34th ANNUAL SAFS GRADUATE STUDENT

SYMPOSIUM

FRIDAY, NOVEMBER 17—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.

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photo credit: Nick Chambers

SCHOOL OF AQUATIC AND FISHERY SCIENCES | UNIVERSITY OF WASHINGTON

FINS presents...

New SAFS Merchandise for 2023-24 Academic Year!

> Cash or check only. Available during GSS Poster Session <

Apparel

NEW 2023
By Kip Howell

$25 (Students: $5 off)

Front (above)
Back (left)

Beanie

~~Was $25~~
Now $15

2022 Quarter Zip
By Debbie Viona

~~Was $45~~
Now $35

Drinkware (Perfect for TGIT and SAFS Café!)

NEW 2023
By Jenny Stern
& Sarah Yerrace

360° art!
Mammals, birds, fish,
inverts and daphnia, oh my!

$10

Salmon Pint Glass
By Jordan Checketts

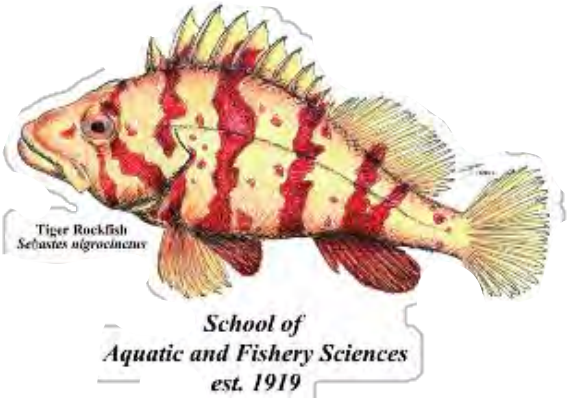
~~Was $10~~
Now $5

Stickers and Accessories

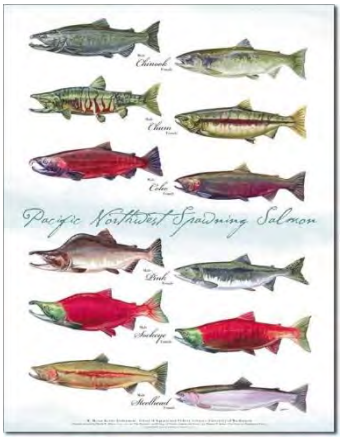
$3 each or any two for $5

NEW 2023
By Terrance Wang

NEW 2023
By Sarah Yerrace



Posters
$10 each or
$3 with purchase
of apparel



**What is FINS? FINS (Fisheries Interdisciplinary Network of Students) is the graduate student organization within the School of Aquatic and Fishery Sciences (SAFS) at the University of Washington. In addition to serving as an umbrella organization for several graduate student committees, FINS also raises funds to support student travel to conferences and organizes academic and social events throughout the year.*

Program

The days are getting rainier. Daylight Savings Time has ended. Teachers and students have the "8th week stare". It must be time for the Graduate Student Symposium!

I've said it before, and I'll say it again: The GSS is always a highlight of the year for me. It provides the chance to see the amazing breadth, quality, and impact of the work being done by our graduate students.

We have salmon, corals, birds and whales! We have microplastics, toxic metals, wind turbines and lakeshore development! We have otolith microchemistry, compound specific stable isotopes, gene expression, and R programming! And finally, we have physiology, ecology, fisheries management, and cultural-ecological systems!

Not only that, the energy and passion behind these science stories is infectious and inspiring.

Great, innovative science and inspiration, that sounds great, right? But wait there's more! Come for the science, stay for the community building ™. That's right, this event is so much more than the plots and figures, clever deductions and expert presentations. It reinforces our connections to each other, and builds new partnerships and collaborations.

As always, a huge thank you to the organizing team: Emily Bishop, Bryan Briones Ortiz, Tessa Code, Nicole Doran and Anna Simeon. So much time and effort go into this event, and they always manage to make it look easier than it really is. Additional thanks to the volunteer judges, whose useful feedback on the science and the presentations is an important part of the GSS experience. Finally, special thanks go out to the Skau family, whose generous gift to the School makes this event possible each year.

Timothy E. Essington

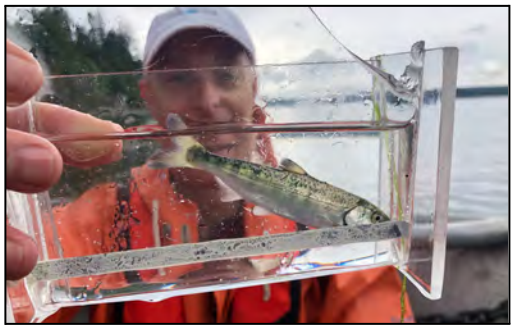


Photo: Emily Bishop

Schedule

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

9:00 Welcome and Opening Remarks - FSH 108
2023 GSS Coordinators—Emily Bishop, Bryan Briones Ortiz, Tessa Code, Nicole Doran, Anna Simeon
GSS Presentation Survey Coordinator – Chris Setzke
Director, School of Aquatic & Fishery Sciences – Dr. Tim Essington

9:15 – 10:15 PhD 15 minute talks (Group I)
FSH 108, Moderator: Jenny Gardner

10:15 – 10:45 Break, move to FSH 107

10:45 – 12:00 MS 15 minute talks (Group I)
FSH 107, Moderator: Arial Brewer

12:00 – 12:30 Lunch Break

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

1:30 – 1:45 Break

1:45 – 2:45 PhD 15 minute talks (Group II)
FSH 107, Moderator: Markus Min

2:45 – 3:30 Lightning Talks
FSH 107, Moderator: Markus Min

3:30 – 3:45 Break

3:45 – 5:00 MS 15 minute talks (Group II) & Leaky Boot
FSH 107, Moderator: Helen McMonagle

5:00 Poster session & Reception
Fisheries Sciences Building lobby

Karl Veggerby, Nicole Doran, and a volunteer from the Drayton Harbor Oyster Company sample from a shellfish aquaculture site in Drayton Harbor, WA. Photo: Mark Scheuerell

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. 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. We invite you to honor the community, past and present, and the land, with gratitude. Consider visiting native-land.ca to learn more.

Presentations

PhD Students (Group I)
15 minute Conference Talks

9:15 - Jeremy Axworthy
Microplastics ingestion and adhesion by reef-building corals under different flow rates

9:30 - Grace Crandall
Gene expression profiles in *Pycnopodia helianthoides* exposed to sea star wasting disease

9:45 - Sabikunnahar Shorna
Ecological and biological drivers of mercury accumulation in fishes of the Tonle Sap Lake, Cambodia

10:00 - Eileen Bates
Can coralline algae habitat bolster the climate resilience of Washington's endangered Pinto Abalone?

10:15 – 10:45 Break, Move to 107

Intertidal creatures on Tatoosh Island, WA. Photo: Liz Allyn

MS Students (Group I)
15 minute Conference Talks

10:45 - Jezella Peraza
Quantifying probabilities of fish and tidal turbine encounters and impacts using empirical and agent-based models

11:00 - Nicole Doran
Defining Cultural-Ecological Resilience through Community and Sovereign Foodways

11:15 - Gio Jacuzzi
Acoustic monitoring reveals effects of silviculture on avian community composition in upland watersheds

11:30 - Callum Backstrom
Investigating the effects of thermal stress on microplastic ingestion and adhesion in two reef-building coral species of Hawai‘i

11:45 - Emily Jameson
Lakeshore development impacts food web network structure in suburban lakes

12:00 – 12:30 Lunch Break

12:30-1:30 Quantitative Seminar
Room: FSH 203

Dr. Pierre-Yves Hernvann
An end-to-end ecosystem modeling approach to lay the foundation of a climate-informed ecosystem management strategy evaluation in the California Current.

Presentations

1:30 – 1:45 Break

PhD Students (Group II)
15 minute Conference Talks

1:45 - Arial Brewer
The relationship between group behavioral dynamics and environmental conditions on the vocal behavior of Cook Inlet beluga whales

2:00 - Bryan Briones Ortiz
Parallel evolution of annual and perennial life histories in the seagrass *Zostera marina* (eelgrass)

2:15 - Julia Indivero
Improving species distribution models through a physiologically based approach: oxygen and temperature effects on groundfish distributions

2:30 - Helena McMonagle
Using Github's Copilot to write R code faster

Lightning Talks

2:45 - Ben Makhlouf
The secret power of a fish ear; otoliths as a tool for addressing ecosystem scale patterns and challenges in Alaskan salmon

2:50 - John Proefrock
Like a Fish Out of Water: seasonal variation in spawning habitats and spatio-temporal genetic adaptation of a climate-vulnerable species

2:55 - Emma Christman
Climate-Driven Shifts in juvenile growth conditions in the lakes of the Nushagak and Wood Rivers

3:00 - Michelle Dyroy
Reducing Pacific halibut (*Hippoglossus stenolepis*) bycatch in the Pacific cod (*Gadus macrocephalus*) bottom trawl fishery

3:05 - Grace Henry
Why use Compound Specific Isotope Analysis?

3:10 - Kelly Neal
Beaver dam impacts on salmonid freshwater life stages

3:15 - Katherine Lasdin
Plastics on the Motus of Tetiaroa

3:20 - Q & A for lightning talk presenters

3:30 – 3:45 Break

Metacarcinus gracilis *volunteered for a safe handling observation during an invertebrate survey in False Bay, WA Photo: Andy Nutzhorn*

Presentations

MS Students (Group II)
15 minute Conference Talks

3:45 - Kathleen Durkin
UCE/Exon Target Enrichment Clarifies Species Boundaries in *Sinularia/Sclerophytum* Soft Corals

4:00 - Sarah Tanja
Corals in a hot plastic ocean: How heat and phthalates shift a Montipora capitata coral microbiome

4:15 - Liam Pendleton
Estimating the influence of environmental conditions on breeding success in Pigeon Guillemots

4:30 - Miranda Roethler
Effects of warming and acidification on different life stages of Bull Kelp (*Nereocystis luetkeana*)

Leaky Boot Talk

4:45 - Connor Whalen & Gabby Commisso
Survival of the Fittest: Application of Darwinism to aid resource allocation in academia

POSTER SESSION

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

Grace Davis
Microsatellites: The key to saving an endangered deer species

California sea lions hauled out at Shilshole. Photo: Arial Brewer

Josephine Grell
Heat and low nutrients: How do bull kelp blade carbon and nitrogen levels change across environmental conditions?

Maia Wrice
Size Distribution and abundance of Acorn barnacle (*Balanus glandula*) along an intertidal elevation gradient

Lindsay Cox, Sophie St. Denis, Jillian Campbell, Erika Miller, Alessia Mei
Temperature Effects on Growth in the Cross Jellyfish (*Mitrocoma cellularia*)

Josephine Grell, Conner Erickson, Mads Hansen, Cheyenne Stirek
Low salinity reduces spine movement and coordination in the Red Sea Urchin (*Mesocentrotus franciscanus)*

Samuel Smith, Nicole Reynolds, Marley Kott, Olivia Cartwright
Diel differences in zooplankton abundance and diversity within exposed and protected locations in San Juan Channel, WA

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A close-up of a Westslope Cutthroat Trout. Identified by its reddish-orange markings towards the bottom of its gill plate and behind the pectoral fins. Photo: Maksim Watton

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Standard Talks: PhD Students I

Jeremy Axworthy
Advisor: Jacqueline Padilla-Gamiño

Microplastics ingestion and adhesion by reef-building corals under different flow rates

Microplastics, plastic particles less than 5 mm in size, are increasing in marine environments worldwide but their fate is not fully understood. Reef-building corals are suggested to serve as sinks for microplastics via two processes: 1) active removal through ingestion and 2) passive removal by adhesion. However, it is not known which type of plastics are more likely to be ingested or adhered to corals and whether water flow rate or coral morphology affects these processes. To understand the mechanisms associated with microplastic removal, we exposed the corals, *Leptoseris sp., Montipora capitata, Montipora digitata,* and *Pocillopora damicornis* to weathered polyester fibers, acrylic fibers, and polystyrene fragments under three flow regimes (2.5, 5 and 7 cm s-1). Results indicate that adhesion rates are higher than ingestion rates and that fibers are more likely to be ingested by and adhered to corals. Adhesion increased with water flow and was also affected by species. Additionally, we observed higher adhesion rates on non-living sections of coral fragments than live tissue suggesting that non-living sections of reefs may also serve as an important sink for microplastics pollution. These data are critical for determining which environments corals are more likely to interact with different types of microplastics and which corals remove more microplastics from the water, ultimately helping to understand the risk to corals and the fate of these pervasive pollutants.

A brown boobie eyes its surveyors on Tetiaroa Atoll, French Polynesia. Photo: Eve Hallock

Abstracts

Tube feet of an adult Pycnopodia helianthoides *(Sunflower star), used in disease challenge experiments at USGS Marrowstone Field Station. Photo: Grace Crandall*

Grace Crandall
Advisor: Steven Roberts

Gene expression profiles in Pycnopodia helianthoides *exposed to sea star wasting disease*

Sea star wasting disease has been impacting sea stars along the North American West Coast for nearly a decade, and the causative agent for this disease has not been identified. One of the hardest-hit species is the Sunflower Sea Star, *Pycnopodia helianthoides*, though it is unknown why this species is particularly vulnerable. A means to assess vulnerability and potential candidates for causative agents is to fully characterize their immune response. Using transcriptomics, non-exposed grossly healthy and disease-exposed *Pycnopodia helianthoideswere* compared to identify differentially expressed genes. Genes were functionally characterized, with specific immune response genes expressed at a higher level in sea stars exposed to disease and exhibiting disease signs. This work will identify genes associated with disease resilience, will aid in identifying populations for conservation efforts, and provide complementary information for identifying causative agent(s).

Sabikunnahar Shorna
Advisor: Gordon Holtgrieve

Ecological and Biological Drivers of Mercury Accumulation in Fishes of the Tonle Sap Lake, Cambodia

The Tonle Sap Lake (TSL), often referred to as the beating heart of Cambodia, is the largest permanent freshwater body in South-East Asia and provides up to 80% of the animal protein and critical micronutrients to local people. The TSL is a classic flood-pulse ecosystem. The vast floodplain area of the lake, combined with the annual rich biodiversity and nutrient-rich sediment supply from the Mekong, makes Tonle Sap one of the most productive freshwater ecosystems in the world. However, this unique connection between the lake and the Mekong River, along with its sensitivity to hydrological changes, makes the Tonle Sap highly responsive to climate change, hydropower development, and industrialization.

We investigated the physical and ecological drivers of Mercury (THg) in 39 species of fish (n=966) from nine locations in the TSL. The average total Hg (THg) content was widely variable among species, ranging from 25.36 to 925.07 µg/g. There was an increase in THg in the majority of fish species during the monsoon season, although seasonal changes in hydrology were not found to be significant drivers of THg levels in fish. Several biological traits were associated with higher THg content, including species length, weight, oral gape position, food habits, and trophic level. Mercury levels in fish in the Tropical Southeast Asia region are variable and influenced more by specific biological traits of the fish than by hydrology.

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Floating village on Tonle Sap Lake, Cambodia
Photo: Sabikunnahar Shorna

Eileen Bates
Advisor: Jacqueline Padilla-Gamiño

Can coralline algae habitat bolster the climate resilience of Washington's endangered Pinto Abalone?

Since 1994, Washington State has seen a 97% drop in the native pinto abalone population. Restoration aquaculture efforts have been underway since 2007 to return the wild population to a self-sustaining density. Restoration groups spawn pinto abalone in hatcheries and rear them for 1-2 years before releasing them to subtidal sites. The success of abalone not only depends on restoration efforts but also on the capacity of abalone to survive and reproduce as threats of ocean acidification and warming increase. Crustose coralline algae can play an important role in the success of restoration efforts by serving as a natural settlement inducer and creating a pH refuge for juvenile abalone. In this study we examined settlement of pinto abalone under different environmental conditions (7.95pH, 14°C (control); 7.95pH, 18°C; 7.6pH 14°C; and 7.6pH, 18°C) using two substrates: clean fiberglass with GABA (a neurotransmitter typically used to induce larval settlement) and CCA covered fiberglass. If presence of CCA can improve settlement and mitigate effects of ocean acidification on larval and juvenile abalone, we may be able to improve the efficacy of abalone restoration efforts in Washington. We tracked settlement rate and then survival, growth, and substrate microbial composition for the first three months of juvenile growth. Our findings will unblock bottlenecks in the hatchery rearing process and provide insights into ideal wild abalone habitat as climate change continues.

Standard Talks: MS Students I

Jezella Peraza
Advisor: Mark Scheuerell

Quantifying probabilities of fish and tidal turbine encounters and impacts using empirical and agent-based models

Tidal turbines are one source of marine renewable energy that can be deployed in high-flowing regions, but development is hampered by concerns of aquatic animal impacts. Potential concerns include animal-turbine encounters, collisions with stationary turbine structures, and/or strikes from rotating blades. A comprehensive model that quantifies occurrence probabilities of approach, potential fish-turbine interaction, and avoidance behavior in sequential steps is lacking. Primarily using acoustic density measurements of Pacific herring (Clupea pallasii) in Admiralty Inlet, Washington, we developed an encounter-impact probabilistic model. Model components include approach, entrainment, interactions, and avoidance with axial or cross-flow tidal turbines to estimate conditional probabilities of fish approaching and potentially interacting with a turbine. A second agent-based simulation model uses the same model components and incorporates empirically-based behaviors, environmental conditions, and turbine characteristics. Maximum probabilities of occurrence for the empirical model occurred for a cross-flow turbine at night with no active or passive avoidance. As expected, estimates were lowest when probabilities were conditional on sequential events, and when avoidance was included for an axial-flow turbine during the day. For the agent-based model, approach probabilities were higher than entrainment probabilities, and impact

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probabilities were lower in higher flow conditions. Increased fish aggregation led to increased active avoidance behavior. Estimating encounter-impact probabilities for both modeling frameworks illustrates utilization of existing data and identifies data gaps needed to calculate risk probabilities for any species, tidal site, and device combination.

Nicole Doran
Advisor: Mark Scheuerell

Defining Cultural-Ecological Resilience through Community and Sovereign Foodways

Resilience within social and ecological contexts has consistently been defined as a product of the external forces acting on a system. This definition is insufficient to describe the forces of systemic racism, injustice, and inequitable power dynamics that are often at play within systems. This paper seeks to expand upon previous frameworks of resilience that have come out of social-ecological systems thinking. It has three major goals: 1) to provide a definition for resilience based on community agency rather than passive acceptance of external disturbances, 2) to address questions of power and injustice within a settler colonial system, and 3) to integrate social and ecological resilience through the understanding that the resilience of cultural systems is built upon the maintenance of relationships, defined broadly to include social and environmental relationships that have been upheld by Indigenous Peoples since time immemorial. By broadening our understanding of resilience, this paper seeks to better link social-ecological systems thinking with thought and practice being produced by Indigenous scholars and Indigenous Peoples. As a case study, this paper develops a framework for cultural-ecological resilience to apply these concepts to sovereign food systems.

Juvenile Bull Trout from an Upper Columbia tributary in the Okanagan. Photo: Nick Chambers

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Gio Jacuzzi
Advisor: Julian Olden

Acoustic monitoring reveals effects of silviculture on avian community composition in upland watersheds

Avian populations in the Pacific Northwest have declined by more than 30% since 1970, with precipitous reductions in forest-breeding species, in part, due to a history of mismanagement. Today, nearly half of Washington's forestland is ""working forest"", managed with the assumption that sustainable silviculture can produce economic value while simultaneously providing sufficient habitat for focal species. This is done by maintaining a patchwork of forest age classes and stand structures – however, the response of entire avian communities to habitat created through such management remains obscure.

By applying machine learning methods to landscape-scale acoustic monitoring we can quantify avian community composition across an entire working forest and assess the effect of silviculture practices. Passive acoustic recordings were made during the years of 2020-2023 at 213 sites stratified by three age classes (stand initiation, stem exclusion, mature) and one management prescription (commercial thinning) in 16 watersheds of the Olympic Experimental State Forest, managed by the Washington State Department of Natural Resources.

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Convolutional neural network classification and indices of bioacoustic activity yielded measures of species richness and relative acoustic abundance of avian assemblages across forest strata. We then quantified differences in ordination of community composition with a principal component analysis.

Initial results indicate significant differences in community composition between age classes, but a marginal effect of thinning treatment. Greatest species richness occurred in early-seral habitat. Future research will explore relationships between habitat structure variables and occupancy, and will be used to evaluate experimental prescriptions that promote avian biodiversity.

Callum Backstrom with coral colonies held in captivity to collect egg-sperm bundles released during the new moon on Kāneʻohe, HI. Photo: Callum Backstrom

Callum Backstrom
Advisor: Jacqueline Padilla-Gamiño

Investigating the effects of thermal stress on microplastic ingestion and adhesion in two reef-building coral species of Hawai'i

The corals that construct vast tropical reef ecosystems face numerous anthropogenic stressors, including ocean warming and pollutants such as microplastics. Some major reef-building corals increase their rates of feeding to survive thermal stress, though preliminary studies have found that some corals prefer microplastics to zooplankton prey when given a choice during feeding. However, little is known about how thermal stress and microplastic type (e.g., composition, shape) affect the rates at which microplastics are adhered to or ingested by corals, which could inhibit coral health and reproduction. In May-August 2023, we designed an experiment at the Hawaiʻi Institute of Marine Biology in which we thermally stressed subsets of two major Hawaiian reef coral species, *Montipora capitata* and *Pocillopora acuta*. Thermal stress induced bleaching, a loss of corals' symbiotic dinoflagellates that we measured by routine color analysis. After simulating a bleaching event and allowing 2 weeks of recovery, we placed all corals in feeding trials where we fed coral fragments combinations of different plastic types (e.g, tire wear particles, polypropylene fragments, polyethylene spheres) and/or zooplankton. After feeding, all corals were preserved in formalin solution and shipped to UW. Dissection and microscopy will help us understand which microplastics were adhered/ingested most by corals, whether bleaching affects the amount of microplastics consumed relative to zooplankton, and whether these responses vary by coral species. This presentation will cover the rationale, experimental design, and next steps in analyses of these coral samples.

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One of UW's "research vessels" during a break at Beaver Lake. Photo: Emily Jameson

Emily Jameson
Advisor: Julian Olden

Lakeshore development impacts food web network structure in suburban lakes

Lakes support diverse species communities and provide important economic, recreational, and cultural ecosystem services. Lakeshore development, including built infrastructure and landscaping activities, can reduce habitat diversity, macrophytes, and woody debris in littoral (nearshore) environments. Despite the widespread ways in which human activities have disturbed lake shorelines, the food web consequences of these impacts remain unclear. Our study investigated the effects of lakeshore development on food web network structure in lakes throughout the Puget Sound Lowlands. Food web network analysis provides a powerful framework to quantify the effects of perturbations on species interactions and community dynamics. Specifically, we determined lake-specific food web network structure, examined changes in structure across a lakeshore development gradient, and analyzed drivers of these changes.
We conducted standardized littoral and riparian habitat surveys in 12 lakes across a lakeshore development gradient (forested to urbanized). To quantify food web networks, we applied the analytical framework, EcoDiet, which combines diet information from three different data sources – existing literature data, stable isotope analysis (SIA), and stomach content analysis (SCA) – into a single hierarchical Bayesian model. Model results indicated changes in overall network structure, across several key network metrics, as lakeshore development increased. Species-specific roles in the food web, however, remained consistent regardless of development. In this study we use quantitative network analyses to unravel the complex web of species interactions in lakes, which could be a stepping-stone towards building predictive models to anticipate consequences of such disturbances.

Standard Talks: PhD Students II

Arial Brewer
Advisors: Andrew Berdahl & Amy Van Cise

The relationship between group behavioral dynamics and environmental conditions on the vocal behavior of Cook Inlet beluga whales.

Many social species rely on acoustic communication to coordinate activities and communicate to conspecifics. These species must be able to communicate important information, such as identity, predator presence, movement decisions and the location of prey sources. Understanding the association between group dynamics and vocal behavior is important in the conservation of these species. Beluga whales (Delphinapterus leucas) are an extremely social and vocal marine mammal, yet little is known about the context or intent of social calls. In this study, we use generalized linear mixed models to investigate how behavior, group size, calf presence and tidal state affect the vocal behavior of Cook Inlet beluga whales. Preliminary results indicate that both the category of call and rate of calling depend on the aforementioned variables. Further work on this project aims to correlate specific

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call types to changes in group dynamics or environmental context. An improved understanding of the context of Cook Inlet beluga vocal behavior can more efficiently inform passive acoustic monitoring efforts and provide important information supporting the management of this endangered population.

Bryan Briones Ortiz
Advisor: Kerry Naish

Parallel Evolution of Annual and Perennial Life Histories in the Seagrass Zostera marina *(eelgrass)*

Shared phenotypes within species may arise via parallel evolution (independent and repeated adaptation) or the retention of ancestral genetic polymorphisms (through incomplete lineage sorting and gene flow). Populations of the seagrass *Zostera marina* (eelgrass) can be annual or perennial. Annual

Cook Inlet belugas swimming near Anchorage, Alaska
Photo: Arial Brewer

eelgrass is often associated with stressful habitats, and plants typically exhibit increased energy allocation to sexual reproduction, followed by senescence, during the first growing season. In contrast, perennial meadows are found in more benign conditions and proliferate via clonal branching. For decades, the annual life history has been viewed as facultative and driven by the environment. However, our empirical evidence has revealed that the life history strategies are genetically and adaptively divergent in Willapa Bay, WA, where annual and perennial meadows co-occur in close proximity. Nonetheless, limited genetic connectivity across regions where both life histories coexist suggests that these distinct phenotypes may have originated independently in different locations, representing separate evolutionary events. My aim is to determine whether multiple evolutionary divergences have occurred between the annual and perennial life histories of *Z. marina* across the species range. I will genotype distant pairs of coexisting annual and perennial meadows to characterize the degree to which selection events may have contributed to single or multiple origins of the annual life history across the range of eelgrass. Systems of replicated evolution offer perspectives on the relative importance of deterministic and stochastic processes in shaping evolutionary paths across similar environments, ultimately providing insights into the predictability and repeatability of evolution.

Julia Indivero
Advisor: Tim Essington

Improving species distribution models through a physiologically based approach: oxygen and temperature effects on groundfish distributions

Species distribution modeling is increasingly being used to describe and anticipate consequences of a warming ocean. These models often identify associations between distribution and relevant environmental conditions such as temperature and oxygen, but rarely consider the mechanisms by which these environmental variables affect metabolism. Oxygen and temperature jointly govern the rate of oxygen supply to oxygen demand, and theory predicts thresholds in these rates below which species densities are diminished. However, parameterizing models with this joint dependence is challenging because of the paucity of experimental work for most species, and the limited applicability of experimental findings in situ. Here we ask whether the joint effects of temperature and oxygen can be reliably inferred from species distribution data, using the U.S. Pacific Coast as a model system. Through simulation testing, we found that our

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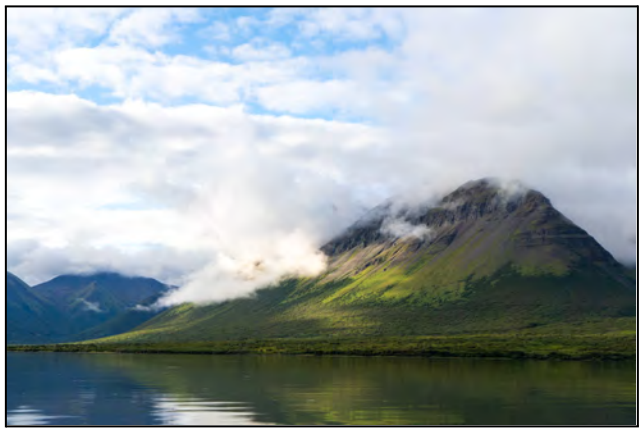
statistical model—which applied an Arrhenius equation to jointly consider oxygen and temperature and used a non-linear threshold function to link oxygen and temperature to fish distribution—could reliably estimate a temperature-oxygen relationship and predict fish densities but could not precisely estimate parameters separately. Our model provided a better fit to sablefish (Anoplopoma fimbria) spatial distribution than previously used model structures. The inclusion of environmental-physiological relationships can advance our ability to effectively explain groundfish habitat use and predict future distributions under climate change.

Helena McMonagle
Advisor: Tim Essington

Using Github's Copilot to Write R Code Faster

Abstract written by ChatGPT: This tutorial is designed for graduate students seeking to expedite their R coding processes in R Studio using Github's Copilot, a powerful generative AI tool. Participants will receive an introduction to Copilot's capabilities and learn how to integrate it into their coding workflows. The session will also include a discussion on the ethical considerations, advantages, and drawbacks of utilizing generative AI in research coding. By the end of the tutorial, participants will be better prepared to enhance their coding efficiency and make informed decisions about the use of generative AI in their academic and research endeavors.



Un-named mountain near Chignik Lake, Alaska on a commute to Black Lake. Photo: Ben Makhlouf

Lightning Talks

Ben Makhlouf
Advisor: Daniel Schindler

The secret power of a fish ear; otoliths as a tool for addressing ecosystem scale patterns and challenges in Alaskan salmon

In recent years, otolith chemistry has emerged as a powerful tool for reconstructing patterns of migration, habitat use, and life history strategies in fishes. For Pacific Salmon in Alaska, these methods have shed new light on the complexity of migration and production patterns at the river basin scale. Due In part to an extreme level of geological heterogeneity, tributaries in Alaska contain unique stable isotope signatures of Sr87/Sr86, which can be related to the measured value in the otolith to place a fish to a geographic location. When this method is expanded to the population scale, researchers can understand how patterns of movement and fish production change over space and time. Traditionally, otolith-based provenance research has been limited by diversity in Sr87/Sr86 signatures across the landscape. This has prohibited the use of these methods for applications on large spatial scale or in geologically heterogenous locations. However, recent advances have reduced the reliance of these methods on isotopic variation alone. In turn, we plan to use otolith microchemistry as a tool to 1) reconstruct increasingly accurate estimates of shifting habitat use and migration patterns in the Yukon and Kuskokwim River basins, and 2) determine previously unavailable natal origin assignments for fish caught as bycatch in the Alaska Pollock fishery. In doing so, we will illustrate how spatial patterns of Alaskan salmon are structured in critical Alaska watersheds and further our understanding of the relative effects of bycatch on declining stocks.

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Mosshead warbonnet peering over a sea cucumber in Puget Sound. Photo: Gregory Jensen

John Proefrock
Advisor: Lorenz Hauser

Like a Fish Out of Water: seasonal variation in spawning habitats and spatio-temporal genetic adaptation of a climate-vulnerable species

Puget Sound's coastal ecosystems are currently undergoing dramatic change as coastal development and beach armoring alter the characteristics of beaches along its shores. In combination with impending sea level rise these modifications may result in changes to the behavior and life histories of species that depend on beaches as vital habitats. The surf smelt (*Hypomesus pretiosus*), an important forage fish in the Puget Sound ecosystem, utilizes the upper intertidal region of sandy beaches to lay its eggs in the sediment. Surf smelt spawn year-round but only on some beaches, and the beach characteristics needed for spawning are relatively unknown. Here, we will correlate seasonal data on beach morphodynamics and ecology with observations of surf smelt spawning, which will provide useful insight into how the species utilizes available habitat. Given strong seasonal variation in upper inter-tidal conditions we will also determine the spatial and temporal population structure of Surf Smelt in Puget Sound to test for adaptive differences between summer and winter spawning populations. Increasing the understanding of how breeding populations are connected, along with where the species prefers to spawn at different times of the year will allow us to understand how vulnerable it is to anthropogenic habitat alteration and climate change.

Emma Christman
Advisor: Daniel Schindler

Climate-Driven Shifts in juvenile growth conditions in the lakes of the Nushagak and Wood Rivers

The recent increase in the production of adult sockeye salmon from the Nushagak River in Bristol Bay presents an opportunity to gain a greater understanding of the links between climate change and increased salmon production in southwest Alaska. Between 1963 and 2020, sockeye from the Nushagak River accounted for about 5% of returns to Bristol Bay, compared to 20% in 2020 and 2021. Much of the record-setting total returns of sockeye salmon to Bristol Bay are accounted for by these unprecedented levels of production from the Nushagak River. Warmer conditions in nursery lakes increases the food supply for the juvenile life stage of Pacific salmon, supported by the higher zooplankton densities. I am investigating whether juvenile salmon in the Nushagak system have been constrained by cold temperatures in the lakes, and if the weakening of this constraint in recent years has allowed for a dramatic increase in juvenile growth opportunity and therefore overall production.

Michelle Dyroy
Advisor: John Horne

*Reducing Pacific halibut (*Hippoglossus stenolepis*) bycatch in the Pacific cod (*Gadus macrocephalus*) bottom trawl fishery*

Pacific cod (*Gadus macrocephalus*) comprise the second largest commercial groundfish catch in Alaskan waters with 330 million pounds harvested in 2021. Limitations on bycatch of Pacific halibut (*Hippoglossus stenolepis*) if exceeded, can close the fishery and leave uncaught cod quota. In the Bering Sea, there has been little research focused on reducing halibut bycatch through use of bycatch reduction devices (BRDs) in the Pacific cod bottom trawl fishery. We will test the use of green LED lights

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at the mouth of the trawl as a deterrent to Pacific halibut entering the net. during at-sea trials in the 2024 Bering Sea cod winter fishery. To better understand the use of artificial light and BRD design, we will develop a BRD Performance Indicator (BPI). The BPI will incorporate results from our light trials, previous research, qualitative data, and review of video footage collected as part of the Stone and Bublitz (1996) halibut BRD study. Our goas are to provide insight into what affects BRD efficacy and to recommend future development of a BRD for this fishery. Because BPIs are a relatively new tool for evaluating BRDs, the results of this study will inform researchers, net manufacturers, and fisherman in their bycatch mitigation efforts.

Grace Henry
Advisor: Gordon Holtgrieve

Why use Compound Specific Isotope Analysis?

Stable isotope analysis has long been used as a method in ecological research for determining trophic position and determining food web structures. Isotopes can offer insight into historic food webs through archived tissues and these tissues are routinely being used to determine trophic dynamics in the past. However, bulk stable isotope analysis is fundamentally flawed in it's ability to accurately determine past trophic position because it cannot account for changes to the isotope signature at the base of the food web. The emerging method of compound specific isotope analysis (CSIA) addresses this limitation by measuring the isotope signatures of individual amino acids that are transferred differently between trophic positions. In this lightning talk, I will give an overview of the precise limitations of bulk isotope analysis and the ways in which CSIA addresses these limitations.

Graduate students Grace Henry and Kelly Neal and field technician Ania Gruchala prepare to set the fyke net to sample sockeye salmon smolts
Photo: Grace Henry

Kelly Neal
Advisor: Gordon Holtgrieve

Beaver Dam Impacts on Salmonid Freshwater Life Stages

There are many studies looking at how beaver dams impact (BDI) salmonids at their various life stages. Most notable effects that ultimately impact salmonids are how beaver dams influence water temperatures, invertebrate abundances and composition, nutrient dynamics, and amount of habitat available. The literature shows contrasting results of these impacts on salmonids, but despite there not being a clear consensus of BDI on salmonids, beavers are an ever increasingly popular tool for restoring riverscapes for juvenile salmonid rearing. The growing use of beavers in restoration projects, without quantification of their effect on salmonids across all life stages, is a crucial knowledge gap that we address here. Through a holistic literature review and meta-analysis, we assess what nuances are responsible for the differing outcomes in studies on BDI to salmonids. Possible explanations for the alternative outcomes include differences between each study's latitude, elevation, land use, land cover, climate, and season. This gap must be filled to improve the design and ultimate success of freshwater salmonid habitat restoration projects. It is necessary then to also increase our understanding of how beavers impact the diverse

freshwater ecosystems that salmonids rely on, and in what capacity, for their ability to be used in an efficient and beneficial manner within the context of salmonid habitat restoration projects.

Brown pelicans hang out in the surf off Tatoosh Island
Photo: Emily Bishop

Katherine Lasdin
Advisor: Jacqueline Padilla-Gamiño

Plastics on the Motus of Tetiaroa

Microplastics are a known and common pollutant in the marine environment. These anthropogenic pollutants have been found globally and in every location scientists have looked for them. While plastics come in a variety of polymer types, shapes and sizes, their mainstream popularity has become a hazard for the marine environment. In October 2022, a research team based at UW went to Tetiaroa, French Polynesia. Tetiaroa is an atoll off the coast of Tahiti that is home to the Brando resort, along with several marine animals including birds, mammals, and turtles. Sand samples were collected on eat motu on the atoll, some on the ocean side and some on the lagoon side for the present of plastics. The samples were collected and then density separated in Tetiaroa before bringing the floating materials from the density separation back to WA. Once in WA, they were shipped to a research team member in Hawaii and further processed, with all potential plastics >1mm being collected and analyzed with an benchtop FTIR for polymer identification. Due to the two rounds of density separation, analyzed samples were divided into 'floating' and "sinking'. Plastics were found at a majority of the motus with 5 polymer types being found in the floating particles and 9 in the sinking particles. One motu in particular, Tiaraunu, had a larger number of plastics found per kg of sand than the remaining motus.

Standard Talks: MS Students II

Kathleen Durkin
Advisor: Steven Roberts

UCE/Exon Target Enrichment Clarifies Species Boundaries in Sinularia/Sclerophytum *Soft Corals*

Coral reefs serve essential ecological and commercial functions but are increasingly imperiled by climate change. Accurate species identification is critical for effective conservation and restoration efforts. However, soft corals, an important but understudied reef taxon in the Octocorallia class, are difficult to identify morphologically due to few diagnostic morphological characters, phenotypic plasticity, cryptic species, and hybridization. Slow rates of molecular evolution within the class have also made DNA barcoding frequently insufficient for resolving species boundaries. I generated and analyzed UCE target enrichment data for clades of the soft coral genera *Sinularia* and *Sclerophytum* to improve species delimitation and inform assessments of population structure and geographical diversity.

Sarah Tanja
Advisor: Jacqueline Padilla-Gamiño

Corals in a hot plastic ocean: How heat and phthalates shift a Montipora capitata *coral microbiome*

Corals survive in nutrient poor waters by relying on the complex relationship with their diverse and abundant endosymbionts and microbiomes. Through their symbiotic partnerships, they sustain 25% of the world's marine biodiversity and are vital to economic and food security for hundreds of millions of people. Unfortunately, coral reefs are in ecological crisis. Climate change and ocean plastic pollution threaten

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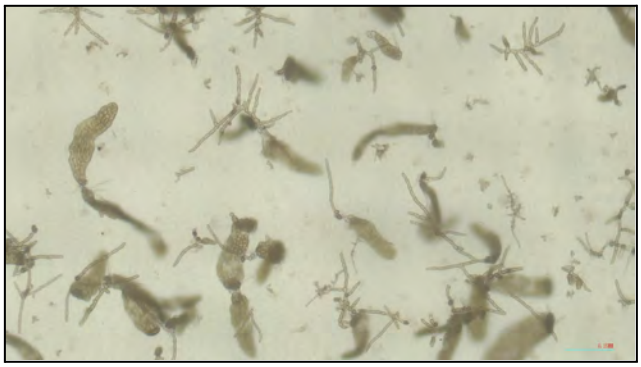
reef-building corals and the global services worth $2.7 trillion USD they provide. Even under an ambitious emissions reduction scenario, 100% of coral reefs are projected to experience annual severe bleaching by 2045; and every year, 4.8 to 12.7 million tons of plastic waste enters the oceans. In this study, we examine the effects of thermal stress and the common suite of plastic-additives known as phthalates on the Montipora capitata microbiome. Using a multiple stressor experiment, this study provides new insight on the impacts of phthalate pollution on coral microbial communities in the context of ocean warming. A delicate balance of microbial community abundance and composition facilitates the stability of symbiosis and ultimately coral reef survival. Managing coral reefs for resilience to thermal stress and reducing pollution is paramount to their conservation, and microbial communities are a key part of coral resilience.

Liam Pendleton
Advisor: Sarah Converse

Estimating the influence of environmental conditions on breeding success in Pigeon Guillemots

The dynamics of seabird populations are tightly linked with oceanographic conditions in the marine habitats where they forage. Pigeon Guillemots (Cepphus columba) have been identified by the Puget Sound Partnership as vital in aiding restoration goals of the Puget Sound, and the population on Protection Island National Wildlife Refuge has been monitored for the past few decades. The purpose of this study is to describe the relationship between demographic rates of the Pigeon Guillemots at Protection Island and oceanographic conditions in the Salish Sea. I used a mark-recapture method to monitor nesting success of chicks and developed a daily nest survival model to explore the effects of oceanographic conditions on survival and chick production. Findings from this study will be shared with the Puget Sound Partnership and Puget Sound Ecosystem Monitoring Project to further inform the status of Pigeon Guillemots in the Salish Sea.



Bull kelp microscopic stages (gametophytes) producing juvenile macroscopic stages (sporophytes) that will soon grow into a giant adult. Photo: Miranda Roethler

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Miranda Roethler
Advisor: Jacqueline Padilla-Gamiño

*Effects of Warming and Acidification on Different Life Stages of Bull Kelp (*Nereocystis luetkeana*)*

Kelp forests along the West Coast are under threat from climate change. While the effect of ocean warming on kelps is well-documented, the effects of ocean acidification are less well understood. We examined the effects of warming and acidification, both separately and concurrently, on bull kelp (*Nereocystis luetkeana*) from two populations in Puget Sound, WA. Bull kelp is the primary canopy-forming kelp species in Puget Sound, and some areas of the Sound have lost over two-thirds of their canopy cover. Our collection sites differed in the overall temperature, urbanization level, and state of the kelp forest. Last summer, we performed brief exposure experiments on blade sections from adult sporophytes and measured photosynthetic and fluorescence parameters. This summer, we performed a 5-week exposure experiment on gametophytes and measured survival, growth, development, and reproductive success from spore settlement through the juvenile sporophyte stage. We also used a Mini-PAM fluorometer to simultaneously measure photosynthesis and respiration of gametophytes. We found that temperatures above 18-20C had a substantial negative impact on photosynthetic health in adult sporophytes. In gametophytes, growth increased but reproductive success decreased at these temperatures. Both sporophytes and gametophytes exposed to elevated

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temperature and pCO2 had slightly higher photosynthetic and fluorescence parameters than those exposed to elevated temperature alone.

Southern resident killer whale breaching in Puget Sound. Photo: Arial Brewer

Leaky Boot

Connor Whalen & Gabby Commisso
Advisor: Chelsea Wood

Survival of the Fittest: Application of Darwinism to aid resource allocation in academia

Scientists have long debated the importance of their study subjects, with each scientist claiming the topic to which they have dedicated their career is of singular peak importance. These are valuable perspectives to consider when applying for funding, seeking career advancement, or even attempting to once again prove to your parents that you ARE a real doctor and it doesn't matter if you went to medical school or not. Further, this information is critical to determining the direction in which research should trend and focus resources. An often understudied and seldom considered parameter when considering these differences between study species and concepts is which would win in a physical fight. While some SAFS faculty study specific species or groups, others study broader concepts or methods. When applicable, these concepts are pitted against animals or each other in an ideological fight if a physical fight is not possible. We have conducted a metaanalysis using a randomized bracket of all the study subjects (species and concepts) of SAFS faculty and concluded whose research subject is, in fact, superior in the ring. These results identify which subject warrants continued funding within SAFS and informs funding sources as to which scientists need to get their act together as their study subject is a wimpy baby that needs to be coddled to make it in the real world.

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Poster Session

Grace Davis
Advisors: Christopher Bird & David Gauthier

Microsatellites: The key to saving an endangered deer species

The Visayan spotted deer, *Rusa alfredi*, is endemic to the Visayas region of the Philippines and is one of the most endangered deer species in the world with ~2000 individuals remaining in the wild. Captive breeding has served as a conservation measure for this species, with plans to reintroduce the individuals to the wild to aid in population recovery. However, we hypothesize that, since the population was founded by a few number of breeding pairs (n = 4), there will be high levels of inbreeding and reduced genetic diversity within the captive bred population. To test this hypothesis, we aimed to estimate the inbreeding coefficient of the captive bred population. As there are currently no microsatellite primers designed for this species, we evaluated and deployed microsatellite primers developed from the closely related sika deer, Cervus nippon. Tissue samples were obtained from nineteen individuals for tissue digestion and DNA extraction. The amplification of nineteen microsatellite loci was then performed with three-primer PCR. Gel electrophoresis confirmed the success of the amplification and fragment analysis was used to size dye-labeled amplicons. Genotyped deer were analyzed for inbreeding coefficients and the observed and expected heterozygosity. The R package "related" was used to perform pairwise relatedness analysis under multiple estimators. This insight will enable managers to improve their captive breeding strategies to lessen the degree of inbreeding. This approach of gathering genetic data will also create an opportunity to collaborate with other managers by including other captive bred populations in the area.

A group of students in Tutuila, American Samoa during the 2023 SAFS Study Abroad trip. Photo: Luke Tornabene

Josephine Grell, Conner Erickson, Mads Hansen & Cheyenne Stirek
Advisor: José Guzmán

Low salinity reduces spine movement and coordination in the Red Sea Urchin, Mesocentrotus franciscanus

Climate change is increasing glacial melt worldwide, causing freshening events in marine ecosystems that rapidly decrease salinity. In the Salish Sea, summer low salinity events occur regularly from the Fraser River meltwater. This negatively impacts many organisms including sea urchins, which are resilient to other climate change impacts like marine heatwaves and reduced food availability. Previous studies found that low salinity impacts tube foot mobility and function in green sea urchins (*Strongylocentrotus droebachiensis*). We replicated the Salish Sea freshening events with a treatment of 20 PSU saltwater (control 30 PSU) to investigate the impacts on red sea urchin (*Mesocentrotus fransiscanus*) coordination and spine movement. This study implemented new techniques to quantify urchin motility to determine the negative effects that low salinity had on sea urchins over 96 hours. We quantified spine movement using image analysis to track individual spines of urchins in low and regular salinities. We also measured righting time, which is an indicator of urchin coordination. We found that urchins exposed to low salinity had significantly longer righting times and less spine movement

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overall. The low salinity treatment spine movement and righting time were highly correlated ($p < 0.01$), but not in the ambient salinity tanks ($p > 0.01$). We found that lower salinity waters have the potential to reduce urchin coordination and movement, which may impact urchin populations and kelp forests in the changing climate. Thus, there may be a lessened impact on the kelp forests needed to maintain ocean health.

Josephine Grell
Advisor: Emily Carrington

Heat and low nutrients: How do bull kelp blade carbon and nitrogen levels change across environmental conditions?

Kelps are a vital component of our coastal marine ecosystems, forming the base of food webs, providing habitat for many fished and unfished species and holding a strong cultural importance to society. Kelps thrive in cold, nutrient-rich waters and are therefore impacted by changing abiotic conditions including warming temperatures and low nutrient availability. Water temperatures and nutrient availability vary across the Salish Sea, with higher nutrients in cold water and lower nutrients in warmer waters. Significant bull kelp forest (*Nereocystis luetkeana*) declines have occurred in Washington, British Columbia, and northern California and are associated with warming or marine heatwaves and other stressors. We hypothesized the quality of kelp tissue would depend on environmental conditions; with higher nutrient levels in kelp blades from regions with cooler oceanic water than from warmer or fresher regions. We compared the carbon-to-nitrogen ratios and stable isotope profiles in kelp blade tissue from eight sites in the Salish Sea across a temperature and nutrient availability gradient. Our results show that the percent nitrogen in the blades is similar across sites and that δ15N levels do not vary greatly, except at Salmon Beach. Our findings contribute to kelp forest ecology by documenting stable isotope signatures which can inform food web studies. Additionally, this work shows blades nitrogen is consistent across sites even when nitrogen availability is low.

Taking in the majesty of Cape Flattery after supporting Sea Grant and Makah Fisheries Management's European Green Crab removal trappings. Photo: Andy Nutzhorn

Maia Wrice
Advisors: José Guzmán & Sasha Seroy

*Size Distribution and abundance of Acorn barnacle (*Balanus glandula*) along an intertidal elevation gradient.*

Acorn barnacles (*Balanus glandula*) are among the most common species found in the Northern Pacific Ocean, inhabiting rocky surfaces across intertidal zones. The distribution of these barnacles is attributed to a variety of factors, including surface exposure, spatial competition, and predation. The size and abundance of barnacles may serve as an indicator of the primary abiotic and biotic processes that influence barnacle populations in highly dynamic intertidal systems. This study tests our hypothesis that higher abundance and smaller-sized barnacles will be observed at higher tide elevations, while lower abundance and larger-sized barnacles will be observed at lower intertidal elevations on the shore. In September 2023, at Friday Harbor, (San Juan Island, WA) we photographed 10 quadrats (24x24cm) at low (0-0.01m), mid (0.89-1m), and high (1.82-2m) elevations. We observed barnacle distributions at two sites along the San Juan Channel. Barnacle abundance and size were measured with ImageJ. We calculated the mean and median barnacle size at each elevation and location. Small barnacles (0-1.5mm) were predominant in the high elevations, whereas large barnacles (>3mm) dominated the lower elevations. Our results may be associated with a combination of abiotic and biotic factors. Abiotic

factors include greater desiccation risks in the high intertidal elevation. Some biotic factors involve food availability, with larger barnacles having greater access to the nutrients coming from the ocean, along with spatial competition, where higher abundance may lead to increased competition, thereby reducing available resources for each individual.

Lindsay Cox, Sophie St. Denis, Jillian Campbell, Erika Miller & Alessia Mei
Advisors: José Guzmán & Sasha Seroy

*Temperature Effects on Growth in the Cross Jellyfish (*Mitrocoma cellularia*)*

Previous studies have found that jellyfish benefit from warming temperatures and eutrophication, shown in jellyfish blooms worldwide. However, the impact of warmer ocean temperatures at the species-specific level, *Mitrocoma cellularia*, has been relatively unexplored. We hypothesize that higher water temperatures would increase *M. cellularia* growth. A total of 36 individuals were collected from the UW Friday Harbor Laboratories Dock, San Juan Island in September 2023. They were observed in individual jars without water flow, and equally split across four separate temperature-controlled baths at 13°C, 16°C, 18°C, and 20°C. Over the 96 hour period, they were fed excess live zooplankton collected before each feeding and had daily water replacements. Measurements were recorded of surface area with ImageJ, mortality, and overall condition after the acclimation period (initial), day two (mid), and day four (final). A growth rate polynomial regression characterized the final measurements of normal condition jellyfish with a maximum at 1.28277 %/hr closest to 16°C, resulting in an R2 =0.24 and p-value <0.05. Condition response to the different temperatures varied among individuals over time, such as shriveling of their bodies and death observed in the 20°C treatment. However, our results show that growth and body condition cannot solely be explained by temperature impacts. While 20°C decreased *M. cellularia* growth, our results support previous studies that jellyfish are resilient to impacts of climate change, up to a certain temperature. Further investigations of the adaptability of *M. cellularia* to changing temperatures is necessary to predict future outcomes of their ecology.

Samuel Smith, Nicole Reynolds, Marley Kott & Olivia Cartwright
Advisors: José Guzmán & Sasha Seroy

Diel Differences in Zooplankton Abundance and Diversity within Exposed and Protected Locations in San Juan Channel, WA

Zooplankton are vital to the marine food web, supplying nutrients and energy from primary producers to secondary consumers. During Diel Vertical Migration (DVM), zooplankton travel between depth and the surface during day and night to capitalize on food and avoid predation. This study investigated diel differences in zooplankton community composition at two locations, one exposed and one protected, in the San Juan Channel, WA over four days in September 2023. Zooplankton were collected using net tows from surface waters at both sites during day and night times. Samples were analyzed using a stereoscope and different taxonomic groups were counted. Copepods were the most abundant zooplankton taxa at both locations, with mean abundances up to 1000 individuals per cubic meter. At the exposed site, there was a significantly higher ($p<0.05$) abundance of zooplankton at night versus during the day. The exposed site had significantly higher diversity than the protected site at night ($p<0.05$). At both locations, species richness was significantly higher ($p<0.05$) at night compared to day. The exposed location also had significantly higher richness ($p<0.05$) compared to the protected location during the day. Our results indicate that zooplankton abundance and diversity in surface waters of the San Juan Channel are controlled by DVM, and differences in locations perhaps due to exposure to different flow regimes. This study reinforces the flexibility of zooplankton community composition and emphasizes the importance of understanding factors that influence changes in the base of the marine food web.

Acknowledgements

The success of the 34th 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 Jenny Gardner, Markus Min, Arial Brewer, Helena McMonagle, Emily Jameson, Julia Indivero, Miranda Roethler, Maria Kuruvilla, Sarah Tanja, Jan Ohlberger, and Mark Scheuerell.
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 34rd Annual School of Aquatic and Fishery Sciences Graduate Student Symposium and we hope you enjoy your time with us.

Sincerely,
Emily Bishop, Bryan Briones Ortiz, Tessa Code, Nicole Doran & Anna Simeon

2023 GSS Coordinators

Group photo from the 2022 Graduate Student Retreat