UNIVERSITY of WASHINGTON

Undergraduate Research Symposium May 17, 2019 Mary Gates Hall

Online Proceedings

Poster Session 1

Commons East, Easel 63

11:00 AM to 1:00 PM

Exploring Interannual Variations of Distinct Populations within the San Juan Channel Pelagic Ecosystem

Emily West Hamacher, Senior, Biology (General)
Mentor: Jan Newton, Applied Physics Laboratory, Schools of Oceanography and Marine Affairs
Mentor: Rebecca Guenther, Friday Harbor Laboratories

The waters surrounding the San Juan Islands in the Salish Sea near Washington state, USA, possess a variety of physical and chemical conditions that combine to support a rich multitude of marine organisms. Five constituents observed and analyzed in this project represent the larger food web found within the Salish Sea: nutrients, phytoplankton, forage fish, seabirds, and marine mammals. I tracked variability in these constituents during the fall over the course of twelve years from 2006 to 2018. This time range was selected to cover the years before, during, and after the North Pacific marine heat wave (2014-2016), and the subsequent return to normal temperatures in the Salish Sea since those years. The abundance and composition of these constituents varied over this time range. We found a significant decrease in both nutrient concentrations and fish condition in the fall of 2014, which had returned to previously observed levels by the fall of 2018. In contrast, the phytoplankton and marine bird and mammal observations remained comparably low in 2018, similar to values observed in fall 2014. The introduction of the marine heat wave into the Salish Sea during 2014 appears to have consequences that span across multiple years after its dissipation in the Pacific Ocean. As marine heat waves are anticipated to become more prolonged and common with global climate change, it's crucial to understand their short- and long-term impacts on local marine populations.

Session 2D

Biological Responses to Environmental Factors

Session Moderator: Frieda B. Taub, Aquatic & Fishery Science

MGH 234

3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

Measuring Microplastic Abundance in Pacific Sand Lance (*Ammodytes personatus*) Habitat on San Juan Island

Kaitlyn Conway, Senior, Envir Sustainability: Envir Comm (Tac)
Mary Gates Scholar
Mentor: Jan Newton, Applied Physics Laboratory, Schools of Oceanography and Marine Affairs
Mentor: Julie Masura, Environmental Science, Interdisciplinary Arts & Sciences, University of Washington Tacoma

Pacific sand lance (*Ammodytes personatus*) are important to the diets of sea birds, other predatory fish, as well as mammals. Microplastics (plastics $<$ 5 mm) have been found in spawning and deep-water habitats for these organisms. This project explored if microplastics are found on beaches near Friday Harbor Labs on San Juan Island, WA., and if so, to determine their concentration and distribution. Nine sediment samples were collected from two beaches (Jackson and South) and a wave field known to be Pacific sand lance habitat in this area. Samples were processed according to NOAA's Microplastics Methods Manual. Presence, abundance, type (fiber, fragment, film, pellets) and size class ($<$ 0.5 mm, 1-5mm, 6-10mm, $>$ 10mm) of microplastics were determined from sediment samples collected. Microplastics were found in all samples. Microfibers were the most abundant microplastic type (86%), and Jackson beach had the highest concentration of microplastics (17 microplastics/m2). On average the sizes were between 1-5 mm, and the number were 13 microplastics/m2 in the study area. Larger pieces (5-10 mm) were not present at the wave field located on the seafloor, although found at both beaches. This research helps connect microplastic presence to Pacific sand lance habitat. Considering the main prey type of Pacific sand lance and microplastics

found in their environment overlap in size classes, it is highly likely that Pacific sand lance are consuming microplastics.

SESSION 2H

MEDICAL IMAGING AND DEVICES

Session Moderator: Eric Seibel, Mechanical Engineering
MGH 251
3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

Ultrasound Imaging for Visualization of Vasculature after Spinal Cord Injury in Rodents
Takunda T (Takunda) Masike, Senior, Electrical Engr: Nanoscience & Molecular
Louis Stokes Alliance for Minority Participation, NASA Space Grant Scholar
Mentor: Matthew Bruce, Applied Physics Laboratory

Spinal cord injury (SCI) is often a life changing and debilitating condition, where the loss of sensory and motor capabilities can be accompanied with bladder, bowel, respiratory and other dysfunctions. It is known that traumatic SCI causes an almost a complete loss of blood flow at the site of injury, as well as significant hypoperfused regions surrounding the injury, resulting in progressive cell death referred to as secondary injury. Counteracting secondary injury of spinal cord tissue, referred to as "rescue-able" tissue, is an active area of neuroprotective research. Surprisingly, there are no existing techniques to detect and assess contused spinal cord tissue at risk for secondary injury clinically or pre-clinically. In this work, we present an approach to visualize and quantify the blood flow changes after SCI by imaging microbubbles, an intravascular contrasting agent, with ultrasound following intravenous injection. Nonlinear Doppler sequences were programmed on a research platform where Doppler processing separates microbubbles in the vasculature from background tissue signals. Our preliminary data demonstrate the ability to visualize changes in blood flow resulting from SCI in a rodent model. We will present results characterizing differences in blood flow associated from different injury severities. The nonlinear Doppler sequences are used to quantify the different characteristics of low velocity blood flow changes in the smaller vasculature and higher velocity blood flow changes in the larger vasculature. In addition, the passage of a bolus injection of microbubbles also highlights differences in blood flow in the contused and surrounding spinal cord tissue. Once translated, this ultrasound imaging technique could assist in detecting and monitoring local tissue perfusion at the injury site, ultimately improving SCI patient outcomes.

SESSION 2H

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Molecular Imaging of Inflammation with Ultrasound and Targeted / Non-Targeted Microbubbles
Mingxin (Ming) Ren, Senior, Bioengineering
Mary Gates Scholar, Undergraduate Research
Conference Travel Awardee
Mentor: Matthew Bruce, Applied Physics Laboratory

The use of targeted microbubbles to image the molecular expression of vascular factors is an active area of ultrasound research. Combining the imaging advantages of ultrasound (e.g. cost, ease of use, availability) with the potential of molecular imaging makes targeted microbubbles especially attractive for studying the expression of vascular factors. During imaging, signals from molecularly attached microbubbles need to be separated from signals of non-attached free-flowing microbubbles in the vasculature. Thus far, different indirect approaches have been used to isolate stationary microbubbles. In this work, we present a direct approach to classify bound microbubbles in the presence of free-flowing microbubbles by processing nonlinear Doppler acquisitions. Nonlinear Doppler sequences are programmed on a research platform where Doppler processing separates low frequency stationary microbubbles signals from high frequency flowing microbubbles signals. In-vitro experiments are conducted by imaging stationary microbubbles surrounded by free-flowing microbubbles in a dialysis tube. In-vivo experiments are conducted by applying this approach to image the extent of inflammation associated with spinal cord injury (SCI), which plays a critical role in progressive tissue loss after injury. Both targeted and non-targeted microbubbles have been imaged in a rat SCI model. Targeted microbubbles were made for the inflammation marker p-selectin. Our in vivo results show successful separation of a limited number of non-targeted microbubbles adhering around spinal cord contusions. We believe this may be due to interactions between microbubbles and activated leukocytes. We expect to observe increases in bubble adherence and differences in the spatial distribution in using targeted bubbles, hopefully elucidating the extent of inflammation due to SCI. This work demonstrates the potential to separate bound targeted microbubbles from of free-flowing microbubbles to image a vascular factor for inflammation, which demonstrates practical pre-clinical ultrasound molecular imaging and opportunities for broader applications.

POSTER SESSION 4

MGH 241, Easel 145

4:00 PM to 6:00 PM

A Comparison of Variability Due to Cross-Validation and Initialization in Neural Networks

Jueyi Liu, Senior, Economics, Applied & Computational Mathematical Sciences (Scientific Computing & Numerical Algorithms)

UW Honors Program

Mentor: Caren Marzban, Statistics, and Applied Physics Lab

It is well known that nonlinear optimization can lead to a local minimum of the loss function. As such, different initial values of the model parameters can give different values for the loss function. In other words, the existence of local minima introduces a source of variability in the loss function. Additionally, model selection often involves resampling, which in turn introduces a second source of variability. In this work, random effects models are employed to estimate these two variance components. More specifically, a neural network model is employed to examine the behavior of these variance components as a function of the variance of the initial weights and the number of hidden nodes (H). It is found that when H is small, weight initialization has a larger effect on variation of loss than cross-validation, and when H is large, these two factors contribute comparably to the variability in loss.

POSTER SESSION 4

Commons East, Easel 62

4:00 PM to 6:00 PM

Photograph Analysis of Wrangel Island Polar Bear Aggregation

Gary Qin, Senior, English, Biology (Ecology, Evolution & Conservation)

Mentor: Eric Regehr, Polar Science Center

Mentor: Kristin Laidre, Polar Science Center/APL and School of Aquatic and Fishery Sciences

The Wrangel Island State Nature Reserve (WISNR) serves as a vital refuge for the Alaska-Chukotka (AC) population of polar bears (*Ursus maritimus*) during the ice-free season. In September 2017, a total of 181 polar bears were observed near a bowhead whale (*Balaena mysticetus*) carcass on the island. This gathering is the largest aggregation of polar bears ever recorded for the AC population. This study sorted, labeled, and processed photographs of the polar bear aggregation taken by a professional photographer from a boat a day before initial ground-based observations were made. Our objective was to use the photographs to evaluate characteristics of the polar bear aggregation including animal sex, age, reproductive composition (e.g., adult females that have first-year or second-year cubs), and body condition (i.e., fatness). To do this, we selected representative subsets of photos, categorized them by time and location, and labeled individual bears across multiple photographs. The resulting set of processed photographs was evaluated by multiple polar bear experts, and the results were statistically analyzed. Based on knowledge of polar bear social systems and an initial review of the photographs, we hypothesized that both feeding activity and the locations of bears in the vicinity of the carcass will be structured by sex, age, reproductive status, and time of day. This study provides a unique opportunity to collect information on a large number of polar bears and document behavioral interactions. The resulting information will help address key conservation challenges for the AC polar bear population, including the effects of sea-ice loss due to climate warming, increased industrial activity, and identifying a sustainable rate for subsistence harvest.