# The development of toxigenic *Pseudo-nitzschia* bloom models in Monterey Bay, CA, and their application at a single monitoring site within the model domain

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# Model development: Location & Motivation

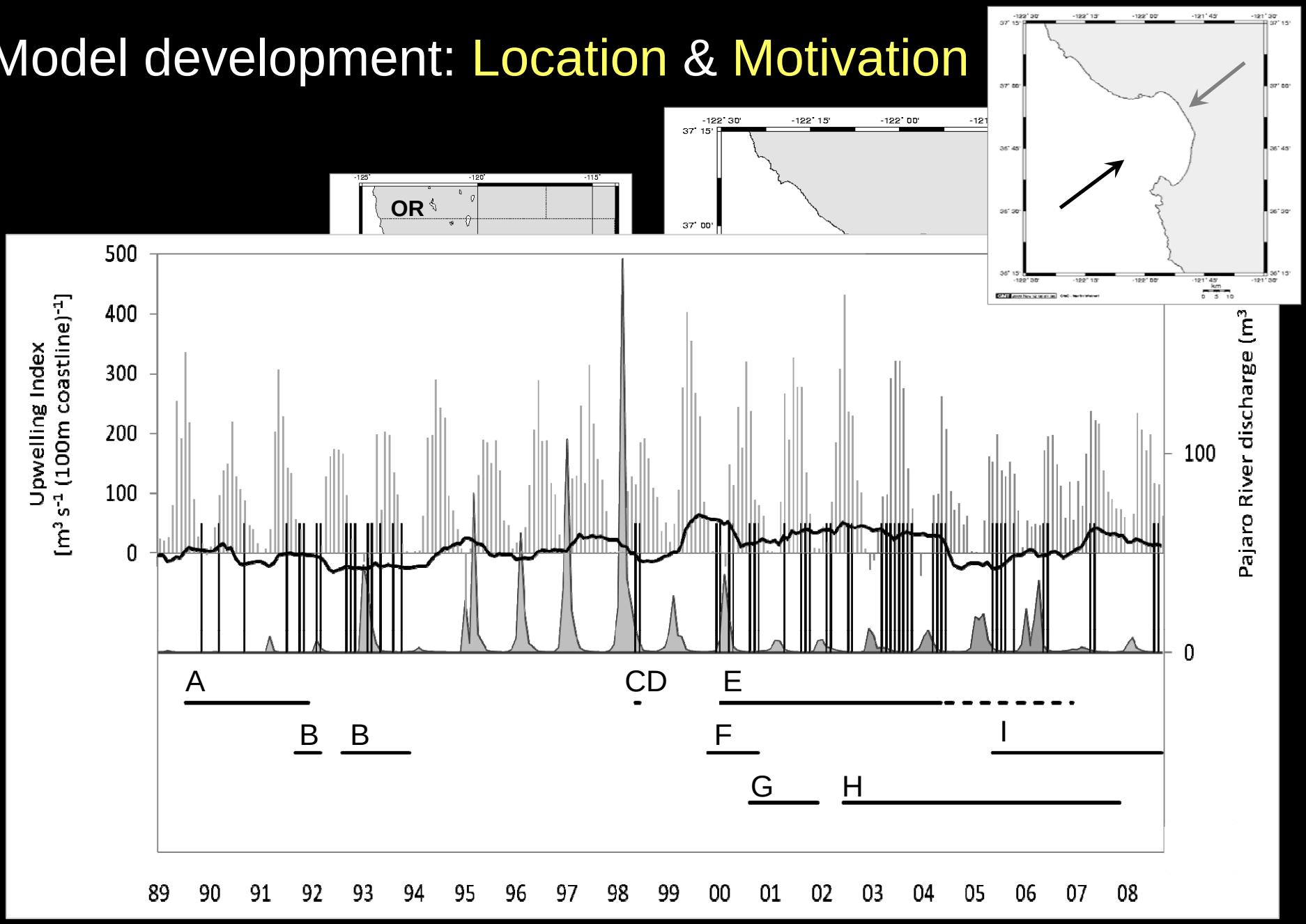


Figure 1. Lane et al. (2009) *Marine Ecology Progress Series*

# Distilling twenty years of observations (plus our own)...

| Number of requisites | Examples of requisites | Model fitness (ROC) |
|---|---|---|
| 1 | Salinity<br>or<br>Silicic acid<br>(etc.) | > 0.4 |
| | | > 0.5 |
| | | > 0.6 |
| 2 | Chl-*a* & 1 more<br>or<br>Upwelling Index & 1 more<br>(etc.) | |
| 3 | Nitrate & 2 more<br>or<br>Temperature & 2 more<br>(etc.) | > 0.7 |
| 2 | Silicic acid & Temperature | |
| 3 | Chl-*a* & Silicic acid & Temperature | > 0.8 |

No fit

Adequate fit

# The models

**Annual model**

LOGIT (p) = 9.763 - 1.700[ln(silicic acid)] + 1.132[ln(chl a)] - 0.800(temperature) + 0.006(upwelling)

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**Spring model** (February 14 - June 30)

LOGIT(p) = 5.835 + 1.398[ln(chl a)] - 1.135[ln(silicic acid)] - 0.549(temperature)

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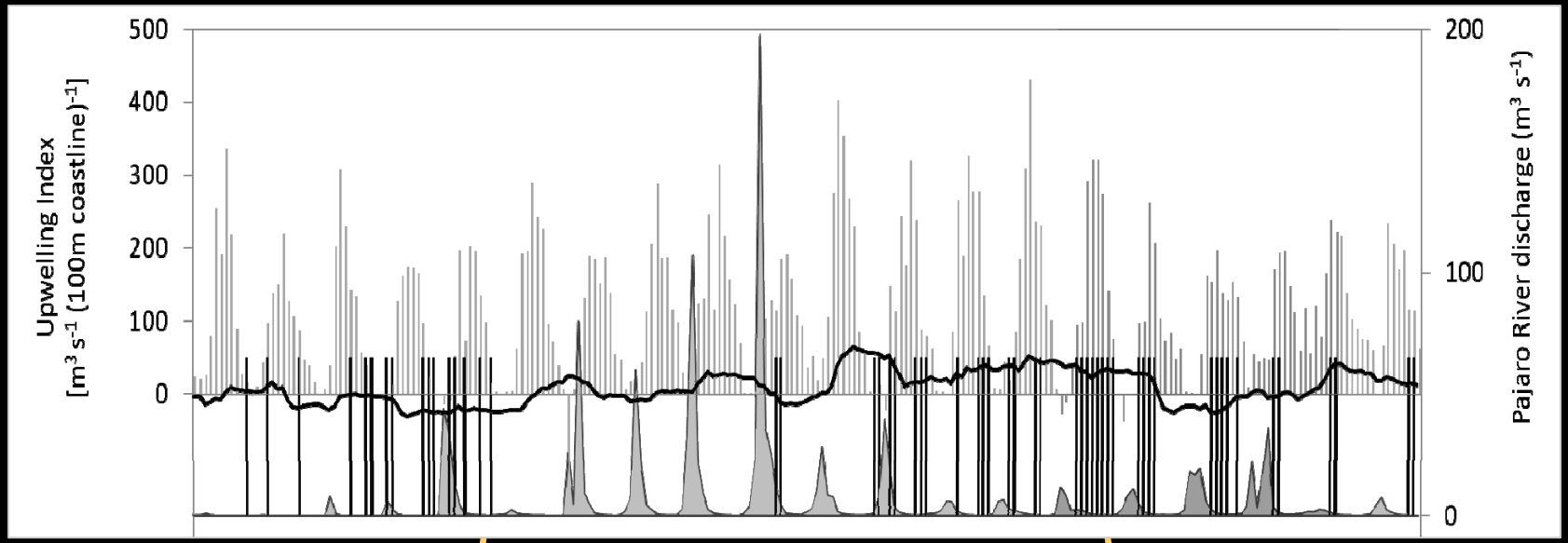
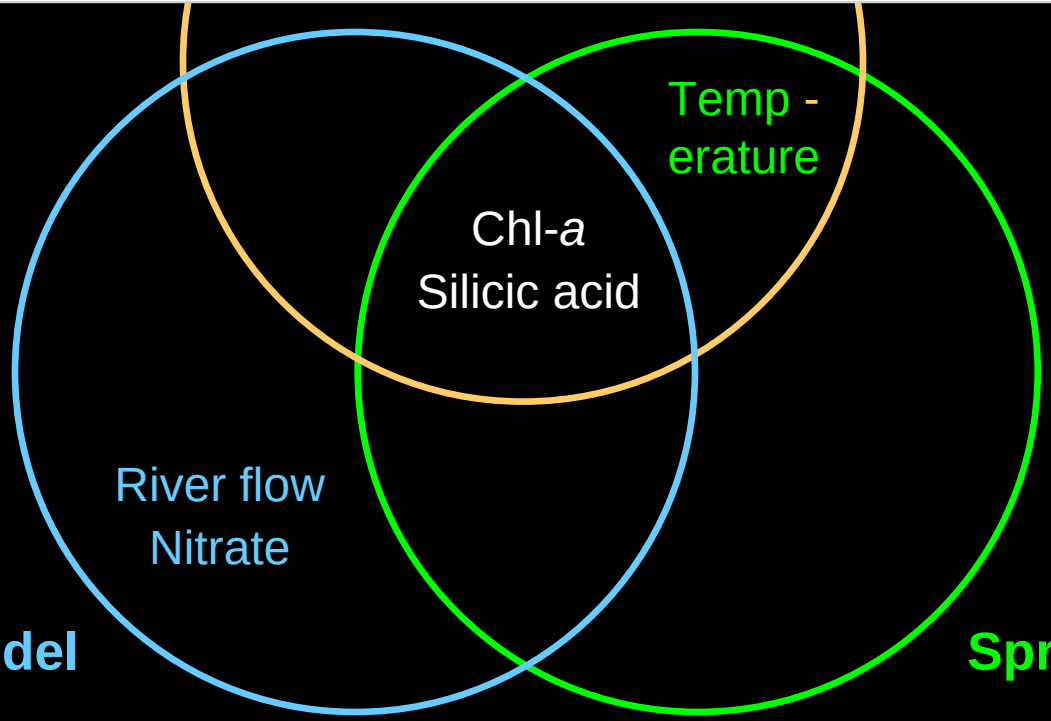
**Fall-Winter model** (July 1 - February 13)

LOGIT(p) = 10.832 - 5.026[ln(Pajaro River)] - 3.893[ln(silicic acid)] + 1.972[ln(chl a)] + 0.652(nitrate)

# Predictor variables



# Predictor variables

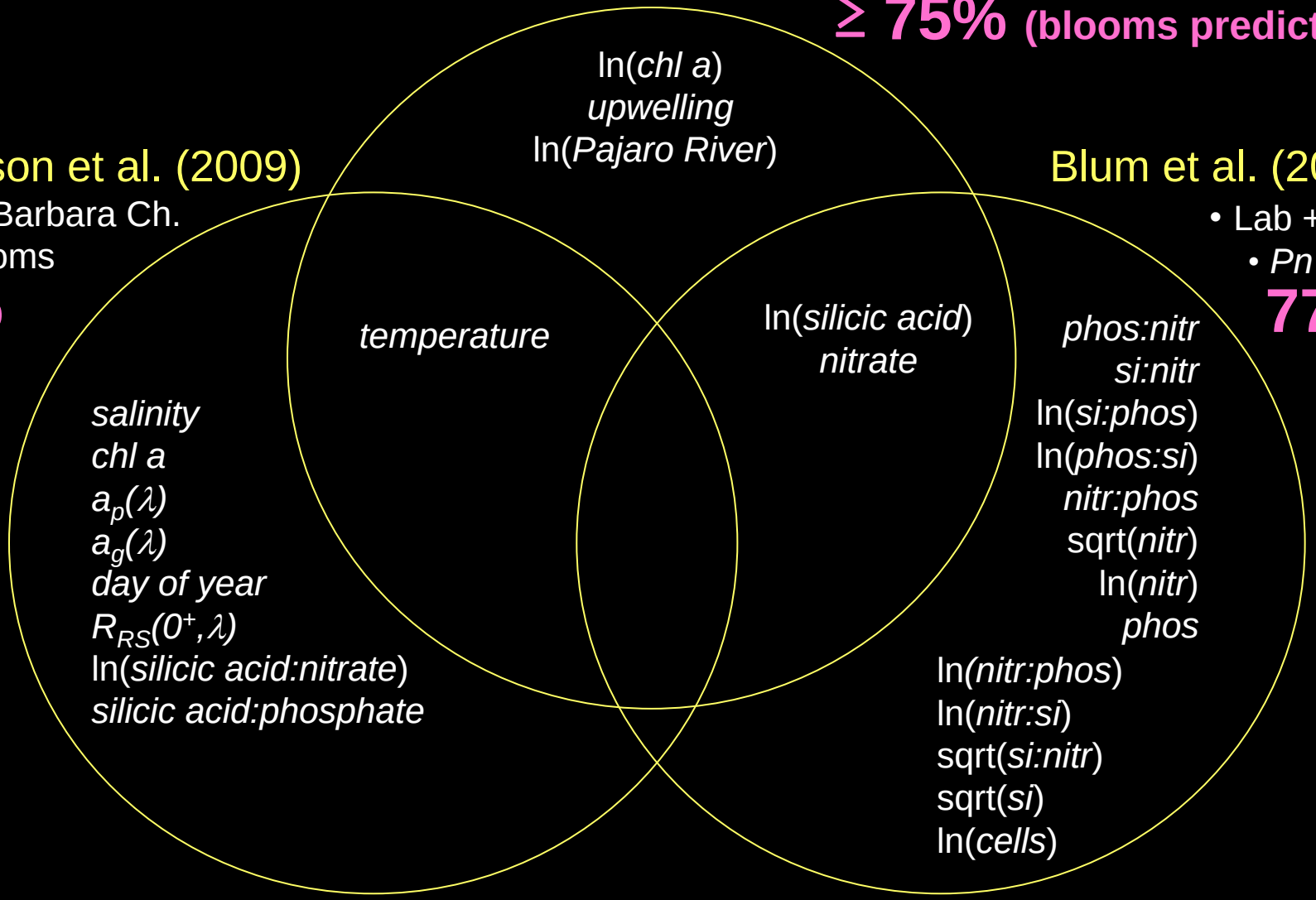
## Lane et al. (2009) versus previous studies

**Chl-*a* anomaly ≤ 56%**

### Lane et al. (2009)

• Monterey Bay; toxigenic *Pn* blooms

**≥ 75% (blooms predicted)**




### Anderson et al. (2009)

• Santa Barbara Ch.

• *Pn* blooms

**75%**

### Blum et al. (2006)

• Lab + field

• *Pn* toxin

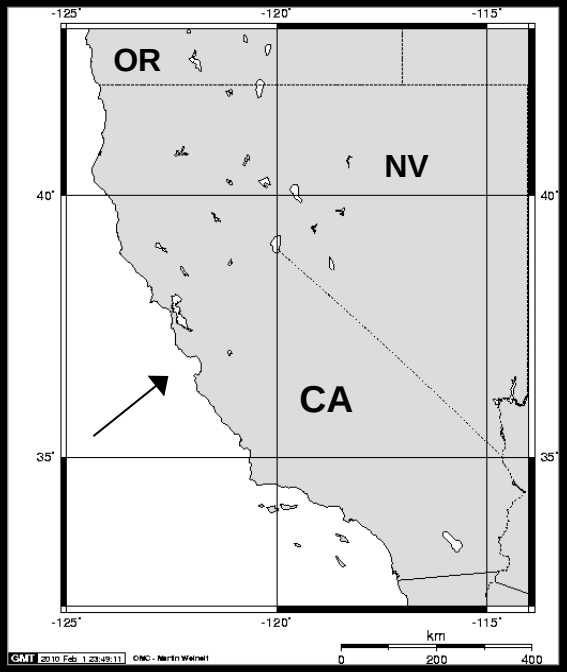
**77%**

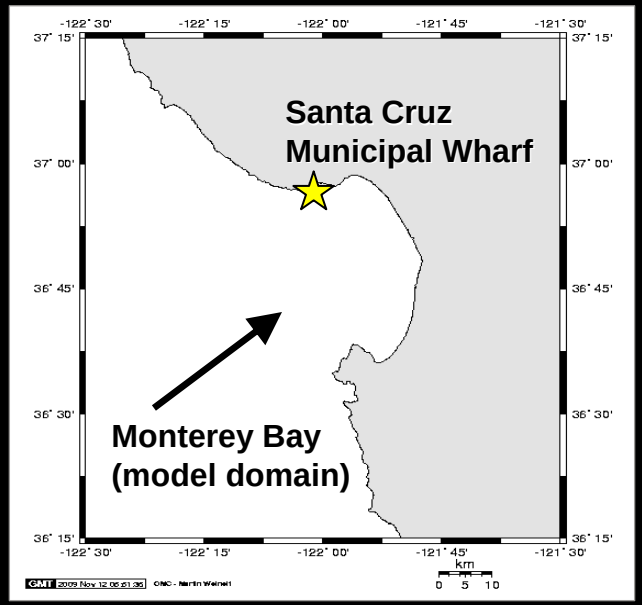
# Development

## Validation

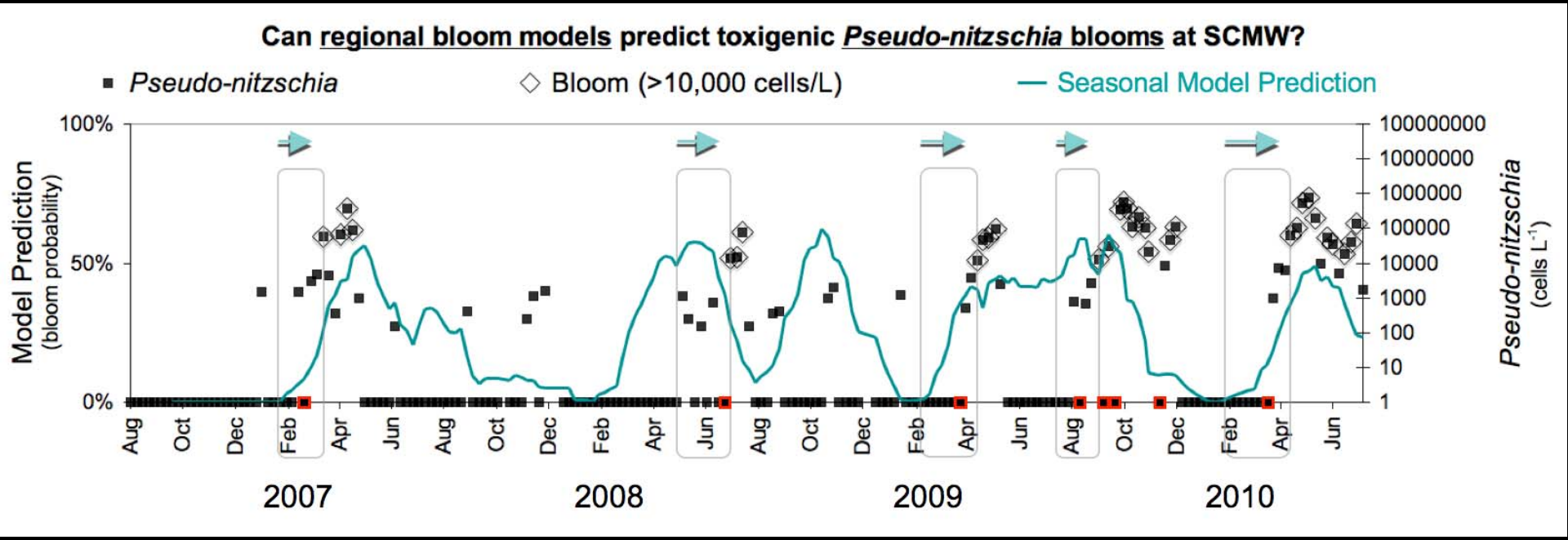
## Application

http://www2.santacruzpl.org




http://oceandatacenter.ucsc.edu

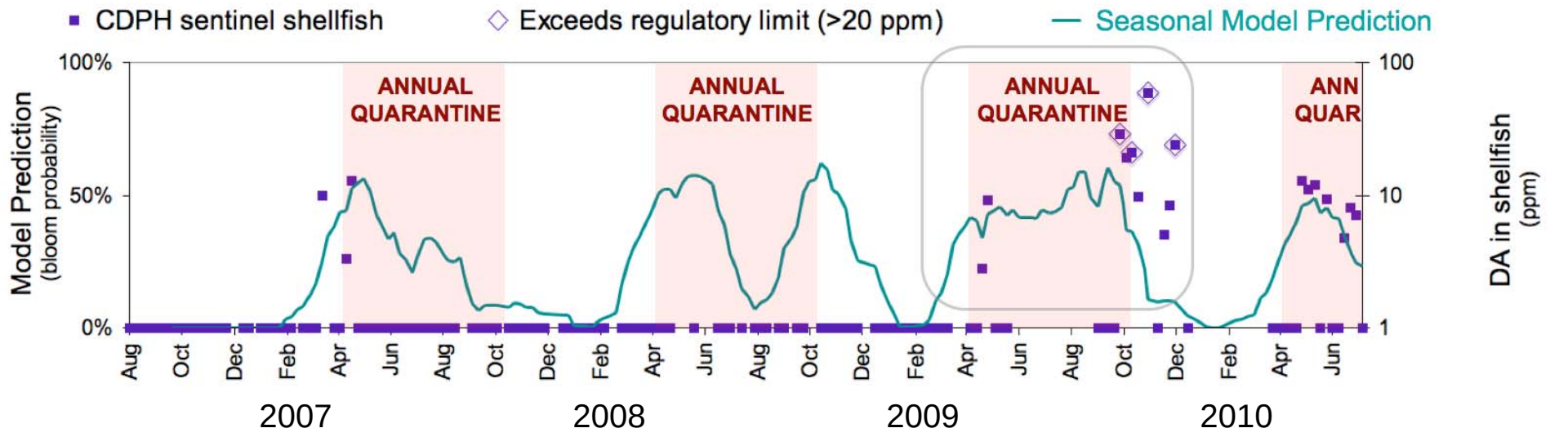



How do predictions from regional bloom models time with bloom observations at SCMW?

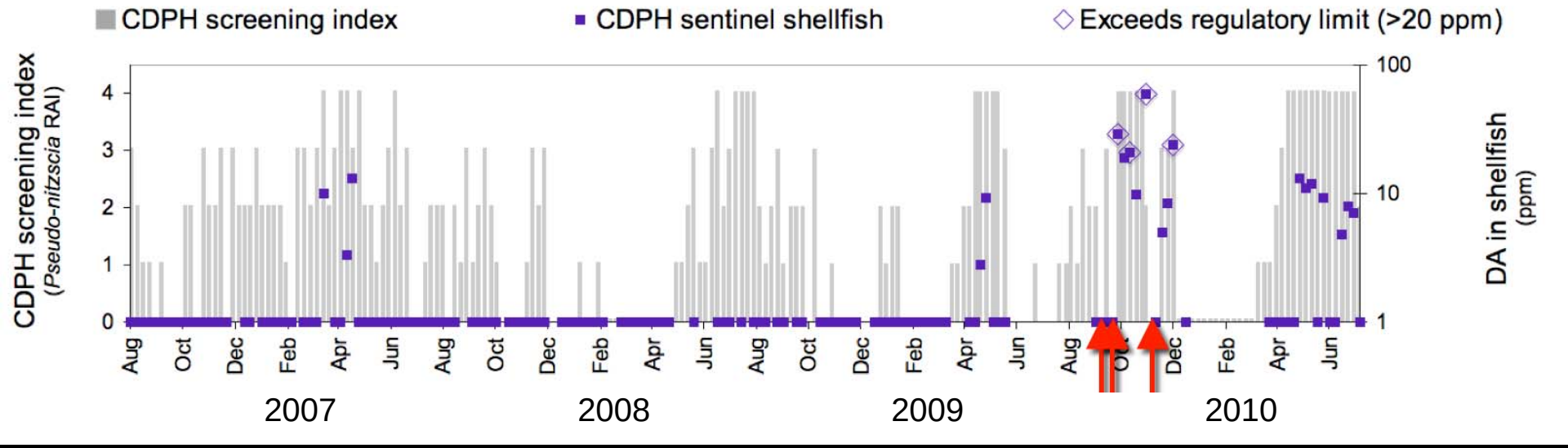
- Bloom predictions precede bloom ‘arrival’.
  Models begin signaling favorable bloom conditions prior to the observation of increasing toxigenic cells.

- Cell counts can remain low (or at zero) up to the week before bloom ‘arrival’, thereby providing no advance warning of a bloom event.

## Can regional bloom models predict shellfish toxicity at SCMW?




## CDPH screening index, used to assess risk of shellfish toxicity at SCMW



# Are the models useful to managers for the prediction of shellfish toxicity at SCMW? → **Yes** (e.g. 2009)


CDPH News Release
CALIFORNIA DEPARTMENT OF PUBLIC HEALTH

**FOR IMMEDIATE RELEASE**
October 28, 2009

**CDPH LIFTS SPORT-HARVESTED MUSSELS QUARANTINE**

**2009**

**Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec**

Fall 2009 toxicity event

Fall-Winter model predictions increased in Sept/Oct, preceding mussel toxicity.

The model predicted blooms through December, predicting mussel toxicity during the quarantine 'off-season'.

Sept 15 : 23%
Sept 23 : 60%
Sept 29 : 88%
Oct 5 : 99%

**Oct → Nov → Dec**
**Toxic shellfish !**

CDPH News Release
CALIFORNIA DEPARTMENT OF PUBLIC HEALTH

**FOR IMMEDIATE RELEASE**
November 13, 2009

**CDPH WARNS CONSUMERS NOT TO EAT SANTA CRUZ COUNTY SPORT-HARVESTED SHELLFISH**

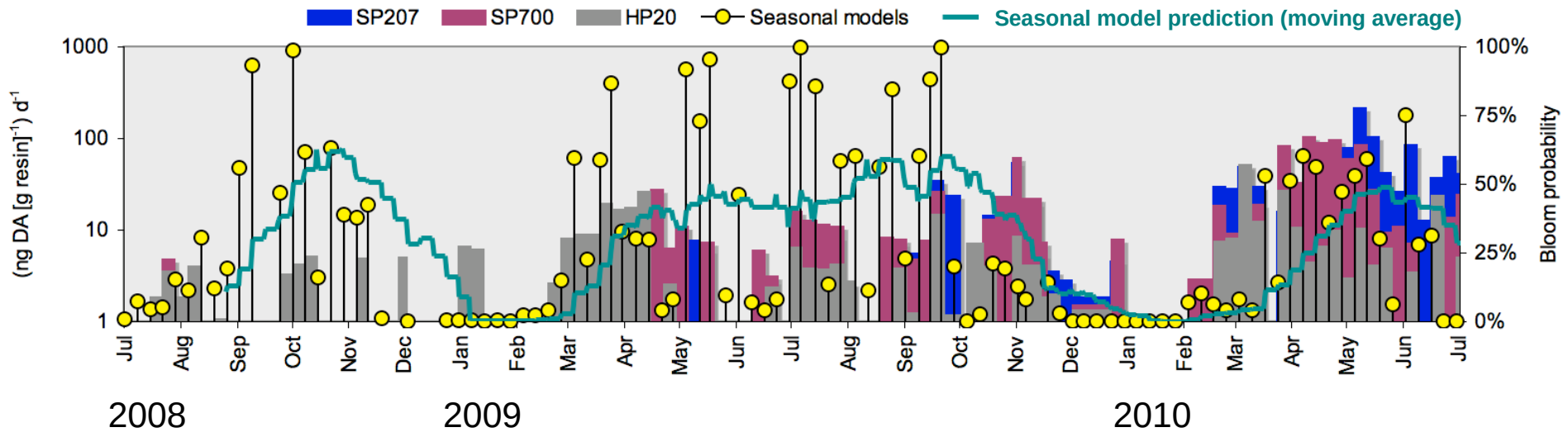
# Solid Phase Adsorption Toxin Tracking (SPATT)

"A simple and sensitive *in situ* (monitoring) method… involves the passive adsorption of biotoxins onto porous synthetic resin filled sachets (SPATT bags) and their subsequent extraction and analysis."
- MacKenzie et al. 2004


K Borchers / San Jose Mercury News


M Roddam / UCSC


M Roddam / UCSC



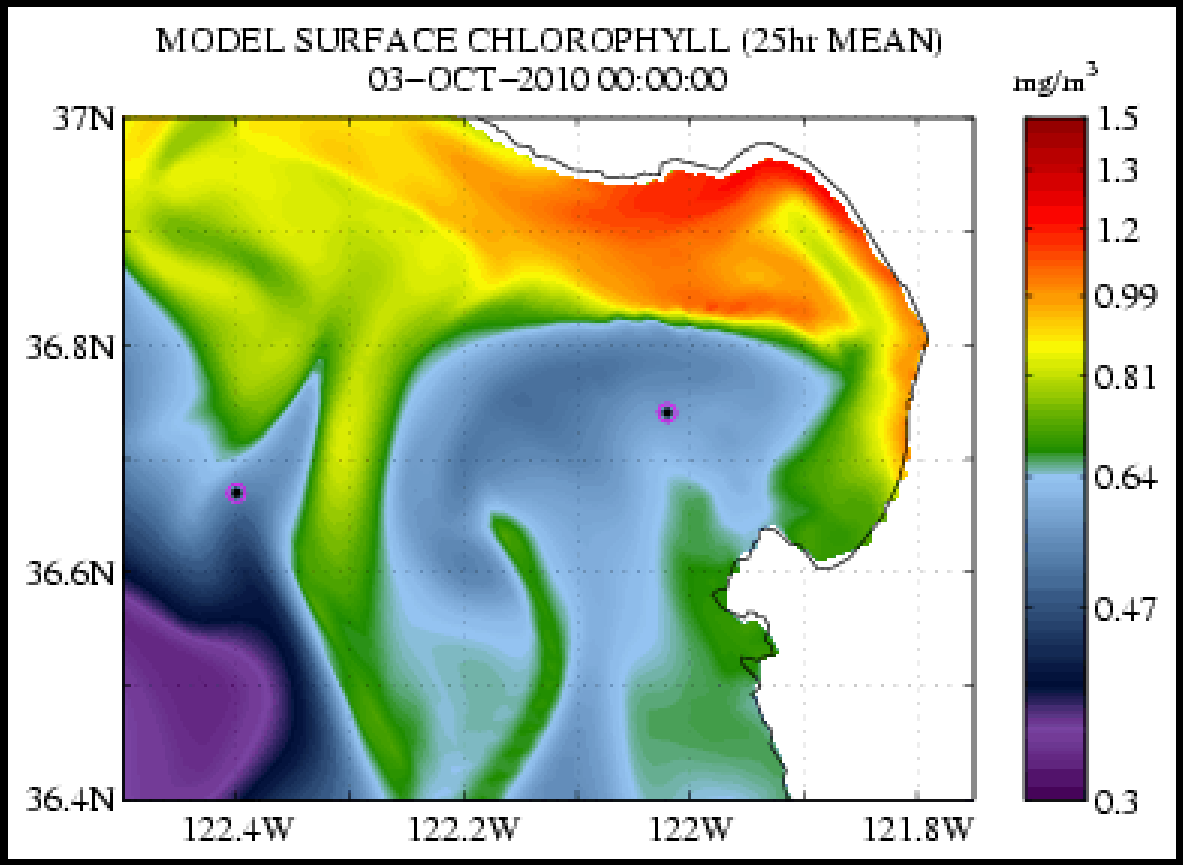

As an integrative sampler, SPATT monitors domoic acid through time (across a week, as deployed at SCMW).

Developed from regional data to describe environmental patterns, the models resolve broad spatial dynamics.

Discrete model predictions and SPATT data match very closely;
the two technologies simultaneously signal bloom conditions (models) and toxin incidence (SPATT) which are otherwise unrecognized and/or unanticipated by RAI, cell counts, etc.

# Looking forward (at 0.4 km resolution)...

- October 2010, Monterey Bay.
- Coupled physical-biological model, running at 400 m resolution.
- Output includes all necessary predictor variables; validation data is available.



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