Summer Internship Opportunity: Work with a NOAA Scientist and Learn to Integrate Mathematics and Fisheries Science

The Northwest Fisheries Science Center (NWFSC) and the University of Washington request applications for students in the Mathematical Sciences for a summer internship at the NWFSC. Interns will spend summer (~16 June – 15 September) working on a research project that integrates mathematics with the science that informs fishery managers. A stipend of $6,000 will be provided from the Usha and S. Rao Varanasi SAFS Faculty Endowment for Student Support, the NWFSC, and the School of Aquatic and Fishery Sciences (SAFS). The successful applicant will also be provided with office space at the NWFSC or SAFS and a NWFSC mentor.

Although any projects related to sustainable management of west coast fish resources would be considered, the following projects are already available and NWFSC mentors identified:

1. Impacts of marine heat waves on primary productivity in the California Current (NWFSC Mentors: Eric Ward, Stephanie Moore, Jens M. Nielsen, and Brian Burke)
2. Modelling species composition of landings to estimate species-specific landings from mixed-species landings (NWFSC Mentors: Kelli Johnson and Chantel Wetzel)
3. Study of coastal upwelling dynamics in the Indian Ocean using machine-learning and remote-sensing data (NWFSC Mentor: Eli Holmes).
4. Utilizing spatial analysis tools to better characterize the overlap in space and time among juvenile salmon, their prey and predators (NWFSC Mentors: Lisa Crozier and Brian Burke)

For more information on these projects contact the primary NWFSC mentors (Eric Ward: eric.ward@noaa.gov; Kelli Johnson: kelli.johnson@noaa.gov; Eli Holmes: eli.holmes@noaa.gov; Lisa Crozier: lisa.crozier@noaa.gov).

The SAFS values the strengths and professional experience that students, faculty, and staff bring to our community. We are committed to providing an excellent education to all of our students, regardless of their race, gender, class, nationality, physical ability, religion, age, or sexual orientation. We are proud of the different roles that our students, staff, and faculty play in the community of the School and the College of the Environment. We also recognize that science is richer, and the SAFS community is more vibrant when a diverse group of people participate in research. We are especially interested in candidates who can contribute to our department's diversity through their life experiences, scholarship, and/or service to the institution. Women, people with culturally diverse backgrounds, people from communities historically excluded from STEM, first generation students, people with disabilities, and veterans are encouraged to apply and will receive equal opportunity.

HOW TO APPLY

To apply for this internship, submit your application to this form https://forms.gle/FegoPQAPzCyB2mDU9 by 15 March 2024.

- Application Materials (in one pdf). Save as "LastnameFirstname_MML2024.pdf" (where Lastname and Firstname are your name):
    - Recent Resumé
    - Unofficial UW Transcript
    - Letter of Interest (maximum of four pages) – include the name of the project that most interests you and why; tell us about yourself and your research interests; explain how the internship will further your studies and career; include other information the selection committee should be aware of, such as what it means to you to have a commitment to diversity, equity, and inclusion.

DEADLINE FOR SUBMISSION

March 15, 2024

DECISIONS

Award notifications will be made by April 19, 2024

Project 1: Impacts of marine heat waves on primary productivity in the California Current

Mentors: Drs. Eric Ward, Stephanie Moore, Jens M. Nielsen, Brian Burke

Background: Primary production in US regional marine ecosystems is a strong determinant of fisheries economic performance. The intensity and timing of phytoplankton blooms vary due to changing climatic and oceanographic conditions, such as nutrients, light, temperature, and wind mixing. We are working on understanding how climate variability, including marine heat waves, affect primary production, using high-resolution mooring data to develop indicators of ecosystem change. The mooring data will be from the Cha'ba mooring located off the Washington Coast. As part of a larger project, we are developing a general modeling framework to assess changes in production dynamics, with a focus on recent marine heatwaves (MHWs). Using statistical models, we can evaluate changes related to MHWs in a discrete framework (e.g. before & after 2014-2015, comparing MHW years vs non-MHW years) or in a continuous framework using non-stationary modeling approaches.

Project: We are looking for a motivated student to (First) construct statistical models of changing time series of environmental variables collected from high resolution oceanographic data (may include linear models, generalized additive models, time series approaches including dynamic linear models). Second, we hope to develop some initial visualizations of the data and trends (ideally, this would be developed in a Shiny app, but could be using R/ggplot2 or other frameworks).

What the intern will gain from this project: The intern will work closely with an established team of PIs and a post-doc. We will have weekly lab meetings / check-ins for the 10-week period, and will be available to provide additional guidance as needed – this may, for example, include additional meetings to discuss technical aspects, or review of code and outputs on Github.

Desired Skills: Experience working with R and with reproducible tools (R-markdown/Quarto, Github) would be a plus.

Project 2: Modelling species composition of landings to estimate species-specific landings from mixed-species landings

Mentors: Drs. Kelli Johnson and Chantel Wetzel

Background: The management of commercially-fished marine species depends on having accurate catch histories. Many fisheries off the U.S. West Coast are considered mixed-species fisheries, meaning that multiple species are often caught and landed at the docks together in mixed-species groups. The data collected at the docks from these mixed-species groups are often estimates of the mass of the entire group rather than species-specific masses. Reconstructing species-specific landings currently relies on samples taken from these mixed-species groups, termed species compositions, that measure the proportion of each species present in the sample. These species-composition samples are then applied to both sampled and unsampled mixed-species landings across ports within a specific sampling time period to estimate species-specific landings. Sampling protocols and the rules around extrapolating estimates often differ by state and sometimes year. This project aims to extend initial work done in 2012 to create a model-based approach to reconstructing species-specific landings from mixed-species landings. Initial explorations of models indicated that model run times were prohibitively slow and results were sensitive to missing data. This was the first use of the Poisson-multinomial in the field of fisheries science and given that the research was initiated over a decade ago, we are certain that some of the previous obstacles can be easily overcome given increased computing power and knowledge about applying statistics to fisheries data. This project aims to support sustainable harvests of marine species by increasing the accuracy of historical landings for mixed-species groups through the application of enhanced statistical methods.

Project: This project will utilize simulated species-composition data to determine the best model-based approach to estimating the composition of unsampled mixed-species landings. Simulated data is necessary because data confidentiality laws restrict the sharing of the sampled fisheries-dependent data. The simulated data will be used to fit various model configurations that range from the status quo borrowing rules to state-of-the-art models used to identify the presence of species through gene sequencing. Depending on the level of model complexities explored and the desire of the intern, cloud-based computing and parallel processing could also be a component of this research.

What the intern will gain from this project: We anticipate the intern will gain improved coding skills given the collaborative nature of the project at hand; gain knowledge about applying statistical methods developed outside of fisheries science to biological data; and become familiar with sampled fisheries-dependent data, which can often be more complex than data provided in an academic setting. The results of this project will lead to information on best practices for modelling species-composition data and will be used to work up landings that are meant to be included in the assessment of marine species off the U.S. West Coast in 2025.

Project 3: Study of coastal upwelling dynamics in the Indian Ocean using machine-learning and remote-sensing data

Mentor: **Dr. Eli Holmes**

Background: Coastal upwelling is a key driver of productive fisheries. It is largely driven by coastal winds that pull surface water away from the coast and which then pulls deep, cold, nutrient rich water to the surface. Strong and consistent coastal upwelling happens in specific regions around the world and supports strong fisheries. An interesting and curious aspect of upwelling is that it is influenced by ocean-atmosphere teleconnections—correlations in ocean climate across long-distances. In plain language, it means that a pattern that arises in one part of the world's oceans will be seen later on the other side of the world. One of these teleconnections is between the North Atlantic Ocean and coastal upwelling off the coast of North Africa (the Canary Upwelling system) and off the southwest coast of India.

Project: In this project, you will explore the use of machine learning or deep learning using ocean remote-sensing data. The goal is to explore how machine-learning, especially neural networks models, teleconnections and remote-sensing data can help us develop predictive models for upwelling. For the internship, you do not need to know machine learning but you should have an interest in learning about it and doing a machine learning project or working with remote-sensing data. There are several popular Python libraries for implementing neural networks with image inputs, including TensorFlow, PyTorch, and Keras, and you'll choose one of these to learn and work with.

Although the topic is specified and you'll be given remote-sensing datasets to work with, you will develop your own project (with guidance) and if a machine-learning approach different than neural networks seems more promising, you can definitely switch. As part of the project, you will have the opportunity to participate in OceanHackWeek (in Seattle) and virtually in the ITCOocean Hackweek (held in India). You will be helping develop data and tutorials used by ocean scientists who are studying the Arabian Sea and Bay of Bengal.

What the intern will gain from the project: This project will give the intern experience working with ocean remote-sensing data and applying image classification and machine learning algorithms to create predictive models. The intern will take part in a research project on novel uses of these approaches in fisheries and have the opportunity to work with others during hackweeks. The intern will get experience with popular Python packages for machine learning (e.g. TensorFlow, PyTorch or Keras). Prior interns have presented their summer projects at undergraduate symposiums.

Required background: The intern will need programming experience in Python to be successful in this project. The intern should be able to read about an algorithm and write code to implement it. The intern should enjoy reading tutorials and then apply the ideas learned to a novel project on a different set of data. Prior experience with machine-learning (classes or self-study) will be helpful but not required.

Project 4: Utilizing spatial analysis tools to better characterize the overlap in space and time among juvenile salmon, their prey and predators

Mentors: Drs. Lisa Crozier and Brian Burke

Background: There is a high degree of uncertainty about how future ocean conditions will impact survival of Pacific salmon, which may conceal or even undermine any management actions aimed at improving survival & productivity during freshwater phases of the life cycle. Current indicators of marine salmon survival rely on correlative relationships, yet it is imperative for decision makers to be prepared for changes in these relationships as we shift into novel ecosystem states in the near and long term. We will build models that represent more mechanistic processes of growth and predation in order to explore how independent rates of change in the associated species interactions could affect salmon survival in a changing climate. The first step toward this goal is to develop more standardized metrics of overlap in space and time among juvenile salmon, their prey and predators. With such a metric, we can better characterize variation in overlap between years, which could then be tested as covariates in models of smolt-to-adult return.

Project: NOAA conducts systematic surveys to sample juvenile salmon survival during their early ocean period. Usually we consolidate all of the information from different survey stations into a simple annual metric. However, by doing so, we lose much of the detailed information from the variation across stations. Moving forward, we would like to capture more specific estimates of overlap across trophic groups to better model how early marine survival in salmon is influenced by bottom up and top down factors.

The project consists of using the sdmTMB package in R to characterize the influence of space and time on species of interest in the Northern California Current. The primary target of the analysis is the Juvenile Salmon Ocean Ecology Survey and the Northern California Current survey. We have conducted surveys since 1998 and are interested in sdmTMB models of numerous species caught in these surveys. We may also use data from other surveys, such as the hake and groundfish surveys. The intern will predict species occurrence onto a standardized grid, so that output from each species' model can be directly compared. All analysis will be done using the R language.

What the intern will gain from the project: We anticipate the intern will improve statistical modeling skills, become familiar with NOAA surveys and better understand the process of transforming data into decision-making tools. The intern will also learn how climate change is influencing ocean ecosystems, which will likely be an important perspective across a wide range of careers in science or fishery management. The products created from this project will find immediate utility and could become a substantial contribution supporting salmon conservation.