Environmental Affects of Marine Shellfish Aquaculture On Benthic Fauna And Water Column Characteristics

Andrew Suhrbier, Daniel Cheney, Mary Middleton and Aimee Christy

Joth Davis

Robin Downey

John Richardson and Carter Newell

Mark Luckenbach

Tessa Getchis and Jamie Vaudrey

Dror Angel

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Why is this and related research important?

- A need to better understand the relationship between culture methods and the environment.
  - Direction to farmers to avoid overcrowding, reduced growth, increased mortalities, and affects on other aquatic species
- Heightened scrutiny by regulatory agencies and expanded permitting authorities.
  - ESA, EFH, Section 10, state and local shorelines permits, etc.
- Desire to expand shellfish farming into new, previously unused habitats.
  - Offshore and subtidal sites, slightly used intertidal lands
- Greater interest and involvement by public agencies.
  - Enhanced use of public lands, more revenues, with increased environmental analyses
- Increased public, NGO and media scrutiny.
  - Highly publicized and tending to polarize opinion

Overall Purpose and Approach

1. Characterize the effects of alternative shellfish culture methods on eelgrass
2. Compare benthic species and fish within and adjacent to shellfish culture and control sites
3. Measure sediment and water column conditions associated with culture method
4. Model carrying capacity, phytoplankton concentrations and sedimentation
5. Develop farming recommendations

Study site example -- Hood Canal

Shellfish Culture Habitats

- *Manila clams*
  - Net-protected
  - Bag-on-bottom
- *Oysters*
  - Bag-on-bottom
  - Rack-and-bag
  - Longline-and-bag
- *Geoducks*
  - With Predator Tubes
  - Without Predator Tubes

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- *Geoducks*
  - With Predator Tubes
  - Without Predator Tubes

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  - Longline-and-bag
- *Geoducks*
  - With Predator Tubes
  - Without Predator Tubes

Shellfish Culture Habitats

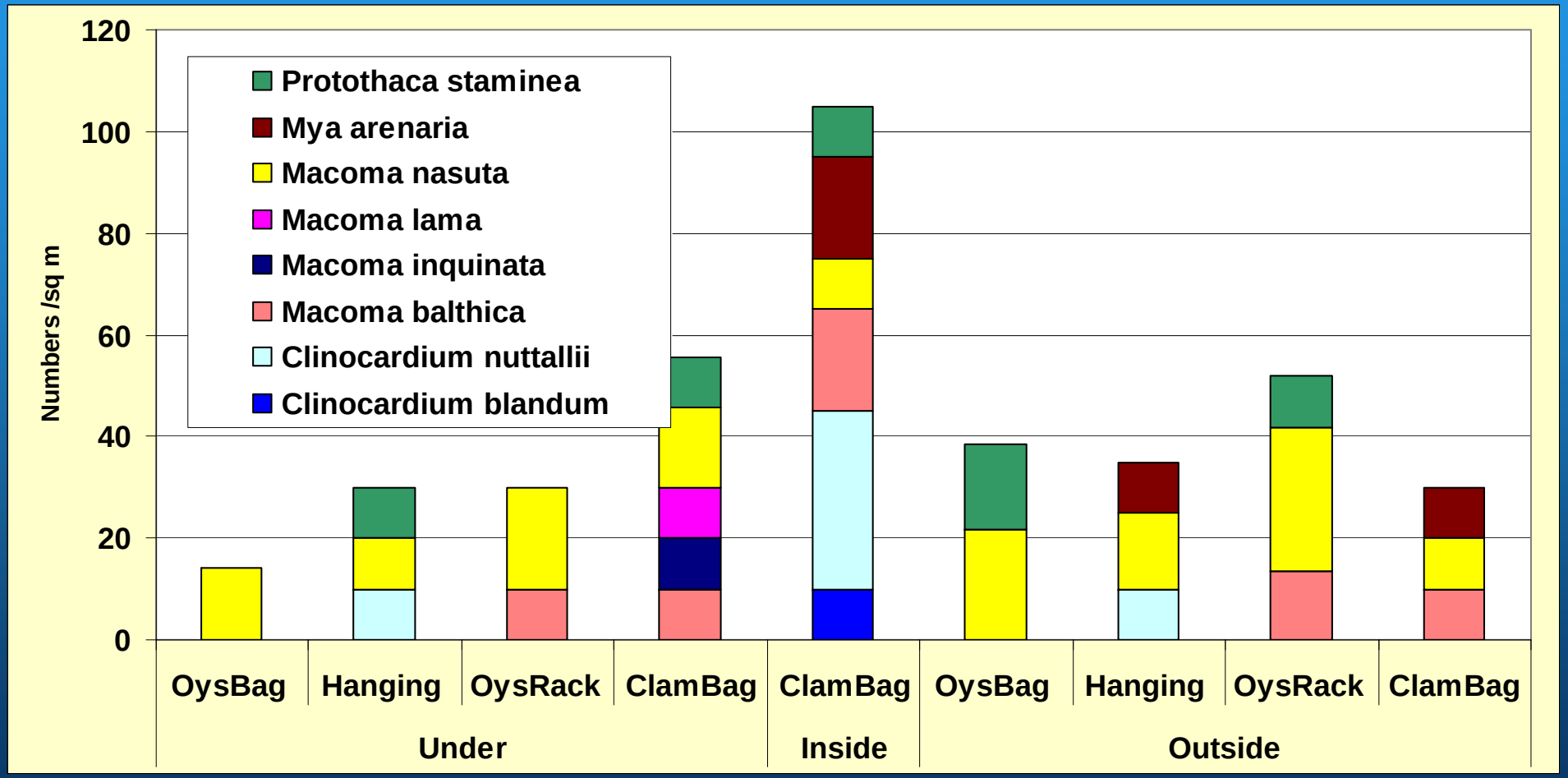
- *Manila clams*
  - Net-protected
  - Bag-on-bottom
- *Oysters*
  - Bag-on-bottom
  - Rack-and-bag
  - Longline-and-bag
- *Geoducks*
  - With Predator Tubes/Netting
  - Without Predator Tubes

Shellfish Culture Habitats

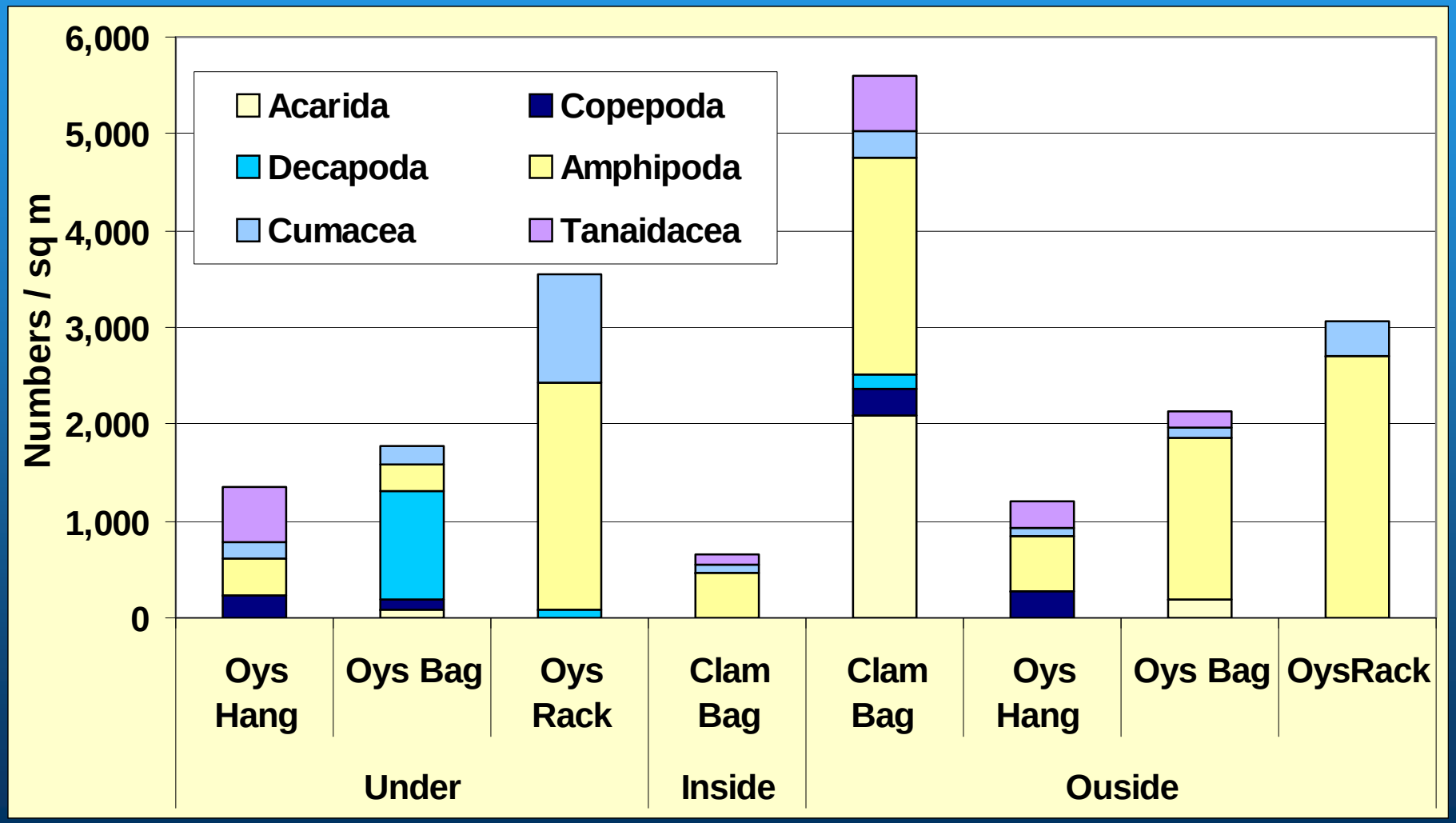
- *Manila clams*
  - Net-protected
  - Bag-on-bottom
- *Oysters*
  - Bag-on-bottom
  - Rack-and-bag
  - Longline-and-bag
- *Geoducks*
  - With Predator Tubes
  - Without Predator Tubes

Biological effects – habitat complexity

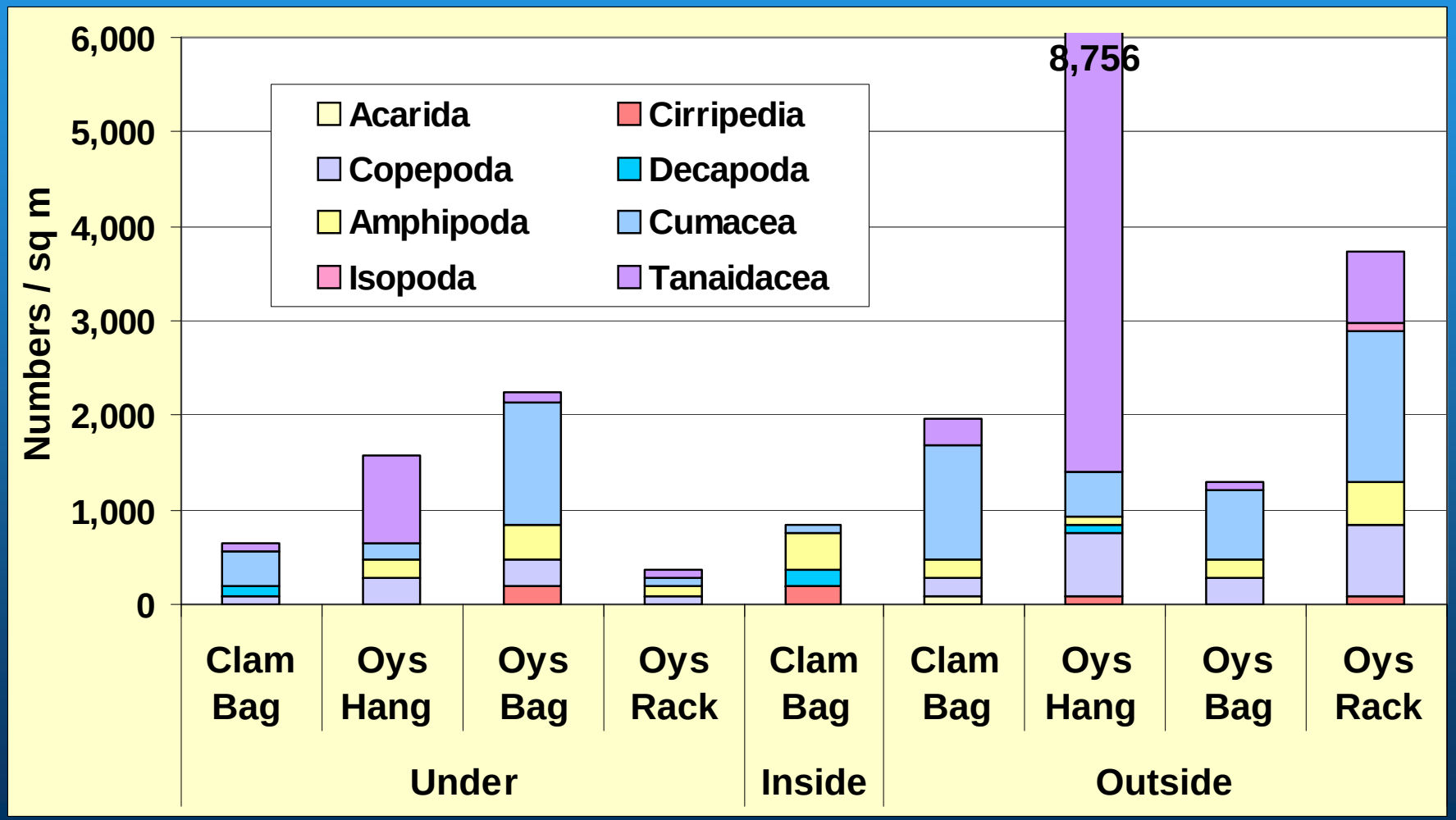
Bivalve recruitment, Hood Canal



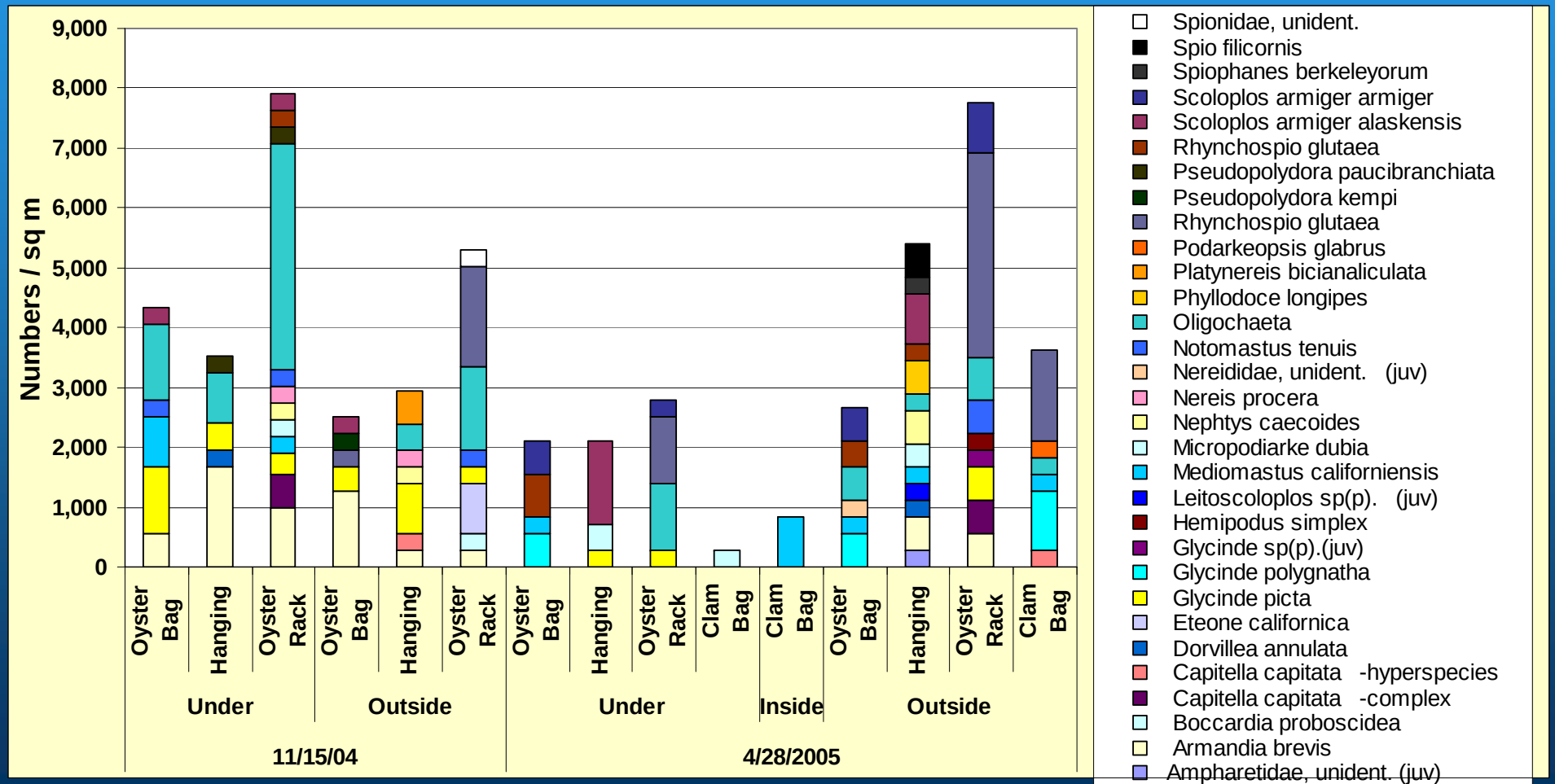
Small Crustaceans – 11/2004



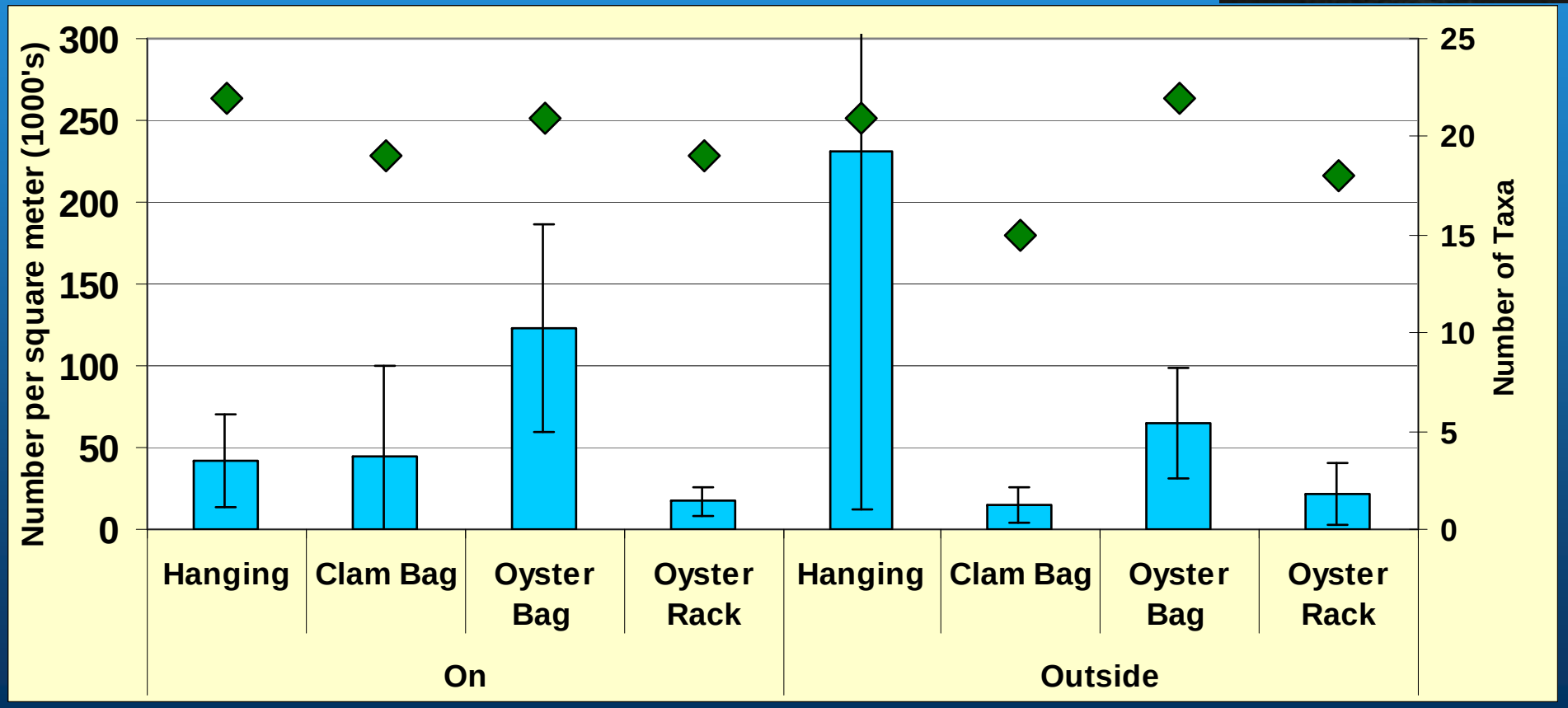
Small Crustaceans – 5/2005



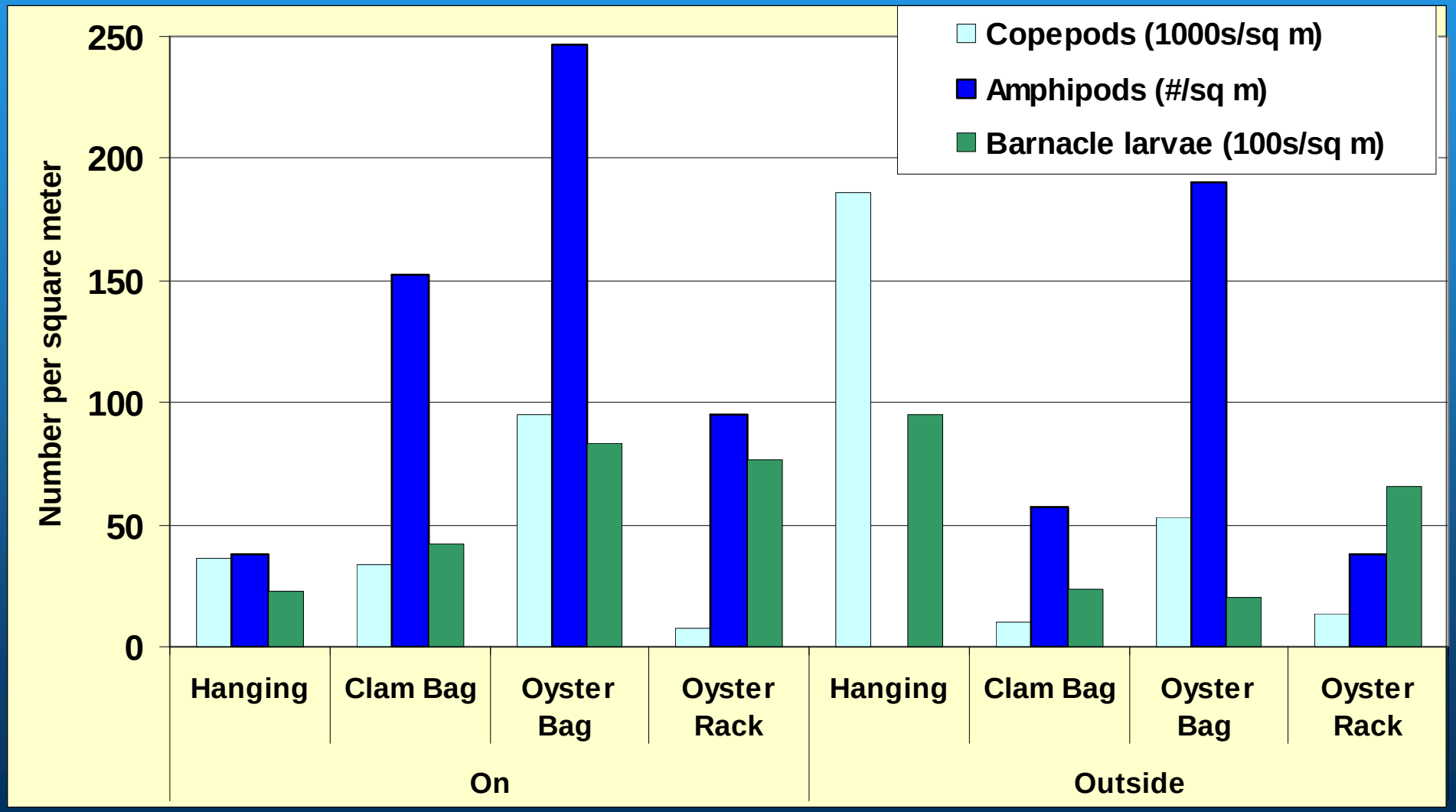
Annelid worms



Epibenthic results



Epibenthic results



Epibenthic animals, top 5

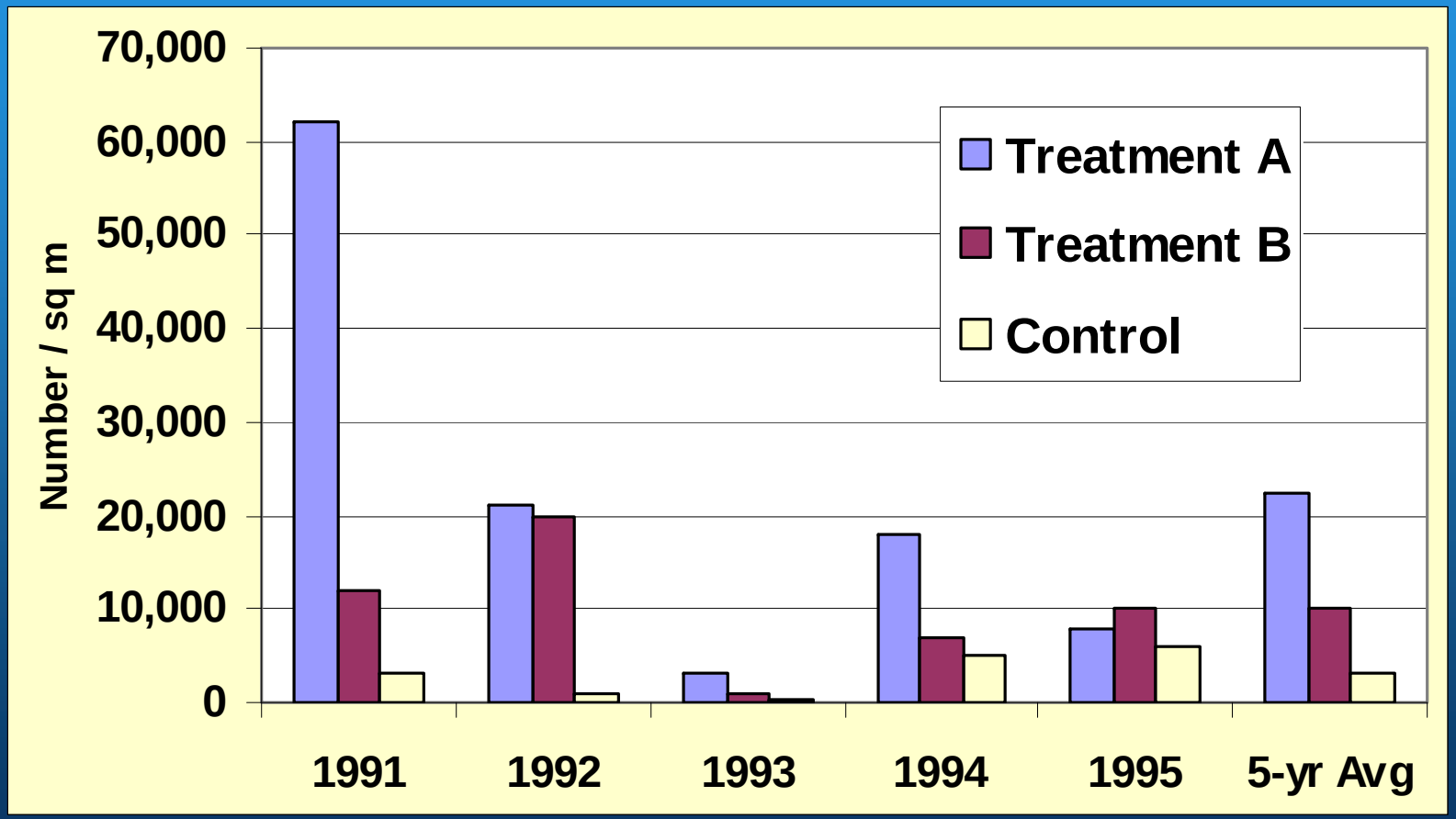
On the Culture Gear

Rank Order	Hanging	Clam Bag	Oyster Bag	Oyster Rack
1	Copepoda	Copepoda	Copepoda	Copepoda
2	Cirripedia	Cirripedia	Nematoda	Cirripedia
3	Nematoda	Nematoda	Cirripedia	Nematoda
4	Ostracoda	Ostracoda	Ostracoda	Ostracoda
5	Foraminifera	Cumacea	Polychaetes	Cumacea

Outside or Adjacent to the Culture Gear

Rank Order	Hanging	Clam Bag	Oyster Bag	Oyster Rack
1	Copepoda	Copepoda	Copepoda	Copepoda
2	Nematoda	Cirripedia	Nematoda	Cirripedia
3	Cirripedia	Nematoda	Cirripedia	Nematoda
4	Ostracoda	Ostracoda	Ostracoda	Cumacea
5	Foraminifera	Cumacea	Oligochaete	Ostracoda

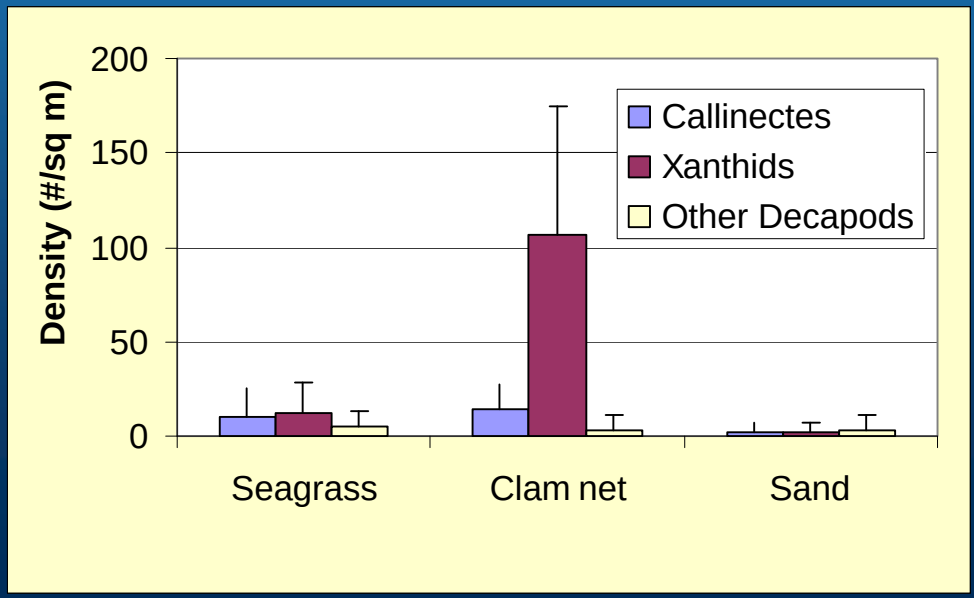
EBM epibenthic totals (rock vs sand/mud)



Biological effects, Chesapeake Bay

Macroalgae on clam nets
- Densities of *Callinectes* = to seagrass beds and > than adjacent sand habitat

Mean density of Xanthid crabs
- > those in the other habitats by more than an order of magnitude



Fish and large epifauna (Video)

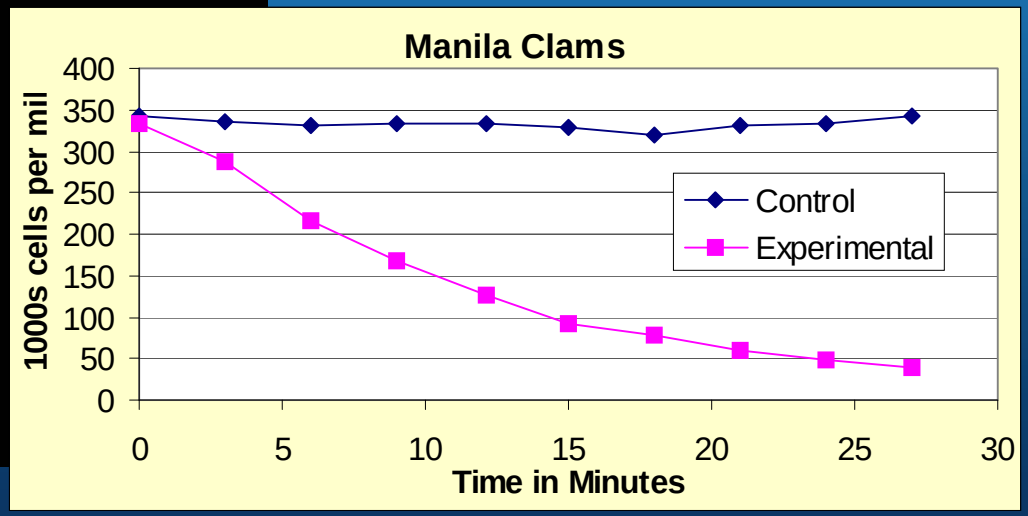
Example of video footage gathered: Clam Bag

Fish and large epifauna (Video)

Example of video footage gathered: Mixed habitats

Phytoplankton feeding – example video

Comparative feeding experiments in 7 liter containers with a starting concentration of ~330,000 cells per ml *Thalassosira* diatom (measured with Coulter counter).



Objectives: Year 2+ (new NOAA funding)

- Complete and expand the analyses and interpretation of data on habitat and community characteristics
- Examine the utilization and habitat responses of resident fish in EFH and ESA listed species in shellfish growout areas
- Further assess and model sediment and water column interactions
- Quantify seasonal patterns of nutrient uptake by macroalgae associated with commercial shellfish growout

Objectives: Year 2+ (new NOAA funding)

Collaborate with growers, researchers, and environmental managers to:

1) prepare relevant findings with an emphasis on the ecological interactions of the specific culture practice,

2) offer guidance for culture practices, and

2) prepare language appropriate for inclusion in the ECOP and regulatory/permitting documents

Thanks to NOAA and the team