Early-Stage Outcomes at the Innovative Sears Point Tidal Marsh Restoration Project

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I. Introduction

Rebuilding tidal marsh elevations to restore emergent vegetated marsh and its associated ecological functions and ecosystem services and having these restored marshes strive to keep pace with sea level rise is a major question being examined in the San Francisco Estuary. The Sears Point Tidal Marsh Restoration Project of the Sonoma Land Trust is located on the northwest shore of San Pablo Bay, the broad, shallow northern embayment in the Estuary (Figure 1) where tidal currents and wind maintain generally very high suspended sediment loads in the water column.

Restoration design took advantage of this setting to utilize natural sedimentation as the approach to rebuild elevations on the property that had subsided to roughly mean lower low water, and it applied lessons learned from the nearby "Carl's Marsh" restoration project that proved to be very effective. Specifically, the design included multiple breaches (two built) and large channels to bring sediment-laden waters into the site and about 500 "marsh mounds" dispersed throughout the site to promote sedimentation and to serve as nuclei of marsh vegetation establishment. (For a variety of reasons, pre-breach vegetation of the mounds to stabilize them did not occur.)

In this poster we present the early results of sedimentation using two airborne LiDAR topographic monitoring data collection efforts and we illustrate the performance of the marsh mounds including their early erosion and later efforts to stabilize and revegetate them.

Figure 1: Vicinity Map

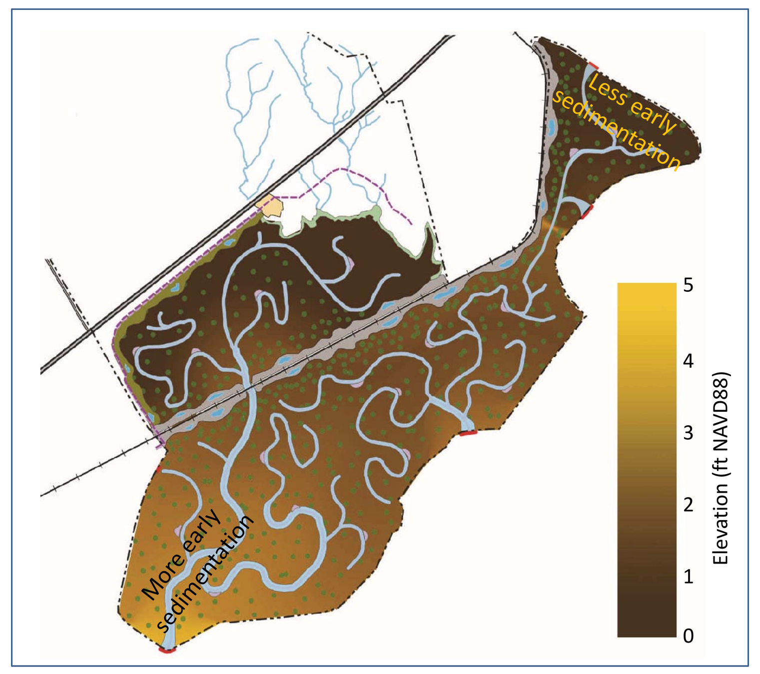
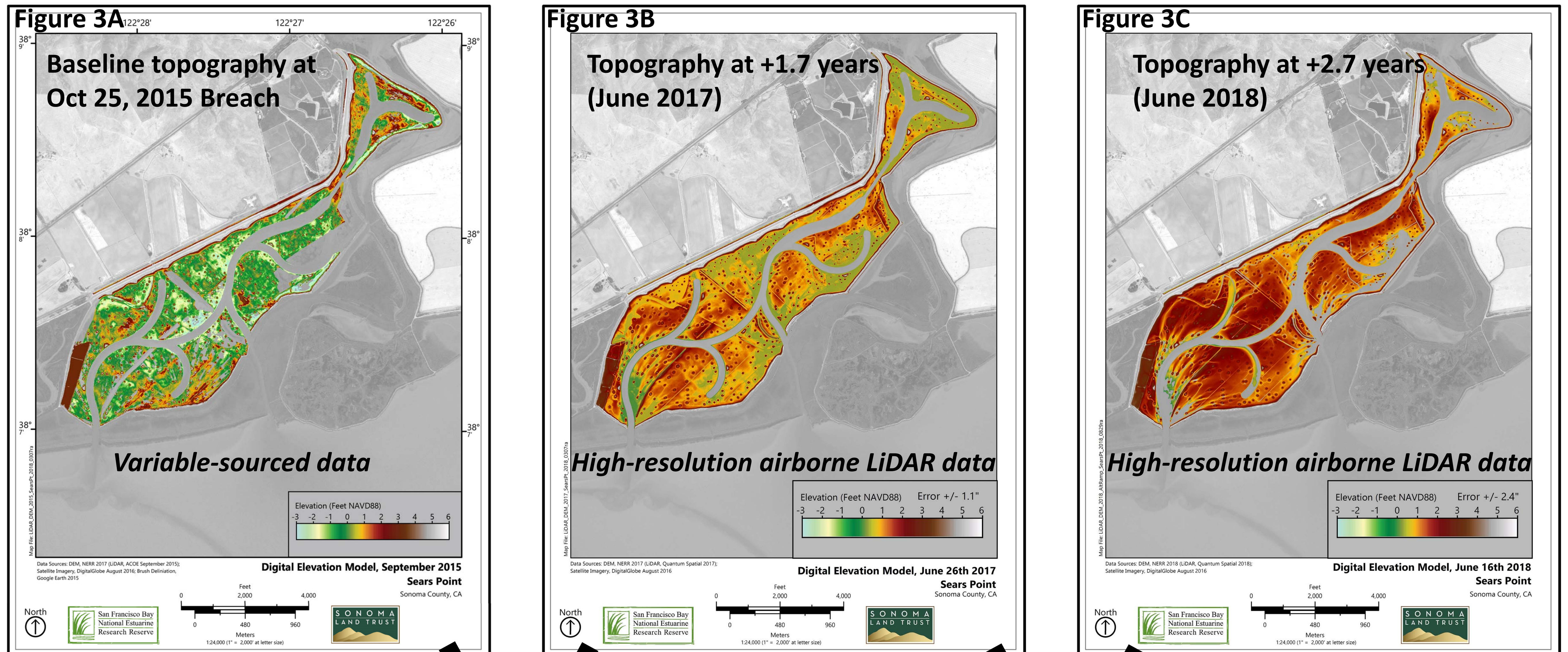


Figure 2: Predicted Early Sedimentation Pattern

The design Report (WWR 2007 Figure 24) predicted early pattern of greater sedimentation near bay (southwest) and lesser sedimentation farthest from bay (northeast). As Figures 3A and 3B show, this pattern has been roughly borne out, with more nuance.



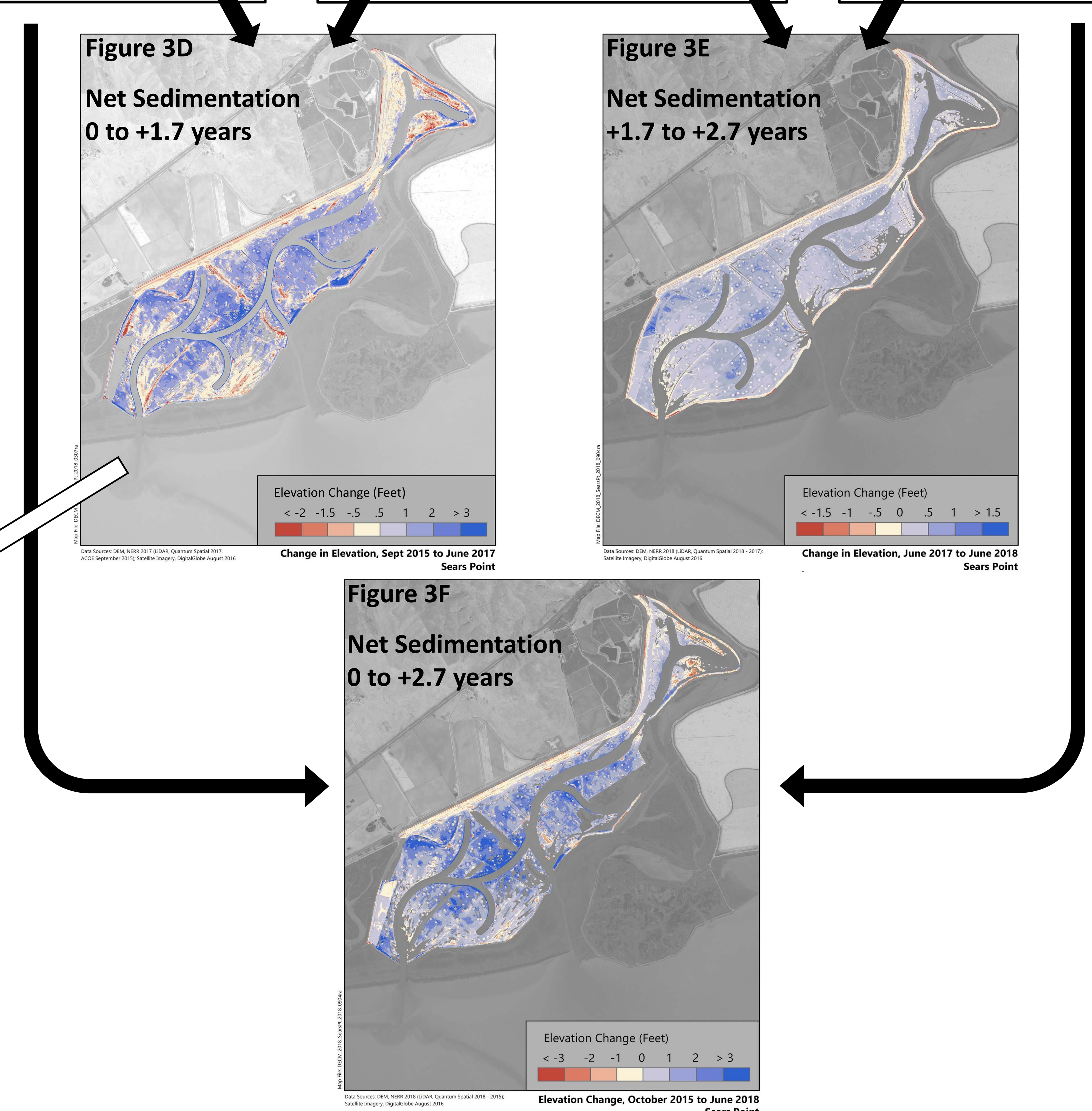


Figure 3: Topography and Net Sedimentation, Baseline to June 2018

II. Topography and Net Sedimentation Baseline to Year 2.7 (June 2018)

Sears Point has undergone a significant amount of natural sedimentation in its first three years of restoration. Figure 3A shows the as-built topography (comprised of mixture of ground-based LiDAR and engineering design elevations). Figure 3B shows the airborne LiDAR data for 1.7 years after breach, June 2017. Figure 3C shows the airborne LiDAR data for 2.7 years after breach, June 2018. Figures 3D through 3F show the *change* in elevation from baseline to Year 1.7, Year 1.7 to Year 2.7, and baseline to Year 2.7, respectively. To date, we have analyzed the 2017 LiDAR data and elevation change, and Figures 4A and 4B present the total accretion and average annual accretion rates, respectively.

At Year 1.7, total net accretion was nearly 4 ft maximum, with a median accretion of 1-1.5 ft (Figure 4A), translating to average annual rates of 0.5-1 ft/yr median and 3-3.5 ft/yr maximum. Net accretion reflects elevation change only and combines all processes of deposition, consolidation, and compaction that intertidally deposited sediment undergoes. These rates are anticipated based on earlier findings from nearby Carl's Marsh (Siegel 2002).

Spatial distribution of accretion also followed general predictions of the "prograding delta" concept wherein more deposition occurs near the inlets and along channel banks as flow velocities reduce and less sediment remains in the water column to deposit in the farthest areas from tidal connections (Siegel 2002, WWR 2007). Figure 2 shows the generalized design prediction and Figures 3B and 3C show the site patterns. Actual patterns reflect interaction of flows through the two breaches.

These findings strongly suggest that tidal marsh restoration sites located near locally abundant sediment supplies and well connected to those tidal waters will undergo rapid natural deposition.

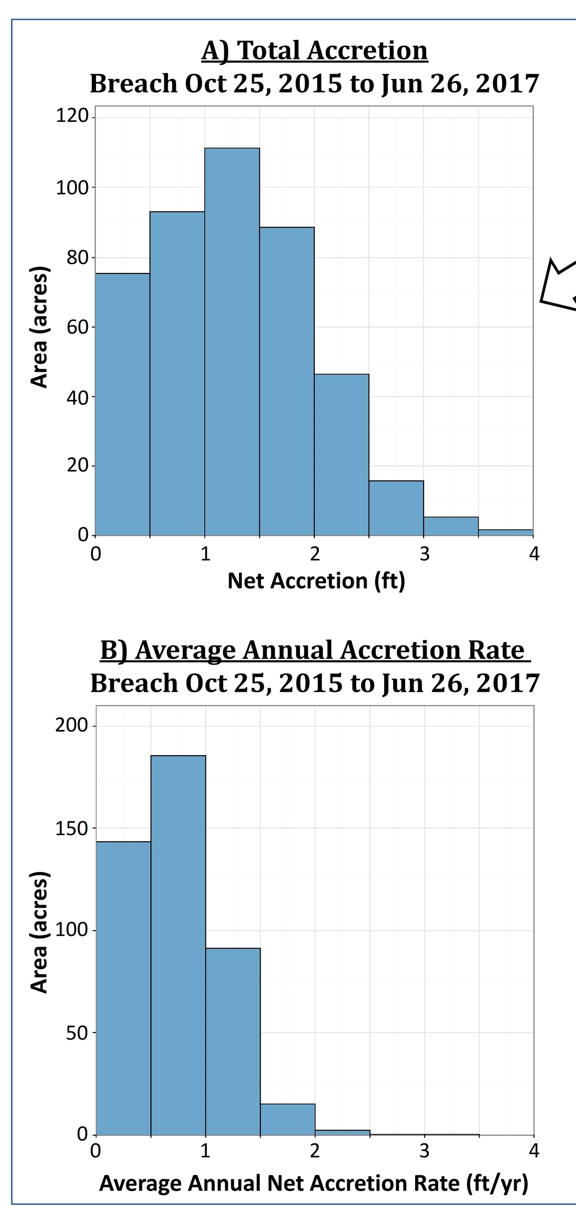


Figure 4: Net Accretion (Total, Average Annual Rate)

III. "Marsh Mounds" – Promote Deposition, Reduce Erosion, and Provide Marsh Vegetation Nuclei

About 500 "marsh mounds" – essentially, piles of on-site soil with top elevations around mean higher high water – were included in the restoration design to promote sediment deposition, reduce erosion of the new perimeter tidal flood control levee, and provide disbursed points of marsh vegetation establishment "nuclei" throughout the restoration site (Figure 5). These ideas originated from lessons learned at nearby Carl's Marsh (Siegel 2002) and observations of the design team (Siegel, Baye, Leventhal, Toms). For a variety of reasons, mounds were not vegetated before breaching and consequently were subjected to significant erosion after breaching (Figure 7). An EOS graduate student (Buchbinder) started field experiments immediately before breach in October 2015 and continued through 2018, surveying mounds for erosion, testing erosion control with coir logs, planting native cordgrass (Figure 6A), and measuring vegetation and other physical and biological responses. That work identified the value of additional native cordgrass plantings, which the Invasive Spartina Project then carried out in March 2018 at more than 30 mounds (Figure 6B). The recent August 2018 site visit found very successful native cordgrass plantings (Figure 6C). Future monitoring will establish both vegetation spread as well as whether sedimentation rates are increased within vegetated areas.

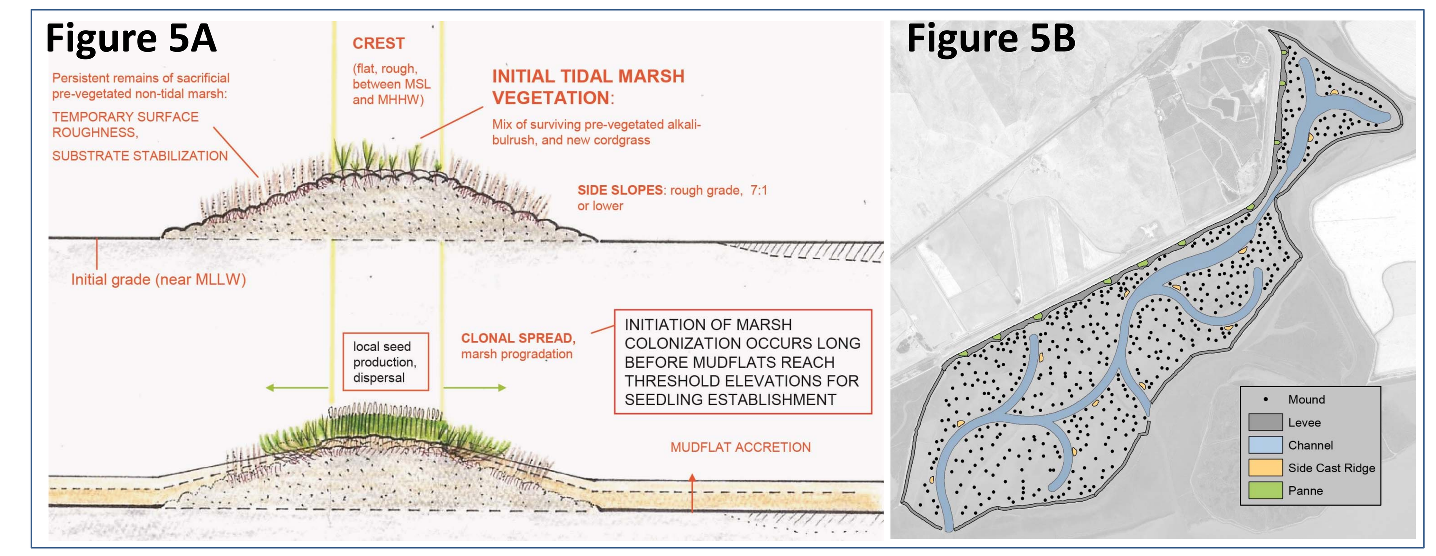


Figure 5: Marsh Mound Design (A) and Constructed Locations (B)

The design report (WWR 2007 Figure 13) called for pre-breach vegetation stabilization (Figure 5A, drawn by Peter Baye) of the ~500 mounds distributed throughout the site (Figure 5B).

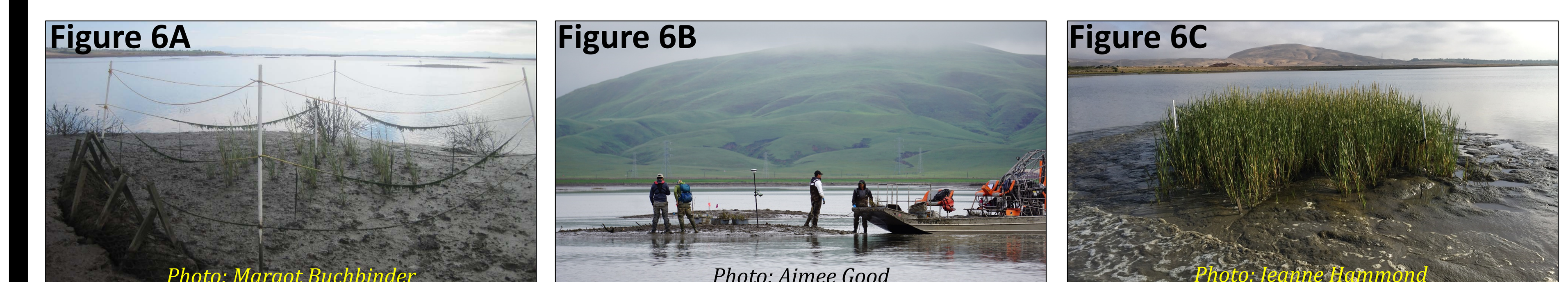


Figure 6: Marsh Mound Experimental Plantings 2016 (A), Plantings by Invasive Spartina Project March 2018 (B), and Resulting Early Vegetation Establishment August 2018 (C)

Planting and erosion control experiments conducted by Margot Buchbinder (SFSU EOS Center graduate student) in 2016 to test mound stabilization approaches with native cordgrass (Spartina foliosa) and coir rolls (Figure 6A). Planting of native cordgrass by the Invasive Spartina Project on ~30 mounds in March 2018 (Figure 6B). Extent of newly establishing native cordgrass on planted mounds as of August 2018 (Figure 6C).

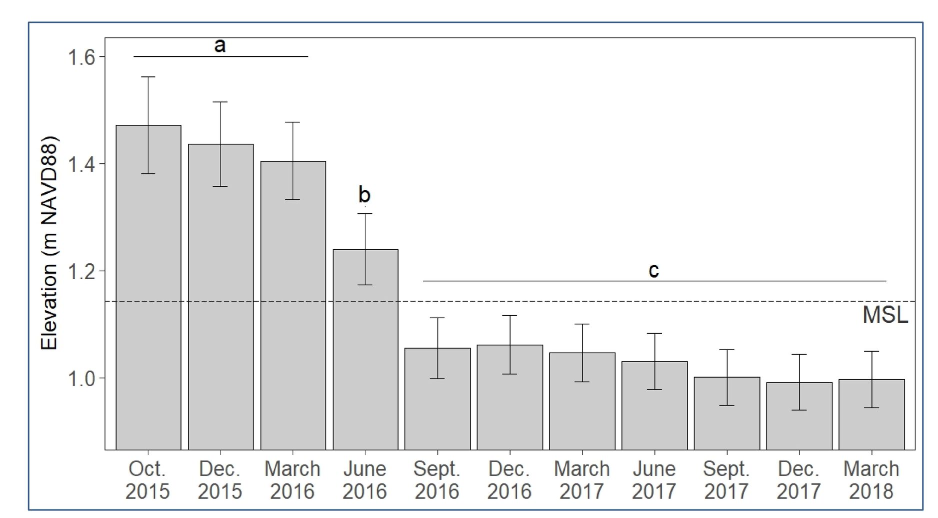


Figure 7: Marsh Mound Early Erosion

Prior to planting experiments and ISP mound planting, many mounds lost about 0.5 m to erosion, indicating the consequence of no pre-breach stabilization planting as designed (see Figure 5A).

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