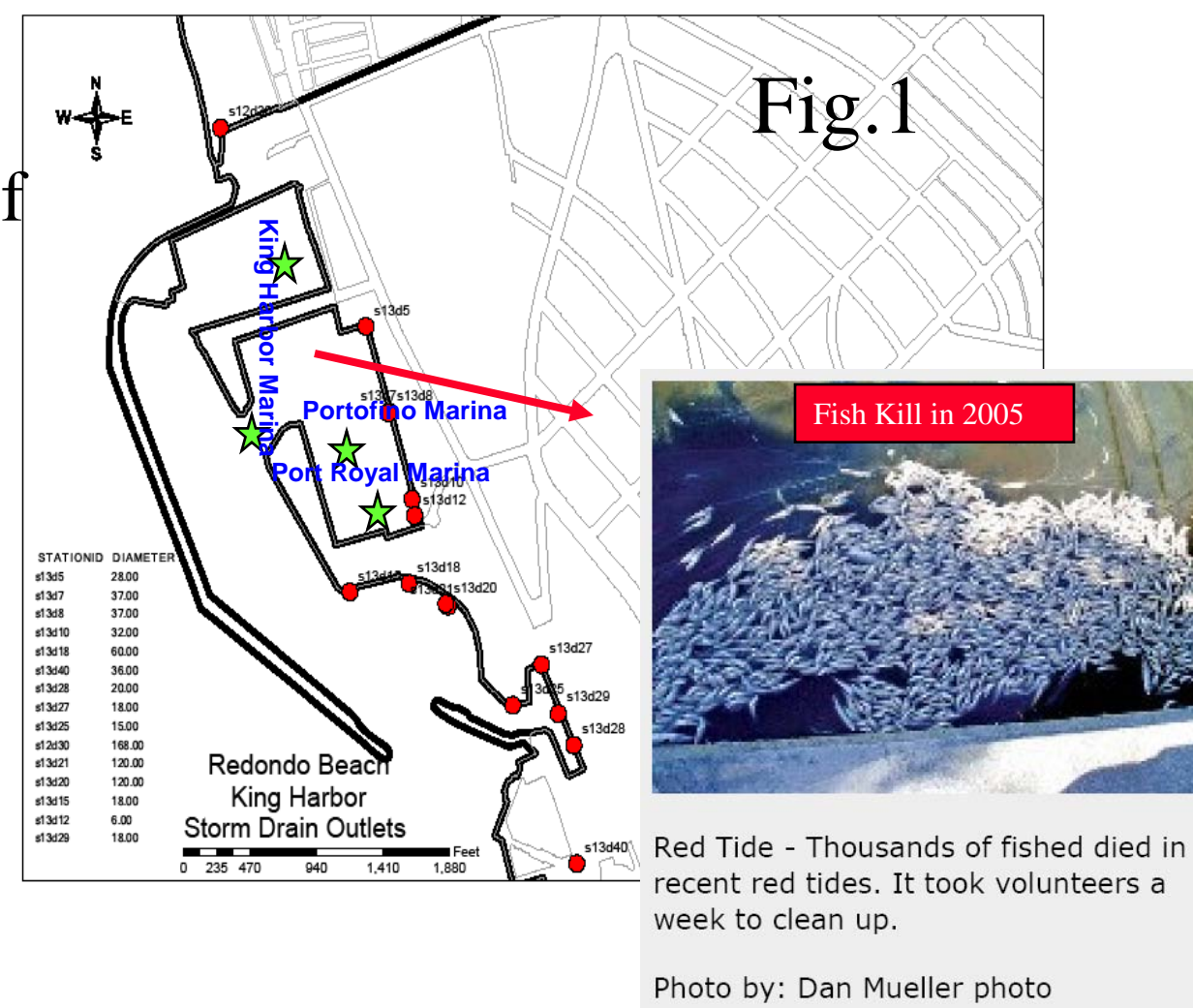


Monitoring and Detecting Harmful Algal Blooms in King Harbor, City of Redondo Beach, CA, Using a Wireless Sensor Network

Xuemei Bai, Beth Stauffer, Astrid Schnetzer, Lindsay Darjany, David A. Caron, Carl Oberg, Amit Dhariwal, Bin Zhang, Arvind Pereira, Jnaneshwar Das and Gaurav S. Sukhatme
 University of Southern California <http://robotics.usc.edu/~namos/>

Developing a Monitoring and Early Warning System for HABs

- Harmful Algal Blooms (HABs)**
 - Commonly known as red tide, which is the proliferation of nuisance algae.
 - It has significant adverse impact on environment, economy, and public health.
- HABs at Redondo Beach**
 - Blooms frequently occurred in recent years, which might be linked to the massive fish kill in 2005.
 - Several potentially harmful algal species coexisted in the harbor.



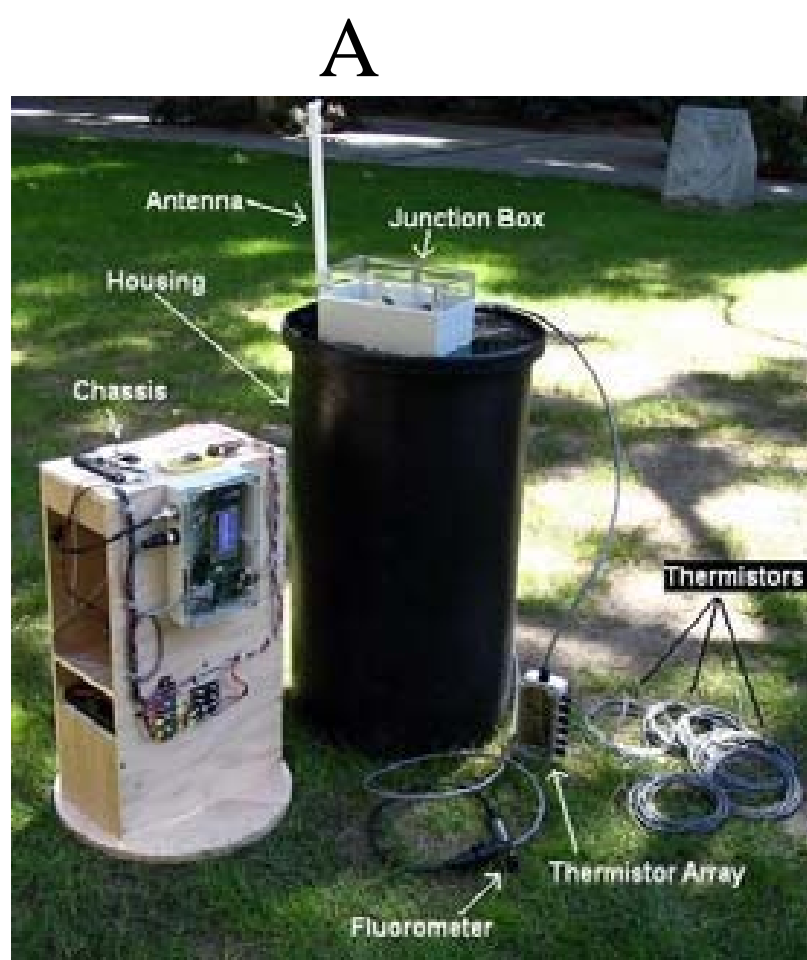
The color of water sample collected during a bloom in 2006

Questions to be addressed in King Harbor

- When and where the blooms are formed (inside or outside the harbor?)
- Solutions to avoid potential fish kill (aeration?)
- The cause of community structure change of HABs species (environmental conditions or trophic interaction).

Approach: Networked Aquatic Microbial Observing System

Static Data Acquisition Platforms



- Four Buoys were deployed at locations indicated in Fig 1.
- The buoys are wirelessly connected and equipped with sensors which allows continuous real-time data acquisition:
 - Six thermistors to monitor temperature distribution at different depths
 - A light meter to monitor light intensity
 - A fluorometer to monitor the Chlorophyll

B



- Multi-sensor equipped Sondes deployed at both surface and near bottom
- Parameters can be measured by the sensors:
 - Conductivity
 - Temperature
 - Depth
 - Chlorophyll
 - Turbidity
 - DO

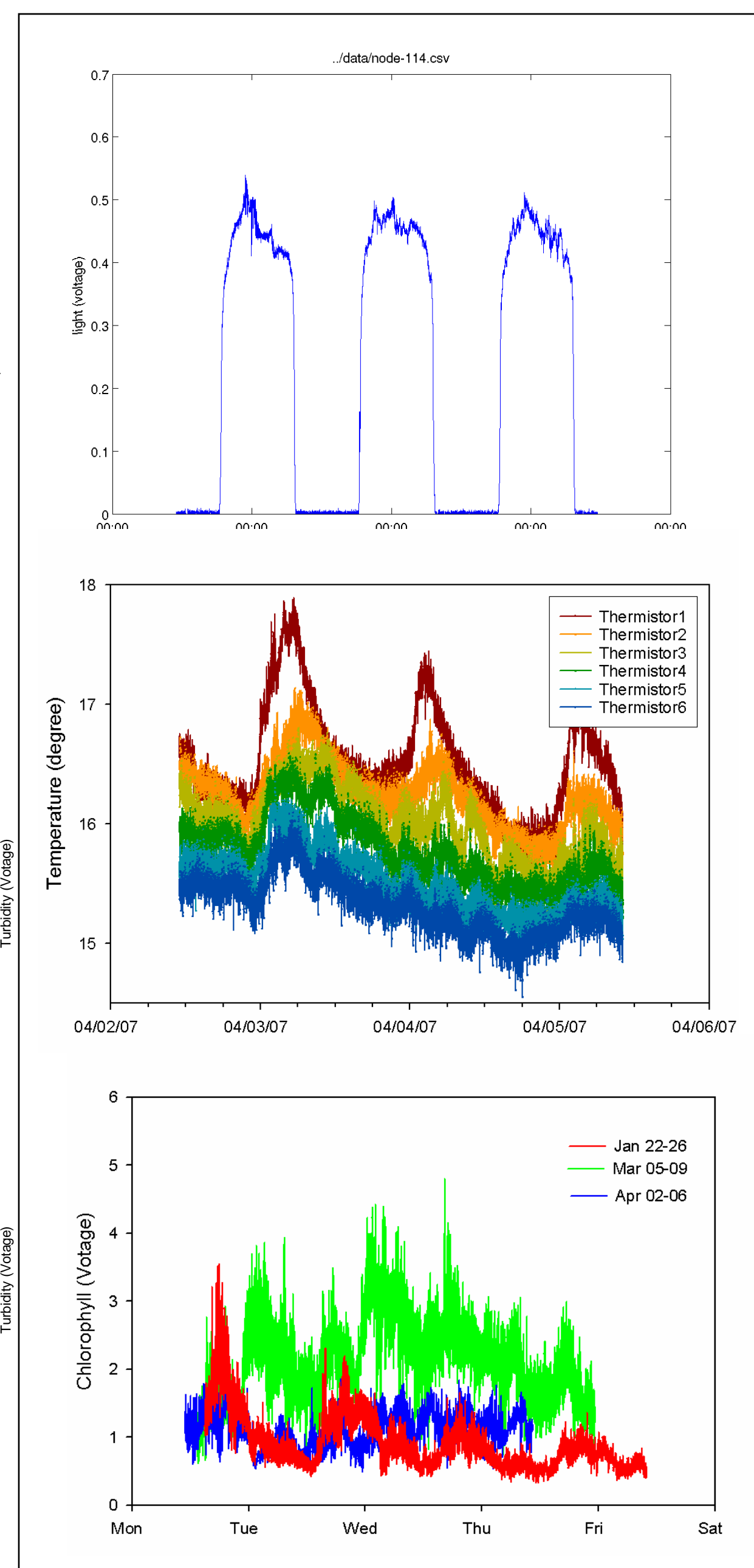
Mobile Data Acquisition System

- Autonomous navigation to desired locations based on data collected from the static sensor networks.
- Capable of vertical profiling
 - Conductivity
 - Temperature
 - Depth
 - Chlorophyll
 - Current speed
 - Current direction

Results: Data From Both Networked Sensors and Lab Experiments

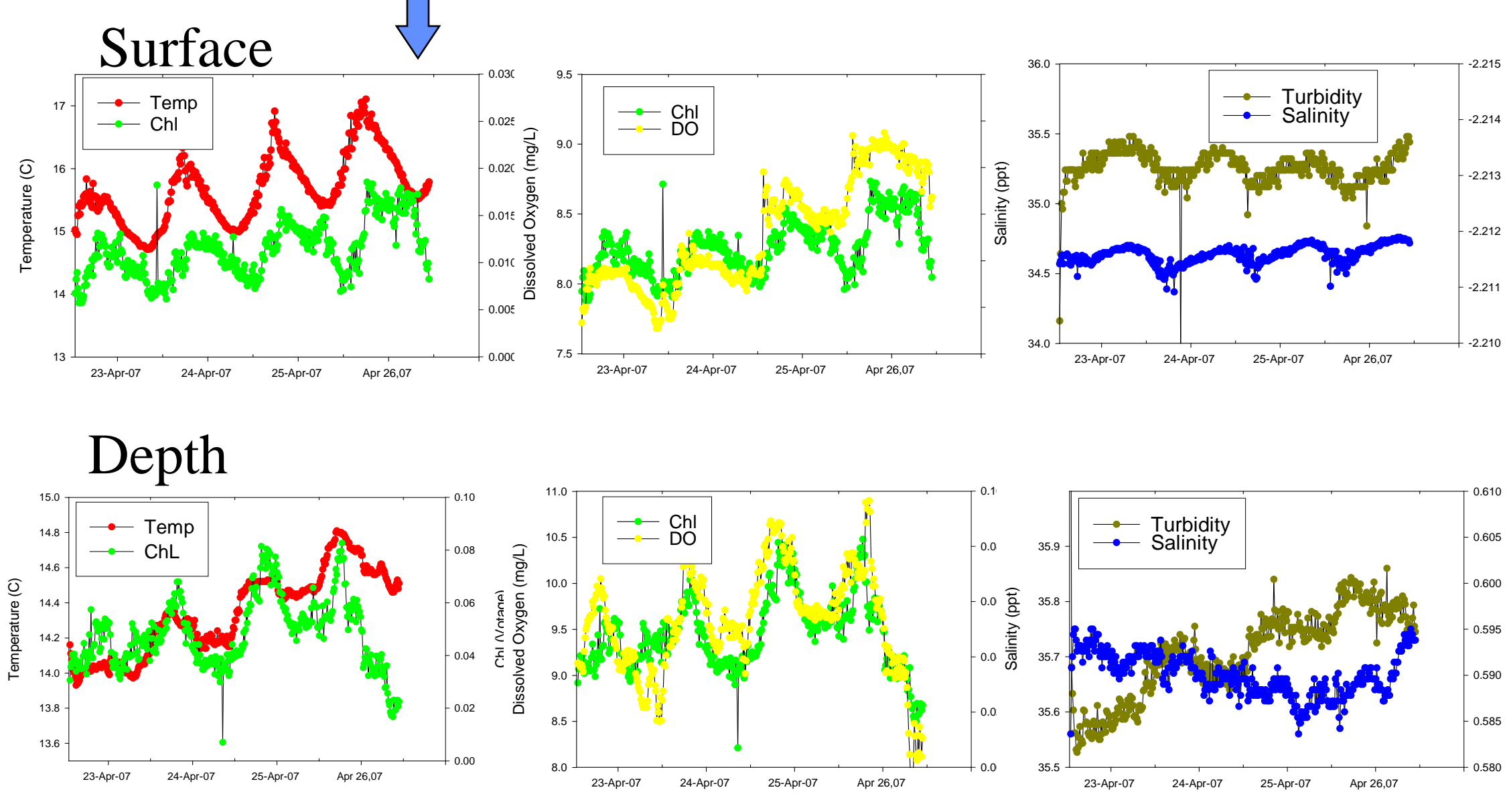
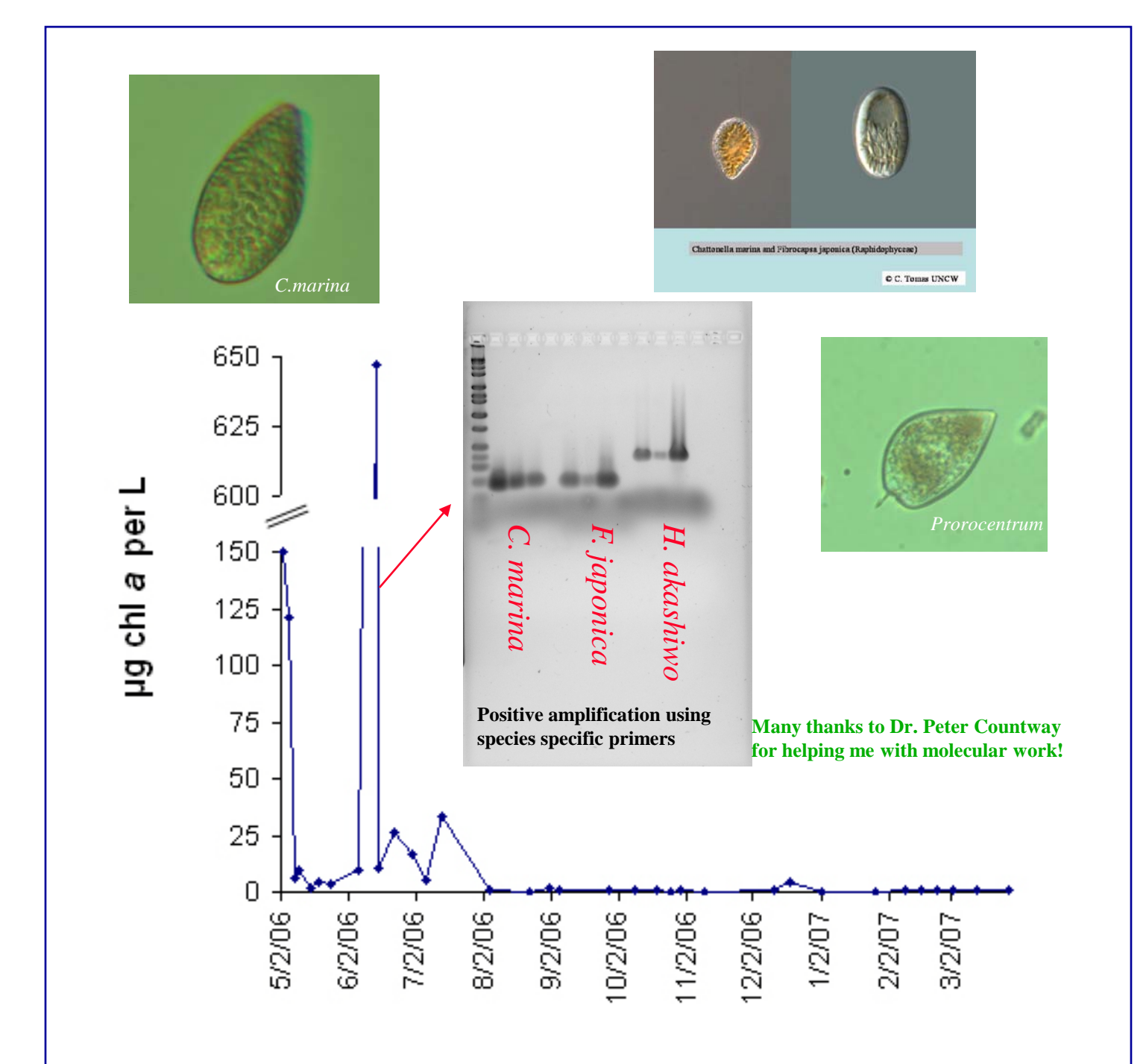
Multi-platform Monitoring

- Continuous data collection from surface and near-bottom Sondes (5 days):
 - Oxygen was highly saturated and the chlorophyll concentrations indicated low phytoplankton biomass.
 - Chlorophyll levels and temperature shared similar diel patterns.
 - Changes of oxygen concentrations were closely associated with changes in chlorophyll.
 - Salinity and turbidity measurements indicated depth-dependent differences.
- Physical and biological data were successfully collected during multiple deployments at various locations to characterize the harbor waters.
 - For instance, depth gradients of temperature were documented and chlorophyll dynamics during non-bloom conditions were characterized (January, March and April).



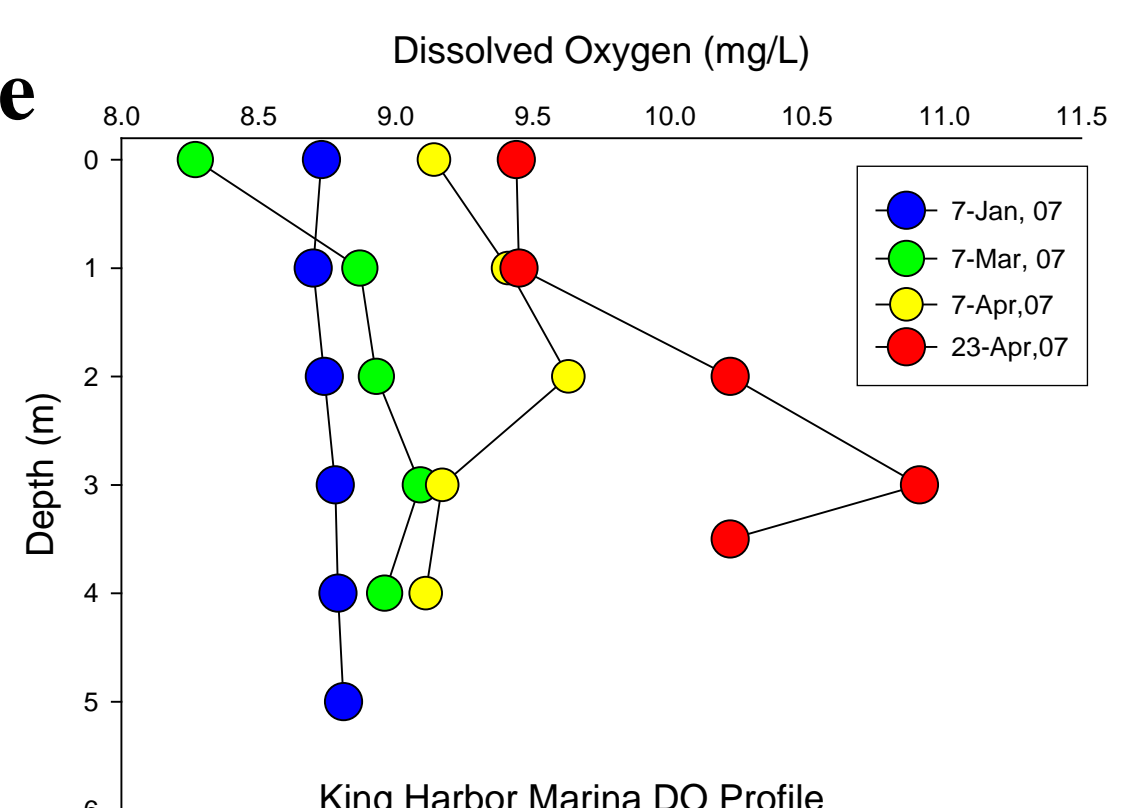
Laboratory Experiments

- Tremendous changes in chlorophyll during bloom events in early 2006 (eg: June 2006) were documented and during these events several dominant species were identified using microscopy and species specific molecular probes.
- Lab experiments are designed to examine changes in community structure of HAB species using molecular approaches (e.g shifts from dinoflagellate to Raphiophyte-dominated assemblage).



Oxygen Vertical Profile

- Measurements using a portable oxygen sensor showed an increasing trend in total DO from January to April. Furthermore, an increase in variability of DO with depth throughout deployments was detected.



Bloom-forming Species and Potential Grazers

