IMOS Integrated **Marine Observing** System

# HABs research as a focus for IMOS


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# Outline

- Introduction
- What is IMOS
- IMOS drivers
- HABs in Australia
- What does IMOS do
- HABs workshop
- Sensors

NCRIS
National Research Infrastructure for Australia
An Australian Government Initiative

# What is IMOS?

- IMOS is a national, collaborative, research infrastructure, funded by Australian Government
- It undertakes systematic and sustained observing of the marine environment
- Open data access, for research and other purposes
- Established in 2006-7
  – tenth year of operation

# Main drivers

- IMOS has many partners and therefore many drivers
- Works across a spectrum from basic research and research training, to applied and mission directed research, to research with operational relevance
- IMOS must also respond to:

1. Australian Government science agenda
2. National Research Infrastructure needs
3. National Science and Research Priorities
4. Australian National Marine Science Plan

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# Response to main drivers

| | Evolving towards | Will require more |
|---|---|---|
| **Basic research and research training** | Data literacy, STEM workforce, research training for industry | open data, virtual laboratories, real time data, autonomous marine systems (platforms and sensors), marine 'omics, time series turned into value added products, remote sensing, fusion of models and data |
| **Applied and mission directed research** | Climate impacts/adaptation, seasonal/decadal timescales, environmental baselines | |
| **Research with operational relevance** | Safety and efficiency of marine industries, defence innovation | |

*Source: Table from page 8 of the IMOS Five Year Plan imos.org.au*

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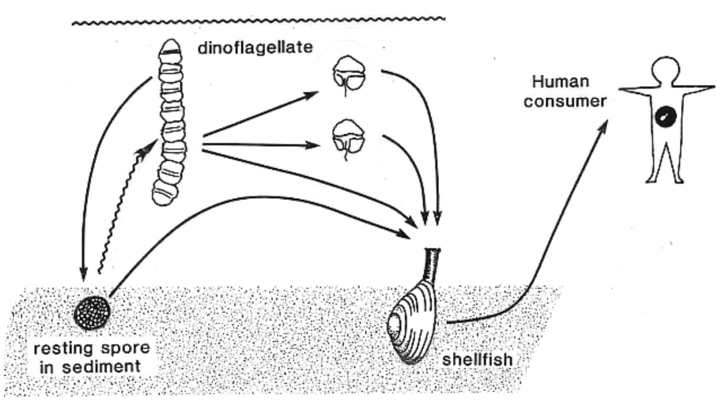
# 80-100 Australian HAB species: impacts are species (strain) specific

1. **Basically harmless water discolourations but in sheltered bays can cause indiscriminate kills of fish and invertebrates due to oxygen depletion**
2. **Species, non-toxic to humans, but harmful to fish and invertebrates in intensive aquaculture by damaging or clogging gills**
3. **Species that produce potent toxins that find their way through the food chain to humans, causing gastrointestinal and neurological illnesses**

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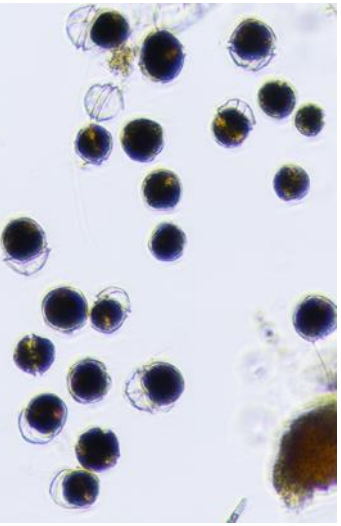
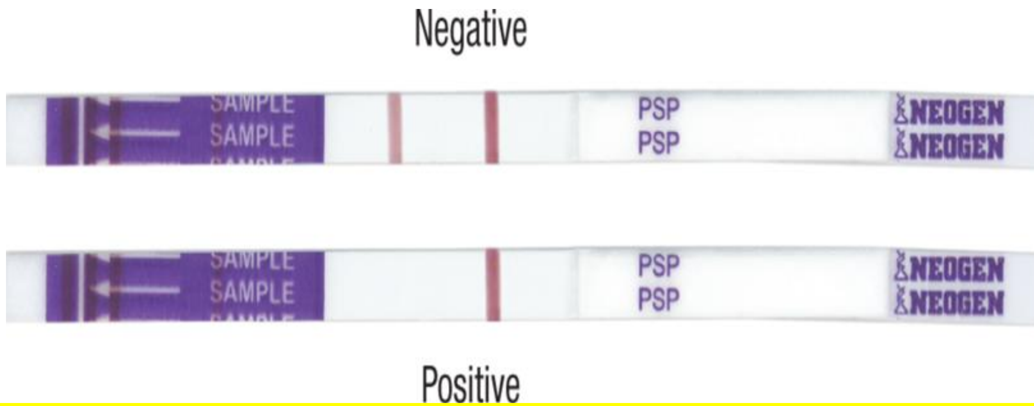
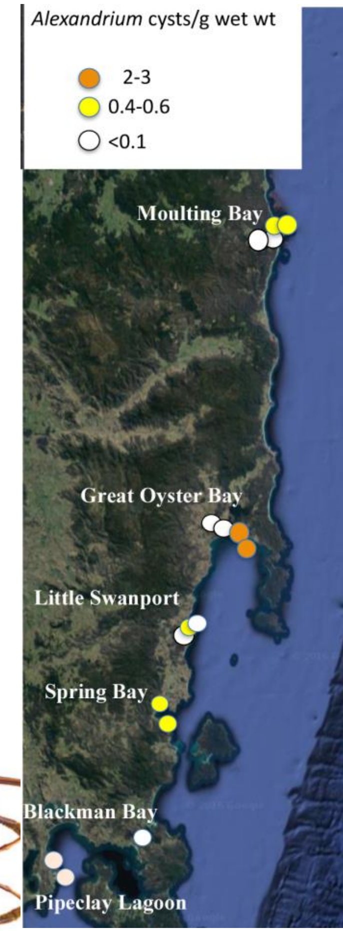
**Oct 2012 *Alexandrium tamarense*; 10 mg PST/kg mussels; $23M loss; Back in 2015; 15 mg PST /kg; 300,000 cells/L; 4 hospitalisations; 2016 24 mg/kg; warning signs to protect tourism**







**Previously nontoxic genotype 5 or weakly toxic genotype 4, now unique variant of genotype 1 (never seen in Australia nor elsewhere). Working Hypothesis: newly stimulated by changed hydrographic conditions. Not response to increased temperatures (10-15°C bloom window).**

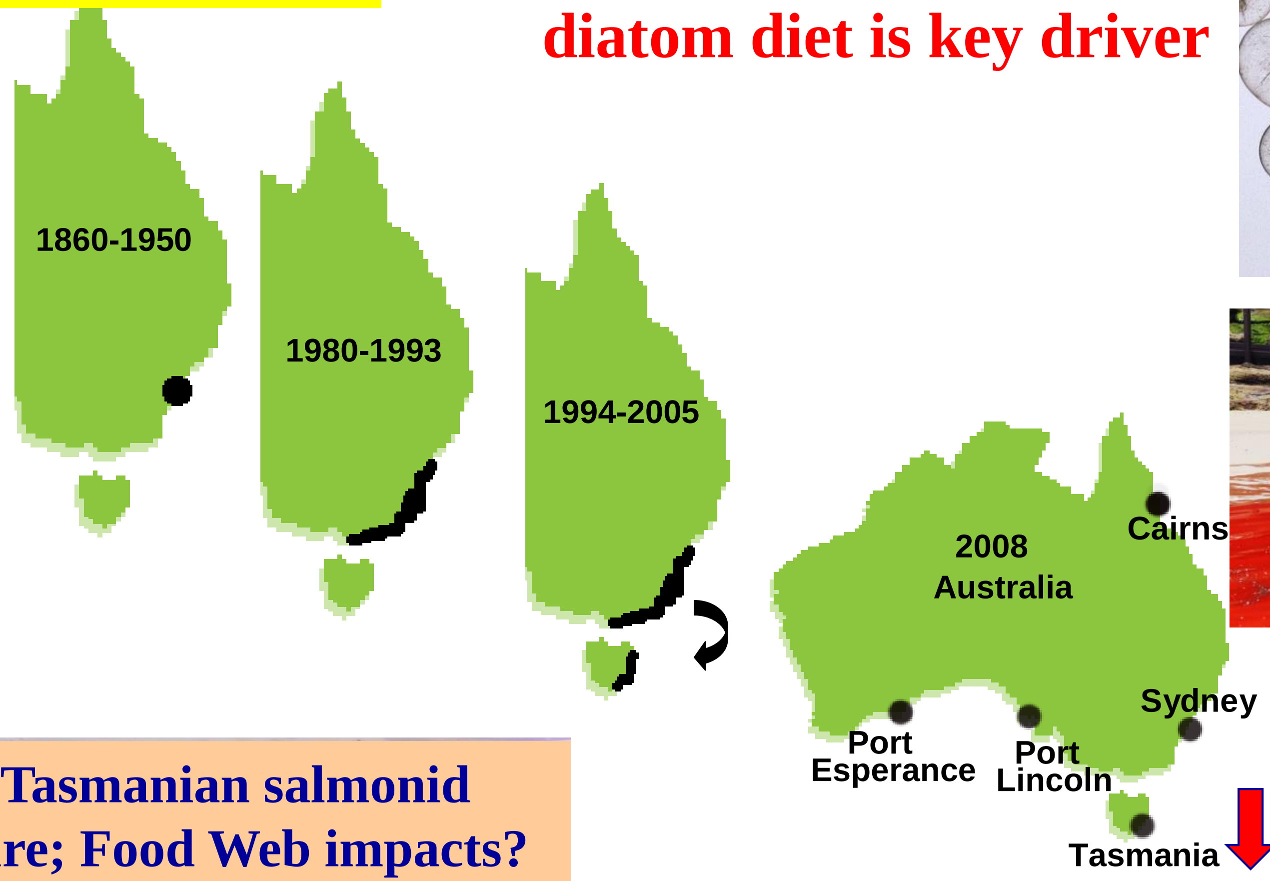



**Cyst surveys**

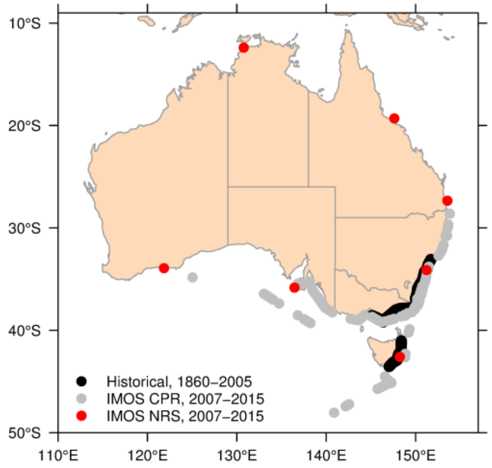
**Failure in *Alexandrium* plankton detection; Failure in PST toxin monitoring; Failure of seafood risk assessment (high risk mussels from poorly monitored new area)**

# Harmless to Humans

# Dinoflagellate *Noctiluca* diatom diet is key driver




## Threat to Tasmanian salmonid aquaculture; Food Web impacts?




## CPR

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# Significance of HABs (1/2)

- An opportunity to increase impact and to exploit the integrated nature of our observing system and its relationship with ocean modelling and forecasting

- It will enable the combined power of in situ observations, remote sensing and modelling/forecasting to come together and deliver impact that could not be achieved by any of these elements working alone

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# Significance of HABs (2/2)

- We are placed in global terms to work at the nexus of satellite remote sensing, in situ ocean optics, biogeochemistry and microbial ecology

- Harmful Algal Blooms (HABs) are a significant issue for the aquaculture and fishing industries, and the potential for IMOS for underpin research into HAB forecasting should be explored

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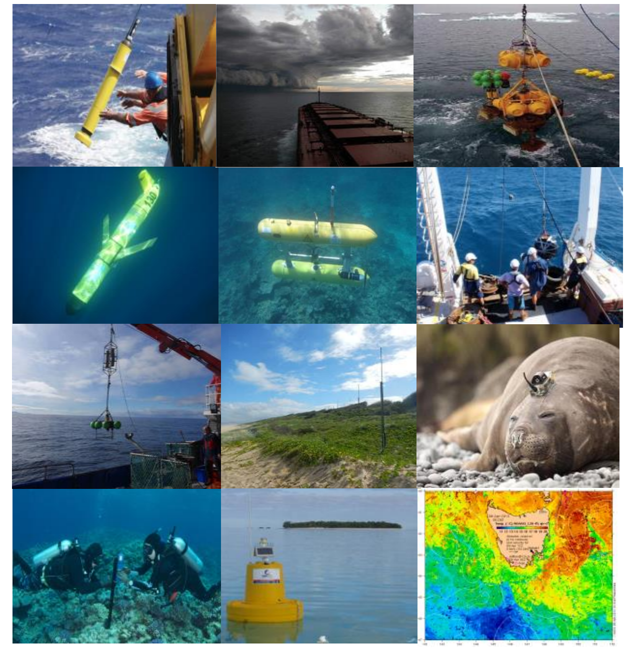
# IMOS Capability
# - multi-institutional

1. Argo Floats
2. Ships of Opportunity
3. Deepwater Moorings
4. Ocean Glider Fleet
5. Autonomous Underwater Vehicles
6. National Mooring Network
7. Ocean Radar Network
8. Animal Tagging and Monitoring Network
9. Wireless Sensor Network
10. Satellite Remote Sensing
11. Ocean Current
12. Australian Ocean Data Network



# In situ observations

| | |
|---|---|
| 1. Temperature- surface | 16. CDOM |
| 2. Sea Surface Height<br>3. Surface waves – amplitude<br>4. Surface waves – spectrum | 17. Chlorophyll a concentration |
| 5. Current velocity (surface and sub-surface) | 18. Phytoplankton species<br>19. Phytoplankton Biomass |
| 6. Wind parameters (stress, speed and direction) | 20. Zooplankton Species<br>21. Zooplankton Biomass |
| 7. Air-sea fluxes | 22. Top Predators species<br>24. Nekton Species<br>25. Benthos (% coverage of species) |
| 8. Temperature- Subsurface | |
| 9. Salinity | |
| 10. Oxygen | |
| 11. Macronutrient concentration | |
| 12. pCO2<br>13. Total. Inorg. Carbon<br>14. Alkalinity | |
| 15. Total Suspended Solids | |

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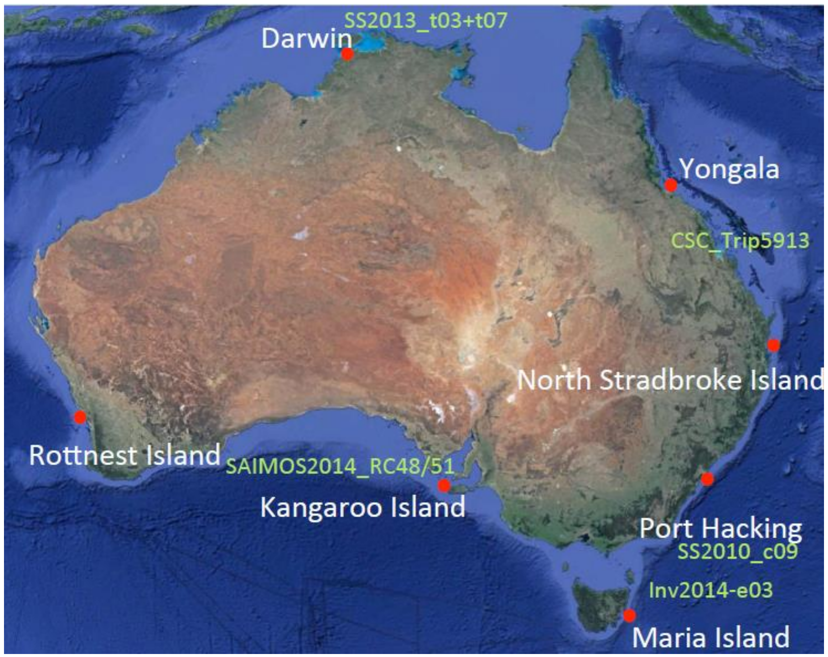
# Australian Marine Microbial Biodiversity Initiative (AMMBI)




Lead by Lev Bodrossy (CSIRO),
Mark Brown (UNSW),
Justin Seymour (UTS)

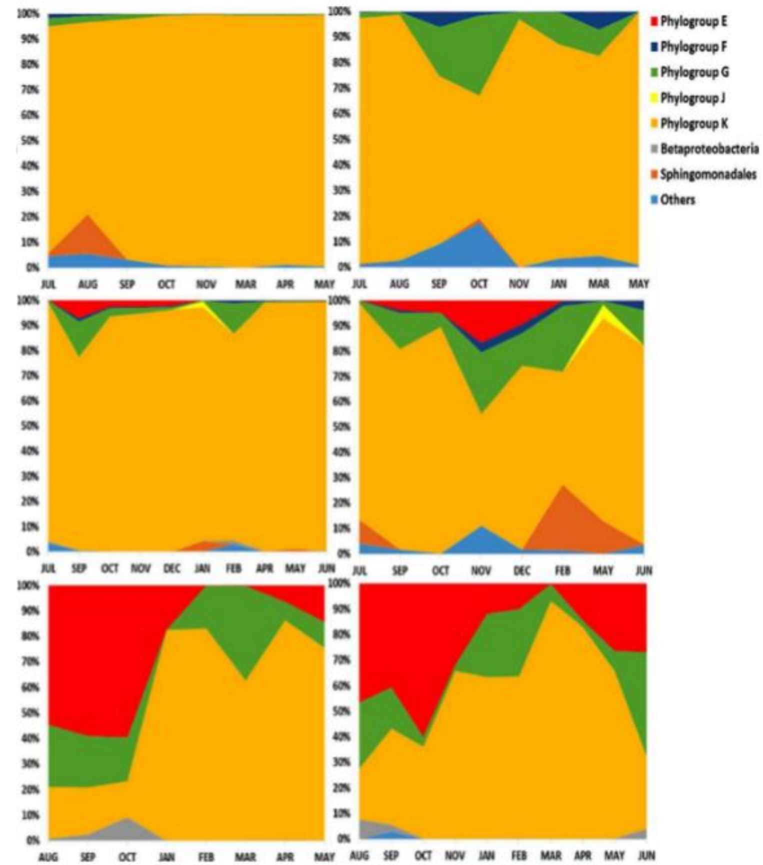
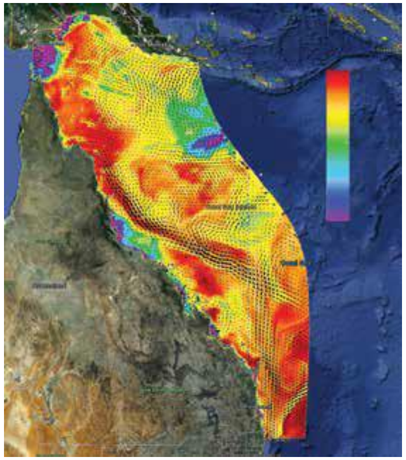


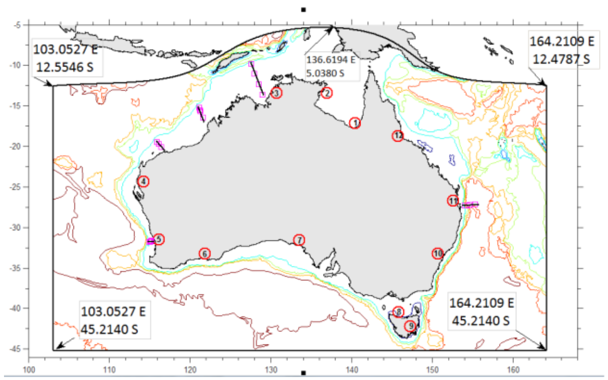

**Fig. 3.** Relative composition of major AAnPB phylogroups at 0 m (left-hand column) and 50 m (right-hand column) throughout the year long sampling period at NSI (top A, B), PHA (middle C, D) and MAI (bottom E, F).

Bibiloni-Isaksson et al 2016

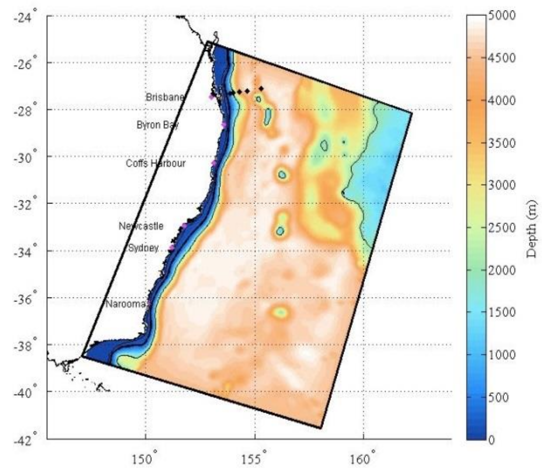
# Modelling

eReefs



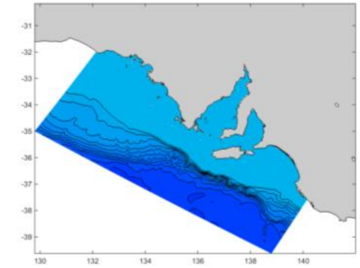


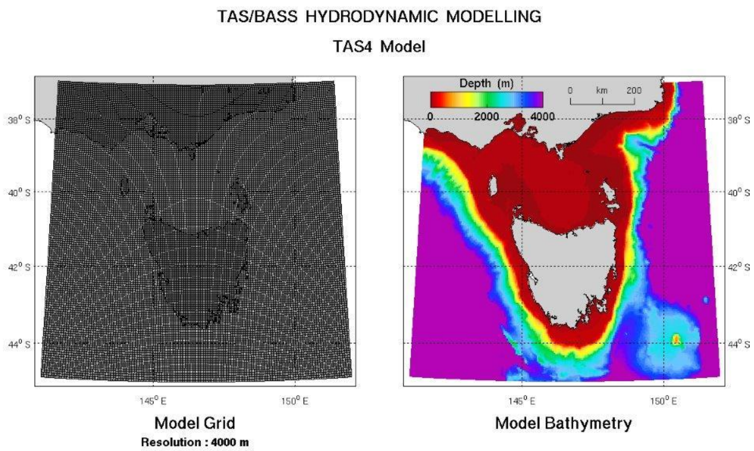

OZROMS



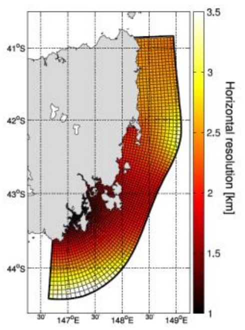

SEAROMS

SAROM

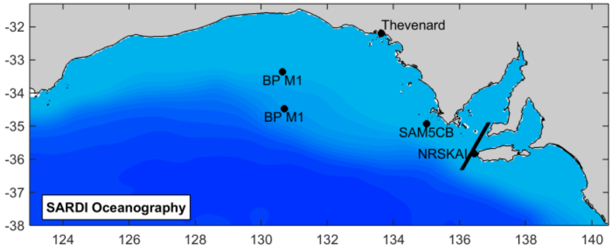





TAS/BASS

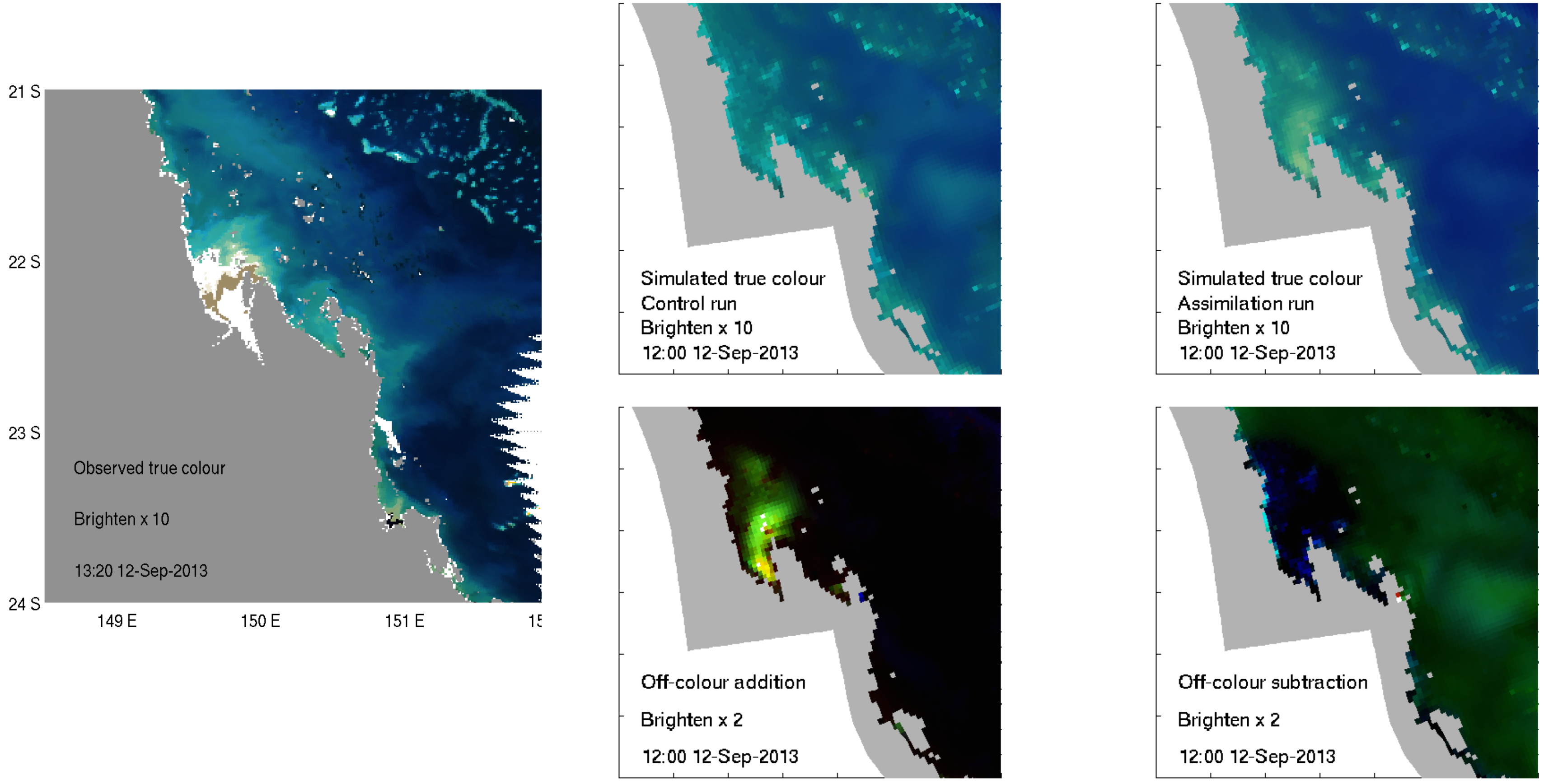



East Tas




SAM(GAB)

# GBR DA: Using Remote Sensing Reflectance to simulate True Colour




Emlyn Jones and co.

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# HABS workshop in Hobart, Nov 2016

17 participants from several universities and organisations (IMOS, UTas, CSIRO, UTS, Curtin U, Macquarie U, Oysters Tas, BoM)

Included algal experts, phytoplankton ecologists, remote sensing specialists, modellers (BGC) and industry rep.

# HABS workshop in Hobart, Nov 2016

OBJECTIVES:

- Identify which observations (IMOS and non-IMOS included) and data sets currently available in Australia would be important in a HABS forecast scenario, and identify gaps
- Discuss ways to address the gaps including the role of new sensors.

# Challenges and needs for HABS forecast in Australia

- Research needs:
  - In-depth eco-physiological knowledge of individual HAB SPECIES
  - Understanding the natural succession in phytoplankton community as context for HAB predictions
  - Understanding of the environmental conditions that favour HAB blooms
  - Improvement of on-shelf monitoring with better phyto/HAB temporal resolution.
- Industry needs:
  - Forecasting system that could ID new species of concern
  - An in-situ sensor that can detect HABs (PST, DST, AST) at low concentrations before the bloom
  - Information delivered on-line (smart phone)
- Modelling needs:
  - species specific information and long term data sets.
  - existing HAB data made public
  - Clear goals for a forecasting system (increase scientific understanding or for management response)

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# GAPS & OPPORTUNITIES

1) Physiology/population info of HAB species
- Species priority list
2) Data inputs/needs/prioritisation
- Access to existing data (including industry)
3) Priority regions
4) Methods
5) Ecology
- Microbial community links
6) Client delivery
- Products and stakeholder engagement

# GAPS & OPPORTUNITIES

## Methods

1) Satellite HAB discrimination algorithms (linked with in-situ)
2) Operational forecast with data assimilation
3) Environmental co-variates
4) Better characterisation of in-situ HABs, sensors
5) Real-time HABS observations
6) Event based sampling

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# Test kits

Toxicon 125 (2017) 110–119

Contents lists available at ScienceDirect

Toxicon

journal homepage: www.elsevier.com/locate/toxicon

ELSEVIER

## Comparative performance of four immunological test kits for the detection of Paralytic Shellfish Toxins in Tasmanian shellfish

CrossMark

Juan José Dorantes-Aranda [a, *], Katrina Campbell [b], Andrew Bradbury [c], Christopher T. Elliott [b], D. Tim Harwood [d], Shauna A. Murray [e], Sarah C. Ugalde [a], Katrina Wilson [f], Megan Burgoyne [f], Gustaaf M. Hallegraeff [a]

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[f] *Tasmanian Shellfish Quality Assurance Program, Biosecurity Tasmania, Department of Primary Industries, Parks, Water and Environment, 13 St Johns Ave, New Town, Tasmania 7008, Australia*

- Abraxis, Europroxima, Scotia (Jellet), Neogen

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# Autonomous sensors

## Environmental Sample Processor:

- High cost >$200k
- Significant time needed for calibration and interpretation
- Can ID HAB species but selection of microarrays very laborious
- Instrument blind to all other organisms not trained to see

## Flow Cytobot:

- High cost ~$150K
- Needs image recognition training programs
- Simple to operate
- Documents entire community
- Not specific for HAB
- More value for money

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# Autonomous sensors

Cytosense/sub:

- High cost ~$300K
- Needs image recognition training programs
- Simple to operate
- Documents entire community
- Not specific for HAB
- Can work with phytoplankton from 1 um

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# MOBI Project

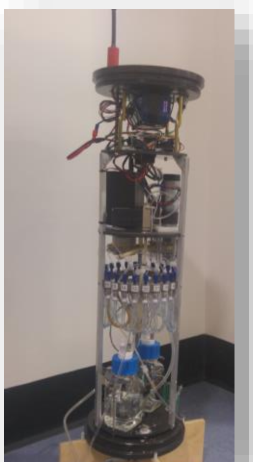
## Microbial Oceanography Biosensing Instrument

- *Development of novel in-situ, remotely operated water sampling and analysis hardware for high spatial and temporal resolution Microbial analysis.*

### SAFA

**Sample Filtration & Archival device**

In situ sampling device. Allows automated collection of 24 samples, on site for later lab analysis.



### STAN

**Standalone Flexible, Modular Microbial Sampling device**

Very low cost, sample collection device. Single sample per device allows greater flexibility in temporal and spatial coverage of analysis area

### MOBI

**Microbial Oceanography Biosensing Instrument**

Fully automated, in situ instruments for DNA analysis of water borne microbes. (in development)


Lev Bodrossy

NCRIS
National Research Infrastructure for Australia
An Australian Government Initiative

UNIVERSITY of TASMANIA

IMOS is a national collaborative research infrastructure, supported by Australian Government. It is led by University of Tasmania in partnership with the Australian marine & climate science community.

www.imos.org.au

The Operators of the IMOS infrastructure are:

sims sydney institute of marine science

CSIRO

Australian Government Bureau of Meteorology

Government of South Australia

SARDI South Australian Research and Development Institute

Australian Government Australian Institute of Marine Science

The University of Western Australia

Curtin University

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