USF UNIVERSITY OF SOUTH FLORIDA
COLLEGE OF MARINE SCIENCE

Postdoctoral Fellow & Research Staff Summer Colloquium

18 June 2010

9:00 AM – 2:45 PM

Marine Science Lab Conference Room

The University of South Florida College of Marine Science Postdoctoral Association welcomes you to the first colloquium featuring the research of our postdoctoral fellows and research staff.

We wish to highlight the kind of research the postdoctoral fellows and researchers are doing here, as well as welcome the opportunity for collaborative research associations with our local partners.

Food provided by:

USF
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COLLEGE OF MARINE SCIENCE

Thanks to Linda Kelbaugh and Ian Dow for assistance!

Colloquium Schedule

9:00-9:15 Welcome and Introduction

PHYSICAL OCEANOGRAPHY

9:15-9:35 *Vembu Subramanian*, Jeff Donovan**: COMPS Data Management: Technology approach towards interoperability**

9:35-9:55 *Yonggang Liu*, Robert H. Weisberg, Lianyuan Zheng, Chuanmin Hu: **Tracking/predicting the oil spill trajectory in the Gulf of Mexico with ocean circulation models and satellite imagery**

9:55-10:15 *Steve D. Meyers*, Amanda Linville, and Mark E. Luther: **Circulation Changes in Tampa Bay due to Large-scale Human Engineering**

10:15-10:30 Coffee Break

CHEMICAL OCEANOGRAPHY

10:30-10:50 *Xuewu Liu*, Robert H. Byrne: **Purification and characterization of meta cresol purple for spectrophotometric seawater pH measurements**

10:50-11:10 *Kelly A. Quinn* and Robert H. Byrne: **Yttrium and Rare Earth Element Sorption: A Study using ICP-MS and EXAFS**

11:10-11:30 *Rob Masserini*, Kent Fanning, Matthew Potter: **The Oceanic Nutrient Laboratory: Chemistries, Capabilities, and Collaborations**

11:30-11:50 *David L. Jones*, Monica R. Lara, Zhongxing Chen: **Variation in otolith elemental signatures among three species of juvenile snapper (PISCES: Lutjanidae) from southern Florida, USA**

11:50-12:50 Lunch Break

BIOLOGICAL OCEANOGRAPHY

12:50-1:10 *Lauren McDaniel*, Elizabeth Young, John H. Paul: **High Frequency of Horizontal Gene Transfer in the Oceans**

1:10-1:30 *Dave John*, John Paul: **Nitric oxide induces programmed cell death in the Florida Red Tide organism *Karenia brevis***

1:30-1:50 *Bhakti Dwivedi*, Mya Breitbart, Robert Edwards: **A Computational Tool for the Identification of Signature Genes Among Phages**

1:50-2:05 Snack Break

2:05-2:25 *Kim Pause Tucker*, Télesphore Sime-Ngando, Soizick Lucas, Agnés Robin, Jonathan Colombet, Yvan Bettarel, Elie Desmond, Simonetta Gribaldo, Patrick Forterre, Mya Breitbart and David Prangishvili: **Virus-host diversity in hypersaline Lake Retba, Senegal**

2:25-2:45 *Eric W. Montie:* **Novel Approaches for Assessing the Effects of Anthropogenic Chemicals and Red Tide Toxins on the Central Nervous System of Marine Vertebrates**

2:45 Concluding remarks and retire to Bayboro Tavern for follow-up discussion

Researchers not available to present:
Heather Judkins: Sperm Whale Acoustic Prey Study (SWAPS)

Physical Oceanography

COMPS Data Management: Technology approach towards interoperability

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The University of South Florida (USF), College of Marine Science (CMS) established a Coastal Ocean Monitoring and Prediction System (COMPS) for the West Florida Shelf in 1997. COMPS consists of an array of marine weather monitoring stations (coastal and offshore buoys) located along the West Florida Shelf from the Florida Panhandle to the Dry Tortugas. A COMPS offshore buoy is suited with meteorological sensors, a bridle mounted Acoustic Doppler Current Profiler (ADCP) and Seabird Electronics SBE-37 Microcat temperature/conductivity sensors mounted in the bridle and attached to the mooring cable. A COMPS coastal station consists of meteorological, acoustic water level/tide gage and conductivity/temperature sensors. We also have mounted water quality sensors on some of our coastal and offshore stations. The sensors and data telemetry deployed on both types of platforms vary with location. Once every hour, the raw data from COMPS coastal and offshore stations are acquired by data loggers and transmitted to the USF/CMS shore station and National Oceanic and Atmospheric Administration (NOAA) Command and Data Acquisition (CDA) station via the Geostationary Operational Environmental Satellites (GOES). Line-of-site radio (once every six minutes) is used to acquire data for coastal stations that are located nearby USF/CMS or emergency management office shore stations. COMPS near real-time in-situ marine observations are made available to students, educators, researchers, local, state and federal emergency management agencies, and public via COMPS web site (http://comps.marine.usf.edu). COMPS observations are also disseminated to the Southeast Atlantic Coastal Ocean Observing Regional Association (SECOORA) and the Gulf of Mexico Coastal Ocean Observing System (GCOOS), regional components of the US Integrated Ocean Observing System (IOOS) and NOAA's National Data Buoy Center (NDBC). Regional Associations and NDBC aggregates COMPS data with other sub regional coastal ocean observing systems located within the southeast US and Gulf of Mexico coastal regions, and the aggregated data are displayed and disseminated in a variety of data formats, including geospatial web services via SECOORA, GCOOS and NDBC web sites. To enable machine-to-machine interoperability and realizing the importance of COMPS in-situ observations being interpreted and used correctly by the data assembly centers, data archives and other data users, we have participated in IOOS community driven data management and QA/QC standards projects and initiatives, and have implemented ocean observing community developed (open source technology) standards based web services. Implemented web services technologies include: OpeNDAP, an Open-source Project for a Network Data Access Protocol with Network Common Data Format (NetCDF), Geography Markup Language (GML), Web Feature Service (WFS), and Open Geospatial Consortium (OGC) Sensor Observation Service (OOSTethys and NOAA IOOS Data Integration Framework (IOOS DIF) SOS). We are currently participating in Quality Assurance in Real-Time Oceanographic Data (QARTOD) to Open Geospatial Consortium (OGC) project called Q2O to encode COMPS in-situ observations data quality flags into Sensor Web Enablement (SWE) Framework. In this paper, we describe and demonstrate our experience in moving COMPS, one of the largest sub-regional coastal ocean observing systems maintained by an academic institution towards interoperability.

Physical Oceanography

Tracking/predicting the oil spill trajectory in the Gulf of Mexico with ocean circulation models and satellite imagery

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As the largest oil spill event in the US history, the massive Deepwater Horizon oil spill posts an unprecedented threat to the Gulf of Mexico and US East coasts. Effective oil spill tracking systems are critical for the ongoing response effort. Here we report an oil spill trajectory forecast system based on nowcast/forecast numerical ocean circulation models and satellite imagery. Surface oil patches inferred from the latest satellite imagery are used to initialize the positions of the virtual Lagrangian particles in the trajectory models, and new particles are added to the models assuming continual oil gushing from the well. Multiple oil trajectory models are further used for ensemble forecast. By providing timely oil trajectory information to various federal and state agencies, research institutions, as well as the general public, the forecast system has been demonstrated to be useful in guiding oil spill response, mitigations, scientific surveys, and enhancing public awareness.

For additional information: http://ocgweb.marine.usf.edu/~liu/oil.html

Circulation Changes in Tampa Bay due to Large-scale Human Engineering

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Identical twin numerical experiments indicate substantial changes to the hydrodynamics of Tampa Bay due to alteration of the bay bathymetry by dredging and the construction of causeways. A realistic numerical ocean model for Tampa Bay is forced with observed variables (e.g., wind speed, river inflow) but with two different bathymetries. The first represents the present ("Present"), the second is based on depth soundings from the year 1879 ("1879"). The model is run for three years (2001-2003) which represent a wide range of fresh-water discharge, but exclude extreme events such as hurricanes. Five different analyses of model variables are presented. 1) Long-term average of current speeds shows large distortion in regions of construction, such as in Old Tampa Bay around the causeways, and Hillsborough Bay by the spoil islands. These results are largely time-independent. The other four analyses show significant variation with time and are divided into three distinct time periods, T1, T2, and T3, each representing different dynamical regimes within the bay. Analysis 2) is 30-d average salinity. The largest Present/1879 changes are found during a period of strong baroclinic circulation. 3) The results are similar for 30-d average velocity. The most surprising result occurs in analysis 4) baywide residence time (the time to flush particles out of the bay). The largest Present/1879 difference was found during a period of weak baroclinic circulation when averaged salinity and velocity and largely unchanged. Lastly, 5) the residence time at small spatial scales reveals a complex spatio-temporal pattern that can have large localized Present/1879 changes.

Chemical Oceanography

Purification and characterization of meta cresol purple for spectrophotometric seawater pH measurements

Xuewu Liu, Robert H. Byrne
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Spectrophotometric procedures allow rapid and precise measurements of the pH of natural waters. However, indicator impurities can significantly affect measurement accuracy. This work reports HPLC procedures for purification of m-Cresol Purple (mCP) and the physical-chemical characteristics of purified mCP over a range of temperature and salinity. Using pure mCP, the pH of seawater on the total hydrogen ion concentration scale (pH_T) is expressed in terms of mCP absorbance ratios ($R = {}_{\lambda 2}A/{}_{\lambda 1}A$) where ${}_{\lambda 2}A$ is an absorbance measured at a wavelength (λ) equal to 578 nm and ${}_{\lambda 1}A$ is an absorbance at 434 nm.

$$pH_T = - \log(K_2^T \times e_2) + \log\left(\frac{R - e_1}{1 - R \times e_3/e_2}\right)$$

The term can be summarized as $= A + B/T + C \times \ln(T) - D \times T$

$A = -299.8886 + 0.117020S + 2.78442 \times 10^{-4} S^2$
$B = 8566.6077 + 2.072716S - 0.0537579 S^2$
$C = 53.915479 - 0.0231757 S$
$D = 0.094647$

and mCP absorbance ratios (e_i) are expressed as
$e_1 = {}_{578}eHI/{}_{434}eHI = -0.007762 + 4.5174 \times 10^{-5} T$,
$e_3/e_2 = {}_{434}e_I/{}_{578}e_I = -0.02567 + 2.6758 \times 10^{-4} T$
where $278.55 \leq T \leq 308.15$ and $20 \leq S \leq 40$.

Yttrium and Rare Earth Element Sorption: A Study using ICP-MS and EXAFS

Kelly A. Quinn and Robert H. Byrne
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One of the major objectives of chemical oceanography is to gain an understanding of processes that control the concentrations and distributions of elements in the oceans. Yttrium and the fourteen stable rare earth elements (YREEs) are of unique value in this regard because of the coherence in their chemical properties. Oceanic YREE concentration patterns are controlled by competitive complexation of YREEs by dissolved ligands, on one hand, and the surface functional groups of particles, on the other. Complexation of cations by dissolved ligands stabilizes metals in solution, and complexation by surface functional groups removes metals from solution via sorption onto solids that are fluxing to the sea floor. While YREE solution speciation has been well characterized, investigations have only recently begun to examine the nature of surface complexation. In order to quantitatively model the processes that control YREE oceanic distributions and concentration patterns, experiments were performed to characterize YREE sorption onto amorphous ferric hydroxide, an abundant substrate in both fresh and saline natural waters. Sorption onto the freshly precipitated solid was examined over a range of pH, ionic strength, and extent of solution complexation. Results were expressed in the form of equilibrium distribution coefficients: $\log {}_iK_{Fe} = [MS_i][M^{3+}]^{-1}[S_i]^{-1}$, where $[MS_i]$ is the concentration of sorbed YREEs, $[M^{3+}]$ is the concentration of free hydrated YREE ions, and $[S_i]$ is the concentration of amorphous ferric hydroxide.

This research produced a molecular model of YREE sorption through analyses conducted using inductively coupled plasma mass spectrometry (ICP-MS). YREE sorption was well described in terms of YREE association with both one and two surface hydroxide functional groups. In the absence of significant solution complexation (i.e., carbonate-free solutions), the model accounts for increases in YREE sorption with increasing pH and temperature. In the presence of extensive solution complexation, the model accounts for complex YREE sorption behavior by postulating the formation of ternary YREE-carbonate-hydroxide surface complexes. The underlying assumption for this model, that YREEs form complexes with one or two surface hydroxyl groups, can not be confirmed using analyses of YREE distributions between solutions and solids. As a critical assessment of this equilibrium coordination model, the coordination of individually-sorbed YREEs was directly examined using Extended X-ray Absorption Fine Structure (EXAFS) analysis. The coordination of three adjacent REEs (Tm-Yb-Lu) was studied in view of the distinct inflection observed for these elements in their fractionation patterns on amorphous ferric hydroxide.

Chemical Oceanography

The Oceanic Nutrient Laboratory: Chemistries, Capabilities, and Collaborations

Rob Masserini, Kent Fanning, Matthew Potter
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Nutrients are both indicators of biological activity and indicators of the identity and mixing of ocean water masses. Their role as indicators derives from the fact that biological processes remove nutrients from much of the surface ocean and deliver nutrients to the deep sea due to the remineralization of organic matter. However, due to the insensitivity of standard nutrient techniques, field investigations on the role of nutrients as tracers have had to focus on the deep sea where the highest nutrient concentrations are located. Nutrients in the upper, sunlit portion of the ocean have been much less studied because easily usable analytical techniques have not been available. Nutrient concentrations in these waters are usually well down into the nanomolar range. The development, construction, and application of chemistries to detect nitrate, nitrite, and ammonium at these low levels is a major portion of our research efforts. While conducting Langragian experiments on the West Florida Shelf, ammonium ion concentrations varied up to many-fold times higher than what appears to be normal background ammonium levels and persisted for days. We are currently investigating likely causes for this vastly different behavior of ammonium relative to nitrate and nitrite which did not exhibit the same behavior. A major part of our fieldwork is to develop a version of the high-sensitivity nutrient sensor that will function in an autonomous underwater vehicle. It will allow us to determine the lateral shapes of patches of coastal water with ammonium enrichments, among other things. Another focus of our research concerns comparisons of and temporal trends in nutrient concentrations within permanently anoxic ocean waters. Multi-year trends are being measured in the Cariaco Basin along the Venezuelan continental margin, and those results are compared to nutrient data from the Black Sea and other anoxic regions in the ocean. The objective of this work is to understand the pathways by which anoxia can alter chemical processes in the sea.

Variation in otolith elemental signatures among three species of juvenile snapper (PISCES: Lutjanidae) from southern Florida, USA

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Snapper (*Lutjanus* spp.) are abundant in the estuarine nursery habitats of southern Florida where they reside as juveniles before migrating to offshore reefs when they mature. Natural tags based on otolith microchemistry provide a tool to gauge the relative contribution of specific nursery habitats in replenishment of adjacent adult populations. Our goal was to determine if otolith elemental tags of gray snapper (*Lutjanus griseus*), schoolmaster (*L. apodus*), and yellowtail snapper (*L. chrysurus*) inhabiting the same nursery sites were similar enough to allow one species to serve as a proxy for another in subsequent studies employing natural tags to track ontogenetic migrations. We also examined whether otolith microchemistry indicated similar use of the nursery habitat among these species. Twenty-seven elements incorporated into the otoliths of these fishes were screened for their ability to discriminate among nursery habitats (within species) and among pairs of co-occurring species. Subsets of this elemental suite were found to substantially contribute to the separation of both *L. apodus* and *L. chrysurus* from *L. griseus*; significant spatial variation was also detected. Our results indicate that variation in elemental chemistry may be used to discriminate among closely related species of lutjanids and identify specific nursery sites on very small spatial scales. This study is the first to compare the otolith elemental chemistry among co-occurring species in the same genus and the first to successfully employ lanthanides in otoliths to discriminate closely related fish taxa. The existence of specific otolith elemental signatures among species inhabiting the same southern Florida nursery grounds emphasizes their differential use of microhabitats within this environmentally heterogeneous region.

Biological Oceanography

High Frequency of Horizontal Gene Transfer in the Oceans

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Oceanic bacteria perform a range of important environmental functions, including the biogeochemical cycling of many elements, metabolism of greenhouse gasses, functioning as an important component of oceanic food webs (the Microbial Loop), and producing valuable natural products as well as viral particles. Here we demonstrate a widespread capability of marine bacteria to participate in horizontal gene transfer (HGT) by a novel mechanism. High frequencies of HGT occurred in coastal and oceanic environments modulated by Gene Transfer Agents (GTAs), viral-like particles produced by alpha-proteobacteria. The gene transfer agents (GTAs) were initially discovered in *Rhodobacter capsulatus* (formerly *Rhodopseudomonas capsula*) and are host-encoded virus-like elements that package random fragments of the host chromosome. The GTA-mediated frequencies observed (up to 10^{-1}) are a thousand to a hundred million fold higher than prior estimates of HGT in the oceans, with up to 47% of a natural microbial population confirmed as gene exchange recipients. These findings provide a plausible mechanism for marine bacteria to acquire novel traits and ensure marine bacterial resilience.

Nitric oxide induces programmed cell death in the Florida Red Tide organism *Karenia brevis*

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Nitric oxide has been shown to induce expression of a death specific protein in the diatom *Skeletonema costatum* (Chung et al., 2008, Appl Environ Microbiol 74: 6521-6527). It appears that nitric oxide (NO) is a crucial secondary messenger that signals expression of the protein Sc*DSP-1* in this diatom. We have determined that NO may be used to trigger cell death in *Karenia brevis*. The response to low concentrations occurs within 24 hours and varies with concentration. To describe the dose response, cultures of *K. brevis* Piney Island A2 were exposed to varied concentrations of the nitric oxide donor diethylamine NONOate (IUPAC name: sodium N-(diethylamino)-N-oxidonitrous amide). Trials tested the effect of DEA NONOate concentrations from 100 µM to 0.1 µM. *K. brevis* cultures were grown in L1 media, and cells were counted by microscopy after staining with Lugol's iodine. Intact cells were counted as live. DEA NONOate at a concentration of 100 µM resulted in 100% lethality by 24 hours. Mid-range concentrations of 20 and 10 µM resulted in 70 – 80% lethality by 24 hours vs. control flasks, while concentrations of 1 and 0.1 µM had no effect. Images of cells were also captured via a FlowCAM. Under mid-range NO concentrations, cells that remained intact took on a rounded, dense appearance similar to cyst-like forms that have been described from *K. brevis* bloom samples. After as few as 48 hours, these cyst-like cells began to recover and regain the typical *K. brevis* appearance, with several images of dividing cells captured. In most cases, populations surviving the initial NO treatment eventually recovered and began to increase after several days. Metacaspase-like sequences have been described from an EST library of *K brevis* and we have cloned putative metacaspases from *K brevis* RNA. Cultures treated with NO exhibited upregulation of caspase-like enzyme activity when measured by colorimetric activity assays.

Biological Oceanography

A Computational Tool for the Identification of Signature Genes Among Phages

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Phages (viruses that infect bacteria) are the most abundant biological entities on the planet. Phages have been central to many molecular biology tools and discoveries, and serve important ecological functions, including structuring microbial communities, driving evolution through horizontal gene transfer, and playing major roles in biogeochemical cycling. Unlike other cellular organisms, there is no single gene that is found in all phages. This makes it difficult to understanding of their evolution and diversity. Often closely related phage genomes contain homologous conserved genes that can be used to define evolutionary relationships amongst them. However, the identification of genes that are shared amongst phages has been difficult due to the lack of an automated tool to identify homologous genes (or signature gene groups) amongst phage genomes of interests.

Here, we describe the development of an automated bioinformatics analysis tool to identify signature genes conserved across completely sequence phage genomes. The program includes three successive steps: 1) pairwise comparison of all proteins encoded in user-selected phage genomes using a Blast similarity search, 2) generation of detailed text-based outputs of genes conserved amongst the phage genomes, 3) generation of sequence alignments of the signature genes using ClustalW, and 4) outputs potential degenerate primers for the user-selected identified signature genes. Overall, this bioinformatics tool will advance the field of phage biology by identifying signature genes that can be used as genetic markers to study phage biodiversity, phylogeny, and evolution. Downstream applications of the data also include primer design for PCR amplification of phage genes from environmental samples.

Virus-host diversity in hypersaline Lake Retba, Senegal

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Microbial communities in extreme environments (*e.g.* high salinity, extreme temperature, or extreme pH) are very difficult to culture in the laboratory. Studying the constituents of these communities with culture independent methods allows for a survey of the total community. The virus-host diversity of a hypersaline lake (Lake Retba, Senegal) was examined using microscopy and genomic analysis. Remarkable morphological diversity of virus-like particles was observed by transmission electron microscopy in a hypersaline water sample from Lake Retba, the majority of which resembled hyperthermophilic archaeal DNA viruses isolated from extreme geothermal environments. Some of the hypersaline viral morphotypes observed have not been previously observed in nature. Culture-independent analysis of the microbial diversity in the sample revealed the dominance of extremely halophilic archaea. Few of the 16S sequences corresponded to known genera (*Haloquadratum*, *Halorubrum*, and *Natronomonas)*, whereas the majority represented novel clades. Metagenomic sequencing of DNA from the purified virus-like particles revealed very few similarities to the NCBI non-redundant database at either the nucleotide or amino acid-level. Some of the identifiable virus sequences were most similar to previously described haloarchaeal viruses, but no sequence similarities were found to archaeal viruses from extreme geothermal environments. A large proportion of the sequences had similarity to previously sequenced viral metagenomes from solar salterns. The results support the notion that archaeal viruses represent a set of unique morphotypes and genomes, which are different from bacterial and eukaryal viruses.

Biological Oceanography

Novel Approaches for Assessing the Effects of Anthropogenic Chemicals and Red Tide Toxins on the Central Nervous System of Marine Vertebrates

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Marine vertebrates bioaccumulate and biomagnify a "cocktail" of environmental chemicals including legacy polychlorinated biphenyls (PCBs) and organochlorine pesticides, as well as emerging pollutants of concern (e.g., polybrominated diphenyl ethers, triclosan, and bisphenol A). Because thyroid hormone is important for development of the brain and especially the auditory system, perinatal exposure to the "cocktail" of legacy PCBs and emerging chemicals may affect neurodevelopment and hearing. It has been shown that exposure of rat offspring to PCBs results in severe cognitive deficits and hearing loss caused by a decrease in circulating thyroxine, but whether similar effects can occur in marine organisms is unknown. Teleost fishes, sharks, and marine mammals may be particularly sensitive to these neurological effects because of additional exposure to marine neurotoxins (from the increasing prevalence of harmful algal blooms) and noise pollution. In this presentation, I illustrate how molecular markers associated with thyroid hormone disruption are being used in health assessment studies of bottlenose dolphins (*Tursiops truncatus*). I also discuss novel applications of magnetic resonance imaging (MRI) and auditory evoked potentials (AEPs) to investigate the potential interactive effects of chemical pollutants, biotoxins, and noise pollution on the structure and function of the central nervous system of marine vertebrates.

Unavailable to Present:

Sperm Whale Acoustic Prey Study (SWAPS)

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Sperm whales (*Physeter macrocephalus*) in the northern Gulf of Mexico are protected by both the Marine Mammal Protection Act and the Endangered Species Act. Sperm whales are present year round in the Gulf of Mexico. The northern Gulf of Mexico is one of the most heavily industrialized bodies of water in the world and is the site of intensive energy exploration and exploitation. The noises associated with these activities may result in behavioral or physiological impacts to these protected animals. The purpose of the SWAPS study is to characterize the species composition and biomass of mid-water squid and small pelagic fish in the GOM that represent the forage base for sperm whales. Studies included quantitative sampling of the mid-water pelagic community within sperm whale concentration sites; examine the relationship between acoustic backscatter and prey taxonomic composition; and compare sperm whale distribution and prey composition across the GOM northern habitats.

Minerals Management Service (MMS) provided funding and NOAA conducted the three month study from January through March of 2009. Mid-water diversity ranged from 35-85 different species per trawl. Cephalopod species were abundant throughout the study. Preliminary results show that there are species of cephalopods that are most likely prey for sperm whales in the GOM based on sizes and abundance. Analysis and final reports are currently being conducted.