2022

NOAA Hollings Internship - NW Fisheries Science Center

Zofia Danielson
Western Washington University

COLLEGE OF THE ENVIRONMENT

WESTERN WASHINGTON UNIVERSITY
MAKE WAVES.

Internship Title: NOAA Hollings Internship - Northwest Fisheries Science Center

Student Name: Zofia Danielson

Internship Dates: 6/14/2021- 8/20/2021

I grant to Western Washington University the non-exclusive royalty-free right to archive, reproduce, distribute, and display this Internship Report document in any and all forms, including electronic format, via any digital library mechanisms maintained by WWU.

I represent and warrant this is original work, and does not infringe or violate any rights of others. I warrant that I have obtained written permissions from the owner of any third party copyrighted material included in this document.

I acknowledge that I retain ownership rights to the copyright of this work, including but not limited to the right to use all or part of this work in future works, such as articles or books. Library users are granted permission for individual, research and non-commercial reproduction of this work for educational purposes only. Any further digital posting of this document requires specific permission from the author.

Any copying or publication of this document for commercial purposes, or for financial gain, is not allowed without my written permission.

STUDENT SIGNATURE Zofia Danielson

DATE: 6/13/2022

NOAA Hollings Internship Reflection

This research was conducted on the lands of the Coast Salish, Suquamish, S'klallam, Twana/Skokomish, Duwamish, Suquamish, Stillaguamish, and Muckleshoot Tribes who have stewarded this land and water since time immemorial.

I. Internship Description/Goals

From June 2021-August 2021, I was a full-time NOAA Hollings intern at the Northwest Fisheries Science Center in Seattle Washington, with mentorship from Kelly Andrews. My goals for this internship were to learn how to develop research questions based on preexisting data, build my R statistical programming skills, analyze large datasets, continue to build my skillset in ArcGIS mapping software, and learn how to write and present a cohesive report of the results of this analysis. The objectives of the research project were to quantify patterns of vertical movement and activity level for Endangered Species Act-listed (ESA) yelloweye rockfish at hourly and seasonal scales and determine whether environmental covariates, such as currents, ocean temperature, and dissolved oxygen (DO) concentration, affect these patterns. This work resulted in a presentation a NOAA Hollings Scholar virtual symposium. Additional work for this project included presenting at two conferences: the national American Fisheries Society conference and Salish Sea Ecosystem Conference. By gaining firsthand experience in fisheries research by conducting an investigation, with assistance from my mentor, and learning to communicate the results of scientific work, I am better prepared for a future career in this scientific field.

II. Introduction

Yelloweye rockfish (*Sebastes ruberrimus)* have been listed on the Federal Endangered Species list since 2010[1]. After rockfish in Puget Sound experienced a nearly 70% decline in

population between 1970 through 2010, yelloweye rockfish, along with canary and bocaccio rockfish were listed on the Federal Endangered Species list and critical habitat areas were designated for these species[1]. These critical habitat areas were designated without information on these species' habitat use, and this lack of information makes determining the effectiveness of these areas difficult.

A management plan for yelloweye, bocaccio, and canary rockfish was created in 2017 and there are several threats-based criteria that must be met in order to de-list this species from the ESA-list.[1] Due to a lack of historical data focused on these threats, this internship project was created to analyze data collected regarding these criteria.

The yelloweye population in Hood Canal is genetically distinct from other populations within Puget Sound which provides a unique challenge for recovery efforts[2]. The density of yelloweye in Hood Canal, as compared to the rest of Puget Sound, is higher which allowed for collection of a large enough sample to study movement patterns with.

Final results will inform questions related to threats to critical habitat (e.g., low DO events) and future directions for management of yelloweye rockfish in Hood Canal.

III. Methods

Fifteen yelloweye rockfish were outfitted with acoustic transmitters and monitored their movements in three acoustic receiver arrays in Hood Canal, WA from October 2016 to October 2017. Five yelloweye were tagged at each site. Each transmitter was outfitted with a pressure and accelerometer sensor that transmitted the depth (m) and activity level (m/s^2) of each fish every 200-320 seconds. The receivers were retrieved and brought back to the Northwest Fisheries Science Center to download on May 3, 2017 and were redeployed on July 21, 2017. Receivers at Seal Rock were retrieved on December 14, 2017 and all other receivers were retrieved on

February 26, 2018. We used environmental covariate data from empirical data collections and a 3-D oceanographic model at each site. The environmental covariates we focused on were Fish ID, time, month, site, temperature, dissolved oxygen, currents, and tide stages. Using generalized additive mixed models, we quantified diel and seasonal metrics of depth distribution and activity levels and tested the importance of the environmental covariates to these movement parameters.

IV. Tasks

My internship focused on organization of the depth and activity level data in addition to compiling environmental covariate data with which to run the generalized additive mixed models. I developed an R script to organize data and conduct these analyses with which will be a tool to assist similar future research projects with data analysis. We met daily to discuss future steps for the project, troubleshoot R code, and split up tasks to accomplish before our next meeting. I worked in R to produce preliminary visualizations of patterns in the temporal and environmental datasets and write out preliminary GLMM code. I also read and compiled background literature on groundfish movement in order to inform my process coding and begin work on the manuscript.

I also created a presentation for this project that was presented at the American Fisheries Science national conference and the Salish Sea Ecosystems Conference. Another future outcome of the continuing work of this project will be presenting the results to local stakeholder groups, such as the Puget Sound Anglers who are impacted by the closure of the yelloweye rockfish fishery in this region.

In addition to these tasks, I attended daily and weekly meetings at the NOAA Northwest Fisheries Science Center to gain a better understanding of research projects at the federal level, learn how different programs under the center collaborate, and gain more knowledge about local

and regional marine research and fieldwork. This component of the internship also included virtual coffee hours with other interns for networking and learning about research occurring by NOAA summer interns across the west coast.

V. Learning Outcomes

This project was an opportunity to learn more about local groundfish research, the plans aiding rockfish recovery, science communication, and analyzing data. The horizontal dataset proved to not add significant information to our findings as the bathymetry of the three tag sites was too rugose for analyzing with ArcGIS software. Compiling the environmental data proved to be a challenge as long-term tidal, temperature, and dissolved oxygen did not exist for the three sites included in this study. This produced an opportunity to collaborate with Dr. Parker MacCready at the University of Washington to work with data from his LiveOcean model, which gave me firsthand experience with cross-organization collaboration.

I have learned a lot about early steps in data processing with a large dataset, which built upon my knowledge of R coding methods that I learned at WWU. Additionally, learning to write the code for the general linear mixed models (GLMMs) improved my ability to both work in R and use biostatistical methods to analyze data. Producing early data visualizations to determine large scale seasonal and daily patterns in data and using these to hone our scientific questions was an invaluable experience. Although it was a steep learning curve, being able to learn these skills and use them to work on a research project that affects a regional scale rockfish recovery plan gave me an appreciation for collaboration among scientists, the beauty of data processing, and using these clues to write a manuscript draft.

Being able to present the preliminary results of this work at three symposiums was also a valuable experience as a student and early career scientists. Working with Kelly to produce a

accessible, informational, and compelling slideshow to present allowed me to explore my interest in science communication. Not only were these conferences networking opportunities, where I was able to share ideas and meet scientists working in the same field I will be pursuing a future career in, but also helped me build science communication skills that will positively benefit my career moving forward.

A final learning outcome from this experience was a gained appreciation for collaborative science. Working with a mentor to formulate these questions about yelloweye rockfish movement, support my learning to use R software to answer these questions, and having support while presenting at conferences allowed me to gain a deeper understanding of the scientific process in fisheries science. Building connections at the Northwest Fisheries Science Center has allowed me to build my scientific network, learn more about complex ecosystem dynamics, and grow as a student and scientist.

VI. Works Cited

1. Drake J.S., E.A. Berntson, J.M. Cope, R.G. Gustafson, E.E. Holmes, P.S. Levin, N. Tolimieri, R.S. Waples, S.M. Sogard, and G.D. Williams. 2010. Status review of five rockfish species in Puget Sound, Washington: bocaccio (Sebastes paucispinis), canary rockfish (S. pinniger), yelloweye rockfish (S. ruberrimus), greenstriped rockfish (S. elongatus), and redstripe rockfish (S. proriger). U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-108, 234 p.
2. Andrews, K.S., Nichols, K.M., Elz, A. *et al.* 2018. Cooperative research sheds light on population structure and listing status of threatened and endangered rockfish species. *Conserv Genet* 19, 865–878 (2018). https://doi.org/10.1007/s10592-018-1060-0

VII. Supporting Information