Image by Yaamini Venkataraman

The University of Washington School of Aquatic and Fishery Sciences presents

THE 28TH ANNUAL GRADUATE STUDENT SYMPOSIUM

Thursday, November 9 2017

ORAL PRESENTATIONS

9am to 5pm in Anderson 207

POSTER PRESENTATIONS & RECEPTION

5pm to 8pm in FSH Lobby

THIS ANNUAL EVENT IS SPONSORED BY THE SKAU ENDOWMENT, ESTABLISHED IN MEMORY OF OSCAR SKAU BY HIS FAMILY AND FRIENDS

From the Director

The Graduate Student Symposium is one of the few opportunities for students from across the School, as well as in 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, and this year is no exception - we have presentations from virtually every lab and program in the School. It is particularly pleasing that there are talks by students who are studying in the labs of our newest faculty hires. Also, the number of presentations by graduate students who only entered the program this quarter suggests that the 2017 intake will be one of the best ever.

This year's talks and posters cover topics as wide-ranging as stock assessment modelling, the potential impact of microplastics, and the population structure of Pacific cod off Korea. The taxonomic scale of the GSS is as broad as always, with multiple talks about salmonids, and several talks on shellfish and marine mammals. As always, there were some talks that really caught my eye as I reviewed the abstracts. This year these included those by Jeremy Axworthy who is planning to examine the impacts of microplastics on corals using laboratory experiments and by Megan Feddern who is aiming to understand changes over time in the trophic position of harbor seals given changes in large-scale climatic conditions. Another topic that I would like to learn more about is changes in foraging the behaviour of polar bears in Baffin Bay.

SAFS students conduct very innovative research and we are very good are getting our work published – SAFS faculty, staff and students have published almost 140 peer-reviewed scientific papers this year already, and graduate students were the first authors of close to 15% of these publications. It remains to be seen whether we are able to publish more than the 222 peer-reviewed papers that came out in 2016, but I am optimistic. Some of the titles of papers published during 2016 and 2017 match those of presentations and posters at previous GSSs, and I expect to see some of the research that is currently in the planning phase turn into papers in the best-of-the-best journals. In addition to our prodigious production of scientific papers, our presence in social media continues to climb as you highlight your research through the web, blogs and of course the twittersphere.

Well done and thank you to the program committee for setting up an excellent program, to those contributing the goodies at the back of the room, and to everyone who is moderating. A special welcome to the alumni and friends who are joining us for GSS this year. Finally, thanks to the Skau family whose gift to the School makes this event possible each year.

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 Coffee & light breakfast

9:00 WELCOME AND OPENING REMARKS
Forest Club Room, 207 Anderson Hall,
2017 GSS Coordinators
Dr. André Punt, Director, School of Aquatic & Fishery Sciences

9:15 – 10:15 Session I
Moderator: Katie McElroy

10:15 – 10:35 MORNING BREAK

10:35 – 12:00 Session II
Moderator: Sean Rohan

12:00 - 1:00 LUNCH

1:00 – 2:00 Session III
Moderator: Marta Gómez-Buckley

2:00 – 2:15 AFTERNOON BREAK I

2:15 – 3:15 Session IV
Moderator: Caitlin Allen Akselrud

3:15 – 3:30 AFTERNOON BREAK II

3:30 – 4:15 Session IV
Moderator: Davey French

4:30 CLOSING REMARKS

5:00 – 8:00 POSTER SESSION & RECEPTION
School of Aquatic & Fishery Sciences Lobby

A pile of Mediterranean mussels (*Mytilus galloprovincialis*) ready to be dissected.
Photo: Lindsay Alma

Cover design: Christina Morrisett

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

Abstracts

SESSION I
Moderator: Katie McElroy

9:15 Kristin Privitera-Johnson
Estimating among-assessment variation based on estimates of overfishing limits

9:30 Megan Feddern
Reconstructing historic changes in marine mammal trophic position and coastal productivity

9:45 Mary Fisher
Population structure of Pacific cod (*Gadus macrocephalus*) around the Korean peninsula

10:00 Caitlin Allen Akselrud
A quinate portfolio: moving from single-species to multi-species management strategies

10:15 – 10:35 MORNING BREAK

SESSION II
Moderator: Sean Rohan

10:35 Adrian Tuohy
Estimating post-release survival of Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*) from an experimental commercial pound net trap in the Lower Columbia River Sub-basin, WA.

Gray Whale - a lone gray whale plunges down to feed
Photo: Erica Escajeda

View from Lake Aleknagik field camp
Photo: Katie McElroy

10:50 Christina Morrisett
The effects of adult ladder passage at Lower Granite Dam on Snake River salmonid migration

11:05 Yaamini Venkataraman
Exploring proteomic variation in Pacific oysters (*Crassostrea gigas)*

11:20 Alex Lincoln
Motivation for selective consumption and prey discard: bears foraging on sockeye salmon search for optimal prey

11:35 Lindsay Alma
Seasonal spatial and temporal conditions impact physiological performance of bivalves in Puget Sound, WA

12:00 - 1:00 LUNCH BREAK

Abstracts

SESSION III
Moderator: Marta Gomez Buckley

1:00 Laura Spencer
Geoduck as indicators of environmental change

1:15 Jane Rogosch
Hydrologic drought favors non-native fishes in a changing climate

1:30 Lee Cronin-Fine
A numerical method for allowing individual variation in both growth parameters (k and L_∞) in size-structured models

1:45 Natalie Lowell
Population genetics of native shellfish aquaculture species and potential genetic risks of cultivation

Vermillion rockfish - Neah Bay
Photo: Gregory Jensen

2:00 – 2:15 AFTERNOON BREAK I

SESSION IV
Moderator: Caitlin Allen Akselrud

2:15 Kelli Faye Johnson
Can autocorrelated recruitment be estimated using integrated assessment models, and how does it affect population forecasts?

2:30 Catherine Austin
Variable anadromy and contradictory maternal patterns in an iteroparous salmonid

2:45 Marta Gómez-Buckley
Using taxonomy and molecular sequencing techniques to study the ecology of cryptobenthic reef fishes in shallow coral ecosystems of Tonga

3:00 Silvana Gonzalez
Characterizing temporal variability in pelagic communities for biological monitoring at marine renewable energy sites

3:15 – 3:30 AFTERNOON BREAK II

SESSION V
Moderator: Davey French

3:30 Morgan Arrington
Exploring environmental variability in the Aleutian Islands with implications for Atka mackerel body condition

3:45 Sean Rohan
Subsurface optical environment variation in the eastern Bering Sea

Abstracts

4:00 Evan Fiorenza
How primary historical data can demonstrate shifting baselines in comparative marine disease studies

4:15 Michelle Chow
Salmon in the city: The effects of urban runoff on juvenile coho salmon

POSTER SESSION

5:00 – 8:00 Poster Session & Reception at SAFS Lobby

Jeremy Axworthy
How do microplastics affect thermally stressed reef-building corals?

Madison Shipley
Bering Sea tanner crab selectivity

Jenny Stern
Foraging strategies of Baffin Bay polar bear

Catrin Wendt
A curious case of herring disease in Cordova, Alaska

Wild Fish Conservancy biologist and UW graduate student Adrian Tuohy hangs web on an experimental pound net trap in the Columbia River.
Photo: Adrian Tuohy

Abstracts

Tagging sockeye at C creek, Lake Nerka
Photo: Katie McElroy

Heading back to field camp from the Columbia River pound net trap site.
Photo: Adrian Tuohy

Cleared and stained sturgeon
Photo: Mary Fisher

Abstracts

SESSION I

Kristin Privitera-Johnson, MS

Major Professor: André E. Punt

Estimating among-assessment variation based on estimates of overfishing limits

Fishing has an important role as a source of income, nutrition, culture, and tradition. Successful fishery science and management practices are contingent upon a good understanding of the inherent uncertainties that accompany data collection, using data and assessment models to determine stock biomass in absolute terms and relative to reference points, and the efficacy of management measures to achieve desired goals. Uncertainties can be broadly categorized as either scientific uncertainty, the uncertainty inherent in data collection and analysis methods, or management uncertainty, the uncertainty associated with the implementation of management regulations. Fishery scientists and managers aim to reduce scientific uncertainty by investing in new data sources and improving modeling and assessment tools. This study involves synthesizing completed stock assessments to identify and quantify the influence of uncertainty on the outcomes of assessments. The buffer between the overfishing limit and the acceptable biological catch for US west coast groundfish and coastal pelagic species is based on a measure of between-assessment variance in biomass estimates from a retrospective analysis, but ignores uncertainty in productivity and target fishing mortality rates. However, this latter uncertainty can be substantial for some assessments. A revised retrospective analysis is therefore undertaken to quantify the total uncertainty associated with estimating overfishing limits using assessment outputs for US west coast groundfish and coastal pelagic species and species in Australia's Southeast Shark and Scalefish Fishery. This uncertainty could be utilized to inform acceptable biological catches for U.S. west coast fisheries.

Megan Feddern, MS

Major Professor: Gordon Holtgrieve

Reconstructing historic changes in marine mammal trophic position and coastal productivity

After passage of the Marine Mammal Protection Act of 1972, pinniped populations along the west coast of North America experienced exponential population increases following historic lows in the 1970's. In Puget Sound and coastal Washington, this increase in pinniped abundance corresponded with changes in large scale climate conditions (Pacific Decadal Oscillation; PDO) and depletion of prey species (forage fish, salmon). Increasing pinniped populations have created new challenges for fisheries management, particularly because some of their prey species are commercially important or protected (e.g., salmon, herring, rockfish in Puget Sound) and little is known about the impact pinnipeds have on fish populations or marine food webs. The objective of this research is to quantify long-term changes in harbor seal trophic position to understand how populations of this generalist predator have impacted and responded to changes in prey abundance and primary productivity with changing climate regime.

Bone specimens collected from ~1950-present and curated by the Burke and Slater Museums were analyzed for $^{15}N/^{14}N$ of 11 individual amino acids (AAs), including both trophic fractionated (trophic) and tropically conserved (source) amino acids. Trophic and source AA data were used to calculate trophic position and as indicators of primary productivity respectively. Changes in trophic position and productivity over time will be compared to changes in indicators of ecosystem condition (prey availability, marine mammal abundance) and environmental condition (sea surface temperature, Pacific decadal oscillation regime shifts) to determine the relationship between harbor seal trophic position and ecosystem dynamics.

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Mary Fisher, MS

Major Professor: Lorenz Hauser

Population structure of Pacific cod (Gadus macrocephalus) around the Korean peninsula

Identification of distinct populations is valuable to fisheries management, as it provides biologically meaningful boundaries for management units in stock assessments. Pacific cod (*Gadus macrocephalus*) is an important fishery species in South Korean coastal waters, where it is currently managed as a single stock. Pacific cod forms spawning aggregates during the winter months, and is thought to home back to those locations. Two prior genetic analyses using microsatellites suggest some regional structure between spawning aggregates, but offer contrasting results. The aim of this study was to determine connectivity between populations with a more powerful genetic marker set, and then cross-reference results with otolith microchemical analyses completed on the same samples. We sampled individuals (n = 256) across nine spawning aggregates around the Korean peninsula, with temporal replicates between and within spawning seasons. We identified 5,405 putative SNPs, including 50 markers with evidence for divergent selection. Our analyses show strong regional differentiation between cod collected on the southern / southeastern, eastern and western coasts. While we did not see significant differentiation between sites within the same region or between temporal replicates, a discriminant analysis of principal components suggests some temporal genetic divergence in individuals spawning at the same site. Slight genetic differentiation between years at the same spawning site and the detection of potential migrant individuals may be suggestive of skipped spawning behavior in these populations. Our study suggests that Pacific cod around the Korean peninsula should be managed as three regional stocks.

Photo: Mary Fisher

Caitlin Allen Akselrud, Ph.D

Major Professor: André Punt & Trevor Branch

A quinate portfolio: moving from single-species to multi-species management strategies

Over-exploitation of small pelagic fish populations is caused by 1) an increase in demand, 2) changes in climate or environmental variables, and 3) non-adaptive management (Merino et al., 2011). When reductions in forage fish populations are observed there is often a lagged response to reduce fishing pressure leading to stock collapse (Essington et al., 2015). However, adaptive management measures are effective in reducing the risk of population collapse, even under poor climactic conditions (Merino et al., 2011).

Fishers in the California market squid (*Doryteuthis opalsecens*) industry catch market squid as part of a portfolio of species, including sardine (*Sardinops sagax caerulea*), anchovy (*Engraulis mordax*), Pacific mackerel (*Scomber japonicas*), and jack mackerel (*Trachurus symmetricus*). This project will examine the role of the market squid fishery as a part of a complex of exploited small pelagic fisheries and to consider management strategies applied in a multi-species context.

SESSION II

Adrian Tuohy, MS

Major Professor: Tom Quinn & John Skalski

Estimating post-release survival of Chinook salmon (Oncorhynchus tshawytscha) and steelhead trout (Oncorhynchus mykiss) from an experimental commercial pound net trap in the Lower Columbia River Sub-basin, WA

Bycatch mortality from gillnets and other conventional harvest techniques impedes the recovery of Endangered Species Act (ESA)-listed salmonids and commercial fishing opportunities when ESA-take limits are exceeded. To benefit wild

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salmon, threatened ecosystems, and coastal fishing communities, Wild Fish Conservancy and local commercial fishermen conducted a post-release survival study in the Lower Columbia River Sub-basin to evaluate the potential of an alternative commercial gear—specifically, an experimental pound net trap—as a stock-selective, sustainable harvest technique. Expanding upon the 2016 pilot study, a modified trap was constructed and operated under a variety of tidal stages, light levels, and weather conditions between August 26th and September 29th, 2017. Utilizing a mark-recapture methodology with Passive Integrated Transponder (PIT) tags, post-release survival from the trap was estimated by comparing tag detections at upstream dams to that of a control source of fish; total catch, catch-per-unit-effort, and covariates of recapture probabilities were analyzed. Preliminary results demonstrate that pound net traps can effectively target commercially viable quantities of hatchery reared Fall Chinook (*Oncorhynchus tshawytscha*) and coho salmon (*Oncorhynchus kisutch*) while reducing immediate and post-release bycatch mortality of ESA-listed species relative to conventional gillnets and seines. Throughout the 33-day test fishing period, the experimental trap captured and released 7,135 salmonids. Relative post-release survival ranged from 96% for steelhead trout (*Oncorhynchus mykiss*) to 99% for Chinook salmon (*Oncorhynchus tshawytscha*). Further investigation will incorporate a sub-sample of genetic data from tagged specimens and a Jolly-Seber survival analysis to reduce potential bias and improve the accuracy of post-release survival estimates.

Christina Morrisett, MS

Major Professor: John Skalski

The effects of adult ladder passage at Lower Granite Dam on Snake River salmonid migration

Snake River adult salmonids *Oncorhynchus* spp. are listed under the Endangered Species Act and are subject to biological sampling for research and recovery objectives. Lower Granite Dam is the last dam these fish must ascend during their homeward migration and has an adult fish ladder equipped with a trapping system to facilitate these objectives. In 2016, a change in ladder operation allowed a rare opportunity to evaluate how different passage routes through the Lower Granite Dam adult ladder affect salmonid migration upstream. This study examined five years of PIT-tag data from upstream tributaries to compare homeward migration success by passage route for five salmonid runs. 2016 was the only year that allowed "free passage," wherein handling within the ladder is eliminated. Although trapped individuals had a longer transit time through the ladder, passage route did not significantly affect homeward migration success for most stocks. Free passage hatchery- and wild-origin summer-run Chinook Salmon were the only run that exhibited a significantly higher homing success rate compared to other routes. Weighted averages across all years did not significantly differ for homing success by the two passage routes available under standard ladder operation. Despite limited evidence supporting the relationship between passage route and homeward migration success, this study advocates for continued free passage ladder operation in subsequent years to increase the sample size necessary for a robust recommendation and to spread the risk of anthropogenic premature mortality.

Spawned Olympia Oysters at Ken Chew Center on the NOAA Manchester marine research center
Photo: Laura Spencer

Yaamini Venkataraman, MS

Major Professor: Steven Roberts

Exploring proteomic variation in Pacific Oysters (Crassostrea gigas)

Pacific oysters (*Crassostrea gigas*) are important species, as they provide crucial ecosystem services and are the basis for aquaculture operations. Like other marine invertebrates, oysters are susceptible to changes in environmental conditions. Increasingly acidified waters pose a threat to larval development and adult shell integrity. Wild oysters also face a second threat: increasing temperature regimes. There

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is a limited set of experiments studying oysters' response to multiple stressors that directly reflect the suite of conditions and variability experienced in the wild. To examine the physiological effects of multiple stressors, including acidification, dissolved oxygen content, and temperature in the wild, 150 sibling *C. gigas* specimens were outplanted in five different study sites in and around Puget Sound, WA. Gill tissue was collected after a month and shotgun proteomic analyses were performed with distinct differences in expression observed based on site characteristics. Upwards of 9,000 proteins were identified in total, including 273 environmental response proteins. These data provide insight into how oysters are impacted by different environmental conditions and offer a framework for future lab experiments to identify viable biomarkers.

Alex Lincoln, MS

Major Professor: Tom Quinn

Motivation for selective consumption and prey discard: bears foraging on sockeye salmon search for optimal prey

Partial consumption of prey by predators is observed across taxa in the animal kingdom. Brown bears (*Ursus arctos*) foraging on salmon exhibit selective consumption, often feeding exclusively on lipid-rich tissues such as brain tissue and eggs and discarding the remains. In addition to partial consumption, bears are also observed killing and abandoning sockeye salmon without any consumption. These discarded fish may support a theory of optimal foraging choices if these fish are of poor quality or bears have limited prey options. Alternately, they may reveal surplus killing behavior if fish are killed and discarded at random or solely based on prey abundance. Utilizing 21 consecutive years of data from sockeye salmon (*Oncorhynchus nerka*) carcass surveys in Alaska, I found that prey discarded without consumption supported the hypothesis that bears search for optimal prey rather than exhibit surplus killing behavior. Prey searching was facilitated by high prey availability on a daily local scale. Bears appeared to search for ripe females, specifically targeting eggs and brain tissue. My results underscore the importance of prey availability, prey attributes, and timing within the salmon run in driving partial consumption behavior in bears, which has implications both in bear nutrition and also for secondary scavengers and riparian ecosystems that may rely on salmon carcass remains for marine-derived nutrients.

Helicopter view of the Kuskokwim River Basin in AK
Photo: Davey French

Lindsay Alma, Ph.D

Major Professor: Jacqueline-Padilla Gamiño

Seasonal spatial and temporal conditions impact physiological performance of bivalves in Puget Sound, WA

Global change stressors such as hypoxia, ocean acidification, salinity, and thermal stress can heavily affect marine invertebrate physiological performance, survival, metabolism, and shell integrity. The Eastern Pacific Coast has already experienced changes in ocean patterns and these conditions are expected to progress in the near-future as more carbon dioxide is added to the atmosphere at an exponential rate. The results of this project explore how key bivalve physiological performance metrics are impacted by variations in depth and season in the Puget Sound, WA, specifically in two economically and ecologically important species, the Mediterranean mussel (*Mytilus galloprovincialis*), and the purple-hinge rock scallop (*Crassodoma gigantea*). Organisms were held at two depths (5 m and 30 m) for six months within the Dabob Bay and allowed to acclimate to different environmental regimes. Results of this study show that both species had significantly greater growth rates at the 5 m depth, in the warmer summer months. Shell integrity of mussels were significantly impacted by both depth and season of collection, while scallop shells were only affected by season and not depth of acclimation. Finally, the standard

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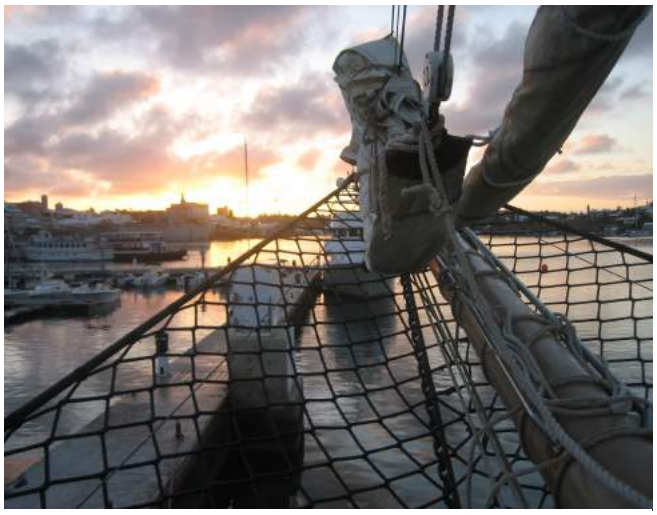
metabolic rate of both species was heavily impacted by laboratory thermal stress treatments, namely those acclimated to 30 m. However, there were no significant differences between groups with varying pH laboratory treatments. These results contributing to our understanding of seasonal variation on oceanographic conditions and their effects on bivalve performance at multiple levels.



SSV Corwith Cramer in Bermuda with Woods Hole Oceanographic Institution (WHOI)
Photo: Caitlin Allen Akselrud

SESSION III

Laura Spencer, MS

Major Professor: Steven Roberts

Geoduck as indicators of environmental change

The Pacific geoduck (*Panopea generosa*) is the largest clam native to the Pacific Northwest and is a burgeoning aquaculture species due to growing export demands from Asia. In Washington State, geoduck support important commercial fisheries via farmed and wild populations in Puget Sound and Willapa Bay. As a sedentary, calcifying bivalve occupying mostly subtidal sediment, geoduck are likely to be impacted by climate stressors, which have already been documented as trending towards warmer, more acidic marine conditions. In summer 2016 we outplanted sibling juvenile geoduck in four sites throughout Washington State. Geoduck were enclosed to minimize predation, water chemistry was continuously monitored, and after four weeks of exposure geoduck gill tissue was taken for protein analysis. Specifically, shotgun then targeted proteomic analyses was performed and revealed expression pattern associated with local conditions. Together these results demonstrate protein profiles can provide valuable information on local conditions including how environmental change can influence bivalve physiology.

Jane Rogosch, Ph.D

Major Professor: Julian Olden

Hydrologic drought favors non-native fishes in a changing climate

Fishes of the American Southwest are poised to be impacted by non-stationary changes in flow regimes driven by increasing water consumption and climatic alterations in temperature and precipitation. Population dynamic models play an important role to anticipate and respond to these looming conservation challenges. We apply matrix population models as a heuristic framework to explore how mixed native and non-native fish communities respond to hydrologic extremes including increasing drought frequency. The model is applied to 7 fish species in the Upper Verde River, Arizona, USA. Flow-ecology relationships were integrated into the population models by allowing key vital rates to vary according to flow year types, and species dynamics were coupled in a single model by using density-dependent reproduction based on the biomass carrying capacity. We validated model parameters by comparing population projections under the flow record to a long-term fish monitoring dataset (1994 – 2008), and then projected the model to recreate community response to increasing drought frequency observed over the past nine years (2009 – 2017). Model projections were moderately correlated with the long-term fish monitoring dataset, where 13 years had spearman correlation coefficients above 0.4 and seven of those had strong correlations ($r > 0.8$). Droughts increased by 50% compared to the previous decade, with coincident increased abundances of non-native species and decreased abundances of native species, resulting in a shift in community composition toward non-native

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species dominance. By integrating causal links between species biology and hydrologic variability, population dynamic models increase our understanding of possible outcomes to environmental change.

Lee Cronin-Fine, Ph.D

Major Professor: André Punt

A numerical method for allowing individual variation in both growth parameters (k and L_∞) in size-structured models

Stock assessment methods for many invertebrate stocks, include stocks of crabs in the Bering Sea and Aleutian Islands region of Alaska, are based on size-structured population dynamics models. A key component of these models is the size-transition matrix, which specifies the probability of growing from one size-class to another after a certain period of time. Size-transition matrices can be defined using three parameters, the growth rate (k), the asymptotic height (L_∞), and the variability in the size increment. Stock assessments can either set the size-transition matrix by analyzing mark-recapture data prior to conducting the stock assessment or the estimation of the size-transition matrix can be integrated into the stock assessment. The latter approach will better allow uncertainty in model outputs to be characterized, but can substantially increase the complexity of the assessment. Consequently, most assessments that integrate mark-recapture data into stock assessments, assume that all individuals followed the same growth curve. However, not accounting for individual variation in growth can result in biased estimators of growth parameters and it is unrealistic to assume that every individual has the same k or L_∞. Unfortunately, to date, the only way to compute the size-transition matrix when allowance is made for individual variation in growth is using simulation, which is both computationally very intensive and non-differentiable. This presentation outlines an approach that uses a numerical integration technique that allows k and L_∞ to vary among individuals, and evaluates it by comparing the results with a simulation-based estimation scheme.

Natalie Lowell, Ph.D

Major Professor: Lorenz Hauser

Population genetics of native shellfish aquaculture species and potential genetic risks of cultivation

Native shellfish aquaculture has many benefits, but interbreeding of hatchery and wild populations may pose genetic risks to wild populations. The type and magnitude of these risks depends in part on the population genetics and structure of native shellfish species. Early studies on population structure of shellfish provide little evidence for it, suggesting that generally shellfish populations exist in panmixia and thus minimizing genetic risks of their cultivation. However, recent population structure studies provide higher resolution and make use of both neutral and non-neutral molecular markers, and suggest some shellfish can exhibit population structure and even local adaptation. Here, we present preliminary results on genetic differentiation between populations of *Crassadoma gigantea* (the purple-hinged rock scallop) and *Parastichopus californicus* (the giant California sea cucumber), two native species that are currently being developed for production in Puget Sound. To conclude, I present a plan to build a genetic risk model to quantify risk under multiple management scenarios and provide decision support to resource managers and other stakeholders.

Geared for cryptobenthic fish sampling in Vava'u, Tonga
Photo: Marta Gómez-Buckley

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SESSION IV

Kelli Faye Johnson, Ph.D

Major Professor: André E. Punt

Can autocorrelated recruitment be estimated using integrated assessment models, and how does it affect population forecasts?

The addition of juveniles to marine populations ("recruitment") is highly variable due to variability in the survival of fish through larval and juvenile stages. Recruitment estimates are often large or small for several years in a row, which can be due to numerous factors, but typically is attributed to multi-year environmental drivers affecting survival. Estimating the magnitude of recruitment autocorrelation within a stock assessment model is uncommon. We used a simulation experiment to evaluate the estimability of autocorrelation within a stock assessment model over a range of levels of autocorrelation in recruitment deviations. The precision and accuracy of estimated autocorrelation, and the ability of an integrated age-structured stock assessment framework to forecast the dynamics of the system, were compared for scenarios where the autocorrelation parameter within the assessment was fixed at zero, fixed at its true value, internally estimated within the integrated model, or input as a fixed value determined using an external estimation procedure that computed the sample autocorrelation of estimated recruitment deviations. Internal estimates of autocorrelation were biased toward extreme values. Estimates of autocorrelation obtained from the external estimation procedure were nearly unbiased. Forecast performance was poor (i.e., true biomass outside the predictive interval for the forecasted biomass) when autocorrelation was ignored, but was non-zero in the simulation. Applying the external estimation procedure generally improved forecast performance by decreasing forecast error and improving forecast interval coverage. However, estimates of autocorrelation were shown to degrade when fewer than 40 years of recruitment estimates were available.

Catherine Austin, MS

Major Professor: Tom Quinn

Variable anadromy and contradictory maternal patterns in an iteroparous salmonid

Migration between distinct habitats influences the population dynamics, ecological interactions, and hence conservation and management of many species. For diadromous fishes, freshwater and marine habitats can differ greatly in availability of prey or breeding habitats, predation risk, contaminant exposure, and fisheries interception. For some salmonid species, the presence of both migratory and non-migratory individuals in a population adds complexity to these dynamics. Using otolith microchemistry, we described patterns of partial anadromy in a threatened, iteroparous species, bull trout (*Salvelinus confluentus*), in the Skagit River basin of Washington State, USA, one of the few anadromous populations of this species. We found that 41% of fish sampled (> 338 mm long) in the river had been to marine waters, typically every year beginning at age 2 or 3. Other uncommon life history patterns included overwintering in salt water, skipping migrations, and possible cessation of anadromy. We also found that rates of maternal anadromy and offspring anadromy were independent, with anadromy being more likely in fish whose mothers had not migrated to marine waters. These results suggest that regional management might consider the relative risks of marine versus freshwater habitats to a highly mobile population that includes an important component of resident individuals.

Purus River, Amazon Basin, Brazil
Photo: Thiago Couto

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Marta Gómez-Buckley, Ph.D

Major Professor: Luke Tornabene

Using taxonomy and molecular sequencing techniques to study the ecology of cryptobenthic reef fishes in shallow coral ecosystems of Tonga

Most coral reef studies focus on the corals themselves, or on impacts to larger fishes, and overlook the equally, or likely more important small cryptobenthic reef fishes. My research focuses on cryptobenthic reef fishes, a major prey group on coral reef ecosystems that supports larger fishes at the top of the coral reef trophic web. Their extremely short life cycles make them ideal bioindicators for the status of reef degradation. Preliminary morphological and genetic analysis of samples that I collected from the Vava'u Archipelago in the Kingdom of Tonga during April 2017 show a remarkable diversity of species. When we compared the Tongan samples with the available database for Indo-Pacific cryptobenthic fishes we found a few matches, which may be indicative of high levels of endemism.

Silvana Gonzalez, Ph.D

Major Professor: John Horne

Characterizing temporal variability in pelagic communities for biological monitoring at marine renewable energy sites

Global concern over environmental impacts from fossil fuels has increased research in renewable energy technologies. Commercial viability of Marine Renewable Energy (MRE) is progressing but no national or international monitoring standards have been established for wave or tidal energy sites. Achieving standardization of monitoring whithin and across MRE sectors is necessary to expedite project development, detect environmental impacts, and enable comparison among sites and technologies. Temporal variability in acoustic backscatter from a bottom-deployed platform at a pilot wave energy site off the coast of Newport, OR was compared to data collected at a tidal turbine site in Admiralty Inlet, WA. Generic biological characteristics at MRE sites could justify the application of common monitoring strategies and analytic methods for MRE development. Four metrics, derived from acoustic backscattered energy, were used to compare temporal variability: density (mean Sv), center of mass, inertia, and an aggregation index. Patterns (periodicity, amplitude and autocorrelation structure) and processes (main influencing variables) were compared. The tidal site was characterized by lower densities and lower variability—driven by tidal dynamics. The wave site showed higher densities and higher variability—driven by a stronger stochastic component (higher ARMA model orders). Common significant periodicities were observed: 24h (diel cycles) for density, aggregation index and center of mass and 64h for inertia. Longer periodicities (>128h) were also observed at the wave site. At MRE sites, standard sampling methods and analytic approaches are possible but site-specific characteristics (e.g. major influencing covariates and periodicity) should be considered for biological monitoring.

Photo: Thomas Pool

SESSION V

Morgan Arrington, MS

Major Professor: Tim Essington

Exploring environmental variability in the Aleutian Islands with implications for Atka mackerel body condition

The Aleutian Island ecosystem is notable for its spatial and temporal heterogeneity. Atka mackerel, one of the most abundant groundfish in this ecosystem, populate areas of high flow in the Aleutian passes. We explored the potential influences of environmental variability on the body

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condition of Atka mackerel in Seguam Pass, home to one of largest populations of Atka mackerel. Female Atka mackerel fecundity has been strongly correlated to body weight, and understanding the potential role of environmental and density dependent factors on variability in body condition will be useful in predicting Atka mackerel reproductive output. In addition, body condition can influence biomass estimation from length weight data and be an indicator of prey quality for Atka mackerel predators such as the endangered Steller sea lion.

Weighing carcasses for scavenging studies
Photo: Alex Lincoln

Sean Rohan, MS

Major Professor: Tim Essington

Subsurface optical environment variation in the eastern Bering Sea

Optical properties of the marine environment influence processes occurring throughout marine food webs, ranging from rates of primary productivity to visual foraging by apex predators. Changes in the distribution and behavior of fish caused by variation in the optical environment can also effect the availability of fish stocks to stock assessment surveys. In this investigation, I examined spatial-temporal variation in the summertime subsurface optical environment of the eastern Bering Sea using subsurface light measurements obtained during with NOAA bottom-trawl surveys over 13 years (2004-2016). I will present preliminary results of the investigation, and discuss implications of the observed variation for ecosystem processes and stock assessment.

Evan Fiorenza

Major Professor: Chelsea Wood

How primary historical data can demonstrate shifting baselines in comparative marine disease studies

Marine disease outbreaks are on the rise. Some drivers believed to drive this increase are climate change, fishing pressure, and changes in land use to name a few. Often time these studies rely on comparisons of disease levels across gradients of impacts or environmental parameters or between perceived 'pristine' or protected sites, such as MPAs, and impacted sites. While this is primarily the only option available for most species, there exists a wealth of information within fish collections around the world. Examination of preserved specimens can elucidate historical parasite assemblages contained within the fish and provide an added dimension to the comparison. To test if there is the potential for shifting baselines in an exploited species, I propose examining lingcod, *Ophiodon elongatus*, for metazoan parasites across space and time. Lingcod have recently experience a recent population crash in the Eastern Pacific and thus provides a chance to compare the parasite assemblages both within and outside protected areas. A historical baseline can be created with a portion of the 750 fish held at the University of Washington. Coupled with this are numerous frozen specimens from a recent collection effort by collaborators at NOAA from both protected and unprotected areas which can be used to compare to the historical baseline. With this dimensionality, there is the potential to elucidate a shifting baseline and provide a basis for the importance of primary historical data.

Abstracts

Michelle Chow, MS

Major Professor: Graham Young

Salmon in the city: The effects of urban runoff on juvenile coho salmon

Urban stormwater runoff is a leading source of nonpoint pollution due to its ability to quickly mobilize a diverse mixture of contaminants into aquatic environments. Direct exposures to highway runoff are known to cause acute mortality in both adult and juvenile coho salmon (*Oncorhynchus kisutch*). Coho exposed to urban runoff display a common suite of symptoms including surfacing, gaping, and a loss of equilibrium. Previous research profiling adult coho blood gas and chemistry during urban runoff exposure indicated disturbances in acid-base and ion regulation. This study investigated the utility of juvenile coho salmon as a surrogate for adult spawners to understand the acute lethal response observed during urban runoff exposure. Juvenile coho were exposed to collected urban runoff or clean control water and sampled at three behavioral stages (asymptomatic, surfacing, and loss of equilibrium). To investigate the physiological response, fish were sampled for arterial blood and tissues. Arterial whole blood, red blood cell lysate, and plasma were analyzed for blood gases and chemistry using an iSTAT point-of-care analyzer. Juvenile behaviors induced by runoff exposures were comparable to those observed in adults and progressed through a distinct pattern starting with discrete surfacing events and eventually leading to a loss of buoyancy. In addition, the blood profile of runoff-exposed fish indicated acid-base and ion regulation disturbances previously characterized in adults. Together, the behavior and physiological response supports the potential of juveniles as a surrogate model to adult spawners.

Orcas in Kenai
Photo: Nicole Baker

POSTER SESSION

Jeremy Axworthy, MS

Major Professor: Jacqueline-Padilla Gamiño

How do microplastics affect thermally stressed reef-building corals?

Microplastic ingestion by aquatic organisms can disrupt vital physiological functions and adversely impact these organism's biology. Recently, researchers reported that corals ingest microplastics, but with unknown effects. Many corals are at risk of bleaching, caused by thermal stress, where a break-down in coral-algae symbiosis reduces photosynthetic energy available to corals. To cope with this some corals increase consumption of zooplankton which may consequently lead to increased microplastic ingestion. In my proposed research I will test the following hypotheses (1) that microplastics negatively affect coral's ability to feed and allocate energy to growth and reproduction, (2) that bleached corals ingest more microplastics than non-bleached coral exacerbating the effects of ingesting microplastics alone, and (3) that that protein expression shifts in response to simultaneous stressors in corals reflecting changes in energy allocation through metabolic and reproductive pathways. In laboratory experiments, I will expose corals to four treatments: (1) ambient temperature and no microplastics (control), (2) ambient temperature and microplastics, (3) increased temperature and no microplastics, (4) increased temperature and microplastics. Throughout the experiment I will measure corals growth, energy reserves (lipids, proteins, carbohydrates), and microplastics ingestion. Additionally, proteomic analysis will be conducted to understand changes in molecular processes. Coral-bleaching is predicted to occur more frequently due to climate change. While this impacts our food supply on a global scale, it mostly affects millions of people in developing countries. This makes it crucial to understand how additional stressors, like microplastics, affect corals so we can mitigate the added stress corals must endure.

Abstracts

Madison Shipley, MS

Major Professor: André Punt

Bering Sea tanner crab selectivity

Tanner crab (*Chionoecetes bairdi*), are a species of true crab found in northern waters and distributed through much of the Bering Sea. A directed fishery for Tanner crab was established in the United States 1974 and since its establishment the fishery has seen dramatic booms and bursts in abundance with multiple fishery closures over the years. Due to the many uncertainties surrounding Tanner crab abundance estimates, the Bering Sea Fisheries Research Foundation (BSFRF) have conducted side-by-side surveys with NMFS where both a NMFS vessel and BSFRF chartered vessel tow in the same station less than 0.5nm away at the same time utilizing two different types of trawls, the NMFS 83-112 and the BSFRF *Nephrops* trawl. This study looks at the differences between crab selectivity for NMFS and BSFRF from 2013-2017 and how selectivity ratios can be used in management.

Jenny Stern, Ph.D

Major Professor: Kristin Laidre

Foraging strategies of Baffin Bay polar bears

Climate change is shifting food web dynamics worldwide. These changes especially affect top predators. Resilience of ice-obligate top predators, such as the polar bear (*Ursus maritimus*), may depend on flexibility in foraging strategies. We collected 138 hair samples from captured polar bears in the Baffin Bay subpopulation in spring of 2009-2013. We processed samples for carbon, nitrogen, and sulfur stable isotopes to evaluate feeding strategies of different ages and sexes and compare differences in isotope signatures based on habitat use. We ran isotope analyses using entire hair samples, assuming hairs represented feeding since the previous molt. We also analyzed proximal and distal subsamples along the hair to investigate intra-annual changes in foraging. This latter analysis compared samples from polar bears that are resident at glacier fronts in West Greenland ('glacier bears') to those that move across the pack ice to Baffin Island and fast during summer ('pack ice bears'). Adult males had significantly higher $\delta^{15}N$ values than adult females, indicating males fed at a higher trophic position. There were no significant differences between entire hair $\delta^{15}N$ or $\delta^{13}C$ values for glacier vs. pack ice bears. We detected a significant difference between proximal and distal subsamples in $\delta^{13}C$ and $\delta^{34}S$ for glacier bears, while for pack ice bears we detected a difference in $\delta^{34}S$, suggesting seasonal variation in habitat use and/or feeding habits for both bear types. This work will provide insight into how foraging strategies of polar bears with differing movement patterns may affect their resilience in an ice-free Arctic.

Catrin Wendt, MS

Major Professor: Chelsea Wood

A curious case of herring disease in Cordova, Alaska

Ichthyophonus hoferi is a protozoan parasite which causes disease in over 80 fish hosts. Although *Ichthyophonus* sp. is found globally, very little is known of its transmission pathways, especially in non-piscivores. Juvenile Pacific herring (*Clupea pallasii*), have exhibited elevated rates of infections in Cordova Harbor, AK, possibly due to offal discharge from a nearby fish processing plant. We propose a study of *Ichthyophonus* sp. disease transmission and spatial distribution in Alaska and Washington. We will use disease mapping and subsequent spatial statistics to identify *Ichthyophonus* sp. hotspots and their relationship to fish processing waste. A positive relationship would indicate that untreated offal amplifies *Ichthyophonus* in natural systems, which could be used to inform commercial fish processing management.

Purple-hinge rock scallop (*Crassadoma gigantea*) being held together by clothespins for tagging.
Photo: Lindsay ALma

Acknowledgements

The success of the 28th 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.

We would like to specifically thank the following volunteers:

Catherine Austin	A/V Coordinator
Charlie Waters	A/V Coordinator
Jenny Gardner	Food Coordinator
Melanie Davis	Food Coordinator
Anonymous student, post-doc, and faculty judges.	

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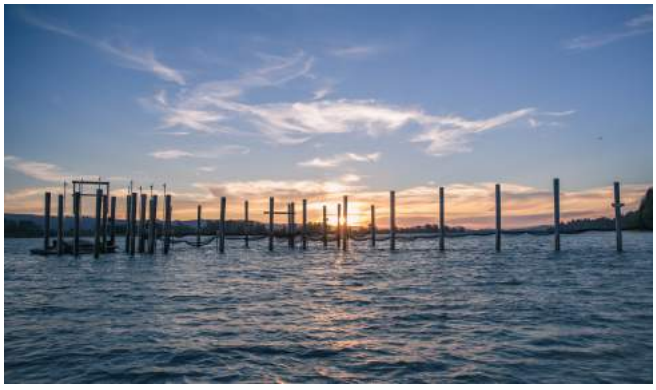
We appreciate your attendance at the 28th Annual School of Aquatic and Fishery Sciences Graduate Student Symposium and we hope you enjoy your time with us.

Sincerely,
Megan Feddern, Christina Morrisett, and Megan Hintz
2017 GSS Coordinators



Experimental pound net trap in the Lower Columbia River
Photo: Adrian Tuohy