A 5-Yr Inter/Multi Disciplinary Study off the Washington State/British Columbia Coasts

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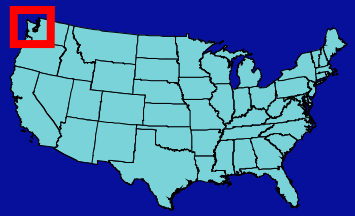
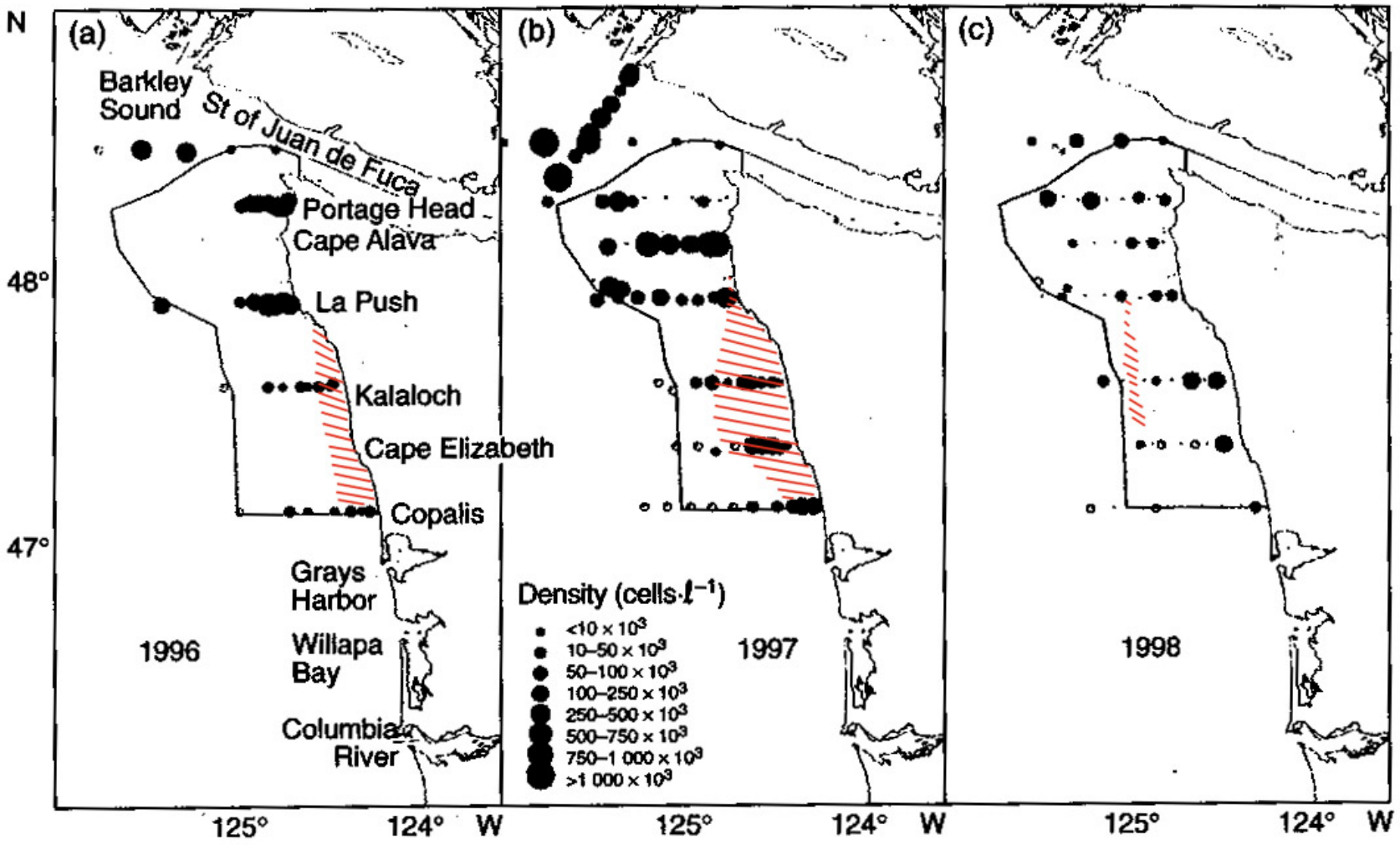
Domoic acid on the Washington coast



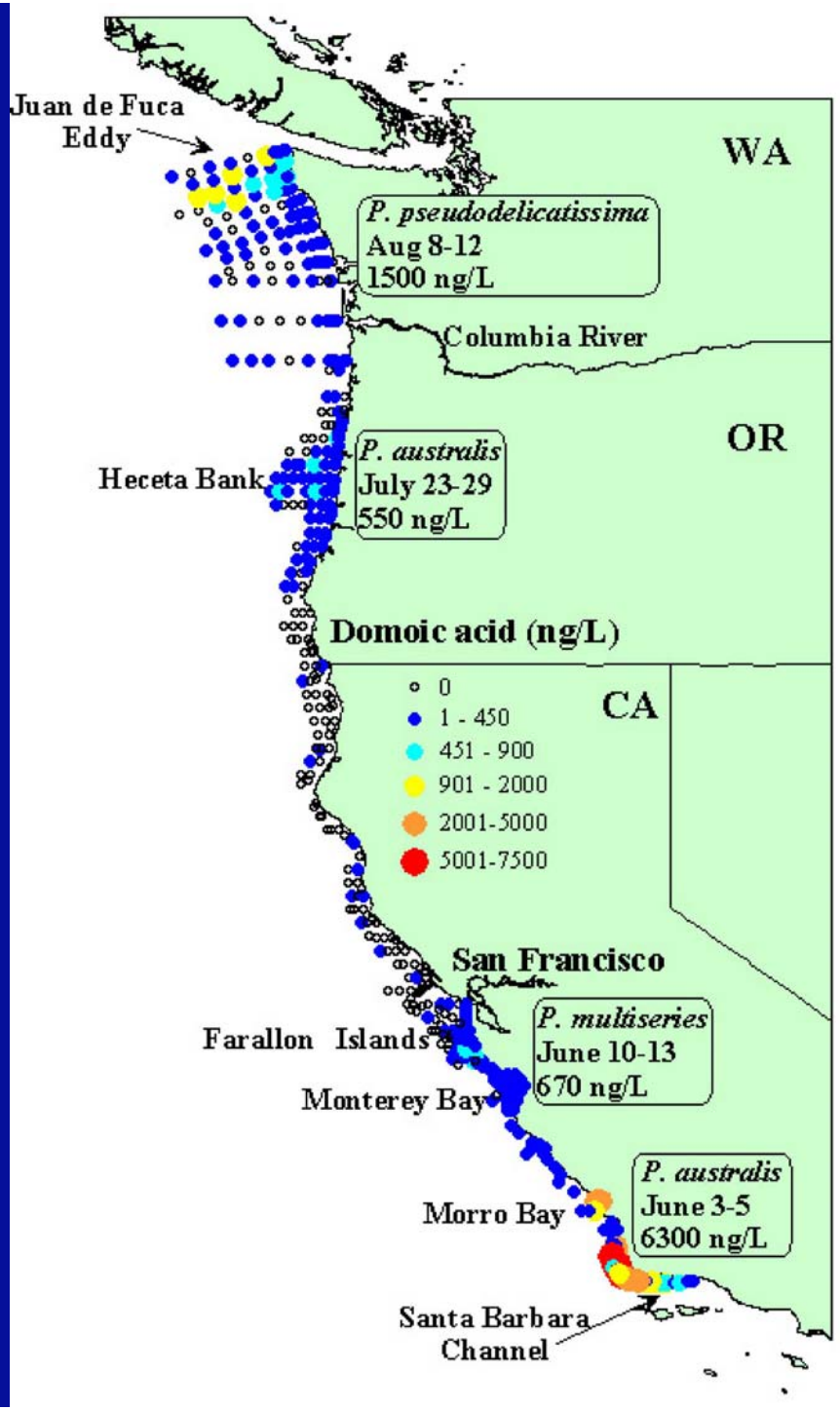
Our Razor Clam Fishery

Distribution and Abundance of *Pseudo-nitzschia* spp. at Sea Surface



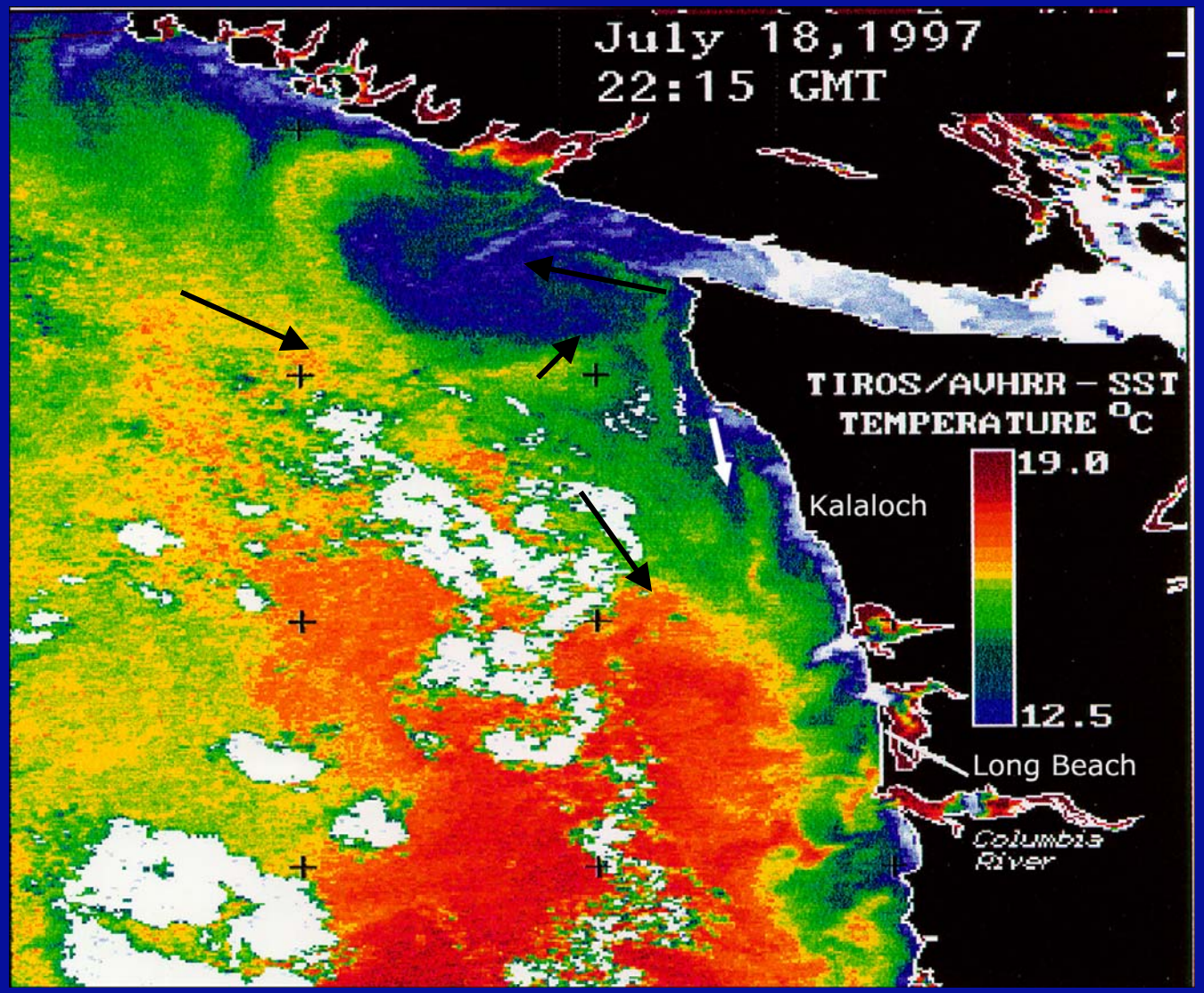
Horner et al. (2000), S. Afr. J. Mar. Sci.

Particulate Domoic Acid along U.S. West Coast in 1998

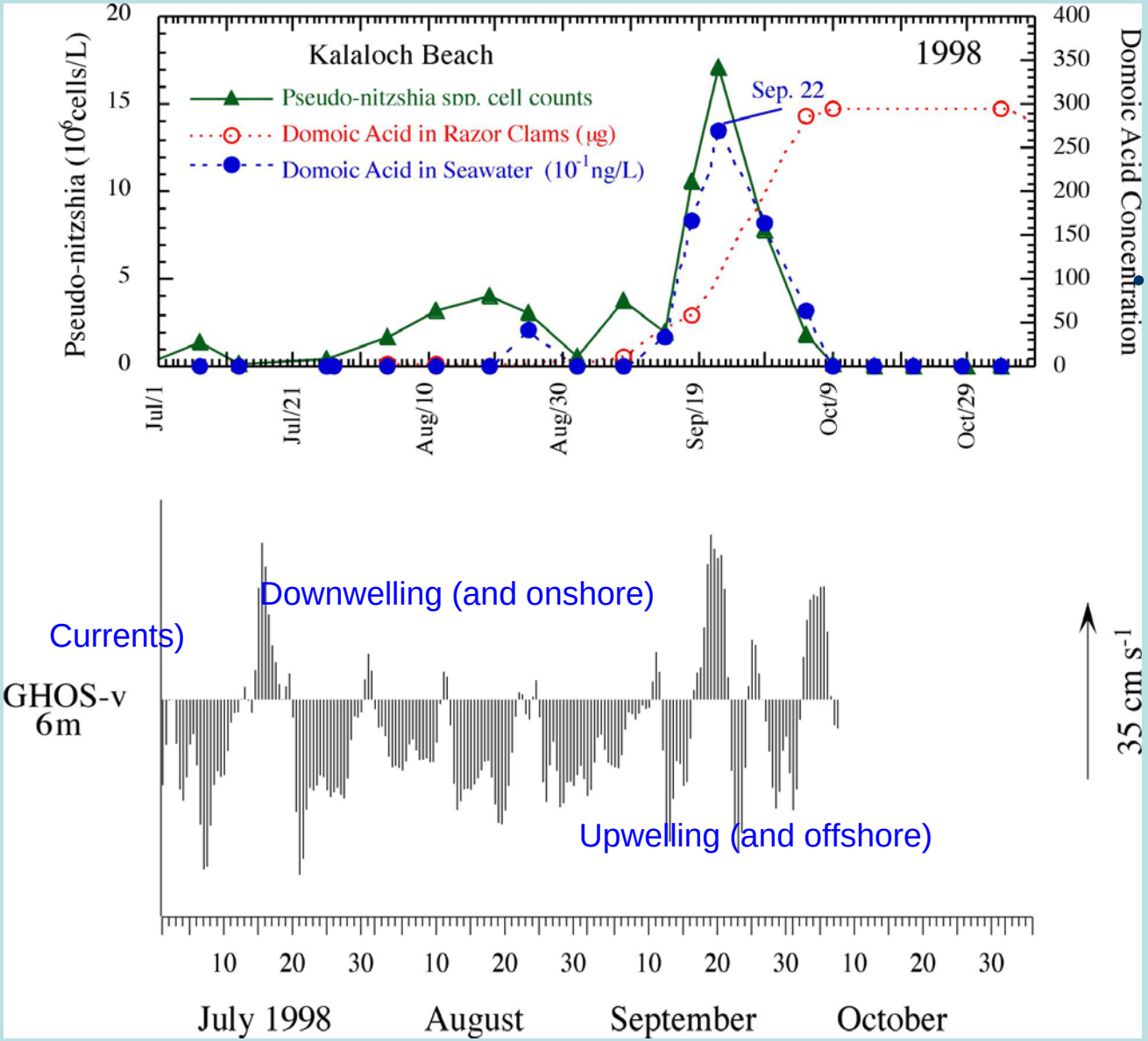


Data from Trainer lab.

The Juan de Fuca Eddy and the Washington Coastal Upwelling Region



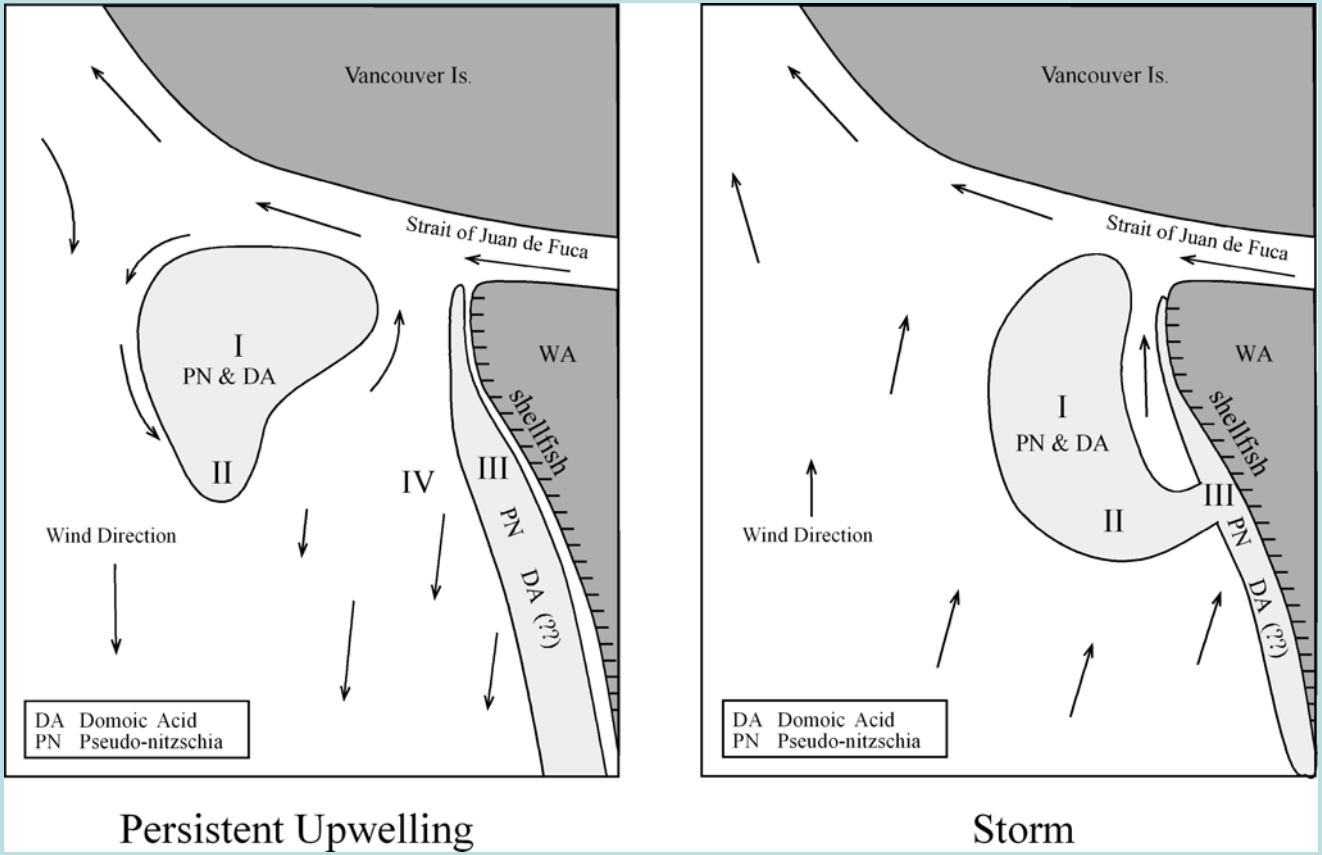
Fall 1998 DA Beach Closure



increase in PN and DA occurs after a period of persistent upwelling followed by a storm

(Trainer et al, 2002)

ECOHAB PNW Working Hypothesis



The model divides the region into **four sampling regimes** based on expected property differences.

I. Eddy Regime

II. Aged Eddy Regime

III. Nearshore Upwelled Water Regime

IV. Aged Nearshore Upwelled Water Regime

STUDY OBJECTIVES

- To determine the physical/biological/chemical factors that make the Juan de Fuca eddy region more viable for growth and sustenance of toxic *Pseudo-nitzschia* than the nearshore upwelling zone;

- To determine the combination of environmental factors that regulate the production, accumulation, and/or release of domoic acid from *Pseudo-nitzschia* cells in the field;

- To determine possible transport pathways between domoic acid initiation sites and shellfish beds on the nearby coast.

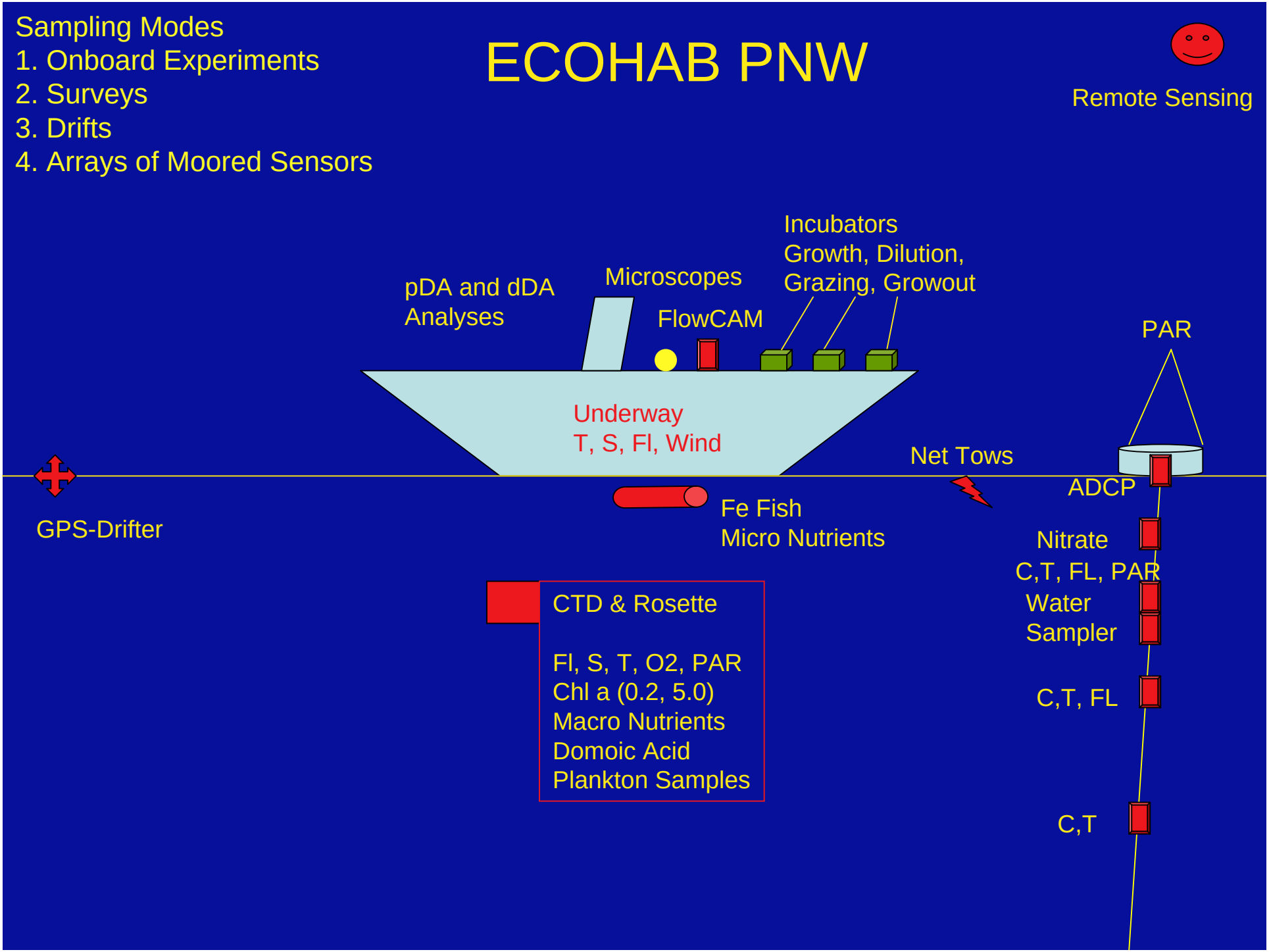
ECOHAB PNW Program Elements and PI Responsibility

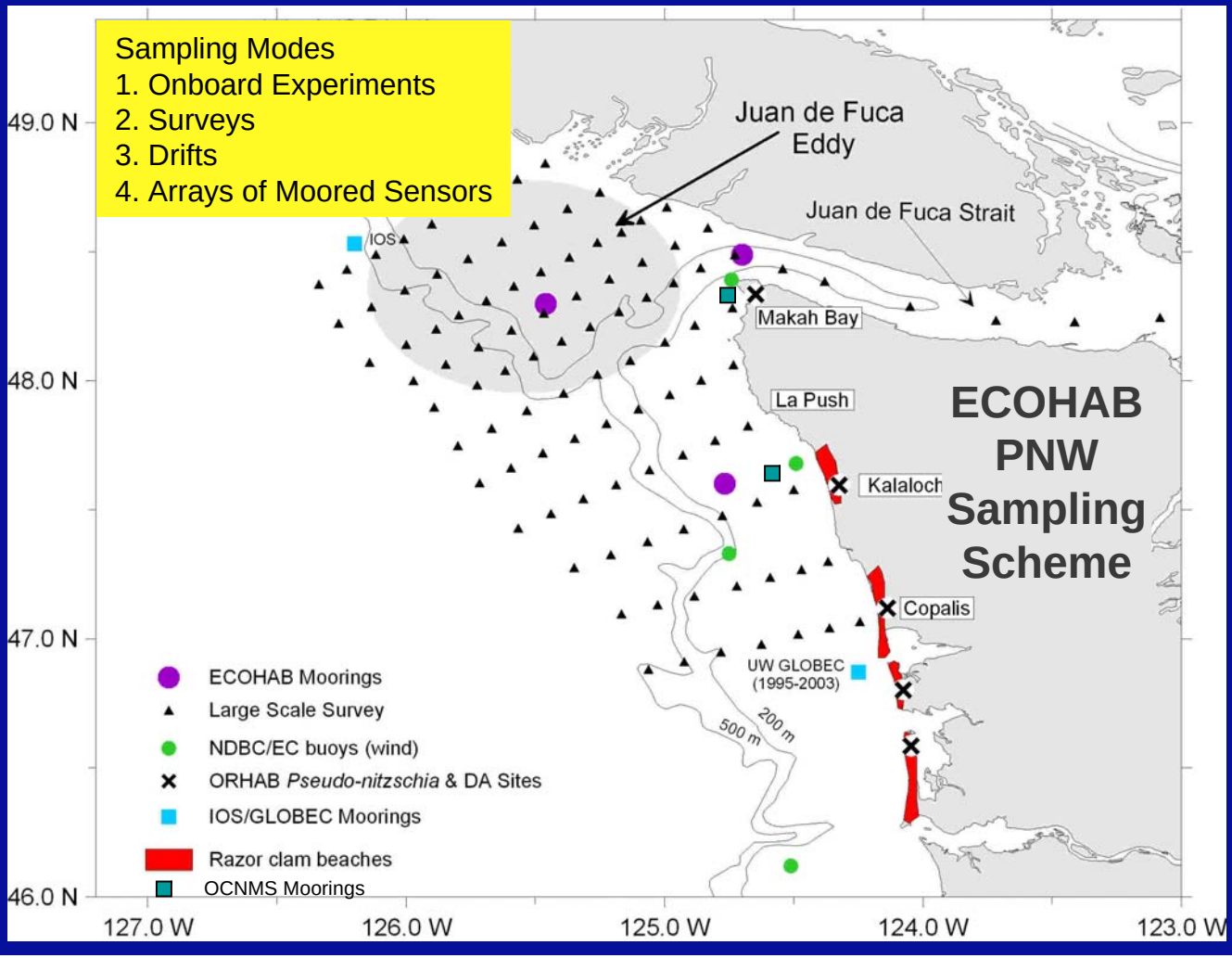
Component	Techniques	Investigator
Project Management		Hickey, Trainer
Currents	Moored arrays, ADCP surveys	Hickey, Thomson
Winds	Moored arrays, NDBC/EC buoys, MM5 Model	Hickey, Foreman
Surface Currents	Drifters	Hickey
Standard Water Properties (T, S, Fluor., PAR, O_2), *PN* abundance	Surveys, flow-through fluorometry, T,S, FlowCAM, CTD, moored arrays	Hickey, Cochlan, Lessard
Chlorophyll *a* and Phaeopigments	*In vivo* and *in vitro* Fluorometry	Trainer, Cochlan
Domoic Acid (particulate & soluble)	Receptor binding assay, Mist Alert, Cell bioassay	Trainer, Trick
Dissolved Nutrients (inorganic and organic)	Lechat autoanalyzer, surveys and moored samplers	Cochlan, Trick
Fe, Other Trace Metals	Flow injection, extraction/ICP-MS	Wells
Pico and Nanoplankton	FCM	Trick
Autotrophic/Heterotrophic Microplankton	FlowCAM, microscopy/image analysis	Lessard
Pseudo-nitzschia Taxonomy	SEM, probes	Trainer
Molecular Probe Development	PCR	Connell
Antibody and Assay Development	Polyclonal, cell fluorescence	Trainer, Trick
Toxic *Pseudo-nitzschia* Species Abundance- rRNA probes	Sandwich hybridization assays (SHA); FISH, FCM	Trainer, Connell Lessard, Trick
Nitrogen Uptake Capabilities	^{15}N nitrogen kinetics (NO_3,NH_4, Urea)	Cochlan
Nutrient Stress and DA Production	Modify nutrient ratios incubation expts.	Trick, Cochlan, Trainer
Fe, Cu Stress and Effects on DA Production as a Chelator	Competing ligand 'grow-outs', Fe uptake kinetics, P vs. E expts. using ^{14}C	Cochlan, Wells, Trick, Trainer
Grazing/Growth of *PN* and other Phytoplankton	Dilution method ? FlowCAM, microscopy, SHA, size-fractionated chlorophyll *a*	Lessard
Identity of Grazers of *PN* Species	Single-cell FISH and immunoassays	Lessard
Bacterial Abundance and Productivity	AO counts; ^{3}H-leucine uptake	Cochlan
Circulation Modeling	Numerical model	Foreman
Trophic Modeling	NPZ model	Pena
Biophysical Modeling	1-D and 3-D models	Foreman, Pena

1. Identify water masses and transport processes (Hickey)
2. Determine in-situ nutrient and chemical (e.g., metals) fields (Cochlan, Wells)
3. Measure plankton community structure, presence/absence and toxicity of Pseudo-nitzschia spp., and potential effects of domoic acid on grazing (Trainer, Trick, Lessard, Connell)
4. Conduct ship-based incubation studies to investigate factors responsible for toxin production (Trick, Cochlan, Trainer and Wells)
5. Develop a bio-physical model that captures water transport and (toxic) plankton dynamics (Thomson, Foreman, Pena)

Sampling Modes
1. Onboard Experiments
2. Surveys
3. Drifts
4. Arrays of Moored Sensors

ECOHAB PNW




Sampling Modes
1. Onboard Experiments
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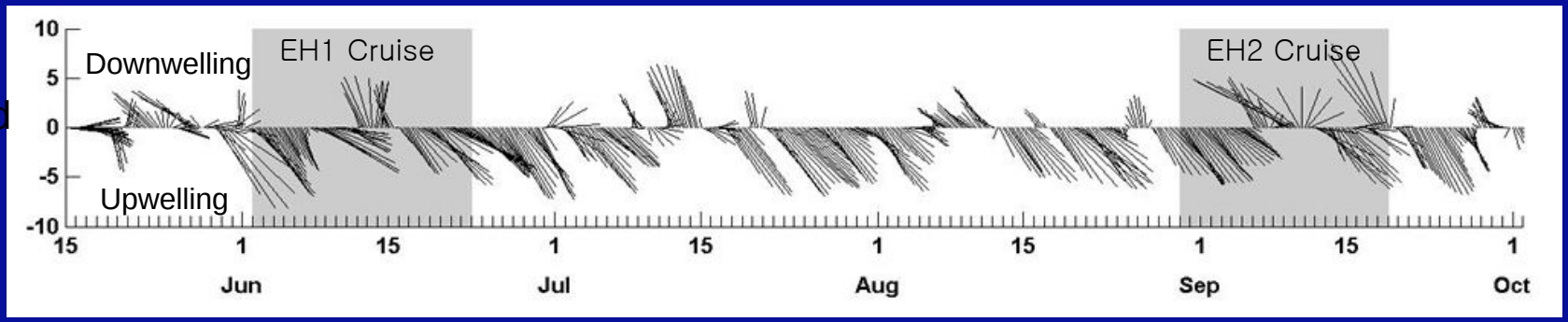
4. Arrays of Moored Sensors
Juan de Fuca Eddy
Juan de Fuca Strait
IOS
Makah Bay
La Push
Kalaloch
Copalis
UW GLOBEC (1995-2003)
200 m
500 m
ECOHAB PNW Sampling Scheme
ECOHAB Moorings
Large Scale Survey
NDBC/EC buoys (wind)
ORHAB Pseudo-nitzschia & DA Sites
IOS/GLOBEC Moorings
Razor clam beaches
OCNMS Moorings
49.0 N
48.0 N
47.0 N
46.0 N
127.0 W
126.0 W
125.0 W
124.0 W
123.0 W

Wind


Downwelling
Upwelling
EH1 Cruise
EH2 Cruise
10
5
0
-5
-10
15
1
15
1
15
1
15
1
15
1
Jun
Jul
Aug
Sep
Oct

Pseudo-nitzschia species and toxicity, Washington State

Which species are known to produce domoic acid?

Pseudo-nitzschia species and toxicity, Washington State

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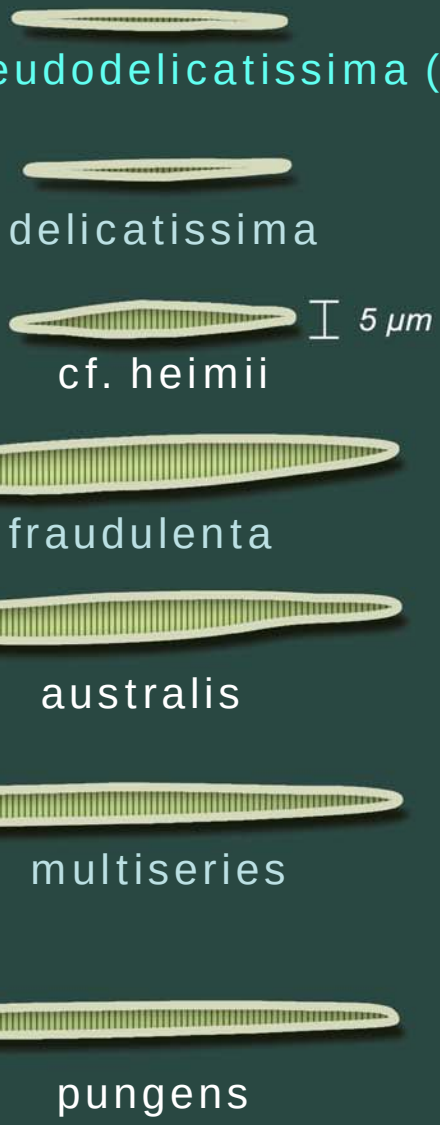

Preliminary Summary

- Juan de Fuca eddy is a persistent feature of coastal Vancouver Island and Washington State whose dynamics and driving forces are not understood.
- These dynamics appear to be ideal for breeding toxin-containing *Pseudo-nitschia*, for reasons not yet understood
- There is a large season and interannual variability in the abundance of Pseudo-nitzschia, and the presence and absence of toxin
- Toxin production and release by the cells varies according to both iron and copper supply
- The Juan de Fuca eddy increasingly appears to be a bioreactor that can export toxicity to both Vancouver Island and Washington State shorelines.