

Sand in San Francisco Bay

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Sand is valuable.



Can we continue to mine it in SF Bay? Should we mine more or less?

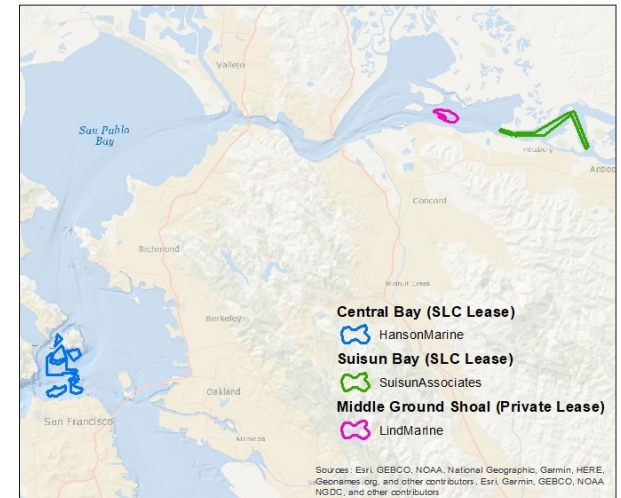
Do benefits outweigh costs?

High-level management questions ...

... Is sand mining at existing lease areas having a *measurable or demonstrable impact* on sediment transport and supply within San Francisco Bay or the outer Coast?

... What are the *physical effects* of sand mining on sand transport and supply to San Francisco Bay and the outer coast?

... Are there *other approaches* to sand mining in San Francisco Bay?

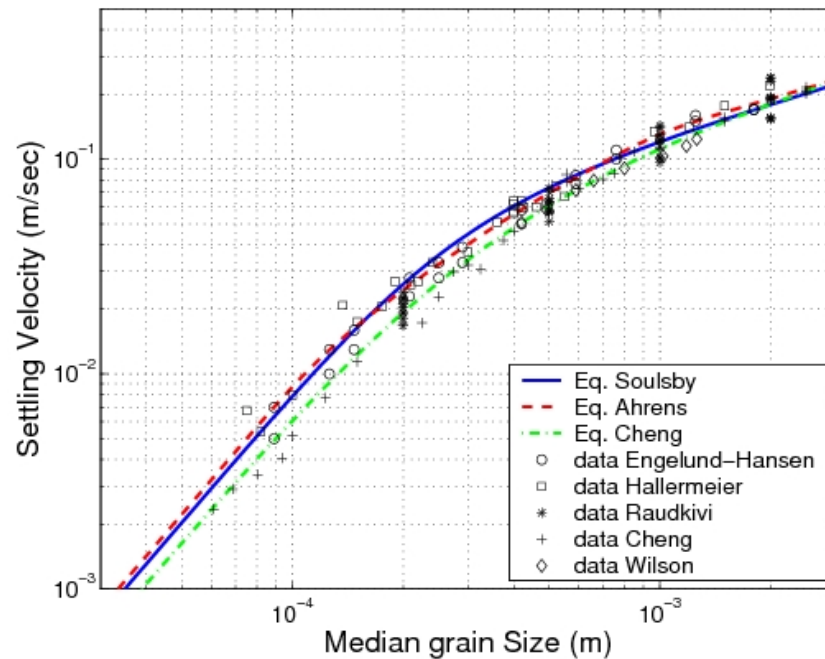


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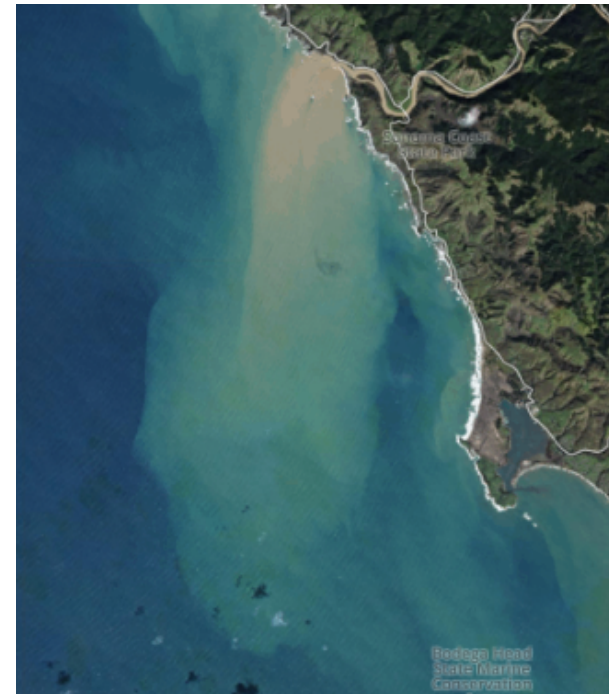
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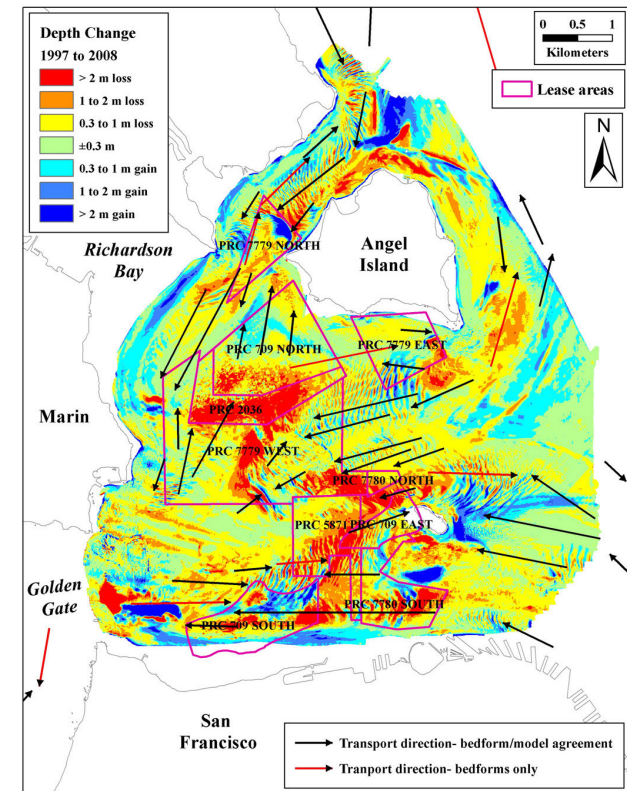


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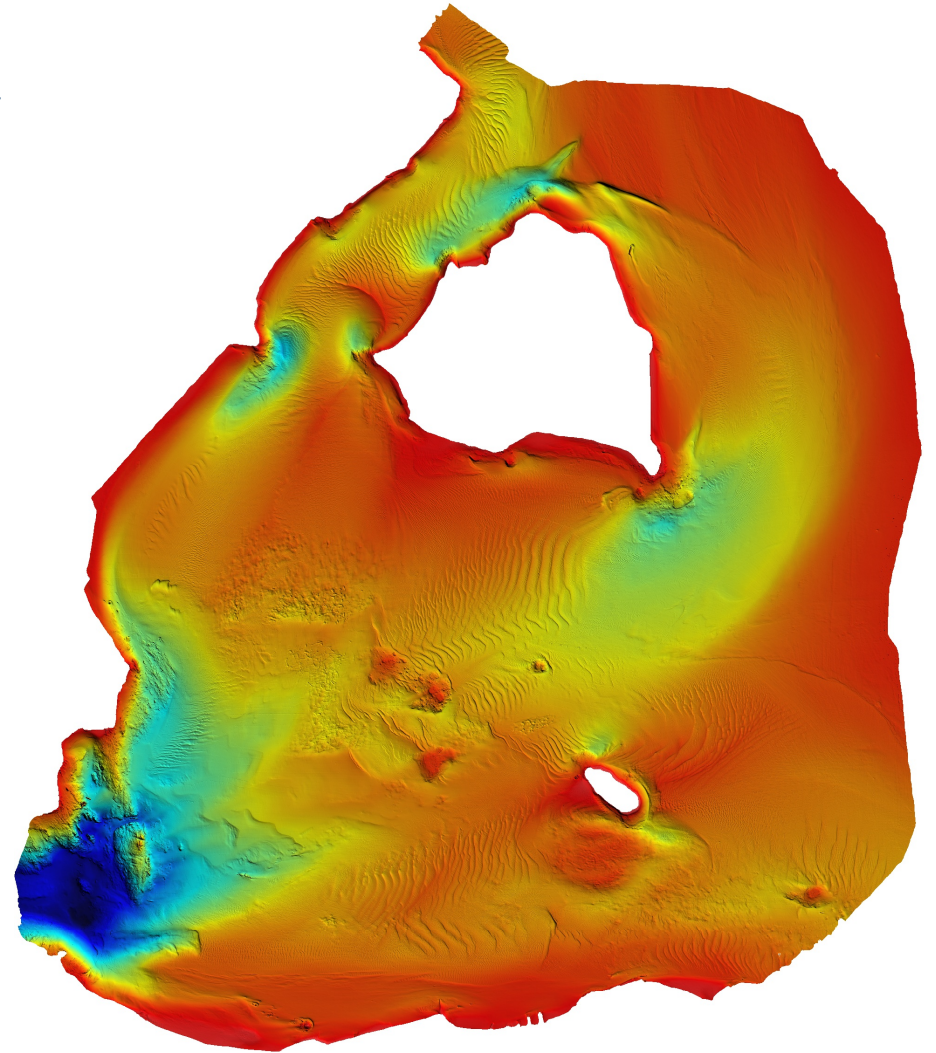
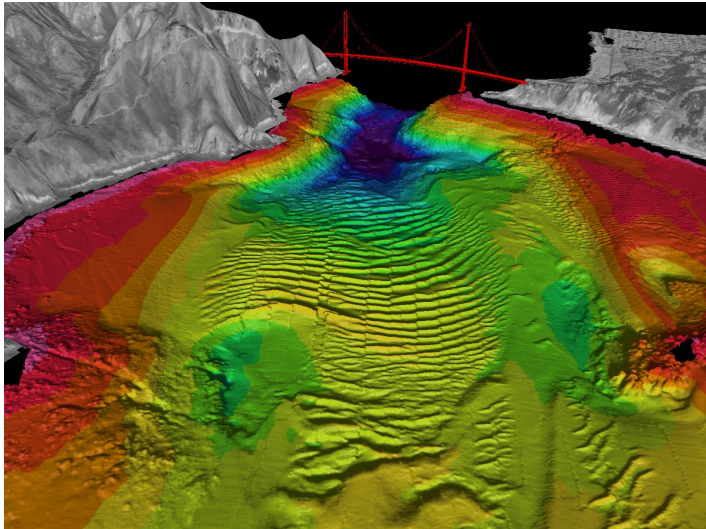
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- Sand can form piles (i.e., “bed forms”) that move.

Bed forms in Central Bay



How does the system work?

- Beaches are just the tip of the iceberg
– most sand on the bottom,
in deeper waters.
- There's lots of sand, but what does the sand budget look like?
... where does sand come from and where does it go (if not removed)?
... how long has it been there and how long will it stay?
... how have humans altered the balance?
- Conceptual model: “renewable resource” or “non-renewable resource”?

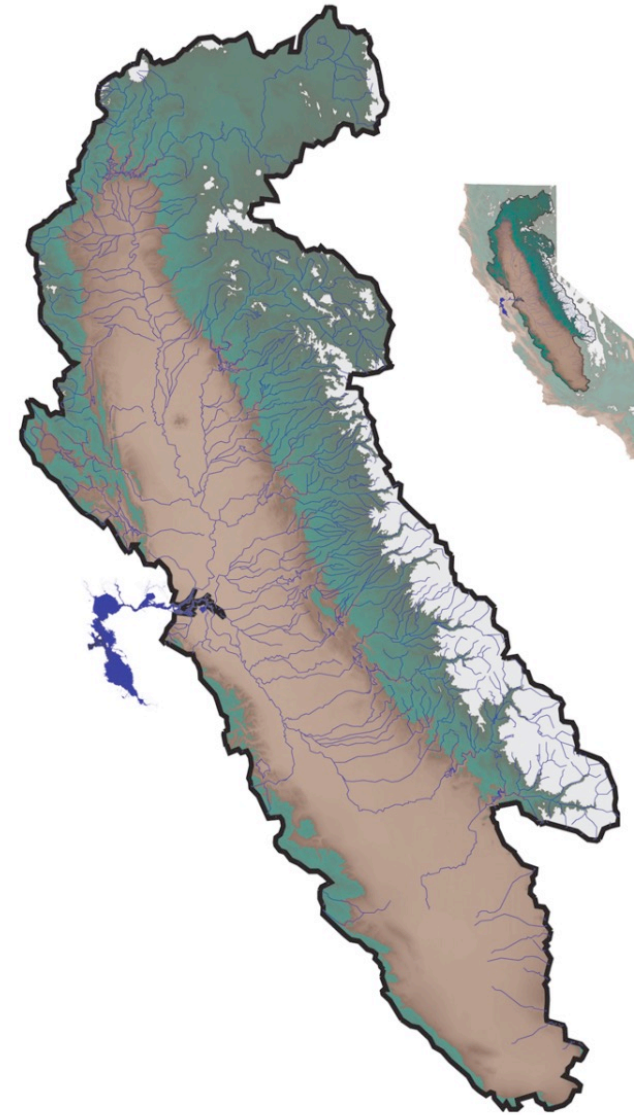


San Francisco Bay is an estuary

- Water flows into bay from watershed
- And water-borne material
 - But what about the butterfly?



Water and material
also comes in and out
with the tide.



San Francisco Bay is an estuary

- Changes in sea level over millennia
- River inflow
- Hydraulic mining
- Tidal currents
- Scour zones (fast current)
- Deposition zones (e.g., bar)
- Muddy shoals
- Waves
- Mining lease blocks

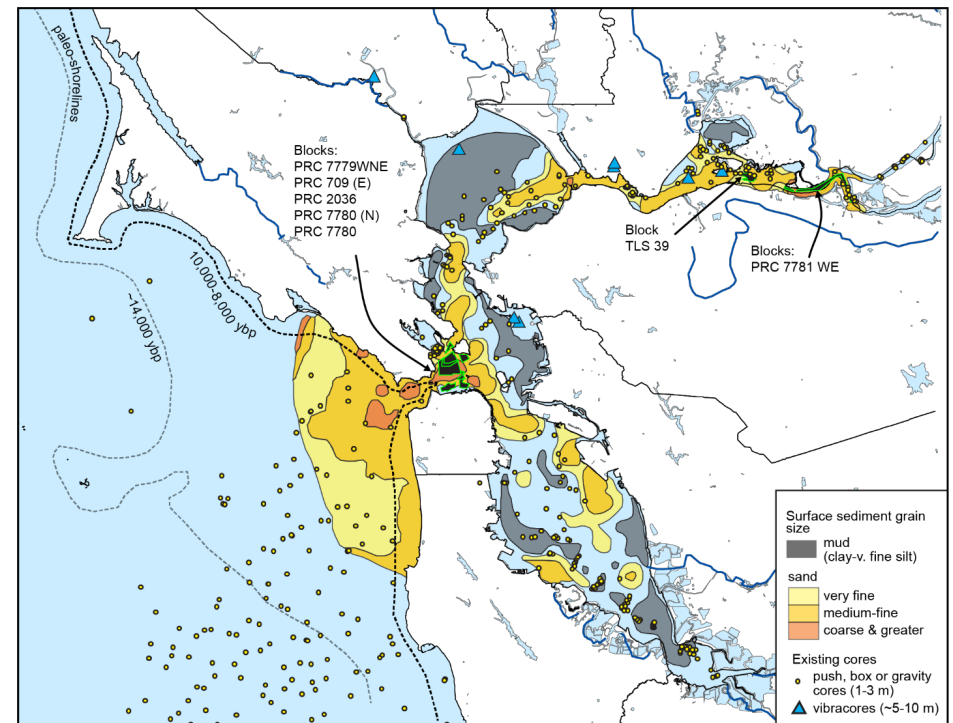


Figure 1. Overview map of the San Francisco Bay Area highlighting grain size distribution, sand mining lease blocks, and the locations of select cores collected since 1990. Dashed lines along coast delineate approximate extent of paleo-shorelines.

Current understanding

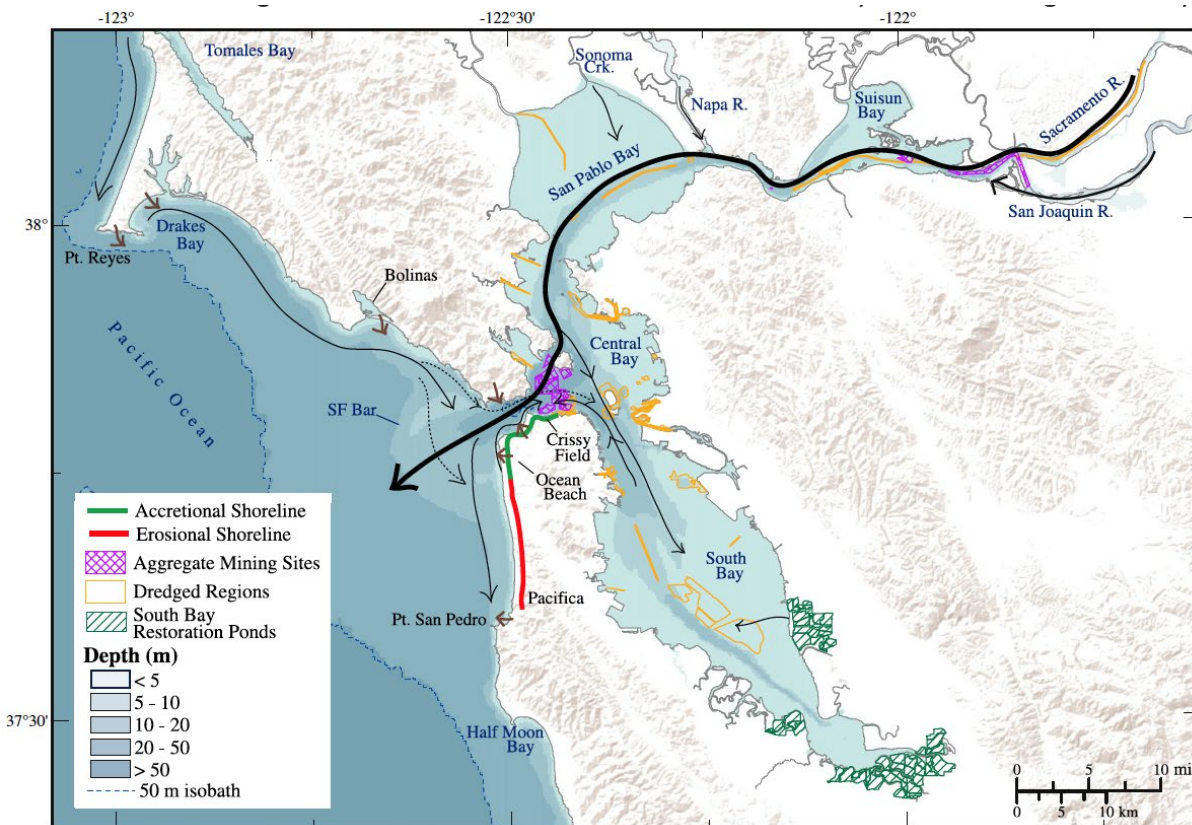


Figure 4. Net sand transport as identified through multiple USGS studies.

Source: Barnard, P. 2013

- Delta to bay
- Other tributaries
- Ocean to bay
- Erosion sites
- Deposition sites
- Human activities
- Restoration sites
- Dredge & mining sites
- Temporal fluctuations
- Temporal trends

Scale of the system

What do we care about?

As in financial budget, scale important
– country, city, or household.

For sand budget, can assess ...

- ... mining lease area
- ... bay compartments
- ... whole bay
- ... delta-bay-gulf system
- ... California coast

*Over what time scale do we want the budget to balance?
(month, season, year, decade, century)*



Next up ...

- ***Stratigraphy & Sand Resource Availability***
... from a record of past sedimentation, can we better understand the system, quantify the terms in the budget, and evaluate fluctuations
- ***Literature review and Sand Budget***
... what can we learn from a review and synthesis of prior work, specifically can we quantify the terms in the sand budget?
- ***Sediment Transport Modeling Study***
... can we simulate the physics in a computer model well enough to represent what has been observed – and then use the model to simulate different past/future scenarios?