SUMMER UNDERGRADUATE RESEARCH FELLOWSHIP
IN OCEANOGRAPHY

(SURFO)

Final Presentations
August 5, 2016

ABSTRACTS

Coastal Institute Auditorium
10:00 to 15:30

The SURFO abstracts are listed in the order of each presentation. Each talk will last ~ 15 minutes (delivery + questions).
Friday August 5\textsuperscript{th} (CIB auditorium)

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Inundation regime is a major determinant of salt marsh vegetation. Chincoteague Bay, adjacent to Assateague Island National Seashore (ASIS), is a micro-tidal system and wind direction has a significant effect on water level. Wind also has a significant effect on dissolved oxygen concentration. Existing data were used from long-term NOAA tide gauge and co-located wind, medium- and short-term National Park Service (NPS) water level gauges, Remote Automated Weather System (RAWS) wind, and dissolved oxygen from NPS Inventory & Monitoring and ASIS sources. A statistical model was developed using RStudio to best estimate water level based on wind. Wind speed and direction were investigated but speed was found not to be significant. The model was then used to estimate the component of water level due to wind direction. Based on the model, wind direction can cause a change in water level of 0.14 m. West winds increase water level the most (0.34 m) whereas east-southeast winds decrease water level (0.20 m) likely due to the shape of the basin. The dominant spring and summer wind is from the south-south west, which also increases water level. A model was also developed to estimate dissolved oxygen concentration based on wind. Wind from the southeast causes an increase in dissolved oxygen whereas westerly winds can cause a decrease in dissolved oxygen. Wind direction affects dissolved oxygen concentration, limiting organism access to oxygen, and water level, likely affecting the location of vegetation growth.
SEASONAL VARIABILITY OF THE CIRCULATION ON THE COASTAL SHELF ALONG THE NORTHEASTERN U.S.

The shelf water of Rhode Island Sound (RIS) becomes anomalously warm and saline after a Gulf Stream warm core ring appears on the shelf break just offshore of RIS. Parcels of water from the warm core ring mix with coastal shelf water through cross-isobath exchange, as indicated by observed net onshore exchanges of salt and nitrate, before transporting those water properties into the RIS. In order to understand the dynamical impact of this anomalous water intrusion one first must establish the climatological seasonal cycle of coastal shelf circulation. This provides the background variability against which the anomaly imposes its dynamics. This study focuses only on wind forcing as the main driving force of the coastal circulation, although the model we have selected to represent these physics includes many other forcings. Zonal winds are strongest in the winter whereas meridional winds are strongest in the summer. Further analysis of the surface wind forcings as well as a review of the model’s climatological seasonal cycle will be done at a later date, and, based on previous work, we are confident that this model will provide realistic circulation patterns for our warm core ring anomaly experiments. Future studies of warm core rings on the shelf break near RIS will also include ecological and biogeochemical impacts such as the distribution of marine organisms and nutrient concentrations.

Nicole Flecchia will enter her senior year at the University of Rhode Island in the fall of 2016. She is majoring in geosciences with a concentration in geological oceanography. Lew Rothstein is her SURFO advisor.
ASSESSING THE EFFECT OF COPEPOD EXCRETIONS ON THE GROWTH AND INGESTION RATES OF THE PHAGOTROPHIC PROTIST **OXYRRHIS MARINA**

The contribution of microbial organisms to the primary production of the world’s oceans has received a great deal of attention over the last decades. There is still a need to develop our understanding of contributions by heterotrophic microzooplankton, which consume approximately two-thirds of daily picoplankton production and play an intermediary trophic role by transferring organic matter to mesozooplankton such as copepods. Copepods are known predators of *Oxyrrhis marina*, which successfully feeds on *Isochrysis galbana*, a microalga. *Oxyrrhis marina* was used as a model for the diverse group of heterotrophic protists, which are known to be sensitive to chemical signals produced by their predators and prey. Cultures of *O. marina* were grown on five concentrations of *I. galbana* and exposed to three concentrations of ammonium, the main excretory product of copepods. Based on published estimates of copepod abundances and excretion rates, ammonium treatments were categorized as low (15 ng NH$_4^+$ L$^{-1}$), medium (744 ng NH$_4^+$ L$^{-1}$), and high (3955 μg NH$_4^+$ L$^{-1}$). Measuring changes in population sizes of *O. marina* and *I. galbana*, we found that *Oxyrrhis* exposed to the high ammonium treatment exhibited lower growth rates than the no-ammonium control at both 24 and 48 hours, while a lag in ingestion rate was observed at 24 hours that wore off at 48 hours. Overall, results showed that ammonium affects *O. marina* growth and ingestion on *I. galbana* only at high concentrations, indicating that dense localized copepod aggregations could have a negative effect on heterotrophic flagellates.

Liza Wright-Fairbanks will enter her senior year at Middlebury College in the fall of 2016. She is majoring in biology and minoring in environmental studies. Susanne Menden-Deuer is her SURFO advisor and Andreas Oikonomou is her SURFO post-doctoral mentor.
PASSIVE SAMPLING OF PERFLUOROALKYL SUBSTANCES IN AQUEOUS FILM FORMING FOAM WITH POLYACRYLATE FIBERS

Perfluoroalkyl substances (PFAS) are organic contaminants found ubiquitously in the environment. PFAS were commonly used in nonstick-cookware, food packaging, pesticides, and alkaline cleaners. PFASs are also key ingredients of aqueous film forming foam (AFFF), mixtures used heavily at airports and military bases to extinguish hydrocarbon fuel fibers. In recent years, exposure to C8 perfluorinated carboxylic acids and sulfonates has been linked to several types of cancer. An accurate way to sample contaminants in the environment is by using passive sampling. This relies on the free flow of analytes from the sampling medium to the collecting device. In this study, polyacrylate fibers were tested as passive samplers for PFAS, particularly perfluorinated carboxylic acids and sulfonates. Polyacrylate passive samplers were used to sample dilutions of AFFF to confirm whether these passive samplers can be used to quantify PFAS in groundwater at suspected contamination sites. Polyacrylate passive samplers were submerged in AFFF dilutions for 1-24 hours; the PFAS were then extracted from the fibers. HPLC/MS-MS was used to determine the concentration of PFAS collected by the fibers. The ratio of the PFAS concentrations of the two sizes of fibers (near unity) indicates that the contaminants are absorbed on the surface of the fibers rather than dissolved in the fibers. Results show that the PFAS concentrations on the fibers decrease from C4 to C8 compounds. Future work should include varying the sampling time and determining the partitioning correlations.

Chris Vatral will enter his senior year at Eastern Nazarene College in the fall of 2016. He is majoring in chemistry. Rainer Lohmann is his SURFO advisor and Rachel Miller is his graduate student mentor.
NON-VOLCANIC TREMORS ASSOCIATED WITH SLOW SLIP EVENT IN SOUTH CENTRAL ALASKA BETWEEN 2010-2013

Slow slip events and tremors are relatively new discoveries in plate tectonics and there is a suspected relationship between the two events. Tremors, which were previously thought to be random noise, are characterized by a higher frequency and longer duration than most earthquakes. A slow slip event near the epicenter of the 1964 M9.2 earthquake in south central Alaska has been recorded between 2009 and 2013. Using seismic data from a seismic network in this region, the data are filtered using a band-pass between 1-6 Hz and potential tremors are detected using a waveform envelope method. The potential tremors are visually inspected under several general criteria for validation. Confirmed tremors are then located using a 1D seismic velocity model. Tremors from January 2005 to May 2015 have been analyzed and an average of 45 tremors per year were recorded during the slow slip event compared to 10 tremors per year before the event and 15 tremors per year after the event. Tremor activity peaked in the summer months, which is likely due to seasonal hydrological loading. Nearly 80 tremors were spatially located and their horizontal locations are near the downdip limit of the slow slip area. However, the depths are not well resolved due to the limited number of stations in the region. This study confirms the occurrence of non-volcanic tremors associated with the 2009-2013 slow slip event in south central Alaska.

Whitney Schultz will enter her senior year at Colorado School of Mines in the fall of 2016. She is majoring in geophysical engineering and minoring in geology. Dr. Matt Wei is her SURFO advisor.
INVESTIGATION OF METHODS FOR THE INTEGRATION OF GENE EXPRESSION DATA IN GENOME SCALE METABOLIC MODELS

Metabolic models are networks of interconnected biochemical reactions designed to simulate the growth of an organism. Traditional simulations account only for reaction stoichiometry, and do not provide a way of accounting for the influence of environmental factors such as oxygen concentration. We have implemented two methods in Python for integrating gene expression data in models that will allow for simulations that better represent growth under these conditions. The first method uses the statistical significance of changes in gene expression between conditions to mark reactions as either ‘on’ or ‘off’. The second method continuously scales the flux through reactions in the model based on expression levels. Initial testing of these methods was done on a toy model. A comparison of these methods to standard modeling procedures, done using a model of *Shewanella piezotolerans* WP3, shows increased precision in characterizing the metabolism of this deep-sea bacterium. This is exemplified in a reduction in the variability of reactions. The continuous method shows more reduction in variability than the ‘on/off’ method. Both show changes to specific metabolic pathways. These two methods for including gene expression data help us understand the adaptations of WP3 to the deep ocean by allowing us to simulate bacterial activity under the oxygen conditions found at depth.

Matthew Gentry will enter his final year of study at the University of Massachusetts Amherst in the Fall of 2016, when he will continue his studies in chemistry and physics. Dr. Ying Zhang from the department of Cellular and Molecular Biology is his SURFO advisor, and Keith Dufault-Thompson is his graduate student mentor.
ZOOPLANKTON BIODIVERSITY AND COMMUNITY COMPOSITION IN RESPONSE TO ENVIRONMENTAL CHANGE IN NARRAGANSETT BAY

Characterized by their immense biodiversity, zooplankton are essential members of the Narragansett Bay estuarine system, facilitating bottom-up energy transfer from primary producers and thus supporting fishery production. Marine ecosystem resilience, stability, and overall health depend on the maintenance of biodiversity. Changes in zooplankton biodiversity in response to environmental shifts may therefore have serious implications for ecosystem dynamics and fishery productivity in Narragansett Bay (NB). We examined temporal changes in both community composition and zooplankton abundance, using body size as a proxy, with samples from the Narragansett Bay Long-Term Plankton Monitoring program and a Bench top Video Plankton Recorder (BVPR). Our study focused on mesozooplankton (200 – 2000 μm), a major group of the common zooplankton in NB, from two sets of three consecutive years (2003-2006 and 2013-2016) to identify temporal changes in the zooplankton community at seasonal, yearly, and decadal scales. We processed a total of 71 samples using the BVPR, producing 56,203 images. We then developed and ran MATLAB codes for image analysis in order to both detect zooplankton objects and measure object sizes for each image. Zooplankton size groups and frequencies from each monthly zooplankton sample will be analyzed to gain insight into changes in the zooplankton community underlying the patterns of size distribution change. By comparing these results to environmental covariates over both short (months) and long (decades) time scales, we hope to determine whether community change is occurring, and if so, which environmental factors are driving these changes in mesozooplankton biodiversity.

Ariel Pezner will enter her senior year at the University of California, Los Angeles in the fall of 2016. She is majoring in Environmental Science and minoring in Conservation Biology and Atmospheric & Oceanic Sciences. Tatiana Rynearson is her SURFO advisor and Gang Chen is her SURFO postdoctoral researcher mentor.
NITROGEN CYCLE CONNECTIVITY ALONG THE AGULHAS CURRENT

The nitrogen cycle plays a key role in the biological productivity of the ocean. Phytoplankton growth is limited by the amount of bioavailable nitrogen. The bioavailable nitrogen budget depends on a balance between input through nitrogen fixation and output through denitrification and the budget appears to be balanced on a global scale. The Indian Ocean has a nitrogen deficit that may be created by excess denitrification, whereas the majority of the Atlantic Ocean has a nitrogen surplus due to excess nitrogen fixation. The South Atlantic Ocean has a small nitrogen deficit with an unclear source. The Agulhas Current delivers water from the Indian to the South Atlantic through eddies and these eddies may carry nitrogen deficient water into the South Atlantic from the Indian Ocean and linking the nitrogen cycles of the two oceans. Denitrification imparts an isotopic signature on a water mass, which is ultimately transferred to sediment on the sea floor. Anticipating that the water mass would be the most important source of the isotopic signature in the sediment, I measured $^{15}$N to $^{14}$N ratios in the bulk sediment through cores from three sites along the Agulhas. The trends in these signals were inconsistent between sites, indicating that N isotope ratio in sediment likely results from a combination of factors for each site. These results do not directly reflect the movement of denitrified water masses from the Indian to South Atlantic Oceans and exemplify the complexity of nitrogen cycle connectivity along the Agulhas Current.

Alexandra Norwood will enter her senior year at Arizona State University in the fall of 2016. She is majoring in anthropology and geological sciences. Rebecca Robinson is her SURFO advisor and Colin Jones is her SURFO graduate student mentor.
APPLICATIONS OF MULTI-SPECTRAL IMAGERY FOR ALGAL BLOOM MONITORING IN RHODE ISLAND

Harmful algal blooms, or HABs, may lead to the production of toxins, that are dangerous to humans and animals. Current methods of monitoring these events are slow and imperfect. Many tests require taking nearshore water samples followed by laboratory analysis, often yielding low spatial resolution. By expanding upon current research to utilize autonomous vehicles to observe HABs this weakness may be overcome. An autonomous kayak will be put on a lake and acquire samples from throughout the body of water. At the same time, a small unmanned aircraft system (sUAS) will utilize multispectral cameras to create a normalized difference vegetation index (NDVI), which is known to have a high correlation with algal biomass. The ability to compare water samples from images taken at the same time and place should grant a more holistic view of the HAB. These tests will also investigate the differences in results of two different camera set ups. One is using a $15000 Tetracam mini-mca 6, which can take images in 5 different spectra, the other is using 4 different $250 MapIr cameras, one that takes images in visible light, red, green, and near IR spectra. Until recently, this work was not feasible as sUASs were not easily available for civilian usage. By expanding on existing sampling techniques and adding a new observation method, this work strives to greatly improve monitoring of HABs and thus aids management.

Scott Goldberg will enter his senior year at Northwestern University in the fall of 2016. He is majoring in Biological Sciences. Stephen Licht is his SURFO advisor and Jordan Kirby is his SURFO graduate student mentor.
SINKING MICROFIBERS IN THE NORTHWEST ATLANTIC OCEAN

While the abundance of microfibers (<5 mm) both at the surface and on the floor of the ocean is well documented, the flux and sinking speed of these particles within the water column remains unknown. In June 2016, the water column abundance and vertical flux profile of microfibers was examined using Niskin bottle collection and a vertical array of surface-tethered sediment traps (STSTs, spanning 60 to 200 meters) on the R/V Endeavor at the continental shelf break south of Rhode Island (40°N, 71°W). Fibers were extracted and analyzed on a Fourier transform infrared spectrometer to determine the type of materials present, namely polyester and cotton. A total of 171 fibers averaging 1100 ± 1000 μm long and 11 ± 7 μm wide were imaged and quantified. Sinking rates ($w_s$) of the fibers were estimated through three independent approaches. The observed sediment tube flux divided by the water column concentration yielded $w_{s,\text{field}} = 2.4 \pm 2.3$ m day$^{-1}$, while settling chamber observations gave $w_{s,\text{lab}} = 16 \pm 4$ m day$^{-1}$. These results were compared to the theoretical Stokes sinking speed for cylindrical particles $w_{s,\text{theory}} = 12 \pm 15$ m day$^{-1}$. In general, the field-based approach indicated roughly 8x slower sinking speeds than those observed in the lab or predicted by theory. Potential explanations for this discrepancy are discussed. To our knowledge, this is the first study that attempts to quantify and compare in situ sinking rates with laboratory and theoretical approaches, to understand the fate of microfibers in the ocean.

Jennie Warmack will enter her senior year at Humboldt State University in August 2016. She is majoring in Oceanography and minoring in Scientific Diving. Her SURFO advisor is Melissa Omand and Noah Walcutt is her SURFO graduate student mentor.
LIGHT-INDUCED MORPHOLOGICAL VARIATION IN DIATOMS

Diatoms are a group of phytoplankton that form cell walls from silica, which allows them to develop complex morphologies including colonies. Intraspecific morphological variation is common and is caused by a variety of factors including response to environmental conditions. Recent advances in holography performed in situ demonstrate that orientation of diatom colonies in the water column may vary under different hydrographic conditions. Chain forming diatoms may regulate the length of their colonies, which alters their physical orientation, thereby increasing the area for light absorption. The physical conditions that lead to horizontal particle orientation are most commonly observed near the pycnocline, where light levels are lower than near the surface. We hypothesize that diatoms will form longer colonies under low light conditions. Chaetoceros physiologically regulate their colony length, and complete, unbroken colonies are easy to distinguish by their specialized hair-like terminal setae, which are very distinct in *C. constrictus*. We cultured *C. constrictus* at two different light intensities (~115 µmol photons m\(^{-2}\) sec\(^{-1}\) and ~30 µmol photons m\(^{-2}\) sec\(^{-1}\)) under a given day-length at cell/colony concentrations representative of those found in nature. Every day, cell fluorescence was measured, and photomicrographs were analyzed for colony length. During a preliminary experiment, differences in growth rates between different developmental stages were not significant, but growth rates obtained from cell counts were significantly higher than those generated from fluorescence reading. Growth rates were greater under high light conditions than low light conditions. Analyses of length frequency data from the different light treatments are currently in progress.

Austin Grubb will enter his senior year at Susquehanna University in the fall of 2016. He is majoring in biology and Spanish and minoring in ecology. Jan Rines is his SURFO advisor.
SEX-SPECIFIC POPULATION DYNAMICS AND TROPHIC ECOLOGY OF SUMMER FLOUNDER (*PARALICHTHYS DENATUS*) IN NARRAGANSETT BAY, RHODE ISLAND

*Paralichthys denatus,* the summer flounder, is an aggressive predator and the most commercially-important finfish in Rhode Island. Accordingly, a long-term increase in abundance documented in Narragansett Bay may prove both economically beneficial and detrimental to resident fish populations. In addition to ecological concerns, management of summer flounder is complicated by sexual dimorphism, with females growing larger and faster than males. This dimorphism, when coupled with previous evidence of spatial sex-segregation, increases the risk of fishing removing a disproportionate number of females. To determine the role of summer flounder in the local ecosystem and elucidate the nearshore sex-driven population dynamics, specimens were collected on the University of Rhode Island weekly fish trawl and Rhode Island Department of Environmental Management monthly fish survey. Individuals were dissected and sexed based on visual inspection of the gonads. The stomach was then removed and classified as full or empty, and its contents identified to the lowest taxonomic level and weighed. Crangon shrimp (*Crangon septemspinosa*), squid (*Doryteuthis pealeii*), and scup (*Stenotomus chrysops*) were important components in the summer flounder diet. As total length increases, the probability that an individual is female was found to also increase; of the 65 fish collected that were legal for recreational harvest, 63 were female. Additionally, a higher percentage of females was found inshore than offshore. These results suggest that implementing a slot-trophy limit on the recreational fishery and restricting inshore commercial harvest would account for the sex-based population dynamics and better protect the spawning stock biomass from future overexploitation.

Adena Schonfeld will enter her senior year at the University of Miami in the fall of 2016. She is majoring in Marine Science and Biology and minoring in Chemistry. Joe Langan and Corinne Truesdale are her graduate student mentors, under the supervision of Jeremy Collie.
ESTIMATING BIOMASS AND ANALYZING BLOOM SEASONALITY OF THE DIATOMS, *Skeletonema* (s.l.), *Detonula confervacea*, AND *Thalassiosira nordenskioeldii* IN NARRAGANSETT BAY

To better understand biomass and bloom seasonality in Narragansett Bay, I compiled and analyzed extant data sets for the commonly found genus of diatom, *Skeletonema* and its competing winter-spring bloom species, *Detonula confervacea* and *Thalassiosira nordenskioeldii*. Our data have shown that when using volume as a steppingstone to biomass in *Skeletonema*, the strongest correlation was with cellular carbon; no correlation was found with nitrogen or chlorophyll. It has been suggested that temperature plays a critical role in dictating the volume of diatoms, which influences biomass; however our data show no indication of a strong temperature influence. Bloom seasonality was analyzed on a pentad timescale for both winter-spring and summer-fall blooms. For both blooms, *Skeletonema* has historically been the dominant species numerically. Cell concentrations were converted to carbon concentrations yielding results indicating that *Skeletonema*, despite its large cell concentration, does not always produce the highest carbon concentrations. *Thalassiosira nordenskioeldii* frequently surpassed *Skeletonema* in carbon concentrations. *Skeletonema* and *Thalassiosira nordenskioeldii* both exhibit long-term trends of extensive growth followed by periods of decreased abundance, making it difficult to clearly define trends. *Detonula confervacea* gradually decrease in both cell and carbon concentrations with time. The data show that bloom seasonality may be shifting from a winter-spring to a summer-fall bloom on a pentad timescale in Narragansett Bay.

Jakob Gessay will be entering his senior year at Coastal Carolina University this August. He is majoring in marine science and minoring in mathematics and Spanish. Dr. Ted Smayda is his SURFO advisor.