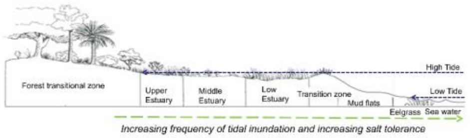
Evolution of Lower River - Estuary Environments in Southeast Alaska: Potential Habitat Winners and Losers

Lee Benda Terrain✦Works Mt. Shasta, CA/Seattle, WA

The lower river - estuary environment is the most biologically productive habitat in southeast Alaska. No other part of the southeast Alaska landscape provides the abundance and diversity of habitat types and food sources for so many species in such a concentrated area. The lower river - estuary complex constitutes less than 1% of the southeast Alaska landscape.



Lower River - Estuary Complex

The lower river - estuary environment is comprised of four distinct but interconnected landforms:
(A) river deltas or estuaries characterized by subtidal and intertidal environments,
(B) supratidal salt marshes,
(C) non-forested river valleys dominated by meadows and wetlands, and
(D) low gradient rivers with forested floodplains.

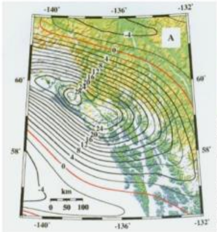
Variable Sizes, Shapes and Distribution of Habitats

Lower river - estuary environments range in size from large (4-5 km^2) to small #6 (0.25 km^2) and vary in shape from broad (1) to long and narrow (4). Complex shapes (amoeba or star like) arise in association with basin morphology including closely spaced intersecting valleys (2). Some complexes contain all four habitat zones of approximate equal proportion (1, 2, 4). Others are dominated by only two or three habitat types (3, 6). In the southern portion of southeast (Prince of Wales Is), river-estuary environments may be completely forested and or have minimal intertidal areas.

Variable Controls

Lower river - estuary complexes are not uniformly distributed across southeast Alaska and variation in their sizes, shapes and habitat domains are an important component of the southeast Alaska ecosystem, yet they remain poorly characterized. Variation in location and size of complexes are related to: 1) watershed size, 2) watershed erosion and sedimentation characteristics, 3) watershed location, 4) mainstem or with tributary valley intersections, 5) valley network geometry (e.g., basin shape), 6) deglaciation history, and 7) isostatic uplift rates.

Isostatic Uplift, Sea Level Rise and Evolution of the Complex



Isohyets of glacial isostatic uplift varies latitudinally across southeast Alaska with the highest rates (28 mm yr^{-1}) in the northern third of the Panhandle (from Larsen et al. 2005).

Potential Habitat Winners

In the northern half of the Alexander Archipelago, a latitudinal gradient of glacial isostatic rebound (5 - 30 mm yr^{-1}) is causing a seaward extension and areal increase of lower river - estuary environments.

In these areas, lower river - estuary habitats may increase significantly over the next century, thus offsetting the projected sea level due to climate change.

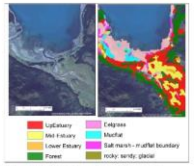
For example, If the gradient of lower river valleys and their associated deltas ranges between 1% and 0.1%, a one to two meter uplift (10mm to 20mm per year) may yield a 100m to 1000m seaward extension of that environment every 100 years.

Potential Habitat Losers

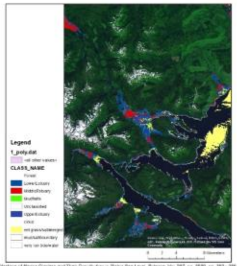
In the southern half of the Archipelago, very low or no uplift, in combination with minimal river sedimentation in some watersheds (small drainage areas, low erosion rates), has resulted in smaller lower river - estuary environments where sea level rise may lead to landward migration of coast lines and submergence of existing habitats.

There is little information on the evolution of lower river - estuary complexes in southeast Alaska. There is, however, considerable understanding about how near shore topography in southeast Alaska is influenced due to a combination of sea level fluctuations, deglaciation, tectonic uplift, and isostatic rebound through the Holocene (Hicks and Shofnos 1965, Mobley 1988, Larson 2005, Baichtal and Carlson 2007, D'Amore et al. 2011). This includes emergence of previously submerged lands along shorelines, often referred to as 'accreted lands' (Motyka 2003) due to uplift. For instance, the new golf course in Gustavus (at the mouth of Glacier Bay) was created on lands that have accreted only during the last century due to isostatic rebound (Connor and Motyka 2009).

Predicting Evolution of Lower River - Estuary Habitats Across SE AK



Fuller et al. (2013) used multi-spectral Landsat 8 imagery to identify the extent of salt marsh and mud flat areas across southeast Alaska. Across the 100,000 km^2 study area, 0.7% was classified as estuary; mudflats occupy 60% or 4,200 km^2 and the estuary occupies 40% or 2,800 km^2.



Considering the lower river - estuary environment is the most productive and diverse habitat in southeast Alaska, it would be prudent to better understand its evolution over time, including in the context of climate change.

Characterizing and quantifying the losses and gains in lower river habitats for salmon and in estuary habitats for marine and non marine species cumulatively across southeast Alaska will require modeling their dynamics, including the seaward extension of those environments due to isostatic rebound and the submergence of habitat due to sea level rise where uplift is negligible or zero.

Analysis will require coupling terrestrial DEMs with digital bathymetry, analysis of multi-spectral imagery, and numerical modeling.

The Tongass National Forest is already covered with NetMap 20m virtual watersheds. Initial multi-spectral analysis has already been completed (Fuller et al. 2013). IfSAR 5m DEMs and digital bathymetry are available.

TerrainWorks is seeking partners and support to evaluate the trajectories of lower river - estuary habitats, including the effects of climate change induced sea level rise, across southeast Alaska (collectively across the hundreds of estuaries), inclusive of the Alexander Archipelago and the mainland watersheds.

References

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Hicks, S. D. and W. Shofnos. 1965. The determination of land emergence from sea level observations in southeast Alaska. Journal of Geophysical Research. Vol. 70(14): 3315-3320.

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