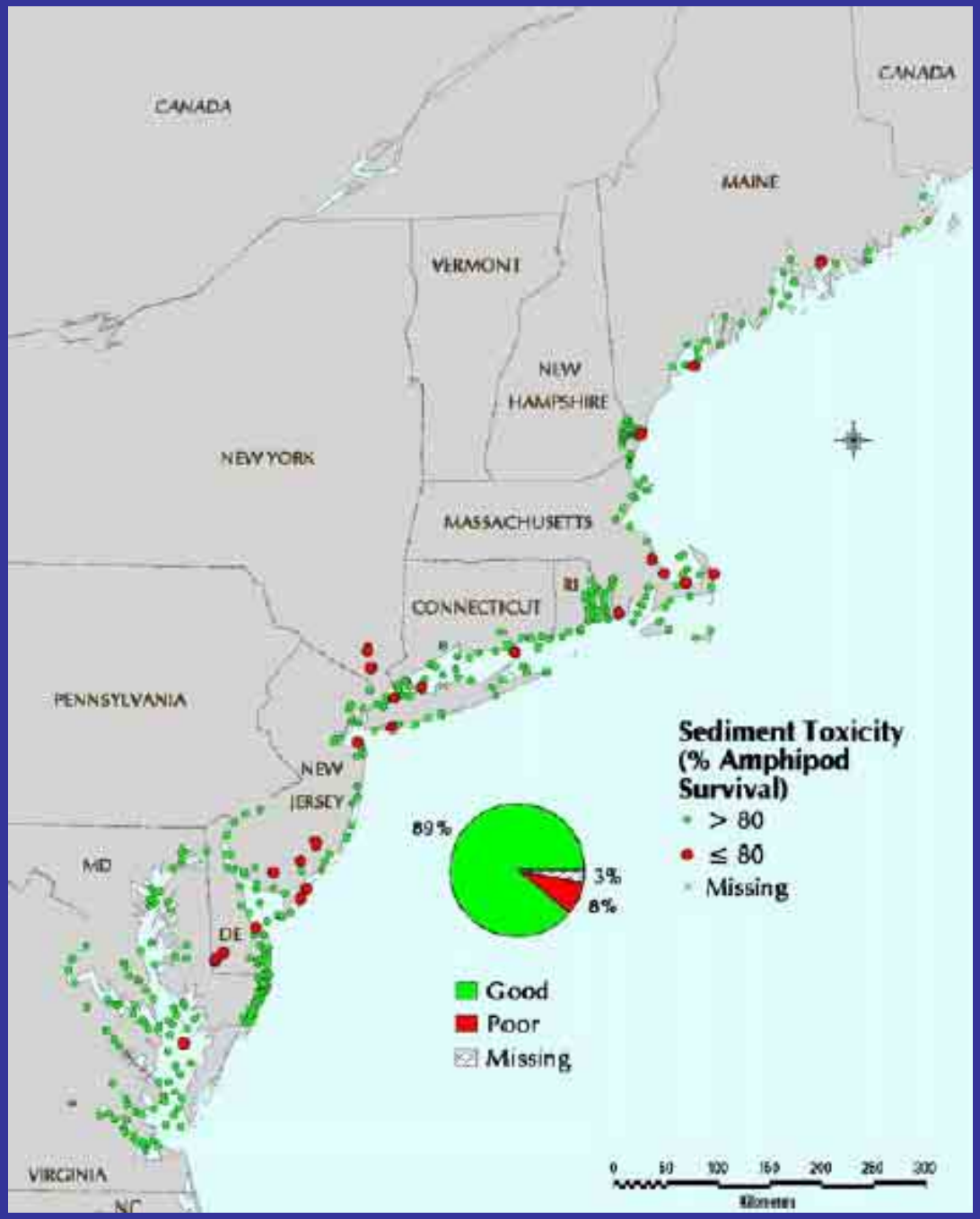
Northeast Coast estuarine conditions (US EPA/NCA 2003)

NE Sediment Sample Locations




CANADA
CANADA
MAINE
VERMONT
NEW
HAMPSHIRE
NEW YORK
MASSACHUSETTS
RI
CONNECTICUT
PENNSYLVANIA
NEW
JERSEY
MD
DE
VIRGINIA
NC
73%
1%
26%
Good
Poor
Missing
Sediment Condition
Good
Poor
Missing
0 50 100 150 200 250 300

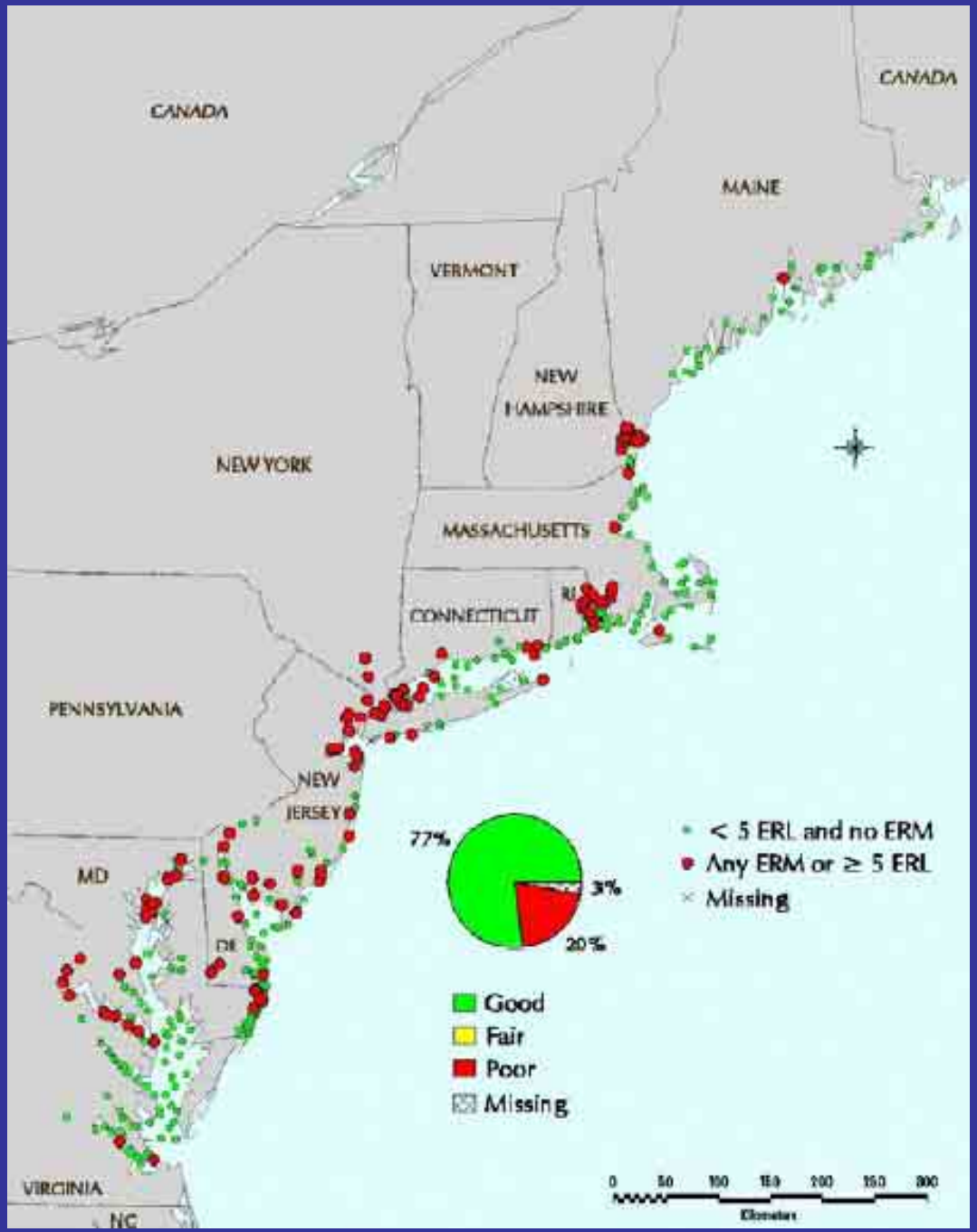
Sediment toxicity based on % amphipod survival in laboratory tests.



Sediment Contaminant Criteria

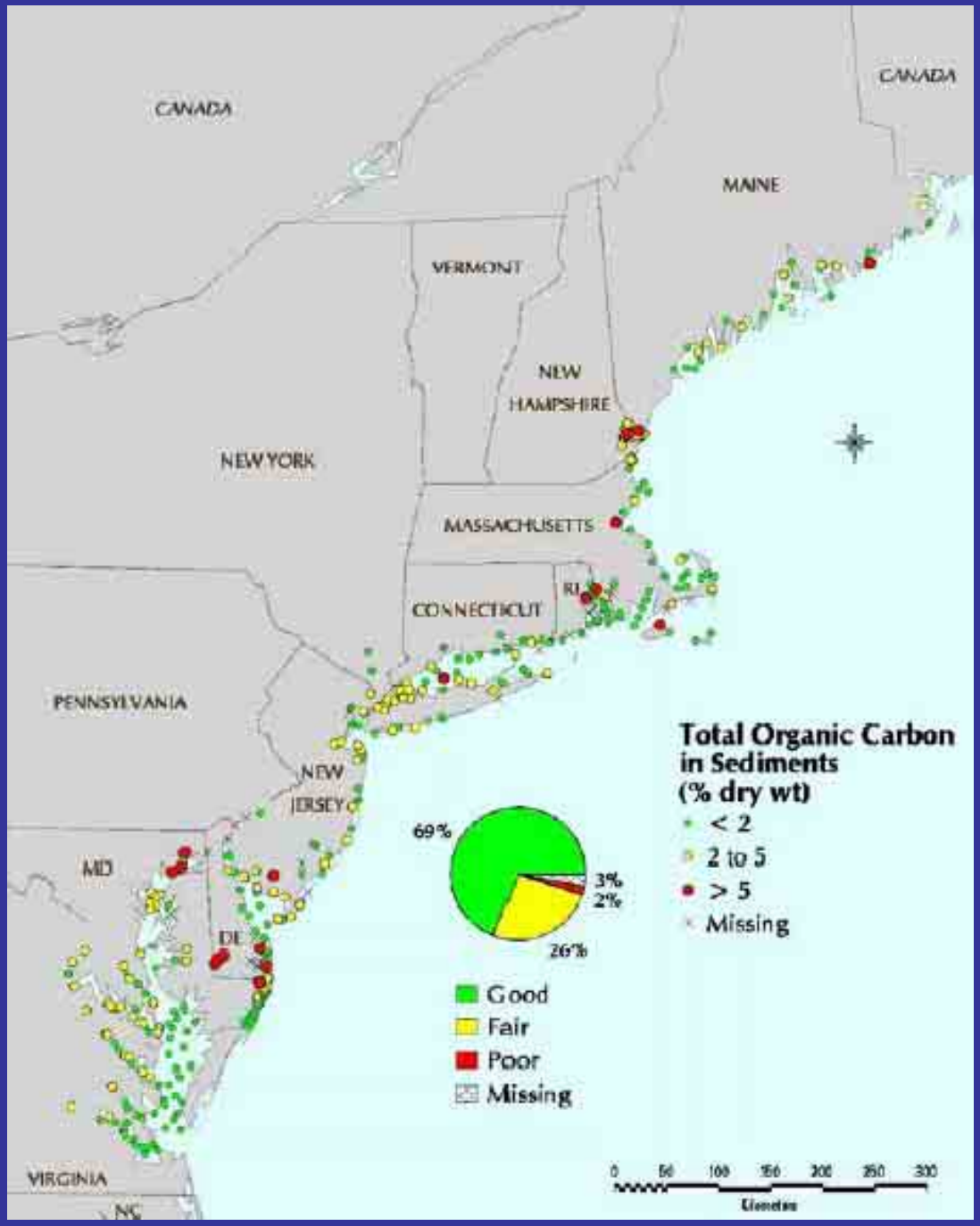
ERM (effects range medium)—The concentration of a contaminant that will result in ecological effects approximately 50% of the time based on literature studies.

ERL (effects range low)—The concentration of a contaminant that will result in ecological effects about 10% of the time.



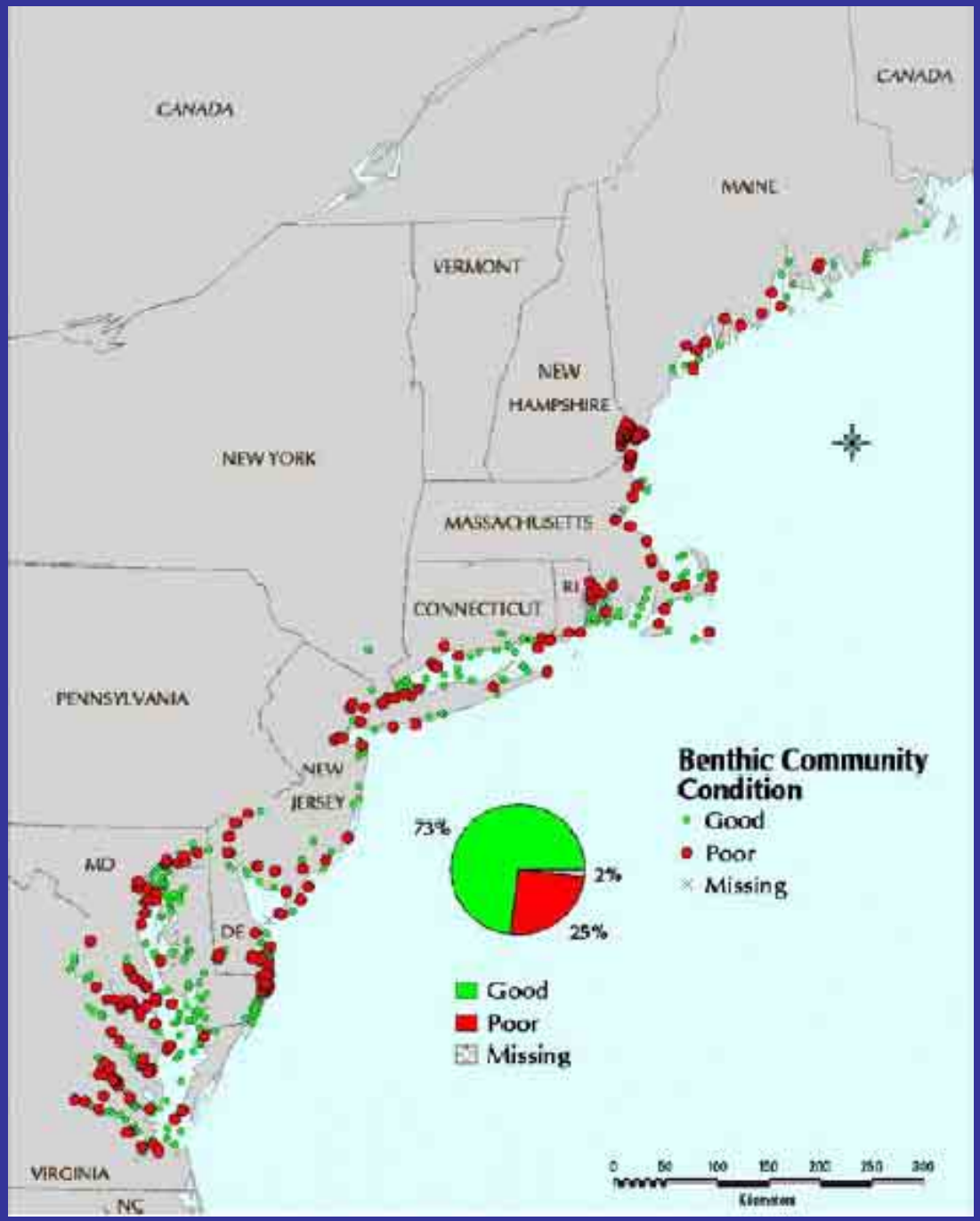
Total organic carbon is a concern for viable SAV growth

TOC ≤5%dwt.

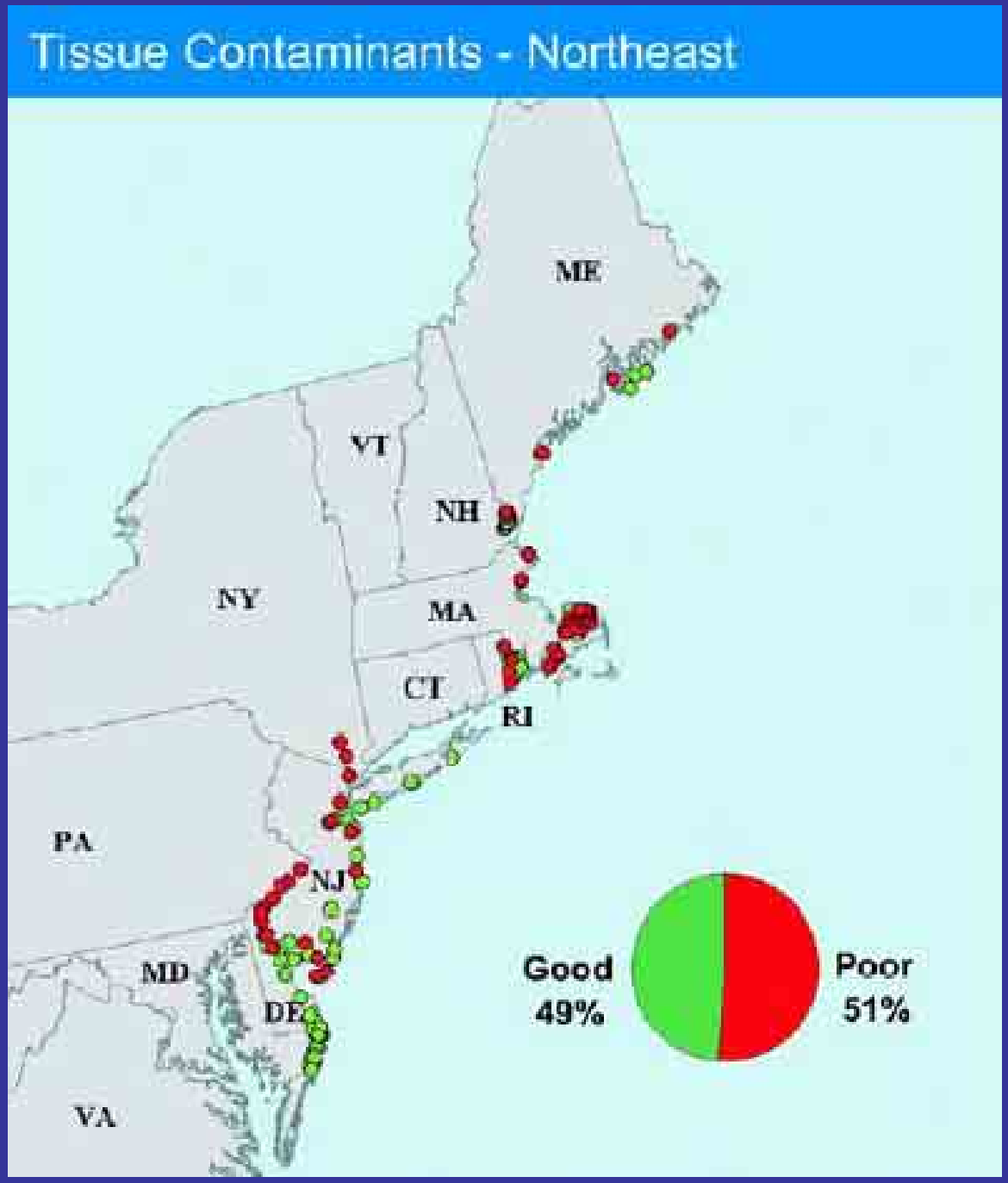


Benthic community condition, based on species diversity and the presence of pollution-tolerant taxa in greater than expected abundance

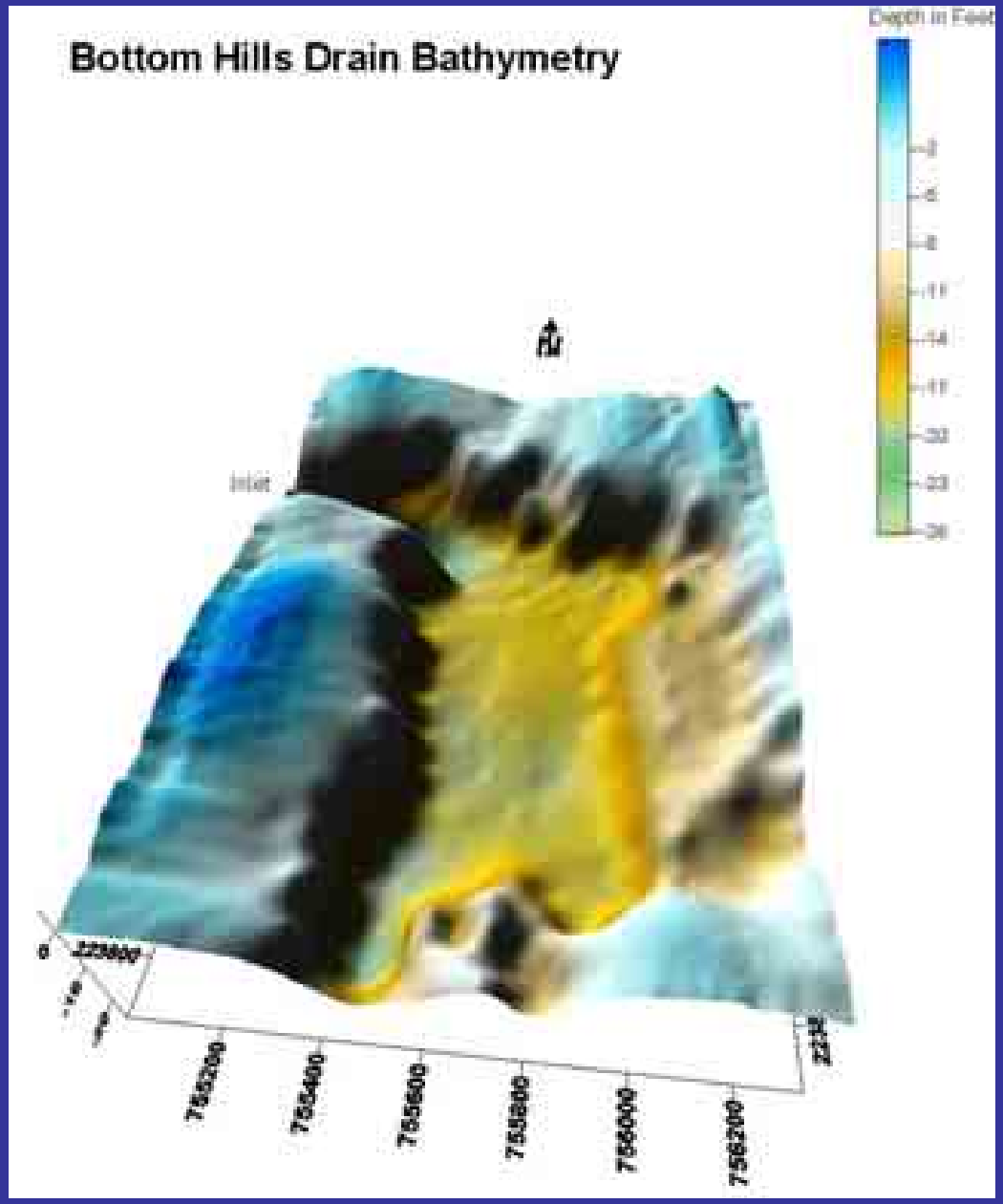
(U.S. EPA/NCA).



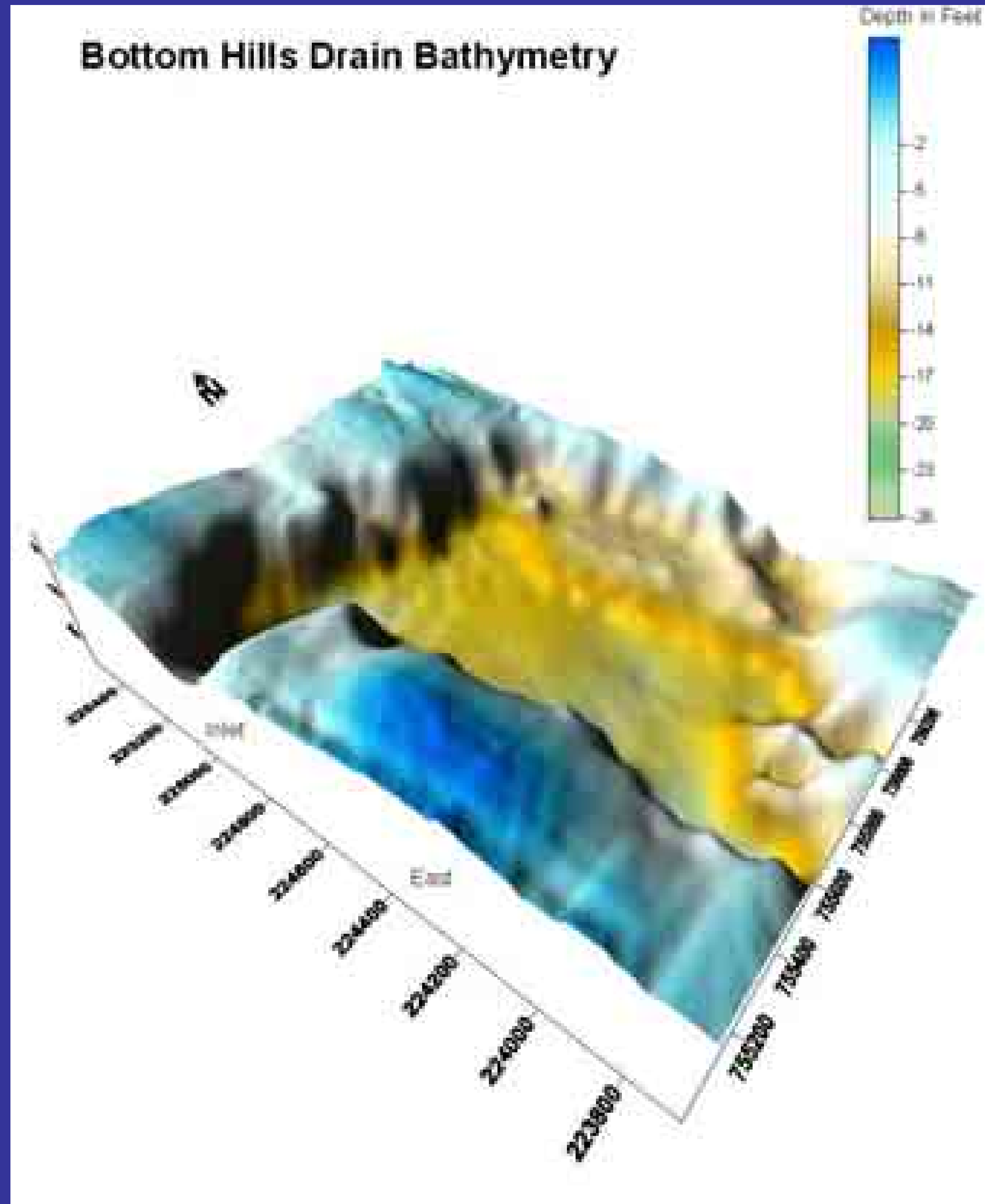
Contaminants in whole fish tissue and locations with elevated contaminant concentrations in the Northeast (U.S. EPA/NCA).



BHD Surfer Image



BHD Surfer Image



Mapping Software

- Nobletec Visual Navigation Suite
- Chart View Pro
- Captn' navigation software

- NMEA data string sentence
  - 0183 ver. X standard