Oil, Floods, and Hypoxia: Zooplankton dynamics in the Northern Gulf of Mexico 2003-2011

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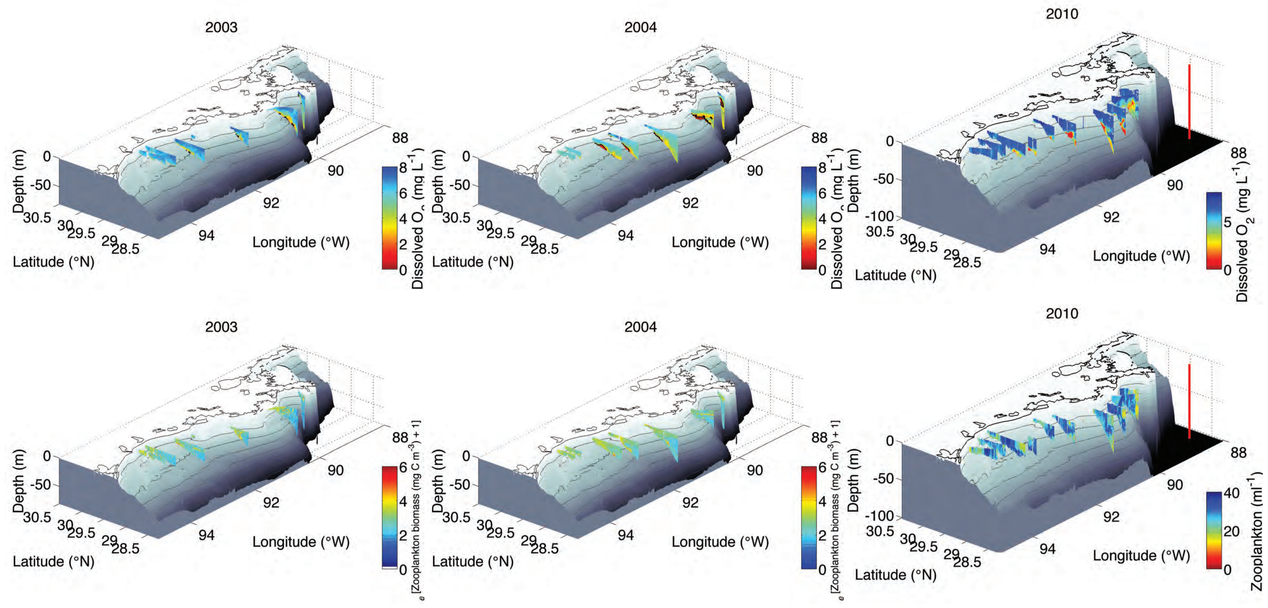
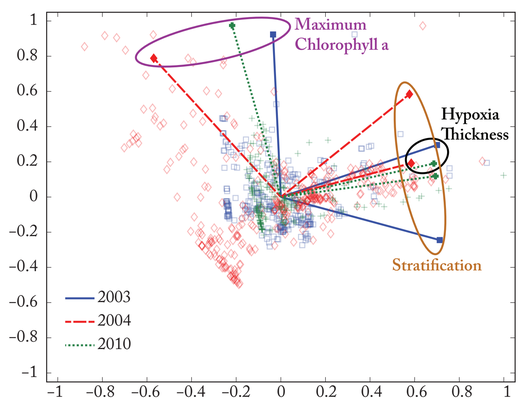
The recent unprecedented events in the Gulf of Mexico, the MC252 oil spill in 2010 and record flooding of the Mississippi River in 2011, likely had far reaching impacts on many aspects of the northern Gulf of Mexico (NGOMEX) pelagic ecosystem.

We are using an 8 year data set of physics and plankton to explore patterns in the data related to environmental conditions, in an effort to develop predictive and diagnostic models of plankton food web response to changing conditions in the region.

Upper Left: The Scanfish being set up on the dock before the 2010 cruise. This instrument is towed beside the ship at 5 knots and collects data with a CTD and a suite of sensors. The instrument on top is the optical plankton counter (OPC) which measures light attenuation by particles between approximately 0.2-5 mm (equivalent spherical diameter, ESD) to estimate zooplankton abundance and size.
Upper Right: Deploying the CTD from the starboard rail of the RV Pelican.
Lower Left: The CTD on deck with 20 L Niskin bottles. These bottles were used to collect plankton from various depths throughout the Northern Gulf of Mexico. The bottles were drained onto 64 µm seives and the samples preserved in formaldehyde.
Lower Right: Towing the Scanfish past an oil platform in the Gulf of Mexico.

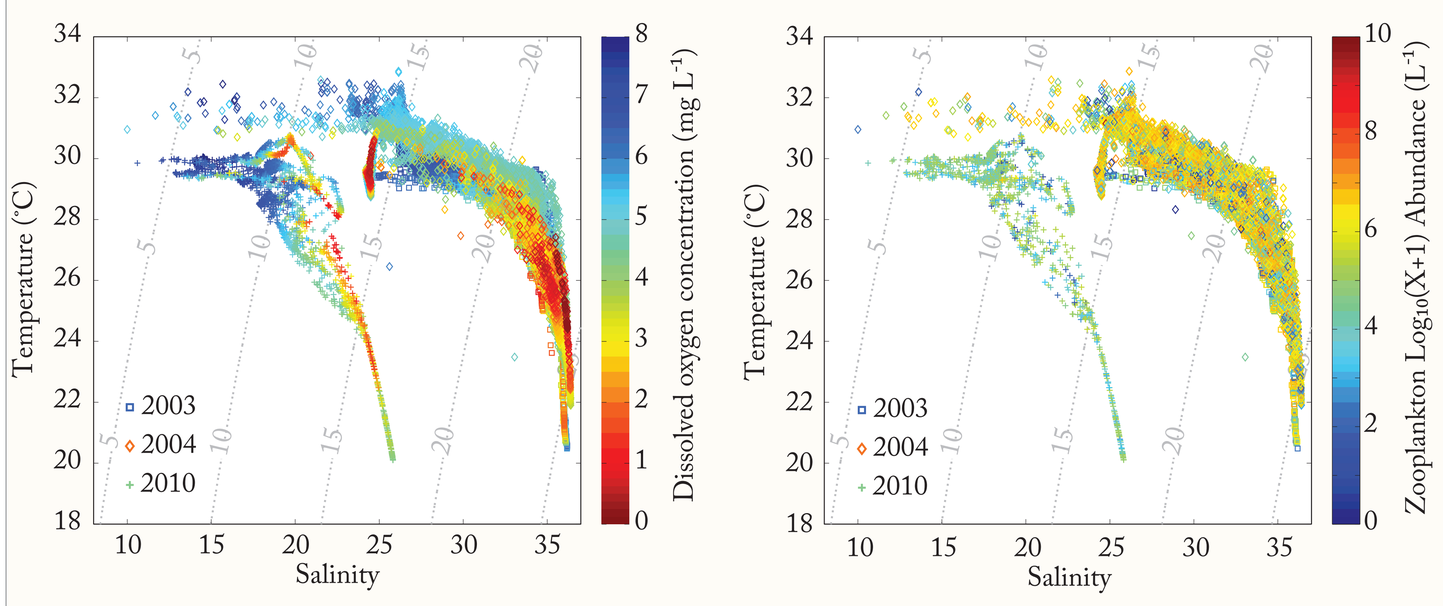
We compared high resolution hydrographic and plankton data from 2003 and 2004 to identically collected 2010 data to determine if there were observable differences.



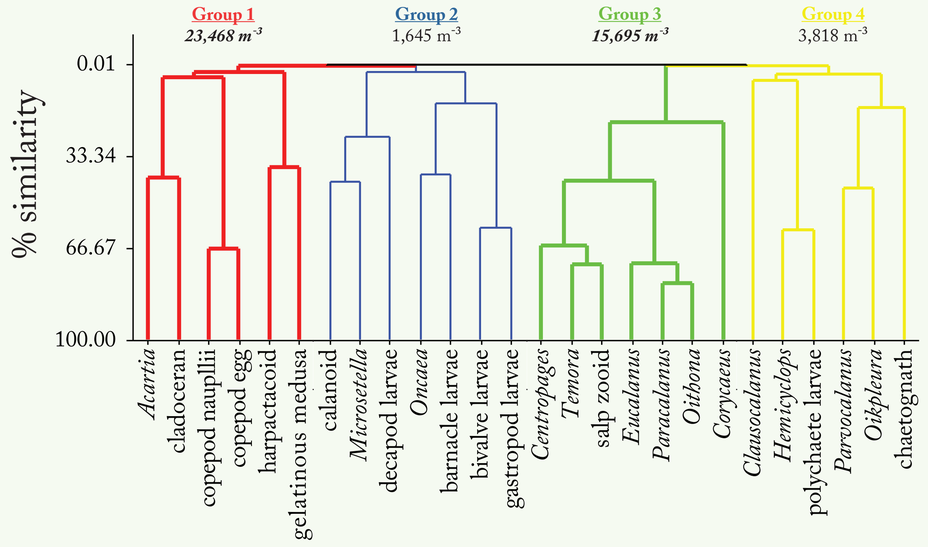


Principle component analysis (PCA) of the Scanfish hydrographic transects, averaged in 1 km horizontal bins

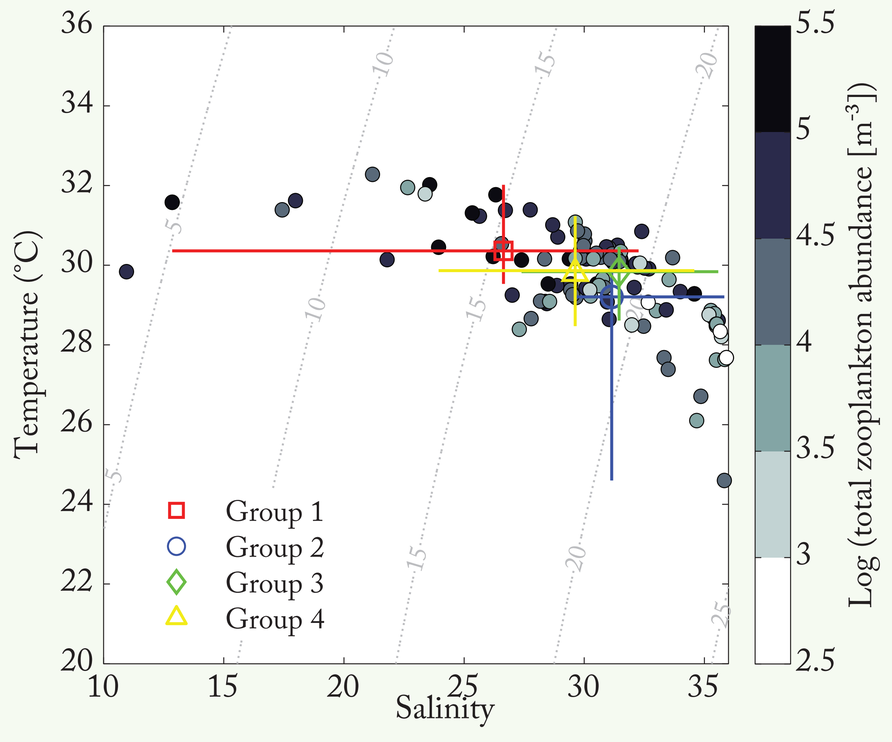
- Stratification and hypoxia thickness are strongly correlated for all years
- Maximum chlorophyll a concentration in each horizontal bin is not strongly correlated to either hypoxia thickness or stratification



Temperature and salinity plots of all Scanfish data from 2003 (squares), 2004 (diamonds), and 2010 (crosses). Colors show the dissolved oxygen (DO, left) and zooplankton (right) concentrations at each temperature and salinity value. Note how much fresher the water in the Northern Gulf of Mexico was in 2010 compared to 2003 and 2004. Data from 2011 is not yet available. Lowest DO concentration is generally at the highest salinity and lowest temperatures. However, there are patches of lower salinity and higher temperature water that also have low DO. Zooplankton abundandances are more variable, however lower abundances are generally found in lower DO, whereas highest abundances are found near DO transition zones.



Cluster analysis of zooplankton samples from 2003-4, 2006-8 showed four distinct groups of taxa with two groups, 1 and 3, representing most of the biomass. Dendrogram shown above shows the taxa from each cluster, and values above each cluster show the average abundance of all taxa in each cluster from all stations
Group 1 was found in lower salinity and water water than group 3 (see figure below), using results from canonical correspondance analysis (CCA).
Cluster analysis and CCA results are from Elliott et al. (accepted *Journal of Plankton Research*)



Conclusions

- In 2003-4 and 2006-8, temperature and salinity were the strongest predictors of zooplankton species composition (Elliott et al. accepted: *Journal of Plankton Research*).
- Salinity was substantially lower in 2010 than in 2003 and 2004, 2011 data is not yet available.
- This coincided with lower zooplankton abundance in 2010 than in the other years.
- Temperature and salinity were strongly negatively correlated for both years, as were minimum DO and maximum chlorophyll a concentration.
- It is likely that salinity and temperature are the dominant factors structuring zooplankton populations in summer in the Dead Zone, as shown for cluster and canonical correspondance analysis for 2003-4 & 2006-8 data.
- ***More mechanistic research on food web and ecological impacts of changing salinity, temperature, and DO are suggested to better forecast changing plankton communities.***

Access to the Scanfish, CTD, and shipboard along track data is avaiable at: http://tiny.cc/ngomexdata
Or if you have a smartphone with a QR code reader, point it at the code at right.
Special thanks to the group at BCO-DMO in helping make the data available, especially Steve Gegg.
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