

# Biological considerations for enclosed coastal water bodies: King Harbor as an example

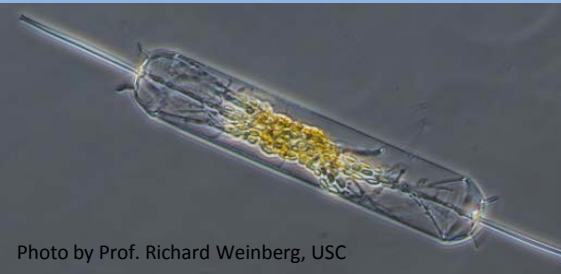


Photo by Prof. Richard Weinberg, USC

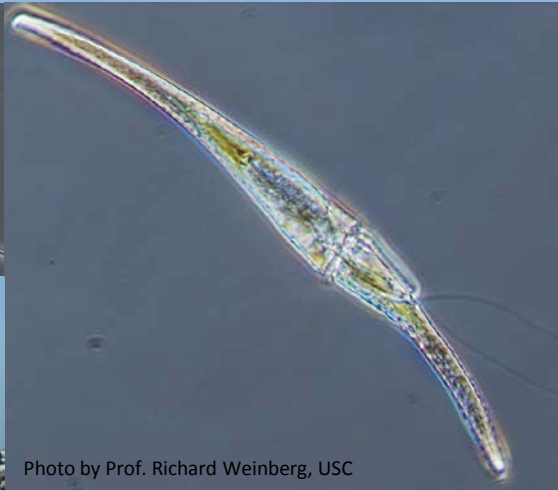


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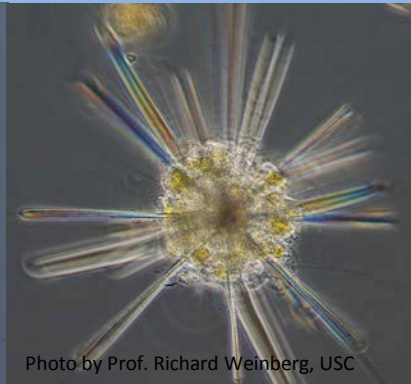


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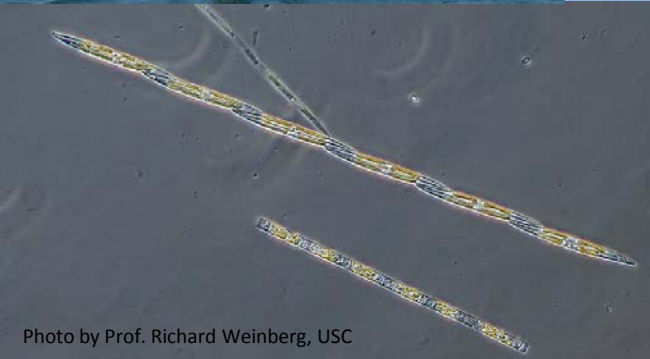


Photo by Prof. Richard Weinberg, USC

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# Embayments provide shelter, but...

- Restricted water flow can reduce oxygen renewal
- Nutrient retention can stimulate algal production

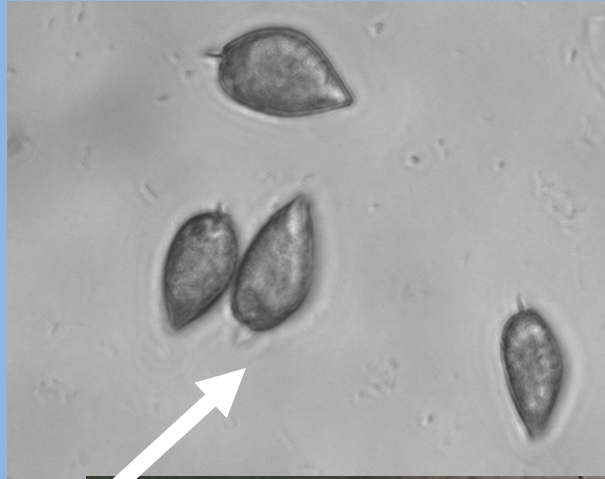




Algal bloom in  
King Harbor,  
May 2006

following a fish kill  
in 2005.

Residual nutrients??







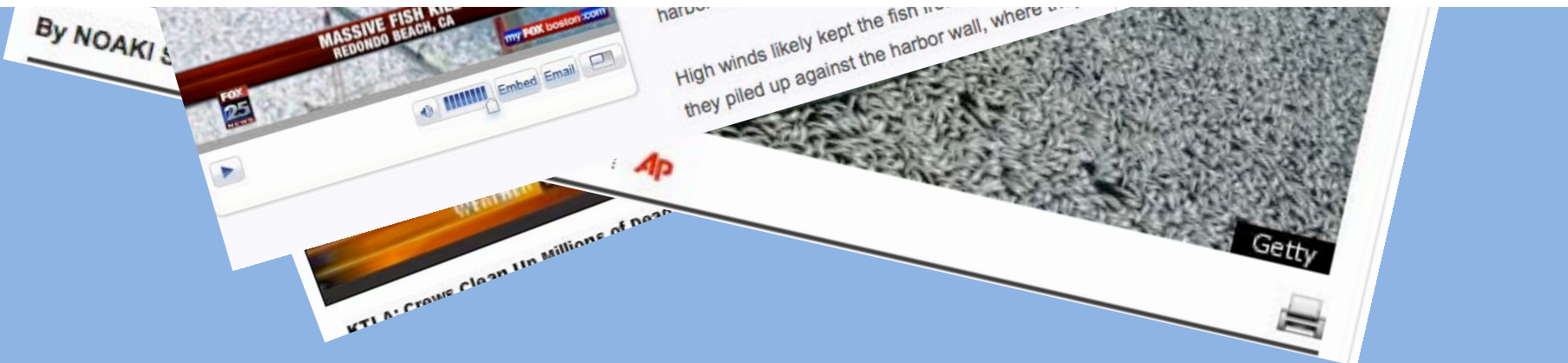




# Redondo Beach Dead Fish: Theories Abound After Millions Of Anchovies Wash Up In Harbor

First Posted: 03-9-11 02:14 PM | Updated: 03-10-11 03:10 AM

Sardines





**175 tons of Pacific sardines  
(approximately 2+ million fish)**



● Continuous-recording sensor packages: present since 2007.

Area of major impact

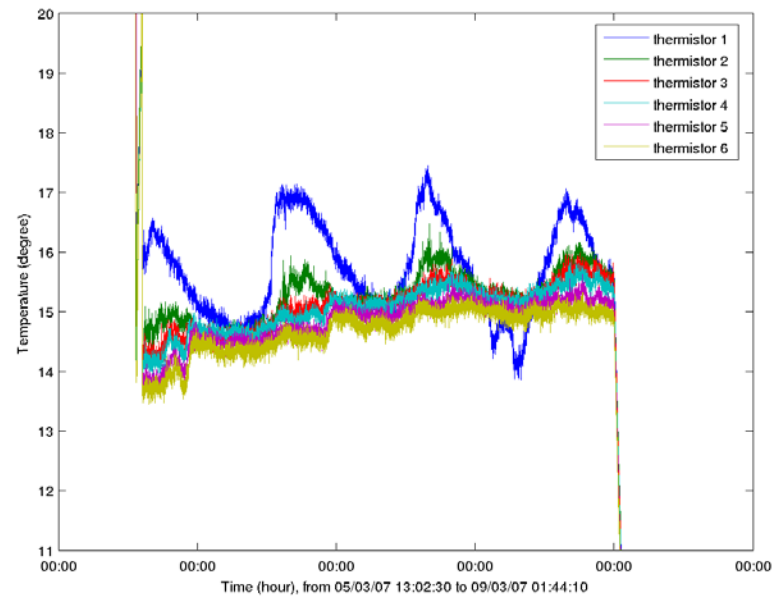
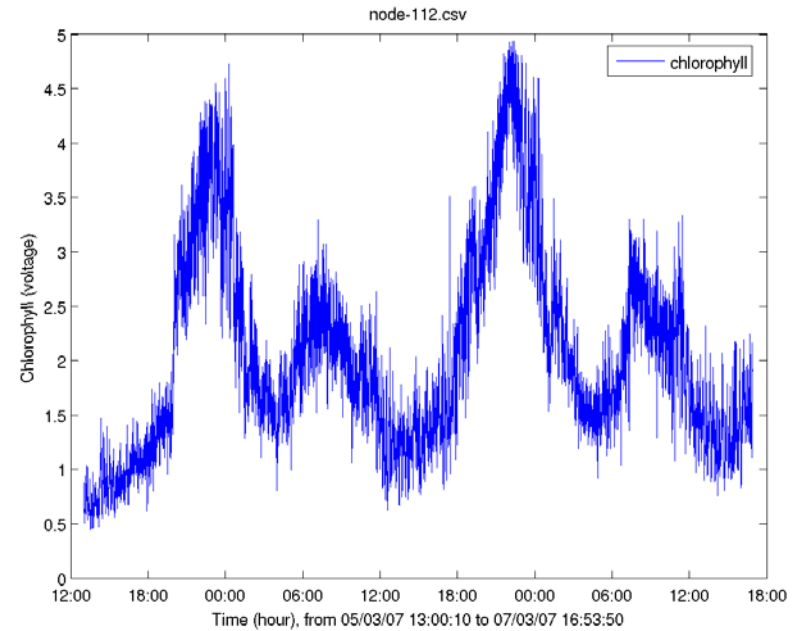


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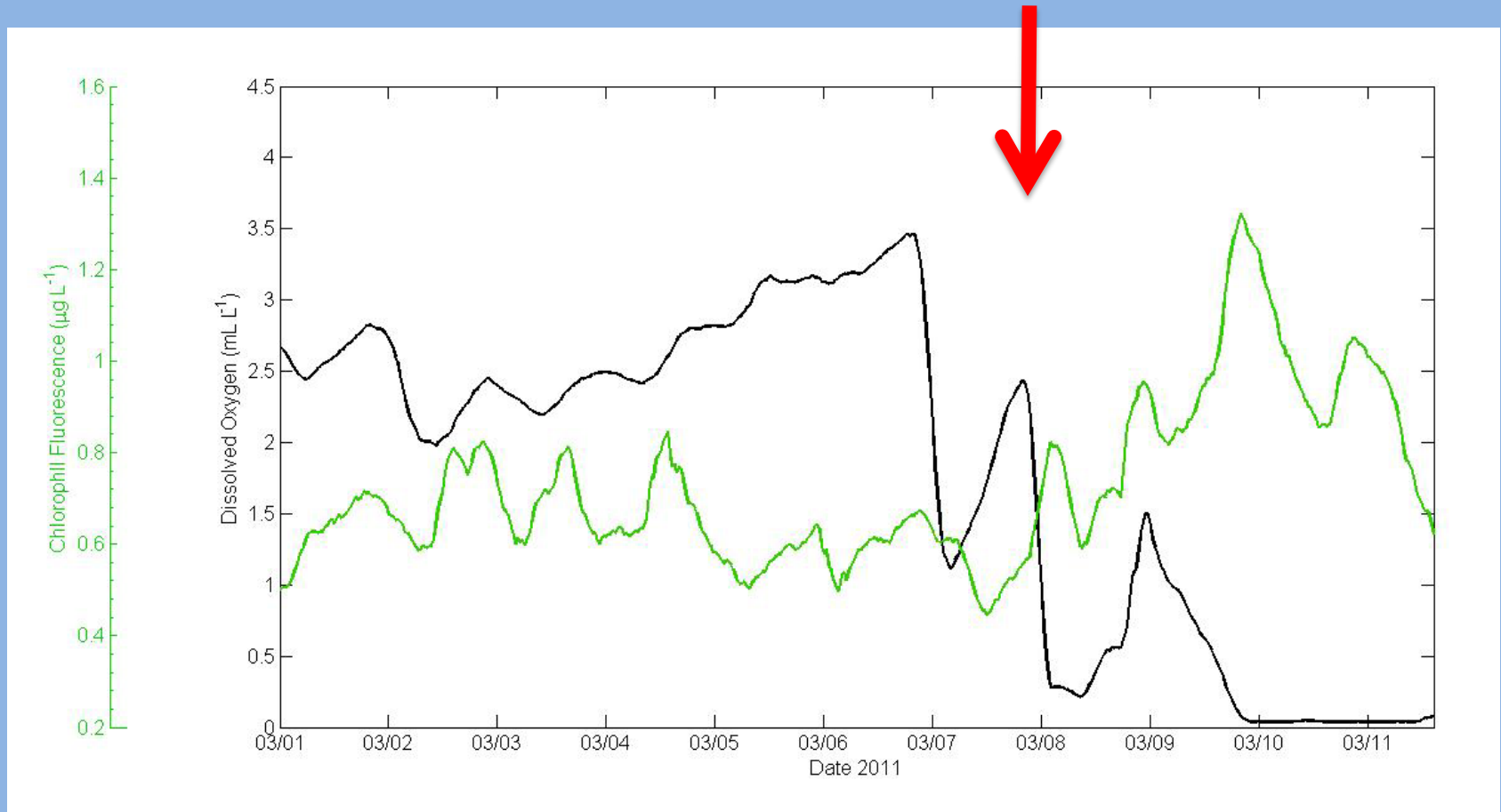
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# Networked sensor buoys



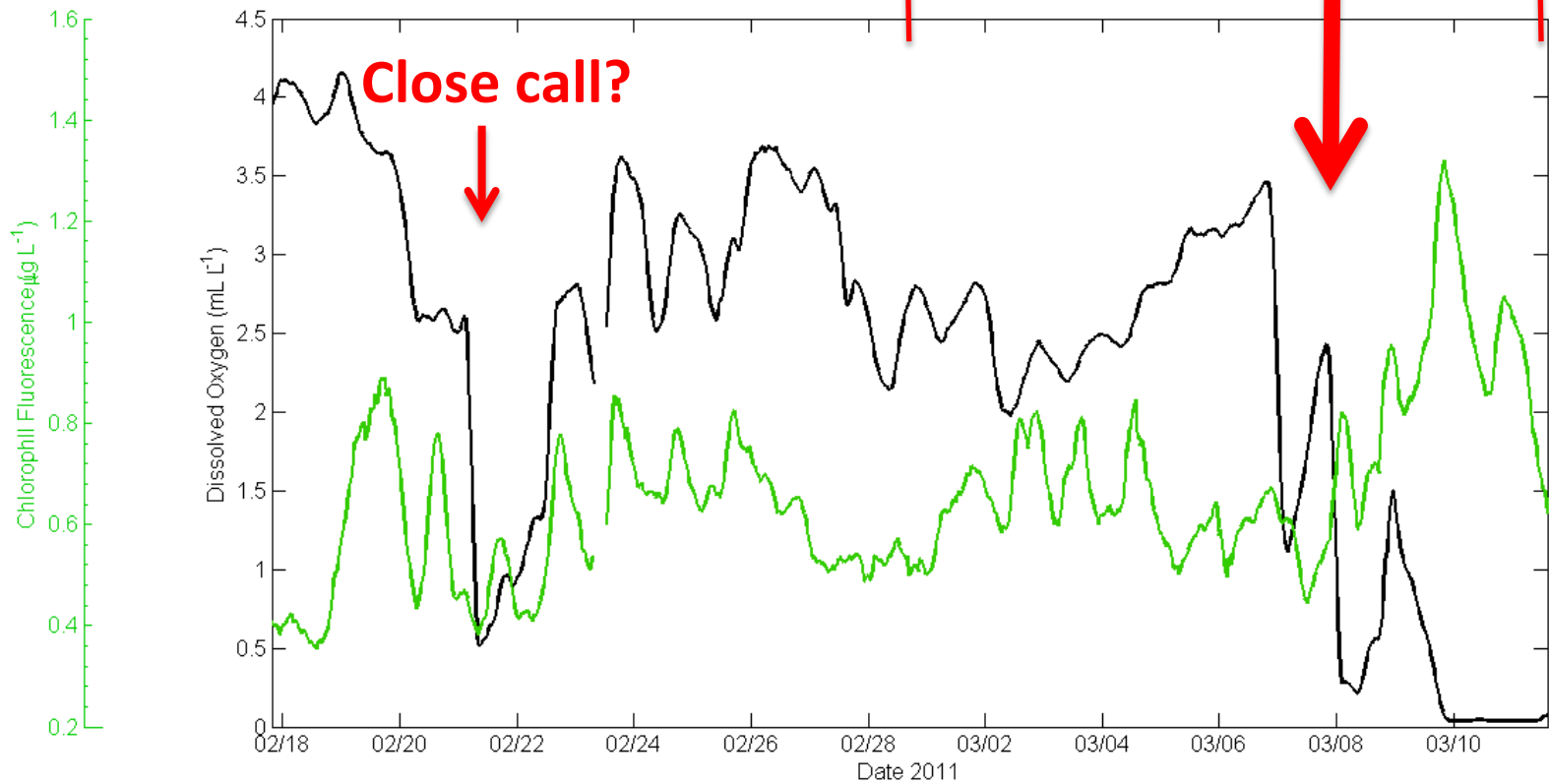
# Temporal changes in chlorophyll fluorescence (proxy for algal biomass) and dissolved oxygen





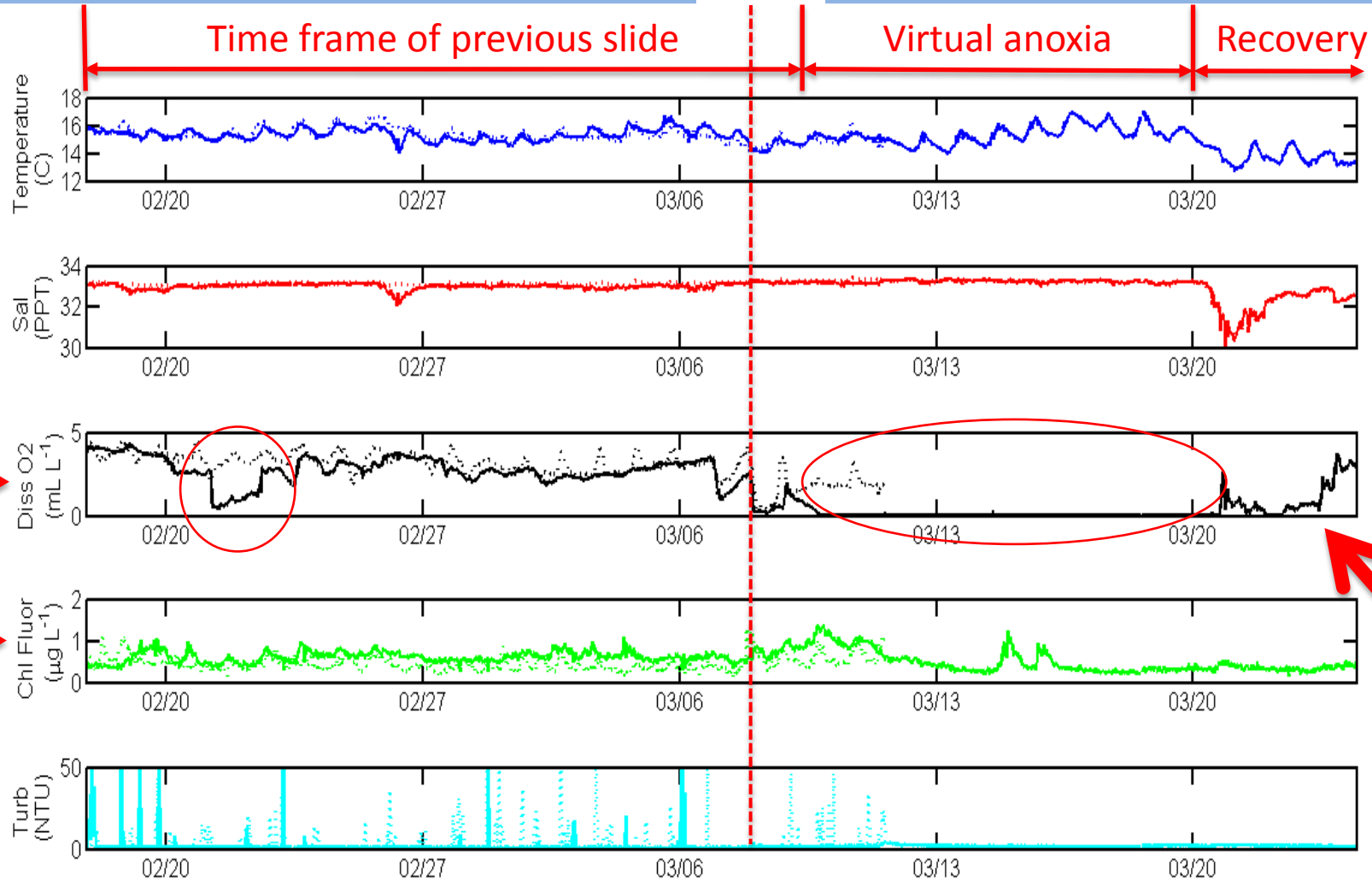
# Temporal changes in chlorophyll fluorescence (algal biomass) and dissolved oxygen

Time frame of previous slide



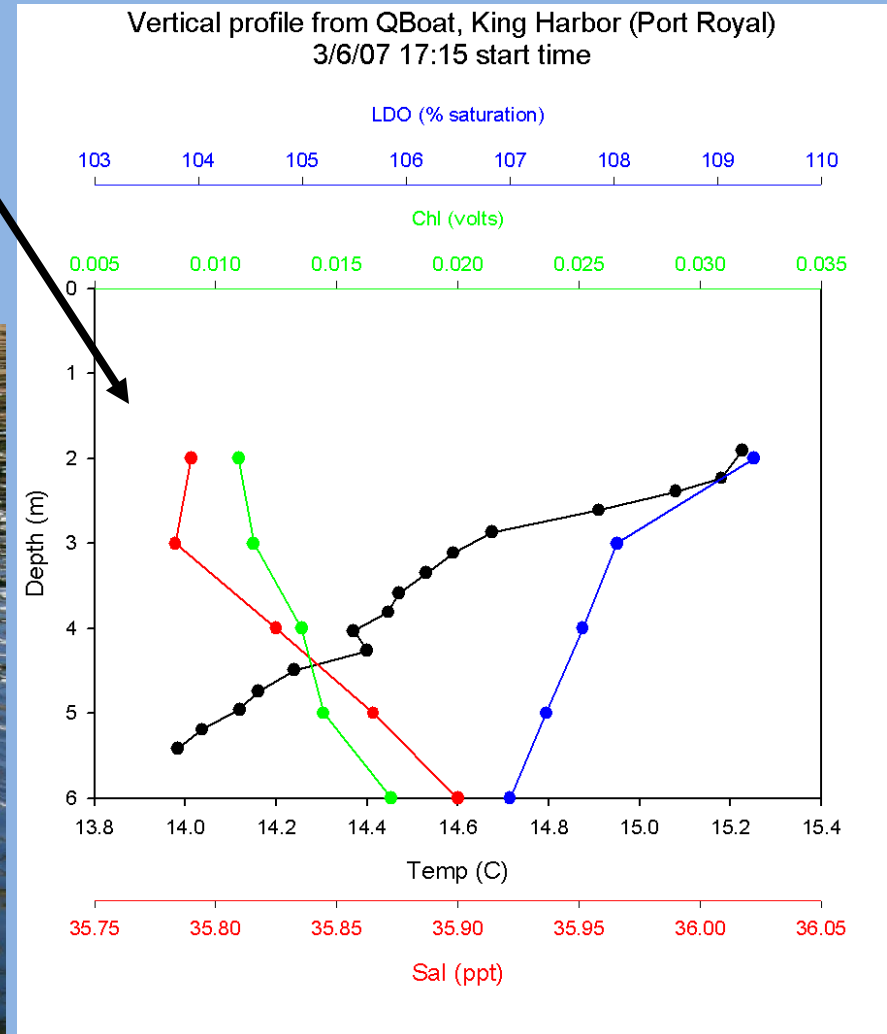
# Temporal changes in chlorophyll fluorescence (algal biomass) and dissolved oxygen

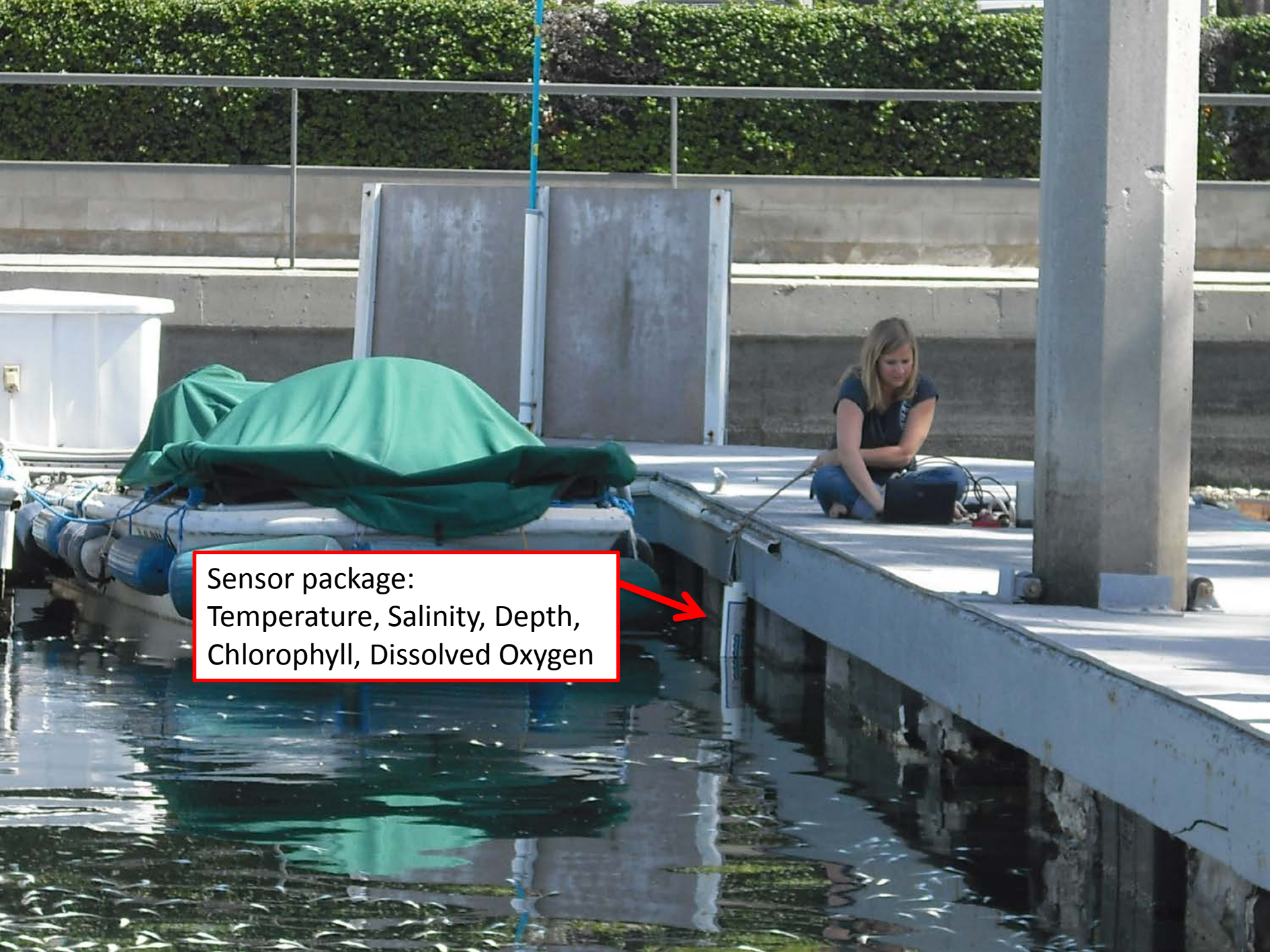
Fish kill





# Robotic boat with vertical profiling sensor package



A woman with blonde hair, wearing a dark t-shirt and jeans, is sitting on a concrete dock. She is looking down at a laptop or device on the dock. To her left, a sensor package is suspended in the water. The package is covered in a green tarp and has a blue buoy attached to it. A red arrow points from the text box to the sensor package. The background shows a concrete wall and a metal railing.

Sensor package:  
Temperature, Salinity, Depth,  
Chlorophyll, Dissolved Oxygen



● Sensing sites.

Area of major impact

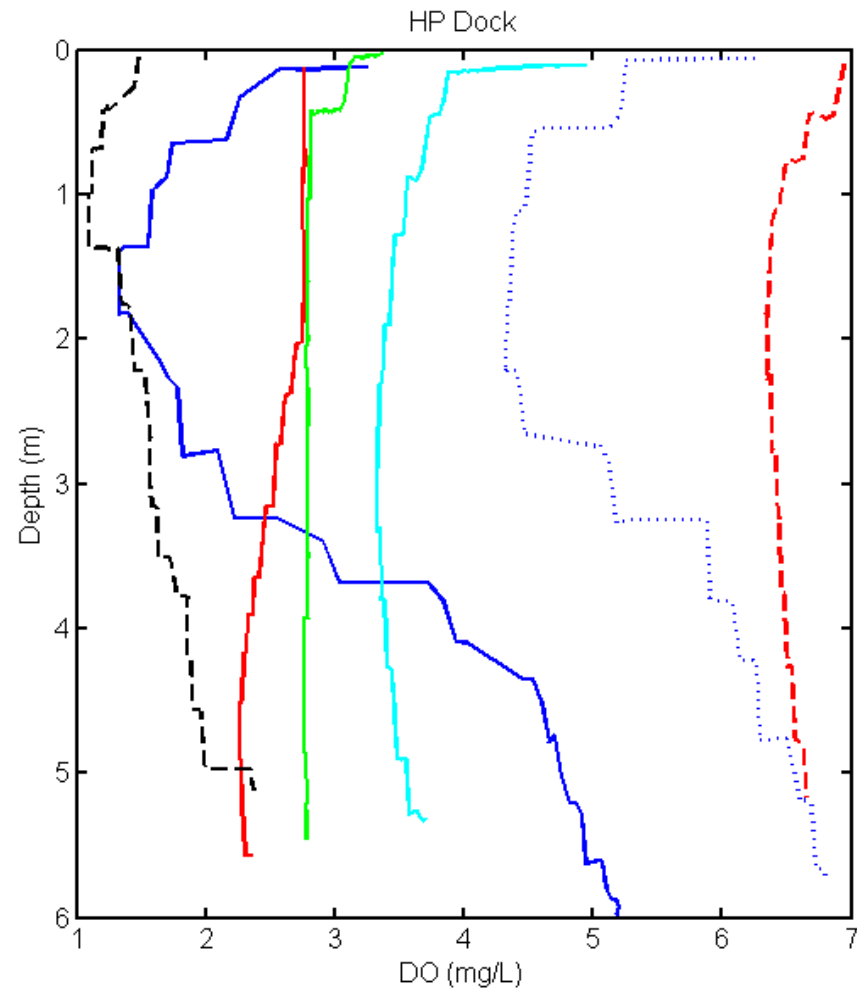
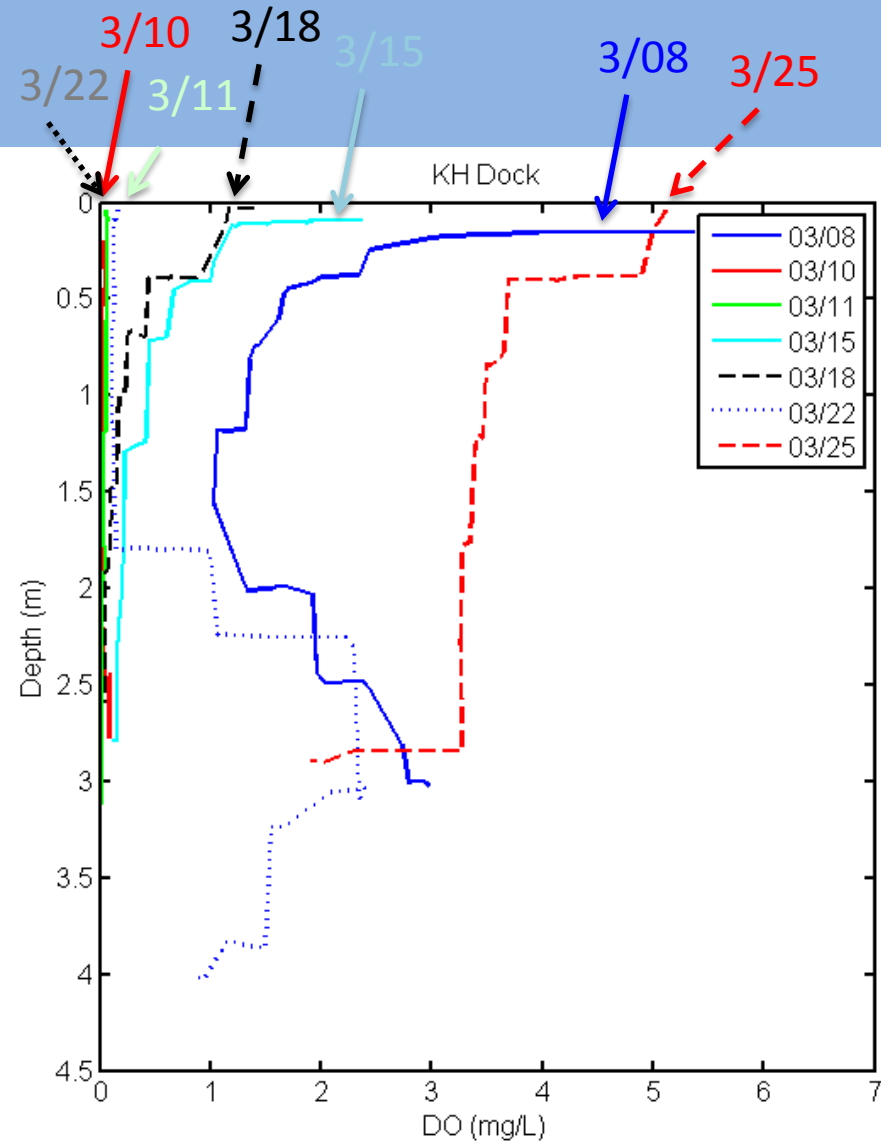
Redondo Beach

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# Vertical profiles of dissolved oxygen in King Harbor Marina and at Harbor Patrol Dock







Sensor package:  
Temperature, Salinity, Depth,  
Chlorophyll, Dissolved Oxygen, Turbidity





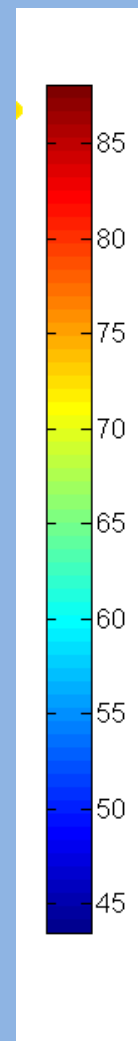
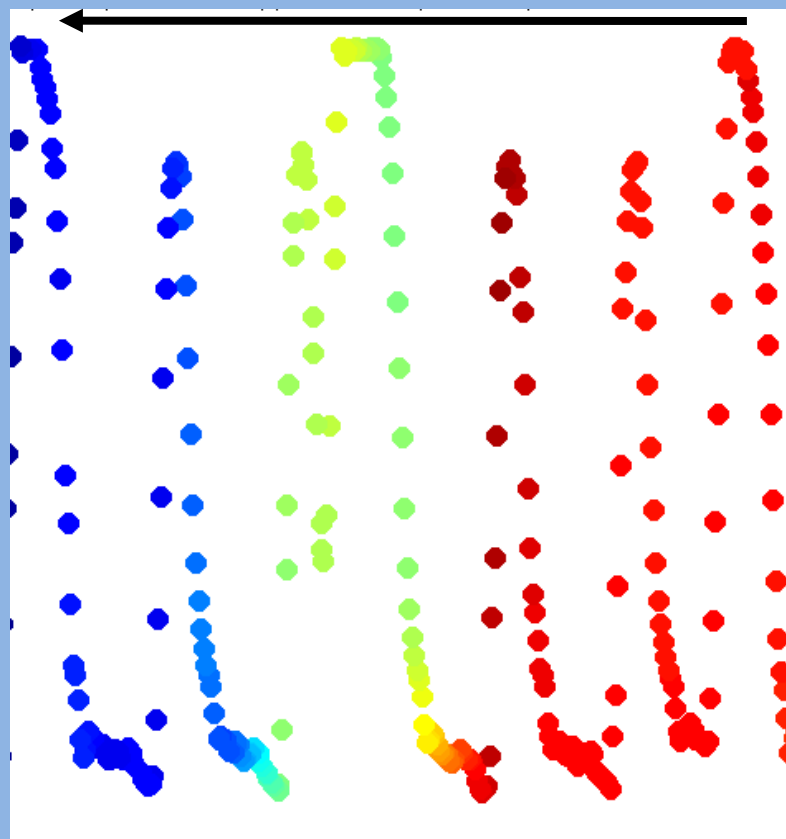




## Dissolved Oxygen (% saturation)

North

South



**175 tons of Pacific sardines in 73,000 m<sup>3</sup> with a standard respiration rate, reasonable respiration rate...**

**...O<sub>2</sub> in water could be consumed in 6-12 hrs.**

**Case closed?**

**Side story...**

**Fish stomachs contained Domoic Acid, a powerful neurotoxin  
Harbor waters did not!**

**(NB: composting destroyed toxin)**

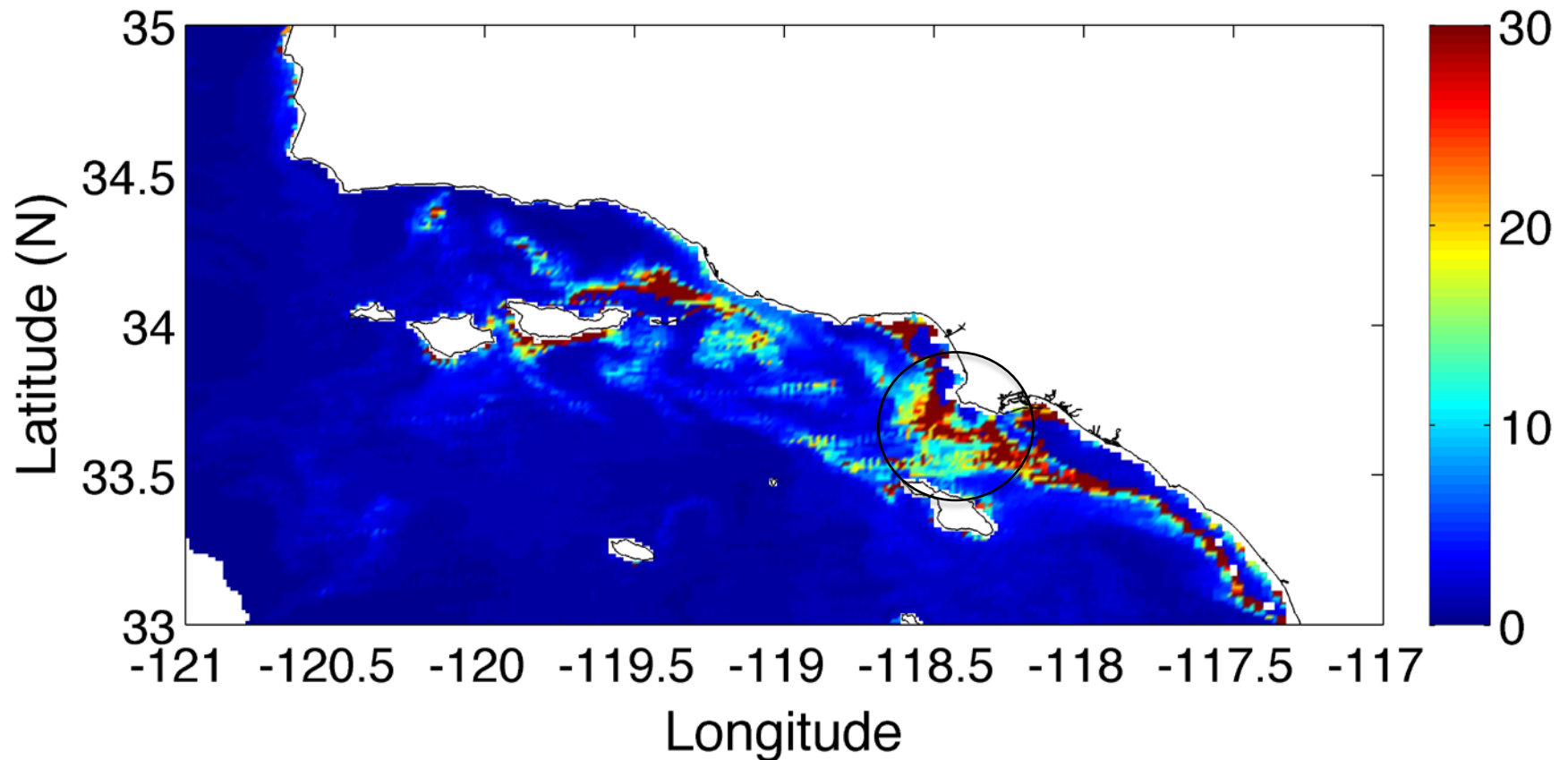




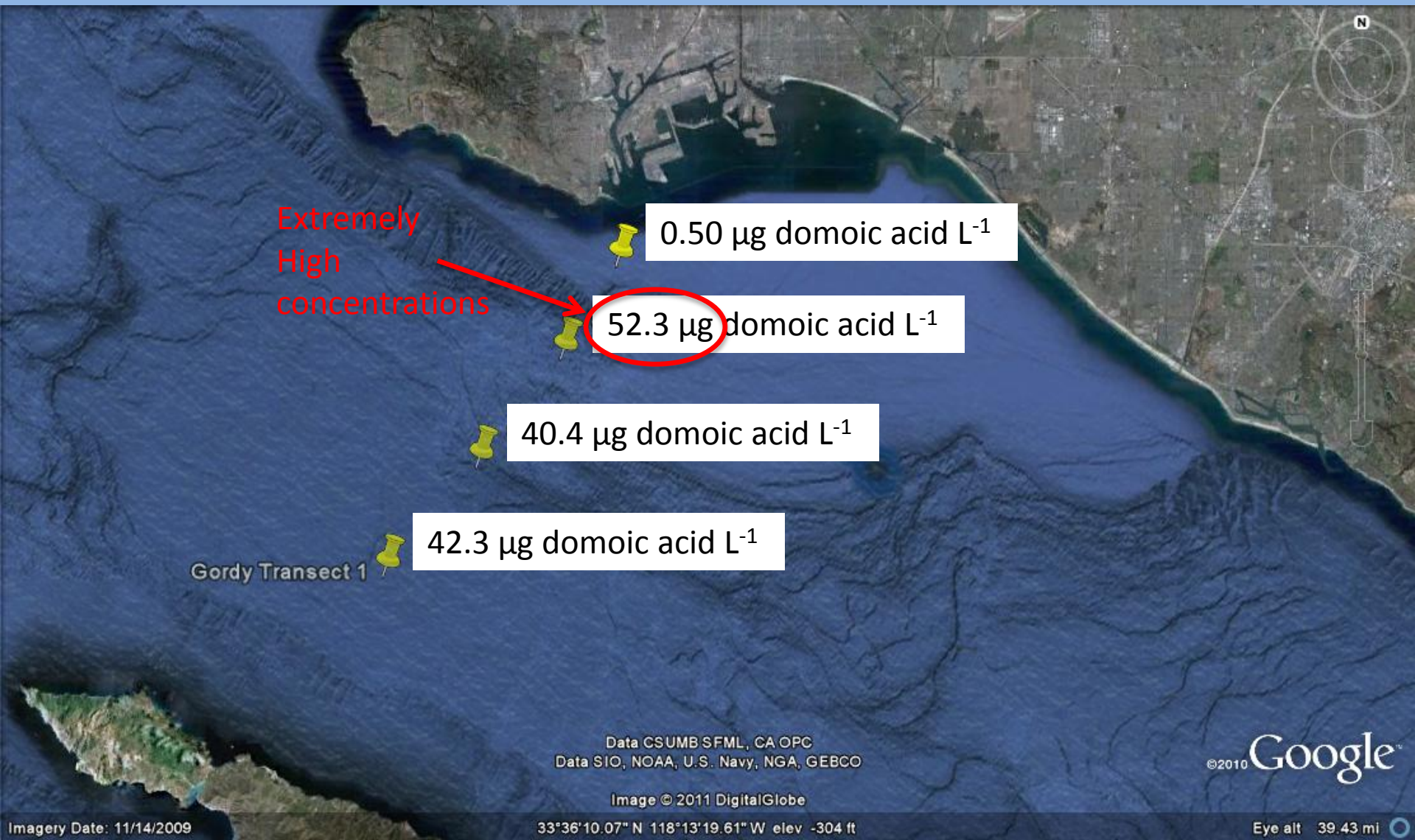
**But... no domoic acid in the harbor, no toxic algae in the harbor.**

**So, where's the toxic bloom?**

MODIS Chlorophyll [ $\mu\text{g} \cdot \text{L}^{-1}$ ] (March 8, 2011) [Source: Coastwatch]



# Take home: Problems in harbors can reflect conditions well outside the harbors.





Theory

S

## Redondo Beach Dead Fish: ~~Theories~~ Abound After Millions Of ~~Anchovies~~ Wash Up In Harbor

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Sardines



NOT a consequence of desal brine.

NOT a consequence of the power plant thermal discharge.

NOT a consequence of the March 2011 Japanese tsunami.  
(as far as we know!)

# Management Considerations

Rapid removal of dead fish *dramatically* improved the rate and degree of recovery of water quality, and probably prevented subsequent algal blooms in 2012.  
(no repeat of what happened in 2005/2006)

Long-term issue for preventing these events should probably focus on preventing precipitous drops in dissolved oxygen.

- enhanced oxygenation of water?
- enhanced flushing of the harbor?
- at the very least, response rapidly!

## Science side note:

Development and application of sensing technology  
Teased apart potential factors leading to the fish kill.





# Acknowledgments

Collaborators: Profs. Gaurav Sukhatme, Burt Jones (USC)

‘Dead Fish’ brigade:

Beth Stauffer (Ph.D. candidate)

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Erica Seubert (Ph.D. candidate)

Astrid Schnetzer (Asst Research Professor)

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Blooms (MERHAB)

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