# Observation system for early warning of HAB events


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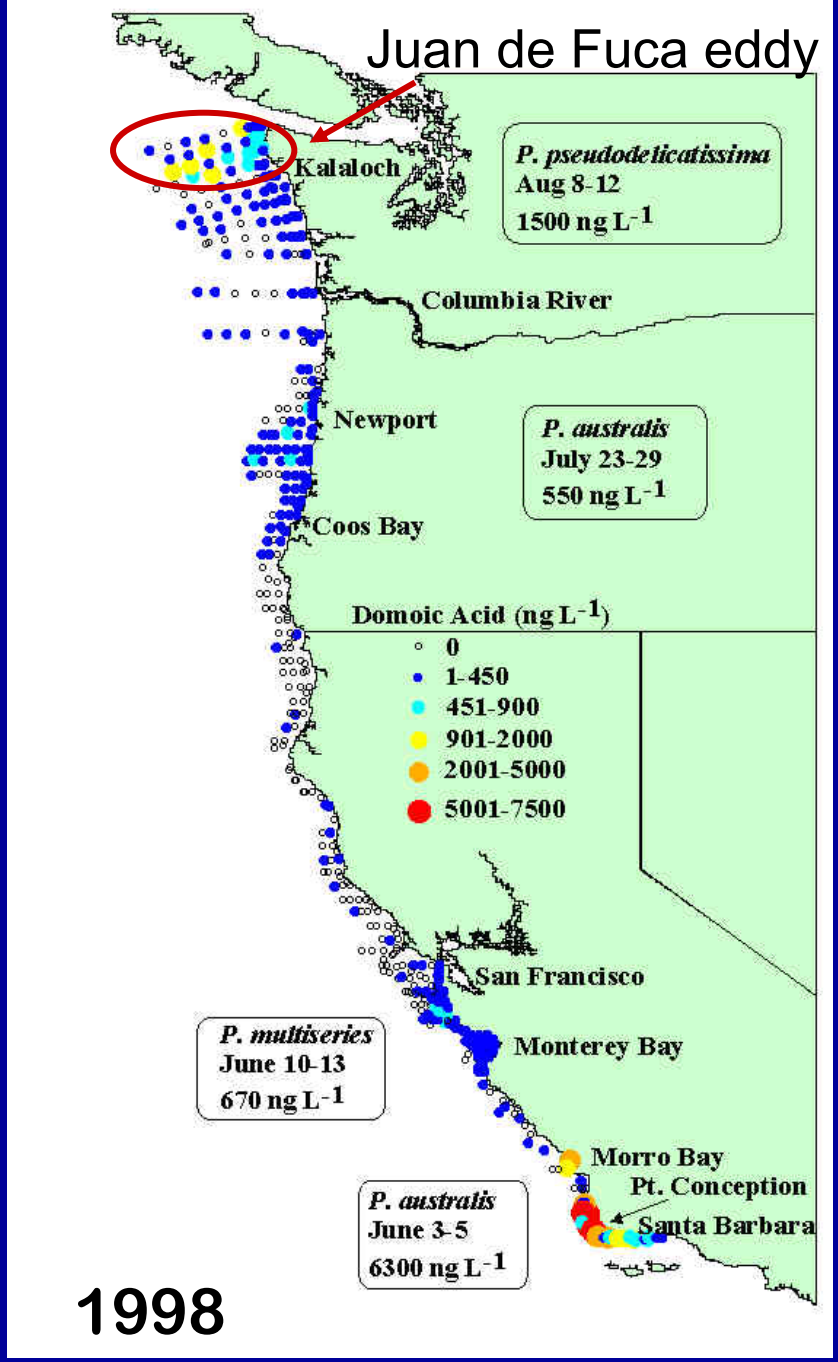
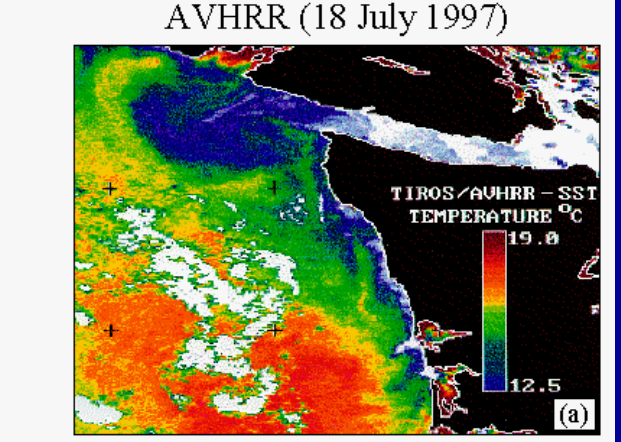
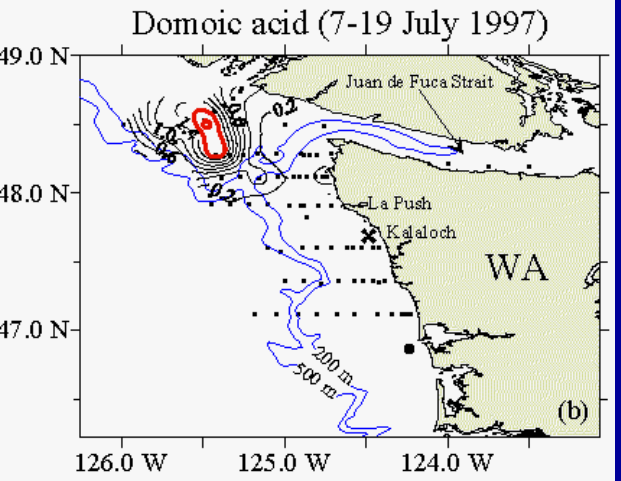
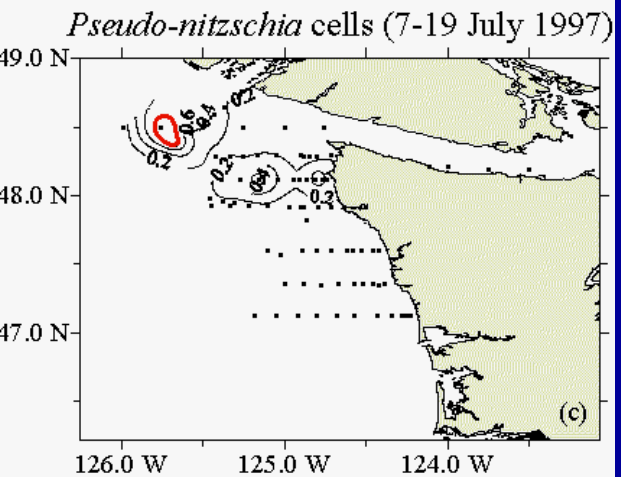



# Regional HAB OOS considerations

- Dominant processes are large scale
- Upwelling is dominant nutrient supply
- North to south advection
- Retentive areas may promote HABs
- Fast response to winds
- Particles move to the coast when winds reverse




# Background

- Juan de Fuca eddy is a summer feature off the entrance of Juan de Fuca Strait
  - comprised of nutrient-rich California Undercurrent water
  - an initiation site for *Pseudo-nitzschia* that produce toxins that impact clam & crab fisheries

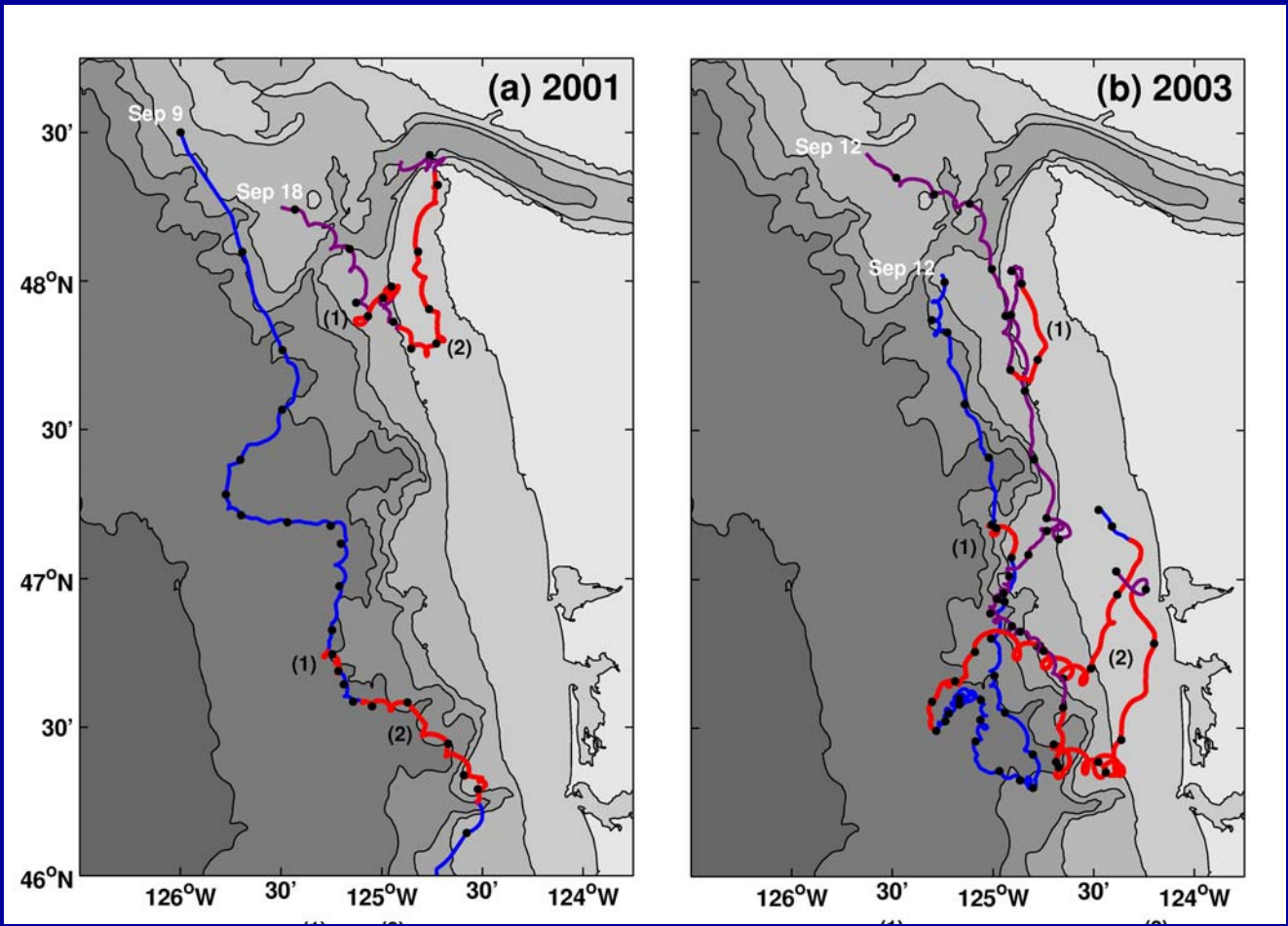
- ECOHAB PNW:
  - multi-disciplinary project to study ecology & oceanography of these HABs

Trainer et al. 2002, Limnol. Oceanogr.

ECOHAB Pacific Northwest

# Storms transport cells from the JdF eddy to the coast

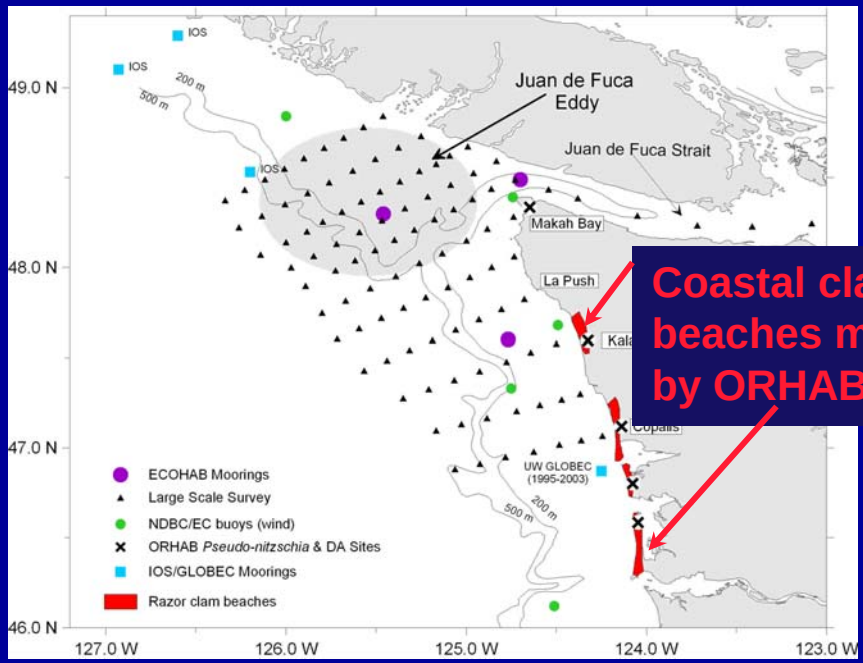
## Upwelling vs downwelling eddy




Upwelling = blue

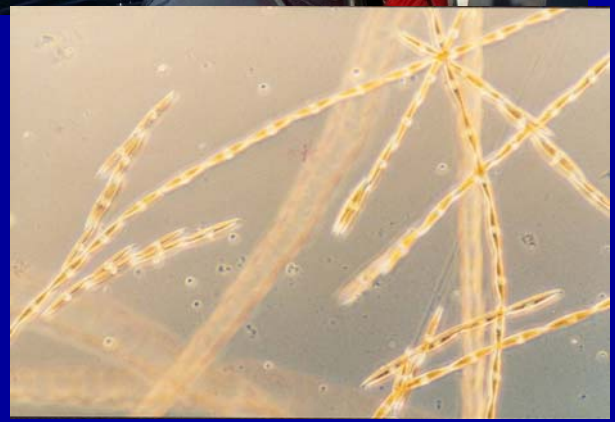
Downwelling = red

# ECOHAB Pacific Northwest




Six research cruises 2004-2006

Coastal clamming beaches monitored by ORHAB



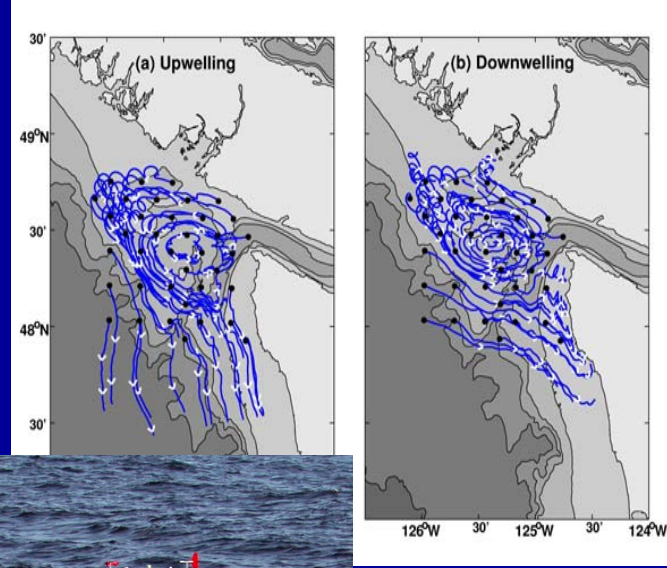
Toxic *Pseudo-nitzschia*

**Findings to date:**

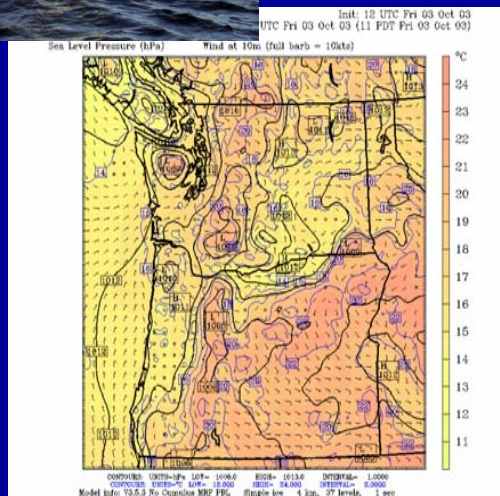
1) The Juan de Fuca eddy region contains toxic *Pseudo-nitzschia* every summer.
2) Species responsible for toxicity differ from year to year.
3) With a combination of winds from the north and south, toxic patches or streamers are ejected from the eddy and transported to coastal beaches.
4) Transport models combined with cell and toxin monitoring may provide early warnings to coastal beaches.

# Idealized PNW HAB Forecasting

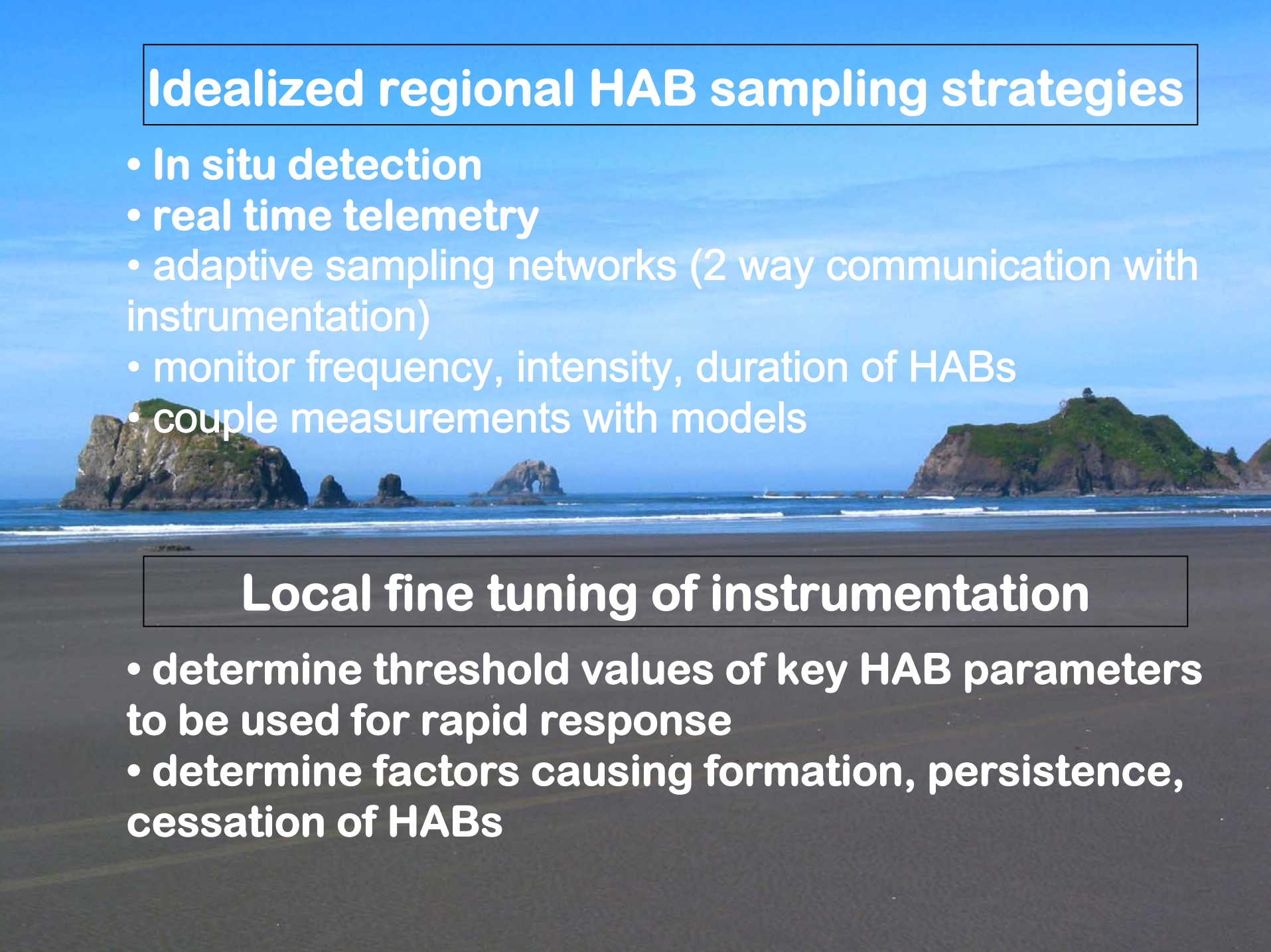
- Realtime data from moorings:
  *PN*, DA, currents, FlowCAM, nutrients, T, S
- Drifter deployments at key locations & times
- Satellite imagery (e.g., SST, chlorophyll for data assimilation)
- Realtime winds & weather forecasts from high resolution model (UW MM5)
- Accurate biophysical model with data assimilation
- Appropriate support for data acquisition, modeling, interpretation by local experts, & communication to managers




Mooring in Juan de Fuca eddy



MM5 – high resolution meteorological forecast for PNW

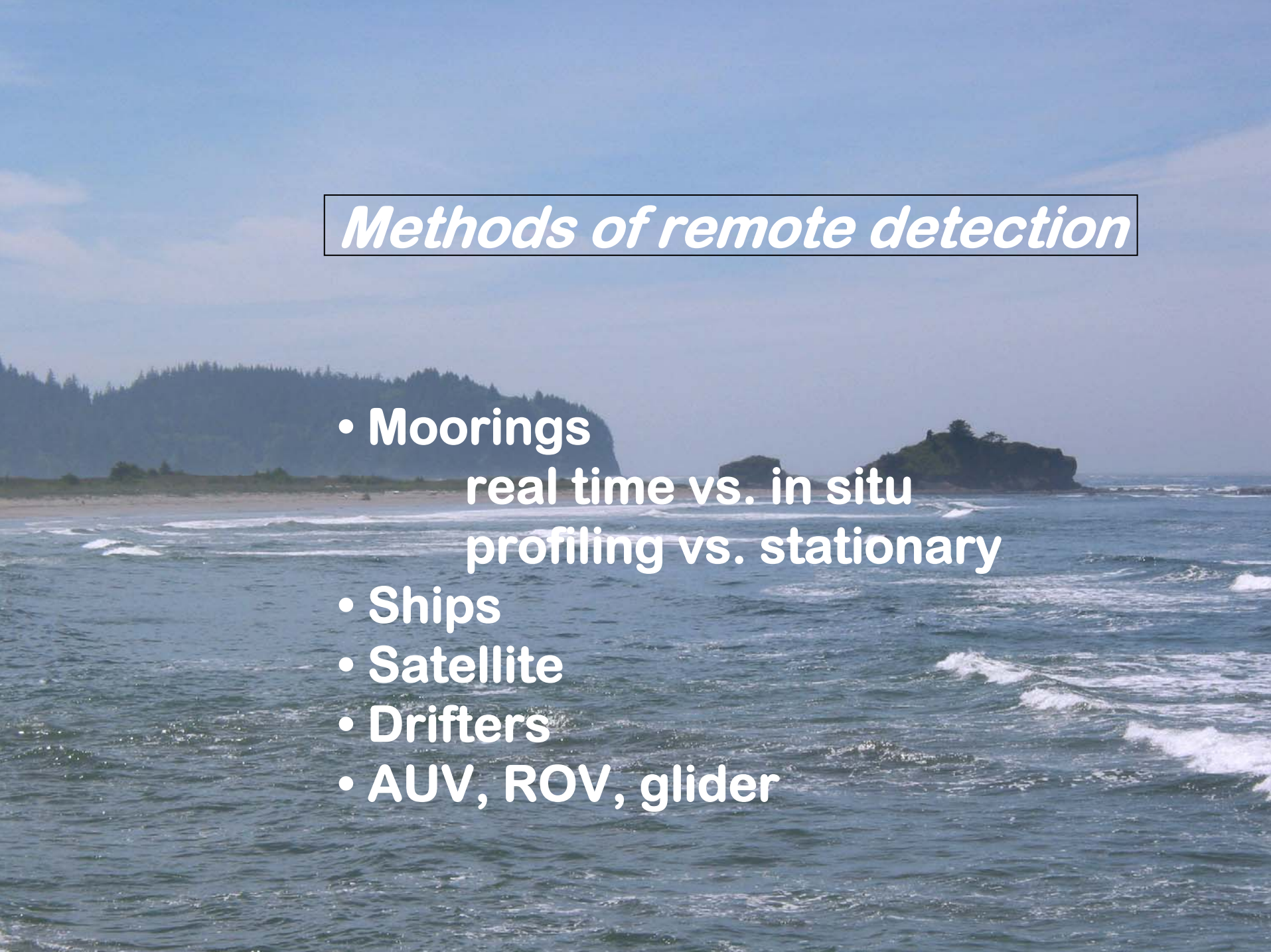


# Idealized regional HAB sampling strategies

- **In situ detection**
- **real time telemetry**
- adaptive sampling networks (2 way communication with instrumentation)
- monitor frequency, intensity, duration of HABs
- couple measurements with models

# Local fine tuning of instrumentation

- **determine threshold values of key HAB parameters to be used for rapid response**
- **determine factors causing formation, persistence, cessation of HABs**



# *Methods of remote detection*

- **Moorings**
  - **real time vs. in situ**
  - **profiling vs. stationary**
- **Ships**
- **Satellite**
- **Drifters**
- **AUV, ROV, glider**

# Example Ocean Observing Systems for Harmful Algal Blooms

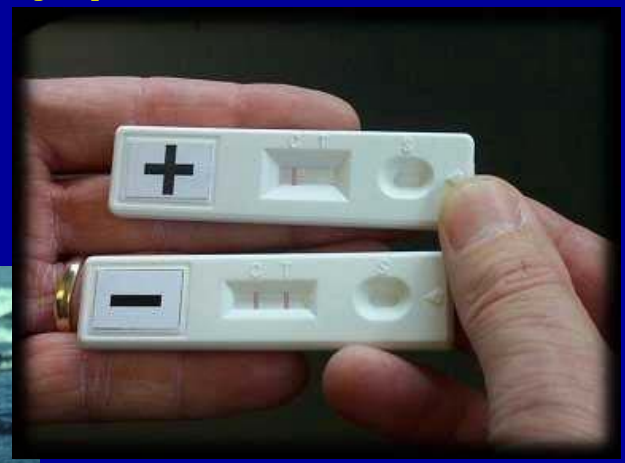
# Example 1:
# Simple observing system for HABs - ORHAB

***Beach Monitoring …***

- **prevents recalls, illness**
- **allows for selective beach openings or closures**
- **provides early warning of HAB events (~ 2-7 days)**

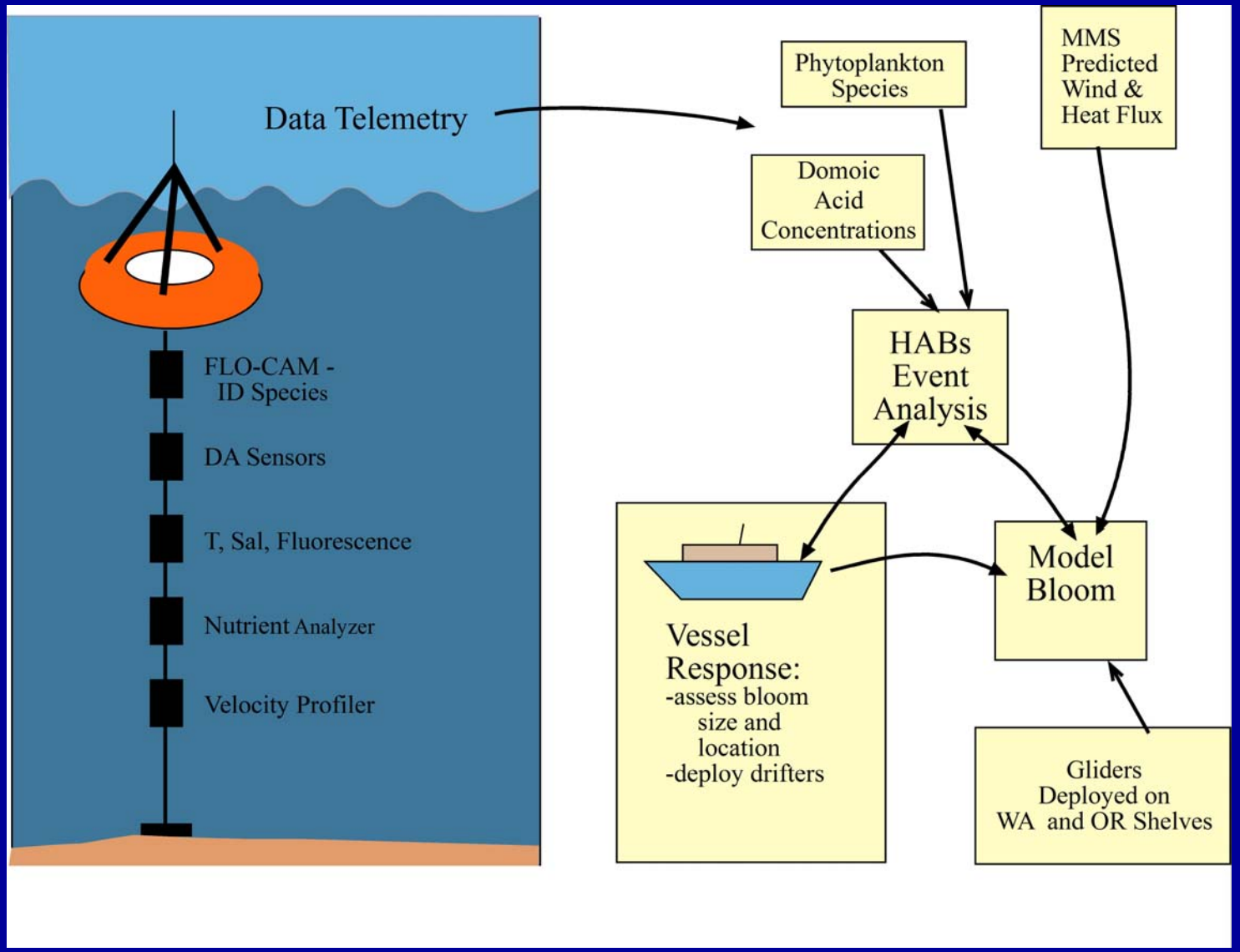
• ORHAB training class

• tribal members digging clams




• seawater sampling and toxin testing is done weekly at 4 beaches

# Example 2:
# Complex Observing system for HABs




**Design is tailored to the needs in each region**

# How will a regional HAB OOS be developed?

*Build upon existing HAB programs*

- ECOHAB PNW
- ORHAB
- RAPDALERT
- Cali-PReEMPT
- MBARI, Scholin ESP

# US West Coast Region

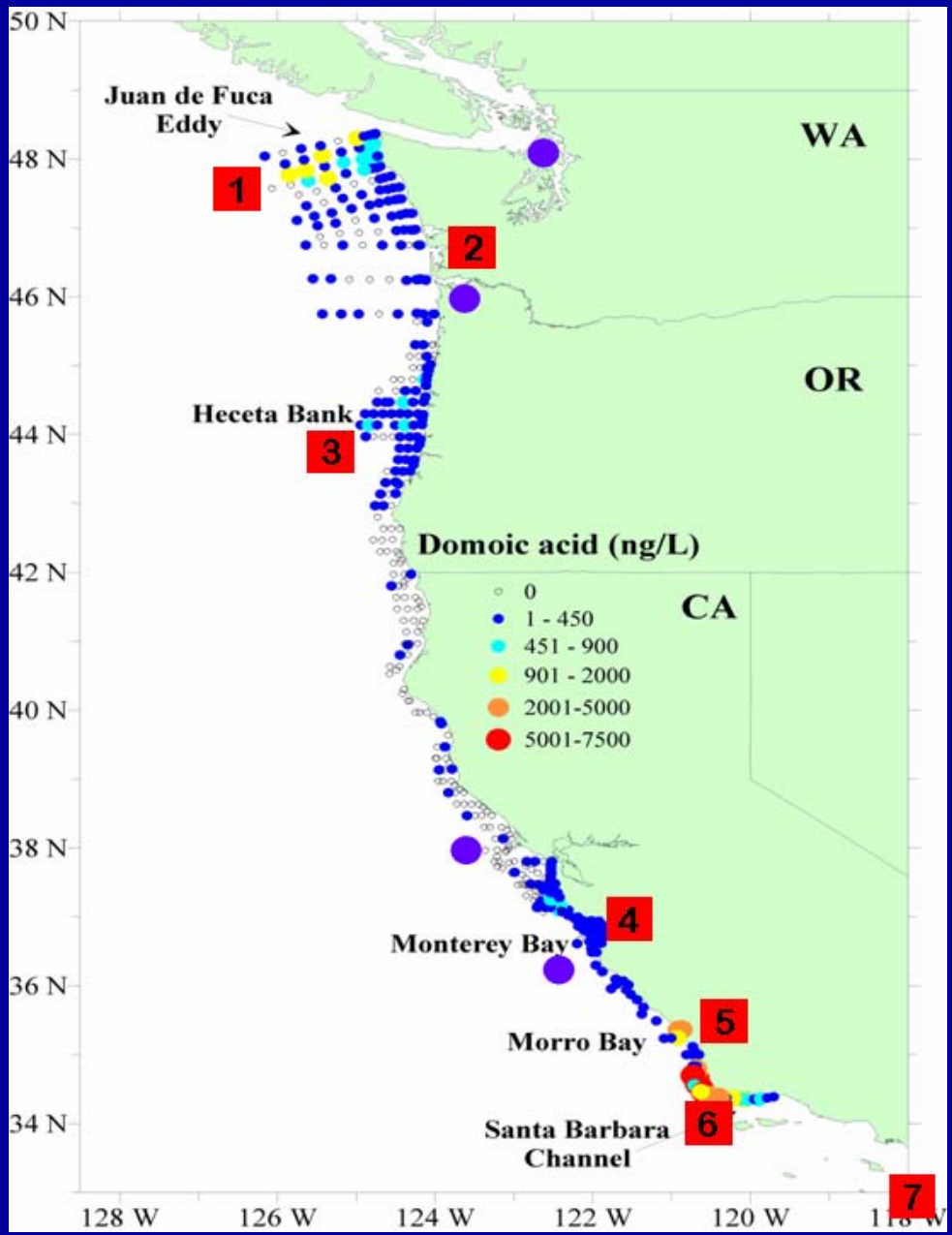
## Proposed HAB IOOS mooring locations

1. Juan de Fuca
2. Willapa Bay
3. Heceta Bank

4. Monterey Bay
5. Morro Bay

6. Santa Barbara channel
7. San Diego

Sites of HAB impact and current programs



# Cal-PReEMPT

California Program for Regional Enhanced Monitoring for PhycoToxins

...to implement an economically sustainable harmful algal bloom monitoring program for the California coastline.

**The goal of Cal-PReEMPT is to implement an economically sustainable harmful algal bloom monitoring plan for the California coastline that exceeds current capabilities of the California Department of Health Services using new technologies for rapid toxin and species detection and tracking.**


*Locations for pilot projects have been selected based on their diversity of ecological conditions and HAB species, high relative frequency of occurrence for the target HAB species and toxins, and availability of historic and/or existing oceanographic programs.*

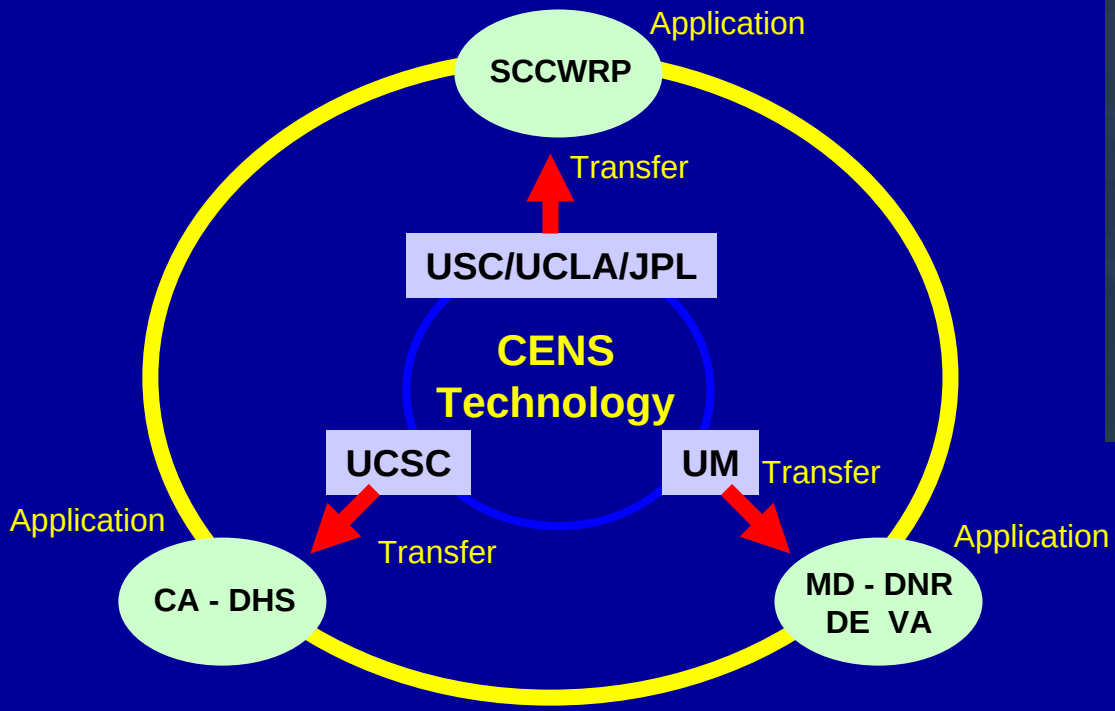
*Example of the simple results obtained when using the Jellet Rapid Testing Ltd. MIST Alert™ test kits.*


Kudela, USC

# MERHAB: RAPDALERT

**R**apid **A**nalysis of **P**seudo-nitzschia and **D**omoic **A**cid: **L**ocating **E**vents in near-**R**eal **T**ime

- **Technology**
  - **CENS Actuation**
  - **Application and Deployment Experience**
- **Partners**
  - **USC, UCLA, UCSC, U Maryland**
  - **Southern California Water Research Project**
  - **JPL**



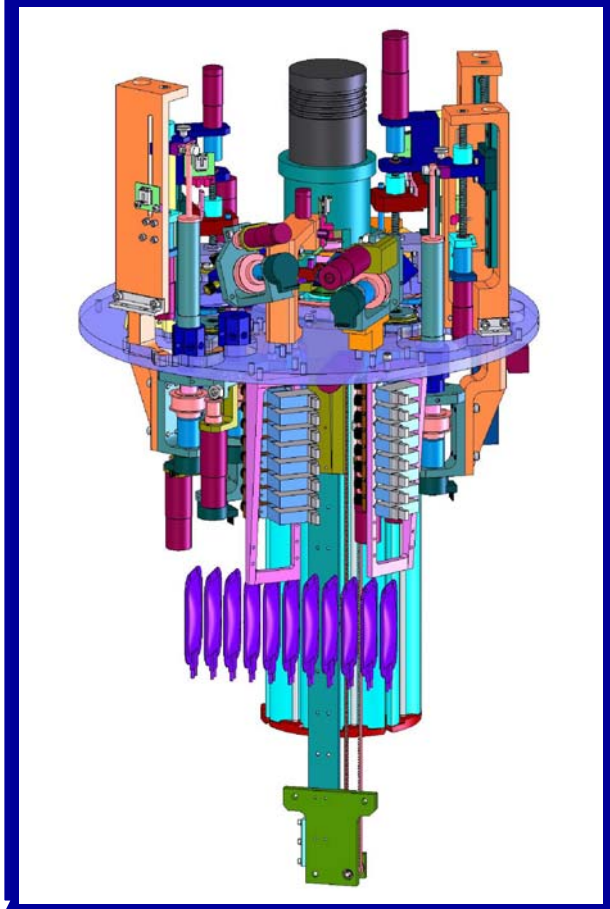


Funding: NOAA

**Caron, USC**

W.M. KECK FOUNDATION

# 2G ESP



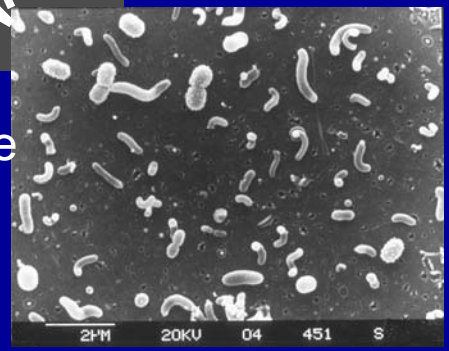

- **Science Drivers**
  - Vrijenhoek et al. – invertebrate larvae
  - Scholin et al. – phytoplankton, HABs
  - DeLong et al. – picoplankton
- **Basic Operations *in situ***
  - Sample Archival
  - DNA Probe Array Development
  - HAB Toxin Detection
- **Planned Deployments '05-'07**
  - ESP Mooring – upper water column
  - ROV – Deep-ESP test fixture, GOC 2006?
  - MARS – Deep-ESP, cabled observatory

# Detection of invertebrate larvae, pennate diatoms and groups of bacteria on a single array:

chemistry control and intensity standards

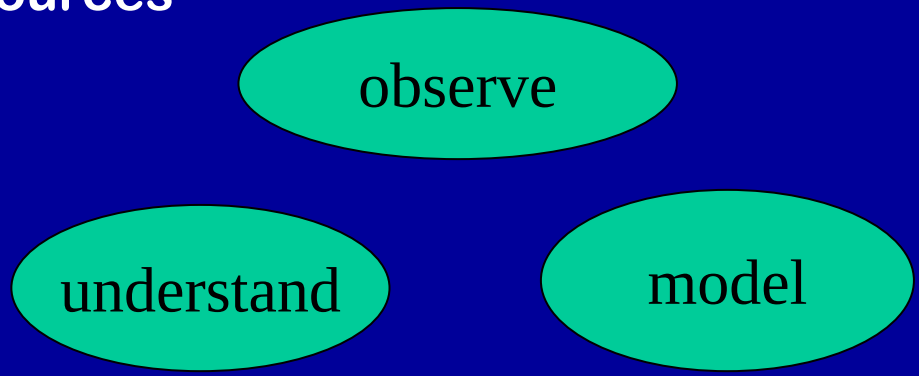
“all eukaryotes”


- 125 ml whole water sample
- 0.45μm filter
- 2ml homogenate



# Societal goals of HAB OOS

- Reduce public health risks
- Protect & restore healthy coastal ecosystems
- Enable sustained use of oceans & coastal resources

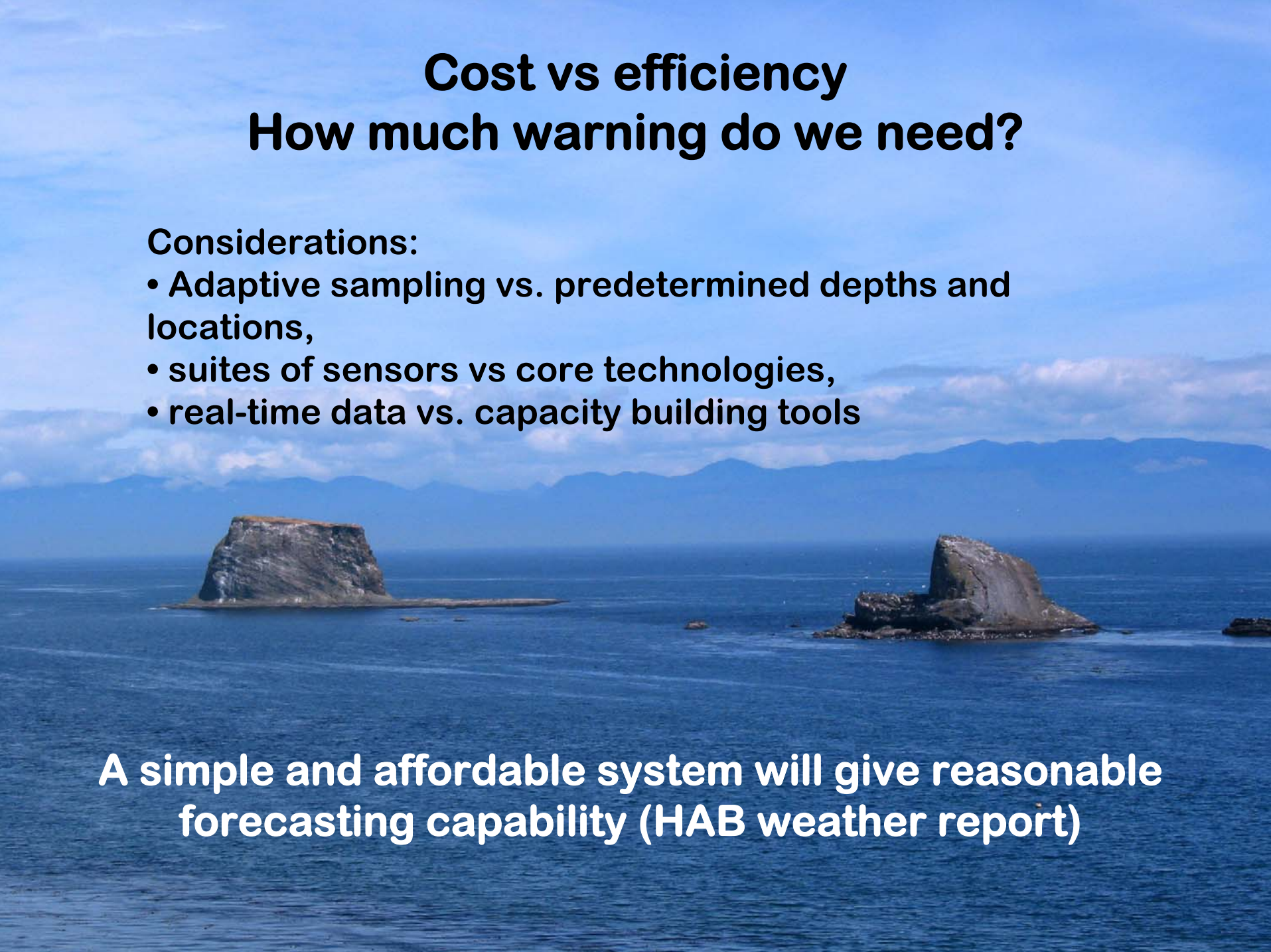



- Weather & climate are integral parts of HAB IOOS
- In situ & remote sensing transcend institutional boundaries (partnership)
- Improves public understanding through sustained communication & education programs

# Cost vs efficiency
# How much warning do we need?

Considerations:

- Adaptive sampling vs. predetermined depths and locations,
- suites of sensors vs core technologies,
- real-time data vs. capacity building tools



**A simple and affordable system will give reasonable forecasting capability (HAB weather report)**