



PRAGMA – A pragmatic and integrated approach
for the evaluation of environmental impact of oil and
chemical spilled at sea: input to European guidelines

EU DG-ENVIRONMENT agreement
number 07.030900/2005/429172/SUB/A5





Kick-off meeting EU-PRAGMA 27 March 2006



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EU call 2005 framework: accidental or deliberate marine pollution

4- Environmental impact of oil spills and other harmful substances

The objective of the action is to analyse the short, medium and long term environmental impact of previous oil and chemical spills, in order to establish criteria and guidelines to define a correct way on monitoring, assessment, and intervention techniques.

More specifically, the action could include the analysis of the behaviour and fate of oil, HNS, and dangerous goods lost at sea in past incidents, exercises, and experiments in order to prepare a code of good practice of incident monitoring.

With a view to assessing their environmental impact, it could also include an analysis of the instruments and techniques capable of detecting and mapping submerged oil and/or other pollutants on the sea-bed.

Expected outcome from the action:

- Guidelines on minimisation of environmental damage in case of marine pollution focusing on organisational and practical aspects.
- Criteria and methodologies regarding the environmental impact of oil, HNS, and dangerous goods lost at sea.

Type of action: training courses and/or workshops and/or pilot projects.



Proposal

- How to estimate the **environmental impact** of spill ?
- Is the **recovered** system identical to the **pre-spill situation** ?
- How to **harmonise communication** of environmental status to decision-makers at the EU level ?
- What can we suggest **practically** to rapidly and hence **cost-effectively** prepare and conduct monitoring in the field in case of accidental spill ?



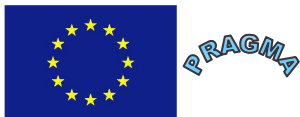
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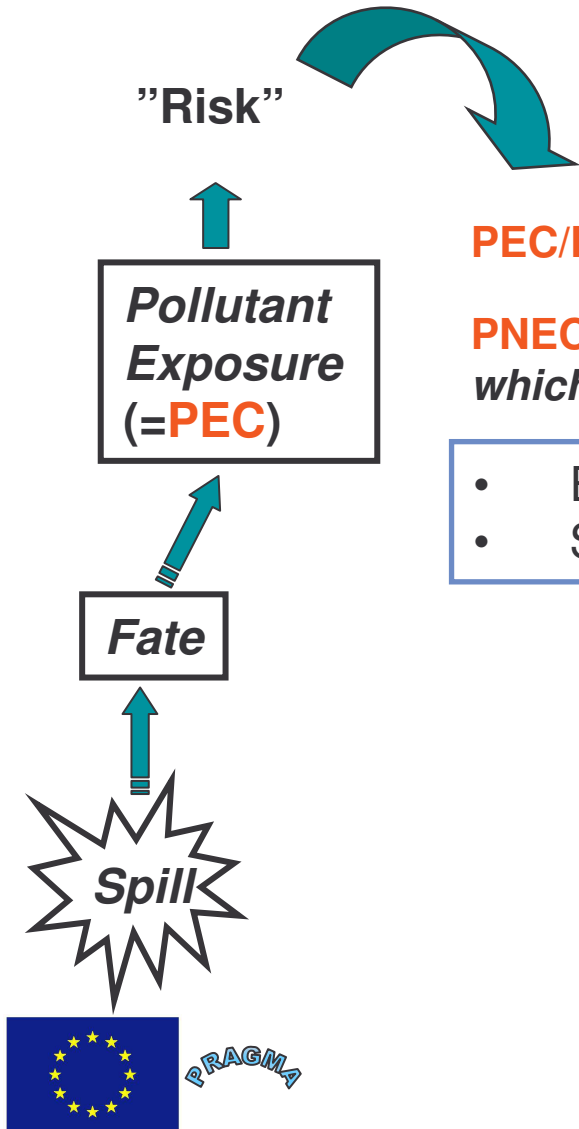
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Pragma in brief ...

- Implement well-established methodologies based on **biological markers** and **integrate** them in current **EU guidelines** as decision-making criteria for the assessment of environmental **impact** in disaster accident (oil & chemical)
- Propose a **pragmatic** monitoring approach based on simple, cost-effective analytical tools like **biosensors** as "first level" monitoring techniques used *in situ*



Current EU approach



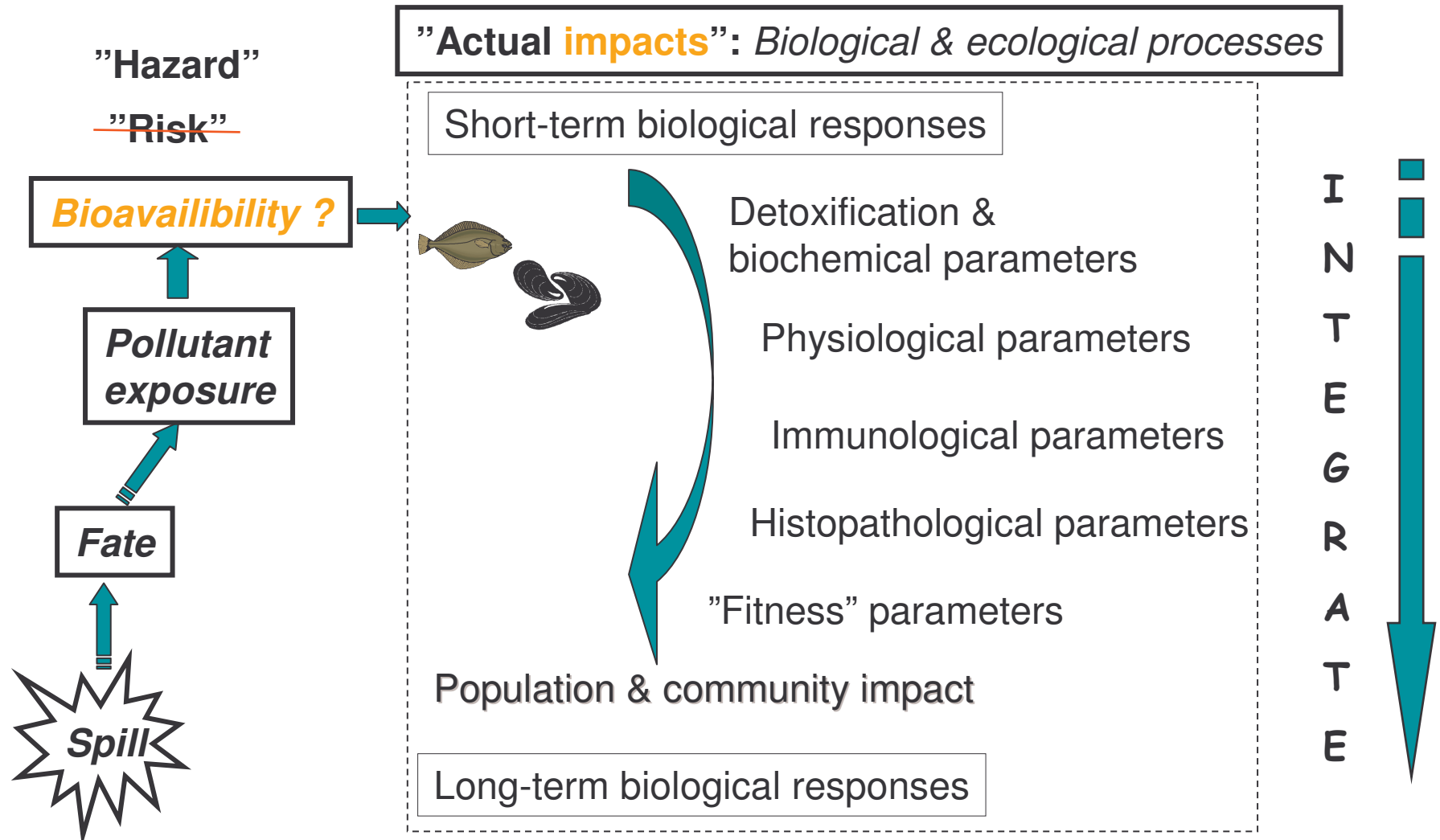
PEC/PNEC

PNEC definition after EU-TGD \approx "The concentration below which *unacceptable effects* on organisms will *most likely* not occur"

- Experimental LOEC / **Assessment factor**
- SSD – concentration that affects **5% of the species**



Alternative approach

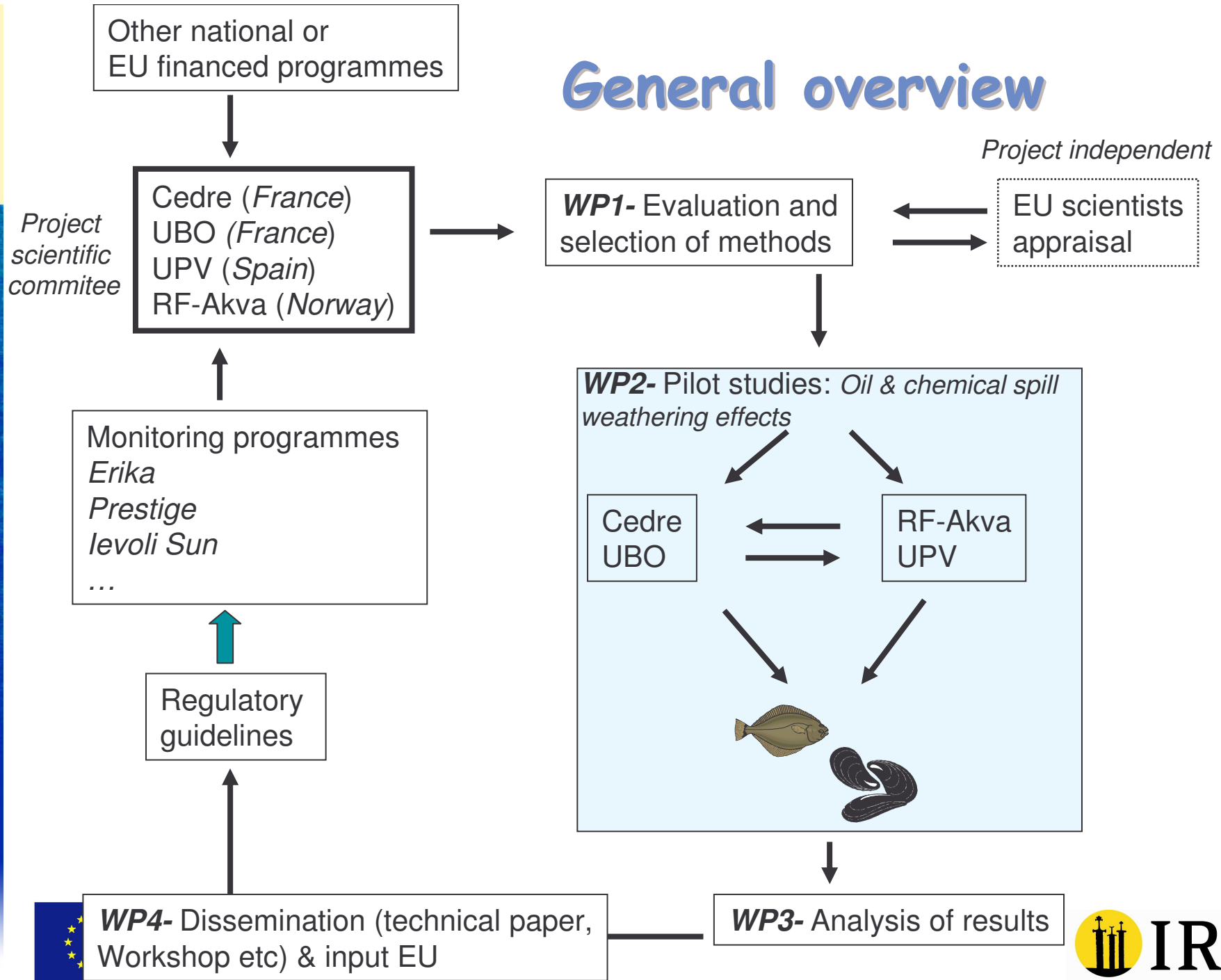


Link to the EU call: "...impact of previous oil and chemical spills..."

- Heavy oil (*Prestige, Erika*)
 - ✓ Low degradation rate, relatively high percentage of potentially toxic compounds e.g. PAH
 - ✓ Bioavailability, resuspension during occasional events
 - ✓ Long-term effect
- Chemical (*levoli Sun* → styrene)
 - ✓ Toxicity mostly assessed from tests in freshwater
 - ✓ Short-term effect i.e. few existing data for chronic toxicity
 - ✓ Need for a refined environmental impact assessment



General overview

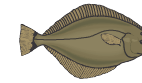


WP1 - Selection of methodologies: the 3 "bio"

- **Biomarker**
 - ✓ Prioritize **easy-to-perform** methods
 - ⇒ (no need for sophisticated instrumentation, facility nor top-trained staff)
 - ✓ "Effect" markers
 - ⇒ General health status
 - ⇒ Fitness assessment
 - ✓ OSPAR/IMO "recommended" biomarkers
- **Bioassay**
 - ✓ Link to population effect
- **Biosensors**
 - ✓ Cost-effective tools to "screen" for potential damaging substances or effects with large potential for **on site** applicability
- Chemistry – Water, body burden



WP1: Proposed methodologies (1)



Exposure

body burden
peroxisome proliferation

EROD
biliary metabolites (FF)

Effect

Genotoxicity

Comet assay

Micronuclei

Endocrine

ALP assay

Vtg/Zrp (Elisa)

Physiology

Lysosomal membrane stability

Haematology

Clearance rate

Homeostasis (gas,

Survival in air

osmolarity)

CI

Lipid

Histology

Digestive gland

Liver, Gonad

gonad, gills

gills

Immunology

Hemocyte counts

blood cell counts

Phagocytic index

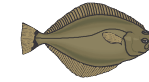


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WP1: Proposed methodologies (2)



Bioassay

Fecundity success
Larvae deformities
Development

(Bio)sensor

Several methodologies i.e. DNA biosensor,
HRP biosensor, "on-line" sensors etc ...

Chemistry

Seawater & uptake by GC-MS (PAH), UV Spectro-
meter (Styrene)





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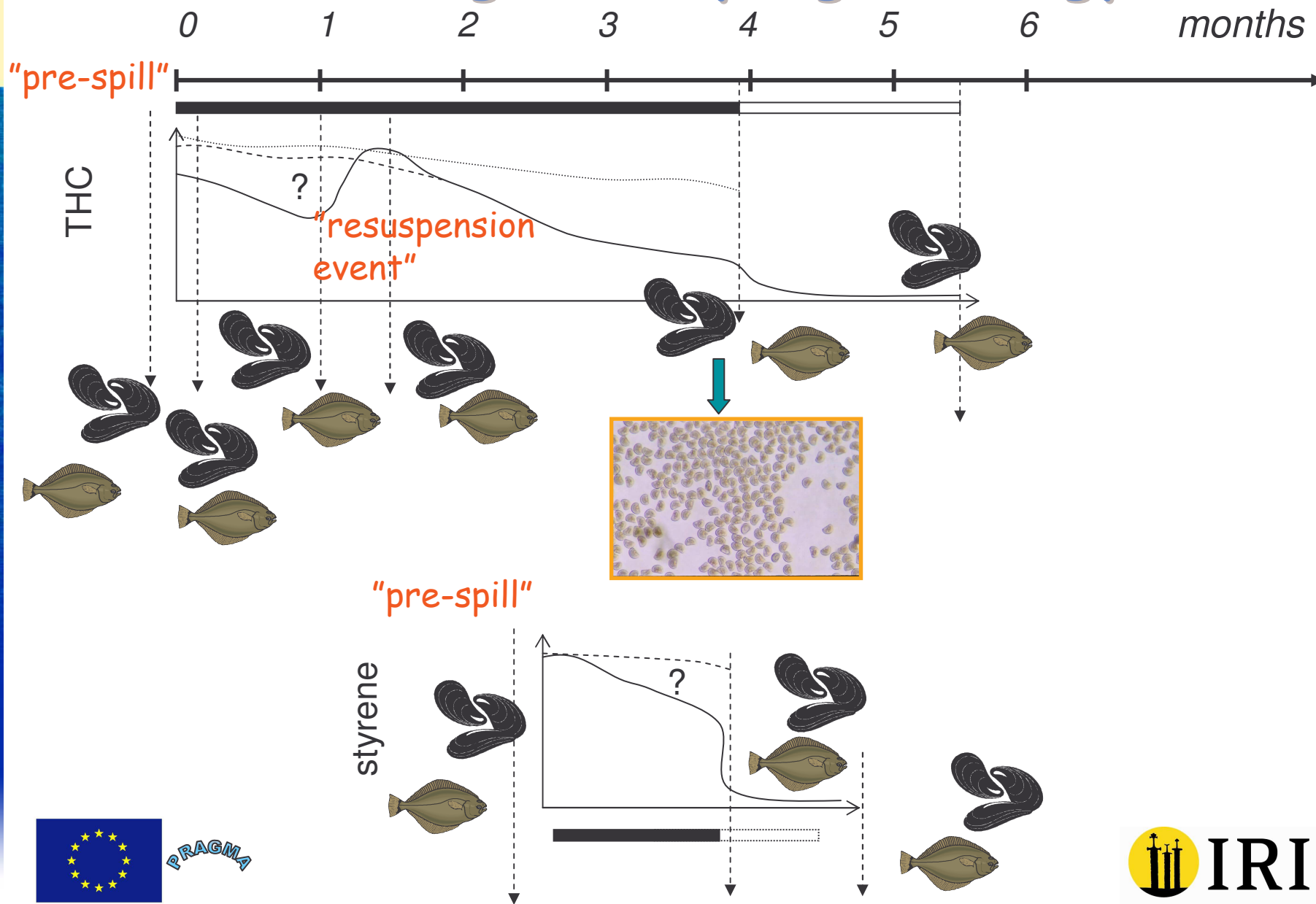
WP2 – Pilot studies

- Selection of species  
- Exposure simulating weathering processes following spill
 - ✓ Heavy oil
 - ⇒ Surface and coated to sediment
 - Water Soluble Fraction (WSF)
 - ⇒ Resuspension of oil after storm (“intermittent pulse”)
 - ⇒ Low degradability → expect relatively high level
 - ⇒ 4 to 5 months exposure + 1 month recovery
 - ✓ Styrene
 - ⇒ Surface
 - ⇒ High evaporation/degradation → expect low level
 - ⇒ 1 month exposure + 1 to 2 weeks recovery



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Envisaged sampling strategy



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WP3 - Analysis of results

- Goal → **Integrate** each individual measurement into a **simple and easy-to-visualize environmental assessment index** of the overall health status
 - ✓ Multivariate-based approach
 - ⇒ MPI (multimarker pollution index; Narbonne *et al.*)
 - ⇒ IBR (integrated biomarker response; Beliaeff and Burgeot)
 - ✓ Other approach
 - ⇒ I.Q. (marine environmental quality index; Pampanin, Larsen and Ravagnan → on-going NFR project)
 - ⇒ B.A.I (bioeffect assessment index; Broeg *et al.*)
 - ⇒ Modeling
 - BSD (biomarker sensitivity distribution; Sanni *et al.*, on-going NFR project)



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WP4 - Dissemination to EU

- Biomarker and regulators
 - ✓ Dilemma: currently, not many enforced in EU or environmental agency guidelines though often use in recent monitoring programmes
 - ⇒ demonstrate their practical use
 - ⇒ bridge biomarker and population effects
 - ⇒ Simplicity of communication → environmental index
- Biosensors and related nanotechnologies
 - ✓ Growing interest in environmental monitoring (also in EU programmes)
 - ✓ Get acceptance into regulatory context that these analytical devices are valuable
 - ⇒ Validation is necessary



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(Bio)sensor *versus* Biomarker



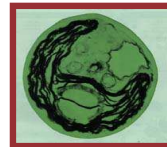
Microtox, Biotox,
Lumitox, Toxalert...



Individual

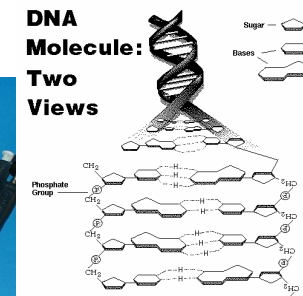
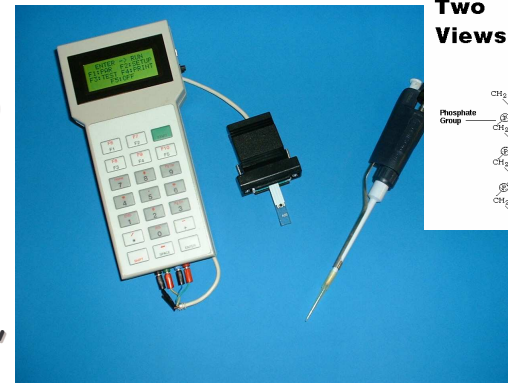


Tissue & organs



Cell

Whole-cell
(Algae, Yeast, Bacteria)
biosensor



Enzymes

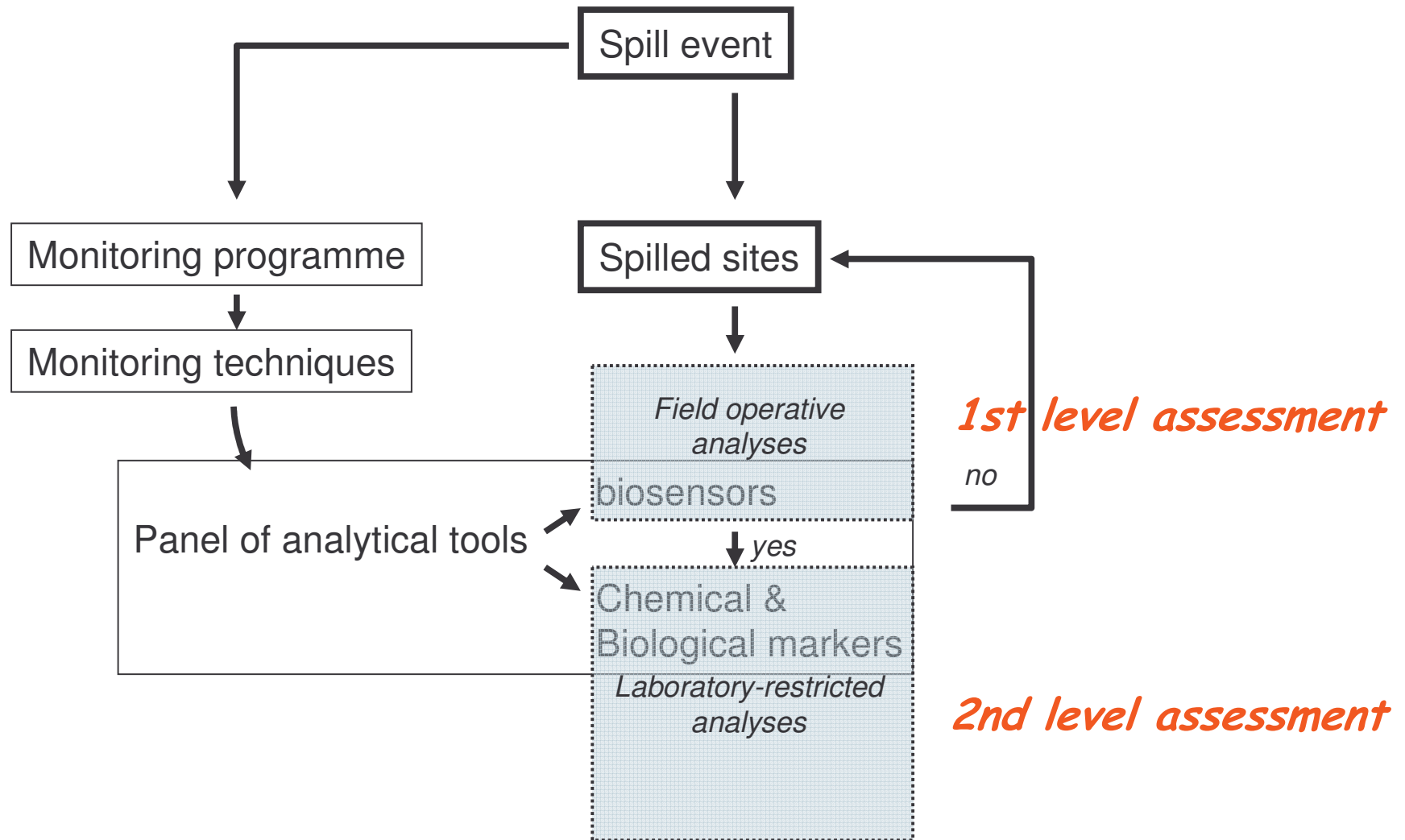
DNA

DNA biosensor,
Immunosensor



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Possible monitoring strategy



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Partners

Partners

- International Research Institute of Stavanger
- University of Brest / UBO/ Unité de Physiologie Comparée et Intégrative
- Le Cedre
- University of the Basque County / Cell Biology and Histology lab - Dep of Zoology and Animal Cell Biolog

Industrial Partner:

- Total E & P Norge AS



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