Returning Balance to the Puget Sound:
Identifying Opportunities for Salmon Habitat Restoration

Source: National Wildlife Federation (https://www.nwf.org/-/media/NEW-WEBSITE/Shared-Folder/Wildlife/Fish/fish_chinook-salmon_gregvandeleest-GettyImages_600x300.ashx)

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OBJECTIVES

Chinook salmon (*Oncorhynchus tshawytscha*) are fundamental to the identity of the Pacific Northwest. As important forms of sustenance to both the Southern Resident killer whales (*Orca orcinus*) and the Indigenous peoples in this region, salmon populations are a key piece of the region's identity and economy. The National Marine Fisheries Service (NMFS) within the National Oceanic and Atmospheric Administration (NOAA) manages Puget Sound Chinook (PSC) salmon and the Southern Resident killer whale population (SRKW), both listed under the Endangered Species Act. NMFS now seeks to expand their understanding of PSC salmon habitat to inform restoration priorities when augmented with factors such as tribal importance, urbanization (i.e. run-off, development, agriculture), and economic feasibility (i.e. cost-benefit of restoration). The objective of this project is to answer the research question: *What areas of PSC salmon habitat should be prioritized for restoration efforts in the future based on ecological and economic factors?* Key objectives include:
1. Understand historical/social/ecological context of salmon management and recovery
    a. Perform a scientific literature review on the main threats to PSC salmon populations
    b. Assess the current state of restoration efforts in PSC salmon habitat across Puget Sound
2. Analyze the cost of restoration in areas of PSC salmon habitat that are identified as having potential for restoration
    a. Complete a cost-benefit analysis of different PSC salmon habitats using a Habitat Equivalency Assessment to understand economic feasibility of restoration
3. Create a spatial model to inform where NMFS should prioritize restoration efforts
    a. Use geographic information systems (GIS) modeling to understand how PSC salmon habitats overlap with their stressors and identify regions with the greatest potential for restoration through incorporation of ecological and economic factors
    b. Create a spatial model that will predict areas where restoration efforts will have the highest success ecologically while also minimizing costs

SIGNIFICANCE

PSC salmon are a threatened keystone species and essential for the survival of the SRKW population. In 2005, NOAA listed SRKW as endangered under the Endangered Species Act, and is currently a high recovery priority species (NMFS, 2022). Since 2008, the SRKW population has declined by 10 percent, with only 73 individuals as of 2021 (NMFS, 2021). NOAA and the Washington State Southern Resident Orca Task Force have listed improving PSC salmon as the top priority for SRKW populations (Southern Resident Orca Task Force, 2019, pg. 8) because PSC salmon make up 80% of the SRKW diet (Hanson et al., 2021). Not only are the SRKW culturally, spiritually, and economically important to the people of the Puget Sound, they are also an indicator species (EPA, 2021b). There is an urgent need to identify target areas in the Puget Sound for habitat restoration to ensure the recovery of SRKW and PSC salmon populations.

PSC salmon are critical to the community in the Pacific Northwest region. Fisheries and Indigenous peoples depend on salmon for their livelihoods. The culture of Indigenous peoples in this region is rooted in their connection to nature and more specifically, salmon (Breda, 2022). In 2018, it was reported that 473,000 adults were estimated in the Puget Sound, a reduction of 60% since 1984 (EPA, 2021a). This reduction in population abundance is threatening indigenous fishing sovereignty and has limited tribes' ability to use salmon for fundamental ceremonial and subsistence purposes (Northwest Indian Fisheries Commission Member Tribes, 2020, pg. 8).

This project will provide a novel tool to inform priorities in habitat restoration. A comprehensive spatial model and literature review will be conducted to identify where to implement restoration efforts. It will utilize data provided by NOAA and other collaborators, to identify regions where habitat restoration efforts have the greatest potential for success in addition to lowest cost. Once these sites are identified, then NOAA can properly appropriate funds for other organizations to lead the restoration effort which

may consist of activities such as culvert replacements and fish barrier removals. This approach is unique in that it will incorporate an economic perspective of which areas are best to target for restoration in addition to ecological needs. The recovering salmon population will restore the cultural livelihood to the land, support SRKW populations, and allow for tribal fishing rights to be honored. NOAA will use the deliverables below to inform their regulatory process and guide financial, labor, and time resources for habitat restoration.

BACKGROUND

In 1999, NMFS listed PSC salmon as threatened (NMFS, 2017, pg. 3). Their populations had fallen to critically low levels due to reduced habitat, pollution, and overfishing. In the most recent 5-year review released in 2017, it was noted that most populations of PSC salmon experienced abundance declines that have continued for the past 7 to 10 years (NMFS, 2017, pg. 19). Additionally, most populations were consistently below the spawner-recruit levels that indicate recovery (NMFS, 2017, pg 66). The review recommended that restoration efforts should be targeted in a way that helps populations in different areas of Puget Sound recover in order to maintain biodiversity (NMFS, 2017, pg. 14). The main threats listed included poor water quality, disruption of nearshore, instream and floodplain habitat and fish passage (NMFS, 2017, pg. 22-23). As a part of the listing, NMFS designated critical habitat for PSC salmon in 2005 that encompasses areas that contain physical or biological features essential to conservation (NMFS, 2017, pg. 4-5; Figure 1, see appendix). This critical habitat can be used as a starting point for restoration efforts, but it is important to consider which specific areas will be both most cost-effective and helpful in recovery of PSC salmon. In order to support SRKW and the health of Puget Sound, recovery of PSC salmon must be a top priority. To improve the health of PSC salmon, habitat with high potential for restoration success needs to be identified to allocate resources accordingly.

EQUITY

NMFS recognizes there are disadvantaged and underserved communities adversely affected by persistent poverty and inequality who bear a disproportionate share of environmental burdens. They are striving to implement equitable programs and policies as part of their core work by including several Executive Order directives for equity and environmental justice. We are currently working on establishing a relationship with an Indigenous group in Puget Sound. Recently, NOAA funded several Tribal Fish Passage Restoration projects in Washington that align with the goals of this project. We are planning on reaching out to these tribes to see if they would be interested in a partnership if this proposal is selected.

AVAILABLE DATA

This project will make use of private NOAA data as well as the following publicly available data:
- Salmon Habitat Status and Trend Monitoring Program Data: Habitat data sets for habitat status and trend monitoring
- Salmon Spawner Abundance Data: Tabular data containing spawning abundance, age structure of wild spawners, fraction of natural spawners that are of wild origin, and the reduction in spawning abundance due to harvest for ESA-listed salmonids
- Salmonid Abundance Summary: Population abundance for salmonid in WA (1949-2015)
- Salmon Population Summary: Models the impact of climate change on salmon life history stages (i.e. juvenile survival prespawn mortality, whole life cycle population viability, etc.)
- Estuarine chinook capacity: GIS dataset that estimates changes in juvenile Chinook rearing area and carrying capacity in estuarine and freshwater habitats of the Puget Sound region
- Abundance Status and Trends Analysis: Washington Department of Fish and Wildlife has population abundance for PSC salmon
- Oregon State's GIS data: fish habitat distribution and pacific northwest marine shoreline

- [Pacific Northwest Salmon Habitat Project Database](): Assesses the success of various methods of salmon restoration in the Pacific Northwest by monitoring changes to population abundance after restoration efforts are in effect
- Online habitat recovery tools to assess the current state of restoration efforts: [here](), [here]() and [here]()
- [Population Density](): Washington Office of Financial Management data to assess the impact of urbanization
- [Water Quality](): Washington Department of Ecology's data on tribal lands of Washington
- [Tribal Lands](): Washington Department of Ecology's data on water quality of Puget Sound
- [Projecting SRKW Population](): Package that includes data relating to SRKW populations trends
- [Killer Whale Prey](): Models showing the impact of Chinook predators

POSSIBLE APPROACHES

1. Conduct a literature review on the state of restoration efforts already made for PSC salmon and the benefit to various stakeholder groups (e.g. fisheries, advocates for SRKW, and Indigenous peoples)
2. Complete a cost-benefit analysis of different PSC salmon habitats in need of restoration using a [Habitat Equivalency Assessment]() to understand economic feasibility of restoration
3. Create a map of the Puget Sound's Chinook salmon habitat compiling NOAA data, urban area/population density data, and other publicly available data to determine the best regions for resource allocation
4. Create a spatial model that highlights regions of highest priority for restoration when considering ecological and economic factors
5. We are looking for the opportunity to connect with Indigenous groups to include the cultural and historical importance of salmon when determining which areas should be prioritized for recovery

DELIVERABLES

- A spatial model that considers priority habitat, stressors to PSC salmon (pollution, urbanization etc.), and cost of restoration in order to map hot spots where restoration should be focused.
- Set of recommendations to NMFS that states which regions of PSC salmon habitat should be prioritized in order to optimize the positive benefits to PSC salmon and reduce costs. This will help NOAA in planning and fund appropriation for future restoration projects by highlighting areas of highest impact.
- A report that includes the recommendations for prioritization of restoration projects along with a map to show the location of these sites in relation to PSC salmon stressors. This report will also contain the greater context of PSC salmon in Puget Sound, including their importance for SKRW recovery and Indigenous communities.

INTERNSHIP

NOAA can support interns via the NOAA Pathways Internship program, which students apply for separately on usajobs.gov. We have advocates in NOAA who are actively looking for interns to work on this type of project this summer.

BUDGET AND JUSTIFICATION

This project should not need funding beyond the given $1,300 from the Bren School.

ACKNOWLEDGEMENTS

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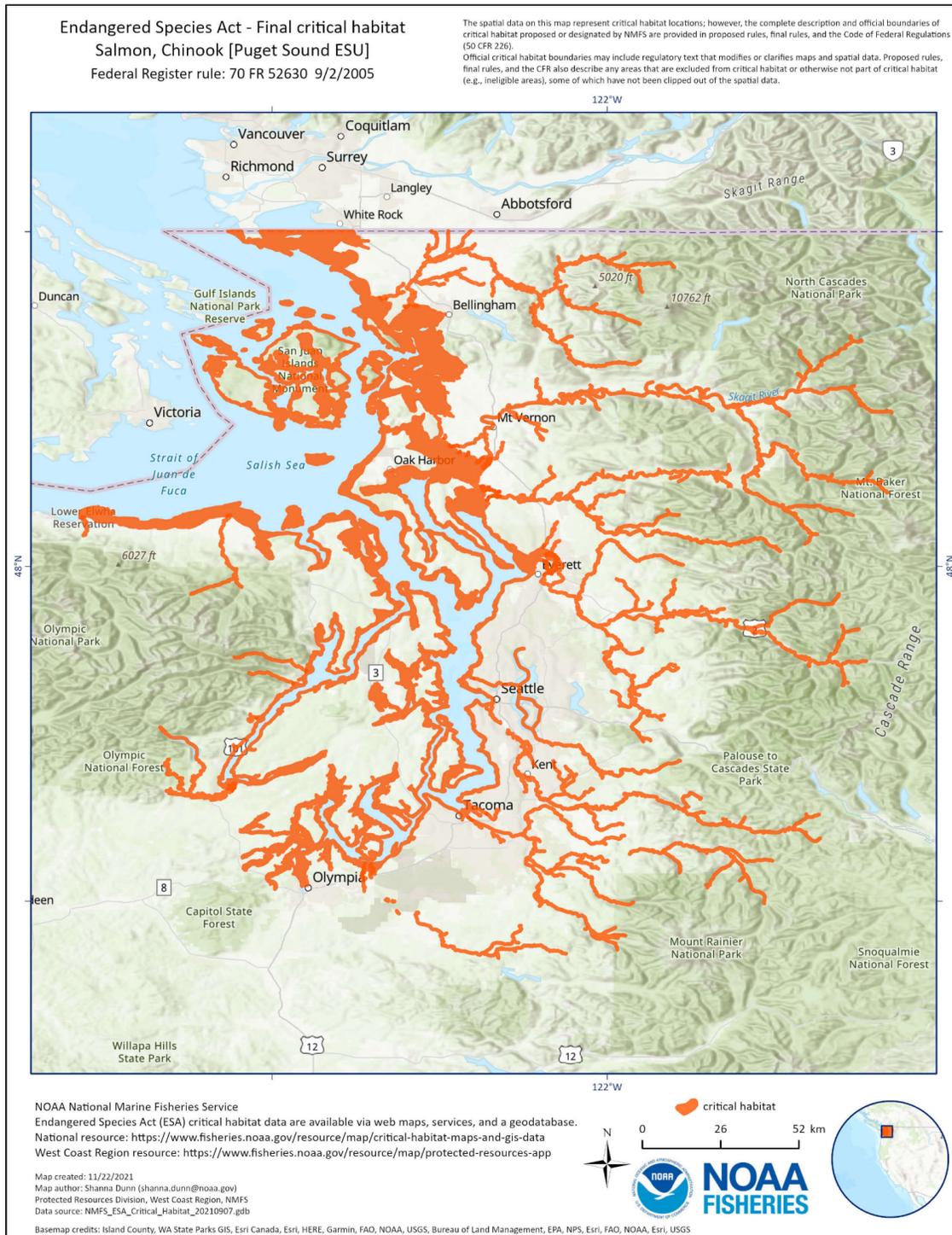
Figure 1. Map of the critical habitat of the Puget Sound Chinook Salmon. Credit: NOAA

January 24, 2023

Group Project Committee
Bren School of Environmental Science & Management
2400 Bren Hall
University of California
Santa Barbara, CA 93106

Re: Group Project Proposal – *Returning Balance to the Puget Sound: Identifying Opportunities for Salmon Habitat Restoration*

Dear Group Project Committee,

We are writing to express NOAA National Marine Fisheries Service's support for and commitment to the Group Project Proposal: Returning Balance to the Puget Sound: Identifying Opportunities for Salmon Habitat Restoration.

This project aims to identify priority regions of critical Puget Sound Chinook salmon habitat where NOAA can focus on restoring and preserving habitat for the survival of the Chinook salmon and therefore the survival of the Southern Resident killer whale (SRKW) population. The project's analytical approach will integrate spatial data from salmon stock populations, SRKW migration patterns, salmon habitat status, aerial surveys, and economic models of restoration cost to define areas where habitat restoration for Chinook salmon will meet multiple objectives and be cost effective. NOAA Fisheries will be end-users of this information to better prioritize areas for future or current restoration projects. NOAA officials will provide guidance and advice to the students as they create a work plan, budget, outcomes/deliverables, and provide support through regular communication and facilitation.

Internships: NOAA has a strong track record of managing and mentoring students and interns. At this time, NOAA can not commit to providing internships to one or more of the students working on the group project, but we are hoping one of the students will be approved for a paid Pathways Program internship to work on the project, and Bren students have been competitive and successful in the past for Pathways internships.

Funding: As the project is focused on processing existing datasets, we do not anticipate the need for funding beyond the costs for NOAA staff time to engage with the project team, which we will contribute as in-kind funding.

Data: The project plans to use publicly available data, as outlined in the proposal. Although the datasets and data products are public, in several cases they are not readily discoverable and instead held by agencies, such as the Washington Department of Fish and Wildlife. We do not anticipate any hurdles to use of the data, but we plan to help Bren students navigate data acquisition.

The proposed project will result in detailed maps identifying key areas where Chinook salmon habitat restoration will help yield stable/increasing salmon stock(s) and address other objectives. The products will be immediately relevant to current regulatory processes underway and guide financial, labor, and time resources to habitat restoration. We are excited to work with Bren School students and offer them valuable science-based management experience during this stage of their career path. As the next leaders in the environmental management field, they soon will be working for the organizations eager to receive these project results. We urge the Bren School to support this timely and important project.

Sincerely,

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