

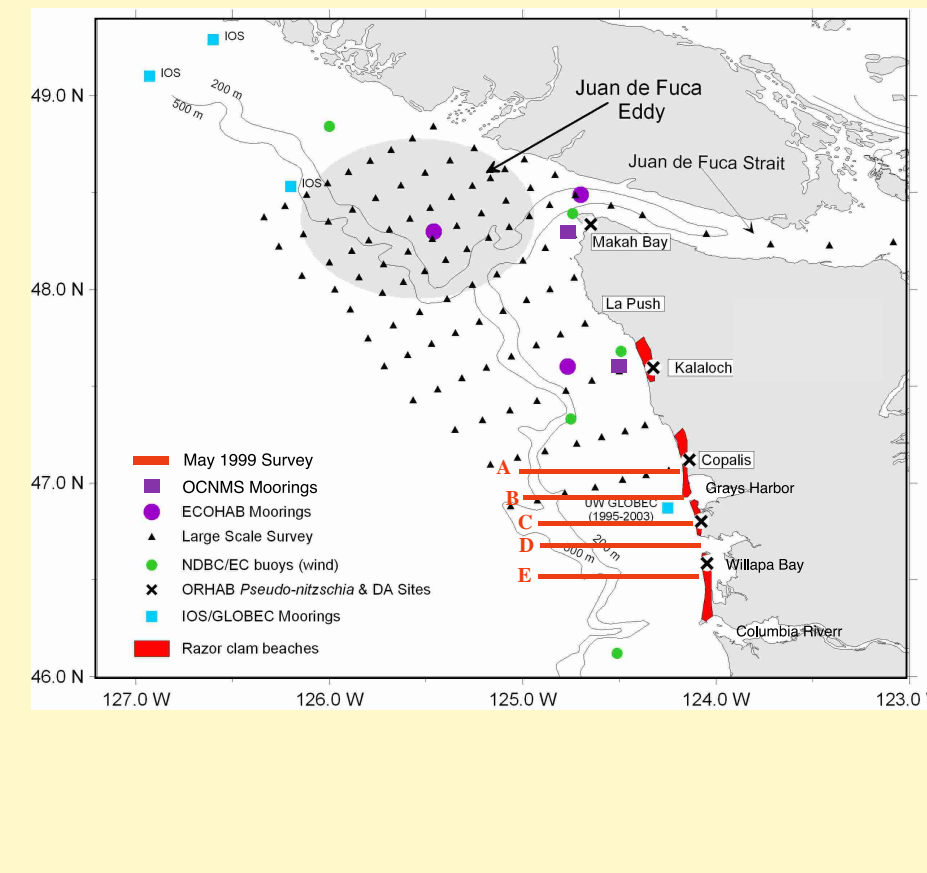
# A Bi-Direction Freshwater Plume in the California Current System

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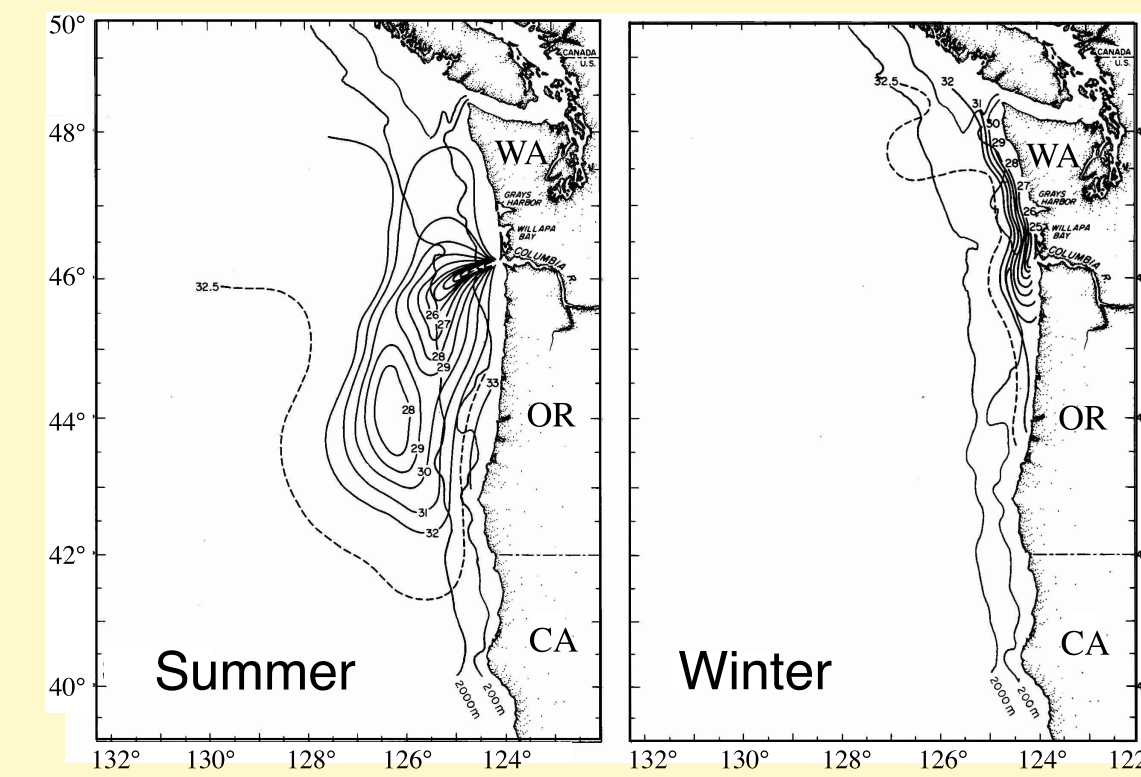
## Abstract

Freshwater plumes have important effects on marine ecosystems: in the presence of a plume, stratification, nutrient pathways, light and circulation patterns are significantly altered from patterns that occur under the influence of wind and ambient currents alone. The historical picture of the plume from the Columbia River consists of a freshwater plume oriented southwest offshore of the Oregon shelf in summer, north or northwest along the Washington shelf in winter. The plume is shallow, with strong frontal regions and current jets near its edges and eddy-like, retentive regions within its body. Both recent and historical data support a picture quite different from the historical seasonal pattern: specifically, the plume is frequently present up to 150 km north of the river mouth on the Washington shelf from spring to fall, even during periods of upwelling. Examples in which the Columbia freshwater plume impedes upwelling of nutrients by capping the upwelling water over the inner shelf are shown. Although the Columbia plume exports little nitrate from the estuary to the coast, it is a major source of silicate and also iron. Thus the position of the plume, as well as where it deposits its iron-rich sediment load is likely to play a first order role in productivity on nearby shelves. Evidence suggests that the Columbia River plume may also provide a barrier to the transport of harmful algal blooms to coastal beaches in summer and early fall.

## Pacific Northwest Study Area

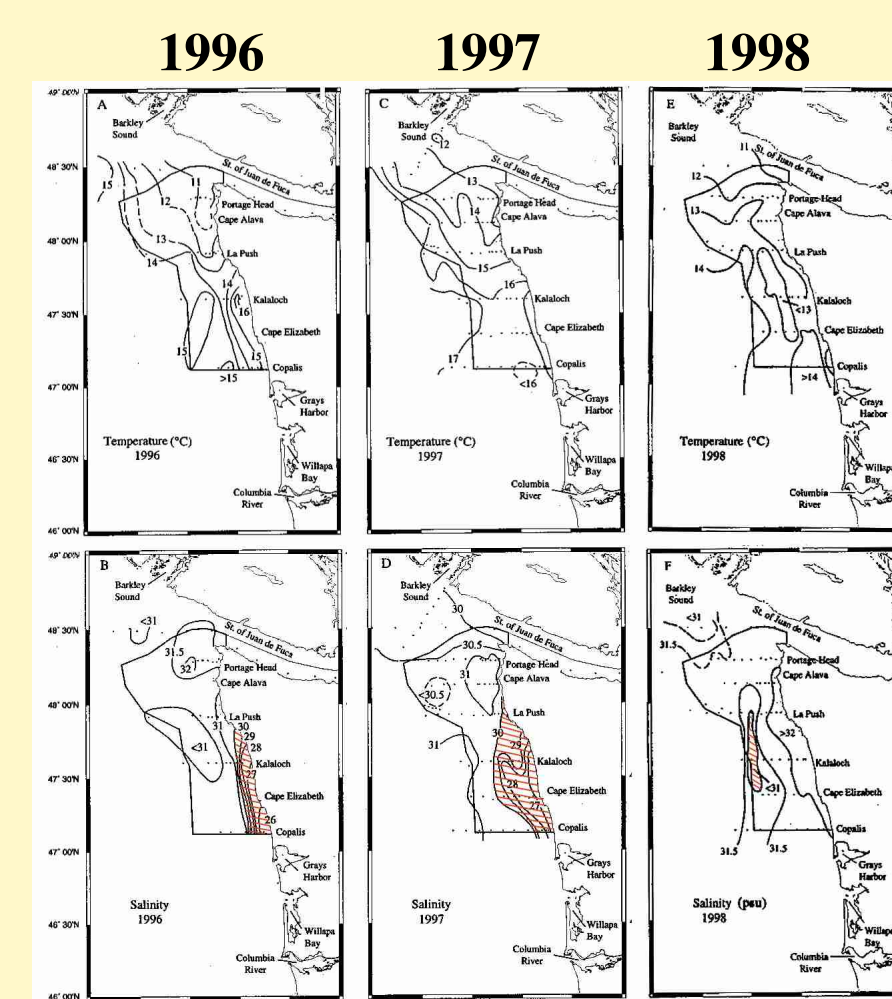


## Traditional View of Columbia River Plume

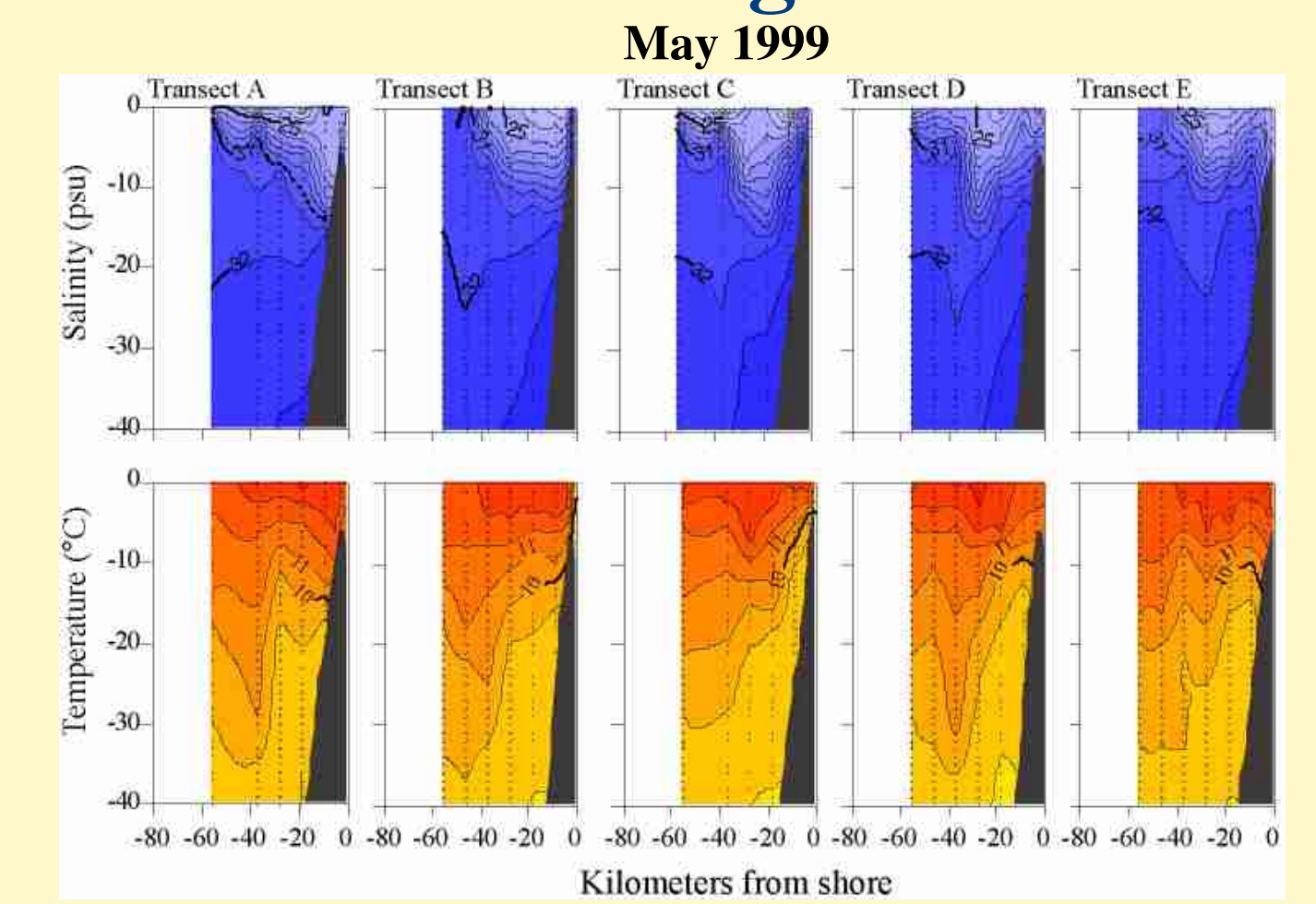
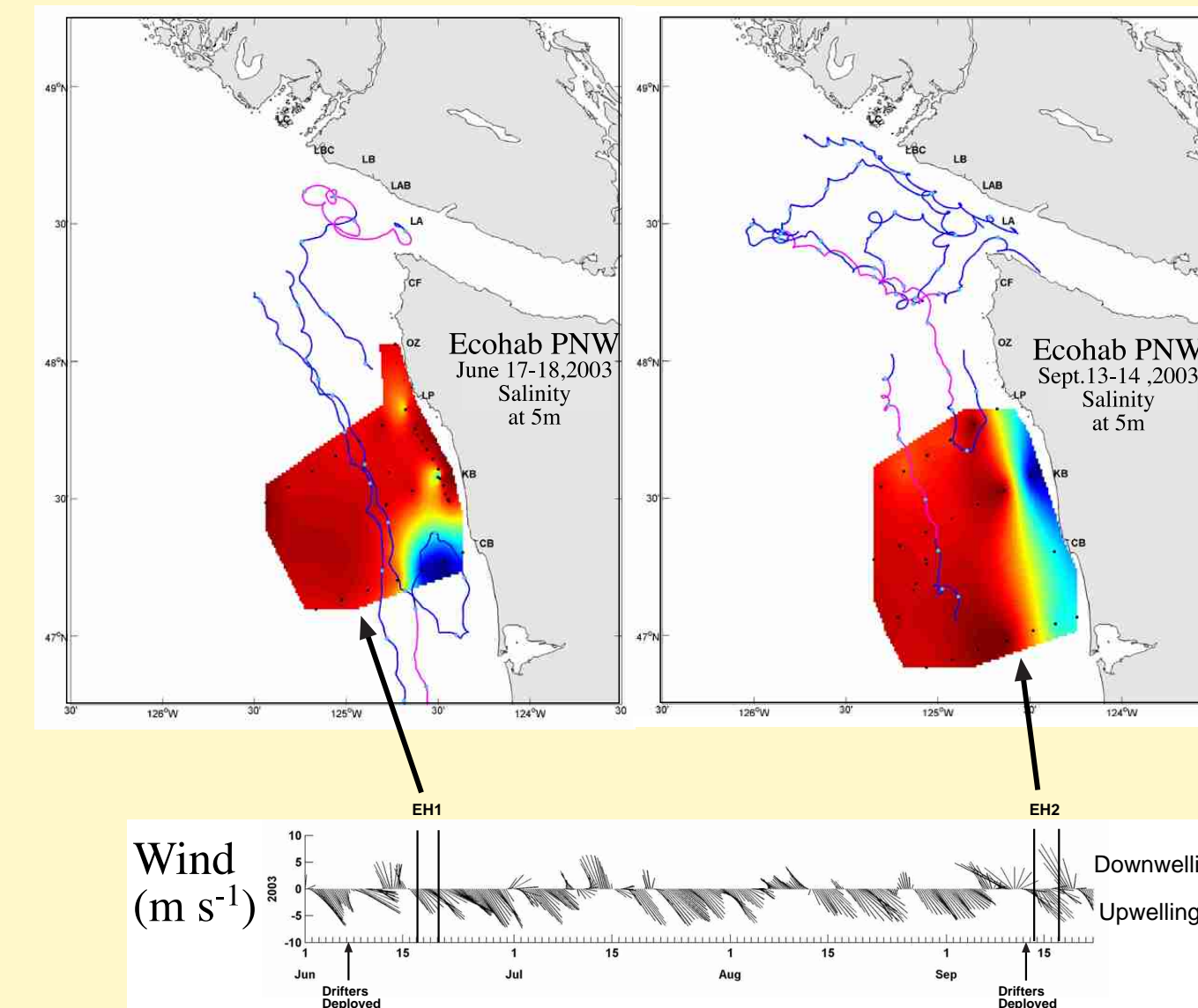


Average Surface Salinity ( Barnes et al., 1972)

## A New View: A Columbia River Plume is Ubiquitous off the WA Coast During Summer



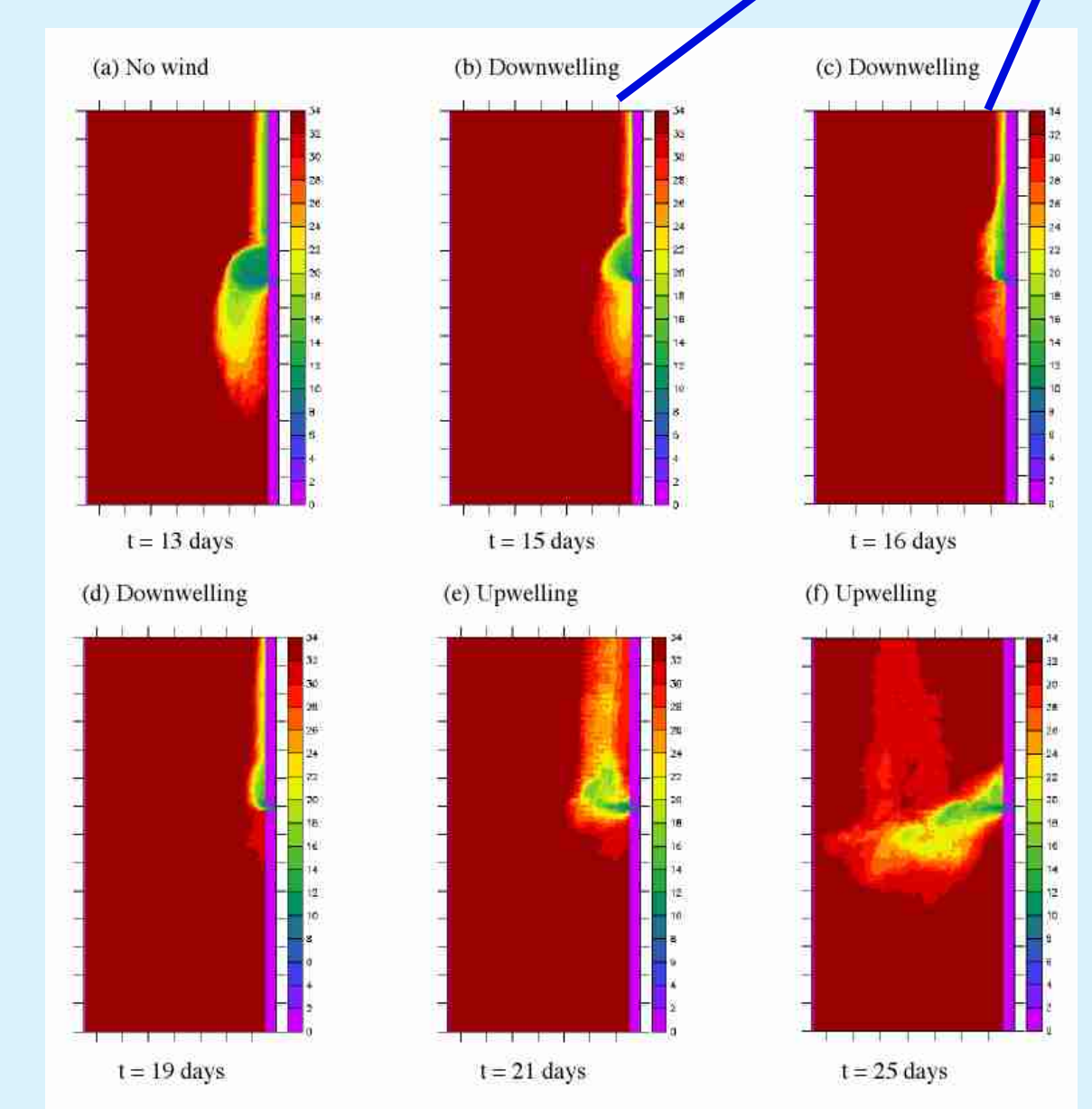
Temperature and Salinity at Sea Surface during Several 1-2 Week Cruises (Adapted from Horner et al., 2000)



Temperature and Salinity Transects During the Cruise in May, 1999. Location of the Transects is Shown on the Base Map. (Adapted from Roegner et al., 2000)

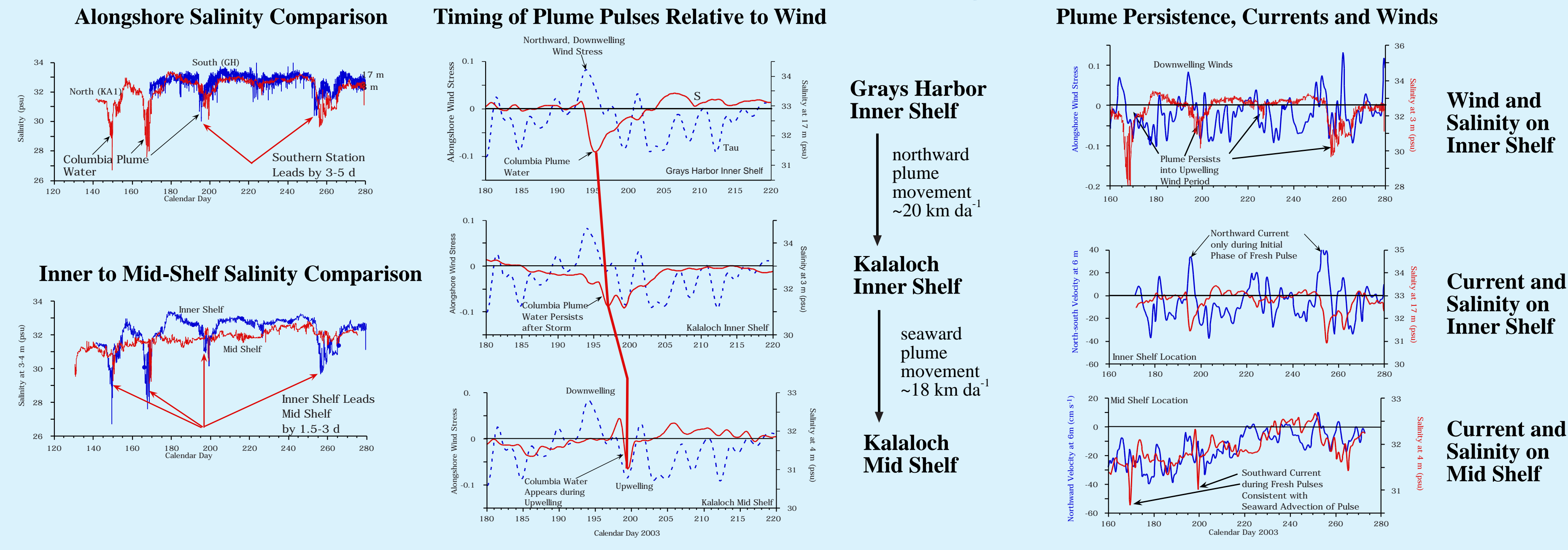
## Bi-Directional Plume

### Model View

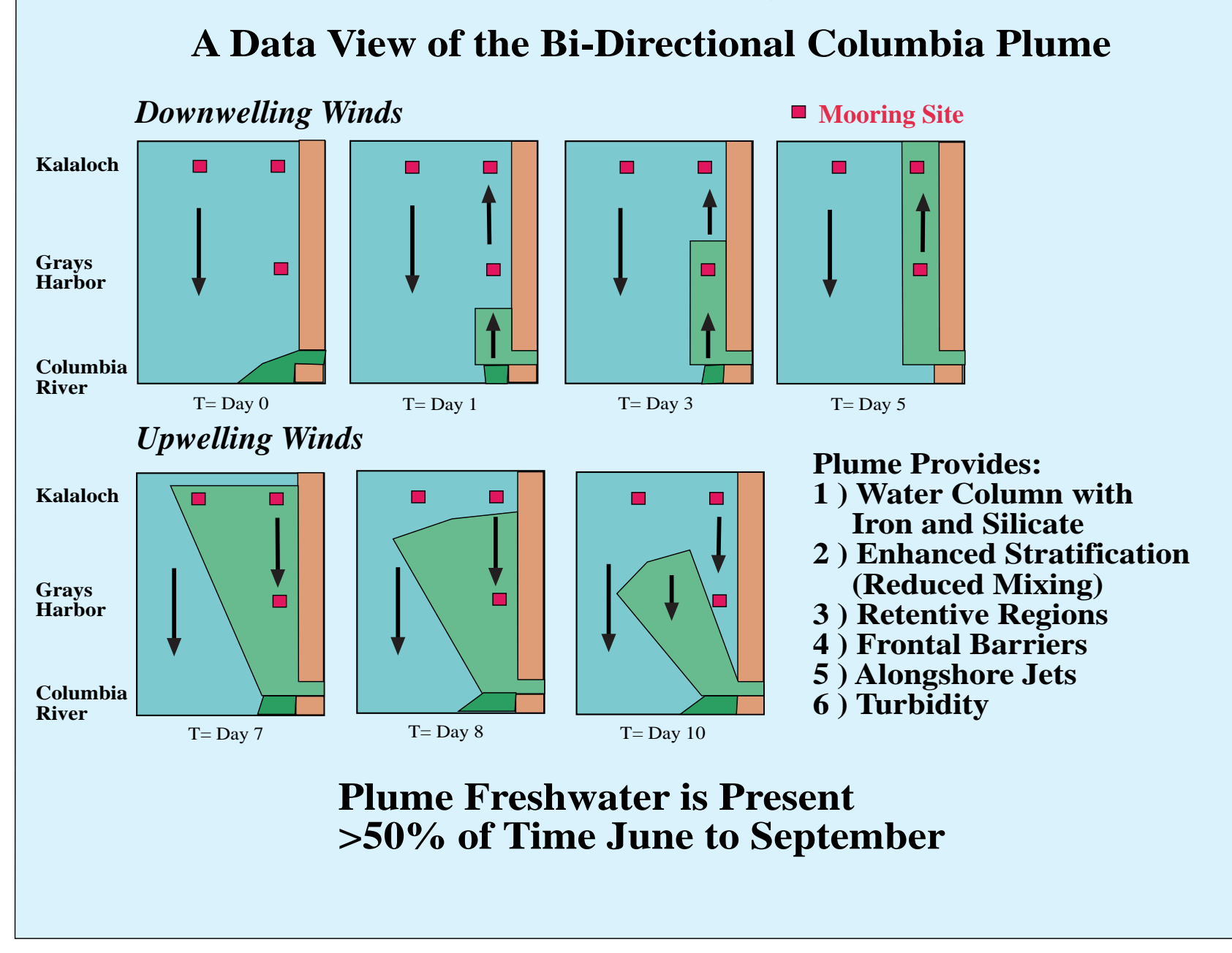


Model results from Garcia-Berdeal et al., 2002. Model has Southward Ambient Flow of 10 cm s<sup>-1</sup>. Typical Summer Wind Magnitude and Columbia R. Outflow.

### Data View for Washington Coast

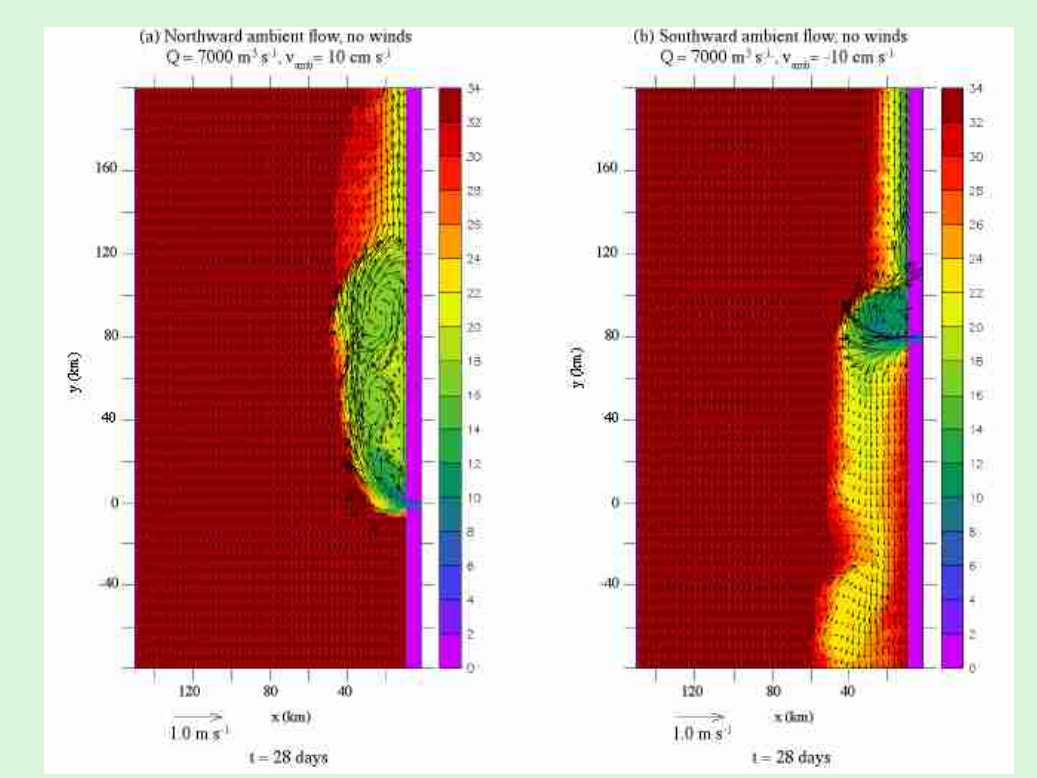


### Summary

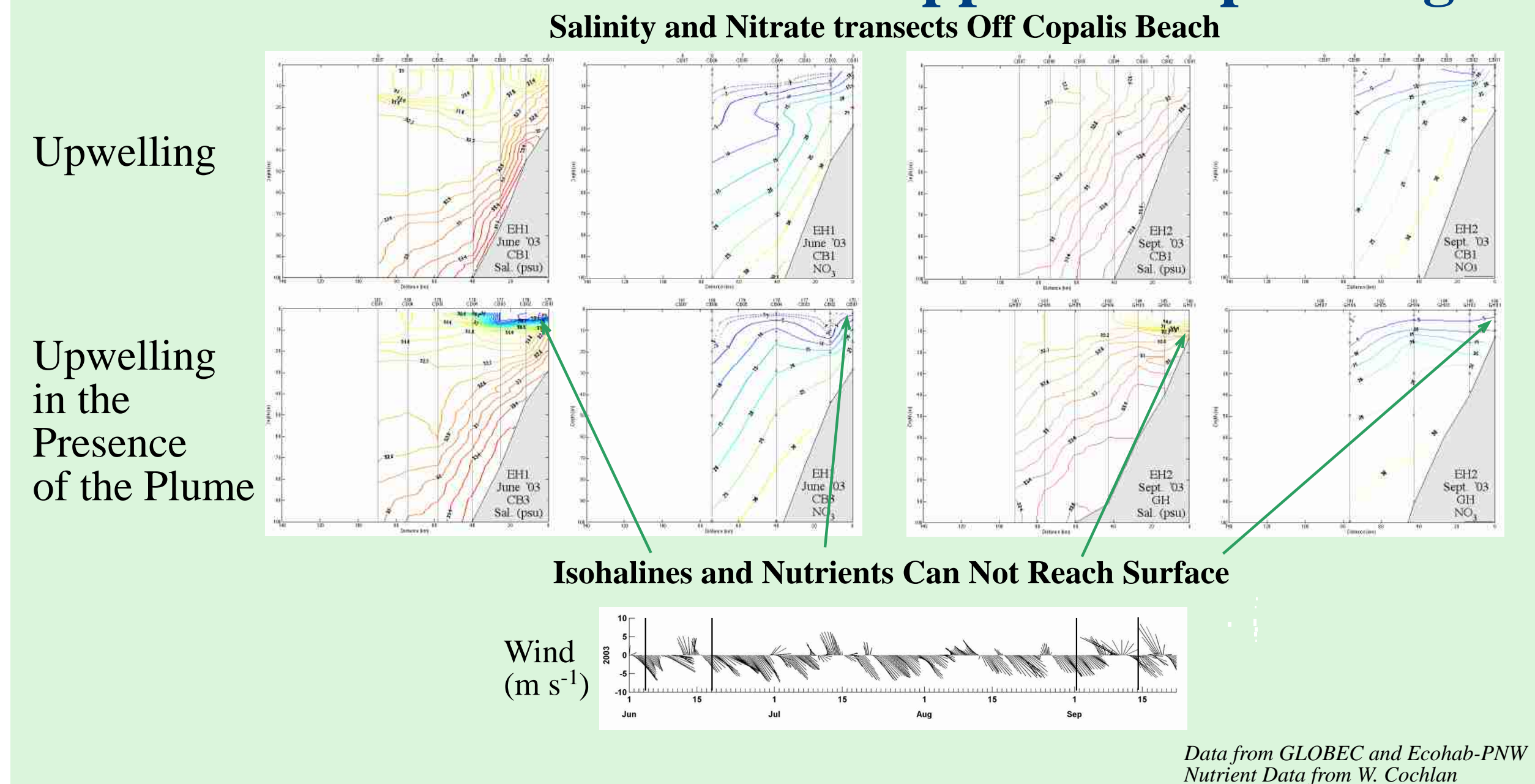


## Temporal Variability of Columbia River Plume During Summer Wind Reversals

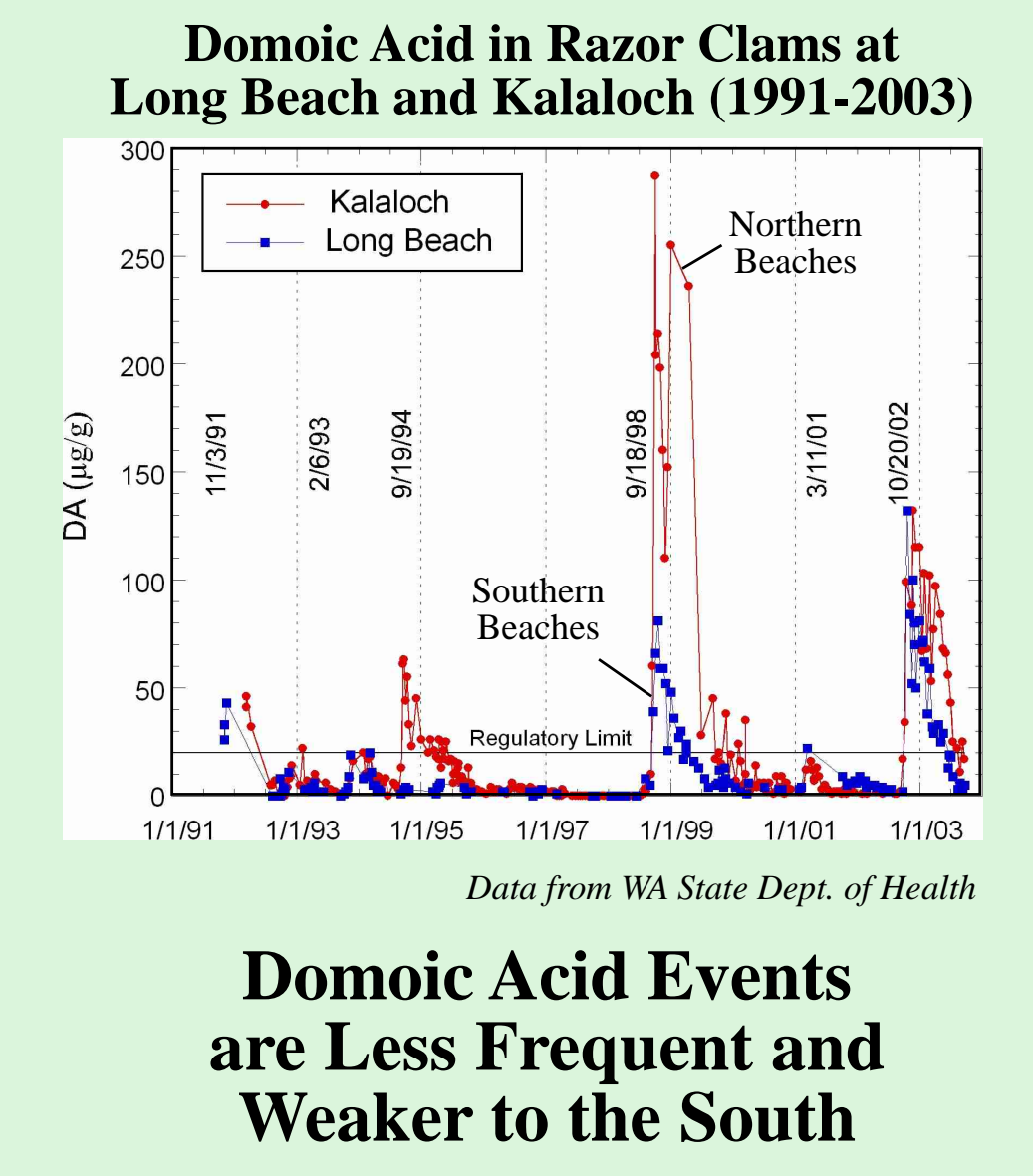
### Plume Modifies Currents



### The Columbia Plume Suppresses Upwelling



### Is the Columbia Plume a Barrier to Onshore Transport of HABs?



Patches of Domoic Acid from Toxic Algae are Transported Southward from the Juan de Fuca Region. If they Impact the Coast Razor Clams Become Toxic and Beaches are Closed to Clam Harvesting.

