Sand Movement along the California Coastline: Focus on the Santa Barbara Littoral Cell

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Ventura Sand Summit

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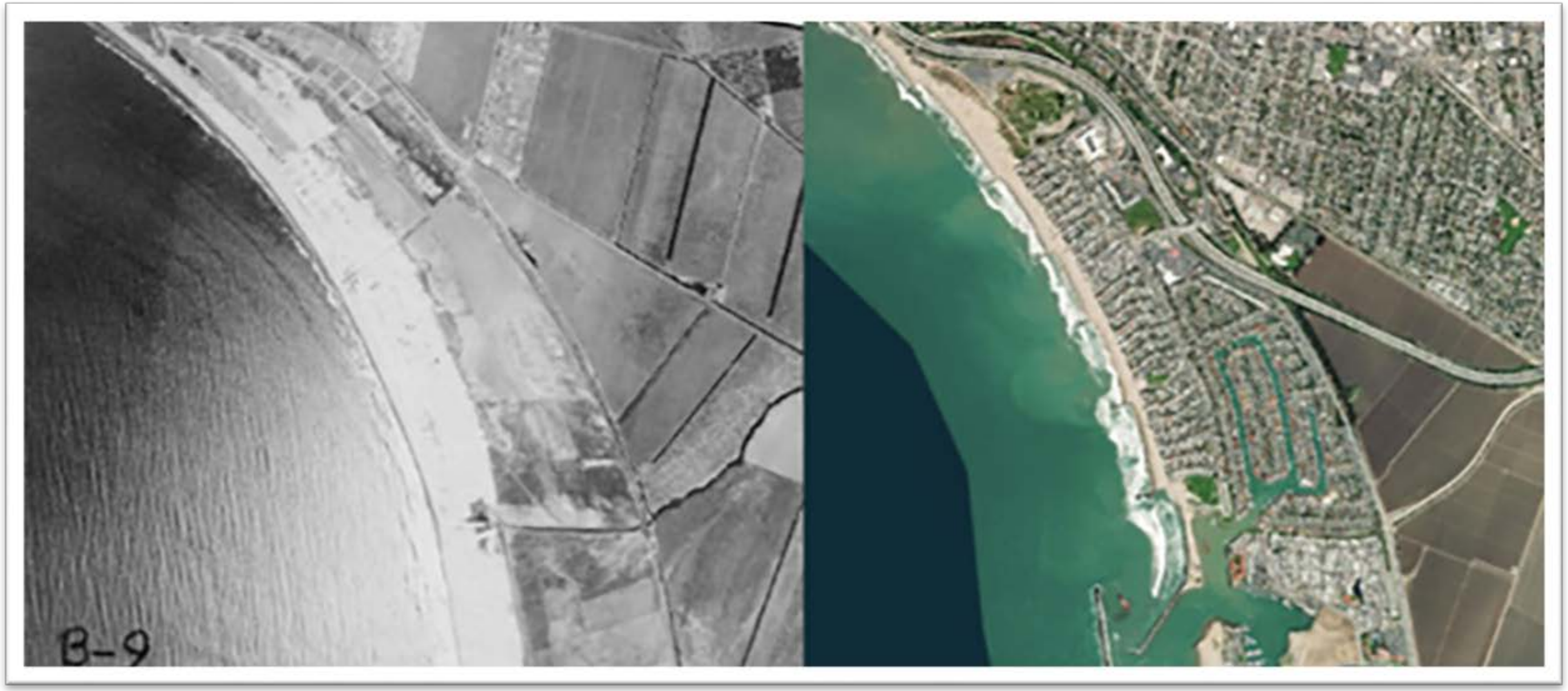
Sandshed.org

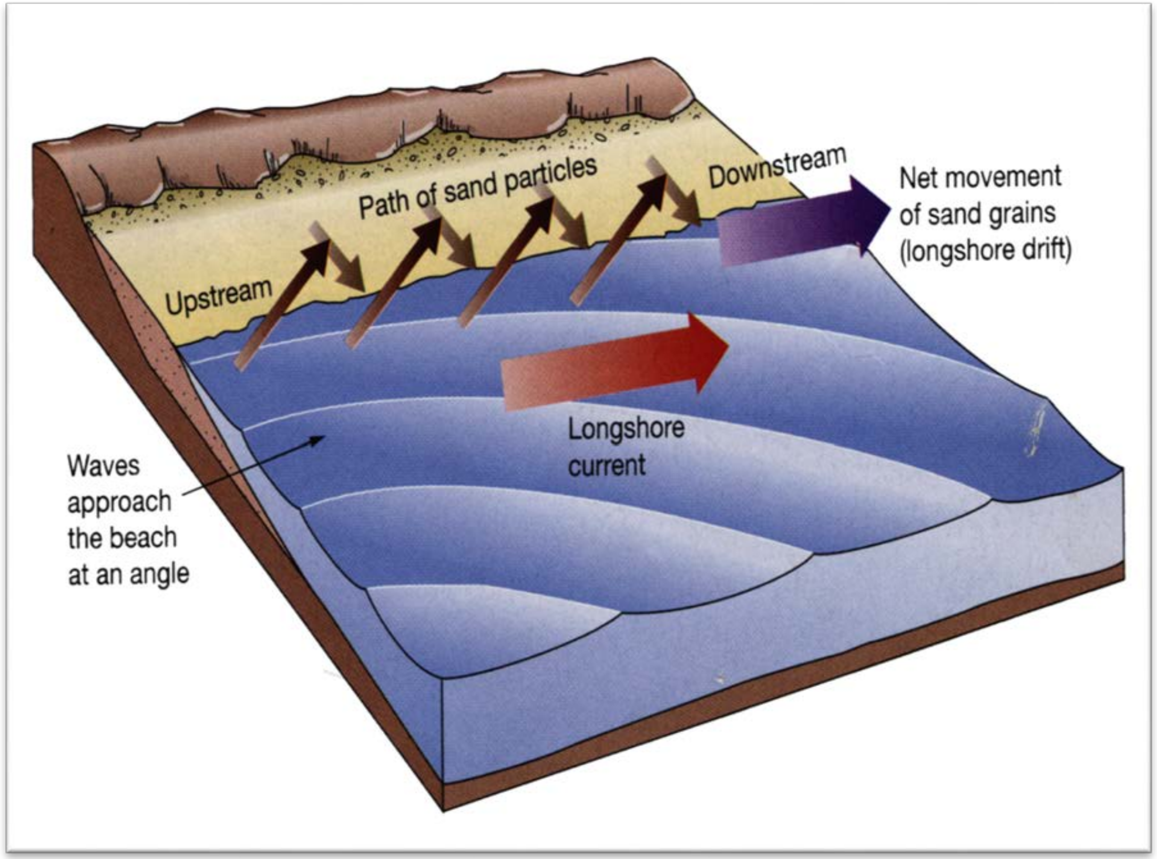
Overview

- How does sand move along the beach?
- How is sand supplied to the beach?
- What is a sediment budget?
- What is regional sand management and why is it important?



Ventura California
1932, 2012

How does sand move along the beach?



C Street, Ventura California January 9, 2021
Photo by Kevin McAtee

These waves don’t have to move the sand very far to produce considerable sand transport

- 5 second waves = **17,000 waves per day**

  (5sec = 720 sec/hour = 17,280/day)
- 10 second waves= **8,640 waves per day**

If we have 10,000 waves per day and sand grains move 2.0 in/wave, sand would migrate **~2,000 ft** alongshore each day!

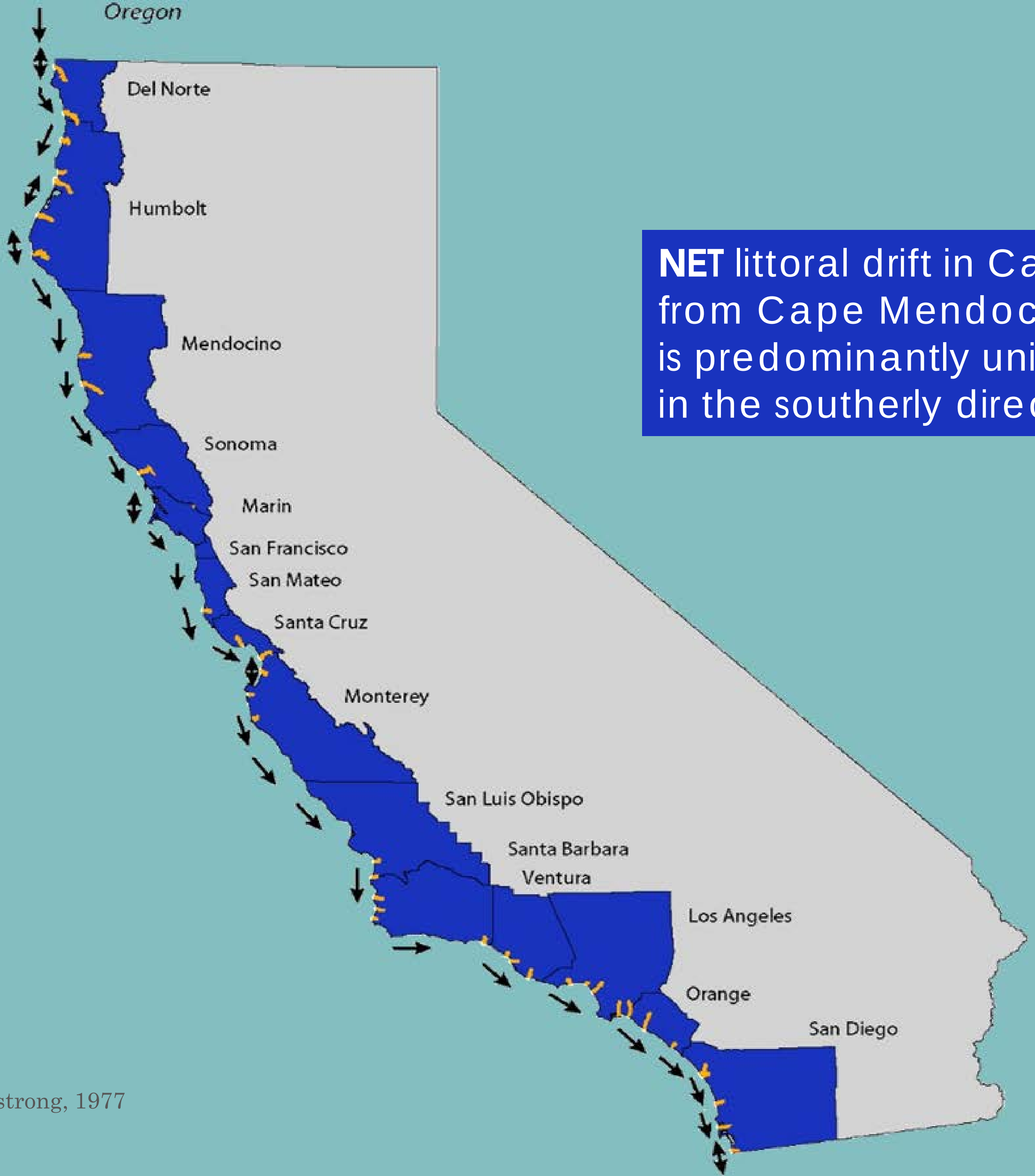
Photo: California Street Surf January 2021 by Kevin McAtee

If we have a littoral zone 200 feet wide in motion, a layer 1 inch think in transit, and are moving ~2,000 feet along shore/day, we could move ~30,000 ft^3/day

- 1000 yd^3/day
- 365,000 yd^3/year

Littoral drift rates along the coast of California are of this magnitude

Predominant strong winter waves from the northwest move sediment



NET littoral drift in California, from Cape Mendocino to San Diego, is predominantly unidirectional, in the southerly direction.

Modified from Habel and Armstrong, 1977

Consequences of Interrupting Littoral Drift

Santa Barbara breakwater construction in 1929

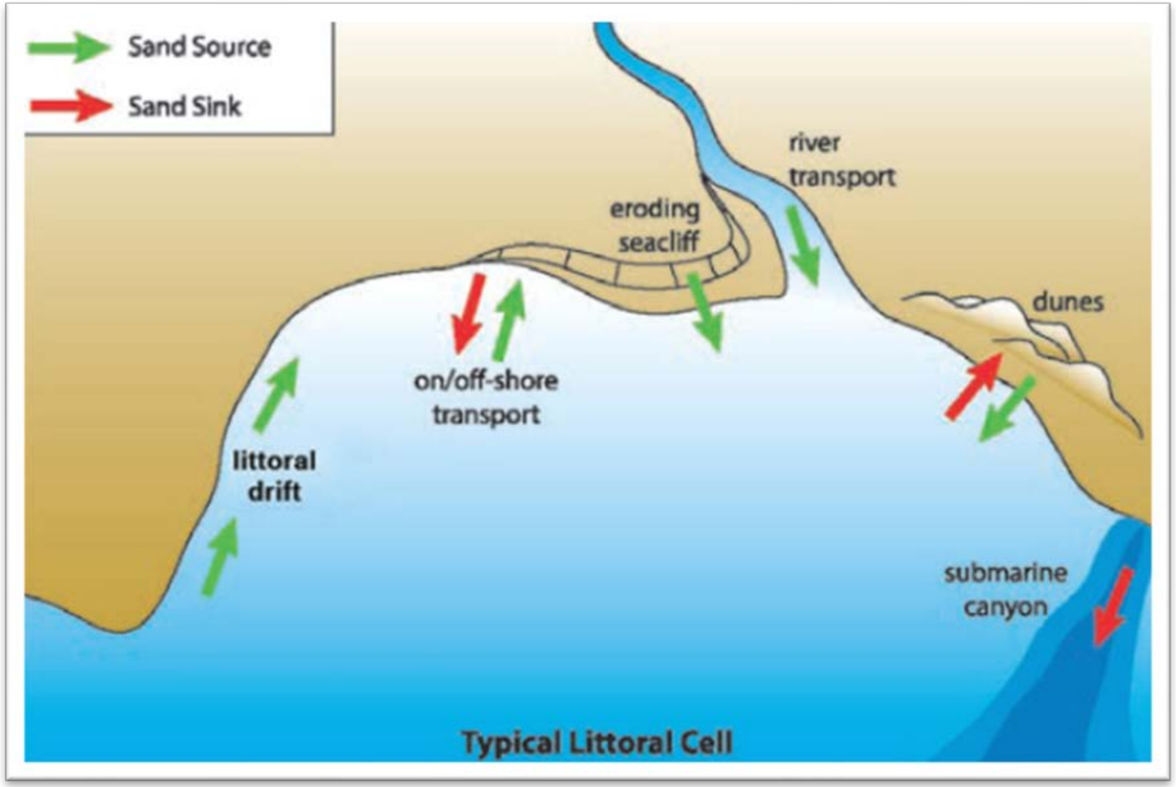
Carpinteria, 1933

Sandsheds
Littoral Cells or Beach Compartments

- Littoral cells form the framework for our understanding of the
  - Sources
  - Sinks
  - Transport
  - Storage

  of sand in the nearshore zone

Littoral Cell Sediment Budgets



In an ideal situation, each cell exists as a distinct entity with little to no transport of sand between cells.

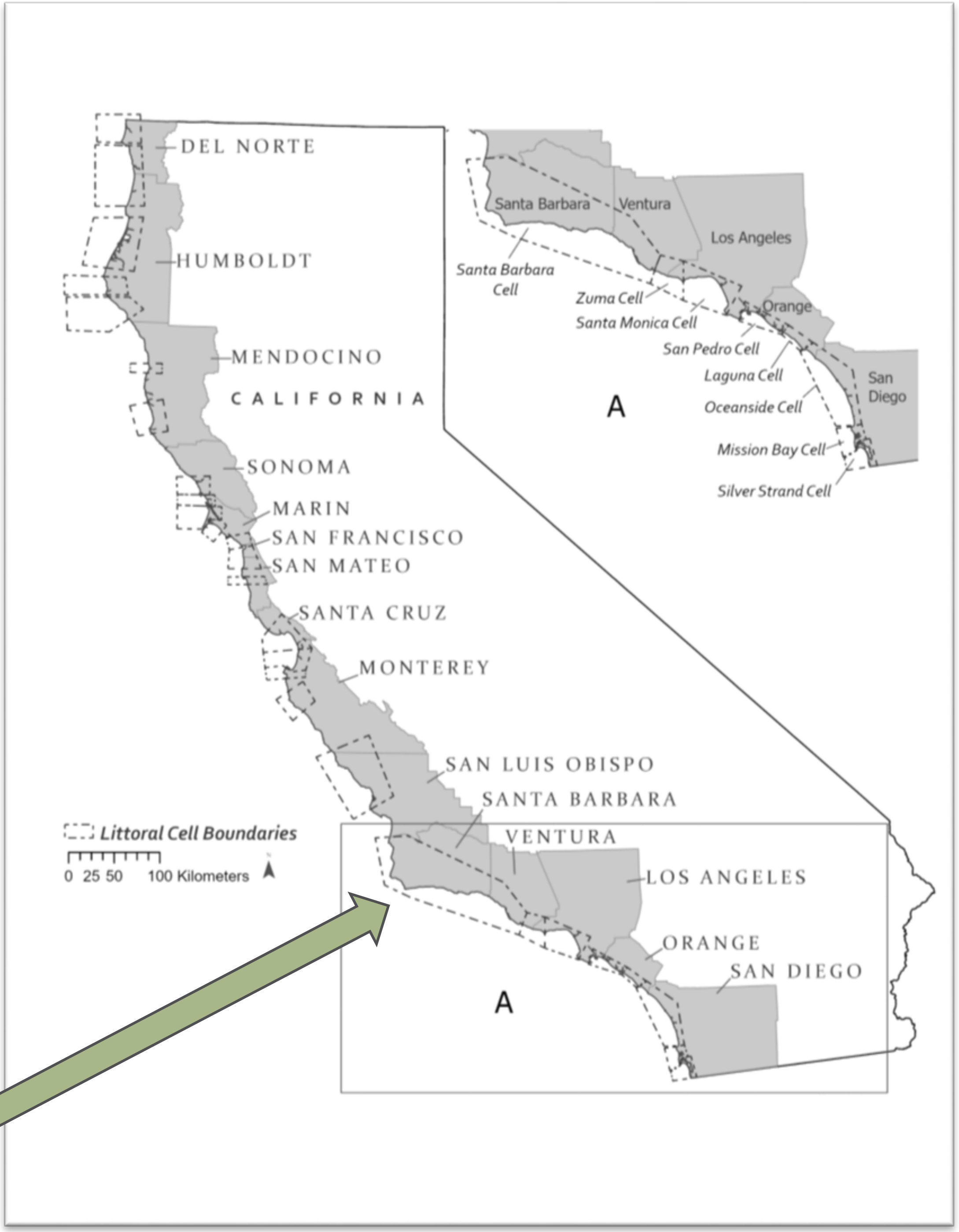
Sources:

- River Transport (70-90% in CA)
- Seacliff Erosion
- Onshore transport
- Beach nourishment
- Wind transport onto the beach
- Longshore transport into the area

Sinks:

- Loss to submarine canyons
- Loss to dune fields
- Offshore movement
- Sand mining
- Longshore transport out of the area

Littoral Cells




Santa Barbara
Littoral Cell
California
Santa Maria River
San Antonio Creek
Santa Ynez River
Santa Ynez Mountain Streams
Ventura River
Santa Clara River
Calleguas Creek
Point Conception
Gaviota
Isla Vista
Santa Barbara
Ventura
Channel Islands/Port Hueneme harbors
Mugu Submarine Canyon
Pacific Ocean
N
15 Miles

Eroding bluffs in Santa Barbara

Santa Clara River Mouth, south of Ventura Harbor

Reductions to the Natural Sand Supply

- Damming rivers
- Armoring sea cliffs
- Channelizing streams
- Impoundment behind shore-perpendicular armoring structures (Groins and Jetties)

Matilija Dam, Ventura River CA

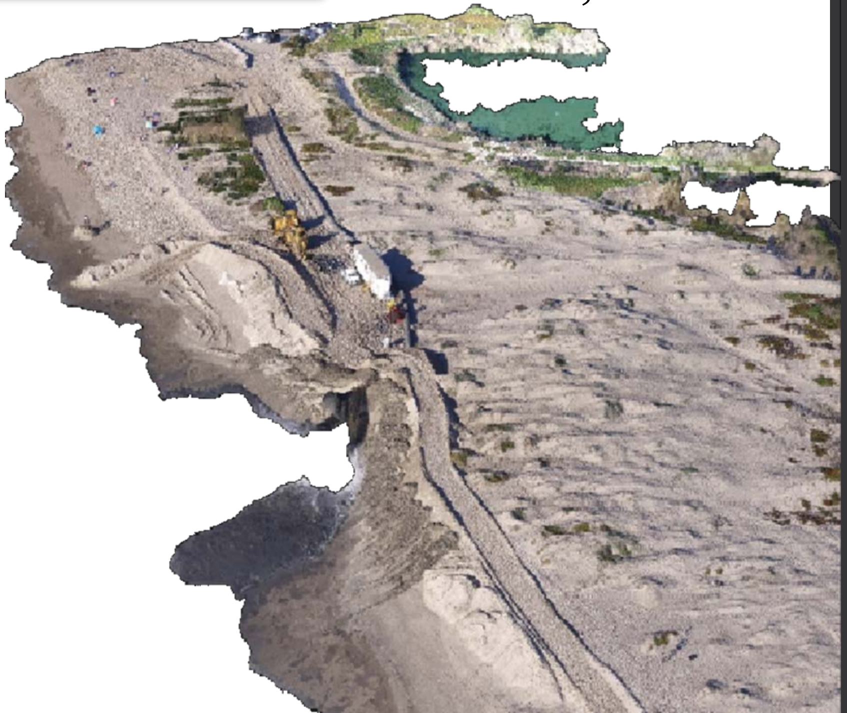
Seawall Construction

Isla Vista, California

Goleta, CA

Ventura, CA

Isla Vista, CA



With the reductions to sand supply and an increasing sea level, what do we do to maintain our beach width?

Regional Sand Management

Changes along the up-drift end of a littoral cell will impact beaches throughout the rest of the cell.

Decisions must be made with a holistic understanding of sand supply and movement along the shores.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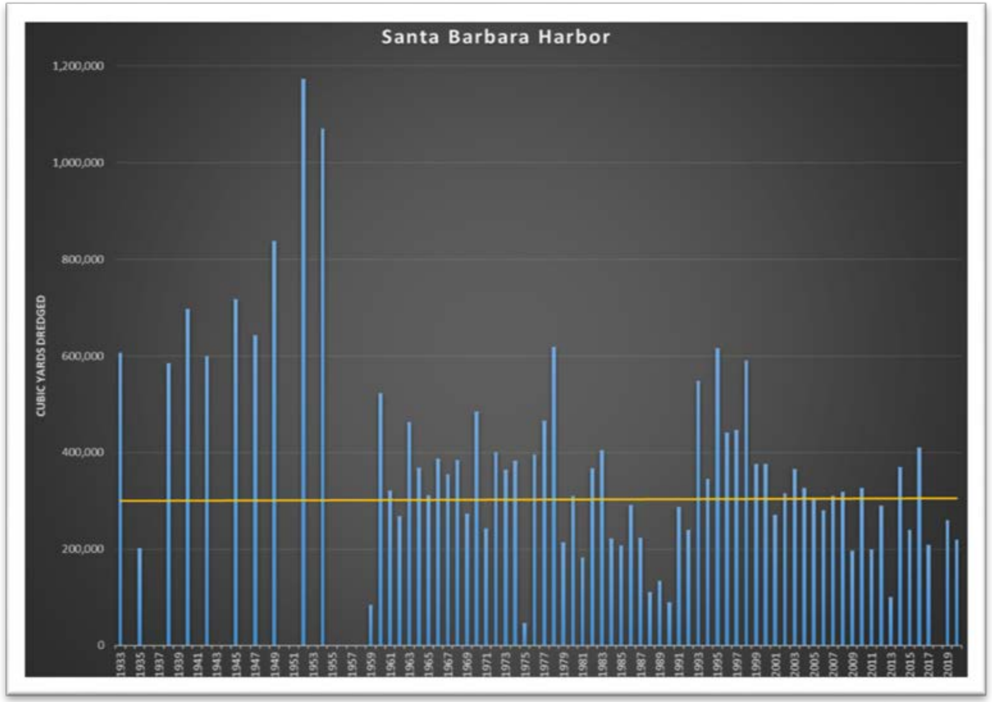
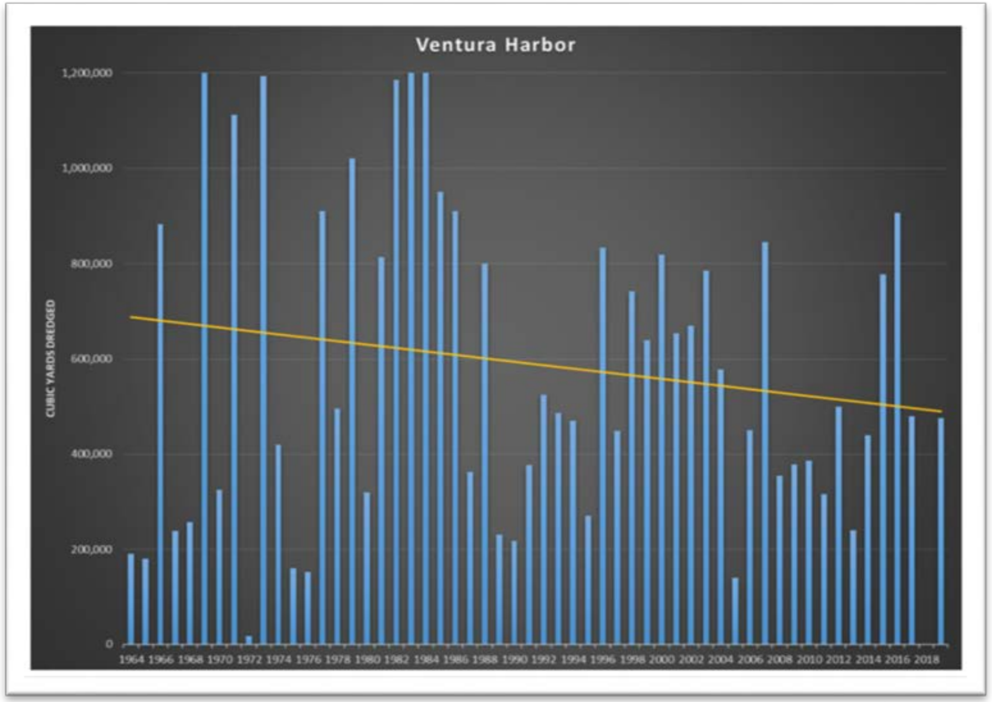
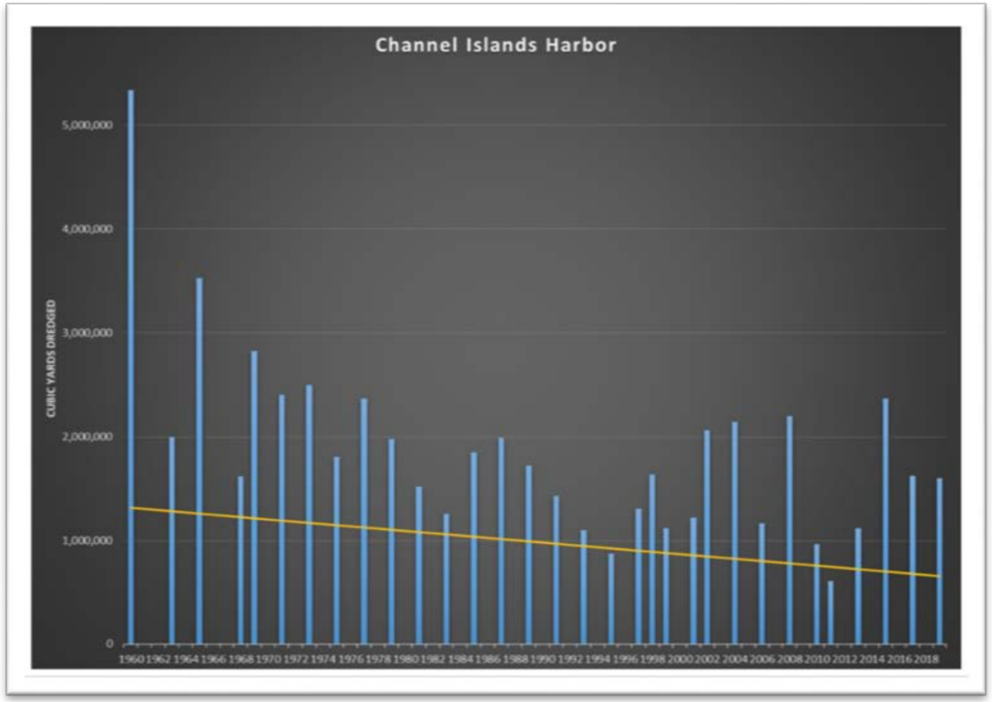
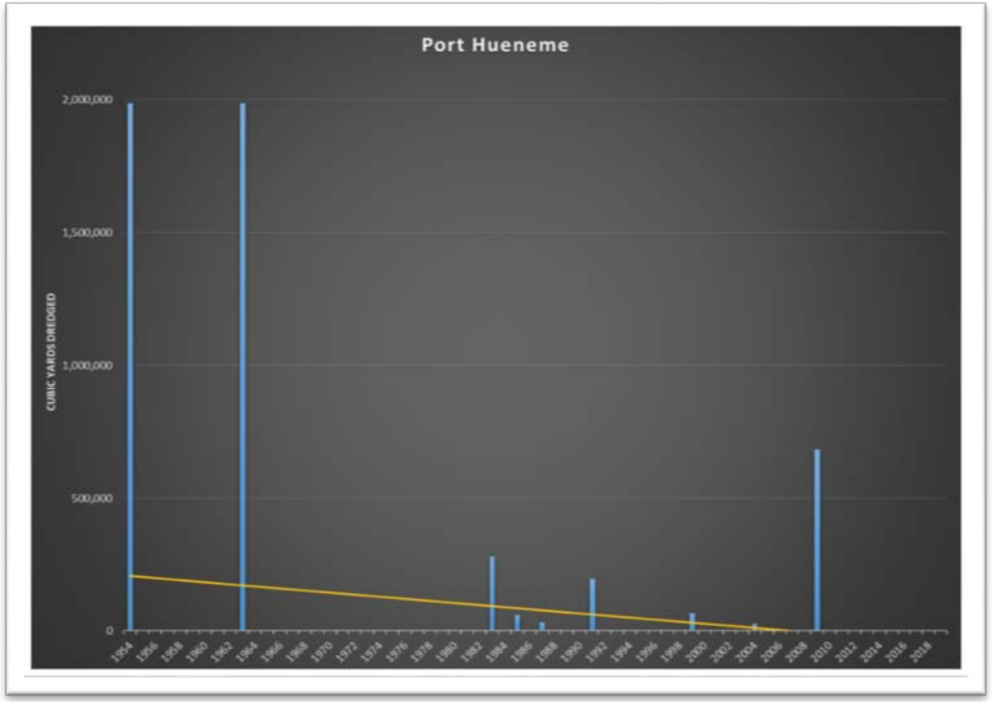
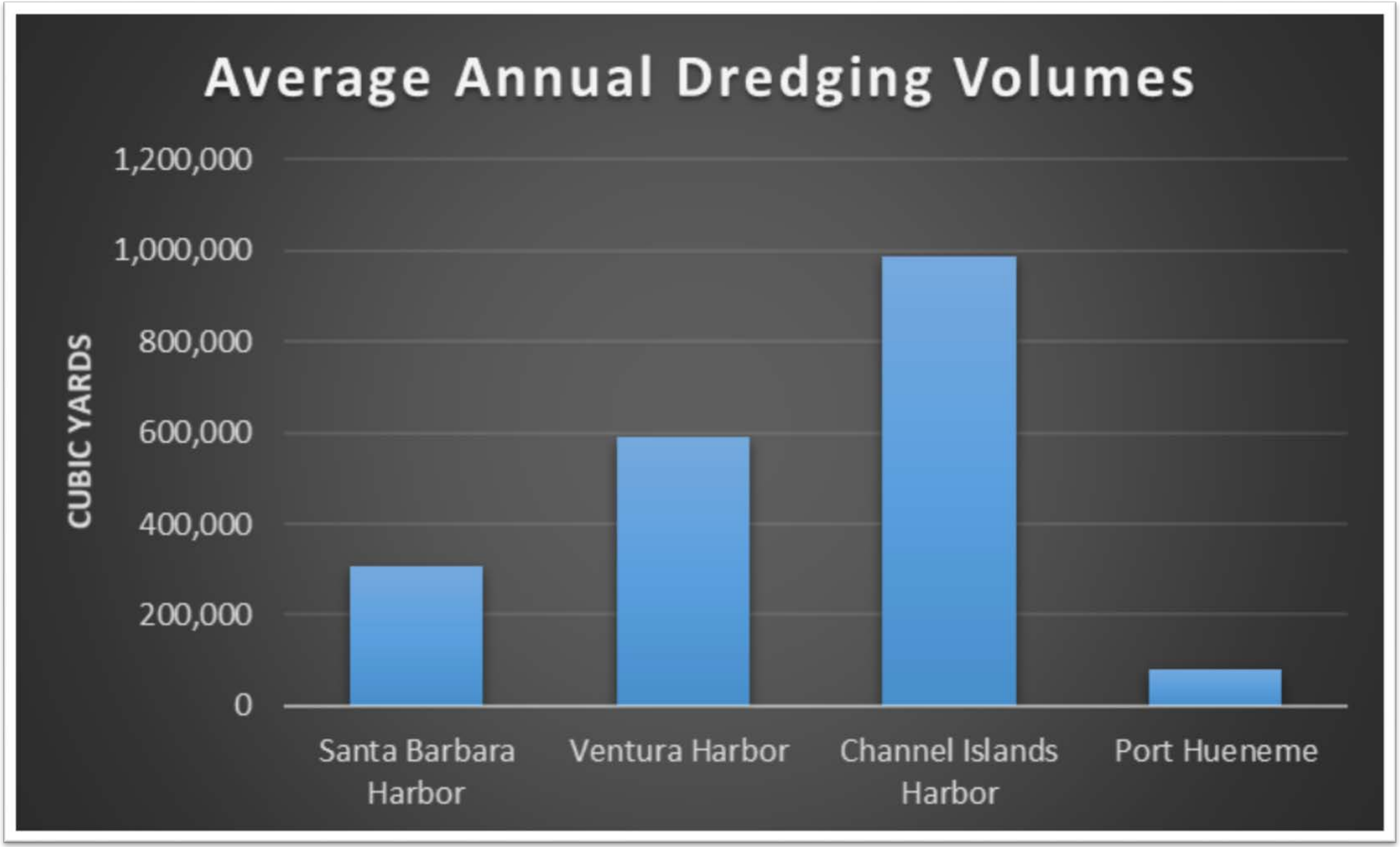

Santa Barbara Harbor
CUBIC YARDS DREDGED


Ventura Harbor
CUBIC YARDS DREDGED


Channel Islands Harbor
CUBIC YARDS DREDGED

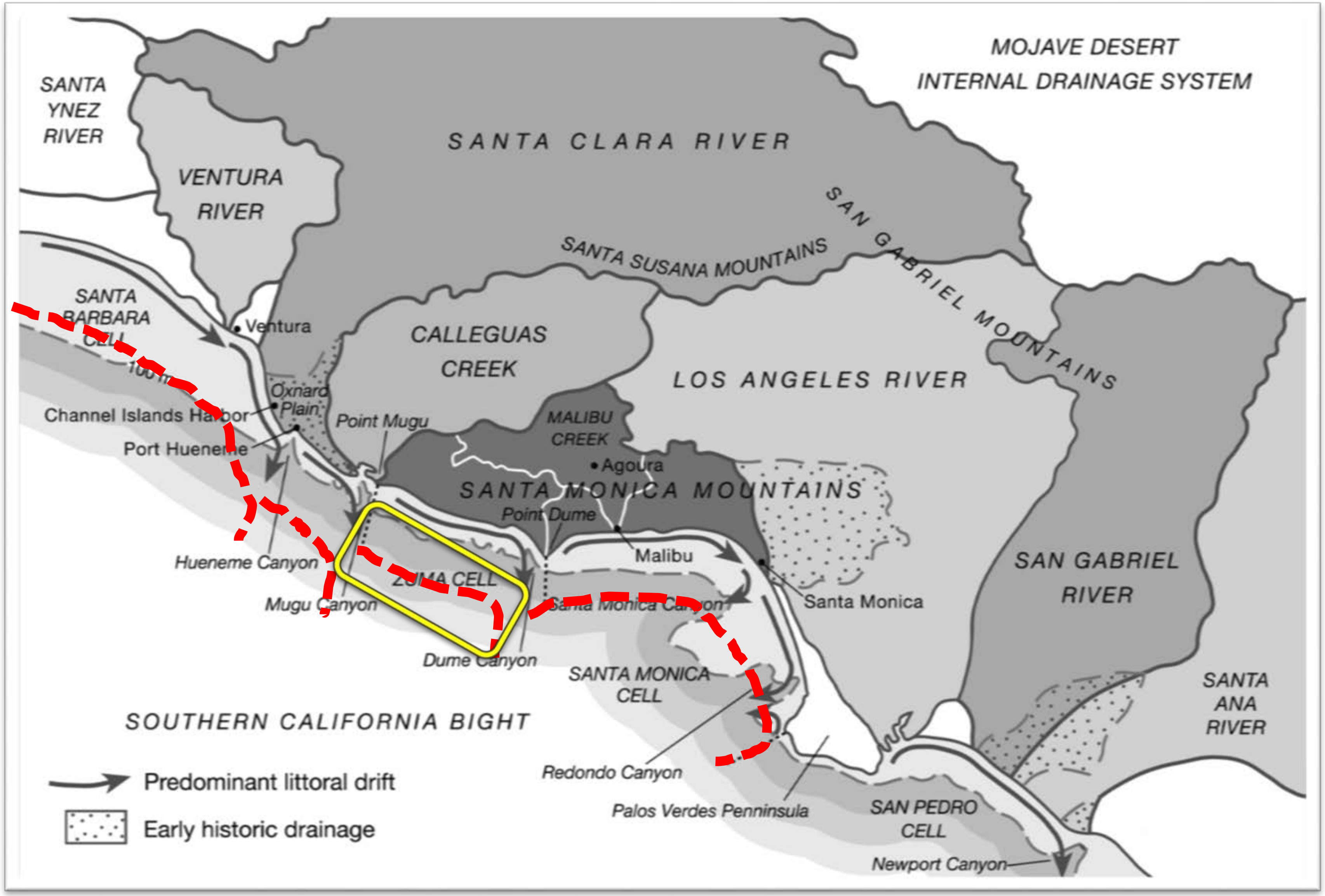

Port Hueneme
CUBIC YARDS DREDGED


Average Annual Dredging Volumes
CUBIC YARDS
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Santa Barbara Harbor
Ventura Harbor
Channel Islands Harbor
Port Hueneme

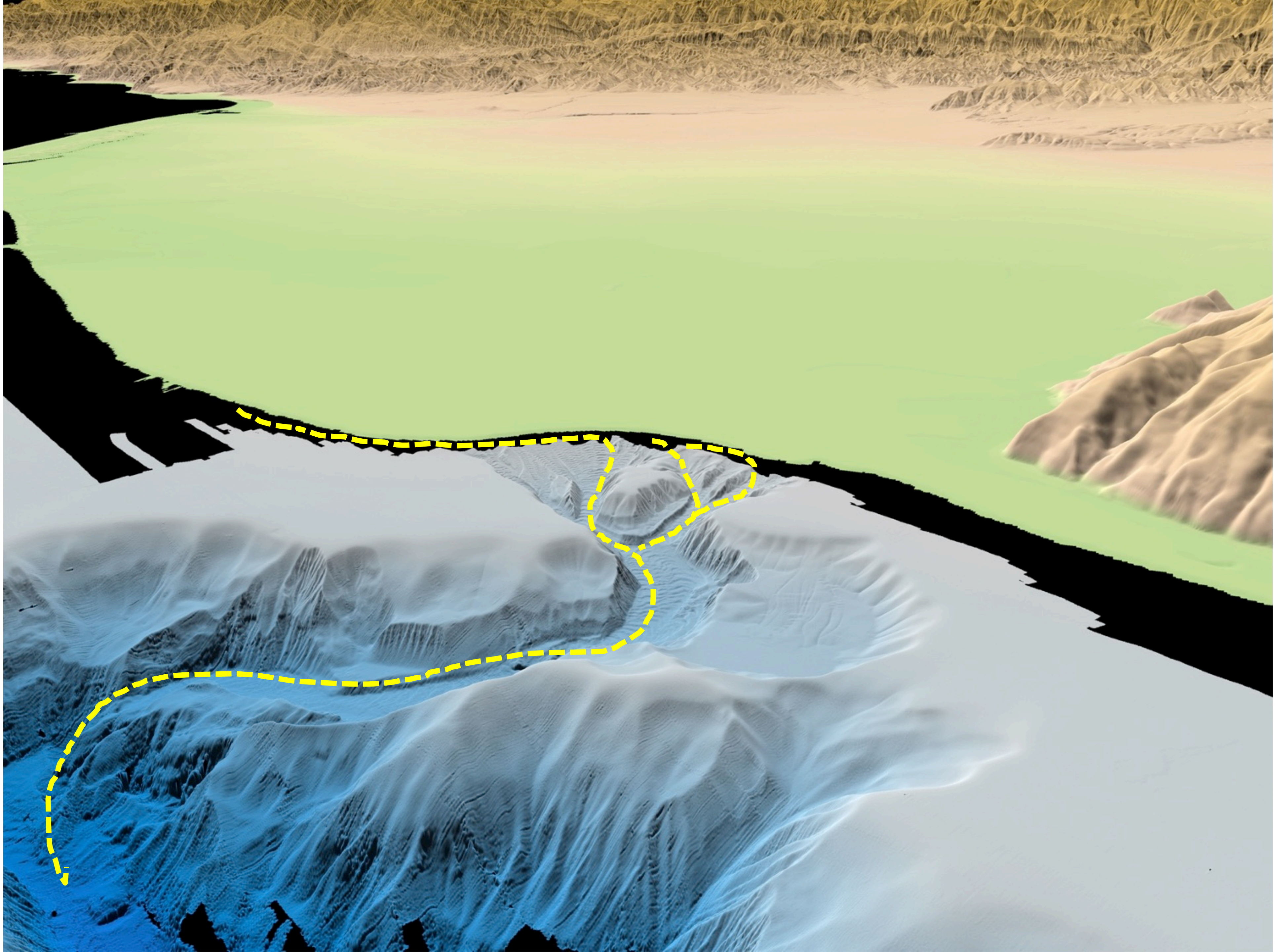
Consequences of interrupting the supply of sand

Hueneme Beach and the dredging of Channel Islands Harbor (2014)

Each littoral cell or beach compartment ends in a submarine canyon where sand is lost.



Hueneme and Mugu submarine canyons capture over a million cubic yards of beach sand each year and transport it offshore.



Pt. Dume is a barrier for the sand that historically was transported from the west and allowed Zuma & Broad beaches to form.

Lechuza Point 1972 and today

Broad Beach 1972

Broad Beach 2013

Take Aways…

- Sand moves along the coast under the influence of waves (Littoral Drift)
- We need to understand the sand budget to understand how beaches will respond
  - Sources > Sinks = Beach Growth/Accretion
  - Sources < Sinks = Long-term beach erosion
  - Sources = Sinks = Equilibrium
- We need to be mindful of the consequences of interruptions to the flow of sand
- **Alterations to the sediment budget need to be considered on a REGIONAL SCOPE, ideally on the littoral cell scale**