

The influence of climate change on coastal processes and benthic habitats: Past observations, present modeling, and future projections

February 12, 1998
Capitola Esplanade
Santa Cruz County, CA



January 30, 1998
Moran Lagoon
Santa Cruz County, CA



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Problem:

Many U.S. West Coast marine and coastal species are in decline.

Concern of Permitting Agencies (FWS, NMFS, NMS, State F&G):

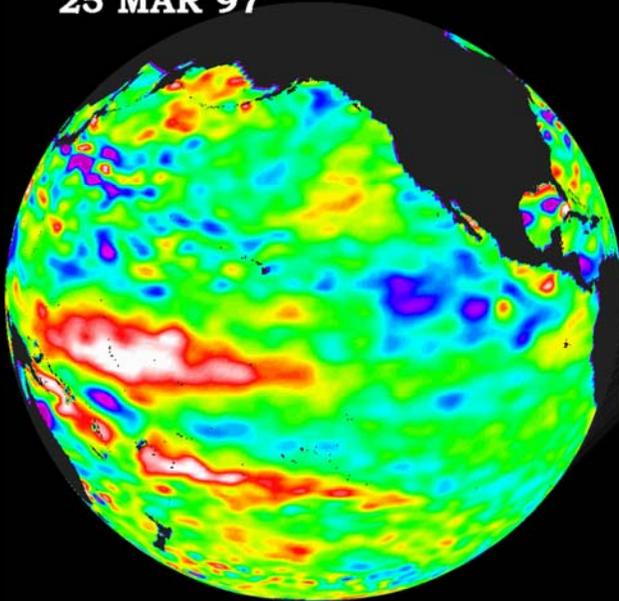
Not only these declines, but also that trawling, dredging, and the emplacement of engineering structures (bridges, pipelines, etc) impact benthic habitats and the ecosystems they support.

Managers' Problems:

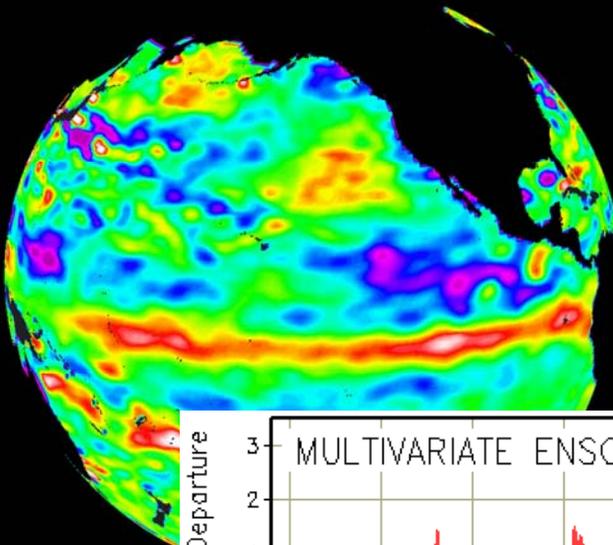
- 1) How does the impact of anthropogenic activities compare to the natural variability in the system?
- 2) What will happen to the "natural" system under climate change scenarios?



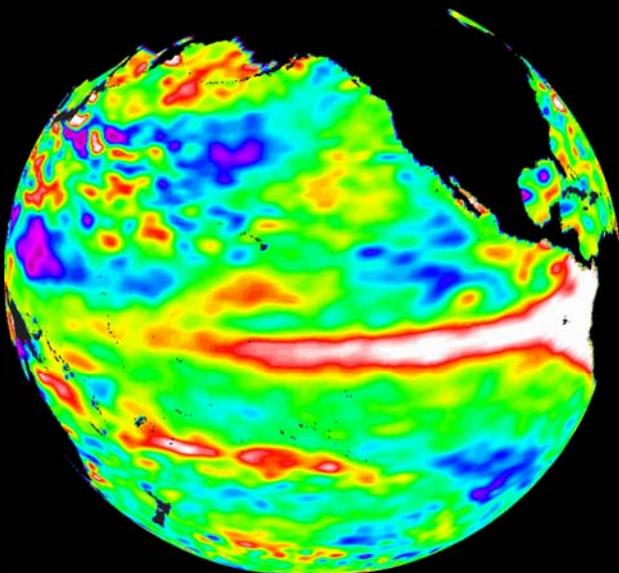
25 MAR 97



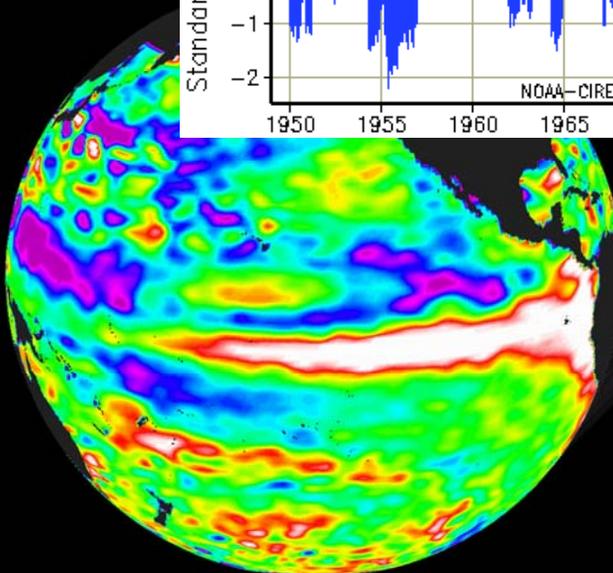
25 APR 97



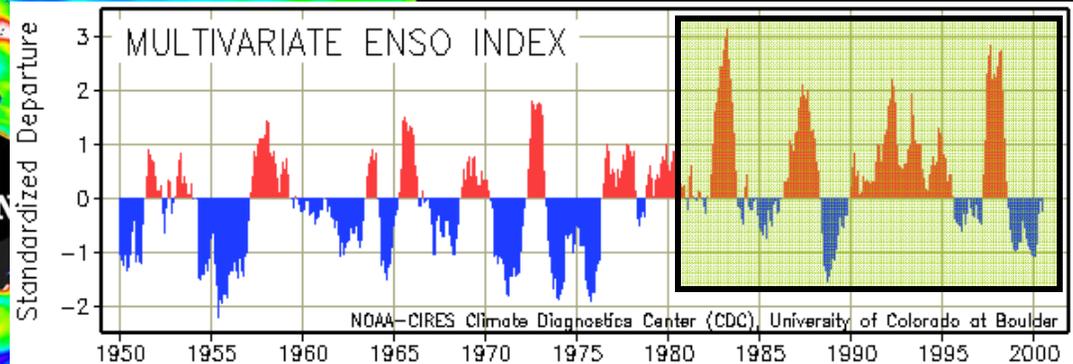
25 MAY 97

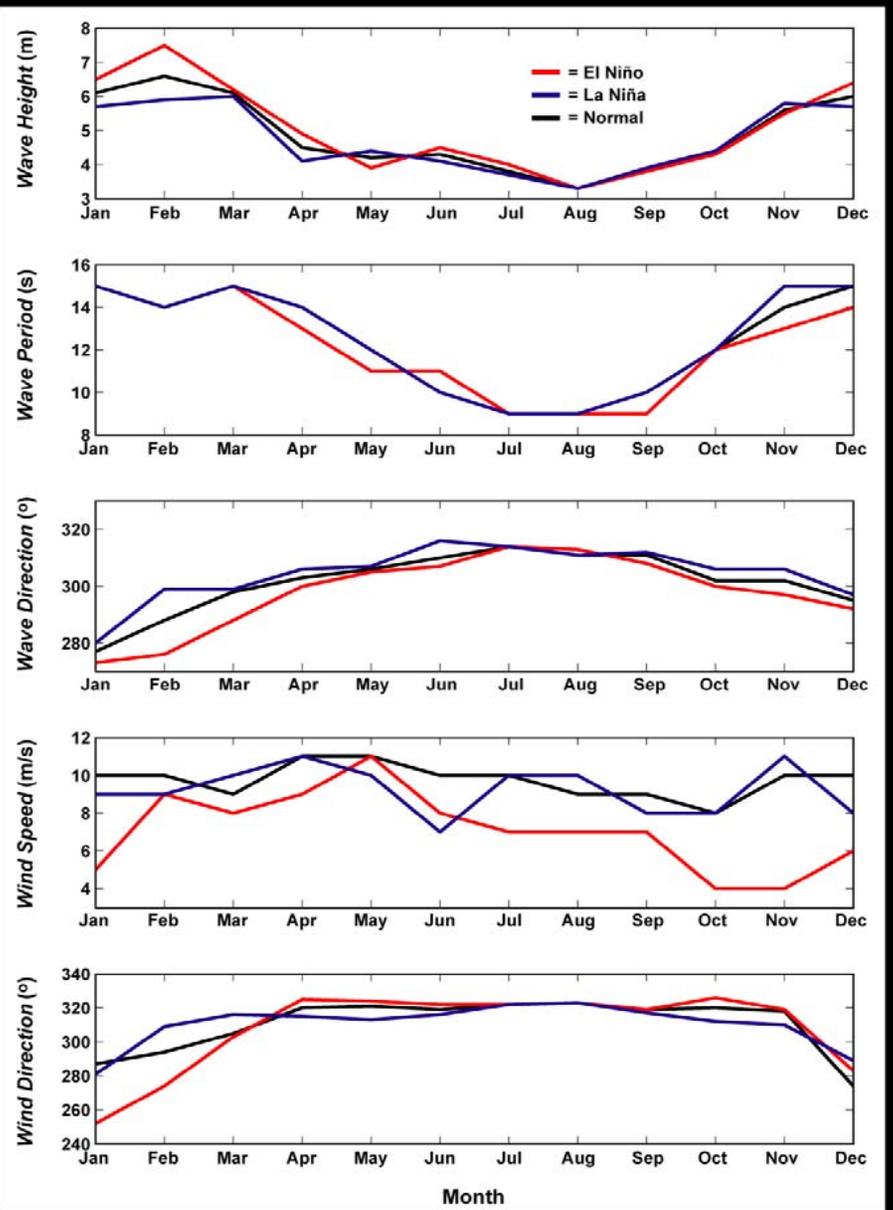
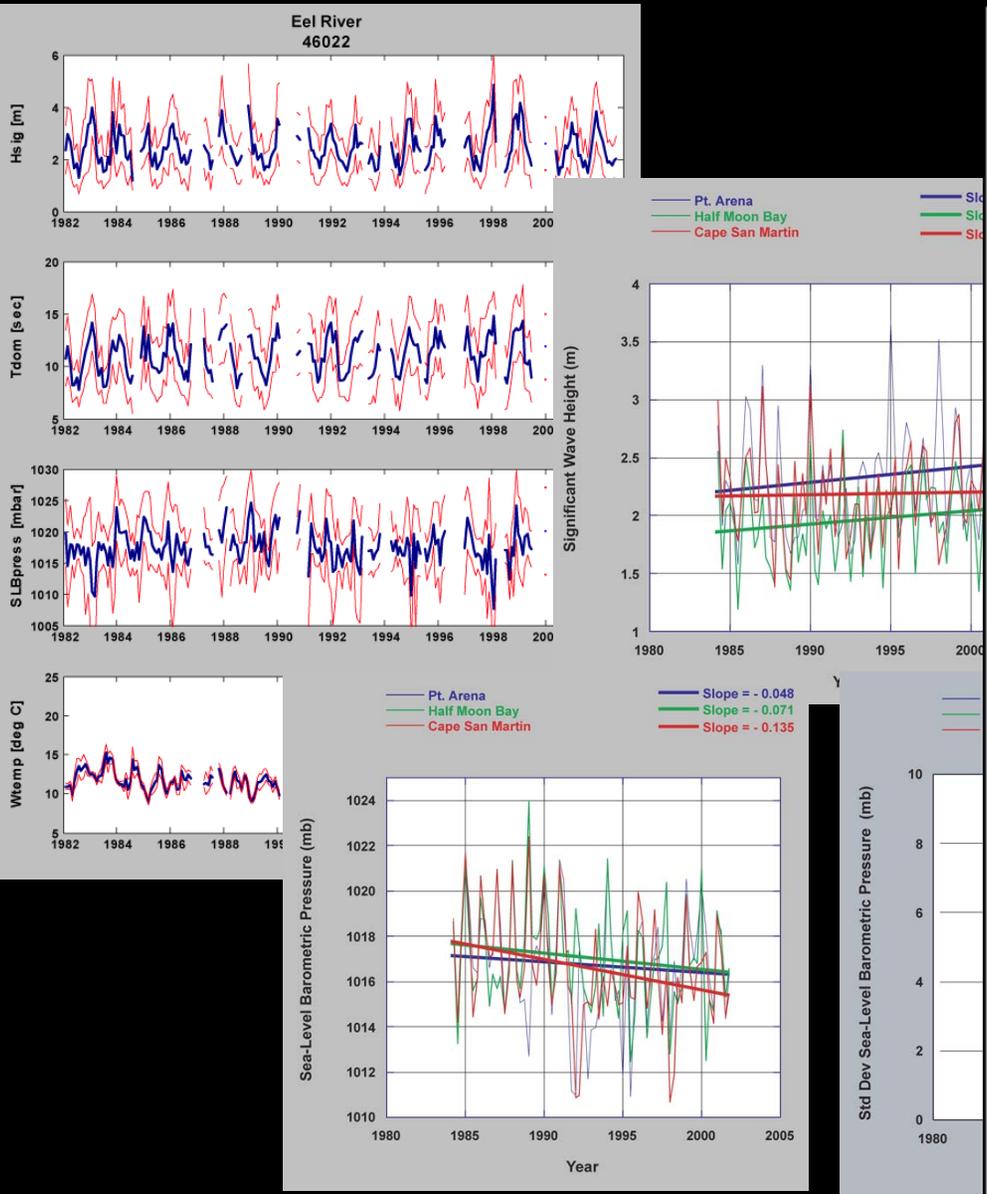


25 JUN 97



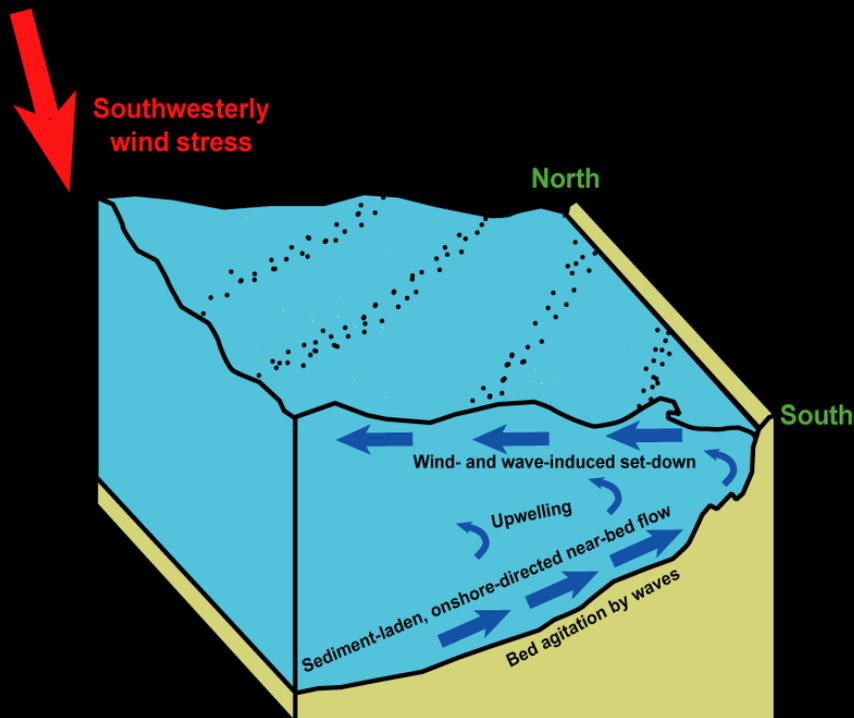
**ENSO:
The dominant
driver of US West
Coast climatic
variability**





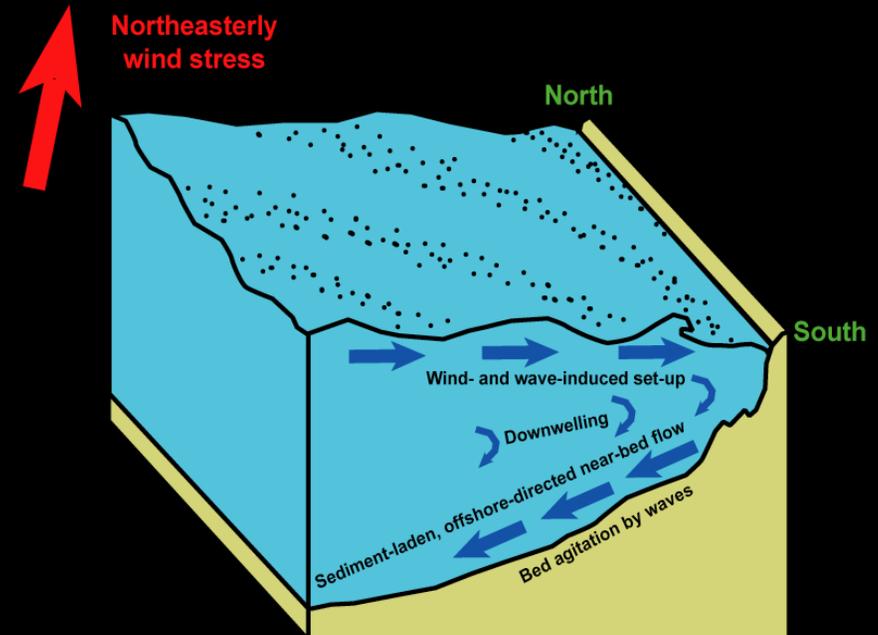
Why Does Wave and Wind Direction Matter?

Winds and Waves from the Northwest



- 1) *Upwelling of nutrient-rich bottom waters and high primary productivity*
- 2) *Onshore transport of seabed sediment -> beach (bar) construction*

Winds and Waves from the Southwest



- 1) *Downwelling results in nutrient-poor surface waters and lower productivity*
- 2) *Offshore transport of seabed sediment -> beach (bar) destruction / erosion*

Four Habitat Types Characteristic of California's Coast

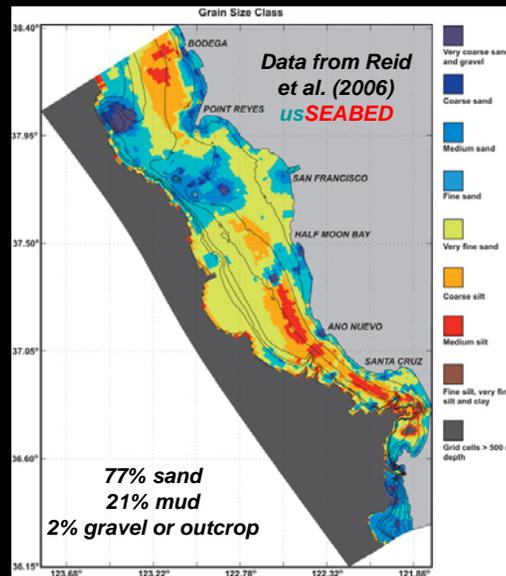
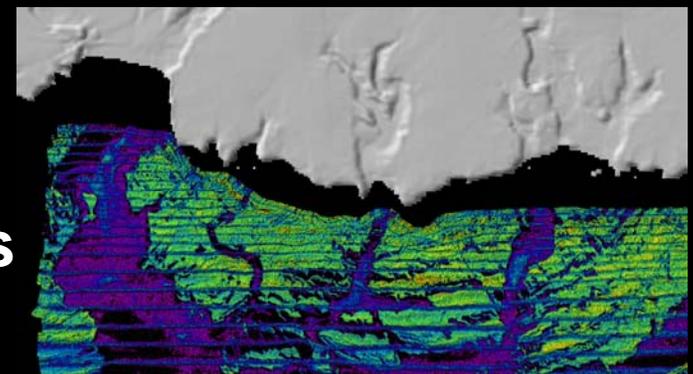
Seacliffs and Pocket Beaches



<http://www.californiacoastline.org>

Bar-Built Estuaries

Rocky Nearshores



Heterogeneous Continental Shelves

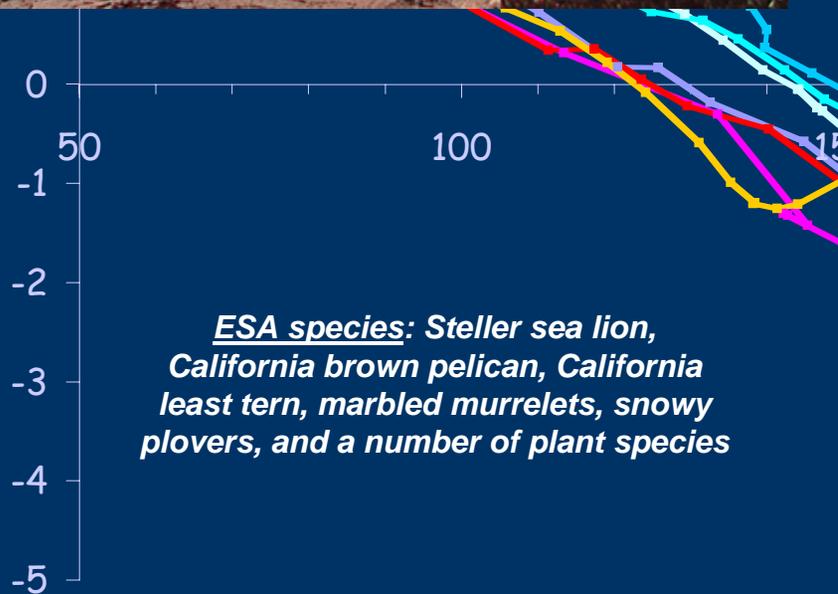
Beaches

October, 1997



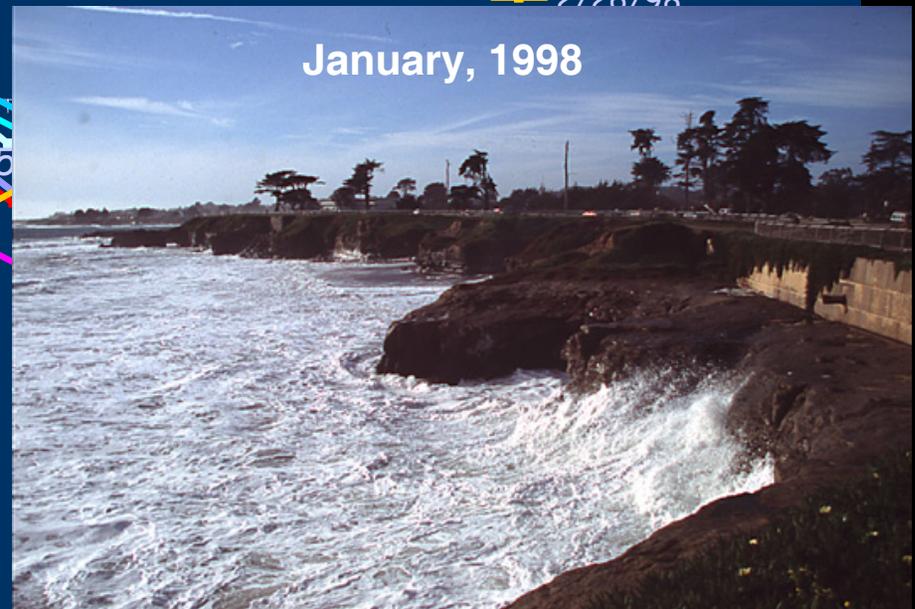
Cowell Beach
Erosional Series

- 10/15/97
- 11/21/97
- 12/17/97
- 1/28/98
- 2/4/98
- 2/9/98
- 2/26/98



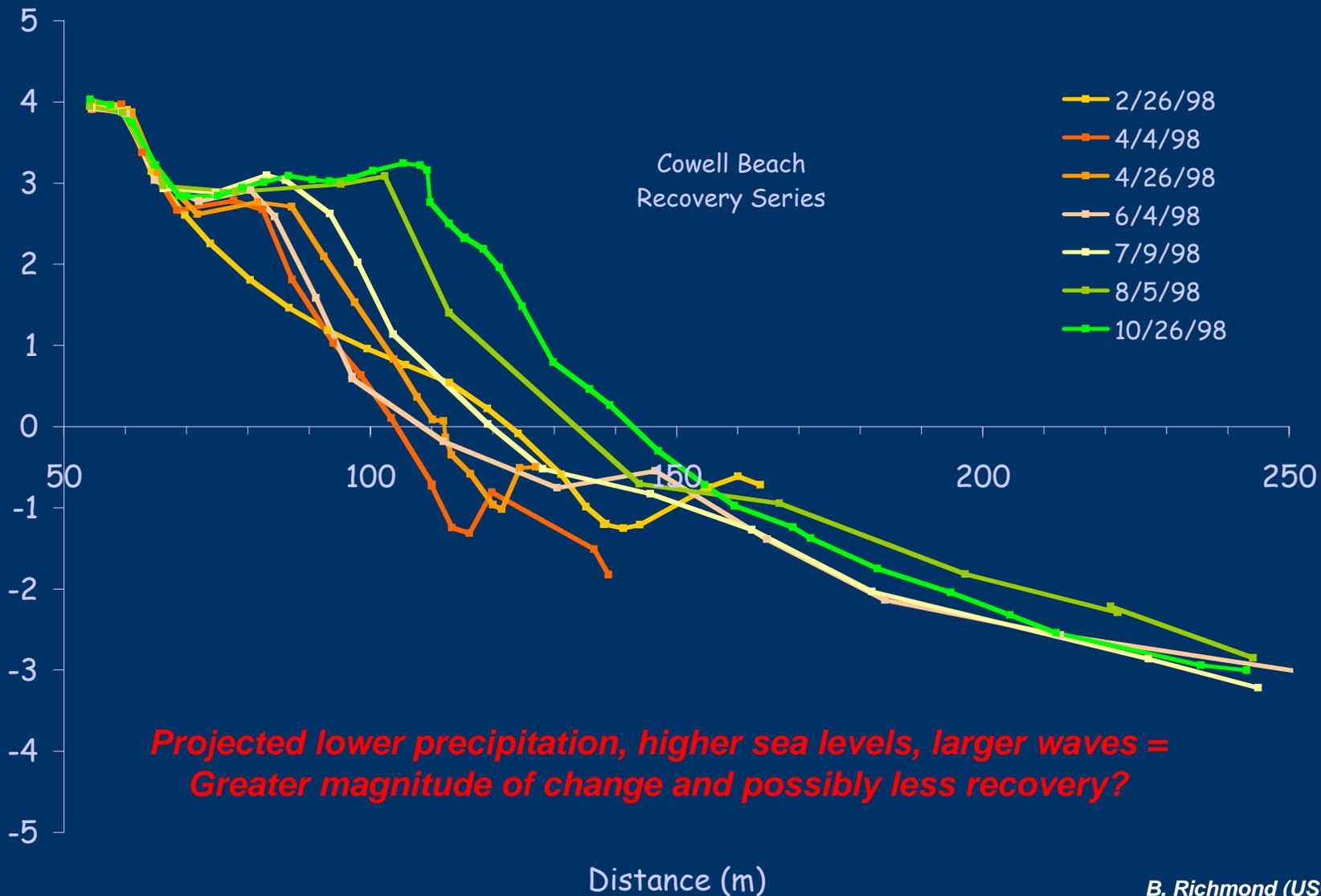
ESA species: Steller sea lion, California brown pelican, California least tern, marbled murrelets, snowy plovers, and a number of plant species

January, 1998

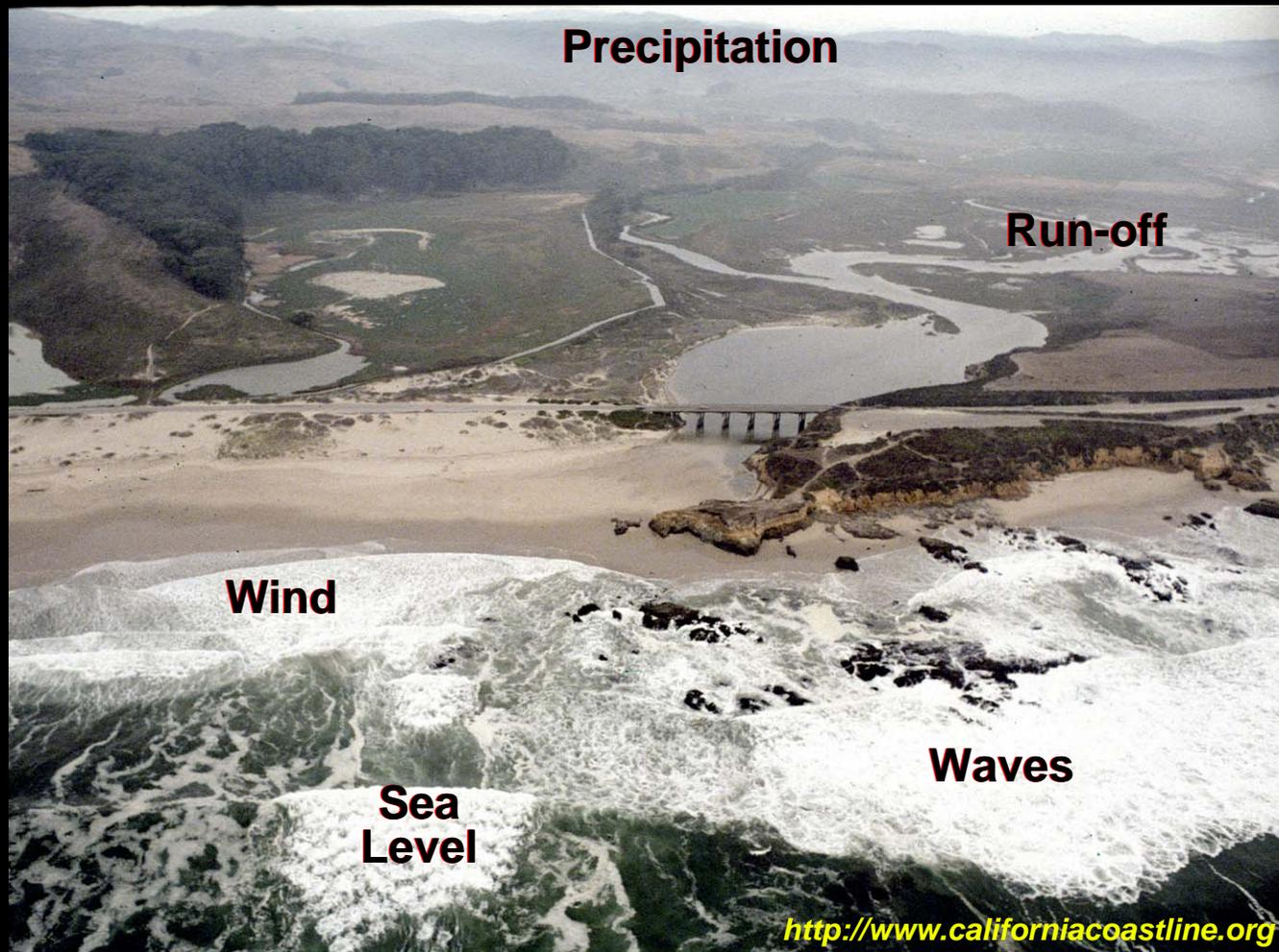


Distance (m)

B. Richmond (USGS)



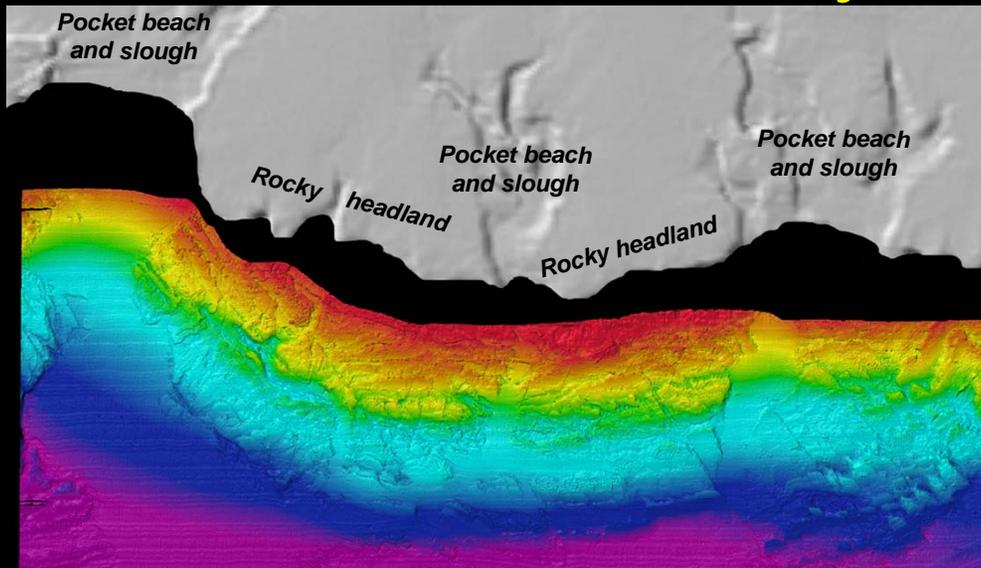
Bar-Built Estuaries



**Projected lower precipitation, higher sea levels, larger waves =
Less frequent bar formation and habitat formation?**

**ESA species: Chinook salmon, Coho salmon, Steelhead trout, tidewater Goby,
California red-legged frog, San Francisco garter snake**

Rocky Nearshores

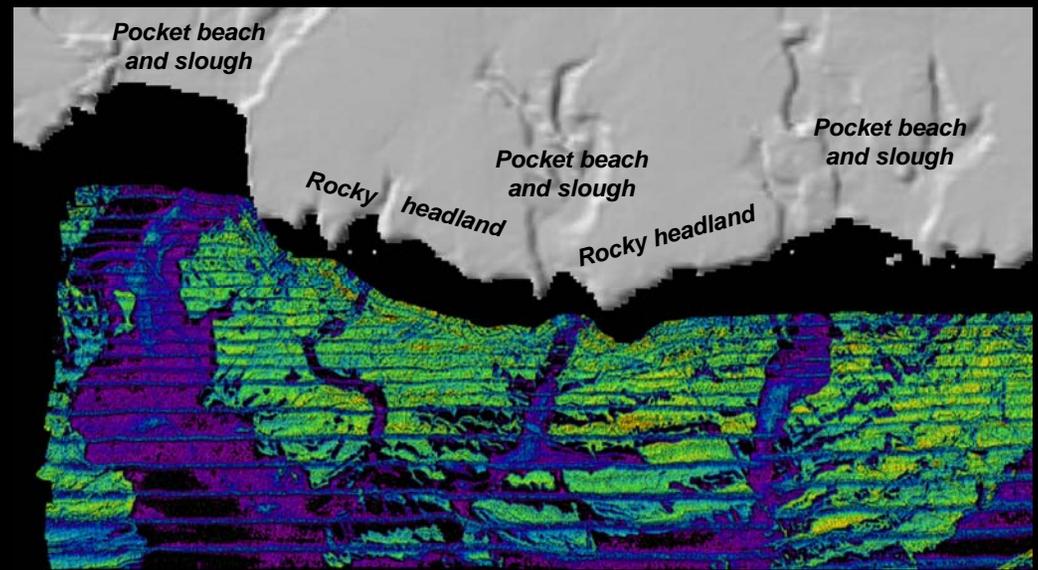


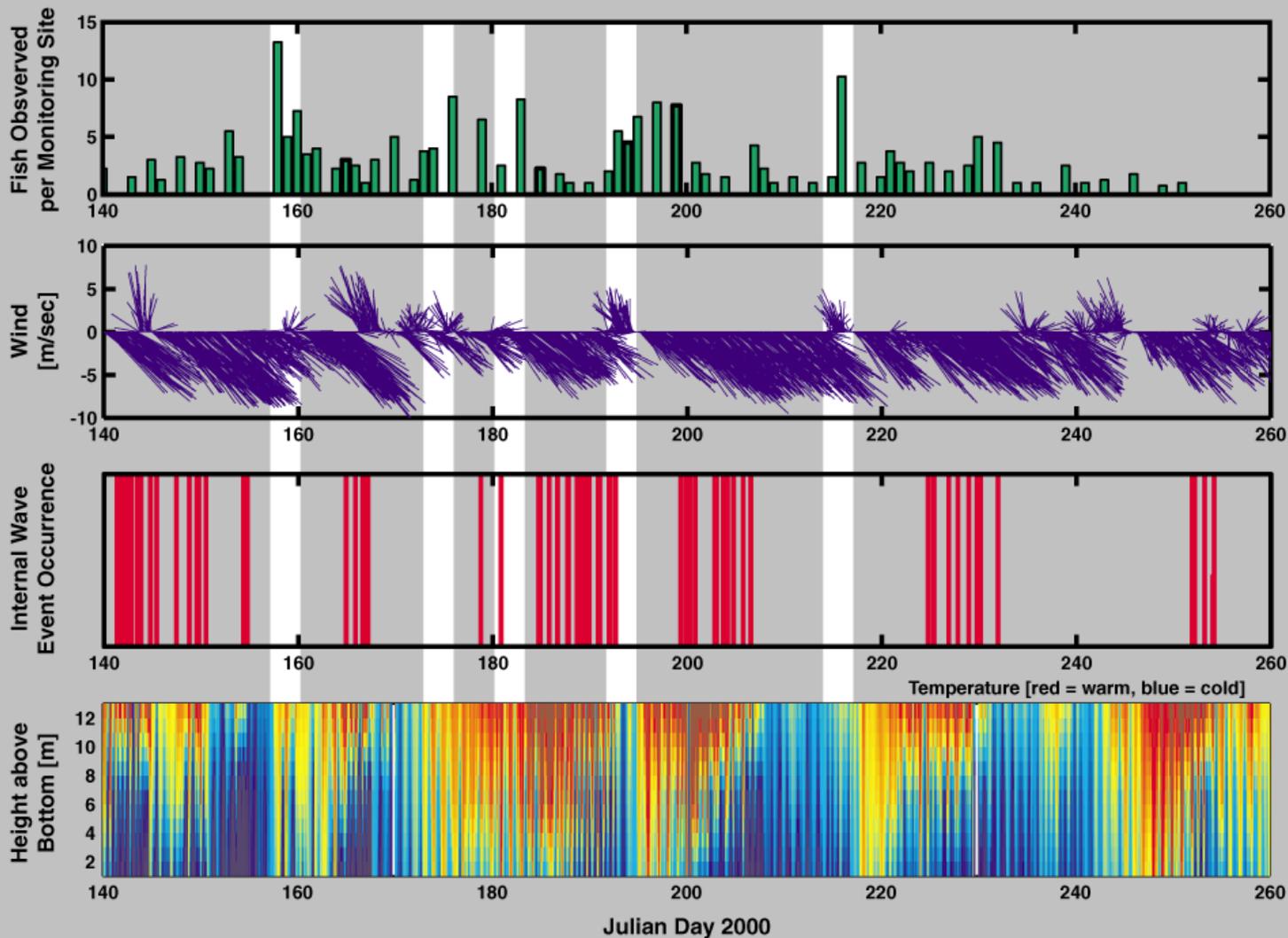
Projected higher sea levels, larger waves = Greater burial, scour, and habitat modification?



Substrate

- Rock
- Sand





**Projected changes in storm tracks =
Changes in timing and intensity of nearshore recruitment?**

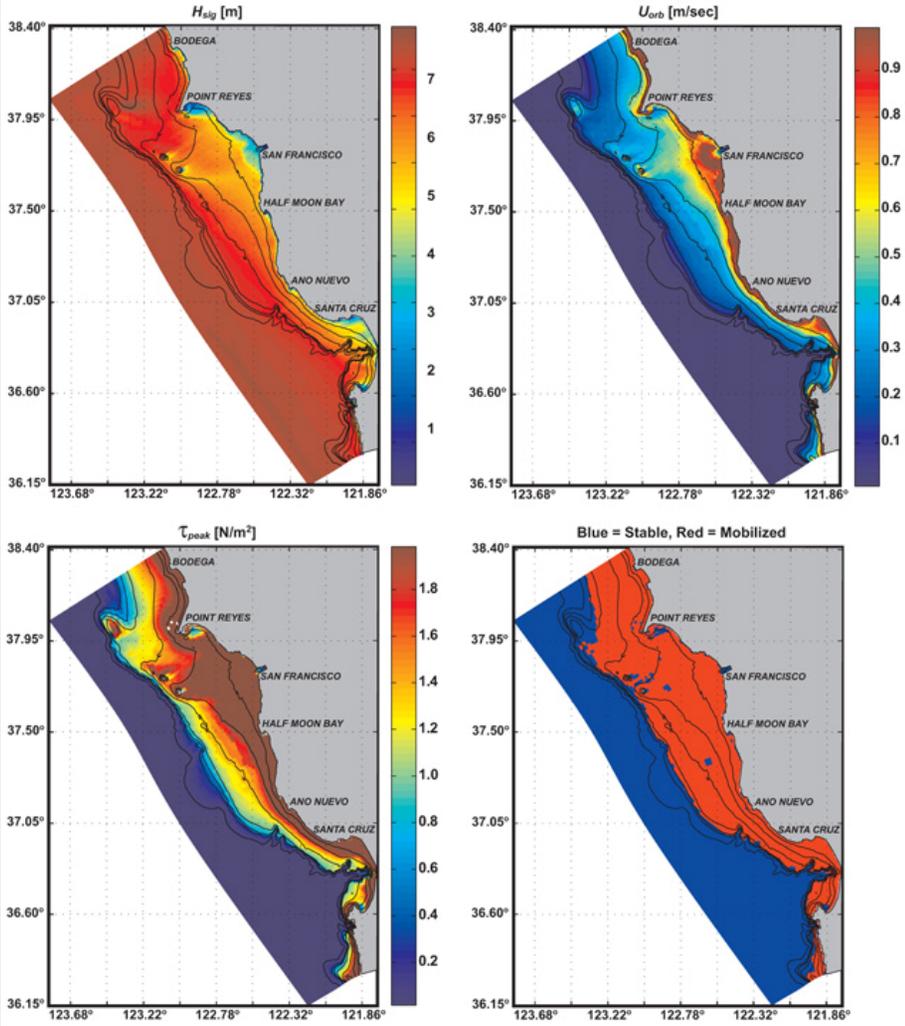
Sebastes spp.
(Federally-managed)



Continental Shelf

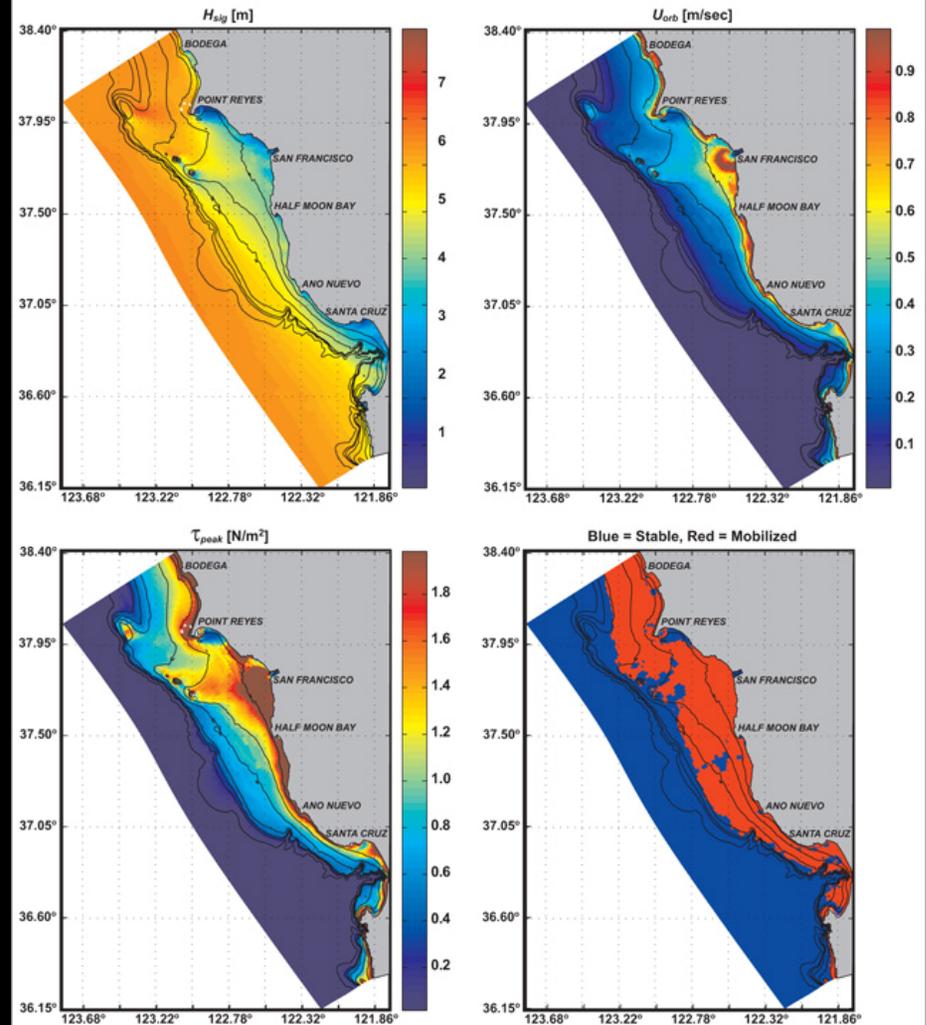
ESA species: Steller sea lion, California brown pelican, California least tern, marbled murrelets, and snowy plovers

El Nino February: $H_{sig} = 7.5m$, $T_{dom} = 14s$, $WV_{dir} = 276^\circ$, $WD_{spd} = 9m/s$, $WD_{dir} = 274^\circ$

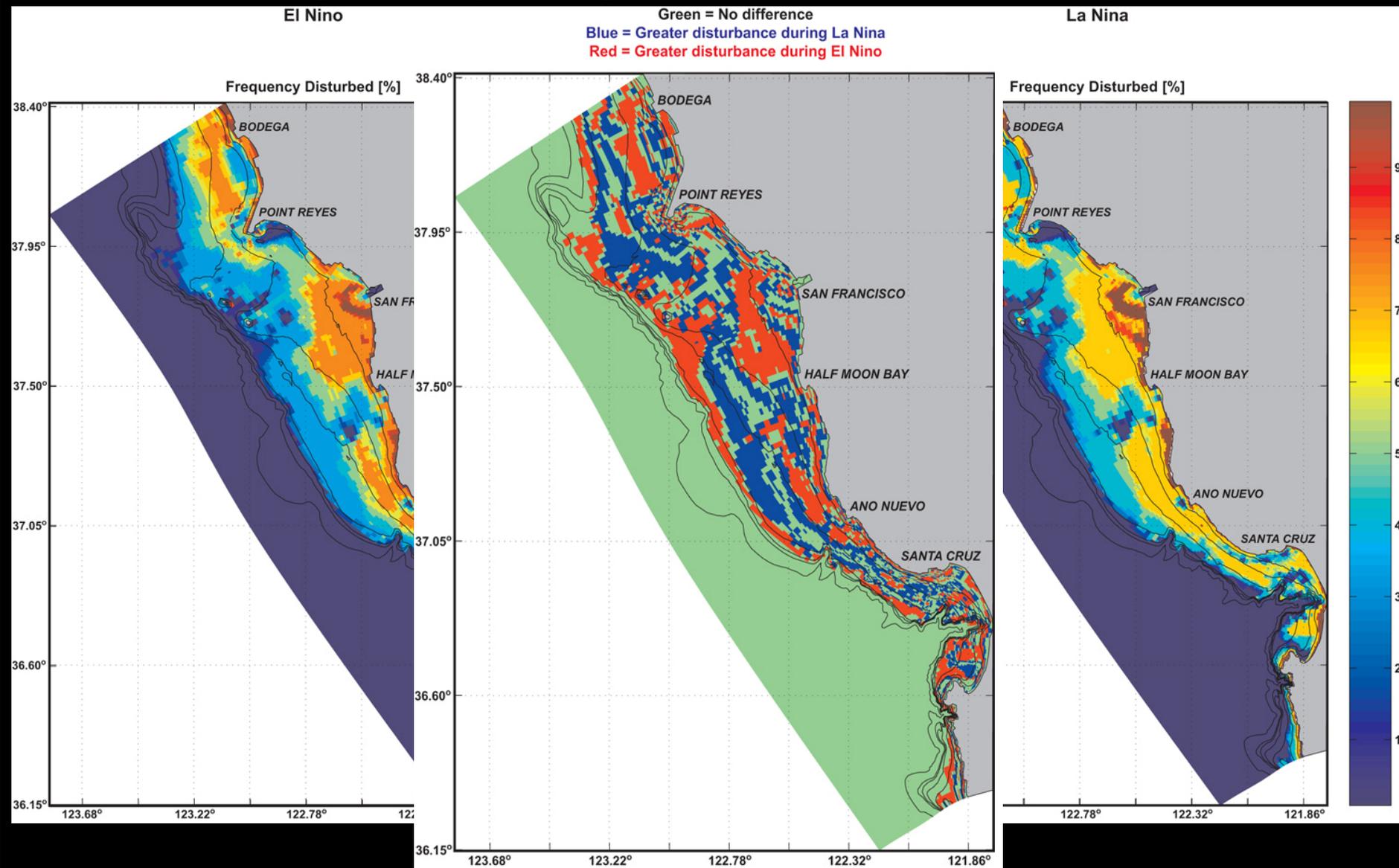


30m, 60m, 90m, 120m, 150m, 200m and 500m isobaths are shown

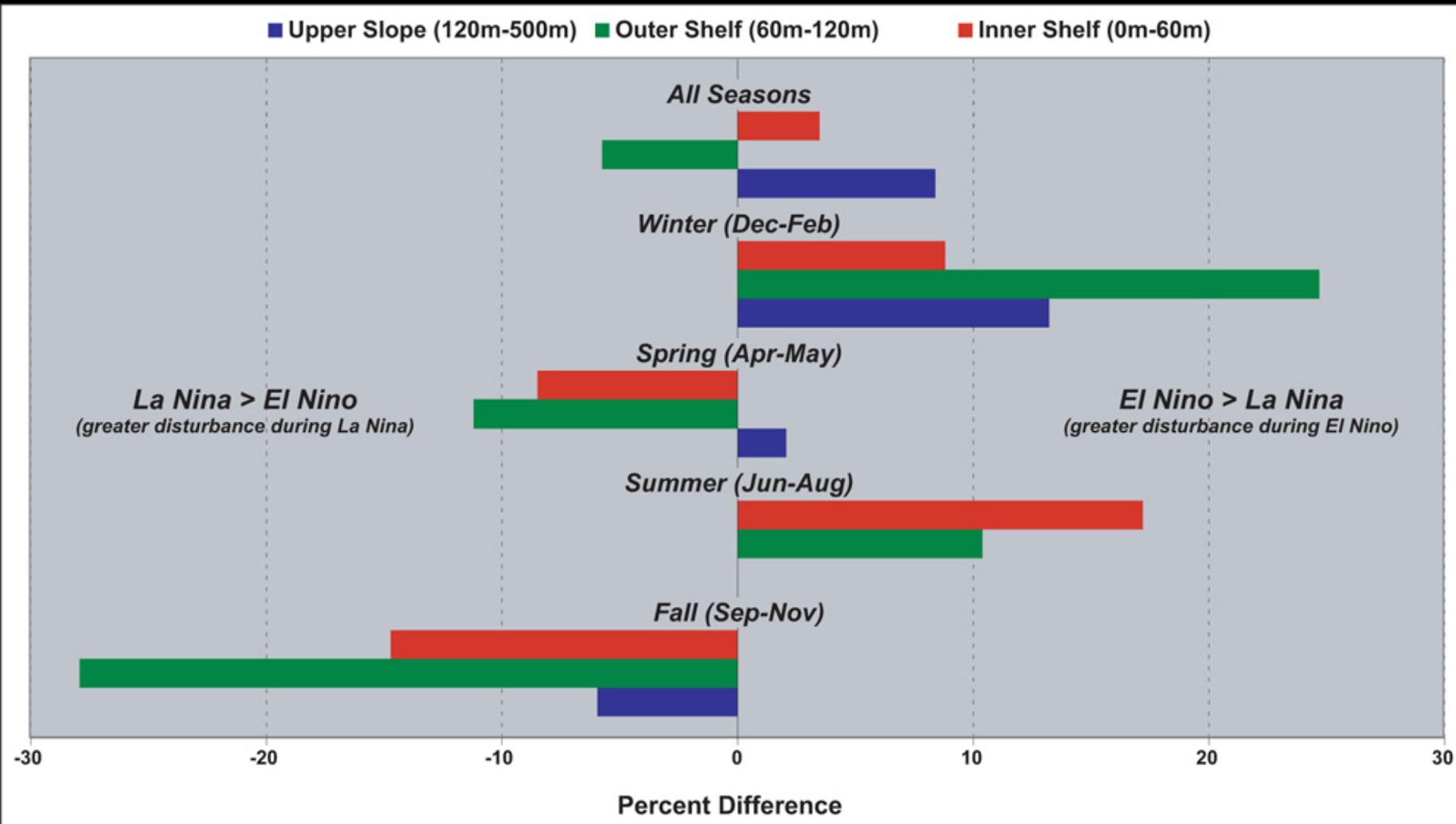
La Nina February: $H_{sig} = 5.9m$, $T_{dom} = 14s$, $WV_{dir} = 299^\circ$, $WD_{spd} = 9m/s$, $WD_{dir} = 309^\circ$



The Federal Marine Life and Fisheries Management groundfish plan includes management measures for: whiting, soles, thornyheads, lingcod, rockfish, sablefish, and several other species.



30m, 60m, 90m, 120m, 150m, 200m and 500m isobaths are shown



Projected changes in storm tracks (timing, intensity, and direction of waves and winds) and higher sea levels = Spatial and temporal changes in natural disturbance of the sea floor?

CONCLUSIONS

**Many of the species dependent on these habitats fall under either
Federal Marine Life and Fisheries Management Plans**

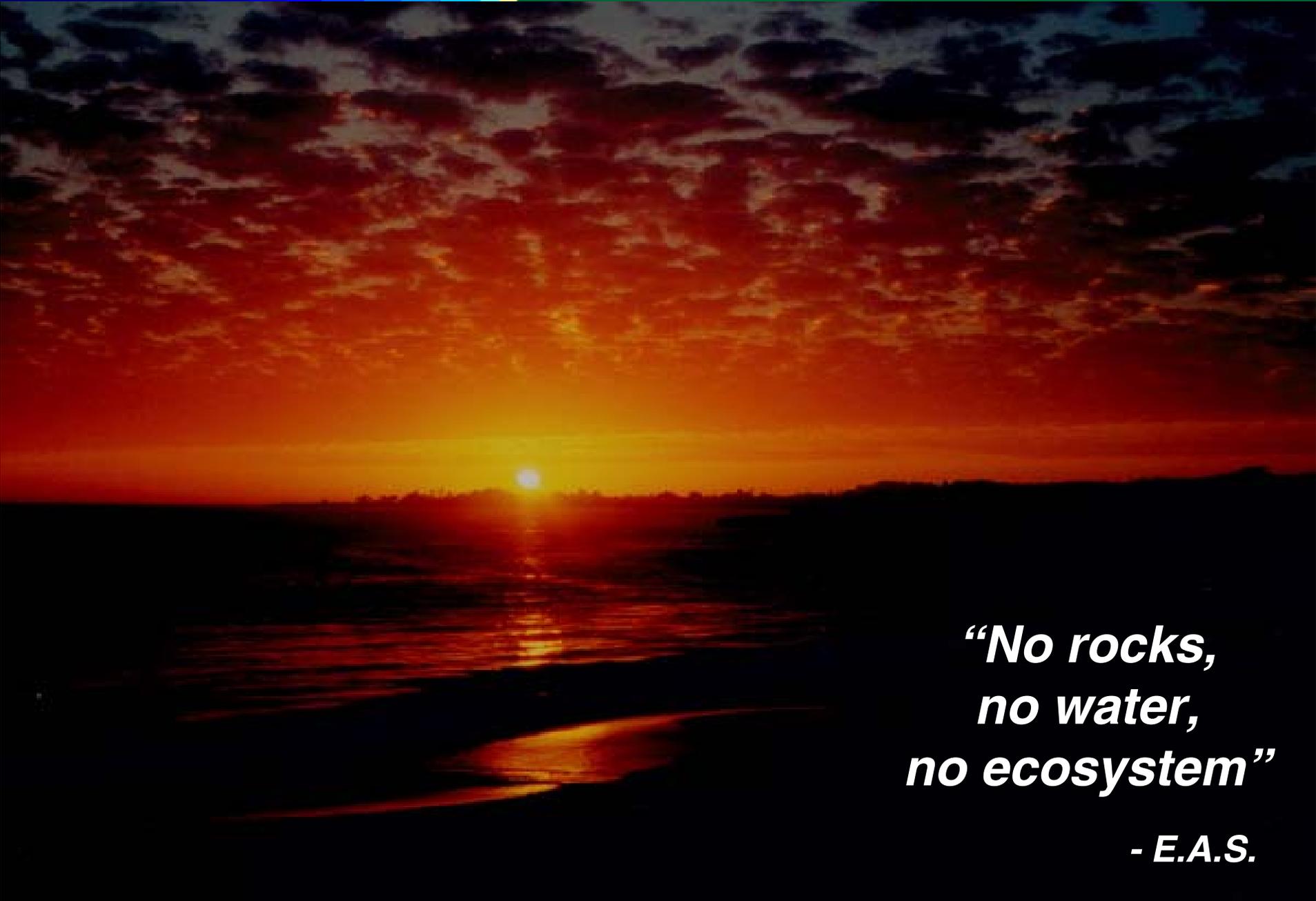
or

The Endangered Species Act

**Current trends and future projections suggest that changes will occur
to the timing and/or intensity of the physical processes
(storms, waves, winds, precipitation, sea level)
that drive the structure of coastal and marine ecosystems**

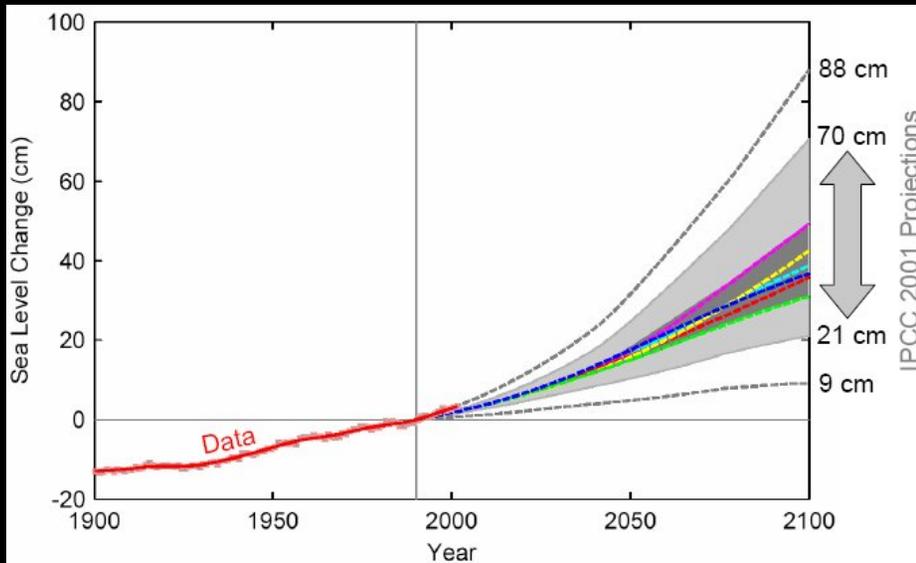
Certainty and Complexity

**These differences in natural disturbance affect not only benthic infauna
and epifauna, but also the overlying pelagic and subaerial
ecosystems upon which they depend.**

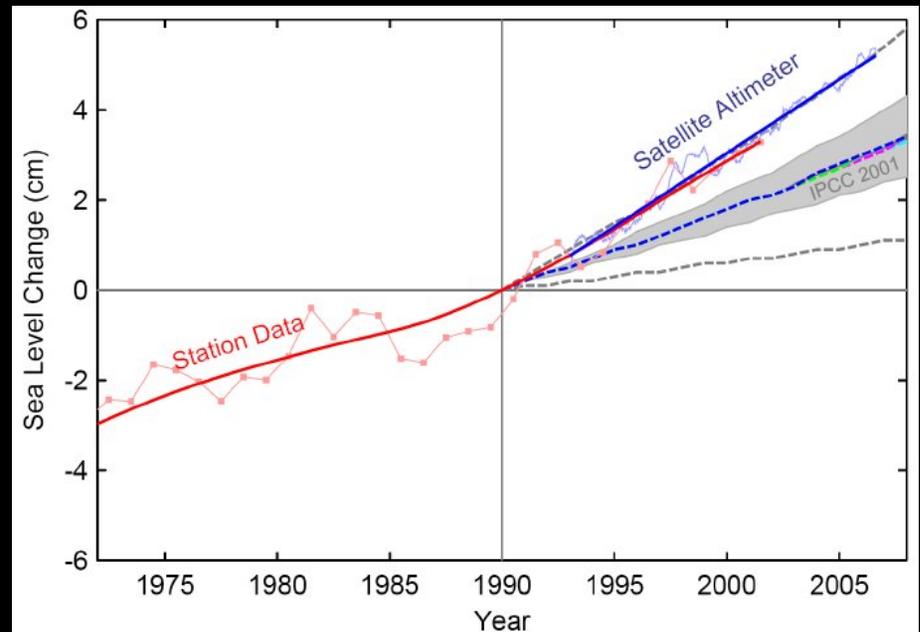


***“No rocks,
no water,
no ecosystem”***

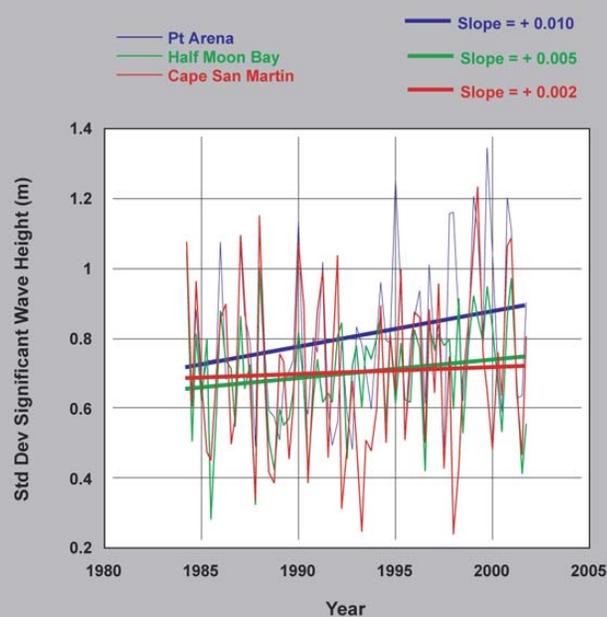
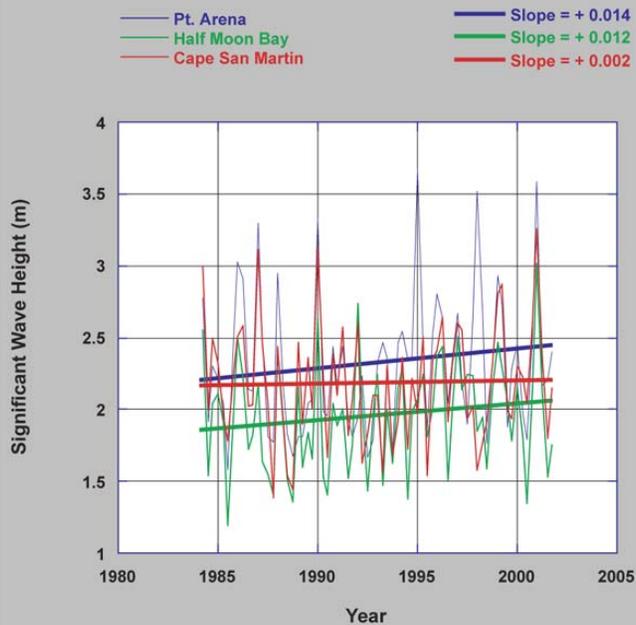
- E.A.S.



Changing Sea Level



IPCC (2001), Church and White (2006)



Changing Storminess

