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Understanding the implications of a changing environment on harvested bivalve populations using habitat suitability models

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United States
Environmental Protection
Agency

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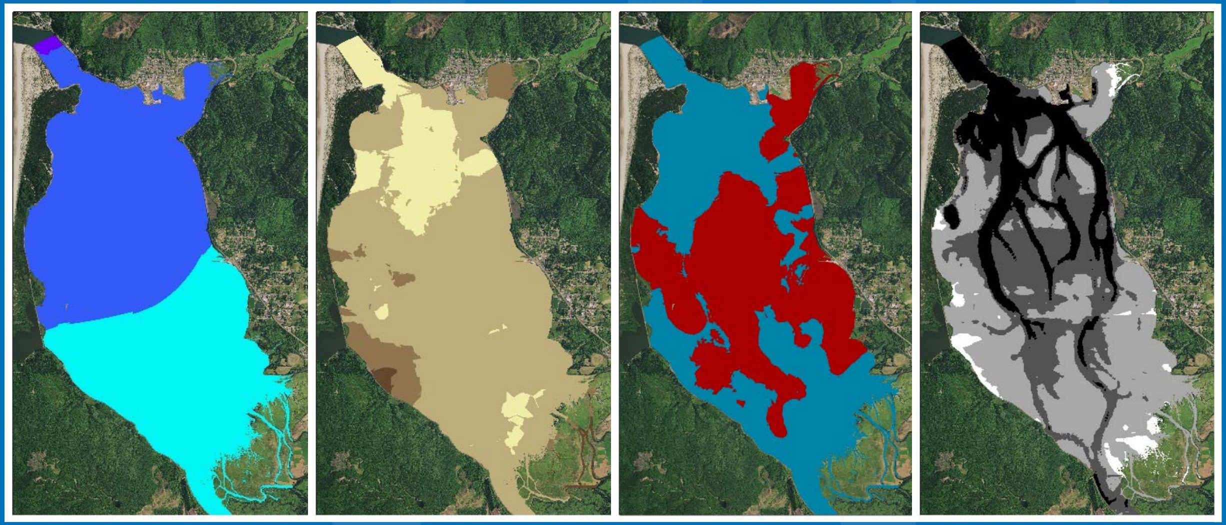
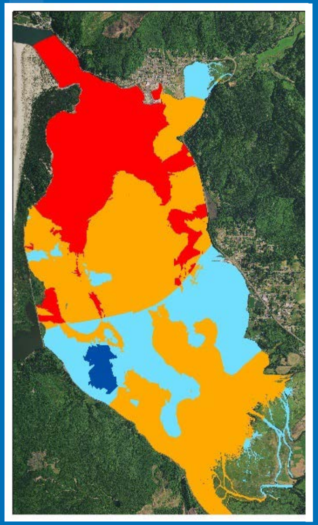
Theodore H. DeWitt, Nathaniel S. Lewis, Eric W. Fox, and Stephen R. Pacella





Pacific NW Bay Clams

Cockle

Softshell

Gaper

Butter

Littleneck

Ecosystem Goods and Services

- Important fisheries
  - Commercial
  - Recreational
- Cultural and provisioning services
  - Food production
- Coastal economies
  - Jobs, tourism, recreation
- Diet source of predators
- Bioturbation / bioirrigation

Resource Dilemma

- Communities and resource managers need to forecast how environmental change may affect bivalve populations
- Uncertainty in a changing climate
- Sampling is time intensive and costly
- Proposed solution: develop habitat suitability models to identify where clam stocks occur and how environmental changes can alter stock distributions

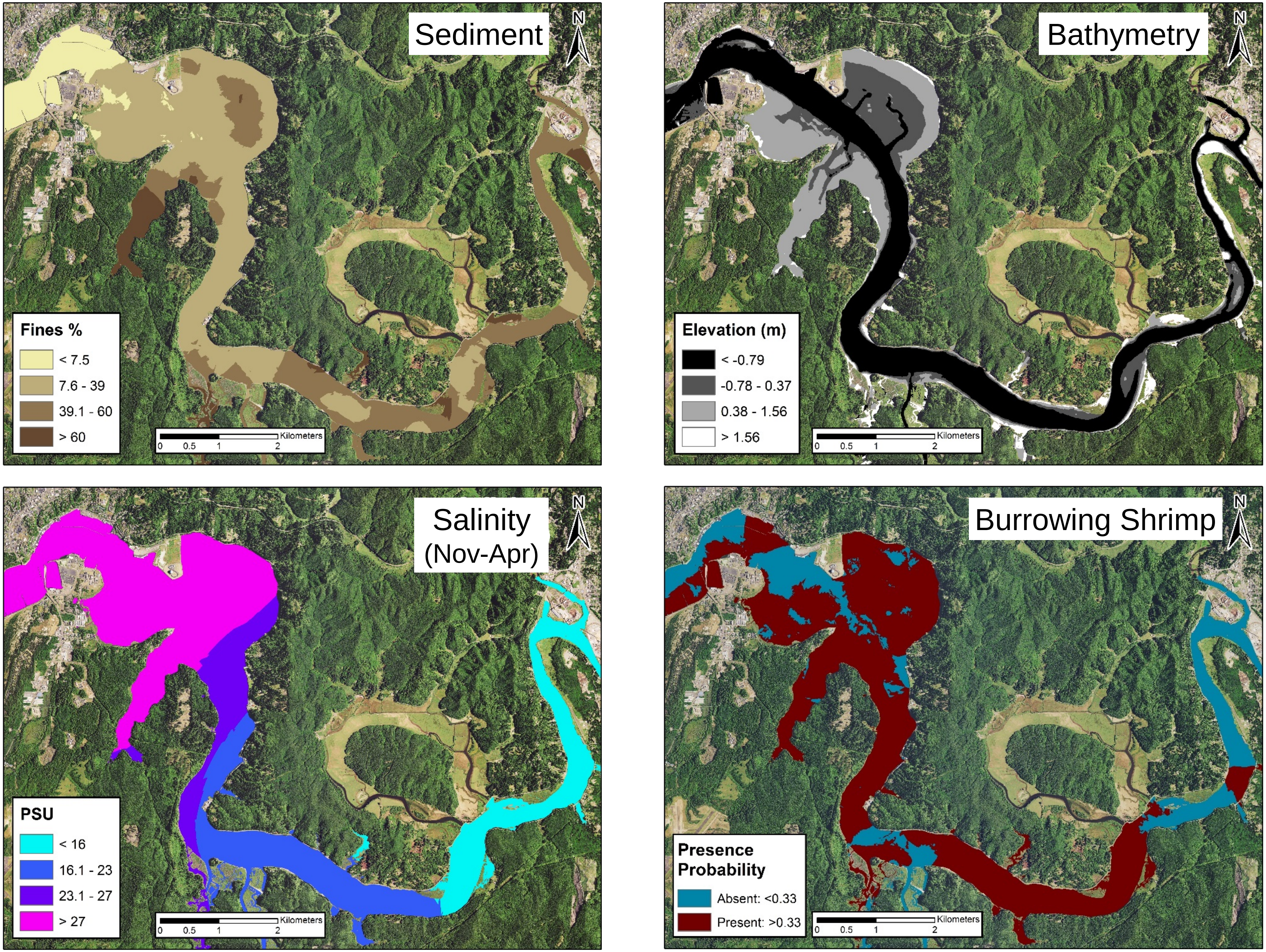
Methods Overview

1. Literature review to identify habitat predictor variables and preferential ranges

2. Gather existing habitat data

3. Format/combine data in a GIS (ArcGIS 10.2.2)

4. Interpolate data to estimate values bay-wide


Sediment
Fines %
< 7.5
7.6 - 39
39.1 - 60
> 60
Kilometers
0 0.5 1 2
Bathymetry
Elevation (m)
< -0.79
-0.78 - 0.37
0.38 - 1.56
> 1.56
Kilometers
0 0.5 1 2
Salinity (Nov-Apr)
PSU
< 16
16.1 - 23
23.1 - 27
> 27
Kilometers
0 0.5 1 2
Burrowing Shrimp
Presence Probability
Absent: <0.33
Present: >0.33
Kilometers
0 0.5 1 2

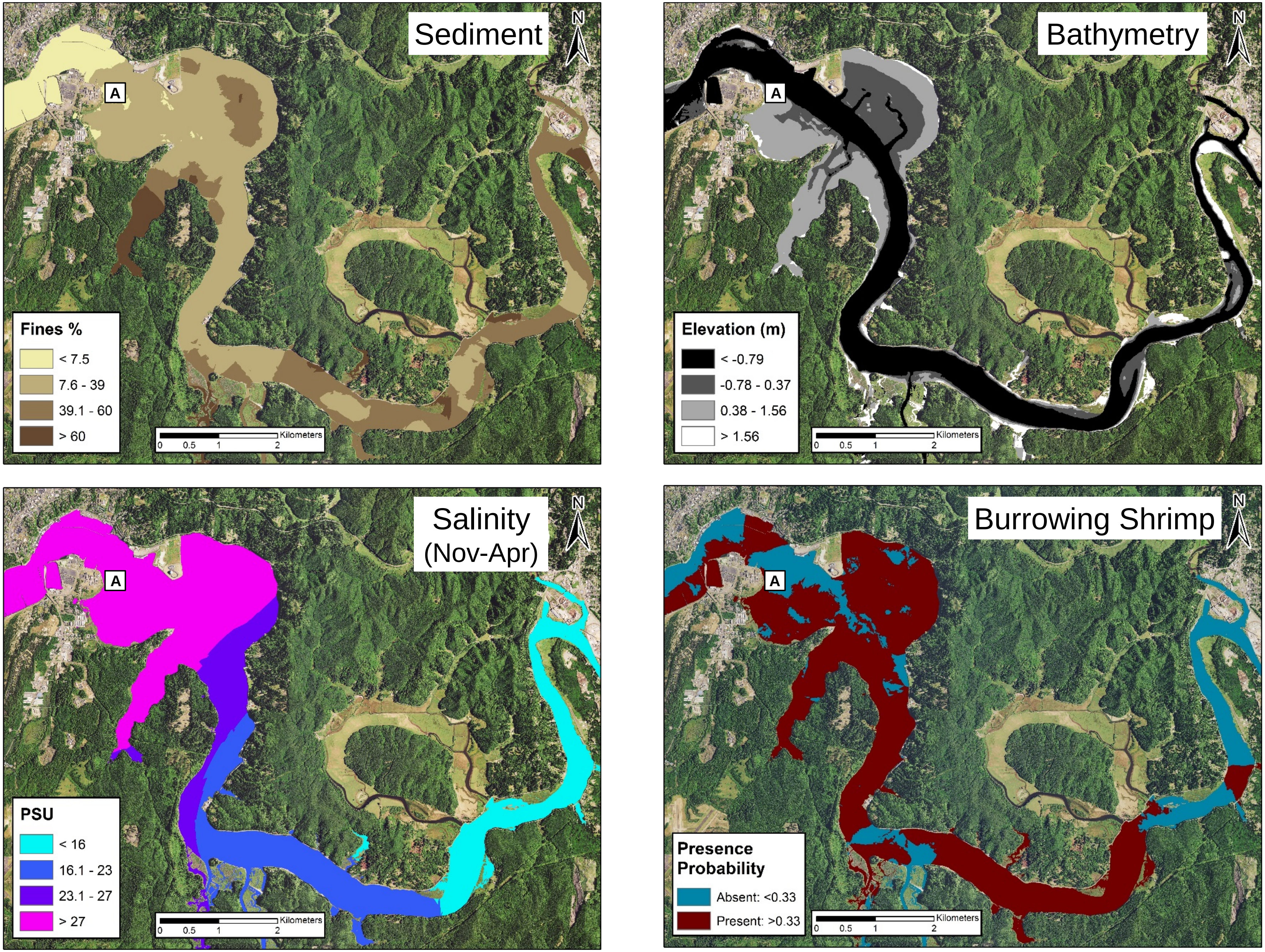
Methods Overview

5. Assign binary suitability values to each variable layer for each species

   0 = Not suitable

   1 = Suitable

6. Overlay habitat variable layers to produce estimated overall suitability value of 1-4 (low-high) for each species


Sediment
A
Fines %
< 7.5
7.6 - 39
39.1 - 60
> 60
0 0.5 1 2 Kilometers
Bathymetry
A
Elevation (m)
< -0.79
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(Nov-Apr)
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PSU
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Burrowing Shrimp
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Presence
Probability
Absent: <0.33
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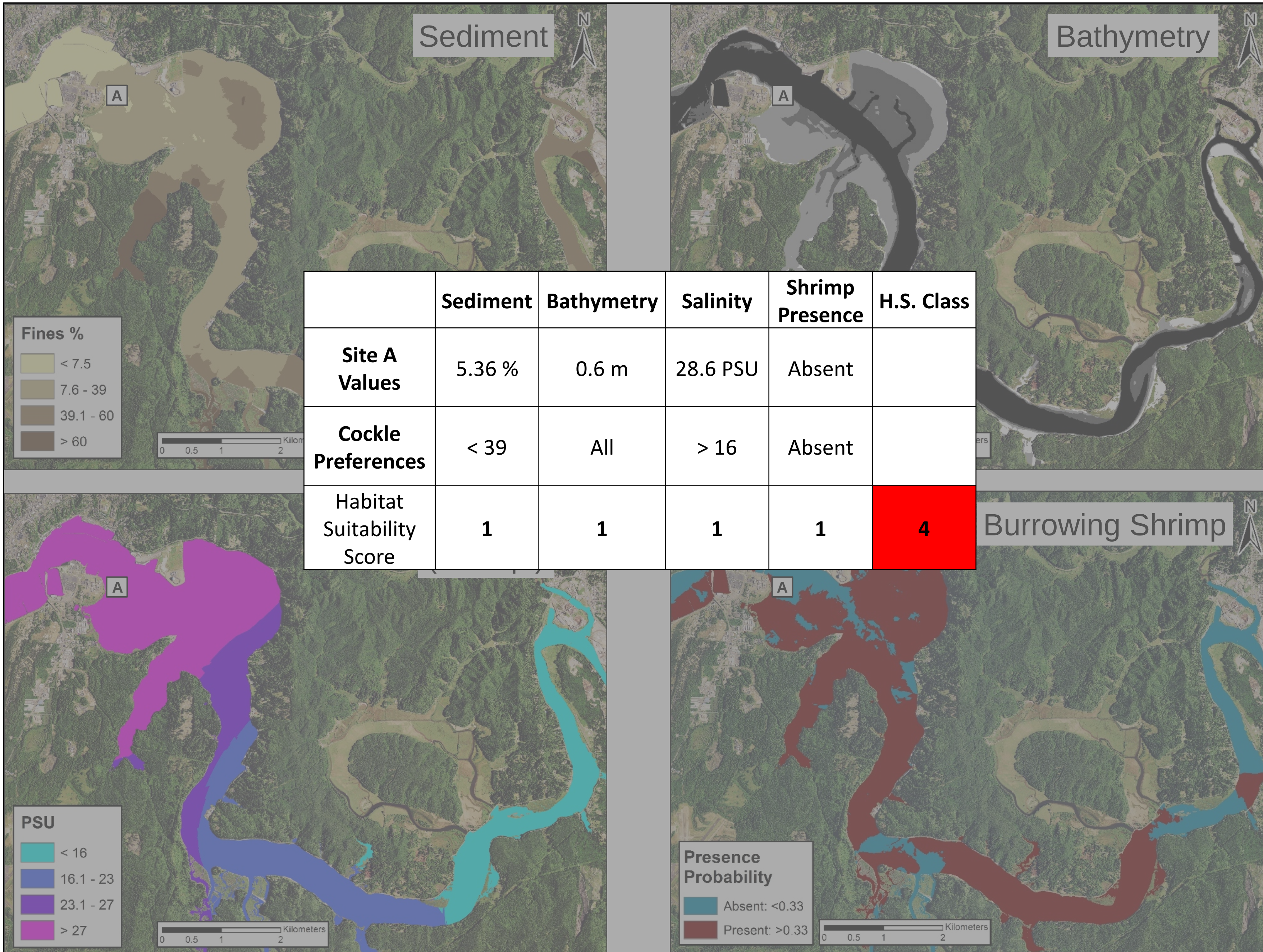
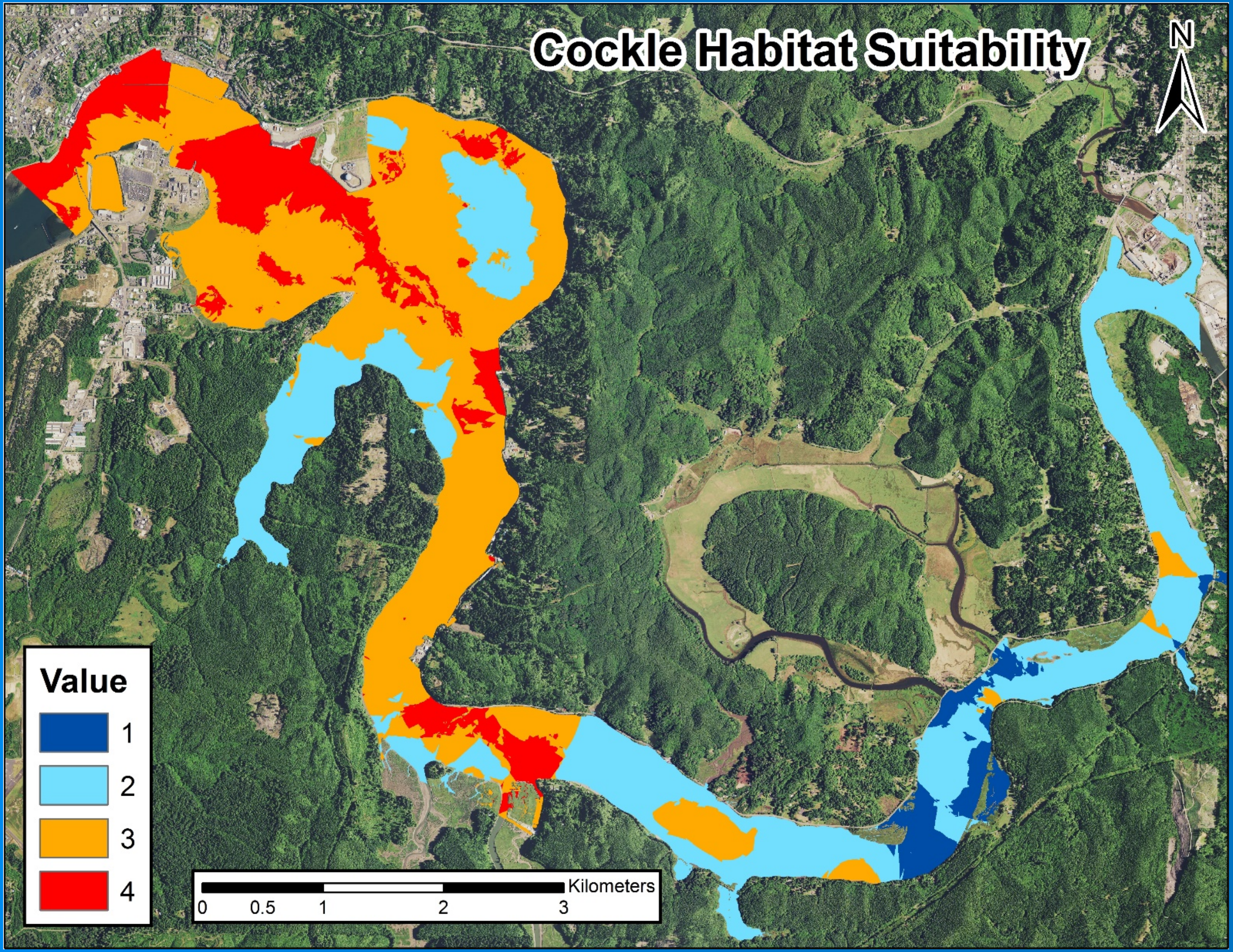
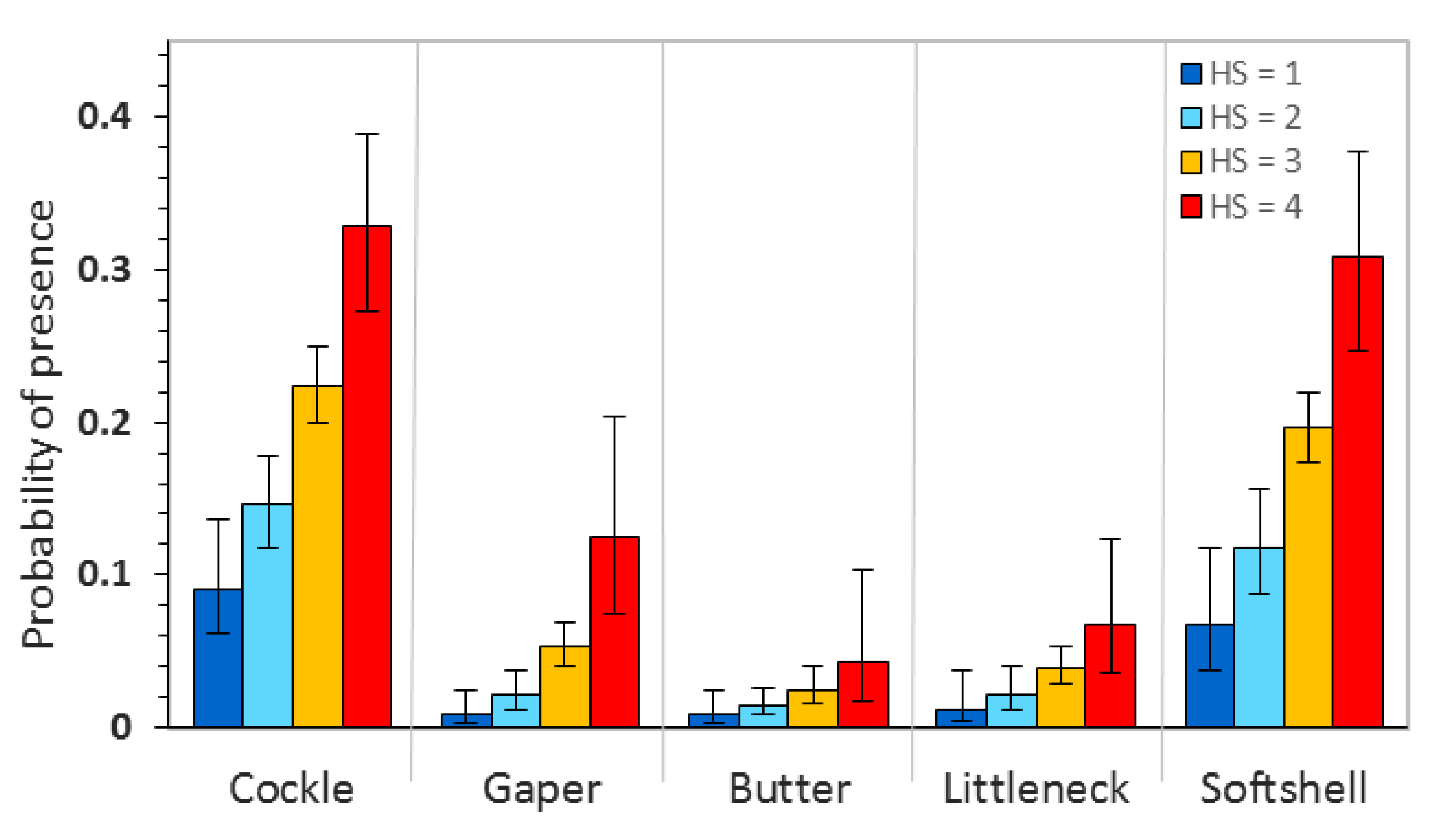


	Sediment	Bathymetry	Salinity	Shrimp Presence	H.S. Class
Site A Values	5.36 %	0.6 m	28.6 PSU	Absent	
Cockle Preferences	< 39	All	> 16	Absent	
Habitat Suitability Score	**1**	**1**	**1**	**1**	**4**

Model Results



Model Validation



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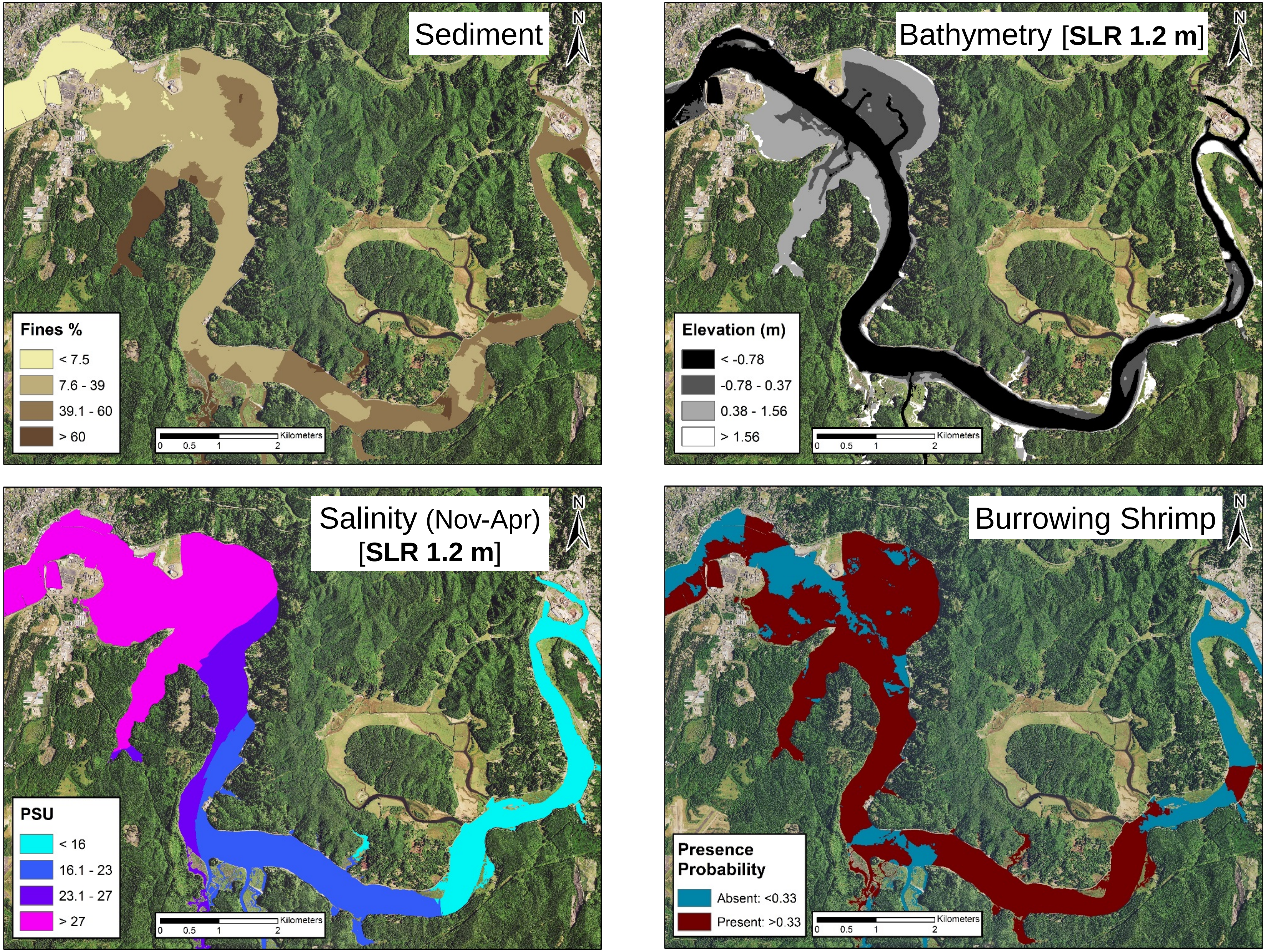
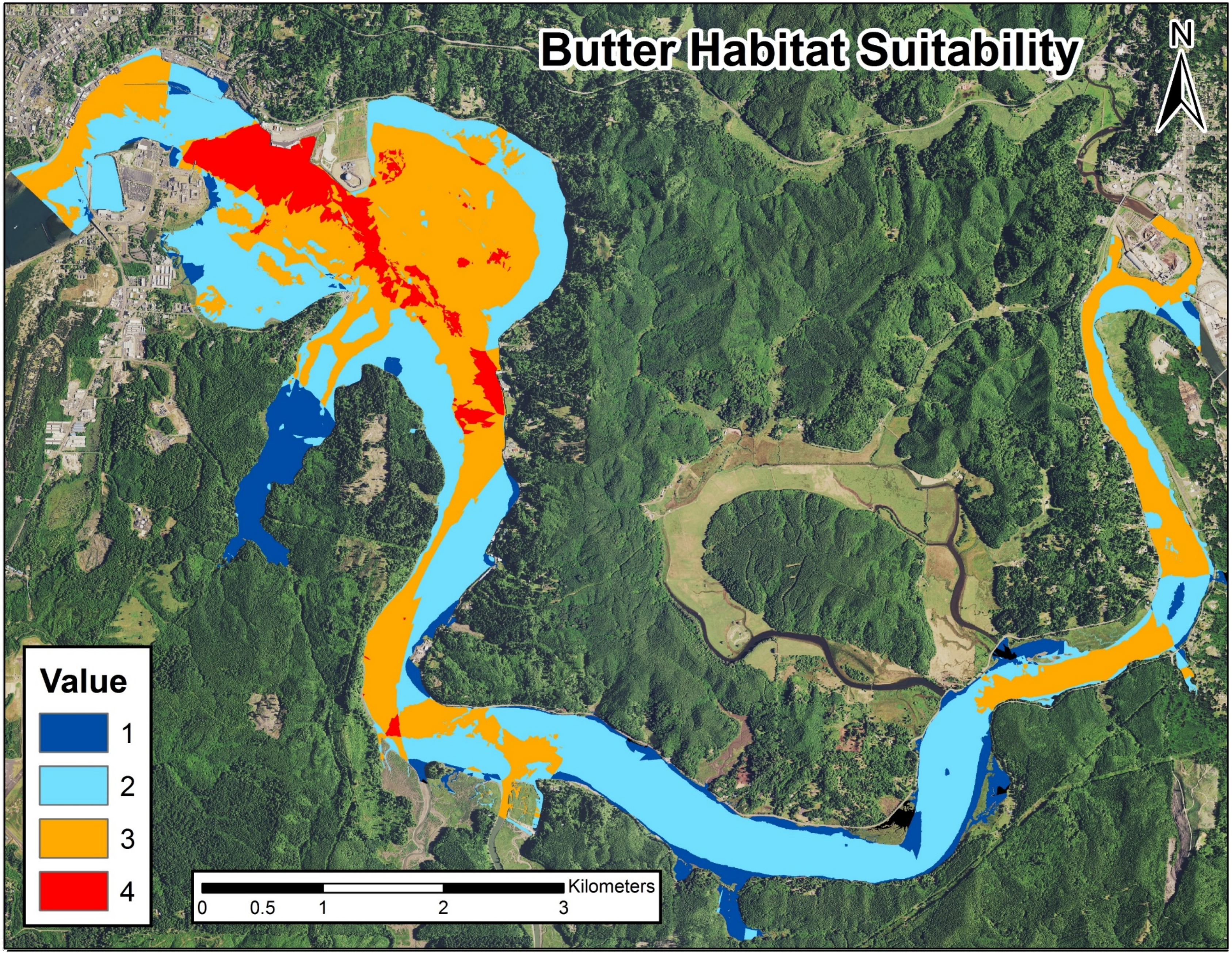
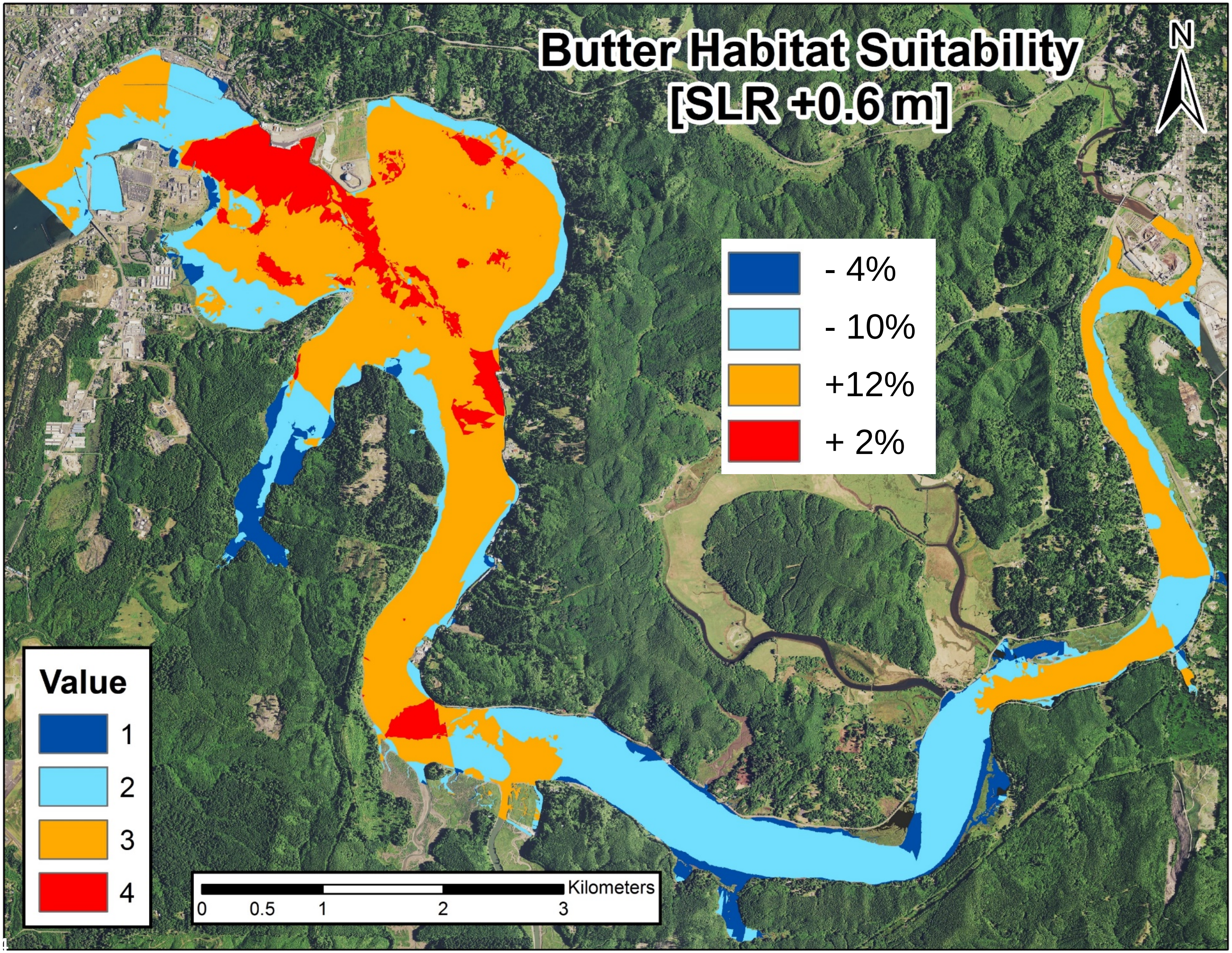
Climate Change Implications

- Estimated the change in habitat suitability under two climate change scenarios
- Applied projected changes to habitat data
- Sea level rise scenarios (0.6, 1.2 m)
- Projected salinity increases of ~2-5 PSU
    - Brown et al. (unpublished)


Sediment
Fines %
< 7.5
7.6 - 39
39.1 - 60
> 60
Kilometers
0 0.5 1 2
Bathymetry [SLR 1.2 m]
Elevation (m)
< -0.78
-0.78 - 0.37
0.38 - 1.56
> 1.56
Kilometers
0 0.5 1 2
Salinity (Nov-Apr) [SLR 1.2 m]
PSU
< 16
16.1 - 23
23.1 - 27
> 27
Kilometers
0 0.5 1 2
Burrowing Shrimp
Presence Probability
Absent: <0.33
Present: >0.33
Kilometers
0 0.5 1 2
N


Butter Habitat Suitability
N
Value
1
2
3
4
Kilometers
0
0.5
1
2
3


Butter Habitat Suitability
[SLR +0.6 m]
N
- 4%
- 10%
+12%
+ 2%
Value
1
2
3
4
Kilometers
0
0.5
1
2
3

Conclusions

- Disparate, independent sets of existing data sufficient to parameterize, create, and validate the model
- Time and cost efficient
- Robust for multiple species and estuaries
    - Yaquina (OR), Tillamook (OR), and Willapa (WA) bays
- Identify highly suitable habitat and how environmental change may alter the distribution of that habitat
    - Associated ecosystem goods and services

Acknowledgements

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- USDA – shrimp data: Brett Dumbauld, Lee McCoy, and Dan Sund

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