

Appendix J

Laumeister Marsh

Introduction

Located in south San Francisco Bay in Santa Clara county, Laumeister Marsh (hereafter Laumeister) is owned by the City of Palo Alto. It is managed by the U.S. Fish and Wildlife Service as part of Don Edwards National Wildlife Refuge which is the largest refuge in SFBE. Laumeister is recognized as an important stopover on the Pacific Flyway and is home for endangered species such as the California clapper rail (*Rallus longirostris obsoletus*).

The focus of this study was on 36.8 ha at Laumeister marsh. Elevation and vegetation surveys were done in 2009 - 2010 using an RTK GPS. To monitor tidal inundation and salinity, two water level loggers were deployed between 2009 - 2010.

Results

Elevation surveys

A total of 717 elevation measurements were taken at Laumeister (Fig. J-1). The elevation range was 1.15 - 2.20 m with a mean of 1.98 m (NAVD88). Over half (53%) of the survey points fell within 1.95 - 2.05 m, with a 0.1 m range. A majority (86%) of the survey points were located at elevations above mean high water (MHW; Fig J-2). Laumeister was the second highest marsh surveyed in this study. A 3-m resolution elevation model was developed in ArcGIS 9.3 (ESRI, Redlands, CA) Spatial Analyst using the Kriging method (Fig. J-3). This baseline elevation model was used as the initial elevation in the WARMER sea-level rise (SLR) model.

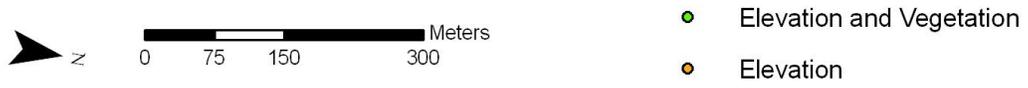


Figure J-1. Laumeister Marsh with elevation and vegetation survey points taken in 2009 and 2010.

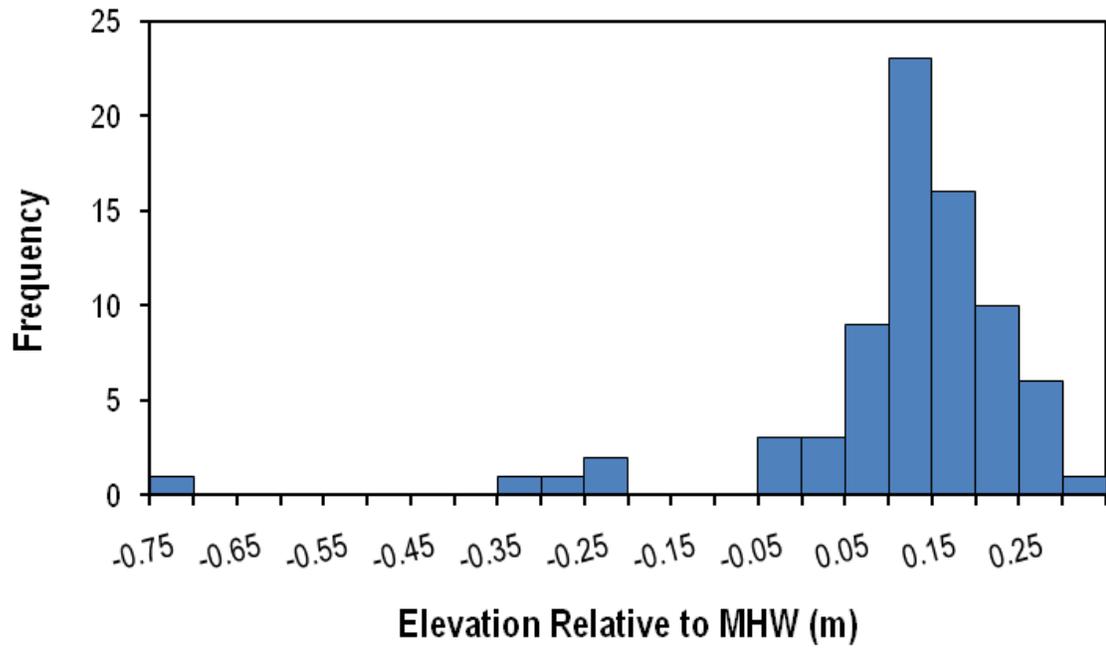


Figure J-2. Distribution of elevation relative to local mean high water (MHW) at Laumeister Marsh.

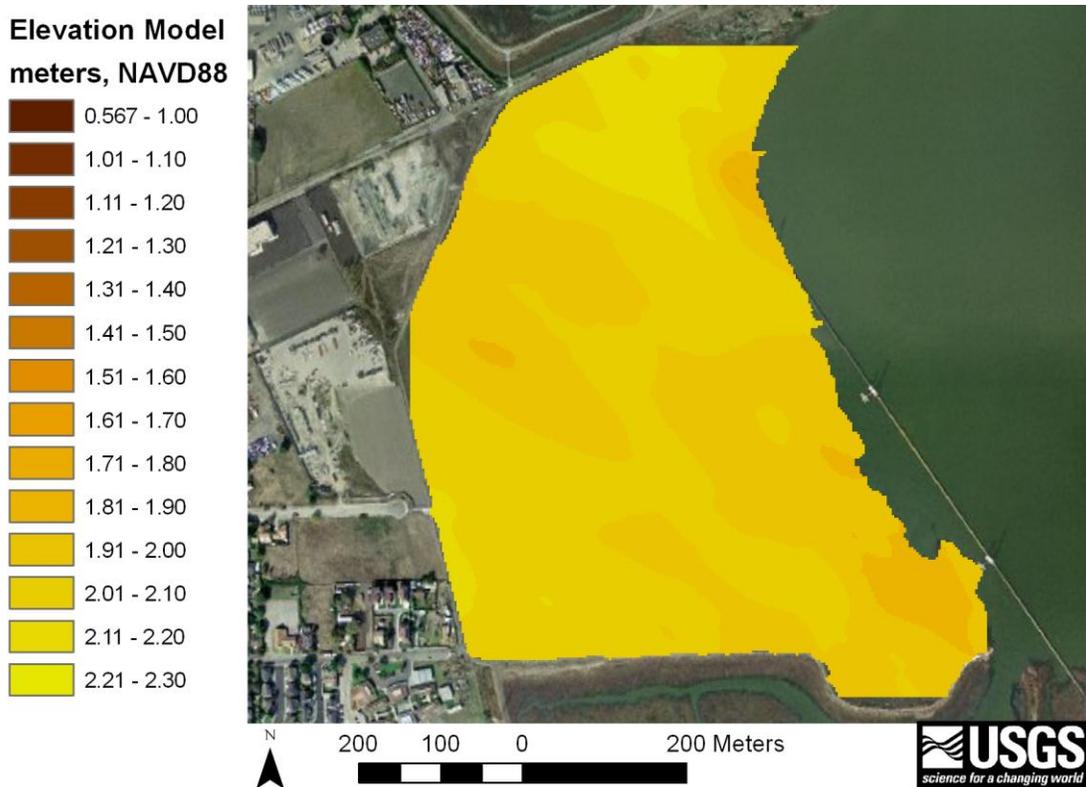


Figure J-3. Elevation model (3-m resolution) developed from ground RTK GPS elevation data.

Vegetation surveys

Vegetation was surveyed concurrently with elevation in 2010. A total of 72 locations (Fig. J-1) were surveyed for vegetation composition, height (cm), and percent cover (Table J-1). We did not distinguish between invasive and native *Spartina* spp. and *Scirpus* spp. in the survey. Vegetation in marshes is sensitive to soil salinity, inundation patterns and disturbance. Therefore, stratification of vegetation species relative to MHW (Fig. J-4) was observed within this low slope marsh.

Table J-1. Mean marsh elevation, avg. and max height (cm), percent cover with standard deviations (SD), and presence by species at Laumeister.

Species	Elevation (MHW, m)	Elevation SD (MHW, m)	Avg. Height (cm)	Avg. Height SD (cm)	Max Height (cm)	Max Height SD (cm)	% Cover	% Cover SD	n	% Presence
<i>Sarcocornia pacifica</i>	0.07	0.15	29.95	7.59	39.34	8.60	72.42	34.57	62	86.11
<i>Spartina spp.</i>	0.00	0.14	57.56	12.86	68.78	11.35	28.41	31.28	27	37.50
<i>Grindelia stricta</i>	0.08	0.21	64.20	12.97	72.20	14.76	27.10	31.09	20	27.78
<i>Jaumea carnosa</i>	0.08	0.07	14.67	4.04	21.33	2.89	55.00	37.75	3	4.17
<i>Frankenia salina</i>	0.25	-	30.00	-	33.00	-	30.00	-	1	1.39
<i>Distichlis spicata</i>	0.08	0.17	23.69	6.07	32.76	6.87	57.41	30.61	29	40.28
<i>Lepidium latifolium</i>	-0.08	0.46	28.50	7.85	44.00	6.73	46.25	44.98	4	5.56

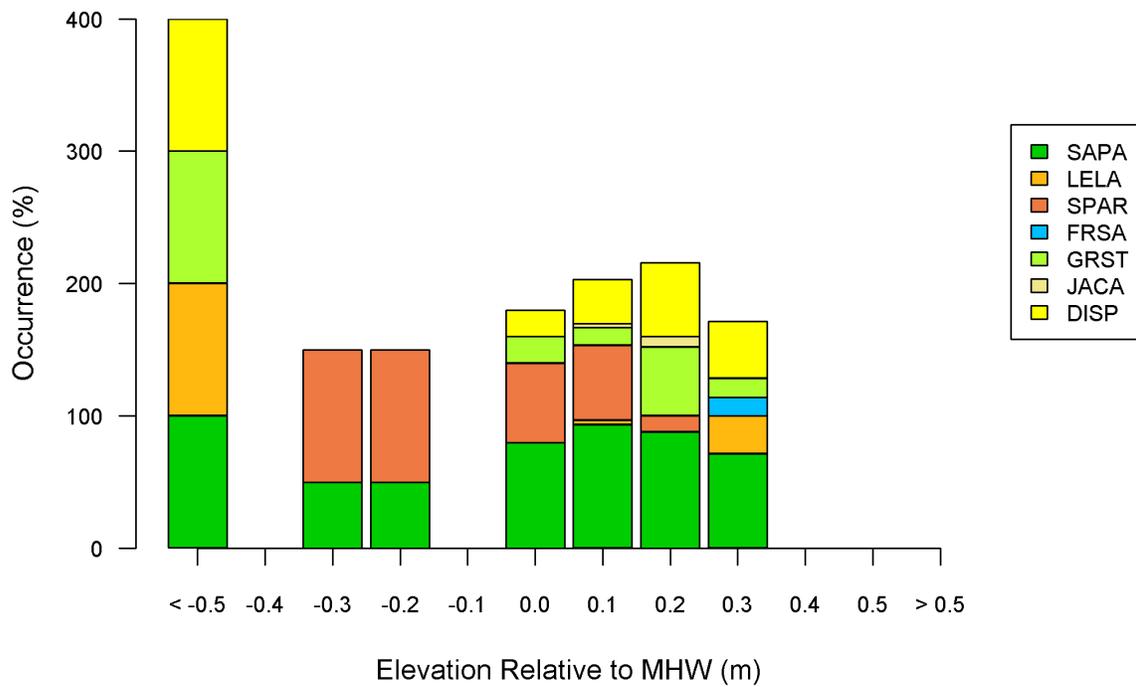


Figure J-4. Stratification of vegetation species was observed relative to MHW. Species codes: SAPA = *Sarcocornia pacifica*; LELA = *Lepidium latifolium*; SPAR = *Spartina spp.*; FRSA = *Frankenia salina*; GRST = *Grindelia stricta*; JACA = *Jaumea carnosa*; DISP = *Distichlis spicata*.

Water level monitoring

Site-specific water level was monitored for one year in December 2009 – May 2010. Water level was measured using two data loggers deployed at the mouth of a second order channel and in the marsh interior. Water levels throughout the year were recorded to evaluate seasonal patterns in tides. We found MHW was at 1.92 m and mean higher high water (MHHW) at 2.09 m for the site (NAVD88). The marsh platform (defined as mean elevation) was inundated most often from December 2009 through February 2010 (Fig. J-5). Those months recorded above average water levels due to several record breaking storms that brought low air pressure and substantial rainfall, resulting in higher than predicted tides. The cumulative rainfall in January 2010 was above average throughout the San Francisco bay area and daily rainfall records were broken in some locations (NOAA). This resulted in longer inundation periods of the marsh platform. Mean salinity during 2010 at Laumeister was 13.4 (SD = 7.9) PSS.

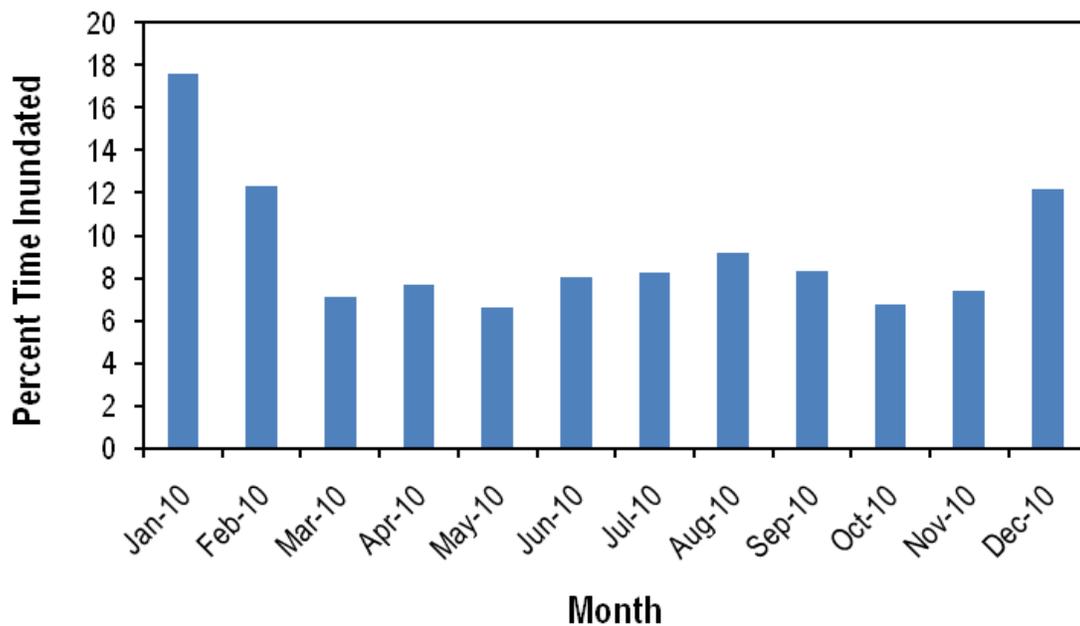


Figure J-5. Percent of time Laumeister was inundated monthly, based on the mean elevation of the marsh platform.

Marsh elevation modeling

Laumeister had high initial elevation and accretion rates which allowed it sustain marsh elevation longer than other study sites. Despite this, WARMER results indicate that Laumeister will not keep pace with local SLR through this century. WARMER results show a gradual reduction in elevation relative to MHW over time, with a more dramatic decline after 2060; by 2050 the marsh is projected to be below MHW (Fig. J-6). By 2100, Laumeister is projected to remain ~ 0.4 m above mean sea level (MSL; Fig. J-7).

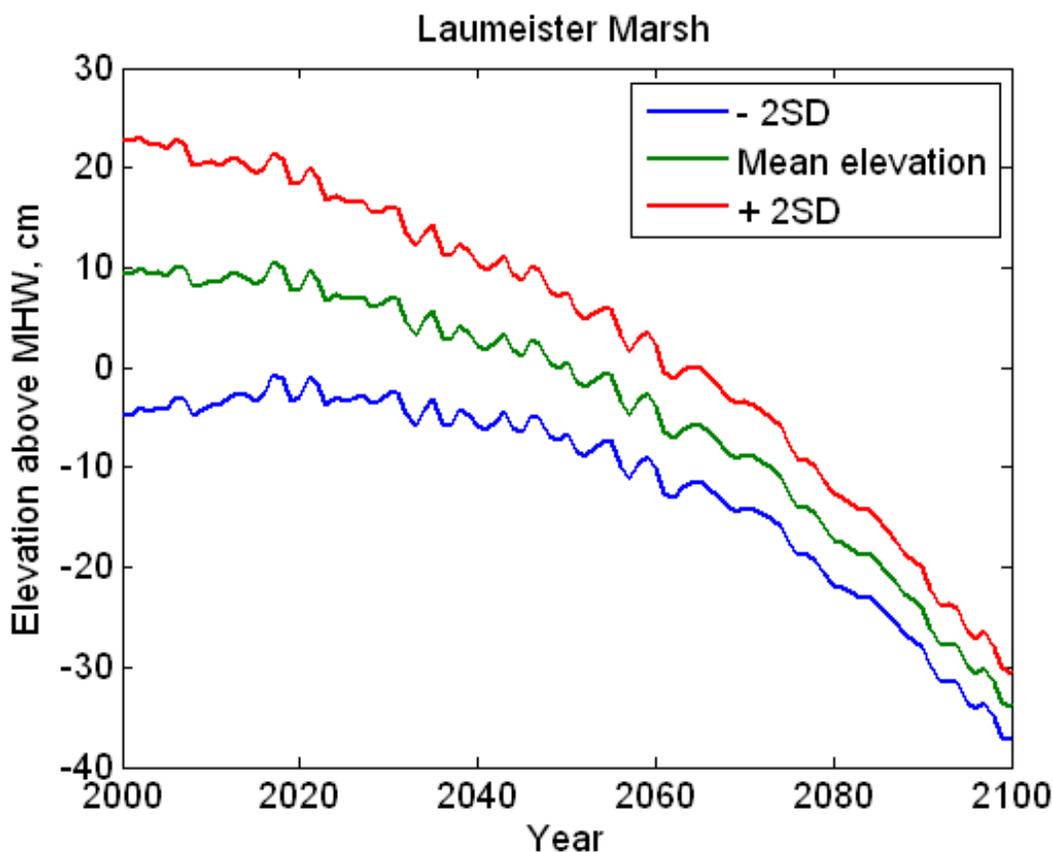


Figure J-6. WARMER scenarios of marsh elevation change for Laumeister. Elevation above MHW is plotted versus model year with two standard deviations (SD).

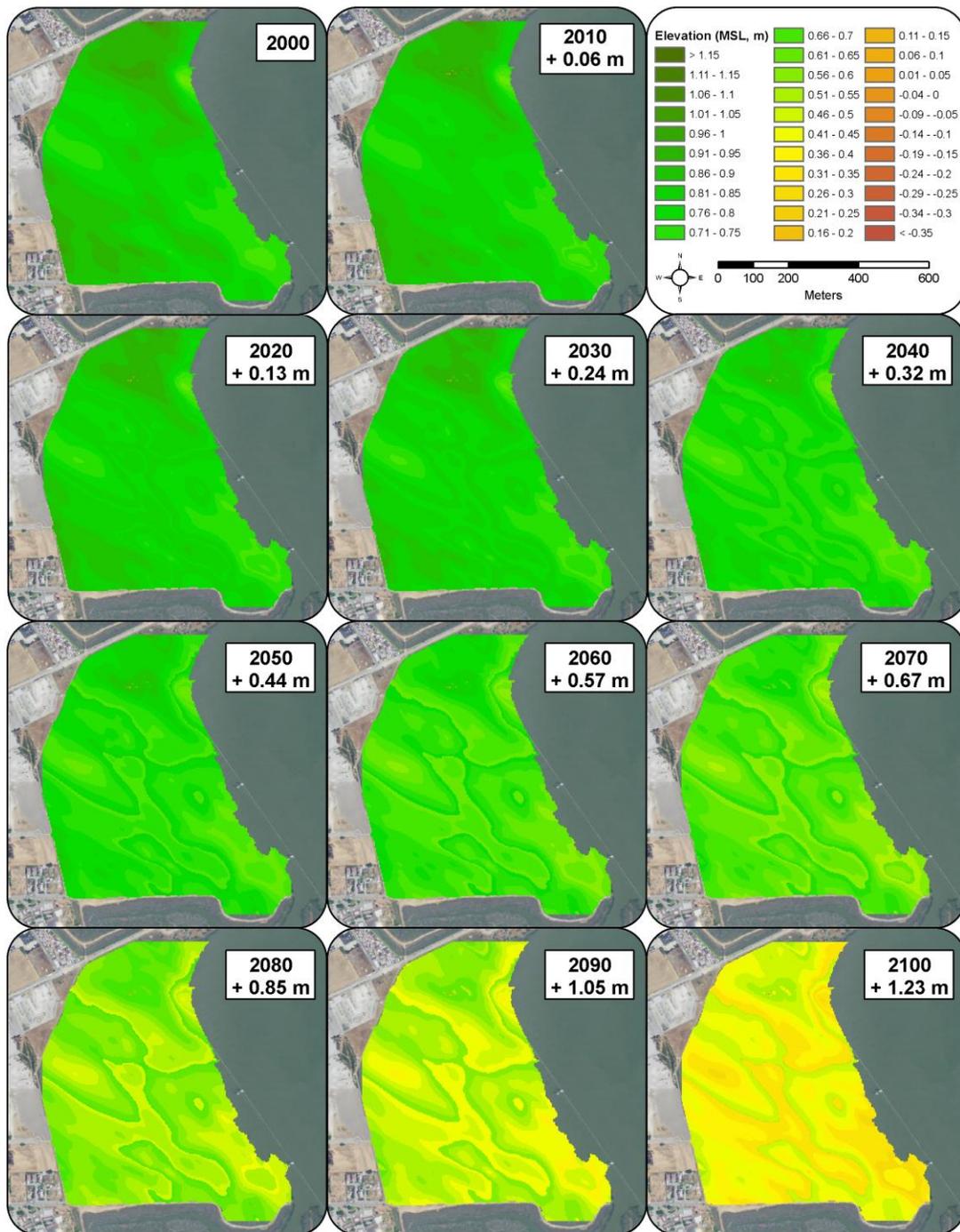


Figure J-7. WARMER results for Laumeister. WARMER accounts for changes in relative sea-level, subsidence, inorganic sediment accumulation, above/below ground organic matter productivity, compaction, and decay. Non-linear sea-level rise projections for California were used (Cayan *et al.* 2009).

Elevation relative to the local tidal datum can be tied to vegetation observations (see methods). Thus, vegetation data were categorized as mudflat, low, mid, high marsh, or upland transition plant communities (Table 4) and used to interpret the WARMER SLR results (Figs. J-8 – J-9). Upland transition (> 1.0 m MSL), is characterized by coyote bush (*Baccharis pilularis*). High marsh (0.7 – 1.0 m MSL), is characterized by *Frankenia salina* and *Jaumea carnosa*, while mid marsh (0.45 – 0.7 m MSL), is dominated by *Sarcocornia pacifica*. Low marsh (0.2 – 0.45 m MSL), is characterized by *Spartina spp.* or *Scirpus spp.* in brackish areas. Mudflat habitat (< 0.2 m MSL), is unvegetated or sparsely covered with *Spartina spp.* Currently, Laumeister is primarily comprised of high marsh vegetation and low marsh dominated with *Spartina*. Model results show that high accretion rates, due in part to high suspended sediment concentrations in south San Francisco Bay sustains high marsh habitat through 2060 (+ 0.57 m SLR). Once the rate of sea-level rise increases in the second half of the century, Laumeister begins to lose relative elevation and transition to predominantly mid marsh habitat by 2080 (+ 0.85 m SLR). By 2100, Laumeister transitions predominantly to low marsh habitat (+ 1.23 m SLR).

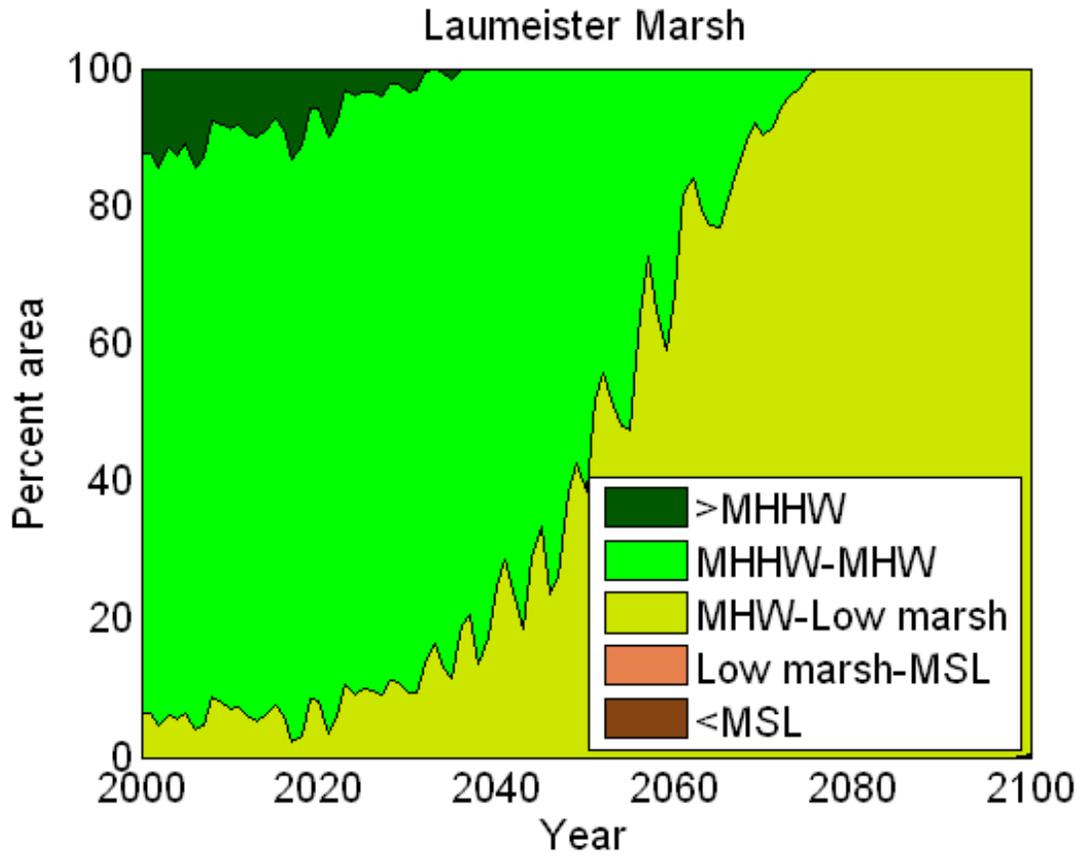


Figure J-8. Area of Laumeister within a given tidal range for the duration of the simulation period.

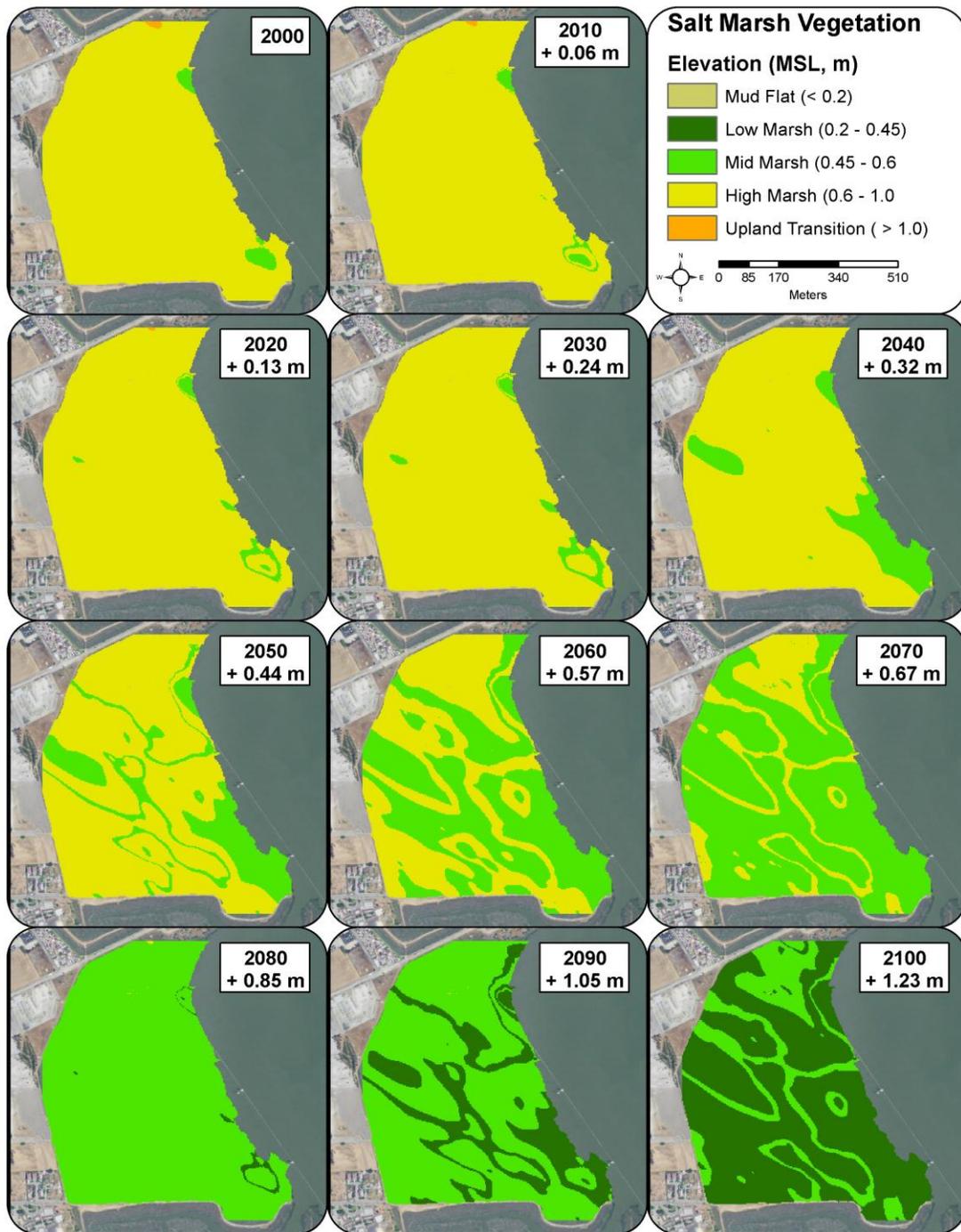


Figure J-9. Laumeister WARMER results in terms of plant communities: mudflat, low, mid, or high marsh, or upland transition.