

## Marine Life Protection Act Initiative



## Oceanography of the MLPA North Coast Study Region

Presentation to the MLPA Blue Ribbon Task Force  
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## Oceanography of North Coast

- Important for MLPA ...
  - determines **habitat**
  - key factor in **connectivity**
- Region characterized by ...
  - wind-driven currents and coastal **upwelling**
  - mediterranean climate (**wet winter**, dry summer)
  - offshore **California Current** System
- Ocean, coast and estuaries



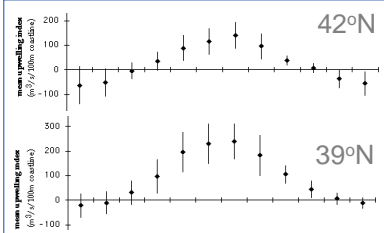
# Seasons

- Summer** ... persistent northerly winds max May-Aug
- ... southward currents max Apr-Jul
- ... upwelling of cold nutrient-rich water
- Winter** ... southerly wind events with rain
- ... freshwater flow to estuary & ocean

- Fall** ... weaker winds Sep-Oct (Nov)
- ... warmer water

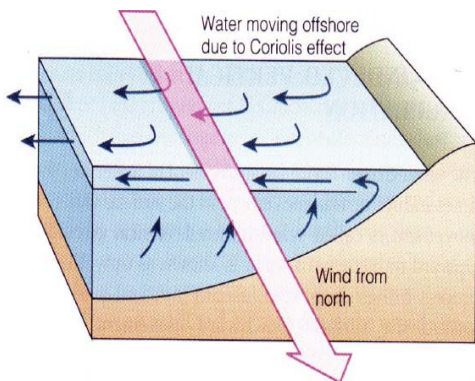
Also, may get warmer in spring (Mar-May)  
 Largier et al (1993): seasons for NoCal phys oceanogr.  
 "upwelling" [Apr-Jul]  
 "relaxation" [Aug-Nov]  
 "storm" [Dec-Mar] (SF Bay to Oregon)

upwelling index



# Upwelling

- The ocean is cold due to wind-driven upwelling.
- North wind with *coriolis* pushes surface water offshore
- Cold, nutrient-rich waters well up from depth to replace this
- Phytoplankton bloom in aging upwelled waters ... blooms nearshore during relaxation events
- North coast is one of the world's major upwelling regions





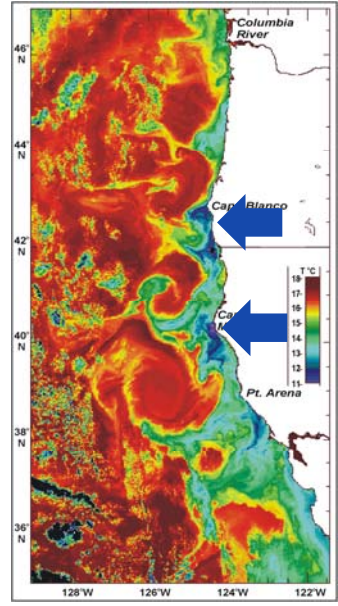
## Upwelling Center and Plume

**Center:** strong persistent upwelling

- Cape Blanco
- Cape Mendocino

**Plume:** cold water streams south, enriched with nutrients and plankton

But, plume often detaches from shore ...



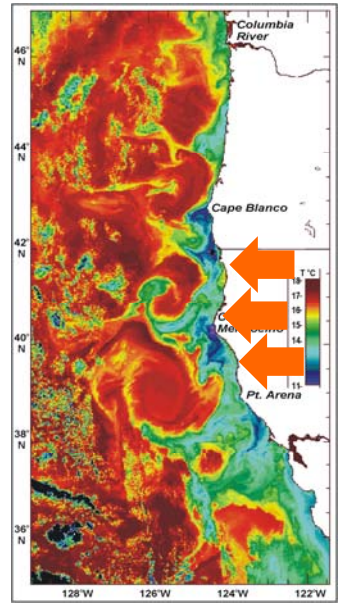
## Upwelling Shadow and Trap

**Shadow:** downwind of headland

- Crescent City vicinity
- Shelter Cove vicinity

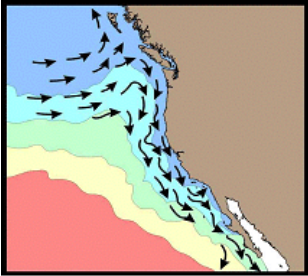
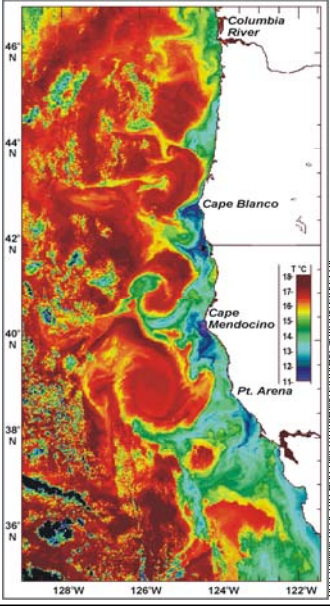
**Trap:** upwind of headland

- Eureka vicinity



## California Current

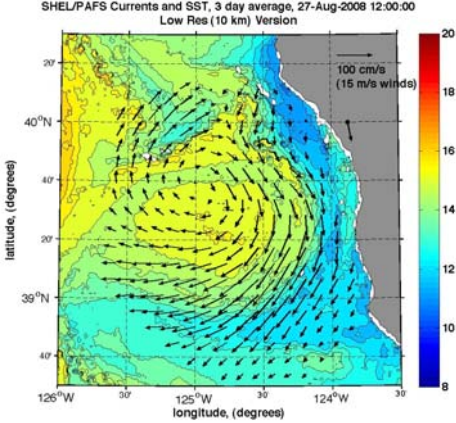
- Offshore: slow southward flow past California (N Pacific gyre)
- Large meanders (eddy > mean speed)
- Northward undercurrent over slope

## Mendocino Eddy

“Mendocino Eddy” persists offshore of upwelling center

- California Current interacts with wind and coast ...
  - large eddies & meanders
- Also eddy/meander off Blanco and Arena
- Larval transport ...
  - Permeable barrier ?
  - Offshore export
  - Alongshore retention

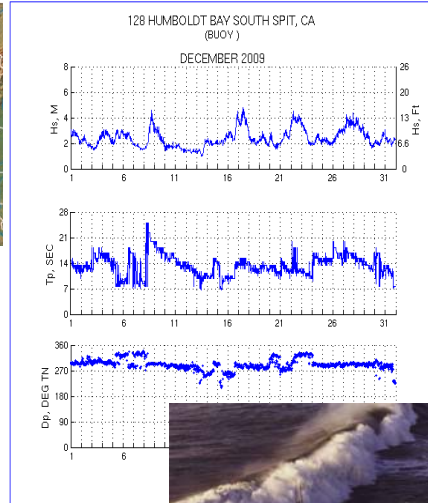


SHEL/PAFS Currents and SST, 3 day average, 27-Aug-2008 12:00:00  
Low Res (10 km) Version



## Wave Exposure

- Deep-sea “swell”
  - ... from north in winter
  - ... sheltered on south side of headlands
  - ... refract over shallows near Humboldt Bay
- “Sea” from local winds
- Alongshore wave-driven transport



Coastal Data Information Program  
<http://cdip.ucsd.edu>



## River Plumes

- Strong winter freshwater inflow from major rivers (e.g. Eel, Klamath)
  - ... attached to coast during south or weak winds
  - ... offshore during upwelling winds
  - ... heavy sediment load in Eel River outflow
- Weak freshwater inflow in summer
  - ... entrained in nearshore, attached to coast



[www4.ncsu.edu/~elleitho/](http://www4.ncsu.edu/~elleitho/)







## Humboldt Bay

- Modified mouth
  - waves, sand, turbid waters
- Channels and shoals
- Winter plume/sediment from Eel River, plus local inflow
- Summer: low-inflow estuary – long residence with marked zones (outer, middle, inner)
- Nutrient supply: ocean upwelling plus local sources



## Estuaries

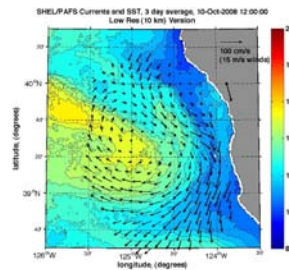
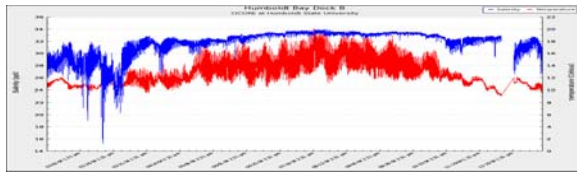
- Seasonal flows – seasonal closure of smaller bar-built estuaries
  - ... population connectivity
- Occasional closure of others
- Channel estuaries highly stratified
  - ... low DO and warm water effects
  - ... salinity intrusion
- Long retention in low-inflow lagoons, bays, coves
  - ... susceptible to inputs of nutrients and contaminants





## Ocean Observing Systems

- Central and Northern California Ocean Observing System (CeNCOOS) and more ...
  - ... radar measurements of surface currents
  - ... time-series data: water properties, waves, winds, river flow, tide levels
  - ... monthly plankton survey
  - ... satellite imagery
  - ... computer model of currents (ROMS)

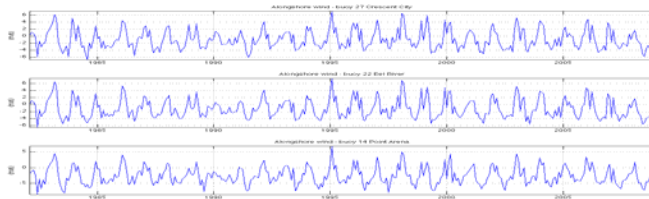


## Environmental Variability

**Short-term variability** characterizes the habitat  
 - need high-resolution monitoring of events

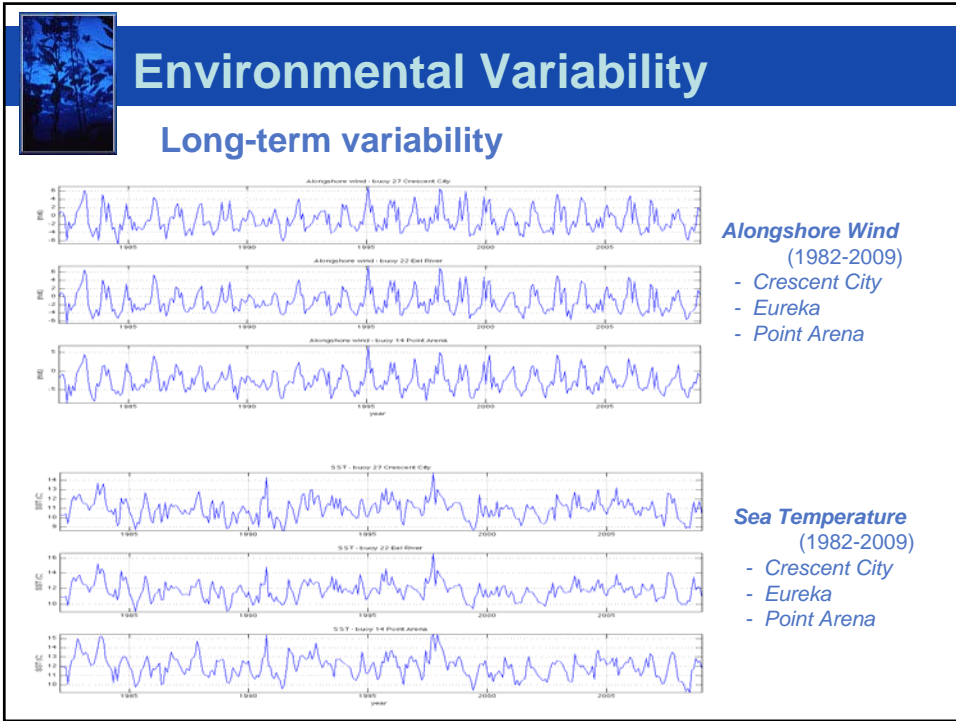
**Long-term variability** characterizes fluctuations in the habitat and thus populations  
 - need persistent monitoring over years

Interaction of seasonal timing of ocean & population  
 e.g., spring transition, salmon smolts, estuary mouth



**Alongshore Wind**  
 (1982-2009)  
 - Crescent City  
 - Eureka  
 - Point Arena

Population change due to MPA may be masked by ocean change



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The photograph shows a scenic view of a coastal area. In the foreground, there is a lush green hillside with some trees. In the middle ground, a sandy beach curves along the shore. The ocean is a clear, light blue-green color, and the horizon is visible in the distance under a clear sky.