Spill impact assessment – going from more traditional to innovative solutions

Arising challenges for the Arctic

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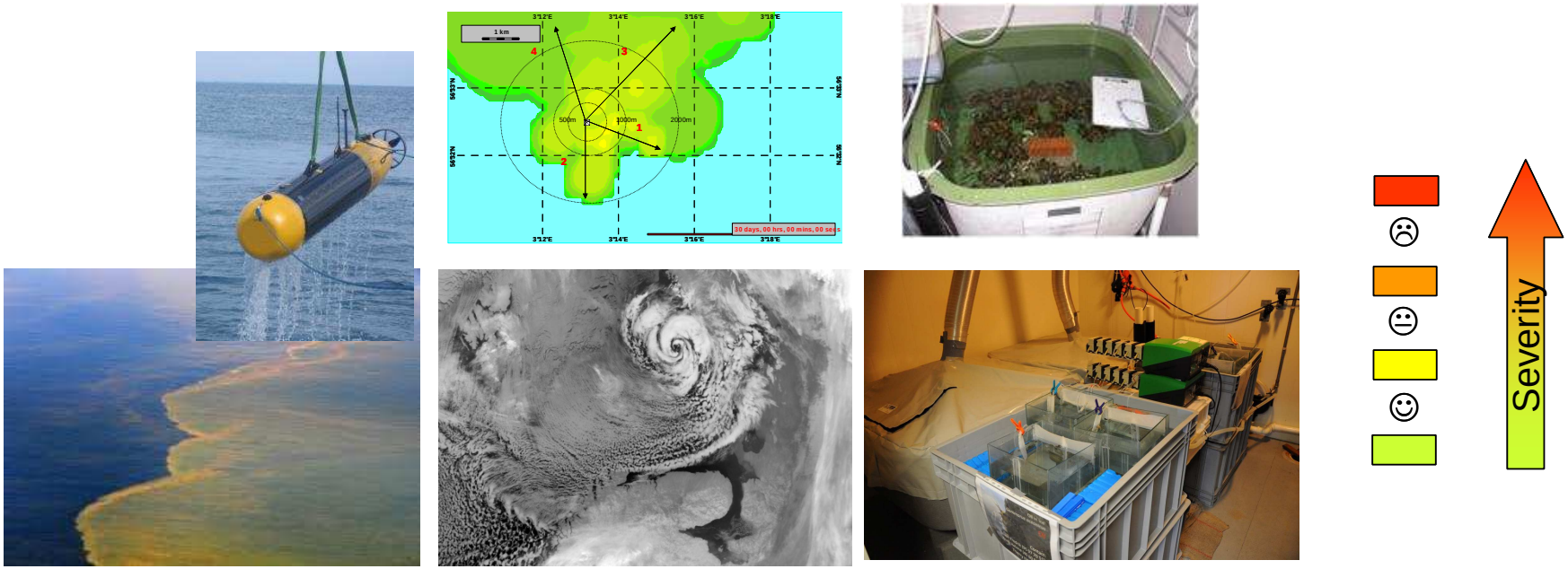
Science Workshop: Spill Impact Assessment



Contingency oil spill response (OSR) toolbox –

A combination of real-time monitoring, on-site sensors and field-optimized biomarkers

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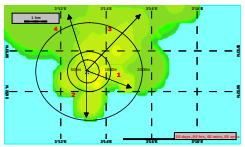
Critical phases	Technology response	Purpose/utility OSR

Acute phase:
”in situ real-time monitoring”



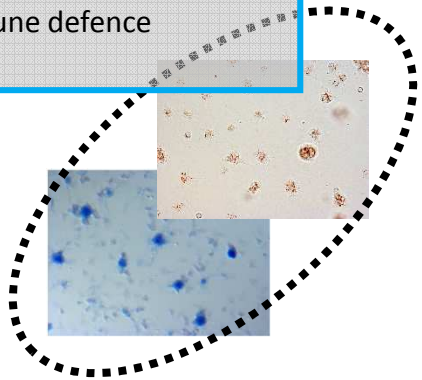
- ❑ Real-time underwater spill detection
- ❑ Key information for guiding clean up & remediation actions

Follow up and aftermath monitoring:
”on-site monitoring”

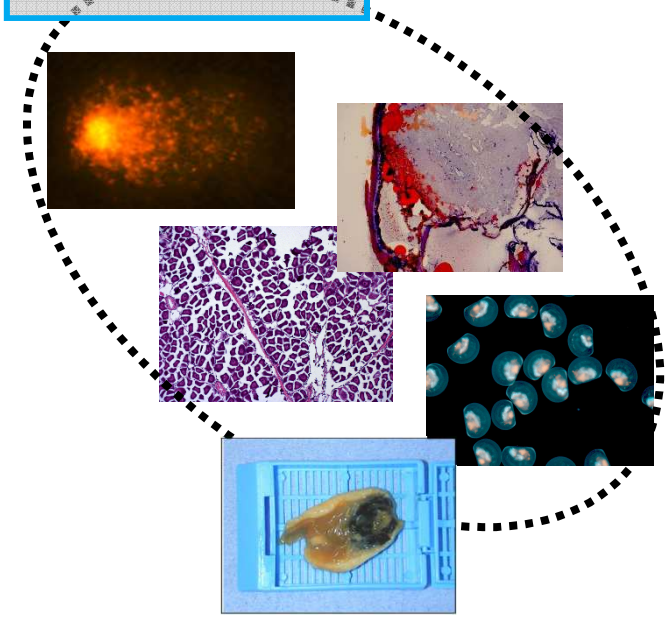
- ❑ Effectiveness of remediation actions
- ❑ Documentation of ecosystem recovery

Biomarkers: Measure of individuals welfare

Tier 1
(***fast markers*** & ***screening***)
Lysosome
Immune defence
…

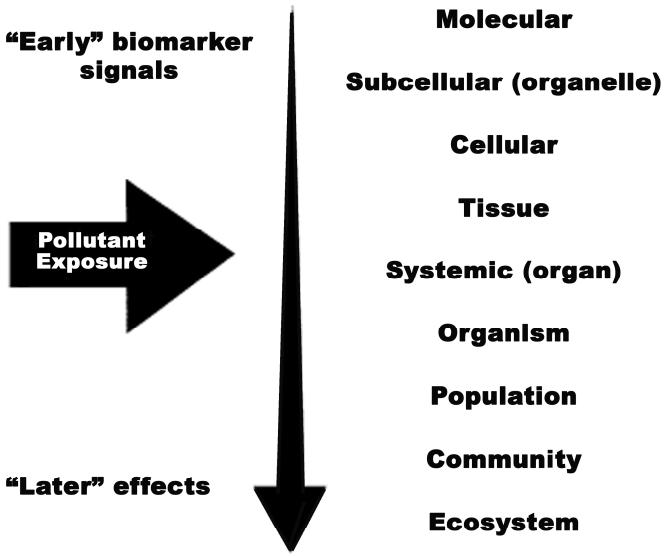


Tier 2
(***investigative markers***)
Tissue indices
Physiology
Histopathology
Genetic
Bioenergetic
Bioassay
….



On-going questions

- What to use?
- What do the results mean?
- How to use that for decision-making
- How can we quantify the results to provide a measure of environmental status?



“Operational” biomarkers

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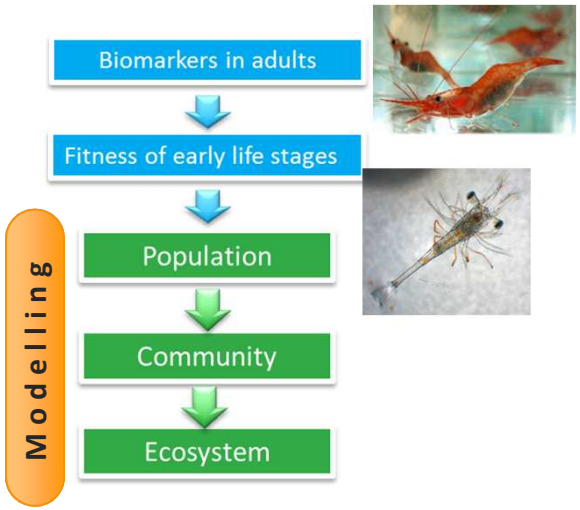
Including meaningful biomarkers in monitoring and assessment programmes after e.g. accidental spill event, should require that



- Their reference levels and natural variation should be known,
- They should be intercalibrated at national and international levels and measured following QA procedures,
- They should respond before more serious effects are measured (“early warning”)
- Hence they should be linked to others analyses and to higher level effects (individual/population/community...).

Using a biomarker response index

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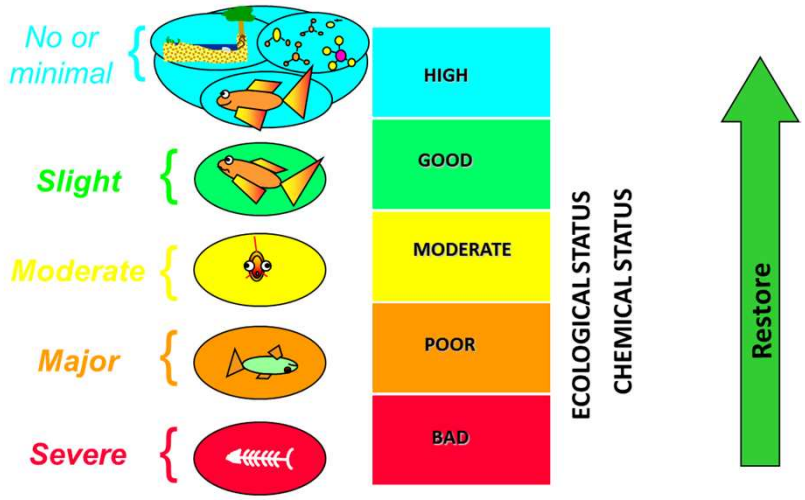
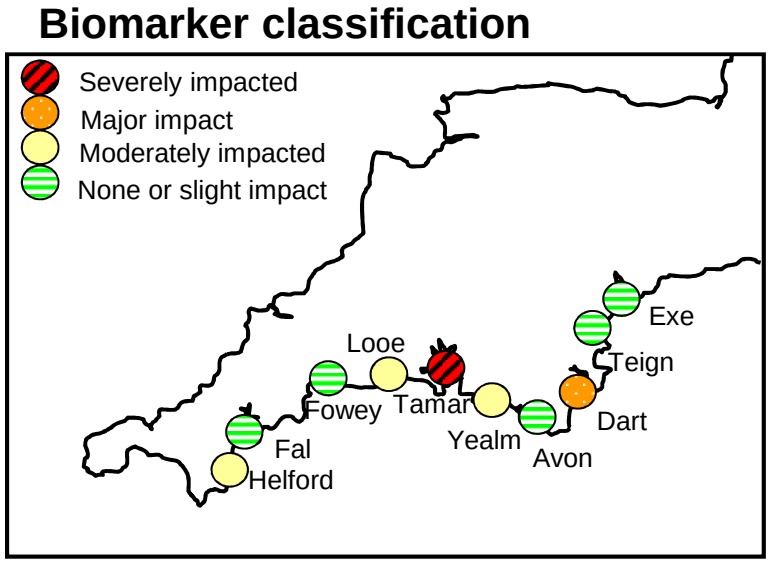
- ✓ Harmonize presentation of the data
- ✓ Follow up water quality and health status post-spill
- ✓ Communicate in a simple manner to decision-makers
- ✓ Harmonisation with e.g. EU Water Framework Directive ?





- ✓ Examples
  - ❑ Integrated Biomarker Response (IBR) (Beliaeff & Burgeot),
  - ❑ Biomarker Response Index (BRI) (Galloway et al.).

Biotools available

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(***investigative markers***)
Tissue indices
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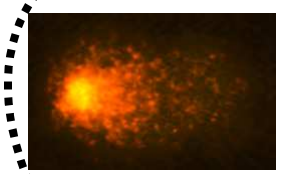
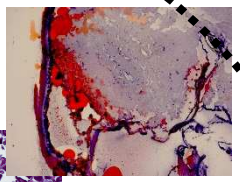
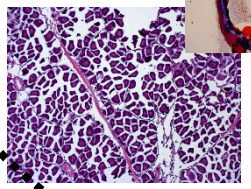
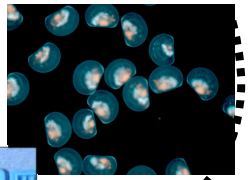
Histopathology
Genetic
Bioenergetic
Bioassay
....









Tier 1
(***fast markers*** & ***screening***)
Lysosome
Immune defence
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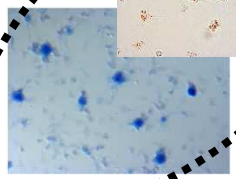

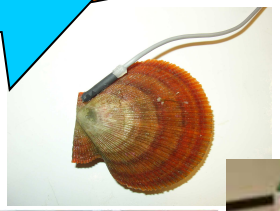

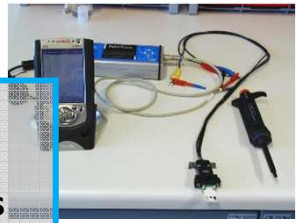

Field-portable techniques

Biosensor=biomarker on-line

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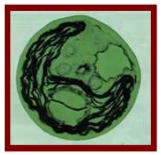
Risk Indicators

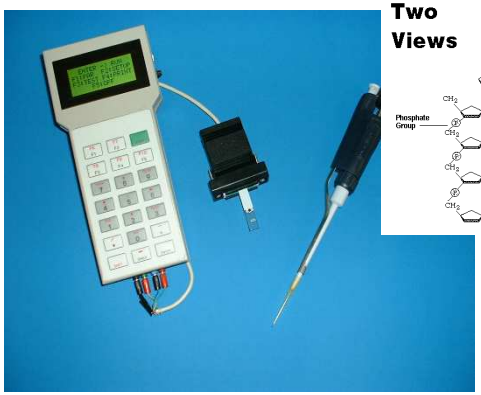
Bioassays → Microtox, Biotox, Lumitox, Toxalert…

Individual

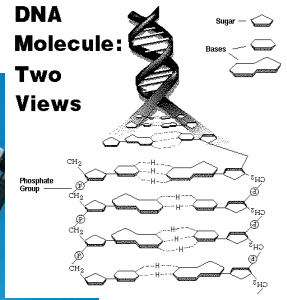
Tissue & organs



Cell → Whole-cell (Algae, Yeast, Bacteria) biosensor



Enzymes DNA → DNA biosensor Immunosensor



Methologies applicable to other areas such as the Arctic ?

Are the current protocols, methologies and data derived from temperate and warm waters applicable for arctic and cold waters ?

Challenges in the Arctic

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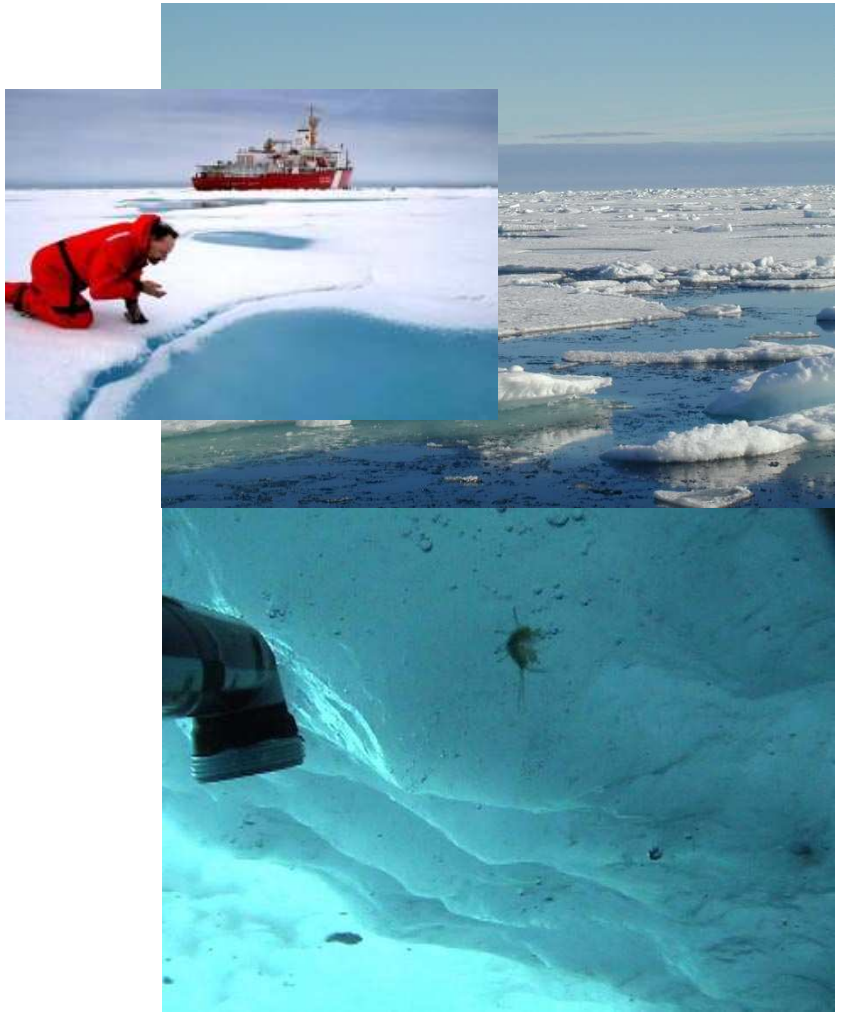
- Logistic
  - Remote, cold & harsh areas
  - Seasonnal presence of ice, dark period
  - ➔ Difficult access to samples
- Environmental
  - Low temperature
  - High fat content
  - High seasonnality
  - ➔ Need for optimization



Use of innovative platforms for spill assessment in remote ice-covered regions ?

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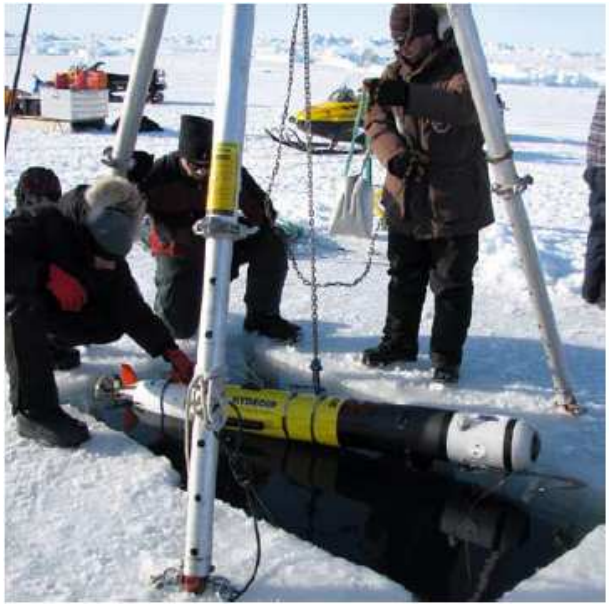
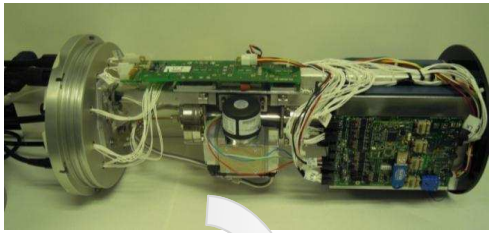
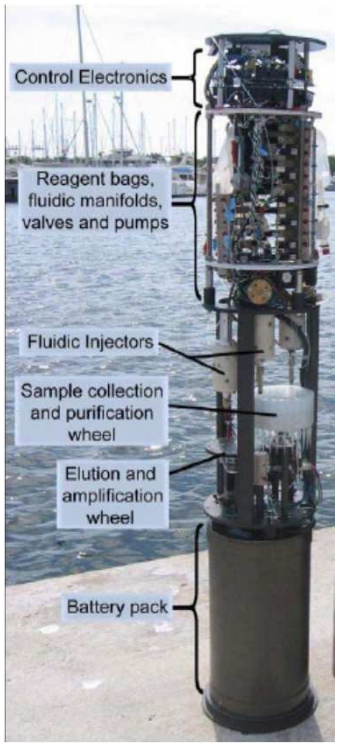


MBARI's «gulper»

SRI Mass spectrometer





Autosampler

Test in relevant cold Arctic water conditions

Environmental Sample Processor – ESP developed at MBARI
Real-time bioindicator species detection

«Molecular lab in a can»

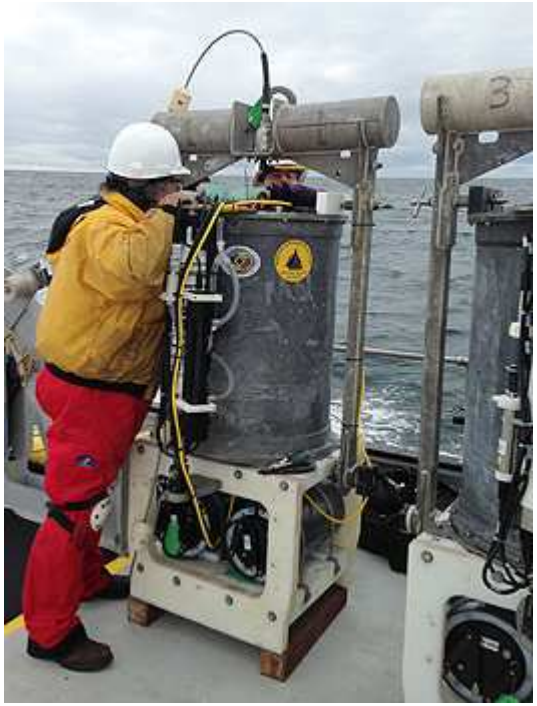
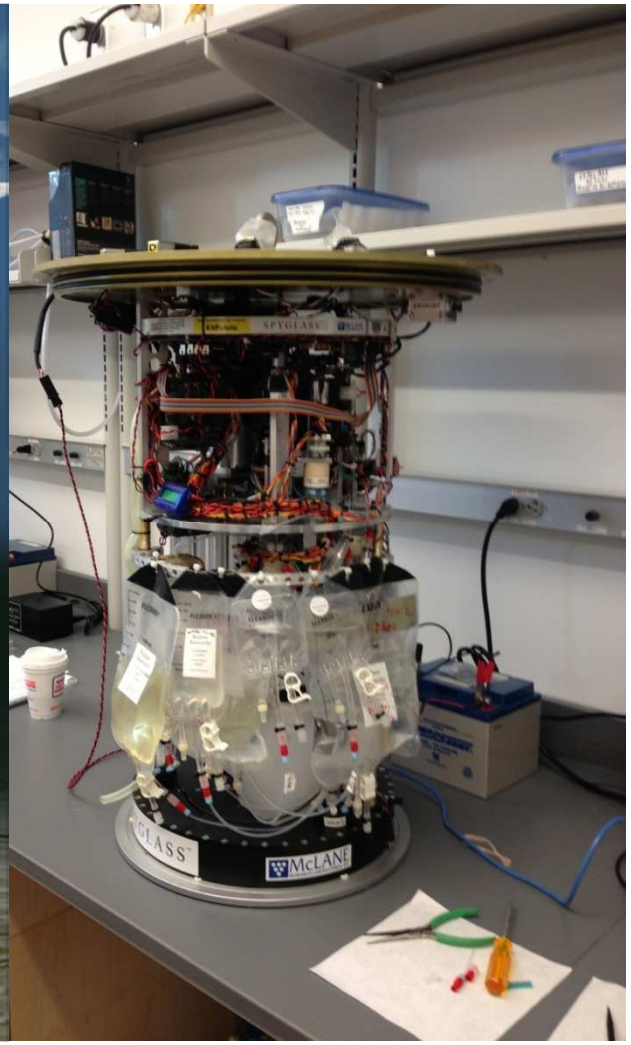
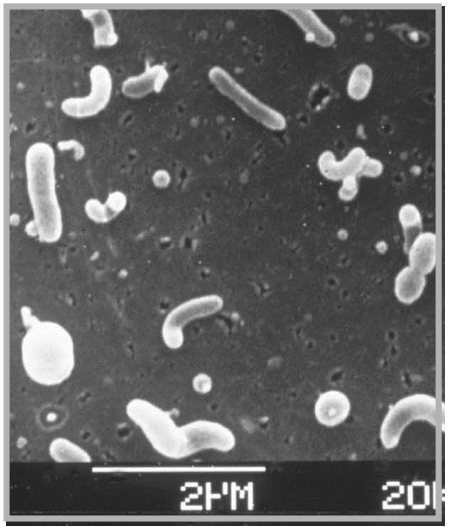


Image: Holly Bowers

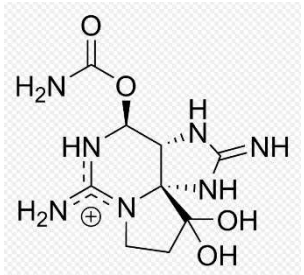


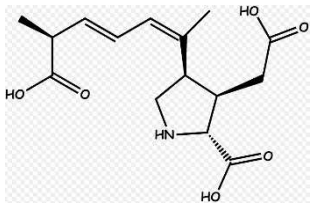
The ESP can detect a wide range of targets based on molecular DNA

Microbes

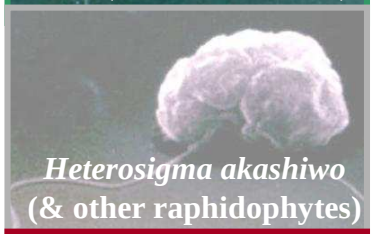


Toxins

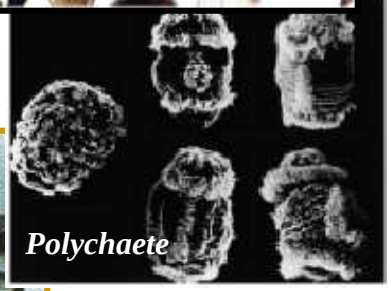




Harmful Algae



Invertebrate Larvae



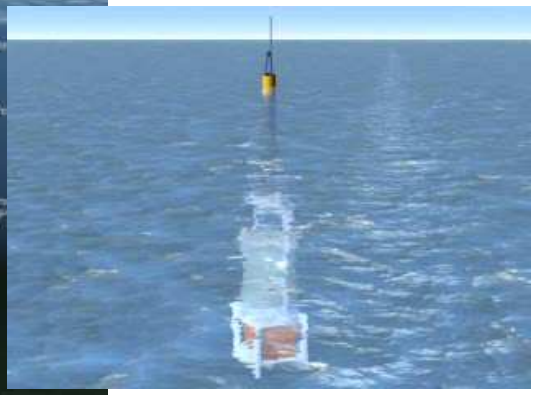
Operational aspects in Northern areas

Forskningsrådet

ConocoPhillips Norge

Lundin

2012-2015



The primary objective of this project is to adapt an Environmental Sampling Processor (ESP) developed at MBARI to the real-time detection of targeted oil-degrading bacteria to track hydrocarbon leak and monitor operational sites.