

# San Francisco Bay Sand Studies

What we know, what we still don't know, and  
what we learned along the way.

Sand Studies Commissioner Working Group

March 18, 2025



# San Francisco Bay Sand Mining Areas

- Central Bay –  
Martin Marietta – 1.14 M cy
- Suisun Bay –  
Suisun Associates – 185,000 cy
- Middle Ground Shoal –  
Lind Marine – 100,000 cy



# 2015 Commissioner Questions

- How much sand in the Bay (volume) and where is it?
- Which areas are in transport and which areas are relic sands?
- Is the sand that is being mined in transport or relic, and what the impacts of mining relic sand?
- What is the impact to active sands (in transport) and the consequences to the Bay's beaches and tides that it feeds?
- If you dig a big hole there and some sediment comes down from the Delta, will it fill in that hole rather than go to the Bay beaches?
- Should there be a modification of mining volume, sites, and conditions?
- What is a sustainable volume for mining? What is "substantial depletion" ?
- Suggested monitoring the impact of the extraction of relic sand and sand in transport.
- What are the limits of BCDC's authority and jurisdiction in relation to sand mining?
- What's the impact to benthic life?

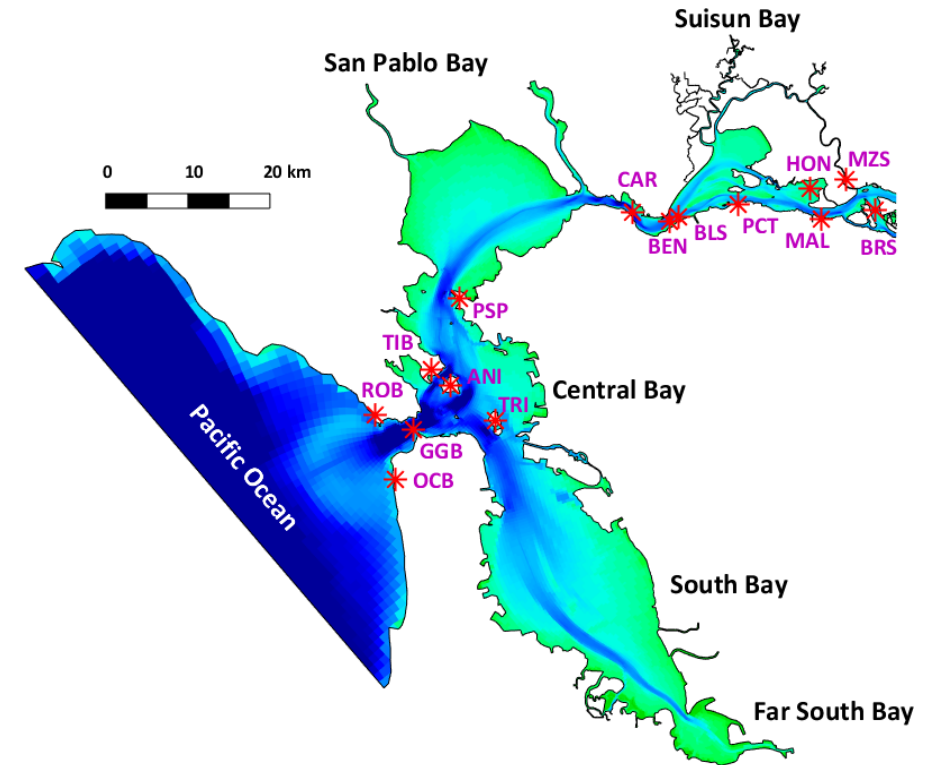


# Transparent Process

- Sand Technical Advisory Committee
- Independent Science Panel
- Research Teams
- Studies
- Science Panel Findings Report

## Sand Studies Commissioner Working Group

- Presentations by scientists & staff
- Industry comment



Angel Island (ANI)  
Treasure Island (TRI)  
Broad Slough (BRS)  
Carquinez Strait (CAR)  
Ocean Beach (OCB)  
Tiburon (TIB)  
Golden Gate (GGB)  
Rodeo Beach (ROB)

Montezuma Slough (MZS)  
Bulls Head Shoal (BLS)  
Honker Bay (HON)  
Mallard Island (MAL)  
Port Chicago (PCT)  
Benicia Bridge (BEN)  
Point San Pablo (PSP)

# Sand Studies Questions

Is sand mining at existing lease areas, at permitted levels, having a measurable or demonstrable impact on sediment transport and supply within San Francisco Bay?

- What is a sustainable number? What is “substantial depletion”?

What are the anticipated physical effects of sand mining at permitted levels on sand transport and supply within San Francisco Bay and the outer coast?

- What is the impact to active sands and the consequences to the beaches and tides that it feeds?
- What’s the impact to relic sands? How much is the volume and where is it?

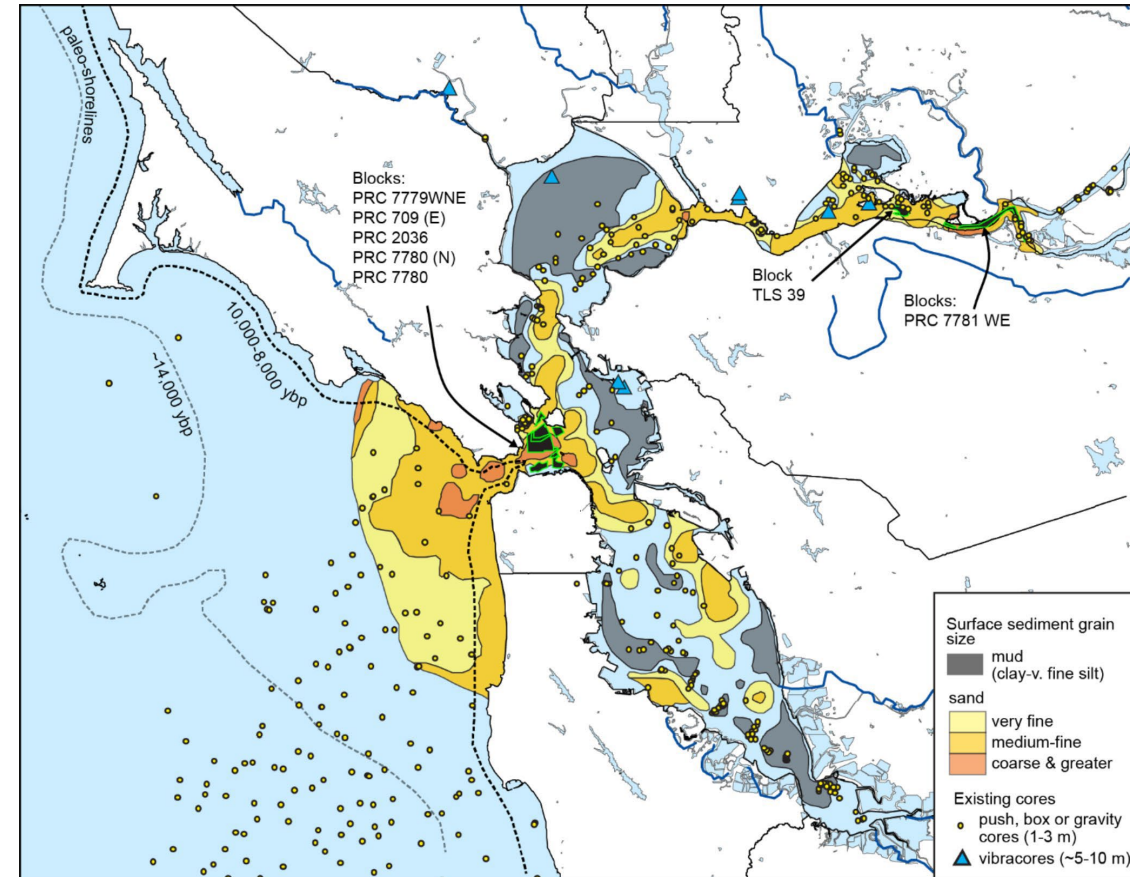
Are there other feasible sand mining approaches to consider in San Francisco Bay?

- Should there be a modification of volume and site and conditions?

# How much sand in the Bay and where is it?

- Bay sediment composition is approximately 80% fine silts and clay and 20% sand and gravel
- Sand is located in deep, high flow areas of the Bay, including portions of Suisun Channel, Bulls Head Reach, portions of Pinole Channel, and deep waters of Central Bay.
- Sand is also located in the Golden Gate and nearshore outer coast
- Moderately sorted coarse grain sand appears limited to northern central bay and southern portions of Ocean Beach
- Suisun, southern central bay, and the outer coast contain well sorted medium grain sand
- Sand is relatively rare in the Bay
  - Subsurface cores found limited amounts of sand
  - Coarse grain sand is more limited than fine grain sand

Malkowski, et. Al, 2024



# How much sand in the Bay and where is it?

*Sand budgets evaluate sand in active layer, not in permanent storage*

- The amount of sand from surface to bedrock is unknown, but a likely a large resource
- There is no appreciable sand entering the Bay from the Delta
- Local tributaries

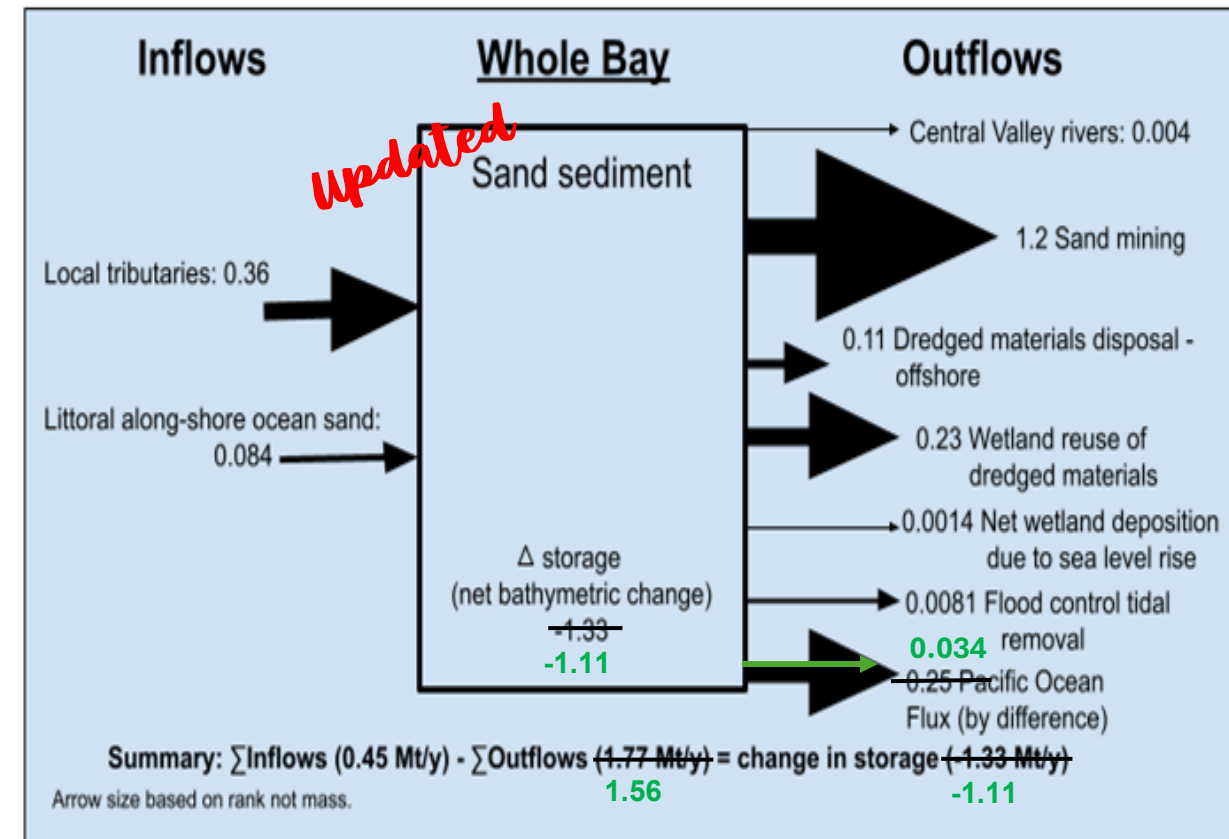
Overall, the Bay net sand budget is erosional with more sand being mined from the Bay than enters it from the Delta, local tributaries, or the Pacific.

67% of the net bed erosion was sand, despite the Bay generally being a muddy system.

Sand mining is the largest driver of sand loss from the Bay by an order of magnitude.

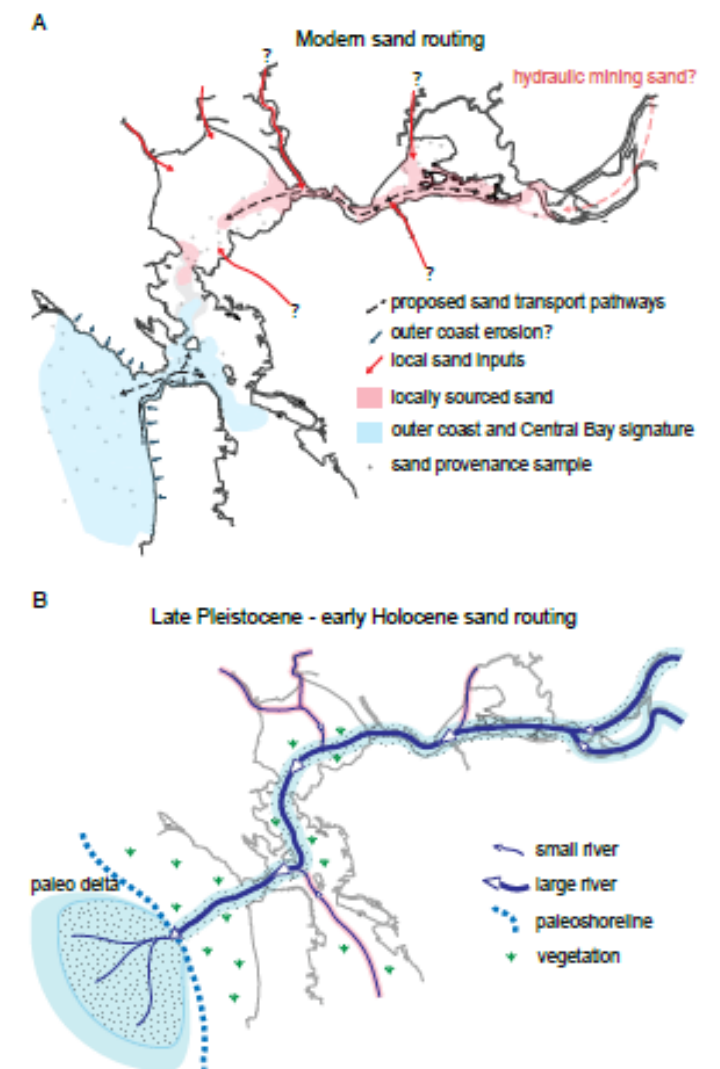
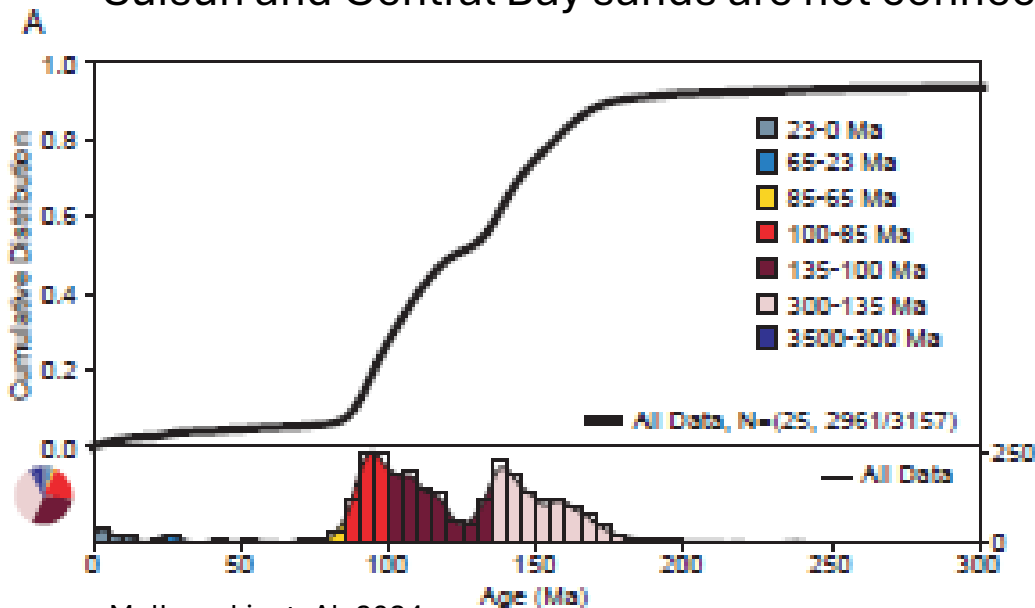
\*Lower South Bay is the exception, and is depositional for the study period

Study Period: 2001 -2020



# Which areas are in transport & which areas are relic sands?

- All Bay sand is relic sand, deposited between 85 and 300 million years ago
- Central Bay and outer coast sand was deposited in the late Pleistocene and Holocene (Sierran river)
- Suisun may have been produced from Gold Rush mining and local, coastal range river sources
- Suisun and Central Bay sands are not connected by transport





# Is the sand that is being mined in transport or relic, and what the impacts of mining relic sand?

The sand that is mined is relic, but some is in transport and some is not.

Mining has a long-term impact on the local bay floor if recovery rates are low.

If these changes do not significantly alter net transport patterns, it is unlikely that the larger system will be affected.

However, if certain (unknown) tipping points are reached, mining may alter the large-scale inlet dynamics.

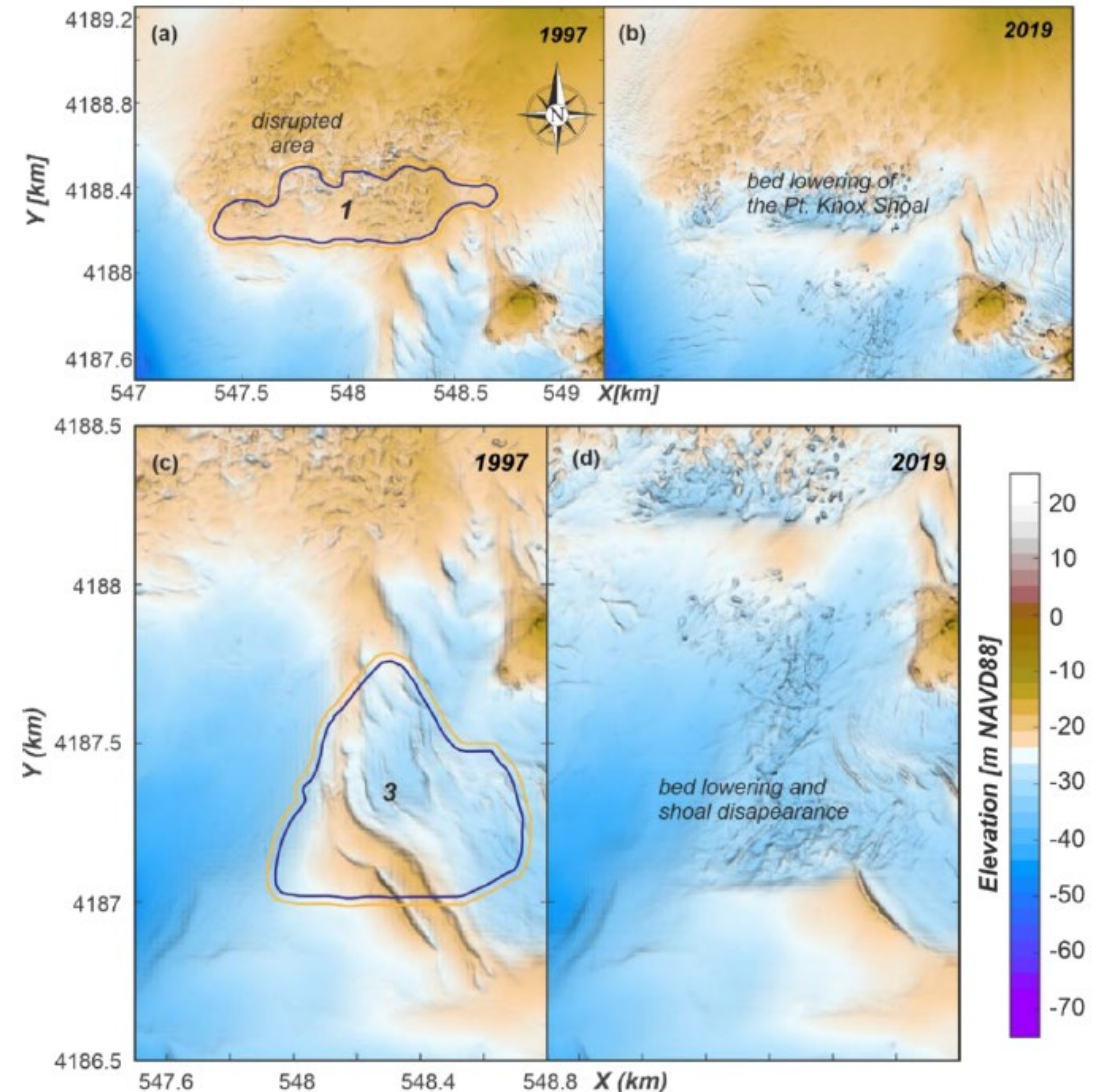
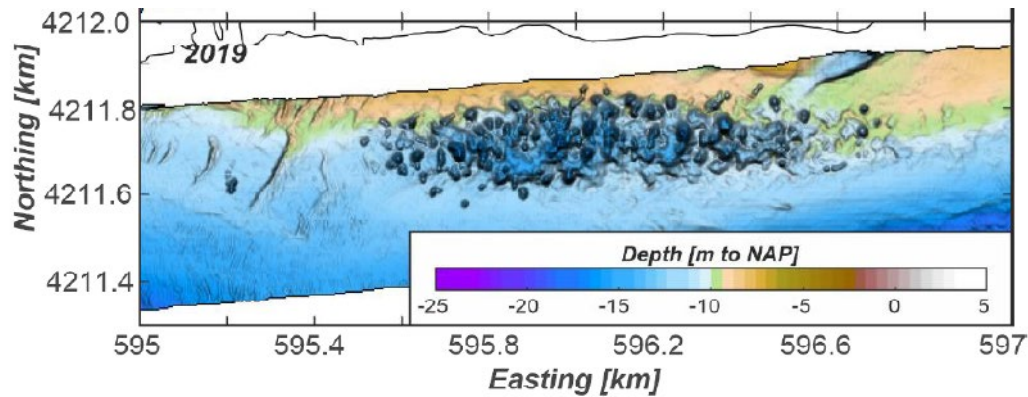


Figure 4-1: Overview of bathymetry in ring polygon 1 (Lease area 2036) and 3 (Lease area 709S) for the years (a, c) 1997 and 2019 (b,d).

# Is the sand that is being mined in transport or relic, and what the impacts of mining relic sand?

The sand that is mined is relic, but some is in transport and some is not.

High recovery rates result in limited long-term impacts on the local bay floor, as sediment is quickly replenished.

However, this sediment sink is expected to cause a sediment deficit elsewhere in the bay or could reduce sediment supply to the outer coast.

Therefore, high recovery rates in the lease areas can be considered as a sink in the overall sediment budget and thus affect transport.

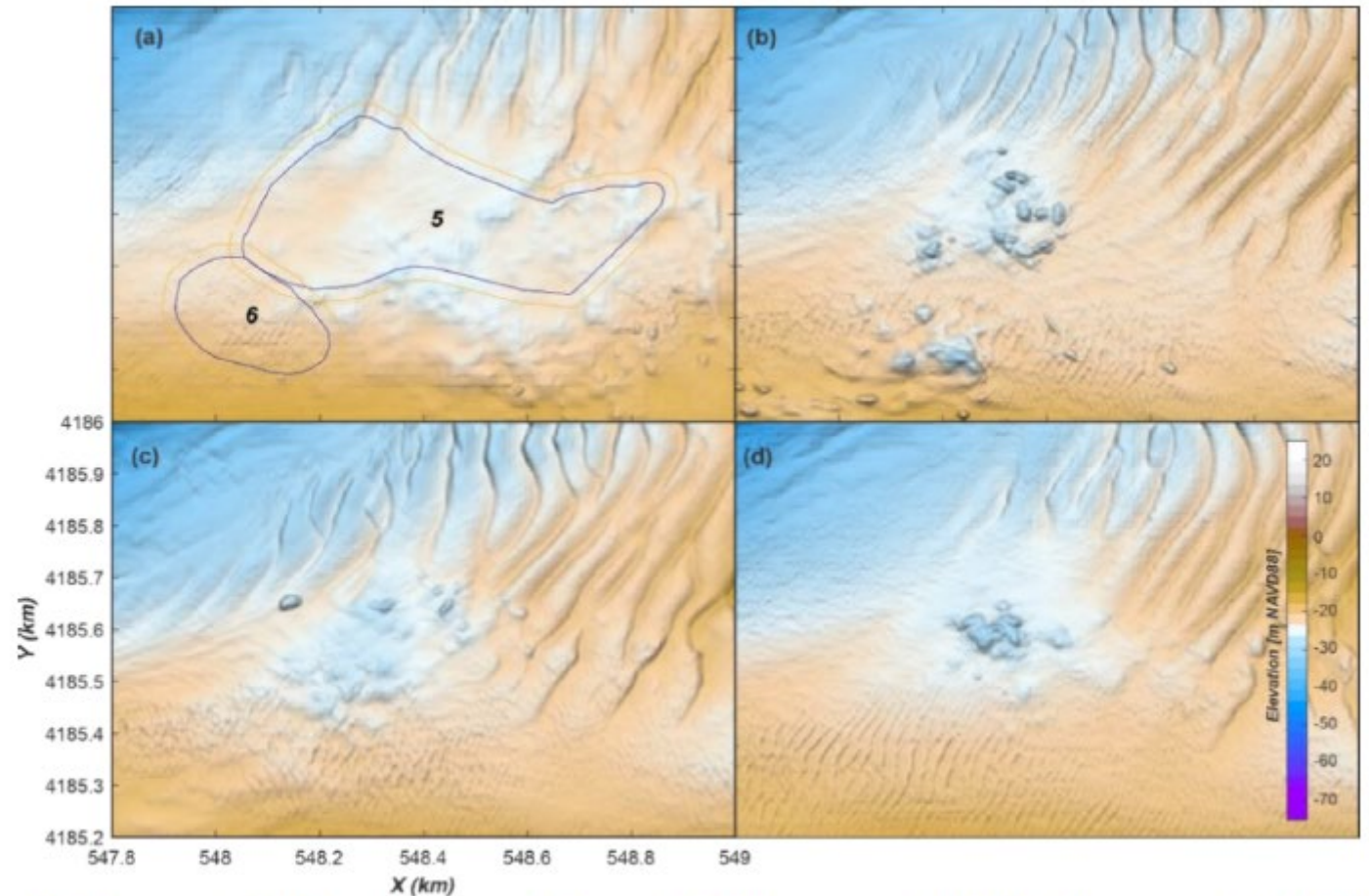
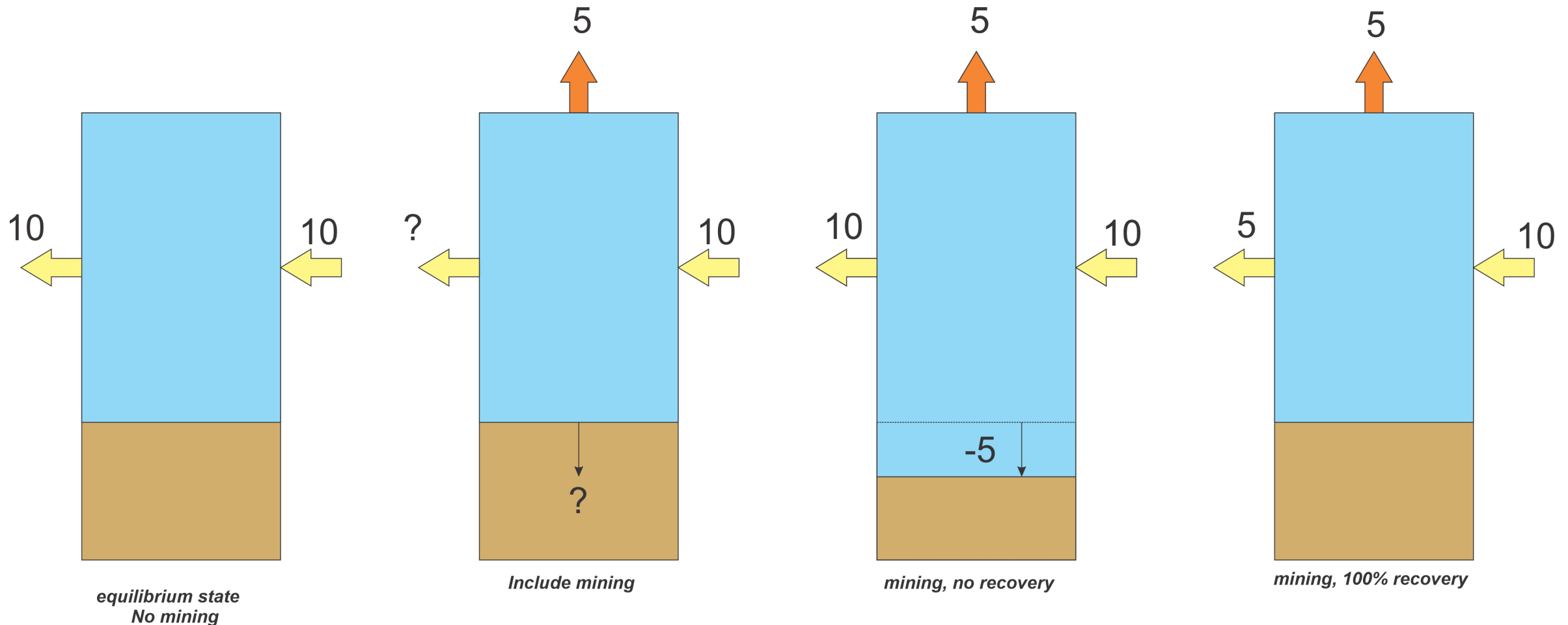


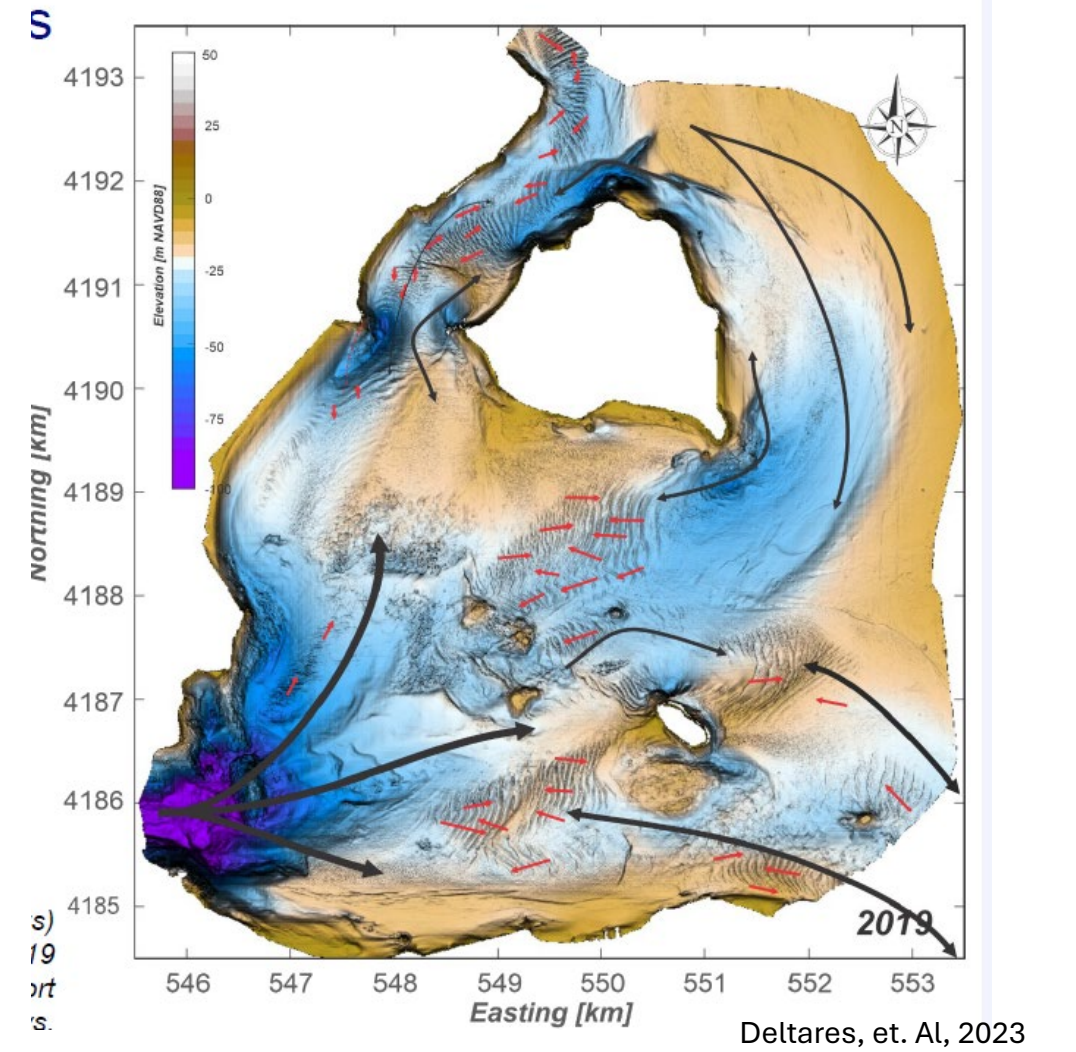
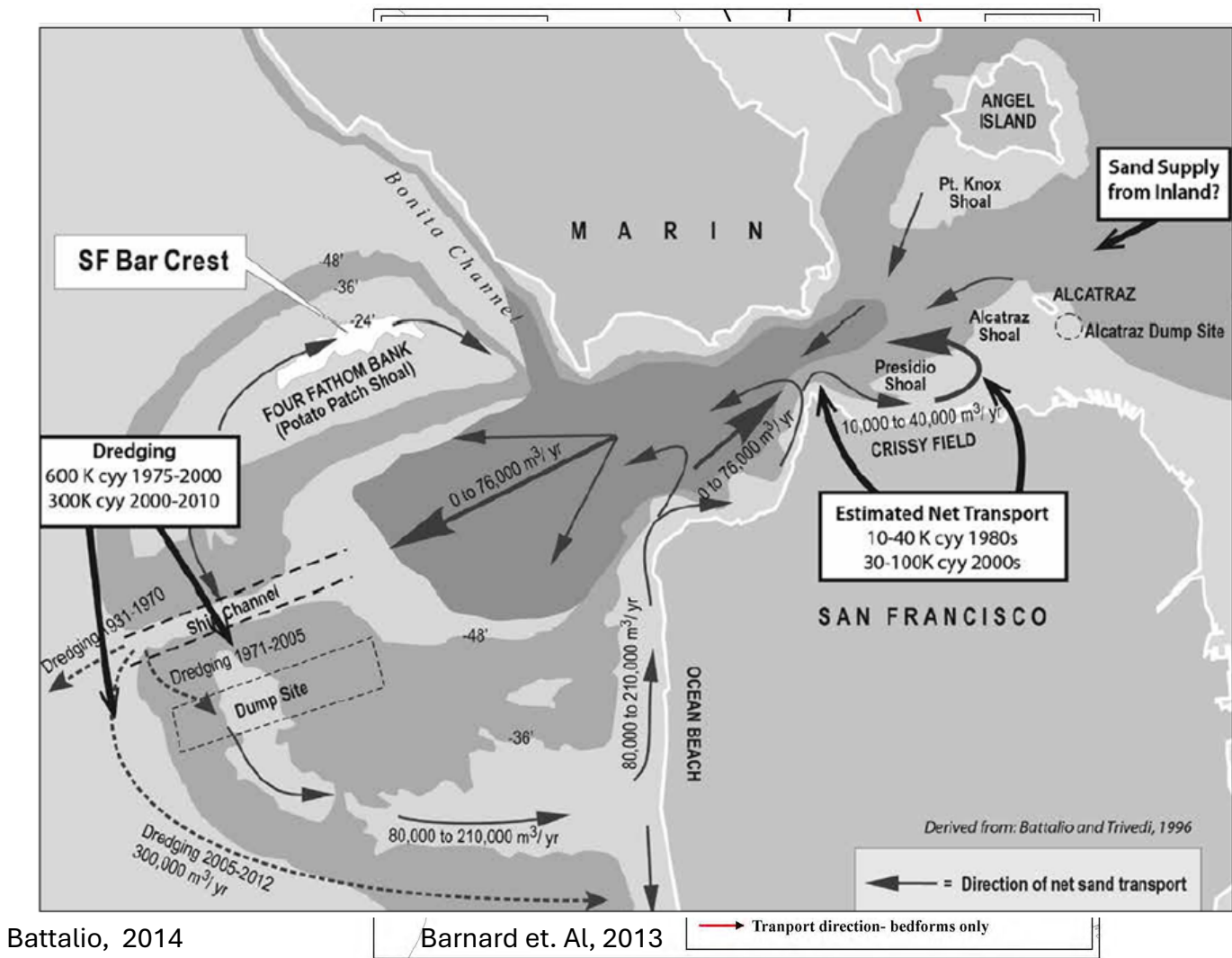
Figure 4-2: Overview of bathymetry in ring polygon 2 and 6 (Lease area 709S) for the years (a) 1997, (b) 2008, (c) 2014 and (d) 2019.

# What is the impact to sand in transport and the consequences to the Bay's beaches and tides that it feeds?





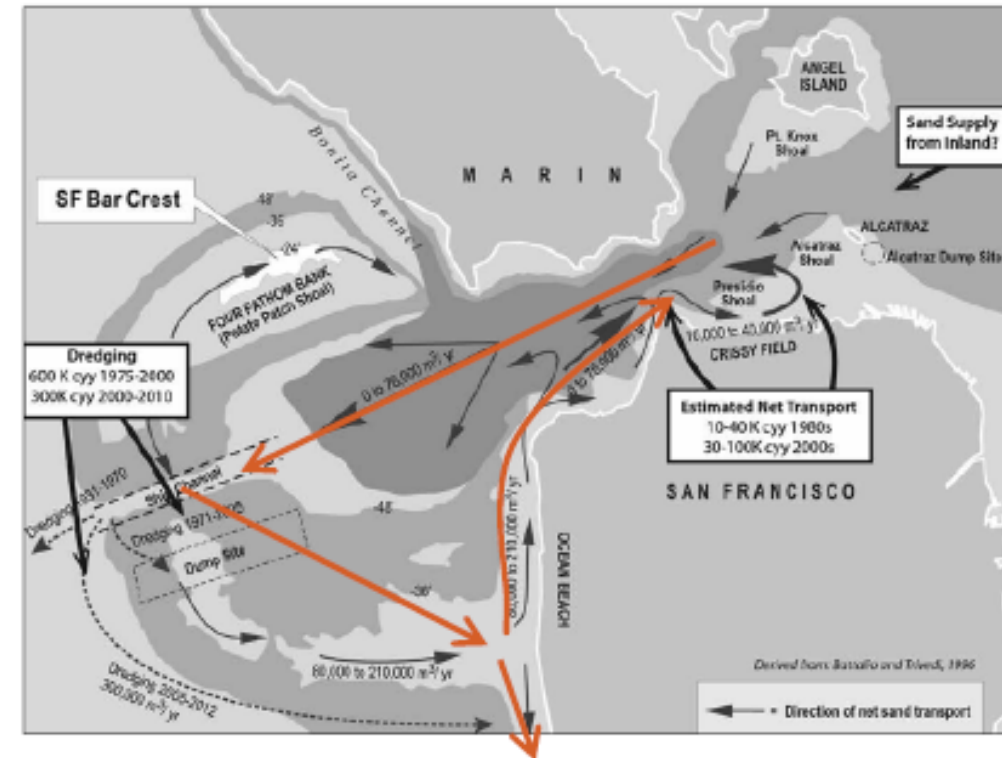
# Is the sand that is being mined in transport or relic, and what the impacts of mining relic sand?





# What is the impact to sand in transport and the consequences to the Bay's beaches and tides that it feeds?

- Net predicted transport of sand out of the Golden Gate to Pacific Ocean
- Sand mining reduced predicted transport of sand out of Golden Gate
  - Little effect at cross sections east of mining
- Removing sand from hypothesized transport cell would reduce sand available to San Francisco Bar and from Ocean Beach to Crissy Field
  - Uncertainty in transport magnitude and lag times preclude determining a direct relationship between mined sand volumes and changes in sand transport in the hypothesized transport cell

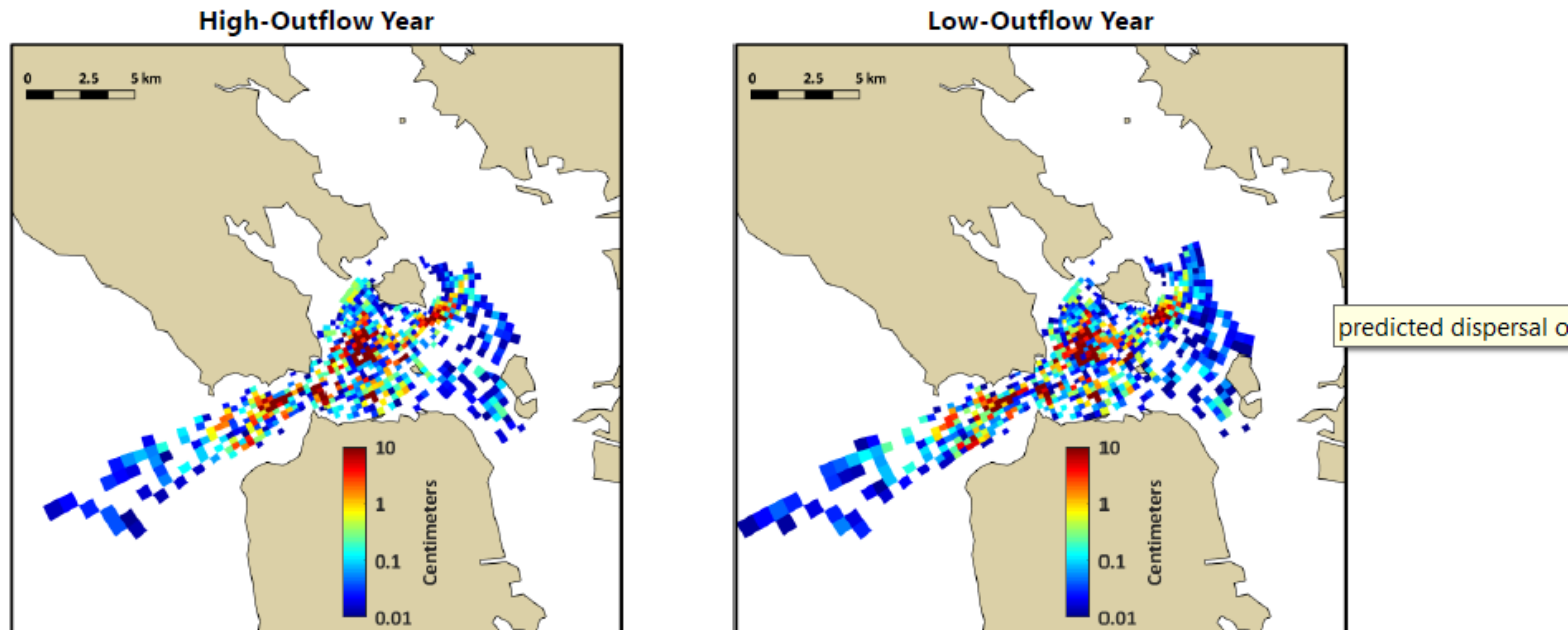


Source: Battalio (2014) Littoral processes along the Pacific and bay shores of San Francisco, California, USA. Shore & Beach 82(1)

# What is the impact to sand in transport and the consequences to the Bay's beaches and tides that it feeds?

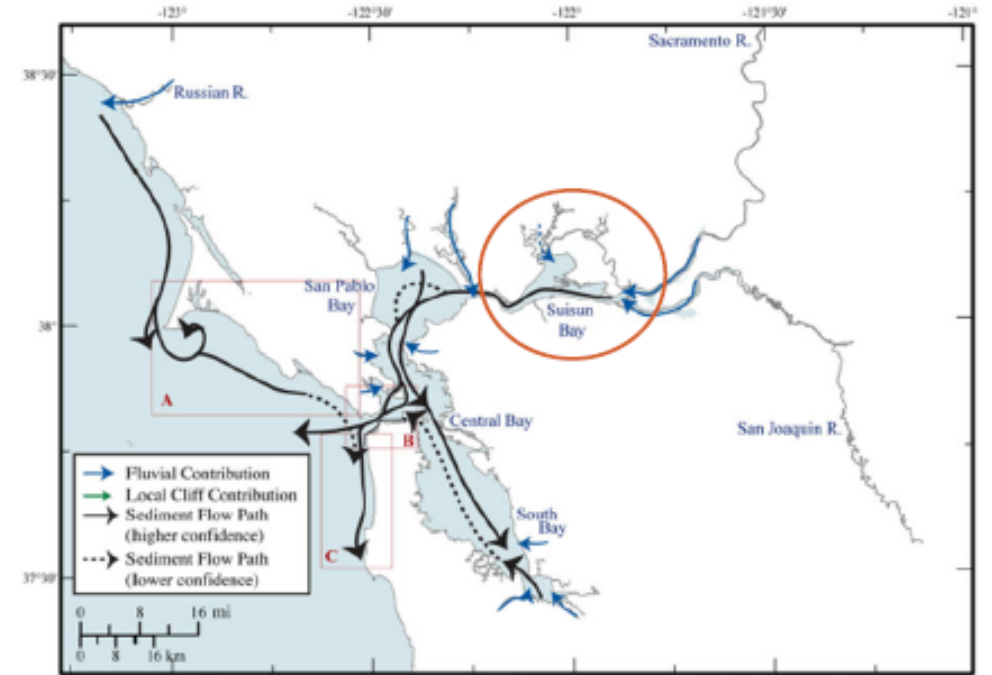
## Predicted Dispersal of Mined Sand (1-Year Periods)

- Mined sand generally predicted to be transported between Richardson Bay, Angel Island, Treasure Island and San Francisco, with transport out of the Golden Gate



# What is the impact to sand in transport and the consequences to the Bay's beaches and tides that it feeds?

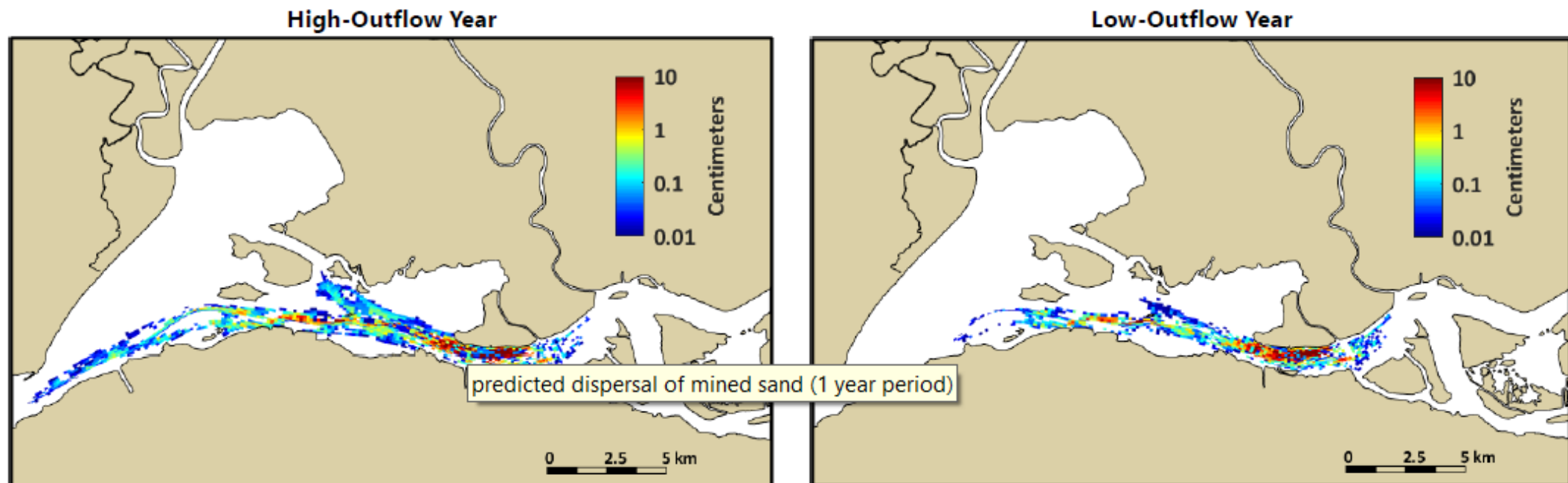
- Episodic westward sand transport
  - Periods of elevated Delta outflow responsible for majority of sand transport toward San Pablo Bay
- Sand mining reduced predicted westward transport of sand
- During 1-year simulation period effects did not extend past Benicia Bridge
  - Sand deposition at Bulls Head Shoal may limit westward effects of sand mining
  - Much longer simulation period may be needed



# What is the impact to sand in transport and the consequences to the Bay's beaches and tides that it feeds?

## Predicted Dispersal of Mined Sand (1-Year Periods)

- Mined sand generally dispersed west from mining areas
- Slight eastward transport





# What is the impact to sand in transport and the consequences to the Bay's beaches and tides that it feeds?

- Wave-induced and density-driven sand transport is not well defined in the Bay
- Wave-driven sand transport and accumulation (beaches, shoals) occurs primarily in relatively shallow waters and were not resolved in the studies
- Density-driven currents are landward at the bed where most sand transport occurs and thus are expected to cause sand transport in the landward direction.
- Variation in sand transport caused by grain size is not known



# What is the impact to active sands (in transport) and the consequences to the Bay's beaches and tides that it feeds?

- Sand mining may have an impact on the volume and characteristics of sand supplies to beaches, but there is not enough information to assess this effect.
- Changes to the way sand moves from subtidal shoals to intertidal flats, marshes, and beaches were also not addressed in the studies and there is no available inventory of regional beach sands.
- While the studies indicate that mining may influence the flux of sand to the outer coast, this potential impact is also not assessed here.



# What is a sustainable volume for mining?

## What is “substantial depletion” ?

- A sustainable volume is not known, though some areas continue to have sand replenished
- Where sand would go if not mined from replenished area is unknown
- The “tipping point” of sand depletion is not known

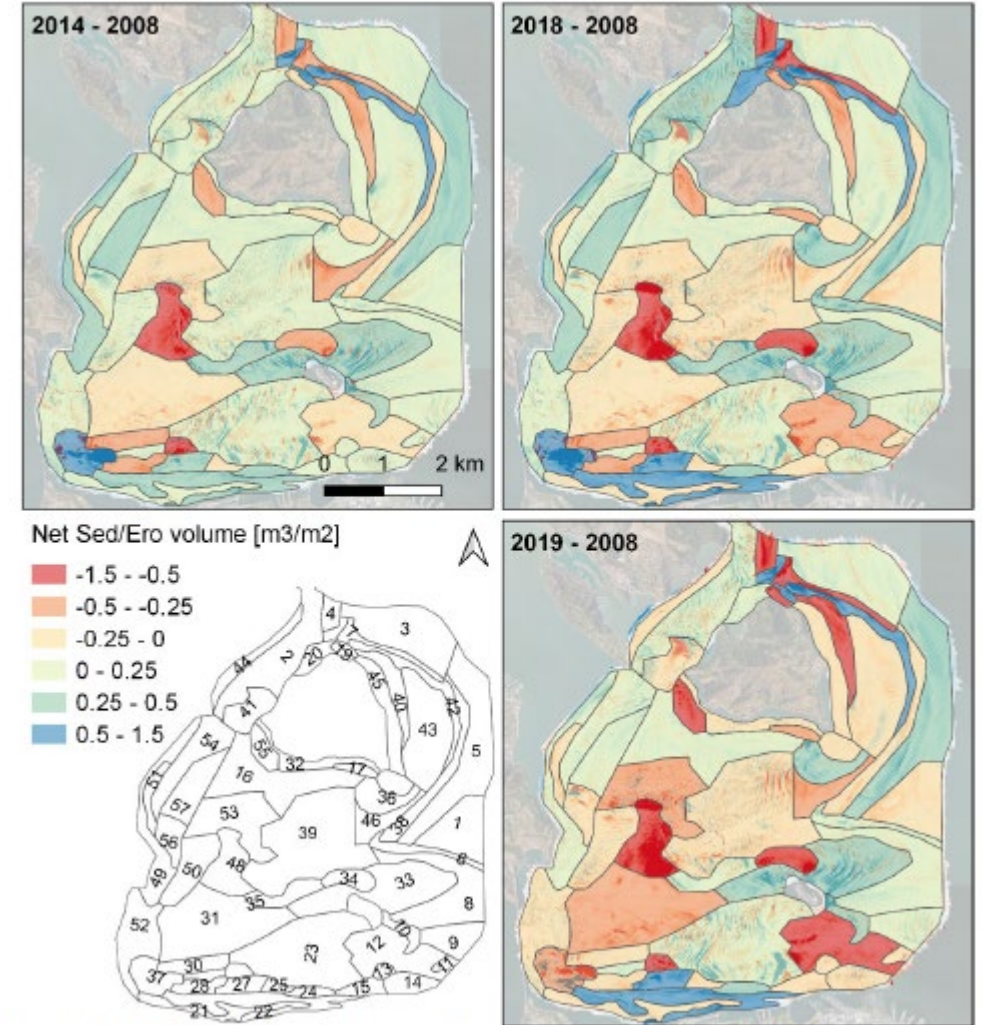


Figure 4-6: Net sedimentation-erosion aggregated per polygon, normalized by the polygon area, for West-central Bay

# Commission Questions

- If you dig a big hole there and some sediment comes down from the Delta, will it fill in that hole rather than go to the Bay beaches?
  - Generally, climate modeling and understanding of sediment supply with flood protections in place, it is considered very unlikely.
  - The trend continues to be loss of sand without significant replenishment
- Should there be a modification of mining volume, sites, and conditions?
  - Commission will need to consider
- Suggested monitoring the impact of the extraction of relic sand and sand in transport.
  - Commission will need to consider

## *Coming Up:*

- What's the impact to benthic life?
- Economics of sand mining in the Bay Area
- What are the limits of BCDC's authority and jurisdiction in relation to sand mining?



# Anthropogenic Impacts to the Bay Sediment System

