CALIFORNIA BEACHES AND SAND SUPPLIES

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Beaches serve to important purposes:

1. A buffer to shoreline wave attack

2. A recreational resource for 39 million residents and ~32 million visitors and at the heart of a $20 billion/year industry

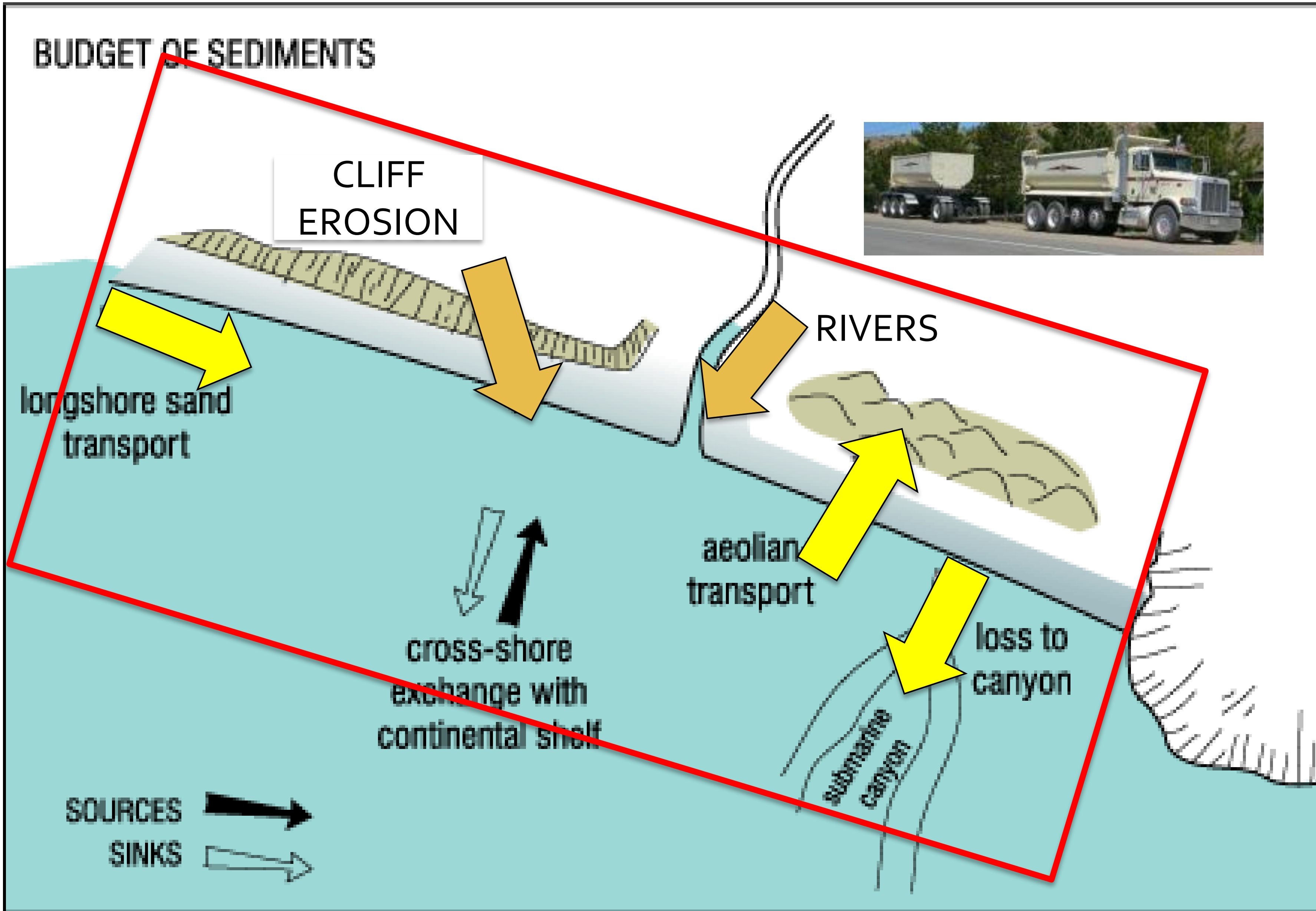
Beach sand has become increasingly important as a tourism and recreational use increases, and also as the most cost-effective short-term buffer to the coastline from wave attack and sea-level rise

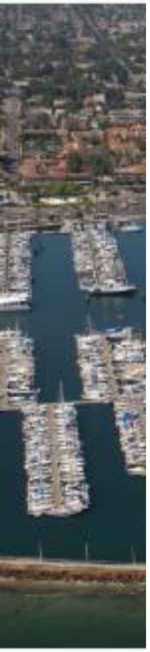
Narrow beaches means less recreational area and increased cliff retreat.

Dominant waves from the northwest drive most of California's littoral drift south, although there are areas with northerly transport, and with seasonal drift reversals.

Sand moves along the coast of California within beach compartments or littoral cells

An individual littoral cell consists of sand sources, littoral drift and sand sinks.





Littoral Cell		Rivers (dams)	Bluff Erosion (armor)	Total Reduction	Beach Nourishment	Balance (nourishment-reductions)
Eureka	Reduction yd^3/yr	N/A	N/A	N/A	0	N/A
	Percent Reduction	N/A	N/A	N/A		
Santa Cruz	Reduction yd^3/yr	6,000	8,000	14,000	0	-14,000
	Percent reduction	3%	20%	6%		
Southern Monterey Bay	Reduction yd^3/yr	237,000	N/A	237,000	0	-237,000
	Percent reduction	33%	N/A	33%		
Santa Barbara	Reduction yd^3/yr	1,476,000	3,000	1,479,000	0	-1,479,000
	Percent reduction	41%	19%	40%		
Santa Monica	Reduction yd^3/yr	29,000	2,000	31,000	526,000	495,000
	Percent reduction	30%	1%	13%		
San Pedro	Reduction yd^3/yr	532,000	0	532,000	400,000	-132,000
	Percent reduction	66%	0%	66%		
Laguna	Reduction yd^3/yr	0	1,000	1,000	1,000	0
	Percent reduction	0%	13%	4%		
Oceanside	Reduction yd^3/yr	154,000	12,000	166,000	111,000	-55,000
	Percent reduction	54%	18%	47%		
Mission Bay	Reduction yd^3/yr	65,000	17,000	82,000	44,000	-38,000
	Percent reduction	91%	18%	50%		
Silver Strand	Reduction yd^3/yr	41,000	0	41,000	256,000	215,000
	Percent reduction	49%	0%	49%		
Total	Reduction yd^3/yr	2,540,000	43,000	2,583,000	1,338,000	-1,245,000
	Percent reduction	43%	11%	39%		
Southern CA Total	Reduction yd^3/yr	2,297,000	35,000	2,332,000	1,338,000	-994,000
	Percent reduction	47%	10%	44%		

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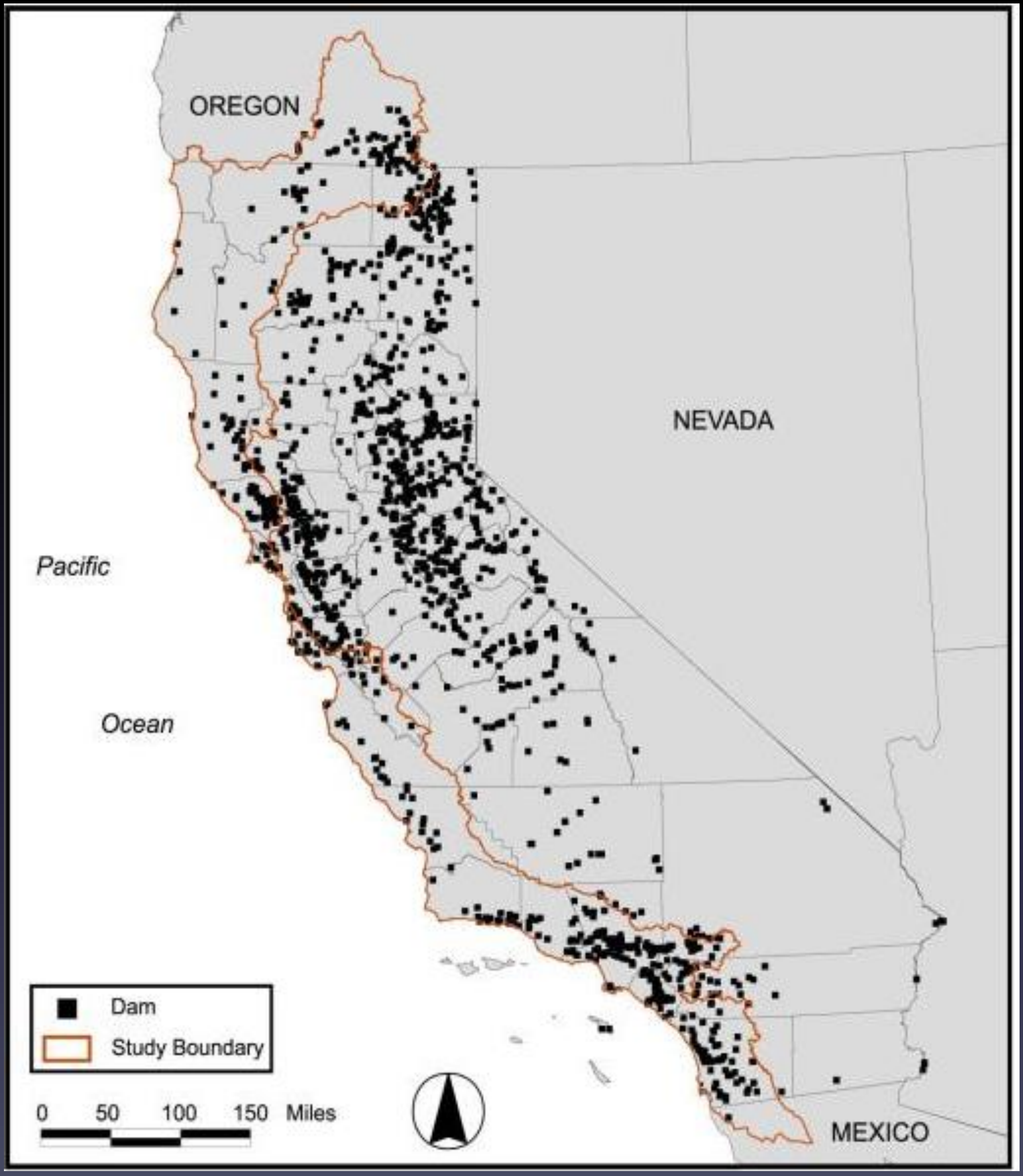
75 to 95% of California’s beach sand is provided by rivers and streams, the remainder by cliff and bluff erosion.

Dams trap sand headed for beaches

Seawalls halt bluff erosion and eliminate bluff contributions to beach sand budget.

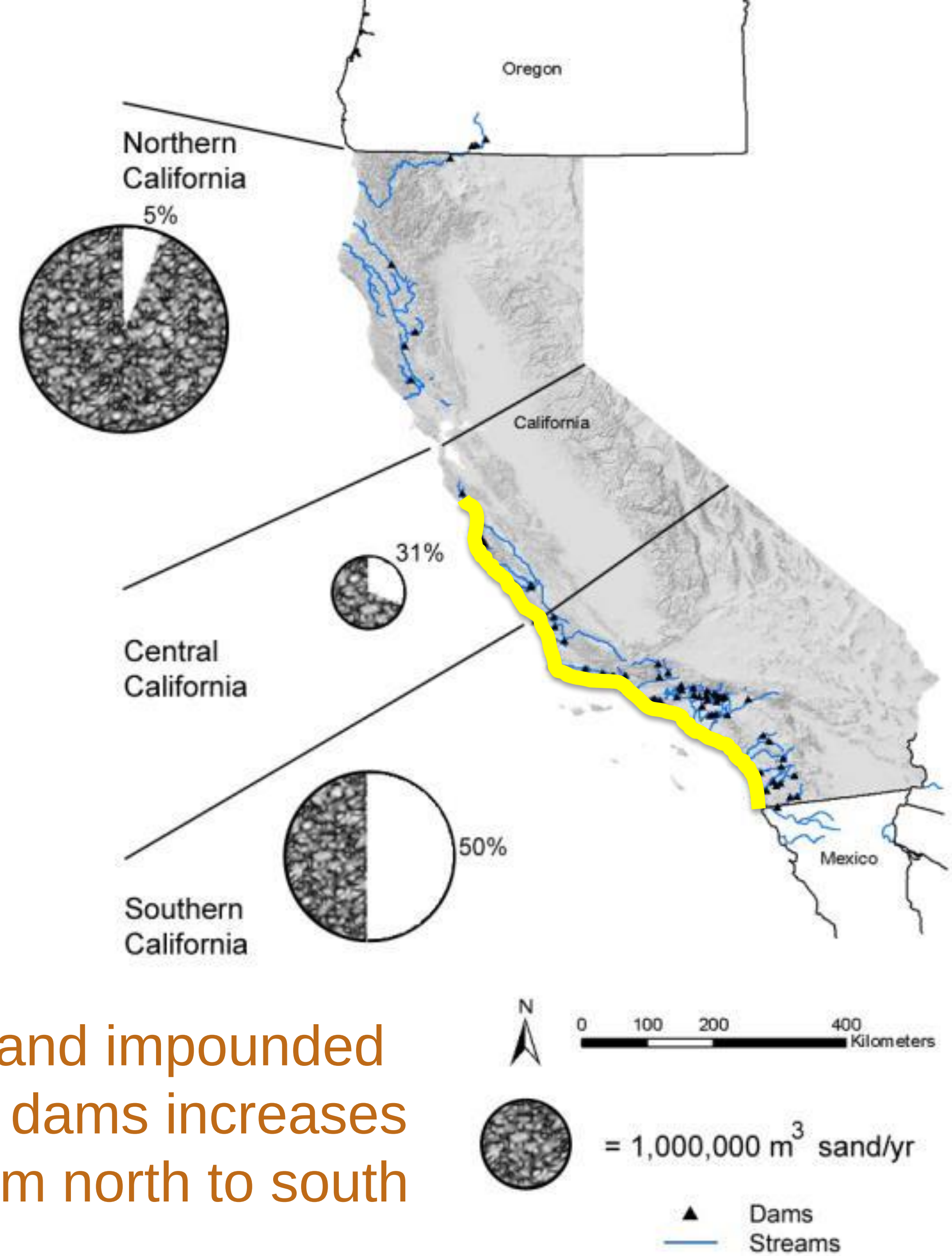
In California, in the last century, 480 major dams and reservoirs and nearly 200 debris basins were built. All of these trap
sand that would have normally flowed to the shoreline.

About 25% of the sand originally supplied by rivers has been cut off by dams



164,000,000 yds^3 is trapped in reservoirs

Enough sand to build a beach 150 feet wide,10 feet thick, and 560 miles long- extending from Santa Cruz to the Mexican border.



Sand impounded by dams increases from north to south

10% of the entire California coast armored, but 33% of the coastline of Southern California has seawalls.

Despite sand reduction from dams and seawalls, beaches haven't systematically been eroded.

Beach changes along the southern
during the 20th centu
A comparison of natural and huma

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ABSTRACT

Rectified vertical aerial photographs and topographic LIDAR sets, geographic information systems, field observations, and historical data are combined to investigate morphological changes for 75 beaches around the Southern California Bight over a period of 56-77 years. These beaches occur within five discrete units: the Santa Barbara, Zuma, Santa Monica, San Pedro and Oceanside littoral cells. No cell-wide net erosional or net depositional trends are identified. Relatively natural beaches, lacking major human impacts, reveal modest cyclic narrowing and widening related respectively to El Niño and La Niña climatic forcing, and longer-term trends weakly related to the Pacific Decadal Oscillation. For beaches influenced by engineering st changes over the tion. First, hard st cells, with accret of jetties and brea artificial nourish erosion also occu the longevity of fill introduced an ent. In most case beaches eroding o cycles of re-nour

Beaches around the Southern California Bight protect backshore development and related infrastructure from potentially destructive storm waves and high tides, provide habitat for plants and animals, and attract recreation and tourism. However, these beaches are often narrow, and in many cases, no longer in a natural state.

ADDITIONAL KEYWORDS: Beach change; littoral cell; sediment transport; beach nourishment; coastal engineering; ENSO; Pacific Decadal Oscillation; Southern California Bight.

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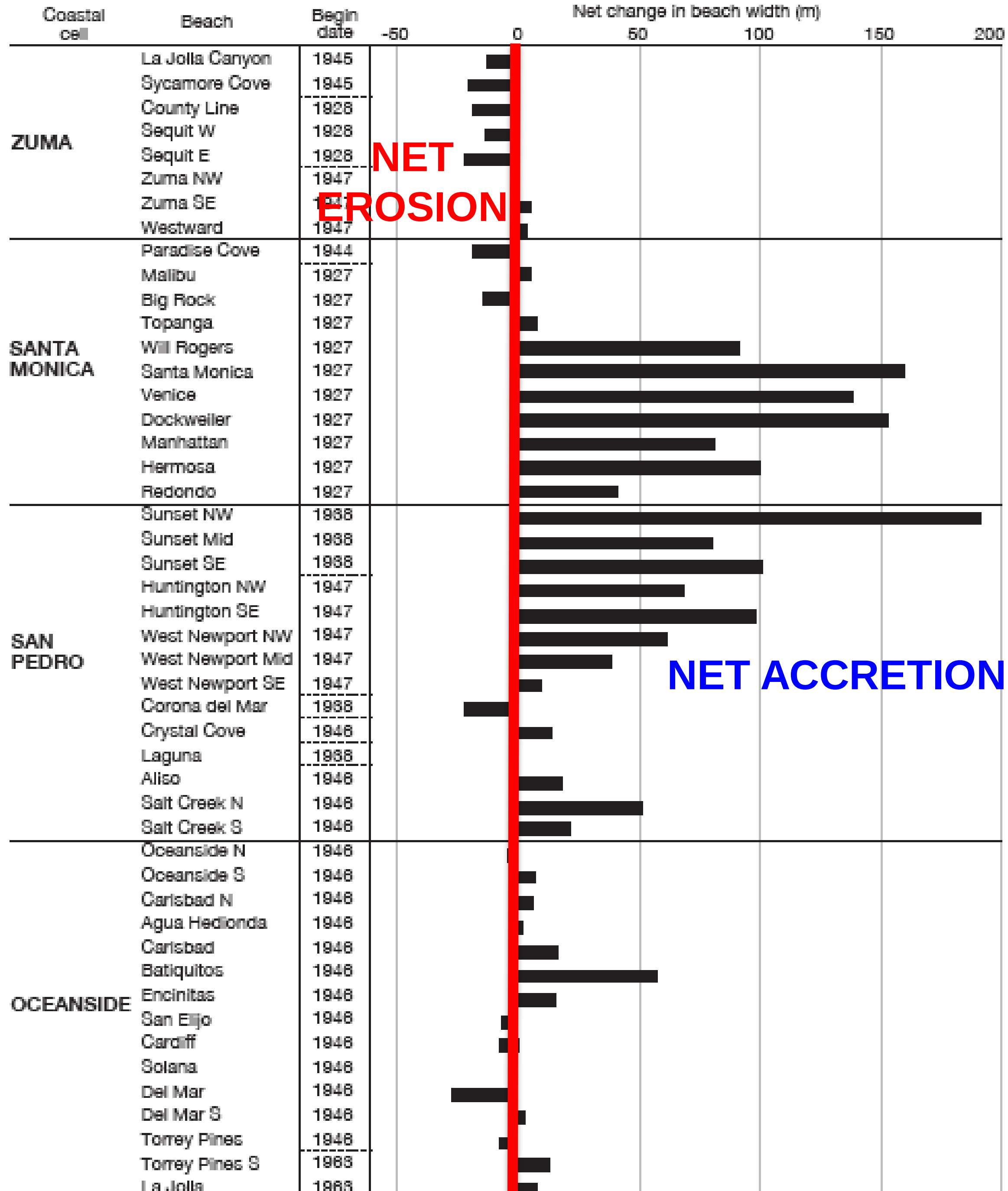
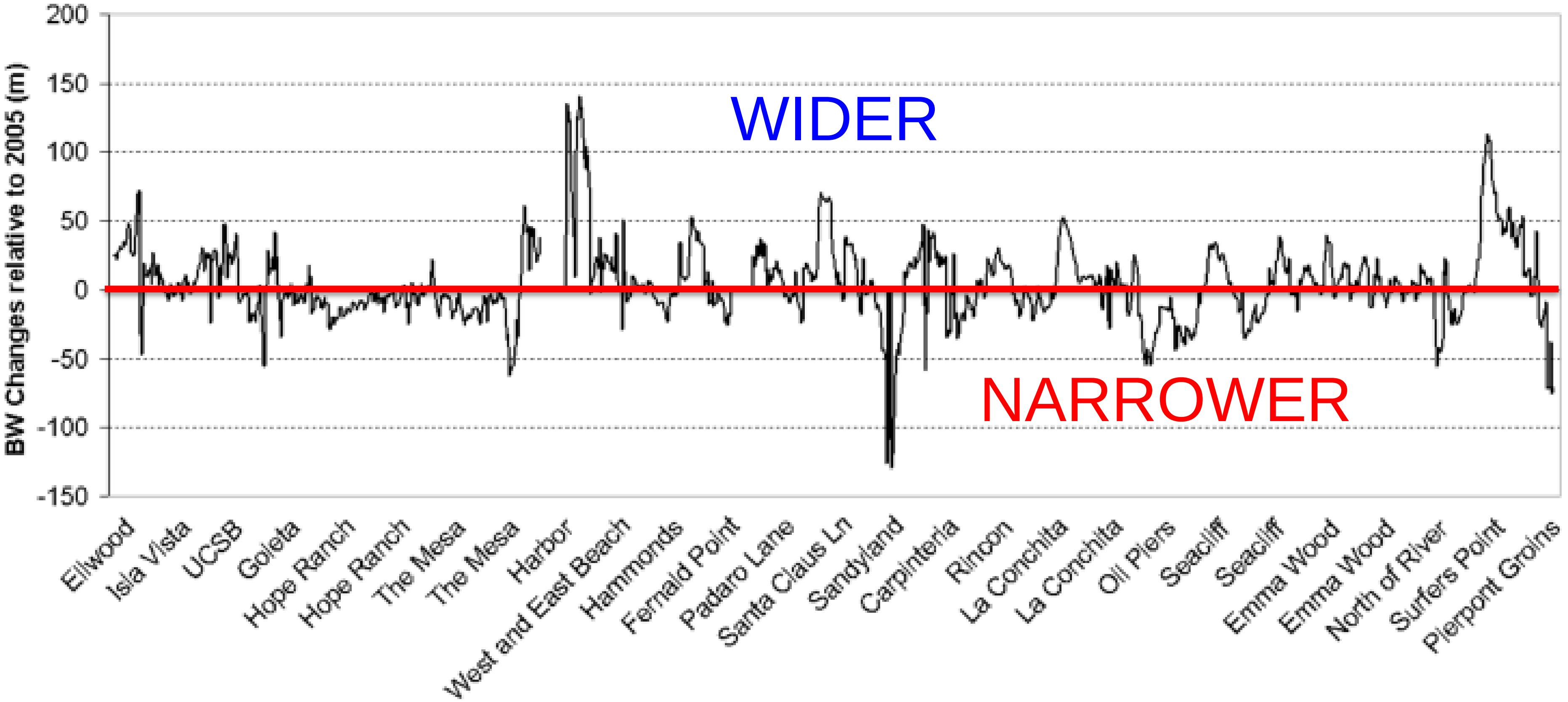
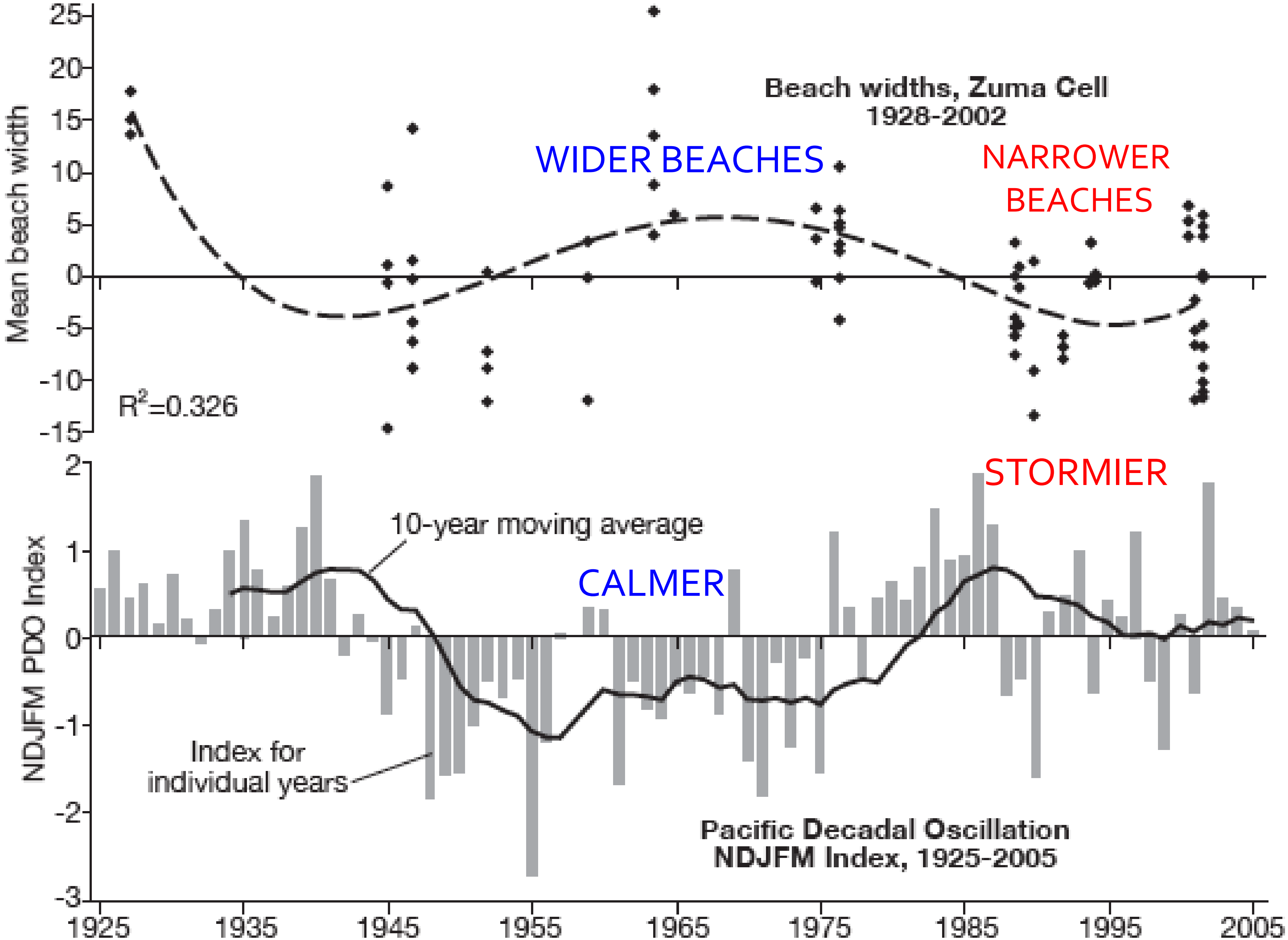
Southern California beaches vary in size in response to natural forcing factors, notably to seasonal sediment inputs from contributing drainage basins typified by a Mediterranean-type climate, and to variations in wave climate. Over periods from a few hours to several days, wave conditions cause changes at the beach face, which complicate interpretation of monthly and seasonal trends. At seasonal scales, and despite winter inputs of fluvial sediment, exposed beaches typically experience net winter erosion by storm waves, and net summer accretion by long-period swells, such that year-to-yea changes are less obvious (Orme 2000 Sheltered beaches suffer less seasona variability. Over the medium term of few years, El Niño-Southern Oscillatio (ENSO) events may also force beac changes (Flick 1998; Inman and Jen kins 1999; Storlazzi and Griggs 2000 Because of this variability, longer-ter trends lasting decades or more are poorl understood but may involve secula changes in ocean-atmosphere forcing an



Long-term beach width changes in Santa Barbara Littoral Cell

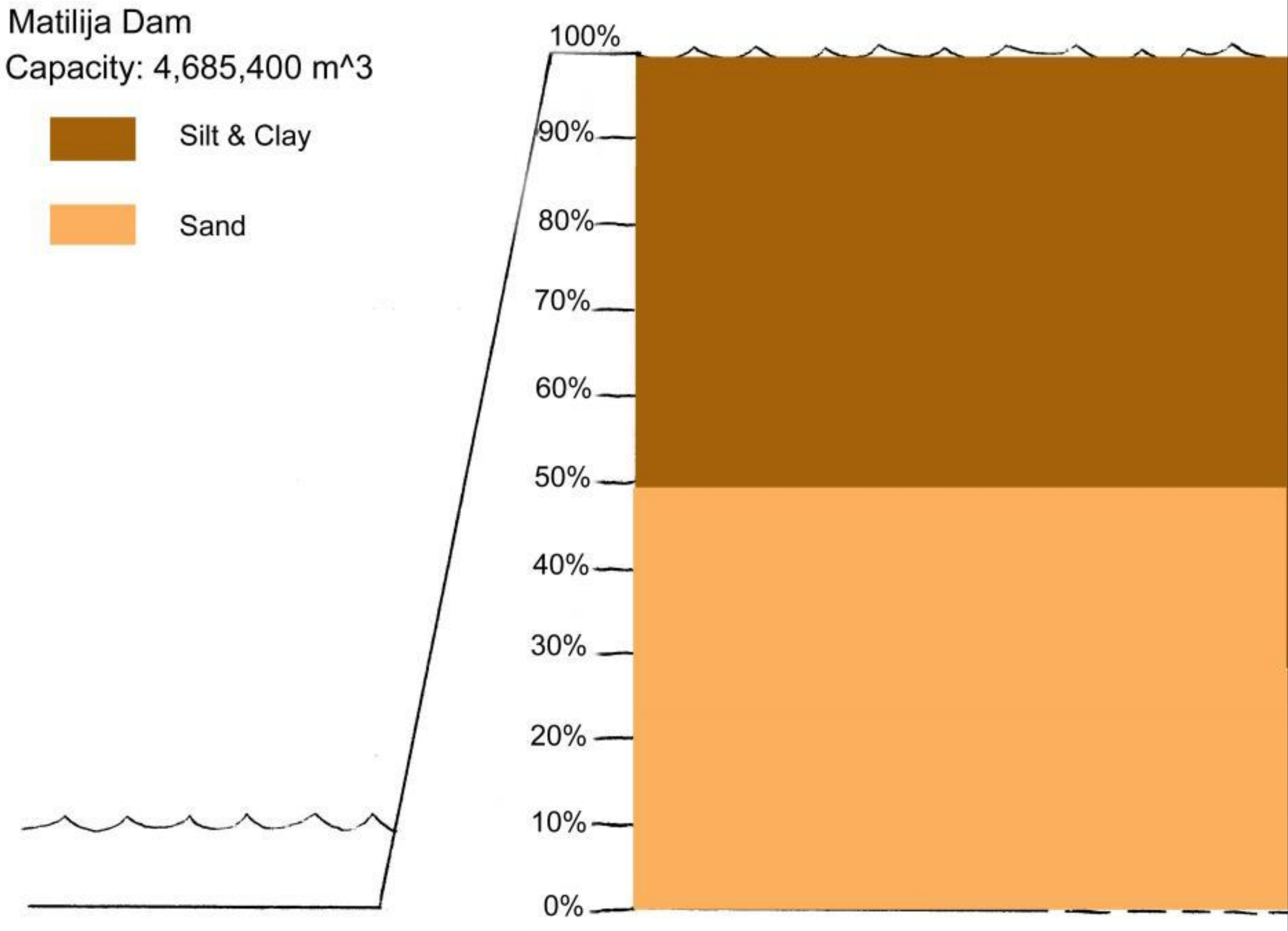


BEACHES OSCILLATE IN WIDTH WITH CLIMATE CYCLES

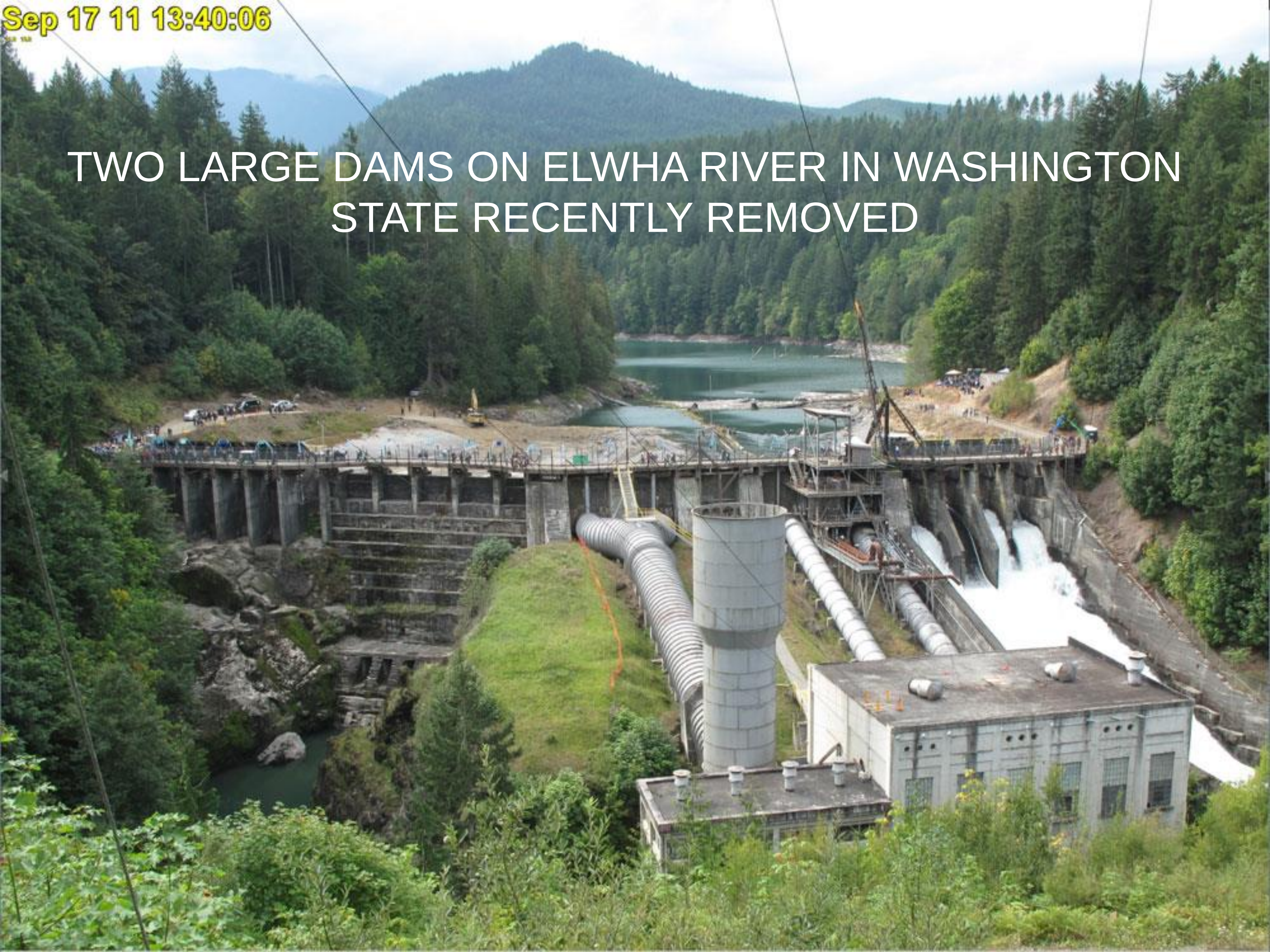


THERE ARE DAMS FULL OF SAND AND TARGETED FOR REMOVAL BUT NO ACTION HAS BEEN TAKEN

Rindge Dam
Malibu Creek


Matilija Dam
Capacity: 4,685,400 m^3
Silt & Clay
Sand
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%


Carmel River being rerouted
around San Clemente Dam

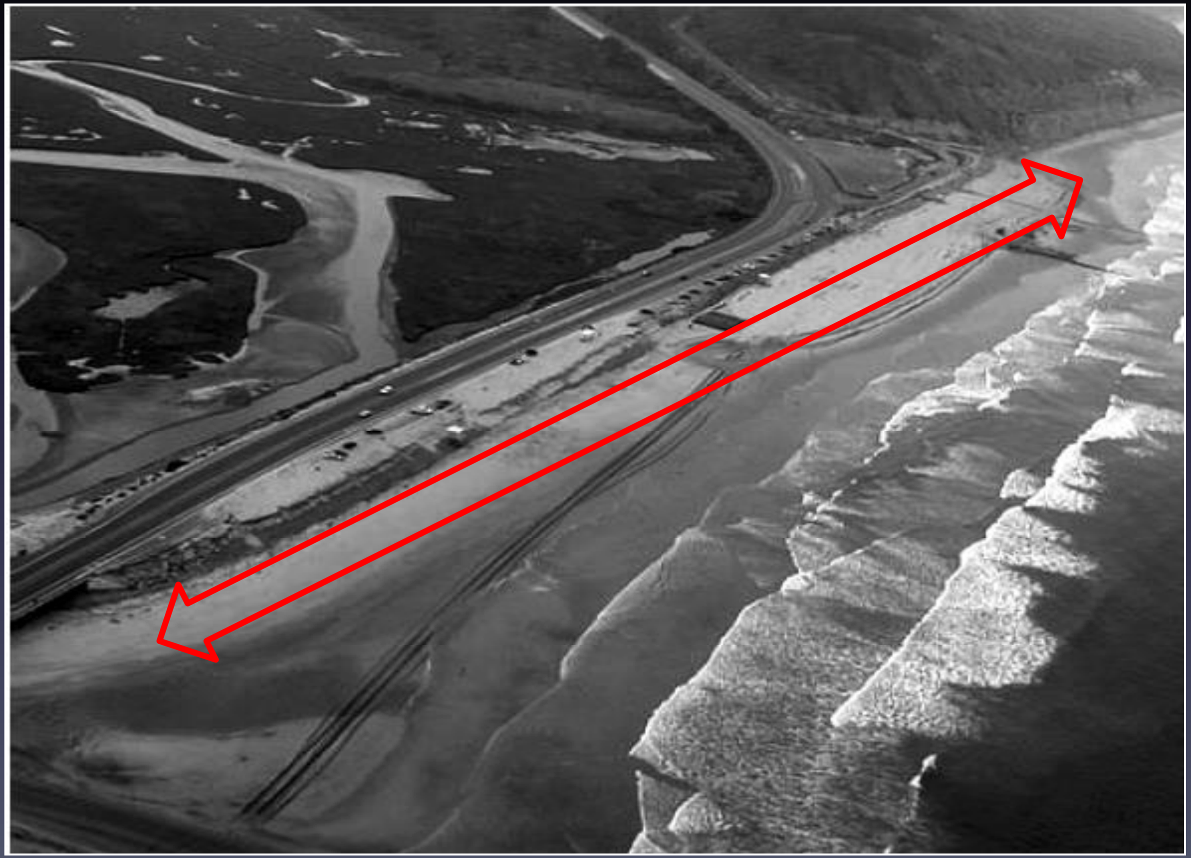

Sep 17 11 13:40:06
TWO LARGE DAMS ON ELWHA RIVER IN WASHINGTON STATE RECENTLY REMOVED

NOURISHMENT ADVOCATED AS A SOLUTION TO SAN DIEGO COUNTY'S "ERODED" BEACHES.

- Two beach nourishment projects completed (in 2001 & 2010): 3,400,000 yds^3 of offshore sand added to beaches at cost of $46 million.
- Most of this sand eroded from exposed beach within first year of placement.

330,000 yds^3 added to Torrey Pines Beach in April 2001.

1. *From April to Nov. 22, waves generally < 3 feet, only modest sand losses.*
2. *At noon on Nov. 22, waves reached 9-10.5 feet for 7 hours.*
3. *Fill began to erode quickly; by daylight on Nov. 23, fill had been almost completely eroded*.



Beach widths, cliff slopes, and artificial nourishment along the California Coast

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ABSTRACT

Wide beaches provide a buffer that can prevent wave run-up and storm surges from reaching back beach areas, whether dunes, cliffs or bluffs. The dissipative role of beaches is especially important on cliffed coastlines where cliff or bluff retreat is an irreversible natural process that can lead to the destruction of cliff top development. Because changes in bluff morphology are process-linked, cliff slope is generally indicative of the relative importance of marine and terrestrial erosional processes. Steep cliffs are usually reliable indicators of the dominance of marine erosion, and their presence provides evidence for the lack of a permanent protective beach. While beach nourishment in California has historically been primarily opportunistic and the by-product of a coastal dredging or construction project, two recent projects in San Diego County (RBSP I and II) were the first large-scale efforts where sand was added to the shoreline from offshore sources for the sole purpose of widening the beaches for both protecting back beach development and increasing recreational opportunities. Every stretch of shoreline has some equilibrium beach width; however, that is a function primarily of 1) the wave climate, 2) coastline configuration, 3) presence of natural barriers to littoral drift, and 4) sediment supply. Overall, the sand added to the relatively narrow San Diego County beaches had a very short life span on the exposed subaerial beach. In a region with relatively high littoral drift rates, and particularly for shorelines fronting steep cliffs, which historically have not had wide beaches, without either repeated nourishment or the construction of retention structures, there is no reason why artificially added sand should widen and remain on subaerial beaches for any extended period of time.

Nearly two-thirds (~60%) or a little over 1000 km of California's coastline consists of bluffs or low cliffs <100 m high, often fronted by beaches of varying widths (Griggs 2010). Sandy beaches provide important buffer zones between marine and terrestrial environments as well as important recreational areas. While unaltered beaches tend to have some long-term equilibrium width, they also fluctuate naturally due to seasonal changes in wave energy and tidal variations, but also in response to variations in sediment input and littoral transport gradients (Hayes and Boothroyed 1969; Komar 1998; Nordstrom 2000). Humans have altered the supply and movement of sand on California beaches; however, both through the construction of dams on coastal rivers and also the emplacement of littoral barriers that trap sand and create artificially widened beaches upcoast, but may also produce sand deficits downcoast.

There is generally a close correlation between beach width and cliff or bluff steepness along California's coast. Where beaches are very narrow or only present seasonally, marine erosion dominates the process of cliff formation, producing steep profiles. Where beaches are very wide, waves rarely reach the back beach area and bluff and cliff evolution tend to be dominated by terrestrial processes, which produce more gentle slopes (Kinsman 2011).

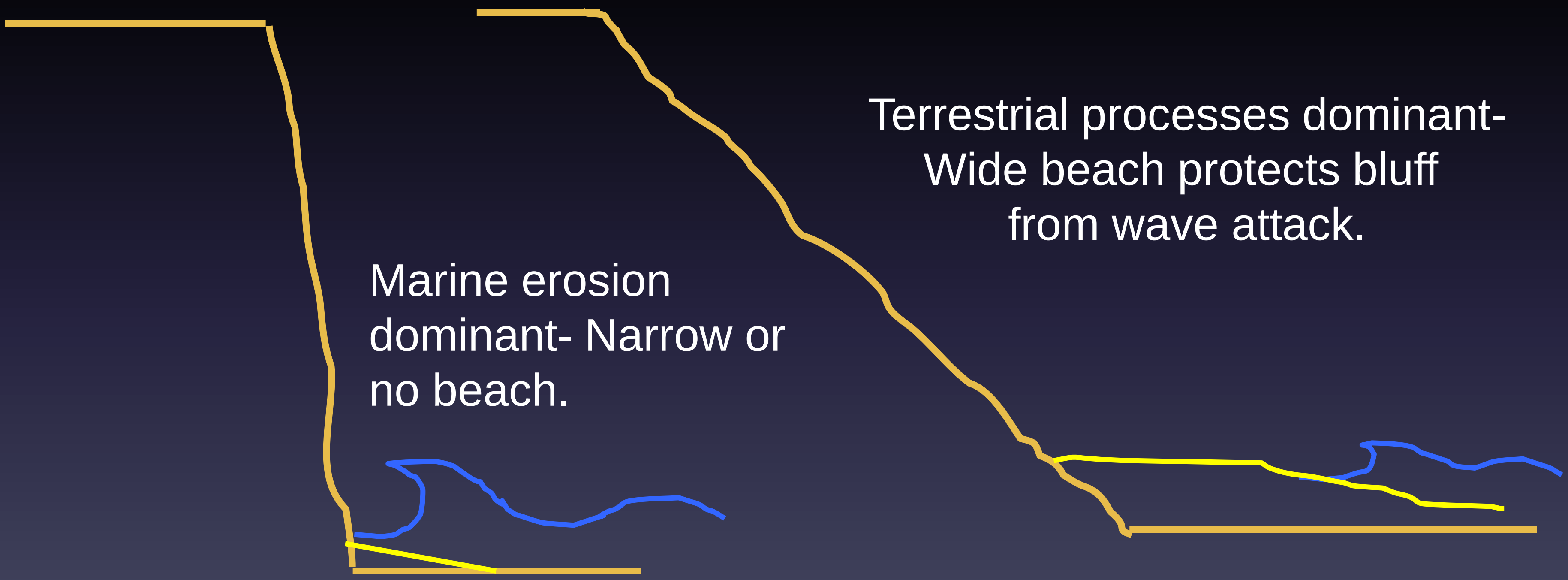
Keywords?

R&A dates?

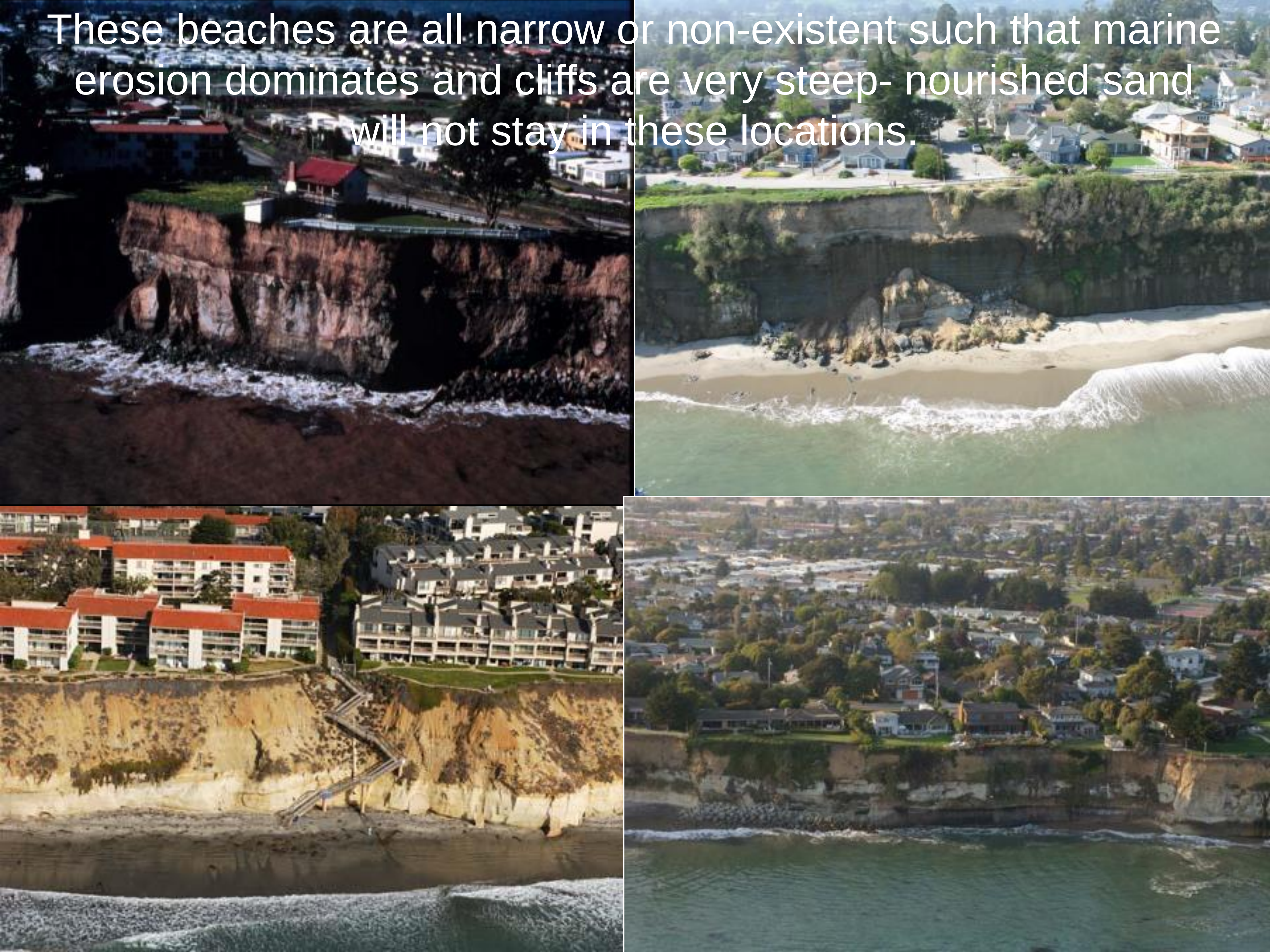
Human impacts on sand delivery to and transport along the shoreline, major storm events associated with a recent warm phase of the Pacific Decadal Oscillation (PDO), short-term increases in local sea level, as well as a gradually rising global sea level, have combined to inflict significant damage on private development and public infrastructure along the California coastline in recent decades. While coastal armor, whether revetments or seawalls, has historically been the most common response to coastal cliff or bluff erosion, concerns regarding potential impacts of protection structures on beaches (Griggs 2005) have led to a significant reduction in permit approval for new armor.

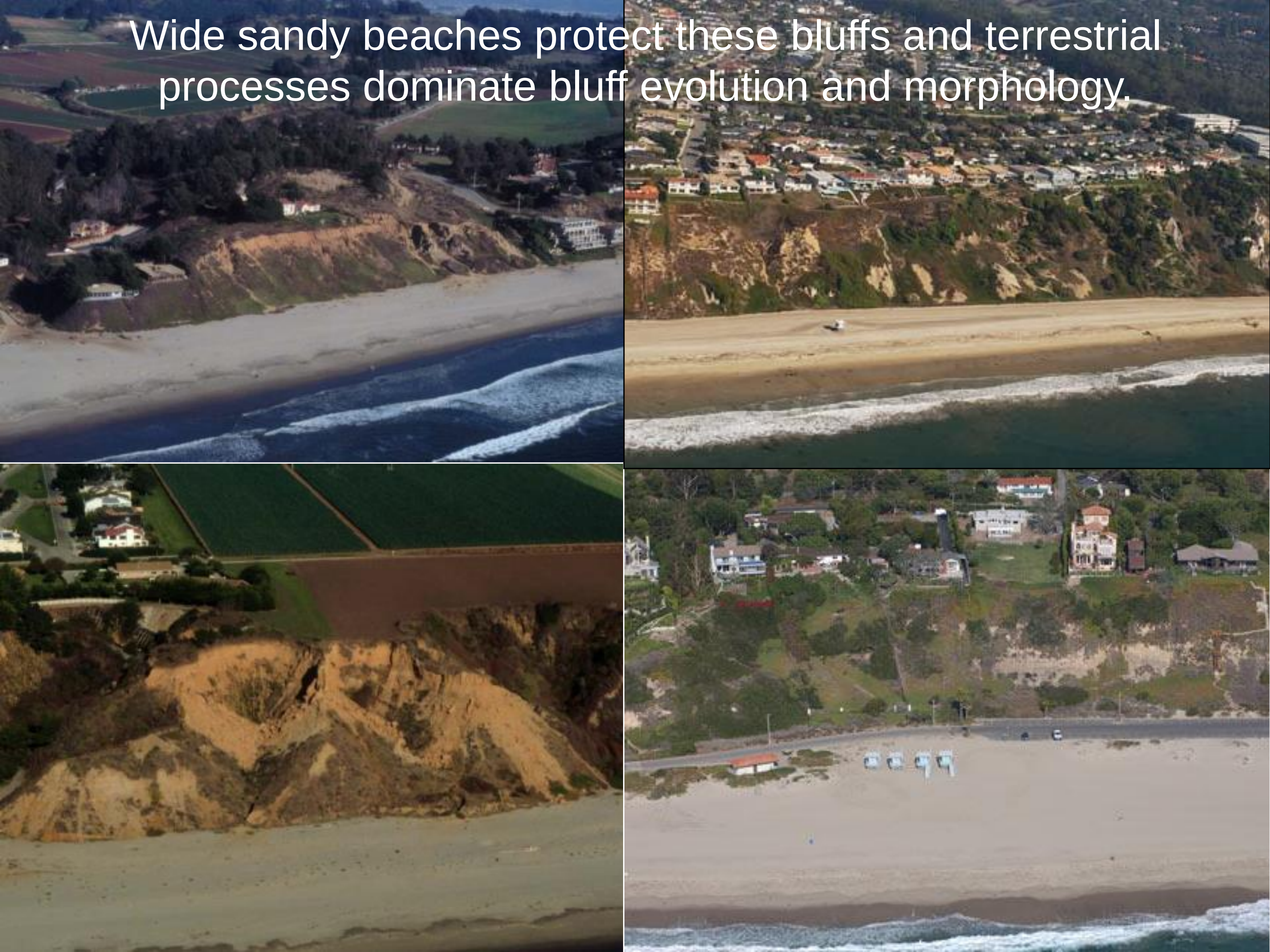
Artificial beach nourishment has long been a common practice along the low-relief, typically barrier island-backed Atlantic coast for mitigating shoreline retreat and beach loss. Until recently this was not the case for California, where almost all beach nourishment was a by-product of large coastal construction and dredging projects (Flick 1993 and Wiegel 1994). Two major beach nourishment projects have recently been carried out in San Diego County (Regional Beach Sand Project I and II or RBSP I & II), which were intensively monitored and provide insight and lessons regarding this approach on California's coast, which differs in many fundamental ways from the Atlantic coast. While additional proposals for large-scale and long-term beach nourishment projects have been proposed and continue to move forward in the planning process in California, the ability of nourished beaches to effectively buffer bluff and cliff backed coastlines from marine erosion for extended periods of time has not been critically evaluated or fully quantified.

Sea cliff profile tells us a lot about the dominant processes responsible for coastal cliff formation.



These beaches are all narrow or non-existent such that marine erosion dominates and cliffs are very steep- nourished sand will not stay in these locations.




Wide sandy beaches protect these bluffs and terrestrial
processes dominate bluff evolution and morphology.

Without repeated nourishment, or the construction of retention structures (groins), to hold beach fill, there is no reason why in an area with narrow beaches or steep cliffs that nourished sand should remain for any extended period of time.