Center for Coastal Studies Provincetown

Hiebert Marine Laboratory
5 Holway Avenue
Provincetown, MA 02657
tel (508) 487-3623 fax (508) 487-4695

Task 5: Map of Intertidal Area

This analysis was designed to update previous work commissioned by the Pleasant Bay Alliance. In 2016 Borrelli et al., provided a study that looked at, in part, the impacts variable rates of sea level had on the spatial extent of intertidal area in Pleasant Bay. That study used effective rates of 1, 2 and 3 ft of SLR rise, low, mid and high, respectively, by 2100 at 30-year intervals: 2040, 2070 and 2100. (Table 1). The findings for that study saw decreases in intertidal areas under the low and mid SLR scenarios with a slight increase in area under the high scenario as new areas were becoming inundated by 2100. However, given the complex nature of the present study and improvements in climate and SLR models it was determined that a rate of 1-2 ft would be used for green and grey infrastructure by 2050, respectively, and single value of 4 ft would be used by 2100. In order to provide a simple and straightforward analysis here that can be easily compared with the previous work we chose to use 1.5 ft for our 2050 analysis rather than a range of 1-2 for the green and gray infrastructure (Table 2). Lidar data used for the 2016 study was a combination of 2013-2014 post-Sandy lidar collected by the USGS and a 2011 topographic lidar data set that filled in aeras not covered by the 2013-2014 lidar. For this study we use 2021 lidar also collected by the USGS throughout the study area.

Estimated Mean Sea Level in Nauset Beach/Pleasant Bay under Low, Mid and High SLR Scenarios.

YEAR	LOW (3 mm/yr)	MID (6 mm/yr)	HIGH (9 mm/yr)
2040	0.20 m (0.7 ft)	0.28m (0.5 ft)	0.35m (1.1 ft)
2070	0.29 m (1.0 ft)	0.46m (1.5 ft)	0.62m (2.0 ft)
2100	0.38 m (1.2 ft)	0.64m (2.1 ft)	0.89m (2.9 ft)

Figure 1. Data from Borrelli, et al., 2016.

Table 2. SLR scenarios for 2050 and 2100.

Year	**2050**	**2100**
SLR (ft)	1.5	4
MHW @ Chat. Hbr (m)	4.47	6.97
MLW @ Chat. Hbr (m)	2.55	5.05

Figure 2 shows four different areas in Pleasant Bay with regards to changes in intertidal area. In the northwest corner of *Big Bay* (Figure 2A) the green areas indicates the current extent of intertidal area, by 2050 with 1.5 feet of sea level rise the intertidal area are shown by the yellow areas, which has been reduced substantially. The areas that were intertidal, colored green, in the current time period are now subtidal or always underwater in 2050. By 2100 the intertidal area decreases further in this area. This is due to the steep sides of the coastal features. Similar to the fate of some salt

marsh there is no space available for the intertidal zone to migrate into as sea level rises. In panel B of Figure 2, we see Meetinghouse Pond in Orleans at the three different time periods. Current intertidal areas are greatly reduced by 2050. While there are some gains from 2050 to 2100 there is still a net loss in this area. Further, those intertial zones shown in 2100 may not be suitable or feasible for twice daily inundation by the tides. Panel C in Figure 2, the northern shore of *Big Bay,* shows some of the most dramatic gains and losses in intertidal areas. In the center right of the figure, large intertidal areas shown in green are lost by 2050, with further loss by 2100, but in the lower left of center area a large gain in intertidal area is shown in 2050 but is lost by 2100. In Panel D we see large areas of gain in 2050 and 2100 but again these areas may not be feasibly inundated and more site-specific work is needed in the future.

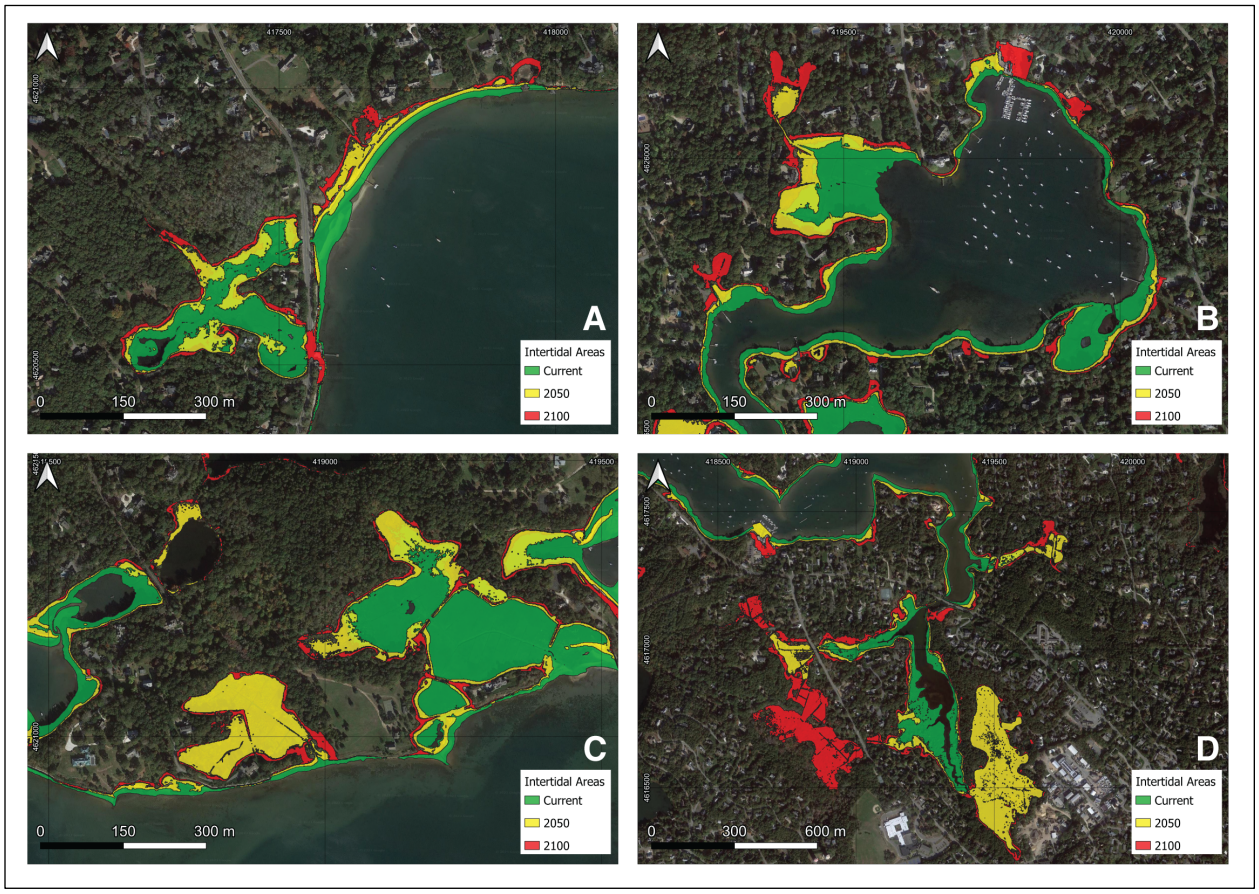

Figure 2. Four areas of Pleasant Bay showing current intertidal area (green) with projections in 2050 (yellow) and 2100 (red).

As mentioned above the 2016 study saw a slight increase in intertidal resource by 2100. Using the greater rates of sea level rise in this study that same pattern is not seen. Here we see intertidal loss throughout the time period even though new areas are being inundated in 2050 and 2100. (Table 3). A 40% decrease (164 acres) in intertidal area is documented between 2021 and 2050

Table 3. Intertidal area in Pleasant Bay.

Pleasant Bay	2021	2050	2100
Total Area (acres)	412.2	247.9	117.9

and a further 47% decrease (130 acres) between 2050 and 2100. A 72% loss of intertidal areas (294.3 acres) was shown from 2021 through 2100. This represents a rate of 5.6 acres/yr from 2021 through 2050, 2.6 acres/yr from 2050 – 2100 or 3.7 acres /yr from 2021 – 2100. The rate of decrease in the second interval is likely due to the overall decrease in available intertidal areas as opposed to decreasing rates of sea level.

It should be noted that differences in lidar products, such as resolution, seasonality of data collection, etc., likely accounts for a very small percentage of change seen in comparisons these datasets. Where possible the footprint of change documented in 2016 was kept for the current analysis to maximize the comparability of the two datasets while reducing the above-mentioned differences in the datasets. While some changes have occurred to the natural and human-altered coastal settings in Pleasant Bay we believe the changes documented here are real and reflect the use best possible data sets available to us.