Integrated Valuation of Socio-Environmental and Resiliency metrics for conservation in a changing climate: a “climate-smart” model for the optimization of tidal salt marsh conservation

Introduction

This project is concerned with the adaptation of land conservation investment practices to the reality of climate change. Conservation practices have historically focused on conserving existing biodiversity, with the assumption those land areas will continue to be biodiversity hotspots into the future. More modern practices attempting to address the problem of a changing climate have focused on “connectivity conservation”, which promotes the building and maintenance of connected environments, allowing species to move freely with the climate. Lawler et al. (2015) suggest instead examining abiotic conditions and conserving areas that offer a diversity of abiotic conditions and high biodiversity today, with the theory that these abiotic “stages” will continue to support high biodiversity into the future. The Nature Conservancy and the North Atlantic Landscape Conservation Cooperative have applied these theories to land units across the Northeast, resulting in a suite of datasets that allow for the consideration of all of these principles in conservation planning. This project stitches together these regional resilience datasets, along with Massachusetts-wide local socio-environmental datasets, to allow for comprehensive consideration of climate change impacts to the landscape when conducting conservation planning in Massachusetts.

Tidal salt marshes—wetland areas along coasts in mid-to-high latitudes, subject to flooding twice per day—provide many services, and thus economic benefits, to society. These services include provisioning services such as raw materials, food, and water purification; regulating services such as regulation of storms and floods, drought, land degradation, and disease; supporting services such as fish and wildlife habitat, soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious, and other nonmaterial benefits. This important ecosystem is most prevalent and nutrient cycling; and cultural services such as recreational, spiritual, religious, and other nonmaterial benefits. This important ecosystem is most prevalent and nutrient cycling; and cultural services such as recreational, spiritual, religious, and other nonmaterial benefits.

Methods and Results

The “Intersect” tool was used to extract the number of acres of each feature-layer criteria on each site. “Tabulate Area” tool was used to determine the number of acres of raster-layer criteria on each site. The equations used to quantity each bin of metrics—Stressors, Resilience, Marsh Migration, Environment, and Social—are depicted with the graphical methods presentation (left). The linear equation used to quantify the conservation value of each site is as follows:

\[-0.2\text{Stressors} + 0.2\text{Resilient} + 0.2\text{Marsh Migration} + 0.2\text{Environment} + 0.2\text{Social}\]

Table 1, below, presents the total number of acres conserved as well as tidal marsh conservation metrics for each run of the model. Four model runs were conducted: a “Balanced” model which weights each bin of metrics fairly equally; a “Marsh” model which heavily weights the (Marsh Migration) and (Resiliency) metrics; a “Social” model which heavily weights the (Social) metrics; and a “No Future Considerations” model, which takes into account only the metrics for what is existing on the site today—(Environment) and (Social) metrics.

<table>
<thead>
<tr>
<th>Model</th>
<th>Tidal Wetland</th>
<th>No Future</th>
<th>Balanced</th>
<th>Marsh Generation</th>
<th>Social</th>
<th>No Future Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acres Conserved</td>
<td>6855.339129</td>
<td>7160.828356</td>
<td>6855.339129</td>
<td>579.0386059</td>
<td>148.0468297</td>
<td>176.5914511</td>
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<tr>
<td>Buffer Area Acres Conserved</td>
<td>21.36089165</td>
<td>256.0468297</td>
<td>256.0468297</td>
<td>256.0468297</td>
<td>256.0468297</td>
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<tr>
<td>Development pressure score</td>
<td>1.0-2.0</td>
<td>1.0-2.0</td>
<td>1.0-2.0</td>
<td>1.0-2.0</td>
<td>1.0-2.0</td>
<td>1.0-2.0</td>
</tr>
</tbody>
</table>

Discussion

The “Marsh” model did not result in a significantly higher number of acres of current tidal marsh or marsh migration area on study area sites. This is likely due to a relatively low number of study area sites currently hosting tidal salt marshes (8.82%) and due to inclusion of a wetland metric in the (Environment) bin. This was by design, as wetlands are already highly protected and considered in conservation planning.

References