

Understanding Impacts of Bay Sand Mining on Transport in San Francisco Bay

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Sand Studies Commissioner Working Group Meeting

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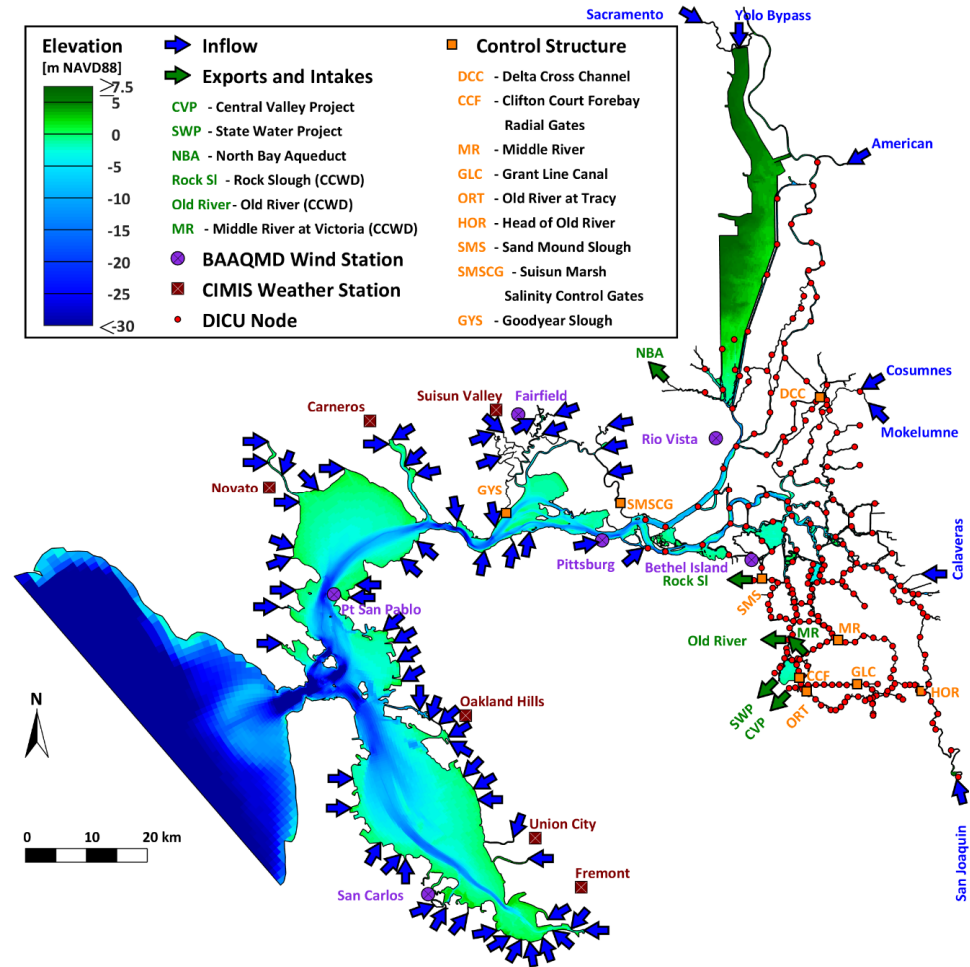
Outline

- Sediment transport modeling
 - Review of model scenarios and analysis approach
 - Predicted effect of sand mining on sand transport
 - Suisun Bay
 - Central Bay
- Synthesis of Primary Findings

Sediment Transport Model Simulations

UnTRIM Bay-Delta Model

- Sand from different sources tracked separately
 - Initial sediment bed and Delta tributaries
 - Bay tributaries
 - Sand representative of mined sand

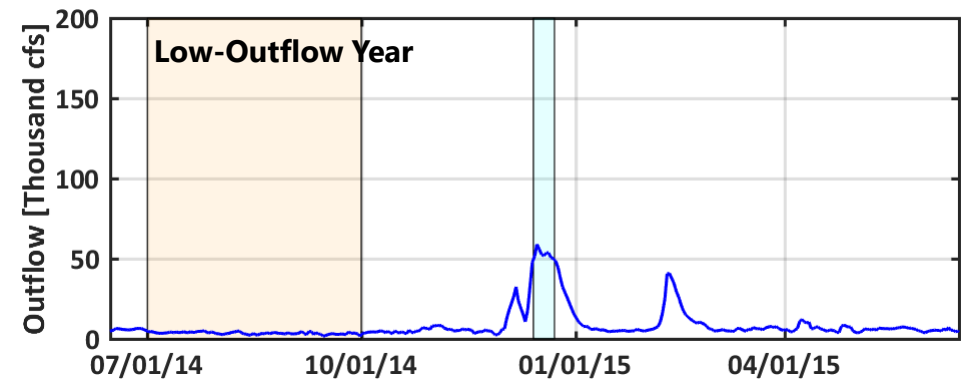
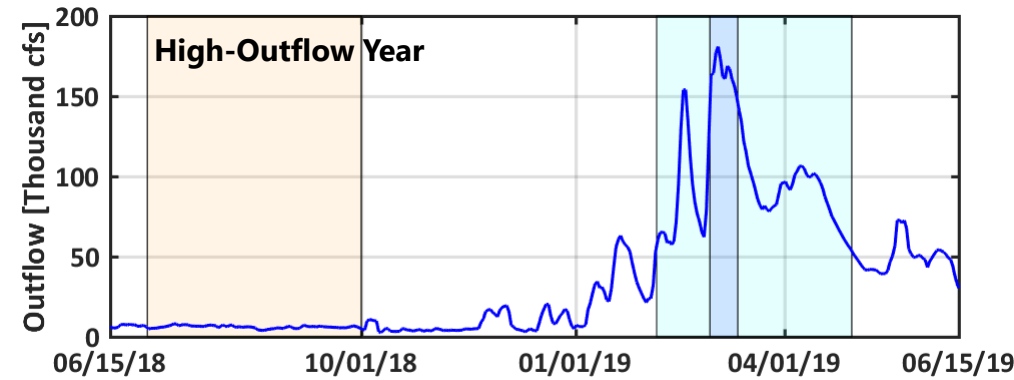


Sediment Transport Model Scenario Approach

- Goal: Investigate how sand mining affects sand transport
- Approach:
 1. Simulate 1-year with existing bathymetry with sand mining
 2. Develop “without sand mining” bathymetry that adds back sediment to the bay equivalent to the annual volume of sand mined
 - › Grain size and spatial distribution of sediment added based on sand mining data
 3. Compare existing and without mining scenarios:
 - › Evaluate transport of sand added that is representative of mined sand
 - › Compare change in sand thickness on the sediment bed
 - › Evaluate sand transport vectors and sediment fluxes at cross sections

Sediment Transport Model Simulations

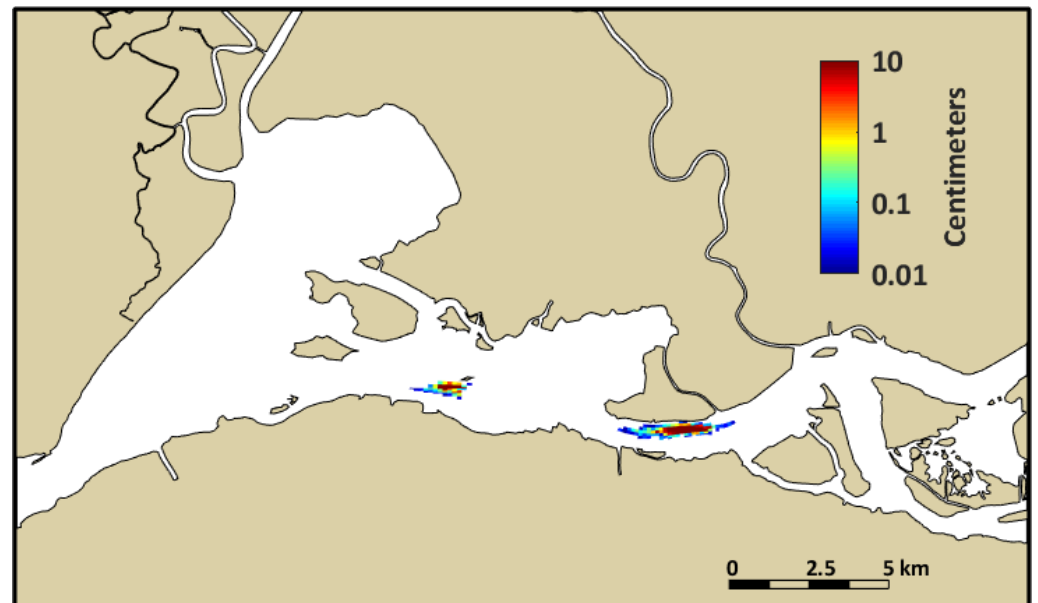
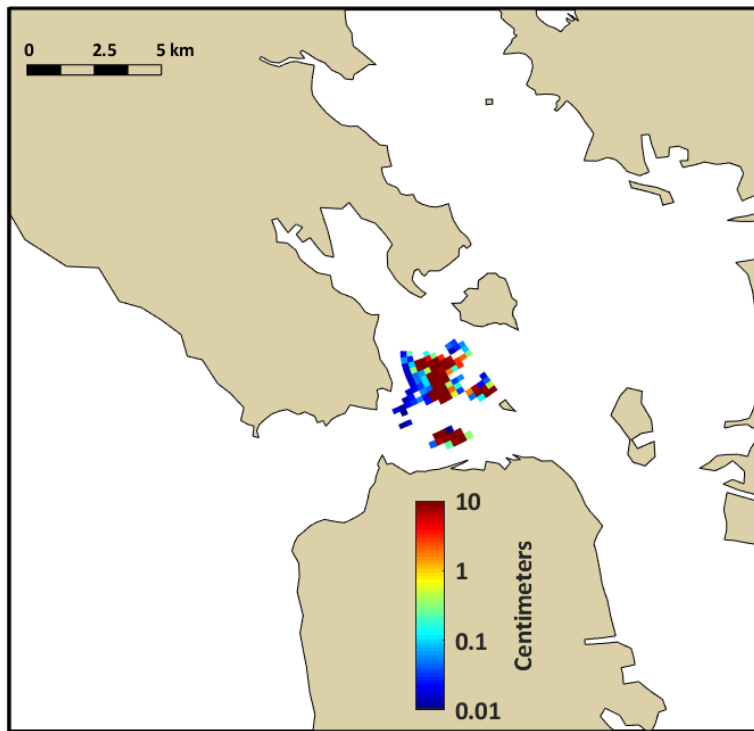
- Goal of analysis of model results
 - Evaluate the effects of sand mining over a year, considering wet and dry/critical years



Year Type	Date	Scenario	
Wet	June 2018 to June 2019	1) Baseline	2) Without sand mining
Critical	June 2014 to June 2015	3) Baseline	4) Without sand mining

Without Mining Simulations

- Addition of sand to account for mining activity

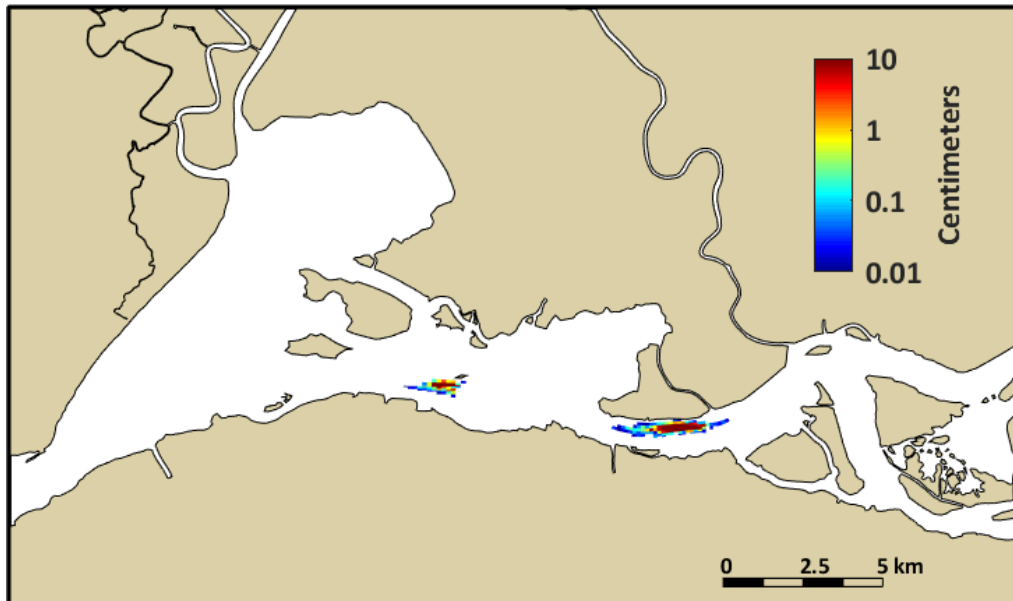


Predicted Effects of Sand Mining

- Suisun Bay
- Central Bay

Without Mining Simulations: Suisun Bay

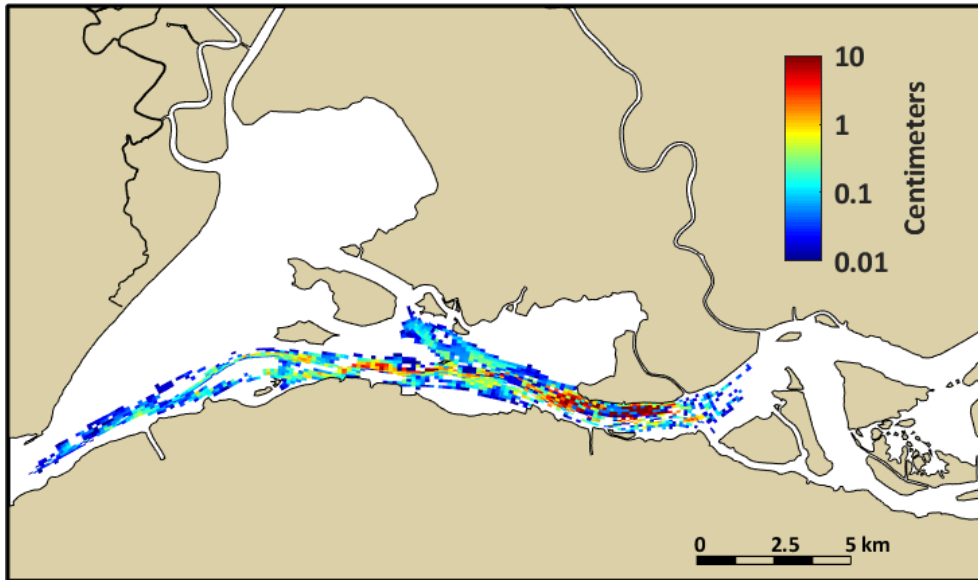
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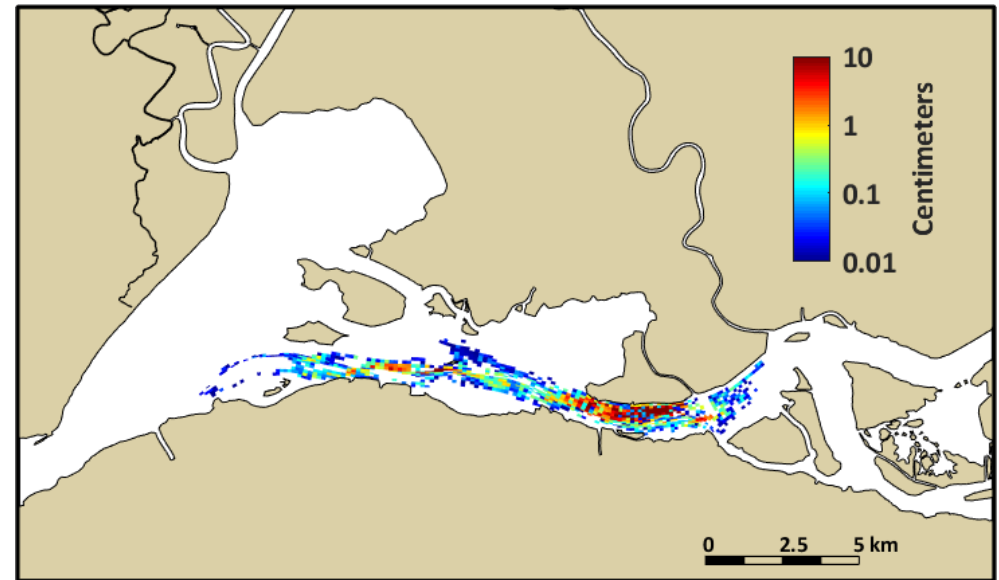
Predicted Dispersal of Mined Sand (1-Year Periods)

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

High-Outflow Year

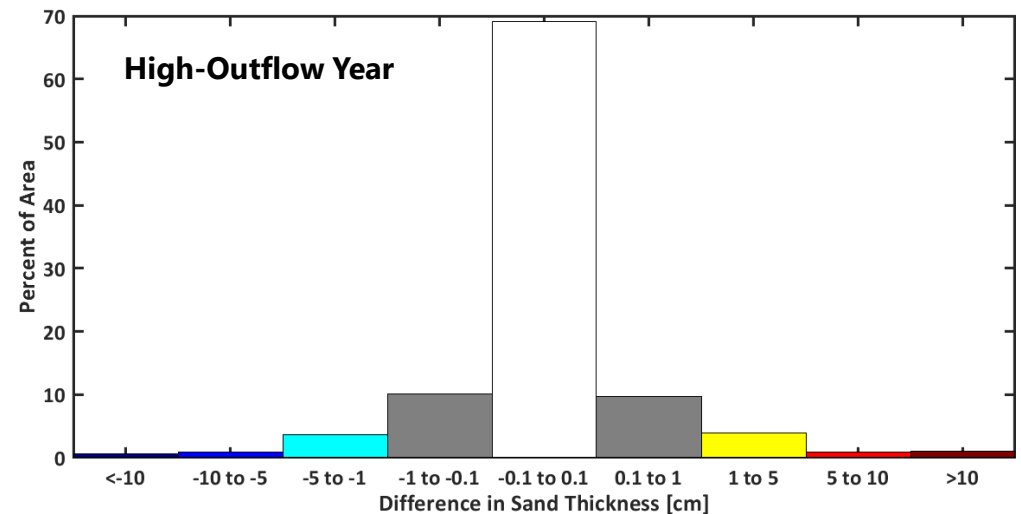
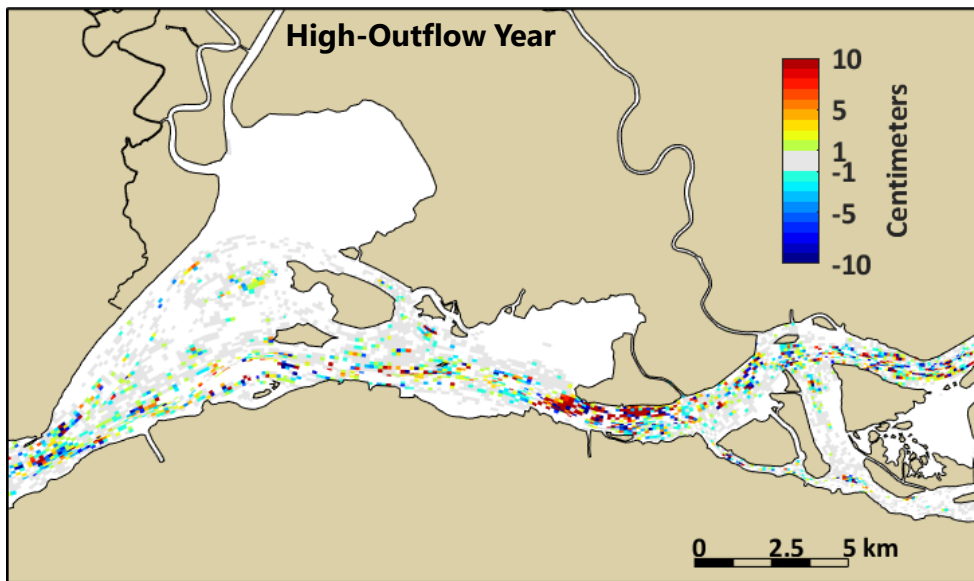


Low-Outflow Year



Predicted Change in Sand Thickness Without Mining

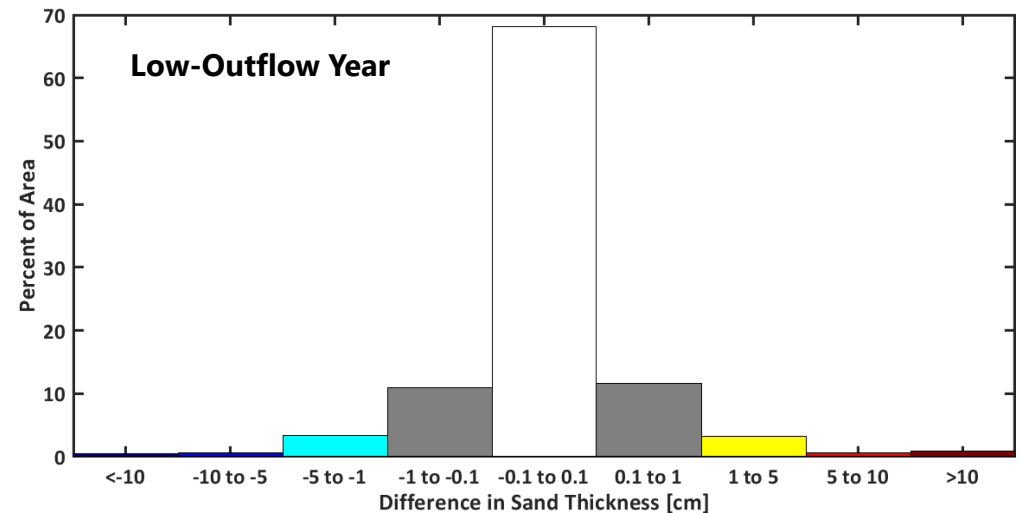
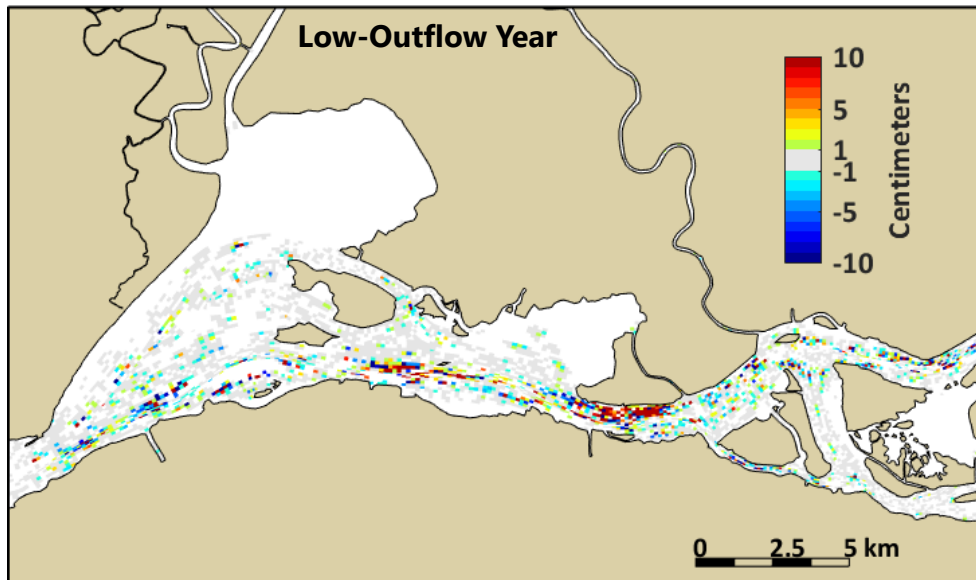
- Predicted change in bed sand thickness is small over the majority of Suisun Bay
- Area of largest sand thickness change without mining is located near the mining areas



Positive values indicate a predicted increase in the thickness of sand on the bed had sand mining not occurred

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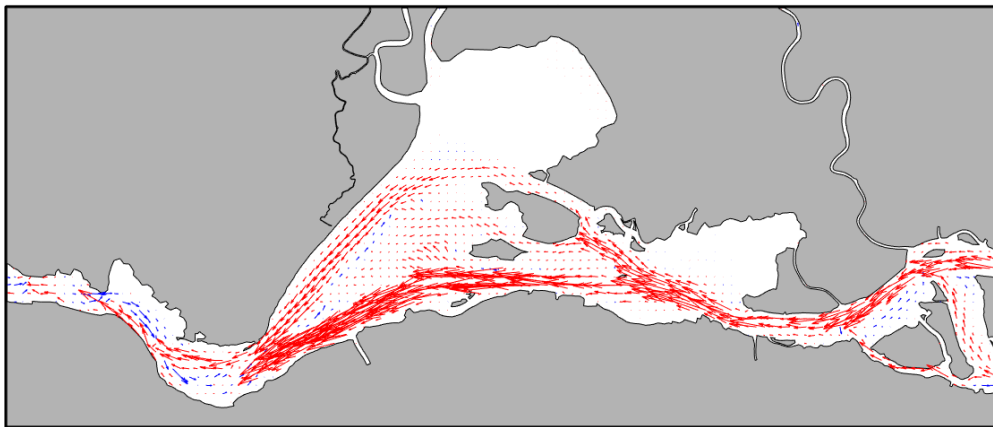


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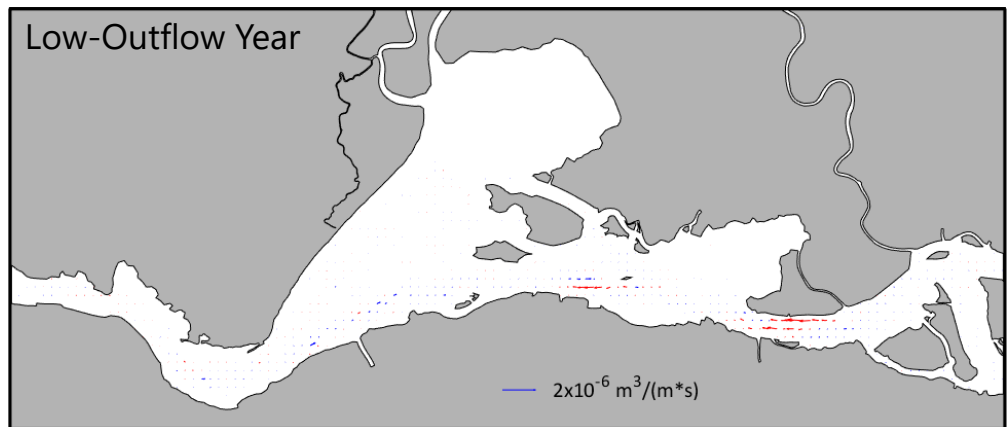
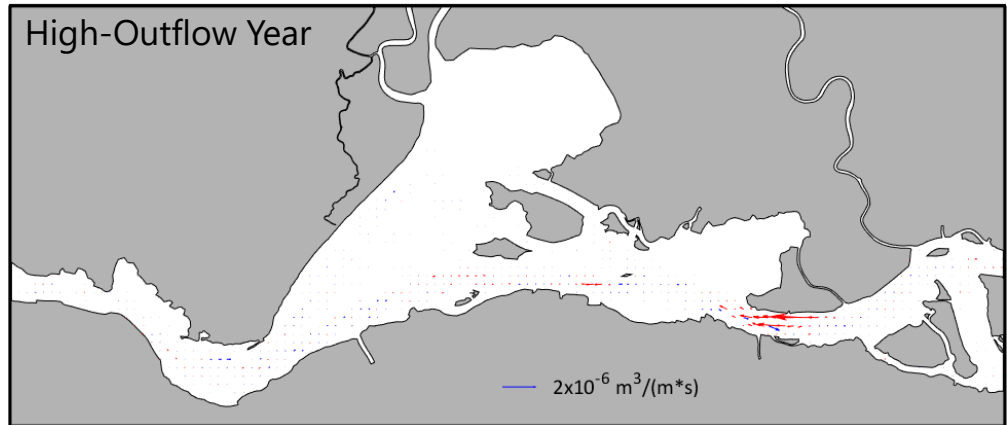
Predicted Sand Fluxes

- Predicted increase in downstream sand transport had sand mining not occurred
- Limited to near mining areas

Predicted Sand Transport During High-Outflow Year

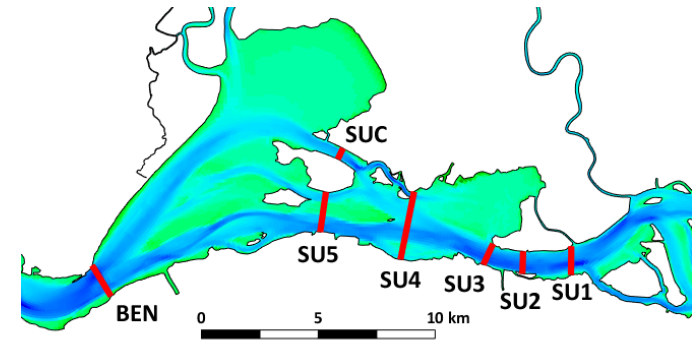


Predicted Change to Sand Transport Without Mining



Predicted Cross-Section Sand Fluxes

- Little predicted effect of sand mining on sand transport away from the mining areas
- Cross sections with a small predicted net flux can have a large percentage change result from a small magnitude change to predicted sand transport

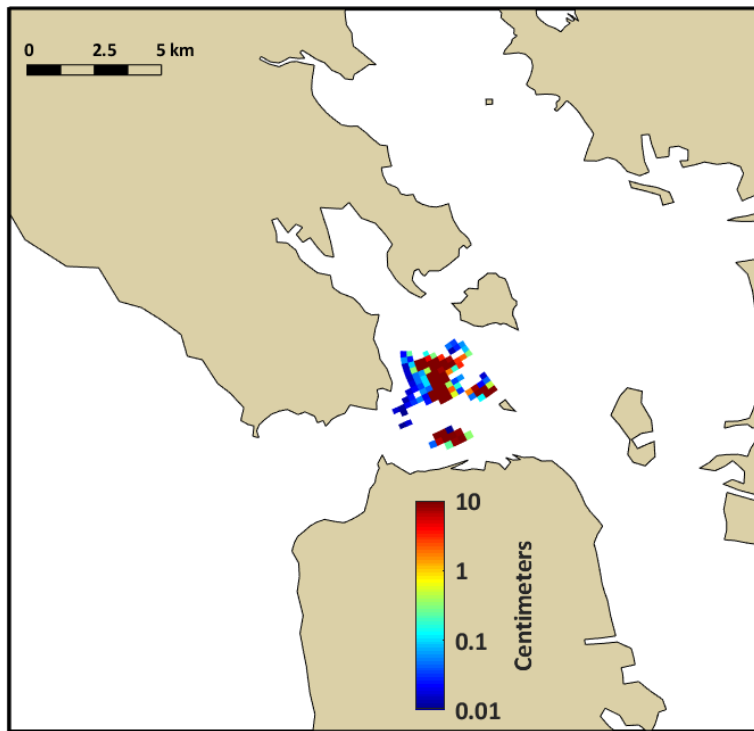


Period	Change in Cross Section Sand Flux (Percent of Total Sand Transport)						
	Suisun 1	Suisun 2	Suisun 3	Suisun 4	Suisun 5	Benicia Bridge	Suisun Cut
2018–2019	-3%	67%	19%	-1%	<1%	<1%	2%
2014–2015	-31%	1000%	-27%	-3%	-1%	-6%	<1%

Positive values indicate an increase in ocean-directed predicted sand transport through the cross section without sand mining

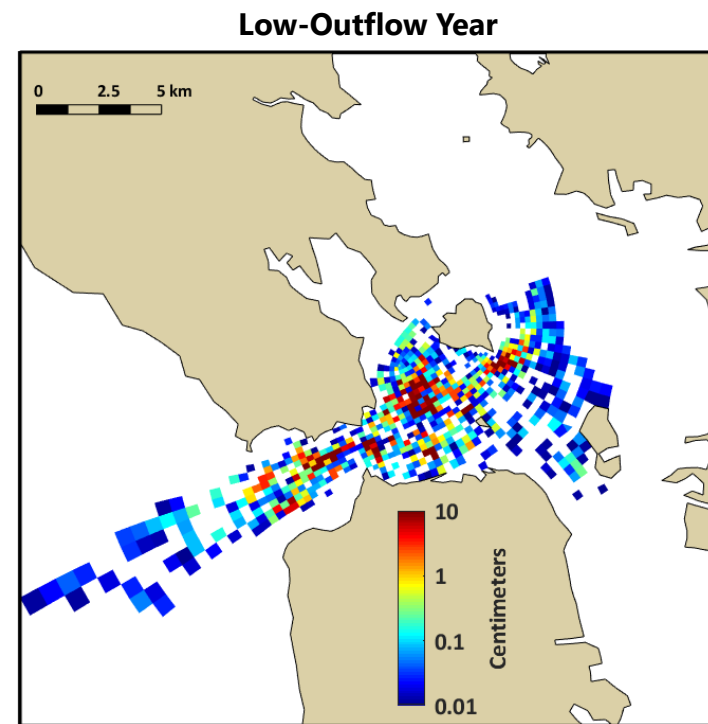
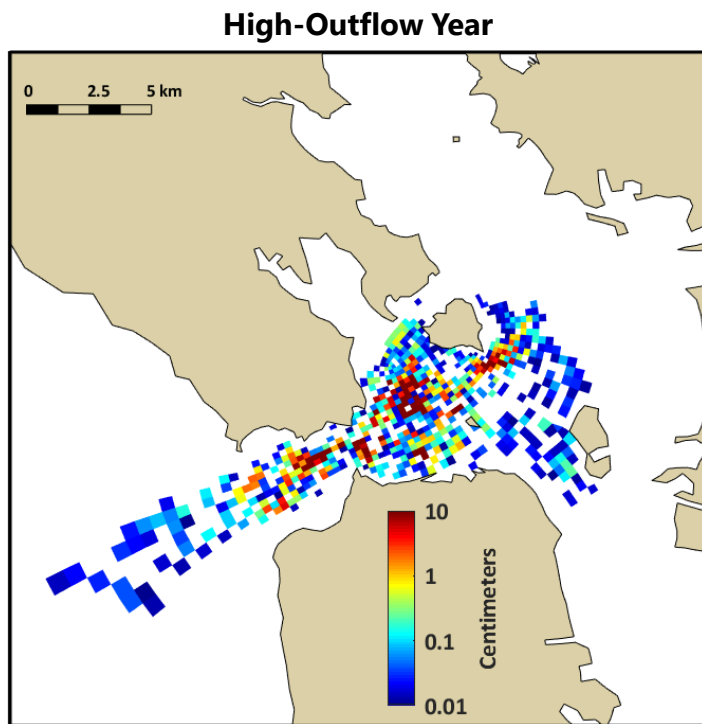
Without Mining Simulations: Central Bay

- Addition of sand to account for mining activity



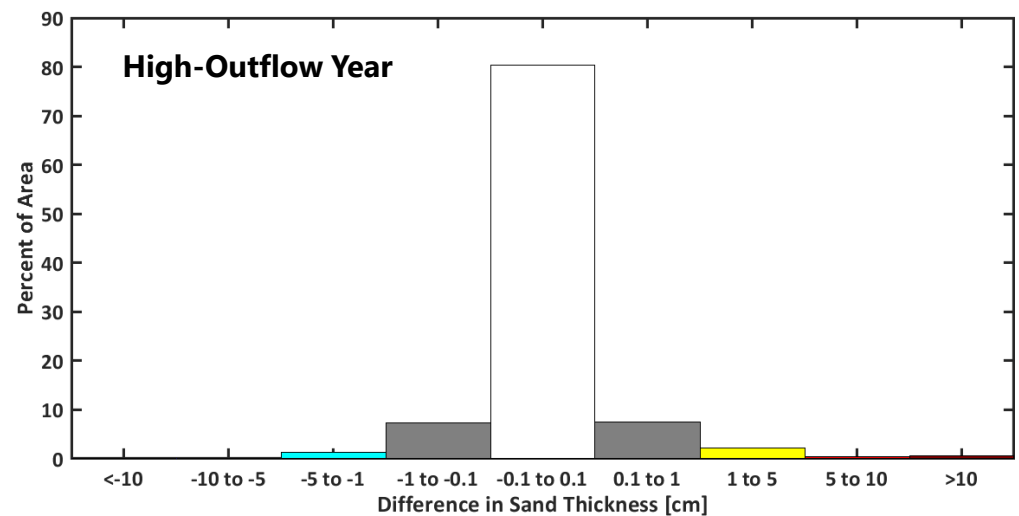
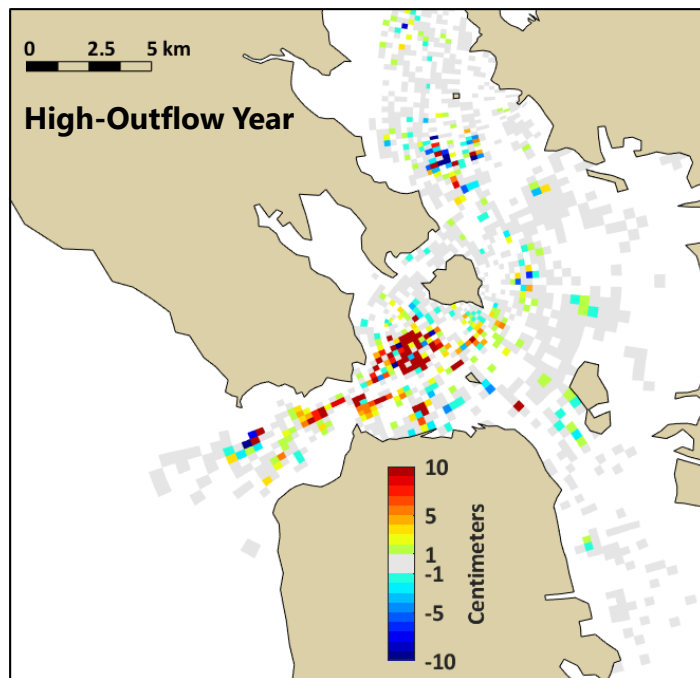
Predicted Dispersal of Mined Sand (1-Year Periods)

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



Predicted Change in Sand Thickness Without Mining

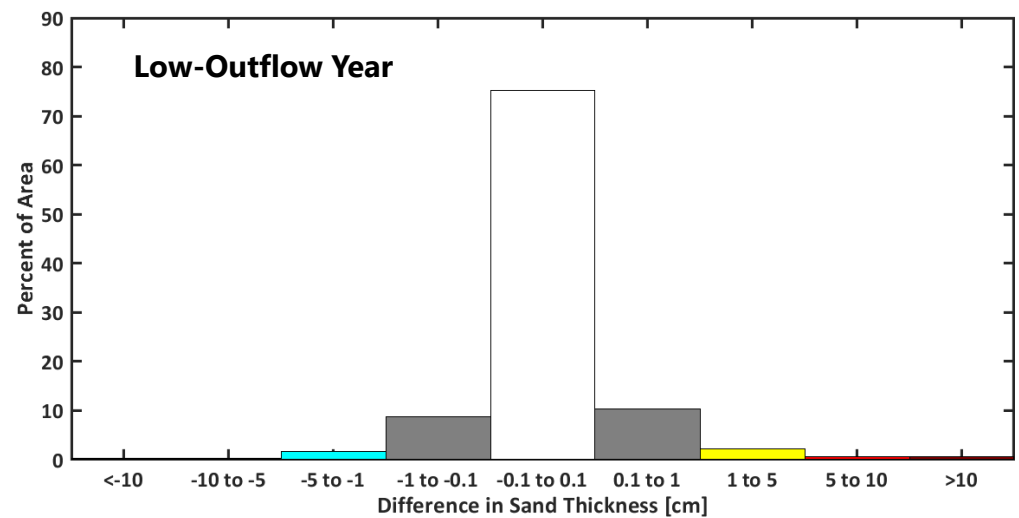
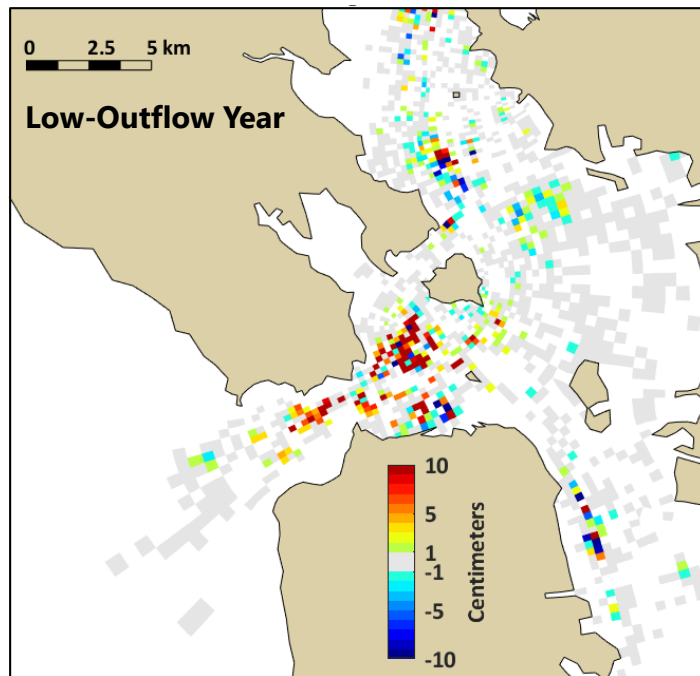
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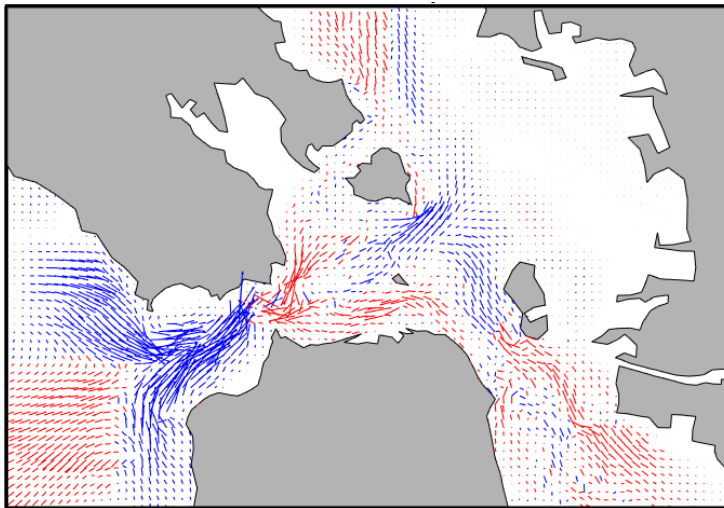


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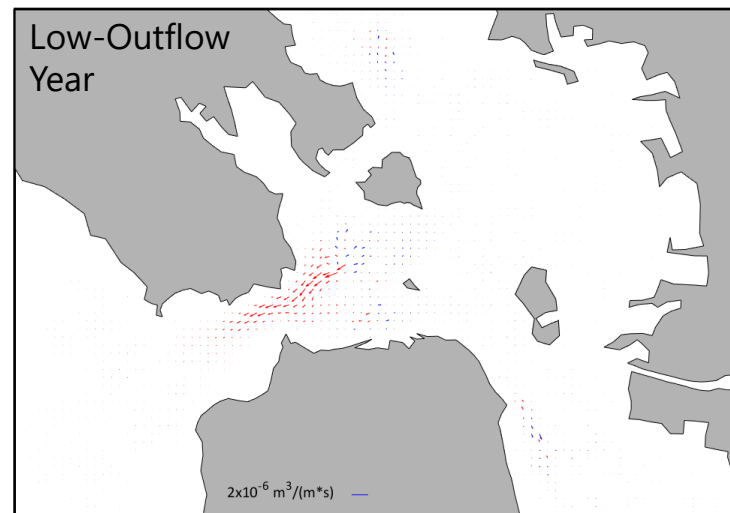
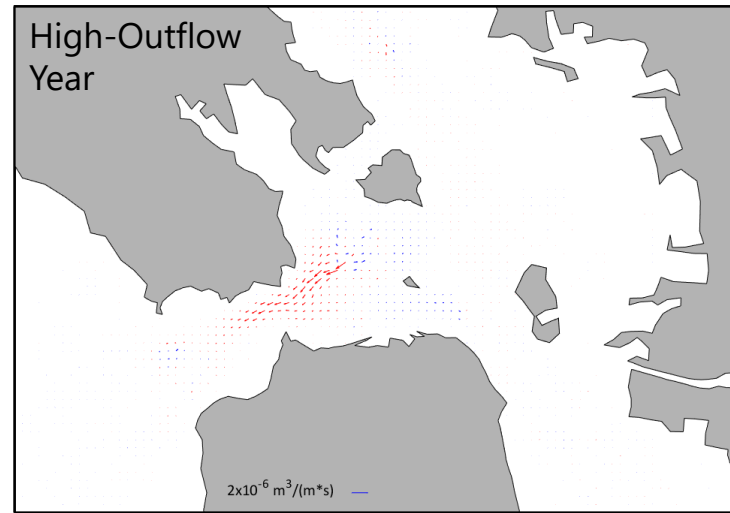
Predicted Sand Fluxes

- Predicted increase in sand transport had sand mining not occurred
- Limited to near mining areas

Predicted Sand Transport During High-Outflow Year

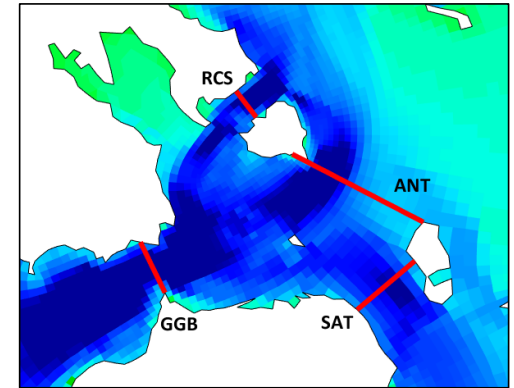


Predicted Change to Sand Transport Without Mining



Predicted Cross-Section Sand Fluxes

- Larger predicted percentage increase during the high-outflow year
 - Results from a lower predicted total sand flux during the high-outflow year than during the low-outflow year



Period	Change in Cross Section Sand Flux (Percent of Total Sand Transport)			
	Golden Gate	Raccoon Strait	Angel Island to Treasure Island	Treasure Island to San Francisco
2018–2019	142%	-8%	<1%	2%
2014–2015	48%	-10%	<1%	<1%

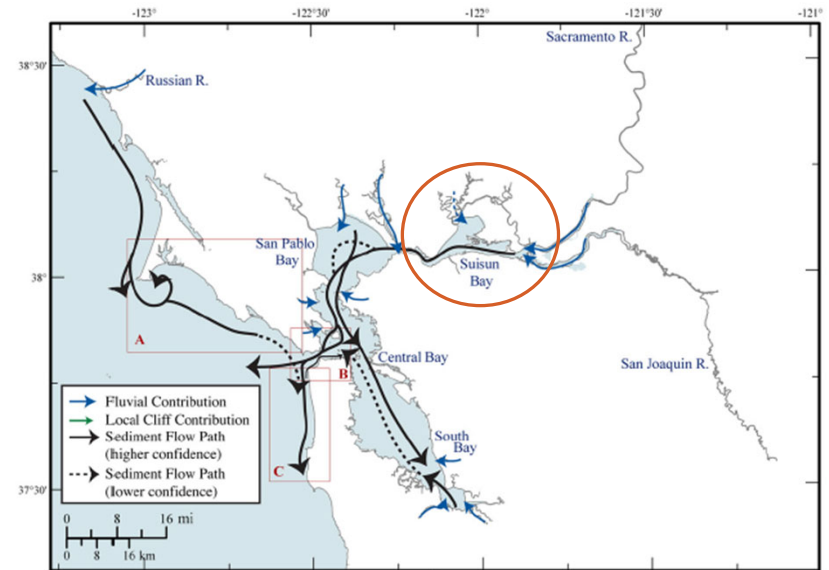
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Predicted Effects of Sand Mining

- Synthesis of Primary Findings

Synthesis of Findings: Suisun Bay

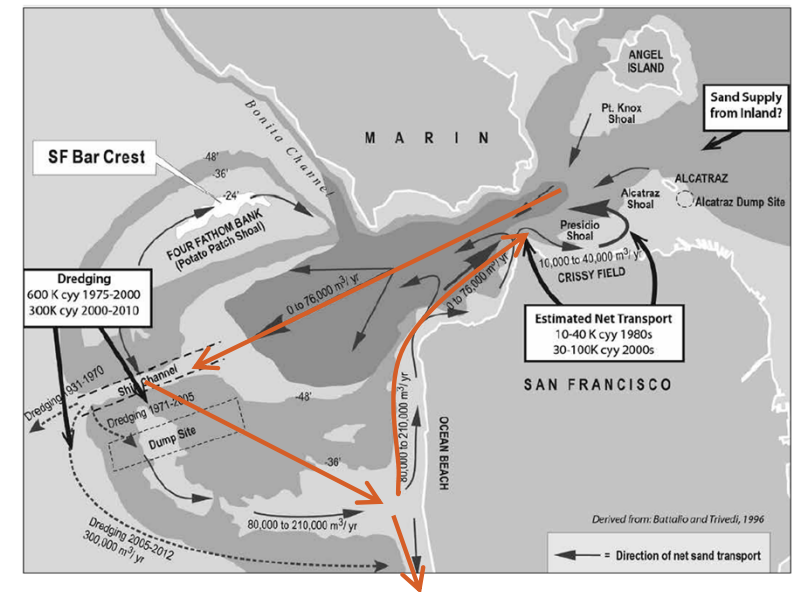
- Episodic westward sand transport
 - Periods of elevated Delta outflow responsible for majority of sand transport toward San Pablo Bay
- Sand mining reduced predicted westward transport of sand
- During 1-year simulation period effects did not extend past Benicia Bridge
 - Sand deposition at Bulls Head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



Source: Hein et al. (2013)
DOI: 10.1016/j.margeo.2013.04.003

Synthesis of Findings: Central Bay

- 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)



Questions and Discussion