photo credit: Ariel Brewer

32nd ANNUAL

SAFS GRADUATE STUDENT SYMPOSIUM

Thursday, November 4, 2021
9am–5pm
Anderson Hall 207*

Poster session and
reception in the SAFS
lobby 5–7pm

Oral Presentations
Lunchtime panels/Workshops

Contact: safsgss@uw.edu

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

**** At the UW College of the Environment, COVID-19 vaccination is required for in-person event attendance, including all SAFS seminars. If you are a student or employee of the UW, please bring your Husky Card. All other guests over the age of 12 will need to provide proof of vaccination or proof of a negative COVID-19 PCR test within 72 hours of the event. Masking is required for all attendees.***

UNIVERSITY OF WASHINGTON
SCHOOL OF AQUATIC AND FISHERY SCIENCES

Program

The Graduate Student Symposium is one of the few opportunities for students from across the School, as well as in the Quantitative Resource Ecology and Management Program to present their past and ongoing work to the entire School community. The talks and posters at the annual GSS highlight the diversity that characterizes the School. The 32nd GSS is special in that it is the first GSS where we are able to be together again following a COVID-19-related need to hold the 31st GSS wholly online. I am looking forward to once again being in Anderson Hall among the SAFS community. As always, it is pleasing to see talks by students who have been with us for many years and those who only joined the program this year.

This year's talks and posters cover topics as wide-ranging as stock assessment modelling, the potential impact of microplastics, conservation aquaculture, and the drivers of schooling behaviour of prey. The taxonomic diversity of talks this year likely exceeds that of last year's GSS, which was one of the most broad ranging ever. This year we have talks on bears, salmon, trout, blue whales, and pollock. The talks include studies based on statistical analyses of data, the results of field work, and those of laboratory studies. Moreover, the talks at this year's GSS not only address conservation and management issues in our backyard of Puget Sound and the West Coast, but also in Hawaii and the Southern Ocean. The disciplinary, taxonomic and geographic reach of SAFS is truly impressive.

As always, there were some talks that caught my eye as I reviewed the abstracts. This year these include Kristin Privitera-Johnson's talk on her experiences on presenting management-related research to a decision making body, the Pacific Fishery Management Council. We in SAFS are justifiably proud that our science is management-relevant but navigating the science-management boundary can be as difficult as doing the science in the first place. Other talks I am particularly looking forward to listening to are Eileen Bates's presentation on what might enhance the recovery of the endangered pinto abalone, given the challenges associated with climate change, and Zoe Rand's presentation on how she intends to understand movement dynamics of Antarctic blue whales.

The mix of the traditional 15-minutes talks, lightning talks and posters highlights the ways in which we present our research – and of course I plan to keep an eye on the SAFS twitter feed. I am pleased to see that for the third time we have time for workshops, which provide a way for our community to increase necessary skills outside of the classroom environment.

Well done and thank you to the program committee for setting up an excellent program, and to everyone who is moderating. Finally, thanks to the Skau family whose gift to the School makes this event possible each year.

As always, I am proud to address you all as Director, and to continue to be part of this vital research community.

André E. Punt

Schedule

8:45 – 9:00 Refreshments (Coffee & Tea)

9:00 Welcome and Opening Remarks
Forest Club Room, 207 Anderson Hall
2021 GSS Coordinators—Miranda Roethler, Maria Kuruvilla, Arial Brewer, Emily Bishop
Dr. Andre Punt, School of Aquatic & Fishery Sciences

9:15 – 10:30 Standard talks – PhD students I
Moderator: Markus Min
10:30 – 11:30 Workshop I

11:30 – 12:00 Lunch Break

12:00 – 1:00 Workshop II

1:00 – 2:00 Lightning Talks
Moderator: Arial Brewer
2:00 – 2:15 Break

2:15 – 3:15 Standard talks – MS students I
Moderator: Jenny Gardner
3:15 – 3:30 Break

3:30 – 4:15 Standard talks – MS students II
Moderator: Brielle Kwarta
4:15 – 4:30 Break

4:30 – 5:00 Standard talks – PhD students II
Moderator: Miranda Roethler
5:00 Poster session & Reception
Fisheries Sciences Building rm 203 and second floor patio

Coho male salmon jumping up a waterfall
Photo: Nick Chambers

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 talks PhD students I

9:15 Natalie Mastick
Opening a can of worms: Historical change in infectious disease risk for marine mammals revealed by archived canned salmon

9:30 Grant Adams
Is ignoring predation mortality leading to an inability to achieve management goals in Alaska?

9:45 Eileen Bates
A multifaceted approach to enhance endangered pinto abalone recovery

10:00 Kristin Privitera-Johnson
Applied fishery science: from models to management

10:15 John Best
Spatially varying catchability for indices of abundance that include fishery-dependent data

San Juan Island prey estimation survey
Photo: Maria Kuruvilla

Southern resident killer whale breaching
Photo: Arial Brewer

Workshop I

10:30 – 11:30 Communication and Conflict

Facilitator: Michael Martínez

11:30 – 12:00 Lunch Break

Workshop II

12:00 – 1:00 Git and GitHub for the Scientific Programmer

Facilitators: Abby Bratt, Brielle K Thompson, and Zoe Rand

Presentations

Lightning talks

1:00 Jennifer Stern
Developing methods to determine bear hair growth rates for conservation and management

1:05 Zoe Rand
Estimating Movement Rates of Antarctic Blue Whales using Mark Recovery Models

1:10 Jeremy Axworthy
Microplastics ingestion and adhesion by reef-building corals under different water velocities

1:15 Julia Indivero
Spatiotemporal dynamics of walleye pollock weight-at-age in the Bering Sea

1:20 Tessa Code
More lights, fewer sockeye? Characterizing Artificial Light at Night in Lake Washington

Surveying Ice Creek, Bristol Bay, Alaska
Photo: Katie McElroy

Wild female Puget Sound summer steelhead, photographed in August
Photo: Nick Chambers

1:25 Jezella Peraza
Encounter and Collision models to quantify animal and tidal turbine risk interactions

1:30 Sarah Tanja
Microbes and Marine Microplastics, Future Research Directions

1:35 Bryan Briones Ortiz
Evidence for Genetic Differentiation Between Eelgrass (*Zostera marina*) Life History Strategies

1:40 Helena McMonagle
Characterizing the uncertainty in estimates of mesopelagic fish-mediated carbon transport

1:45 Q & A for lightning talk presenters

2:00 – 2:15 Break

Presentations

Sunset at Friday Harbor Labs
Photo: Maria Kuruvilla

Standard Conference Talks – MS students I

2:15 Maria Kuruvilla
Is warmer better for schooling fish? The effect of temperature on the ability of schooling fish to escape from predators

2:30 Callum Backstrom
Nitrogen exchange between hosts and algal symbionts enables acclimatization in a mesophotic coral community (*Leptoseris* spp.) in Hawai'i

2:45 Nick Chambers
Revisiting the Critical Period Hypothesis: How Intraspecific Competition and Limited Ability for Dispersal Among Steelhead (*Oncorhynchus mykiss*) Fry may Influence Population Dynamics and Estimates of Carrying Capacity in Freshwater

3:00 Howard Baek
Changes in coastal upwelling off the U.S. Pacific Northwest: an analysis using an SST data and an automatic upwelling detection method

3:15 – 3:30 Break

Standard Conference Talks – MS students II

3:30 Kelly Mistry
Comparison of existing and spatio-temporal methods to apportion catch limits for subregional management of groundfish in the Gulf of Alaska

3:45 Corinne Klohmann
Pathogen Filtration: an untapped ecosystem service

4:00 Markus Min
Data-limited fisheries methods shed light on the exploitation history and population dynamics of ESA-listed Yelloweye Rockfish in Puget Sound, Washington

4:15 – 4:30 Break

Giant Pacific Octopus at Friday Harbor
Photo: Lindsay Alma

Presentations

Standard Conference Talks – PhD students II

4:30 Marie Zahn
Acoustic differentiation and classification of wild belugas and narwhals using echolocation clicks

4:45 Christopher Setzke
Conservation Genomics of Kokanee (*Oncorhynchus nerka*) at their Northern Range Periphery

Basket star at Friday Harbor Labs
Photo: Lindsay Alma

POSTER SESSION

5:00 – 8:00 Poster Session & Reception at SAFS rm 203 / 2nd floor patio

Aina Hori, Fred Hope, Jessica Duong, and Michelle Gibson
The Effect of Increased Temperature on Phytoplankton Growth and Mussel Filtration Under Different Stress Conditions

Samantha Kuhn, Muki Kian, Irissa Danke
Intertidal Organisms' Trophic Responses to Extreme Temperature and Salinity

Nicole Reynolds
Feeding Ecology of *Batillaria attramentaria* in Padilla Bay, WA

Emily Sellinger
Recruitment regimes and fish longevity

Terrance Wang
Changes in fleet behavior and fuel use in response to Bering Sea crab distribution shifts

Abstracts

Male sockeye salmon hiding under a bubble curtain in Bacon Creek, an Upper Skagit tributary, Washington
Photo: Nick Chambers

Abstracts

Standard talks: PhD students I

Natalie Mastick, PhD

Major Professor: Chelsea Wood

Opening a can of worms: Historical change in infectious disease risk for marine mammals revealed by archived canned salmon.

How has the risk of parasitism changed for marine mammals over the past several decades? Parasitological assessments of marine mammals are rarely performed and are biased toward unhealthy animals. A more practical method for assessing long-term change in risk might be to measure the abundance of parasite infectious stages in marine mammal prey, like salmon. Parasitic nematodes of the family Anisakidae (anisakids) use salmonids as intermediate or paratenic hosts in life cycles that terminate in marine mammal definitive hosts. These infections can cause acute gastritis and peritonitis in cetaceans. To assess whether anisakid burden – and infection risk for marine mammals – has changed in salmonids over time, we used a novel data source: salmon that were caught, canned and thermally processed in Alaska, USA for human consumption. We examined canned filets of pink (*Oncorhynchus gorbuscha*, n = 58), red (*Oncorhynchus nerka*, n = 45), and chum salmon (*Oncorhynchus keta*, n = 35) processed between 1979 and 2019. We dissected each filet and quantified the number of worms per gram of salmon tissue. Anisakid burden increased over time in chum ($p < 0.0001$) and pink ($p < 0.01$), but not red salmon ($p = 0.56$). These results suggest that marine mammals consuming chum and pink salmon may have experienced an increasing risk of intestinal parasitism over the study period.

Male Coho salmon
Photo: Nick Chambers

Grant Adams, PhD

Major Professor: Andre Punt

Is ignoring predation mortality leading to an inability to achieve management goals in Alaska?

Changes in the dynamics of exploited marine resources have long been understood to coincide with, or be the result of, trophic interactions. However, tactical management of exploited marine resources generally ignores trophic interactions despite many calls for Ecosystem Based Fisheries Management (EBFM). In particular, predation is thought to represent a large proportion of mortality of groundfish in Alaska and a clearer understanding of impacts on single-species assessment performance is needed. Here we use a management strategy evaluation approach to examine the impact of ignoring trophic interactions within the current management system for walleye pollock, Pacific cod, and arrowtooth flounder in the Gulf of Alaska and Bering Sea. We developed multi-species age-structured operating models conditioned on available assessment and food habits data. From this operating model data are simulated and tested using single-species assessment models and harvest control rules given uncertainty in future predation, environmental conditions, and fishing scenarios. We developed performance metrics related to multispecies stable distributions in biomass relative to different individual fishery (stock specific) goals. We found that while predictions are conditioned on past trends, the fishery objectives and relative values of these species play an important role for advising fisheries managers.

Abstracts

Eileen Bates, PhD

Major Professor: Jacqueline Padilla-Gamiño

A multifaceted approach to enhance endangered pinto abalone recovery

From 1992 to 2017, the native pinto abalone experienced a 97% decline in Washington waters. This is loss for indigenous tribes, recreational divers, and the health of rocky reefs and kelp beds, and led the Washington Department of Fish and Wildlife (WDFW) to list pinto abalone as an endangered species in 2019. WDFW and Puget Sound Restoration Fund have been working together to use conservation aquaculture to produce genetically diverse juveniles for restoration of wild populations in the San Juan Archipelago since the early 2000s, but they face high mortality rates at all life stages. I plan to use a combination of laboratory and field studies to optimize production and survival of abalone. In the laboratory, I will study the possibility of using coralline algae as a settlement substrate for larval abalone to see if it helps protect them from negative effects of climate change and if it leads to better survival and faster growth. In the hatchery, I will be studying the tank surface biofilms to see if different microbes may be responsible for the die-offs of juvenile abalone that occur each year in the hatchery. Finally, in the field, I will use oceanographic sensors to monitor the water conditions at different restoration sites and will conduct habitat surveys to determine what conditions correspond to successful and unsuccessful restoration sites. Results from these studies can be used by Washington Department of Fish and Wildlife and Puget Sound Restoration Fund to bring back endangered pinto abalone.

Intertidal zone, Ruby Beach, Washington
Photo: Arial Brewer

Fieldwork in Burrow Creek, Arizona
Photo: Jessica Diallo

Kristin Privitera-Johnson, PhD

Major Professor: Andre Punt

Applied fishery science: from models to management

The art of creating models to produce scientific advice involves both creating the model and communicating essential but technical topics such as uncertainty to a non-technical audience. This science-policy interface forms the basis of the practical management of aquatic resources and is the focus of many SAFS courses, theses, and dissertations. Many students are drawn to SAFS because of its history and network of scientists conducting applied science that feeds back to the communities from which the data are collected. In this talk, I will outline my personal experience with presenting my Masters thesis work to the Scientific and Statistical Committee of the Pacific Fishery Management Council for scientific review and share some management outcomes of the resulting scientific advice. This work, combined with efforts from SAFS and QERM alumni, fundamentally changed how catch limits are determined for U.S. West Coast groundfish and coastal pelagic species. While the specifics of the model are essential for scientifically-informed management, I will focus on the applied components and how they inspired the work I am doing for my PhD dissertation.

Abstracts

John Best, PhD

Major Professor: Andre Punt

Spatially varying catchability for indices of abundance that include fishery-dependent data

Indices of abundance are commonly used in stock assessments, playing an important role in our knowledge of a stock's status. Spatiotemporal index standardization methods are increasing in popularity. These methods are generally applied to fishery-independent data, even if spatially referenced fishery-dependent data are available. This leaves substantial abundance information unutilized. In order to standardize fishery-dependent catch observations, we estimate spatial variation in catchability of fishery-dependent observations relative to the fishery-independent survey. This produces an index of abundance that uses both sources of data. When spatial variation in catchability is independent of abundance, there is no advantage in estimating spatial catchability. There is little apparent downside in terms of the index of abundance. On the other hand, if catchability and abundance covary, there can be an advantage to estimating the spatial variation in abundance and using all available data sources. Indices using both types of data were more precise compared to indices based on fishery-independent observations alone. Standardizing and including fishery-dependent data in this way opens the possibility of increasing the number of observations used to derive an index of abundance by an order of magnitude or more. Indices of abundance with increased precision will better inform stock assessments, allowing for improved scientific advice to managers.

Sea turtle in Oahu
Photo: Dr. Jacqueline Padilla-Gamiño

Workshop I

Communication and Conflict

Facilitator: Michael Martínez

This workshop will explore the basics of cross cultural communication and conflict. There are many aspects of communication style, and those aspects vary between people and cultures. When those variations/differences are not addressed, conflict can occur. Participants will learn useful frameworks and strategies for understanding their communication styles, their roles in conflict, and ways to communicate through conflict. Participants will have time to practice and will leave with access to free resources for further learning.

Lunch Break 11:30 – 12:00

Workshop II

Git and Github for the Scientific Programmer

Facilitators: Abby Bratt, Brielle K Thompson, Zoe Rand

Hey you! Do you write code as part of your research? Ever wanted to go back in time to a version of your code that worked? Ever wanted to work collaboratively on a project? Ever wanted your work to be widely available and reproducible? Then this is the workshop for you! This hands-on workshop provides an introduction to using Git and GitHub to manage your scientific code. This workshop is geared at R/RStudio users of any level, though we hope that programmers in any language will find benefit.

Abstracts

Sunset near Whitefish Point on Lake Aleknagik in Bristol Bay, Alaska
Photo: Katie McElroy

Lightning Talks

Jennifer Stern, PhD

Major Professor: Kristin Laidre

Developing methods to determine bear hair growth rates for conservation and management

Much of what is known about the ecology of bears is based on analysis of tissues collected from capture-based research efforts, harvested animals, or minimally invasive approaches. However, inference about data from hair has been limited by a lack of quantitative data on the timing of the molt and hair growth rates. My co-authors and I conducted a pilot study to design methods to quantify hair growth rates in two species of bears (n= 1 polar bear, n= 4 black bears) through a collaboration with zoos. We identified and implemented an effective visual and biochemical approach proven safe for humans and other animals to quantify the rate and timing of hair growth. The pilot study included a) feeding an isotopically-labeled ingestible glycine (amino acid) capsule that 'marks' time at a particular location as it is incorporated within the hair and, b) the application of a small patch of hair dye on the rump or leg. We collected hair at regular intervals (every 1-2 weeks) for five months from locations on the bear consistent with commonly sampled collection points in wild-caught bears. Hair samples were used to determine the timing of incoming new hairs, preliminary growth rates, and the incorporation and circulation times of glycine. The future goal of this project is to provide a foundation for incorporating seasonality in the wild-collected hair samples by assessing growth over an annual cycle. The information gained through this study will be essential for making full use of bear hair samples for wild bears.

Zoe Rand, PhD

Major Professor: Trevor Branch

Estimating Movement Rates of Antarctic Blue Whales using Mark Recovery Models

Antarctic blue whales (*Balaenoptera musculus intermedia*) were formerly the most abundant blue whale subspecies, but due to commercial whaling they are likely at no more than 3% of their pre-exploitation abundance. Current assessments of Antarctic blue whales assume that they make up a single population that is distributed across the Southern Ocean. Using mark recovery data from the Discovery program (1934-1968), we investigate this assumption by estimating movement rates of Antarctic blue whales between ocean basins. Multistate mark recovery models will be built both in R and RMark to estimate these movement rates while accounting for changes in whaling effort over time and across ocean basins. Findings from this study can be combined with mark recaptures from photo-id data, analysis of song types, satellite tagging data, and genetic evidence to infer the population structure and spatial distribution of Antarctic blue whales which can be used for future assessments of this subspecies.

Acanthocephalan parasite
Photo: Emily Oven

Abstracts

Jeremy Axworthy, MS

Major Professor: Jacqueline Padilla-Gamiño

Microplastics ingestion and adhesion by reef-building corals under different water velocities

Microplastics, small plastic particles less than 5 mm in size, are increasing in marine environments worldwide. Reef-building corals are thought to serve as major sinks for microplastics via two processes: 1) active removal from the water through ingestion and 2) passive removal by adhesion to their surface. However, it is not known which type of plastics are more likely to be ingested by or adhere to corals and whether water velocity or coral morphology affects these processes. This winter, we will attempt to address these knowledge gaps by performing a controlled laboratory experiment. Fragments of *Montipora capitata* (branching and plating morphologies) and *Pocillopora damicornis* (branching morphology), collected from Hawaii, will be exposed to weathered polyester and acrylic microplastic fibers, polystyrene microplastic fragments and tire particles at different water velocities (5 cm s-1 and 10 cm s-1) in a custom experimental flume system. Ingestion will be measured by dissecting coral polyps under a microscope and adhesion will be measured visually under a microscope. Additionally, we will use high speed video imaging to characterize hydrodynamic processes that affect ingestion and adhesion rates. Results of this experiment will help determine which plastic types are more likely to be ingested by or adhere to corals, which environments (low or high water velocity) corals are more likely to encounter microplastics and whether coral morphology influences these interactions.

Julia Indivero, MS

Major Professor: Tim Essington

Spatiotemporal dynamics of walleye pollock weight-at-age in the Bering Sea

Environmental conditions can create spatial and temporal variability in the demographic processes of fish populations. However, the extent to which these processes operate is often not well known nor incorporated into stock assessment models. As a tractable step in addressing this question, I am using the walleye pollock NOAA survey data from the Bering Sea as a case study of how one population trait—weight-at-age—varies spatiotemporally and in relation to environmental characteristics. Stock assessments often assume that weight-at-age and local density are unrelated and do not incorporate spatiotemporal variability into models. In the Bering Sea walleye pollock stock assessment, for instance, average weight-at-age is included in the age-structured population model, but is stratified across broader spatial areas to estimate catch-at-age. However, more fine-scale differences in habitat across the region may cause greater variation in weight-at-age than currently captured in this framework. By accounting for these fine-scale environmental impacts on fish demographics, integrating spatiotemporally explicit weight-at-age processes into stock assessment may consequently provide more accurate forecasting of future stocks under changing environmental conditions, such as climate change.

Tuxedni Bay, Alaska
Photo: Arial Brewer

Abstracts

Tessa Code, MS

Major Professor: John Horne

More lights, fewer sockeye? Characterizing Artificial Light at Night in Lake Washington

In aquatic ecosystems, daily light fluctuations serve as signals to aquatic animals to seek refuge or forage, while seasonal light cycle changes serve as cues to migrate and reproduce. Artificial light at night (ALAN) disrupts natural light cycles by extending twilight periods, increasing nocturnal light levels, and blurring indicators of seasonal change. ALAN threatens fish populations by mediating changes in behavior and predation mortality, which is potentially amplified in systems with visual predators. Sockeye salmon (*Oncorhynchus nerka*) spend between 12 to 15 months in lakes before out migrating and provide an ideal case study of a species with increased mortality risk in freshwater watersheds due to ALAN. In urbanized watersheds, ALAN increases light throughout the water column leaving juvenile sockeye at higher risk of predation. Lake Washington, a heavily urbanized lake adjacent to Seattle, contains a resident population of sockeye with dramatically reduced survivorship. My research will characterize the light environment of Lake Washington using a combination of satellite and field data. Satellite data products will be used to quantify Lake Washington ALAN levels through time and over space. Empirical light intensity profiles will be used to quantify light intensity as a function of depth and turbidity. The combination of remote sensed and empirical data products will then be used to quantify changes in the relative predation risk of juvenile sockeye salmon throughout their Lake Washington residence.

Jezella Peraza, MS

Major Professor: John Horne

Encounter and Collision models to quantify animal and tidal turbine risk interactions

Tidal turbines are one sector within Marine Renewable Energy (MRE) that generate energy from hydrodynamics through waves, tides, and rivers. MRE plays an important role in climate change mitigation by providing a cleaner source of energy that is more predictable and consistent than wind or solar power. Obtaining permits to deploy MRE devices is hampered by the lack of research and high uncertainty on potential impacts of MRE devices on marine communities. Perceived risks of encounters, collisions, injuries, and mortalities between aquatic animals and MRE devices are based on extremely limited empirical monitoring data. An alternate approach to field studies is the combination of encounter and collision statistical models combined with empirical data to estimate the likelihood of encounter and collision rates. After a review of existing encounter models, I will develop a candidate model for individual animal collision risk, use empirical data to parameterize model variables, and conduct sensitivity tests on model parameters. An individual-based model may be used to simulate movement and encounter rates of individuals within aggregations as an independent prediction of collision risk with a MRE device. Results of these efforts will also be used to identify empirical data needed to validate encounter and collision risk models.

Experimental aquaria
Photo: Maria Kuruvilla

Abstracts

Sara Faiad in the BSL-2 lab
Photo: Dr. Chelsea Wood

Sarah Tanja, MS

Major Professor: Jacqueline Padilla-Gamiño

Microbes and Marine Microplastics, Future Research Directions

In this presentation I will briefly cover current topics in marine microplastics research and discuss future research directions. Global plastic production has increased rapidly since the 1950's. Approximately 9.2 billion tons of plastic has been produced in the last 70 years. Plastics enter the environment and persist for centuries, or possibly forever. In the environment plastics break down into smaller and smaller pieces, called microplastics. I'm particularly interested in how microplastics interact with microbial communities and the effects those interactions may have on organisms and on biogeochemical cycles.

Bryan Briones Ortiz, MS

Major Professors: Kerry Naish & Jennifer Ruesink

Evidence for Genetic Differentiation Between Eelgrass (Zostera marina) Life History Strategies

Eelgrass (*Zostera marina*) are indispensable ecosystem engineers in estuarine habitats and can display dramatic trait variation. Annual life histories in eelgrass occur when plants germinate and form generative shoots within a single growing season. These annual ecotypes have been recognized for decades, from many different parts of the broad range of this seagrass, including The Netherlands, Korea, and the US West and East Coasts. Early genetic work based on allozymes indicated that annual (100% flowering) and perennial (low-flowering frequency, predominantly clonal reproduction) populations were not genetically differentiated, but no recent work exists comparing life history types using modern genomic approaches. We investigated patterns of genetic variation associated with co-occurring life history strategies in eelgrass. Using SNPs, we performed population genetic analyses on shoots sourced from pairs of neighboring annual and perennial meadows located in two distant areas within an estuary. Perennial populations situated 12 km apart were more genetically similar to each other than to nearby (ca. 250 m) annual populations, suggesting significant structuring between geographically proximate life history strategies that may be linked to fine-scale adaptation or limits to dispersal.

Group of bright Coho high up in a Skagit River tributary in August
Photo: Nick Chambers

Abstracts

Helena McMonagle, MS

Major Professors: Tim Essington & Ray Hilborn

Characterizing the uncertainty in estimates of mesopelagic fish-mediated carbon transport

Mesopelagic fishes dominate the global biomass of fishes, and may contribute substantially to active transport of carbon from surface waters into the deep sea via diel vertical migration. By consuming organic carbon near the surface at night and releasing it in the mesopelagic zone during the day through respiration, egestion and mortality, mesopelagic fish contribute to high seas carbon capture. However, the magnitude of this transport and associated uncertainties are not well understood. Only a handful of studies have estimated mesopelagic fish-mediated carbon transport and uncertainties are large. No study has formally propagated error in estimates of fish-mediated carbon transport, or thoroughly investigated which parameters contribute most to the uncertainty. Therefore, I asked, "What are the parameter uncertainties in estimates of fish-mediated carbon transport?" and "Which parameters contribute most to uncertainty in the magnitude of this transport?" To address these questions, I used a Monte Carlo simulation that calculated carbon transport by mesopelagic fish throughout plausible parameter space. This involved first describing probability distribution functions for each parameter based on previous knowledge, and then randomly sampling the parameter space and calculating carbon flux for each sampled vector of model parameters. Sensitivity analysis revealed which parameters contribute most to uncertainty. This study will inform prioritization of research efforts to fill knowledge gaps in our understanding of this component of the biological carbon pump. This research is timely due to recent interest in harvesting mesopelagic fish, and the need to better understand the ecosystem services that these fish provide.

Multi-day fieldwork in the Quantitative Conservation Lab
Photo: the Converse Lab

Standard Talks: MS students I

Maria Kuruvilla, MS

Major Professor: Andrew Berdahl

Is warmer better for schooling fish? The effect of temperature on the ability of schooling fish to escape from predators

Temperature is highly influential on the physiology and behavior of ectotherms. In fish, temperature is known to affect social interactions such as schooling behavior, which is a primary defense against predation for many species. However, the effect of temperature on the ability of fish within a school to collectively respond to a predatory threat is unknown. We used a repeatable looming stimulus to simulate an approaching predator that elicited a fleeing response in schooling fish over a range of water temperatures (9 - 29°C) and group sizes (1-16 fish). During a simulated predation event, the proportion of fish in a group that startled was greatest at 15°C whereas latency to respond had a minimum at 19°C. While speed and acceleration exhibited a positive curvilinear response to temperature, the optimal temperature at which performance peaks was different when fish were responding to a predation threat versus when they were unperturbed. Similarly, we did not observe any effect of temperature on group-level metrics in the absence of a threat, but immediately after a simulated predation event both average nearest neighbor distance and convex hull area decreased monotonically with temperature, whereas polarization had a minimum at 19°C. Our results suggest that ectothermic fish may be able to compensate for their slower swim speeds by increasing the probability to respond to predators. More generally, we show that the effect of temperature on fish schools may depend on both the behavioral trait in question and the context of trait response.

Abstracts

Callum Backstrom, MS

Major Professor: Jacqueline Padilla-Gamiño

Nitrogen exchange between hosts and algal symbionts enables acclimatization in a mesophotic coral community (Leptoseris spp.) in Hawai'i

In mesophotic coral ecosystems (30-150 m), coral hosts and their photosynthetic symbionts can survive with less than 1% of surface light irradiance. By comparing distinct combinations of coral host species and symbiont haplotypes, we assessed the trophic mechanisms controlling niche partitioning across depth in the mesophotic zone. We analyzed the stable carbon (δ13C) and nitrogen (δ15N) isotopic signatures of a *Leptoseris* community from the 'Au'au Channel, Hawai'i (65-125 m). This community consists of four host species (*L. tubulifera, L. scabra, L. hawaiiensis*, and *Leptoseris* sp. 1) living symbiotically with three algal haplotypes (COI mtDNA types 1, 2, and 3). We characterized the isotopic signatures of host and symbiont tissues across species and depth. For the *Leptoseris* community, we found that δ13C of symbionts was 0.5 permil higher than host δ13C at all depths, indicating that relative rates of autotrophy and heterotrophy remained constant across depth. In contrast, δ15N of host and symbiont tissue differed by up to 3.7 permil at shallower depths but had similar values at deeper depths, suggesting that, when light is limited, *Leptoseris* colonies enhance sharing of available nitrogen between hosts and symbionts. Photophysiological adaptations (e.g., chlorophyll content, accessory pigments) may explain depth partitioning of different host species and symbiont haplotype combinations across depth. However, all *Leptoseris* species seem to rely on photosynthesis as an energy source similarly, regardless of symbiont haplotype or depth across the mesophotic zone. Future studies should consider the persistent contribution of autotrophy, and the role of nitrogen exchange between host and symbionts, as potentially crucial components of reef coral survival in the mesophotic zone.

Fieldwork in Burrow Creek, Arizona
Photo: Jessica Diallo

Nick Chambers, MS

Major Professor: Daniel Schindler

Revisiting the Critical Period Hypothesis: How Intraspecific Competition and Limited Ability for Dispersal Among Steelhead (Oncorhynchus mykiss) Fry may Influence Population Dynamics and Estimates of Carrying Capacity in Freshwater.

Among species with limited capacity for dispersal at early life stages, spatial heterogeneity of nest sites can elicit strong effects on population dynamics. When individuals are unable to migrate from densely populated areas, intense competition can result in high mortality rates early in life. For salmonids, this “critical period” of density dependent mortality is generally thought to last the first 1-3 months following emergence, after which density may influence growth more strongly than mortality. These relationships are well described for Atlantic Salmon (*Salmo salar*) and Brown Trout (*Salmo trutta*) yet little is known about the timing of density dependence in freshwater for Pacific Salmonids such as steelhead (*Oncorhynchus mykiss*). To address this, dispersal distance of steelhead fry from individual and clustered redds was quantified during their first summer of life. Observations were obtained in the mainstem Skagit River and select tributaries by day and night snorkel surveys at previously located redds. Dispersal of fry was highly variable with maximum distances ranging from 120m - 450m downstream and 5m - 60m upstream. Dispersal distance was greatest on long, low gradient cobble bars and shortest when deep pools and high velocities occurred together along shorelines. While small sample size and imperfect redd detection limit conclusions from this initial field season, preliminary data aligns with values from the literature on Atlantic Salmon and Brown Trout. These findings lend support to the idea that uneven redd distribution can lead to underestimates of carrying capacity in populations which have been exposed to high levels of harvest.

Abstracts

Howard Baek, MS

Major Professor: Eli Holmes

Changes in coastal upwelling off the U.S. Pacific Northwest: an analysis using an SST data and an automatic upwelling detection method

Recent research has argued that coastal upwelling will change as the earth warms and coastal winds increase due to land heating faster than the ocean. Using remotely sensed gridded daily SST (sea surface temperature) data, we developed an automatic algorithm to identify upwelling using the difference between coastal and offshore SST. Our objective was to study whether the seasonality and duration of upwelling along the Oregon, Washington and Vancouver Island coasts has changed from 1980 to 2020. Using our upwelling algorithm, we categorize each day at each 0.25 degree latitude along the coast 1980-2020 as upwelling or not upwelling. Our results echo prior results (using wind-based upwelling indicators) showing that upwelling is most frequent 40°N ~ 45°N compared to 45°N ~ 50°N, with a sharp change in upwelling frequency at 45°N. An extremely high upwelling percentage (close to 50% of the year) was found for the band 40°N to 42.5°N. The north-south difference was largely due to the length of the upwelling season: the season extended from June to October in the south but was confined to August to September in the north. The length of the season has been lengthening in the south, with the start of upwelling moving earlier into July in the last decade. In the north, no change in the seasonality was observed but there are decadal patterns of strong and weak upwelling years. Our work highlights the insights that can be gained from designing an automatic detection system for upwelling.

The Converse Lab in the field
Photo: the Converse Lab

Standard Talks: MS students II

Kelly Mistry, MS

Major Professor: Mark Scheuerell

Comparison of existing and spatio-temporal methods to apportion catch limits for subregional management of groundfish in the Gulf of Alaska

Management of fisheries relies on model predictions of the estimated biomass of stocks in order to determine how many fish can be safely harvested in a given year without negatively impacting the population. Consequently, continually seeking the most accurate and precise models possible for this use is always a goal of fisheries' managers. Towards that end, this study compares the current modeling approach to predict stock biomass, a random walk model, with a delta-GLMM spatiotemporal model implemented using the VAST package, for groundfish stocks in the Gulf of Alaska (GOA) that are managed using subregional catch allocation. These subregions in the GOA include 3 areas: western, central and eastern GOA. This analysis uses bottom trawl survey data collected by NOAA for two species of groundfish, Pacific Ocean Perch (*Sebastes alutus*) and Northern Rockfish (*Sebastes polyspinis*). The performance of the random walk and delta-GLMM models will be evaluated by using jackknife resampling and several evaluation metrics, including a metric to quantify the amount of variation associated with each model's predicted biomass as well as a metric to evaluate how accurate the model predictions are in comparison to the survey data for each subregion. Since the currently used random walk model relies only on temporal data while the delta-GLMM model incorporates both temporal and spatial information, it is expected that the delta-GLMM model will perform better for all metrics.

Abstracts

Corinne Klohmann, MS

Major Professor: Jacqueline Padilla-Gamiño

Pathogen Filtration: an untapped ecosystem service

Eelgrass (*Zostera marina*) is a marine angiosperm found in coastal temperate waters worldwide. Eelgrass is a vital part of coastal ecosystems providing nurseries for fish, habitat for invertebrates, sediment stabilization, coastal protection, water filtration, and carbon sequestration. In the tropics, seagrass beds have demonstrated their ability to decrease the abundance of the bacterial pathogen *Enterococcus*. *Enterococcus*-associated pathogens can sicken humans and other animals in the water. This study will address temperate seagrass pathogen filtration and examine pathogen filtration under changing ocean conditions. Using field data and laboratory experiments I will evaluate the pathogen filtration capability of *Z. marina* in the coastal waters of Puget Sound. Additionally, I will assess the impact of light, dissolved oxygen, temperature, and pH on the potential filtration service. This research has large implications for aquaculture, fisheries, conservation, and human health. Furthermore, given the global distribution of eelgrass, this research has direct applications to human and ecosystem health worldwide.

Coral fieldwork in Oahu
Photo: Dr. Jacqueline Padilla-Gamiño

Markus Min, MS

Major Professor: Mark Scheuerell

Data-limited fisheries methods shed light on the exploitation history and population dynamics of ESA-listed Yelloweye Rockfish in Puget Sound, Washington

Yelloweye Rockfish in the Puget Sound/Georgia Basin were listed under the Endangered Species Act (ESA) in 2009, and a formal recovery plan for these species was published by NOAA Fisheries in 2017. Under this recovery plan, the criteria for delisting or downlisting are specified as certain levels of spawning potential ratio (SPR), a proxy for relative stock biomass (a commonly used metric of stock status). To estimate SPR, we reconstructed the catch history from fisheries records and collated length data from contemporary and historical hook-and-line surveys to fit a data-limited version of a statistical catch-at-age model. Small sample sizes and low confidence in the historical catch data translated into large uncertainty intervals in the population dynamics of the species. Despite this uncertainty, the stock assessment model estimates Yelloweye Rockfish is above 25% of unfished biomass (the limit biomass reference for federally managed rockfishes on the Pacific coast) under the assumption of deterministic recruitment. However, the distinct population segment of Yelloweye Rockfish listed under the ESA extend from south Puget Sound to Queen Charlotte Strait in British Columbia, and the Canadian portion of this population (which contains the majority of the biomass) is currently estimated to be at 32% of unfished biomass (95% quantiles: 15 to 68%). Thus, the disjunction between the biological boundaries of the population and the jurisdictional boundaries between DFO and NOAA present an additional source of uncertainty in assessing recovery.

Abstracts

Standard Talks: PhD students II

Marie Zahn, PhD

Major Professor: Kristin Laidre

Acoustic differentiation and classification of wild belugas and narwhals using echolocation clicks

Belugas (*Delphinapterus leucas*) and narwhals (*Monodon monoceros*) are highly social toothed Arctic cetaceans with large vocal repertoires and similar acoustic profiles. Passive Acoustic Monitoring (PAM) that uses multiple hydrophones over large spatiotemporal scales has been a primary method to study their populations, particularly in response to rapid climate change and increasing underwater noise. This study marks the first acoustic comparison between wild belugas and narwhals from the same location and reveals that they can be acoustically differentiated and classified solely by echolocation clicks. Acoustic recordings were made in the pack ice of Baffin Bay, West Greenland, during 2013. Multivariate analyses and Random Forests classification models were applied to eighty-one single-species acoustic events comprised of numerous echolocation clicks. Results demonstrate a significant difference between species' acoustic parameters where beluga echolocation was distinguished by higher frequency content, evidenced by higher peak frequencies, center frequencies, and frequency minimums and maximums. Spectral peaks, troughs, and center frequencies for beluga clicks were generally > 60 kHz and narwhal clicks < 60 kHz with overlap between 40–60 kHz. Classification model predictive performance was strong with an overall correct classification rate of 97.5% for the best model. The most important predictors for species assignment were defined by peaks and notches in frequency spectra. Our results provide strong support for the use of echolocation in PAM efforts to differentiate belugas and narwhals acoustically.

Isopod parasite
Photo: Emily Oven

Christopher Setzke, PhD

Major Professor: Kerry Naish

Conservation Genomics of Kokanee (Oncorhynchus nerka) at their Northern Range Periphery

Genetic tools have played key roles for informing fisheries management, including for kokanee, the freshwater resident form of sockeye salmon (*Oncorhynchus nerka*), particularly in the southern portion of its North American range. Here, we investigated stock diversity, population history and hatchery representation of kokanee at the northern extent of its range in Canada in Kluane National Park and Reserve (KNPR) located in the Yukon. In addition, we reconstructed the genetic consequences of a recent 12-year population crash followed by a rapid increase in numbers. First, using restriction-site associated DNA sequencing, we genotyped individuals at 11,442 single nucleotide polymorphisms (SNPs) that were sampled from putative reproductive shore- and stream-spawning ecotypes in KNPR and broodstock from the Whitehorse Rapids Hatchery. We found no evidence ecotype differentiation based on neutral SNPs nor previously identified outlier loci. Within-population genetic diversity and effective population size were substantially higher in the wild population relative to the hatchery and significant differentiation was detected, suggesting the hatchery population was not representative of wild stock diversity. Then using Genotyping-in-Thousands by sequencing we genotyped the previously mentioned individuals, as well as pre-crash archival samples from KNPR and the nearby extirpated Frederick Lake, at 271 SNPs. We observed similar diversity metrics and low differentiation between pre- and post-crash individuals in KNPR. We also found that the Frederick Lake population had lower diversity metrics than that observed in KNPR, a possible factor in its extirpation. This population was highly differentiated from the one in KNPR, constituting the loss of a unique population.

Abstracts

Poster Session

Aina Hori, Fred Hope, Jessica Duong, Michelle Gibson

Major Professor: José Guzman

The Effect of Increased Temperature on Phytoplankton Growth and Mussel Filtration Under Different Stress Conditions

As climate change worsens, understanding the effects on key species is vital to the health of an ecosystem. The blue mussel, *Mytilus trossulus*, is in the Pacific Northwest and feeds on phytoplankton. This study aims to analyze the effect of different temperatures on phytoplankton growth (experiment 1) and blue mussel filtration rate in the absence or presence of local predators (experiment 2). For experiment 1, plankton samples were collected from water off the shore of Friday Harbor Labs using plankton trawl nets while rowing. For experiment 2, mussels were collected from the Jackson Beach dock in Friday Harbor, WA, and placed in beakers containing seawater (control, absence of predators) or seawater with added water collected from tanks containing crabs or seastars (presence of predators). For each experiment groups were exposed to three temperatures: 12℃, current seawater temperature, 20℃, and 22℃, for four days (experiment 1), or 24 hours (experiment 2). Fluorometer readings were taken for analysis after the trials, showing that phytoplankton growth increases as temperature increases. Mussel filtration without any predation decreases as temperature increases. With the introduction of crab water, mussel filtration increases with temperature; however, with the introduction of seastar water, mussel filtration does not show a consistent trend. As temperature increases, phytoplankton growth rate increases. When predation is introduced, mussel filtration increases with increasing temperature. This could be the result of increased stress due to predation.

Samantha Kuhn, Muki Kian, Irissa Danke

Major Professor: José Guzman

Intertidal Organisms' Trophic Responses to Extreme Temperature and Salinity

Intertidal organisms must withstand extreme salinity ranges and fluctuating temperatures. The intergovernmental panel on climate change predicts ocean temperature increases of up to 4°C and more extreme weather events like storms and droughts, which would influence tide pool salinity. We evaluated changes in feeding rates of Blue Pacific Mussels (*Mytilus Trossulus*) and Green Sea Urchins (*Strongylocentrotus droebachiensis*) at these parameter extremes as well as in the presence of predator cues. We introduced both species to a range of temperature and salinity conditions based on measurements from different points around San Juan Island (WA). The experiments exposed the organisms to a range of three salinities (15 ppt-40 ppt) and three temperatures (12.2°C to 18.3°C) to determine the impact of these extremes on feeding. Our third trial sought to identify a compounding effect between the two extremes by also exposing organisms to predator cues. Sea urchin consumption of kelp was measured by grid assessment. Mussel consumption of phytoplankton was measured using a fluorometer. Mussels in extreme parameters combined with predator cues increased their filtration of phytoplankton. Conversely, increased stressors shocked urchins yielding little to no consumption of kelp. Our results suggest that mussels may be well suited to acclimating to our changing oceans, as feeding was not severely inhibited by increased environmental stress, even in the presence of a supposed predator.

Sockeye entering Hansen Creek on Lake Aleknagik in Bristol Bay, Alaska
Photo: Katie McElroy

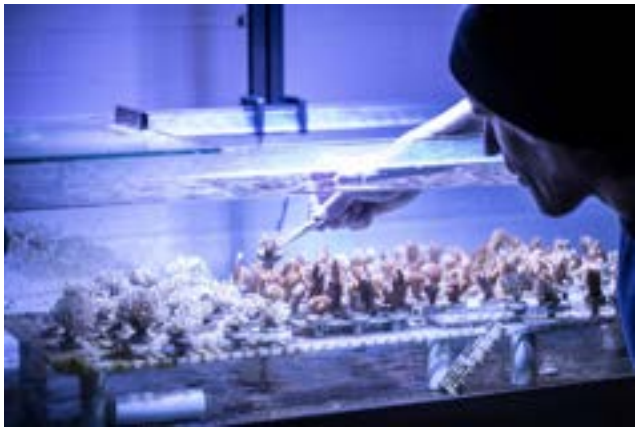
Abstracts

Nicole Reynolds

Feeding Ecology of Batillaria attramentaria in Padilla Bay, WA

Batillaria attramentaria (hereafter *Batillaria*) is a highly prolific species of mud snail in Padilla Bay, WA, with numbers estimated to be over 9 billion individuals in the bay alone. Understanding the feeding ecology of *Batillaria* is important, as it is an invasive species and its ecological role with respect to detritus and decomposition is unknown. This study aims to identify *Batillaria*'s substrate preference when given access to bare sediment, algae, and *Zostera* detritus in Padilla Bay. Three experiments were developed to test the hypothesis that *Batillaria* prefers algae detritus over *Zostera* detritus, over mud. First, a field substrate preference experiment was set up at two locations: Interpretive Center (IC), and West-90 (W90), with three plot types: algae, *Zostera*, and control (mud). Both sites were resampled three times over a 21-day period. A second experiment was designed to obtain a higher resolution of temporal data. The second experiment used two plot types: algae and control, which were conducted at IC over a 9-day period. A third experiment was conducted in the lab to see if and how snails would move toward specific kinds of detritus. From the field experiments, it was determined that *Batillaria* highly prefers algae detritus over *Zostera* detritus at IC, but at W90, *Batillaria* did not show a preference between *Zostera* detritus and algae. At both sites, detritus was preferred over bare sediment. In contrast to findings in the field, in the lab experiment, *Batillaria* was found to prefer *Zostera* detritus over algae detritus, over no detritus.

Views during the Alaska Salmon Program
Photo: Dan Dinicola



Jeremy Axworthy checking on his corals
Photo: Dennis Wise

Emily Sellinger, MS

Major Professor: Andre Punt

Recruitment regimes and fish longevity

The relationship between recruitment and spawning biomass has been of interest to fishery scientists and managers for decades. However, the primary driver in the spawner-recruit relationship has been a source of debate. Myers and Barrowman (1996) suggested reduced spawning biomass was associated with reduced recruitment. Gilbert (1997) argued that instead of spawning biomass driving recruitment, changes in recruitment resulted in lower spawning biomasses. Szuwalski et al. (2015) examined the common assumptions about recruitment drivers using the RAM Legacy Stock Assessment database. With the addition of new time series data to the database, our goal was to determine if Szuwalski et al.'s results still hold. Also, the potential correlation between the presence and duration of recruitment regimes and fish lifespan was investigated.

The Marine Birds and Mammals class in the field in Friday Harbor, Washington
Photo: Maria Kuruvilla

Abstracts

Terrance Wang

Major Professors: Ray Hilborn & Andre Punt

Changes in fleet behavior and fuel use in response to Bering Sea crab distribution shifts

As global demand for animal protein rises, the need to understand the mechanisms of the rise of marine fisheries' greenhouse gas (GHG) emissions per tonne of production (28% from 1990 to 2011) grows increasingly paramount for evaluating the sustainability of the industry. Fuel-intensive crustacean fisheries are largely responsible for this upward trend in GHG emissions given their high demand and commercial value. Climate-induced spatio-temporal distribution changes in crustacean fishing ground locations may exacerbate emissions as fleets may need to travel farther for targeted species and transport them back to ports while timing supply chains. Snow crabs, Tanner crabs, and red king crabs of the Bering Sea already show evidence of shifting polewards, however little work has linked these shifts to the fisheries fuel consumption. This study aims to identify the relationship between spatio-temporal changes in crab distributions and fishing fleet behavior in the Bering Sea, and quantify their impact on these fisheries' fuel use intensities. To measure how well fishing fleets track crab distributions, historical distributions of crab abundance and fishing fishing fleet traffic data from the Automatic Identification System (AIS) will be overlapped in space and time. Degree of crab distribution change between subsequent years will be related to fishing fleet position overlap, distance traveled, speed profile, and fuel consumption. Significant relationships will be used to forecast fishing fleet behavior and fuel consumption based on future projections of crab distributions. These forecasts serve to assess the long-term carbon footprint of crustacean fisheries in a changing, uncertain seascape.

Dr. Wood's fisheries class in the field
Photo: Mark Stone

Alaska Salmon Program
Photo: Dan Dinicola

Acknowledgements

The success of the 32nd Annual School of Aquatic and Fishery Sciences Graduate Student Symposium is due to the efforts of many dedicated students, faculty, and staff. We are so excited to be hosting an in-person GSS once again. Thank you for contributing your time, ideas, and energy. This year's GSS may look a little different than those in years past, so we thank everyone for their help in making this year's event safe. 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 Markus Min, Jenny Gardner, Brielle Kwarta, Anne Polyakov, Helena McMonagle, Sarah Tanja, Emily Jameson, Kali Stone, Corinne Klohmann, Kerry Accola, Anita Wray, Rachel Fricke, Anna Simeon, Callum Backstrom, 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 graduate students contributing oral and poster presentations for being eager to share your research.

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We appreciate your attendance at the 32nd Annual School of Aquatic and Fishery Sciences Graduate Student Symposium and we hope you enjoy your time with us.

Sincerely,
Miranda Roethler, Maria Kuruvilla, Arial Brewer, and Emily Bishop
2021 GSS Coordinators

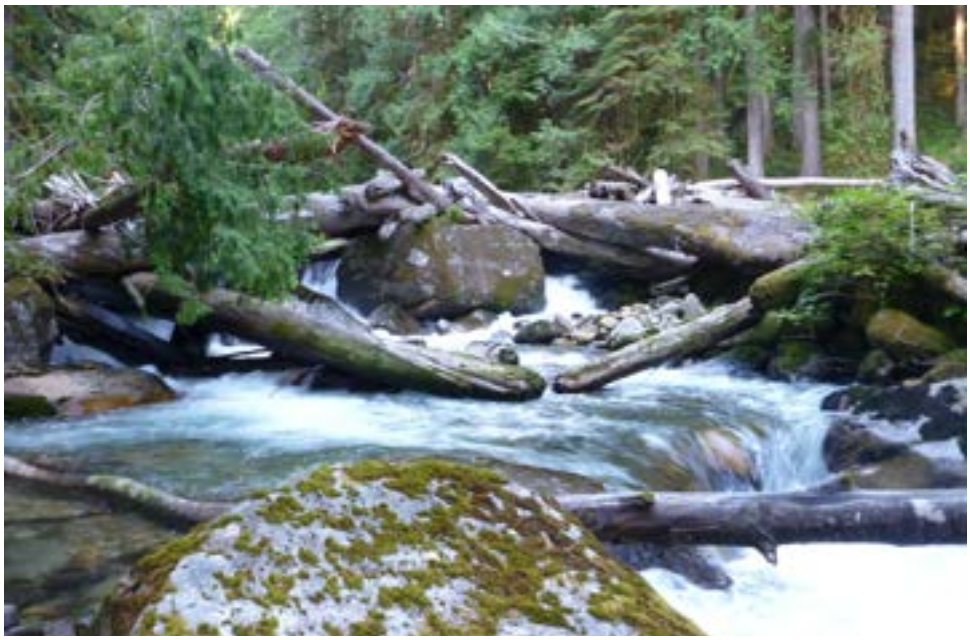

Photo: Mark Sorel