ENVIRONMENTAL MONITORING AND ANALYSIS

For Effects of Inhaled Florida Red Tide Brevetoxins

Richard H. Pierce, Ph.D.

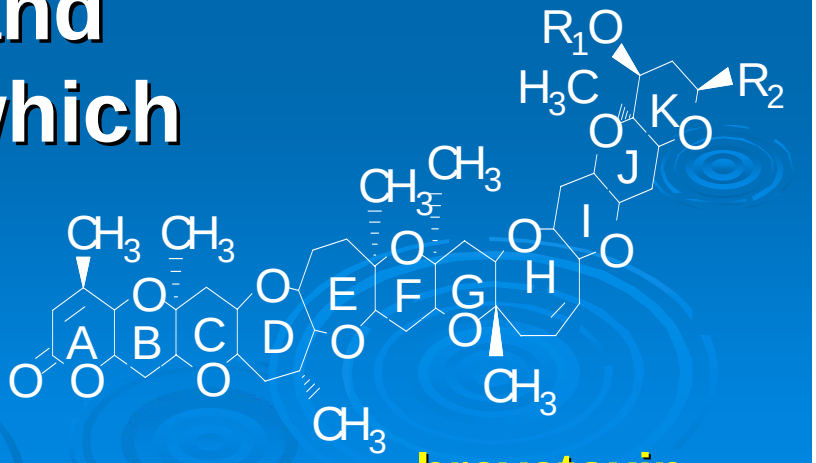
MOTE MARINE LABORATORY

Sarasota, Florida, USA

Purpose for Environmental Monitoring

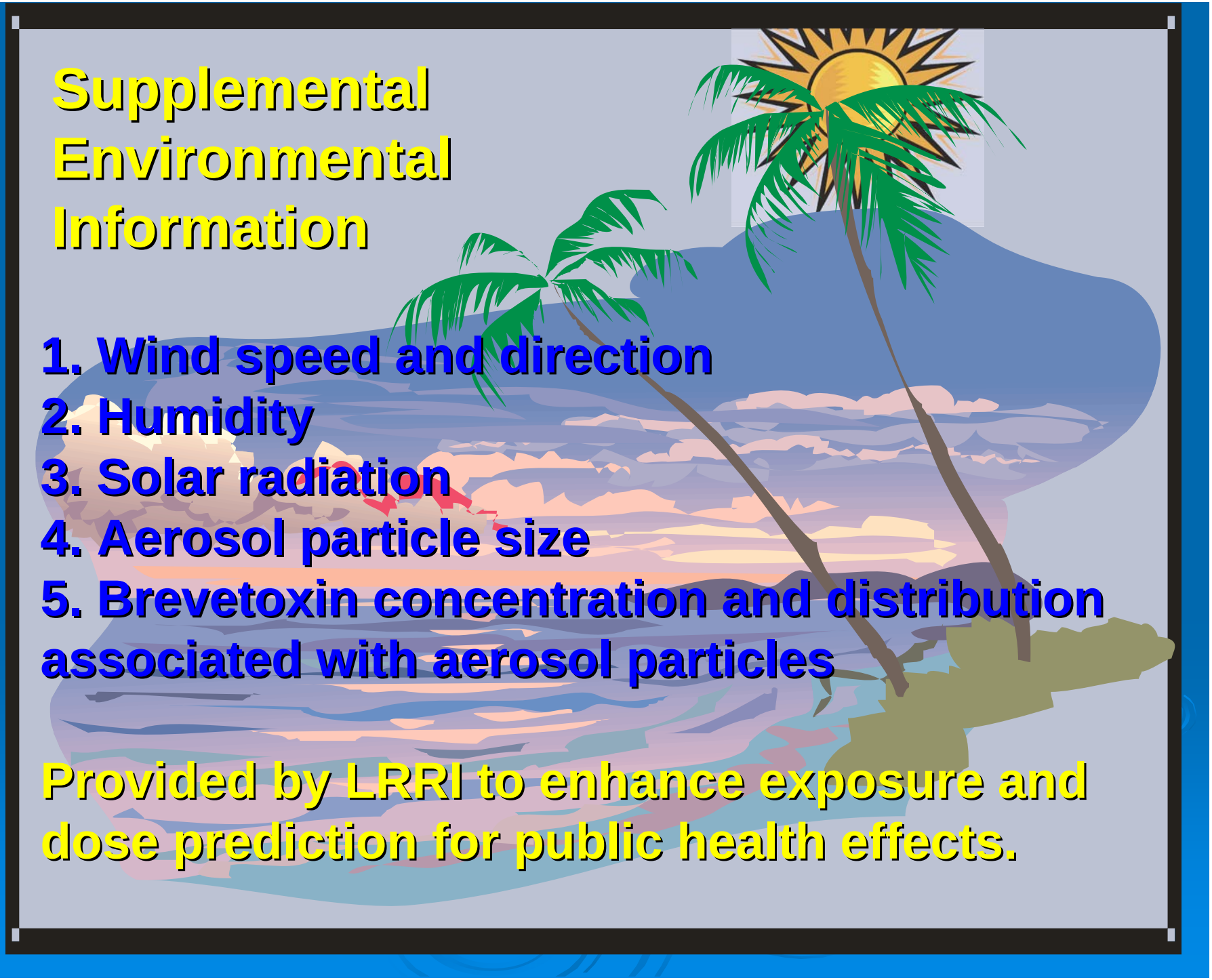
1. Determine the concentration of Red Tide cells (*Karenia brevis*) in water along the beach.

2 Determine the amount and type of brevetoxins to which subjects are exposed;



brevetoxin

Providing a cause and effect relationship for toxin exposure and observed symptoms.



Supplemental Environmental Information

1. Wind speed and direction
2. Humidity
3. Solar radiation
4. Aerosol particle size
5. Brevetoxin concentration and distribution associated with aerosol particles

Provided by LRRI to enhance exposure and dose prediction for public health effects.

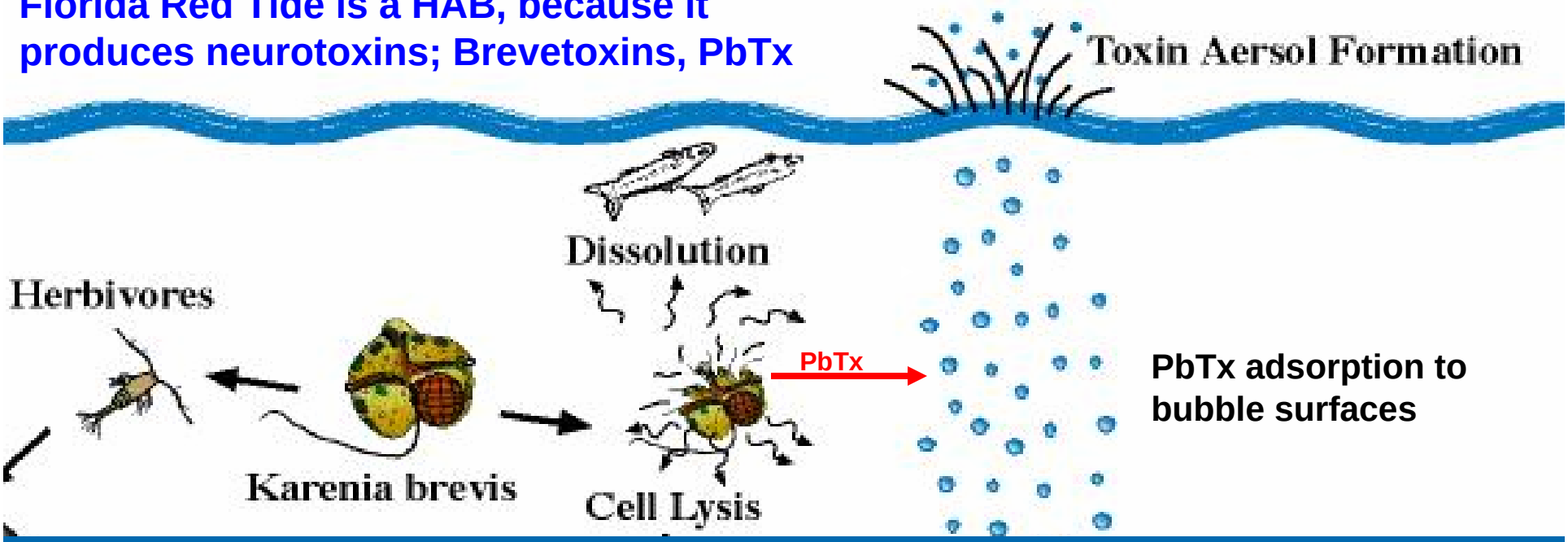
Environmental Monitoring for Aerosol Effects Studies 2005

- **February 4 – 6, 2005**
  - 3-Day Beach Exposure Study
- **February 7 -11**
  - 5-Day Inland Transect Follow-up
- **March 11 – 14, 2005**
  - 4-Day Beach Exposure Study
- **March 15 – 19**
  - 5-Day Inland Transect Follow-up

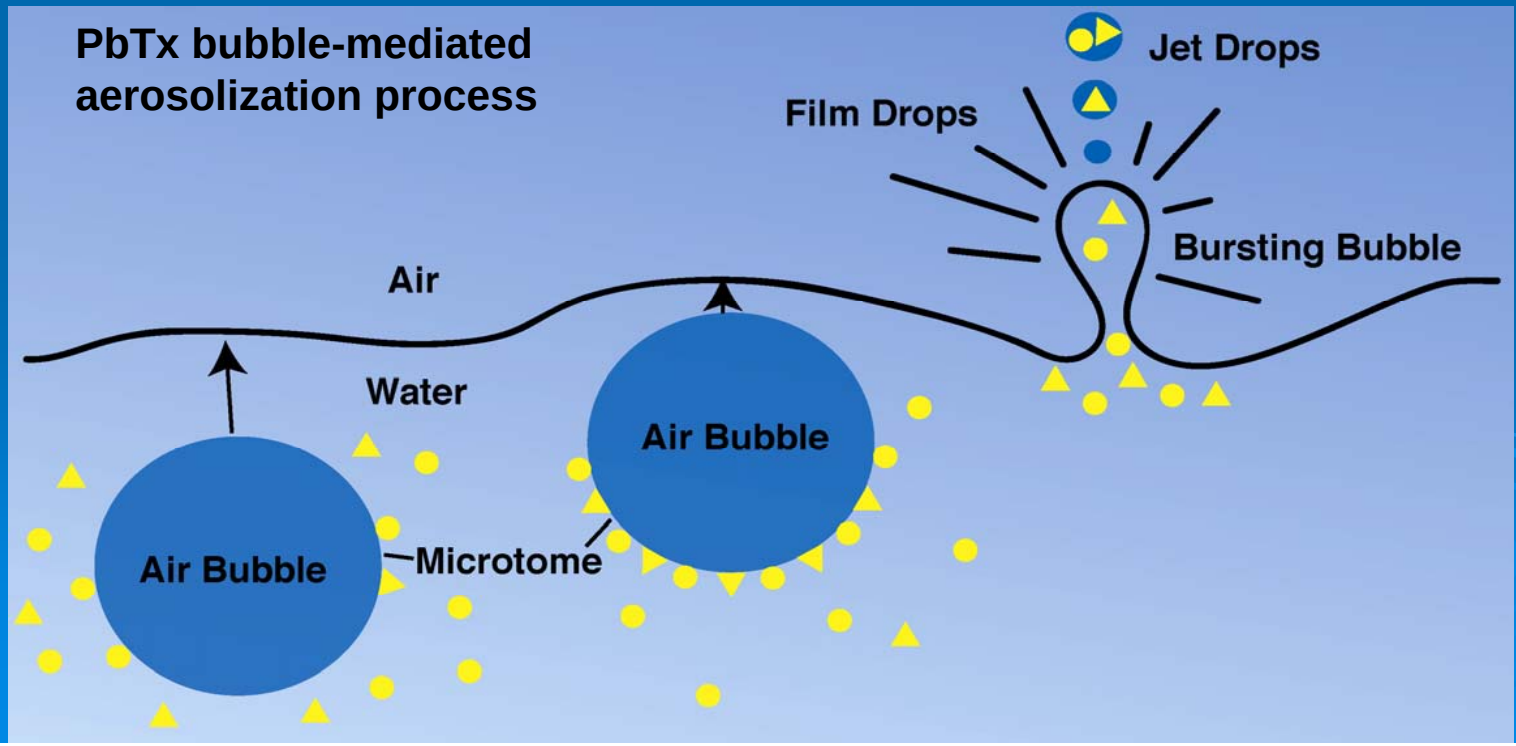
Non-Exposure Studies:

Date	Water ug/L	Air ng/m^3
10/16-10/18/04 - Beach	< 0.05	< 0.2
10/19-10/23/04 - Inland	---	< 0.2
6/16-6/18/06 - Beach	0.05 < 2,000	< 0.2
6/19-6/23/06 – Inland	---	< 0.2

Florida Red Tide is a HAB, because it produces neurotoxins; Brevetoxins, PbTx

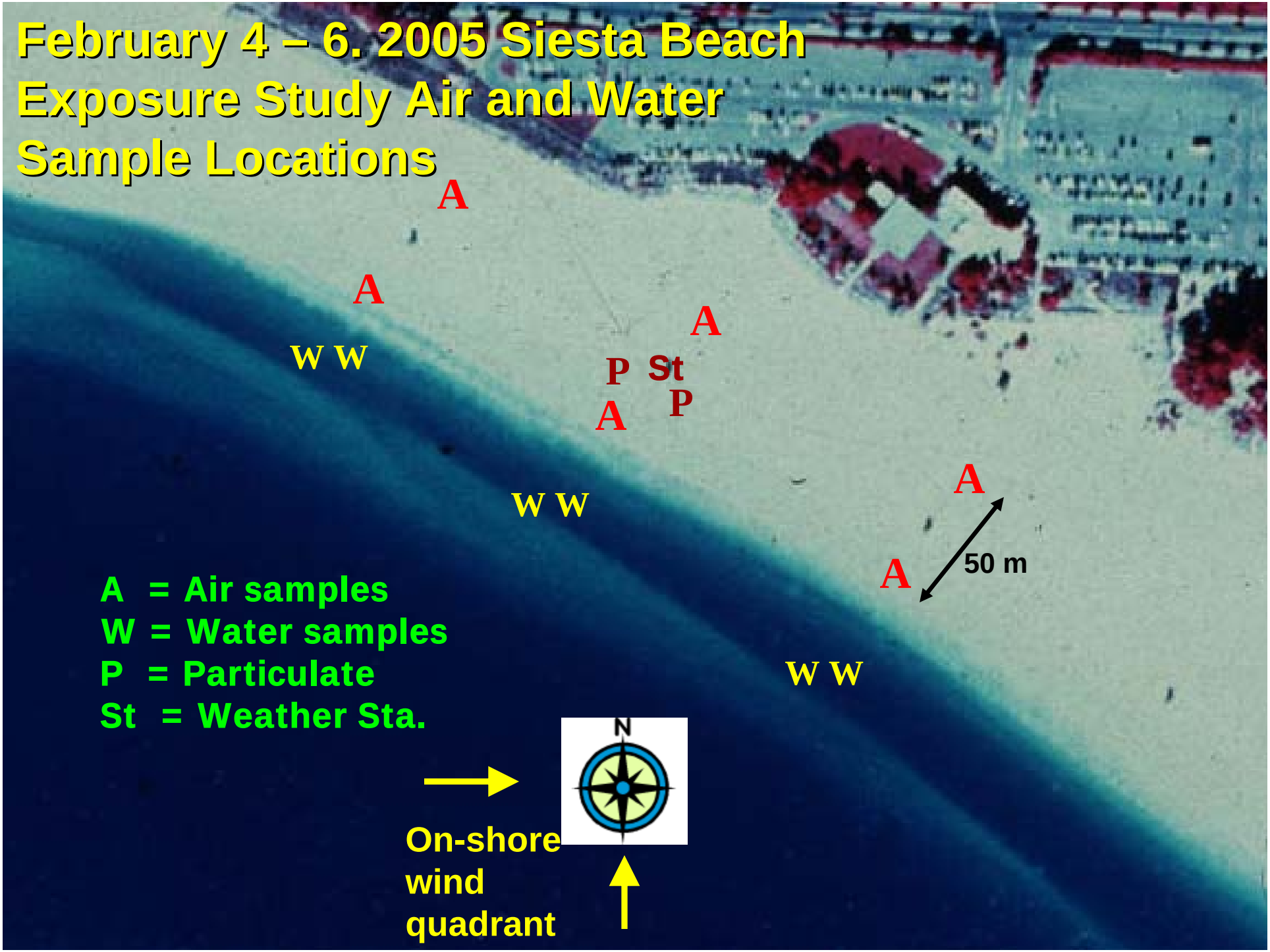


PbTx adsorption to bubble surfaces



Red Tide bloom:

Dynamic System (Patchy, moves with currents; horizontal & vertical)


February 4 – 6. 2005 Siesta Beach
Exposure Study Air and Water
Sample Locations
A
A
A
W W
P St
P
A
W W
A
A
50 m
A = Air samples
W = Water samples
P = Particulate
St = Weather Sta.
W W
N
On-shore
wind
quadrant

High-Volume Air Sampler Weather Station and Water Sampling

Water Samples:

Six, 1-L samples:
Collected 8:30AM; Noon; 4:00PM
K. brevis Cell counts
PbTx analyses; LC-MS and ELISA

Aerosol Samples:

Mote:

Six High-Vol: 9:00 AM to 12:30; 12:30 to 4:00 PM
Analyses; LC-MS and ELISA

LRRI / UNCW:

Two Hi-Vol, hourly;
One Particle-Size , All Day
Analyses; LC-MS and ELISA
Personal Air Samplers
Field aerosol particle counter
Field weather station

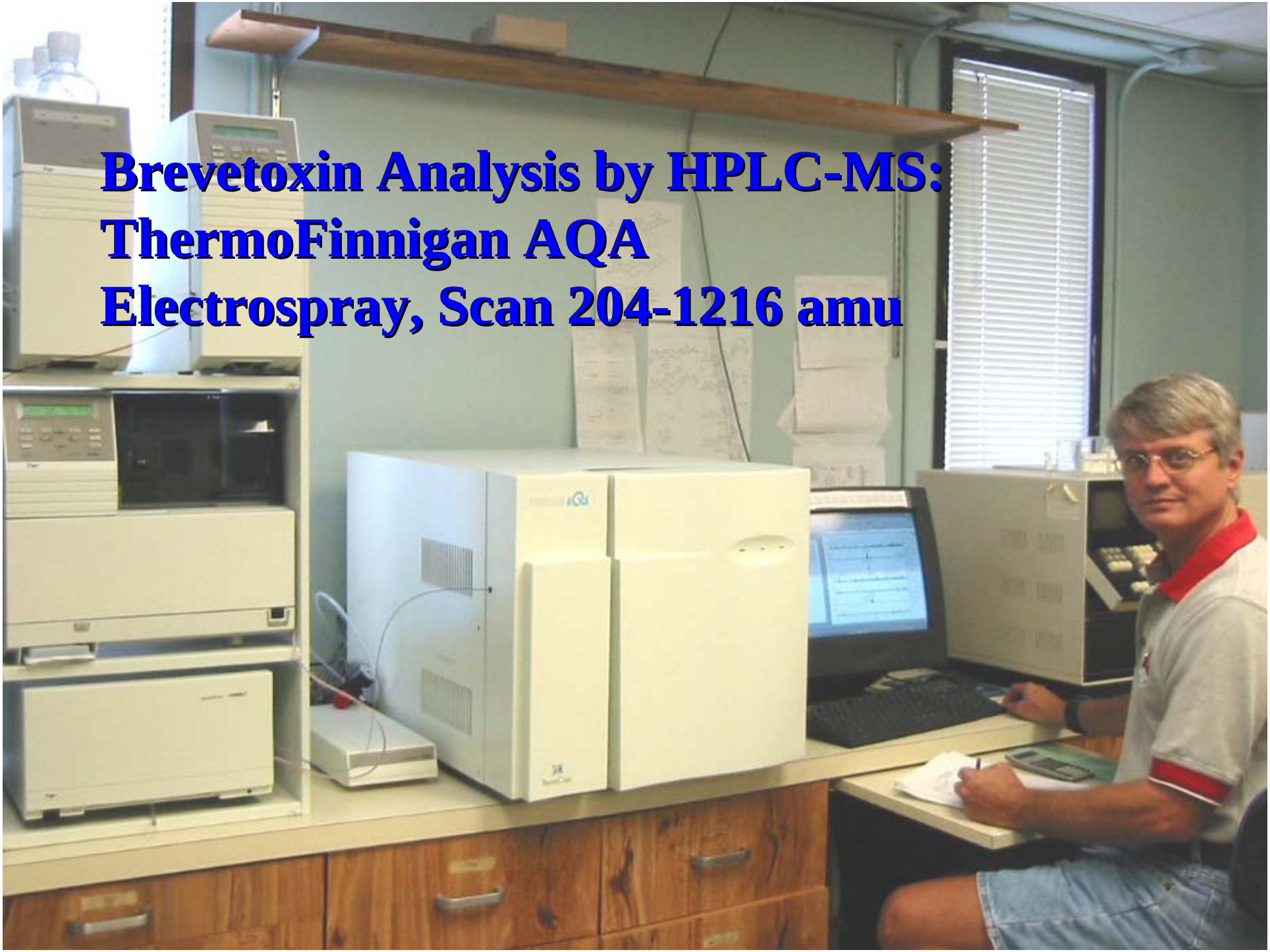
Toxin Aerosol Collection:

High Volume Air Sampler

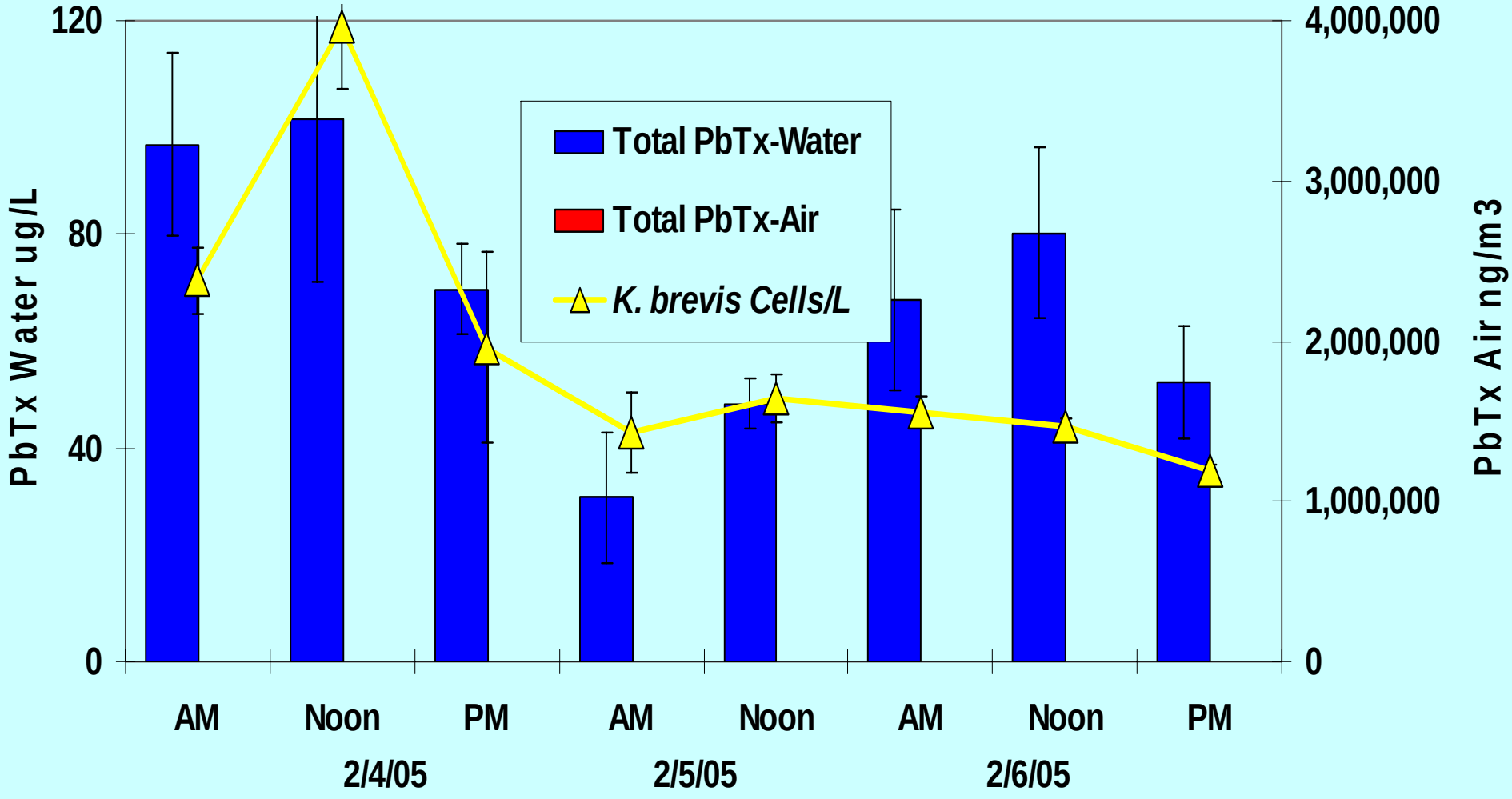
Personal Air Sampler (LRRI)

Brevetoxin recovery from water on C-18 discs

Brevetoxin Extraction from Air Filters


Brevetoxin Analysis by HPLC-MS:
ThermoFinnigan AQA
Electrospray, Scan 204-1216 amu

PbTx in Water and Air, with *K. brevis* Cells/L; February 4 - 6, 2005

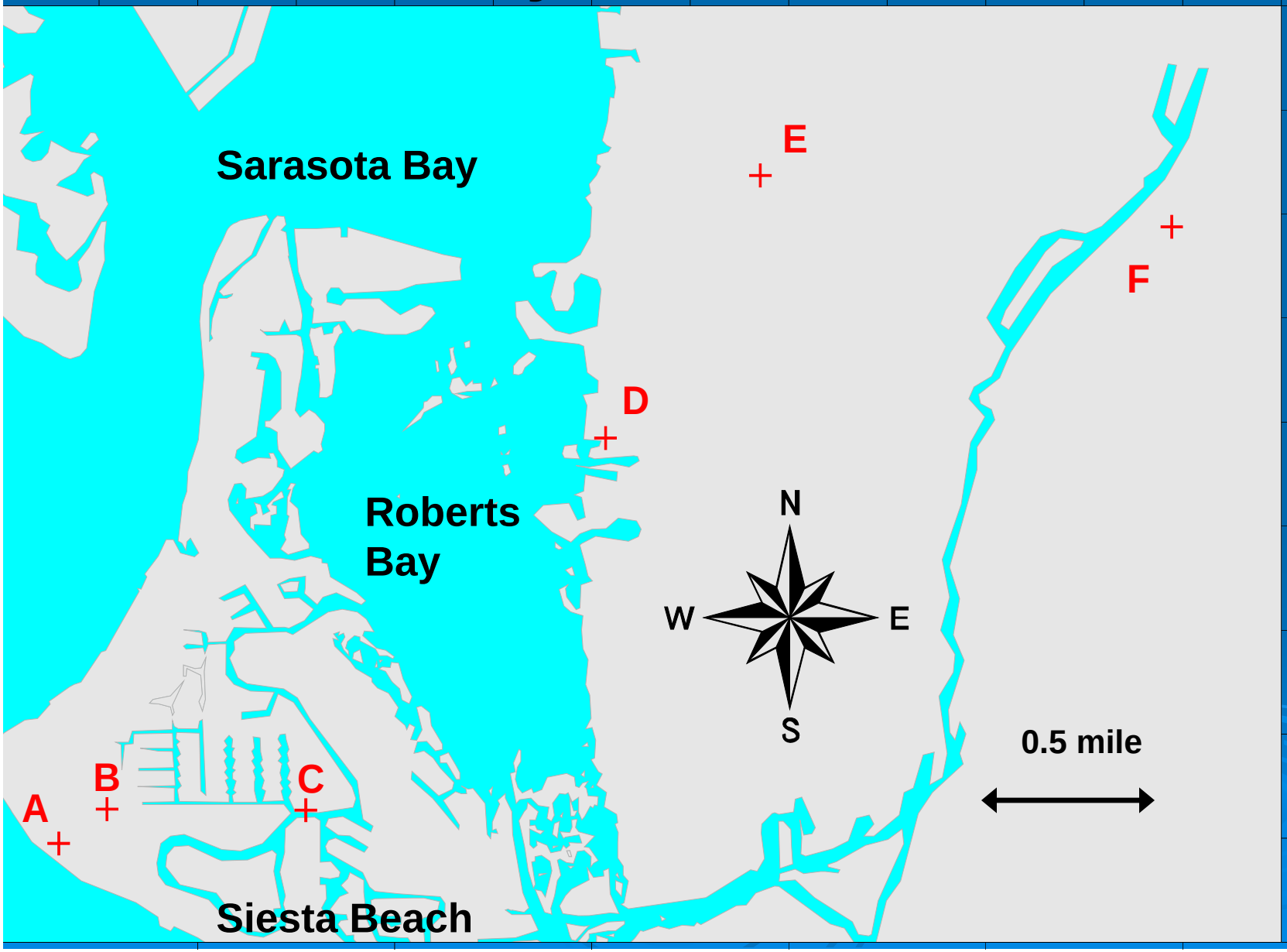


Wind: Easterly (Off-shore all three days)

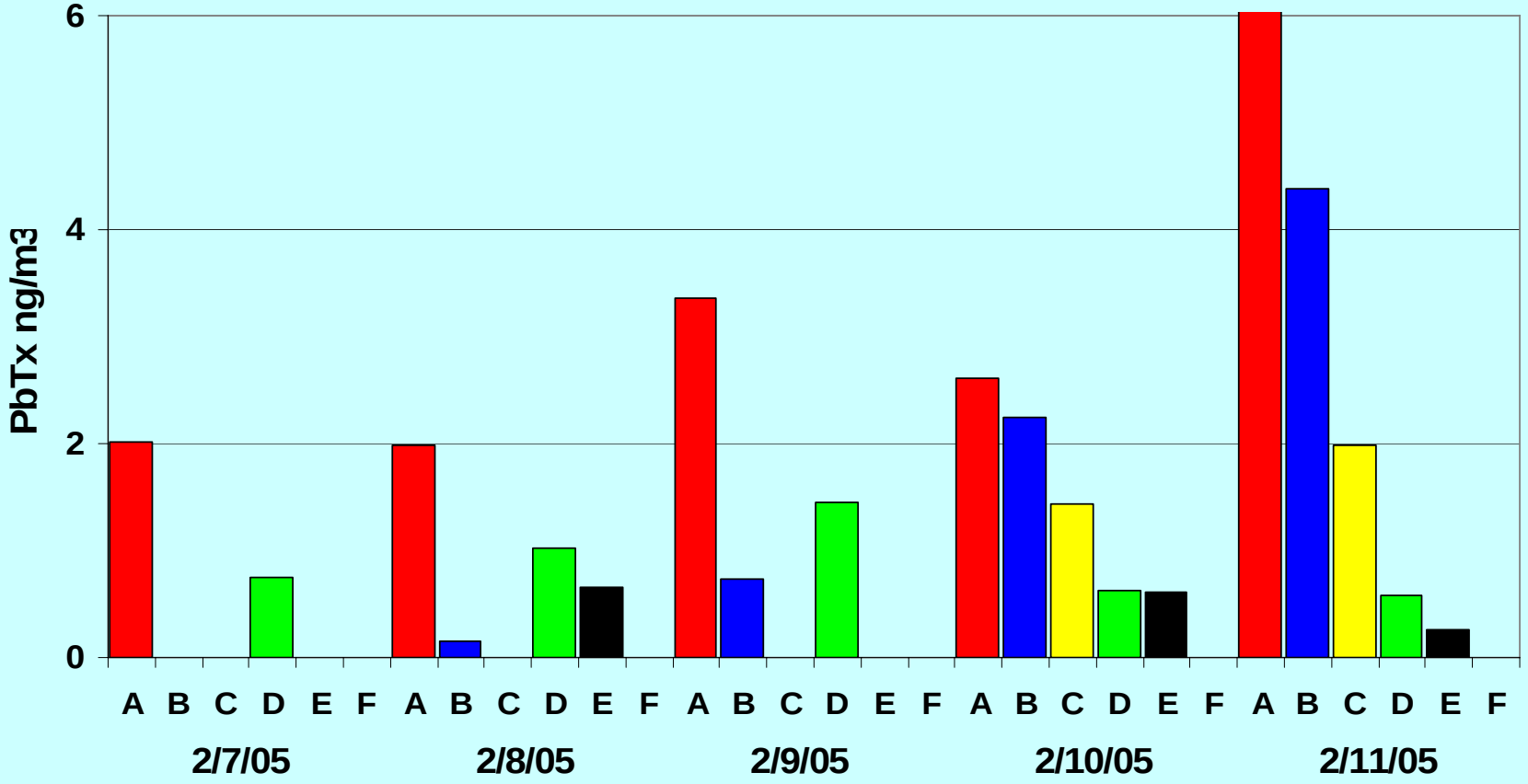
Conclusions from Beach Study February 2 – 4, 2005

1. High concentrations of *Karenia brevis* cells (1.95 ± 0.89 x 10^6 cells/L)
2. High concentration of PbTx in Water;
   (68.5 ± 24.3 ug/L Total PbTx)
3. No PbTx detected in aerosol (< 0.2ng/m^3)
   - Why? - Winds off-shore, toxins off-shore
4. Possible low-level PbTx exposure from Roberts Bay, up-wind from Siesta Beach

5-day Inland Transect Stations
February 7 – 11, 2005



Total Pbtx in Aerosol at Inland Transect Sites; February 7 - 11. 2005



Wind: Direction / Speed (mph)

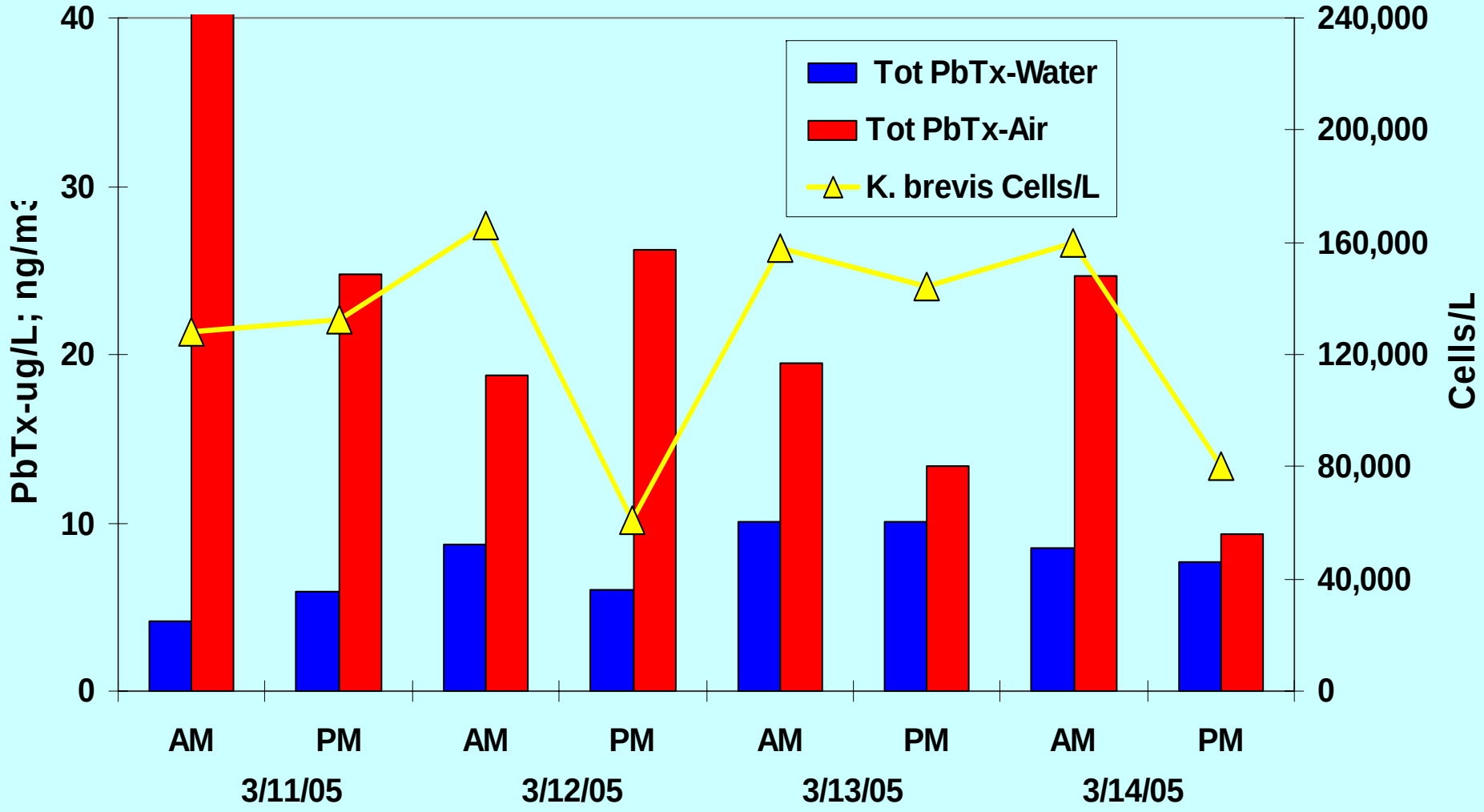
AM:	**Off / 8-10**	**Off / 2-6**	**Varr / 2-14**	**On / 14-27**	**On / 19-29**
PM:	**On / 12-16**	**On / 10-16**	**On / 8-14**	**On / 24-34**	**On / 24-30**

Results; 5-day Inland Transect, 2/7/05 – 2/11/05

- Continued Exposure away from the beach
- Diminished with distance from source
  - Detected up to 0.5 miles from source water (Gulf and/or Bay)
- Varied with wind speed and direction

March 11 – 14. 2005
Siesta Beach Exposure Study

Total PbTx in Water and Air, with K. brevis cells/L; Siesta Beach Study March 11-14, 2005

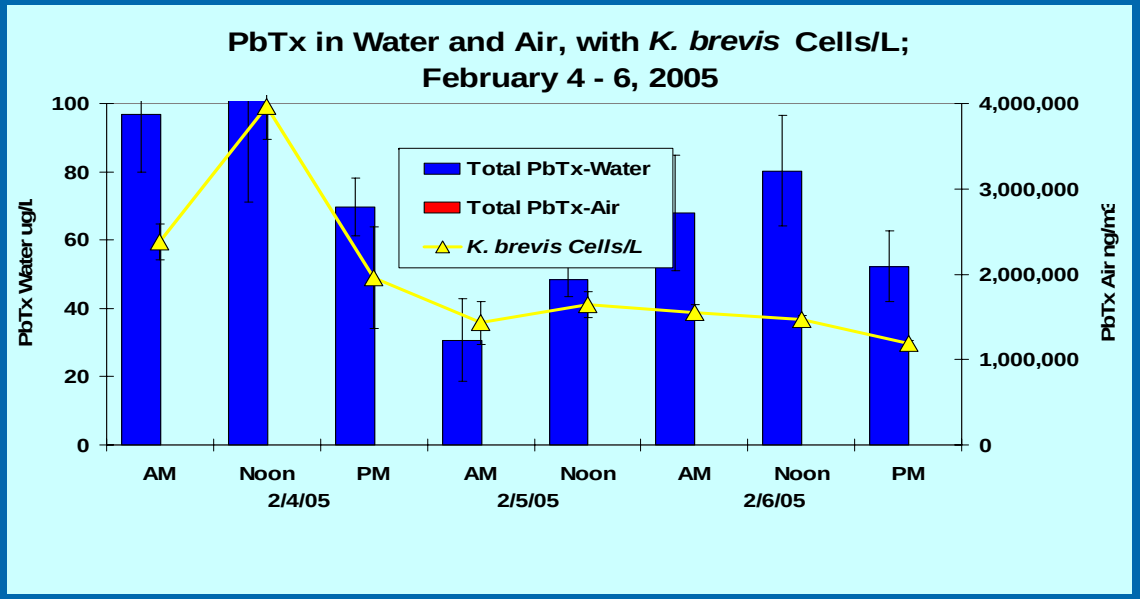


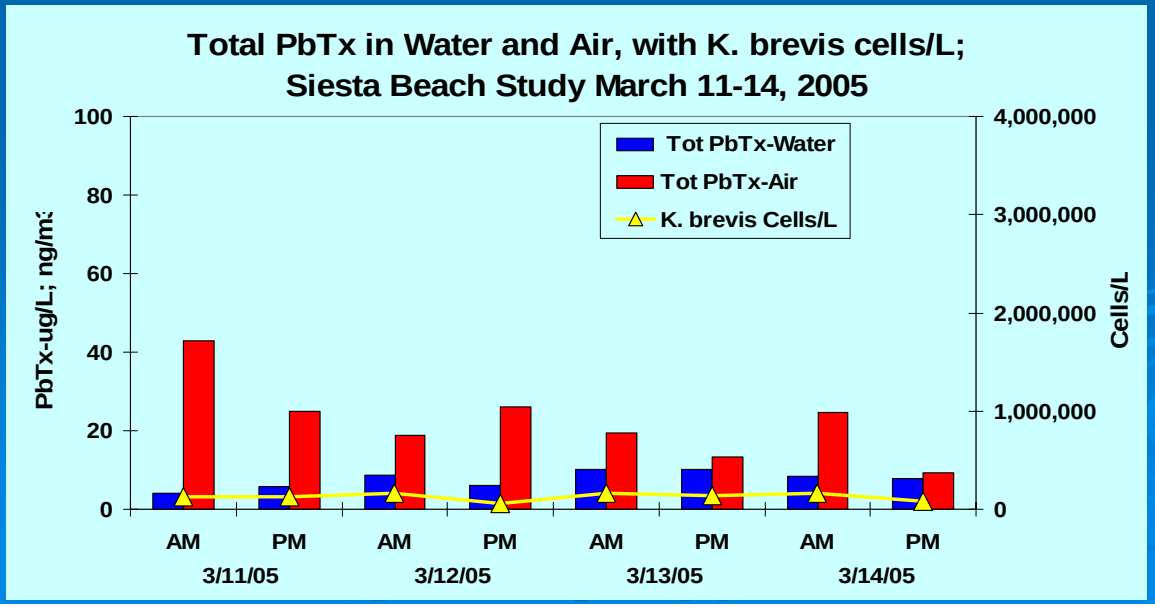
Wind: Direction On-shore through out 4-day beach study

Results of March 11-14, 2005 Siesta Beach Study

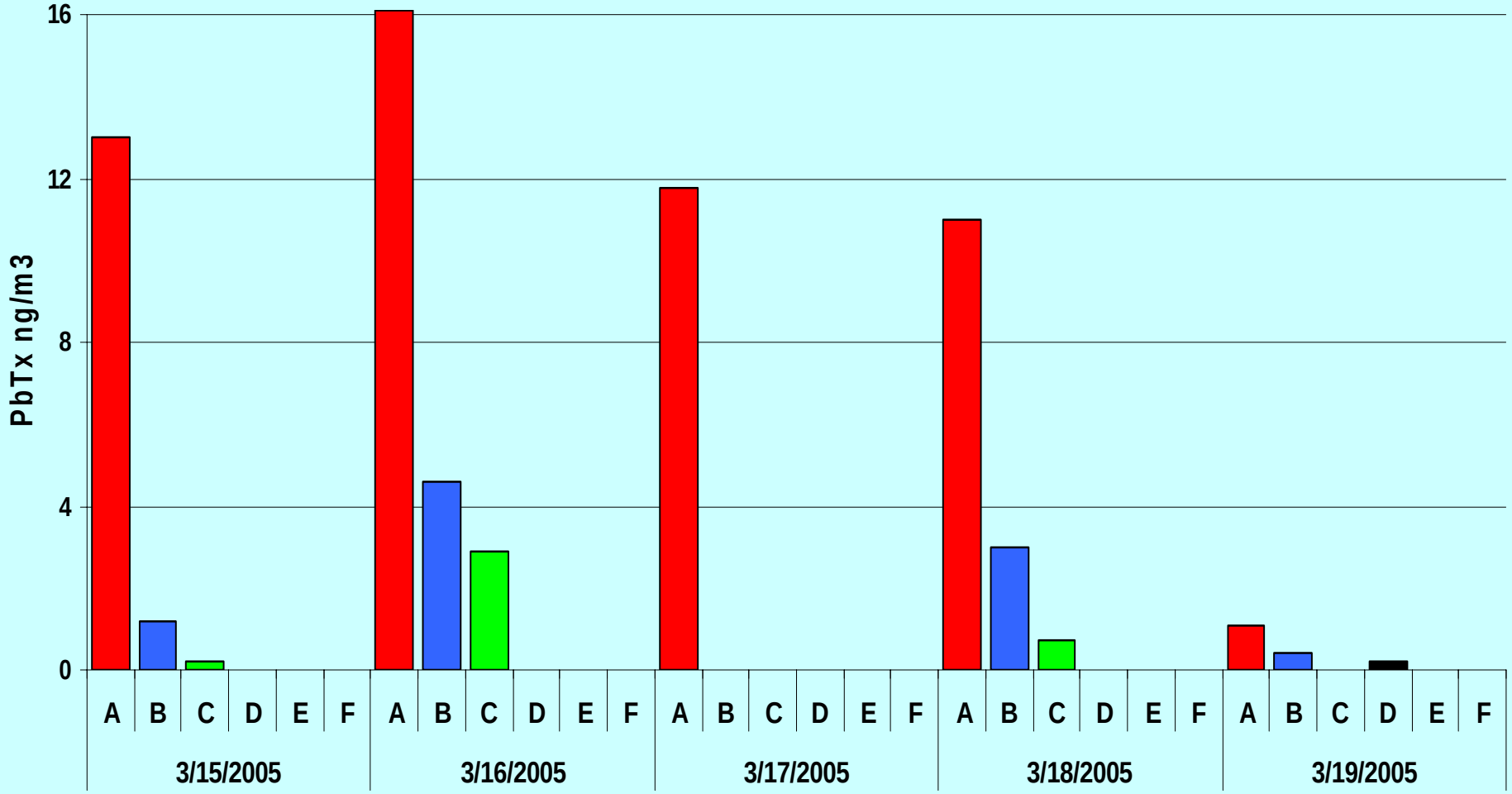
- Moderate concentration of red tide present in water (130,000 ± 38,000 Cells/L)
- Moderate concentration of PbTx in Water (7.6 ± 2.1 ug/L total brevetoxins)
- Moderate concentrations of PbTx in air (27.6 ± 14.3 ng/m^3 total brevetoxins)

Comparison of Cells and Toxins: February and March 2006





Total PbTx (ng/m^3) in Aerosol at Inland Transect Sites; March 15 - 19, 2005.

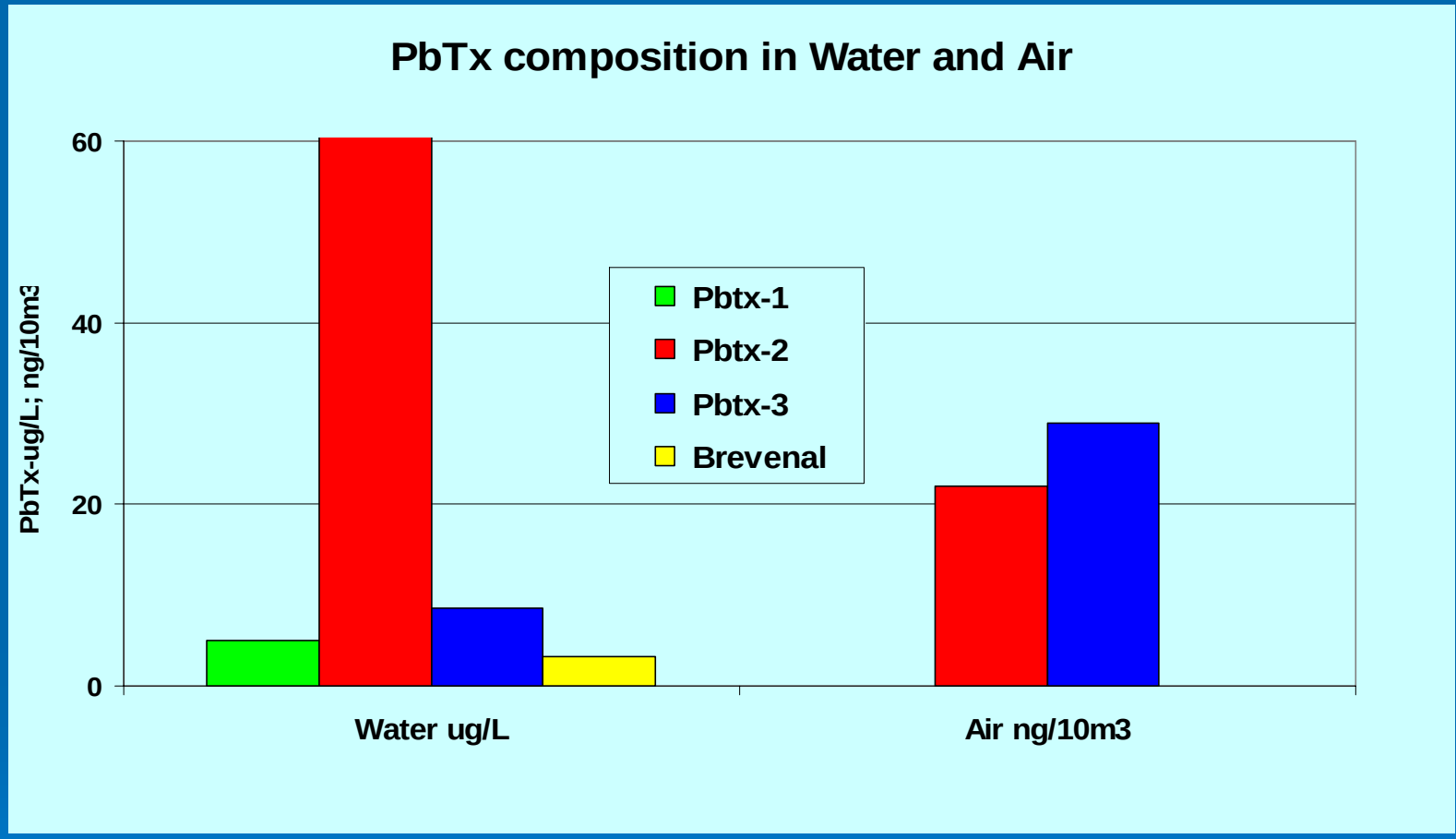


Wind Direction / Speed (mph)

AM: On / 2-8 ; On / 21-28 ; Along / 9-22 ; Vari / 17-22 ; Off / 11-16

PM On / 5-11 ; On / 22-34 ; Along / 8-12 ; Along / 12-20 ; Along/ 13-20

Comparison of PbTx Composition in Water and Air for 2005 Siesta Beach Study



Results: Water, PbTx 2 most abundant toxin

Air, PbTx-3 most abundant toxin

Environmental Assessment
Brevetoxins in Siesta Aerosol

- Aerosol 3/11/05 = 43 ± 18 ng PbTx/m^3
  Equals ~ 40 pg PbTx/Liter Air

- @ 25 L/min inhalation[1] x 40 pg/L;
  Human exposure on Siesta = 60 ng/hr

[1] Ref. Yung-Sung Cheng; 1994

Prediction of Human Exposure

- **Prediction of Human Exposure to Aerosol brevetoxins is a function of:**
  - **Brevetoxin concentration and composition in the source water**
  - **On-shore component & velocity of wind**
  - **Wave dynamics generating surf and aerosol**
  - **Marine aerosol composition/particle size distribution**

PARTICIPANTS
For Environmental Analyses

Mote Marine Laboratory

Richard Pierce

Michael Henry

Patricia Blum

Shannon Osborn

UNC, Wilmington, Center for Marine Science

Jerome Naar

Susan Campbell

Jody Lamberto

Lovelace Respiratory Research Institute

Yung Sung Cheng

Yue Zhou

Mitch Irvin

Acknowledgements

This study was funded by:

- **National Institutes of Environmental Health Sciences, Grant No. PO1 ES10594-03, In cooperation with UNC Wilmington, Center for Marine Science.**
- **Centers for Disease Control & Prevention, and the FL Department of Health, Grant # U50-CCU423360-01**
- **Florida Fish and Wildlife Conservation Commission, Grant No. 04089**