AGRICULTURAL RESEARCH FOUNDATION
INTERIM REPORT
FUNDING CYCLE 2020 – 2022

TITLE: Quantifying Chemical Habitat Suitability of Aquatic Species Assemblages

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COOPERATORS: Brooke Penaluna (Co-PI)

EXECUTIVE SUMMARY: Due to COVID-19 restrictions both at OSU and the US Forest Service, this project was delayed one year. After receiving the necessary permits to collect fish samples from the Willamette River and its tributaries, electrofishing and chemical sampling occurred from 67 slices May – September, 2021. We used non-target chemicals to identify the chemical features that are diagnostic of the presence of different fishes. Previously, PI Jones developed a chemical fingerprinting workflow to predict the presence/absence of different pollution sources based on the chemical composition of the samples. Using the same workflow, we selected the chemical features that were most diagnostic of the presence/absence of different fish species. While the workflow's accuracy was near perfect when predicting the presence/absence of pollution sources, the accuracy was considerably lower when predicting the presence/absence of different fish species. This is likely due to higher false negative rates (i.e., failing to detect a true fish presence) when sampling organisms. While true negatives were correctly classified with near perfect accuracy, false negatives in the model were high. Approaches that utilize 95% convex hulls could be used to help identify false negatives and improve the performance of the model. While methodological limitations need to be addressed, our initial results suggest that chemical fingerprinting could be useful for quantifying the chemical conditions that are unsuitable for supporting aquatic community assemblages in addition to source apportionment and pollution source tracking.

OBJECTIVES: Our objectives are as follows:
1. Develop chemical fingerprints associated with decreased fish abundance/diversity.
2. Identify the landscape origin of chemical features driving low fish abundance/diversity.
3. Predict in-stream fish abundance/diversity based on the chemical signatures present within water samples.

PROCEDURES:
River slices were selected at random from Eugene to Portland (Figure 1). Due to warm temperatures during the summer months, we were not able to electrofish all sampling locations. Therefore, tributaries were opportunistically sampled (e.g., McKenzie River, Figure 1). Fish-in-hand data was compiled by a technical in co-PI Penaluna's lab and chemical samples were processed by an undergraduate and graduate student in PI Jones' lab. Chemical data was analyzed at Oregon State University's Mass Spectrometry Center. Once the fish and chemical data were processed and collected, we used support vector classification to select the chemical features that were most predictive of largemouth bass and rainbow trout.

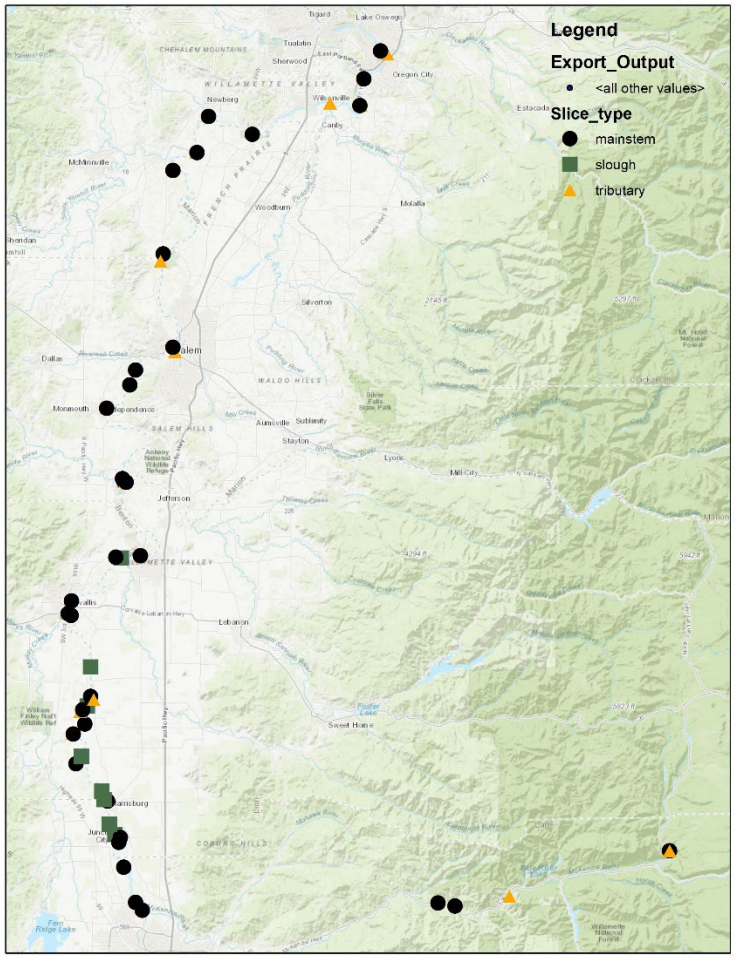

Figure 1. Fish and water sampling locations within the Willamette River Basin during the 2021 field season.

SIGNIFICANT ACCOMPLISHMENTS TO DATE: Field sampling occurred from May-September, 2021. In October, water samples were analyzed to obtain the holistic chemical composition of each sample. In November, the chemical data were processed, and we performed the chemical fingerprinting analysis. While the chemical fingerprinting results are promising, it is clear that there are limitations in our analysis. As previously mentioned, the model struggled to predict false negatives (i.e., predicting a fish to be absent when it was actually present). We've developed a strategy for addressing these limitations. This work was presented at the Department of Fisheries, Wildlife, and Conservation Sciences seminar series in November 2021.

To date, we've analyzed a small portion of the dataset. Of the 35 species detected, we've performed the chemical fingerprinting analysis on 2 species. At the end of the 2021/22 academic year, a PhD student (Lya Carini) will start on this project and use this dataset as a dissertation chapter. Lya is currently training in PI Jones' lab and is getting experience with the machine learning tools described within. Lya is currently taking BOT 570 and is analyzing this data for a class project. In this class, the student will perform the chemical fingerprinting for all fish species.

ADDITIONAL FUNDING RECEIVED DURING PROJECT TERM: No additional funding has been acquired for this project.

FUTURE FUNDING POSSIBILITIES: To the best of our knowledge, no other study has linked the chemical composition of a sample to the habitat preferences of an organism. Although we are still developing the statistical techniques to overcome, we are optimistic that this tool could be used to assess the chemical suitability of various aquatic species. We also expect that these techniques could be useful for ecosystem health assessments. There are various funding possibilities related to this research, mostly within NSF. We expect that the preliminary data collected for this project will be pertinent to the Division of Environmental Biology (DEB).