

Monday, May 14th, 2007

9:30 AM Coffee and pastries – Brooke Hall Conference Center
10:00 AM **Welcome and Announcements**
- Dr. Neal Pettigrew

SESSION 1

Moderator: Wayne Slade

10:15 AM **A stirring investigation of stratification in the Gulf of Maine** - Heather Deese

10:30 AM **Investigation of the impacts of mobile fishing gear on soft sediment benthic community structures in the Gulf of Maine and the analysis of the effects of fishery closures on fishing industry and fishery management** - Mateja Nenadovic

10:45 AM **The road to recruitment: local multi-scale patterns and processes in coral settlement** - Suzanne Arnold

11:00 PM **Break**

SESSION 2

Moderator: Margaret Estapa

11:15 AM **Spatial and seasonal variability of CDOM, phytoplankton and accessory pigments in the Gulf of Maine** - Michael Sauer

11:30 AM **An obligate association between the brittlestar *Ophiocreas* sp. cf. *oedipus* and the octocoral *Metallogorgia melanotrichos* from the Corner Rise and New England Seamounts** - Celeste V. Mosher

11:45 AM **Decadal-Scale T, S and NO₃ Climatology for the Gulf of Maine and Observed Trends** - Nathan Rebuck

12:00 AM **Lunch**

Tuesday May 15th, 2007

8:30 AM	Breakfast – Brooke Hall Conference Center, lower campus
----------------	--

SESSION 5

Moderator: Celeste V. Mosher

10:00 AM **Characterization of a rocky intertidal shoreline within Acadia National Park: Impact of short-term trampling and implications for management** - David Olson

10:15 AM **The use of cDNA libraries to investigate asexual reproduction in *Porphyra umbilicalis* (L.) Kützing** - Nicolas Blouin

10:30 AM **Implementation of a wetting and drying scheme in the Princeton Ocean Model** - Yi Du

10:45 AM	Coffee Break
-----------------	---------------------

SESSION 6

Moderator: Heather Deese

11:00 AM **Developing and evaluating biological reference points for the American lobster fishery management** - Yuying Zhang

11:15 AM **Measuring algal concentration and composition as a proxy for water quality** - Christopher Procter

11:30 AM **Developments in the green sea urchin *Strongylocentrotus droebachiensis* aquaculture in the Gulf of Maine: juvenile cage growout** - Nicole Kirchhoff

11:45 AM **Student Recognitions and Closing Remarks**
- 2007 SMS Graduate Symposium Committee

12.00 PM	Lunch
-----------------	--------------

1:00 PM	SMS Graduate Student Meeting – Brooke Hall
----------------	---

Poster Presentations

Having a pee in the sea: voluntary participation at New England Fisheries Management Council meetings - Danielle Brzezinski

*New techniques for non-lethal DNA extraction from, and passive integrated transponder (PIT) tagging of, the soft-shell clam *Mya arenaria** – Scott A. Hamilton

The culture and use of novel prey organisms for marine ornamental aquaculture – Soren L. Hansen

*The search for horizontal gene transfer in the kleptoplastic sea slug *Elysia chlorotica** – Krishna Kannan

Modeling iron and carbon cycle in the Equatorial Pacific Ocean – Artur P. Palacz

Determining the effects of Fe(III) complexing ligands on the phytoplankton community using a sea-going continuous culture incubator – Lisa Pickell (in absentia)

Persistence of Fe(II) in surface waters of the Western Subarctic Pacific – Eric G. Roy (in absentia)

Survey of reproduction in the octocoral fauna of Alaska's Aleutian Archipelago – Anne W. Simpson

*Relationships between historic alewife (*Alosa pseudoharengus*) harvest and spawning success: effects of past harvest, water levels, and climate on run size* – Erin E. Spencer

Population abundance, distribution and structure of six groundfish species in the coastal waters of Maine – Keri L. Stepanek (in absentia)

Digestibility of alternative feed ingredients for Florida pompano: an assessment of nutrient utilization for successful growth – Terhea N. Williams

Lagrangian dispersion due to sub-grid scale mixing with application to the transport of lobster larvae in the coastal waters of the Gulf of Maine – Danya Xu

Seasonal cycle, interannual and decadal variability of Peruvian anchovy population dynamics: a model study – Yi Xu (in absentia)

ARNOLD, SUZANNE N PhD MB 4th (BOB STENECK)

The road to recruitment: local multi-scale patterns and processes in coral settlement

The importance of scale to the recovery of benthic reef communities has been largely understudied. This study addresses the spatial and temporal scales over which coral recruitment operates in an effort to discover the critical points of variability in settlement and post-settlement processes. The three sequential steps to successful coral recruitment were investigated, attempting to sort out if the observed variance in coral settlement is the result of differences in 1) availability of competent larvae, 2) larvae's propensity to settle, or 3) availability of nursery habitats where post-settlement mortality of larvae is low. We measured coral settlement on terracotta plates on the coral reefs of Bonaire both inside and outside damselfish territories. Damselfish function as biological cages in which algal biomass is increased. We also mimicked this algal garden effect with fouled wire cages on a subset of plates. Results point to the importance of each of the three sequential steps at scales of a meter or less. Local turf algal cover may occlude larvae from accessing the benthos, and after 27 months, spat densities were 73% higher outside of damselfish territories. Spat were found to settle preferentially, demonstrating the demographic importance of facilitator substrates. However, settlement densities declined on preferred substrate on caged plates inside damselfish territories as the cages fouled and the subcryptic undersides were occluded. Finally, the small percentage of surviving spat found to have successfully "run the gauntlet" of recruitment (~10% of the total number found in the 27 month study period) had settled primarily within the outer 1.5 cm perimeter of the underside of uncaged plates that were located outside damselfish territories.

BLOUIN, NICOLAS A PhD MB 1st (SUSAN BRAWLEY)

The use of cDNA libraries to investigate asexual reproduction in *Porphyra umbilicalis* (L.) Kützting

Gene expression varies across different cell types within organisms. I am investigating gene expression during asexual versus sexual differentiation in *Porphyra umbilicalis*. This red alga is a model organism for studying differences in gene expression during reproduction because of its reproductive biology. *Porphyra umbilicalis* reproduces sexually in the northeastern Atlantic while it appears to have lost this ability in at least part of the northwestern Atlantic (the Gulf of Maine). I constructed lambda phage cDNA libraries from poly(A)+ RNA extracted from vegetative tissue and tissue of either differentiating or fully mature asexual reproductive structures from northwestern Atlantic *P. umbilicalis*. I plan to generate libraries from sexually reproductive tissue and construct subtracted libraries to identify genes specific for both sexually and asexually differentiating tissue. Preliminary screening of clones derived from the library of asexually differentiating tissue has revealed genes encoding proteins involved in photosynthesis, translation, signaling, and nutrient transport. Further screening of the libraries will allow me to identify specific genes that may be involved in sexual/asexual differentiation. Differences in expression levels will be confirmed using quantitative RT-PCR and northern blot analysis of targeted genes. This study could lead to new information concerning regulatory control of biochemical pathways during reproduction and to knowledge of the advent and persistence of asexuality within a sexual lineage.

BROTHERS, LAURA L PhD ERS 1st (JOSEPH KELLEY)

New insights into the stratigraphy and activity of a nearshore pockmark field, Belfast Bay, ME

Biogenic natural gas deposits and circular seafloor depressions, or pockmarks, are a global phenomena recognized in a variety of continental settings including deltas, shelf basins, and areas of petroleum production. Pockmarks are also widespread in mid-latitude estuaries, especially in formerly glaciated regions such as the Gulf of Maine. In different regions of the world, methane-sourced pockmark fields actively vent and create new craters. In some locations, the methane escape resulting from pockmark formation is of significant quantity to impact the calculation of greenhouse gas emissions. Despite their ubiquity, pockmarks are one of the least understood underwater landforms on the coast of northeastern North America. Pockmarks are sourced by methane escaping from organic-rich sediments in the deep Holocene sections of Belfast Bay, Maine, and similar settings in the region. We hypothesize that the source beds are early Holocene terrestrial (bog or lake) or estuarine (salt marsh, tidal flat, or bay) sediments that accumulated at a time of lower-than-present sea level. Recently gathered high-resolution Chirp seismic profile data, in conjunction with interferometric sidescan sonar remapping of Belfast Bay's bathymetry, show distinct seismic facies above the Pleistocene/Holocene unconformity. This unit ranges in thickness from 0 m to 3 m and has layered bedding. We speculate that this reflector represents the Holocene source bed and/or the pathway for gas escape and pockmark formation. A comparative analysis of the swath bathymetric survey and a previous bathymetric survey conducted by NOAA in 1999 indicates the dynamics of the Belfast Bay Pockmark differ from previous interpretations and may involve low-scale venting activity for field maintenance and episodic, catastrophic events for pockmark formation.

BRZEZINSKI, DANIELLE MS MB, MP 1st (YONG CHEN, JIM WILSON)

Having a pee in the sea: voluntary participation at New England Fisheries Management Council meetings

Insufficient and unrepresentative participation in voluntary public hearings and policy discussions has been recognized as problematic since Aristotle's time. Research has shown that financially resourceful and extreme-opinioned stakeholders dominate among those involved in fisheries management. Also, groups with lower costs of travel and attendance are advantaged. Consequently, physically remote stakeholders feel isolated from the process. The New England Fisheries Management Council's sign-in sheets for 2003-04 were reviewed and analyzed. Participants' travel distances, costs, and associations with the groundfish, scallop, or herring industries were determined. The initial results, calculating distance as-the-crow-flies, show a strong correlation between attendees and their costs of attendance. In future analyses, travel distance will be measured more accurately using a road network. Unusually high attendance rates for particular industries will be related to specific policy decisions at the meetings using motion minutes and meeting agendas. Initial analyses show some linkage between policy decisions and industry attendance. These results suggest an elevated amount of influence on policy from those stakeholders with lower attendance costs, disadvantaging parties that must incur higher costs.

DEESE, HEATHER E PHD O 3rd (Neal Pettigrew)

A stirring investigation of stratification in the Gulf of Maine

Density is one of the key physical characteristics of all ocean environments. Horizontal and vertical differences in density are directly related to currents, mixing, and internal waves, and therefore influence how wind forcing, heat fluxes, tides, and bottom friction are translated through the water. At the same time, these physical processes constantly modify density. The resulting density field creates dynamic, three-dimensional habitats for species from plankton to sharks. In temperate continental-shelf environments such as the Gulf of Maine, stratification (the change in density with depth) is thought to play a particularly important habitat role by facilitating or limiting primary production. The overall goal of this investigation is to understand how stratification in the Gulf of Maine varies in time and space, what causes this variation, and the implications for primary production. I am using more than five years of oceanographic data from the Gulf of Maine Ocean Observing System to describe the seasonal cycle and shorter-term stratification events at locations throughout the Gulf. I am developing a method to classify these events based on the tell-tale signatures of different physical drivers. By comparing time series of classified stratification events with time series of atmospheric and other ‘forcing’ events, I aim to identify controls on stratification in different areas of the Gulf, at different times of year, and during different years. This enhanced understanding of the physical dynamics will provide a solid basis for future investigations into the relationship between stratification events and biological events such as plankton blooms.

DORGAN, KELLY M PhD O 5th (PETE JUMARS)

Burrowing in muddy sediment by crack propagation

Marine muds are elastic solids through which animals move by propagating a crack-shaped burrow. Dilations previously considered anchors serve to exert radial compressive stress that, through elastic behavior of the medium, focuses axial tensile stresses strongly at the tip of the burrow. This focused stress breaks adhesive bonds, propagating a crack for the animal to follow. The force required to propagate a crack by the polychaete *Nereis virens* has been measured in gelatin, an analogue of muddy sediment, using photoelastic stress analysis. Numerical modeling confirms experimental observations in gelatin and is used to determine the effect of differences in mechanical properties between sediment and gelatin. Newly calculated forces are lower than previously measured and call into question the reputed great expense of burrowing as a form of locomotion, although data on metabolic cost of transport are lacking.

DRZEWIANSKI, ANDREA F MS O 2nd (MARY JANE PERRY)

Diel changes in phytoplankton absorbance spectra in the Gulf of Maine

Phytoplankton adapt to changing light levels by adjusting their pigment composition and concentrations. Photoprotective pigments, a group of pigments not used in photosynthesis, help limit light damage in the cells by absorbing harmful light and defusing excess energy. Changes in photoprotective pigment composition and concentration can be observed with VIS/UV spectrometry. Absorbance spectra, *in vivo* chlorophyll *a* fluorescence, variable fluorescence, chlorophyll *a* concentrations, and nutrients were measured hourly at depths from 0-25 m during two day-long time courses in the Gulf of Maine in June 2006. Phytoplankton absorbance spectra were determined on glass fiber filters and variable fluorescence (Fv/Fm) measurements were made on discrete water samples. Profiles of *in vivo* fluorescence were collected on the CTD system. I observed accumulation of UV-absorbing pigments with increasing light levels throughout the day and decreasing levels in the evening, with more UV absorbance at the surface than at depth. Both *in vivo* fluorescence, normalized to chlorophyll *a* concentration, and Fv/Fm decreased during the day. Although UV-absorbing photoprotective pigments are produced under conditions of high light and are rapidly turned over through the course of the day, the question remains as to their function in reducing photo-induced stress.

DU, YI MS O 2nd (HUIJIE XUE)

Implementation of a wetting and drying scheme in the Princeton Ocean Model

Flows in estuaries, inlets and lagoons are often characterized by shallow depths of wide lateral extent. Areas of the foreshore (seabed) can become submerged (exposed) as the water level moves up (down) due to tides and wind such that the lateral boundary that divides land and water moves back and forth accordingly. In coastal ocean models that have fixed boundaries, assumptions such as never negative water depth and tall vertical wall boundary prevent the overland propagation of the fluid. These simplified models can be applied to large water bodies in which the portion with water depth less than the range of water level movement is small compared to the whole domain. However, to simulate circulations in systems encompassing considerable areas where the water depth is less than the range of water level movement, a numerical procedure known as wetting and drying (WAD) that allows land cells to become water cells and vice versa plays an important role in determining the circulation. In this study, a WAD scheme modified from Oey (2005) is implemented in the Princeton Ocean Model (POM), which conserves mass and momentum. A minimum depth (5cm) is defined to determine “dry” or “wet” state of each cell. Velocities are calculated only for wet cells. Several experiments have been conducted with idealized model settings to illustrate the capability of the scheme to simulate moving land-water interfaces associated with WAD.

ERRIGO, MICHAEL PhD MB 3rd (YONG CHEN)

The effects of random errors and outliers on the performance of a Bayesian size-structured stock assessment model

Random and atypical observation and process errors are common in fisheries. Normal distribution functions are commonly used in formulating likelihood functions in stock assessment modeling, but have been shown to be sensitive to the assumptions of normality on data errors. In this study, we evaluated the effects of different levels of random error in catch, CPUE, and size composition data, as well as outliers in natural mortality, on the estimation of model parameters using a size-structured stock assessment model for American lobster in the Gulf of Maine. We also compared the robustness of normal and Student t distribution likelihood functions to errors and outliers in the input data. Sixteen scenarios were considered in order to test various combinations of errors of different levels and likelihood functions. The scenarios with the highest average absolute percent bias were those with random outliers in natural mortality; those that also had high error in the size composition data had the highest average absolute percent biases. Surprisingly, there was no significant difference between scenarios using a normal likelihood function and those using a t distribution likelihood function for the scenarios tested in this study. This study suggests that we need to pay more attention to atypical process errors resulting from unusual events in modeling fish population dynamics.

ESTAPA, MARGARET L PhD O 2nd (LARRY MAYER, EMMANUEL BOSS)

Oxygen and the photodissolution of shallow coastal suspended sediments and phytoplankton detritus

Significant photochemical dissolution of particulate organic carbon (POC) from resuspended estuarine and deltaic bottom sediments has recently been reported (Mayer et al 2006, Kieber et al 2006). The consumption of dissolved oxygen during photodissolution of particulates in the coastal zone may influence the formation of suboxic bottom waters in the northern Gulf of Mexico. We report dissolved oxygen consumption measured during this “photodissolution” process. Irradiations of suspensions of bottom sediments from Atchafalaya Bay, LA, and the membrane fraction of phytoplankton cells were conducted in a solar simulator. Dissolved oxygen, POC, and dissolved organic carbon (DOC) were measured at the beginning and end of each 24-hour irradiation. Dissolved oxygen levels did not change in dark controls but did decrease in irradiated suspensions in proportion to POC loss, with one mole of O₂ consumed for every 2-3 moles of organic carbon (OC) lost from the particulate phase. Suspensions of phytoplankton membranes and Mississippi river delta sediments were irradiated under air vs. nitrogen gas. POC photodissolution was inhibited in the anoxic algal membrane suspensions but was of similar extent in the oxic and anoxic sediment suspensions. The involvement of oxygen in this photodissolution reaction hence may be integral to photodissolution with some substrates and a side-reaction with others.

HAMILTON, SCOTT A MS MB 1st (LAURIE CONNELL)

New techniques for non-lethal DNA extraction from, and passive integrated transponder (PIT) tagging of, the soft-shell clam *Mya arenaria*

Attempts to characterize the population dynamics of the soft-shell clam *Mya arenaria* are complicated by a lack of non-lethal genotyping techniques and reliable tagging methods. An easier and non-lethal technique for clam genotyping is presented here. In addition, I propose a new method for clam tagging, which will increase the consistency of identification when retrieving tagged clams. A non-lethal method of genotyping, using small amounts of hemolymph, was tested for the first time with *Mya arenaria*. A small syringe was used to extract ~200µl of hemolymph from the clams' abductor muscles, which was then applied directly in a polymerase chain reaction to successfully amplify a DNA fragment for sequencing. Afterwards, all tested clams survived. Using this method, clams can easily be genotyped then placed back in natural conditions for observation. PIT tags are a useful way to reliably track individual animals in the field. By inserting PIT tags into soft-shell clams between the mantle and shell, the loss of clam identification could be consistently avoided. This project is designed to determine if PIT tags can be non-lethally inserted, and remain in the clam without rejection. Three groups of clams will be acclimatized in a natural sea water flow-through tank. One group will act as a control without tags; while the experimental group will have tags inserted. A third group will receive the same treatment as the tagged group without tag insertion. The clams will then be monitored for a number of weeks for death and tag rejection.

HANSEN, SOREN L PhD MB 3rd (DAVID TOWNSEND)

The culture and use of novel prey organisms for marine ornamental aquaculture

The aim of this study is to investigate the potential of various zooplankton organisms for use as live prey for the culture of small-mouth pelagic marine ornamental fish larvae. First feeding is considered the most critical period of a fish larvae's life and is one of the bottlenecks to the successful culture of most marine ornamental species. Currently only about 30 species of marine ornamental fish are successfully reared at a commercial level out of 1200+ species imported to the US every year. It is important to develop rearing protocols for more species of marine ornamental fish to reduce fishing pressure on the reefs and to protect species from overexploitation and possible extinction. Due to the small size (<2 mm) of these pelagic fish larvae conventional culture methods using rotifers *Brachionus* sp. and brine shrimp *Artemia* sp. have proven unsuccessful. A new source of live-prey organisms suitable for first feeding of small-mouth pelagic fish must therefore be identified and investigated. Objectives of this study are to: 1) identify a suitable live-food source, 2) carry out first-feeding larval rearing trials with novel live-food prey organisms, and 3) develop culture protocols and technology for intensive culture of suitable prey organisms. Zooplankton prey organisms that are currently being investigated at the Aquaculture Research Center include species of Calanoid copepods, dinoflagellates, sea urchin larvae, and oyster trochophores. The results from this study will lay the foundation for the successful culture of "new" species of marine ornamental fish.

KANNAN, KRISHNA PhD MB 1st (MARY RUMPHO-KENNEDY)

The search for horizontal gene transfer in the kleptoplastic sea slug *Elysia chlorotica*

Early in development, the sacoglossan mollusc *Elysia chlorotica* feeds on and acquires chloroplasts from the heterokont alga *Vaucheria litorea*. This symbiotic (or kleptoplastic) association sustains the sea slug photoautotrophically for its entire ten month life-cycle in the absence of any additional algal food supply; only light and a source of CO₂ are required. To date, no algal nuclei have been detected within the cells of the mollusc and the 115 kb chloroplast genome codes for less than 10% of the essential chloroplast proteins needed to sustain photosynthetic activity. Horizontal gene transfer (HGT) of algal nuclear genes to the sea slug nuclear and/or mitochondrial genome(s) is a more plausible source for the essential nuclear-encoded chloroplast-targeted proteins. To determine if any algal genes have been transferred into the sea slug mitochondrial genome, we are sequencing the entire mitochondrial genome using multiple PCR reactions and primer walking. To date, we have obtained sequences for about 12000 bp of an expected 14 to 16 kb mitochondrial genome. Preliminary analysis has demonstrated high homology to cytochrome oxidase subunits I, II and III; ribosomal RNAs (small and large subunits); cytochrome b; nad 5, 6, 4, 4L, 2 and 3; and ATP synthase subunits 6 and 8 in other sacoglossan molluscs. Analysis of the mitochondrial genome to reveal algal HGT events as well as the strategy employed to identify HGT of light harvesting proteins will be presented.

KIRCHHOFF, NICOLE T MS MB 2nd (NICK BROWN)

Developments in the green sea urchin *Strongylocentrotus droebachiensis* aquaculture in the Gulf of Maine: juvenile cage growout

The sudden collapse in wild stocks of green sea urchins in the Gulf of Maine has stimulated interest in stock enhancement and aquaculture. Land-based aquaculture of urchins can produce large numbers of animals, yet growout beyond the hatchery phase can be very space, power, and labor intensive. Juveniles less than 15mm in diameter are vulnerable to predation in the wild; therefore a protected nursery phase is required. This study investigated the feasibility of an on-bottom nursery cage system. Survival and growth of juvenile urchins in culture tubes in relationship to culture environment in Penobscot Bay was observed. Wild-caught juvenile urchins (average diameter 7.933 +/- 0.645mm) were held in specially design mesh tubes and distributed on 3 bottom types (mussel, cobble, and ledge) and two lease sites (Sloop Island and Job Island). Groups of urchins were counted and measured after 5 weeks, 3 months, and 6 months to gauge handling mortality, growth, and survival. Handling mortality after 5 weeks was 4% with no significant difference between treatments. Final survival indicated that cobble bottom type supported the highest survival at both Job Island (89%) and Sloop Island (71%), followed by Sloop mussel (59%) and Sloop ledge (56%). After 6 months the average diameter reached 11.08 +/- 1.488mm. Final average test diameter was significantly larger for Sloop ledge (12.17 mm) and Sloop mussel (12.58) than Sloop cobble (9.83) and Job cobble (9.66). These results suggest on-bottom culture through the critical nursery phase is technically feasible and may represent the most economical way to rear hatchery produced green sea urchin seed to the 'planting out' size.

MOSHER, CELESTE V MS O 2nd (LES WATLING)

An obligate association between the brittlestar *Ophiocreas* sp. cf. *oedipus* and the octocoral *Metallogorgia melanotrichos* from the Corner Rise and New England Seamounts

Deep seamount communities face increasing danger of being damaged or destroyed by ever more intensive fishing methods. While temperate-water coral ecosystems of seamounts have been gaining more attention in the last decade, the organisms that live within and rely upon these corals for survival are studied to a lesser degree. Throughout the New England and Corner Rise Seamounts of the western North Atlantic, several ophiuroid species are conspicuously epizoic on gorgonian corals. The objective of this project was to study the interspecies relationship of an ophiuroid, *Ophiocreas* sp. cf. *oedipus*, and its host octocoral, *Metallogorgia melanotrichos*, on these seamounts. We explored degree of host fidelity, patterns of post-larval life history, and benefits of the symbiotic relationship. Colonies of *Metallogorgia* sp. with their *Ophiocreas* sp. symbionts were collected from eleven of the New England and Corner Rise Seamounts in 2003, 2004 and 2005 via submersible. *Ophiocreas* sp. appears to be obligate to *Metallogorgia* sp. Correlation between size of the brittlestar and growth stage of the coral is highly significant suggesting that the brittlestar may grow up on its host. No other brittlestar was found to reside upon *Metallogorgia* sp. and the distribution of brittlestars among coral colonies is significantly more uniform than expected by chance, with most corals hosting only one *Ophiocreas* sp. individual. In light of such tight associations between seamount species, degradation of cold-water coral communities may have more dire consequences to deep-sea biodiversity than previously expected.

NENADOVIC, MATEJA MS MB, MP 2nd (LES WATLING, JIM WILSON)

Investigation of the impacts of mobile fishing gear on soft sediment benthic community structures in the Gulf of Maine and the analysis of the effects of fishery closures on fishing industry and fishery management

Fishing with mobile gear is the most common source of anthropogenic disturbance in marine systems and can directly alter the biological structure of benthic communities, thereby changing functionality of the benthos. Consequently, the use of mobile fishing gear has the potential to cause ecosystem perturbation with a long-term impact on many marine organisms. The first objective of this research is to investigate impacts of mobile fishing gear on the soft sediment benthic infaunal community, originating in mud and sand. Both fished and closed area sites in the Stellwagen Bank National Marine Sanctuary (SBNMS) and the Western Gulf of Maine Fishery Closure (WGoMFC) were sampled over the five-year period (2001-2005) using a Smith-McIntyre grab. Since disturbance events are expected to cause a decrease in structure, species richness and community diversity, it is anticipated that this study will demonstrate a lower diversity and abundance of benthic infauna in the fished areas compared to un-fished areas. The second objective is to evaluate the impacts of the WGoMFC on fishing industry and to determine its importance as a fishery management tool. Data was obtained through a questionnaire conducted among Maine groundfishermen and fishery scientists and managers. Implications of these results may suggest the lack of effective communication between the fishing industry and fishery management and the possibility of its negative effects on the area closure.

OLSON, DAVID E MS MB, MP 2nd (SUSAN BRAWLEY, JIM WILSON)

Characterization of a rocky intertidal shoreline within Acadia National Park: Impact of short-term trampling and implications for management

Millions of people visit Acadia National Park (ANP) in Maine each year. For example, over six million people visited ANP between 2004 and 2006, with the peak period being July - September. In July 2002, ANP staff received management responsibilities from the National Park Service (NPS) for a 2 km section of shoreline and approximately 100 acres of land located on Schoodic Point, Winter Harbor, Maine. Prior to July 2002, this land and shoreline were a U.S. Naval Base. Due to its military status, there was no public access to this shore from the mid-1930s until its transfer to the NPS in 2002. The restricted access protected the shore, which appears to be unusually pristine. Studies elsewhere have found an inverse relationship between the intensity of foot traffic on rocky intertidal shores and the abundance of large, sessile organisms and percent cover of macroalgae. In summer 2006, we conducted an observational pilot study to determine what visitors to ANP do in the intertidal zone and how much time they spend in the intertidal zone. We observed higher numbers of visitors at sites with designated pull-out areas and easy access to the shoreline. We will conduct a full study of visitor intensity and activities in summers 2007 and 2008. In addition, we will characterize the biota on the shoreline and conduct an experimental trampling study. Characterization of the shoreline will provide the NPS with a baseline on the assemblage structure at five study sites with similar exposures in ANP, and results of the trampling study will provide data on potential impact from visitor use. The Park Service will use these data in management of the shores.

PALACZ, ARTUR P MS O 1st (FEI CHAI)

Modeling iron and carbon cycle in the Equatorial Pacific Ocean

Iron limitation in the Equatorial Pacific Ocean keeps the biological productivity below the maximum level, resulting in high nutrients and low chlorophyll conditions. Changes in rate and depth of upwelling exert primary control on variable iron supply to the euphotic zone, but iron cycling also depends on variations in biological uptake and scavenging rates. To constrain the iron, aluminum, and carbon budgets, this project combines observational data with circulation model output. Although iron and aluminum are commonly supplied to the Equatorial Pacific by the Equatorial Undercurrent, field measurements from December 2004 showed a greater decrease in the concentration of iron relative to the decrease in aluminum. Physical fluxes of iron and aluminum are to be calculated using a box model approach. The obtained difference in net outflux will be attributed to preferential biochemical scavenging of iron, which will provide an estimate of the rate of iron scavenging required to match the disjoint distribution of iron and aluminum in the eastern Equatorial Pacific. Parameterization of biochemical scavenging of iron will be incorporated into a three-dimensional coupled ecosystem model of iron and carbon cycling in the Equatorial Pacific.

PICKELL, LISA PhD O 4th (MARK WELLS)

Determining the effects of Fe(III) complexing ligands on the phytoplankton community using a sea-going continuous culture incubator

Insight into the effects of iron speciation on natural phytoplankton communities has been attained through the use of strong Fe(III)-complexing ligands during shipboard experiments. However, such growth experiments have primarily been limited to batch incubations. Because all cells are maintained in these enclosed systems, batch cultures provide limited information about species progression under changed iron conditions. With the flow-through nature of continuous culture systems, the community structure instead becomes defined based on successful growth competition. Adopting this approach, a sea-going continuous culture system was used to investigate the impact of strong [desferrioxamine B (DFB) and rhodotorulic acid (RA)] Fe(III)-complexing ligands on the biomass and species composition of the phytoplankton assemblage. Ligand additions were made to natural phytoplankton communities from a coastal region in the Pacific Northwest off Washington. Phytoplankton that could not access the iron complexes were washed out in the continuous flow, whereas ones that could eventually dominated the resulting community. The value and effectiveness of the continuous system were demonstrated when some experiments showed no difference in chlorophyll biomass between treatments, however upon examination, had dramatically different resultant communities. These experiments offer exciting possibilities on which to base a new approach for assessing trace metal-phytoplankton interactions.

PROCTOR, CHRISTOPHER W MS O 2nd (ANDY THOMAS)

Measuring algal concentration and composition as a proxy for water quality

The purpose of this project was to develop a real-time warning system for detecting accidental or deliberate contaminations of domestic water supplies. Paired optical sensors (Ecotriplets, WETLabs, Inc.) were designed to provide continuous observations of the bulk inherent optical properties (IOPs) of a water body. They monitor specific aquatic components: suspended particulate matter, dissolved organic matter, and phytoplankton composition. Perturbations in these parameters, and in particular phytoplankton concentrations and community composition, are used as indices for environmental changes. One instrument measures backscattering at 660nm, fluorescence by colored dissolved organic matter (excitation at 370nm, emission at 460nm) and phycoerythrin (a pigment found in some cyanobacteria and cryptomonads; excitation at 540nm, emission at 570nm). The second sensor is a fluorometer designed to quantify the composition of light harvesting algal pigments. It measures chlorophyll fluorescence at 695 nm resulting from three excitation wavelengths: 435nm, 470nm, and 532nm. Phytoplankton have varying pigment compositions based in large part on taxonomy and thus dominant groups can be identified by the characteristic ratios of these pigments they contain. Calibration and characterization experiments were performed using monospecific cultures of dinoflagellates, diatoms, chlorophytes, prymnesiophytes and cyanobacteria to quantify instrument detection capabilities. Robust calibration results indicated that the instruments are stable, and that phytoplankton grown at controlled nutrient and light conditions have stable and repeatable fluorescence to chlorophyll ratios. Using models made from the calibration information, the sensors are used to assess the temporal variability of phytoplankton populations, and as a ground truth for satellite derived color data.

REBUCK, NATHAN D PhD O 2nd (DAVID TOWNSEND)

Decadal-Scale T, S and NO₃ Climatology for the Gulf of Maine and Observed Trends

To examine fluctuations in nutrient fields, I generated a library of temperature, salinity, and nitrate data from the Gulf of Maine (40-45N, 65-71W). The data were collected from three sources: the publicly available National Ocean Data Center (NODC), the Bedford Institute of Oceanography, and the Townsend Lab at the University of Maine. The dataset contains over 40,000 samples from the years 1932-2006 and is heterogeneous in both space and time. A preliminary analysis of the data shows a general decrease in salinity since 1960, yet an increase in temperature over the same time period. The increase in temperature suggests a change in atmospheric heat dynamics, either locally or upstream of the Gulf of Maine. A decrease in salinity, a conservative property, suggests an increase in the contribution of Scotian Shelf Water (SSW) and/or Labrador Sea Slope Water (LSSW). The decline in salinity is in contrast to a predominantly positive North Atlantic Oscillation Index (NAOI), which often corresponds to a decrease in the concentration of lower salinity SSW and LSSW water masses. As different nutrient concentrations accompany the slope waters that source the Gulf of Maine, a change in shelf and slope water dynamics could lead to altered nutrient concentrations and ultimately a change in production and biomass.

ROY, ERIC G PhD O 3rd (MARK WELLS)

Persistence of Fe(II) in surface waters of the Western Subarctic Pacific

The distribution of dissolved Fe(II) was studied in the high nitrate low chlorophyll western subarctic Pacific during the SEEDS II iron enrichment experiment using highly sensitive flow-injection chemiluminescence. Vertical profiles of dissolved Fe(II) and total dissolved iron were measured outside of the fertilized patch to investigate the chemical speciation of iron in this iron-limited region. Ambient total dissolved Fe concentrations ranged from 50-100 pmol L⁻¹ in surface waters depending on depth and sampling times. Unexpectedly, Fe(II) accounted for up to half of the total dissolved Fe, with concentrations up to ~50 pmol L⁻¹ Fe(II). These elevated Fe(II) concentrations decreased exponentially with depth to undetectable levels below 50 m depth. There was no evidence of increased Fe(II) concentrations in the proximity of the subsurface chlorophyll maximum, indicating that photolysis of Fe(III) species was the primary source of Fe(II). Fe(II) concentrations in the fertilized patch remained elevated relative to ambient levels more than a week after enrichment, indicating the persistence of photochemical cycling of Fe in these waters. The temperature-dependent Fe(II) oxidation rates measured in the dark at near ambient Fe (II) concentrations and pH were significantly slower than predicted by current Fe(II) oxidation models that consider only inorganic complexes. These findings suggest that Fe(II) binding ligands exist in these HNLC waters, with conditional stability constants on the order of 10⁸-10⁹ (mol L)⁻¹ with respect to Fe²⁺. The accumulation of Fe(II) during daylight hours did not alleviate the Fe limitation of eukaryotic phytoplankton in these waters, contrary to predictions of current Fe uptake models.

SAUER, MICHAEL J PhD O 2nd (COLLIN ROESLER)

Spatial and seasonal variability of CDOM, phytoplankton and accessory pigments in the Gulf of Maine

The Gulf of Maine (GOM) is a complex, biologically active, marginal temperate sea controlled by variable spatial and temporal physical processes. Well-mixed in winter, the GOM is seasonally stratified due to a combination of springtime warming and significant spring and autumn freshwater inputs from a distributed river system. Radiometric and bio-optical surveys of the GOM during fall 1999 and spring 2000 provided observations of size-fractionated *in situ* bio-optical profile observations, discrete fractionated chlorophyll concentrations, and dissolved and particulate absorption coefficients. Significant spatial variations in optical properties were observed during the two cruises, with distinct patterns of absorption, periodically dominated by CDOM, non-algal particles, or phytoplankton. Regional salinity and dissolved absorption relationships suggest distinct water mass characteristics and non-conservative mixing between fresh and marine end-members with seasonal modifications due to changes in the freshwater source of CDOM and stratification. Distributions of discrete, size-fractionated phytoplankton suggested that larger cells dominated patchy coastal upwelling zones and nearshore stations during spring while chlorophyll-pheophytin ratios during the fall implied that over half of the surface pigmented particles from offshore stations were grazed or non-algal. Ratios of chlorophyll *a*: fucoxanthin, and chlorophyll *a*:peridinin suggest that diatoms (dinoflagellates) dominated spring (fall) phytoplankton communities.

SIMPSON, ANNE W PhD MB 3rd (LES WATLING, KEVIN ECKELBARGER)

Survey of reproduction in the octocoral fauna of Alaska's Aleutian Archipelago

From 2002-2004, tissue samples from diverse Aleutian octocoral taxa were collected for reproductive studies during annual summer research cruises. Coral collections were made as part of a U.S. National Marine Fisheries (NMFS) exploration of coral habitat in the Aleutian Archipelago. The goal of the NMFS study was to examine the interaction between corals and the areas' diverse fisheries, which are responsible for an estimated ninety-one percent of the 82 metric tons of coral by-catch from Alaskan fisheries (NMFS 2004). Aleutian coral habitats exhibit high species diversity and biomass, with mean coral abundances (1.23 colonies m⁻²) greatly exceeding that known from other high-latitude ecosystems. Areas of high density 'coral gardens' (3.85 colonies m⁻²) appear to be a unique habitat feature unknown in other cold-water environments. Gorgonian-type octocorals and stylasterid hydrocorals are the most abundant types of coral in the Aleutians although stony corals (non-hermatypic scleractinians) and other octocorals (i.e. sea pens and soft corals) are present. This survey is the first to provide descriptions of sexual reproduction in Aleutian octocorals. Data on reproductive cycles is severely limited by restriction of sample collection to a few weeks in summer (late June – early August) owing to the weather-related logistical difficulties of conducting research operations in the area of the Bering Sea. Despite a lack of seasonal samples, reproductive data show Aleutian octocorals are gonochoristic and exhibit a wide range in the number of reproductive products present and in the timing of germ cell development.

SLADE, WAYNE HOMER PhD O 3rd (EMMANUEL BOSS)

Using in situ observations to understand the relationship between particle dynamics and optical properties

The scattering of light in the ocean, especially the nearshore environment, is dominated by the effects of particulate material. The shape and magnitude of optical scattering depend strongly on the concentration, composition, and size distribution of particulates, controlled by multiple concurrent physical processes, including resuspension, settling, advection, aggregation, and disaggregation. Aggregation and disaggregation modulate the transfer of mass across the size spectrum, moving fine-grained material into and out of much larger, faster-sinking aggregates. Despite the importance of aggregation to material fluxes and optics, there is no accepted framework to describe the optical properties of marine aggregates, and their role in ocean optics has been largely ignored. In order to understand the effects of particle dynamical processes on optical properties, a suite of measurements were made at ~1.2 meters above bottom in a shallow nearshore environment. These included: in situ measurements of particle size distributions derived from laser-diffraction particle sizing and digital microphotography (diameters spanning 2–1000 microns), bulk inherent optical properties, and physical forcing. Using resulting data and simple models, I have begun to separate and describe the effects of settling, aggregation, and disaggregation on optical scatter and attenuation.

SPENCER, ERIN E MS MB/MP 2nd (ROBERT STENECK, JAMES WILSON, THEODORE WILLIS)

Relationships between historic alewife (*Alosa pseudoharengus*) harvest and spawning success: effects of past harvest, water levels, and climate on run size

Alewife populations have steadily declined in abundance since 1960 and today the National Marine Fisheries Service lists them as a ‘species of concern’. Unfortunately, little is known about alewife population size, so we used harvest data to assess trends in commercially harvested alewife runs. Can harvest data be used as a tool to assess trends in commercially harvested alewife runs? We hypothesized that seasonal harvest of alewives would influence alewife harvests in year $t+4$. Landings data for three separate watersheds were collected from 1900- 2000 primarily referencing Annual Town Reports and, in later years, harvest records from the Maine Department of Marine Resources. On average, harvests declined by 195% between 1904 and 1943 and by 8513% between 1943 and 1999. Additional causes of declines in alewife runs were hypothesized and include: spring discharge, obstructions to fish passage (i.e. dam history) and reduced access to spawning grounds and river usage. To test spring discharge, data were collected from the Maine Department of Hydrology. We correlated harvest in year t with harvest in years $t+3$, $t+4$, and $t+5$. Lag years correspond to when mature alewife return to rivers. We also correlated harvest in year t , $t+3$, $t+4$, and $t+5$ with spring discharge in year t . Lag analysis in this case was meant to evaluate relationship between spring discharge and alewife reproductive success. Future work includes relationship analyses between alewife harvest data and dam history, access to spawning grounds and river usage.

STEPANEK, KERI L MS MB 1st (YONG CHEN)

Population abundance, distribution and structure of six groundfish species in the coastal waters of Maine

Accurate assessment of fish stock abundance and distribution is vital to their sound and sustainable management. The Maine-New Hampshire Inshore Trawl Survey was initiated in 2000 to fill a significant information gap on nearly two-thirds of the inshore portion of the Gulf of Maine, which contains some of the Gulf's most important spawning and nursery grounds. Valuable information on population abundance, distribution, reproductive status and feeding habits is collected for over 30 species of commercially and recreationally important fish and invertebrates, together with information on key environmental variables. In this study, spatial and temporal variations in abundance and size distributions of Atlantic cod, haddock, white hake, monkfish, American plaice and witch flounder will be evaluated with respect to environmental variables. Time series of standardized indices of abundance will be derived for each of these species. These can then be compared with abundance indices, derived from NMFS groundfish surveys focusing on offshore areas, and incorporated into future stock assessments.

WILLIAMS, TERHEA N MS MBR 2nd (WILLIAM CONGLETON)

Digestibility of alternative feed ingredients for Florida pompano: an assessment of nutrient utilization for successful growth

Florida pompano are a highly prized fish species and have the potential for commercial aquaculture provided properly formulated diets could be developed for them. This study sought to determine whether digestibility coefficients would be affected by the substitution of alternative protein ingredients in pompano. The apparent nutrient digestibility coefficients for 3 plant and 3 animal by-product alternative proteins were calculated for Florida pompano, *Trachinotus carolinus*. During a 28-day trial, 15-20 pompano were fed a diet composed of 70% reference to 30% substituted ingredient. Diets were rotated weekly in a 4x4 Latin square design. Fecal samples were collected twice a week and analyzed for energy and crude protein. The addition of yttrium oxide allowed the digestibility coefficients of the diets and fecal samples to be calculated. While calculations of organic matter and apparent digestibility are still pending analysis, the general trend appears to suggest that the substitution of feed ingredients had no effect on the energy, crude protein, or digestibility. This information is key to future commercial rearing of pompano since nutrient requirements and digestibility information have yet to be compiled for this species.

XU, DANYA PhD O 5th (HUIJIE XUE)

Lagrangian dispersion due to sub-grid scale mixing with application to the transport of lobster larvae in the coastal waters of the Gulf of Maine

Random walk model is a powerful tool to simulate the individual organism or particle diffusive transport process through a turbulent environment. In oceanic simulation, most of these models are applied in 1-D without considering convection effect. The combination of advection and diffusion will generate more complex Lagrangian behavior and it is important to interpret the basic transport mechanism in realistic flow field. A coupled biophysical individual based model is used to simulate development and transport of lobster larvae hatched along the coast of the Gulf of Maine. Several different numerical schemes are tested to approximate particle dispersion due to subgrid scale mixing. In horizontal advection dominated flow field, small diffusivity won't make much difference between different schemes. Model results showed that larvae hatched at different times around the Gulf result in a great deal of spatial and temporal differences in life history since both the flow field and the surface temperature change seasonally and spatially.

XU, YI PhD O 4th (FEI CHAI)

Seasonal cycle, interannual and decadal variability of Peruvian anchovy population dynamics: a model study

The coastal waters of Peru are among the most productive of ocean ecosystems with the world's largest single-species fishery, the Peruvian anchovy. Coastal upwelling brings cool, nutrient-rich, deep water into the euphotic zone and thus enhances biological production at all levels of the food web. The Peru coastal upwelling ecosystem varies dramatically in responding to El Nino Southern Oscillation. In order to link natural climate variability with nutrients and plankton dynamics to Peruvian anchovy growth, distribution and abundance, a Peru upwelling ecosystem model has been developed, which consists of three components. First, a Pacific basin-wide circulation model based on the Regional Ocean Model Systems (ROMS), is forced with daily air-sea fluxes derived from the NCEP reanalysis between 1990 and 2004. Such a basin-wide physical model is necessary for simulating effects of ENSO on the Peru coastal upwelling system. Second, biogeochemical processes are simulated with the Carbon, Silicate, Nitrogen Ecosystem (CoSINE) model containing multiple nutrients and plankton groups. The third component is an anchovy population model using individual based model (IBM) approach. The IBM anchovy population model takes the coupled physical-biological model outputs and links each life-stage of the anchovy population growth and reproduction with environmental conditions. The IBM anchovy model also tracks the location and moving trajectory of each individual, ranging from the egg to adult life-stage. Our analyses will focus on each sub-model system performance, their connections, and how these processes along the coast of Peru respond to natural climatic variability.

Developing and evaluating biological reference points for the American lobster fishery management

The American lobster (*Homarus americanus*) supports one of the most valuable commercial fisheries in the United States. There is a great controversy in the biological reference point (BRP) used in assessing the lobster stock status over the last two decades. The status of the lobster stock determined, based on the current BRP F10%, is considered inconsistent with the reality of the lobster fishery in the Gulf of Maine (GOM), calling for the evaluation of the current BRP and development of new BRPs. In this study, we simulate a lobster fishery based on the data collected from the GOM lobster fishery from 1981 to 2003 and apply different BRPs in managing the simulated fishery. The BRPs considered in the evaluation include biomass-based and fishing mortality-based BRPs, and survey abundance index-based and fishery CPUE-based references points. Different scenarios are considered in the simulation, including the length of testing period (5 and 25 years), temporal variations in recruitment, natural mortality, growth rates, and gear selectivity. We then compare the performance of different BRPs in managing the simulated lobster fisheries, and identify the effectiveness of each BRP in managing the GOM lobster stock.