



Photo Credit: Eiko Jones

Applying portfolio theory to improve spatial recovery planning for Pacific salmon



Client:

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Proposers:

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Objectives

The main goal of this project is to aid the nonprofit Wild Salmon Center (WSC) in optimizing conservation strategies to recover Oregon Coast (OC) coho salmon populations. The 21 independent salmon populations are grouped within the OC Coho Salmon Evolutionary Significant Unit (ESU) and are listed as threatened under the US Endangered Species Act. Federal recovery goals include increasing overall salmon abundance and resilience (e.g., a decrease in interannual variability of returns). However, recovery planning is challenged by a lack of a quantitative framework that identifies how each population can best contribute to recovery goals. Modern Portfolio Theory (MPT) provides such a framework by quantifying how mean annual returns of each independent population, their interannual variance, and their degree of synchrony (i.e., covariance) can contribute to the performance of the entire ESU (Schindler et al. 2015). Consequently, the project objectives are to guide coho salmon recovery planning by:

- 1)** Assembling adult abundance data for 21 OC coho independent populations and using MPT metrics to characterize which populations most strongly affect the mean, variance, and covariance of ESU-scale salmon returns.
- 2)** Using MPT to optimize which populations to target for conservation and restoration investments that best meet the combined goals of larger and less variable salmon returns.
- 3)** Synthesize results from objectives 1 and 2 with knowledge from salmon restoration practitioners (e.g., WSC staff) to identify restoration actions that support optimal strategies identified by the application of MPT.

Significance

The watersheds that drain the 300-mile Oregon coast contain some of the most intact and diverse salmon ecosystems south of British Columbia. However, 160 years of resource extraction has impacted the health of Oregon's coastal watersheds causing declines in coho populations. Despite a legacy of land use impacts, Oregon's coastal watersheds are largely farm and forest land uses with free-flowing rivers, little hatchery coho production, and a well-regulated coho fishery. As such, Oregon Coast coho presents a unique, achievable opportunity for salmon recovery.

Watershed restoration called for in the federal recovery plans is undertaken largely by local watershed groups, government agencies, and NGOs that partner with public and private landowners to implement projects on the ground. The capacity of both the project managers and the landowners is limited relative to the size of the watersheds and the magnitude of the habitat degradation, which began well over a century ago. Accordingly, it is imperative that the limited federal, state, and private funds committed to watershed restoration are spent strategically and on the highest impact projects. The proposed project seeks to ensure this occurs by providing guidance on optimizing investments in targeted recovery actions.

Background

The project takes place in Oregon's 21 major coastal watersheds from the Columbia River south to Cape Blanco (Figure 1). The decline and federal listing of OC coho as threatened was precipitated

in large part by land use impacts compounded by accelerating climate change, highlighting the need for accelerated and strategic watershed restoration.

To address this need, the public-private [Coast Coho Partnership](#) — which includes the Oregon Watershed Enhancement Board (OWEB), Oregon Department of Fish and Wildlife (ODFW), NOAA Fisheries, NOAA Restoration Center, National Fish and Wildlife Foundation (NFWF), and Wild Salmon Center (WSC) — convenes to support locally-driven efforts to restore coastal watersheds and recover OC coho. The proposed project will help guide these local efforts by identifying recovery strategies most likely to increase the abundance and resilience of each independent population as well as how each population contributes to the ESU-scale recovery goals.

Equity

Salmon are a culturally, economically, and ecologically important species across the West Coast. The decline of salmon, including Oregon Coast coho, has negatively impacted multiple communities and stakeholders with consequences for equity and environmental justice. Firstly, the decrease in salmon have been a significant loss for Indigenous peoples whose culture and traditions are highly interwoven with salmon. For example, many tribes experience a reduced ability to practice traditional harvest methods. Population declines have also led to the complete elimination of coho fisheries that support rural economies and reduced the availability of affordable wild salmon in local food systems. Lastly, coho salmon are a keystone species, returning nutrients to inland ecosystems that sustain and enhance the growth of hundreds of species from plants, insects, and mammals. Their decline has impaired natural functioning processes in ecosystems that provide numerous ecosystem services to communities.

Research outcomes from this project will inform equitable recovery planning and decision making and ultimately, the successful recovery of coho salmon will advance equity and social justice across many impacted tribes and communities.

Available Data

Core analysis data has already been collated by WSC and includes wild coho salmon abundance obtained from ocean harvest records and annual spawning ground surveys conducted in each independent OC population from 1994 – 2021 collected by the Oregon Department of Fish and Wildlife (ODFW). Additional environmental and fisheries related dataset locations relevant to this project can be found [here](#). Students will also have access to [Netmap Virtual Watershed](#) datasets for each independent OC coho population. These custom datasets, funded by the Coast Coho Partnership, contain numerous environmental attributes along with a large suite of custom GIS-based tools to support resource management planning within the Oregon Coast coho ESU.

Other publicly available datasets that may be useful within the project scope include:

- [AdaptWest](#) current and projected climate data for North America
- [Google Earth Engine](#)'s catalog of satellite imagery and geospatial datasets
- [Oregon Explorer](#)'s array of geospatial datasets
- [StreamNet](#) – fish data for the Pacific Northwest

Possible Approaches

The project will apply Modern Portfolio Theory (MPT) to identify strategic and targeted recovery strategies for coho salmon. MPT is borrowed from finance and has increasingly been used in ecology to understand how the dynamics of aggregate resources (i.e., a “portfolio”) emerge from the performance of its individual components (i.e., “assets”) (Hilborn et al. 2003). In this case, the independent salmon populations can be thought of as assets within the portfolio of a salmon ESU. As in finance, the goal for this portfolio is to increase the mean annual return of salmon while minimizing the risk of poor returns occurring. Here, risk is defined as the observed temporal variability of returns of individual populations as well as their covariances (e.g., synchrony).

Wild Salmon Center has already done a preliminary analysis to characterize risk and return dynamics for the OC coho portfolio (including independent population contributions to the mean, variance, and covariance of ESU-scale returns).

The group project will build on this analysis to explore optimal investments among portfolio assets in actions to increase mean annual salmon returns or reduce the risk of poor returns (or both). For example, the group may identify portfolio investments that are optimal in the sense that for a given level of return there is no strategy with a lower level of risk and for a given level of risk there is no portfolio with a higher expected return (e.g., Ando and Mallory 2012).

The group will then work with salmon conservation practitioners at Wild Salmon Center to connect these results to real-world habitat restoration actions through tools such as GIS that could achieve the potential benefits identified through MPT analysis.

Deliverables

In addition to the required deliverables, this project will provide:

- A well-annotated data depository (Github, etc.) to extend utility of data analysis to potential future research and partner collaborations.
- Findings outlined in a format suitable for pursuing publication in a scientific journal.

Internships

Wild Salmon Center commits to host and mentor one paid intern with a \$6,000 stipend during the summer of 2023. The intern may choose to work remotely or from our headquarter office in the Jean Vollum Natural Capital Center in Portland, OR; however, housing arrangements would need to be secured by the student for the duration of the ~10-week internship. Up to \$1,500 additional funds will be provided by WSC to cover the intern’s travel related expenses to our Portland office or for field visits to project watersheds during the internship. In addition to furthering project goals, the intern will have opportunities to engage on a variety of other salmon conservation related projects to advance their skillsets in GIS and other data science, scientific communication, and potentially field-based restoration work.

Supporting Materials

Citations

Ando, A.W. and Mallory, M.L., 2012. Optimal portfolio design to reduce climate-related conservation uncertainty in the Prairie Pothole Region. *Proceedings of the National Academy of Sciences* 109:6484-6489.

Hilborn, R., Quinn, T.P., Schindler, D.E. and Rogers, D.E., 2003. Biocomplexity and fisheries sustainability. *Proceedings of the National Academy of Sciences* 100:6564-6568.

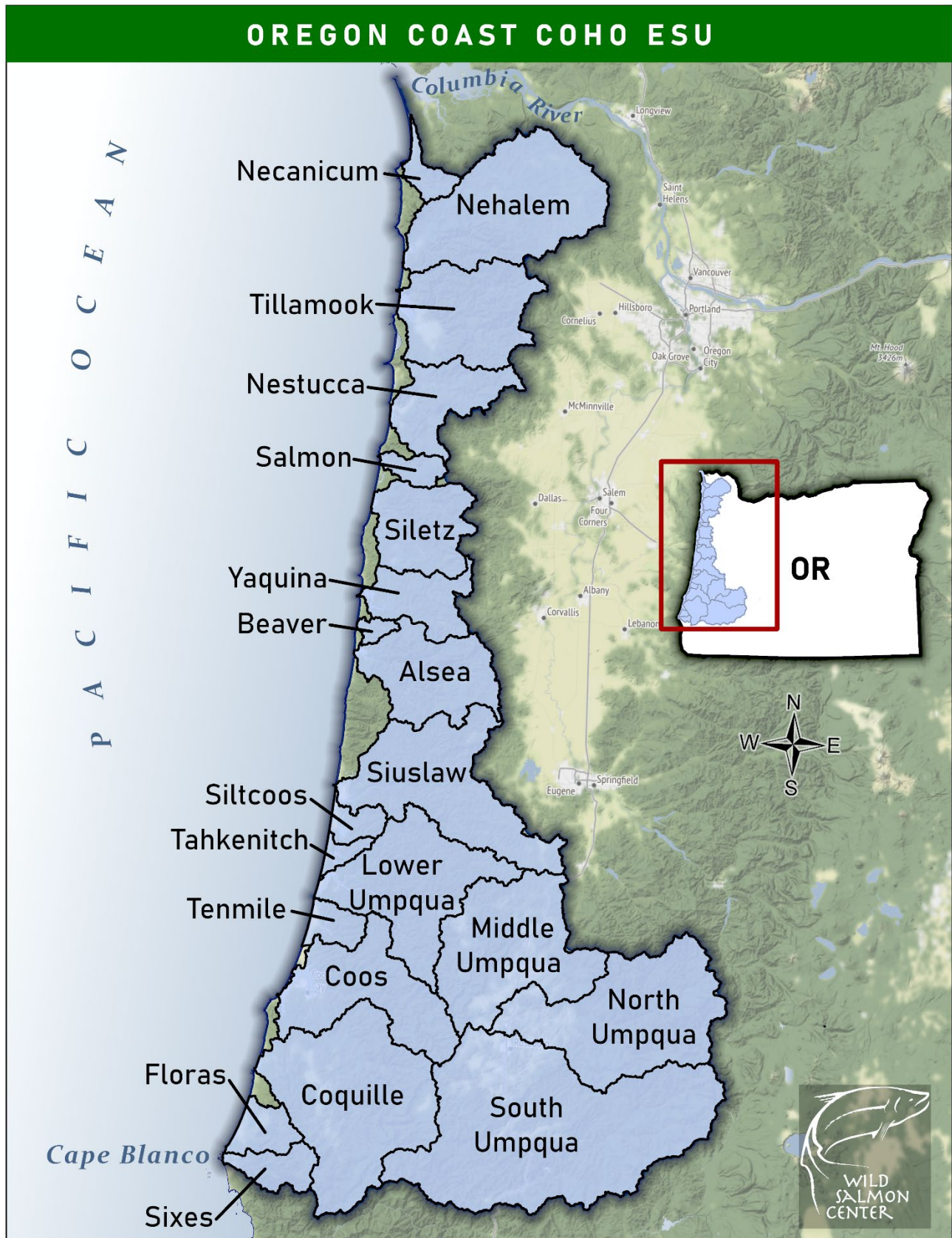
Schindler, D.E., Armstrong, J.B. and Reed, T.E., 2015. The portfolio concept in ecology and evolution. *Frontiers in Ecology and the Environment* 13:257-263.

Budget & Justification

Wild Salmon Center does not anticipate the need for project-related funding beyond the \$1,000 provided by the Bren School.

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Figure 1. Map of the Oregon Coast Coho Evolutionary Significant Unit (ESU) comprised of 21 independent populations that make up the project area. The ESU, listed by NOAA Fisheries under the Endangered Species Act in 1998, includes naturally spawned coho salmon originating from coastal rivers south of the Columbia River and north of Cape Blanco.





January 23, 2023

MESM Group Project Selection Committee
Bren School of Environmental Science and Management
2400 Bren Hall
UC Santa Barbara, California 93106

Dear Bren Group Project Committee,

We are writing to express our support for a Bren School group project titled **“Applying portfolio theory to improve spatial recovery planning for Pacific salmon”**. Wild Salmon Center (WSC) is the leading international organization working to protect wild salmon and the strongest wild salmon rivers around the North Pacific. Our science program conducts pioneering research through a networked approach, collaborating with scientists, institutions, and nonprofit partners around the Pacific Rim. We view the group project as an exciting opportunity to build upon these important long-term relationships and collaborate with Bren students on a meaningful and timely component of our work.

This project will advance our coho conservation work in the Oregon Coast (OC) Coho Salmon Evolutionary Significant Unit (ESU), a collection of 21 independent coho salmon populations listed as threatened under the Endangered Species Act. Students will expand on previous work completed by the WSC and our collaborators to better understand spatial and temporal patterns of OC coho population response diversity and how they influence ESU stability. The analyses performed in this project will help elucidate key factors in ESU recovery plans and inform conservation planning priorities within Strategic Action Plans currently being developed by the [Coast Coho Partnership](#)—a team of public and private conservation partners managed by the Wild Salmon Center. Oregon Coast coho are uniquely poised for recovery with the right strategic research and management actions. This will be an exciting opportunity for Bren students to play a role in the recovery of what would be the first wild salmon run removed from the ESA.

To advance project goals as well as provide opportunities for professional skills development and exposure to the nonprofit sector, WSC commits to host and mentor one paid intern during the summer of 2023. A stipend of \$6,000 has been earmarked in our 2023 budget and will be paid directly to the student intern for their time. Should they choose, the student will have the opportunity to work from our Portland, OR office in the Jean Vollum Natural Capital Center, a longtime center for the conservation economy in the city's lively Pearl District. Alternatively, students may choose to perform their internship duties remotely. Up to \$1,500 additional funds will be provided by WSC to cover the intern's travel related expenses to our Portland office and/or field visits to project watersheds. The intern will have the opportunity to work on an array of other projects that help advance core skill sets taught in the Bren School curriculum.

INTERNATIONAL HEADQUARTERS

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We confirm that WSC will provide all internal core data needed to complete project goals without restriction of publication. All coho abundance data, supplemental datasets, and potential models are publicly available with a non-exhaustive list provided in the data section of this proposal.

Jon Hart, our GIS Analyst and Bren alumnus, will be available to mentor group members and the intern for the duration of the project. Having first-hand experience on the student side of the process, Jon is excited to help facilitate successful outcomes and ensure a meaningful learning experience for the Bren students.

Wild Salmon Center thanks you for considering our proposal and looks forward to working with the Bren School team.

Sincerely,

Matthew Sloat

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