Undergraduate Research Symposium May 17, 2013 Mary Gates Hall

Online Proceedings

SESSION 1L

QUANTIFYING THE EFFECTS OF HUMANS ON THE ENVIRONMENT

Session Moderator: Bonnie Becker, Academic Affairs (Tacoma)
271 MGH
1:15 PM to 2:45 PM
* Note: Titles in order of presentation.

Metallothionein as a Bio-Indicator of Metal Toxicity in South Puget Sound
Michelle M. (Michelle) Mc Cartha, Senior, Environmental Science, UW Tacoma
Katie Best, Non-Matriculated,
Mentor: Bonnie Becker, Academic Affairs (Tacoma), UW Tacoma
Mentor: Jim Gawel, Environmental Science, University of Washington Tacoma

Metallothionein (MT) is produced by benthic invertebrates in response to metal pollution, and as such provides a valuable tool for monitoring metal contamination impacts in Puget Sound. In this study, we explored the degree of correlation between MT in benthic invertebrates and metal contamination both in the field and in the lab. Seven stations were sampled, including five in Commencement Bay, an industrial harbor, and two control sites near the less impacted Nisqually delta. MT concentrations in collective samples of benthic worms were analyzed and compared with metal concentrations (Cd, Cu, Pb, and Zn) found in sediments to determine the benthic response to metal stress *in situ*. In addition, sediments were collected from all stations and used in a lab validation study exposing clean polychaete worms, *Alitta virens* (formerly *Nereis virens*), to metals in the sediments for 21 days in order to determine how the proteins develop in a controlled environment absent of normal adaptive responses. Both the collective sample of worms and *Alitta virens* were analyzed for MT concentrations using a published spectrophotometric method. Results indicated that average MT concentrations for *in situ* worms and metals concentrations Cu, Pb, and Zn at the Point Defiance station were higher than other stations. This is suggestive of a relationship between metals in the sediment and MT in the worms, although in some cases, the pattern is complicated by the bioavailability of metals as reflected with grain size. Quantifying MT allows for measurement of the bioavailability of metals, which can be difficult to quantify in other ways, such as directly sampling sediments. The use of MT in marine worms as a bioindicator of metal stress may be beneficial in monitoring the health of Puget Sound.

SESSION 2S

ASTRONOMY AND PHYSICS

Session Moderator: Suzanne Hawley, Astronomy
026 JHN
3:45 PM to 5:15 PM
* Note: Titles in order of presentation.

Detection of Transiting Exoplanets using Kepler Lightcurves
John Mark (John) Mehlhaff, Junior, Computer Science, Physics: Comprehensive Physics
NASA Space Grant Scholar
Nancy Helen (Nancy) Thomas, Senior, Astronomy, Physics
Mary Gates Scholar, NASA Space Grant Scholar, Undergraduate Research Conference Travel Awardee, UW Honors Program
Christopher James Martin, Senior, Astronomy, Physics
Mentor: Eric Agol, Astronomy
Mentor: Andrew Becker, Astronomy
Mentor: Benjamin Vega-Westhoff, Astronomy

Exoplanets are planets outside our solar system, and the current explosion in exoplanet discoveries is revolutionizing our understanding of the potential for extraterrestrial life. This prolific era of detections has stemmed largely from the unprecedented observing capabilities of NASA's Kepler Space Telescope. The Kepler Spacecraft collects high precision time-series photometric data on a fixed group of approximately 160,000 stars. The data are represented by temporal lightcurves (i.e. brightness vs. time) that can be used to detect transiting exoplanets, the topic of our research. Transits are events where an orbiting planet partially eclipses its host star, casting a small shadow on the telescope. To detect transit signals, we rely on the Quasi-Periodic Automated Transit Search Algorithm (QATS). As an automated tool, QATS provides a crucial means to reduce the Kepler dataset to a manageable size. However, since the algorithm is sensitive to stellar variability, eclipsing binary stars, and systematic artifacts of the

spacecraft, additional analysis is required to separate true detections from false positives. Determining the best way to do this is the present focus of our work. Concurrently, we are exploring the potential for QATS not only to determine orbital period, but also to constrain transit depth and duration (properties related to the size of the exoplanet and to the density of the stellar host). While this increases the complexity of the QATS algorithm and the amount of output to manage, it provides greater potential for a fully automated transit search process with results that are more descriptive of the exoplanet systems detected.

POSTER SESSION 3

Balcony, Easel 97

2:30 PM to 4:00 PM

Mapping Thirteen Years of Benthic Invertebrate Monitoring Data in Puget Sound, WA

Sharon Ellen (Sharon) Hunter, Senior, Environmental Science, UW Tacoma
Michelle Christine Knowlen, Fifth Year, Environmental Science, UW Tacoma
Mentor: Bonnie Becker, Academic Affairs (Tacoma), UW Tacoma

The presence, absence, and abundance of pollution sensitive and pollution tolerant benthic invertebrate (benthos) species are a key indicator of the health of the Puget Sound. We worked with the Washington State Department of Ecology's Marine Sediment Monitoring Team, part of the Puget Sound Ecosystem Monitoring Program (PSEMP), to compare how the abundance of pollution sensitive and pollution tolerant benthos has changed both spatially and temporally in the Puget Sound region. Data from 1997-2009 was provided by PSEMP and, in addition, we assisted in data collection during the 2012 field season. Marine stations throughout the Puget Sound region were selected by random spatial design and sampled with a Van Veen sediment grab. All collected benthos were sorted and identified to the lowest possible taxonomic level. To track spatial and temporal changes in benthos populations at each station, we constructed maps using ESRI ArcMap 10.0 GIS mapping software. Of the 60 species analyzed, the two strongest pollution sensitive (genera *Ampelisca* and *Amphiodia*) and pollution tolerant (family Cirratulidae and genera *Axinopsida*) were selected to show changes in distribution patterns over time to reflect contamination patterns. Overall, total abundance of benthos has decreased over time throughout the Puget Sound region. Within urban bays in particular, pollution sensitive genera appear to be decreasing in abundance while that of pollution tolerant genera is increasing. Areas where significant cleanup efforts have occurred, such as Commencement Bay, have seen an increase of some pollution sensitive genera (*Amphiodia*). Our results suggest that there has been a decline in benthic health and diversity over time in the Puget Sound area.

POSTER SESSION 3

Balcony, Easel 100

2:30 PM to 4:00 PM

Olympia Oyster Larval Distribution in a Small Restored Bay in Puget Sound: A Pilot Study Using Passive Tube Traps and qPCR

Hannah Parker, Senior, Environmental Science, UW Tacoma
Mentor: Bonnie Becker, Academic Affairs (Tacoma), UW Tacoma

The Olympia oyster (*Ostrea lurida*) is the subject of many restoration projects in the Pacific Northwest. In situ larval counts during breeding seasons can be used to assess the efficacy of such projects and the health of *O. lurida* populations, but sorting and identifying larvae is time and resource intensive, limiting the practicality of this method. In this experiment, we combined time-integrating larval tube traps and quantitative polymerase chain reactions (qPCR) to determine the applicability of using these methods in tandem for larval surveys. Fidalgo Bay, a site with a restored population of *O. lurida*, was chosen for the pilot, where we deployed six traps for one week and an additional set the following week in the same locations. I filtered, prepared, and analyzed our trap samples using the qPCR method. Inhibition of qPCR was detected in some standards and field-collected samples. Preliminary results derived from samples without inhibition indicate larvae in approximate quantities realistic to the scope of this study. With minor modifications, these methods have the potential to simplify and make feasible larval surveys that could otherwise be too impractical to undertake.

POSTER SESSION 3

MGH 241, Easel 155

2:30 PM to 4:00 PM

Temperature Effects on Byssal Thread Production in the Mussel, *Mytilus trossulus*

Michelle Christine Knowlen, Fifth Year, Environmental Science, UW Tacoma
Angeline Blattenbauer, Sophomore, Biology (Ecology, Evolution & Conservation)
Mentor: Marianne Porter, Friday Harbor
Mentor: Bonnie Becker, Academic Affairs (Tacoma), UW Tacoma
Mentor: Laura Newcomb, Biology

Mussels attach themselves to hard substrates by extruding thin, strong, and flexible hair-like attachments known as byssal threads, which are anchored in place with small adhesive plaques. While many studies have examined how multiple abiotic variables affect mussel attachment strength, few

have performed extensive single variable tests within a controlled lab setting. In this study, we investigated the effects of temperature on byssus production in the native Northern Pacific intertidal blue mussel, *Mytilus trossulus*, and expected to see a decline in production with increasing temperatures (specifically, between 18C-25C). We also hypothesized that threads produced in warmer temperatures would show a visual decline in quality, either through thinning, degradation, or tearing. Mussels were placed in a temperature controlled flume for 24 hours. Six different trials were run at 10C, 14C, 18C, 20C, 22C, and 25C. Byssal threads were counted for the duration of each trial to determine production and rate of attachment. Threads produced under these different temperature regimes were analyzed using scanning electron microscopy to visually compare differences in quality. Overall, there was a significantly negative correlation between thread production and increases in temperature, with the highest amount occurring at 18C (11.25 threads +2.0 s.e.m.) and the lowest at 25C (0 threads). Acclimatization and rate of thread production was also negatively affected by temperature increases. In addition, we saw a significant difference in percentage of mussel attachment between temperatures, with up to 93% attached in the 10C and 18C treatments and 50-0% in the 20C-25C treatments. However, visual analyses of thread quality differences were inconclusive. Our findings indicate that climatic temperature increases may negatively affect both the range of *M. trossulus* within Northern Pacific rocky intertidal zones as well as potentially setback the aquaculture of the species.

POSTER SESSION 3

Balcony, Easel 101

2:30 PM to 4:00 PM

Effects of Low-Severity Fire on Structural Attributes and Radial Tree Growth in Abies Concolor-Dominated Forest, Yosemite National Park, CA

Jamie Maran (Jamie) Wilson, Senior, Environmental Studies
Mentor: Kendall Becker, School of Environmental and Forest Sciences
Mentor: James Lutz, Forest Resources

A century of fire suppression has led to higher tree densities, higher basal area, and increased abundance of shade-tolerant Abies concolor and Calocedrus decurrens in the lower montane forests of Yosemite National Park. Although fire was reintroduced to these systems over forty years ago, the effects of fire on forest structure and radial tree growth are still not well understood. This study compares live tree and snag basal area and density, seedling establishment, and radial growth patterns at four 0.1 ha plots in A. concolor-dominated stands of similar climatic water balance. Two sites had burned at different levels of low-severity fire in 2005, and two sites had not burned since the onset of fire suppression. On average, unburned plots had three times the tree density and 2.6 times more trees with DBH between 2.5 cm and 30.0 cm than burned plots. Burned plots had a mean seedling density 3.8 times greater than unburned plots. Low-severity fire also appeared to affect radial growth patterns as both burned plots showed decreased growth relative to the control plots for two years immediately post-fire. However, only burned plot 1, which burned at a higher severity than burned plot 2, showed increased growth relative to control plots 3 to 5 years post-fire. This study has implications pertaining to frequent fire forests of the West.

POSTER SESSION 3

Commons East, Easel 48

2:30 PM to 4:00 PM

Adoptively Transferred Lymphocytes Influences Immunological Profile and Myelin Composition Following Stroke

Derek Tang (Derek) Nhan, Senior, Neurobiology, Biochemistry
Howard Hughes Scholar, Mary Gates Scholar, Washington Research Foundation Fellow
Mentor: Kyra Becker, Neurology

Approximately 800,000 Americans suffer a stroke each year, making this neurological disease the leading cause of adult disability in the US. An ischemic stroke occurs when blood flow to the brain is interrupted, resulting in inadequate oxygen delivery to brain cells. Currently, only one intervention has proven to improve outcome after stroke and must be given shortly after stroke onset. Effective interventions given at delayed time points after stroke are needed. During stroke, breakdown of the blood-brain barrier allows for interactions between once-segregated central nervous system antigens and the systemic immune system. My project investigates the effects of a cellular immune response directed towards myelin basic protein (MBP) and the interactions between $CD8^+$ on myelin and stroke outcome in experimental cerebral ischemia. In this model, Lewis rats are subjected to middle cerebral arterial occlusion (2 hours) and injected with either lipopolysaccharhide, shown to elicit an immune response to MBP, or saline (control). I performed a battery of behavioral tests, including a standard neurological score for rodents and evaluation of rotarod performance at set time points before and after stroke. Using double-label immunocytochemistry, the brain sections were labeled for $CD8^+$ and MBP. Quantitative analysis of myelin between the infarcted and non-infarcted hemispheres was performed using *Metamorph*; the numbers of $CD8^+$ lymphocytes were counted in a standard fashion. Preliminary data show prominent demyelination in the infarcted regions. Additionally, we observed a correlation between myelin loss and performance on the rotarod immediately post-stroke, though further results are

pending. The goals for this project are to (1) determine if animals receiving MBP specific lymphocytes adoptively at stroke onset suffer more myelin loss than those receiving lymphocytes unreacted to MBP and (2) determine if the number of $CD8^+$ lymphocytes within the infarct correlate with the extent of myelin loss, and degree of the MBP response among the adoptively transferred lymphocytes.

POSTER SESSION 3

Commons East, Easel 47

2:30 PM to 4:00 PM

Survival Pathways in Cancer Cells: E-selectin and the Activation of Anti-Apoptotic Pathways in Acute Myeloid Leukemia

Siraj Ul (Siraj) Haq, Senior, Biology (General)
Mentor: Pamela Becker, Medicine

Acute myeloid leukemia (AML) is a cancer characterized by the accumulation of abnormal immature white blood cells in the bone marrow. This proliferation impairs normal blood production and leads to suppression of normal blood counts, increasing susceptibility to infection and bleeding. Adhesion of leukemia cells within the bone marrow confers resistance to chemotherapy drugs. E-selectin is a molecule on the surface of endothelial cells lining blood vessels; it mediates the adhesion of white blood cells to vessels within bone, and may play a role in the residence of leukemia in the bone marrow "vascular niche." Interaction of cancer cells with E selectin has been shown to activate survival pathways such as PI3K-NFκB, making cells less susceptible to apoptosis (programmed cell death). Using an assay for E-selectin and analysis via RT-PCR, we have preliminary data suggesting that binding of cells from a specific patient sample to E-selectin up-regulated genes in the TGF-beta, Wnt and Hedgehog signaling pathways, the latter of which may play a role in drug resistance in CD34+ leukemia cells. Further work aims to demonstrate that the activation of these survival pathways is consistent across a range of cell samples, and to investigate whether up-regulation extends to other pathways known to inhibit apoptosis in cancer cells. Knowledge of the mechanisms by which leukemia cells increase their survival upon binding ligands in their environment such as E-selectin could aid the design of therapies aimed at treating AML, and potentially help overcome the persistent problem of resistance to chemotherapeutic agents.