

Changes in San Francisco Bay Bathymetry

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Changes in San Francisco Bay Bathymetry

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SF Bay Regional Water Quality Control Board

EPA

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Santa Clara Valley Water District

Collaborators include:

NOAA, Center for Operational Oceanographic Products and Services

Changes in San Francisco Bay Bathymetry

Many people contributed to this study including:

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Chris Malzone

Ryan Leach

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Melissa Ingraca

Changes in San Francisco Bay Bathymetry

Main Points

- 1) Analysis of bathymetric surveys of San Francisco Bay from the 1850s to 2010s shows that, overall, the Bay gained sediment until the 1950s and lost sediment afterwards.
- 2) The volumes and patterns of sediment gain and loss are complex and change over time and space.
- 3) This information is useful for understanding sediment transport in the Bay, developing and validating morphodynamic models, habitat change, legacy contaminants, and improving forecasts for how the Bay will change in response to sea level rise and climate change.

Outline

- Bathymetric surveys of San Francisco Bay
- How the Bay has changed since the 1850s
- Summary and future work

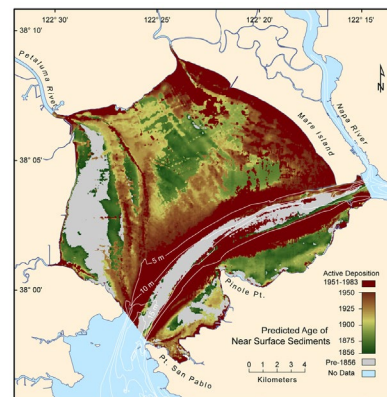
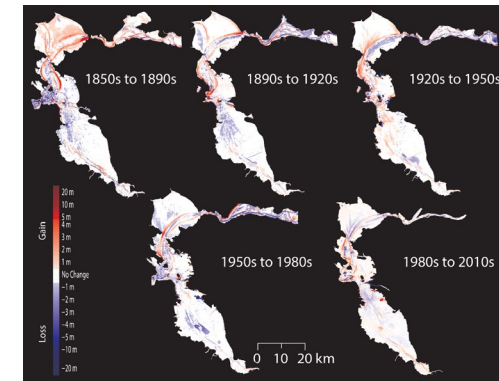


Fig. 6. Spatial distribution of historical sediments in San Pablo Bay predicted using the Bathychronology methodology. Sediment ages represent the predicted year of deposition at the top of each reconstructed sediment age profile.

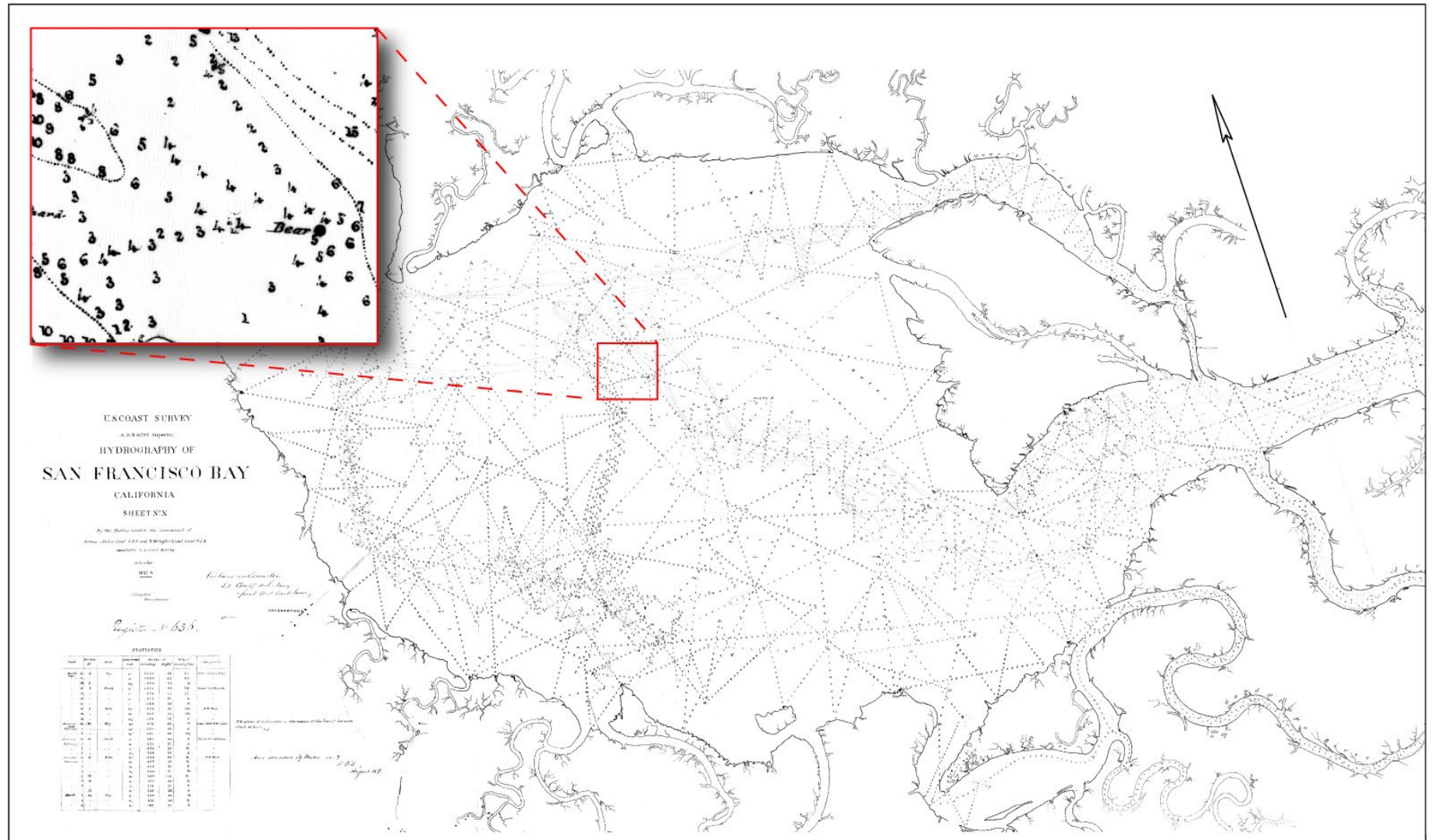
First comprehensive bathymetric survey of San Francisco Bay was made in the 1850s/1860s



Image obtained from NOAA photo library (www.photolib.noaa.gov)

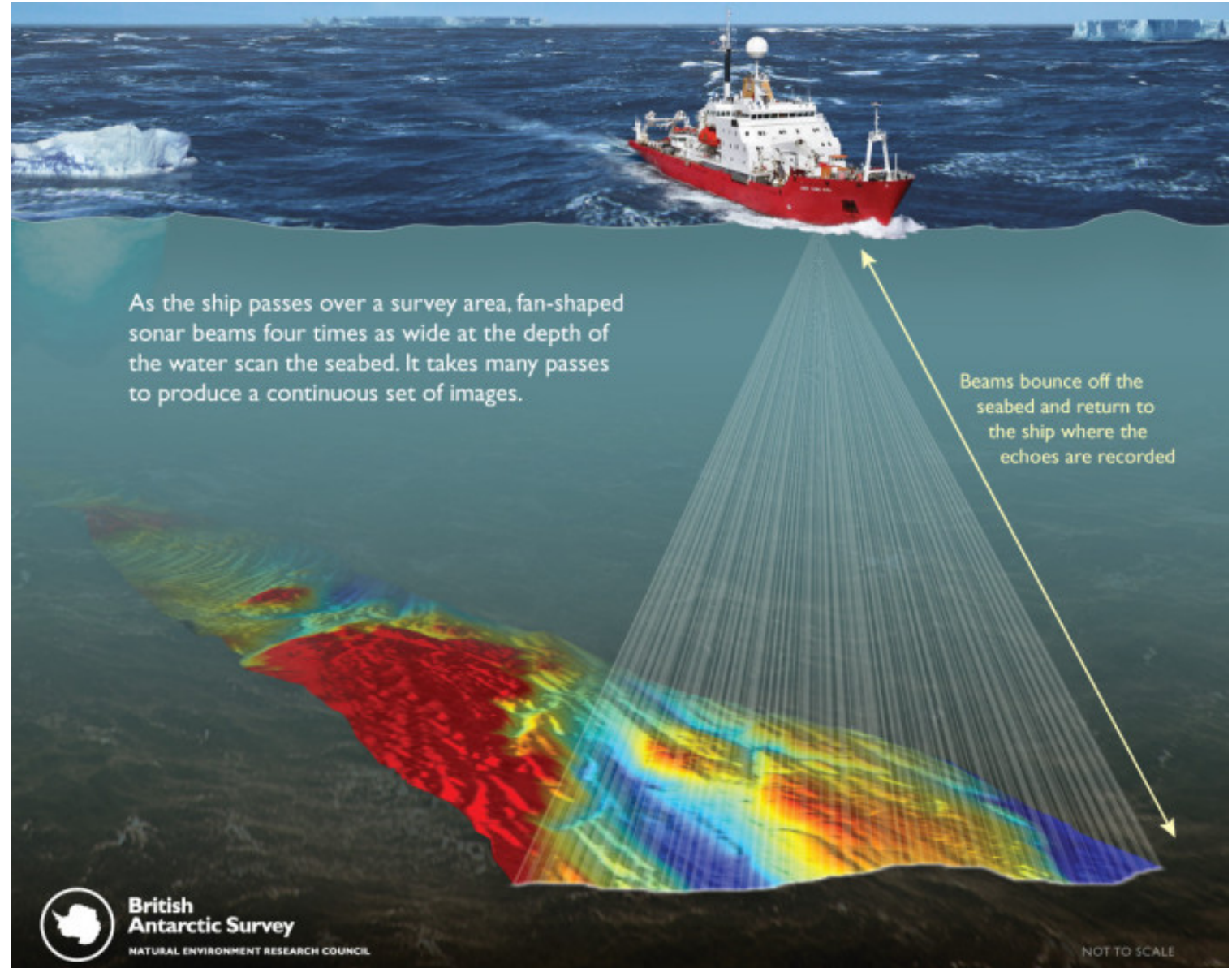
1858
Hydrographic
Sheet of
South Bay

Part of a
comprehensive
survey of the Bay
by the US Coast
and Geodetic
Survey
(predecessor to
NOAA)

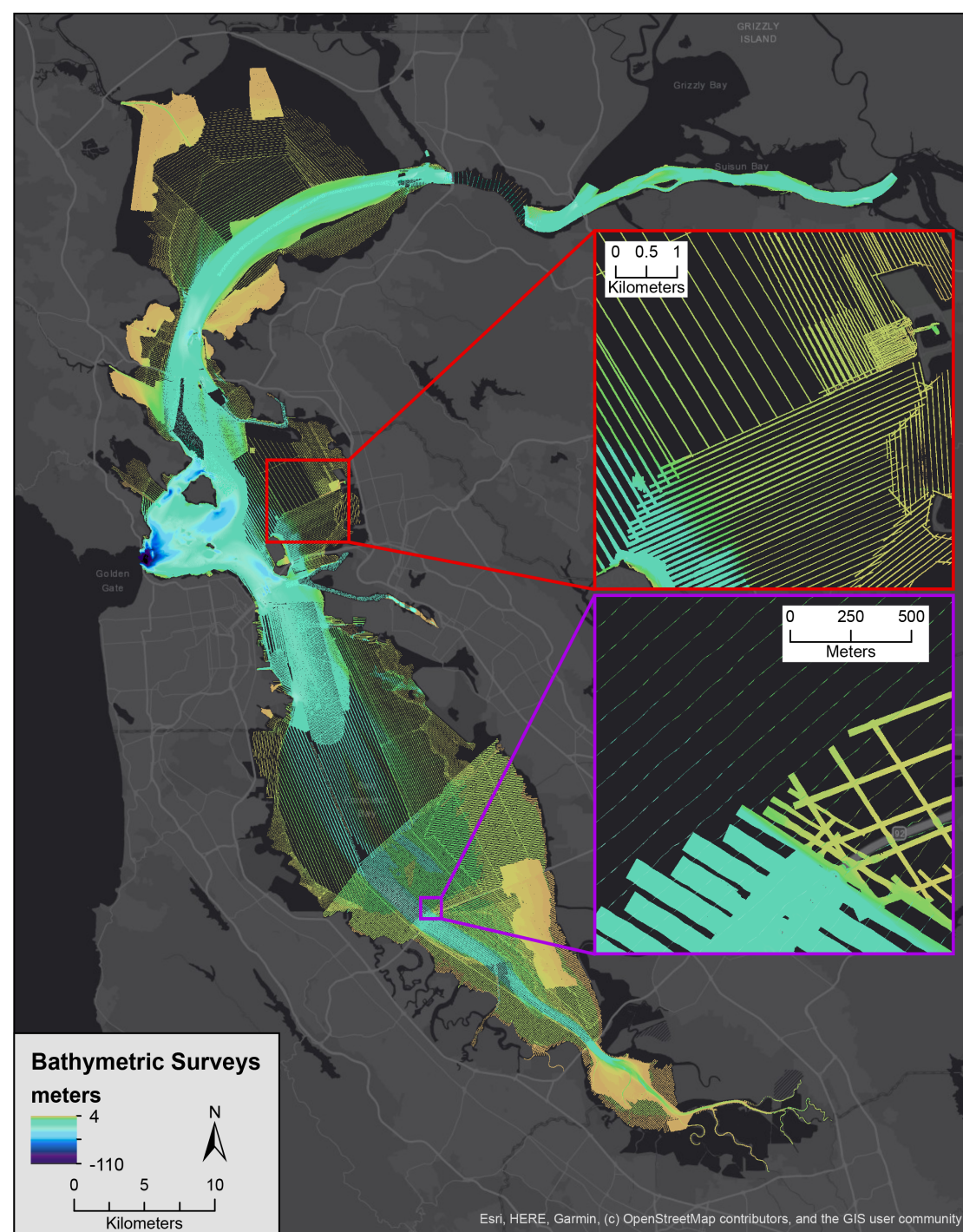


Latest bathymetric survey of San Francisco Bay:

Multibeam or interferometric sidescan swath bathymetry



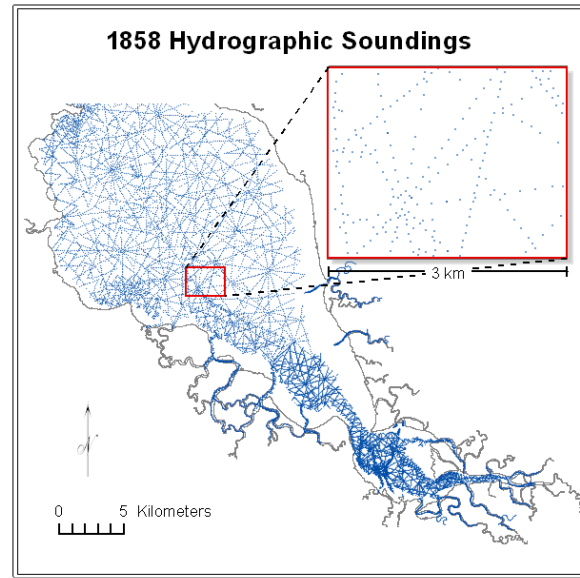
Latest bathymetric surveys of San Francisco Bay used in this study were collected from 1999 to 2020



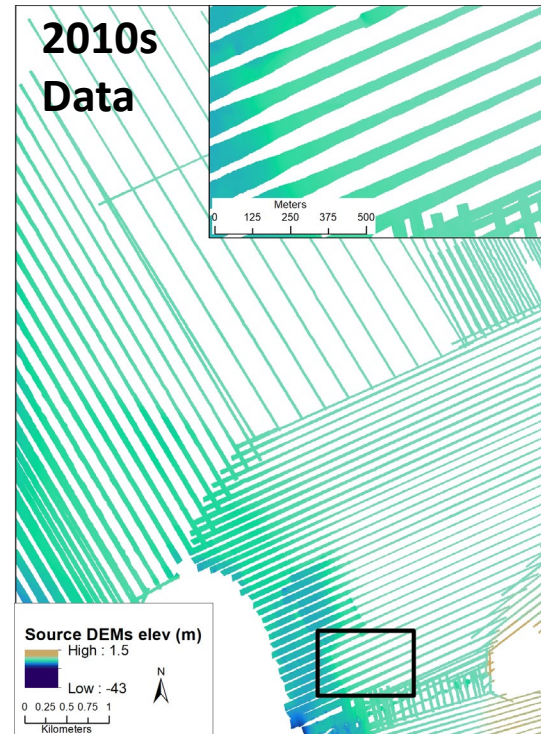
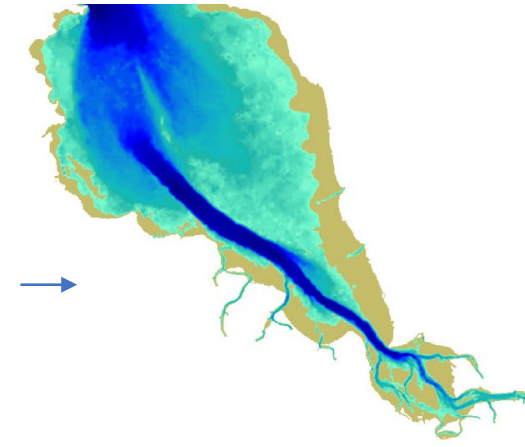
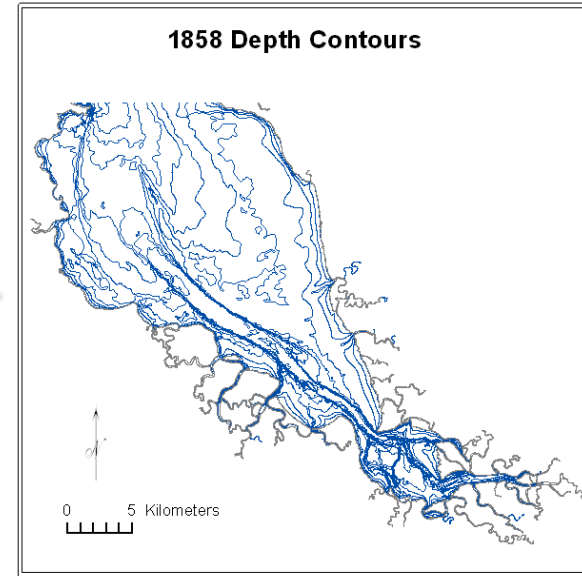
Fregoso et al.
in prep.

Creating bathymetric surface grids:

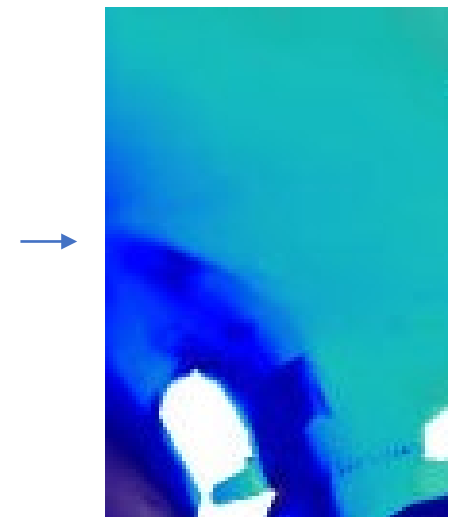
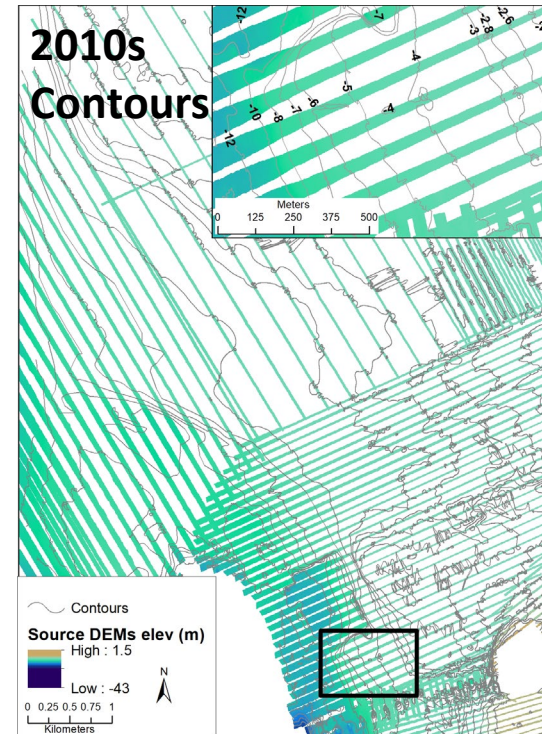
- Digitize soundings (historical surveys)
- Add contours
- Error check
- Grid to create a continuous surface



+



+



From the 1850s to
2010s the Bay was
surveyed 6 times

Details in:

Jaffe et al. 1998

Cappiella et al. 1999

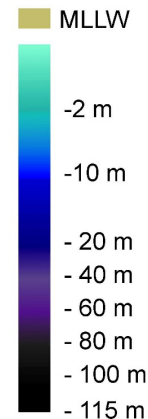
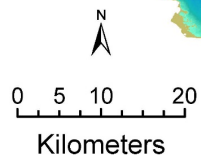
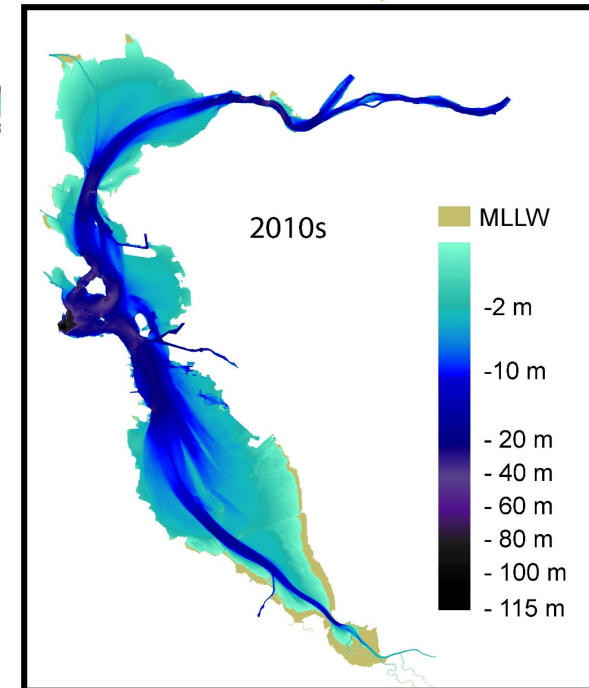
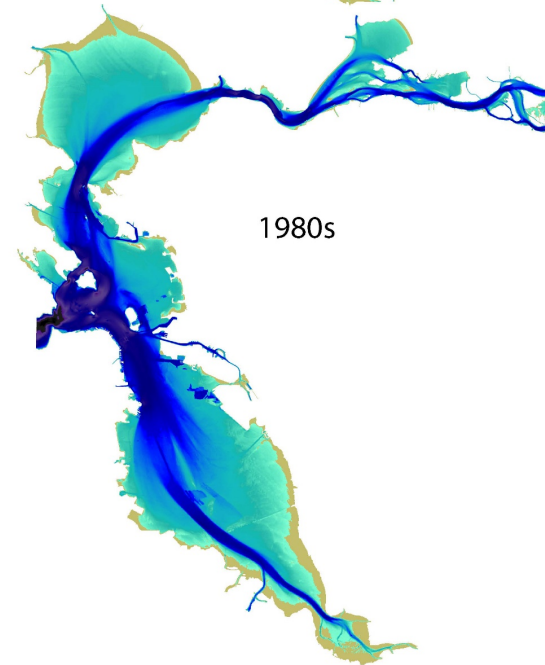
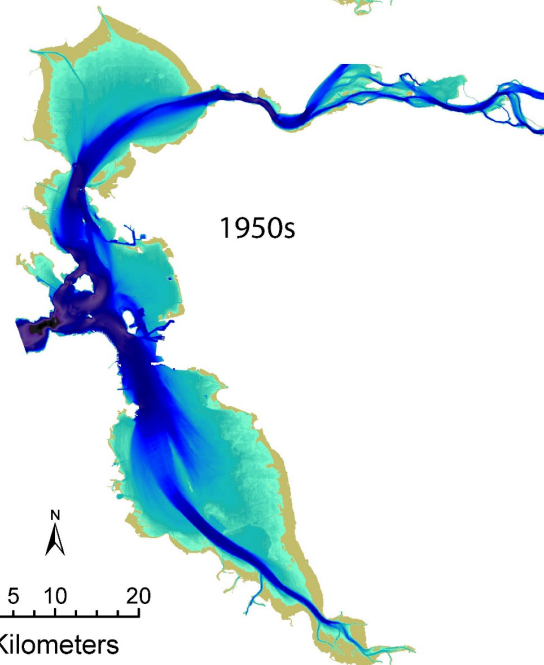
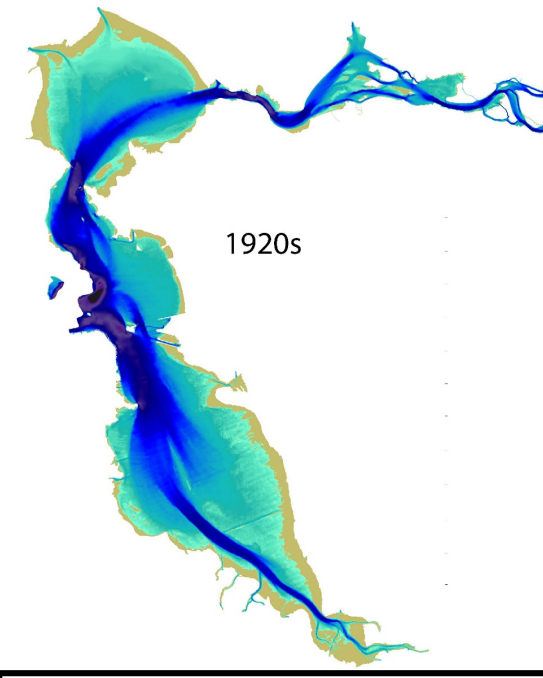
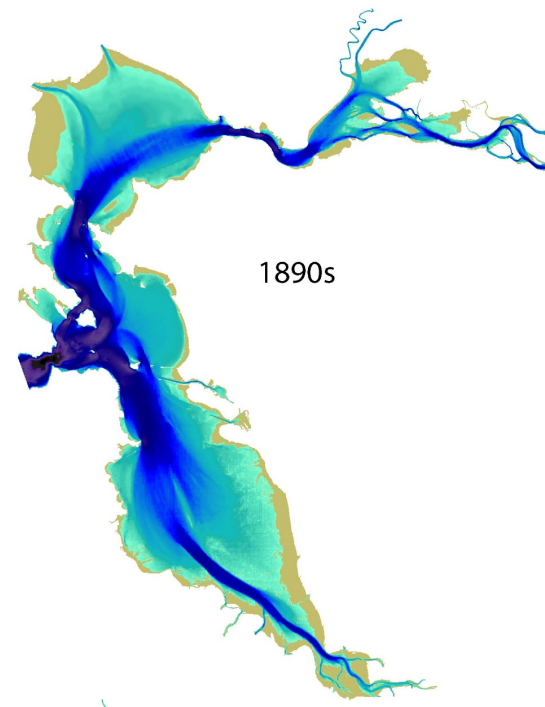
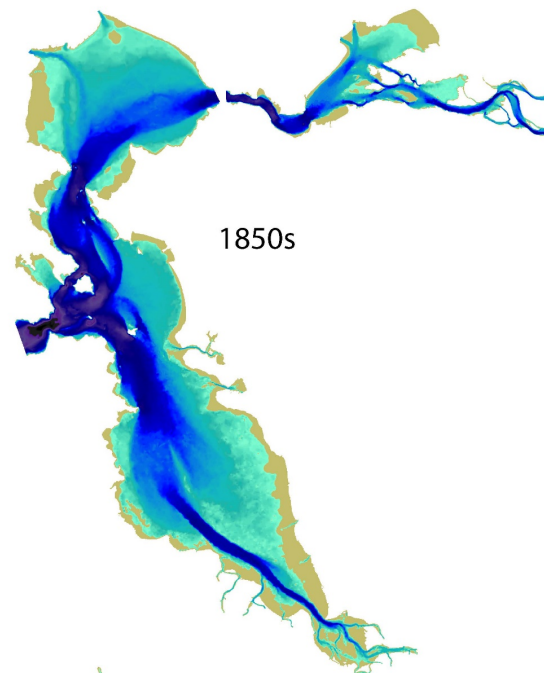
Foxgrover et al. 2004

Jaffe and Foxgrover 2006

Jaffe et al. 2007

Fregoso et al. 2008

Fregoso et al. in prep.



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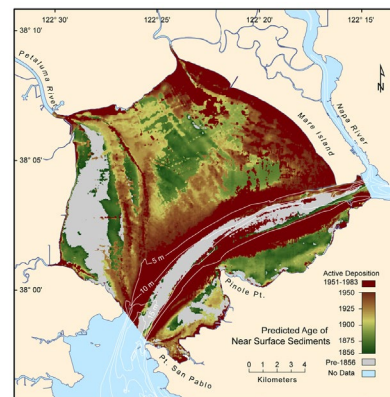
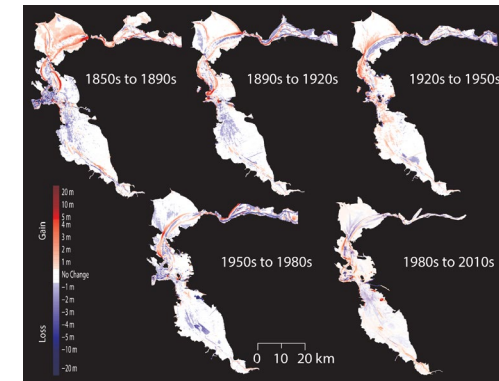
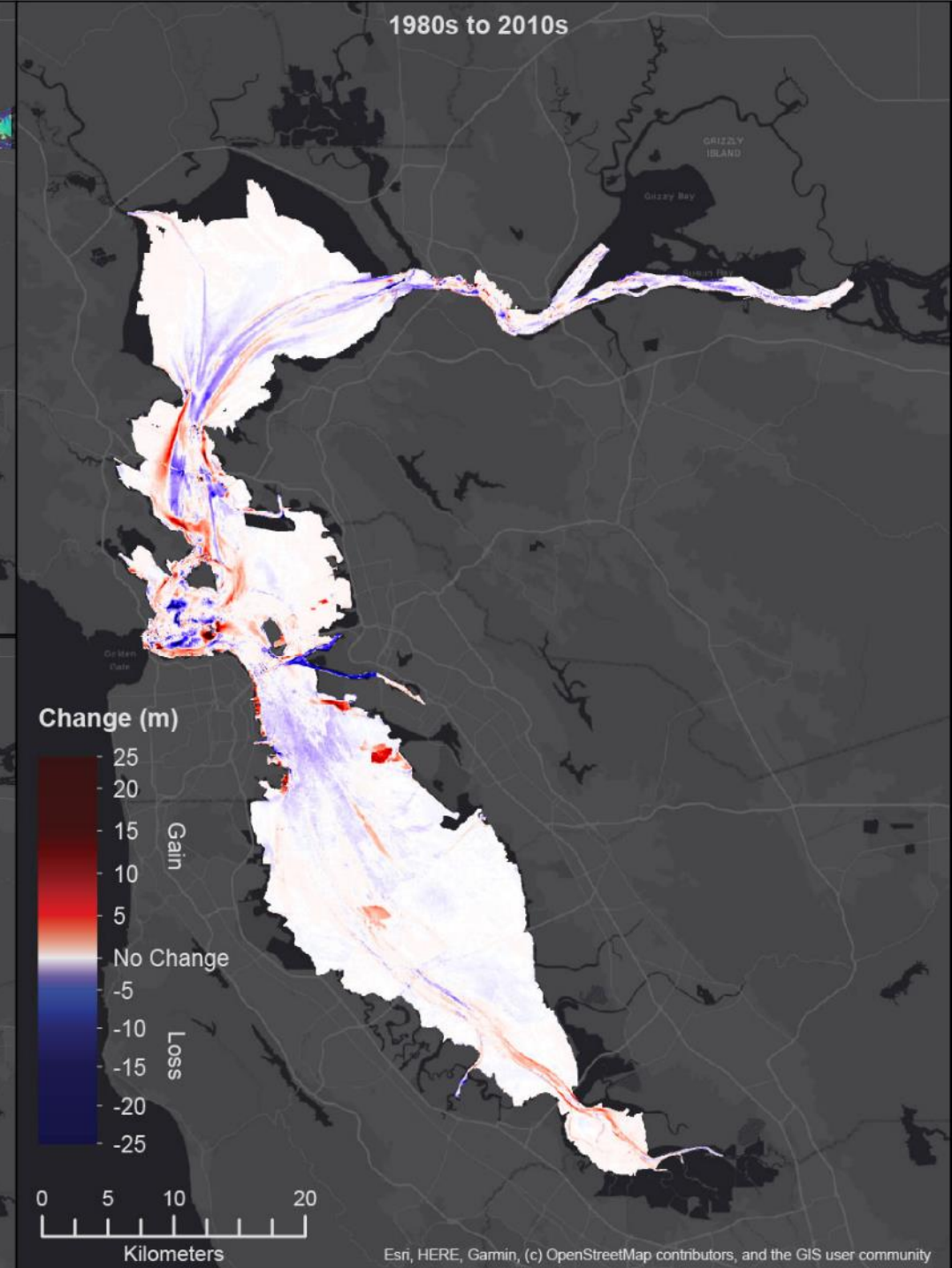
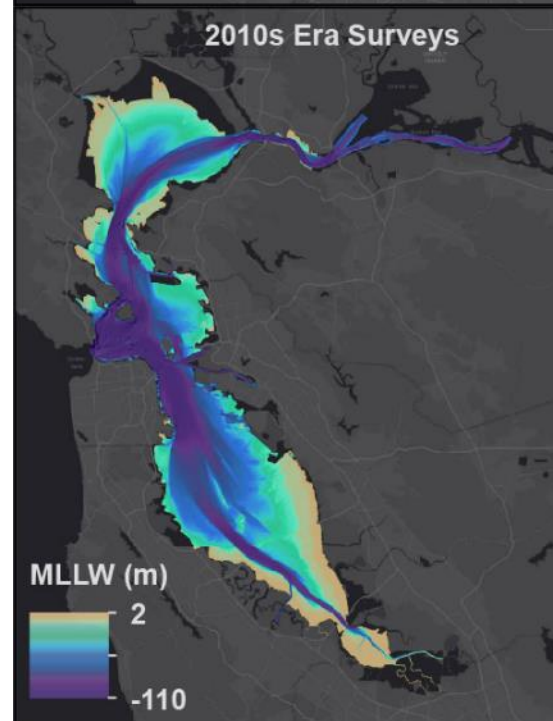
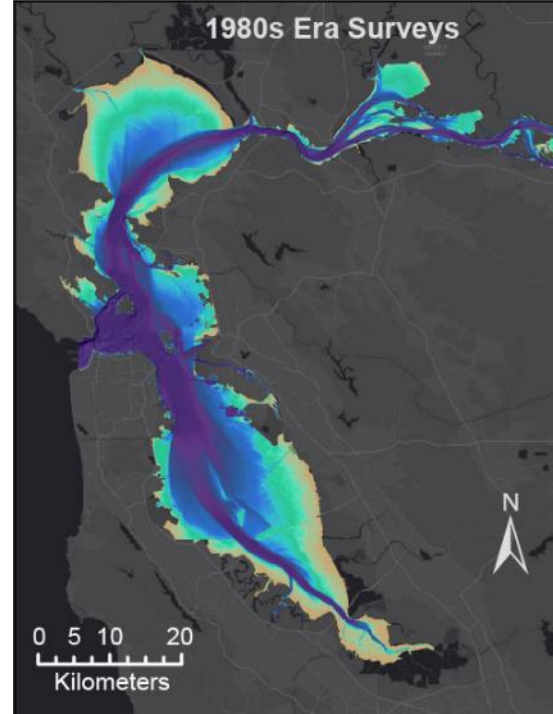


Fig. 6. Spatial distribution of historical sediments in San Pablo Bay predicted using the Bathychronology methodology. Sediment ages represent the predicted year of deposition at the top of each reconstructed sediment age profile.

Bathymetric change grids are created by differencing two bathymetric surface grids (after bringing them to a common vertical datum)

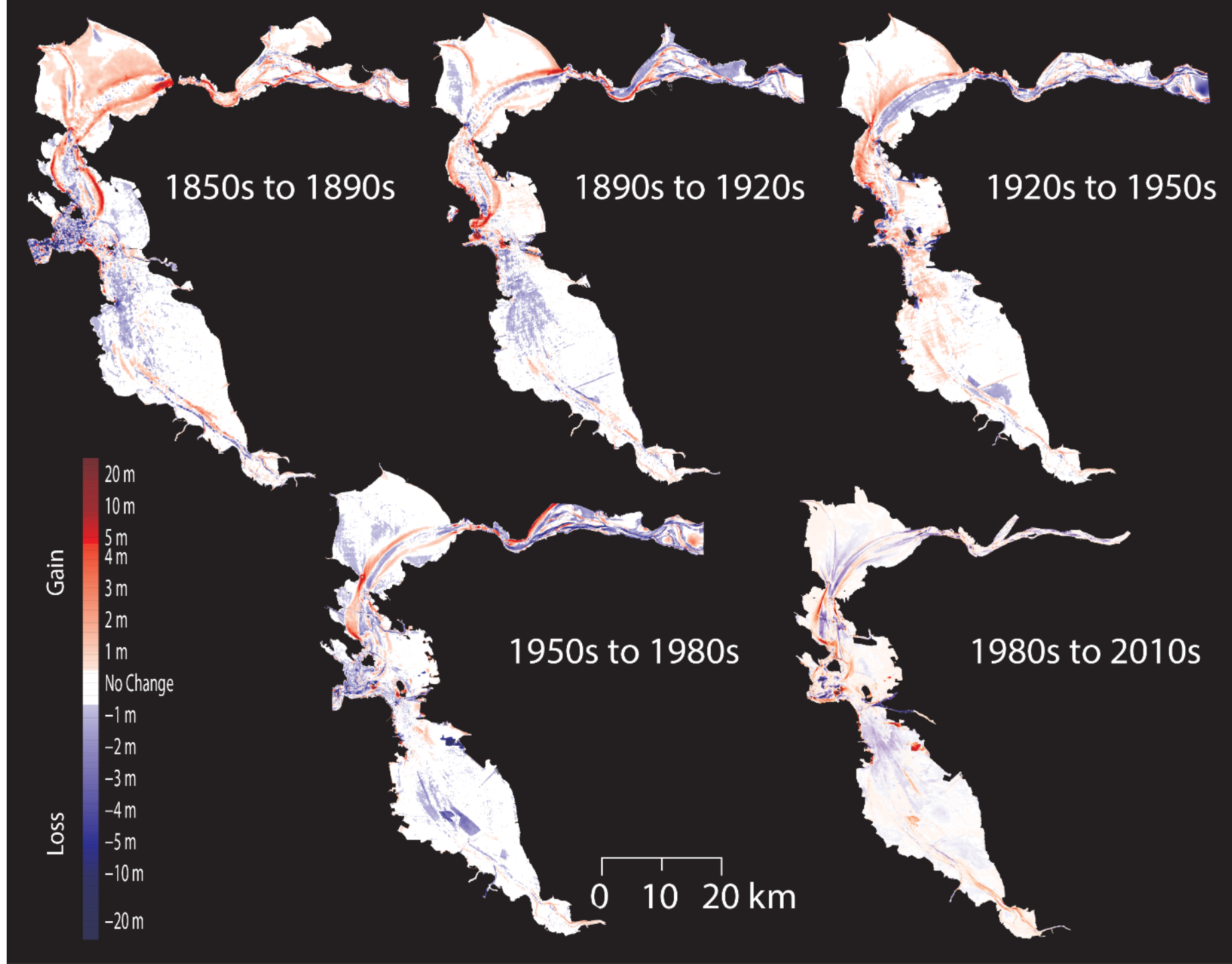


Bathymetric change for 5 time periods

Reds are sediment gain

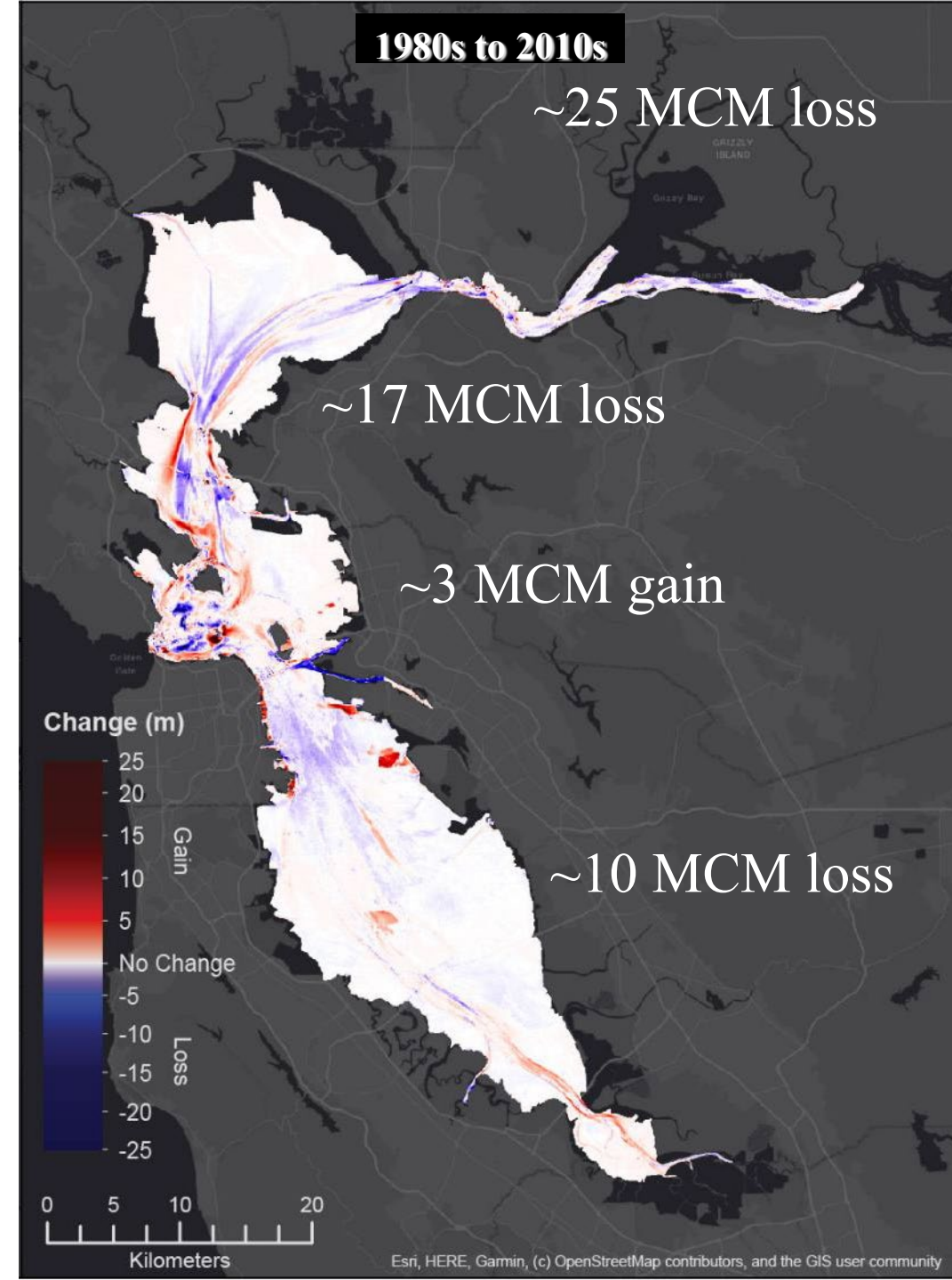
Blues are sediment loss

More intense colors are
greater change



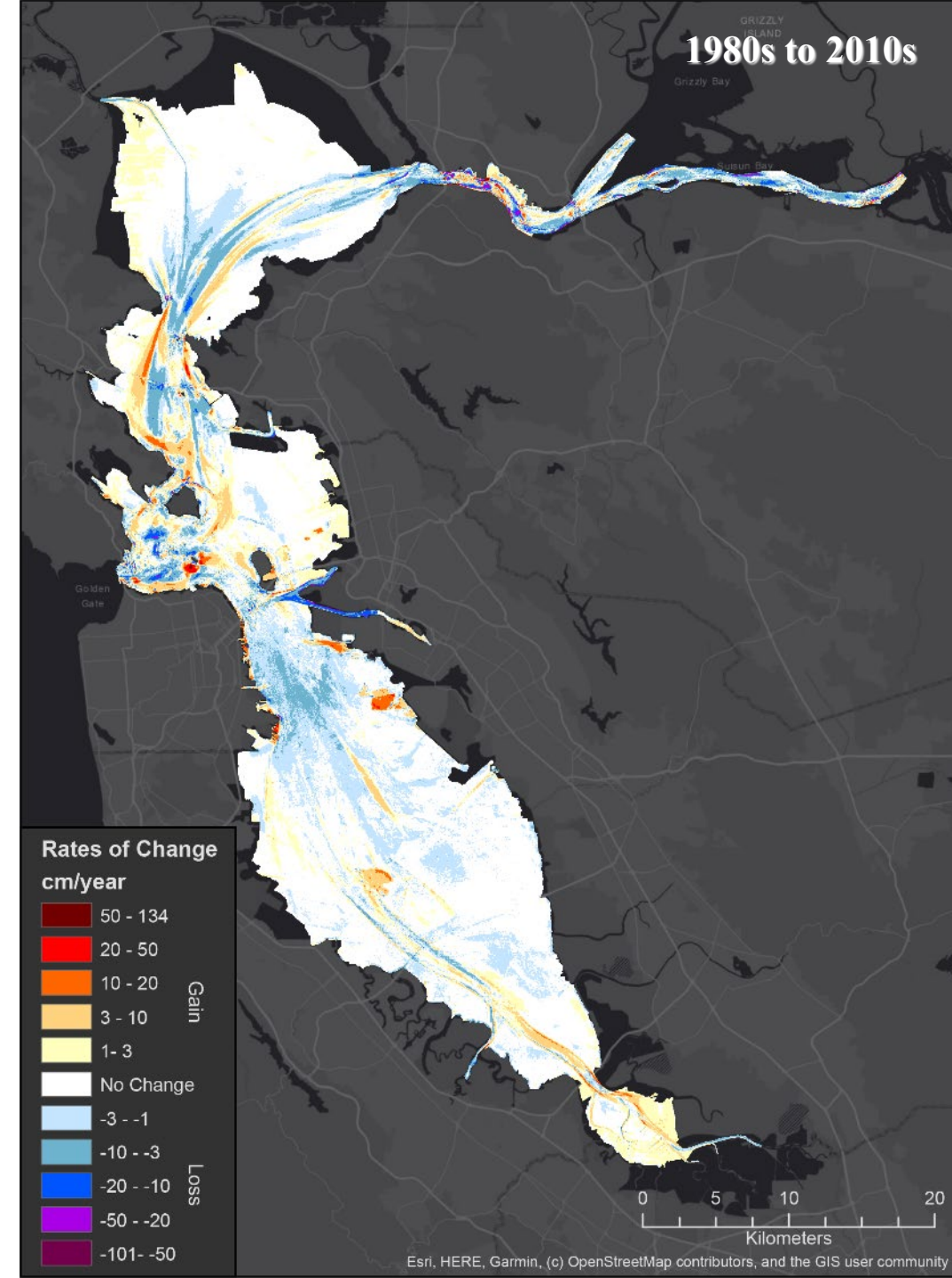
Volumes of sediment losses and gains for each subembayment

Note: Missing data, especially in Suisun Bay limits conclusions that can be made about net sediment volume change in the entire Bay

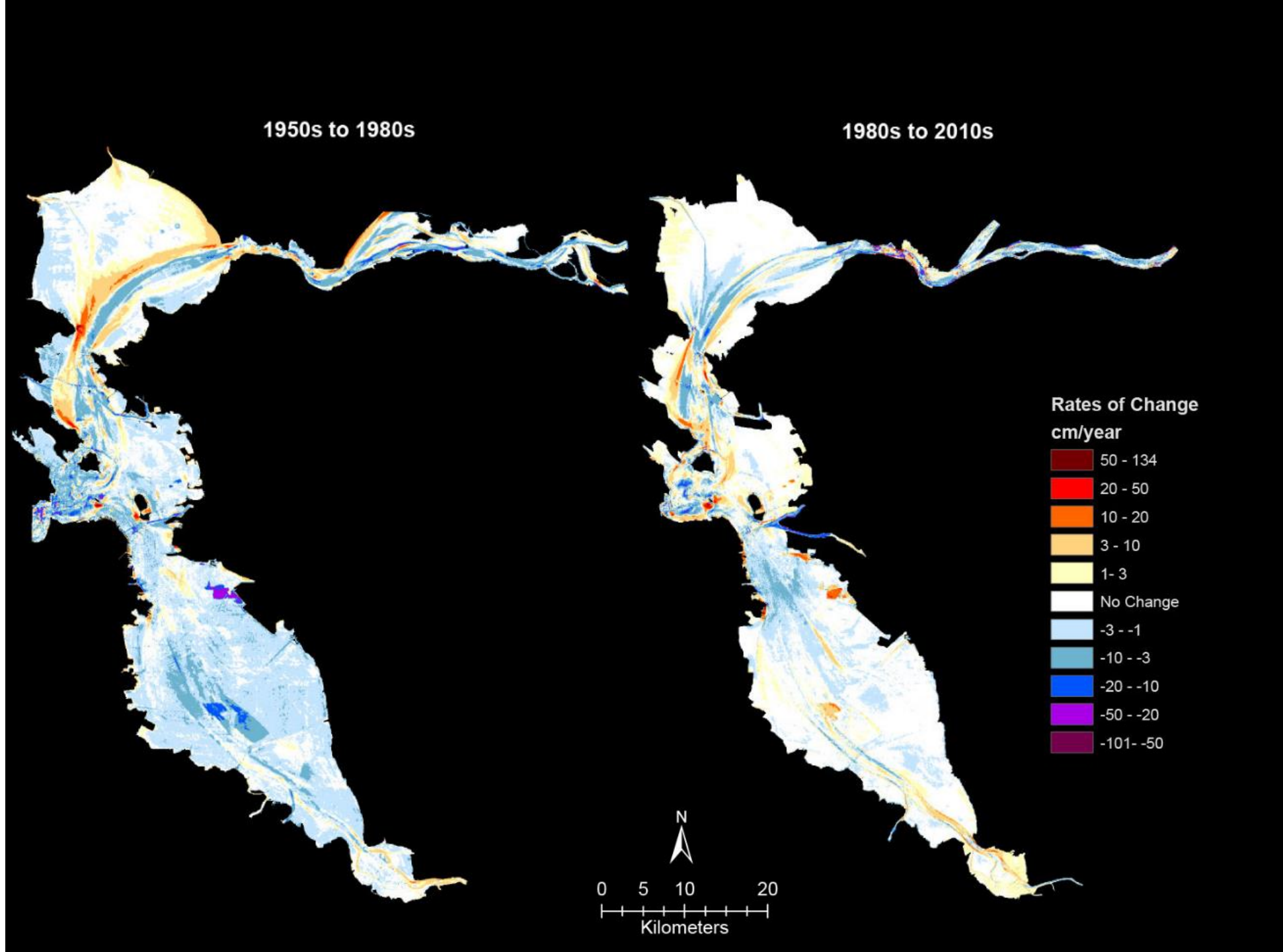


The time between surveys varies for different parts of the Bay

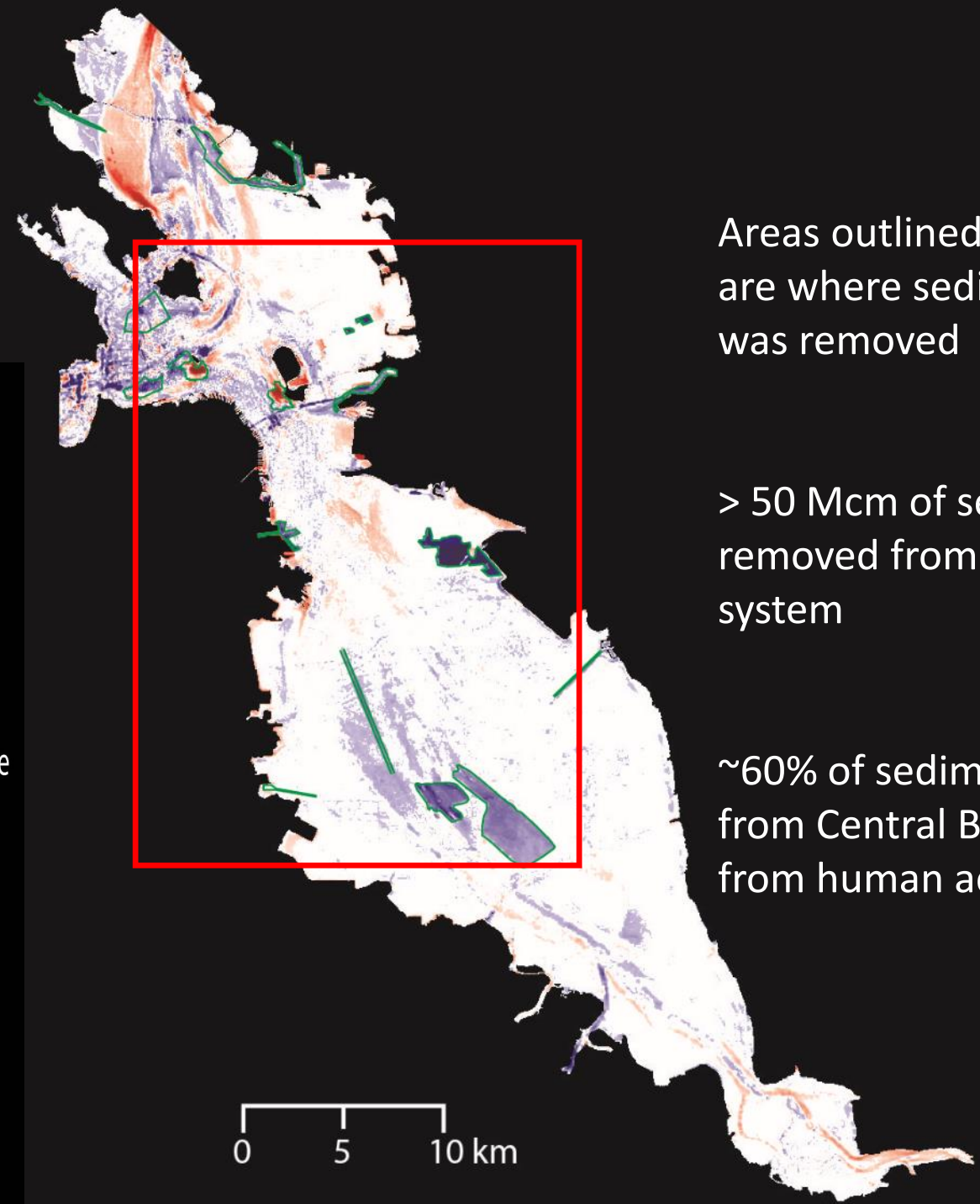
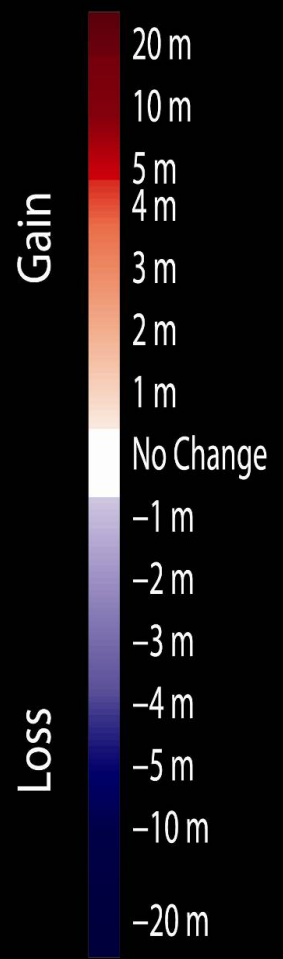
Analyzing rates of change accounts for variations in timespans and allows for direct comparisons with earlier periods



Comparison of rates of bathymetric change



Sediment removal from 1950s to 1980s

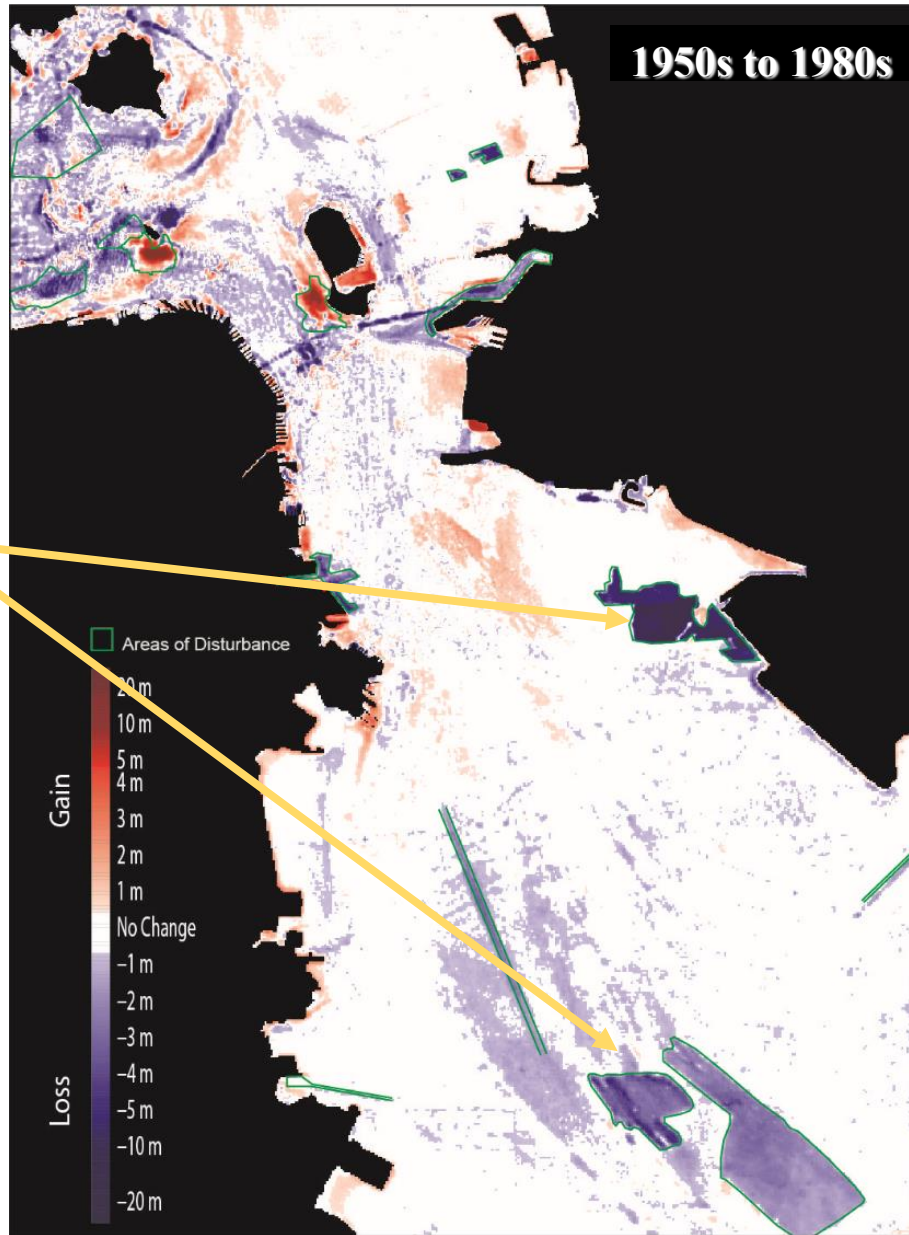


Areas outlined in green
are where sediment
was removed

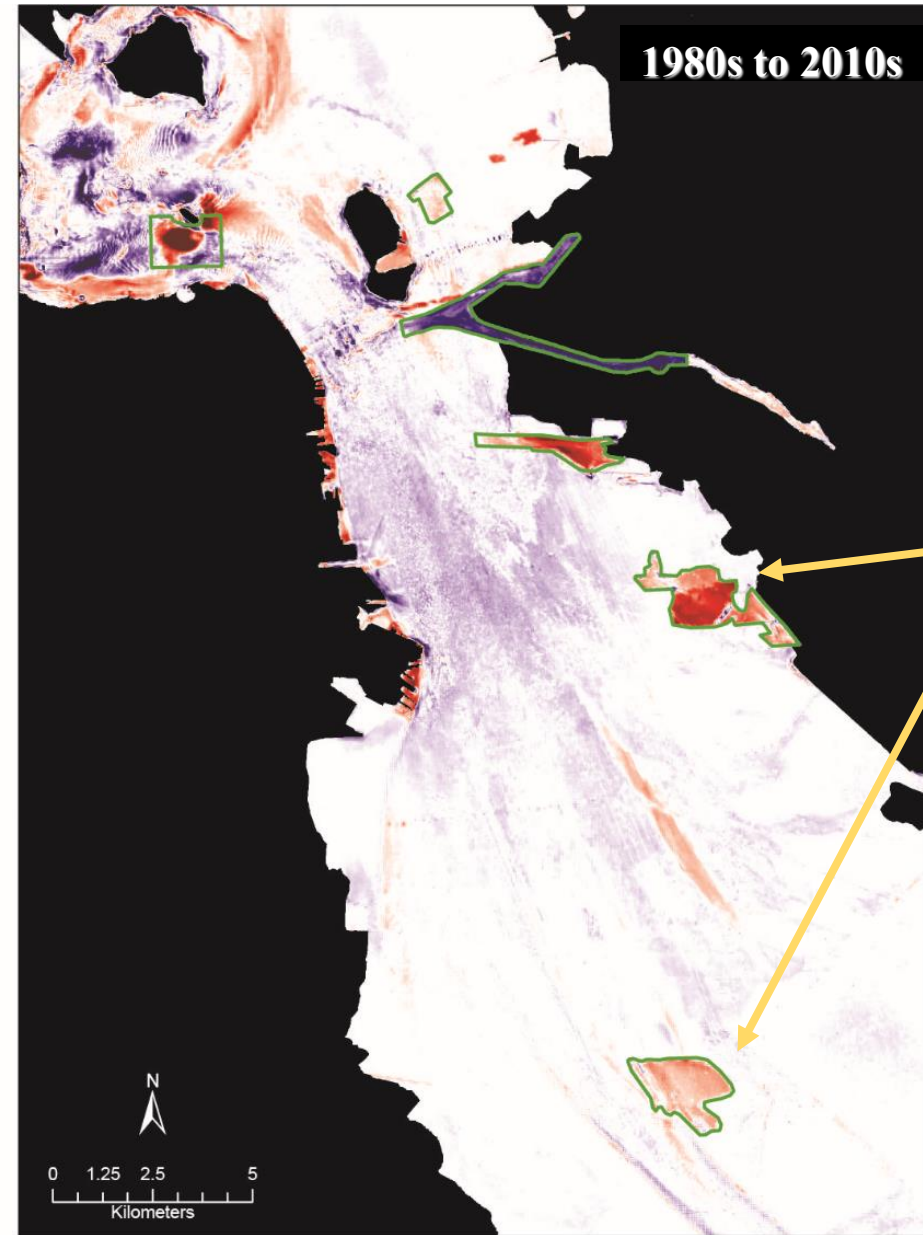
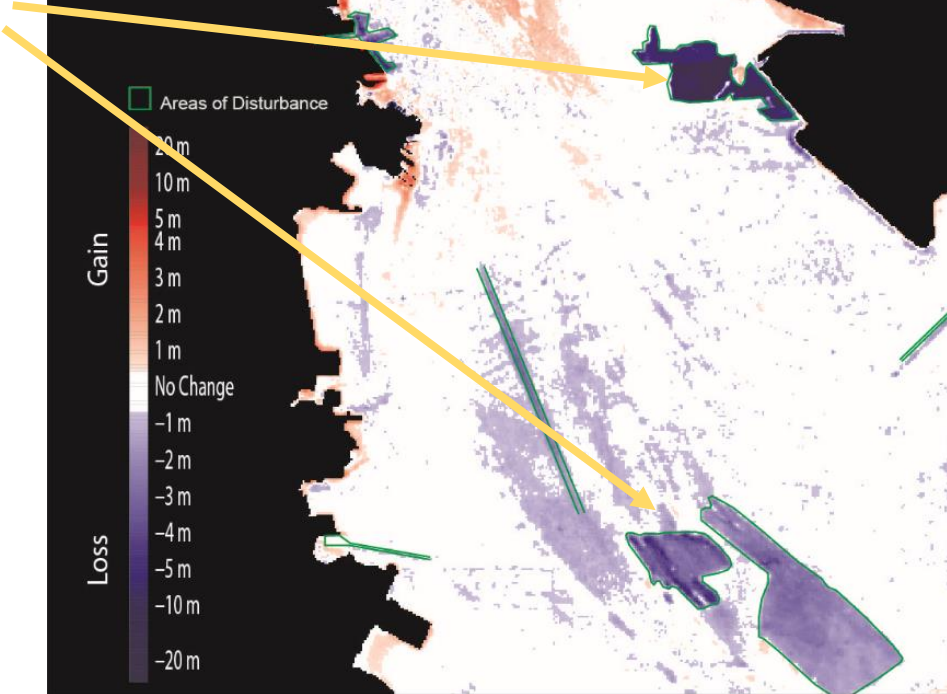
> 50 Mcm of sediment
removed from the
system

~60% of sediment loss
from Central Bay was
from human activities

Effects of Human Activities



Sediment
extraction

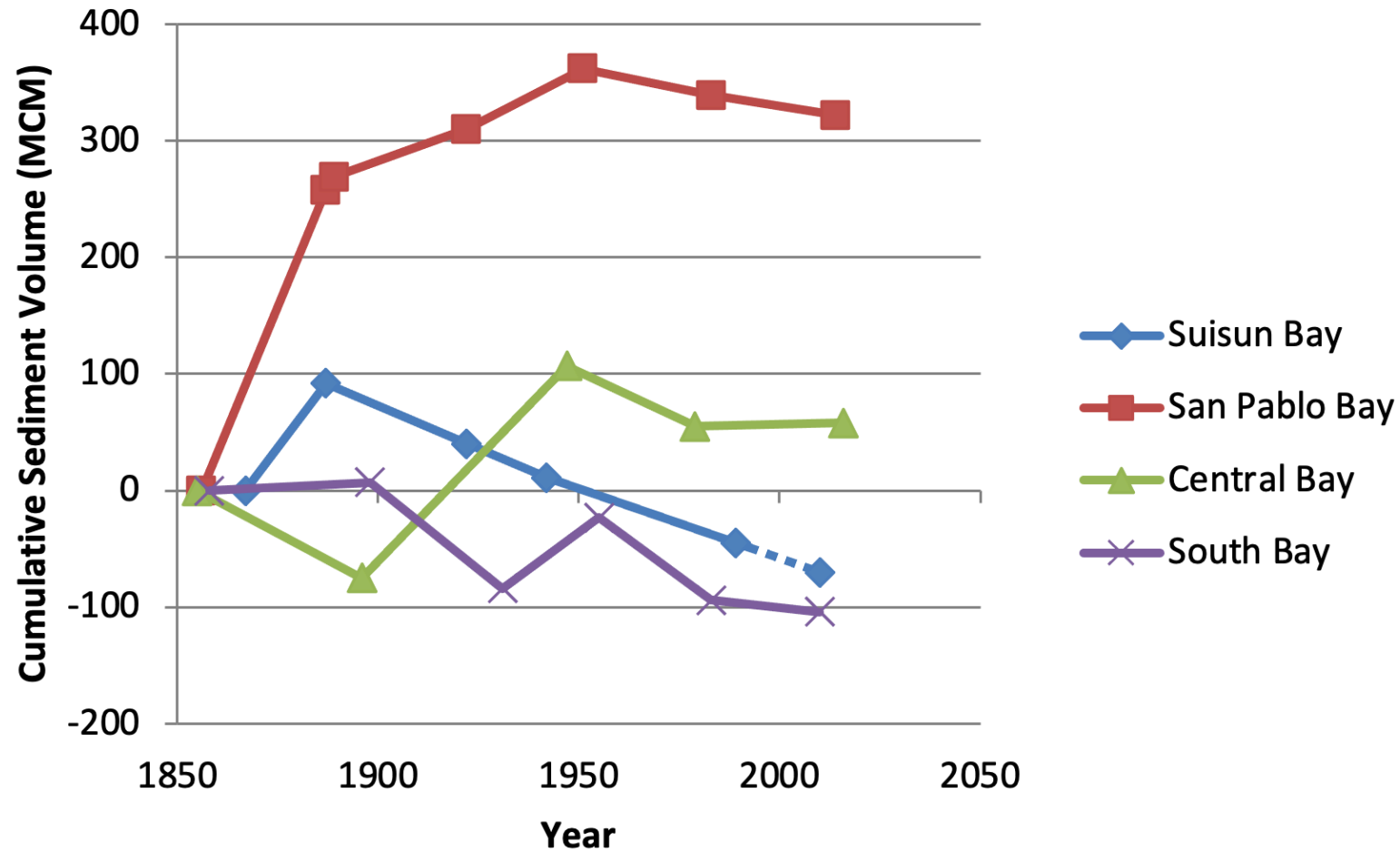


Enhanced
deposition



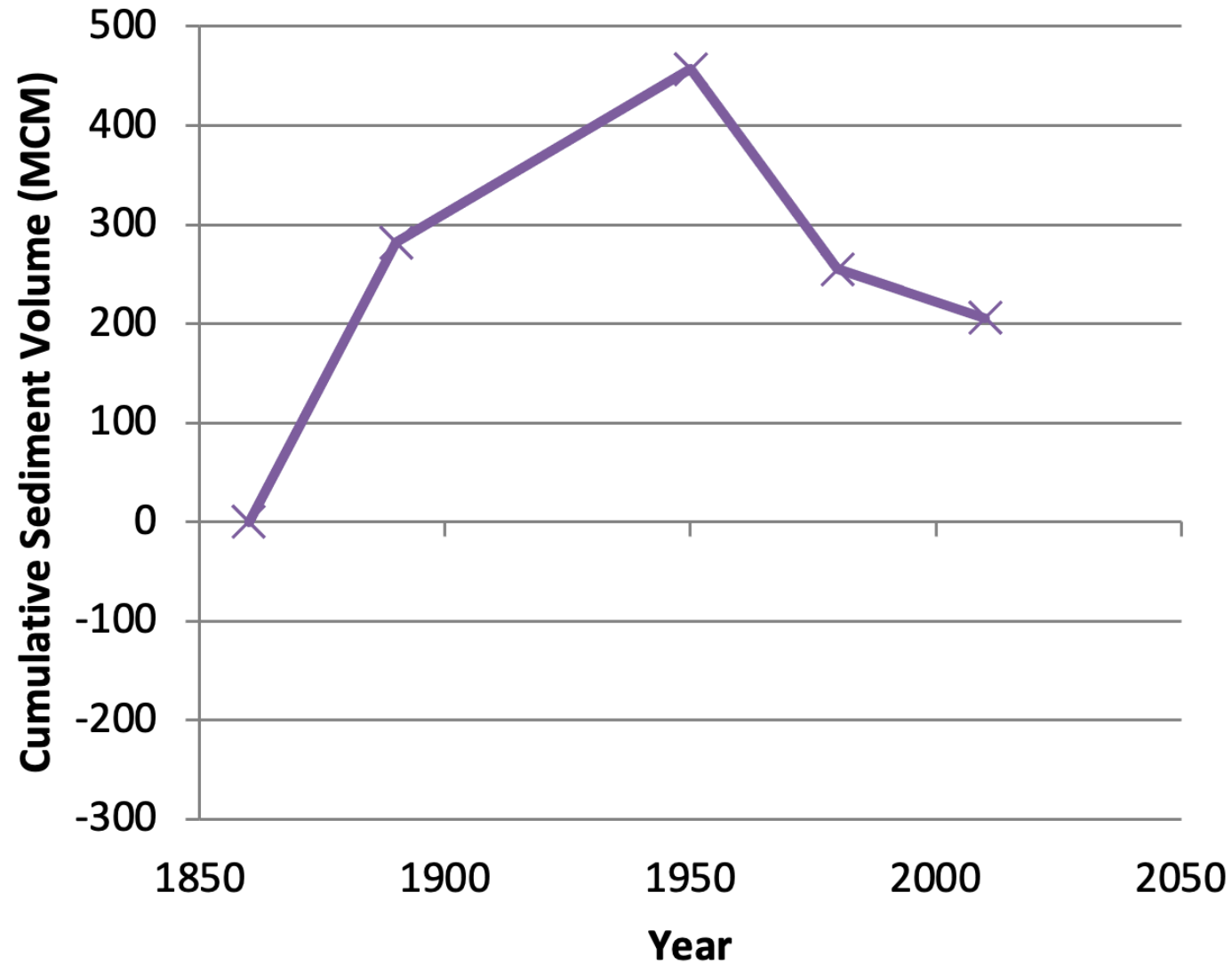
Cumulative net volume change in subembayments

- includes human activities that remove sediment



* Survey area varies with time period

Cumulative net volume change in the "entire" Bay



* Survey area varies with time period

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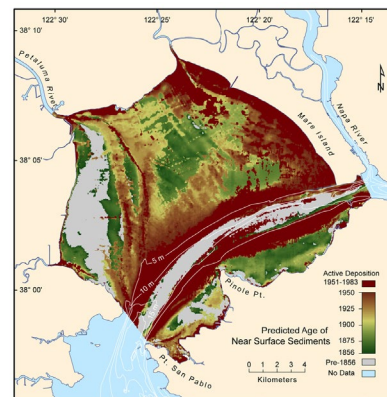
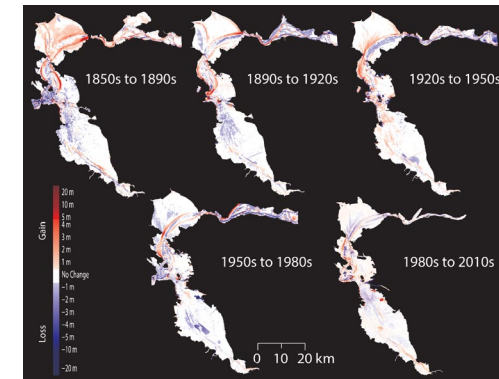


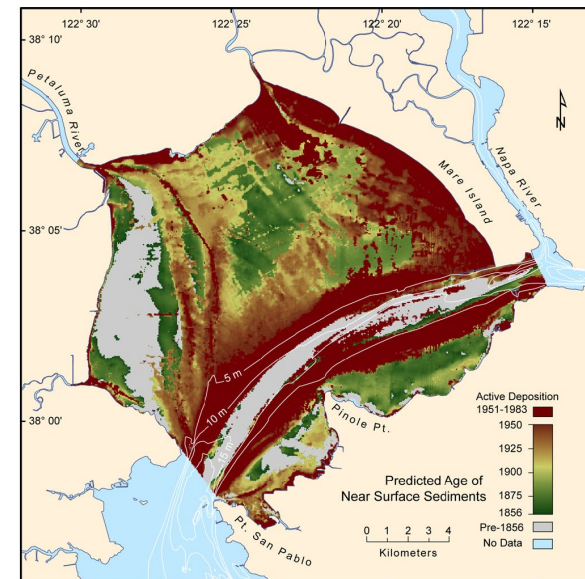
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Summary

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- 2) The volumes and patterns of sediment gain and loss are complex and change over time and space.
- 3) This information is useful for understanding sediment transport in the Bay, developing and validating models, and improving forecasts for how the Bay will change in response to sea level rise and climate change.

Future Work

- Publication of bathymetric change from the 1980s to 2010s
- Explore morphodynamic response to sea level rise and climate change (modeling)
- Incorporate bathymetric change in sediment budgets for Bay
- Forecast future habitat change
- Apply information on age of near-surface sediments reconstructed from bathymetric surveys to better understand legacy contaminants in Bay



Higgins et al.
2007

Fig. 6. Spatial distribution of historical sediments in San Pablo Bay predicted using the Bathychronology methodology. Sediment ages represent the predicted year of deposition at the top of each reconstructed sediment age profile.

DEPARTMENT OF THE INTERIOR
 FRANKLIN K. LANE, Secretary
 UNITED STATES GEOLOGICAL SURVEY
 GEORGE OTIS SMITH, Director
 Professional Paper 105

HYDRAULIC-MINING DÉBRIS IN THE SIERRA NEVADA

BY
 GROVE KARL GILBERT

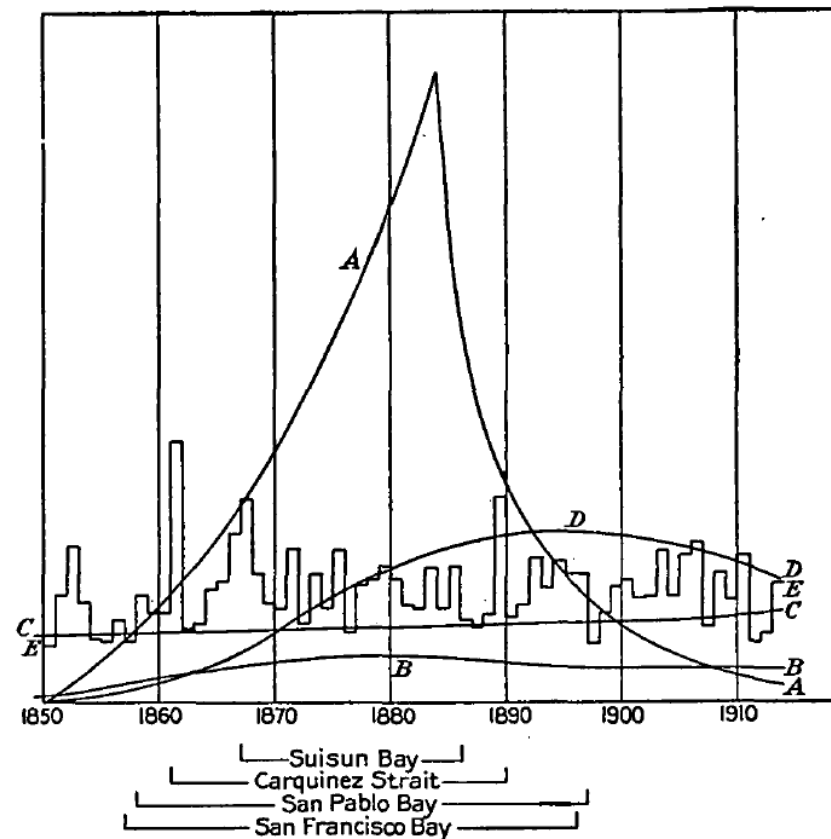


FIGURE 5.—Graphic statement of factors controlling estimation of deposition in bays and strait for periods not covered by measurements. The periods covered by measurement are indicated for the several units. *A*, Output of mining debris; *B*, soil waste; *C*, percentage of fine debris not deposited on inundated lands; *D*, delivery of debris to bays; *E*, relative precipitation.