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

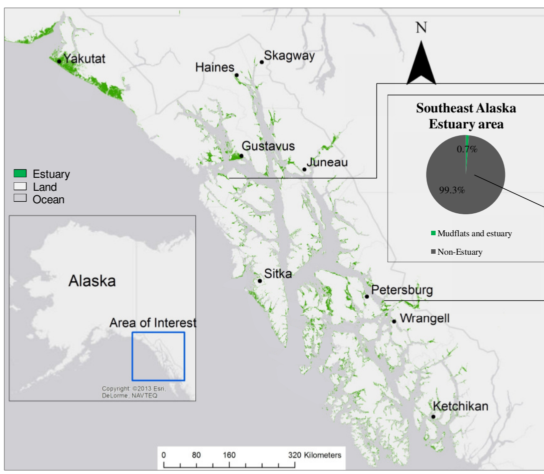

Fig. 2. Southeastern Alaska spanning from Yakutat to the southern tip of Alaska. The inlay pie char shows the percentage of land-cover that is estuary.

References

Albert, D., C. Shanley, and L. Baker (2010) A preliminary classification of bays and estuaries in Southeast Alaska: A hierarchical Framework and Exploratory analysis. Coastal ecological systems in Southeast Alaska, June, Nature Conservancy Report.

Larsen, C. F., R. J. Motyka, J. T. Freymueller, K. A. Echelmeyer, E. R. Ivins (2005) Rapid viscoelastic uplift in southeast Alaska caused by post-Little Ice Age glacial retreat. Earth and Planetary Science Let., 237, 547-560 doi:10.1016/j.epsl.2005.06.032.

Sun, W., S. Miura, T. Sato, T. Sugano, J. Freymueller, M. Kaufman, C. F. Larsen, R. Cross, and D. Inazu (2010), Gravity measurements in southeastern Alaska reveal negative gravity rate of change caused by glacial isostatic adjustment, J. Geophys. Res., 115, B12406, doi:10.1029/2009JB007194.

Research Objectives

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
- 15 scenes cover the entire extent
- were captured in 2013 between 6/10 – 8/25
- Scenes are, on average, within 2 hours of low tide

Radiometric correction → Restacked bands to mimic Landsat 7 format for ENVI processing

Mask probable estuary areas:

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

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

Tasseled Cap analysis

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

Accuracy assessment using 55 randomly generated points per class to calculate overall accuracy and the Kappa statistic.

Results

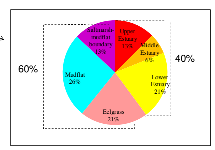

Fig. 3. Percentage of each estuarine land-cover class. The total mudflat areas total 4200 km² and the estuary areas total 2800 km².

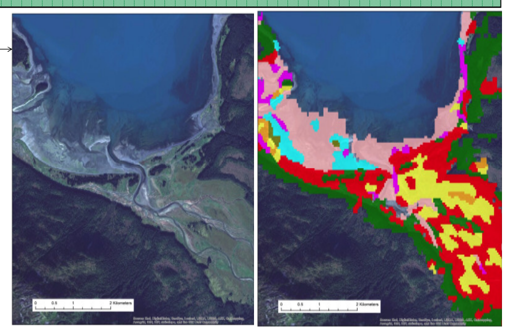

Fig. 4. Estuary near Gustavus showing fine resolution imagery from ESRI (left) and land-cover classification (right).

UpEstuary | Eelgrass
Mid-Estuary | Mudflat
Lower Estuary | Salt marsh - mudflat boundary
Forest | rocky; sandy; glacial

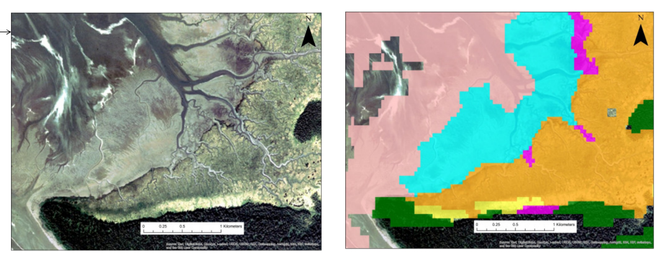

Fig. 5. Estuary between Wrangle and Petersburg showing fine resolution imagery from ESRI (left) and land-cover classification (right).

Classification

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

Mud flats
- Mudflats – estuarine mud and silt tidal deposits; not vegetated
- Eelgrass – submerged/partially submerged grass-like vegetation
- Rocky, sandy, & glacial flow – brightly reflective deposits

Transitional Forest – forest cover intermingled within the estuary or near 20 m in elevation.

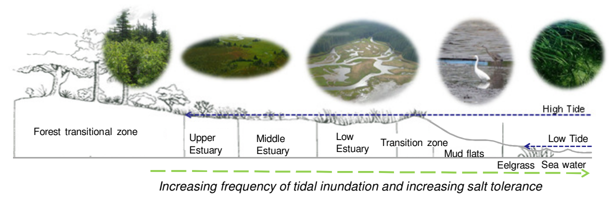

Fig. 1. The various ecotones that can be found in an estuary.

Results

- Across the extent of this study (~1,000,000 km²) where 0.7% is estuarine habitat, the mudflat class occupies 60% or 4200 km² and the estuary occupies 40% or 2800 km² (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).

Class	Commission accuracy	Omission accuracy
Forest	95%	93%
Mudflat	91%	92%
Estuary	89%	89%

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

Discussion and Future Work

- 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.
- Estuarine classes and area data will be integrated with NetMap stream reach attributes to determine spatial relationships between estuaries and the watersheds upstream. The classification can be joined to a number of physical and biological variables (land cover, topography, watershed area, and stream geomorphology) to further inform estuarine mapping and models.