The University of Washington's

School of Aquatic and Fishery Sciences

Presents:

The 22nd Annual

Graduate Student Symposium

November 17th, 2011

From The Director

SAFS is the nexus of interdisciplinary collaboration that is central to research and outreach in the College of the Environment. This cultural norm is deeply embodied in the spectrum of work done by the School and showcased in the range of talks planned for GSS this year. I have met with Dean Lisa Graumlich on many occasions to tell her about the excellent qualities of SAFS, and among those highlighted have been the quality and achievement of our graduate students. I have told her of your efforts to organize this provocative venue of talks that showcase the breadth of science within the School and, more importantly, the skill and sophistication manifested in your ideas, research, and presentations. We are amazed and impressed by our Graduate Students, thankful that you are part of the SAFS community, and excited by your future that the Faculty help shape as you learn and train.

You came to the best School for preparation for your careers. SAFS continues to be rated the top aquatic and fishery science program in the nation and evidence of this stature is exemplified in support from the NOAA Fishery Centers to hire faculty in critical areas relevant to sustainable management, now including resource economics. The reputations of faculty who attracted you to come here are well known around the country and reason that we have been able to partner in ways that keep the School vital. Our mission to teach and train has been greatly expanded by ability to hire new faculty who will provide even more range of subjects for training of students in strategic areas of aquatic and fishery sciences and ensure jobs when you finish. We continue to emphasize critical thinking and rigorous research that leads you to publish peer-reviewed papers and give professional talks as part of the experience needed for future careers. GSS reminds us of such an important part of being faculty: the pleasure of working with smart, excited students who challenge and reward us in many ways….certainly GSS is part of the reward!

Thanks again for the program this year and thank you for opportunity to address you all while Director these past years.
David Armstrong

Schedule

8:45 – 9:00 Coffee & light breakfast

9:00 WELCOME AND OPENING REMARKS
Forest Club Room, 207 Anderson Hall
Dr. Dave Armstrong, Director School of Aquatic & Fishery Sciences

9:15 - 10:15 Genetic Approaches to Populations
Moderator: Marine Brieuc

10:15 - 10:30 MORNING BREAK

10:30 – 12:00 Fish and Habitat Interactions
Moderator: Charlie Waters

12:00 - 1:15 LUNCH

1:15 – 2:30 Ecology of Modified Environments
Moderator: Jen Griffiths

2:30 - 2:45 AFTERNOON BREAK I

2:45 - 3:45 Population Dynamics, Fisheries and Management
Moderator: Kale Bentley

3:45 – 4:00 AFTERNOON BREAK II

4:00 - 4:45 Community Patterns and Ecology
Moderator: Marissa Jones

4:45 CLOSING REMARKS

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

SCHOOL OF AQUATIC & FISHERY SCIENCES
22ND Annual GRADUATE STUDENT SYMPOSIUM

Program

SESSION I
Genetic Approaches to Populations

9:15 Mackenzie Gavery
Investigating the role of DNA methylation as an epigenetic mechanism in the Pacific oyster (*Crassostrea gigas*)

9:30 Daniel Drinan
Genetic variation in westslope cutthroat trout *Oncorhynchus clarkii lewisi*: implications for conservation

9:45 Daniel Peterson
Dispersal, local adaptation and inbreeding in a metapopulation of Alaskan sockeye salmon

10:00 Teresa Sjostrom
Hybridization between naturally sympatric steelhead and coastal cutthroat trout in Western Washington

10:15 - 10:30 MORNING BREAK

SESSION II
Fish and Habitat Interactions

10:30 Lauren Kuehne
Interactive effects of temperature and predation on behavior, physiology, and growth of juvenile Chinook salmon

10:45 Jennifer Griffiths
Six decades of freshwater sockeye salmon growth on the Alaska Peninsula: the relative importance of climate, density, and geomorphic evolution

11:00 Iris Kemp
Feeding interactions between juvenile Chinook salmon and herring in Puget Sound

11:15 Jessica Rohde
Movement Patterns of Sub-Adult Coho Salmon in Puget Sound

11:30 Adam Hansen
Effects of a Seasonal Temperature-Oxygen Squeeze on Piscivory: Insights from Linking Ultrasonic Telemetry to a Visual Foraging Model for Cutthroat trout

11:45 Gregor Passolt
Critical size for salmon smolts

11:45 - 1:00 LUNCH BREAK

J. Armstrong

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SESSION III
Ecology of Modified Environments

1:15 Emma Timmins-Schiffman
Ocean acidification impacts the growth and physiology of larval Pacific oysters (*Crassostrea gigas*)

1:30 Dale Jacques
Evaluation of acoustic technologies for biological monitoring at a proposed marine hydrokinetic site

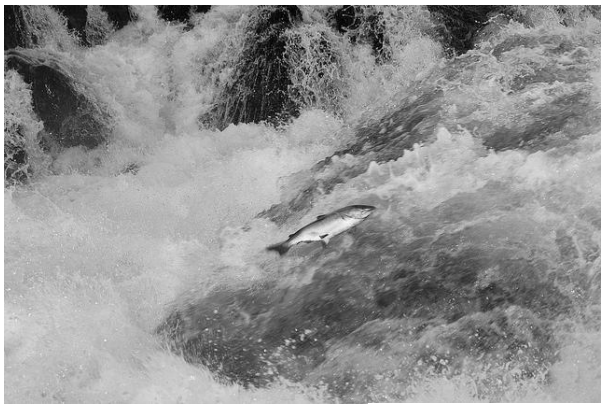
1:45 Louisa Harding
Effects of an environmental estrogen, ethynylestradiol, on the coho salmon pituitary transcriptome

2:00 Stuart Munsch
Assessing the effects of urban infrastructure on the nearshore ecology of juvenile salmon in Elliott Bay, Washington

2:15 Sarah Heerhartz
Effects of shoreline armoring on ecosystem linkages in Puget Sound nearshore environments

2:30-2:45 Afternoon Break I

R. Hovel



J. Armstrong

SESSION IV
Population Dynamics, Fisheries and Management

2:45 Cody Szuwalski
Regime shifts and oscillating control of snow crab recruitment (*Chionoecetes opilio*) in the eastern Bering Sea

3:00 Aneesh Hariharan
An Adaptive Cluster Sampling (ACS) design for estimation of thresher shark catch/effort in a recreational fishery

3:15 Megan Stachura
An investigation of environmental influences on Northeast Pacific groundfish recruitment

3:30 Donna Hauser
Killer whales (*Orcinus orca*) in the Canadian Arctic: distribution, prey items, group sizes, and seasonality

3:45 – 4:00 AFTERNOON BREAK II

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SESSION V
Community Patterns and Ecology

4:00 Jason Helyer
A spatial framework for describing coral responses to a changing climate in the northwestern Hawaiian Islands

4:15 Rachel Lange
Living in the dead zone: Patterns of microbial communities in Hood Canal, WA

4:30 Andy Whitehouse
Modeling the eastern Chukchi Sea food web with a mass-balance approach

4:45 Closing Remarks

R. Hovel

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

POSTER SESSION

Kristin Broms
Modeling the ranges and movements of select South African bird species

Cole Monnahan
Predicting run abundance in real time using pit tag returns for Columbia River spring Chinook

Sarah Heerhartz
Effects of shoreline armoring on nearshore fish, birds and invertebrates of central Puget Sound

Meryl Mims
Does hydrology determine population connectivity and persistence of desert anurans?

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Abstracts

Kristin Broms, PhD

Major Professor: John Skalski

Modeling the ranges and movements of select South African bird species

An occupancy model, which may be written as a hierarchy of logistic regressions, separates and accounts for false-negatives in presence-absence data, where sampled sites are each surveyed multiple times to determine the occupancy, or usage, of an area by the species of interest. A false-negative occurs when a site is occupied by the species but it was not detected. I use this model as a base to analyze the Southern African Bird Atlas Project data, which is a database of bird detections and non-detections collected from avid bird-watchers in 1987-1991 and 2007-Present. For my PhD research, I will complete simulation tests of the occupancy model and augment the model by including a spatial component, a CAR-process variable, in the estimation of occupancy.

Daniel Drinan, PhD

Major Professor: Kerry Naish

Genetic variation in westslope cutthroat trout *Oncorhynchus clarkii lewisi*: implications for conservation

Twenty-five populations of westslope cutthroat trout from throughout their native range were genotyped at 20 microsatellite loci to describe the genetic structure of westslope cutthroat trout. The most genetic diversity existed in populations from the Snake River drainage, while populations from the Missouri River drainage had the least. Neighbor-joining trees grouped populations according to major river drainages. A great amount of genetic differentiation was present among and within all drainages. Based on Nei's DS, populations in the Snake River were the most differentiated, while populations in the Missouri River were the least. This pattern of differentiation is consistent with a history of sequential founding events through which westslope cutthroat trout may have experienced a genetic bottleneck as they colonized each river basin from the Snake to the Clark Fork to the Missouri river.

Mackenzie Gavery, MS

Major Professor: Steven Roberts

Investigating the role of DNA methylation as an epigenetic mechanism in the Pacific oyster (*Crassostrea gigas*)

Environmentally induced epigenetic changes are increasingly acknowledged as important factors contributing to the physiological and ecological responses of organisms to environmental change. Considering the importance of DNA methylation in gene regulation, its susceptibility to environmental influence, and its potential heritability, this epigenetic mechanism is an ideal candidate for providing insights into how shellfish respond and adapt to their environment. DNA methylation has been well studied in mammals, however the same level of research has not been extended to invertebrates and surprisingly little is known about this mechanism in these taxa. Recently, we have applied *in silico* approaches to characterize DNA methylation in Pacific oysters (*Crassostrea gigas*). Our results suggest that DNA methylation has regulatory functions in *C. gigas*, particularly in gene families that have inducible expression, including those involved in stress and environmental responses. In light of these findings, we are currently adapting a number of new technologies to experimentally investigate the relationship between DNA methylation patterns and environmental stress in oysters

Abstracts

Jennifer Griffiths, PhD

Major Professor: Daniel Schindler

Six decades of freshwater sockeye salmon growth on the Alaska Peninsula: the relative importance of climate, density, and geomorphic evolution

Summer growth is critical for juvenile sockeye salmon (*Oncorhynchus nerka*) survival and can determine the duration of freshwater residence and timing of outmigration. Growth is typically a density dependent process that is modified by lake productivity and temperature. In an Alaska Peninsula lake experiencing warming air temperatures and declining lake volume over the past 50 years, we assessed the importance of climate, density, and geomorphic evolution as well as their interactions for juvenile sockeye growth. We compare the importance of these factors for two datasets: juvenile sockeye captured via townet (1961-1977, 1992-2010) and adult scales sampled in the fishery (1950-1992). We assessed a range of competing models that accounted for a variety of density and environmental effects using standard model selection procedures (AICc). Fish are now larger on average at the end of their first growing season than in the past, a result shared by the datasets. However, there was no trend in the growth achieved during the spring of outmigration which was only assessed in the scale dataset. Density was also an important predictor of growth in both datasets. However, the importance of environmental indicators relative to density varied among datasets as well as growth periods for the scale data.

Adam Hansen, MS

Major Professor: Dave Beauchamp

Effects of a Seasonal Temperature-Oxygen Squeeze on Piscivory: Insights from Linking Ultrasonic Telemetry to a Visual Foraging Model for Cutthroat trout

Habitat heterogeneity mediates predation by limiting prey detection and capture and by creating refugia for prey. In pelagic systems, environmental stress can drive the formation of refuge habitat if asymmetries in physiological tolerance generate divergent spatial-temporal distributions that segregate predators from prey. However, little is known about how periods of stress alter fine-scale overlap of predators and prey and the resulting foraging success of piscivores. For example, environmentally-driven segregation may not severely limit predation rates if the timing of overlap is restricted to periods that are favorable to prey encounter and capture. We studied how a temperature-oxygen squeeze influenced the foraging success of piscivorous cutthroat trout *Oncorhynchus clarki* feeding on juvenile salmonids in Strawberry Reservoir, Utah. We combined ultrasonic tracking of diel-vertical movements of the piscivores and diel-vertical distributions of prey with a visual foraging model to estimate prey encounter and predation rates for three distinct limnological periods. In early August, piscivores were confined to the metalimnion by warm epilimnetic waters and a hypoxic hypolimnion. Prey fish were only accessible in the metalimnion during short crepuscular periods. The visual foraging model indicated that the piscivores achieved only 2-6% of the maximum predation rate that would have been possible had they not been confined to the metalimnion. When the metalimnion became hypoxic during mid-August, piscivores moved into the warmer epilimnion and performed diel vertical

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migrations. The increased overlap with prey increased their estimated predation rates to 35-47% of the maximum. During destratification in October, the piscivores more consistently maintained overlap with prey across diel periods and achieved an estimated 41-97% of the maximum rate. Comparison to independently-derived fish consumption rates suggested that visibility during prey encounters affected capture efficiency. Encounters during crepuscular periods were more profitable. Even though piscivores tracked during destratification in October overlapped more with prey, the majority of this overlap (83-97%) occurred during daylight when visual conditions reduced capture success. Piscivores tracked during environmental stress in August experienced greater fractions of encounters during crepuscular periods (7-84%). However, the magnitude of these encounters still limited foraging success despite occurring under conditions favorable to prey capture.

Louisa Harding, MS

Major Professor: Graham Young

Effects of an environmental estrogen, ethynylestradiol, on the coho salmon pituitary transcriptome

Many environmental contaminants in sewage effluent are able to disrupt normal endocrine function and reproduction in fish. Ethynylestradiol (EE2), a synthetic estrogen present in oral contraceptives, is one of the most potent endocrine disrupting compounds in the aquatic environment. Although extensive work has been done on the effects of EE2 on the fish brain, gonad, and liver, little attention has been focused on the pituitary. Our previous studies in juvenile coho salmon (*Oncorhynchus kisutch*) have shown that a two-week waterborne exposure to EE2 alters mRNA levels for pituitary gonadotropin subunits and plasma steroid hormones at concentrations as low as 2.5 ng/L presumably through feedback on the brain-pituitary-gonad axis. The goal of the present study is to provide additional information on effects of EE2 on pituitary function using a transcriptome–wide analysis using Ilumina® sequencing. Individually tagged 1+ age coho salmon smolts were exposed to 0 or 12 ng EE2/L via tank water in duplicate tanks for 6 weeks. This exposure was designed to reflect an environmentally relevant level during the period of outmigration when salmon would potentially be exposed. After 1 and 6 weeks of exposure; length, weight, gonad weight, and liver weight were recorded and pituitary, gonad, plasma, brain, and liver were collected from 5 fish of each sex per tank. Histological analysis of the ovaries did not reveal any significant differences in follicular stage. The Illumina sequences were aligned into a backbone resulting in 86,956 contiguous sequences (contigs). Of these, 6554 contigs were expressed 2 or more fold higher in the EE2-exposed fish pituitaries and 2481 contigs were expressed 2 or more fold higher in the unexposed fish pituitaries. Initial analysis of pituitary transcripts by quantitative real time PCR revealed that EE2 exposed fish had lower pituitary FSHβ mRNA levels suggesting a negative feedback of EE2 on follicle stimulating hormone synthesis. In contrast, EE2 exposure induced a 367-fold increase in LHβ mRNA levels at 1 week and 757-fold at 6 weeks indicating positive feedback regulation of luteinizing hormone. These data suggest that even one-week exposure to environmentally relevant concentrations of EE2 disrupts key reproductive hormones in salmon. Funding for this project was provided by Washington SeaGrant (Project #RB49).

Abstracts

Aneesh Hariharan, PhD

Major Professor: Professor Vince Gallucci

An Adaptive Cluster Sampling (ACS) design for estimation of thresher shark catch/effort in a recreational fishery

A stratified simple random sampling design is currently in place to estimate the fishing effort and catch of thresher sharks in a recreational fishery along the coast of California. The suggested sampling design is based on data collected in the NOAA SWFSC juvenile thresher shark survey, and research by the Pfleger Institute of Environmental Research and Scripps Institution of Oceanography. These studies and anecdotal reports from fishermen demonstrate aggregation of threshers into clusters. Anglers exploit these aggregations by departing in abundance from nearby marinas and launch sites and returning to the same locations after fishing.
The objective of the adaptive sampling procedure is to maximize the number of observations that contain a thresher shark relative to the number of vessels sampled. The design takes advantage of "prior" information, based on 5 years of sampling effort from the California Recreational Fishery Survey (CRFS) at selected landing sites for recreational boats. Boat trip effort, angler effort, and catch estimators are developed for stratified adaptive cluster sampling and used to estimate CPUE, along with their variance estimates. A theorem-based argument is provided to describe sufficient conditions for the adaptive cluster sampling design to outperform a simple random sampling design. In comparison to simple random sampling, this adaptive cluster sampling design is expected to provide more precision in catch and effort estimation where target species and fishing activities are patchily distributed.

Donna Hauser, PhD

Major Professor: Kristin Laidre

Killer whales (*Orcinus orca*) in the Canadian Arctic: distribution, prey items, group

Killer whales (*Orcinus orca*) have a global distribution, but many high-latitude populations are little understood. Climate models of declining sea ice extent and duration suggest that increasing habitat and resources will be likely be available to killer whales in warming high latitude regions. This talk will present a comprehensive review of the history and ecology of killer whales in the Canadian Arctic, for which there has previously been little information. We compiled a database of 450 sightings from multiple sources, including peer-reviewed literature, consultants, Arctic researchers, and via interviews with community members, among others. With sightings spanning over 15 decades (1850-2008), our goal was to document the historical occurrence, distribution, feeding ecology, and seasonality of killer whales observed throughout the region. Sighting reports per decade increased substantially since 1850 and were most frequent in the eastern Canadian Arctic. The mean reported group size was 8.3 (median = 4, range 1-100), but group size varied significantly among regions and observed prey types. Observations of predation events indicated that Canadian Arctic killer whales prey upon other marine mammals. Monodontids were the most frequently observed prey items, followed by bowhead whales (*Balaena mysticetus*), phocids, and groups of mixed mammal prey. No killer whale sightings occurred during winter periods, with sightings gradually increasing from early spring to a peak in summer, after which sightings gradually decreased. Our results suggest that killer whales are established, at least seasonally, throughout the Canadian Arctic. An increasing killer whale presence may have complex ecological implications.

Abstracts

Jason Helyer, MS

Major Professor: Loveday Conquest

A spatial framework for describing coral responses to a changing climate in the northwestern Hawaiian Islands

The Northwestern Hawaiian Islands (NWHIs) are a model system for investigating coral response in a changing climate since many of the anthropogenic stressors which can confound results are absent. However, variable distribution patterns and non-random sampling of coral populations in the NWHI may be constraining our understanding of the ecology of this reef system and therefore our ability to predict and test hypotheses about coral responses to climate change. To overcome these limitations, I use a regional data set which utilized probability sampling to describe the distribution of corals at seven major reefs in the NWHI. Using a spatial framework which accounts for reefs, geomorphic zones (backreef, forereef, lagoon), and exposure (northwest, southeast) I present both relative and absolute estimates of percent cover for the main coral species across the NWHI and describe how this framework can be used to help interpret results from previous bleaching events as well help develop working hypotheses for future responses.

Sarah Heerhartz, MS

Major Professor: Charles Simenstad

Effects of shoreline armoring on ecosystem linkages in Puget Sound nearshore environments (Oral Presentation)

Shoreline armoring can disrupt natural ecosystem functions in nearshore marine and estuarine environments, yet quantitative studies documenting actual negative impacts of armoring on ecosystem health are rare. This study uses a comparative approach to quantify the comprehensive ecological effects of shoreline armoring in Puget Sound. Specifically, the research objectives are to: (1) characterize habitat functions and ecosystem services for fish and birds produced in the supralittoral ecotone of Puget Sound beaches, and (2) quantify the physical and biological effects of shoreline armoring on those functions. We are measuring multiple abiotic and biotic parameters at paired armored and unarmored beaches throughout central Puget Sound to characterize the physical setting and identify armoring effects on habitat functions for fish and birds. Snorkel studies of juvenile salmon alongshore and bird observations on the high shore are being used to characterize organism assemblages and habitat use patterns along the shoreline, with particular focus on the upper intertidal ecotone. Based on preliminary results and a review of shoreline armoring literature, conceptual models were developed to summarize the known and hypothesized linkages between shoreline armoring and juvenile salmon, birds and shoreline resilience. This presentation will focus on the data incorporated into each model and uncertainties that remain to be investigated, particularly with respect to how they might be addressed in this study.

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Sarah Heerhartz, MS

Major Professor: Charles Simenstad

Effects of shoreline armoring on nearshore fish, birds and invertebrates of central Puget Sound (Poster)

Shoreline armoring is thought to be a major factor disrupting natural ecosystem processes and functions in nearshore marine and estuarine environments, yet few studies have documented actual ecological effects of armoring. The demand for shoreline armoring is likely to increase with heightened concerns about erosion caused by sea-level rise related to climate change, and defensible scientific data are needed to inform responsible management of shoreline alterations and to guide relevant conservation and restoration actions. This study uses a comparative approach to quantify the comprehensive ecological effects of shoreline armoring in Puget Sound. The objectives of this research are to: (1) characterize habitat functions and ecosystem services for fish and birds produced in the supralittoral ecotone of Puget Sound beaches, and (2) quantify the physical and biological effects of shoreline armoring on those functions. We are measuring sediment grain sizes, beach slope, wave energy, wrack abundance and composition, and log abundance at multiple paired armored and unarmored beaches to characterize differences in the physical setting and fish and bird habitat functions. Quantitative amphipod and insect sampling, snorkel studies of juvenile salmon alongshore, and bird observations on the foreshore will identify organism assemblages and habitat use patterns along the shoreline, with particular focus on the upper intertidal ecotone. Results of this study will provide data on marine-terrestrial linkages in the nearshore environment of Puget Sound and the effects of disrupted connectivity across shore associated with shoreline armoring on habitat functions for fish, birds and invertebrates.

Dale Jacques, MS

Major Professor: John Horne

Evaluation of acoustic technologies for biological monitoring at a proposed marine hydrokinetic site

Marine hydrokinetic (MHK) turbines harness energy from water flows to produce electricity. MHK tidal sites are inherently high flow environments, with strong currents and turbulence that result in unique challenges to both direct and indirect sampling of biological communities. Because of these challenges, little is known about biological communities in high flow marine environments or the potential impact that MHK turbines will have on these communities. Remote active acoustic monitoring may be a viable technique to monitor spatial and temporal variability of biological communities at MHK sites. A baseline surface survey was conducted to characterize the local biological community and facilitate comparisons between three bottom deployed acoustic packages at a proposed MHK pilot site in Admiralty Inlet, Puget Sound. The surface survey was centered over the acoustic packages and conducted along fixed transects. The surface survey employed splitbeam echosounder and multibeam sonar over two-12 day cruises in May and June, 2011. The three bottom acoustic packages, a splitbeam echosounder, a mulitbeam echosounder, and an acoustic camera, sampled the water column for 12 minutes at 1 Hz at two-hour intervals throughout May and early June of 2011. The primary objective is to compare the results of the baseline survey with the bottom acoustic data to evaluate the three types of acoustic technologies as potential monitoring tools at MHK sites. Ultimately, the study results will be used to develop recommendations for standardized remote sensing of biotic communities at MHK sites.

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Iris Kemp, MS

Major Professor: David Beauchamp

Feeding interactions between juvenile Chinook salmon and herring in Puget Sound

Early marine feeding and growth of Puget Sound Chinook salmon are tightly correlated with smolt to adult returns, so factors such as competition that affect feeding success during this life stage could have important influences on marine survival. During the critical summer growing season, herring dominated the biomass of the shallow pelagic planktivorous fish community and exhibited extensive diet and spatial overlap with juvenile Chinook and other salmon. A bioenergetic analysis indicated that herring consumed 10-47 times more biomass of the key prey resources eaten by Chinook salmon during the critical early marine growth period. These results suggest that any assessment of marine carrying capacity will need to account for the population and feeding dynamics of all major daylight planktivores, especially herring. Determining factors that affect growth performance during this critical period and the consequent influences on mortality during subsequent life stages will inform managers and researchers about the role of the Puget Sound food web in supporting production and survival of Chinook and associated pelagic species.

Lauren Kuehne, MS

Major Professor: Julian Olden

Interactive effects of temperature and predation on behavior, physiology, and growth of juvenile Chinook salmon

Temperature regimes affecting freshwater fishes are projected to change in many regions due to climate change and human water use. Although predation is understood to be a key determinant of behavior and growth of juvenile fishes, the extent to which these interactions are temperature mediated is rarely tested experimentally. In this study, we tested the effects of increased water temperature on the vulnerability of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) to the direct (mortality and growth) and indirect (behavior and physiology) effects of predation by smallmouth bass (*Micropterus dolomieu*). We examined the importance of temperature and predation at multiple levels, from individual behavioral and stress responses to growth and survival at the group level, during 48-hour trials in large, semi-natural stream channels.
Contrary to expectation, there was no significant difference in consumption of juvenile Chinook due to predation with warmer temperatures, but predator treatments resulted in significant changes in behavior and physiological stress responses. Moreover, our results show that warmer temperatures interact with predation pressure to cause decreased physiological capacity and more variable behavioral responses to predation, resulting in an additive negative effect on growth. These results indicate that multiple stressors expected under climate change scenarios have the capacity to tax physiological and behavioral compensation systems of juvenile fishes and result in significant growth reductions during summer rearing periods.

Abstracts

Rachel Lange, MS

Major Professor: Claire Horner-Devine

Living in the dead zone: Patterns of microbial communities in Hood Canal, WA

Microbial communities are abundant, complex, and diverse and thus play a crucial role in ecosystem function. However, we are only beginning to understand their distribution over space and time. To elucidate patterns of microbial communities we are using next generation 454 pyrosequencing and multivariate statistical analyses to examine the relative influence of biotic and abiotic factors (including nutrients, dissolved oxygen, temperature, salinity, chlorophyll a, and spatial distribution) on the ecology of microbial communities residing in Hood Canal, WA. Hood Canal is a glacial fjord that demonstrates classic estuarine circulation and remains stratified year-round, which constrains circulation and allows little transport of new water carrying transient microbes, making it an ideal study site. Additionally, the circulation patterns and surrounding land use contribute to eutrophication of Hood Canal waters, resulting in extremely low levels of dissolved oxygen. At the southern end of Hood Canal, waters have remained hypoxic for up to twelve consecutive months in the past decade resulting in harm or death to fish, shrimp, and other benthic organisms. Despite the increasing number of hypoxic/anoxic waters and the resulting ecological and economic impacts, relatively little is known of the microbes driving nutrient and energy cycling process residing in these dead zones. Using deep-sequencing methods, we examine drivers of microbial community composition in order to gain insight into the impacts of hypoxia on the remaining life in the dead zone.

Meryl Mims, PhD

Major Professor: Julian Olden

Does hydrology determine population connectivity and persistence of desert anurans? (Poster)

Desert streams play a prominent role in shaping hydrological, biogeochemical, and ecological structure of arid and semi-arid ecosystems. Obligate aquatic organisms in much of the American Southwest rely on flows generated by winter storms and summer monsoons to provide favorable breeding habitat and to provide hydrologic connectivity with individuals or populations that are otherwise isolated by harsh and dry habitat. The predictability, frequency, and magnitude of these flows will likely be altered by climate change and by increasing human requirements for freshwater. These changes may result in habitat loss and increasingly isolated populations for many aquatic organisms. Understanding where and how to manage freshwater habitats in light of these changes is essential for conservation of aquatic species. In this poster I summarize the major goals of my PhD examining the role of hydrology in the population structure, connectivity, and persistence of desert anurans in several areas of southeast Arizona. Questions shaping my research include: 1) What is the role of hydrology and other landscape variables in the populations structure of native anurans? 2) Do anuran life history strategies predict the relationships between hydrology and population structure? 3) Can the distribution and population structure of an invasive anuran (American bullfrog) help structure effective management strategies? 4) Can we forecast responses of amphibians to climate-induced changes in flow permanence and hydrologic connectivity?

Abstracts

Cole Monnahan, MS

Major Professor: Jim Anderson

Predicting run abundance in real time using PIT tag returns for Columbia River spring Chinook (poster)

Management of the in-river harvest of Columbia River adult spring Chinook is complex because managers have limited preseason and real-time information on the total run size and run timing. Without both it is difficult to assess a run's status in real time and so correctly allocate harvest across the entire run. In this study I explored how daily detections of individual returning hatchery adult fish tagged as juveniles with passive integrated transponders (PIT) can be used to update the preseason estimates of the total run abundance. I developed a model which makes evolving estimates of abundance based on the daily PIT tag data from early returning hatchery stocks at Bonneville dam. This "real-time" method estimates the same abundance as the current preseason estimate, and so the accuracy of the two is compared by calculating a blended estimate for each day where the weightings reflect the relative performance. Although this simple real-time model performs well at early stages of the run, several areas for further model development are proposed and discussed. From the study I conclude that there is significant potential for improving management harvest decisions by capitalizing on the information contained in the early part of the run. The PIT tag data used in this study have only recently become both sufficiently large and consistent enough across years for practical use, and so this project represents an initial attempt at utilizing a new data source for informing harvest decisions made by managers.

Stuart Munsch, MS

Major Professor: Charles Simenstad

Assessing the effects of urban infrastructure on the nearshore ecology of juvenile salmon in Elliott Bay, Washington

Coastal urbanization is a globally prevalent form of habitat degradation that potentially affects the community and behavioral ecology of coastal ecosystems by altering the physical shoreline environment. Assessing the functional value of altered nearshore ecosystems is particularly important in the context of juvenile salmon habitat rehabilitation, as evaluating the effectiveness of enhancement actions requires an understanding of pre- and post-rehabilitation habitat conditions. The densely urban shoreline of Elliott Bay, Washington has been modified by coastal urban infrastructure, which may decrease the functional value of its habitat to juvenile salmon. Current knowledge of the impacts of coastal habitat degradation on the nearshore ecology of juvenile salmon is limited by studies based on instantaneous measures of habitat use. My M.S. research will explore novel methods to more holistically assess the functional value of nearshore habitats by incorporating metrics of juvenile salmon behavior e.g., foraging and movement patterns. I will utilize these behavioral metrics, in addition to instantaneous measurements of habitat use, to quantify the effects of the existing urban infrastructure in Elliott Bay with particular attention to the effects of coastal armoring and overwater structure shading. This information will likely provide more functional information to the near-term assessment of the effects of the Elliott Bay Seawall reconstruction and possible implementations of associated enhancement of juvenile salmon habitat.

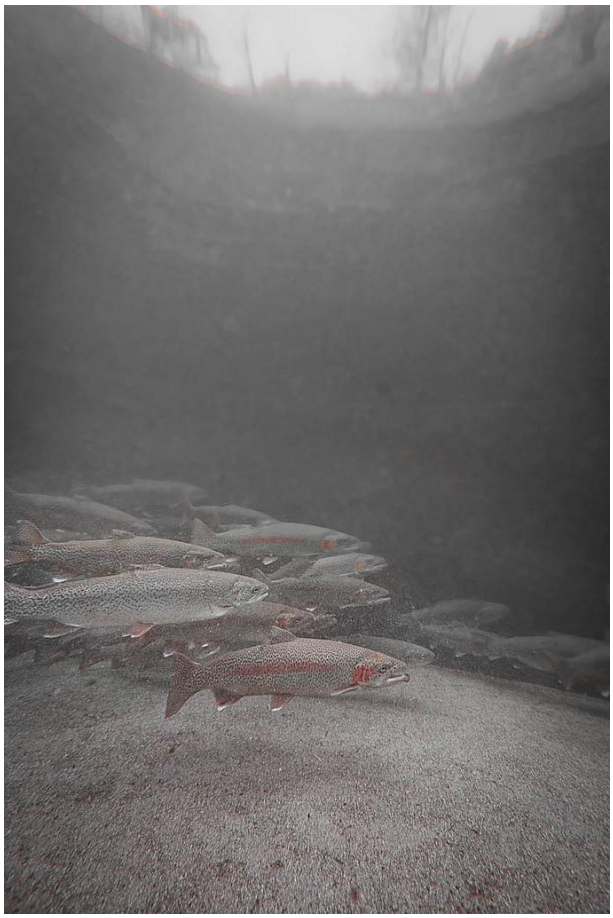
Abstracts

Gregor Passolt, MS (QERM)

Major Professor: Jim Anderson

Critical Size for Salmon Smolts

In the course of downstream migration, chinook salmon (*Oncorhynchus tshawytscha)* face significant size-selective predation. A simple model looks for a critical size beyond which smolts become much safer and the magnitude of such an effect. The model is applied to PIT-tag data survival data from two hatcheries to Lower Granite Dam, and extends findings adult returns in a much larger data of both hatchery and wild fish passing Lower Granite in 1998-2009.



J. Armstrong

Daniel Peterson, MS

Major Professor: Lorenz Hauser

Dispersal, local adaptation and inbreeding in a metapopulation of Alaskan sockeye salmon

Gene flow occurs when individuals disperse from one population to another and successfully reproduce. Thus, the level of gene flow between two populations is determined not only by the number of dispersers but also by their relative reproductive success. Dispersers are often assumed to have lower reproductive success in general than non-dispersing (philopatric) individuals because they are not genetically adapted to their spawning habitat. However, in small, isolated populations, genetic drift may overwhelm selection, possibly leading to a reduction in reproductive success for philopatric, inbreeding individuals and a relative advantage for immigrant dispersers. This study investigates the relative importance of local adaptation and inbreeding to the reproductive success of spawning adults in a metapopulation of Alaskan sockeye salmon. Specifically, we ask whether immigrants display reproductive success that is higher than, lower than, or equal to the local philopatric individuals, and whether any differences are caused by local selection, mate choice, or genetic incompatibilities. We have tagged and sampled an almost complete survey of two proximate subpopulations of sockeye salmon during five spawning seasons (2004, 2005, 2008, 2009 & 2010). After genotyping all sampled individuals, parentage analysis will allow us to determine which adults from 2004 and 2005 mated and how many returning adult offspring each pair produced. This measure of lifetime reproductive success will be associated with dispersal status and relatedness between the parents to determine which factors are important to the microevolution of this metapopulation. This work is ongoing but I will present the results from preliminary analyses.

Abstracts

Jessica Rohde, MS

Major Professor: Tom Quinn

Patterns of Sub-Adult Coho Salmon in Puget Sound

Migration is a central mechanism affecting the distribution of mobile populations, and intra-specific variation in migration patterns can affect many aspects of their the ecology and conservation. Most sub-adult Chinook and coho salmon rear over the continental shelf or offshore waters of the North Pacific Ocean but some Puget Sound salmon exhibit an alternative migratory pattern, spending all or part of their marine lives within Puget Sound. This "resident" behavior has been linked to decreased growth and increased contaminant accumulation. However, little is known about the movements of individual salmon and duration of their residency in Puget Sound. Accordingly, we tagged 45 sub-adult coho salmon in central Puget Sound with acoustic transmitters and tracked their movements using the array of moored receivers throughout the Salish Sea. Our initial results indicated that most individuals remained in Puget Sound, though several individuals were detected leaving through the Strait of Juan de Fuca and the San Juan Islands. Additionally, between basin movement was minimal; no individuals were detected entering Hood Canal or southern Puget Sound, but there was some movement into the Whidbey Basin. Overall, these results indicate that coho salmon found within Puget Sound in winter-spring are largely separated from those rearing off the coast, thus resident and migratory individuals seem to be distinct categories, though the factors determining these two pathways are unclear.

Teresa Sjostrom, MS

Major Professor: Kerry Naish

Hybridization between naturally sympatric steelhead and coastal cutthroat trout in Western Washington

Hybridization is the interbreeding of individuals from genetically distinct populations, and while hybridization has the potential to introduce adaptive genetic variation, extensive genetic mixing may also threaten evolutionary lineages. In the coastal region of western North America, natural hybrids between *Oncorhynchus mykiss* (steelhead and rainbow trout) and coastal cutthroat trout (*O. clarki clarki*) have been documented in numerous rivers and streams ranging from Northern California to Southeast Alaska, and the frequency of hybrids is variable among streams. The causes and long-term outcomes of hybridization are unclear. Here, we aim to identify environmental and biological variables, including anthropogenic factors, associated with the extent of hybridization, thus providing a tool to help predict levels of hybridization in populations of interest. We are measuring hybridization in twelve Western Washington streams that encompass a range of habitat types and land use patterns necessary to test whether specific environmental characteristics influence hybrid incidence. Species specific molecular markers have been used to measure the frequency of hybrids in each population. We have implemented a Bayesian statistical approach to assign individuals to specific hybrid classes and a hybrid index to classify individuals along a continuum based on the proportion of species specific alleles. These analyses are being used to assess whether hybridization is recent or on-going within the sampled populations. Overall, this project will improve our understanding of the distribution, dynamics, and potential causes of hybridization between these species.

Abstracts

Megan Stachura, MS

Major Professor: Nate Mantua

An Investigation of Environmental Influences on Northeast Pacific Groundfish Recruitment

Marine ecosystems may respond to physical forces in the ocean environment through direct and indirect pathways, causing the abundance and productivity of marine species to vary over broad scales. Fish are especially susceptible to these forces during their early life due to their small size and limited swimming capabilities, causing large interannual variability in recruitment for some stocks. Changes in the mean level of recruitment may also occur through regime shifts. Species with related life history traits have been shown to experience co-variations in recruitment, possibly due to similar responses to environmental forcing. We used time series and multivariate analysis of recruitment and stock-recruitment residual time series to evaluate the dominant modes of variability in recruitment of commercially harvested groundfish stocks in the Northeast Pacific. Hierarchical cluster analysis was used to identify groups of stocks based on similarities in these recruitment indices. This was then linked to life history traits potentially important to recruitment and susceptibility to environmental variables. While preliminary results of this analysis show some grouping based on biologically related species groups (e.g., rockfish, flatfish, gadids), correlation between these groupings suggest other similarities in exposure to environmental factors in early life history. Further analysis will investigate the roles of physical and biological factors in these recruitment variations with statistical modeling.

Cody Szuwalski, PhD

Major Professor: Andre Punt

Regime shifts and oscillating control of snow crab recruitment (*Chionoecetes opilio*) in the eastern Bering Sea

Regime shifts are prominent features of the physical environment of the eastern Bering Sea, and in recent years have happened in approximately 1977, 1989 and 1999. Average snow crab (*Chionoecetes opilio*) recruitment changed after the year 1989. Oscillating control models are presented for recruitment that use estimated female survey spawning biomass during the pre-1989 regime. The winter Pacific Decadal Oscillation index is used during the period from 1989-present for one model and another model uses sea surface temperature during the month of May in the Bering Sea during the 1989-1999 regime and tests other covariates for the current regime. The hypothesized mechanism behind these relationships involves the influence of temperature during regimes on the timing of the ice retreat and its associated consequences (e.g. food availability, pelagic vs. benthic dominant ecosystems, length of the pelagic stage in snow crab, and size of cold pool) for the survival of pelagic larvae and juvenile crab.

Abstracts

Emma Timmins-Schiffman, PhD

Major Professor: Steven Roberts

Ocean acidification impacts the growth and physiology of larval Pacific oysters (*Crassostrea gigas*)

Climate models predict unprecedented changes to the global atmosphere and oceans throughout the 21st century and beyond. Many of these changes will be caused by increased CO_2 emissions and other greenhouse gases. Ocean acidification, a direct consequence of increased atmospheric pCO_2, has already begun to occur in the open ocean and in Puget Sound. To understand some of the effects that ocean acidification will have, larval Pacific oysters were exposed to three levels of dissolved CO_2 corresponding to present and projected levels: 400 µatm (control), 700 and 1000 µatm (elevated end-of-century projections). The larvae showed evidence of decreased growth and calcification and altered physiology after 4 days of exposure to elevated pCO_2. These early life history effects could impact later survival and fitness of oysters.

J. Armstrong

Andy Whitehouse, PhD

Major Professor: Tim Essington

Modeling the eastern Chukchi Sea food web with a mass-balance approach

Several changes in arctic ecosystems have been attributed to climate change and many more are anticipated. Food-web models can improve our understanding of community structure and enhance our ability to recognize changes in ecosystem function. Presented here is a mass-balance food web model of the eastern Chukchi Sea which provides an annual snapshot of community structure. Species were represented individually where data permitted or were aggregated where data was sparse. The bulk of total system biomass is concentrated in benthic invertebrates and accordingly most of the mass flow above trophic level 2.0 was through this group. Mass flows to higher trophic levels through pelagic groups like zooplankton were an order of magnitude less. Arctic cod (*Boreogadus saida*) were the principal fish prey connecting production between lower and upper trophic levels. Additionally, we use a set of system metrics derived from a common modeling framework to highlight differences in ecosystem structure between the eastern Chukchi Sea and the nearby subarctic eastern Bering Sea and the more distant Barents Sea. The total biomass density (t km^{-2}) of the eastern Chukchi Sea was nearly equal to the eastern Bering Sea but had only half the total production (t $km^{-2}yr^{-1}$) and system throughput (t $km^{-2}yr^{-1}$). The Chukchi was approximately double the Barents in total biomass density (t km^{-2}), production (t $km^{-2}yr^{-1}$), and throughput (t $km^{-2}yr^{-1}$). A key distinction between the Chukchi and Barents community structure was the much more balanced distribution of biomass and associated flows between benthic and pelagic components.

Acknowledgements

Every year, the success of the School of Aquatic and Fishery Sciences Graduate Student Symposium is attributed to the efforts of the graduate students, faculty and staff who are committed to carrying on this tradition. Again this year, we'd like to thank everyone involved for the generous contribution of time and resources. Each volunteer has played a significant role in making GSS a valuable opportunity for students to share their research and for the School to celebrate the creativity and dedication of our graduate students.

Specifically, we would like to thank the following volunteers:

Peter Lisi and Laura Twordochleb	Food and beverages
Jessica Rohde	Reception
Jonny Armstrong	Artwork
Abby Tillotsen	Program design and layout
Marcus Duke	Website
Adam Hansen and Curry Cunningham	A/V coordination
Emma Timmins-Schiffman and Rachel Lange	Judge coordination

Judges will remain anonymous, but not unappreciated!

We'd like to thank the numerous volunteers who helped with set-up and clean-up, and session moderation, ballot counting, and baked goods, for your help in making the day run smoothly. These volunteers include Donna Hauser, Jen Griffiths, Kale Bentley, Rachel Lange, KathiJo Jankowski, Charlie Waters, Beth Phillips, Megan Statchura, Juliana Houghton, Lisa Crosson, Marine Brieuc, Mackenzie Gavery, Polly Gibson, Morgan Bond, Marissa Jones, Lauren Kuehne, Neala Kendall, Dave MacGowan, Sarah Heerhartz, Emma Timmins-Schiffman, Meryl Mims, Daniel Peterson, Theresa Sjostrom, Louisa Harding, and many more who signed up for volunteering after the program was complete!

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The symposium would not have been possible without the graduate students who delivered oral presentations and contributed posters. Thank you all for being the focus of GSS and for your enthusiasm for sharing your research.

Finally, the contributions of the Skau Endowment deserve a special note for making this annual event possible. We offer our sincere thanks to the friends and family of Oscar Skau for their generous gift to SAFS.

We appreciate that you've shared this event with us, and hope you enjoy the day.

Rachel Hovel and Iris Kemp
2011 GSS Coordinators