Estuarine habitat modeling in Southeast Alaska

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Background

- Estuarine habitats in Southeast Alaska include an extensive network of intertidal mudflats and salt marshes.
- Estuarine habitats are ecologically and economically important. They provide critical habitat for diverse flora and fauna, protect shorelines from erosion and flooding, support recreation and commercial fisheries, and sequester large amounts of carbon (Albert, 2010).
- Delineating the variable spatial extent of estuarine habitats in Southeast Alaska will provide a better understanding of critical habitats and will lead to improved ecological mapping and classification.
- Since the Little Ice Age (1700's) rapid and widespread glacial retreat has resulted in isostatic adjustment in SE Alaska (Larsen et al., 2005). There is a strong N-S gradient in rate of uplift varying between 1 to 32 mm/yr. (Sun et al, 2010). Uplift is causing estuarine areas to enlarge over time.
- Knowledge of the spatial distribution of estuaries, in combination with other watershed characteristics such as fish habitats, floodplains and network geometry, will be used to develop a watershed ecological classification scheme.

Results

1. To identify estuarine habitat using geomorphic variables and Landsat 8 imagery for Southeast Alaska.
2. Identify the extent of salt marsh and mud flat area per estuarine area.
3. Calculate total estuarine habitat for Southeast Alaska.

Data Processing

- Multispectral imagery: Landsat 8
- Radiometric correction
- Restacked bands to mimic Landsat 7 format for ENVI processing
- Water mask: NDVI (values: -0.2 to 1)
- Cloud Mask: Landsat 8 Cirrus band
- Elevation Mask: ASTER Digital Elevation Model (DEM): -5 to 20 meters
- Mask probable estuary areas:
  - Reclassify and multiply the DEM, Cirrus clouds, and NDVI:
    - 1 – region of interest (ROI)
    - 0 – No Data
  - Add the Estuary ROI to spectral data as a band layer and apply ROI

Image Classification

- Supervised classification: 35+ training polygons per class
- Method: maximum likelihood classifier

Land-cover Classes:

- Salt marsh
- Upper Estuary - no inundation and densely vegetated
- Middle Estuary - occasionally inundated and vegetated
- Lower Estuary - frequently inundated; sparsely vegetated with salt tolerant vegetation
- Salt marsh mudflat transition zone - areas not definitively salt marsh or mudflat
- Mudflats - estuarine mud and silt tidal deposits; not vegetated
- Eelgrass - submerged/partially submerged grass-like vegetation
- Transitional Forest - forest cover intermingled within the estuary or near 20 m in elevation.

Fig. 1. The various estuaries that can be found in an estuary.

Fig. 2. Southeastern Alaska spanning from Yakutat to the southern tip of Alaska. The inlay pie chart shows the percentage of land-cover that is estuary.

Fig. 3. Percentage of each estuarine land-cover class. The total mudflat area total 4200 km$^2$ and the estuary areas total 2800 km$^2$.

Fig. 4. Estuary near Gustavus showing fine resolution imagery from ESRI (left) and land-cover classification (right).

Fig. 5. Estuary between Wrangell and Petersburg showing fine resolution imagery from ESRI (left) and land-cover classification (right).

Discussion and Future Work

- Across the extent of this study (~1,000,000 km$^2$) where 0.7% is estuarine habitat, the mudflat class occupies 60% or 4200 km$^2$ and the estuary occupies 40% or 2800 km$^2$ (Fig 3).
- The differences among estuary habitats can be identified using multispectral imagery captured proximal to low tide (Fig 3).
- An accuracy assessment of 55 random points per class resulted in a good overall accuracy of 91% and Kappa statistic of 87% (Table 1).
- The estuary habitats land-cover classification for SE Alaska provides detailed information of estuary characteristics and supports continued ecological and economical research.
- In other studies, isostatic rebound was shown to result in the regional uplift (Larsen et al., 2005). Next, we will pair each estuary classification, slope, and area to estimate the extent of accretion per estuary.

Table 1. Accuracy assessment for the estuary, mudflat, and forest classification.

<table>
<thead>
<tr>
<th>Class</th>
<th>Commission accuracy</th>
<th>Omission accuracy</th>
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<tbody>
<tr>
<td>Forest</td>
<td>95%</td>
<td>93%</td>
</tr>
<tr>
<td>Mudflat</td>
<td>91%</td>
<td>92%</td>
</tr>
<tr>
<td>Estuary</td>
<td>89%</td>
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References

