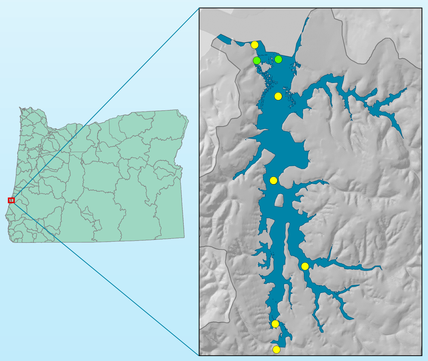
Ostrea lurida: Exploration of Optimal Habitat in Coos Bay's South Slough Estuary Under Various Sea Level Rise Projections



INTRODUCTION: The Olympia Oyster, *Ostrea Lurida*, is native to the Pacific coast of North America. Once common in estuaries from Alaska to Mexico, the species was almost wiped out due to over-harvesting and habitat degradation caused by humans. Identifying potential restoration habitat is critical for the survival of the species, especially in a changing environment. Investigating the impacts of sea level rise on potential habitat is crucial for making informed restoration decisions.

METHODS: A site suitability analysis was performed using the Multi-Criteria Evaluation (MCE) method to identify optimal Olympia Oyster habitat in the South Slough estuary of Coos Bay, OR. Five water quality variables that have each been correlated to high abundance of the species (Wasson 2009) were used: temperature, salinity, pH, fluorescence, and nitrate concentration. Changes in optimal habitat were investigated under two scenarios of sea level rise: the 50% likelihood scenarios for the years 2050 (0.48m) and 2100 (1.4m). The correlation between each variable and the downstream flow length from where they were measured was found using a linear regression model. The linear regression equation was used to convert the raster of downstream flow length to raster datasets for each of the 5 variables. These variable rasters were then reclassified into 4 discrete classes. The optimal range of values (Wasson 2009) were given a rank class of 4. Successively less suitable ranges were classified into rank classes of 3, 2, and 1. A weighted overlay of the 5 variables was performed to identify regions of optimal habitat (score of 4) in the South Slough. A bathymetric dataset of the South Slough was converted into predicted depth values for 2050 and 2100 (NOAA). The weighted overlay results were clipped to optimal habitat depth of 4 meters under the current sea level (CSL), and the 2050 and 2100 projected sea levels. A comparison of the three weighted overlays can be found in Table 2.

RESULTS/DISCUSSION: The results of the weighted overlay analysis show a strong gradient of habitat suitability, with optimal habitat lying close to the mouth of the South Slough and the least preferable habitat at the South Slough's various headwaters. This is intuitive, as suitability for all variables was inversely correlated to distance from the mouth of the slough with the exception of temperature, which was directly correlated.

Overall available habitat increased by 47% and 51% under the 2050 and 2100 sea level rise scenarios, respectively. However, optimal habitat only increased by 26% and 29%, while the least suitable habitat increased by 150% and 170% under 2050 and 2100 conditions, respectively. Overall optimal habitat shrunk from 56% of the study site to 47% under both sea level rise scenarios. These results indicate a decrease in quality of available habitat as sea level rises over the 21st century.

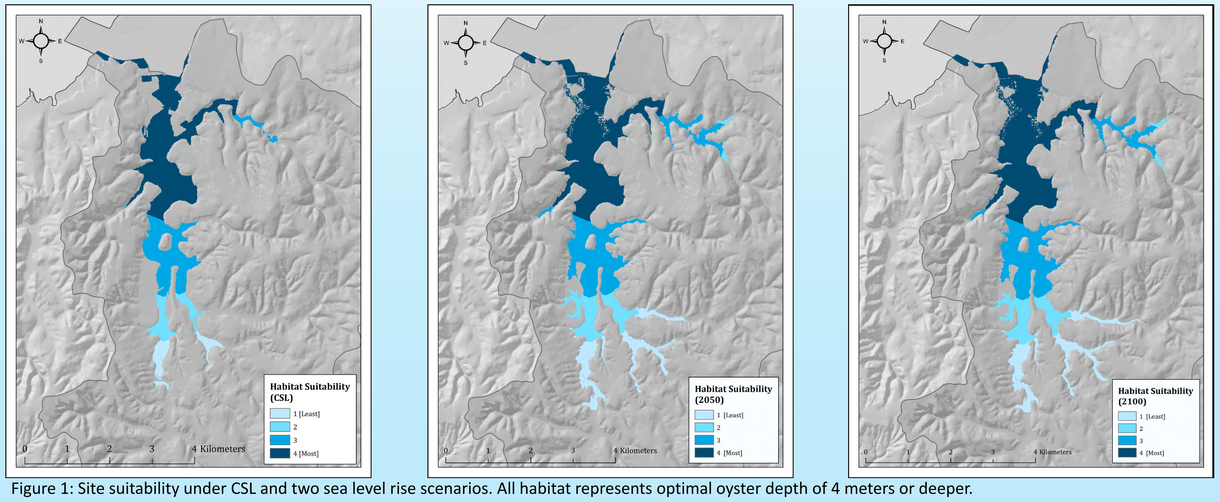


Figure 1: Site suitability under CSL and two sea level rise scenarios. All habitat represents optimal oyster depth of 4 meters or deeper.

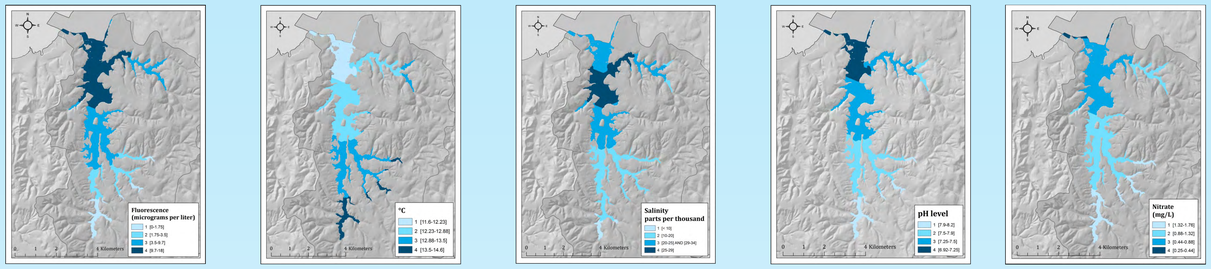
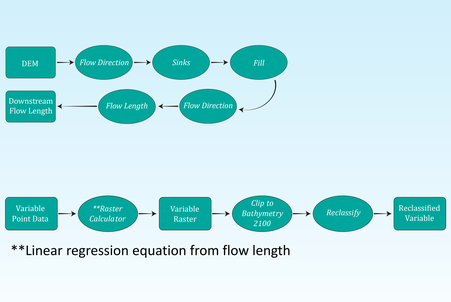
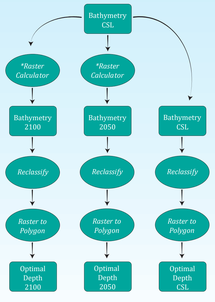
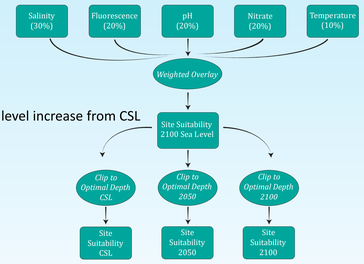


Figure 2: Reclassified variable rasters



**Linear regression equation from flow length





*Subtracted sea level increase from CSL

	Salinity	pH	Fluor.	Temp.	Nitrate
R Squared	0.92	0.86	0.94	0.71	0.88
p-value	0.03	0.07	0.03	0.15	0.06

Table 1: R Squared and p-values for linear regression analysis.

Suitability	CSL Area (m^2)	% of Total Area	2050 Area (m^2)	% of Total Area	Increase, CSL to 2050	2100 Area (m^2)	% of Total Area	Increase, CSL to 2100
1	364900	7.48%	913900	12.74%	150.45%	984500	13.34%	169.80%
2	444800	9.11%	855100	11.92%	92.24%	878100	11.90%	97.41%
3	1337700	27.41%	1962400	27.35%	46.70%	1990800	26.98%	48.82%
4	2732900	56.00%	3444300	48.00%	26.03%	3524200	47.77%	28.95%
Total	4880300	100.00%	7175700	100.00%	47.03%	7377600	100.00%	51.17%

Table 2: Comparison of total and relative land cover of four suitability types.

CONCLUSIONS: Based on our weighted overlay results, the South Slough of Coos Bay represents an ideal spot for Olympia Oyster restoration efforts. However, impending sea level rise will likely degrade the proportion of optimal habitat. The results of our model suggest that current water quality and nutrient levels near the mouth of the study site and the adjacent upstream basin are adequate for the reintroduction of the native oyster. This is further supported by the reported presence of Olympia Oysters at two locations at the mouth of the slough. This leads us to conclude that water quality and nutrient values are not what is restricting the distribution of Olympia Oysters in our study site. A glance at the substrate data for the slough suggests that improper hard substrate for the attachment of oysters is preventing them from establishing themselves. This assumption was supported by input from Jenni Schmitt, the Watershed Monitoring Coordinator for the South Slough. Therefore, we recommend establishing hard concrete substrates into the optimal habitat identified by our study to aid in the growth of oyster reefs.

LIMITATIONS: One limitation of this study is the use of current variable values when projecting future suitable habitat. The study model does not take into account changes in salinity, temperature, pH, etc., due to climate change. The use of only 6 spatial data points limited the strength of the linear regression analysis. Lastly, we used average annual values for our model parameters. Seasonal fluctuations in these parameters likely affect the survival of native oysters in the South Slough.

VALIDITY: Optimal water quality and nutrient ranges were taken from Wasson's study, which correlated the abundance of *Ostrea lurida* to the 5 parameters used in this study. Variable weights in the weighted overlay were adjusted so that optimal habitat in the model output matched the known location of *Ostrea lurida* in Coos Bay.

REFERENCES:

Wasson, Kerstin. 2009. *Informing Olympia Oyster Restoration: Evaluation of Factors That Limit Populations in a California Estuary.* Wetlands (2010) 30:449-459

Mamat, Norhanini, *et al.* 2014. *GIS-Based Multi-Criteria Decision Making System for Determining Potential Site of Oyster Aquaculture in Terengganu.* IEEE CSPA 7-9.

Scott Groth & Steve Rumrill. 2009. *History of Olympia Oysters in Oregon Estuaries, and a Description of Recovering Populations in Coos Bay.* Journal of Shellfish Research, 28(1): 51-58

South Slough National Estuarine Research Reserve

Datasets

JALBTCX, NOAA, Oregon Coastal Management Program, Oregon Spatial Data Library, NERRS

Andrew Brown, Andrew Daws, Chelsey Buffington