Science, Service, Stewardship

Seasonal Variation in Immunology of Long Island Sound Bivalve Species

April N. Croxton[1], Inke Sunila[2], Dylan Redman[1], and Gary H. Wikfors[1]

[1]Northeast Fisheries Science Center-Milford Laboratory

[2]Connecticut Department of Agriculture, Bureau of Aquaculture

NOAA FISHERIES SERVICE

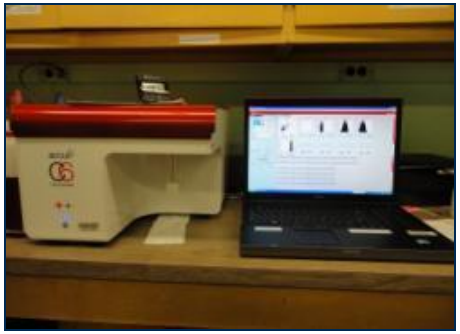
April 22, 2014

34th Milford Aquaculture Seminar

NOAA FISHERIES SERVICE

Overview

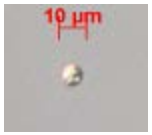
- **Background and Experimental Rationale**
  - Bivalve Immunology
  - Warming Trends
  - Seasonal Variation
- **Preliminary Study**
- **Results**
- **Discussion**
- **Future Work**



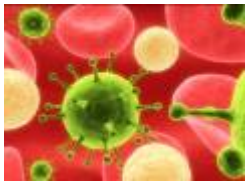
NOAA FISHERIES SERVICE

Bivalve Immunology

- Bivalve cellular immunity
  - open circulatory system
  - cell types (*granular and agranular*)
  - functions (*nutrition, waste disposal, defense*)

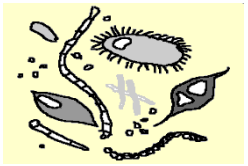


- Defense functions
  - adhesion
  - phagocytosis
  - ROS production



hemocyte

recognition



foreign particle

aggregation/adherence

ingestion

Intracellular digestion

- Environmental Factors
  - water quality (*temp, DO*)
  - pollutant stressors
  - food availability

H_2O_2 , O_2^-

Reactive oxygen species

NOAA FISHERIES SERVICE

Warming Trends

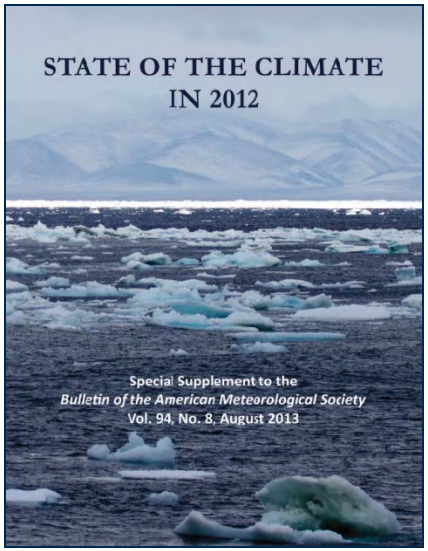
Warmer water temps:

Good news….for pathogens

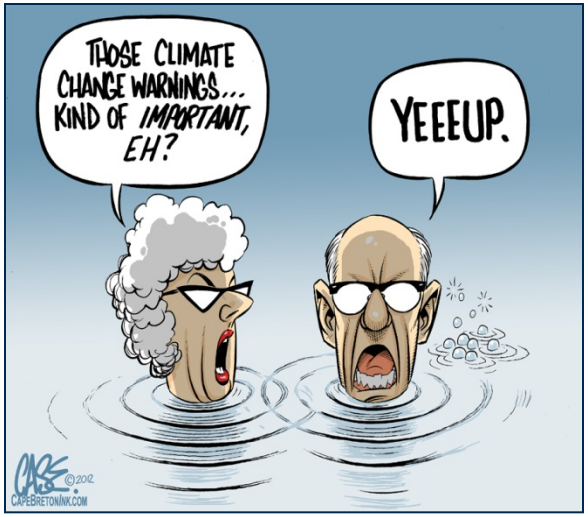
- *Fish Farming News, 2013 vol. 20, 4.*

Atlantic temps set record, may affect marine life

- New Haven Register, 9/20/12



2012 was one of the 10 warmest years on record globally



……and seasonal variation……

NOAA FISHERIES SERVICE

Seasonal Variability in Bivalve Species

Available online at www.sciencedirect.com
ScienceDirect
Aquaculture
Aquaculture 264 (2007) 73–81
www.elsevier.com/locate/aqua-online

Seasonal variations of immune parameters in diploid and triploid Pacific oysters, *Crassostrea gigas* (Thunberg)

Matthieu B. Duchemin [a,b,*], Michel Fournier [b], Michel Auffret [a]

- ***"…immune parameters varied between months…"***
- ***hemocyte subpopulations impacted by temperature***

Available online at www.sciencedirect.com
SCIENCE DIRECT
Aquaculture
Aquaculture 229 (2004) 401–418
www.elsevier.com/locate/aqua-online

Impact of season and rearing site on the physiological and immunological parameters of the Manila clam *Venerupis* (=*Tapes*, =*Ruditapes*) *philippinarum*

P. Soudant [a,*], C. Paillard [a], G. Choquet [a], C. Lambert [a], H.I. Reid [b], A. Marhic [a], L. Donaghy [a], T.H. Birkbeck [b]

Journal of Experimental Marine Biology and Ecology 377 (2009) 1–11
Contents lists available at ScienceDirect
Journal of Experimental Marine Biology and Ecology
journal homepage: www.elsevier.com/locate/jembe

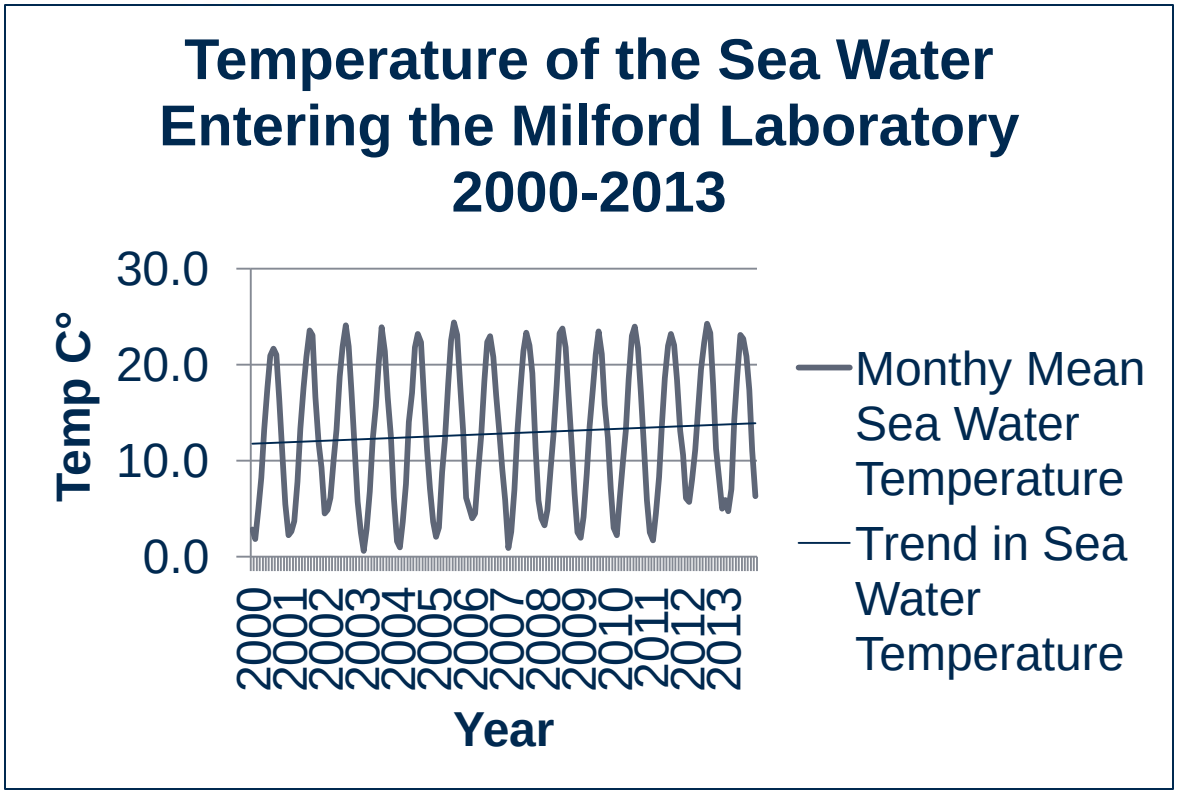
Variability of the hemocyte parameters of *Ruditapes philippinarum* in the field during an annual cycle

Jonathan Flye-Sainte-Marie, Philippe Soudant, Christophe Lambert, Nelly Le Goïc, Madeleine Goncalvez, Marie-Agnès Travers, Christine Paillard, Fred Jean *

Université Européenne de Bretagne, France
Université de Brest, CNRS (CNRS/INSU) UMR 6539 LEMAR, IUEM, Place N. Copernic, 29280 Plouzané, France

NOAA FISHERIES SERVICE

The Status of Long Island Sound Bivalves



***Monthly means were derived from daily temperature monitoring**

Annual Fall Survey

HOST-PARASITE BALANCE ??????

Parasites

PATHOGENS

Bivalve Species of Interest

“the usual suspects”

“ Aquaculture hand model”
Gef Flimlin

Northern quahog
Mercenaria mercenaria

Soft-shell clam
Mya arenaria

Blue mussel
Mytilus edulis

Bay scallop
Argopectin irradians

Eastern oyster
Crassostrea virginica

All species of commercial or *recreational importance in the Northeastern US*

NOAA FISHERIES SERVICE

Preliminary Seasonal Immune Competence Study in LIS Bivalve Species

Experimental Species

Bay scallops
Blue mussels
Eastern oysters
Northern quahog
Soft-shell clams

10-12 individuals

Immune Analyses

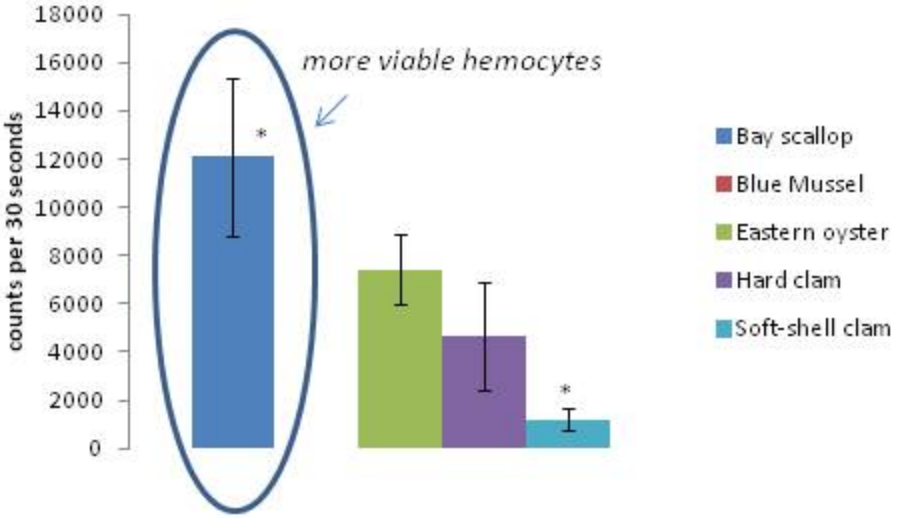
characterization
viability
adhesion
phagocytosis
ROS production
apoptosis

Sampling Frequency

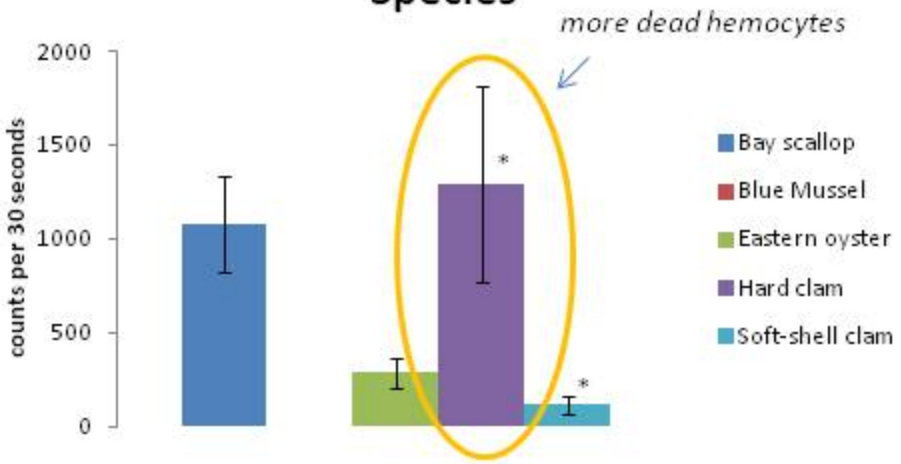
Late summer/Early Fall 2012
Winter 2013
Summer 2013

Late Summer/ Early Fall (August-September 2012)

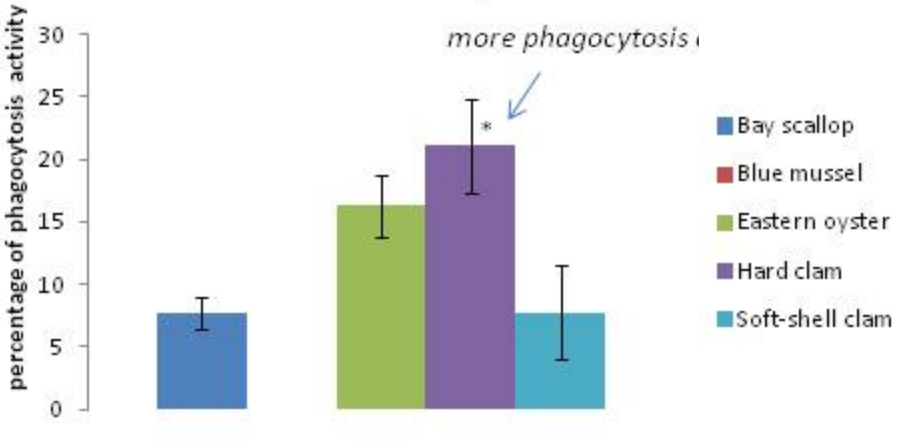
Total Hemocytes in Bivalve Species



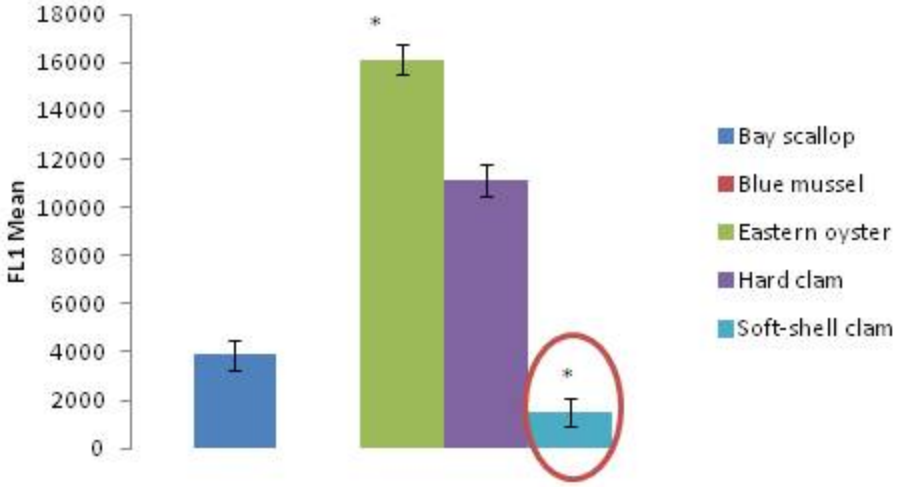
Total Dead Hemocytes in Bivalve Species



Phagocytosis Activity in Bivalve Hemocytes

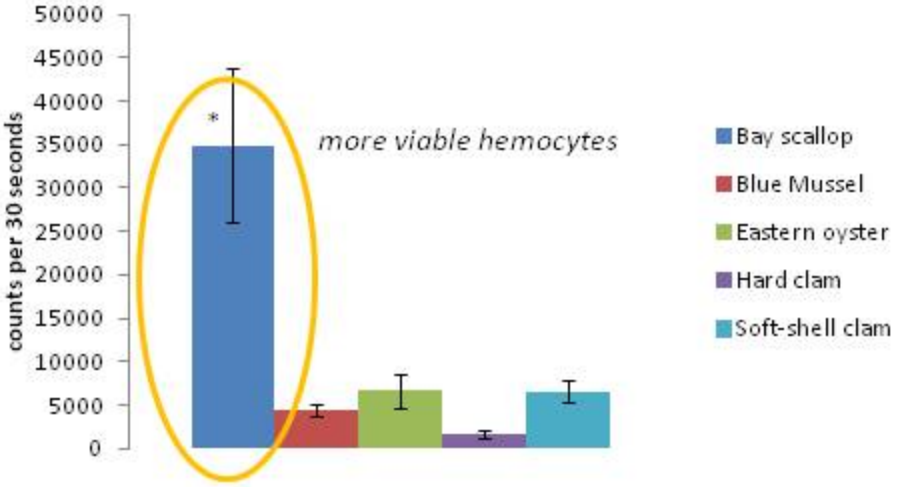


ROS Production in Bivalve Hemocytes

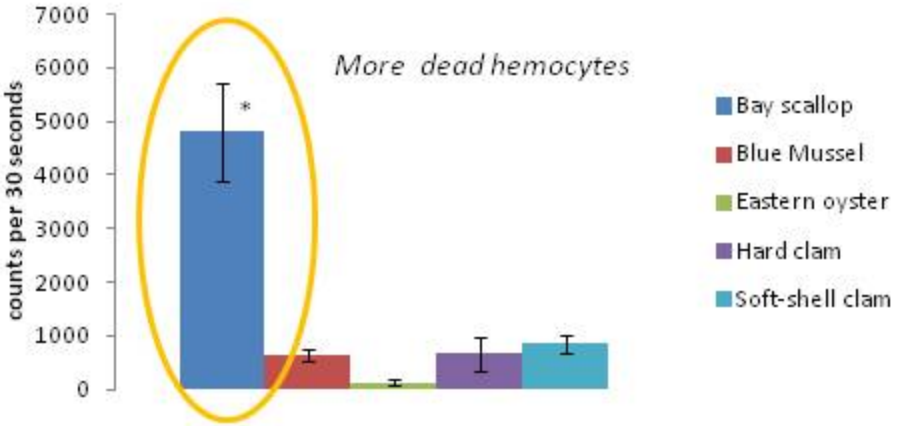


Winter
(January-February 2013)

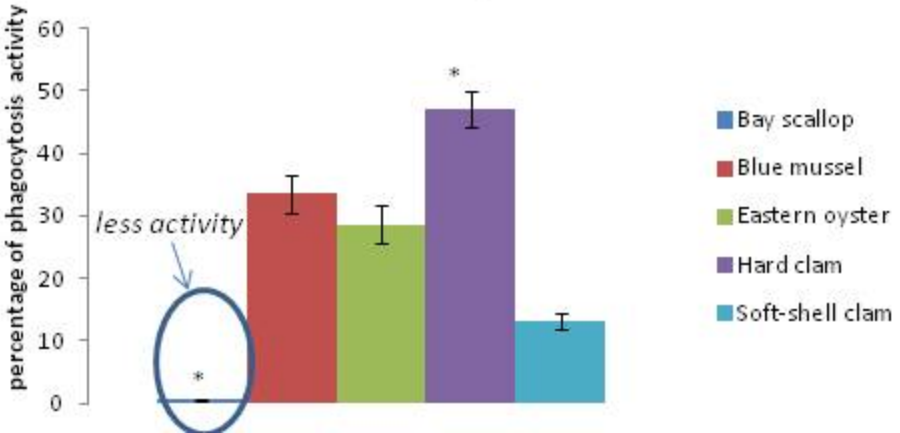
Total Hemocytes in Bivalves Species



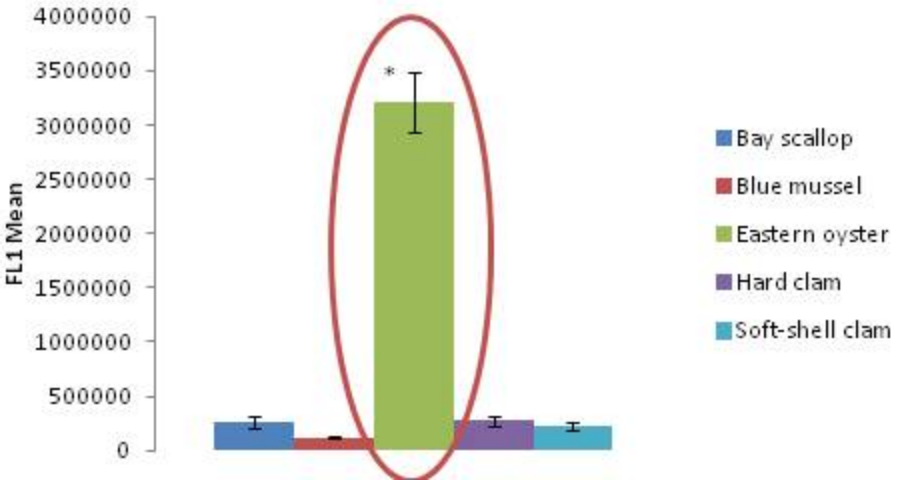
Total Dead Hemocytes in Bivalve Species



Phagocytosis Activity in Bivalve Hemocytes

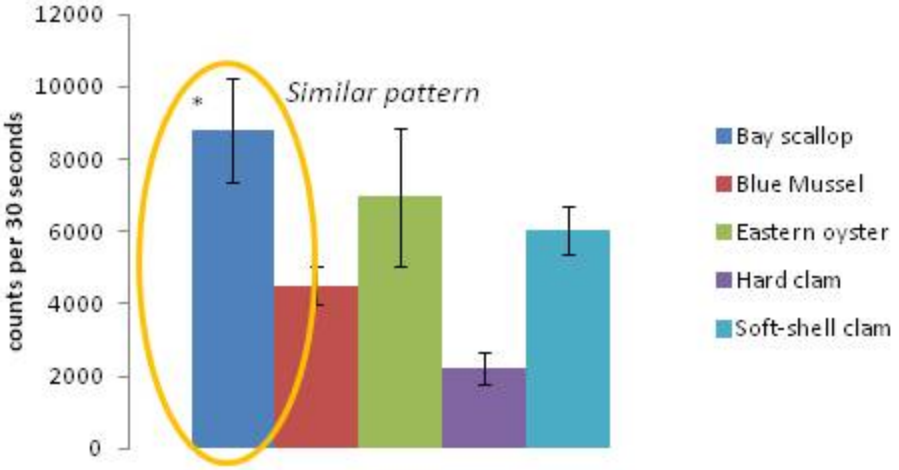


ROS Production in Bivalve Hemocytes

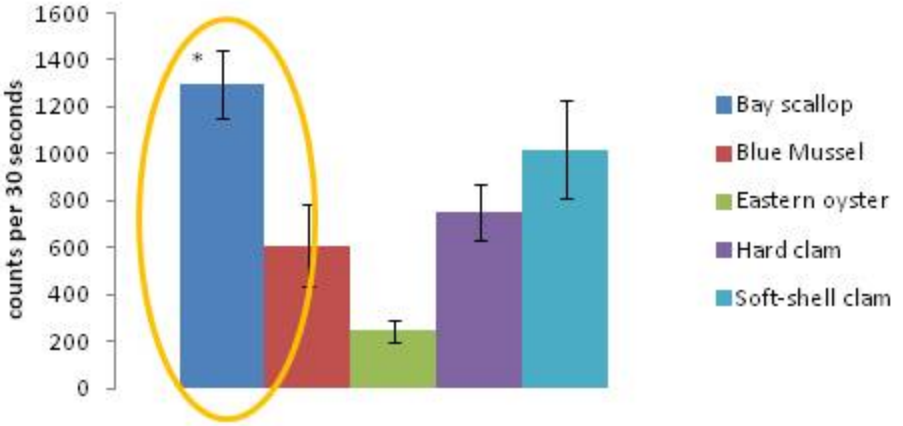


Summer
(July 2013)

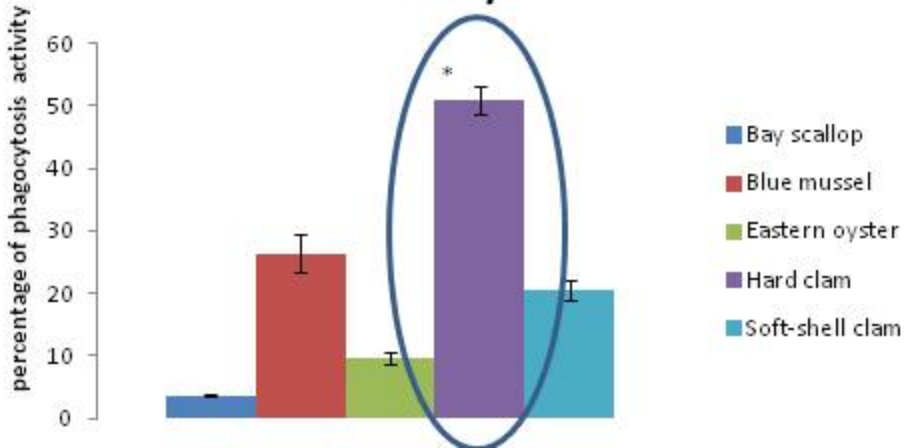
Total Hemocytes in Bivalve Species



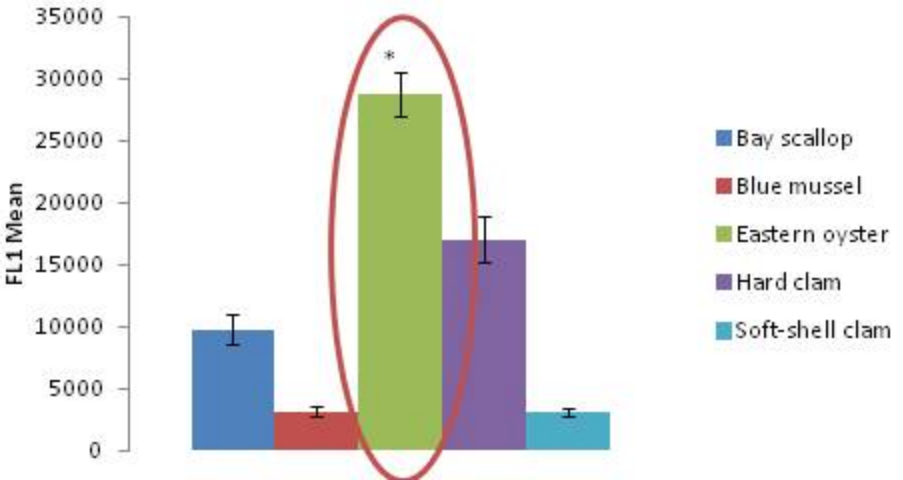
Total Dead Hemocytes in Bivalve Species



Phagocytosis Activity in Bivalve Hemocytes



ROS Production in Bivalve Hemocytes



NOAA FISHERIES SERVICE

Sampling Comparison

Species	Total Hemocytes	Total Dead Hemocytes	Phagocytosis Activity	ROS
Bay scallop	↑ Winter 2013	↑ Winter 2013	↓ Winter 2013	↑ Winter 2013
Blue Mussel *	ND	ND	ND	↑ Winter 2013
Eastern oyster	ND	ND	↑ Winter 2013	↑ Winter 2013
Hard clam	ND	ND	↓ LS/EF 2012	↑ Winter 2013
Soft-shell clam	↓ LS/EF 2012	↓ LS/EF 2012	↓ LS/EF 2012	↑ Winter 2013

NOAA FISHERIES SERVICE

Proposed Future Work

- **Goal*:*** A comprehensive seasonal study measuring immune and histopathology variables in LIS bivalve species
- **Anticipated outcomes*:*** clearer understanding of environmental variation, disease pressure, and immune competence

NOAA FISHERIES SERVICE

Acknowledgements

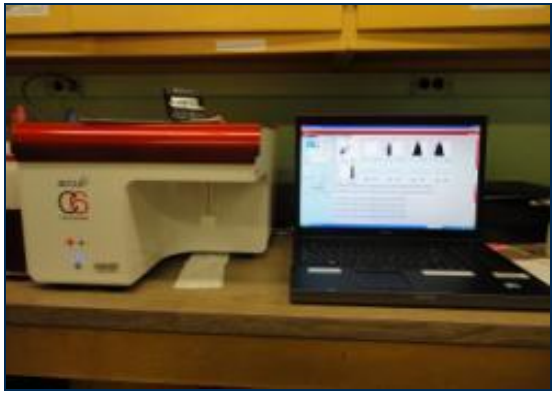
CT Department of Agriculture-Bureau of Aquaculture

Milford Lab Genetics Group

Walter Blogoslawski

NOAA Dive Program-Milford Lab

Robert Alix and Werner Schreiner



Spring is in the air!

NOAA FISHERIES SERVICE

Proposed Future Work

A comprehensive seasonal study measuring immune/histopathology parameters in LIS bivalve species

- 30 individuals shellfish per species (blue mussel, northern quahog, soft-shell clam, eastern oysters)
- measurement of hemocyte characterization and function (*total hemocyte count, mortality, adhesion, phagocytosis activity, ROS production, apoptosis*)
  - hemolymph extraction
  - fcm analysis (*fluorescent probes and beads*)
- histopathology
  - Dermo analysis in oysters
  - infectious agents in all species