Quantifying Legacy Mercury Remobilization Associated with Wetland Restoration in San Francisco Bay

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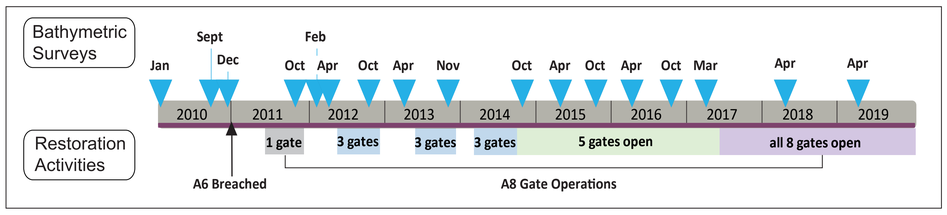
Introduction

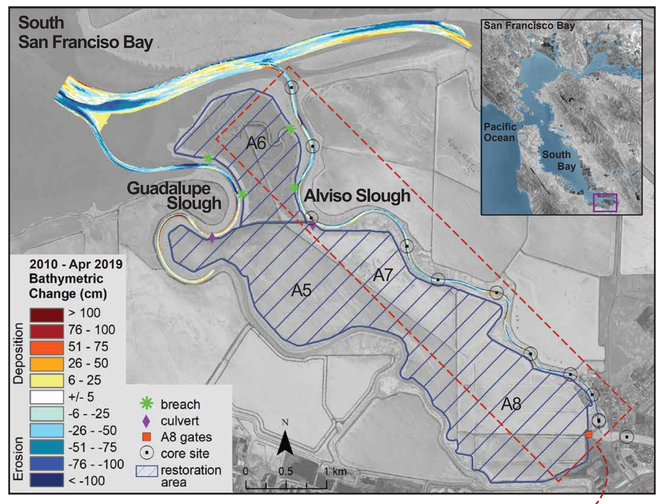
Alviso Slough in South San Francisco Bay, California is the site of an ongoing salt pond restoration project complicated by (1) high sediment demand due to historic ground subsidence and (2) legacy mercury contamination within subsurface sediments of the slough and surrounding ponds. Due to concerns regarding the remobilization of the legacy mercury deposits resulting from historic mining operations in the upstream watershed, a cautious, methodical approach to intertidal marsh restoration was required. In 2010, breaches were cut in the levee separating Pond A6 from the adjacent sloughs, opening the pond closest to the Bay to tidal exchange. Approximately 7 km up slough, where mercury contamination is higher, a tidal control structure was constructed within the levee, and the width and duration of the opening gradually expanded to increase tidal flows between the larger Pond A8 complex and Alviso Slough. To aid restoration managers and inform the adaptive-management process, we developed a technique using high-resolution bathymetric surveys of sediment scour, in combination with total mercury (THg) concentration measurements from deep sediment cores (up to 2 meters), to estimate how much legacy mercury was remobilized from bed sediment as the restoration project progressed.




Collecting swath bathymetry in Alviso Slough.


Alviso Slough at high tide.

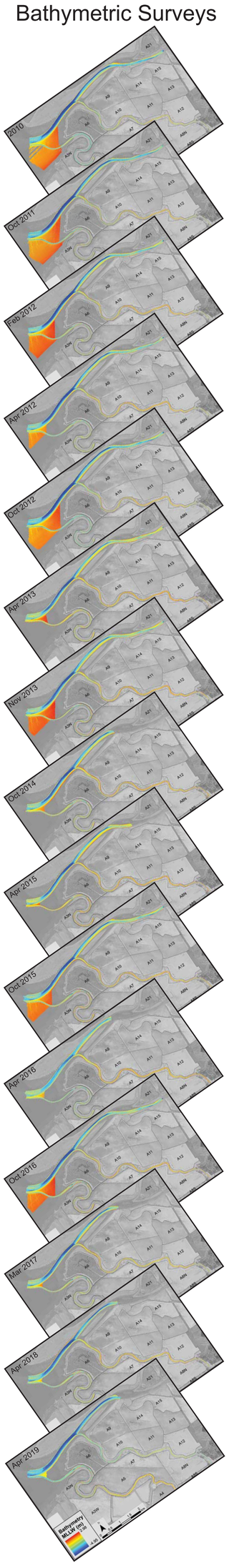
Study Area




Pond A6 (breached in 2010) at high tide.

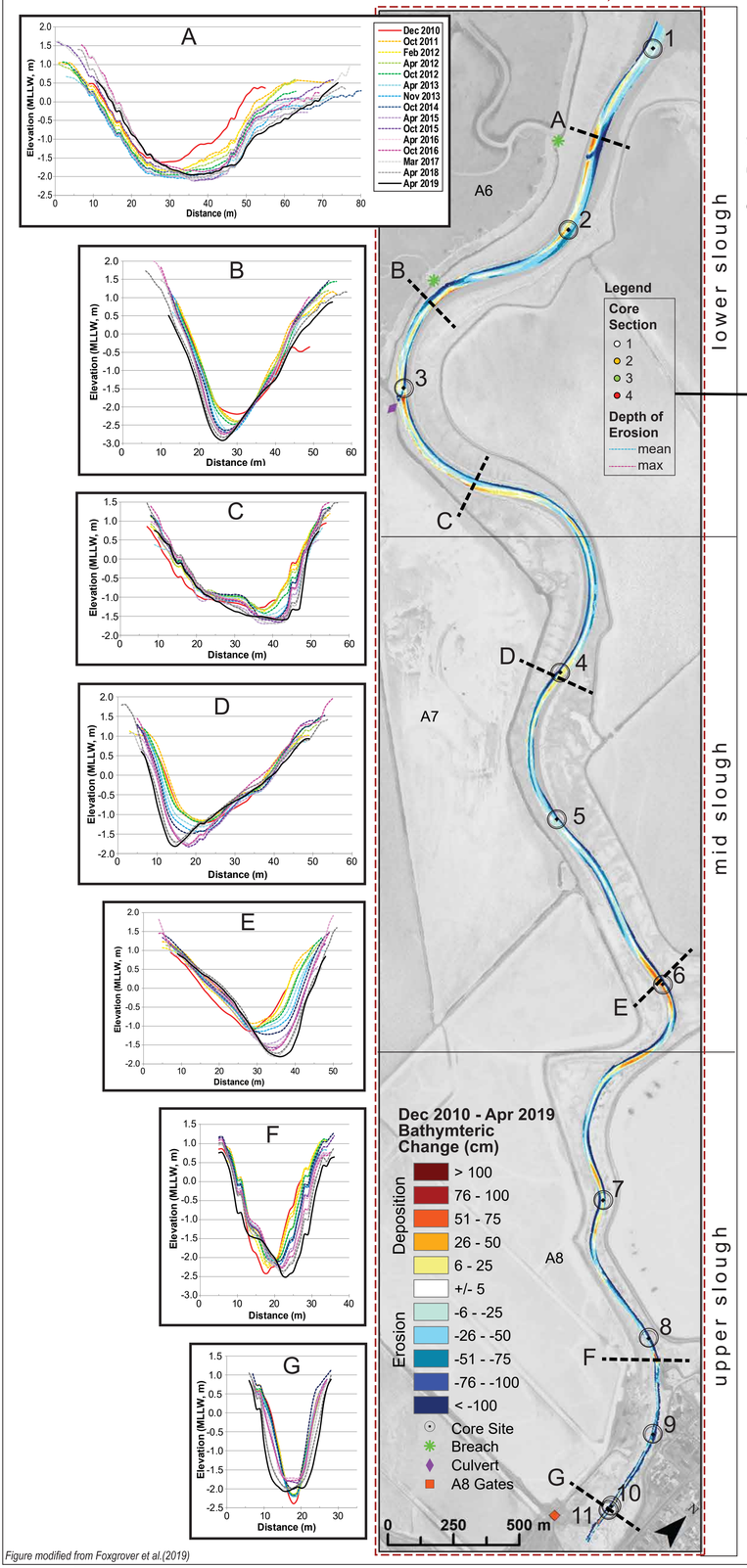

Flow-control structure at Pond A8. The opening of each 1.5-m-wide gate was phased to gradually increase tidal flows to the Pond A8 complex.

Bathymetric Surveys



Measurements

Bathymetric Change Through Time



Total Mercury Concentration from 12 Sediment Cores

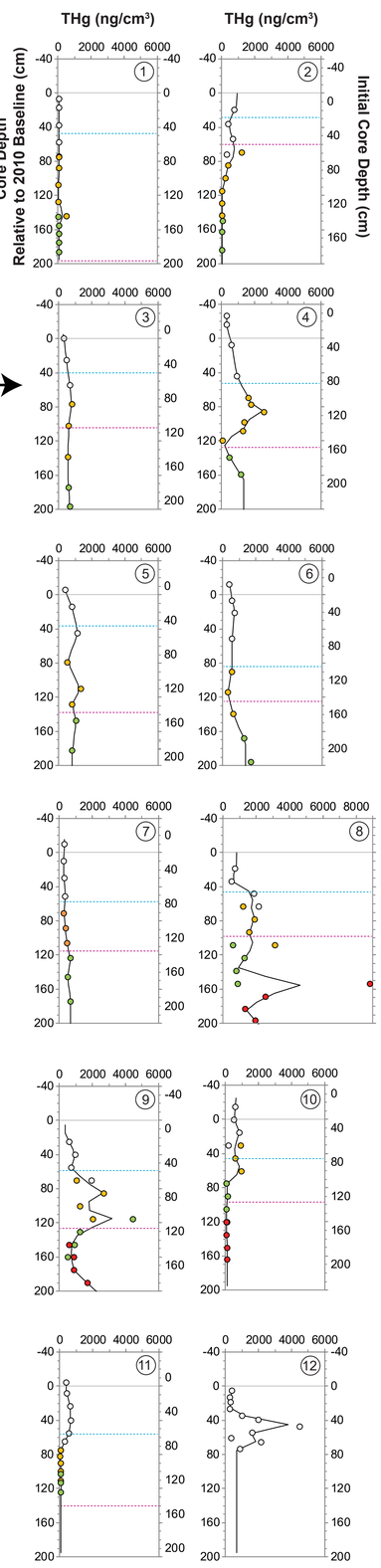
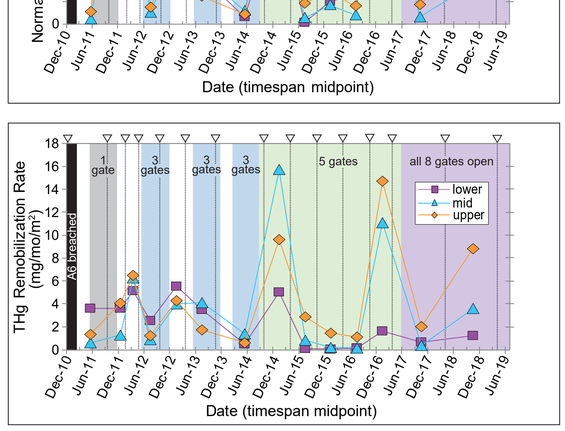
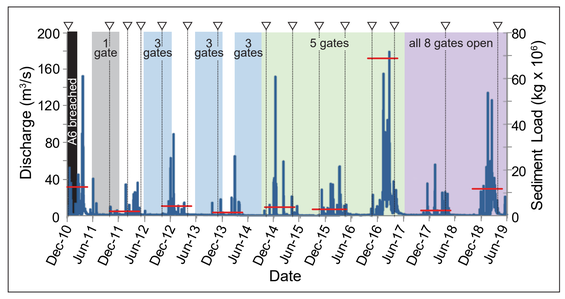


Figure modified from Foxgrover et al.(2019)

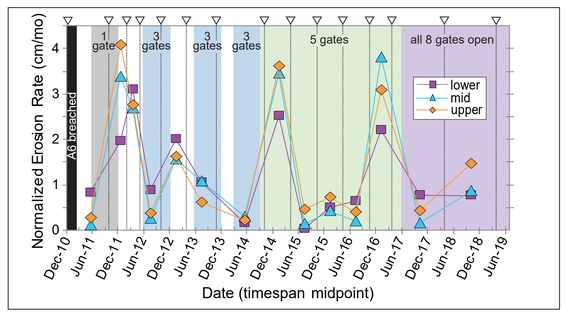
Results



Area-normalized net change rates highlight variations by season and by slough segment. A8 gate operations indicated by color shading and bathymetric surveys by dashed vertical lines.

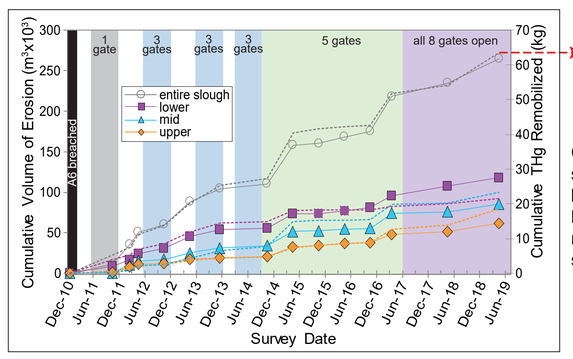


River discharge at USGS Guadalupe River station 1169025 (located 7.5 km upstream of the A8 gates) depicts years with increased freshwater inputs and cumulative suspended sediment loads (horizontal red lines).



Area-normalized erosion rates highlight periods of peak sediment scour. Note that the 3 peak erosional events occurred during periods of varying river discharge and A8 gate operations.

Area-normalized rates of THg remobilization show an increase in the rate of remobilization in the mid and upper slough since the winter of 2014/2015. This increase suggests that deeper sediments with higher THg concentrations are being remobilized.

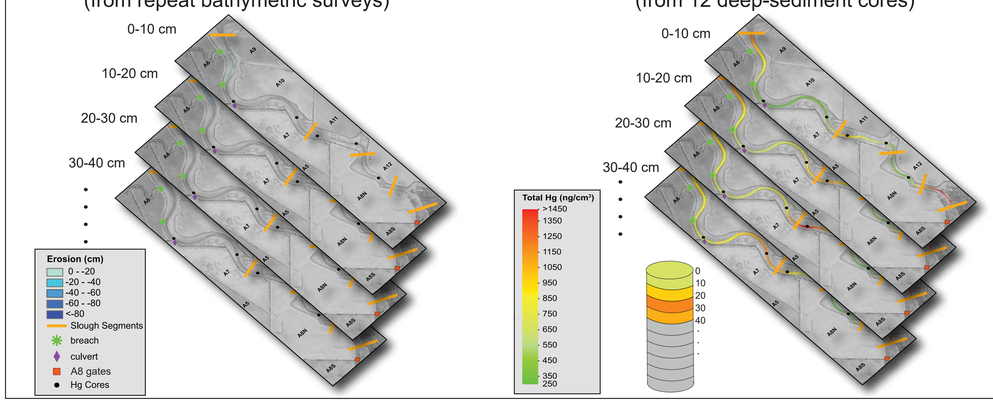


64 kg of THg remobilized from December 2010 to April 2019.

Cumulative volume of sediment erosion (solid lines) and the estimated kilograms of THg remobilized from bed sediments (dashed lines).

Method

x



Conclusions

- Alviso Slough is evolving in response to both restoration actions as well as natural seasonal variability in precipitation and larger-scale sediment transport patterns within San Francisco Bay.
- An estimated 64 kg of THg has been remobilized as a result of sediment scour within Alviso Slough since restoration began in December 2010.
- The lower slough appears to be approaching a new equilibrium whereas the mid to upper slough is still evolving and remains a potential area of THg remobilization in the future.

References

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