Tracking, Understanding and Predicting
Toxic Phytoplankton blooms and their effects on King Scallops populations
in the Bay of Seine
(Task 5: ANR Systerra-COMANCHE)

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[1]IFREMER, Laboratoire Environnement et Ressource de Normandie, Avenue du Général de Gaulle, BP 32, 14520 Port en Bessin, France. [2]Equipe Biologie des Ecosystèmes Côtiers, UMR 100 IFREMER - PE2M , Université de Caen Basse-Normandie, Esplanade de la Paix 14032 Caen, France.[3]IFREMER, Service Interfaces et Capteurs, Unité Recherches et Développements technologiques, Technopôle, 29280 Plouzané, France.

BAY OF SEINE: 2 MAJOR TOXIC EVENTS

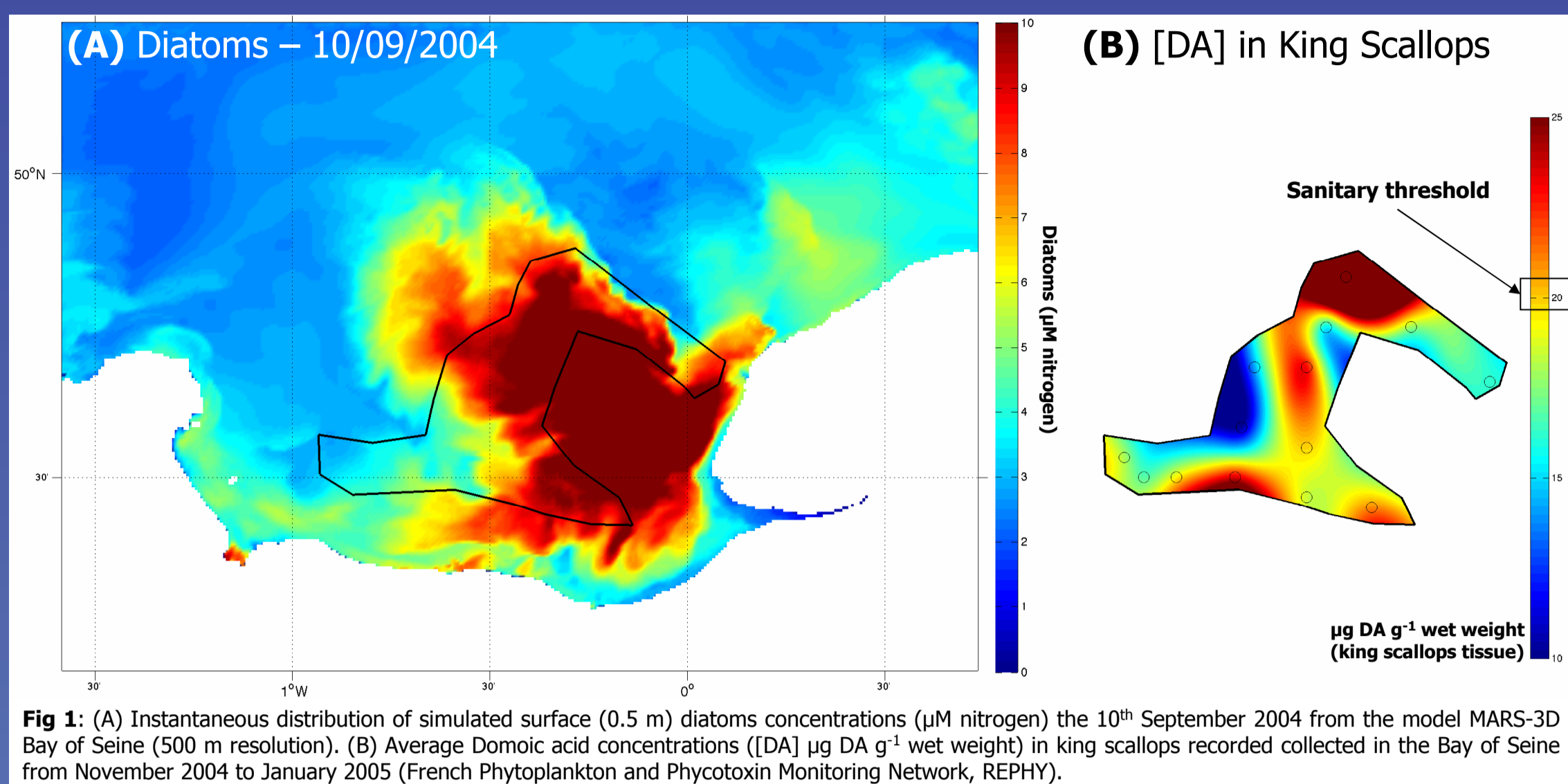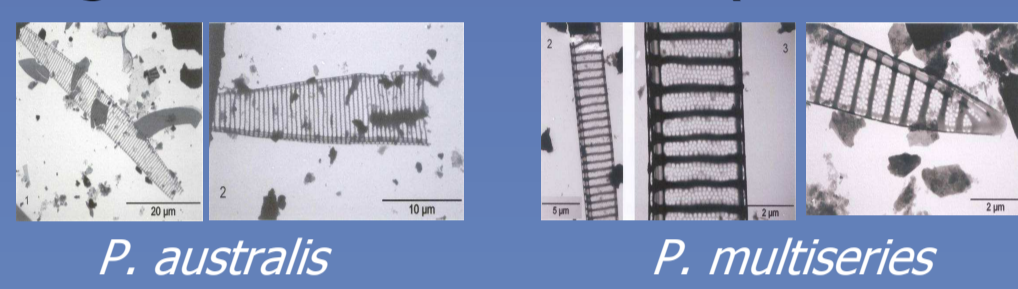### 2004 – Amnesic Shellfish Poisoning (ASP)

Fig 1: (A) Instantaneous distribution of simulated surface (0.5 m) diatoms concentrations (µM nitrogen) the 10th September 2004 from the model MARS-3D Bay of Seine (500 m resolution). (B) Average Domoic acid concentrations ([DA] µg DA g[-1] wet weight) in king scallops recorded collected in the Bay of Seine from November 2004 to January 2005 (French Phytoplankton and Phycotoxin Monitoring Network, REPHY).

❖ Intense bloom of diatoms in September 2004 (Fig. 1A)
❖ [DA] > sanitary threshold (i.e. >20 µg DA g[-1] ww) from Nov. 2004 to Jan. 2005 (Fig. 1B)

2 *Pseudo-nitzschia* species were identified as the potential source of DA during the 2004 toxic event (Nézan et al. 2006)

P. australis   *P. multiseries*

CLOSURE OF KING SCALLOPS HARVESTING SITES IN 2004 & 2005

❖ King scallops, *Pecten maximus*, is the first species in landing (in tons and value) for the fishing fleet in the Bay of Seine.

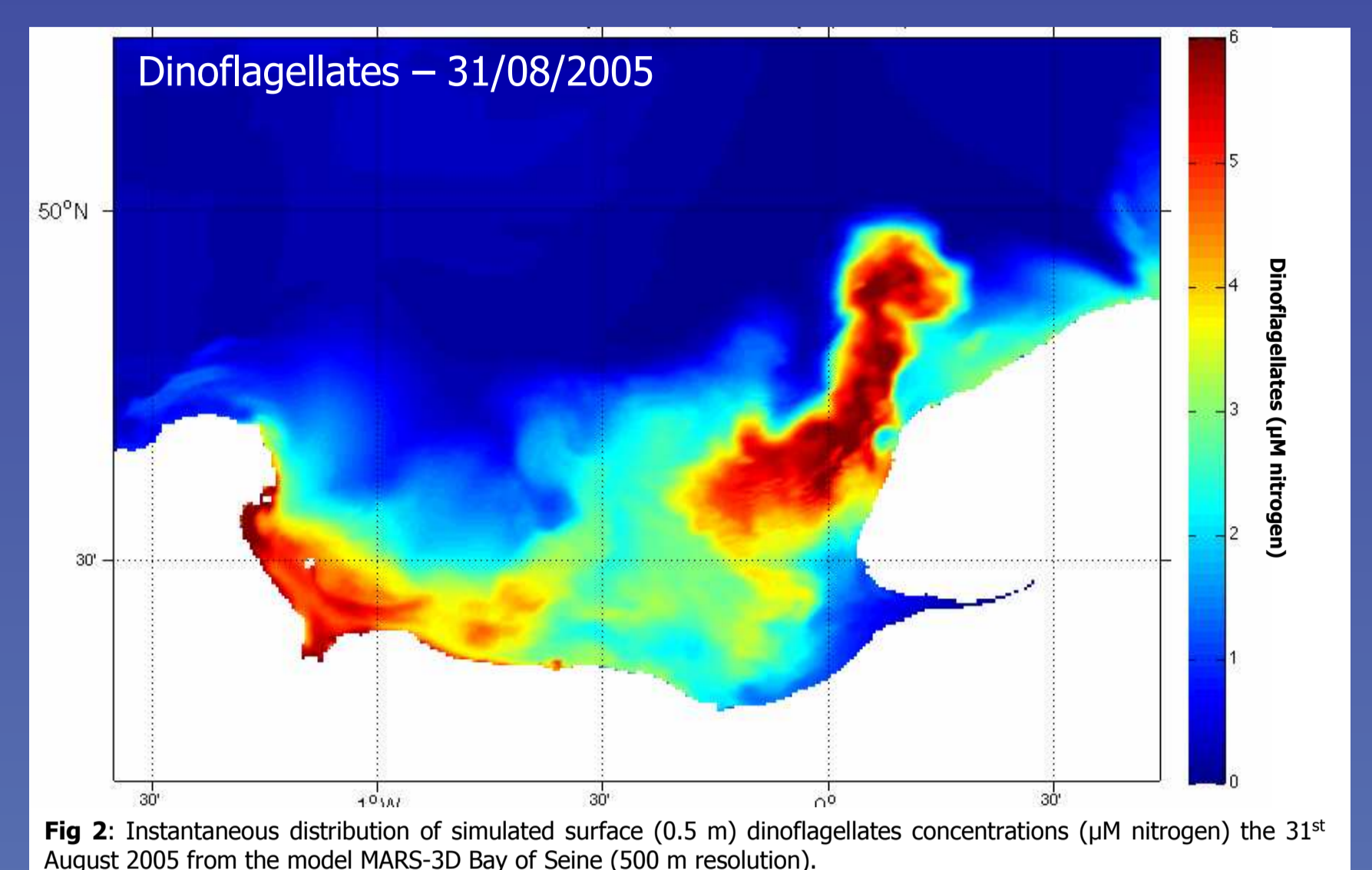### 2005 – Diarrheic Shellfish Poisoning (DSP)

Fig 2: Instantaneous distribution of simulated surface (0.5 m) dinoflagellates concentrations (µM nitrogen) the 31st August 2005 from the model MARS-3D Bay of Seine (500 m resolution).

❖ Many blooms of dinoflagellates were observed in July/August 2005 (Fig. 2)
❖ Positive DSP mouse bioassays & very high [OA+DTX3] from Oct. to Dec. 2005 (Amzil et al. 2007)

Dinophysis sp. was identified as the source of OA during the 2005 toxic event (Amzil et al. 2007)

D. cf. acuminata

AN IMPROVED UNDERSTANDING OF THE DETERMINISM OF THESE TOXIC BLOOMS IS CRITICALLY NEEDED
TO DEVELOP LONG TERM MANAGEMENT STRATEGIES FOR KING SCALLOPS FISHERIES IN THE BAY OF SEINE

ONE TASK OF THE COMANCHE PROJECT
(Ecosystems interactions and anthropogenic impacts on King scallops populations in the English Channel)

UNDERSTANDING PAST EVENTS & MONITORING TOXIC PHYTOPLANKTON BLOOMS
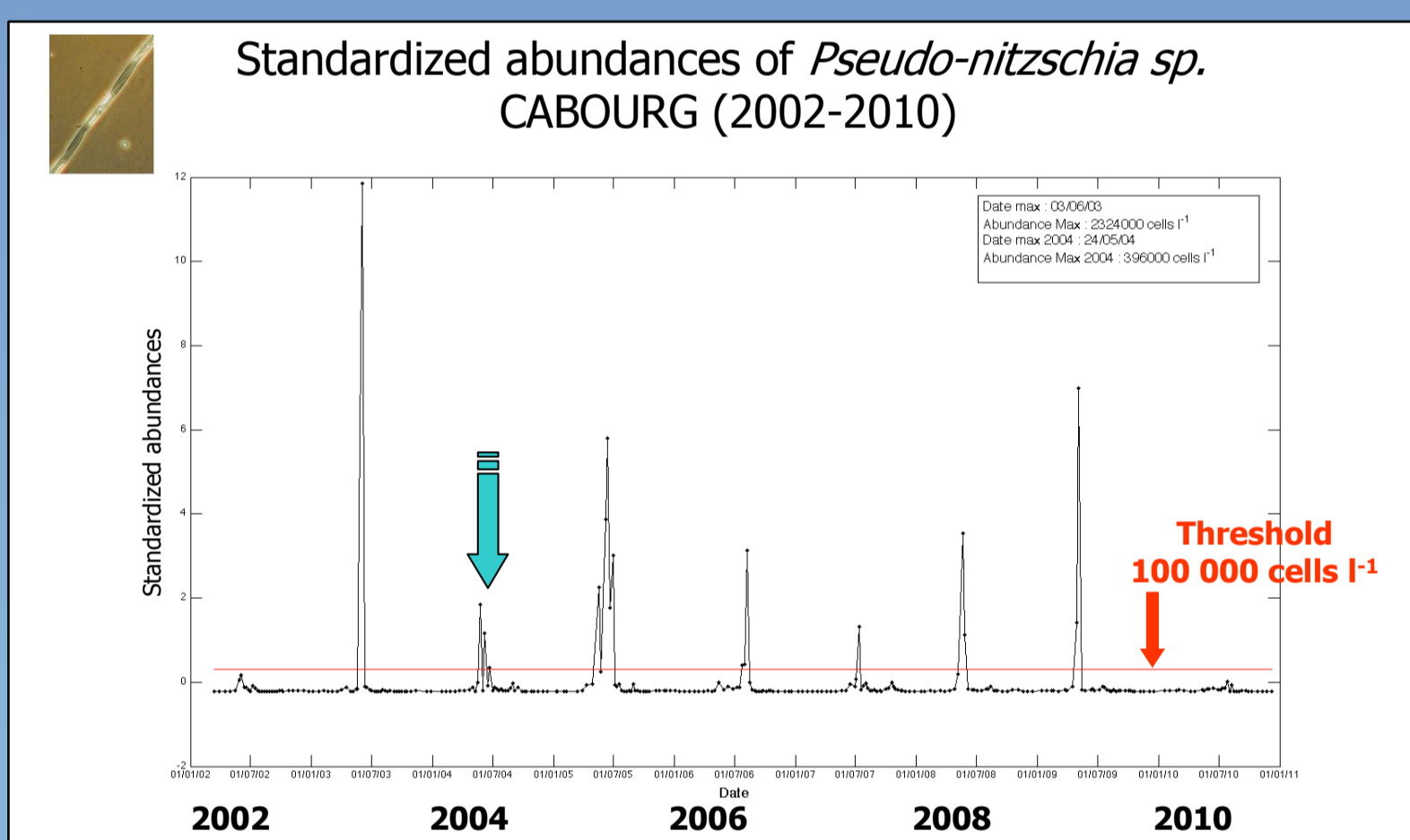

Fig 3: Standardized abundances of *Pseudo-nitzschia* sp. recorded at the REPHY sampling site 'Cabourg' (cf. Fig. 5) from 2002 to 2010 (data source, REPHY). The green arrow indicates the 2004 toxic event. The red line represents the sanitary threshold (i.e. 100 000 cell l[-1]).

❖ Survey ASP and DSP toxicity levels in king scallops in relation with the proliferation of toxic phytoplankton blooms (French Phytoplankton and Phycotoxin Monitoring Network, REPHY)

❖ Study past toxic events (ASP & DSP) in relation with the variability of environmental parameters and climatic events (REPHY and RHLN data; Normandy Hydrology Monitoring Network)

LIMITATIONS
❖ Identification of toxic species
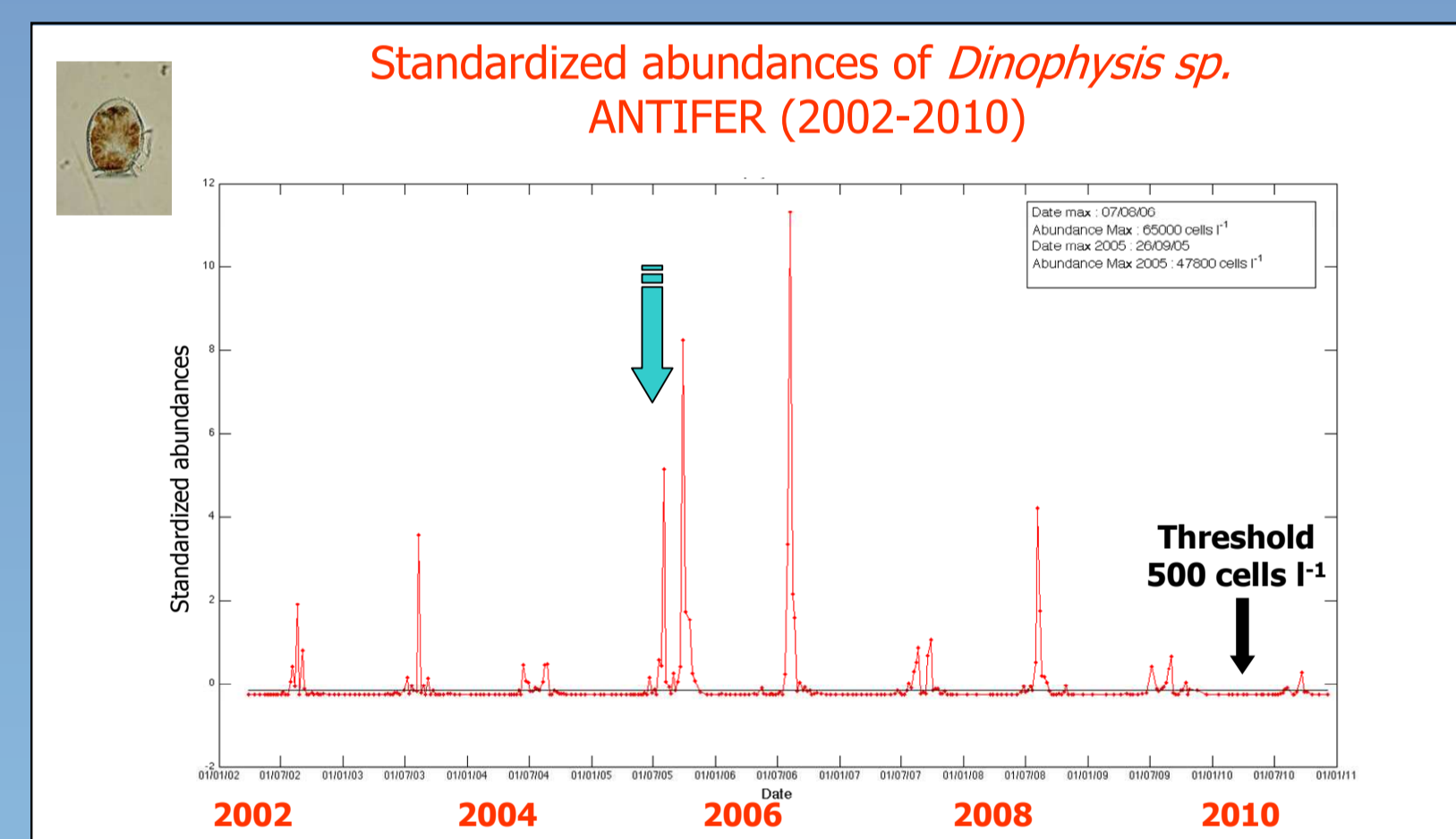❖ Eco-physiology poorly documented

Fig 4: Standardized abundances of *Dinophysis* sp. Recorded at the REPHY sampling site 'Antifer' (cf. Fig. 5) from 2002 to 2010 (data source, REPHY). The green arrow indicate the 2005 toxic event. The black line represents the sanitary threshold (i.e. 500 cells l[-1]).
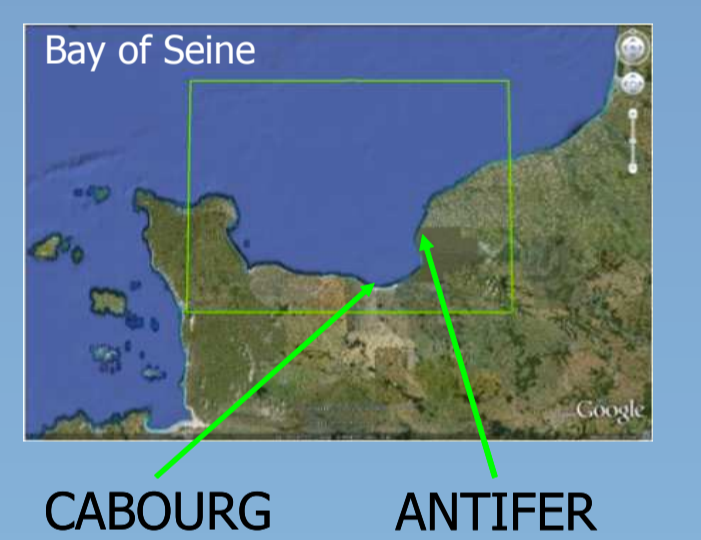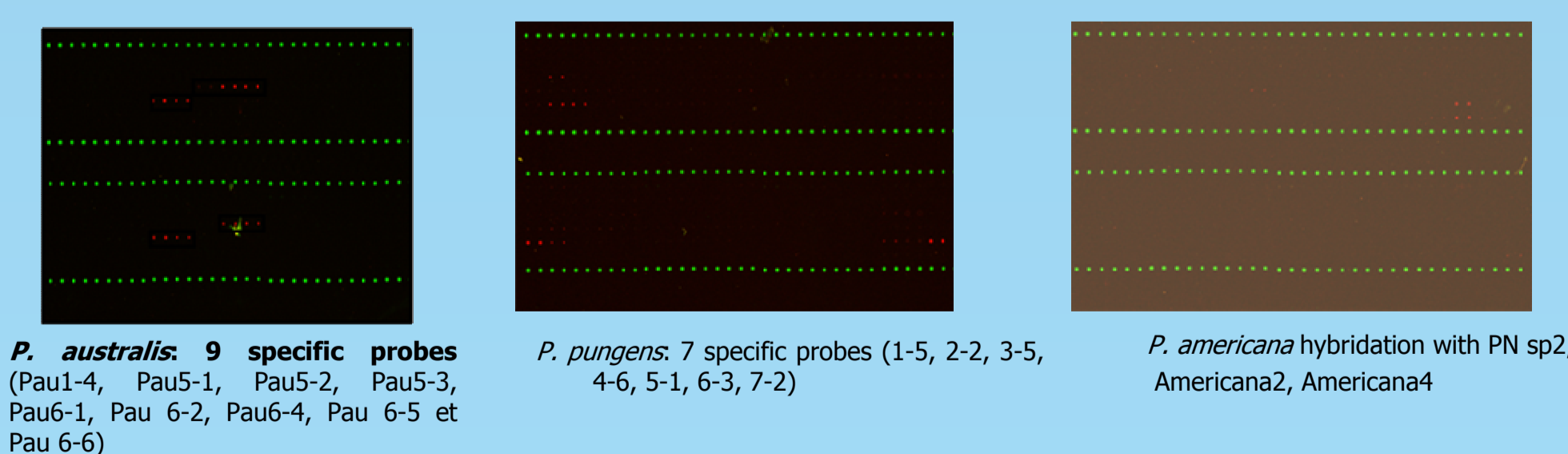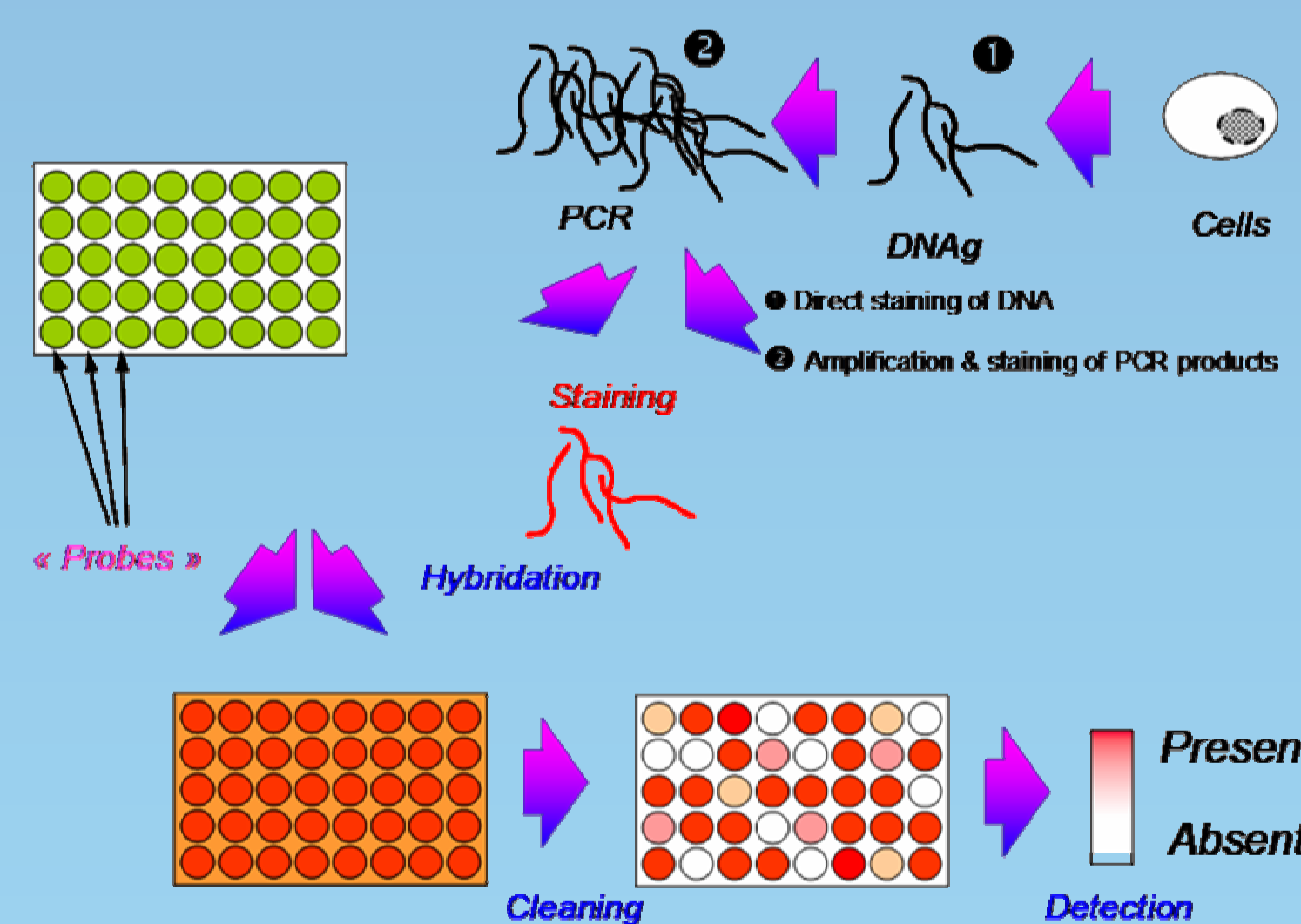
Fig 5: Location of the REPHY sampling sites 'Cabourg' and 'Antifer.

TRACKING:
DEVELOPMENT OF DNA MICROARRAYS FOR PHYTOPLANKTON IDENTIFICATION = "PHYTOCHIPS"
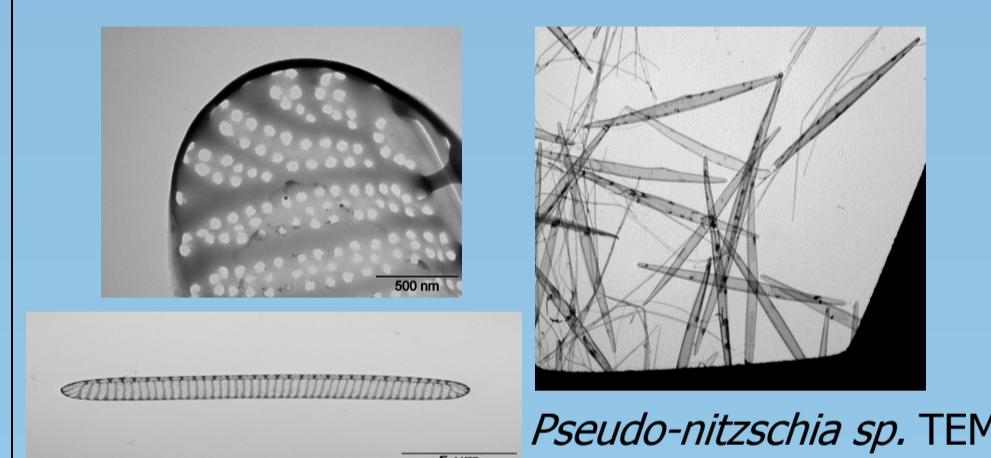
❖ A microarray has been designed using oligoprobes (25 mers) matched to toxic microalgae ribosomal RNA.

❖ For *Pseudo-nitzschia sp*, labelled target DNA was prepared by polymerase chain reaction amplification of ITS region using a Cy5-labeled primers. DNA was extracted from monoclonal cultures. Hybridization was performed according to the method described by Le Berre et al. (2003).

❖ **Preliminary data** show that the current chips can specifically detect and discriminate *P. americana*, *P. pungens*, *P. australis*, *P. multiseries* and *P. fraudulenta*.

P. australis: 9 specific probes (Pau1-4, Pau5-1, Pau5-2, Pau5-3, Pau6-1, Pau 6-2, Pau6-4, Pau 6-5 et Pau 6-6)

P. pungens: 7 specific probes (1-5, 2-2, 3-5, 4-6, 5-1, 6-3, 7-2)

P. americana hybridation with PN sp2, Americana2, Americana4

ECOPHYSIOLOGY OF TOXIC PHYTOPLANKTON

❖ **Identification** of the different *Pseudo-nitzschia* strains present in the Bay of Seine using Transmission Electronic Microscopy (TEM).

Pseudo-nitzschia sp. TEM

❖ **Isolation & culture** of the different *Pseudo-nitzschia* strains

❖ **Eco-physiology** of the different *Pseudo-nitzschia* strains

❖ Light
❖ T°C
❖ Nutrients (N, P, Si)
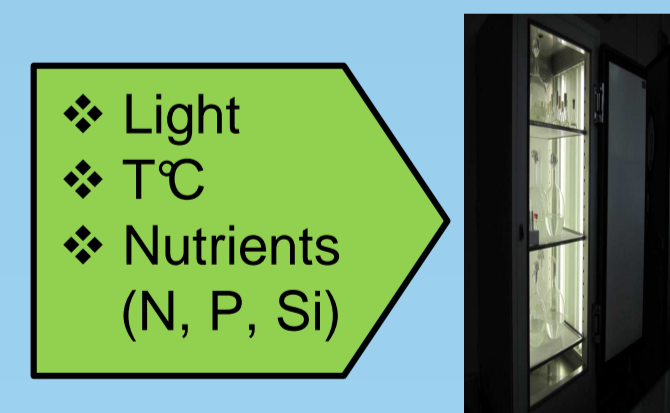
Growth
Photosynthesis
Physiological state
Production of domoic acid

P. Fraudulenta *
From Claquin *et al* 2008
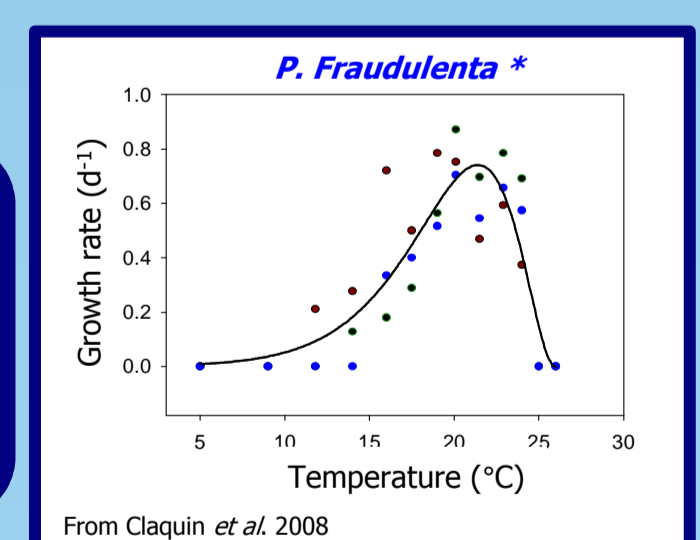
❖ **Biological & physiological "ID card"** for each strains isolated in the Bay of Seine

Pseudo-nitzschia pungens
✓ Size (min-max)
✓ Maximum growth rates
✓ Optimal growth conditions (temperature, light)
✓ Photosynthetic parameters
✓ Domoic acid production

PREDICTING TOXIC PHYTOPLANKTON BLOOMS IN THE BAY OF SEINE

❖ The **Hydro-biological model, MARS3D** has recently been refined for **the Bay of Seine (500 m resolution)**.
❖ Different phytoplankton groups (i.e. diatoms, dinoflagellates and nanophytoplankton) have been incorporated to the physical model (**cf. Fig. 1&2**).
❖ **This model** has been **validated** with the data set provided by the RHLN (Normandy Hydrology Monitoring Network).
❖ Finally a representation of a **toxic diatom - *Pseudo-nitzschia* –**will be added.

References cited:
Amzil et al. (2007) Sixth International Conference on Molluscan Shellfish Safety, 307-314.
Claquin et al. (2008) Aquatic Microbial Ecology, 51, 1-11.
Le Berre et al. (2003) Nucleic acid Research, 31 (16) e88.
Nézan et al. (2006) Harmful Algae News, 31, 1-3.