What is Killing the Eelgrass in the Niantic River Estuary? A Biogeochemical Study of Eutrophication

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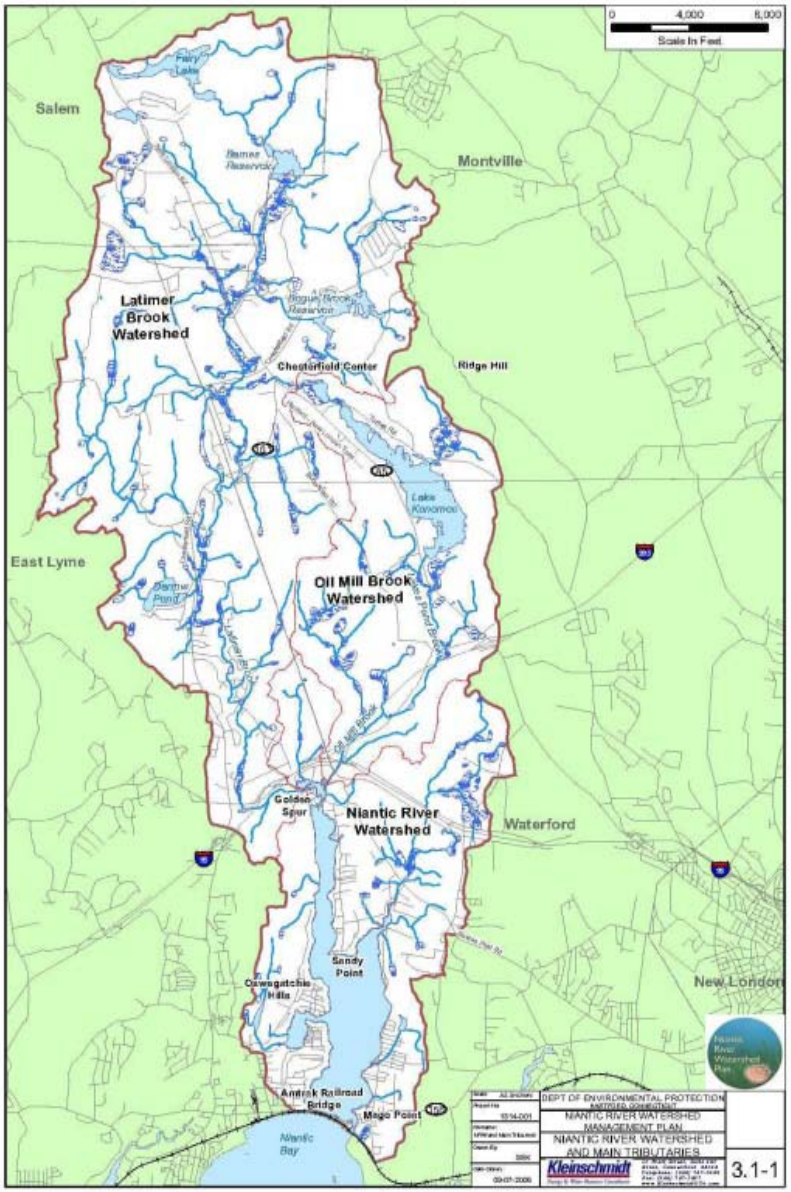
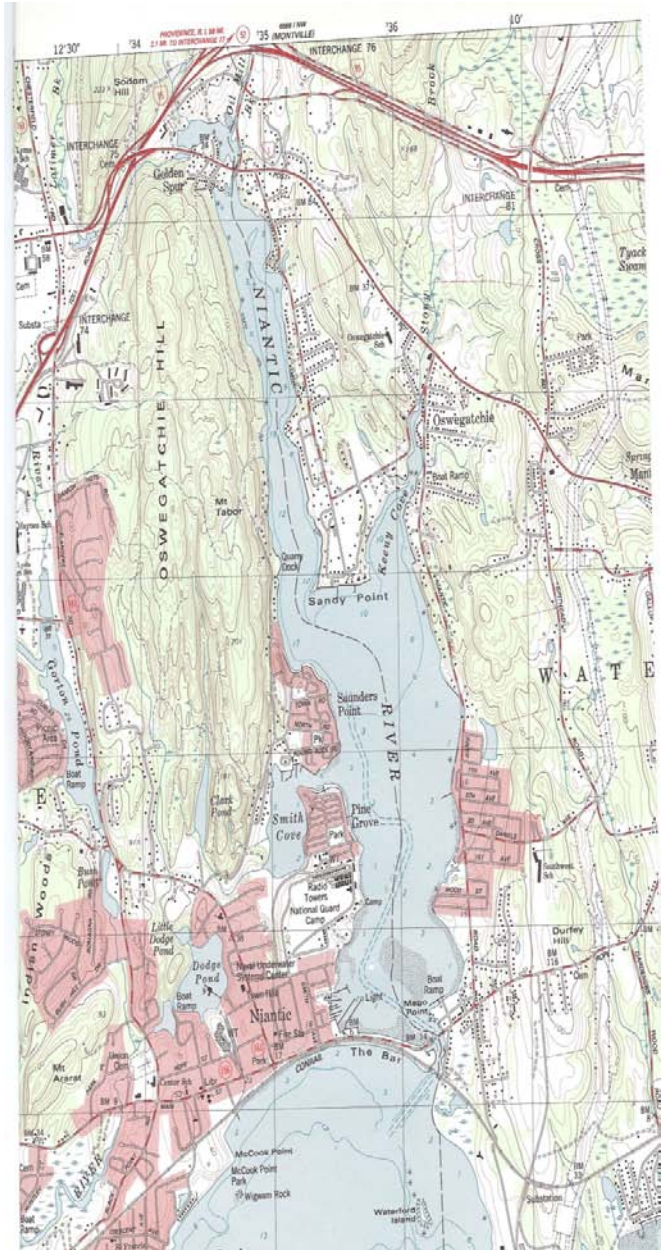
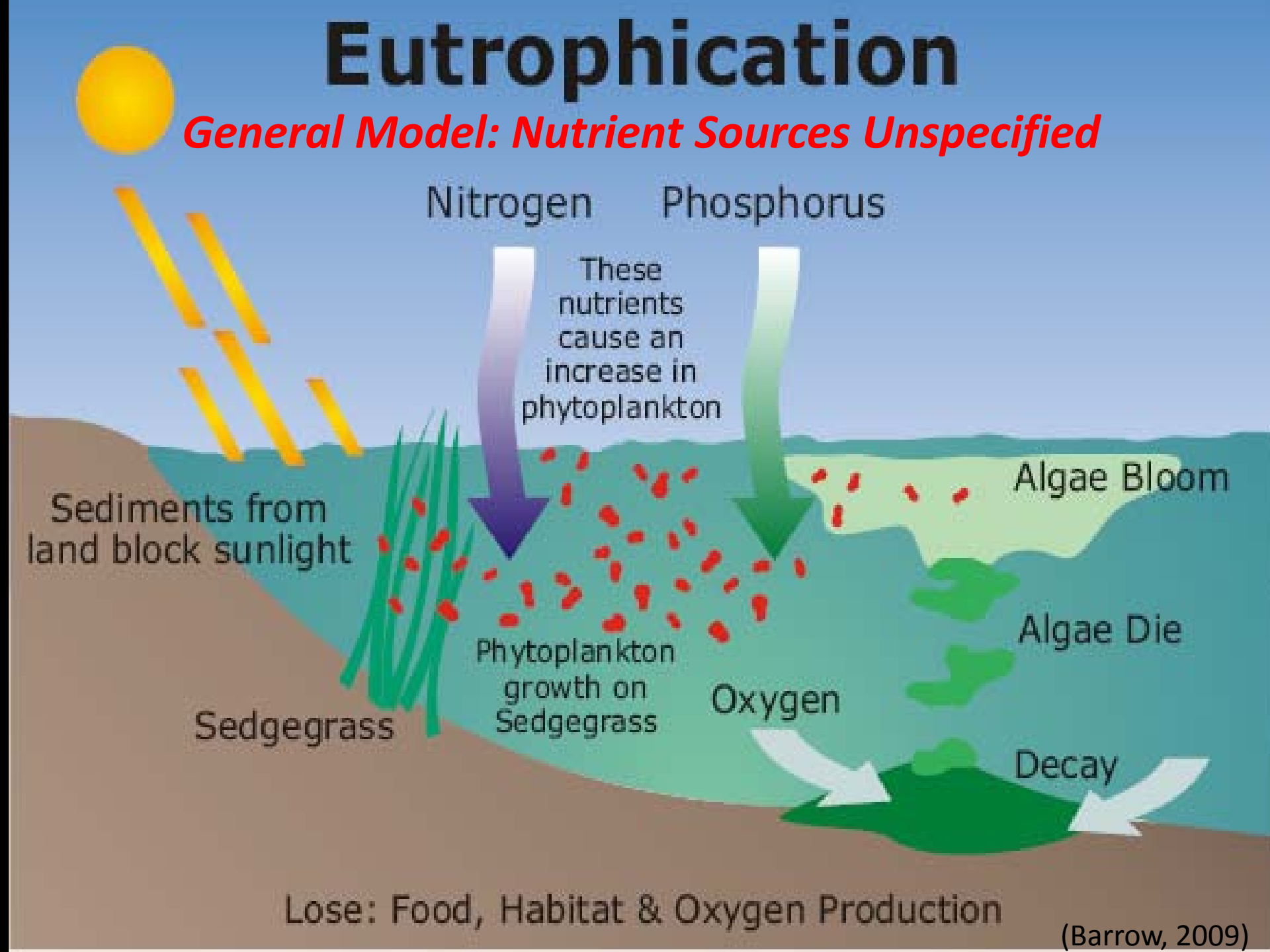
The Niantic River Watershed



The Niantic River Estuary



(USGS, 1983)


Eutrophication
General Model: Nutrient Sources Unspecified
Nitrogen
Phosphorus
These nutrients cause an increase in phytoplankton
Sediments from land block sunlight
Algae Bloom
Algae Die
Phytoplankton growth on Sedgegrass
Oxygen
Sedgegrass
Decay
Lose: Food, Habitat & Oxygen Production

(Barrow, 2009)

Estuarine Circulation and the Nutrient Trap

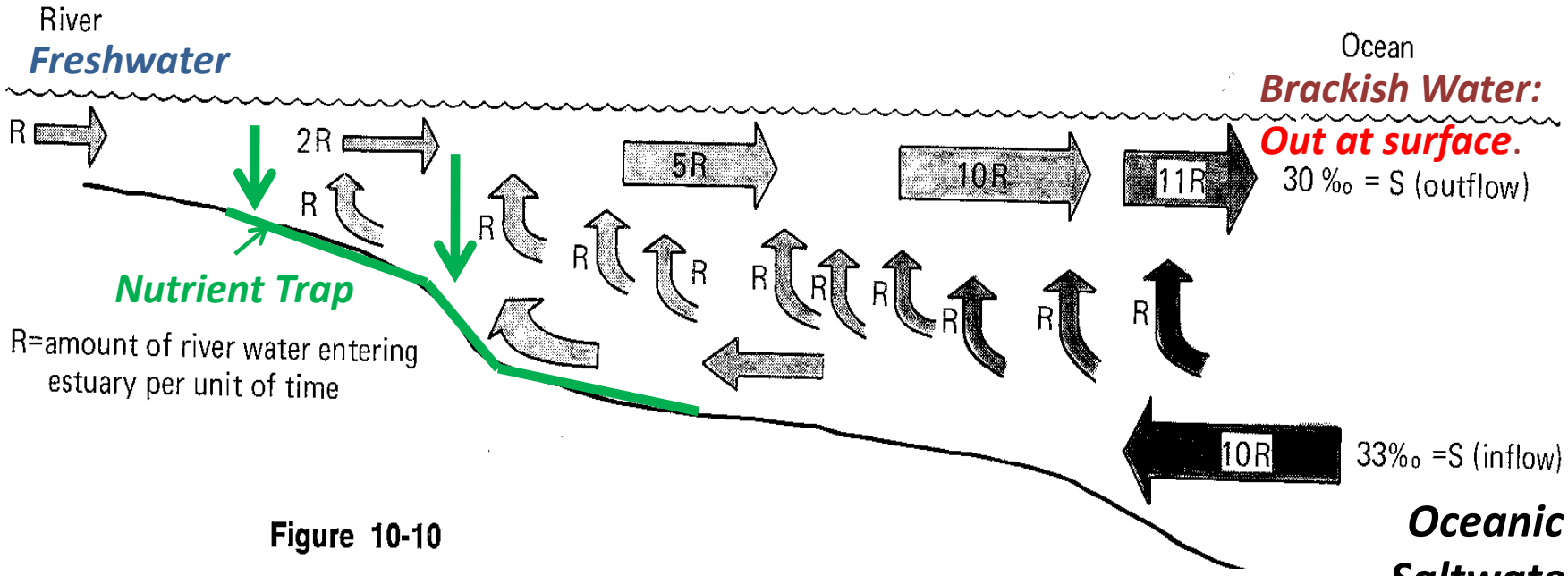


Figure 10-10

Examples of Estuarine Circulation:

1. Riverine estuaries.
2. Coastal upwelling zones.
3. Global ocean.

Estuarine Chemistry and Mixing: PO_4 vs Salinity:

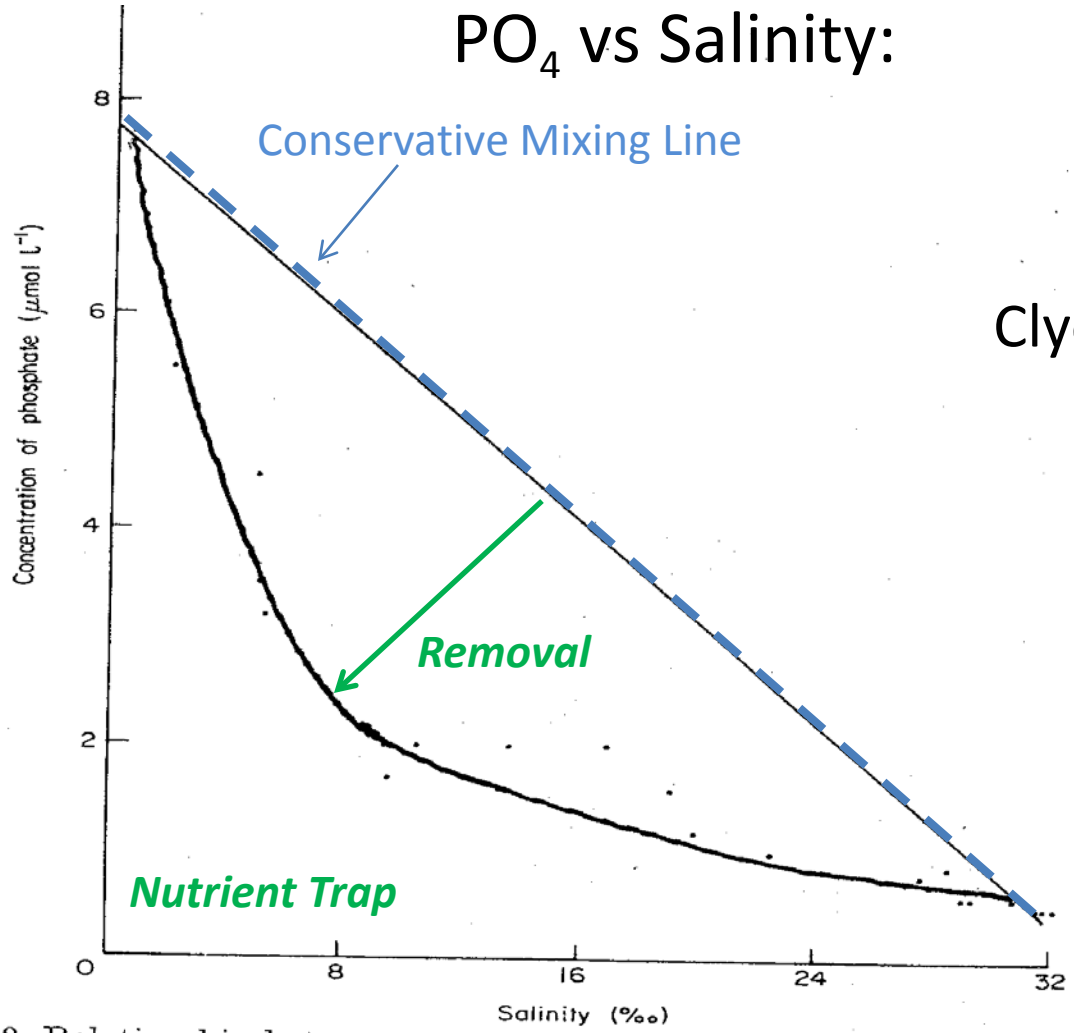
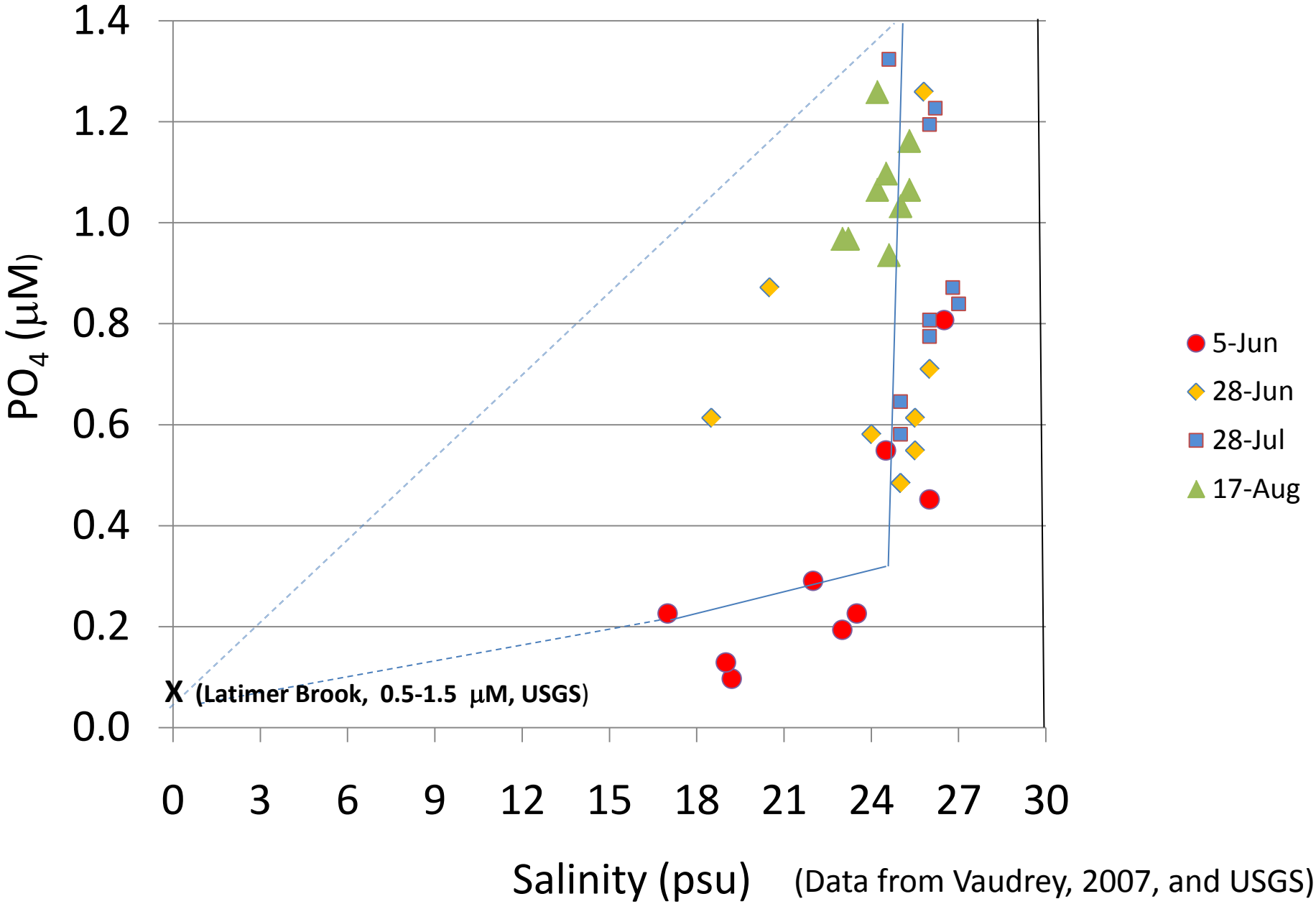
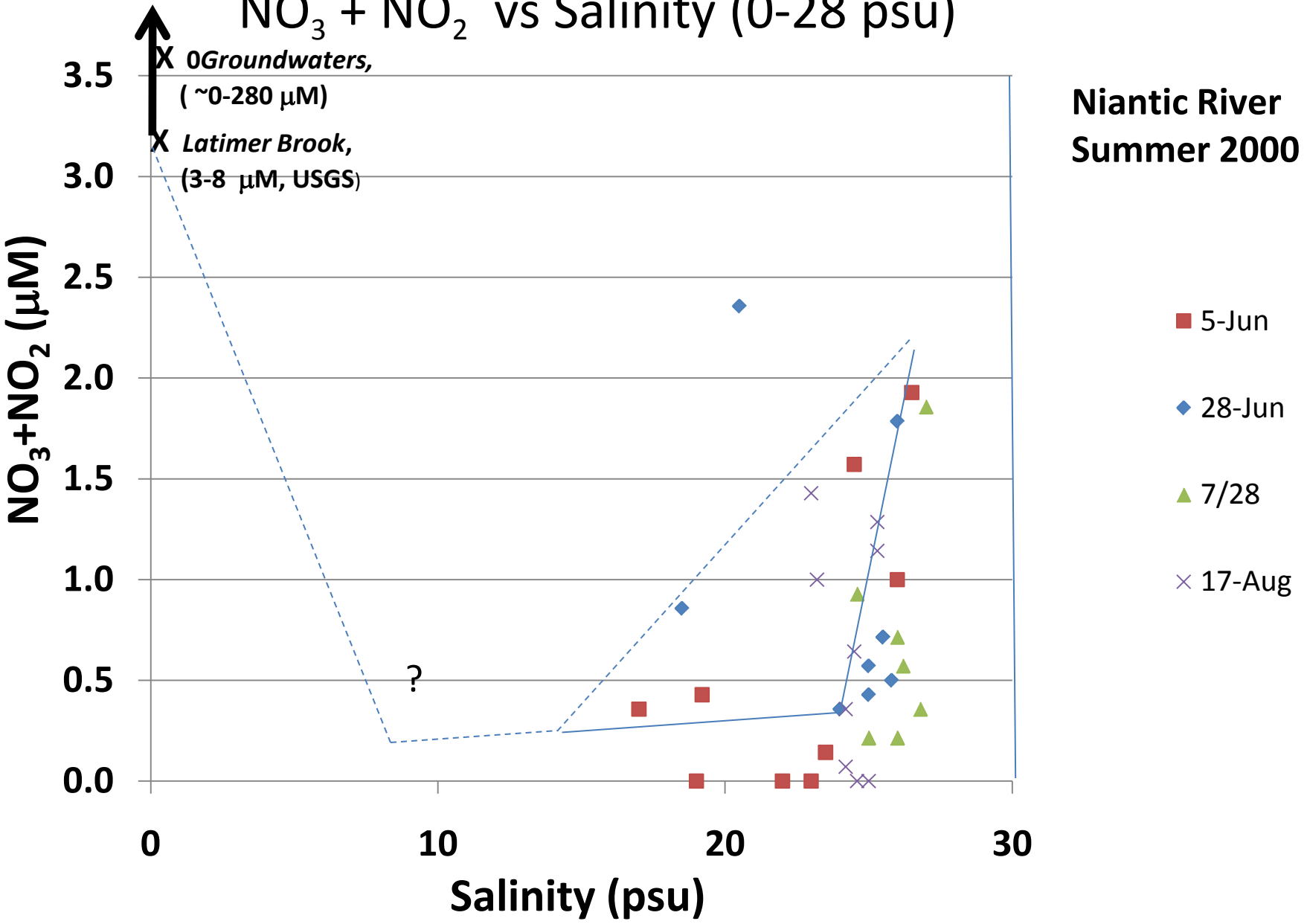


Fig. 9. Relationship between concentration of phosphate and salinity; survey of 12th April, 1973. The theoretical dilution line is shown.

Clyde Estuary, Scotland

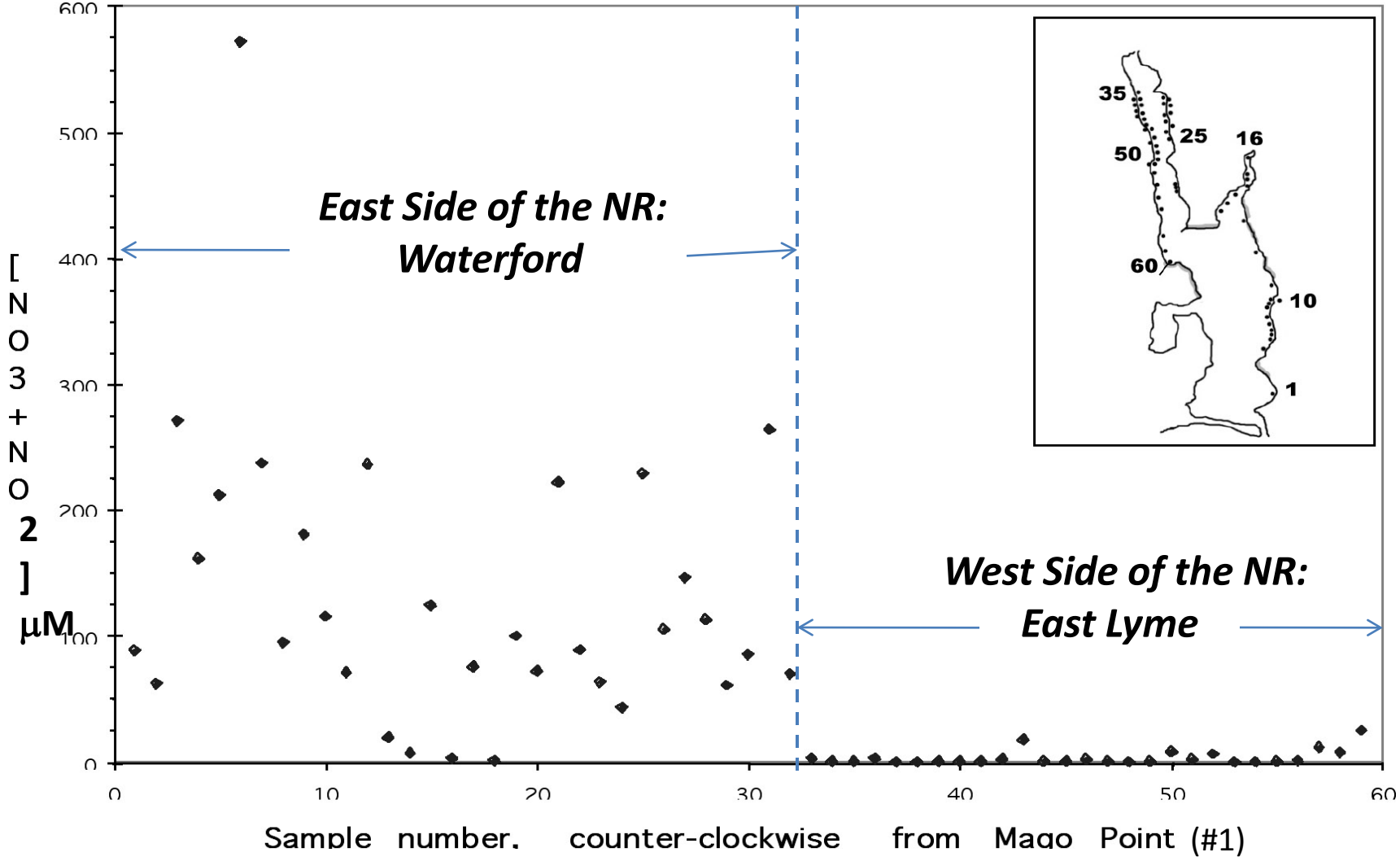
(Mackay & Leatherland, 1976)


Niantic River, Summer 2000: PO4 vs. Salinity (0-28 psu)
PO4 (µM)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
3
6
9
12
15
18
21
24
27
30
Salinity (psu)
X (Latimer Brook, 0.5-1.5 µM, USGS)
5-Jun
28-Jun
28-Jul
17-Aug
(Data from Vaudrey, 2007, and USGS)

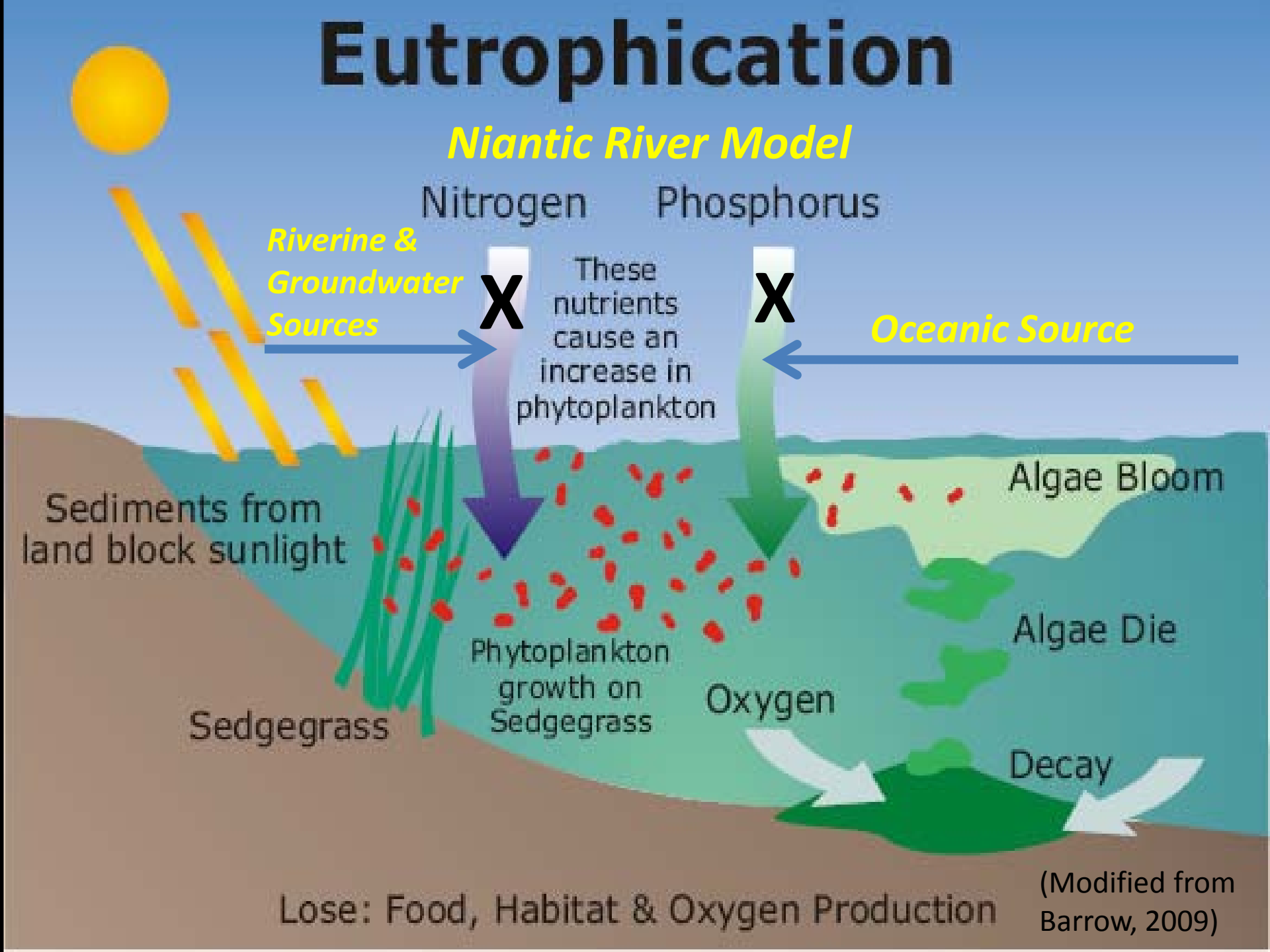


(Data from Vaudrey, 2007, and USGS)

Niantic River Periphery: Groundwater $NO_3 + NO_2$

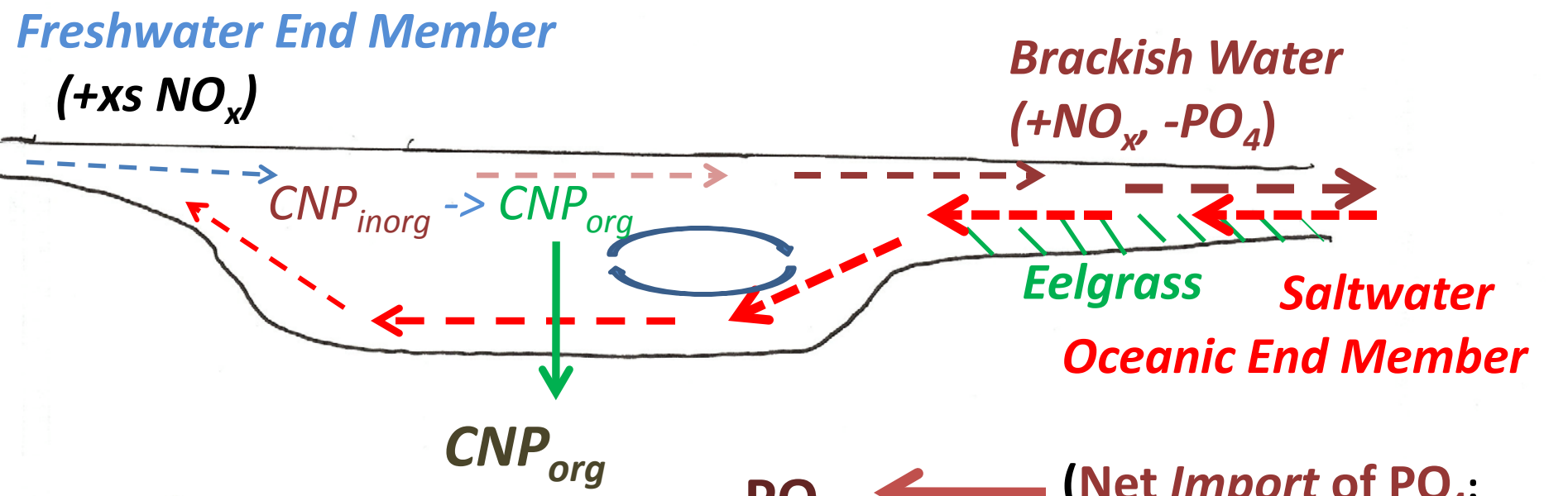


(Vaudrey & Kremer, 2007)



(Modified from Barrow, 2009)

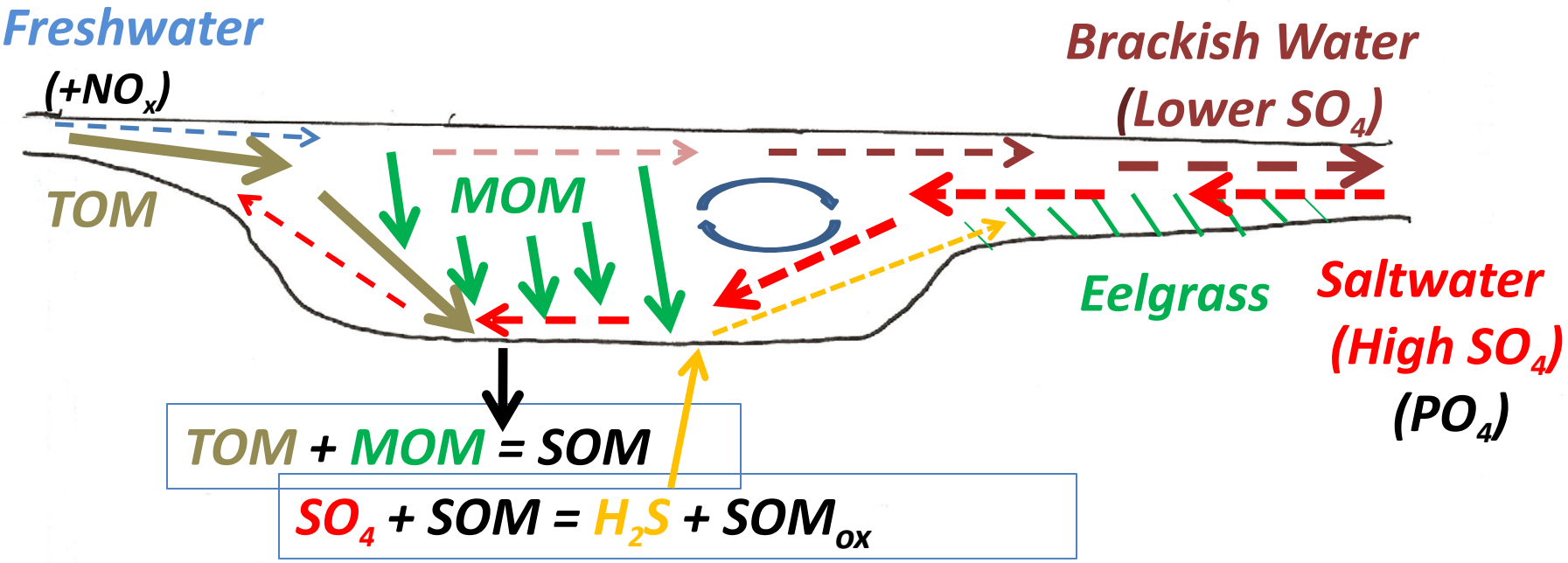
Nutrient (N, P) Budget of the Niantic River Estuary



PO_4 ← (Net *Import* of PO_4:
In: 0.90 µM; *Out*: 0.75 µM.)

NO_x → (Net *Export* of NO_x:
In: 0.80 µM; *Out*: 0.73 µM)

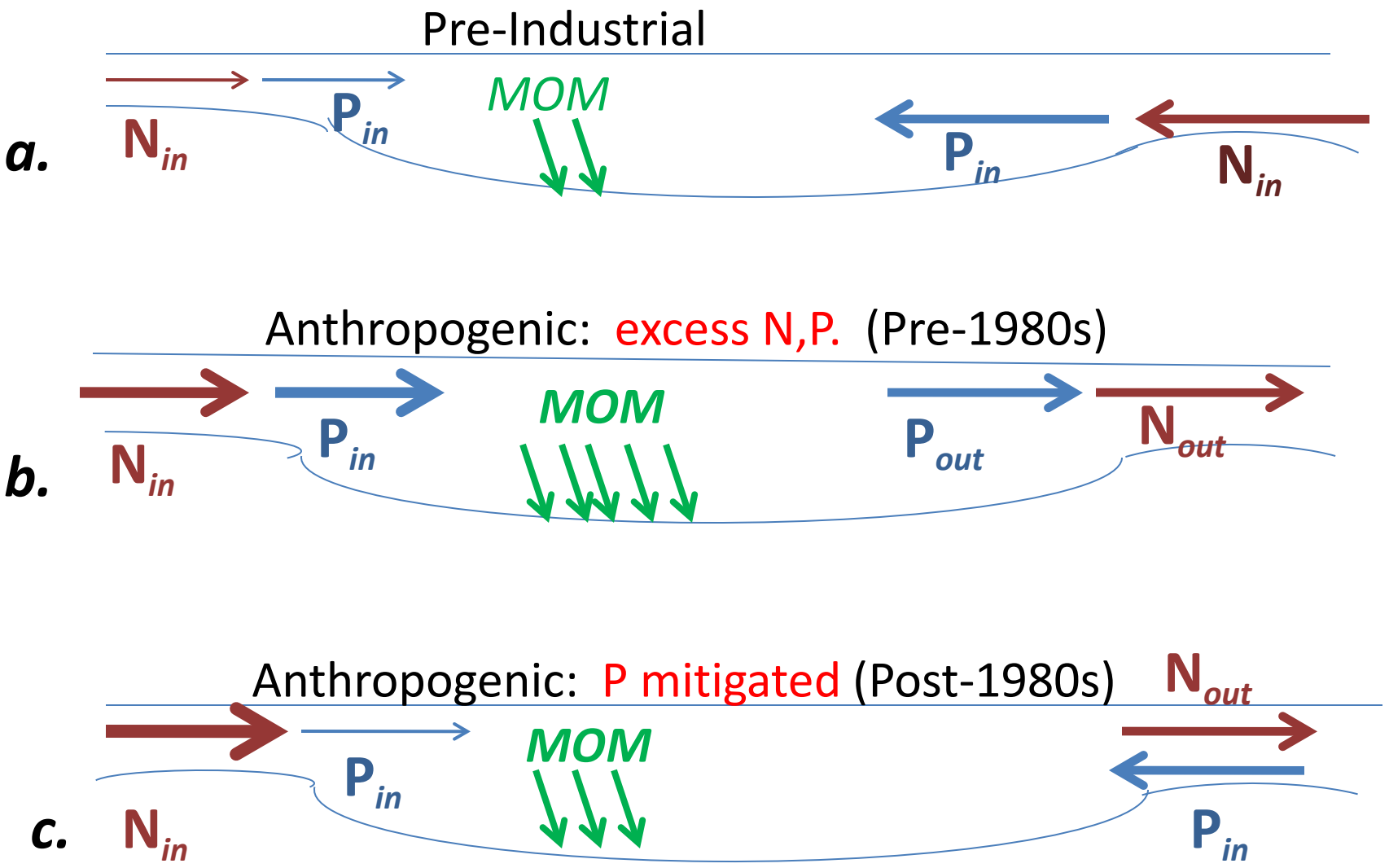
Biogeochemical Circulation of the Niantic River Estuary



$$2\ \text{“}CH_2O\text{”} + SO_4^{2-} \rightarrow H_2S + 2\ HCO_3^-$$

Question: *What type of organic matter – terrigenous or marine – drives H2S production that kills eelgrass?*

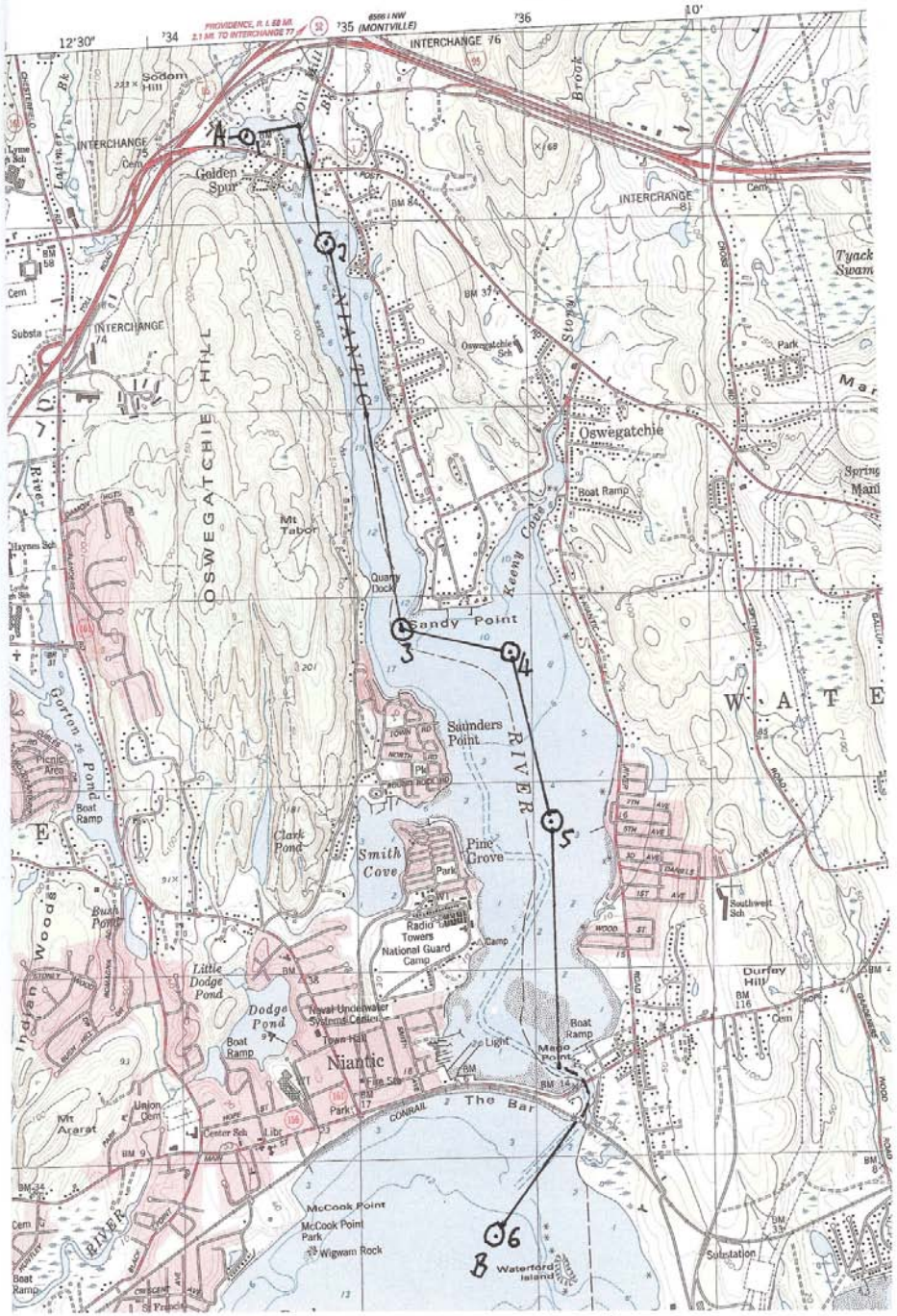
Net Estuarine Nutrient Circulation: Historical Changes



Summary: A Working Hypothesis

A simple biogeochemical model of the circulation of the Niantic River Estuary (NRE) has been developed from NR data. A eutrophic 'nutrient trap' (typical of estuarine circulation) works as follows:

1. ***Nutrients*:**
   a. **PO_4 enters the NRE from the Long Island Sound (the oceanic end member);**
   b. **NO_x enters the NRE from three brooks and through ground waters (the terrigenous end members).**
2. ***Sedimentary Organic Matter* (SOM):**
   a. **Marine Organic Matter (MOM) is produced with water-column nutrients;**
   b. **Terrigenous Organic Matter (TOM) runs off from the land, amplified by riparian erosion.**
3. **Hydrogen Sulfide inhibits or kills Eelgrass (*Zostera sp.*):**
   a. **Seawater (LIS) SO_4 enters the NRE and is reduced to H_2S in sediments;**
   b. **The H_2S (perhaps in reducing sediment particles) is transported to the Eelgrass beds where it impacts the Eelgrass.**



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Niantic River Estuary:

Sub-bottom Profiling Track and Sediment Core Locations

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Eutrophication: Sedimentary History