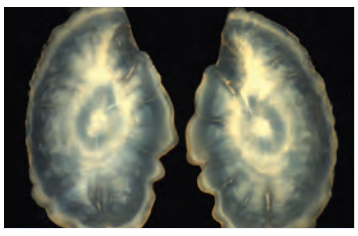
33rd ANNUAL

SAFS GRADUATE STUDENT SYMPOSIUM



Friday, November 18, 2022
9am–5pm
FSH 107

Oral Presentations

Poster session and reception in the SAFS lobby at 5pm

Contact: safsgss@uw.edu

This annual event is sponsored by the Skau Endowment, established in memory of Oscar Skau by his family and friends.

photo credits: center: Jess Diallo; clockwise from upper right: Arial Brewer, Markus Min, Emily Bishop, Jess Diallo, Miranda Roethler

SCHOOL OF AQUATIC AND FISHERY SCIENCES
COLLEGE OF THE ENVIRONMENT | UNIVERSITY OF WASHINGTON

Program

Believe it or not, my first GSS event was way back in Autumn of 1995. I was a graduate student spending a quarter at the then-named School of Fisheries and got wind of this "graduate symposium thing." Naturally, my interest was piqued, so I arrived that day thinking I'd learn a thing or two. I had no idea what I was walking into. Nothing had prepared me for the breadth of research topics and scientific approaches, the quality of the science being presented, or the quality of the dialogue among the students. Needless to say, I was impressed.

Fast forward to 2003, I returned to the School, this time as a wide-eyed Assistant Professor, and once again got wind of this "graduate student seminar" and that "this is a big deal" and "you should cancel your classes." Being an Assistant Professor, I did as I was told, headed over to Anderson Hall, wondered why there was a big Elk on the wall, and settled into a kinda gross-but-still-comfortable plush chair for a full day of presentations. I was treated to talks spanning aquaculture, salmon biology and ecology, population genetics, stock assessment, and even one talk on Elk.

In my nearly 20 years here at SAFS, GSS has remained one of my fondest events of the year. Every year I learn something. Every year I grow more impressed with the sophistication of the research being done and the extremely high level of academic achievement that is on display. And every year, the quality of the science and presentations remarkably gets better and better. The evolution of this program to include a wider diversity of talks and workshops speaks to the exceptional forward-thinking leadership of the SAFS graduate student body.

This year's lineup of presentations is as diverse as ever. We'll be hearing from graduate students in their first year and in their fifth year. There will be coral reefs, there will be oysters, and there will be polar bears. And for possibly the first time, there will be more presentations about cetaceans than salmon!

Many thanks to the organizing team – Arial Brewer, Emily Bishop, Maria Kuruvila, Jessica Diallo, and Tessa Code – not only for their exceptional organization but also their adaptability to respond to changing availability of rooms and resources. Thank you as well to all of the volunteer judges. Finally, special thanks go out to the Skau family, whose generous gift to the School makes this event possible each year.

I look forward to seeing everyone in the not-so-gross-but-not-plush chairs in FSH 107.

Timothy E. Essington

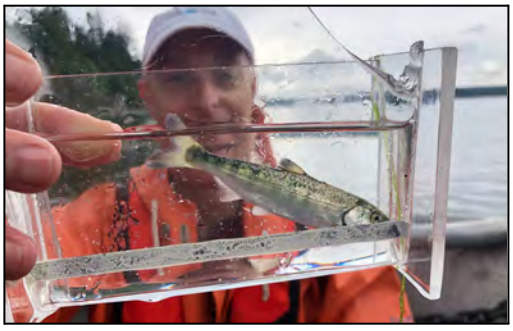


Photo: Emily Bishop

Schedule

9:00 – 9:15 Refreshments (Coffee & Tea)

9:20 Welcome and Opening Remarks
FSH 107
2022 GSS Coordinators—Emily Bishop, Maria Kuruvilla, Arial Brewer, Jessica Diallo and Tessa Code
Dr. Tim Essington, School of Aquatic & Fishery Sciences

9:30 – 10:30 Standard talks – MS students I
Moderator: Helena McMonagle

10:30 – 10:45 Break

10:45 – 11:45 Lightning Talks
Moderator: Miranda Roethler

11:45 – 12:30 Lunch Break

12:30 – 1:30 Quantitative Seminar
room FSH 203

1:30 – 1:45 Break

1:45 – 3:00 Standard talks – MS students II
Moderator: Anna Simeon

3:00 – 3:15 Break

Zooplankton samples collected for the long term limnological monitoring in Lake Washington
Photo: Tessa Code, hand model: Arielle Tonus Ellis

3:15 – 4:15 Standard talks – PhD students & Leaky Boot Talk
Moderator: Terrance Wang

4:15 – 5:00 Break /Optional Powerpoint Karaoke Game

5:00 Poster session & Reception
Fisheries Sciences Building lobby

This annual event is sponsored by the Skau Endowment, established in memory of Oscar Skau by his family and friends.

We invite those joining us for this event to reflect on and acknowledge the people whose ancestral homelands and traditional territories you are calling in from. We invite you to honor the community, past and present, and the land, with gratitude. Consider visiting native-land.ca to learn more.

The University of Washington acknowledges the Coast Salish peoples of this land, the land which touches the shared waters of all tribes and bands within the Suquamish, Tulalip, and Muckleshoot nations.

Presentations

Standard Conference Talks – MS students I

9:30 Callum Backstrom
Tracking heavy metals in tissue, skeleton, and gametes during bleaching stress and recovery in the Hawaiian reef building coral *Montipora capitata*

9:45 Jessica Diallo
Fish invaders cause a lifetime of trophic change in native desert fishes

10:00 Miranda Roethler
Effects of climate change on bull kelp photophysiology

10:15 Sarah Teman
Epizootiology of a *Cryptococcus gattii* outbreak in porpoises and dolphins from the Salish Sea

10:30 – 10:45 Break

Beach seine in Lake Wilderness, Photo: Jessica Diallo

Lightning talks

10:45 Nicole Doran
Investigating the Impacts of Multiple Stressors on an Urban Freshwater Ecosystem

10:50 Eve Hallock
A Baseline Study of Breeding Seabirds on a Tropical Atoll

10:55 Sarah Yerrance
Shooting Deepwater Aliens with a Submarine

11:00 Emily Bishop
Evaluating associations between shoreline armoring and subtidal fish distribution

11:05 Claire Vaage
Combining a topographic model and land cover classification to enable targeted restoration of riparian vegetation in semi-arid watersheds

11:10 Sarah Tanja
A little is a lot: plasticizers reduce coral fertilization success

11:15 Zach Bengtsson
Understanding the epigenetics of resilience in marine invertebrates

11:20: Markus Min
Questionable historical marine mammal management practices in Washington state

11:25 Zoe Rand
Fetal sex ratios of exploited whales

Presentations

11:30 Helena McMonagle
Fish and the carbon cycle: do they matter?

11:35 Q & A for lightning talk presenters

11:45 – 12:30 Lunch Break

12:30-1:30 Quantitative Seminar
room FSH 203
Dr. Lisanne Petracca
Optimizing range-wide monitoring of a burrow-nesting seabird in its North American range

1:30 – 1:45 Break

Standard Conference Talks – MS students II

1:45 Olivia Cattau
Citrate-Synthase Response and Multiple-Stress in Pacific Oysters (*C. gigas*)

2:00 Liz Allyn
Mysid distribution, demographics, and co-occurrence with gray whales in northwest Washington State

2:15 Bryan Briones Ortiz
Landscape Genetics of Eelgrass Populations and Life History Types in the Pacific Northwest, USA

2:30 Arial Brewer
Vocal behavior of the endangered Cook Inlet beluga whale population

2:45 Nick Chambers
Variation in dispersal capacity may influence recruitment of steelhead (*Oncorhynchus mykiss*)

3:00 – 3:15 Break

Deep in an undercut, these Summer Coho, Bull Trout and Summer steelhead have found a low water refuge
Photo: Nick Chambers

Standard Conference Talks – PhD students

3:15 Chris Setzke
Impacts of managed gene flow on disease resistance in captive breeding Chinook salmon

3:30 Jenny Stern
Space-use strategies drive diet composition of Baffin Bay polar bears

3:45 Juliette Jacquemont
Can MPAs contribute to climate change mitigation and adaptation?

Presentations

Janay holding a red swamp crayfish
Photo: Emily Jameson

Leaky Boot Talk

4:00 Karl Veggerby & Zoe Rand
Grandma's Little Munchkins: How to lose the Nenana Ice Classic

POSTER SESSION

5:00 – 7:00 Poster Session & Reception at SAFS FSH Lobby

Marta Gomez-Buckley
The Cryptic Taxonomy of Cryptobenthic Reef Fishes in the *Eviota sigillata* Complex

Anna Hedemark
Effects of Temperature and Salinity Changes on the Clearance Rate of the Pacific Blue Mussel (*Mytilus trossulus*) in Friday Harbor, San Juan Islands, WA.

Andrea Limon, Michael Yurecko
Effects of High Temperature, Low Salinity And Predator Cues on Byssal thread production of Pacific Blue Mussel, *Mytilus trossulus*

Ella Persson, Jules Yearous, Jake Elliot
Change in Purple sea urchin (*Strongylocentrotus purpuratus*) Feeding Preference in Different Environments

Erika Pirozok, Josie McKillop, Emma Smith, Madison Weise
The Impacts of Temperature and Salinity on Growth Rates of Kelp Species

Olivia Anderson
Effects of Temperature Change on Bioluminescent Dinoflagellate *Noctiluca scintillans*

Sculpin at Turn Island, San Juans
Photo: Emily Bishop

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Pigeon guillemot banding on Protection Island
Photo: Liam Pendleton

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Standard talks: MS students I

Callum Backstrom, MS

Major Professor: Jacqueline Padilla-Gamiño

Tracking heavy metals in tissue, skeleton, and gametes during bleaching stress and recovery in the Hawaiian reef building coral Montipora capitata

Rising sea temperatures have led to increased rates of coral bleaching, causing thermally stressed corals to expel their algal symbionts, stunting growth and reproduction. During bleaching, corals can rely heterotrophically on zooplankton/detritus for energy. However, these food sources could also cause bleached corals to bioaccumulate heavy metals, which can be toxic in elevated concentrations. We investigated two questions: 1) Does thermal stress increase heavy metal levels in coral tissues due to increased heterotrophy? 2) Does bleaching status influence heavy metal levels in coral gametes? In September 2017, we thermally stressed *Montipora capitata* colonies in Kāneʻohe Bay, Hawaiʻi and sampled bleached and nonbleached colonies through July 2018. We collected egg-sperm bundles released during the 2018 summer spawning event to quantify metals within gametes. After thermal stress, arsenic, cadmium, manganese, and vanadium decreased in coral tissue, ranging from 25% (for arsenic) to 57% (for cadmium), possibly due to the loss of symbiotic algae. All depleted metals increased to pre-bleaching levels by the time full symbiont recovery was recorded (June 2018), suggesting these metals are stored or acquired only in the presence of symbionts, and not by increased heterotrophy. Previous bleaching history of parent colonies did not affect metal levels in egg-sperm bundles. However, gamete arsenic concentrations were notably high (up to 70% of parent tissue arsenic concentrations), possibly due to arsenic's high lipid affinity. This study shows the variability in heavy metal loss and acquisition in bleached corals and the relative consistency of heavy metal transfer to gametes despite prior bleaching stress.

Callum leads the Marine Biology class on a field trip to Alki Beach
Photo: Miranda Roethler

Jessica Diallo, MS

Major Professor: Julian Olden

Fish invaders cause a lifetime of trophic change in native desert fishes

Invasive fishes modify the structure and function of riverine food webs through their presence and competitive and predatory interactions with native fishes. The degree of trophic plasticity of native fishes at different life stages in response to invaders is unknown. Here, we gain insight into life-long trends in dietary isotope values using fish eye lenses that grow incrementally and are comprised of metabolically inert, proteinaceous tissue. The findings demonstrate significant shifts in 13C/12C and 15N/14N throughout an individual's lifetime

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that vary ontogenetically and differ for native species in native-only versus mixed native-invasive fish assemblages. Trophic level generally increases throughout ontogeny, with native fishes in mixed assemblages displaced to a lower trophic position compared to native-only. Native fish conservation should consider how invasive fishes impact native fishes at multiple life stages, with implications for individual growth and population persistence.

Miranda Roethler, MS

Major Professor: Jacqueline Padilla-Gamiño

Effects of climate change on bull kelp photophysiology

Bull kelp (*Nereocystis luetkeana*) is a vital ecosystem engineer that provides food, habitat, carbon sequestration, recreation opportunity, shoreline protection, and cultural identity to residents of the Salish Sea, humans and fauna alike. Recent studies have documented a decline in bull kelp in the Salish Sea, and this decline is at least in part due to rising ocean temperatures. The purpose of this study was to see how bull kelp photophysiology (photosynthesis, respiration, and fluorescence) was affected by future ocean conditions (elevated temperature and pCO2). Adult sporophyte blades from two genetically distinct populations in Puget Sound (Elliott Bay and Whidbey Island) were collected and exposed in the lab to short-term heat and acidification trials, after which we measured fluorescence and photosynthesis rates. The two populations had different overall rates of photosynthesis and fluorescence but had similar reactions to elevated temperature and pCO2; namely, low pH (7.4) resulted in higher photosynthetic rates, whereas high temperatures resulted in lower photosynthetic rates, and 20-25C was a critical threshold beyond which photosynthesis was severely compromised. This study demonstrates the important role of temperature in shaping kelp photophysiology, and further demonstrates how kelp in the Salish Sea may respond differently to stressors, even at a very fine geographic scale.

A reproductive bull kelp blade that has shed its sori
Photo: Miranda Roethler

Sarah Teman, MS

Major Professor: Kristin Laidre

Epizootiology of a Cryptococcus gattii outbreak in porpoises and dolphins from the Salish Sea

Cryptococcus gattii is a fungal pathogen that primarily affects the respiratory and nervous systems of humans and other animals. *C. gattii* emerged in temperate North America in 1999 as a multispecies outbreak of cryptococcosis in British Columbia (Canada) and Washington State and Oregon (USA), affecting humans, domestic animals, and wildlife. Here we describe the *C. gattii* epizootic in odontocetes. Cases of *C. gattii* were identified in 42 odontocetes in Washington and British Columbia between 1997 and 2016. Species affected included harbor porpoises *Phocoena phocoena* (n = 26), Dall's porpoises *Phocoenoides dalli* (n = 14), and Pacific white-sided dolphins Lagenorhynchus obliquidens (n = 2). The probable index case was identified in an adult male Dall's porpoise in 1997, 2 yr prior to the initial terrestrial outbreak. The spatiotemporal extent of the *C. gattii* epizootic was defined, and cases in odontocetes were found to be clustered around

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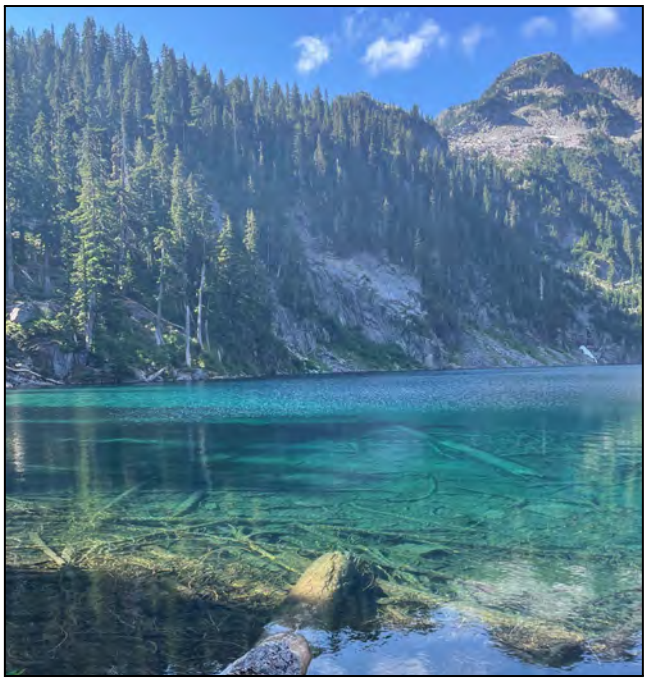
terrestrial *C. gattii* hotspots. Case-control analyses with stranded, uninfected odontocetes revealed that risk factors for infection were species (Dall's porpoises), age class (adult animals), and season (winter). This study suggests that mycoses are an emerging source of mortality for odontocetes, and that outbreaks may be associated with anthropogenic environmental disturbance.



Lake Malachite
Photo: Jessica Diallo

Lightning Talks

Nicole Doran, MS

Major Professor: Mark Scheuerell

Investigating the Impacts of Multiple Stressors on an Urban Freshwater Ecosystem

Urban freshwater ecosystems are impacted by multiple anthropogenic stressors such as climate change, urban development, and introduced species. There has been increased interest in understanding how stressors interact to affect important top-down and bottom-up processes. In some cases, quantitative approaches have been used to estimate the direction and magnitude of various effects, but these studies have multiple limitation that make them unsuitable for data poor systems. In this study we provide a framework for studying multiple interacting stressors in an understudied freshwater ecosystem, Lake Sammamish, located in western Washington, where a genetically distinct population of Kokanee salmon. has experienced drastic declines from numerous synergistic causes. These include loss of spawning and rearing habitat in the lake and its tributaries, increased temperature and decreased dissolved oxygen regimes owing to climate change, and introduced piscivorous fishes such as Smallmouth Bass and Yellow Perch. However, the degree to which each of these factors affects different life stages of Kokanee and inhibits their recovery is unknown. Here we describe a framework for combining multiple complementary approaches to address these shortcomings in our knowledge. In partnership with local citizens, tribes, non-governmental organizations, and government agencies, we are undertaking a complimentary set of observational and comparative studies, which include assessments of predator diets, stable isotope analyses of food web structure and energy flow, and life cycle modeling. By leveraging the complementary strengths of different stakeholder groups, we can better tease apart the interactions among multiple stressors to understand their combined impact on the Lake Sammamish Kokanee population.

Eve Hallock, MS

Major Professor: Sarah Converse / Beth Gardner

A Baseline Study of Breeding Seabirds on a Tropical Atoll

In 2018, the Quantitative Conservation and Quantitative Ecology labs commenced a baseline breeding seabird study on Tetiaroa Atoll in French Polynesia. Eleven seabird species, including the Red-footed Booby (*S. sula*), Brown Noddy (*Anous stolidus*), White Tern (*Gygis alba*) Brown Booby (Sula leucogaster), and others breed on twelve low-lying coral motus (islets). A large-scale rat eradication project is in progress to remove two species of non-native rats: the Polynesian rat (Rattus exulans) and Black rat (R. rattus), which predate seabird eggs.

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We plan to compare nest success of the Brown Booby population prior to and post eradication. In addition, we are conducting point and nest density counts of all avian species across 110 sites, 41 of which have continuous audio recorders deployed. With this count data, we will determine breeding peaks and seasonality for all nesting and resident species, and develop a model to predict shifts in seabird distributions.

Emily Bishop, Kali Stone & Julia Indivero out surveying fish by Vashon Is.
Photo: Emily Bishop

Sarah Yarrance, MS

Major Professor: Luke Tornabene

Shooting Deepwater Aliens with a Submarine

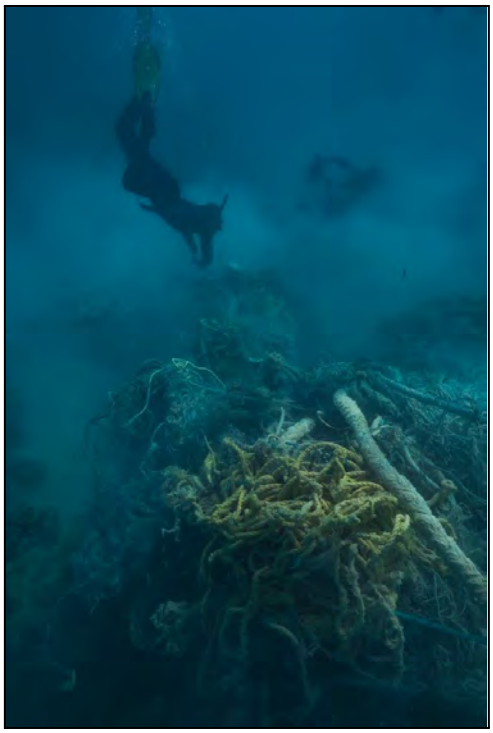
What are lionfish doing past recreational dive limits? Are they eating undescribed species unchecked? Are they reproducing wildly? Just hanging out? Through gut content analysis and potentially size/gonad data, I'm going to try to uncover lionfish ecology and evidence of vertical migrations in the Caribbean.

Emily Bishop, MS

Major Professor: Tim Essington

Evaluating associations between shoreline armoring and subtidal fish distribution

Coastal nearshore marine habitats play an important role for the juvenile life phase of many culturally and economically significant fish species, but these environments are frequently altered by humans. For example, in the Puget Sound region of the Salish Sea 29% of shorelines have some form of armoring. Armoring refers to artificial structures, in the form of bulkheads, seawalls, and revetments, which landowners install to slow natural erosion to stabilize and preserve upland area. Protection of upland area, however, comes at the cost of dynamic ecological processes at the land-water interface and into the subtidal environment. Armored shorelines have reduced intertidal habitat, coarser sediment, and steeper slopes than natural beaches which may have a significant and overlooked effect on the ecology of neighboring subtidal marine species. My research aims to advance our understanding of the circumstances which cause armoring to have an impact on nearshore fish populations in order to maximize habitat restoration potential in urban estuaries. To that end, the first chapter of my thesis will explore how armoring extent influences fish abundance across spatial scales. This will enable more efficient use of restoration funds and support commercially valuable species, which in turn support the wellbeing and sense of place for Puget Sound residents.



Freediving to remove derelict fishing equipment in the Papahanaumokuakea National Monument
Photo: Tessa Code

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A 22-lb Tiger Muskie Claire netted during overnight electrofishing surveys with the Idaho Department of Fish and Game at Carlson Lake, Custer County, Idaho. Photo: Claire Vaage

Claire Vaage, MS

Major Professor: Julian Olden

Combining a topographic model and land cover classification to enable targeted restoration of riparian vegetation in semi-arid watersheds

Riparian vegetation is critically important for dryland ecosystem functions which include maintaining water temperatures for resident fish populations, enhancing carbon sequestration, stabilizing stream banks, and supplying and retaining nutrients within water systems. Development of restoration strategies for these vital zones should reflect our knowledge of geomorphological controls and accurate identification of the true extent of characteristic riparian vegetation. Modeling hydrological dynamics within an ecosystem requires defining a riparian buffer through fixed-width or variable-width approaches. Fixed-width buffers are not practical for restoration-oriented management because they do not accurately capture smaller, unique riparian areas and are designed for purposes like pollutant removal. Using a 1-m spatial resolution digital elevation model (DEM) derived from aerial lidar, we created a hydrologic network to represent the riparian zones within the southwestern section of the Dry Creek Experimental Watershed in Idaho, USA. To create our spatial model, we generated random points on the stream network for digitization and ground truth verification. Then, we developed a regression model to predict riparian vegetation width using terrain-based variables and tested fixed distances at 10-, 20-, and 30-meters from the hydrologic network. Combining this model with a land cover classification, we identified areas that should be targeted for restoration. Our results include a framework that leverages the increasing availability of remotely sensed data and land cover classification technology that can guide restoration efforts and enable additional research on the processes of riparian ecosystems within arid and semi-arid watersheds.

Sarah Tanja, MS

Major Professor: Jacqueline Padilla-Gamiño

A little is a lot: plasticizers reduce coral fertilization success

A quick chat on preliminary data regarding a controlled experiment dosing Montipora capitata coral egg-sperm bundles with low and high concentrations of phthalate-acid esters, commonly known as plasticizers. Initial results show that plasticizers reduce fertilization success in corals in an expected non-monotonic response, meaning not dose-dependent! A tiny amount reduces fertilization success just as much as a large amount. A little, is a lot!

Rice coral (Montipora capitata) Photo: Sarah Tanja

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On board the F/V Noah's Ark during the NWFSC West Coast Groundfish Bottom Trawl Survey
Photo: Markus Min

Zach Bengtsson, MS

Major Professor: Steven Roberts

Understanding the epigenetics of resilience in marine invertebrates

Planning for future climate challenges is limited by our understanding of how organisms cope with changing environmental conditions at the molecular level. I present a research plan drawing on an array of molecular techniques to examine mechanisms that may convey resilience to environmental stress in Eastern oysters (*Crassostrea virginica*), stony corals (*Pocillopora acuta, Montipora capitata*), and foolish mussels (*Mytilus trossulus*). The first chapter of my thesis will address heat stress response in foolish mussels using quantitative PCR methods to examine the expression of stress-related genes. My second chapter will identify long non-coding RNAs (lncRNAs) in Eastern oysters and stony corals via RNA-seq to examine their role in the regulation of gene expression and DNA methylation. A better understanding of environmental-epigenetic linkages could inform how we conceptualize rapid adaptation and prioritize the mitigation of many anthropogenic stressors.

Markus Min, MS

Major Professor: Mark Scheuerell

Questionable historical marine mammal management practices in Washington state

In the name of saving valuable food fish, the Washington Department of Fisheries used to do some weird stuff. In this lightning talk, I discuss one such example that I came across while going through old fisheries reports during my search for rockfish catch records from Puget Sound.

Lake Ballinger, WA Photo: Larissa Faria

Zoe Rand, PhD

Major Professor: Trevor Branch

Fetal sex ratios of exploited whales

It is often assumed that sex ratios of mammals at birth are 50:50. This seems logical, as biased sex ratios are likely to return to equilibrium since those producing the rare sex would have higher lifetime reproductive success. However, there are many theories as to how a deviation from 50:50 birth sex ratios could arise in mammals. These theories are hard to test because there are few large-scale datasets of mammalian fetal sexes. Large cetaceans were heavily exploited by whaling in the 20th century. Though this decimated many populations of whales, data gathered during this exploitation provides an extensive record of fetal sexes. We investigate deviations from a 50:50 fetal sex ratio in large

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cetaceans, while accounting for potential measurement and recording biases in the data. Findings from this study could be used in future population assessments of large cetaceans as well as provide evidence for fetal sex ratio theories.

Helena McMonagle, PhD

Major Professor: Tim Essington

Fish and the carbon cycle: do they matter?

Mesopelagic fishes dominate the global biomass of fishes. These small but abundant fishes are thought to contribute to marine carbon transport by consuming organic carbon near the surface at night and releasing it in the mesopelagic zone during the day. But could these small fishes substantially affect global carbon cycling? What drives uncertainty in these estimates? To investigate, we estimate the magnitude of fish-mediated carbon transport and determine which parameters contribute most to total uncertainty. We find that carbon flux estimates associated with each individual fish vary six-fold. Scaling up from the individual fish level to the ecosystem level using fish biomass data could add an order of magnitude of uncertainty.
Respiration-related parameters contribute most to parameter uncertainty, but we discover from further empirical work that these rates are challenging to measure. We conclude that it is not currently possible to estimate fish-mediated carbon flux precisely. In the future, these estimates may be incrementally constrained through dedicated empirical work on the most influential parameters. For now, we recommend honest communication of uncertainty in our understanding of this fishy ecosystem service.

Giant green anemones on the Olympic coast
Photo: Arial Brewer

Standard Talks: MS students II

Olivia Cattau, MS

Major Professor: Steven Roberts

Citrate-Synthase Response and Multiple-Stress in Pacific Oysters (C. gigas)

All oysters are experiencing a variety of increasingly intensive stressors such as temperature and ocean acidification but also, an additional stressor, polyploidy . The most troubling of these concerns is the increase in summertime low tide temperatures that causes heat and desiccation stress as the oysters are exposed to open air and direct sunlight. Despite the natural resilience of this species, there is increasing evidence that they are approaching their thermal limit as large-scale mortality events increase in frequency and intensity amongst the triploid stocks in particular. A new way to predict climate change tolerance in Pacific oysters (*C. gigas*) is to measure maximum aerobic capacity by direct measurement of citrate synthase (CS) enzyme activity. In this study, it was important to determine how the CS response changes with multiple increasing stressors (heat, desiccation and polyploidy). In theory, as CS response increases, the cellular respiration rate will increase and therefore thermal tolerance will decrease. Based on empirical observations, the CS response should be more intense with triploids rather than diploids. Interestingly, there was no significant evidence that triploids had higher CS levels than diploids. This leads to the conclusion that it is not heat or ploidy status alone that is causing mass mortality events rather, a combination of multiple factors.

Liz Allyn, MS

Major Professor: Tim Essington

Mysid distribution, demographics, and co-occurrence with gray whales in northwest Washington State

Mysid shrimps (Mysidacea) are an important prey item for the group of gray whales that feed along the coast of northern California to British Columbia,

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known as the Pacific Coast Feeding Group (PCFG). Previous studies documented close relationships between gray whale foraging behavior and mysid population dynamics in the PCFG range. We hypothesized that gray whale use patterns in northwest Washington would be associated with mysid density and species composition. Prey samples were collected in June – November 2019 and June – September 2020 using a vertically-towed plankton net at 7 sites in the Strait of Juan de Fuca and 7 sites in the Pacific Ocean in areas where gray whales were known to feed. The length, sex, species, maturity, and gravidity were recorded for sampled mysids. In 2019, the density of mysids increased throughout the feeding season and was composed of small (avg 4.7mm), immature mysids from both *Holmesimysis sculpta* and *Neomysis rayii*. In 2020, mysid density peaked in July and was composed of large (avg 13.3mm), sexually mature *H. sculpta*. Whale presence in the study area peaked in October 2019 and July 2020, followed by almost no whale presence after July 2020. The similar patterns in whale presence and mysid density points to a close relationship between gray whales and their primary prey in the region. The vastly different assemblage of mysids in 2019 and 2020 highlight the variation of prey availability in the PCFG range, and the complex tradeoffs that likely determine gray whale foraging distribution within this range.

Bryan Briones Ortiz, MS

Major Professor: Kerry Naish

Landscape Genetics of Eelgrass Populations and Life History Types in the Pacific Northwest, USA

The application of modern genetic techniques to the study of diversity in seagrasses may significantly improve their conservation success. Restoration in eelgrass (*Zostera marina*) is often hampered by a lack of information about the value of specific meadows to the population as a whole, because little is known about their population structure and potential for local adaptation. Most restoration efforts have approached success by evaluating transplant methods, timing of outplants, or comparing site conditions. However, less attention has been paid to matching phenotypes with environments, and maintaining population structure and diversity. Here, we aim to improve science-based decision-making by capitalizing on next-generation sequencing approaches to characterize patterns of eelgrass population structure across the landscape, and investigate evidence for divergence between life histories. Specifically, we use SNPs to describe genetic relatedness among 16 eelgrass populations distributed across the West Coast of the United States to provide insight about the relationship between population stratification and geography. In addition, we explore evidence for genetic differentiation between conspecific annual and perennial reproductive types, and between subtidal and intertidal habitats. The outcomes of this work will inform the selection of populations that best serve as sources for successful transplants during restoration and mitigation, and predict how such transplants would influence existing population genetic structure and disrupt local adaptation.

Cook Inlet beluga whales in Eagle Bay, Alaska
Photo: Arial Brewer

Arial Brewer, MS

Major Professor: Andrew Berdahl / Amy Van Cise

Vocal behavior of the endangered Cook Inlet beluga whale population

Understanding vocal behavior is crucial in the study of endangered species who rely heavily on acoustic communication for survival. It can reveal critical information communicated among conspecifics regarding predator avoidance, foraging locations, mate selection, and group cohesion, and aide managers in species conservation. Vocal repertoire

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analysis can provide a baseline for studies on conspecific communication, vocal learning in young animals, and population structure. Beluga whales (*Delphinapterus leucas*) are a highly gregarious and vocal species of cetacean and have a circumpolar distribution. Of the five populations in Alaska, the Cook Inlet population is the most endangered with a population estimate of 279 individuals. Among the threats listed as high concern, impacts from anthropogenic noise have the potential to negatively impact how this population communicates to conspecifics. We measured the acoustic characteristics of Cook Inlet beluga vocalizations (n=1,633) from two critical habitat locations (Trading Bay and Susitna River) across multiple seasons. Following previous repertoire studies, we classified vocalizations into three categories: whistles (n=1,264, 77.4%, 25 types), pulsed calls (n=354, 21.68%, 15 types) and combined calls (n=15, 0.92%, 7 types). We then compared the Cook Inlet beluga repertoire with published repertoires of other beluga populations to qualitatively describe geographic variation in call use. Since anthropogenic noise is considered a threat to this population, we also investigated the potential masking effect that commercial ship noise may have on important vocalizations. Understanding how and which vocalizations may be masked could provide important information supporting the management and conservation of this endangered population.

Steelhead parr enjoying the local nightlife in the Upper Skagit River, Photo: Nick Chambers

Nick Chambers, MS

Major Professor: Daniel Schindler

Variation in dispersal capacity may influence recruitment of steelhead (Oncorhynchus mykiss)

Salmonid populations are often assumed to follow an ideal free distribution where fish distribute themselves in a pattern that reflects the abundance and quality of habitats across a stream reach. This approach does not account for the ability of fish to access even relatively close habitat patches during life stages where dispersal may be limited and mortality is high. Limited dispersal distance of salmonid fry has been suggested to downwardly bias estimates of freshwater habitat capacity because models typically overestimate the amount of habitat fry are able to reach. To evaluate this theory, we assessed the dispersal distance of steelhead (*Oncorhynchus mykiss*) fry in the mainstem Skagit River and tributaries during the summer of 2021 and 2022. The majority of sites with single redds exhibited dispersal kernels where fry remained within 300m of linear stream channel from the redd. At sites with clustered redds the dispersal kernels extended up to approximately 1km of distance although most were substantially less. At all sites few fish were able to successfully disperse outside of the habitat unit where the redd was created. Reductions in the amount of accessible fry habitat at low adult escapements may result in capacity estimates which are lower than would be generated under an assumption of ideal free distribution. This may also lead to reduced per-capita growth rates and longer times to population recovery than expected using current assumptions.

Standard Talks: PhD students

Chris Setzke, PhD

Major Professor: Kerry Naish

Impacts of managed gene flow on disease resistance in captive breeding Chinook salmon

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Breeding individuals that hatch and rear in the wild with hatchery broodstock has been shown to reduce genetic divergence of hatchery populations from their natural source populations. Such managed gene flow – or "integration" - may reduce adverse effects of domestication selection on wild populations. However, the effects of such practices on disease resistance in hatchery individuals is unknown. If natural-origin individuals are more genetically diverse than hatchery-reared fish that are maintained as closed populations (segregated lines), they may have the ability to respond to selection following disease exposure. On the other hand, disease resistance can increase in smaller populations through genetic drift. Here we use challenge data from segregated and integrated hatchery lines of Chinook salmon in Washington State to assess the effectiveness of different hatchery strategies in mitigating disease risk in hatchery individuals. We challenged 1,125 juvenile Chinook salmon from integrated and segregated lines with Vibrio anguillarum and measured mortality for 14 days. Genomic data generated using RADseq was used to assign offspring to their respective parents and families. A generalized linear mixed model was then performed, with the best fit model including the fixed effects of line (integrated or segregated) and body length, and the random effect of family. We found that individuals from the integrated line had lower mortality, that mortality decreased with increased body length, and that there were large variations in mortality between families, both within the integrated and segregated lines. This study will help inform best management practices for disease mitigation in hatcheries.

Jenny Stern, PhD

Major Professor: Kristin Laidre

Space-use strategies drive diet composition of Baffin Bay polar bears

Polar bears depend on sea ice to hunt their ice-associated prey. Climate-induced sea ice loss is expected to result in bears changing space-use strategies, which will force bears to spend more time on land or find alternative habitats. Reliance on freshwater glacier ice provides an alternative habitat with year-round access to prey. Here, we use adipose tissue from polar bears (n = 114) live-captured in West Greenland from the Baffin Bay subpopulation during the spring in 2009−2013 to investigate dietary patterns between space-use strategies, demographic groups, and across sampling years. Using Quantitative Fatty Acid Signature Analysis (QFASA) to generate diet estimates, we indicate that ringed seals were the primary prey of Baffin Bay polar bears for all age classes and sampling years, apart from a single anomalous year with high beluga/narwhal consumption. We identified distinct differences in fatty acid compositions and QFASA estimates between polar bears using coastal and offshore space-use strategies. 'Offshore' adult females, bears that make long-distance movements across the pack ice, showed a strong linkage to the pelagic food chain with high proportions of 22-carbon length monosaturated fatty acids. 'Coastal' adult females, bears that remain resident at glacier fronts in Northwest Greenland year-round including the ice-free season, consumed proportionally more ringed seals and less beluga/narwhal and harp/hooded seal than offshore females. Developing a better understanding of how diet variability is related to space use in a rapidly changing environment will be important to understanding climate impacts on polar bear physiology and body condition.

A young polar bear pauses on the Canadian tundra. Photo: Jenny Stern

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Juliette Jacquemont, PhD

Major Professor: Luke Tornabene

Can MPAs contribute to climate change mitigation and adaptation?

Marine protected areas (MPAs) are increasingly being promoted as an ocean-based climate solution. Yet such claims remain controversial due to the diffuse and poorly synthesized literature on climate benefits of MPAs. To address this knowledge gap, we conducted a systematic literature review of 22,403 publications spanning 241 MPAs and analyzed these across 16 ecological and social pathways through which MPAs could contribute to climate change mitigation and adaptation. Our meta-analysis demonstrates that marine conservation can significantly enhance carbon sequestration, coastal protection, biodiversity and reproductive capacity of marine organisms, as well as fishers' catch and income. Most of these benefits are only achieved in fully or highly protected areas and increase with MPA age. Although MPAs alone cannot offset all climate change impacts, they are a useful tool for climate change mitigation and adaptation of social-ecological systems.

Leaky Boot

Karl Veggerby & Zoe Rand

Major Professor: Mark Scheuerell & Trevor Branch

Grandma's Little Munchkins: How to lose the Nenana Ice Classic

The Nenana Ice Classic is a yearly competition in Nenana, Alaska where participants guess down to the minute when a pole frozen into the river ice will fall over as the ice melts in spring. Started in 1917 as a diversion for bored railway engineers with a betting pot of $800, the Nenana Ice Classic has since become a beloved local tradition where hundreds of thousands of dollars are won and lost yearly. The record of ice melt times has been used as a non-traditional dataset which was published in the journal Science to track local ice melt timing over the past century as the global climate has steadily warmed. After reading this paper, confident in our scientific prowess, we spent 45 minutes building a model whose predictive power we were sure would outcompete the purely random guesses of everyone else in the competition. Using this model to predict ice melt times in spring 2022, we proceeded to lose approximately $120. This is our story.

Tessa Code conducting snorkel surveys of endangered elkhorn coral (Acropara Palmata)
Photo: Tessa Code

Poster Session

Marta Gomez-Buckley, PhD

Major Professor: Luke Tornabene

The Cryptic Taxonomy of Cryptobenthic Reef Fishes in the Eviota sigillata Complex

With 123 species described to date, the genus *Eviota* (Gobiidae) is the most specious among the coral reef fishes. Most species of Eviota are small (<2 cm), and together with other cryptobenthic reef fishes, are one of the largest contributors of consumed biomass within coral reef ecosystems. Recent phylogenetic analysis of the genus *Eviota* revealed a multitude of species complexes, including cases in which only one nominal species contains multiple genetically distinct groups, with very subtle or non-existent differences

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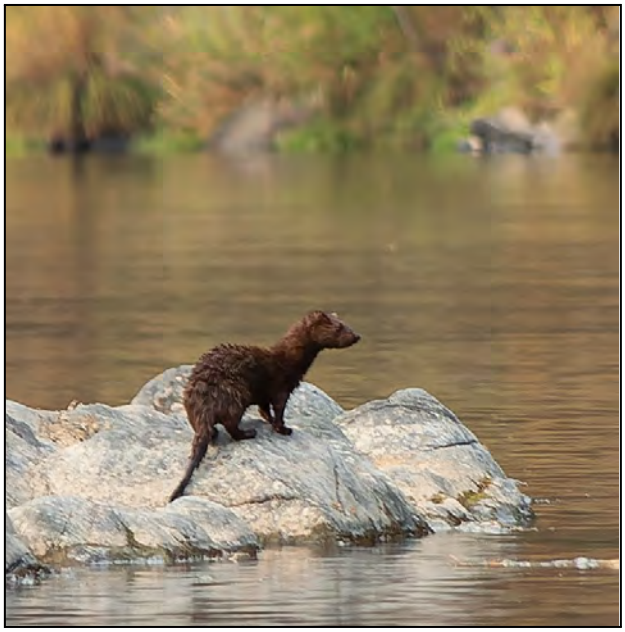
in morphology or pigmentation (cryptic species). For this study, we concentrated on the *E. sigillata* complex. Currently two species, *E. sigillata*, and *E. shimadai*, have been described within this complex but drawing from available molecular analysis (based on COI sequences), it is projected that at least ten more species could be present. We examined over 100 *E. sigillata* specimens collected through the entire Indo-west Pacific, and from paratypes from museum collections. We recorded extensive morphological and meristic data, as well as live coloration patterns (~40% of all specimens available), in addition to the molecular analysis. Ongoing wide genome ddRADseq analysis is expected to shed light on how many species the *E. sigillata* complex contains.



A Mink pauses briefly while hunting crayfish in a heavily burned portion of Oregon's Rum Creek Fire
Photo: Nick Chambers

Anna Hedemark

Major Professor: José Guzman

Effects of Temperature and Salinity Changes on the Clearance Rate of the Pacific Blue Mussel (Mytilus trossulus) in Friday Harbor, San Juan Islands, WA.

Changes in water quality affect both the organisms that inhabit aquatic ecosystems and the communities that rely on those water systems; new methods to reduce particulate matter in the water column are necessary. Previous literature indicates that climate change will affect the filtration rates of shellfish, causing both physiological changes in the organisms and changes in the turbidity of the water column. We aim to determine if changes in temperature and salinity affect the clearance rate of algal cells in Pacific Blue mussels (*Mytilus trossulus*). Mussels were gathered from San Juan Island, WA, and acclimated to various temperatures (15˚, 20˚, 25˚ C) and salinity values (20, 30 PSU) before being exposed to algal food, Shellfish Diet, diluted to 1 million cells/mL in a contained tank (500 mL). Mussels were fed for 3 hours and samples were taken every hour. A spectrophotometer was used to determine algal concentration; by creating a calibration curve using standard cell concentrations. The filtration rate was highest in the control tank at 15˚C and 30 PSU (268 mL/mussel/hour). Salinity at 20 PSU produced a significantly reduced filtration rate at our control temperature (15˚C). The San Juan islands regularly experience low salinity in the summer due to the Fraser river, thus our results suggest mussels may already be slowing their filtration rates during these periods. Understanding how abiotic factors affect filtration rates gives us better predictions of how shellfish filtration rates will change as climate shifts.

Andrea Limon & Michael Yurecko

Major Professor: José Guzman

Effects of High Temperature, Low Salinity And Predator Cues on Byssal thread production of Pacific Blue Mussel, Mytilus trossulus

Salinity and water temperatures influence the Salish Sea's ecology. Mussels, an ecologically important organism in Puget Sound, produce protein structures known as byssal threads to affix on rocky substrates. Some evidence suggests that changing environmental conditions influence byssal thread production. However, little research has been conducted on the combined factors of salinity, temperature, and predator presence on the Pacific Blue Mussels' ability to produce byssal threads. Here

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we tested the production of byssal threads by Pacific Blue Mussels harvested from San Juan Island, Washington, exposed to low salinity, high temperature, and predator cues. Treatments included a high temperature of 20℃ and low salinity of 20 PSU with predator cues from ochre sea stars, *Pisaster ochraceus*. Byssal thread production was determined by counting each thread after 24-hour exposure to each factor. Our study revealed that lower salinity had a greater effect on the average byssal thread production than high temperature. Higher byssal production was seen in high temperatures and less in low salinity conditions. We determined that regardless of high temperature and low salinity, the introduction of predator cues always increased byssal thread production. These findings demonstrate the importance of understanding the environmental conditions for mussels' ability to create the byssal fiber threads and the small effect predator cues have on the adaptive inducible defense of the mussel. As a critical species of the Puget Sound's consumer-resource system, understanding the effects a changing climate may have on the mussels is critical in projecting and sustaining the ecology of the Salish Sea.

Ella Persson, Jules Yearous, & Jake Elliott

Major Professor: José Guzman

Change in Purple sea urchin (Strongylocentrotus purpuratus) Feeding Preference in Different Environments

Purple sea urchins (*Strongylocentrotus purpuratus*) pose a serious threat to the environment by consuming entire kelp forests that serve ecological functions like carbon sequestration. We compared the preference of purple sea urchins on various kelp species to understand how feeding habits changed across different environments: temperature (ambient 13 °C, high 20 °C) and salinity (ambient 30 PSU, low 22 PSU). Urchins were collected from the subtidal zone in Friday Harbor, San Juan Island, WA. At the University of Washington Friday Harbor Labs, urchins were exposed to either ambient (6.8L), high temperature and ambient salinity (6.8L), low salinity and ambient temperature (6.8L), or high temperature and low salinity water (3.1L). Within these treatments urchins were given Bull Kelp (*Nereocystis luetkeana*), Ribbon Kelp (*Alaria marginata*), and Fringed Sieve Kelp (*Neoagarum fimbrata*) for 24 hours. To track kelp consumed, we weighed the kelp before and after each trial. Results showed that Bull Kelp was consumed the most in every environment except high temperature, low salinity. In low salinity and high temperature urchin feeding was significantly different and lower from the ambient environment, as most urchins ate nothing over 24 hours (Kruskal Wallis and Dunn's test, p-value > 0.05). Our findings suggest that in areas with lower salinity and higher temperatures, urchins may be a smaller threat to kelp. In many environments, bull kelp is most vulnerable to urchin feeding, making it an important species for conservation efforts.

Golden Dirona nudibranch at Friday Harbor Labs
Photo: Miranda Roethler

Erika Pirozok, Josie McKillop, Emma Smith, & Madison Weise

Major Professor: José Guzman

The Impacts of Temperature and Salinity on Growth Rates of Kelp Species

Understanding how species of kelp perform under different environmental factors is critical for the management of kelp farming and its effects on carbon sequestration. In this study we evaluated how low salinity and water temperature affect two kelp species: bull kelp (*Nereocystis luetkeana*) and ribbon kelp (*Alaria marginata*). Pulse-amplitude modulated (PAM) fluorometry was used as a proxy

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for health, while wet weight and the hole-punch measurement method determined growth. At Friday Harbor Laboratories (San Juan Island, WA), we collected and exposed ribbon and bull kelp to different treatments under grow lights for a standard photoperiod (12 hours/day) in closed-circulatory sea tables for 72 hours. Our treatments were high temperature (20ºC/ 30PSU), low salinity (12ºC/ 25PSU), high temperature with low salinity (20ºC/ 25PSU), and control (12ºC/ 30PSU). The results of the stress test via PAM fluorometry demonstrated 0% survivability of bull kelp for both heat and the combination of heat and salinity at 24 and 48 hours (Fv/Fm = 0) while ribbon kelp survived. When comparing percent change of wet weights, ribbon kelp gave a p-value of <0.05, with significant differences between combined treatment with control and salinity treatments, whereas bull kelp gave a p-value >0.05, however temperature treatments of bull kelp did not survive (Kruskal-Wallis test and Dunn's post-hoc). These results indicate that heat has a more significant effect on kelp than salinity. This data is increasingly relevant as the environmental effects of climate change increase global temperatures and could identify which kelp species are most vulnerable.

Olivia Anderson

Major Professor: José Guzman

Effects of Temperature Change on Bioluminescent Dinoflagellate Noctiluca scintillans

The bioluminescent dinoflagellate *Noctiluca scintillans*, also known as the 'sea sparkle', is an abundant planktonic species found throughout the world's oceans. With warming marine waters, sea sparkles have become invasive and harmful in new regions globally. As global ocean temperatures continue to rise and marine heatwave events become more common, it is important to understand how these environmental changes may impact the abundance of sea sparkles. For this study, we aimed to assess the potential effects of an extreme marine heat wave on sea sparkles by measuring their survivability when exposed to high temperatures. Sea sparkle samples were collected via a plankton tow conducted at 9:00 pm in late September at Friday Harbor Labs, San Juan Island, Washington. Survivability was measured in the lab by comparing the percentages living vs dead cells under two conditions: (control: 13°C) and high temperature (marine heatwave: 20°C). For each of the conditions, the experiment was replicated 17 times using test tubes. Cells were counted using a compound microscope after one hour of exposure time for each group. The control group had an average of 29% ± 10.6 for live cells, and the marine heatwave group had 45% ± 12.1 living cells. A proportion test was done and found a p-value of 0.259, meaning we cannot conclude that these results are significant. We believe that improvements to our experimental design, such as a larger sample size, would help create a more clear picture as there is some indication; based on our own observations and previous literature, that sea sparkles may become more widespread and impact marine ecosystems as global ocean temperatures continue to rise.

Rachel Fricke measuring discharge on the White River in Mt. Rainier National Park
Photo: Rachel Fricke

Acknowledgements

The success of the 33rd Annual School of Aquatic and Fishery Sciences Graduate Student Symposium is due to the efforts of many dedicated students, faculty, and staff. Thank you for contributing your time, ideas, and energy. Each of you has played a key role in creating this year's event and your hard work has resulted in a wonderful showcase of our school's current graduate student research.

Thank you to the volunteers helping with set-up, clean-up, session moderation, and ballot counting for making this day run smoothly. These volunteers include Helena McMonagle, Miranda Roethler, Anna Simeon, Terrance Wang, Emily Jameson, Callum Backstrom, Mico Kinneen, Rachel Fricke, Nicole Doran, Liz Allyn, and several more who volunteered after the program was complete.

Thank you so much to our faculty, postdoc, and grad student judges for volunteering their time.

Thank you to all the students contributing oral and poster presentations for being eager to share your research.

The Graduate Student Symposium is funded through contributions from the Skau Endowment. We offer sincere thanks to the friends and family of Oscar Skau for your generous gifts to the School of Aquatic and Fishery Sciences.

We appreciate your attendance at the 33rd Annual School of Aquatic and Fishery Sciences Graduate Student Symposium and we hope you enjoy your time with us.

Sincerely,
Emily Bishop, Maria Kuruvilla, Arial Brewer, Jessica Diallo and Tessa Code
2022 GSS Coordinators

Group photo from the 2022 Graduate Student Retreat