

# Where are the **phytoplankton**?

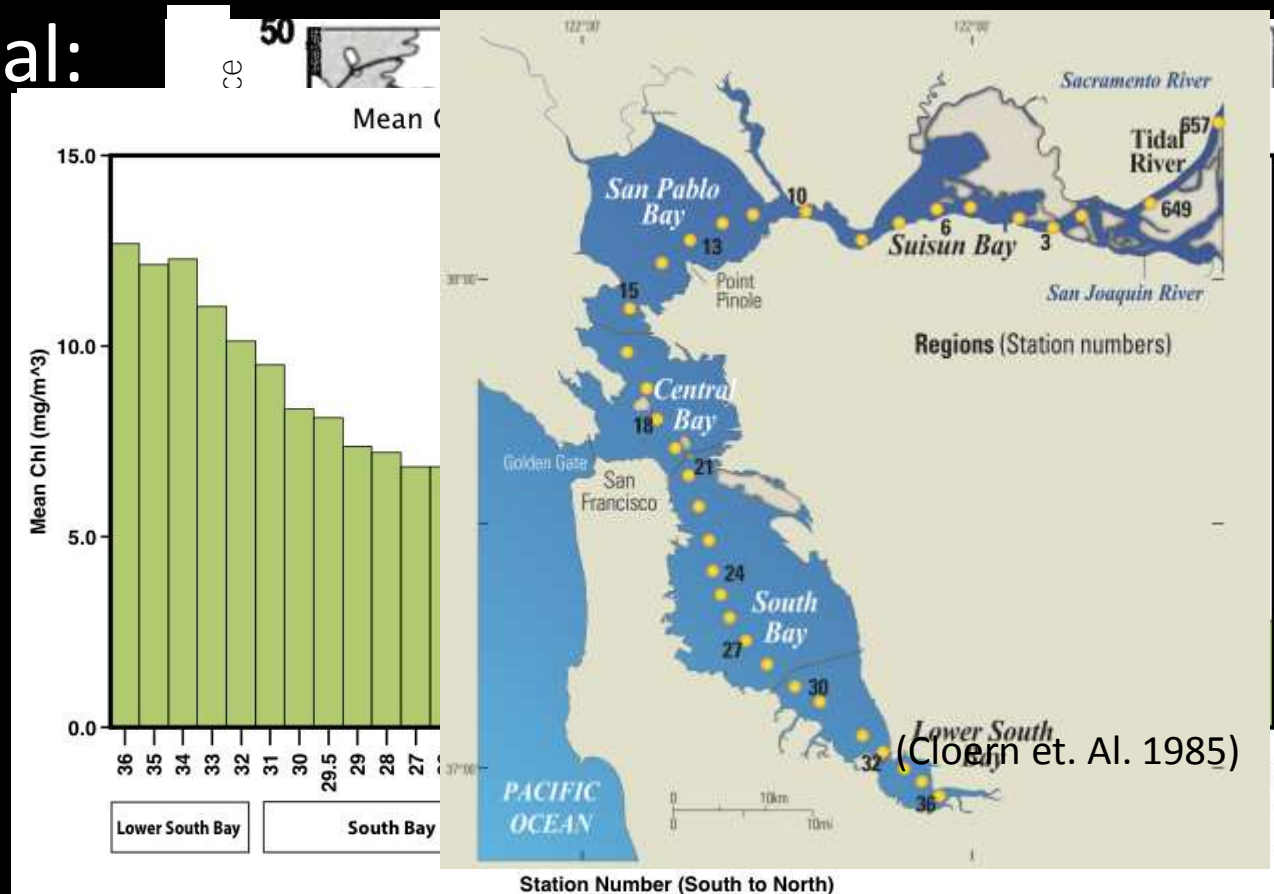
*Vertical Distributions of Phytoplankton Biomass as  
Chlorophyll-a in San Francisco Bay*

Charles Martin, Tara Schraga, Jim Cloern  
US Geological Survey, Menlo Park, CA



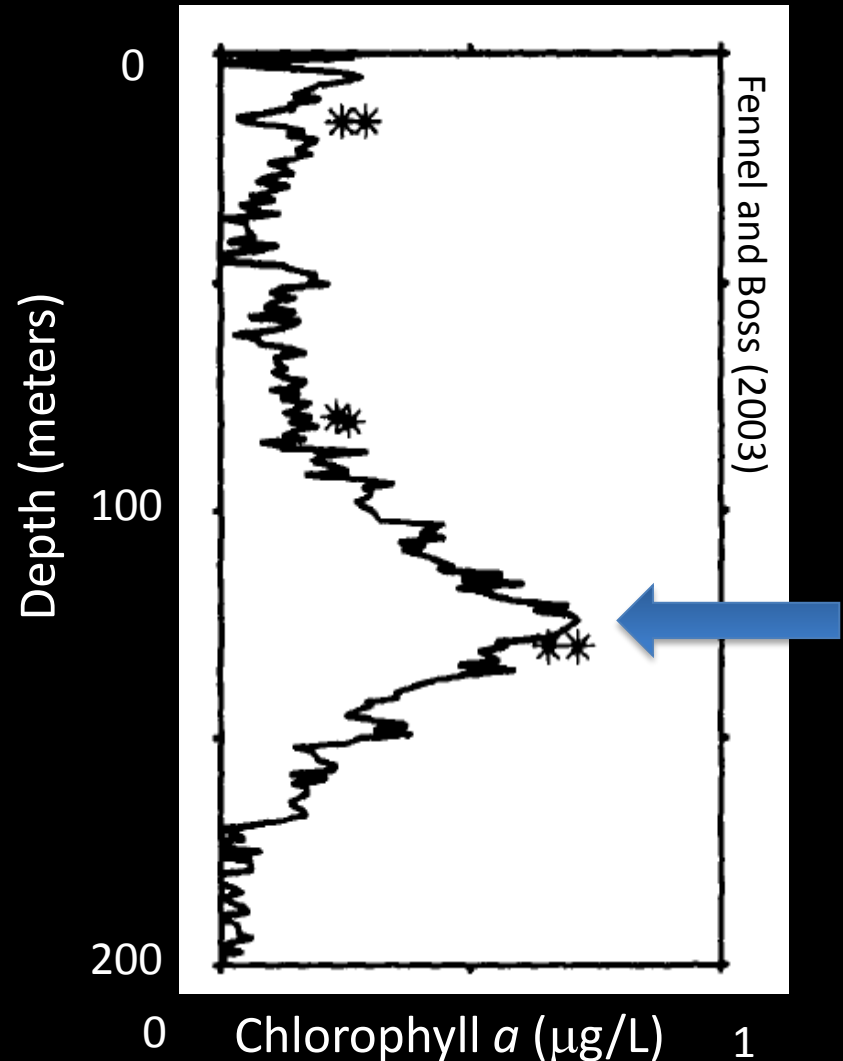
# Chlorophyll distributions in SF Bay

- 3 spatial dimensions for phytoplankton investigation in SF Bay
- Longitudinal:
- Lateral:
- Vertical:

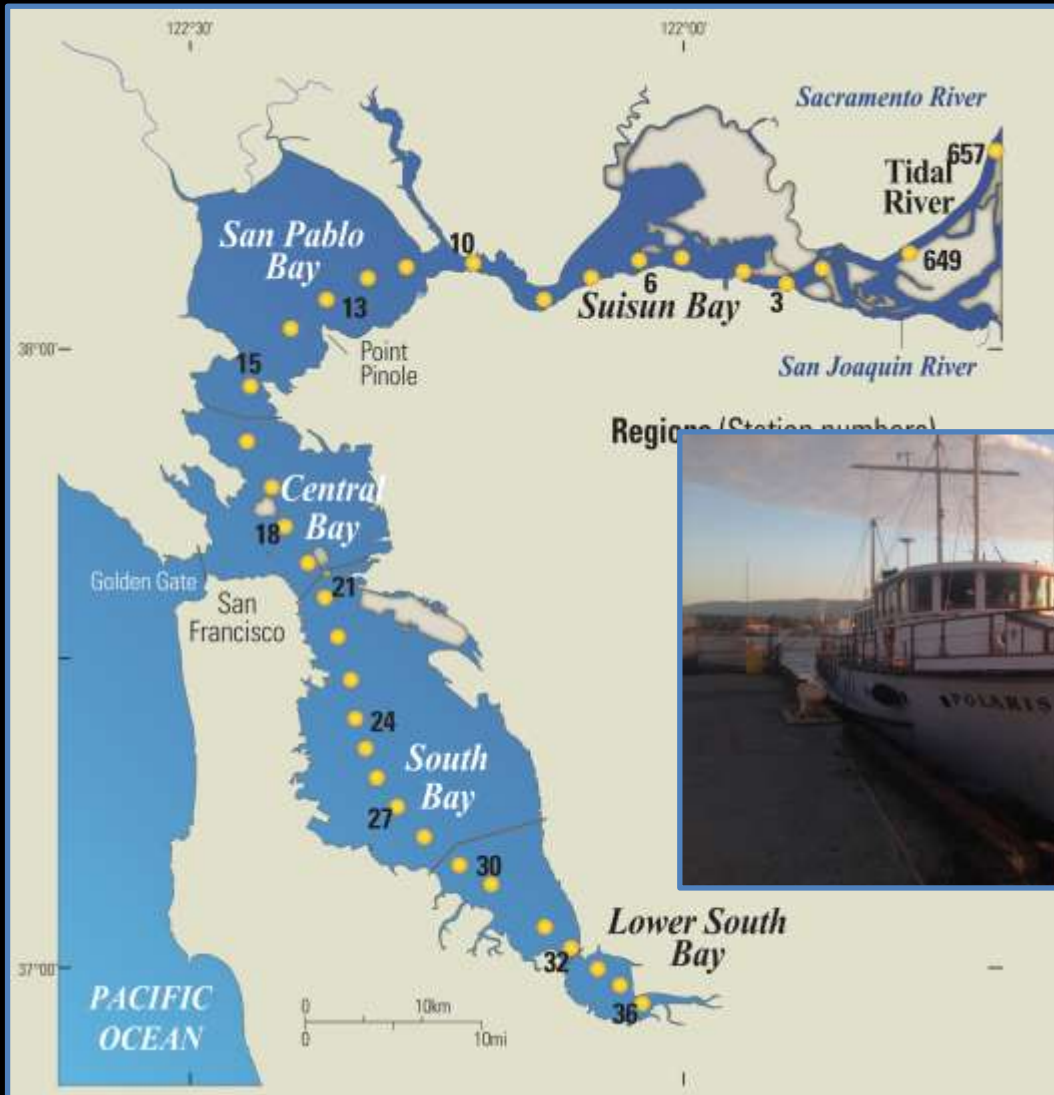


# Why we are curious

- Large vertical variability of fluorescence in lakes and oceans
- Vertical profile of chlorophyll-a in Crater Lake:
  - Stars = extracted chl-a.
  - Line = derived chl-a from in-vivo fluorescence



# What do we do in SF Bay?



- Water quality since 1968
- Phytoplankton biomass 1978
- Vertical profiles of fluorescence with a CTD, calibrated with discrete **chl-a** water samples **every** cruise



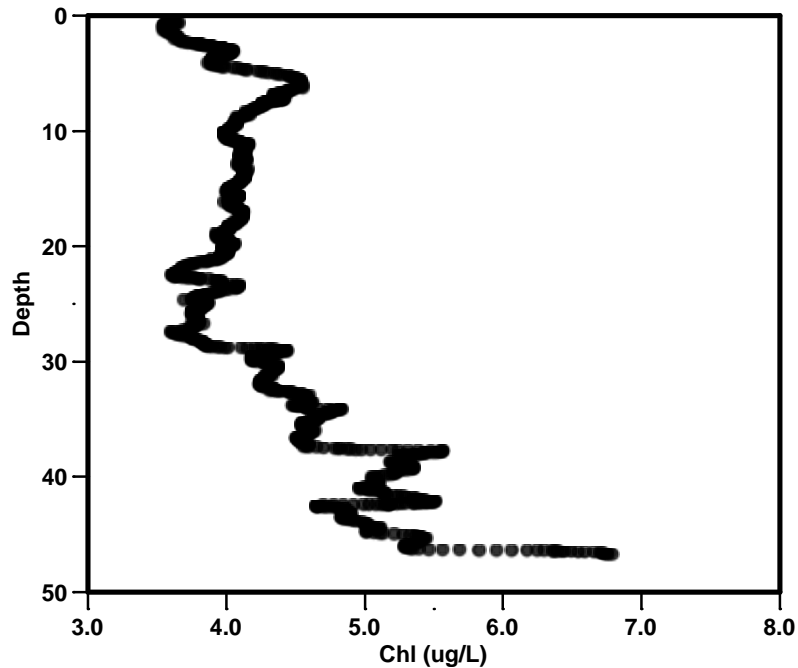
# What are our questions?

- Do sub surface peaks (SSP) form in SF Bay?
- Where do they occur?
- What is the frequency of occurrence?
- Is there a seasonal pattern?
- At what depth?
- What are the implications for monitoring programs and future research?

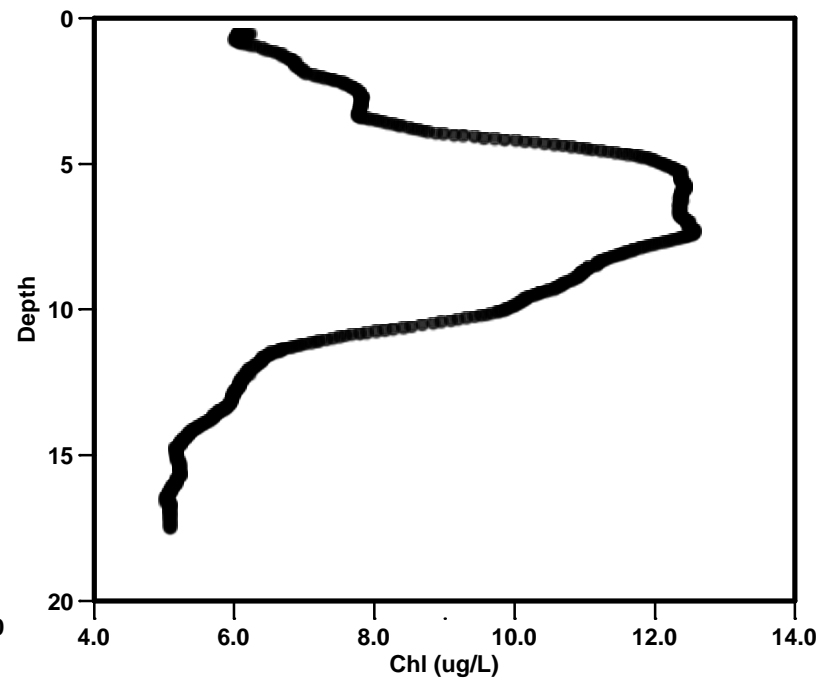
# Our data and defining a SSP

- All CTD casts 1991-present were analyzed
- 11669 fluorometer profiles
- The criteria for a subsurface peak are:
  - A **vertical** profile (at least **5 meters deep**)
  - **Max chl-a** at a **depth  $\geq 2$  meters**
  - The max chl-a is ***at least 20%*** greater than the **average chl-a**

# Examples of sub surface peaks



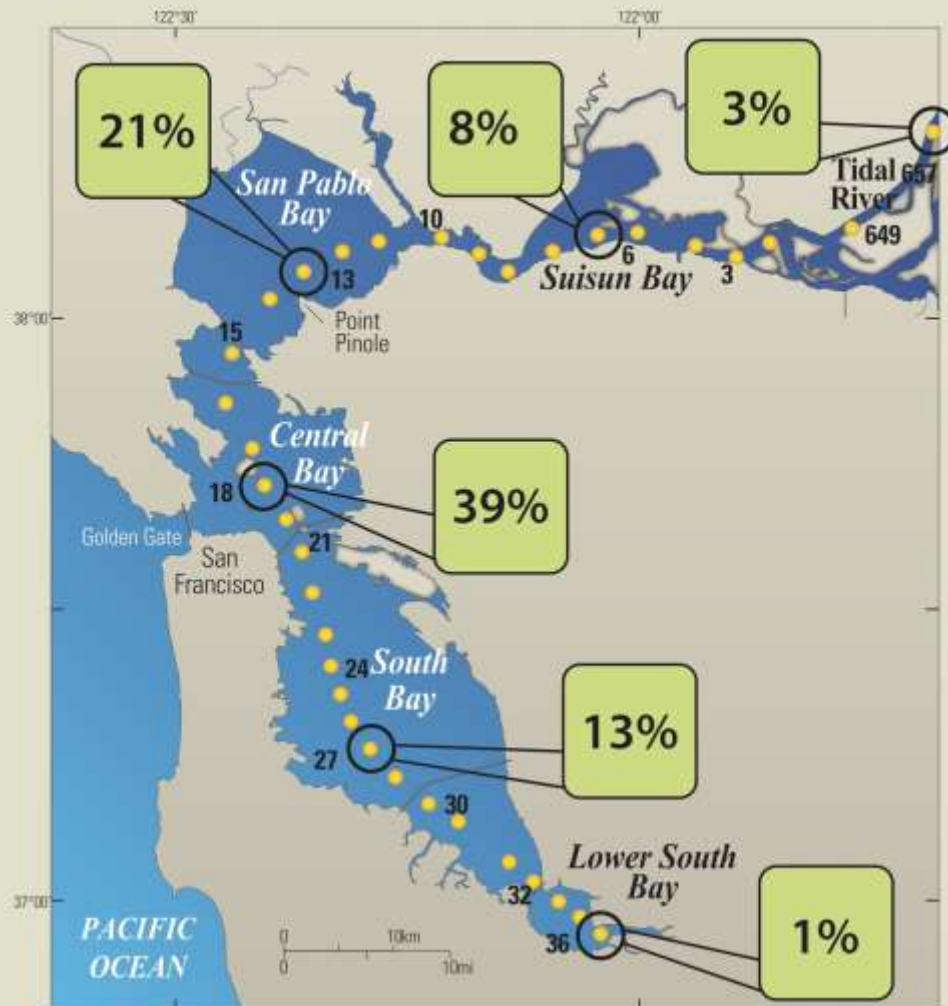
**Station 18 11-July-2012**



**Station 21 7-March-2006**

# Where and how frequent are SSPs?

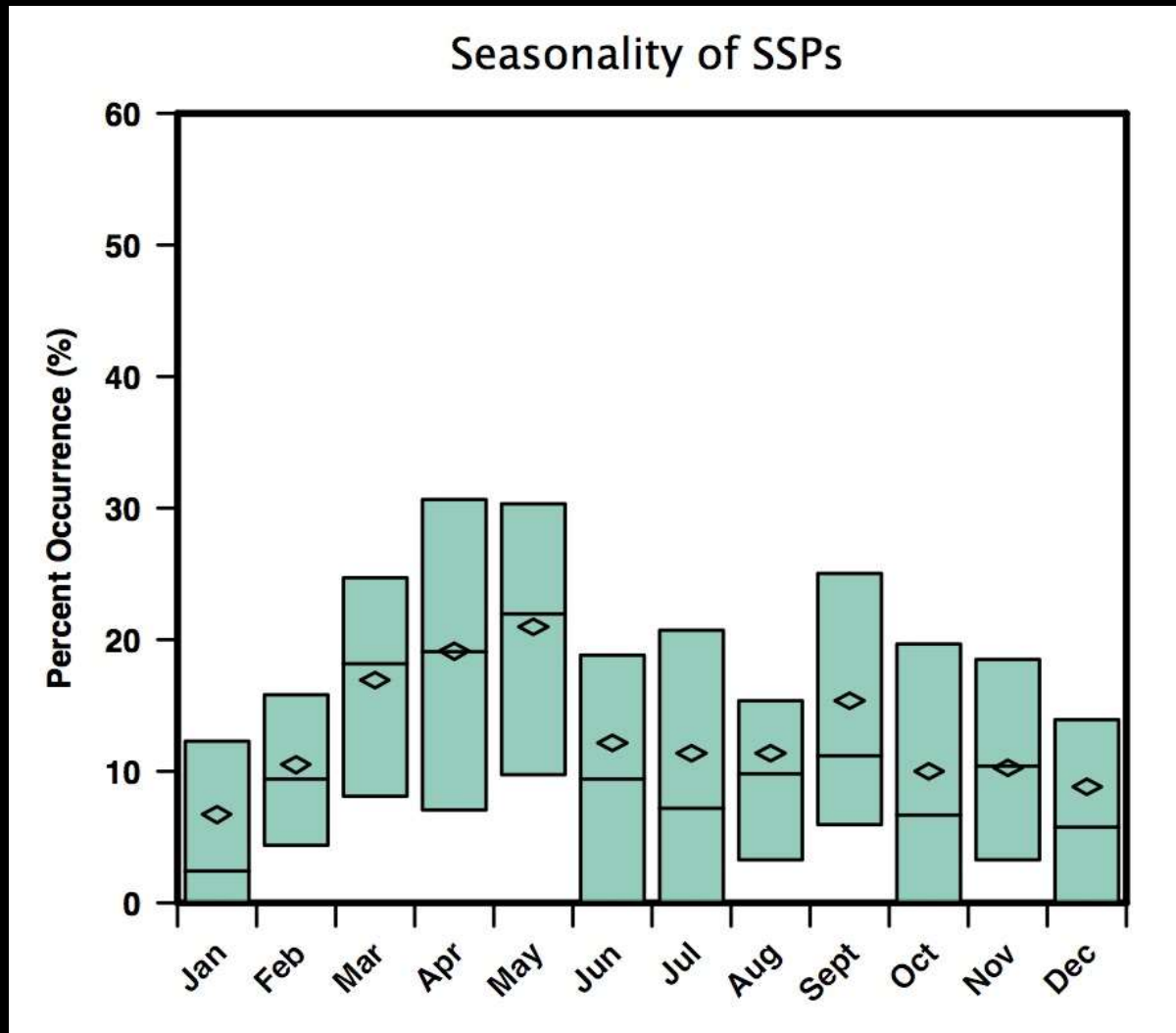
% with Sub Surface Peaks



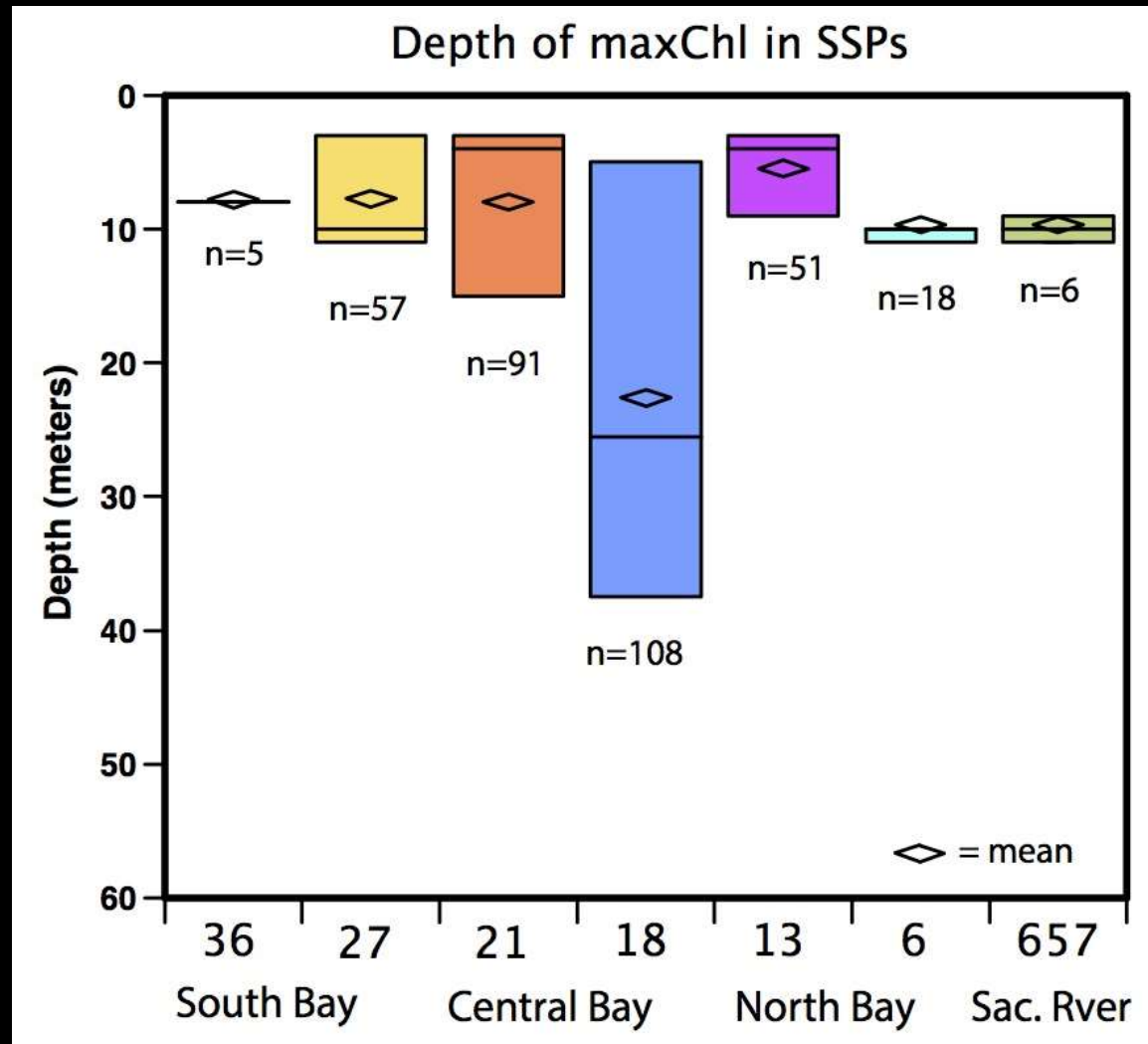
- 15% of *all* fluorometer profiles qualify as an SSP
- Longitudinal variability
- Each station is different



# Are they seasonal?

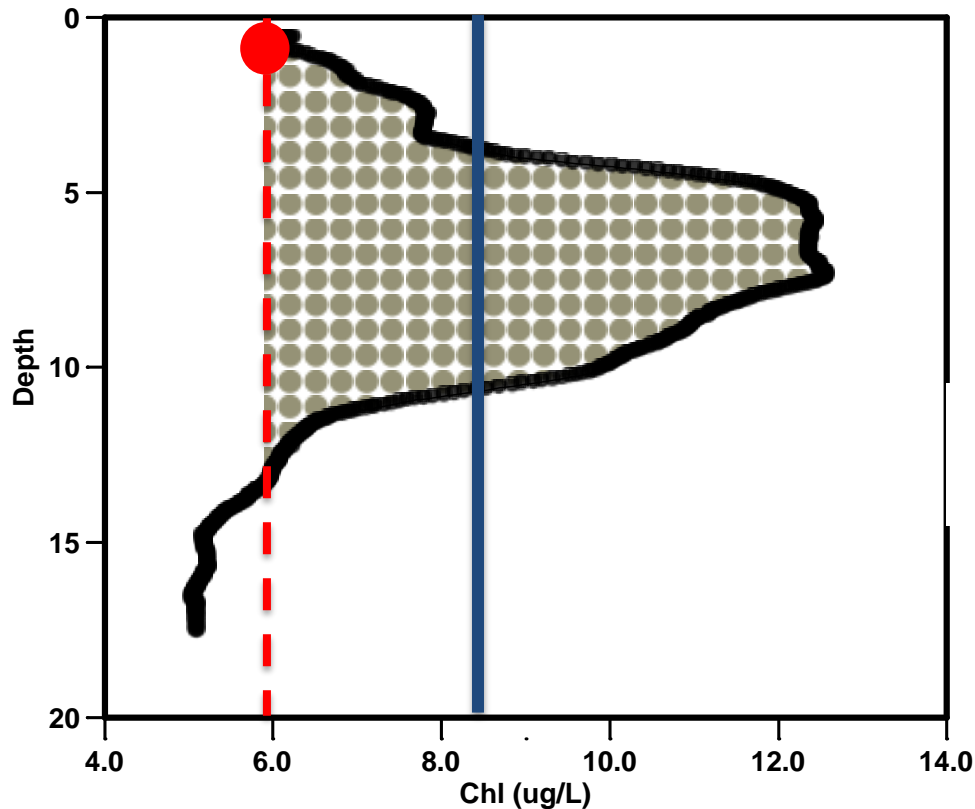


# How deep are the SSP's?



# Possible error from surface sampling

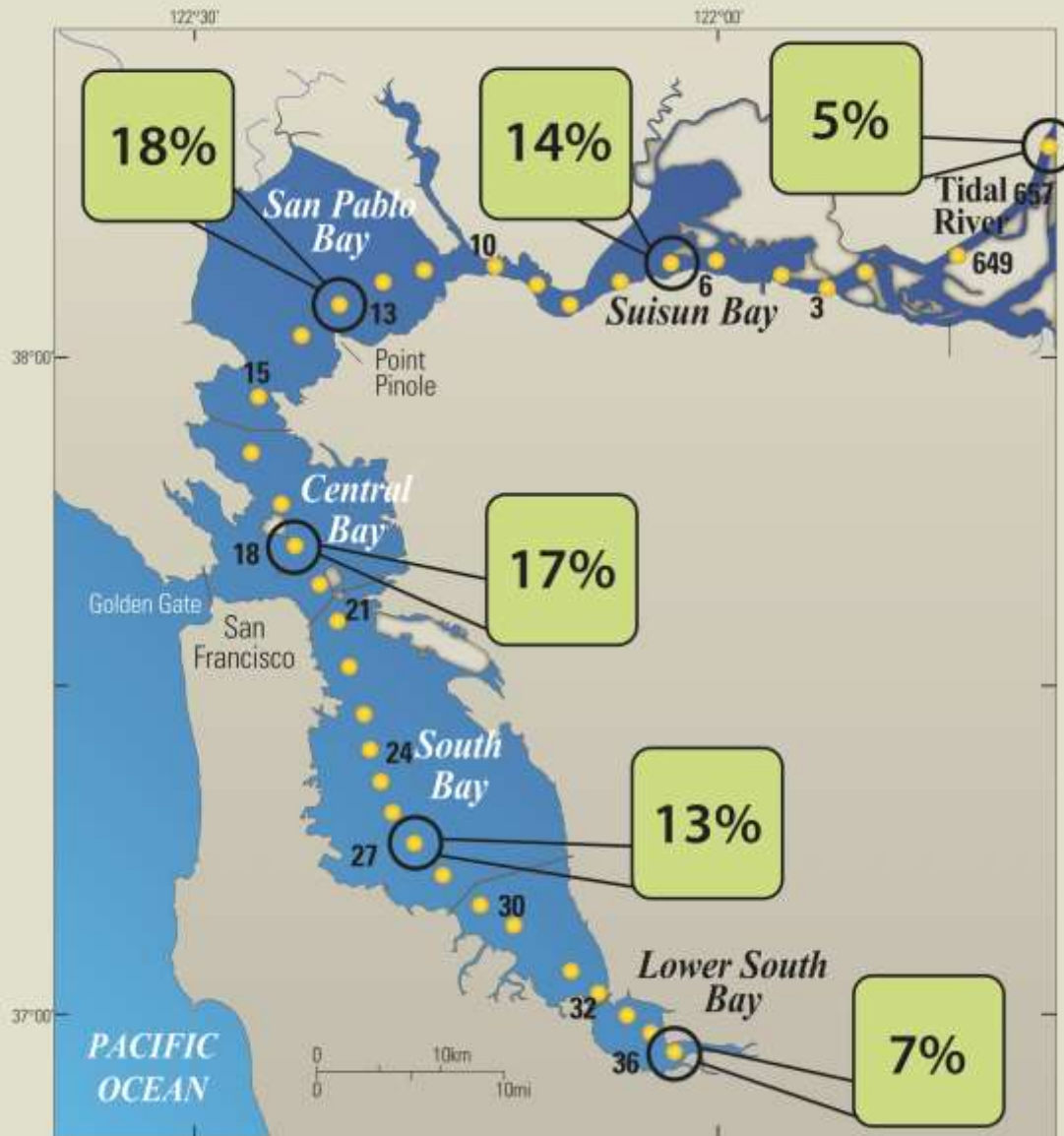
Stn 21 7-March-2006



$$Error = \left| \frac{1m - avgChl}{avgChl} \right|$$

$$Error = \left| \frac{6.0 - 8.1}{8.1} \right| = 26\%$$

## (Abs) % Error of using 1m to estimate AvgChl



# Percent Error

- (abs) % error between the 1m conc. of chl-a and the depth averaged conc. of chl-a was calculated for every vertical fluorometer profile
- The mean error was calculated for each of the representative stations

# Take home messages

- Chlorophyll concentration variability is a 3D question
  - Deep to shallow
  - Along the salinity gradient
  - Vertically in the water column
- San Francisco Bay has vertical variability of chl-a and include SSP's as we see in lakes and oceans
- Surface samples do not indicate what is happening in the whole water column, especially in deeper, and more strongly stratified stations
- As we think about developing a monitoring program for San Francisco Bay, we need to include measurements of vertical variability of chlorophyll