

Time series of gelatinous zooplankton in Chesapeake Bay, USA: Environmental controls and interspecific interactions



Joshua Stone, Mary Fabrizio, and
Deborah Steinberg

Interest in long-term changes in jellyfish populations

Increasing jellyfish populations: trends in Large Marine Ecosystems

Lucas Brotz • William W. L. Cheung •
Kristin Kleisner • Evgeny Pakhomov •
Daniel Pauly

Recurrent jellyfish blooms are a consequence of global oscillations

Robert H. Condon^{a,1}, Carlos M. Duarte^{b,c}, Kylie A. Pitt^d, Kelly L. Robinson^{a,e}, Cathy H. Lucas^f, Kelly R. Sutherland^g, Hermes W. Mianzan^h, Molly Bogeberg^a, Jennifer E. Purcellⁱ, Mary Beth Decker^j, Shin-ichi Uye^k, Laurence P. Madin^l, Richard D. Brodeur^m, Steven H. D. Haddockⁿ, Alenka Malej^o, Gregory D. Parry^{p,2}, Elena Eriksen^q, Javier Quiñones^r, Marcelo Acha^h, Michel Harvey^s, James M. Arthur^d, and William M. Graham^t

Jellyfish species of the Chesapeake

- Two common jellyfish species in the summer
 - Sea nettle – *Chrysaora quinquecirrha*
 - Ctenophore – *Mnemiopsis leidyi*
- *Chrysaora* predate heavily on *Mnemiopsis*
- *Chrysaora* alternate between planktonic medusae and benthic polyps



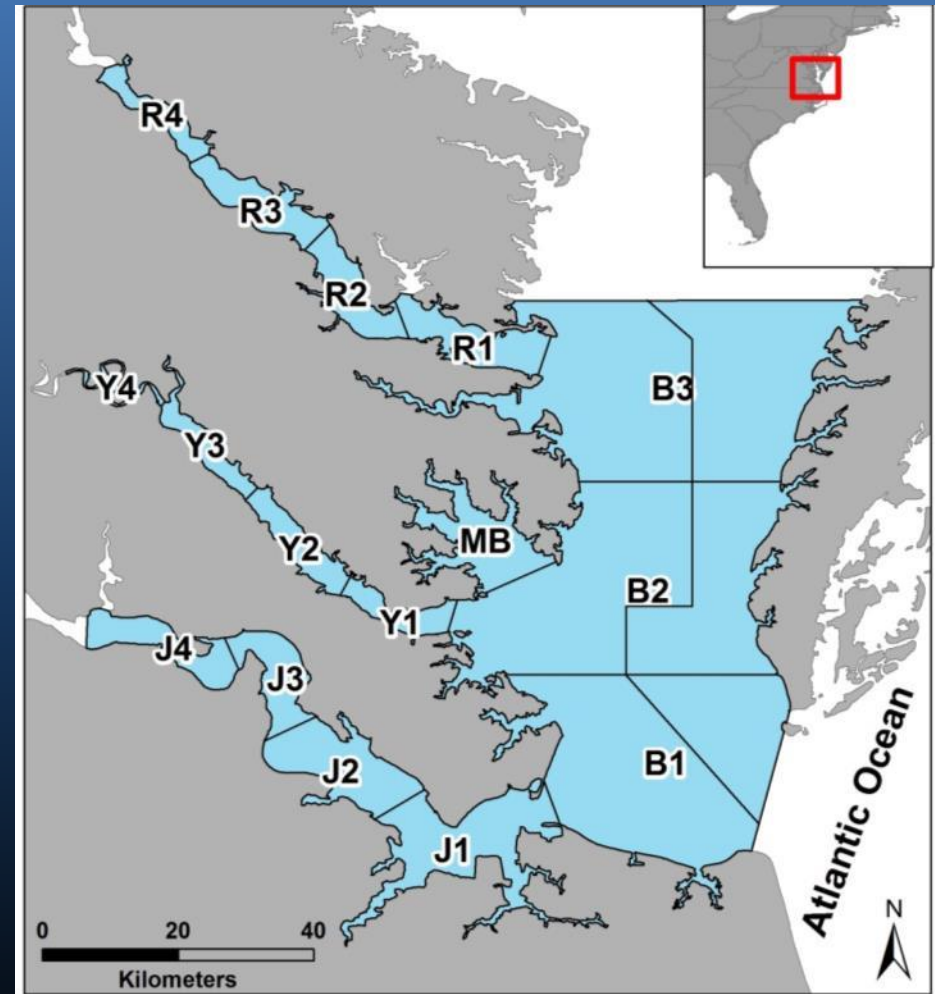
*Chrysaora
quinquecirrha*

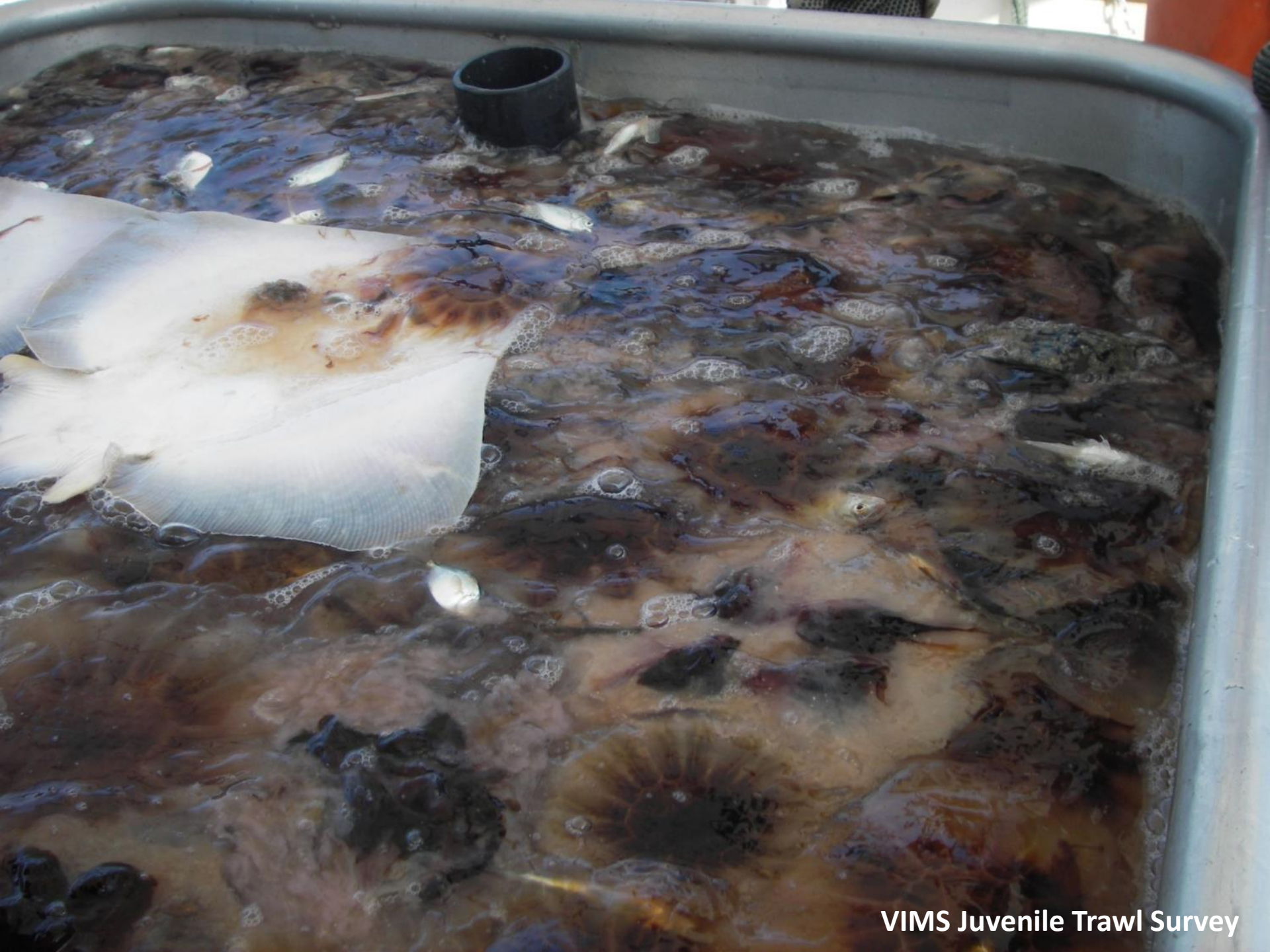


*Mnemiopsis
leidyi*

VIMS Juvenile and Blue Crab Trawl Survey

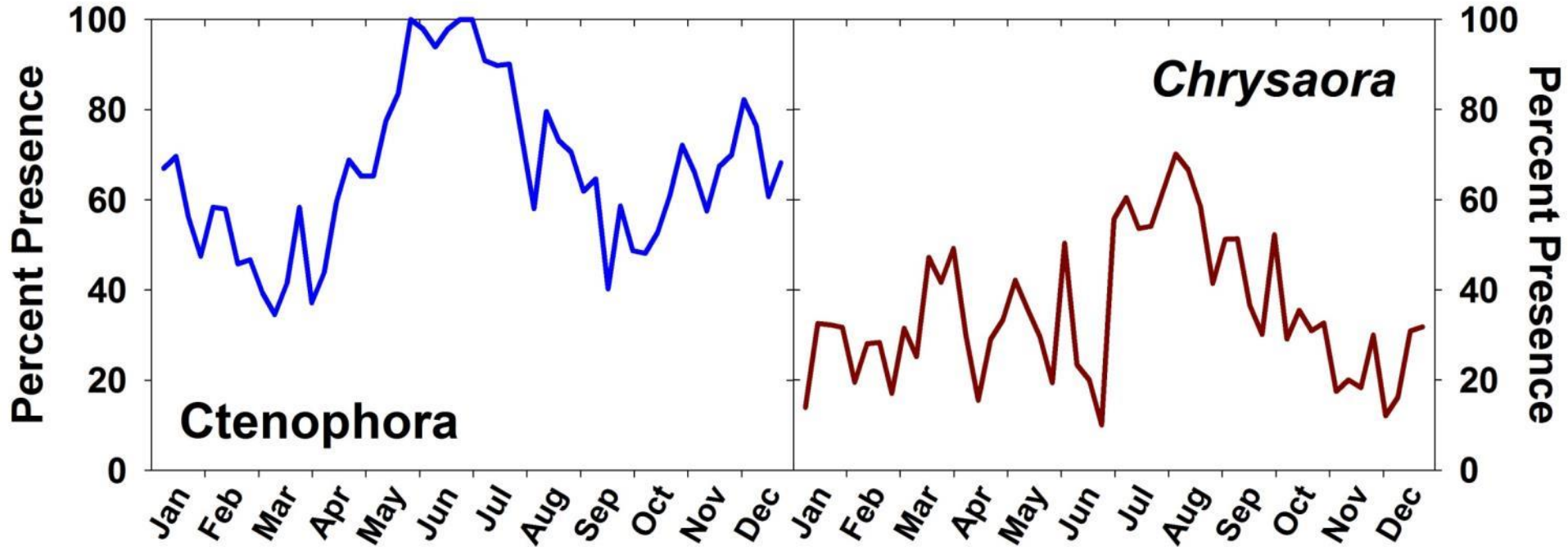
- Random and fixed monthly sampling in each region and at four depth strata
- Benthic otter trawl – 5 min
- 38 mm stretched mesh and 6.35 mm cod end liner
- Total jellyfish biovolume was recorded as bycatch from 1999 – 2012
- Presence/absence of jellyfish species
- 8,386 total observations





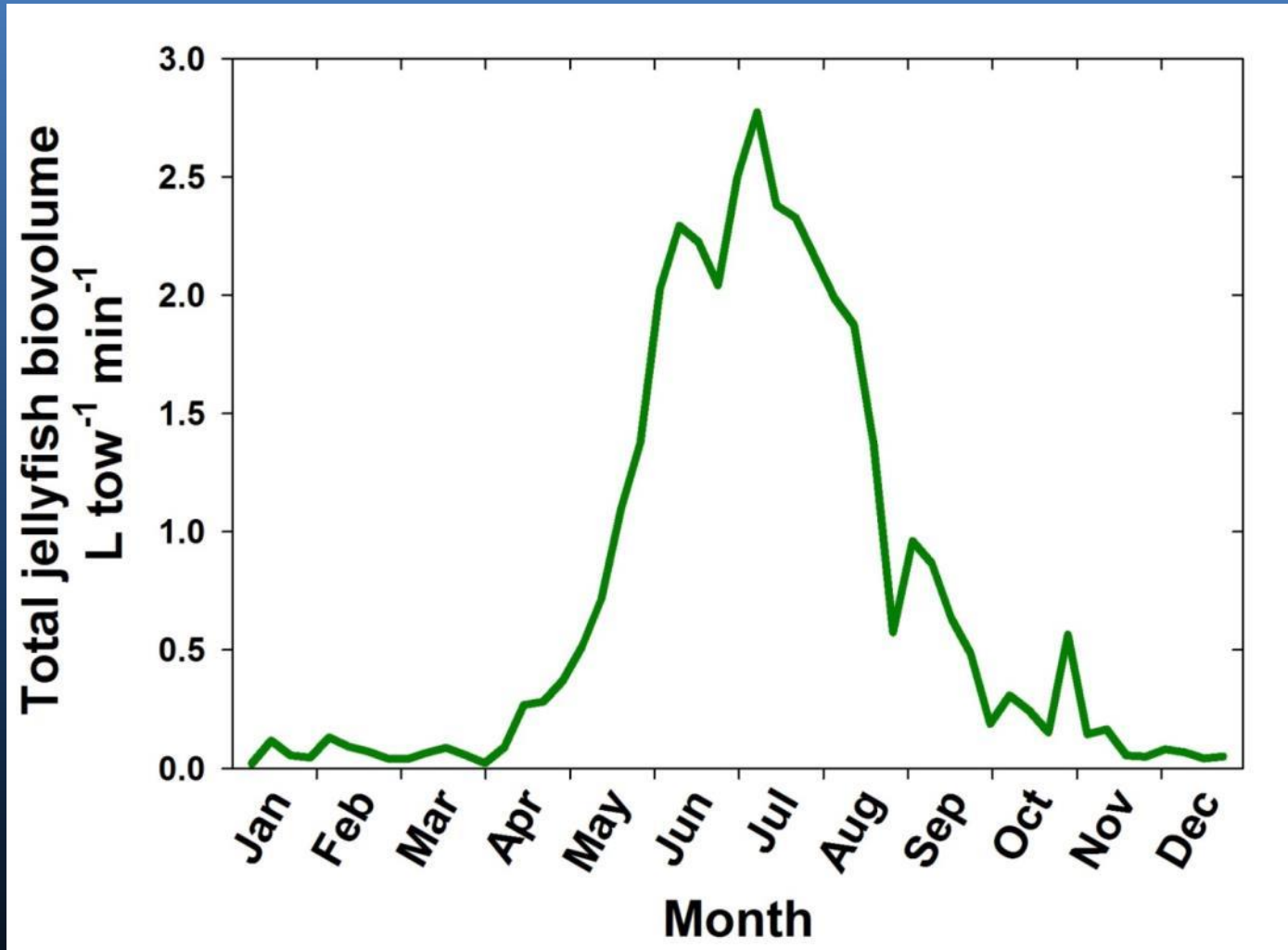
VIMS Juvenile Trawl Survey

Seasonality



Average across all stations and years (1999-2012)

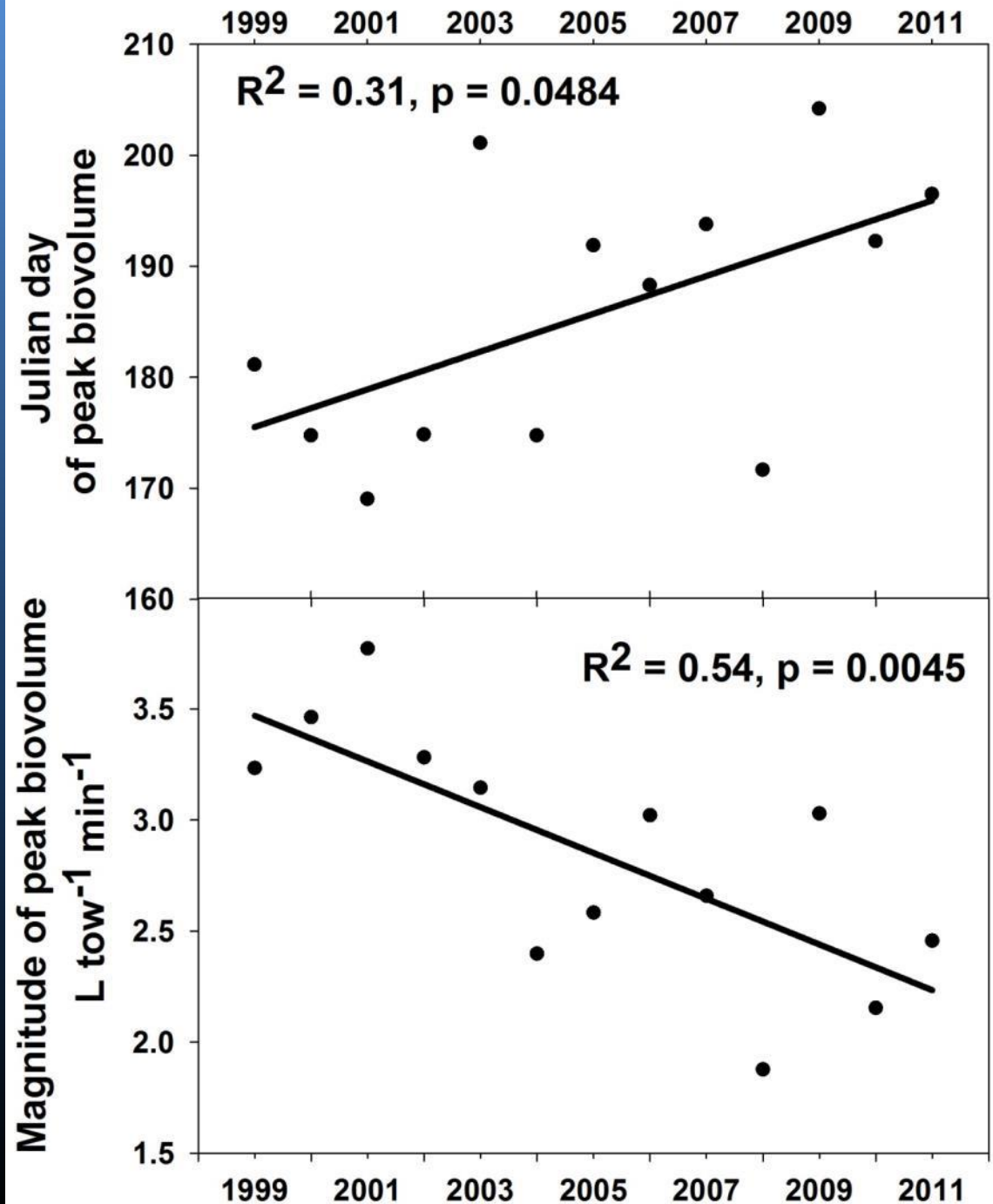
Biovolume



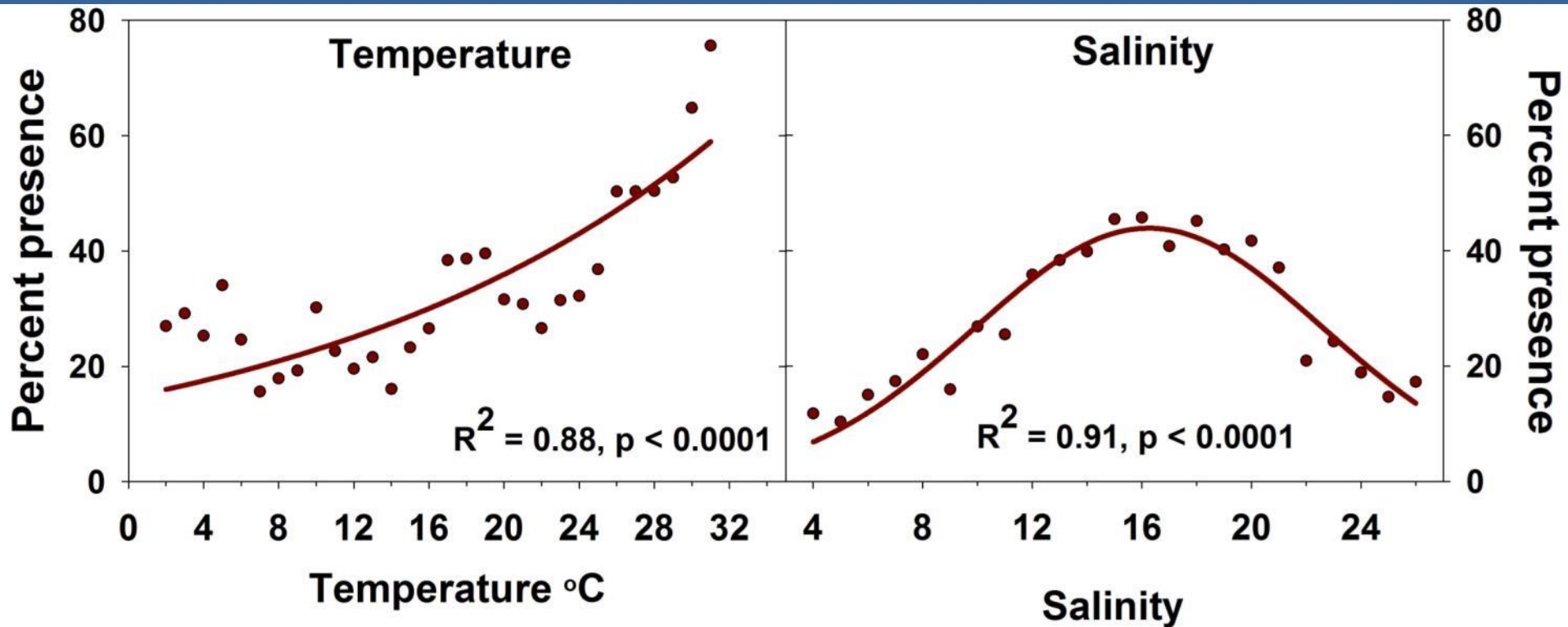
Average across all stations and years (1999-2012)

Timing of peak bloom

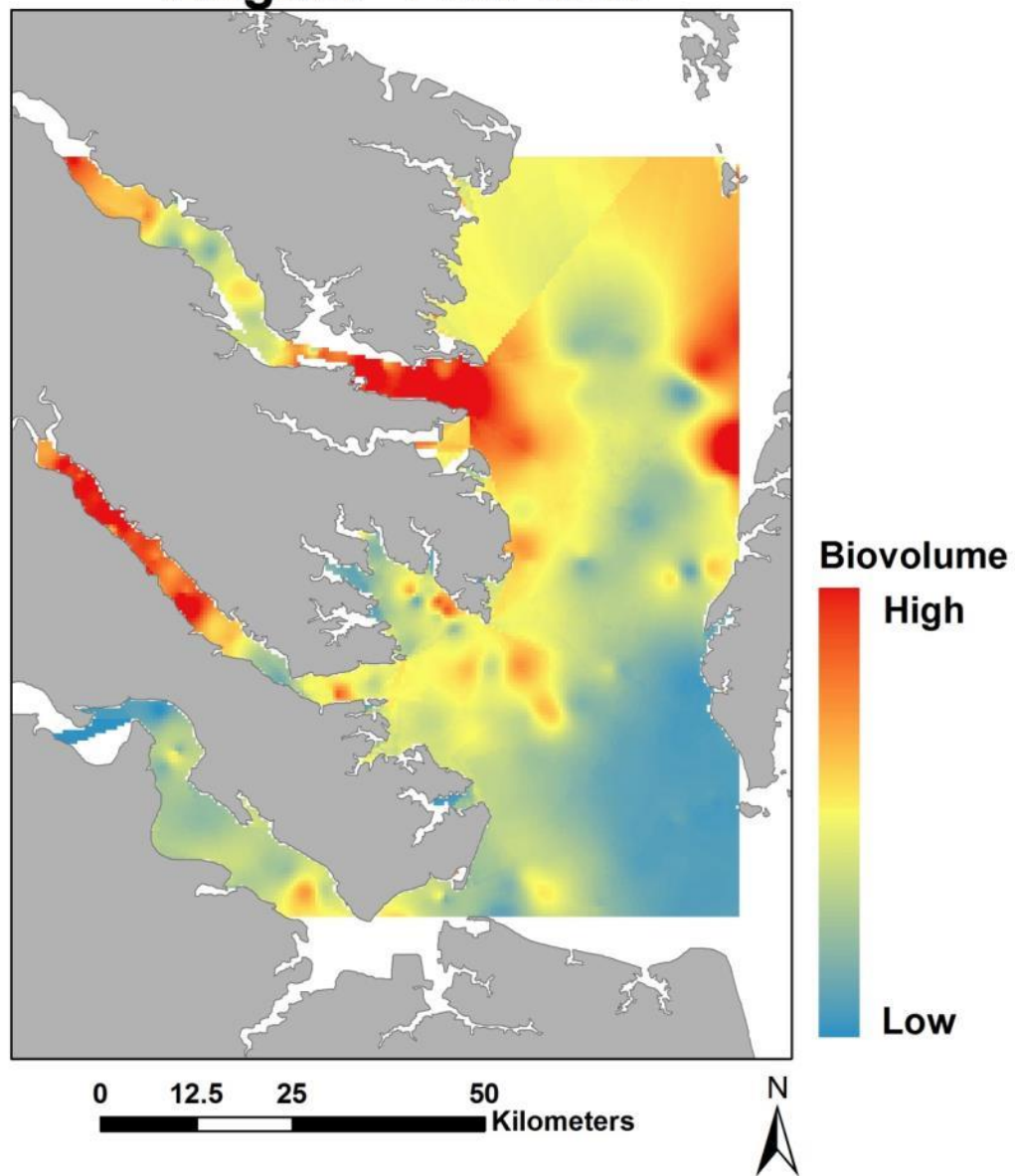
- Peak biovolume occurs later
- Peak biovolume is decreasing
- Day of peak and peak biovolume not correlated



Chrysaora habitat preference

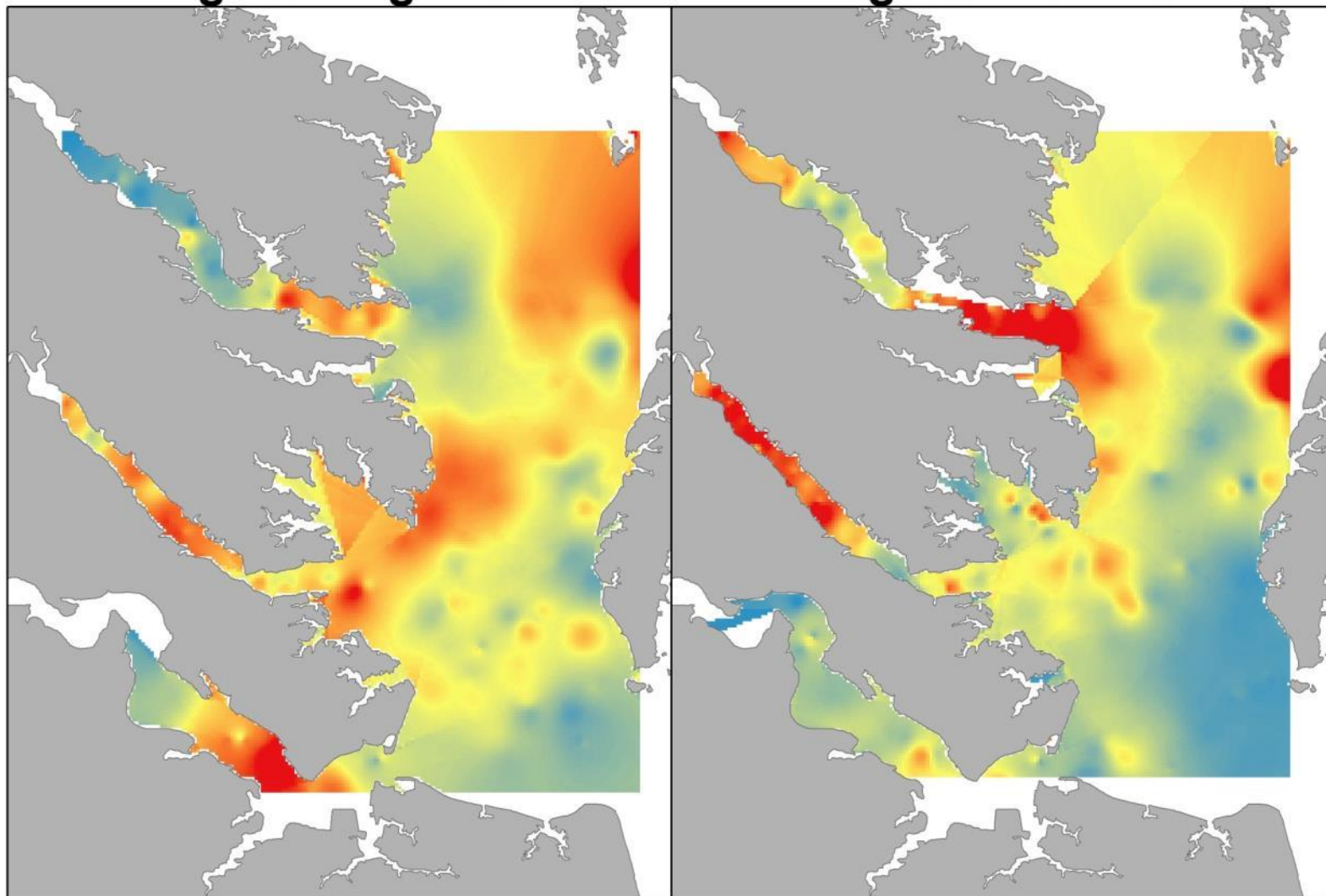


August - Low flow



August - High flow

August - Low flow



Biovolume

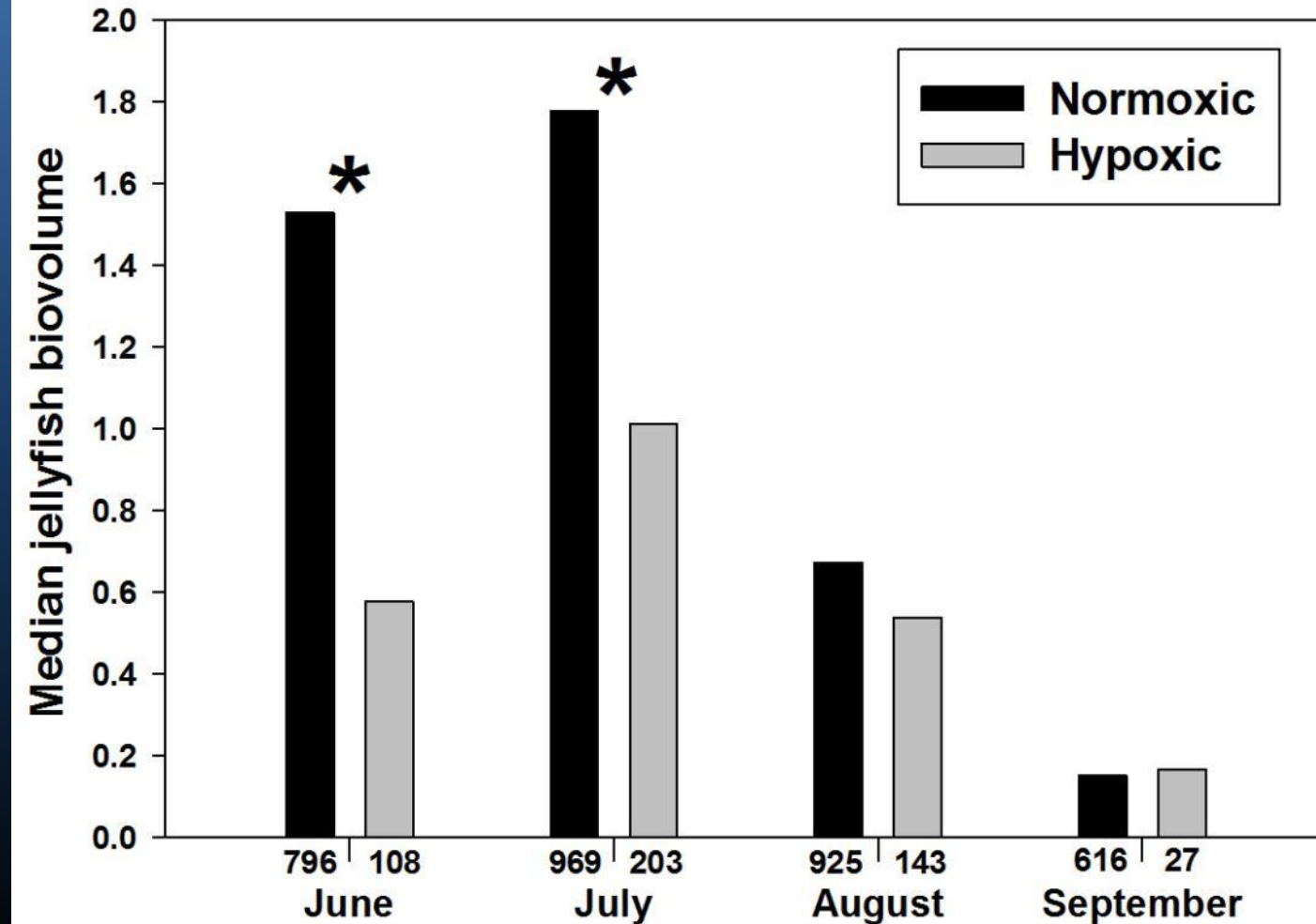
High

Low

0 12.5 25 50 Kilometers

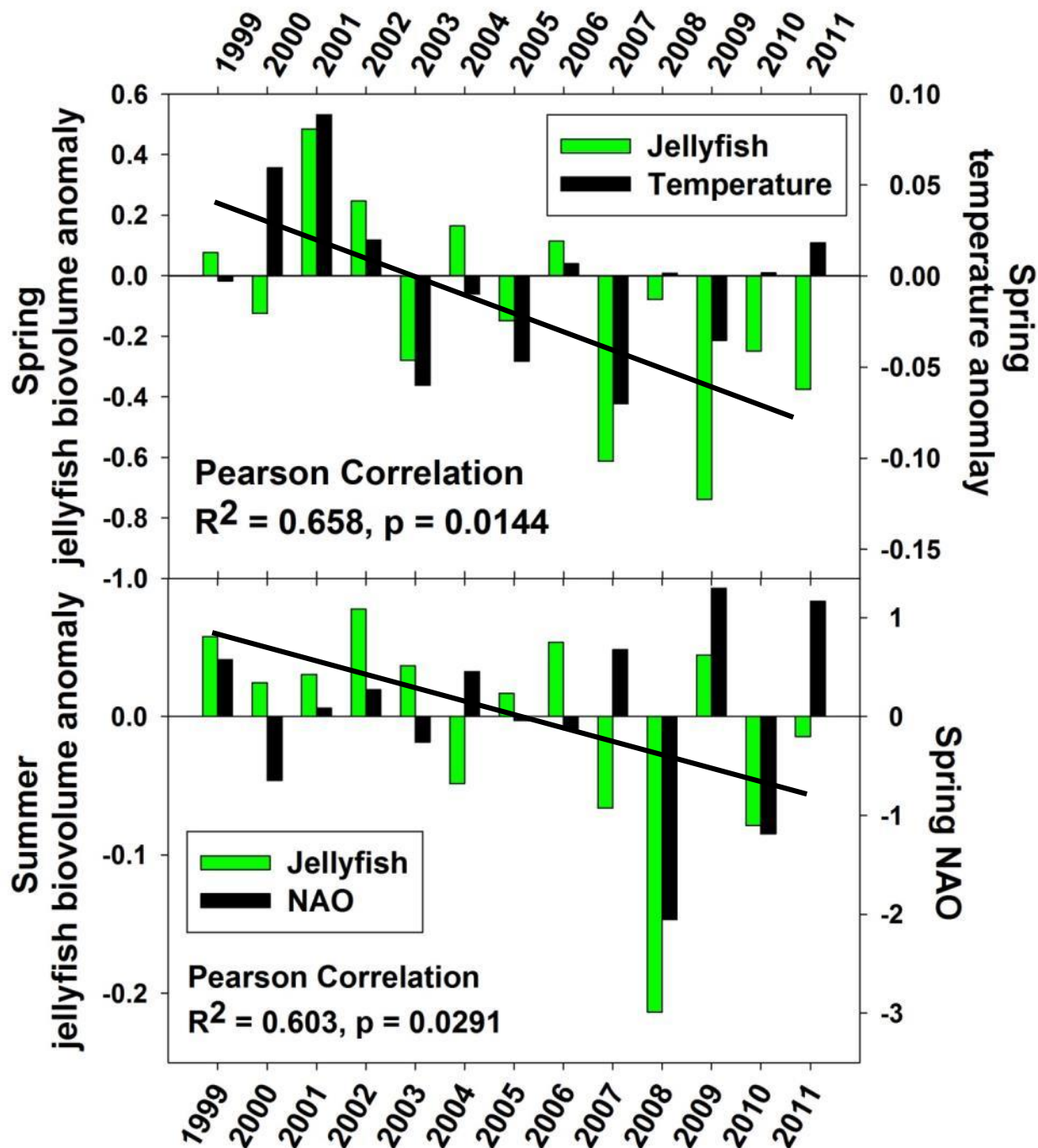


Effect of hypoxia on total jellyfish biovolume



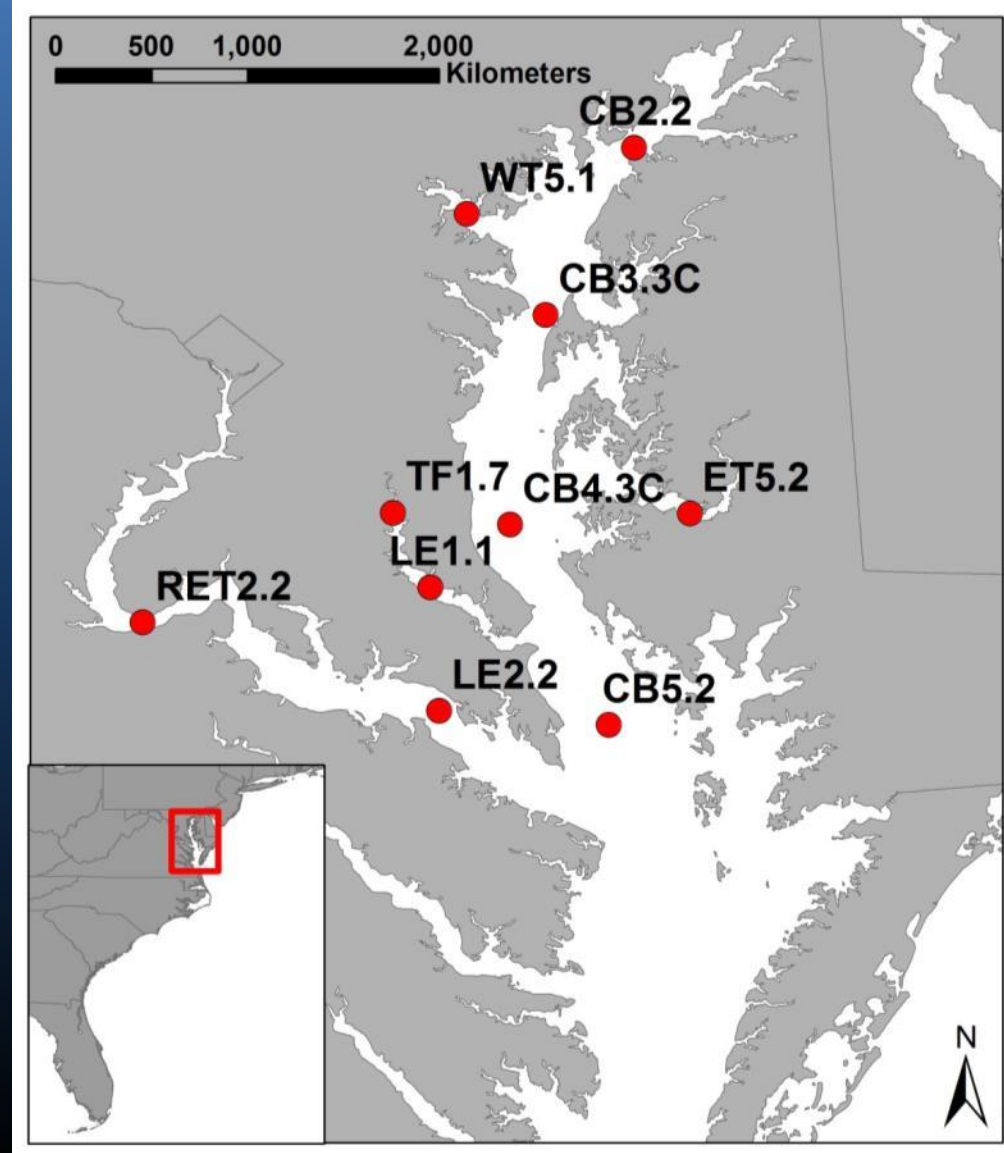
Biovolume Anomalies

- Jellyfish biovolume decreases
- Spring jellyfish anomaly correlated with spring temperatures
- Summer jellyfish anomalies not correlated with spring anomalies, but is with Spring NAO



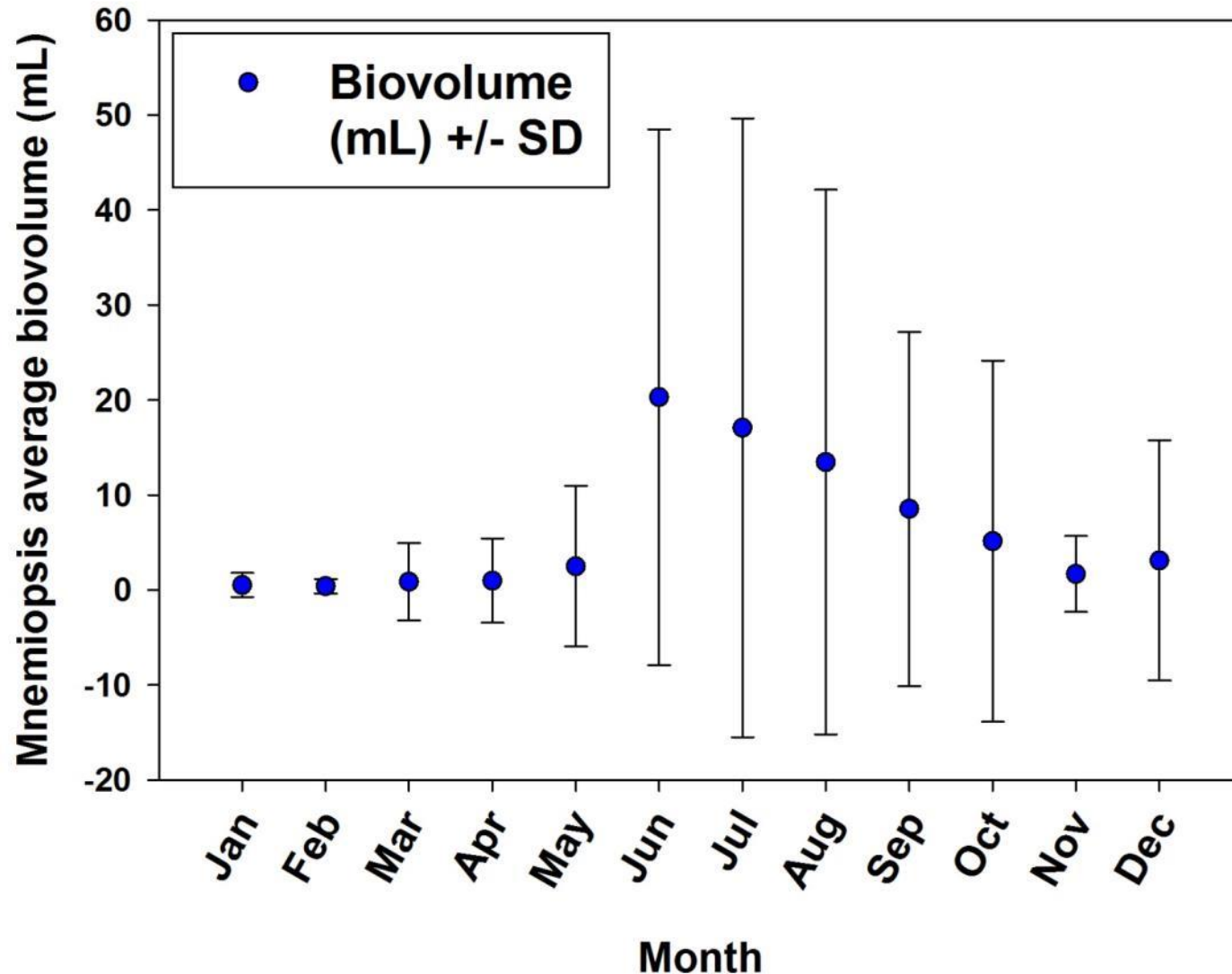
Chesapeake Bay Program – Zooplankton monitoring

- Monthly sampling
- Two stepped, oblique tows through the water column
- Paired bongo nets with 202 μm mesh
- Complete mesozooplankton identification and enumeration from 1984 - 2002
- *Mnemiopsis* and *Chrysaora* were biovolumed
- 1,810 total observations

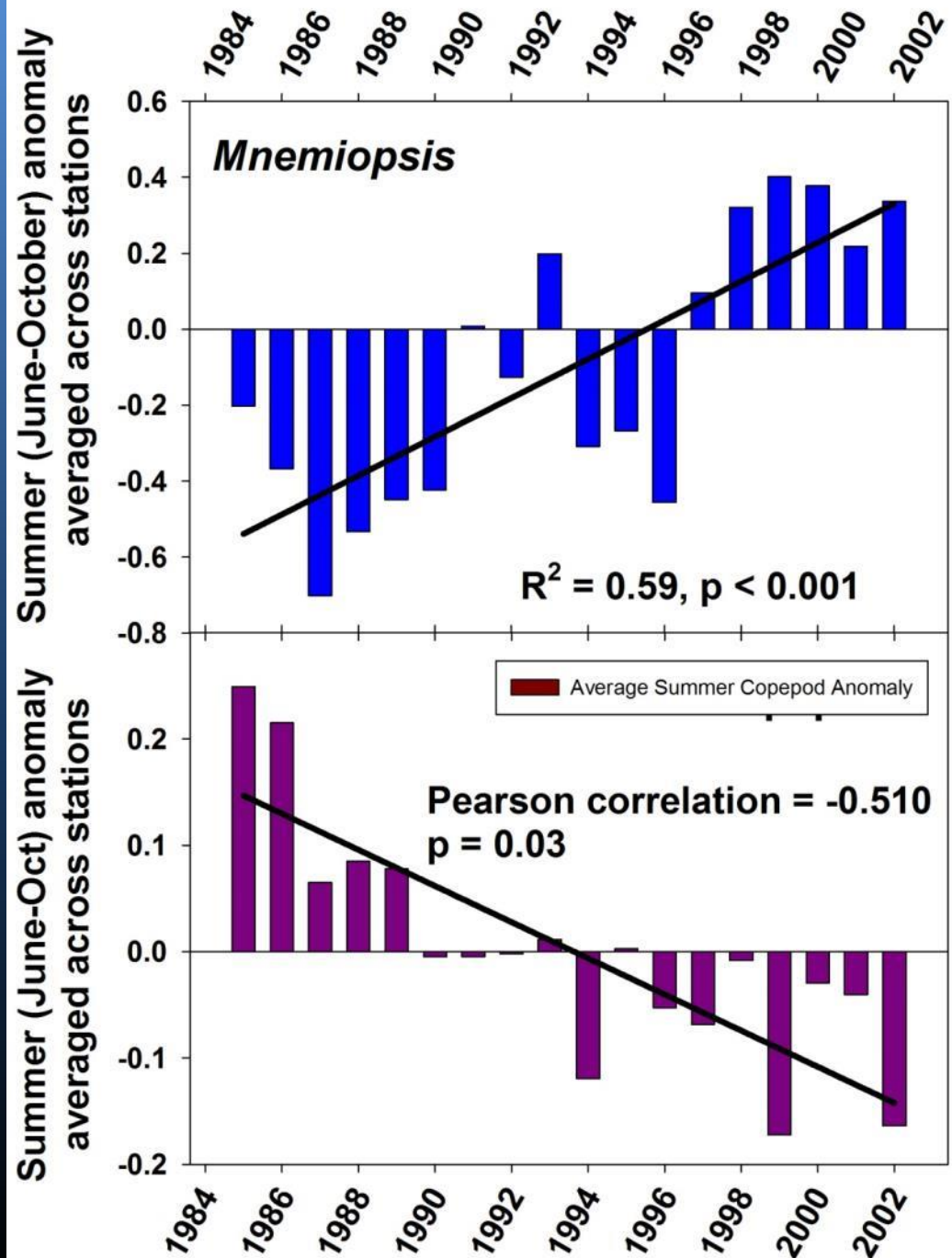


Mnemiopsis seasonality

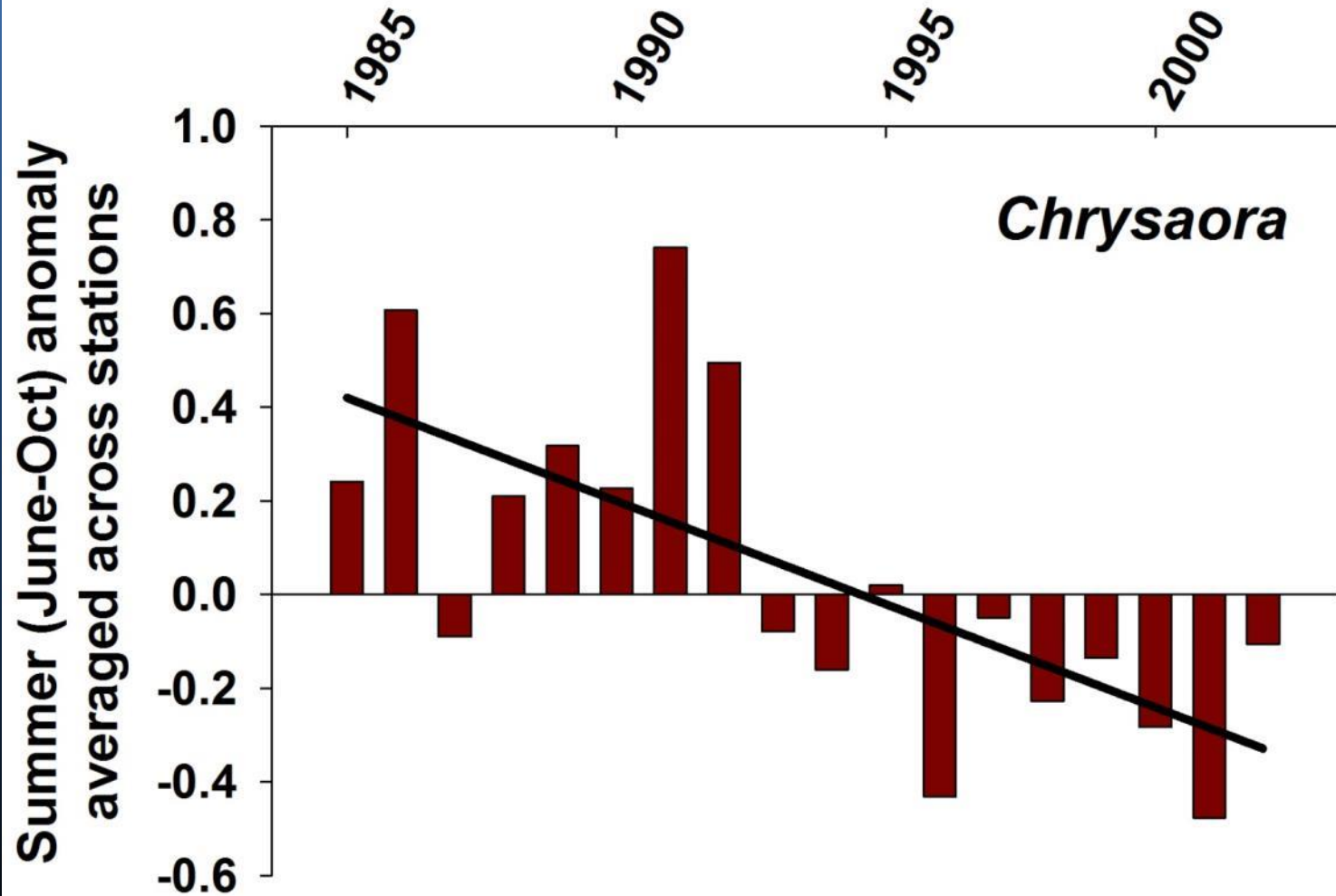
Mnemiopsis biovolume averaged across all stations and years



- Increase in *M. leidyi* biovolume not correlated with any change in environment
- Was significantly negatively correlated with copepod abundance

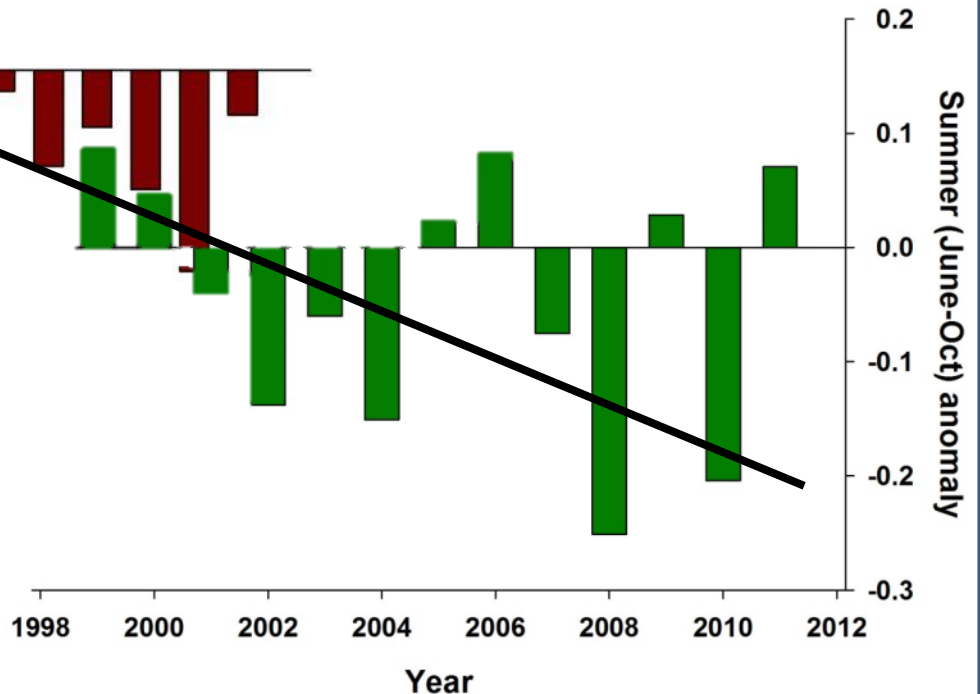
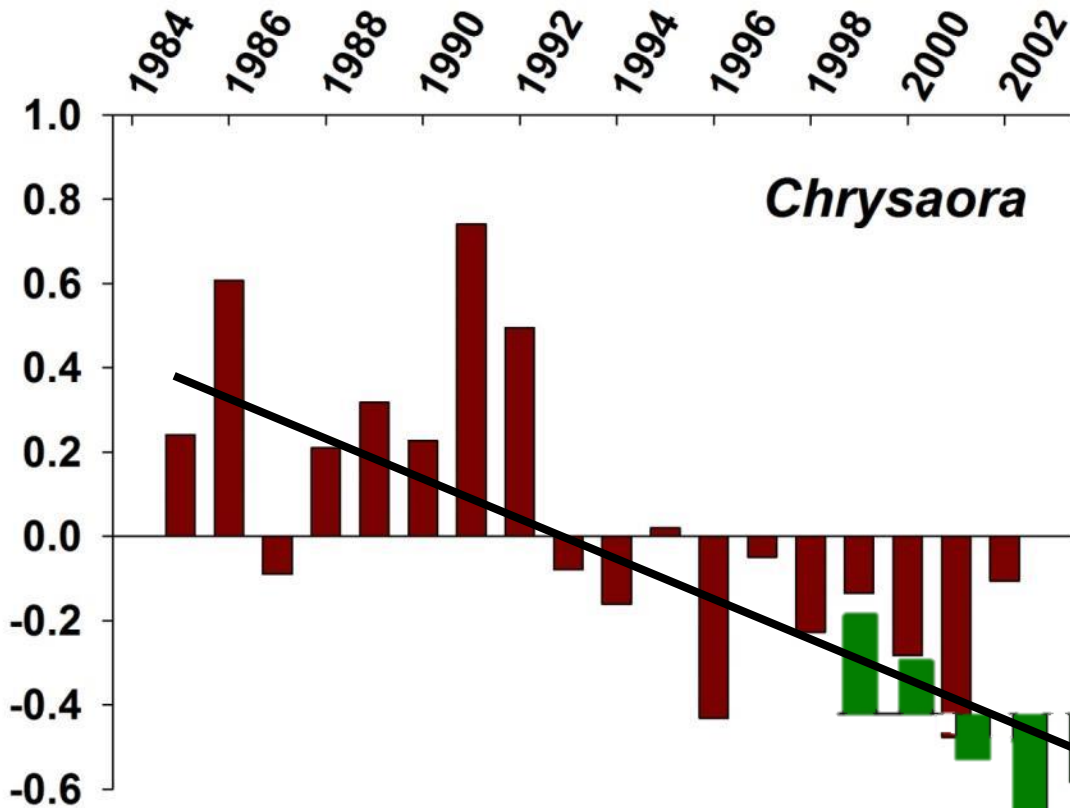


Chrysaora anomaly



Chesapeake Bay Program

Summer (June-Oct) anomaly averaged across stations



VIMS Trawl Survey

Summary

- *Chrysaora* habitat is controlled by temperature and salinity during the summer
 - Occupies a wider range than previously thought
- Hypoxia decreases overall jellyfish biovolume in late spring
- Increases in spring temperatures lead to increases in jellyfish biovolume in the spring but not summer
- Peak bloom is later and smaller over the time series
- *Mnemiopsis* increased from 1985 to 2002, and is negatively correlated with copepod abundance
- *Chrysaora* populations decreased from 1985 to 2011

Conclusions

- Increases in spring hypoxia may be contributing to the observed decrease in *Chrysaora*
- Future decreases would have cascading effects down the food web, with corresponding increases in *Mnemiopsis* and decreases in copepod abundance

Thank you

- Crew of the VIMS Juvenile Trawl Survey
- Chesapeake Bay Program
- PICES Student Travel Grant
- Virginia Sea Grant

