If you knew the hue of the blue ...
Patterns of dispersal and pelagic habitat …
Area characterized by upwelling & mediterranean climate.

- The **Upwelling** Story …
  … upwelling center at Point Arena;
  … retention areas;
  … time & space scales of phytoplankton blooms.

- The **Bay Outflow** Story …

- The **Estuary** Story …
  … outflow;
  … inflow.

- *The Wave Exposure* Story.

- The Story of **Temporal Variability**.
The Upwelling Center

- Point Arena is a strong and persistent upwelling center.
- Area of active upwelling expands and contracts.
- Cold water streams south to Point Reyes, Cordell Bank, Farallones Islands and Gulf of the Farallones.
- Cold upwelled water is loaded with nutrients.
• Drakes Bay is primary retention zone ("upwelling shadow")
  … but, note shallow thermocline, influence of bay outflow, and nearshore upwelling.
• Also, water may be retained in Bodega-Tomales system.
• "Detention" along north shore of Point Reyes.
• Small-scale nearshore areas.
• Retention in offshore mesoscale eddies.
Upwelling Plume

- Upwelling plume - a plume of cold, nutrient-rich water - streams south from Pt Arena.
- Plume is deflected by Pt Reyes, exporting material offshore.

Drifters deployed off Bodega Head (Largier et al)
Upwelling at Capes

- Upwelling Jet
- Upwelling Trap
- Upwelling Shadow
- Upwelling Plume
- Downstream convergence
Phytoplankton

Upwelling center:
- 2 days
- 3.5 days
- 5 days
- 7 days
• Phytoplankton response time is several days.
• This is seen as a plume of chlorophyll, attaining maximum concentrations 50-100km downstream of upwelling center.
• Cordell Bank, Pt Reyes, Farallones Islands and Gulf of the Farallones are supported by Pt Arena upwelling.

Average chlorophyll concentration from SeaWiFS (courtesy Andrea Vander Woude)
Phytoplankton & Relaxation

- Relaxation of the wind leads to phytoplankton blooms - shallow stratified surface layer.

HF radar maps of surface current during upwelling and relaxation.

SeaWiFS image of chlorophyll concentration.
San Francisco Bay Outflow

- Moves south during upwelling - minimal contact with shore.
- Found attached to shore up to Bolinas (frontal feature) & low-salinity surface water up to Pt Reyes.
- Moves north during weak or southerly winds & after strong freshwater flow - contact with shore.
Not washed out of Drakes Bay during upwelling.
San Francisco Bay Outflow

- Moves south during upwelling - minimal contact with shore.
- Moves north during weak/south winds & after strong freshwater flow - maximum contact with shore & min dilution ... positive and negative impacts.
• **Low-inflow estuaries**, like Tomales Bay and Bodega Harbor.

• Long residence, clear longitudinal zonation - importance of “backwaters”
• **Low-inflow estuaries**, like Tomales Bay and Bodega Harbor.

• Nutrient supply from ocean - spatial pattern of phytoplankton.
Estuaries

- **Bar-built estuaries**, like Russian River, Gualala, Salmon Creek.
- Highly stratified at times, leading to high T and low DO.
- Deep pools on curves vs shallow sections.
- Salinity intrusion.
- Residence time.
- Mouth closure.
- Outflow plumes (Stewarts Point 2007).
Wave Exposure

- Deep-sea “swell” refract and diffract.

- Also, “sea” from local winds.

- Alongshore transport - zone of impact associated with land runoff.

CDIP data - Coastal Data Information Program
http://cdip.ucsd.edu
• Have described spatial patterns.

• Recognize temporal variability - diurnal, synoptic, seasonal, interannual, trend.

• **Short-term variability** characterizes the suitability of habitat - need high-resolution monitoring.

• **Long-term variability** characterizes fluctuations in a population - need long-term monitoring.

• Interaction of time scales, e.g., timing of spring transition, match-mismatch ideas (salmon smolts entering ocean).
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