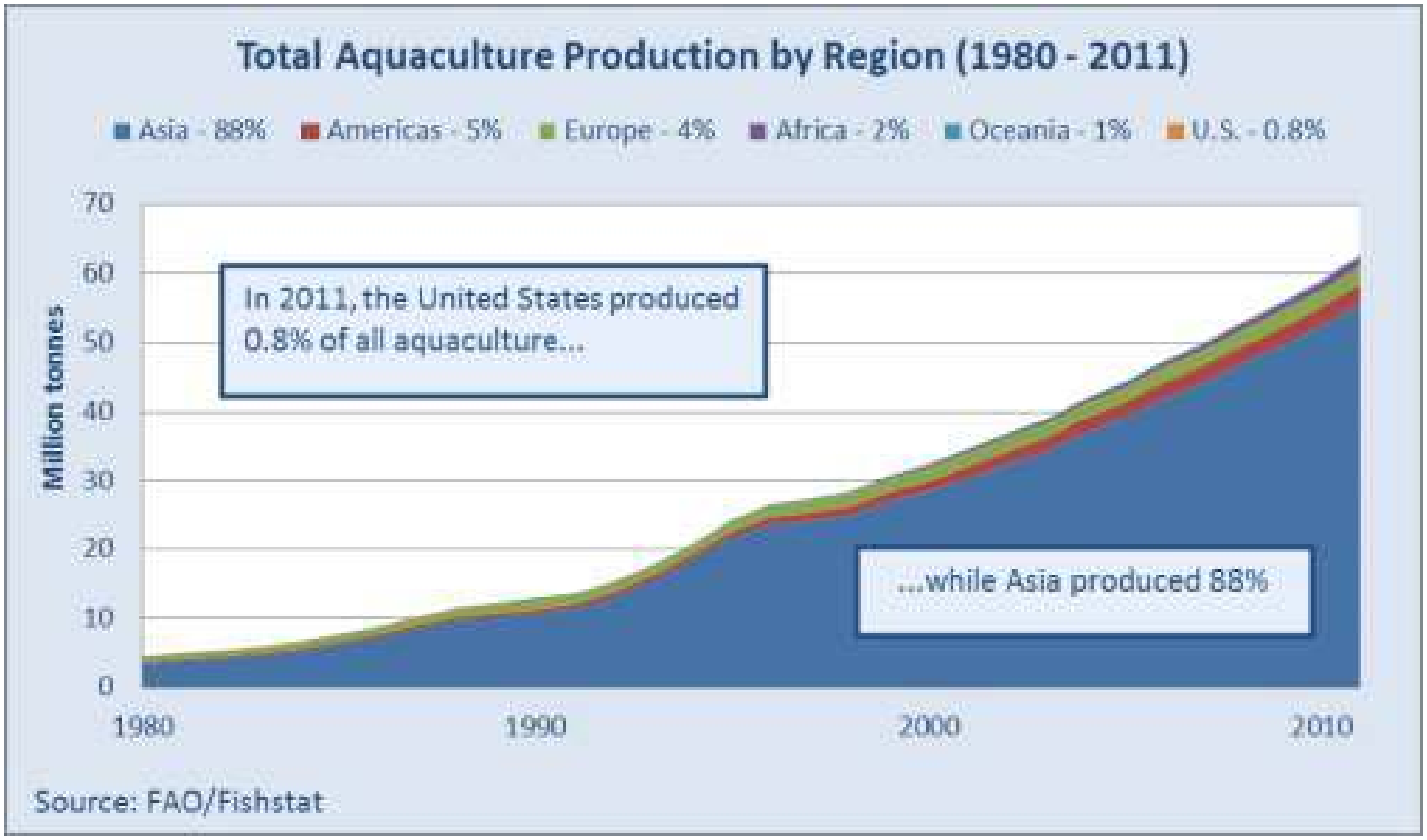
The importance of considering primary productivity in bivalve aquaculture site selection – an example from the Bronx, New York

Judy Yaqin Li, Shannon L. Meseck,
Mark S. Dixon, Genevieve Bernatchez,
Julie M. Rose, Eve Galimany,
Marguerite Petit, and Gary H. Wikfors

NOAA Fisheries Milford Laboratory
212 Rogers Ave., Milford, CT 06460

Milford Aquaculture Seminar, February 2014

Source: http://www.nmfs.noaa.gov/aquaculture/aquaculture_in_us.html



The United States ranked 15th in total aquaculture production in the world in 2012

Source: http://www.nmfs.noaa.gov/aquaculture/aquaculture_in_us.html

Total Seafood Consumed, 2009 by Country (tonnes)

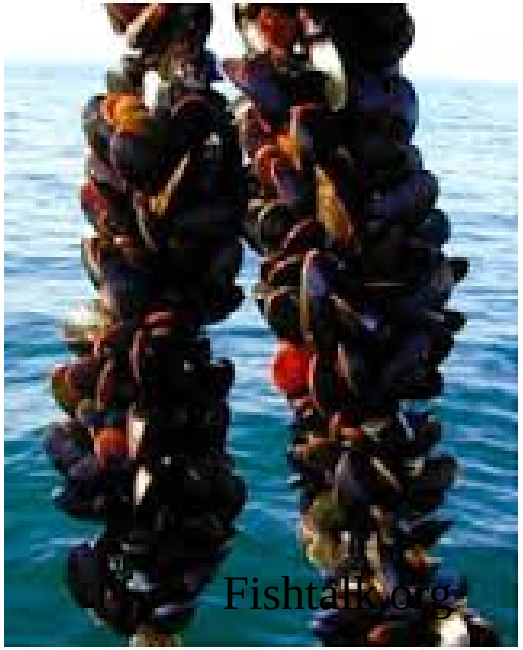
China	42,365,316
United States	7,424,152
Japan	7,163,895
India	6,646,244
Indonesia	6,040,631
Republic of Korea	2,691,931
Thailand	1,690,540

Source: FAO FishStat

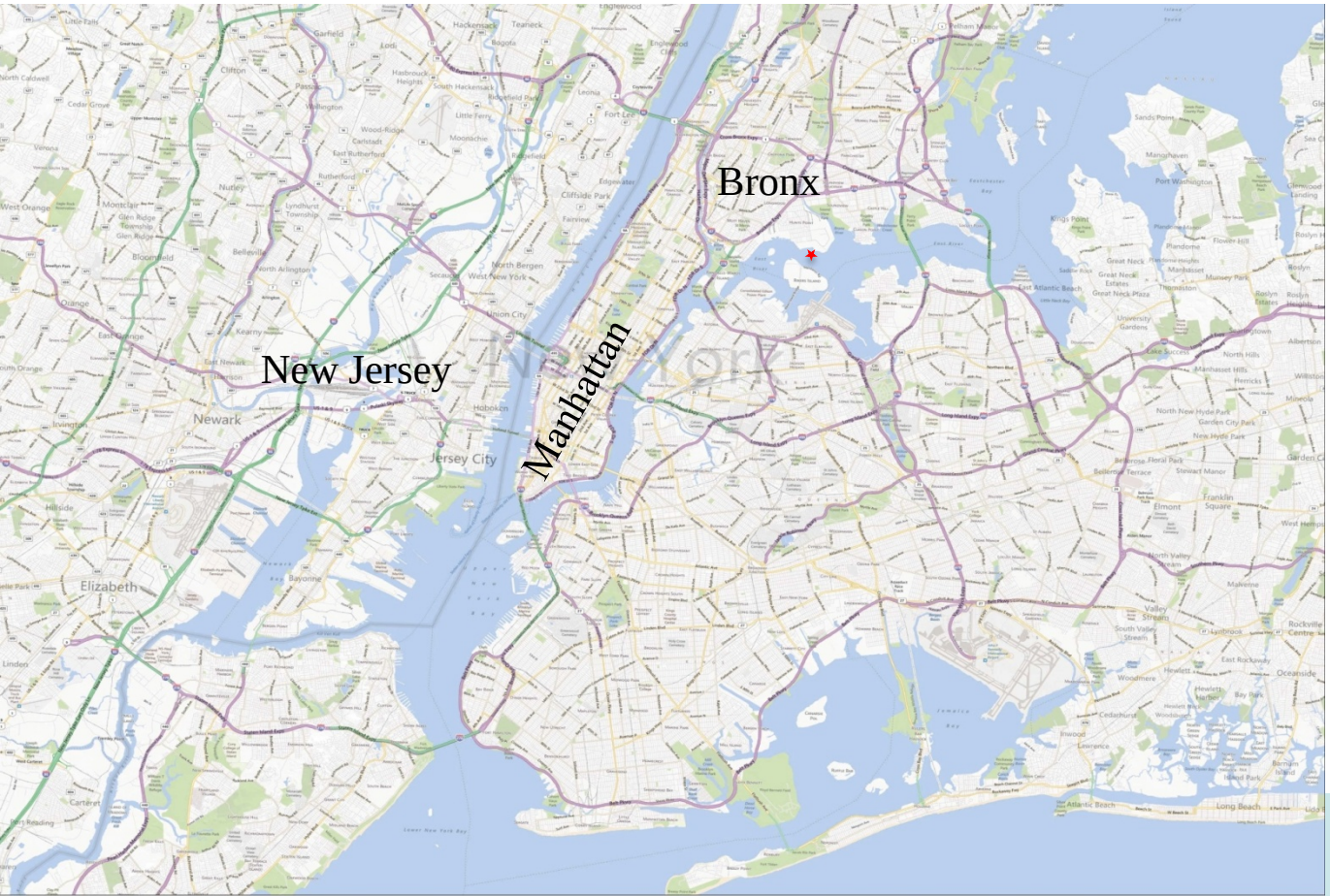
In the USA, 2/3 of marine aquaculture production is of the bivalve mullusks: clams, oysters, mussels, etc. (NOAA Aquaculture office)

Aquaculture site selection:

- **Physical location**
- **Local hydrographics**
- **Water quality**
- **Food availability**



Milford Harbor, Milford CT
Hunts Point, Bronx NY


Bronx
New Jersey
Manhattan

Feeding studies with ribbed mussels
Comparing Bronx New York to Milford, CT

Galimany et. al. 2013

Milford: clearance rate ↑ pseudofeces ↓

Bronx: clearance rate ↓ pseudofeces ↑

Absorption Efficiency =

Feeding studies with ribbed mussels
Comparing Bronx New York to Milford, CT

Galimany et. al. 2013

Milford: clearance rate ↑ pseudofeces ↓

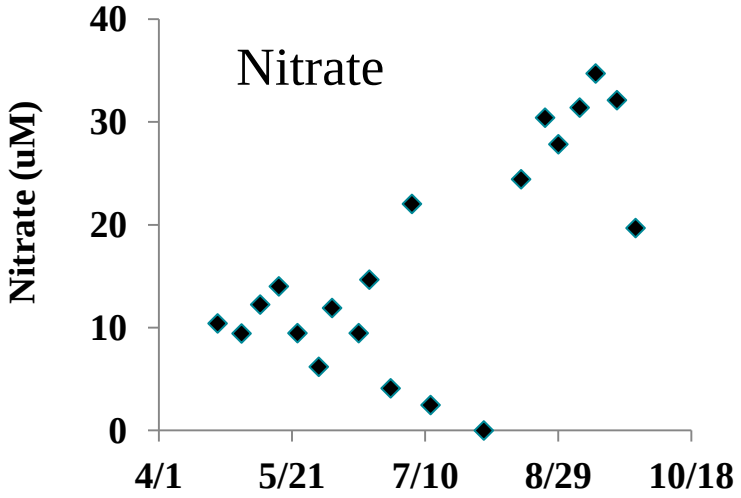
Bronx: clearance rate ↓ pseudofeces ↑

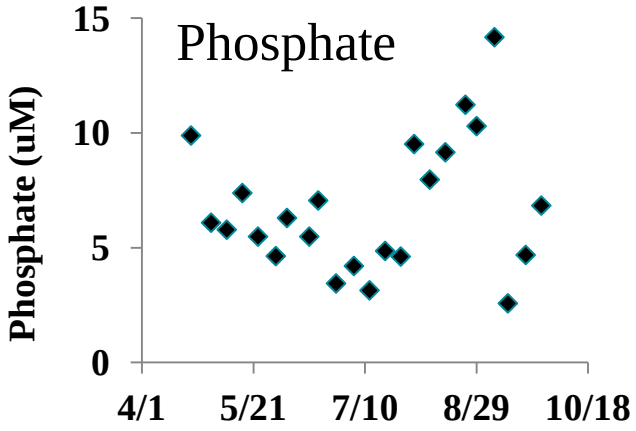
Absorption Efficiency =

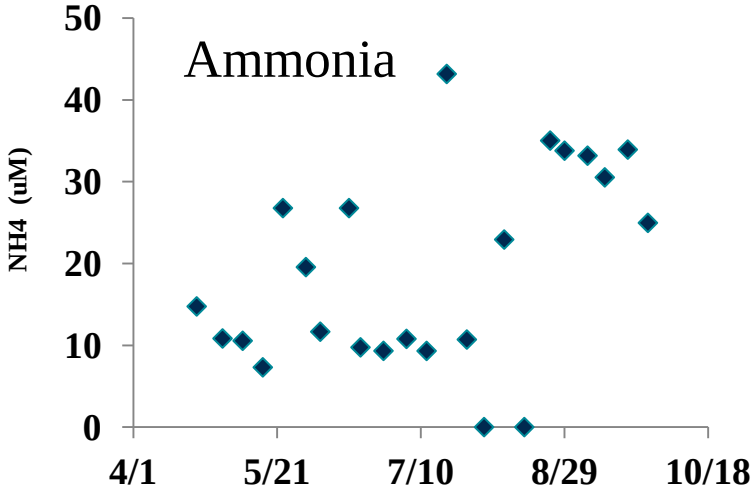
Milford: soft tissue content ↑

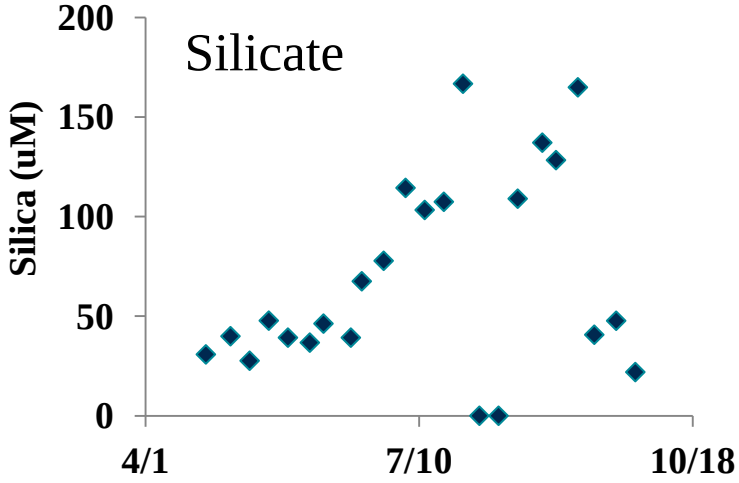
Bronx: soft tissue content ↓

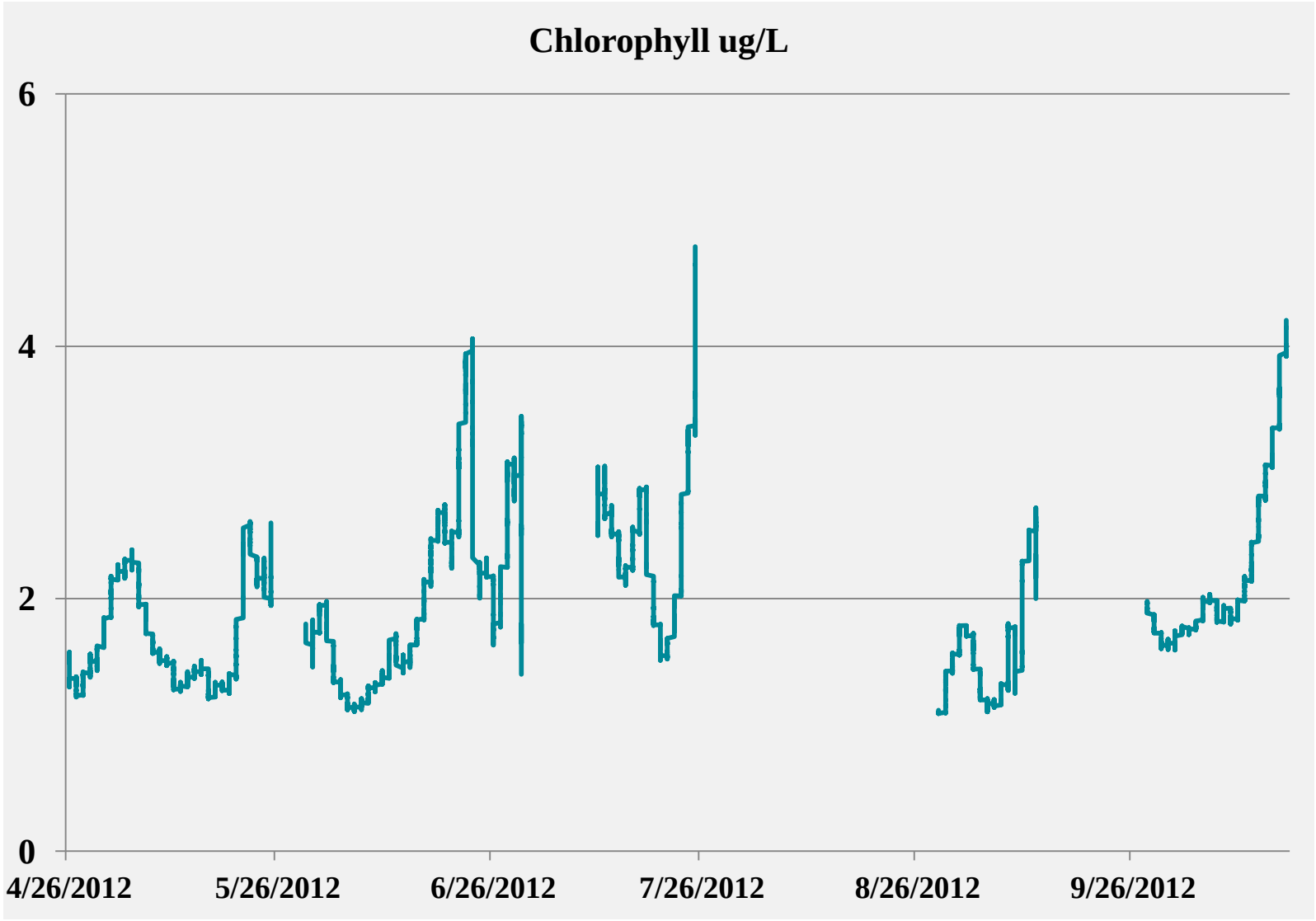
Inorganic Nutrients

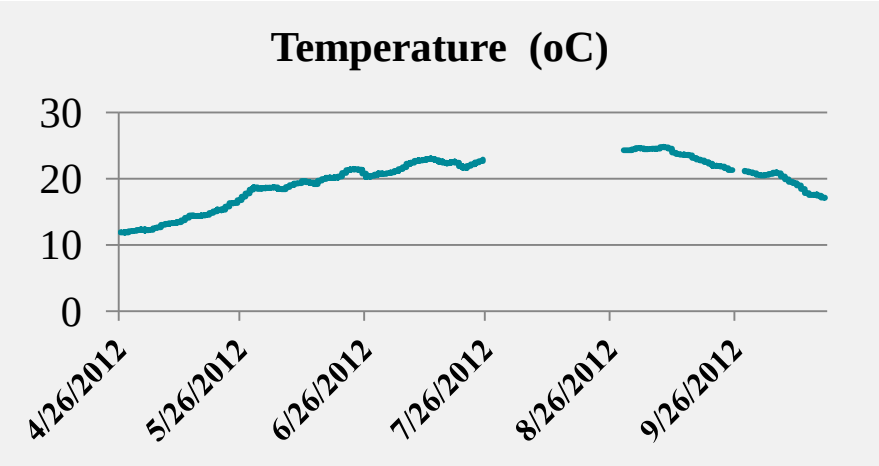


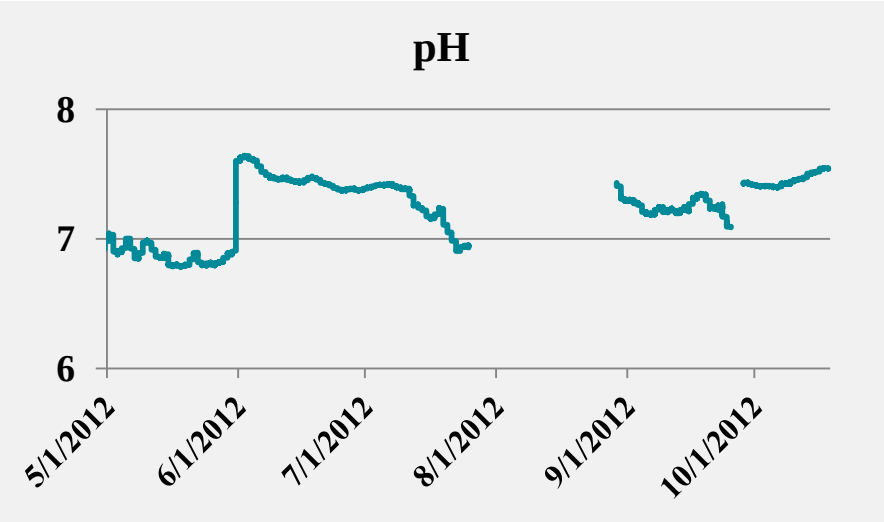


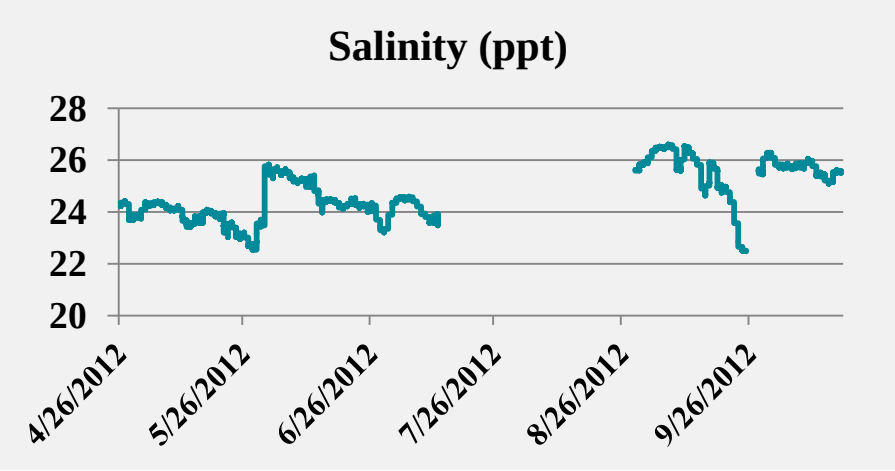


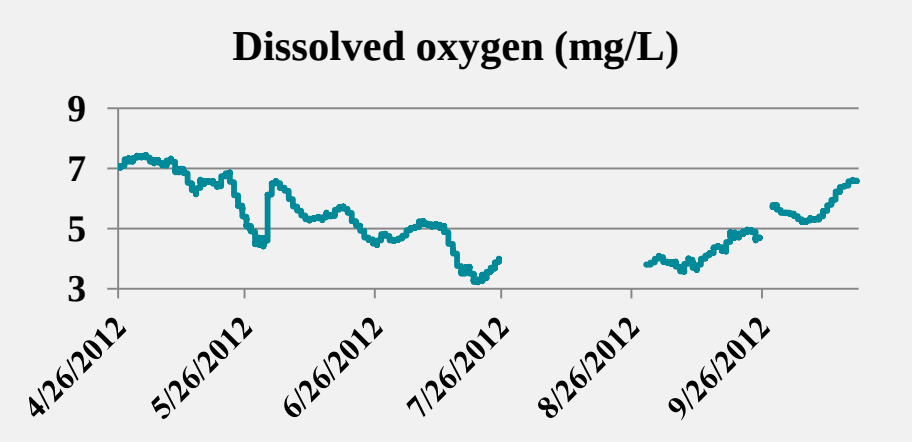



Chlorophyll ug/L
Chlorophyll ug/L
6
4
2
0
4/26/2012
5/26/2012
6/26/2012
7/26/2012
8/26/2012
9/26/2012

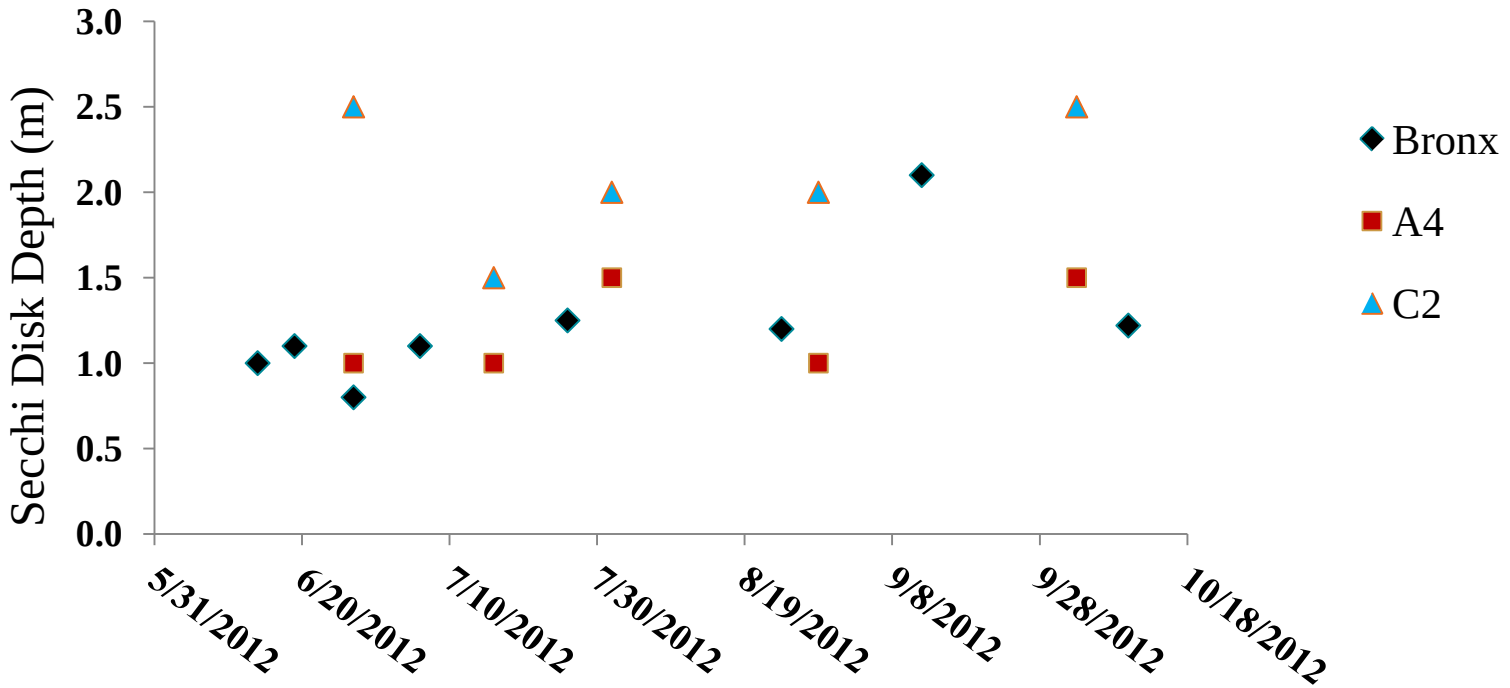

Temperature (oC)
30
20
10
0
4/26/2012
5/26/2012
6/26/2012
7/26/2012
8/26/2012
9/26/2012


pH
8
7
6
5/1/2012
6/1/2012
7/1/2012
8/1/2012
9/1/2012
10/1/2012

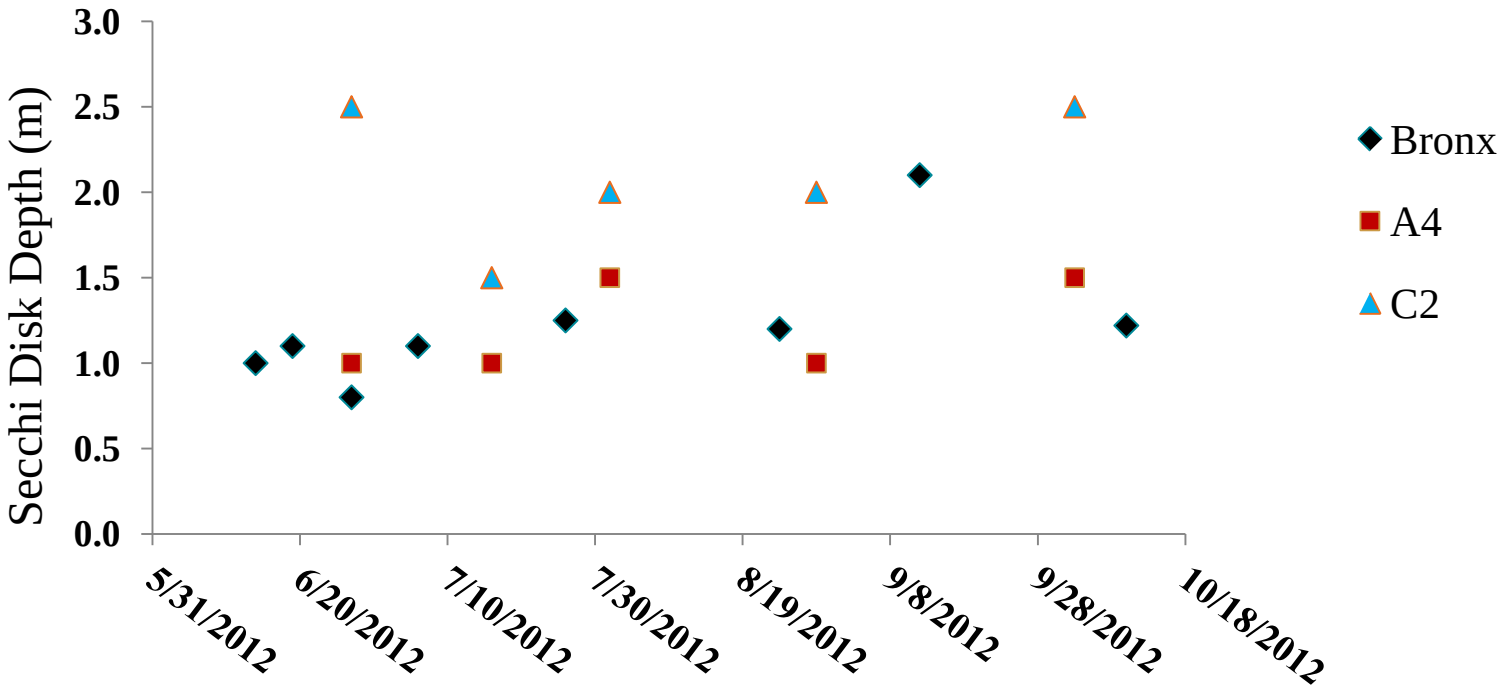

Salinity (ppt)
28
26
24
22
20
4/26/2012
5/26/2012
6/26/2012
7/26/2012
8/26/2012
9/26/2012

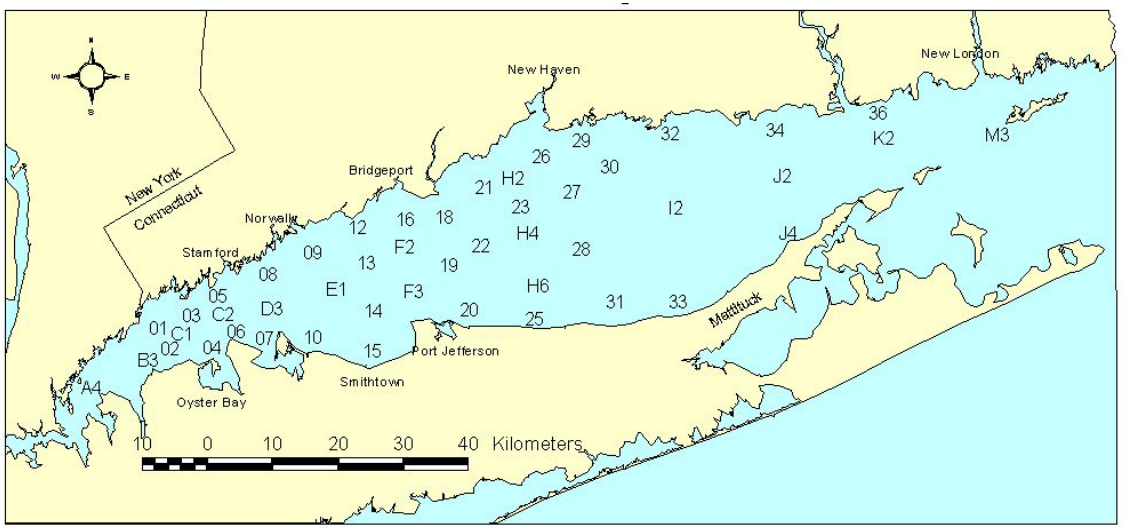

Dissolved oxygen (mg/L)
9
7
5
3
4/26/2012
5/26/2012
6/26/2012
7/26/2012
8/26/2012
9/26/2012

Secchi Disk Depth

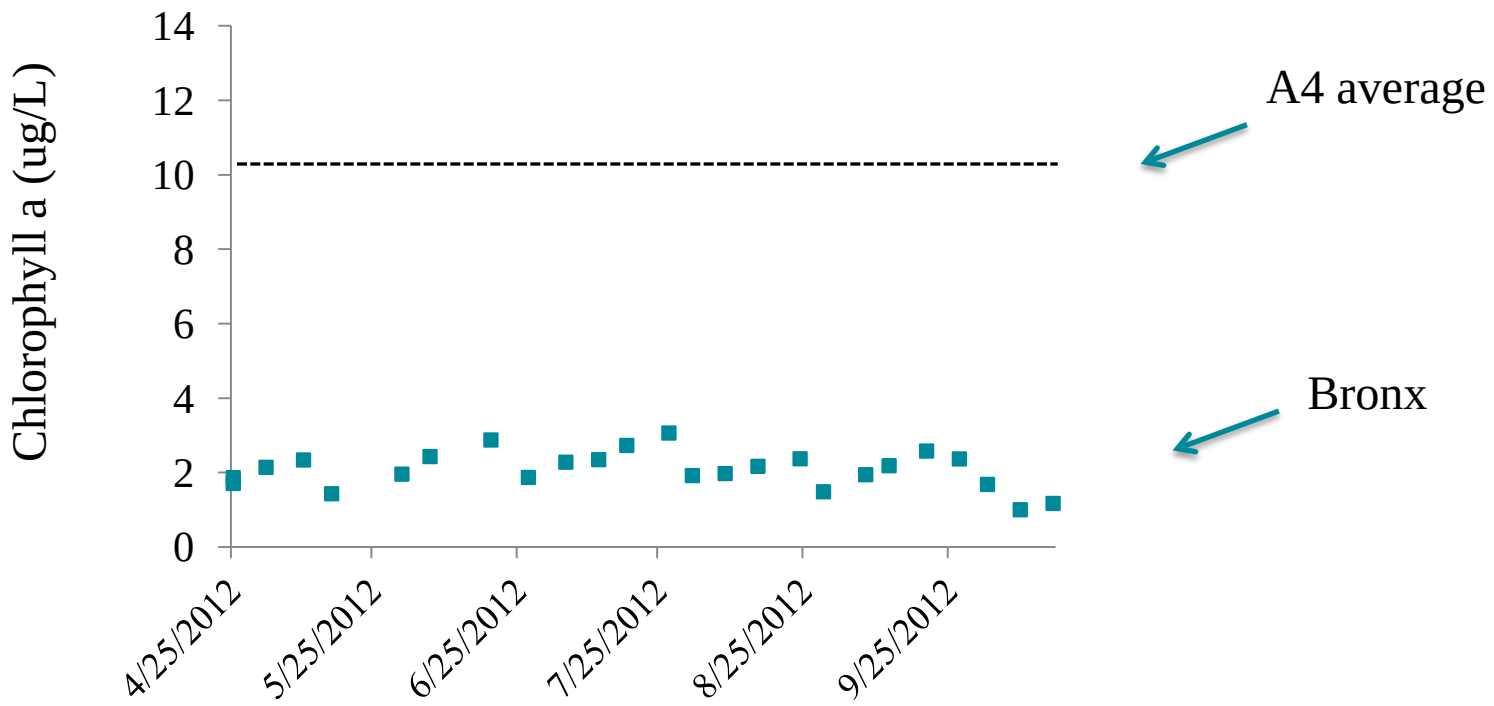


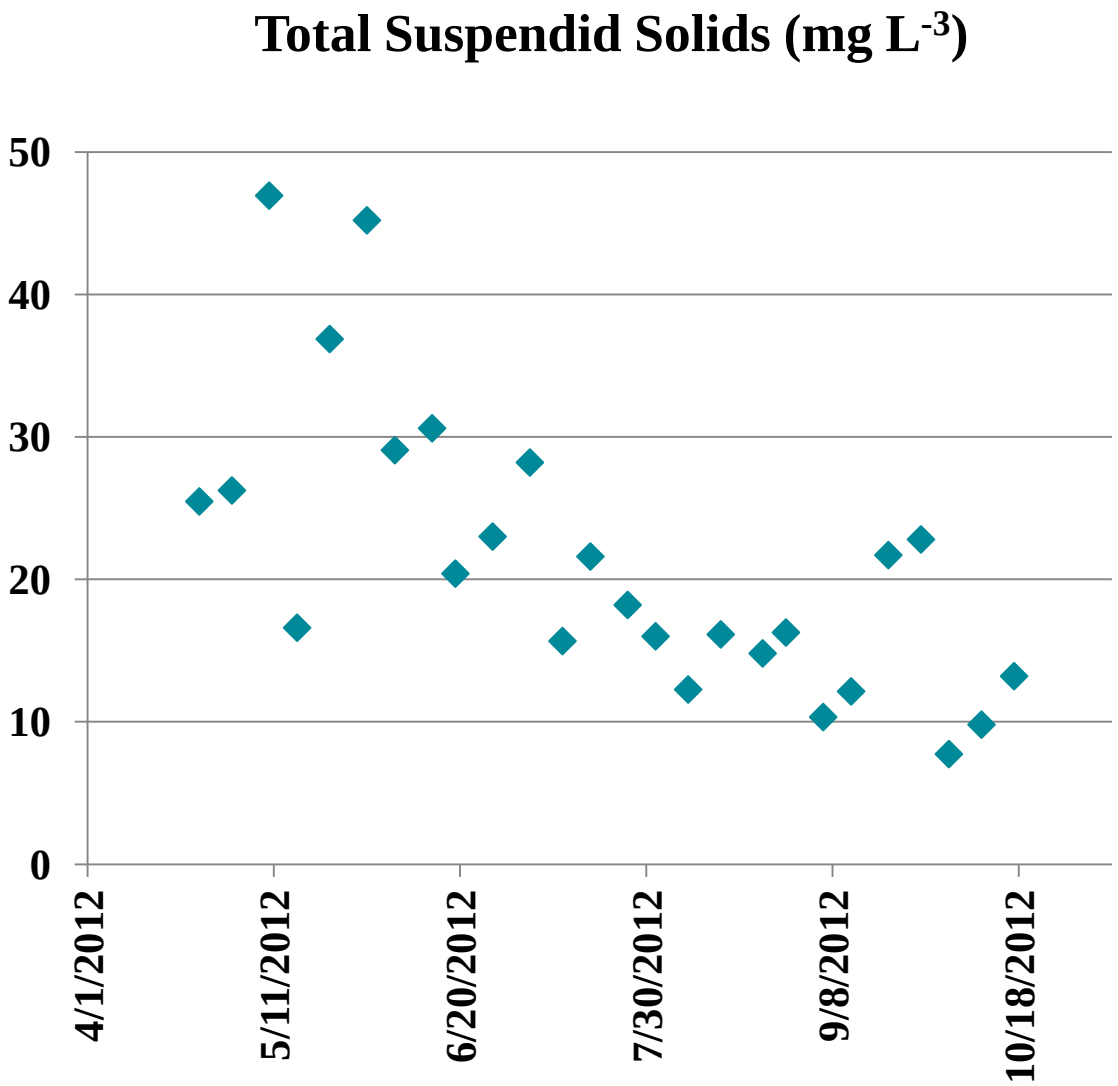
Secchi Disk Depth





Chlorophyll a (ug/L)

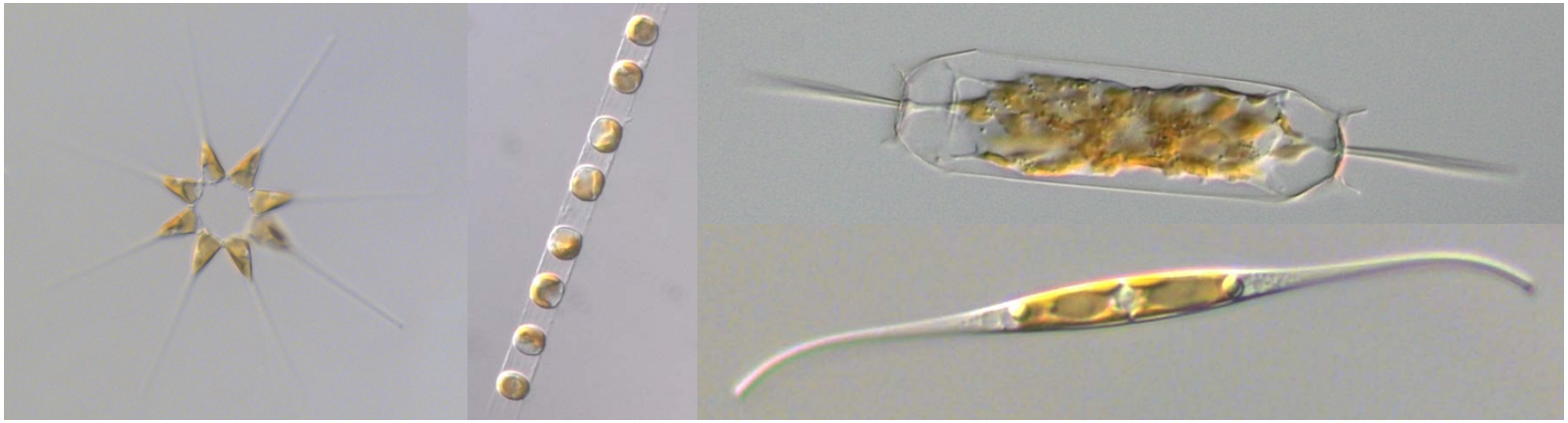



Total Suspendid Solids (mg L-3)
50
40
30
20
10
0
4/1/2012
5/11/2012
6/20/2012
7/30/2012
9/8/2012
10/18/2012

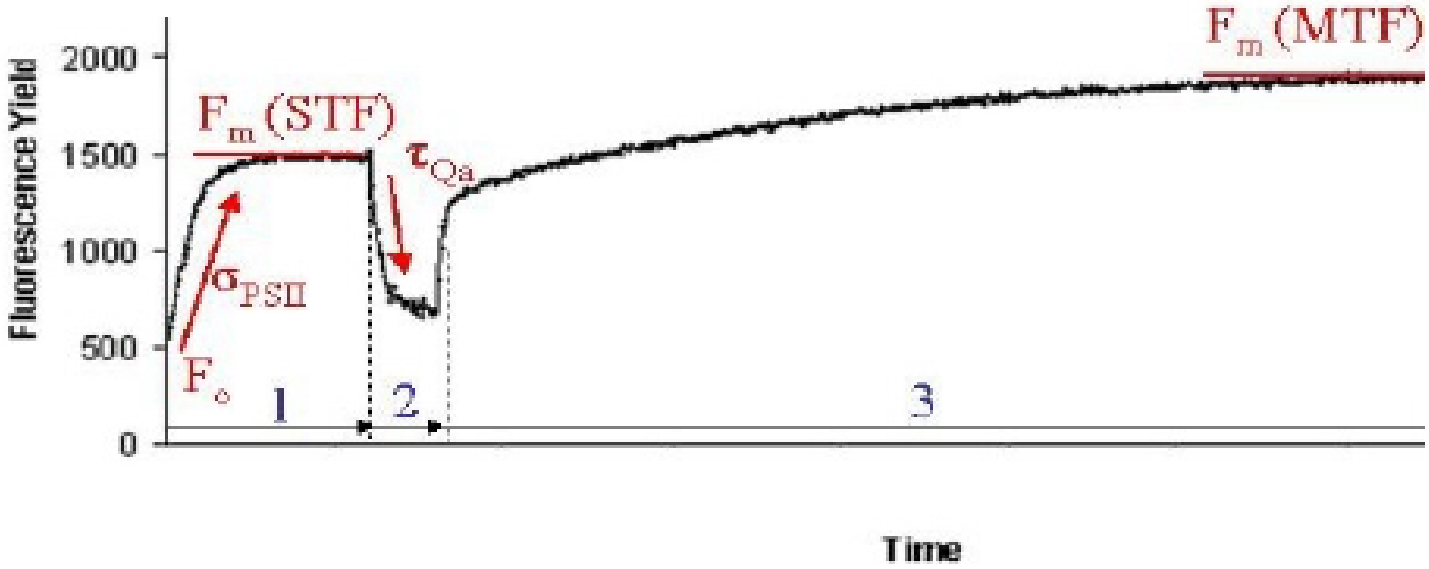
Hypothesis:

✓**The low amount of phytoplankton that is available for the ribbed mussels is a result of low local primary productivity rather than loss of productivity from grazing or flushing.**

✓**The primary productivity in the high nutrients low chlorophyll East River Tidal Strait is limited by light, rather than nutrients.**



Fire (**F**luorescence **I**nduction and **Re**laxation) Fluorometer System Satlantic, Inc.



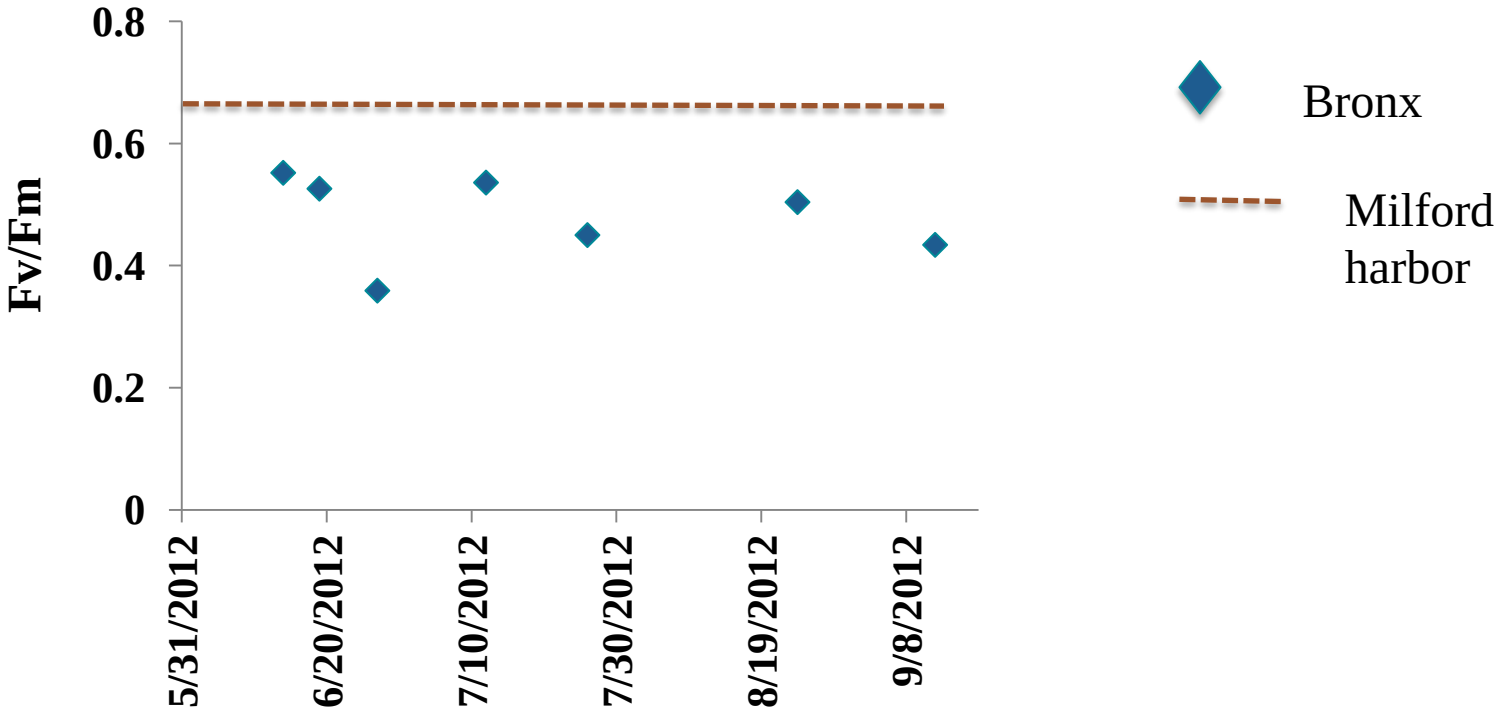
Fluorescence Induction and Relaxation Profile as measured with the FIRe

Variable fluorescence by FIRe = *Fluorescence Induction and Relaxation*

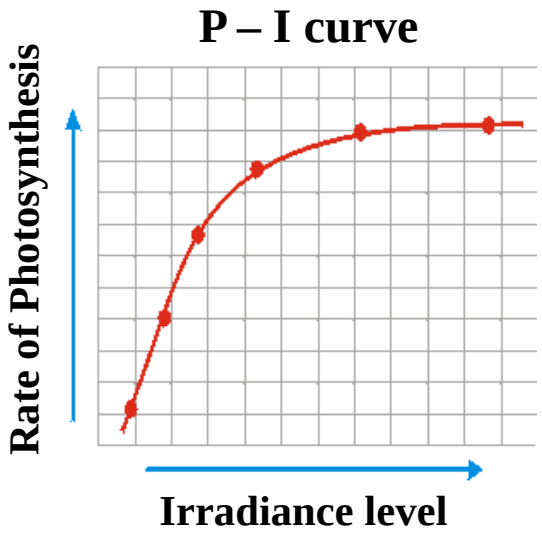
- **Fo,** the minimum and maximum fluorescence yield (Fm) in the dark and light
- **Fm,** maximum fluorescence yield
- **Fv/Fm,** the maximum quantum efficiency (or maximum quantum yield) of photochemistry of PSII, also indicates the physiological status of phytoplankton
- Parameters derived can be used to estimate the primary productivity
  - **α** Phosynthetic efficiency
  - **Ek** Light acclimation index
  - **rETR** relative electrotron transfer rate

Measurements in the field

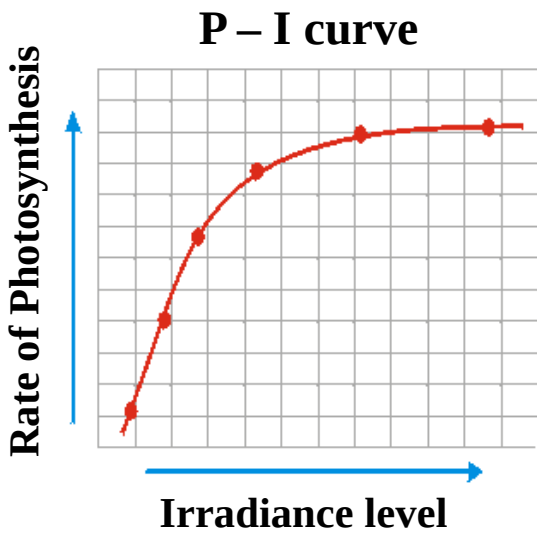
Fv/Fm the maximum quantum efficiency (or maximum quantum yield) of photochemistry of PSII

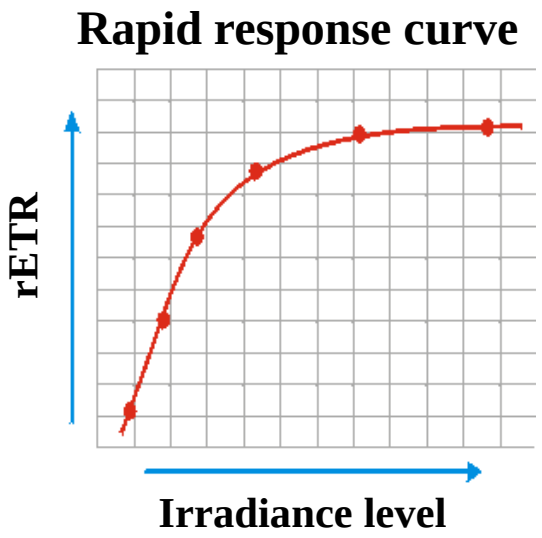


Rapid response curve:



Rapid response curve:



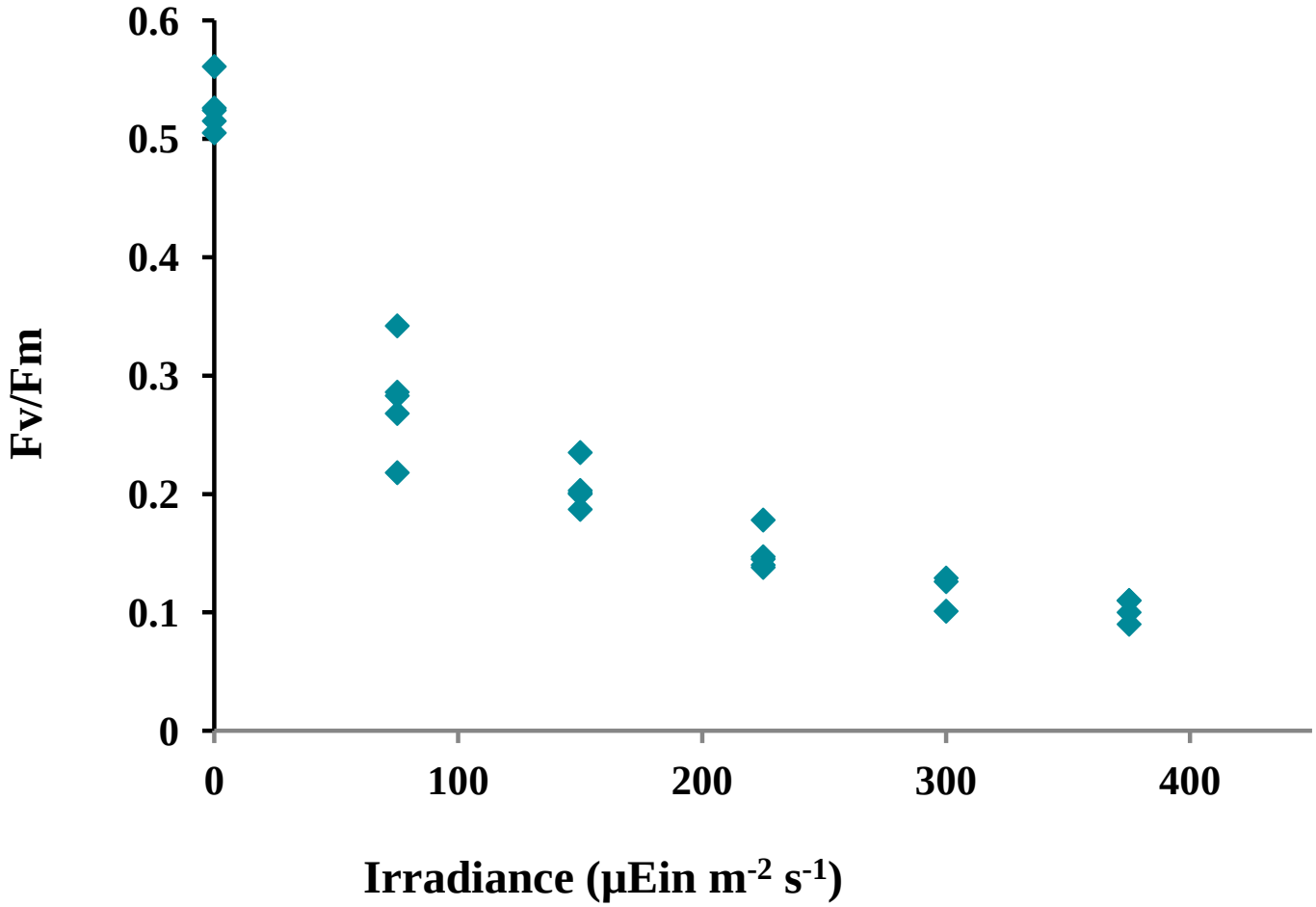


Rapid response curve:

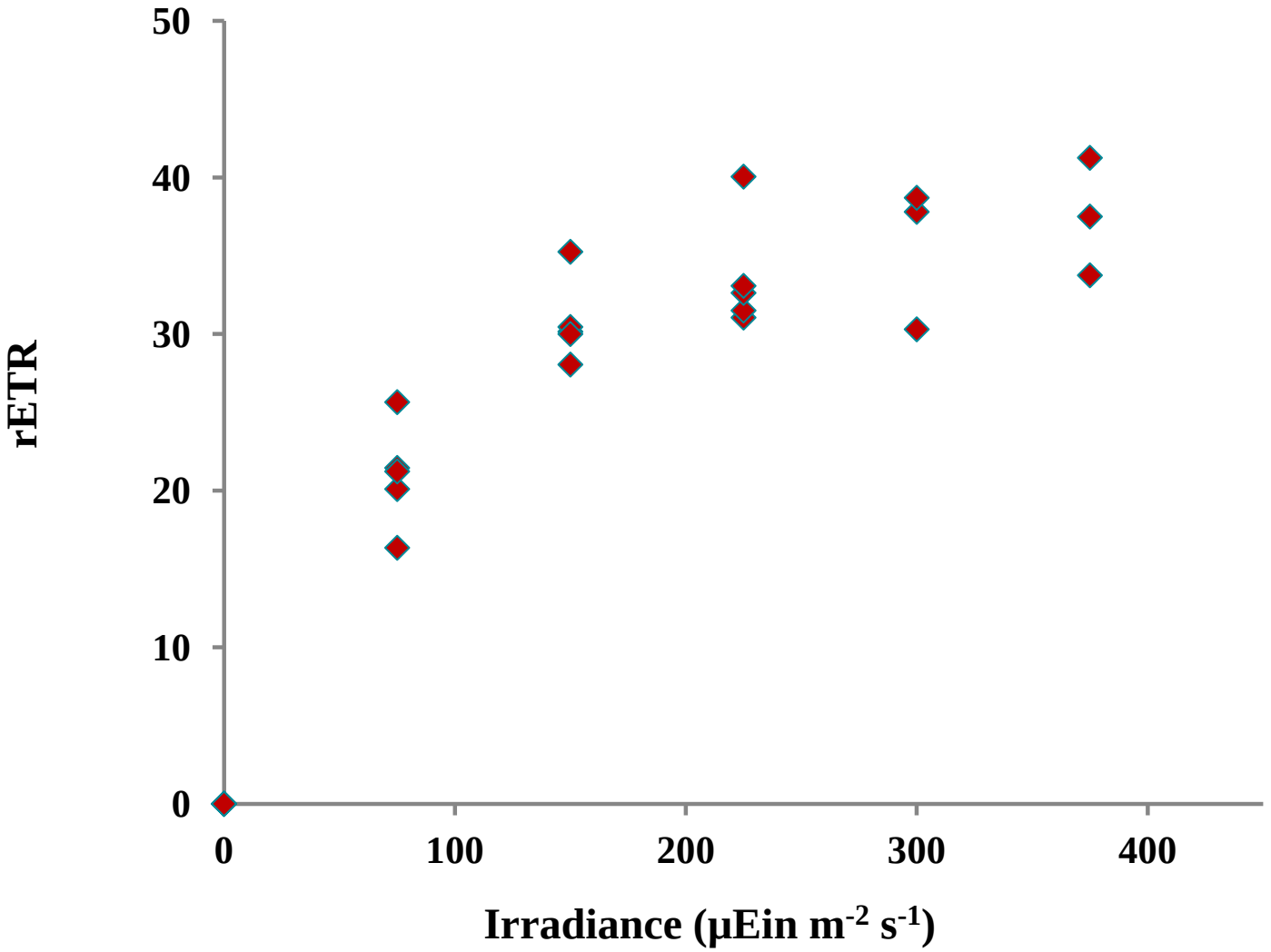
- Gave water samples a series of consecutive 10-s intervals of light of increasing intensity
- Measured the quantium yield at the end of each light interval
- Calculated the rETR for each interval
- rETR vs. irradiance fitted to the Jasby and Platt (1976)'s PI curve

$$P = Pmax * e^{(-\alpha E / Pmax)}$$

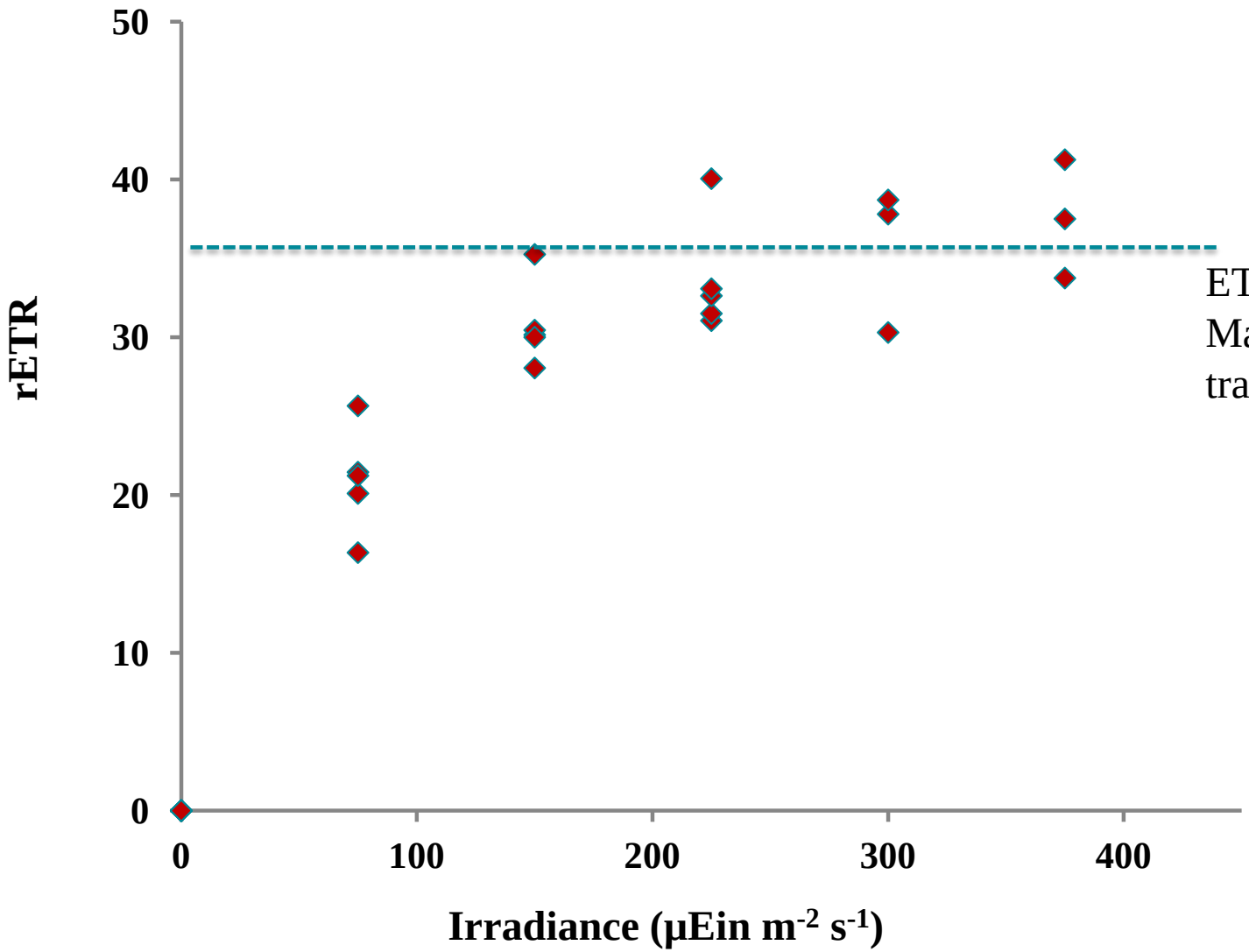
Fv/Fm, the maximum quantum efficiency (or maximum quantum yield) vs. irradiance



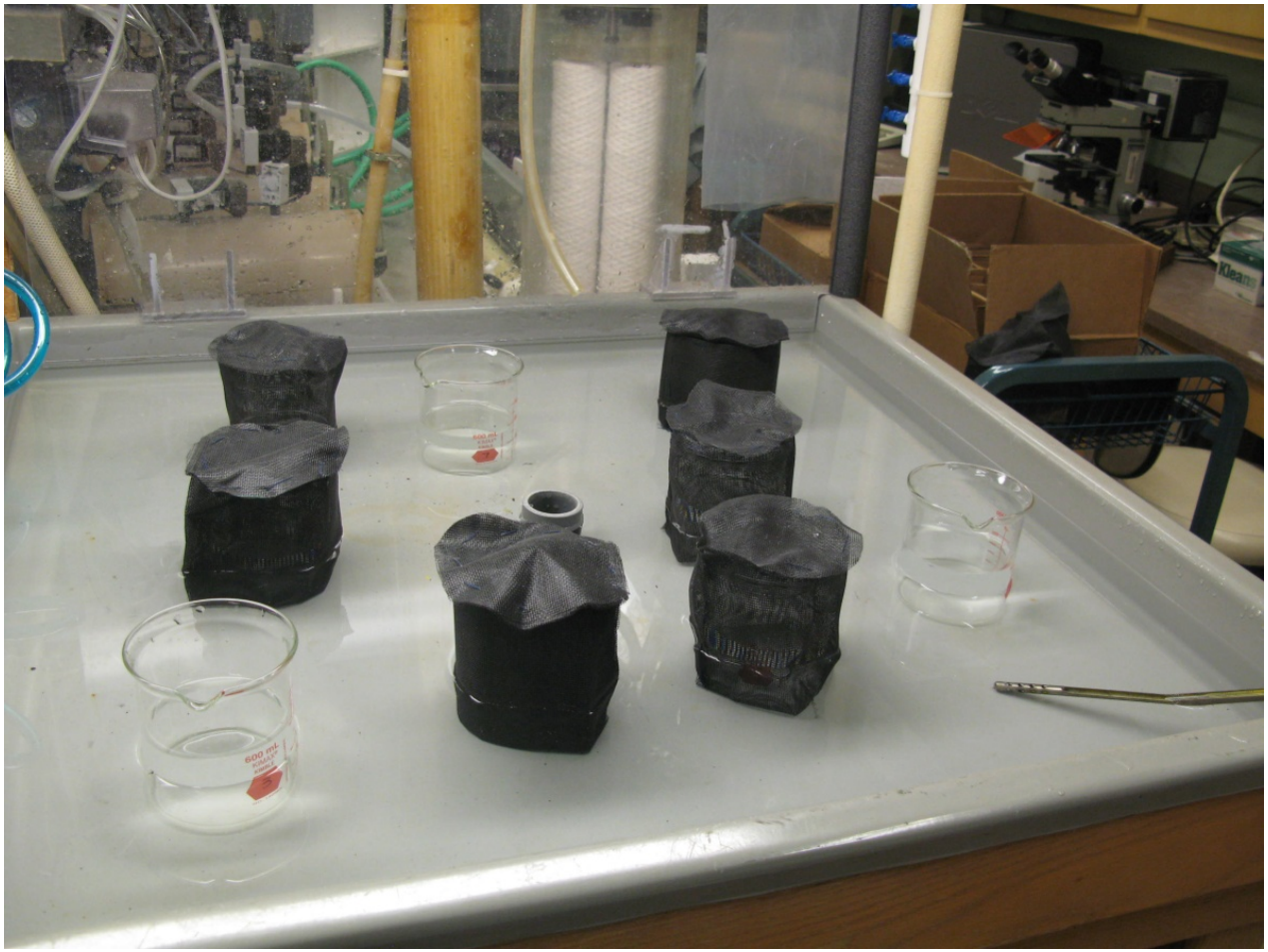
Relative electron transport rate (rETR) vs. irradiance



Relative electron transport rate (rETR) vs. irradiance



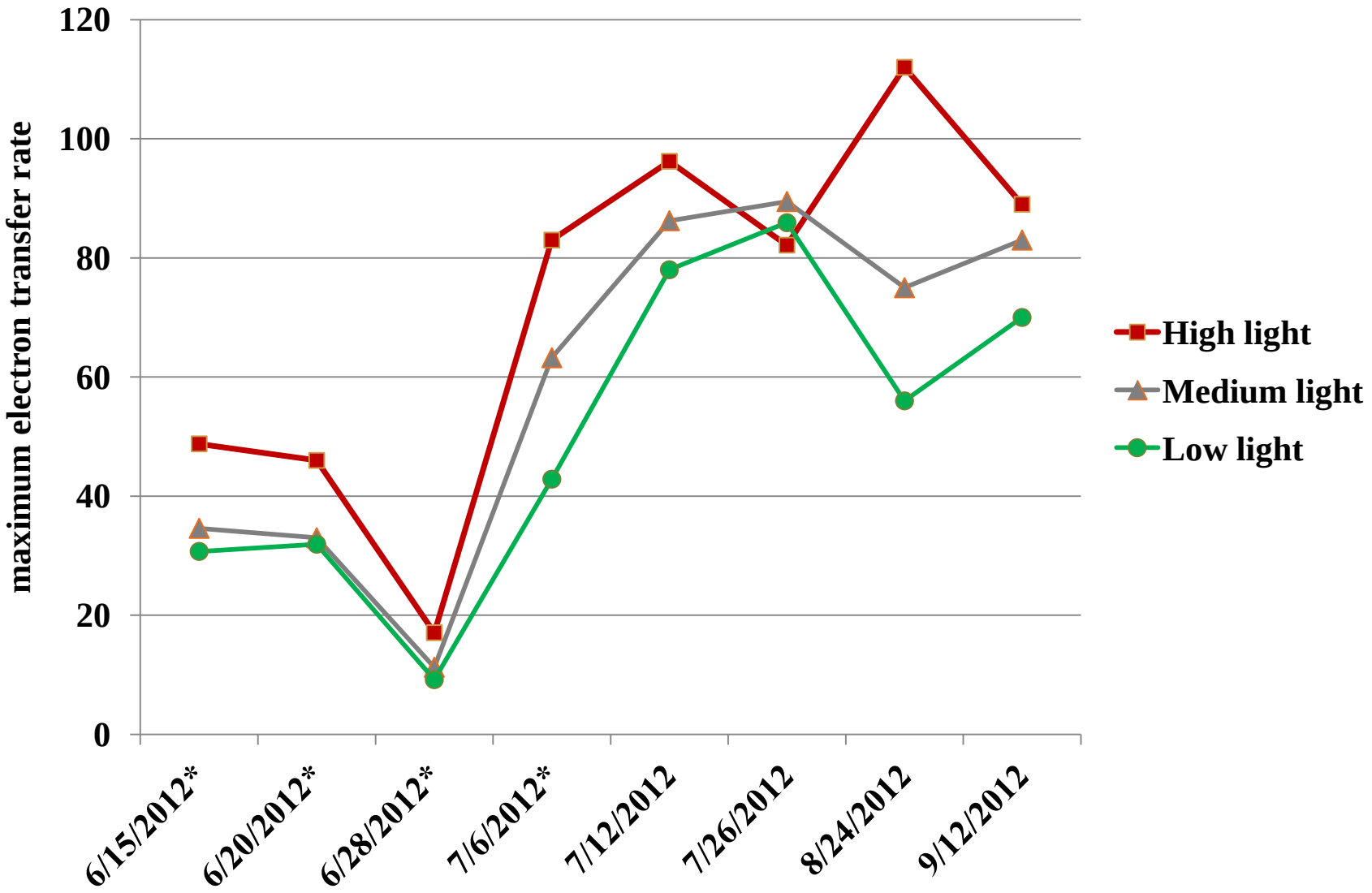
What happens when phytoplankton in the East River tidal strait are given more light?



2 hours incubation
3 irradiance levels:
160 µEin $m^{-1}s^{-1}$
360 µEin $m^{-1}s^{-1}$
650 µEin $m^{-1}s^{-1}$

Variable fluorescence measurements

Maximum electron transport rate ETRmax under different light treaments



Summary:

✓The low amount of phytoplankton that is available for the ribbed mussels is a result of low local primary productivity rather than loss of productivity from grazing or flushing.

✓The low primary productivity coupled with the high inorganic silt in the water make it not an ideal location for bivalve growth.

In general, coastal area:

High nutrients → high chlorophyll = high food availability for bivalves

In Bronx:

high nutrients ≠ high chlorophyll ≠ food availability for bivalves

NOAA FISHERIES

Thank You!

This study was supported by NOAA Fisheries Office of Aquaculture and NOAA Fisheries NEFSC.