Estimating the Distribution of Harvested Estuarine Bivalves with Natural History-based Habitat Suitability Models

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The Problem & Our Approach

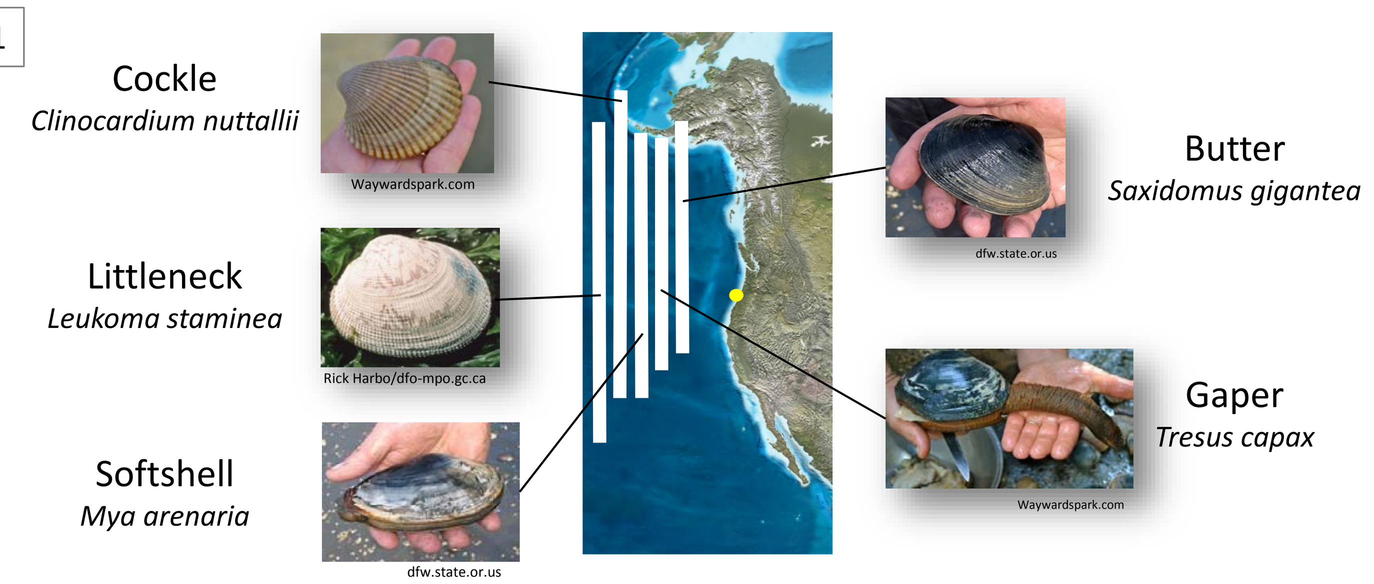
- Coastal communities depend on harvesting clams for food, commerce, jobs, recreation, and tourism
- Stakeholders and resource managers need to forecast how environmental change could affect clam stocks
- But, measuring the abundance and distribution of harvested species of clams is expensive
- Habitat suitability models and maps are useful for identifying where clam stocks occur, their proximity to sources of stress, and assessing how environmental change could affect clam stocks
- Therefore, we set out to develop a low-cost method to estimate the distribution of bivalves using existing information on their sensitivity to habitat variables, the spatial distribution of those variables within estuaries, and a transferable, GIS-based, habitat-suitability mapping algorithm
- We demonstrate this approach for five species of harvested bivalves in Yaquina Bay, Oregon (USA), and apply the approach to estimate the effects of climate change on bivalve habitats

Methodology

- A literature review determined the sensitivity of juveniles and adults of five harvested bivalve species, common to many Pacific NW estuaries (Figure 1)

Bay Clams of Oregon

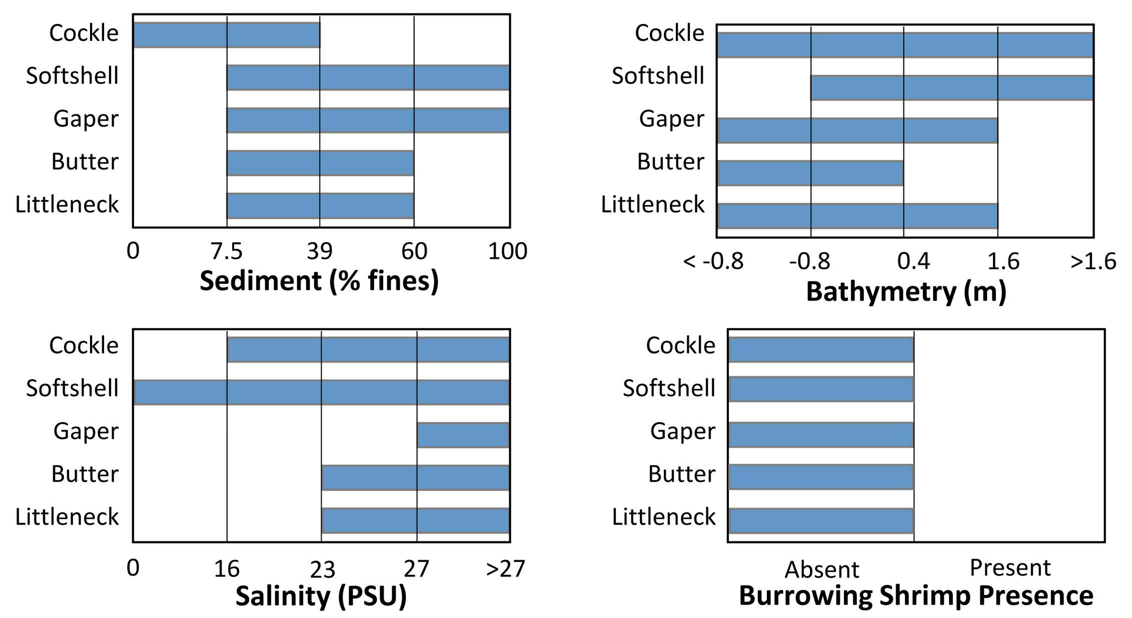
Figure 1



- For each species, we determined binary tolerance limits for each habitat variable based on the values at which lethality or absence was documented (Figure 2)

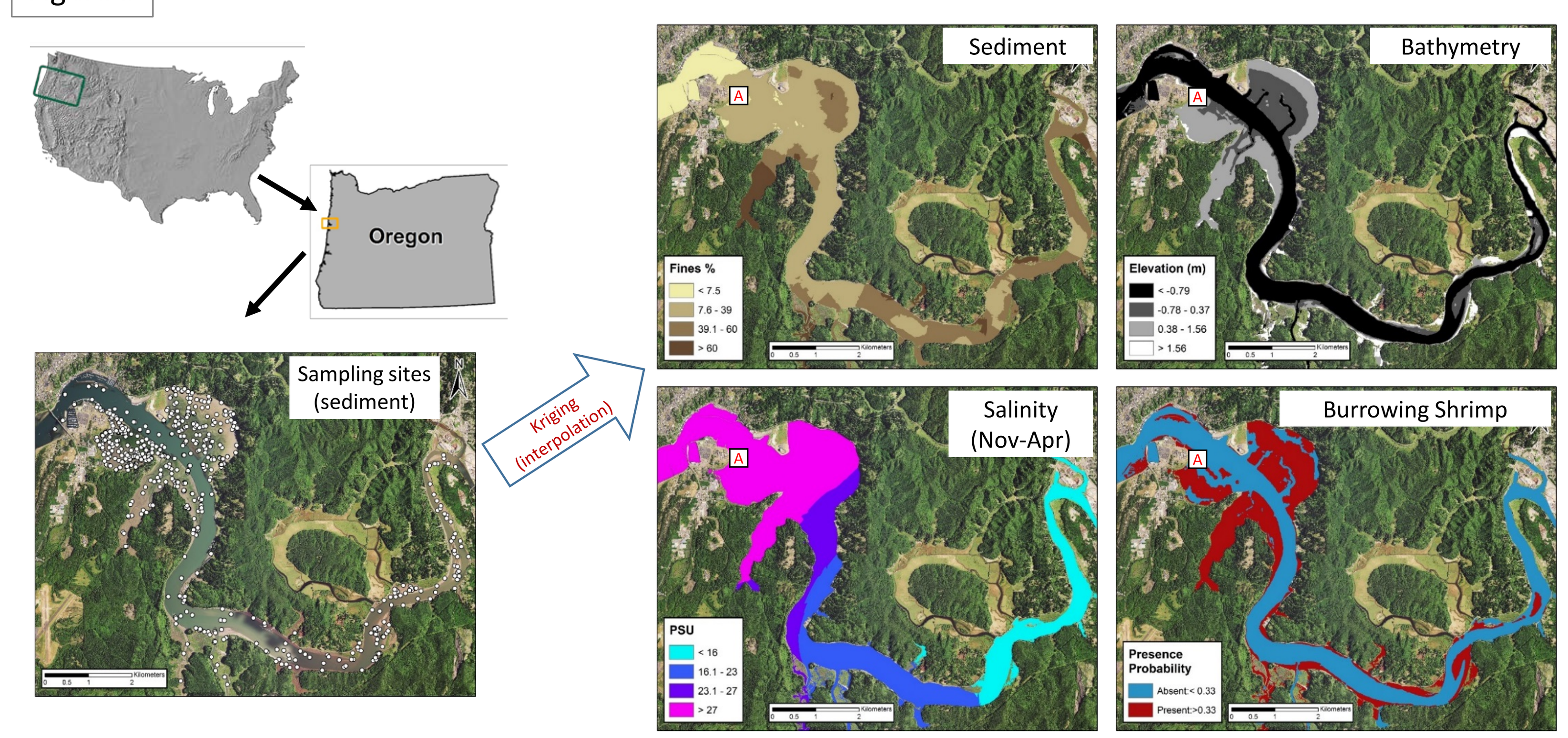
Figure 2

Species-specific Tolerance Ranges to Habitat Variables



- For each habitat variable, we obtained existing data and their spatial coordinates, and interpolated the distribution of the variables across Yaquina Bay (Oregon, USA) estuary (Figure 3)

Figure 3



Methodology (cont'd)

- For each bivalve species, **the suitability of a habitat variable at any location was scored as "1" if its value fell within the tolerance range for the clam, or "0" if outside the range**
- For that species, the net habitat suitability score (0-4) for that location was determined as the sum of the suitability values for all habitat variables (Table 1; example for 2 species at site A on Figure 3)

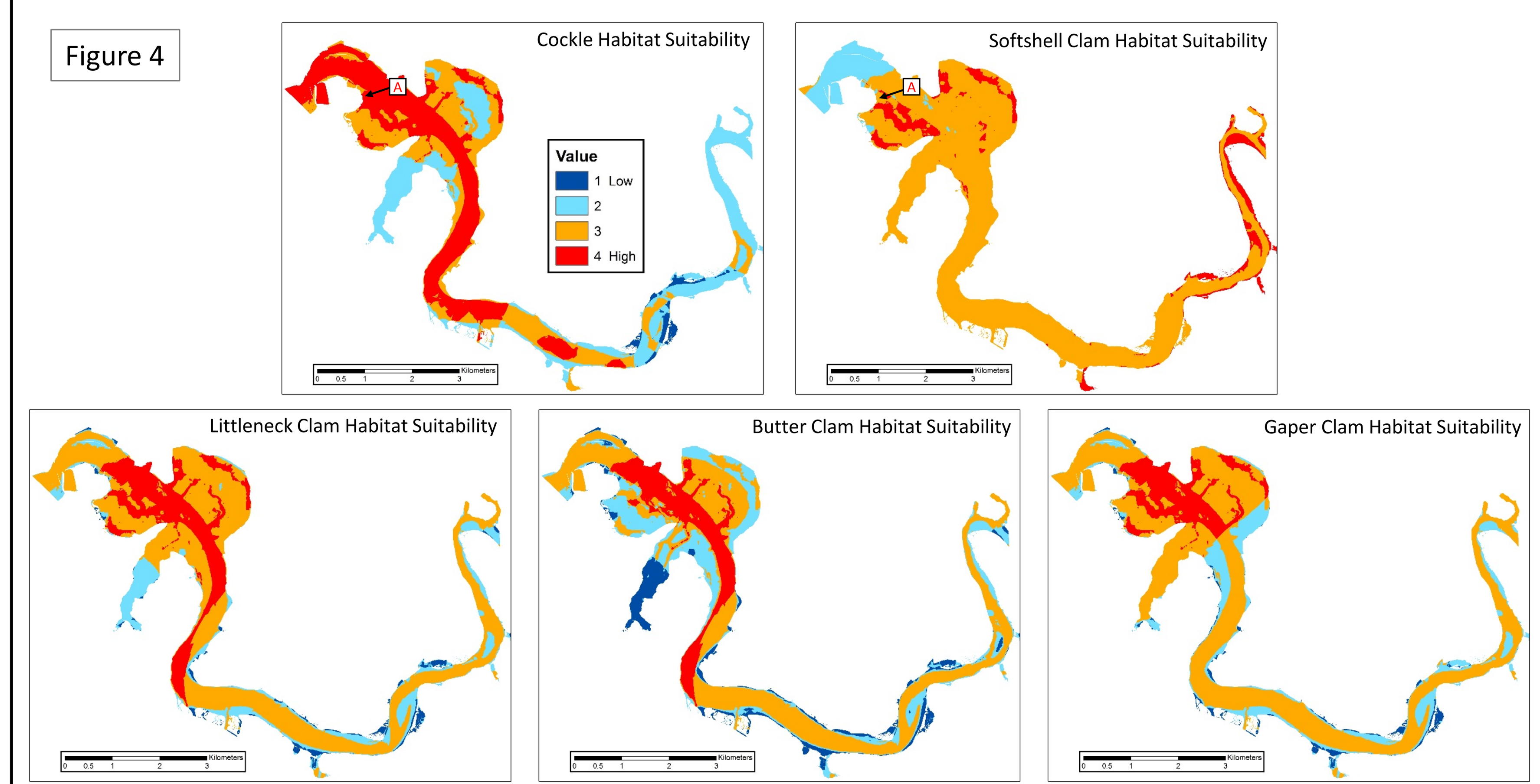
Table 1

	Sediment (% fines)	Bathymetry (m, MLLW)	Salinity (PSU)	Shrimp Presence	Net H.S. Score	Habitat Quality Class
Site A (see Figure 3)	5.36	0.6	28.6	Absent		
Cockle Tolerance	< 39	All	> 16	Absent		
Cockle Habitat Suitability Score	1	1	1	1	4	Highest
Softshell Clam Tolerance	> 7.5	> -0.8	All	Absent		
Softshell Habitat Suitability Score	0	1	1	1	3	Moderately High

Results

- That operation was repeated for all 2x2m cells within the estuary to produce a habitat suitability map for each species (Figure 4). Note the calculated habitat suitability scores for cockles and softshell clams at site A (Table 3)
- The lower reaches of Yaquina estuary contain a higher proportion of high suitability habitat (i.e., classes 3 & 4) for all five species, with the main channel containing a high proportion of the best habitat for four species

Figure 4



- Habitat suitability models were validated by comparing the probability of presence of a species (derived from independent species distribution data; net 787 samples) in each habitat suitability class (Figure 5). The most suitable habitats had the highest occurrence of clams for all five species
- Logistic regression models for each species' presence probability, using the same habitat data, resulted in the same ranking of habitat suitability and also validated our modeling approach (Figure 6 for cockles and softshell clams)

Figure 5

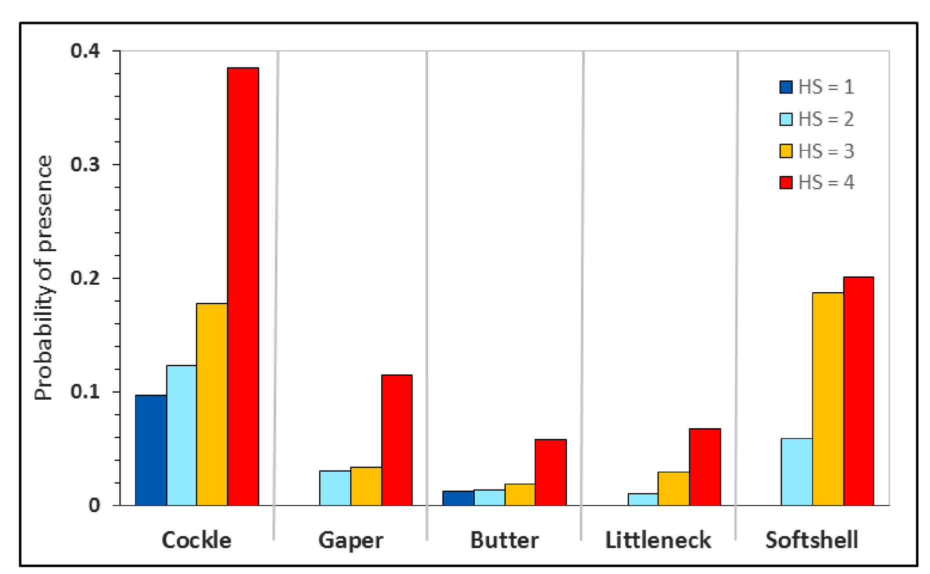
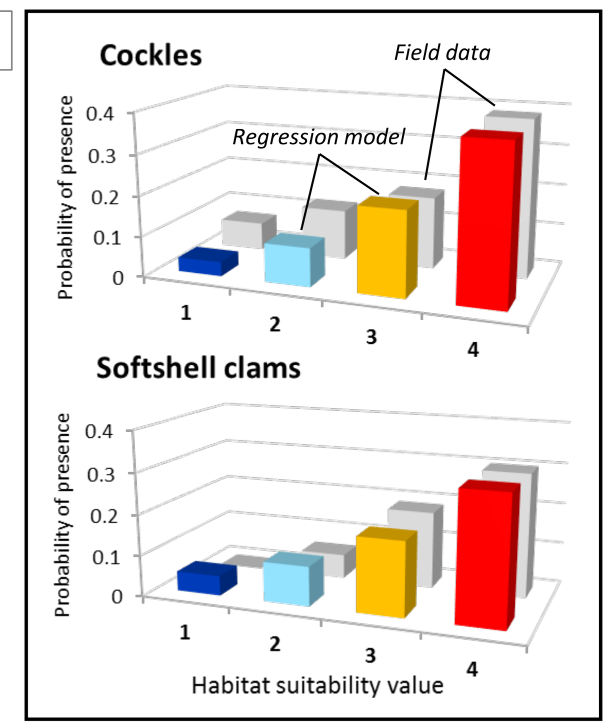


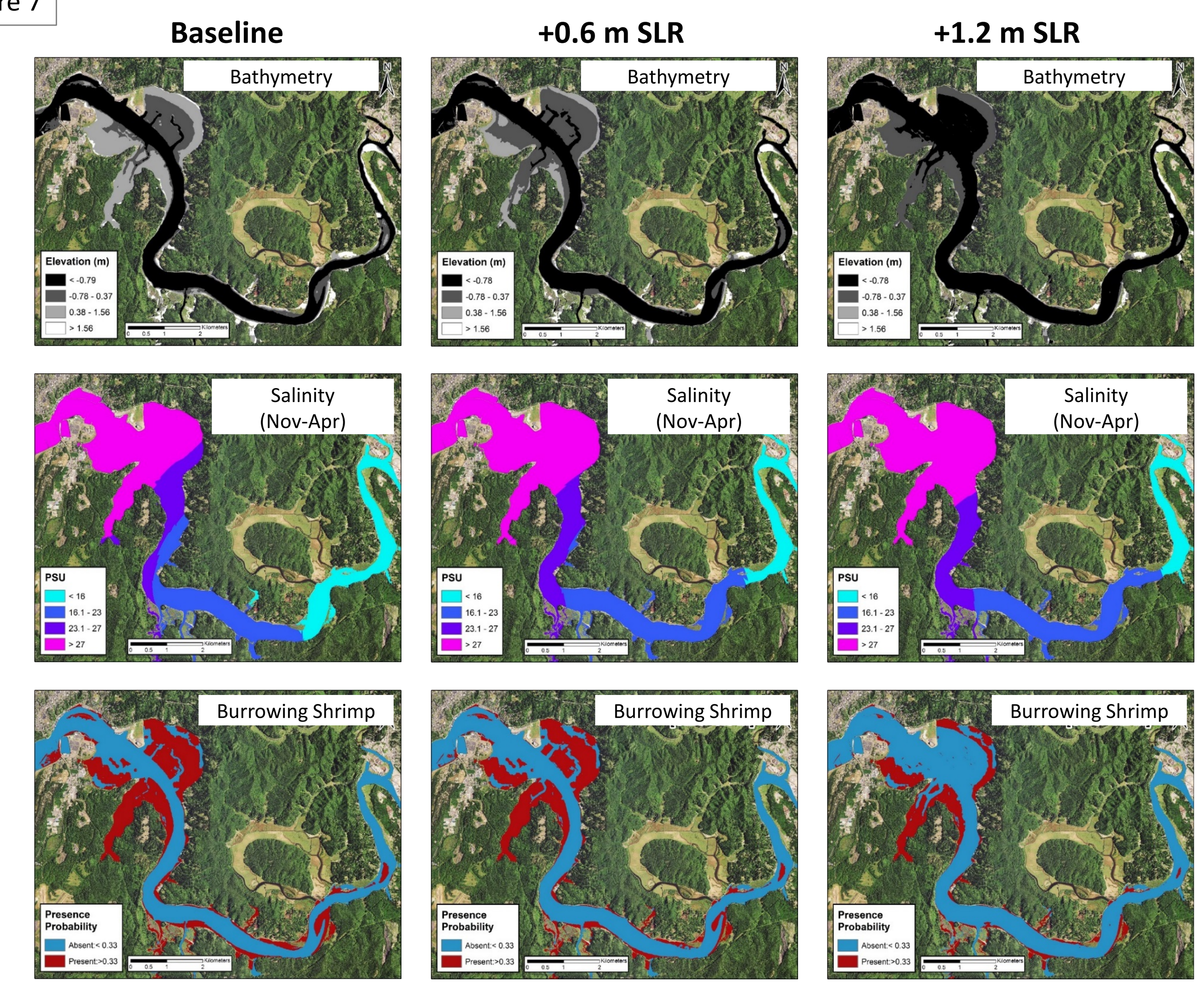
Figure 6



Projecting the Effects of Climate Change on Bivalve Habitats

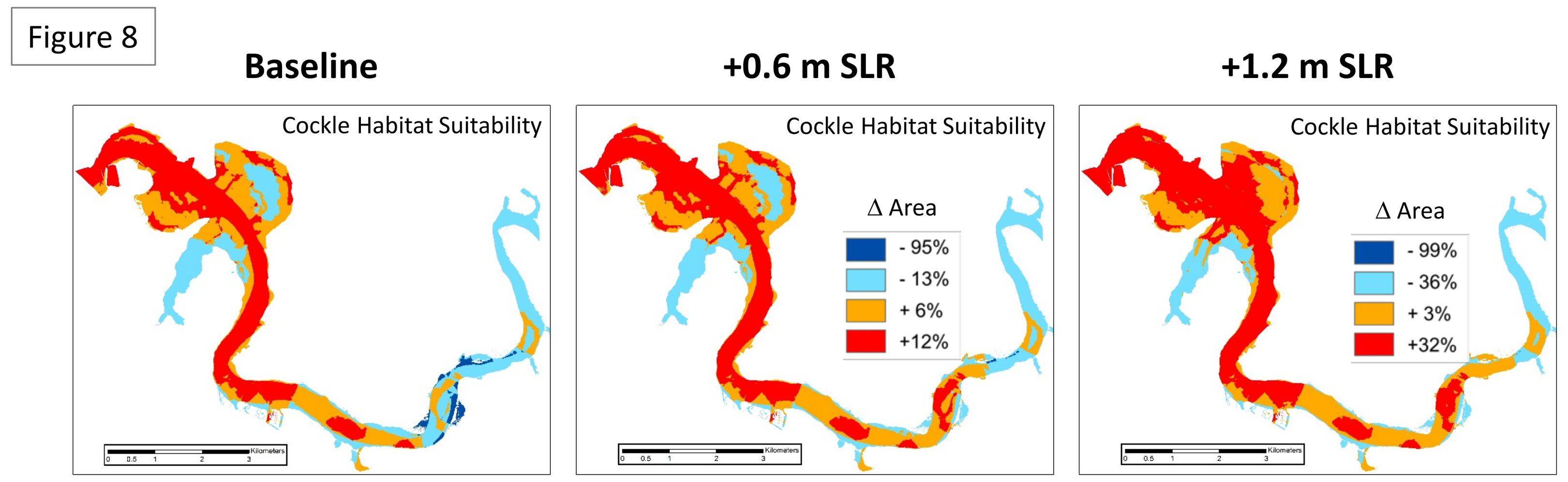
- We modeled changes to habitat variables resulting from two climate change scenarios for Yaquina Bay estuary, modeled by Brown et al. (in prep.). The scenarios included projected changes in air temperature, precipitation, and sea level rise of +0.6m or +1.2m, respectively (Figure 7)

Figure 7



- Consequently, the distribution of suitable habitats for bivalves would change (see Figure 8 for cockles)

Figure 8



- The area of the most suitable cockle habitats (i.e., classes 3 & 4) would increase, primarily in the lower estuary, while the area of the least suitable habitats (i.e., classes 1 & 2) would decrease
- Similar changes were obtained for the other four harvested bivalve species, but are not shown here

Conclusions

- Simple approach, based on published, species-specific tolerance ranges to habitat variables
- Cost & time efficient
    - Disparate, independent data sets are sufficient to parameterize and validate the models
- Robust for multiple species and estuaries
    - Approach was successfully applied to five species common to many PNW estuaries
    - Models were applied successfully in Tillamook Bay (OR) and Willapa Bay (WA); results not shown here
- Approach can be transferred to relatively data-poor systems with modest field sampling investment
- Useful to identify highly suitable habitat and how environmental change may alter the distribution of that habitat
    - Location of at-risk habitat
    - Target restoration efforts

Acknowledgements

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