Identifying linkages between zooplankton dynamics, fishery resources and climate change in the Northern Gulf of Mexico

NGI Plankton Group

NOAA/National Marine Fisheries Service
Joanne Lyczkowski-Shultz

USM/GCRL
Sara Lecroy
Harriet Perry
Guillermo Sanchez-Rubio

LSU
Malinda Sutor
Mark Benfield

DISL
Monty Graham
Frank Hernandez
• SEAMAP: an ongoing state-federal cooperative, fisheries-oceanographic, sampling program (29 yrs and counting)
• Generated a record of plankton assemblages in the form of preserved plankton samples from over 250 stations in GOM LME
• resulted in an extensive database on the early life stages of fishes but..............................
the invertebrate zooplankton fraction had been neglected...
Rectifying this situation

Zooplankton ecologist colleagues at USM/GCRL, DISL and LSU joined NOAA/NMFS researchers to initiate analyses of various invertebrate zooplankton components of SEAMAP plankton samples.

Our project brings together regional plankton and fisheries expertise along with new technologies and methodologies to expand the SEAMAP database to include information on invertebrate zooplankton.
Overall Project Goals

1. Establish digital record of SEAMAP samples
2. Improve taxonomic resolution of invertebrate zooplankton using new and traditional methodologies
3. Improve the SEAMAP plankton sampling program relative to invertebrate zooplankton
4. Identify relationships between larval fishes and their zooplankton predators and prey
5. Examine variability and changes in plankton composition as related to local, regional and global scale climatic events
6. Incorporate zooplankton data into SEAMAP database
Project Objectives: USM/GCRL/SIPAC and NMFS

1. Inventory SEAMAP samples lost to Katrina and those recovered at SEAMAP Invertebrate Archiving Center (SIPAC) at USM/GCRL

2. Verify and improve resolution of larval decapod crustacean identifications
SIPAC project goals are two-fold

1. Post-Katrina recovery and management of unsorted plankton and identified invertebrate samples:
   - 4900 unsorted plankton samples recovered (54%)
   - 3921 identified invertebrate samples recovered (55%); mostly decapods
   - 1404 invertebrate zooplankton samples received from NMFS Pascagoula (includes 387 portunid, 7 menippid, 285 penaeid and 130 sicyonid lots)
   - 649 unsorted plankton samples (1982-84) sent to LSU for scanning
2. Improvement in taxonomic resolution of portunid, menippid, penaeid and sicyonid larval IDs and transfer of identified reference material to LSU for scanning:

Poster:

Diversity and Distribution of Portunid Crab Megalopae from SEAMAP Plankton Samples – Preliminary Results.

Carley Knight (USM GCRL)
Sara E. LeCroy (USM GCRL), Chet F. Rakocinski (USM GCRL)
and Joanne Lyczkowski-Shultz (NOAA NMFS)

Identification of portunid megalopae undertaken first

Tentative key to genera created for portunid megalopae

Reference set of portunid megalopae established to provide to LSU team for creation of training sets for image recognition software development

Preliminary density and distribution data examined (MS thesis project)
Project Objectives: LSU (results and progress presented here)

5. Assemble an electronic image database of SEAMAP plankton samples using new imaging technologies to archive and analyze SEAMAP plankton samples

6. Assemble a reference series of invertebrate zooplankton specimens for development of zooplankton ‘classification’ software and the subsequent analysis of scanned images
Bottlenecks in Analysis:
Time series like SEAMAP produce a lot of samples...
Physical samples are fragile...

Gulf Coast Research Lab, 
SEAMAP sample repository 
Hurricane Katrina, 2005
Dramatic Events...

Deepwater Horizon, May 2010 M/V Bunny Bordelon
Digital methods allow us to create a record of a sample that can be shared and stored in multiple locations.
Example Zooscan Images
Advantages of Semi-automated Software

Error rates between humans and software are comparable in systems that classify objects in up to 30 categories.

Untrained taxonomists can operate the software and complete the majority of classifications.

The work can be checked by more experienced taxonomists and corrections and more difficult classifications can be made.

Analyses are completed faster and cheaper.

Quality control and assurance is easier to do.

LSU MILESTONES

Full analysis of 130 images:

2 samples split to 1/4 and 1/32

1 sample split to 1/4, 1/16, and 1/32

using both manual and semi-automated techniques to determine potential biases with SEAMAP samples

RESULT: Semi-automated results are not significantly different and are up to 20 times faster than manual analysis

Continue scanning and analyzing samples with new emphasis on samples that may be useful to understand potential impacts of DWH in addition to our other objectives
Project Objective: NMFS and ZSIOP

7. Undertake analysis of SEAMAP samples for zooplankton at ZSIOP* from select SEAMAP surveys to complete temporal and spatial survey coverage for decapod crustacean early life history stages

8. Replace lost samples at SIPAC with samples still in Poland

* Plankton Sorting and Identification Center Szczecin and Gdynia, Poland
Analysis of the invertebrate zooplankton component of SEAMAP plankton samples

Andrew Millett (NOAA/NMFS/IAP World Services),
Joanne Lyczkowski-Shultz (NOAA NMFS),
and Wanda Kalandyk (MIR/ZSIOP)

Calanoid copepods
Cyclopoid copepods
Harpacticoid copepods
Ostracods
Mysid shrimp
Cladocerans
Amphipods
Euphausiids (all life stages)
Isopods
Barnacles (all life stages)
Stomatopod larvae
Chaetognaths
Hydromedusae
Siphonophores (Calycophora)
Ctenophore larvae
Polychaetes (all life stages)
Pteropods
Heteropods
Gastropod larvae
Bivalve larvae
Cephalopods
Salps
Doliolids
Larvaceans
Lophophores
Echinoderms (all life stages)
Other zooplankton

Decapod Crustacean Larvae
Phyllosoma
Penaeid postlarvae
Portunidae megalopae
Sicyoniidae postlarvae
Menippe megalopae
Geryonidae megalopae
Penaeidae larvae
Portunidae zoeae
Sicyoniidae larvae
Geryonidae zoeae
Menippe zoeae
Sergestidae
Lucifer spp.
Solenoceridae
Misc. Decapods
Other Decapods
Project Objective: DISL and NMFS

8. Undertake analyses of zooplankton and fish eggs in CUFES (continuous underway fish egg sampler) samples taken during recent SEAMAP Gulfwide plankton surveys; and evaluate results of these collections

Integration of new (to SEAMAP) methodologies for underway zooplankton sampling
Poster:

Using Zooplankton Community Distribution to Identify Large Marine Ecosystem Sub-Units within the Northern Gulf of Mexico

WM Graham¹, FJ Hernandez¹, Jr, AF Millett², L Carassou¹, G Zapfe², KL Robinson¹,³, MA Bogeberg¹, A Hunter¹, J Lyczkowski-Shultz⁴

¹Dauphin Island Sea Lab, Dauphin Island, Alabama ²NOAA NMFS IAP World Services, Pascagoula, Mississippi ³University of South Alabama Department of Marine Sciences, Mobile, Alabama ⁴NOAA/NMFS/SEFCS Mississippi Laboratories, Pascagoula, Mississippi.

Hierarchical cluster and correspondence analyses enabled the grouping of zooplankton taxa into three aggregates. These aggregates reflected similar trophic relationships and corresponded to the sub-units defined by other parameters.
Project Objective: DISL and NMFS

9. Establish observational and sampling protocols for gelatinous zooplankton collection during SEAMAP surveys; implement these and evaluate results of data collected during surveys in 2009-2010
Expanding data collection for gelatinous zooplankton during SEAMAP plankton surveys

Andrew Millett (NOAA NMFS IAP World Services), William M. Graham (DISL), and Glenn A. Zapfe (NOAA NMFS)

Jellyfish sampling protocols were implemented in 2009 and have been conducted on the following SEAMAP Plankton Surveys:

- Winter 2009: 4 Feb – 16 Mar
- Spring 2009: 29 Mar – 1 Jun
- Fall 2009: 25 Aug – 30 Sept
- Spring 2010: 3 Apr – 23 May
- Fall 2010: 24 Aug – 30 Sept

Jellyfish collected during bongo, neuston, or MOCNESS plankton tows are removed from samples for identification, counts and measurement.
Project Objective: USM/GCRL/CFRD, DISL, LSU and NMFS

10. Identify sources, assemble and summarize relevant environmental and climate data; and undertake analytical steps to identify linkages between abundance of fish larvae, zooplankton composition and abundance, and climatic and physical factors in the northern Gulf of Mexico.
Atlantic Multidecadal Oscillation (AMO), North Atlantic Oscillation (NAO), and El Nino Southern Oscillation (ENSO) have been found to influence the climatology of the northern GOM during the winter months.

- In 1982, the combination of AMO cold, NAO positive, and ENSO warm phases produced wet winter conditions.
- In 1999, the opposite phases of these modes of variability produced dry winter conditions.

More focused comparisons and analysis of biological responses to the shift in climate-related hydrological regimes are forthcoming.
Any questions?