Industry, Science and Environment – Towards a Sustainable Future

Conference Handbook
Global leaders driving world class innovation

World first microscope innovation

Professor Paul Dastoor and his team from the University of Newcastle (UON) Australia, have developed a breakthrough new microscope in collaboration with the University of Cambridge (UK). The new microscope - which uses neutrally charged helium instead of light - allows for delicate material to be accurately imaged with zero damage. This world first innovation has many potential applications across a broad range of fields including defence, medical and biology; sustainability and the solar energy industry; and chemical fingerprinting.

To find out more about Professor Paul Dastoor and his research visit newcastle.edu.au/innovate

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On behalf of the Organising Committee, it gives me great pleasure to extend a warm welcome to all academic, government, business and industry professionals and students to Hobart for the 2016 Society of Environmental Toxicology and Chemistry - Australasia Conference.

This year’s conference theme is “Industry, Science and Environment: Towards a Sustainable Future”. The theme is broad and challenging, and emphasises our multidisciplinary approach to finding environmental solutions, an approach which underpins our Society’s founding principles. Hobart and the state of Tasmania offer many examples of local partnerships, particularly industry working closely with state government, local councils, and research providers at scientific institutions. These partnerships work to minimise environmental impacts, to ensure a sustainable use of resources and environmental protection into the future.

Hobart is a key centre for marine science and aquaculture in Australia and is the hub of Australia’s Antarctic research, policy and operational activities. Hobart’s rich and diverse art culture also provides a unique opportunity to link science and the arts to enhance environmental awareness and to engage the wider community in finding solutions to environmental challenges.

This conference will provide a great opportunity to showcase the latest advances in research and policy arenas, and to network with professional colleagues from a range of government and non-government sectors. We will also showcase, for the first time ever at an Australasian conference, a Reddit Ask Me Anything (AMA) session. This provides an opportunity for the general public to ask scientific questions of the expert delegates in attendance.

In the interest of supporting the professional development of our student and early career members, we are offering a range of initiatives to enhance opportunities to this important group within our membership. Initiatives include our student mentoring buddy system, special student social functions, and engagement of students as session co-chairs.

The organising committee promise you an exciting scientific program, fun social events, great local produce and some of the best wine produced in Australia, set in an idyllic location on the Derwent Estuary. We welcome you to Hobart and hope that you enjoy the program that has been created for you.

Dr Catherine K. King
SETAC-AU 2016 Conference Chair
REGISTRATION DESK
The registration desk is located on the mezzanine floor of the Hotel Grand Chancellor Hobart. Please direct any questions you may have regarding the conference to the staff from Leishman Associates. The registration desk will be open at the following times:

- Tuesday 4 October: 16.00 – 19.00
- Wednesday 5 October: 7.00 – 17.30
- Thursday 6 October: 7.30 – 17.30
- Friday 7 October: 8.00 – 17.00

ACCOMMODATION
If you have any queries relating to your accommodation booking, please first see the staff at your hotel. Your credit card details have been passed on to the hotel to secure your booking. If you have arrived 24 hours later than your indicated arrival day, you may find you have been charged one nights accommodation.

SPECIAL DIETS
All catered events have been advised of any special dietary preferences you have indicated on your registration form. Please identify yourself to venue staff as they come to serve you and they will be pleased to provide you with all pre-ordered food. For day catering, there may be a specific area to where special dietary requirement food is brought out; please check with catering or conference staff.

CONFERENCE NAME BADGES
All delegates and exhibitors will be provided with a name badge; please wear your name badge at all times as it will be your entry ticket into all sessions and all social functions.

ENTRY TO CONFERENCE SESSIONS
Delegates are asked to arrive at preferred sessions promptly to ensure a seat, and so as to not disturb the presenter.

INFORMATION FOR PRESENTERS AND SESSION CHAIRS
All speakers are asked to report to the Speakers Preparation Room to load their presentations onto the conference network. This must be done AT LEAST four hours before you are due to present.

An audiovisual technician will be available throughout the conference. Speakers are asked to introduce themselves to their session chair during the break – at least ten minutes before the session, and to familiarise themselves with the room and equipment.

The Speakers Preparation Room is located on the mezzanine level of the Hotel Grand Chancellor, near the registration desk. Please see the staff at the registration desk for further assistance or directions.

POSTER PRESENTATIONS
Posters will be displayed in the Harbour View One Room for the duration of the conference. There will be a poster session on Wednesday from 3.30pm – 5.30pm and on Thursday and Friday during the lunch breaks. It is encouraged to have at least one author available during these times to answer any questions. Please hang posters before the end of lunch on Wednesday.

ENTRY TO SOCIAL EVENTS
Entry to social events will be as per your paid registration.

Attendees and additional guests will appear on a guest list at the venue entrance. Delegates are asked to wear their name badge for identification by conference staff. If you are unsure about whether you are registered, please see the staff at the registration desk.

DRESS CODE
The dress code for the conference sessions and social functions is smart casual.

CONFERENCE WIFI
Delegates have access to complimentary WIFI for the duration of the conference. Please note that movies, music or illicit downloads are restricted.

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Updated Conference information can be found at
www.setachobart2016.com.au

MOBILE PHONES
As a courtesy to other delegates, please ensure that all mobile phones are turned off or are in silent mode during all sessions and social functions.

DISCLAIMER
The 2016 SETAC Conference reserves the right to amend or alter any advertised details relating to dates, program and speakers if necessary, without notice, as a result of circumstances beyond their control. All attempts have been made to keep any changes to an absolute minimum.

CONFERENCE LOCATIONS

- Hotel Grand Chancellor: 1 Davey St, Hobart
- IMAS: 20 Casray Esplanade, Battery Point
- EPA: 6th Floor, Lands Building, 134 Macquarie St, Hobart
- Jack Greene Bar: 49 Salamanca Place, Battery Point
- Brooke St Pier: Franklin Wharf, Hobart

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## MONDAY 3 OCTOBER 2016

### PRE-CONFERENCE WORKSHOP
The Institute for Marine and Antarctic Studies (IMAS)

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Dr Simon Wright, Australian Antarctic Division, Tasmania, Australia |

## TUESDAY 4 OCTOBER 2016

### PRE-CONFERENCE WORKSHOP
The Institute for Marine and Antarctic Studies (IMAS)

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### PRE-CONFERENCE WORKSHOP
Environmental Protection Agency (EPA)

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Paul Irving, Australian Maritime Safety Authority, ACT, Australia  
Dr John Gorrie, EPA Tasmania, Australia  
Dr Andrew Revill, CSIRO, New South Wales, Australia  
Dr David Griffin, CSIRO, Tasmania, Australia  
Dr Charlotte Stalvies, CSIRO, Western Australia, Australia  
Dr Anthony Chariton, CSIRO, New South Wales, Australia |

## SETAC-AU 2016 CONFERENCE
Hotel Grand Chancellor Hobart

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| 1600-1900 | Registration Open  
Mezzanine Level |
| 1700-1900 | Conference Welcome Reception  
Conference registrants are invited to the welcome icebreaker reception where you can mingle with fellow conference attendees and enjoy fresh Tasmanian produce, wine and beer.  
Harbour View Room One |
| 1900  | Free evening for delegates |
**CONFERENCE PROGRAM**

**WEDNESDAY 5 OCTOBER 2016**

**SETAC-AU 2016 CONFERENCE** Hotel Grand Chancellor Hobart

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<td></td>
<td><em>Chair: Dr Andrew Harford</em></td>
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<tr>
<td>0945-1015</td>
<td>Keynote Speaker</td>
<td>Grand Ballroom</td>
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<tr>
<td></td>
<td>Prof Vance Trudeau – University of Ottawa, Ontario, Canada</td>
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<tr>
<td></td>
<td>Causes and consequences of neuroendocrine disruption of vertebrate reproduction</td>
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<td></td>
<td><em>Chair: Dr Kathryn Hassell</em></td>
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</tr>
<tr>
<td>1015-1040</td>
<td>Morning Refreshments &amp; Trade Exhibition</td>
<td>Mezzanine Level</td>
</tr>
</tbody>
</table>
## Conference Program

### Session 2

<table>
<thead>
<tr>
<th>Time</th>
<th>Room One</th>
<th>Room Two</th>
<th>Room Three</th>
</tr>
</thead>
<tbody>
<tr>
<td>1040-1100</td>
<td>The psychiatric pollutant fluoxetine compromises antipredator behaviour in fish</td>
<td>Risk assessment and remediation of contaminants in Antarctic and subantarctic regions</td>
<td>Validation of a new analytical method for the analysis of multiple steroid hormones in humpback whale blubber by LC-MS/MS</td>
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<tr>
<td></td>
<td>Jake Martin</td>
<td>Dr Catherine King</td>
<td>Greta Dalle Luche</td>
</tr>
<tr>
<td>1100-1120</td>
<td>Is diclofenac toxicity in fish species specific?</td>
<td>Sensitivity of subantarctic marine invertebrates to metal contamination</td>
<td>Persistent organic pollutants and Australian seabirds</td>
</tr>
<tr>
<td></td>
<td>Nicole McRae</td>
<td>Jessica Holan</td>
<td>Phoebe Lewis</td>
</tr>
<tr>
<td>1120-1140</td>
<td>Investigation of the mechanisms underlying estrogen-induced vitellogenin gene expression in Sydney rock oysters (Saccostrea glomerata)</td>
<td>Biopiles - A successful remediation approach for hydrocarbon-contaminated soil and reuse at Casey Station, Antarctica</td>
<td>Application of X-ray absorption spectroscopy to examine selenium speciation in contaminated Australian Lake Macquarie sediments and biota</td>
</tr>
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<td></td>
<td>Thi Kim Anh Tran</td>
<td>Dr Rebecca McWatters</td>
<td>Dr Olha Furman</td>
</tr>
<tr>
<td>1140-1200</td>
<td>Uptake and depuration kinetics of ingested microplastics in Antarctic krill (Euphausia superba)</td>
<td>Permeable reactive barriers for contaminant containment and treatment in the Antarctic and sub-Antarctic environments</td>
<td>Identification, effects and management of toxicants in Western Port, a large, semi-enclosed bay in Victoria</td>
</tr>
<tr>
<td></td>
<td>Amanda Dawson</td>
<td>Dr Kathryn Mumford</td>
<td>Dr Kathryn Hassell</td>
</tr>
<tr>
<td>1200-1220</td>
<td>Chemical pollutants sorbed to microbeads from personal care products bioaccumulate in fish</td>
<td>Changes in the contamination of a marine inlet following remediation of an abandoned waste disposal site at Casey Station, Antarctica</td>
<td>Quantification of biosolids application on soil organic carbon dynamics: a meta-analysis</td>
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<tr>
<td></td>
<td>Dr Bradley Clarke</td>
<td>Dr Scott Stark</td>
<td>Hasintha Wijesekara</td>
</tr>
<tr>
<td>1220-1320</td>
<td>Lunch &amp; Trade Exhibition</td>
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</tbody>
</table>

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
## Session 3

### Grand Ballroom One

**3.1 Metal toxicity and environmental chemistry**

Chairs: Dr William Bennett & Francesca Gissi

- Evaluation of *Corbicula australis* for metal toxicity assessment: an in situ case study integrating chemical and biomarker analyses
  - Dr Anne Taylor

### Grand Ballroom Two

**3.2 Terrestrial Ecotoxicology**

Chairs: Dr Jane Wasley & Divya Vinod

- Phytotoxic activity of non-protein amino acids synthesised by cyanobacteria
  - Kate Samardzic

### Grand Ballroom Three

**3.3 Sustainable waste management and human health issues**

Chairs: Dr Kathy Northcott & Erik Prochazka

- Sampling the sh.. out of Australia on census
  - Dr Jochen Mueller

### Schedule

<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>Chair(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1320-1340</td>
<td>Evaluation of <em>Corbicula australis</em> for metal toxicity assessment: an in situ case study integrating chemical and biomarker analyses</td>
<td>Dr Anne Taylor</td>
</tr>
<tr>
<td>1340-1400</td>
<td>Chronic toxicity of aluminium to the sea anemone <em>Exaiptasia pallida</em></td>
<td>Dr Melanie Trenfield</td>
</tr>
<tr>
<td>1400-1420</td>
<td>Investigating the bioaccumulation kinetics and internal distribution of the radionuclides cesium and strontium under environmental conditions</td>
<td>Dr Tom Cresswell</td>
</tr>
<tr>
<td>1420-1440</td>
<td>Impacts of coal mining on native amphibians: uptake and biodistribution of toxic metals and metalloids</td>
<td>Chantal Lanctot</td>
</tr>
<tr>
<td>1440-1500</td>
<td>Cu-induced changes in intracellular thiols in marine microalgae</td>
<td>Assoc Prof Dianne Jolley</td>
</tr>
<tr>
<td>1500-1530</td>
<td>Afternoon Refreshments &amp; Trade Exhibition</td>
<td>Mezzanine Level</td>
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</tbody>
</table>
**Session 4**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
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</thead>
<tbody>
<tr>
<td>1530-1730</td>
<td>Poster Session &amp; Snapshots</td>
<td>Harbour View Room One</td>
</tr>
<tr>
<td>1730</td>
<td>SETAC Annual General Meeting</td>
<td>Grand Ballroom One</td>
</tr>
<tr>
<td>1930</td>
<td>Student Function</td>
<td>Jack Greene Bar, 49 Salamanca Place</td>
</tr>
</tbody>
</table>

*Poster Session & Snapshots*

Snapshot presentations of some posters will be given by authors, followed by an informal poster session and a chance to enjoy fresh Tasmanian produce, wine and beer.

*SETAC Annual General Meeting*

*Student Function*

This event is for students to discuss their research with their peers. Invited guest speakers will give informal five minute discussions on their work. Some food and drinks will be provided.
# THURSDAY 6 OCTOBER 2016

## SETAC-AU 2016 CONFERENCE
**Hotel Grand Chancellor Hobart**

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<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
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<tbody>
<tr>
<td>0730-1730</td>
<td>Registration Open</td>
<td>Mezzanine Level</td>
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<tr>
<td>0830-0930</td>
<td>Plenary Speaker</td>
<td>Grand Ballroom</td>
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<tr>
<td></td>
<td>Assoc Prof Christian Ritz, University of Copenhagen, Denmark</td>
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<tr>
<td></td>
<td>Improvements in statistics for ecotoxicology and guideline derivation</td>
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<td></td>
<td>Chair: Dr Lisa Golding</td>
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<tr>
<td>0930-1000</td>
<td>Keynote Speaker</td>
<td>Grand Ballroom</td>
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<td></td>
<td>Frances Bender – Huon Aquaculture Company</td>
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<td></td>
<td>The future of fish farming, driving innovative and sustainable outcomes</td>
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<tr>
<td></td>
<td>Chair: Dr Tom Cresswell</td>
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<tr>
<td>1000-1030</td>
<td>Keynote Speaker</td>
<td>Grand Ballroom</td>
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<tr>
<td></td>
<td>Assoc Prof Erica Donner – University of South Australia</td>
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<td></td>
<td>Speciation, transformation, and selective pressure of silver in the environment: Understanding microbial toxicity and resistance</td>
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<tr>
<td></td>
<td>Chair: Assoc Prof Dianne Jolley</td>
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<tr>
<td>1030-1100</td>
<td>Morning Refreshments &amp; Trade Exhibition</td>
<td>Mezzanine Level</td>
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</tbody>
</table>
## Session 2

### Grand Ballroom One

**2.1 Water quality guidelines and statistical methods**

Chairs: Assoc Prof Christian Ritz & Abigail Proctor

- Improved time-independent sensitivity estimates for Antarctic species using no effect concentrations
  - Abigail Proctor

### Grand Ballroom Two

**2.2 Transport, fate and exposure modelling of chemicals**

Chairs: Assoc Prof Erica Donner & Dr Munro Mortimer

- Glacial suspended sediment: character, composition and adsorptive behaviour in the Waitaki catchment, New Zealand
  - Philip Clunies-Ross

### Grand Ballroom Three

**2.3 Environmental analysis and monitoring**

Chairs: Dr Kathryn Hassell & Jill Bartlett

- Cellular energy allocation and the use of near infra-red spectroscopy for measuring stress responses in common Australian bivalve species
  - Jill Bartlett

### 1100-1120

- **1100-1120** Improved time-independent sensitivity estimates for Antarctic species using no effect concentrations
  - Abigail Proctor

### 1120-1140

- **1120-1140** Revised guideline values for pesticides detected in Great Barrier Reef catchments
  - Olivia King

### 1140-1200

- **1140-1200** A revised water quality guideline for cobalt in freshwaters
  - Alicia Hogan

### 1200-1220

- **1200-1220** Derivation of a marine arsenic water quality guideline value
  - Dr Lisa Golding

### 1220-1240

- **1220-1240** Ammonia toxicity to six tropical species in low pH waters, and derivation of site-specific water quality guidelines
  - Dr Tom Mooney

### 1240-1330

- **1240-1330** Lunch & Trade Exhibition
  - Mezzanine Level

- **Poster Session**
  - Harbour View Room One

### 1240-1630

- **1240-1630** Reddit AMA Session
  - Harbour View Room One
### Conference Program

#### Session 3

<table>
<thead>
<tr>
<th>1330-1350</th>
<th>Grand Ballroom One</th>
<th>1350-1410</th>
<th>Grand Ballroom Two</th>
<th>1410-1430</th>
<th>Grand Ballroom Three</th>
</tr>
</thead>
<tbody>
<tr>
<td>The effect of seawater inundation on the mobilisation of trace metals from a contaminated wetland sediment</td>
<td>3.1 Metal toxicity and environmental chemistry</td>
<td>The toxicity of metal mixtures to Antarctic marine algae</td>
<td>3.2 Risk assessment, ecotoxicology and remediation in extreme environments</td>
<td>Black, white or clear, does river water type and dissolved organic carbon affect toxicity of nickel in the Amazon Basin?</td>
<td>3.3 Natural resources industries - Impacts and remediation</td>
</tr>
<tr>
<td>Dr William Bennett</td>
<td>Chairs: Assoc Prof Dianne Jolley &amp; Timothy Coggan</td>
<td>Darren Koppel</td>
<td>Chairs: Dr Kathryn Mumford &amp; Jack Churchill</td>
<td>Dr Alecia Hollard</td>
<td>Chairs: Dr Jill Woodworth &amp; Chantal Lanctot</td>
</tr>
<tr>
<td>Microbial communities as indicators of anthropogenic and natural disturbances to Antarctica and subantarctic Macquarie Island</td>
<td>Not so hot under the covers: lessons from the Casey biopiles, Antarctica</td>
<td>Effects of freezing and thawing on the colloidal metal compositions in soil interstitial water</td>
<td>Ecological toxic effect and human health risk of reusing metal mine wastes</td>
<td>Dr Daniel Wilkins</td>
<td>Kathryn Berry</td>
</tr>
<tr>
<td>The establishment of closure criteria as targets for the successful rehabilitation of the Ranger Uranium Mine</td>
<td>Effects of coal contamination on tropical marine organisms</td>
<td>Ecological toxic effect and human health risk of reusing metal mine wastes</td>
<td></td>
<td>Dr Eun-Ah Kim</td>
<td>Dr Eun Hea Jho</td>
</tr>
<tr>
<td>Filling the gaps: nickel toxicity to tropical marine biota</td>
<td>Challenges for risk assessment in deep sea environments</td>
<td>Keeping it clean: selenium uptake in plant proteins determines suitability for mine site remediation</td>
<td></td>
<td>Francesca Gissi</td>
<td>Divya Vinod</td>
</tr>
<tr>
<td>Metal impacts on edible biota in the Finniss River ecosystem</td>
<td>antFOCE (Antarctic Free Ocean CO2 Enrichment) - Ocean acidification under sea ice and its effects on benthic communities</td>
<td>Assessment on human and environmental risk for recycled slag ball: consideration of chemical and physical stability</td>
<td></td>
<td>Dr Diane Purcell-Meyerink</td>
<td>Dr Jonathan Stark</td>
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<tr>
<td>Dr Diane Purcell-Meyerink</td>
<td>Assoc Prof Amanda Reichelt-Brushett</td>
<td>Won Jung Ju</td>
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1510-1530 Afternoon Refreshments & Trade Exhibition | Mezzanine Level |
# Conference Program

## Session 4

<table>
<thead>
<tr>
<th>Grand Ballroom One</th>
<th>Grand Ballroom Two</th>
<th>Grand Ballroom Three</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4.1 Arsenic contamination - Impacts and remediation</strong></td>
<td><strong>4.2 Fuels, oils and produced waters - Toxicity and risk assessment</strong></td>
<td><strong>4.3 Emerging ecotoxicological methods</strong></td>
</tr>
<tr>
<td>Chairs: Dr Scott Stark &amp; Timothy Remaili</td>
<td>Chairs: Dr Sharon Hook &amp; Gabriella Macoustra</td>
<td>Chairs: Dr Tom Cresswell &amp; Amanda Dawson</td>
</tr>
<tr>
<td><strong>1530-1550</strong> Arsenic bio-accessibility and availability in arsenic contaminated soils: earthworm, and physiologically-based and sequential extraction investigation</td>
<td>Behaviour of hydrocarbons from fuels in polar seawater and effects on the Antarctic amphipod <em>Paramoera walkeri</em></td>
<td>Can image recognition technology be used to propel copepod larval development tests into the 21st century?</td>
</tr>
<tr>
<td>Md Sydur Rahman</td>
<td>Kathryn Brown</td>
<td>Monique Binet</td>
</tr>
<tr>
<td><strong>1550-1610</strong> Using graphene-based materials for remediation of arsenic and cadmium</td>
<td>Toxicity of physically and chemically dispersed fuels to Antarctic marine invertebrates</td>
<td>Development of a chronic whole-sediment algae bioassay using chlorophyll extractions</td>
</tr>
<tr>
<td>Supriya Lath</td>
<td>Frances Alexander</td>
<td>David Spadaro</td>
</tr>
<tr>
<td><strong>1610-1630</strong> Role of different origin mycorrhiza in remediation and improving maize growth in soil with high concentrations of arsenic</td>
<td>Ecotoxicity and toxicity identification evaluation of produced waters from offshore oil and gas facilities</td>
<td>Diurnal activity patterns as a sensitive toxicity outcome in fish</td>
</tr>
<tr>
<td>Sahar Al-shamma</td>
<td>Merrin Adams</td>
<td>Dr Steven Melvin</td>
</tr>
<tr>
<td><strong>1630-1650</strong> Environmental risks arising from elevated arsenic at an abandoned gold mine in New Zealand</td>
<td>An integrated approach to measuring changes in fish physiology following sublethal exposure to a light crude oil</td>
<td>Sensitive sperm: a measure of heavy metal toxicity in the marine environment</td>
</tr>
<tr>
<td>Dr Jo Cavanagh</td>
<td>Dr Sharon Hook</td>
<td>Antony Lockyer</td>
</tr>
<tr>
<td><strong>1800-2230</strong> Conference Dinner</td>
<td><strong>The Stackings Restaurant, Peppermint Bay, Woodbridge</strong></td>
<td>Optional function at $120.00 per person. Bookings Essential. Ferry departs Brooke Street Pier, Sullivans Cove at 18:00.</td>
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</table>
## Conference Program

**FRIDAY 7 OCTOBER 2016**

**SETAC-AU 2016 CONFERENCE** Hotel Grand Chancellor Hobart

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<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
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<tbody>
<tr>
<td>0800-1700</td>
<td>Registration Open</td>
<td>Mezzanine Level</td>
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<tr>
<td>0900-1000</td>
<td>Tony Roach Memorial Plenary Address</td>
<td>Grand Ballroom</td>
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<tr>
<td></td>
<td>Assoc Prof Amy Ringwood, The University of North Carolina Charlotte, U.S.A.</td>
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<tr>
<td></td>
<td>Biomarkers, bioreactivity – and blink</td>
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<td></td>
<td>Chair: Assoc Prof Dianne Jolley</td>
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<tr>
<td>1000-1030</td>
<td>Keynote Speaker</td>
<td>Grand Ballroom</td>
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<td></td>
<td>Dr John Gorrie, EPA Tasmania, Australia</td>
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<td></td>
<td>The Role of the Environmental Regulator in Emergency Response</td>
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<td></td>
<td>Chair: Dr Ruth Eriksen</td>
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<tr>
<td>1030-1100</td>
<td>Morning Refreshments &amp; Trade Exhibition</td>
<td>Mezzanine Level</td>
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### Session 2

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<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
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</thead>
<tbody>
<tr>
<td>1100-1120</td>
<td>2.1 Biomarkers and bioindicators</td>
<td>Grand Ballroom One</td>
</tr>
<tr>
<td></td>
<td>Chairs: Assoc Prof Amy Ringwood &amp; Dr Anne Taylor</td>
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<tr>
<td></td>
<td>New Zealand mud snail (Amphibola crenata) as a bioindicator for estuarine trace metal</td>
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<td>contaminants: laboratory study using multiple biomarkers</td>
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<td>Nuwan De Silva</td>
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<tr>
<td>1120-1140</td>
<td>2.2 Pesticides/herbicides - Ecological risk assessment</td>
<td>Grand Ballroom Two</td>
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<td></td>
<td>Chairs: Assoc Prof Vincent Pettigrove &amp; Maximilian Obinna Obiakor</td>
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<td></td>
<td>Biomarkers to assess the toxicity of pesticide mixtures to the yabby Cherax destructor</td>
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<td>Prof Dayanthi Nugegoda</td>
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<tr>
<td>1140-1150</td>
<td>2.3 Perfluorinated and brominated chemicals - Fate and consequences</td>
<td>Grand Ballroom Three</td>
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<td></td>
<td>Chairs: Dr John Gorrie &amp; Dr Jochen Mueller</td>
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<td></td>
<td>Detection of novel brominated flame retardants (NBFRs) in the urban soils of Melbourne,</td>
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<td>Australia</td>
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<td>Thomas McGrath</td>
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<tr>
<td>1150-1200</td>
<td>A meta-analysis evaluating the evidence of a relationship between aquatic pollutants</td>
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<td>and larval deformities in the Chironomidae from laboratory studies</td>
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<td>Bryant Gagliardi</td>
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<td>1200-1215</td>
<td>Development and application of a multispecies microalgal bioassay to assess the toxicity</td>
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<td>of herbicides in Northern Queensland catchments</td>
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<td></td>
<td>Sarah Stone</td>
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<td>1215-1230</td>
<td>Fingerprinting strategies for source identification of poly- and per-fluorinated alkyl</td>
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<td>substances (PFAS)</td>
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<td>Dr Karl Bowles</td>
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21
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Location</th>
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</thead>
<tbody>
<tr>
<td>1140-1200</td>
<td>Invertebrates as bioindicators and biomarkers for trace metals and other contaminants in coastal and freshwater habitats</td>
<td>Prof Islay Marsden</td>
</tr>
<tr>
<td></td>
<td>Lethal and sublethal effects of the herbicide fluazifop-p-butyl on the seagrass Zostera nigricaulis</td>
<td>Timothy Coggan</td>
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<tr>
<td></td>
<td>Pointing the finger at a point source, release and fate of PFCs in a semi-arid environment</td>
<td>Dr Jochen Mueller</td>
</tr>
<tr>
<td>1200-1220</td>
<td>Biochemical effects in juvenile tiger prawns (Penaeus monodon) after inorganic mercury diet exposure</td>
<td>Cyntia Ayumi Yokota Harayashiki</td>
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<tr>
<td></td>
<td>Sub-lethal effects of the herbicide fluazifop-P-butyl and the adjuvant hasten on seagrasses</td>
<td>Megan Carve Luzardo</td>
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<tr>
<td></td>
<td>Per and poly fluorinated alkyl substances – Where are we, ecologically speaking?</td>
<td>Therese Manning</td>
</tr>
<tr>
<td>1220-1240</td>
<td>Health status of sand flathead (Platicephalus bassensis), inhabiting an industrialised and urbanised embayment, Port Phillip Bay, Victoria as measured by biomarkers of exposure and effects</td>
<td>Jared Baker</td>
</tr>
<tr>
<td></td>
<td>“Australianising” pesticides environmental risk assessments</td>
<td>Chris Lee-Steere</td>
</tr>
<tr>
<td></td>
<td>Risk-based assessment, guideline development and management of PFOS and PFOA</td>
<td>Dr Jill Woodworth</td>
</tr>
<tr>
<td>1240-1300</td>
<td>Evaluation of fish as potential bioindicators of ecosystem health in a major coal-producing region in central Queensland, Australia</td>
<td>Evan Chua</td>
</tr>
<tr>
<td></td>
<td>Quantifying and communicating the ecological risk of pesticides for the Reef Water Quality Protection Plan</td>
<td>Dr Rachael Smith</td>
</tr>
<tr>
<td></td>
<td>Brominated flame retardants in air at Toolik Lake, Arctic Alaska</td>
<td>Assoc Prof Kimberly Hageman</td>
</tr>
<tr>
<td>1300-1400</td>
<td>Lunch &amp; Trade Exhibition</td>
<td>Mezzanine Level</td>
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### Session 3

<table>
<thead>
<tr>
<th>Location</th>
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<th>Location</th>
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</thead>
<tbody>
<tr>
<td>Grand Ballroom One</td>
<td>3.1 Environmental omics and emerging ecotoxicological methods</td>
<td>Grand Ballroom Two</td>
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<tr>
<td></td>
<td>3.2 Toxicity of mixtures and multiple stressors, and life cycle assessments</td>
<td>Grand Ballroom Three</td>
</tr>
<tr>
<td></td>
<td>Chairs: Dr Anthony Chariton &amp; Rod Ubrihien</td>
<td>Chairs: Dr Lisa Golding &amp; Merrin Adams</td>
</tr>
<tr>
<td>1400-1420</td>
<td>Development of a 7 day chronic toxicity test for larval Northern Trout Gudgeon, <em>Mogurnda mogurnda</em>, using sub-lethal growth endpoints</td>
<td>Building a predictive adverse outcome pathway for mixtures of acetylcholinesterase inhibitors to estimate effects to population scale endpoints</td>
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<tr>
<td>1420-1440</td>
<td>Development of an acute and chronic toxicity test for the freshwater mussel <em>Velesunio angasi</em> and an assessment of ammonia toxicity</td>
<td>Assessing the micropollutant burden in small streams in the Rhine catchment using chemical analysis and bioanalysis</td>
</tr>
<tr>
<td>1440-1500</td>
<td>Hypoxia-induced epigenetic changes and transgenerational reproductive defects in marine medaka</td>
<td>The effects wastewater’s on rock oyster species <em>Saccostrea mordax</em>: assessment of general and reproductive health and larval development</td>
</tr>
<tr>
<td>1500-1520</td>
<td>Eukaryotic communities in a dynamic tropical saltwater floodplain, the South Alligator River, Kakadu National Park, Australia</td>
<td>Global guidance on land use impacts on biodiversity indicators in LCA</td>
</tr>
<tr>
<td>1520-1540</td>
<td>RNA-seq Analysis of <em>Isidorella newcombi</em> exposed to copper</td>
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<tr>
<td>1540-1600</td>
<td>Afternoon Refreshments &amp; Trade Exhibition</td>
<td></td>
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<tr>
<td>1600-1630</td>
<td>Closing Ceremony &amp; Student Awards Presentations</td>
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The 2016 SETAC-AU Conference reserves the right to amend or alter any advertised details relating to dates, program and speakers if necessary and without notice, as a result of circumstances beyond their control. All attempts will be made to keep any changes to an absolute minimum.
The 2016 SETAC-AU Conference will begin with the Welcome Reception at the Hotel Grand Chancellor Hobart.

This is a great opportunity to catch up with colleagues and meet other attendees, and enjoy fresh Tasmanian produce, wine and beer. Cary Lewincamp, one of Tasmania’s most loved musical icons will play acoustic guitar compositions and create a beautiful ambiance for this event.

CONFERENCE DINNER

Date: Thursday 6 October 2016
Time: 6.00pm–11.00pm
Venue: Stackings Restaurant, Peppermint Bay Woodbridge
Cost: Dinner tickets $120 per person

The Conference dinner is the social highlight of the program and should not be missed. Departing from the tourist hub of Brooke Street Pier in Hobart, the Peppermint Bay Cruise takes in harbour and city views, the River Derwent and its magnificent estuary, slicing its way along the stunning d’Entrecasteaux Channel, arriving in the near-pristine waters of Peppermint Bay.

The Stackings restaurant at Peppermint Bay provides an unforgettable culinary and dining experience. Using only the best of Tasmania’s famous fresh produce sourced from local farmers and fishermen, chef David Moyle creates distinctive dishes that showcase the unparalleled qualities and flavours of Tasmania. The Stackings restaurant sources much of its produce from onsite gardens ensuring the freshest dining experience possible.

Bringing together beautiful scenery, friendly, professional and informed service, outstanding food and a formidable wine list, The Stackings is sure to provide you with a memorable conference dinner experience.

Live music will be provided by local Hobart band, Detour, so put on your dancing shoes and get ready for a great night of entertainment.

Ferry will depart promptly from Brooke Street Pier at 6pm.
STUDENT SOCIAL ACTIVITIES

BUDDY SYSTEM BREAKFAST

Date: Wednesday 5 October 2016  
Time: 6.45am–7.45am  
Cost: Free for Mentors and Mentees of the Buddy System  
Location: Chancellor Room 6

The Buddy System matches long-term members of SETAC (Buddy Mentors) with first time, international and student attendees (Buddy Mentees) at SETAC annual meetings. The SETAC Australasia annual meeting is a great resource for scientific discourse, increasing knowledge and networking. However, the meeting can be a challenge for first time, international and student attendees. Buddy Mentors and Mentees will be matched by early August, given an opportunity to chat in advance and will be asked to meet in person at designated events during the Hobart conference.

You will be expected to commit at least a couple of hours with your Buddy Mentor/Mentee during the conference, with the flexibility to extend the contact during the conference. The Buddy System is solely for the duration of the conference and does not lock participants in to the longer-term SETAC AU Mentor Programme. Participants are invited to attend the Buddy System breakfast (at no extra cost) on the first morning of the conference where you will meet your Buddy Mentor/Mentee.

For those attending the conference dinner, tables will be reserved to seat Buddy System participants together during this great social event.

STUDENT FUNCTION

Date: Wednesday 5 October 2016  
Time: 7.30pm–9.30pm  
Cost: Free for Student Members of SETAC  
Location: Jack Greene, 49 Salamanca Place

Hosted by SETAC, this valuable event is for students to discuss their research with their peers, in a casual setting at a local venue. This event will host one or two plenary speakers to give informal five minute discussions on their work and the paths that brought them to their current position. Students are encouraged to use this opportunity to ask questions, as well as have one-on-one discussions with the speakers. This informal event is a much anticipated night for returning students and we are excited that this year’s event has been scheduled at an iconic hangout on the Salamanca waterfront. Some food and drinks will be provided.
PRE-CONFERENCE WORKSHOPS

STRATEGIES FOR SCIENTIFIC WRITING: HOW TO WRITE, GET PUBLISHED, AND CITED

Date: Monday 3 October 2016
Time: 10:00pm–4:00pm
Location: The Institute for Marine and Antarctic Studies (IMAS), 20 Castray Esplanade, Battery Point

PRESENTER:
Dr Simon Wright, Australian Antarctic Division, Tasmania, Australia

ABOUT THE WORKSHOP:
Written communication is an essential part of scientific research, yet very few scientists have any formal training in scientific writing. Instead, most pick up writing habits and styles from other untrained scientific writers – or from non-scientific writers – to the detriment of their readers and the scientific literature. This workshop will provide strategies and techniques for effective writing, aiming not only to facilitate the writing process but also to produce a paper that others will want to read, to comprehend and ultimately to cite. We will discuss tools for collecting and organising ideas and demonstrate how they can be used to develop a structured narrative that provides a clear, logical path through a document. We will not focus on grammar but will show how text can be structured for maximum clarity and comprehension. The workshop should benefit all scientists, from postgraduate students to seasoned veterans (as well as their reviewers and readership!).

Simon Wright is a former Principal Research Scientist, Australian Antarctic Division.

Simon completed a PhD in biochemistry at University of Melbourne in 1978, before joining the AAD to study phytoplankton biology. He pioneered the use of HPLC pigment analysis for studying phytoplankton populations and led the Marine Microbial Ecology program at AAD for eight years. As co-author and editor of the SCOR/UNESCO monograph Phytoplankton Pigments in Oceanography, he developed a keen interest in editing, and he has since advised on countless papers for colleagues and students. He officially retired in 2013, but continues to enjoy teaching and mentoring students and other scientists.
STATISTICAL METHODS IN ECOTOXICOLOGY USING R

Date: Tuesday 4 October 2016
Time: 9.00pm–5.00pm
Location: The Institute for Marine and Antarctic Studies (IMAS)

PRESENTER:
Associate Professor Christian Ritz, University of Copenhagen, Denmark

ABOUT THE WORKSHOP:
The open source statistical environment R (http://www.r-project.org) has become the lingua franca of data analysis among statisticians and is also in widespread use in many applied sciences. Many advanced or recent statistical and graphical/visualisation techniques are only available in R. In short, it is an extremely powerful all-in-one alternative software to specialised commercial data analysis software currently used by many ecotoxicologists. Moreover, it encourages collaborative and reproducible research.

The focus will be on giving the participants practical experience with the software as it requires some training to get going using the programme. The course material will be a blend of lectures and case-studies with toxicological data, from recent publications in ET&C and elsewhere.

ANOVA methods will be revisited as well as linear, non-linear regression (including dose-response analysis). Logistic and Poisson regression models will be introduced through case studies. More advanced topics such as linear mixed models, mixture modelling, and multiplicity adjustment of p-values will also be touched upon. Participants will need to bring their own laptop and are encouraged to bring their own data.

Christian Ritz, is an Associate Professor in statistics at the University of Copenhagen, Denmark.

Christian is an Associate Professor in Statistics in the Department of Nutrition, Exercise and Sports at the University of Copenhagen, Denmark. He is an expert on dose-response modelling, co-authoring the R package “drc” (cited more than 300 times). He is co-author on numerous papers on statistical analysis of toxicology data and on a book on nonlinear regression. He has been giving courses in statistics for over 10 years at the SETAC Europe annual meetings, and this is the first time such a course has been given by Christian in the Australasian region.
OIL SPILL RESPONSE MONITORING

Date: Tuesday 4 October 2016
Time: 9.00pm–5.00pm
Location: Environmental Protection Agency (EPA)
6th Floor, 134 Macquarie St, Hobart

PRESENTERS:
Dr Sharon Hook, Commonwealth Scientific & Industrial Research Organisation
Paul Irving, Australian Maritime Safety Authority

ABOUT THE WORKSHOP:

Australia is still at risk of major spills into the marine environment – response will occur. Recent increasing economic activity (imports, exports, petroleum production) has increased shipping traffic, offshore petroleum activities, and the need for more ports. Australia is already the fifth largest shipping nation globally, and relies on shipping for almost all of its imports and exports, with ship-based commodity exports expected to increase. Increased exploitation of Australia’s oil and gas resources coupled with increased shipping traffic strongly indicates that significant oil spills are highly likely and smaller spills inevitable.

Oil spill response requires appropriate, timely and accurate information gathering and communication. Without suitable scientific assessment (monitoring), the effects may never be known and the ability to prevent these events or respond effectively is diminished. The uncertainty associated with the observations, sampling and analysis (both pre-spill and post-spill) needs to be recognised to ensure risk assessment, contingency planning, and decision-making are not compromised.

Monitoring (and other good science) doesn’t just happen – it needs to be planned. Understanding of and planning for information gathering and communication functions should be a key function in pre-spill contingency preparedness. Experience has shown that without preparation for monitoring, activities can be constrained.

The purpose of this workshop will be to walk participants through the back ground information they need to understand the “why” behind monitoring plans, and well as practical guidance for the planning and implementation of spill response monitoring.

Dr Sharon Hook is a Senior Ecotoxicologist for CSIRO Oceans and Atmosphere, Sydney. Sharon has over 20 years of experience in aquatic ecotoxicology and oceanography. Her research interests include applying modern omics-based approaches to environmental problems, determining the impacts of low level, long-term toxic responses, and the design and implementation of toxicity testing. She has been involved in the risk assessments following several oil spills, including the Exxon Valdez, the SelendagAyu spills (both prior to joining CSIRO) and the Montara well release. She is involved in ongoing projects for BP and Chevron characterising the Great Australian Bight. Sharon has authored over 60 scientific publications.

Paul Irving is Scientific Coordinator at the Australian Maritime Safety Authority, responsible for marine environment protection and maritime spill response science and advice.

A diverse 30 year background across many aspects of marine and coastal science, conservation and management, from tropical to Antarctic, provides a unique perspective on Australasian and Pacific marine pollution response. As a firm believer in collaboration and partnership to provide practical solutions, Paul spends much of his considerable energies looking for ways to incorporate new science and research knowledge into spill planning, so that communities (social and ecological) affected by maritime pollution get the effective response they deserve.
REDDIT ASK ME ANYTHING (AMA) SESSION

REDDIT AMA

Date: Thursday 6 October
Time: 12:40pm–4:30pm
Location: Harbour View Room One

For the first time at an Australasian conference, SETAC-AU will be hosting a Reddit Ask Me Anything (AMA) session (online platform). This was a great success at the SETAC North America meeting in 2015 and at the SETAC Europe meeting in 2016. Reddit provides an opportunity for the general public to ask questions in relation to environmental science which can then be answered by our experts. This platform is a great way to encourage discussion and facilitate outreach between practising scientists and the general public.

We will run our live AMA session on Thursday 6 October between 12:40pm and 4:30pm. We will have an area set up in Harbour View Room One (look out for the Reddit logo) with laptops and we ask you, our experts to volunteer as little or as much time as you like to come along and answer some questions. We will also be able to provide you with a link to the AMA so that you can access it and answer questions on your own devices. This is a great way to advertise SETAC-AU, who we are and the great work we do in environmental research.
ASSOC PROF
AMY RINGWOOD
The University of North Carolina, Charlotte, USA

Date: Friday 7 October
Time: 09:00–10:00

BIOGRAPHY:
Amy H. Ringwood, PhD, is an Associate Professor in the Department of Biological Sciences at the University of North Carolina, USA. Her professional career has included positions in both government (Marine Resources Research Institute, SC Department of Natural Resources) and academia (UNC Charlotte and graduate faculty positions at the College of Charleston, Medical University of SC, and University of South Carolina). Her primary area of research is in characterizing the impacts of anthropogenic and natural stressors on marine invertebrates, including developmental stages (embryos and larvae) as well as adults.

ABSTRACT:
Biomarkers, bioreactivity—and blink
Biomarkers serve as early warning diagnostic signals of bioreactivity and potential impacts on organismal health. While they are readily embraced by the medical community, they are used more cautiously for environmental evaluations. I will briefly discuss some of the important attributes of some well-established biomarkers and comment on some critical issues for emerging tools. Greater integration of biomarkers into environmental assessments will provide more rapid, diagnostic potential especially as newer biotechnologies are used. For this presentation, I will draw extensively from our work as well as others throughout the world, including my Australian colleagues, regarding lysosomes. Lysosomal assays are noted for their sensitivity, broad applicability across species, reliability, low-costs, and linkages to higher-level effects. But because lysosomal function is often evaluated using a live-cell microscopic assay, concerns regarding subjectivity and potential bias are sometimes raised. However with a little bit of cross-training, and encouraging subconscious scoring (e.g. “blink”), lysosomal assays can be broadly used by different analysts. I will share a story about a training session where Tony Roach pointed out this powerful blink concept from Malcolm Gladwell’s book. I will also discuss this power-of-the-subconscious paradigm in a wider context, for integrating multiple biomarkers and linking established assays to “omics” tools, as essential for advancing the science. Recognition of bioreactivity patterns and their significance is an art of science that is the culmination of cumulative scientific knowledge and experiences managed by our more unbiased subconscious.

TONY ROACH MEMORIAL
PLENARY ADDRESS
ABSTRACT:

Research & industry partnerships to deliver innovative environmental solutions in polar regions

Industry participation in Antarctic projects presents a unique logistical, operational and regulatory environment for innovation and development of water and contaminated site management technologies. It is for this reason that Veolia Environnement (Veolia) and the Australian Antarctic Division (AAD) signed a ten year cooperation agreement in October 2001, in the area of water and waste management in Antarctica. This was the first of a number of cooperative agreements between Veolia and countries operating in Antarctica, including:

- CONAMA (Chile), October 2002, and
- IPEV (France), July 2003

Since the signing of that first agreement over fifteen years ago, Veolia has collaborated with both the AAD and a number of partner organizations on high profile and innovative projects, such as:

- The Thala Valley landfill remediation project, Casey Station
- The AWRCoE-funded Robust Recycling Project, Davis Station
- The treatment of soil and water contaminated by diesel-based hydrocarbons, Casey Station

This paper provides examples of how partnerships between polar research institutes, academia and industry provide significant benefits to each of these sectors. Experiences gained and tools developed provide research and business with an international platform from which to share expertise and resources.

DR KATHY NORTHCOTT
Research & Technical Manager, Veolia Australia-New Zealand, Victoria, Australia

Date: Wednesday 5 October
Time: 08:45–09:45

BIOGRAPHY

Kathy Northcott, PhD, is Research & Technical Manager for Veolia Australia—New Zealand. Kathy is a chartered chemical engineer and Fellow of the Institute of Chemical Engineers (IChemE). Her professional career has included a range of both industrial and research roles in the water, gas and power industries, as well as being involved in contaminated site remediation and water/wastewater plant design for the Australian Antarctic Division. She was the recipient of a national engineering excellence award for the design of a water treatment system to remediate contaminated sites in cold regions.
ASSOC PROF
CHRISTIAN RITZ
University of Copenhagen, Denmark

Date: Thursday 6 October
Time: 08:30–09:30

BIOGRAPHY

Christian Ritz, PhD, is an Associate Professor in Statistics in the Department of Nutrition, Exercise and Sports at the University of Copenhagen, Denmark. He is an expert on dose-response modelling, co-authoring the R package “drc” (cited more than 300 times). He is co-author on numerous papers on statistical analysis of toxicology data and on a book on nonlinear regression. He has been giving courses in statistics for over 10 years at the SETAC Europe annual meetings, and will deliver a course in “Statistical Techniques in Ecotoxicology using R” as a pre-conference workshop in Hobart.

ABSTRACT

Improvements in statistics for ecotoxicology and guideline derivation

The talk will touch upon a number of recent developments in statistical methodology used in ecotoxicology and trends towards better modelling strategies in general. Frequentist versus Bayesian modelling approaches will be addressed in particular. Another aspect is the ongoing discussion about the use of EC and NOEC as endpoints, in view of scientific and regulatory practice.
KEYNOTE

DR VANCE TRUDEAU
University of Ottawa, Ontario, Canada

Date: Wednesday 5 October
Time: 09:45–10:15

BIOGRAPHY

Vance L. Trudeau, PhD, received his BSc and MSc (Animal Sciences) from McGill University and PhD (Zoology) from the University of Alberta (1991). Dr. Trudeau is Professor of Biology and holds the University of Ottawa Research Chair in Neuroendocrinology. In 2011, Trudeau co-founded (with R.J. Denver and C. Aramburo) the North American Society of Comparative Endocrinology (NASCE).

Trudeau leads an international team (www.teamendo.ca) of students and young researchers that study both fish and frogs. The long-term objective of his research program is to understand how the brain and pituitary transduce environmental and physiological signals into changes in reproductive function. This deep understanding of neuroendocrinology is fundamental to our understanding of successful vertebrate reproduction under normal conditions or when the environment is under stress from pollution. Studies on pharmaceuticals and other aquatic contaminants are at the leading edge to endocrine disruption research. The work has shown that the brain is a major target for the actions of contaminants and that these disrupt normal development and reproduction. Such research has helped to shape the emerging field of “neuroendocrine disruption”.

ABSTRACT

Causes and consequences of neuroendocrine disruption of vertebrate reproduction

Agricultural pesticides, pharmaceuticals and industrial chemicals or waste are now widely present in the environment. This contamination may be found in soil, water, air, and animal and human tissues. My colleagues and I have proposed that the term ‘neuroendocrine disruption’ expands the concept of endocrine disruption to include the full breadth of integrative animal physiology. Upsets to normal homeostatic mechanisms following exposure to such pollutants can affect an animal’s ability to reproduce or develop normally. Results from various laboratories around the world will be drawn upon to illustrate the concept of neuroendocrine disruption. Prozac (fluoxetine) and other antidepressants are environmental contaminants that disrupt reproduction, behaviour and metabolism in teleost fish, demonstrating the complex and pervasive effects of neuroendocrine-active pollutants. Zebrafish exposed to Prozac during serotoninergic system development display more anxiety-like behaviours and have reduced cortisol production as adults. Bisphenol A (BPA) is a plasticizer that affects diverse species. Gestational exposure to BPA in rodents has been reported to affect socio-sexual behaviours in offspring. These and other examples indicate that neuroactive pollutants adversely affect neuroendocrine processes across taxa and generations.
KEYNOTE SPEAKERS

FRANCES BENDER
Executive Director,
Huon Aquaculture, Tasmania, Australia

Date: Thursday 6 October
Time: 09:30–10:00

BIOGRAPHY
Frances Bender is the co-founder and Executive Director of Huon Aquaculture Group Limited, a salmon farming company founded with her husband Peter in 1986. Frances has led the development and growth of the Huon brand and has been a strong advocate for transparency and broader engagement regarding communicating environmental management practices within the industry. She was a driving force behind the development of Huon Aquaculture’s industry leading online reporting tool, the Sustainability Dashboard, which aims to communicate the company’s commitment to improving environmental sustainability through monitoring, innovation and technological advancement.

Frances is currently a member of the NSW Primary Industry Ministerial Advisory Council and a member of the Food Safety Council of the Tasmanian Institute of Agriculture. With over 30 years’ experience with the company, Frances provides Huon a leading voice in local, national and international industry, regulatory and stakeholder forums. She is passionate about the communities in which Huon Aquaculture operates and is a strong advocate for regional development and training for people in rural communities.

ABSTRACT
The future of fish farming, driving innovative and sustainable outcomes

Since it’s inception in 1986, Huon Aquaculture has grown to be Australia’s signature producer of salmon, recognised around the world for the quality of their salmon and the ingenuity of their operations. A commitment to constantly innovating and seeking out world’s best practice by Huon Co-founders Peter and Frances Bender has shaped the sustainable, highly advanced operation that exists today.

In 2014 Huon Aquaculture undertook a strategy which marked a complete step-change in farming practices, technology and the approach to farming sustainably in Tasmania. Frances Bender shares the Huon story, how research and environmental sustainability have changed over the past 30 years and the ways in which Huon communicates its sustainability story.
ASSOC PROF ERICA DONNER
University of South Australia, Australia

Date: Thursday 6 October
Time: 10:00–10:30

BIOGRAPHY
Erica Donner, PhD, is an Associate Professor and ARC Future Fellow based in the Future Industries Institute at the University of South Australia. She works across a range of topics in environmental biogeochemistry, with a major emphasis on contaminant fate and effects in (waste)water, biosolids, and soil. Prior to joining UniSA Erica completed her undergraduate training at the University of New South Wales. She obtained her PhD in Environmental Soil Chemistry from The University of Reading (UK) and subsequently worked as a researcher on a pan-European project supporting the technical implementation of the EU Water Framework Directive. In her current research, Erica is particularly interested in understanding the links between chemical selective pressure and microbial ecology and resistance.

ABSTRACT
Speciation, Transformation, and Selective Pressure of Silver in the Environment: Understanding Microbial Toxicity and Resistance

Silver is a potent antimicrobial agent that has been a topic of widespread research interest in recent years due to its increasing use in biomedical applications and consumer products. Many consumer products that include (nano)Ag as an active ingredient are used dispersively or in applications directly linked to the production of wastewater (e.g. personal care products or textiles). This has focussed significant attention on the fate and effects of silver in environmental release pathways, and highlighted the need for further risk assessment. Our interest in this topic has ranged from investigating the transformation, fate, and effects of engineered silver nanoparticles in freshwater, seawater, wastewater, biosolids, soils, sediments, and air, to investigating the prevalence and mechanisms of silver resistance in environmental microorganisms, and the relevance of environmental silver resistance and selective pressure to clinically-relevant resistant pathogens.

Studying engineered nanoparticles under real environmental conditions is very challenging due to their tiny size and low concentrations in the environment. To facilitate the in situ study of engineered nanoparticles we have developed and deployed a form of passive sampling device called ‘nano In situ Deployment Devices’ (nIDDs) which allow us to collect time-resolved transformation data. Plasma polymerization is used to immobilize nanoparticles onto a substrate, thereby allowing us to place the nanoparticles directly into complex environmental compartments and retrieve them again for analysis. These nIDDs can be constructed in a variety of ways to cater specifically to the research question and environmental compartment of interest. For example, the shape and size of the nIDDs can be tailored to allow exploration of heterogeneous environments and the substrate can be selected (e.g. glass, polymide tape, silicon wafers) to fit the requirements of specific analytical techniques. The surface polymer applied to the substrate can carry either positive or negative charge to provide suitable anchoring for nanoparticles with different surface functionalizations. These devices have proven very useful for elucidating transformation
reactions that occur under natural conditions that cannot easily be reproduced in laboratory or mesocosm studies (e.g. tidal fluctuations). Examples from the studies we have conducted using nIDDs in different environments will be presented.

Overall our results from these studies have shown that silver is highly reactive in natural environments, and that Ag2S-nanoparticles are the most environmentally relevant form of silver entering soils and water through the wastewater/biosolids release pathway. These particles are very stable with extremely low silver lability under relevant environmental conditions. This may minimise the long-term risks of silver toxicity to some organisms, but not to all. Our recent research exploring the effects of silver on environmental microorganisms has shown a range of microbial responses. For example, monitoring of microbial respiration and 9 soil enzyme activities in 9 different soils exposed to 0 - 2000 mg kg-1 silver stress gave EC50 values ranging from 3-500 mg kg-1, and changes in differential abundance of bacterial and fungal operational taxonomic units were observed at doses as low as 1 - 50 mg kg-1 indicating strong microbial responses at environmentally relevant silver concentrations. We have also been interrogating the links between silver selective pressure and bacterial resistance and cross-resistance in municipal wastewater influents, treatment stages, and effluents and this ongoing research is yielding very interesting results. For example, partial 16S rRNA Illumina MiSeq sequencing of bacterial communities in influent wastewater subjected to silver pulse dosing has indicated that silver may rapidly select for opportunistic and clinically relevant pathogens (e.g. *Acinetobacter*, *Arcobacter* etc.). Highlights from this research will also be presented.

**KEY WORDS**
Silver, nanosilver, fate, toxicity, resistance, risk assessment

**AUTHORS**
Erica Donner¹, Sotirios Vasileiadis¹, Gianluca Brunetti¹, Ryo Sekine¹,², Maryam Khaksar¹, Kirk Scheckel³, Krasimir Vasilev⁴, Enzo Lombi¹

1 Future Industries Institute, University of South Australia, Mawson Lakes, Adelaide, Australia
2 Centre for Ecology and Hydrology, Wallingford, United Kingdom
3 National Risk Management Research Laboratory, US Environmental Protection Agency, Cincinnati, Ohio, USA
4 School of Engineering, University of South Australia, University of South Australia, Mawson Lakes, Adelaide, Australia
ABSTRACT

The Role of the Environmental Regulator in Emergency Response

Emergencies, such as floods, earthquakes, oil spills and fires have the potential to cause significant harm to the natural and built environment. It is now increasingly recognised that inappropriate responses to these emergencies can exacerbate the harm caused. This is particularly the case regarding the tactics used to suppress structural and bush fires. Recent advances in firefighting equipment and tactics have the potential to improve environmental outcomes related to fire suppression. However, in order for these potential improvements to be realised, a cultural change is required within fire agencies, and between fire agencies, environmental regulators and other stakeholders, including environmental scientists.

Case studies will be used to demonstrate the environmental benefits of collaboration between EPA Tasmania and the Tasmanian Fire Service, and note the organisational cultural challenges that need to be addressed. The presentation will also explore the issues involved in working towards acceptance that sometimes it may be beneficial to allow a structure to burn in order to reduce the environmental impact that would occur if suppression was the primary response.
THE PSYCHIATRIC POLLUTANT FLUOXETINE COMPROMISES ANTIPREDATOR BEHAVIOUR IN FISH

AUTHORS
Mr Jake M. Martin¹, Dr Minna Saaristo¹, Mr Michael G. Bertram¹, Miss Phoebe J. Lewis², Mr Timothy L. Coggan¹, Dr Bradley O. Clarke², Dr Bob B. M. Wong²

¹ School of Biological Sciences, Monash University
² Centre for Environmental Sustainability and Remediation, RMIT University

ABSTRACT
Pharmaceuticals are increasingly being detected in aquatic systems around the world. Of particular concern are pharmaceutical pollutants with the capacity to adversely impact exposed wildlife, even at extremely low concentrations. Fluoxetine is one such contaminant. This widely prescribed antidepressant has an extensive environmental presence and possesses the ability to disrupt neuroendocrine and behavioural pathways in wildlife. Despite this, relatively limited research has addressed the behavioural effects of fluoxetine at environmentally realistic exposure concentrations. Here, using two separate experiments, we show that 28-day fluoxetine exposure at ecologically relevant dosages alters the antipredator behaviours of Eastern mosquitofish (Gambusia holbrooki). In the first experiment, we found that irrespective of the presence or absence of a predatory dragonfly nymph (Hemianax papuensis), fish exposed to low fluoxetine had increased activity levels compared to unexposed fish, whereas high-exposed fish showed no change in activity. Additionally, fish exposed to both fluoxetine concentrations entered the striking range of the predator more rapidly than did unexposed fish. In a second experiment, fluoxetine-exposed fish showed a reduction in freezing behaviour—a common antipredator strategy—following a simulated predator strike. Specifically, female fish exposed to the low concentration, and males exposed to both the low and high concentrations, showed a decrease in freezing behaviour. Together, these findings suggest that 28-day exposure to fluoxetine at environmentally realistic levels can alter antipredator behaviour in fish and, in doing so, may impact the fitness of exposed wildlife. Further, the results of these experiments suggest that fluoxetine exposure can cause both non-monotonic and sex-dependent shifts in behaviour.

KEYWORDS
Antidepressant, antipredator behaviour, behavioural ecotoxicology, fluoxetine, Gambusia holbrooki, mosquitofish, pharmaceutical pollution
IS DICLOFENAC TOXICITY IN FISH SPECIES SPECIFIC?

AUTHORS
Nicole McRae¹, Dr Chris N. Glover², Prof Bryan Brooks³, Dr Sally Gaw¹

¹University of Canterbury, Christchurch, New Zealand
²Athabasca University, Athabasca, Canada
³Baylor University, Waco, United States of America

ABSTRACT
Emerging contaminants, such as the pharmaceutical diclofenac, are considered one of the major drivers of aquatic organism toxicity and habitat decline. Diclofenac, a non-steroidal anti-inflammatory drug, was recently placed on the European Union Water Framework Directive watch list. However, very little is known regarding the toxicity of this drug to aquatic biota. To date the majority of toxicology studies have been conducted on model Northern Hemisphere fish species and there has been limited assessment of Southern Hemisphere fish. This is important as some of these species, such as the widespread freshwater fish inanga (Galaxias maculatus) have a number of unusual physiological characteristics including the use of skin as an uptake surface. This study investigated the mechanisms of diclofenac toxicity in three fish species: the Southern Hemisphere inanga, and two common model Northern Hemisphere species (zebrafish, Danio rerio; fathead minnow, Pimephales promelas). Fish were exposed to graded concentrations of diclofenac for 96 h. Sublethal oxidative stress parameters (catalase and lipid peroxidation) were examined, in addition to tissue diclofenac accumulation. Sublethal endpoints were affected at environmentally-relevant concentrations, and although there were similarities in toxic responses, differences between different species were also displayed. These are the first such data to investigate the toxic effects of diclofenac on inanga. This research identifies conserved mechanisms of toxicity, which will facilitate the development of predictive approaches and will allow for protection of aquatic biota against impacts of pharmaceuticals.

KEY WORDS
Diclofenac, inanga, oxidative stress, zebrafish, fathead minnow, tissue accumulation
INVESTIGATION OF THE MECHANISMS UNDERLYING ESTROGEN-INDUCED VITELLOGENIN GENE EXPRESSION IN SYDNEY ROCK OYSTERS (SACCOSTREA GLOMERATA)

AUTHORS
Thi Kim Anh Tran1,2, Geoff MacFarlane1, Richard Yuen Chong Kong1, Wayne A. O’Connor4, Richard Man Kit Yu1

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ABSTRACT
It is well-known that environmental estrogens can interfere with development and reproduction in a wide range of marine invertebrates, causing problems such as changes in vitellogenin production, sex ratio, intersex gonads and ultimately declines in reproductive success. Our previous studies have developed an oyster biomonitor to indicate the presence of estrogenic compounds in marine environments through exploiting the induction of vitellogenin (Vtg). Despite this, the mechanism through which estrogens exert their action on vitellogenesis is currently unknown. This study presents investigations on the mechanisms of how estrogens can induce vitellogenin gene expression in the Sydney rock oyster (sgVtg). In vitro and in vivo exposure experiments showed that ovarian sgVtg mRNA expression was upregulated by 17-estradiol (E2). Notably, treatment with an estrogen receptor (ER) antagonist in vitro abolished the upregulation, suggesting a requirement for an estrogen-dependent receptor for transcriptional activation. Using conserved primers designed from the vertebrate ERs, we then successfully isolated a putative molluscan ER in the oyster (sgER). The sgER can activate sgVtg gene expression through increasing luciferase activity driven by a sgVtg promoter fragment containing three ERE half sites. In addition, its mRNA expression was upregulated in response to E2. However, a requirement for estrogen was not observed for the transactivation of sgVtg by sgER and the sgER is devoid of estrogen binding in a ligand binding assay. In order to determine whether sgVtg expression is regulated epigenetically, the DNA methylation status of its putative CpG island downstream of the transcription start site was assessed using bisulfite genomic sequencing of the in vivo ovarian samples. The results indicated that this region is hypomethylated regardless of the gene expression levels. Overall, the results suggest that the estrogen responsiveness of sgVtg is regulated by a novel ligand-dependent receptor involved in estrogen signalling.

KEY WORDS
Vitellogenin, Estrogen receptor, gene expression, gene promoter, the Sydney rock oyster, molluscs
UPTAKE AND DEPURATION KINETICS OF INGESTED MICROPLASTICS IN ANTARCTIC KRILL (EUPHAUSIA SUPERBA)

AUTHORS
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ABSTRACT
Microplastics (plastics particles less than 5mm) are ubiquitous contaminants of the marine environment. Their concentration is increasing worldwide and reaching the most remote ecosystems. As such, it has become necessary to develop a greater understanding of how marine species interact with this anthropogenically derived threat.

Uptake, depuration and bioaccumulation kinetics are routinely assessed in the field of engineered nanoparticles and chemical compounds, to date; this area of research has received little attention in the field of microplastics. To determine the uptake and depuration of microplastics in Antarctic krill, krill were fed a diet of microplastic beads and instant (non-viable) algae. The diet consisted of 20% plastic per dry weight of algae, which equated to approximately 29 plastics mL⁻¹. Krill were fed plastic for 10 days, after which the diet was switched to 100% algae for a further 15 days. Krill were harvested on days 1, 2, 4, 7, 10, 15, 20, and 25 to assess body burden of plastic and establish uptake and depuration kinetics. Harvested krill were enzymatically digested and the residue was vacuum filtered onto filter papers. Body burden was quantified using Fluorescence Laser Scanning Confocal Microscopy and subsequent image analysis.

Microplastics were noted in faecal pellets, oesophagus, cardiac stomach, mid gut, and hind gut of deceased and live krill. Krill were observed to mechanically fragment the plastic beads after ingestion. This is the first instance of a planktonic species contributing to the fragmentation of plastics through ingestion. The body burden of individual krill appears to be variable. Rates of uptake and depuration of microplastics are further interpreted within this presentation.

KEY WORDS
Microplastics, Antarctic krill, Ingestion, Uptake
CHEMICAL POLLUTANTS SORBED TO MICROBEADS FROM PERSONAL CARE PRODUCTS BIOACCUMULATE IN FISH

AUTHORS
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ABSTRACT
The contamination of the natural environment with plastic debris is an increasingly high-prioritised concern among regulators, scientists and citizens. Aside from negative impacts on natural aesthetics, plastic debris causes a range of ecological harm from entanglement to starvation when mistakenly ingested by animals. Plastic adsorbs and concentrates pollution from the surrounding environment but the role that plastic debris plays in the movement of chemical pollution and contamination of food chains is largely unknown. Recent studies show that plastics facilitate the bioaccumulation of pollution to a variety of exposed organisms. Here we show for the first time that fish fed microbeads, isolated from a commercial facial cleanser and contaminated with the persistent organic pollutants polybrominated diphenyl ethers (PBDEs), bioaccumulated PBDEs in their tissues.

A fish dietary exposure (Murray River rainbow fish) study was conducted that involved three treatment groups: food only (control group 1), clean microbeads (control group 2) and PBDE spiked onto microbeads (exposure group). PBDEs were detected in both the control treatments and the exposed fish at all times points and this reflects the ubiquitous nature of PBDEs in organisms. After 21 days the mean $\sum$PBDEs concentrations in fish exposed to microbeads with PBDEs were more than three times larger than mean concentrations in both control treatments. The magnitude of PBDE difference between exposure and control treatments increased with time, whereby mean $\sum$PBDEs in exposure samples after 42 and 63 days were almost seven and ten times greater, respectively, than those in control treatments. After 63 days of exposure, mean $\sum$PBDEs concentrations indicate an accumulation of 9.7 ng g$^{-1}$ ww in exposed fish. Linear regression analysis estimates the rate of $\sum$PBDEs accumulation in exposure treatments over the period was approximately 115 pg g$^{-1}$ day$^{-1}$ ($R^2 = 0.59$). A two-way ANOVA test run on $\sum$PBDEs indicated significant differences among sampling times ($p = 0.002$), treatments ($p < 0.001$) and time-treatment interaction ($p < 0.001$). No significant difference in $\sum$PBDE concentrations were found between food only and clean s-MPPs treatments at any of time points.

KEY WORDS
Microbeads, microplastics, sorbed pollutants, bioavailability, PBDEs
2.2 Risk Assessment, Ecotoxicology and Remediation in Extreme Environments

Session Chairs: Tim Spedding & Darren Koppel
Time: 10:40–12:20

Risk Assessment and Remediation of Contaminants in Antarctic and Subantarctic Regions

Authors
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Abstract
A range of contaminants, including metals, fuels and oils, pose a risk to subantarctic and Antarctic environments. Contaminated sites exist due to past and current human activities, including waste disposal, accidental fuel spills and waste water discharge. These contaminated sites are often located on rare ice-free coastal soils and in shallow nearshore marine habitats in the vicinity of Antarctic stations. Species compositions at these sites are unique with high levels of endemism. The biota generally exhibit slow growth rates and long life cycles. These characteristics determine that standard toxicity tests, using standard test species, are not suitable for determining species sensitivities for the derivation of water, soil and sediment quality guidelines. We are therefore working to develop a suite of toxicity tests optimised for the indigenous biota of these cold regions. These tests include a mix of traditional and novel approaches including single species toxicity tests, community based assessments and alterations to soil microbial processes. The results will be used to derive Environmental Guidelines based on the potential risk contaminants pose to native biota, and will inform environmental decision making for the region. In parallel to toxicity test development and site specific risk assessments, Australia is working to develop remediation techniques for a number of contaminated sites within the vicinity of our stations. The extreme environmental conditions and remote location makes the clean-up of contaminants difficult and resource intensive. Past clean up solutions have often relied on contaminated material being returned to Australia for treatment and disposal. However, on-site remediation techniques are preferable as they allow for the reuse of remediated soils within station sites. Standard remediation techniques and technologies, such as biopiles and permeable reactive barriers, require modifications to work effectively in Antarctica. This talk will provide an overview of our progress over the last decade in developing toxicity tests and environmental guidelines, utilising site specific risk assessments procedures and designing effective remediation technologies for the Antarctic and subantarctic regions.

Key words
Risk assessment, remediation, toxicity, contaminants, Antarctic, subantarctic
SENSITIVITY OF SUBANTARCTIC MARINE INVERTEBRATES TO METAL CONTAMINATION

AUTHORS
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ABSTRACT
Areas of the subantarctic are isolated, cold, harsh and generally pristine. However, the presence of humans leads to contamination, particularly around research stations and legacy refuse sites. Increases in ship visits to the region will heighten the chance of fuel spills and increase copper concentrations, due to its use as a biocide on ship hulls. There is currently very limited data available on the sensitivity of subantarctic marine biota to contaminants, and no environmental quality guidelines exist for this region. The aim of this study was to determine sensitivities of several subantarctic marine invertebrates to a range of common metal contaminants (copper, lead, zinc). In addition, we determined the interactive effects of climate change stressors on the toxicity of copper to several taxa. This was particularly important as many areas of the subantarctic are already experiencing relatively rapid changes in climate. We conducted toxicity tests on ten marine invertebrate species at different life stages, collected from a variety of habitats within the intertidal and subtidal zones of subantarctic Macquarie Island. This required the development of specific test procedures in order to account for the unique characteristics of each species and of subantarctic biota in general. Copper was found to be the most toxic of the three metals tested. Sensitivity differed substantially between the ten species, and patterns appeared to correlate with the species distribution and habitat on the shoreline. Additionally, early life stages were generally more sensitive than adults, and additional climate change stressors altered copper toxicity. For example, an increase in as little as 2 °C significantly increased the toxicity of copper to a subantarctic copepod. Sensitivity to copper was particularly high for some species compared to analogous species from temperate and tropical regions. This work therefore highlights the need for the development of specific water quality guidelines for the subantarctic region based on the sensitivity of local taxa, as guidelines developed in other regions may not adequately protect subantarctic species from certain contaminants. It is recommended that any future environmental guideline development for the subantarctic region consider early life stage sensitivity, include species from a wide range of habitats, and incorporate interactions with climate change variables.

KEYWORDS
Toxicity, Macquarie Island, climate change, water quality guidelines, polar
BIOPILES – A SUCCESSFUL REMEDIATION APPROACH FOR HYDROCARBON-CONTAMINATED SOIL AND REUSE AT CASEY STATION, ANTARCTICA

AUTHORS
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ABSTRACT
Hydrocarbon contamination in Antarctic environments can pose potential toxic and long-term effects on the sensitive ecosystems. Three fuel spills at Australia’s Casey Station (66°17’ S 110°31’ E) in Antarctica, identified in 1999, 2010 and 2015 have resulted in contaminated sites. The clean up approach required low cost remediation techniques suitable for the Antarctic conditions and to allow signatory nations to the Antarctic Treaty to meet obligations under Annex III of the Environmental Protocol. Remediation of the 1999 fuel spill was the first major instance in Antarctica of a comprehensive remediation strategy which involves managing the contaminated site using biopiles. Biopiles are an active treatment method using the native microorganisms present in the soil to degrade the hydrocarbons. In Antarctica, microbial inocula and organic bulking agents are prohibited. Biopile operations included an initial fertiliser application, biannual mechanical turning of the soil and minimal leachate recirculation. For five years, the biopiles operated successfully within constraints typical of harsh climates and remote sites (e.g. limited resources, cold temperatures and short field seasons). Research has also focused on the long-term performance of geosynthetic barrier system used in the biopile to impede contaminant migration in the cold and arid Antarctic environment. The biopiles are a practical approach to remediate contaminated soils in the Antarctic. So far, 370 tonnes of remediated soil has been reused in a building foundation after a conducting a human health and environmental risk assessment. The biopiles at Casey Station demonstrate that bioremediation is a viable strategy for Antarctica and other cold regions and soil can be returned to the environment post-remediation with managed reuse.

KEY WORDS
Cold regions, bioremediation; fuel spills
PERMEABLE REACTIVE BARRIERS FOR CONTAMINANT CONTAINMENT AND TREATMENT IN THE ANTARCTIC AND SUB-ANTARCTIC ENVIRONMENTS

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ABSTRACT
The growing presence of human activity in Antarctica and sub-Antarctic has resulted in significant environmental impacts. With the adoption of the Environmental Protection Protocol in 1998, the development of remediation practices to minimise human impacts has become an important part of Antarctic science programs. One key technology that has had considerable success has been Permeable Reactive Barrier’s (PRB’s). The first PRB was installed in Antarctica during the 2005/06 summer season at Casey Station. This PRB was designed to contain and remediate hydrocarbon contaminated soil and water. Since installation, this PRB has been providing valuable information regarding; the overall performance of PRB’s in the Antarctic environment and areas that require further research in order to improve PRB longevity and reduce on-going management and operational costs. It has also provided the opportunity to trial alternate reactive materials for different duties and provided the basis for three further PRB’s installed at Casey and the first PRB installed at Macquarie Island during the 2014/15 season. This presentation will provide an overview of the development of PRB technologies for the Antarctic and sub-Antarctic environments since the original installation. It will also identify areas requiring further research to reduce the on-going cost of management and operation.

KEY WORDS
Permeable reactive barriers, in situ water treatment, Antarctica
CHANGES IN THE CONTAMINATION OF A MARINE INLET FOLLOWING REMEDIATION OF AN ABANDONED WASTE DISPOSAL SITE AT CASEY STATION, ANTARCTICA

AUTHORS
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ABSTRACT
Thala Valley near Casey station in the Australian Antarctic Territory was the location of a landfill or tip site used to dispose of station refuse including domestic rubbish, construction materials, machinery parts and waste chemicals from ca. 1964 through to the 1980s. Much of this waste material ended up in adjacent Brown Bay through the practice of ‘sea icing’, while the erosion of soil by meltwater flow through the valley and tidal inundation input around 10 m³ of weathered materials and contaminated soil to the Bay annually. This resulted in a significant negative human impact on the marine ecosystem of Brown Bay, contaminating the sediment with metals such as Cd, Cu, Pb and Zn and petroleum hydrocarbons.

In 2003–04 the Australian Antarctic Division, directed by Australia’s obligations to cleanup abandoned waste outlined in the Madrid Protocol to the Antarctic Treaty, undertook a remediation of the Thala Valley site. Frozen waste and contaminated soil were excavated into containers for transportation to Tasmania for chemical treatment (metal fixation) and disposal.

Measurement of contaminants in the terrestrial and marine environment – in samples of soil, sediment, and water – has been an integral component of the remediation process at Thala Valley. Chemical assessment of the contaminated site and the surrounding marine environment, correlated with measurement of infaunal community patterns, demonstrated a causal link between anthropogenic contamination and ecosystem damage (i.e. human impacts), triggering the decision to proceed with the cleanup operation. Chemical monitoring of contaminants during, and ~5 and ~10 years after the cleanup, performed in conjunction with biological monitoring of the marine ecosystem, have informed on the fate of contaminants in the benthic environment and the degree of success of the cleanup.

This talk will present an overview of contamination data for Thala Valley and Brown Bay determined pre-, during and post-cleanup of the tip site, documenting the chemical changes occurring in Brown Bay sediment over this time period. It will focus principally on metals, but also include data for hydrocarbons and POPs, and involve some discussion of the analytical methodology employed to acquire the data, touching on potential future developments to improve capability in monitoring contaminants in cold and remote regions.

KEY WORDS
metals, hydrocarbons, POPs, contaminants, marine sediment, soil, analysis, remediation, Antarctica
VALIDATION OF A NEW ANALYTICAL METHOD FOR THE ANALYSIS OF MULTIPLE STEROID HORMONES IN HUMPBACK WHALE BLUBBER BY LC-MS/MS

AUTHORS
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ABSTRACT
The development of non-invasive methodologies for measuring steroid hormones in free-swimming cetaceans represents a priority challenge of modern whale research. Readily accessible information regarding steroid profiles and levels would insight into species-specific endocrinological patterns and potentially their relationship with changing environments. Although a wide range of species, methods and tissue matrices have been investigated in recent years, only a limited collection of steroid hormones have been targeted. Further, most of the current studies focus only on one single compound at the time. Steroid hormones act through complex pathways and their absolute and relative concentrations can induce dramatically different physiological feedbacks. Consequently, limited or inaccurate hormone data might provide misleading information and interpretation of the results.

Here we report the successful development of a novel analytical approach for the LC-MS/MS analysis of multiple steroid hormones in the blubber of humpback whales (Megaptera novaeangliae). The method, derived from the work of Boggs et al. on dolphin blubber, was developed and evaluated for precision and accuracy at the National Institute of Standards and Technology (NIST) laboratories (SC, USA). The method was adapted to blubber samples collected from stranded southern hemisphere humpback whales (n=6). Isotopically marked analogues were used as internal standards.

Preliminary data show that progesterone, 17-OH-progesterone, testosterone, androstenedione, cortisol, 11-deoxycortisol, cortisone, corticosterone, estrone and estradiol were all detectable and quantifiable with a great repeatability (RSD ranging 4 % to 15% depending on the compound) in small quantities of whale blubber (0.3-0.8 g). This sample volume can be systematically collected from live cetaceans in the wild though standard dart biopsy. No negative effects on hormonal concentration were observed after 3 freeze-thaw cycles of the sample. Instead, the experiment suggested that blubber lipid percentage may influence hormonal measurements in this matrix.

It is the first time that this suite of endogenous compounds has been simultaneously measured in a large baleen whale.

The relationship between circulating hormones and blubber residue has not been studied yet. However our results suggest that blubber is a good matrix for hormone analysis as it provides biologically relevant concentrations of different classes of steroids. Further development of this research, will improve the knowledge about the humpback whale physiology, reproduction and health.

KEY WORDS
Steroid hormones, whale, blubber, monitoring, mysticete, alternative matrices
PERSISTENT ORGANIC POLLUTANTS AND AUSTRALIAN SEABIRDS

AUTHORS
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ABSTRACT
Seabirds have historically served as sentinels of environmental pollution, and concentrations of persistent organic pollutants (POPs) are often high due to their position as apex predators. However, monitoring is a challenge due to uncertainty regarding the most reliable and/or non-destructive sampling methods. We investigated the relationship between internal POP body burden and feather contamination in two species of seabird: flesh-footed shearwaters Ardenna carneipes and wedge-tailed shearwaters Ardenna pacifica from Lord Howe Island. Analysis of liver, kidney, muscle, blood, and feather samples was carried out using selective pressurised liquid extraction (S-PLE) and gas chromatography coupled to triple quadrupole mass spectrometry (GC-QqQ-MS/MS). Results have provided the first baseline data for POPs contamination within Australian species, including polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs), as well as the first quantification of novel flame retardant (NBFRs) contamination in seabird species from the Southern Hemisphere. Higher PCB contamination was found in comparison to other contaminants, which is consistent with studies conducted worldwide on species of the same family (Procellariidae). Contaminants appear to preferentially accumulate in the lipid-rich tissues of the liver, while low concentrations found in feathers indicate they may not be the most appropriate non-destructive biomonitoring tools for organic pollutants. POPs levels found within these species from a so-called ‘pristine’ environment show pollution from a mixture of persistent chemicals is widespread, relevant and urgent issue requiring further research.

KEY WORDS
Persistent organic pollutants, seabirds, polychlorinated biphenyls, polybrominated diphenyl ethers, novel brominated flame retardants, gas chromatography mass spectrometry, selective pressurized liquid extraction
APPLICATION OF X-RAY ABSORPTION SPECTROSCOPY TO EXAMINE SELENIUM SPECIATION IN CONTAMINATED AUSTRALIAN LAKE MACQUARIE SEDIMENTS AND BIOTA

AUTHORS
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ABSTRACT
Lake Macquarie is the largest estuarine barrier lake in Australia and has a long history of Se contamination. Selenium speciation and the biological transformation of Se in sediments control the environmental partitioning and bioaccumulation of toxic Se in aquatic organisms. Selective extraction procedures applied to soil and biological matrices have shown limitations such as Se redistribution during extraction procedures and inaccurate Se characterization. Therefore, non-destructive Se K-edge X-ray absorption near edge structure (XANES) spectroscopy was employed for detailed non-destructive bulk solid-state Se characterization in sediments and biota. Our preliminary results suggest that Se speciation in fish tissues determined by linear combination fittings of Se XANES spectra were in agreement with a high performance liquid chromatography-inductively coupled plasma mass spectrometry (HPLC-ICP MS) results. Specifically, Se-methionine and Se-cysteine species contributed 63-73% to total Se in fish muscle tissues as was determined by linear combination fittings, whereas 52-95% of total Se was Se-methionine and Se-cysteine based on HPLC-ICP MS measurements. The remaining Se species in fish muscle tissues were species characterized by lower Se electronic oxidation state (elemental Se, selenosulfides and selenocystine) (20-36%) and higher Se electronic oxidation state (R-Se(O)-OH) (<10%) as determined by Se XANES. Sediments have shown significantly greater percentage of reduced Se species as compared to fish tissues confirming further the transformation of reduced Se to Se-methionine and Se-cysteine compounds in higher organisms (fish). In addition, fish muscle tissues of carnivores appeared to contain greater percentages of Se-methionine and Se-cysteine than muscle tissues of detritivores indicating that Se speciation in fish muscle tissues is influenced by their feeding behaviour and Se speciation in their diet. Further study will employ extended X-ray absorption fine structure (EXAFS) spectroscopy to distinguish elemental Se and other reduced Se species in contaminated fish tissues and examine Se metabolic pathways in fish in marine lake systems.

KEY WORDS
Selenium speciation, X-ray absorption near edge structure spectroscopy
IDENTIFICATION, EFFECTS AND MANAGEMENT OF TOXICANTS IN WESTERN PORT, A LARGE, SEMI-ENCLOSED BAY IN VICTORIA

AUTHORS
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ABSTRACT
Western Port is a large, semi-enclosed bay south-east of Melbourne, Victoria with diverse natural assets including marine national parks, large areas of mangroves and seagrasses, and it is also recognised as a RAMSAR site of international significance for migratory birds. Western Port is valued for recreational fishing and until recently, supported a commercial fishery, however, the Western Port landscape has been altered substantially by agricultural and industrial activities in the last century and is under increasing pressure from rapid urban growth.

In 2011, a scientific review consolidating knowledge of the Western Port environment was produced by Melbourne Water. This report identified threats to environmental assets and critical knowledge gaps, which led to 43 research priorities that would inform future investment to protect and improve the health of Western Port. One priority area that was identified was the need to determine the extent to which toxicants pose a threat to the Western Port environment.

Over the last 4 years, CAPIM and Melbourne Water have been working to understand risks and provide evidence to inform decisions around toxicant management in Western Port. Initial screening of toxicants from inflowing waterways and the bay identified pesticides of highest risk and led to more targeted research and monitoring programs that assessed temporal and spatial variability. A large number of pesticides were detected in freshwater, estuarine and marine areas, including fungicides, herbicides and insecticides. Smooth toadfish (Tetractenos glaber) sampled from multiple estuaries throughout Western Port showed significant differences in some biological measurements, although no one site was consistently the most affected. We found no evidence of endocrine disruption-related changes (i.e. vitellogenin induction, testis-ova formation), however we did observe some differences in male-specific and female-specific gonadal changes between sites. Histological changes in toadfish livers were also observed, including a low incidence of pre-cancerous and cancerous growths, as well as the presence of nematode parasites and other infectious agents.

Here we present an overview of the pesticide sourcing and biological assessments (microalgae, invertebrates and fish) which provide multiple lines of evidence to demonstrate environmental impacts at some locations. These results have been used to identify targeted management actions that will support the protection and improvement of the unique Western Port environment.

KEY WORDS
Estuary, fish, toxicity, pesticide, biomonitoring
QUANTIFICATION OF BIOSOLIDS APPLICATION ON SOIL ORGANIC CARBON DYNAMICS: A META-ANALYSIS

AUTHORS
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ABSTRACT
Biosolids produced from sewage treatment facilities are increasingly applied to agricultural lands for improving soil health and increasing soil carbon storage. Although numerous case studies have been reported on increased Soil Organic Carbon (SOC) as influenced by land application of biosolids, there remains a lack of comprehensive quantification assessment. This abstract presents a case study that quantified SOC changes in surface soils (top 15 cm) for two years as impacted by a single application of biosolids at 5 tonnes/ha in an oat paddock at Point Pass, Adelaide. A LECO:TruMac CN/S analyser was used to quantify SOC. A Meta-Analysis (MA) comprised 175 paired-treatments of data across 25 countries and was applied to quantitatively compare results derived from the case study. The MA compared SOC changes over two main categories comprised within twelve groups: application age (time after application) as <1, 1-3, 3-5, 5-8, 8-11, >11 year and cumulative application rate as <1-50, 51-100, 101-150, 151-200, 201-250, >251 tonnes/ha. The Comprehensive Meta-Analysis version 3.0 program was used for data analysis.

After two years of the single application of biosolids, SOC concentration had increased slightly showing 0.1 g kg⁻¹ (p>0.05) as the mean difference between control and biosolids treated soils. However, the MA showed that short term (1-3 year group) application of biosolids resulted in the highest SOC content of 2.5 g kg⁻¹ (p<0.05). A negative correlation between increasing the time after biosolids application and soil carbon storage was observed. The highest mean difference for SOC content of 2.8 g kg⁻¹ (p<0.05) observed at 201-250 tonne/ha group reflecting the appropriate cumulative rate for application of biosolids for most of soil types analysed in this study. A positive correlation was observed between increasing the rate of application and SOC content. Overall, this study shows that land application of biosolids can be used to increase soil carbon storage and therefore has the potential to be a strategy for soil carbon sequestration.

KEY WORDS
Biosolids, Soil Organic Carbon, Meta-Analysis, Carbon Sequestration
3.1 METAL TOXICITY AND ENVIRONMENTAL CHEMISTRY

Session Chairs: Dr William Bennett & Francesca Gissi
Time: 13:20–15:00

EVALUATION OF CORBICULA AUSTRALIS FOR METAL TOXICITY ASSESSMENT: AN IN SITU CASE STUDY INTEGRATING CHEMICAL AND BIOMARKER ANALYSES

AUTHORS
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ABSTRACT
A weight of evidence approach is used in environmental assessment, which includes the use of biomonitor organisms to measure metabolically available contaminant concentrations and lethal and sub lethal responses in an exposure, dose and response framework. We assessed the suitability of Corbicula australis, an endemic Australian freshwater clam, as a test species for assessing metal toxicity using in situ river sediment exposures. Clams were deployed in four locations in the Molonglo River in South Eastern NSW, which has a legacy of sediment metal contamination, following eight decades of mining for zinc, copper, lead, silver and gold in its upper reaches. A sediment metal contamination gradient was evident from 12.5 to 47 km downstream of the mine. Sediments had elevated zinc: 851 - 130 > lead 104 - 7 > copper 31 - 5 > cadmium 2 - 0.3 mg/kg-1. Corbicula australis exposed at these locations accumulated metals relative to sediment and water metal concentrations. Mean tissue concentrations were; zinc 1358 - 236 > copper 24 - 20 > cadmium 4.7 - 0.7 = lead 4.2 - 1.8 µg/g-1. Biomarker responses showed increased sub lethal impairment with increased tissue metal bioaccumulation. Total antioxidant capacity was mildly impaired with corresponding increased lipid peroxidation at the higher tissue metal concentrations. Lysosomal membrane destabilisation increased with increased metal bioaccumulation. Corbicula australis proved to be an effective biomonitor organism for sediment metal assessment, as it is able to accumulate metals relative to sediment concentrations and showed a pattern of increased sub lethal impairment with increased tissue metal bioaccumulation. We suggest it would be a suitable species for incorporation into local freshwater monitoring and assessment programs.

KEY WORDS
Bivalve, Freshwater, Sentinel, Biomarkers, Lysosomes
CHRONIC TOXICITY OF ALUMINIUM TO THE SEA ANEMONE EXAIPTASIA PALLIDA

AUTHORS
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2Charles Darwin University, Darwin, Australia,
3Australian Institute of Marine Science, Brinkin, Australia,
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ABSTRACT
Many of the world’s bauxite mines and alumina refineries are located in tropical or sub-tropical regions. The discharge water from these processes can contain elevated aluminium (Al), from 30-1000 mg/L, which may present a risk to aquatic biota. A recently revised water quality guideline value for Al in seawater (24 mg/L) incorporated chronic toxicity data from both temperate and tropical marine species. However, data for tropical species have been lacking due to a paucity of standardised chronic toxicity test methods. Additional information on the toxicity of Al is needed to inform the environmental regulation and management of alumina refinery operations in tropical coastal regions.

This study was part of a project conducted from 2013-2016 to develop chronic toxicity test methods for tropical marine species, including a microalga (72-h Isochrysis galbana), gastropod (96-h Nassarius dorsatus), hermit crab (144-h Coenobita variabilis) and barnacle (96-h Amphibalanus amphitrite). Here we report a 14-d toxicity test for the sea anemone, Exaiptasia pallida.

Asexual reproduction and growth rates of E. pallida were assessed using the number of lacerates produced and oral disc diameter. The effectiveness of the toxicity test was assessed using exposure to a reference toxicant, copper (Cu) at 28°C, with asexual reproduction toxicity estimates of 10% (EC10) and 50% (EC50) effect concentrations, calculated as 10 µg/L and 31 µg/L Cu, respectively. Growth rate was a suitable additional endpoint (EC50 = 35 µg/L Cu). The EC10 and EC50 for Al (total fraction, based on reproduction) at 28°C were 820 µg/L and 2300 µg/L respectively. The toxicity of Cu and Al was also assessed at 24°C and 31°C, representing the average year-round water temperatures for sub-tropical and tropical Australian coastal environments. Changing the temperature from 28°C to 24°C or 31°C resulted in up to 43% less reproduction of unexposed anemones and an increase in the toxicity of Cu (EC50s: 24°C = 21 µg/L, 31°C = 23 µg/L). The effect of these temperature changes on Al toxicity is difficult to interpret. EC50s could not be calculated (with any confidence) for the responses to Al at 24°C and 31°C due to a plateau in the response at a 30-40% EC. This is possibly due to observed precipitation and a potential decrease in the bioavailability of Al. This test is a reliable addition to the suite of tests developed for tropical marine species.

KEY WORDS
tropical, North Australia, asexual reproduction, metal toxicity
INVESTIGATING THE BIOACCUMULATION KINETICS AND INTERNAL DISTRIBUTION OF THE RADIONUCLIDES CESIUM AND STRONTIUM UNDER ENVIRONMENTAL CONDITIONS

AUTHORS
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ABSTRACT
The radionuclides 137-cesium and 90-strontium are products of the nuclear fission and can often be found in environmental compartments at key Australian locations (Maralinga, Montebello Island test sites) and following accidents at nuclear power plants such as Chernobyl, Ukraine and Fukushima, Japan. Owing to the long half-lives of these isotopes (approximately 30 years), they have the demonstrated tendency to accumulate in aquatic organisms. Once within the ecosystem the radionuclides have the potential to bioaccumulate up the food chain and possibly cause detrimental effects to those organisms at higher trophic levels (including humans). It is believed that the dominant basis for this food chain bioaccumulation is via the sediment, where these radionuclides often persist for decades.

This study aimed to confirm the importance of diet in radionuclide transfer to aquatic biota. The study also aimed to determine whether the transfer pathway (the uptake of dissolved species via gills or ingestion of dietary-associated radionuclides) affects the site of internalisation of each radionuclide and its bioaccumulation kinetics.

The results from laboratory-based bioaccumulation studies using 134-cesium and 85-strontium radioisotope tracers and an estuarine crab species (Paragrapsus laevis) are presented in terms of biokinetics of accumulation and depuration from solution and diet. The effects of organism moulting (ecdysis) on radionuclide bioaccumulation will also be discussed. Whole-body autoradiographs are used to demonstrate the organ-specific distribution of each radionuclide and Synchrotron X-ray Fluorescence Microscopy is used to explore in detail the specific binding of radionuclides within organs. The information from this study will be used in organ-specific dose modelling for aquatic organisms, which will aid in the protection of aquatic life through an increased understanding of radionuclide-biota interactions.

KEY WORDS
Radionuclide, bioaccumulation, invertebrate, internal distribution, ecotoxicology
IMPACTS OF COAL MINING ON NATIVE AMPHIBIANS: UPTAKE AND BIODISTRIBUTION OF TOXIC METALS AND METALLOIDS

AUTHORS
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ABSTRACT
Coal mining generates large quantities of complex effluent, which often contains high levels of contaminants including metals, hydrocarbons and salts. Substantial volumes of mine water are periodically discharged into the environment, through both planned and accidental releases, raising concerns about the potential for adverse toxicological effects in aquatic wildlife. There have been few attempts to explore sub-lethal effects of coal mine wastewater (CMW) on amphibians, and this is particularly true for Australian species. To address existing knowledge gaps, we conducted a two-part study to investigate the bioaccumulation of metals in striped marsh frog (Limnodynastes peronii) tadpoles exposed to CMW. In the first experiment, tadpoles were exposed to CMW collected from two holding dams with distinct physico-chemical properties located at an open cut mine in Central Queensland. Tadpoles were exposed for four weeks, after which concentrations of a range of metals and metalloids were measured in tails and livers. Exposed tadpoles had elevated levels of Se, Co, Mn and As compared to controls, with hepatic tissue accumulating 8–9 times higher concentrations of Co, Mn and Se compared to tails. Subsequent experiments were carried out to investigate the biokinetics and biodistribution of trace elements of concern. Tadpoles were exposed to radiolabeled Cd, Se and Zn individually and in a mixture, and gamma spectroscopy was used to track their uptake and retention over time. Results show that Cd uptake is reduced when animals are exposed in a mixture with Se and Zn, and that bioconcentration was greatest for Se. Bioaccumulation kinetics and internal distribution of Se were quantified throughout metamorphosis using individually dissected organs and whole-body autoradiography. Following 7 days exposure to Se (as sodium selenite), tadpoles accumulated 0.3 µg Se/g wet weight, and retained 10-20% of the accumulated Se after 10 to 27 days of depuration in clean water. Selenium bioaccumulation was greatest in digestive and excretory organs. Furthermore, we found the bioconcentration of selenite to be 3 times greater compared to selenate, but rates of elimination were similar for both forms. Results demonstrate how the use of radiotracing techniques can significantly improve our understanding of metal bioaccumulation, including biokinetics and tissue distributions, during amphibian development.

KEY WORDS
Coal mine wastewater; Metal bioaccumulation; Biodistribution; Radioisotope tracer; Amphibian
CU-INDUCED CHANGES IN INTRACELLULAR THIOLS IN MARINE MICROALGAE

AUTHOR
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ABSTRACT
Toxicity of metals to aquatic organisms is dependent on both external factors, such as exposure concentration and water quality parameters, and intracellular processes including specific metal-binding sites and detoxification. Current models used to predict copper (Cu) toxicity in microalgae do not effectively consider the intracellular processes. This research examined the toxicity of Cu towards microalgae by investigating the intracellular Cu-binding ligands of phytochelatins and glutathione from four species of marine microalgae exposed to Cu at their respective IC₅₀ (concentration of Cu required to inhibit population growth by 50 %) at intervals over 72-h. IC₅₀ values were chosen to represent equal amounts of cellular stress across the four species despite their differences in Cu tolerance.

Despite similar Cu tolerances in Phaeodactylum tricornutum and Ceratoneis closterium, differences in internalised Cu, phytochelatin production and reduced glutathione were observed. P. tricornutum maintained reduced glutathione at 58 - 80% of total glutathione levels throughout, whereas in C. closterium reduced glutathione constituted <10% of total glutathione after 48 h of Cu exposure. P. tricornutum internalising significantly less Cu but produced more phytochelatins and of longer chain length than C. closterium. Two green algae, Dunaliella tertiolecta and Tetraselmis sp. had very different Cu tolerances, and also exhibited differences in internalised Cu, phytochelatin production and reduced glutathione concentrations. Tetraselmis sp. internalised three times more Cu than D. tertiolecta and had significantly more intracellular thiols. In both green species a decrease in the reduced:oxidised glutathione ratio was observed following Cu exposure. Phytochelatin production was markedly different between acute (< 24 h) and chronic exposures (24 – 72 h), with shorter chain lengths dominating for chronic exposures. Reduced glutathione increased slightly at longer exposures in both species, potentially indicating a decrease in intracellular oxidative stress despite a consistent increase in intracellular Cu.

This work has shown that the intracellular reaction to Cu is species specific, and responses were not necessarily related to their respective tolerances, or the amount of intracellular Cu. This suggests that there may be multiple modes of Cu toxicity and that detoxification processes vary between species.

KEY WORDS
Copper, phytochelatins, intracellular complexation, thiols, glutathione
**PHYTOTOXIC ACTIVITY OF NON-PROTEIN AMINO ACIDS SYNTHESISED BY CYANOBACTERIA**

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**ABSTRACT**

**Background:** In addition to being building blocks for proteins, the 20 DNA-coded protein amino acids play essential roles in a wide range of metabolic pathways in many organisms. Hundreds of non-protein amino acids (NPAAs) exist in nature, many are synthesised by plants, and are often used in plant defence to disable predators and as allelochemicals. In some cases their toxicity is due to their ability to replace protein amino acids in protein synthesis, thus becoming misincorporated into proteins in place of a protein amino acid [1]. The NPAAs ß-N-methylamino-L-alanine (BMAA), which is synthesised by most strains of cyanobacteria, has been implicated in neurological disorders in humans [2]. The effects of NPAAs synthesised by cyanobacteria on plant growth however has not been examined.

**Aims:** To examine the effects of BMAA and its structural isomer 2,4 diaminobutyric acid (DAB) on M. sativa (alfalfa) and O. sativa (rice) development.

**Methods:** The phytotoxicity of BMAA and DAB were assessed on alfalfa and rice seedlings. Root and shoot growth was measured following 5 days exposure to BMAA and DAB (0, 150, 300, 500, 1000, 1500 and 2000 µM). The alfalfa proteins were extracted from roots, hydrolysed and examined by triple quadrupole mass spectrometry (MS) for the presence of BMAA and DAB in proteins.

**Results:** Both BMAA and DAB were found to be toxic to alfalfa and significantly inhibited root growth by up to 58.4%, 66.6% and 59.7% (p < 0.0001) at 2000 µM for the BMAA, DAB and mixture treatments respectively. MS confirmed the presence of BMAA and DAB in hydrolysed alfalfa root proteins suggesting that they had been mistakenly used in protein synthesis as has been demonstrated in mammalian cells and the plant T. aestivum (wheat) [3, 4].

**Conclusions:** Irrigation of plants with water that is contaminated with cyanobacteria could potentially inhibit the growth of the plants. In addition, this is a mechanism whereby these NPAAs could enter the human food chain.

**KEY WORDS**
Cyanotoxins; non-protein amino acids; BMAA; DAB; phytotoxins
**BIOACCUMULATION, UPTAKE AND TOXICITY OF CARBAMAZEPINE IN SOIL – PLANT SYSTEMS**

**AUTHORS**

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**ABSTRACT**

Since the detection of active pharmaceutical ingredients (APIs) in various environmental media, research has transitioned to examining the potential uptake and toxicity of these chemicals into both terrestrial and aquatic species. A number of short-term studies have also suggested that certain APIs induce toxicity in plants. However, long-term effects of APIs on fruiting plants remain relatively unexplored. Carbamazepine (CBZ) is an antiepileptic pharmaceutical that is abundant in urban wastewater streams, due to its widespread use, and has the potential to be taken up from soils by several plant species. However, data on bioaccumulation and toxicity of CBZ in fruiting species are limited. This study therefore explored the uptake, bioaccumulation and toxicity of CBZ in *Cucurbita pepo* (Zucchini) over a 14-week period from seed to full maturity. This study also explored the toxicity of CBZ on the nitrification capacity of the soil. A sandy soil was spiked with concentrations of CBZ from 0.1 to 20 mg/kg for the uptake studies and 0.1 to 50 mg/kg for the nitrification study. There was no effect of CBZ on the nitrification capacity of the soil within the concentration range used. Plant biomass, chlorophyll and total nitrogen concentrations were affected at soil concentrations of 10 mg/kg and higher. There were clear visual symptoms of toxicity on the leaves, including chlorosis and necrosis at soil concentrations of 1 mg/kg and increasing in severity up to 20 mg/kg. Due to the visual symptoms further assays were conducted to determine effects on sugar metabolism. Detectable concentrations of CBZ were found in the edible fruit of *C. pepo* indicating the possibility of bioaccumulation from soil to plant to human.

**KEY WORDS**

*Cucurbita pepo* (Zucchini); LC-MS/MS; Starch assays
A COMPARISON OF FIELD- AND LAB-BASED METHODS FOR DETERMINING THE TOXICITY OF DIESEL TO SOIL INVERTEBRATES ON SUBANTARCTIC MACQUARIE ISLAND

AUTHORS
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ABSTRACT
After a fuel spill incident a complex mixture of hydrocarbons known as the UCM (unresolved complex mixture) may persist in soils for decades or centuries, and be carcinogenic and mutagenic to soil biota. Toxicity thresholds for a range of individual species are typically required to develop remediation targets for contaminated sites, but few studies to date have related these traditional lab-based toxicity tests to field observations. Similarly, model test species are often used in toxicity assays but with little effort to “ground truth” the results against endemic species from a contaminated area, the specific ecological relevance of the results is uncertain.

The subantarctic Macquarie Island has been subject to a number of fuel spill events, with low temperatures and water-logged soils retarding the natural biodegradation process. Full-scale remediation works have been underway on site since 2009, but no soil quality guidelines exist for subantarctic islands to inform the endpoint of these works. This study compares field observations of soil invertebrate assemblages in areas of Macquarie Island known to be contaminated by weathered diesel, with toxicity assays using both a commonly used OECD model species of earthworm (Eisenia fetida) and an earthworm endemic to Macquarie Island (Microscolex macquariensis).

Both species of earthworm responded similarly and appeared relatively tolerant of petroleum hydrocarbon contamination, but some evidence of a physiological response to the contamination was indicated by the occurrence of hormesis. Results of the field observations highlighted the importance of factors other than contamination, such as disturbance to the soil profile and vegetation cover, when considering the ecological impact of spills. The findings of this study will contribute directly to the establishment of remediation guidelines for fuel contamination on subantarctic islands, while also providing broader insight into the rarely addressed link between laboratory- and field-based tests.

KEY WORDS
Contaminated land; bioremediation; toxicity test, polar
CHANGES IN GROUNDWATER BIOTA WITH HYDROCARBON CONTAMINATION ON MACQUARIE ISLAND

AUTHORS
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ABSTRACT
With a history of fuel spills on subantarctic Macquarie Island, hydrocarbon contamination of soil and groundwater has been identified at several sites on the northern end of the Island near the current station. Monitoring of hydrocarbon concentrations in soil and groundwater is part of the ongoing remediation program for the Island. As part of this work, groundwater samples were collected in Summer 2012-13 from sites that span a contamination gradient. Samples were analysed for groundwater biota. Visual counts of live meiofauna (predominantly copepods, nematodes and rotifers) were made on freshly collected groundwater samples. Samples of water were also filtered and microbial assemblages analysed using DNA ‘fingerprinting’ of the microbial assemblages.

Invertebrate assemblages found in sites with contaminated groundwater had fewer animals than in clean sites, and there was an obvious shift in community composition. In this talk we identify taxa-specific relationships between abundance and hydrocarbon concentrations in the groundwater, and discuss the relationships between hydrocarbons and microbial assemblages. The context of this work is the changing groundwater concentrations as the remediation program continues.

KEY WORDS
Groundwater; Stygofauna; hydrocarbons; Macquarie Island; sub Antarctic; microbial assemblages
THE FUELTOX PIPELINE: MICROFLUIDIC QPCR FOR MICROBIAL ECOTOXICOLOGY IN SOIL

AUTHORS
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ABSTRACT
Quantitative PCR (qPCR) allows researchers to assess the impact of contamination on microbial communities involved in key processes such as nitrogen cycling, but is labor intensive, costly and requires a high degree of operator skill. Investigations are therefore usually restricted to quantifying 3-4 genes. Microfluidic qPCR (MFQPCR) has recently emerged as a high-throughput, semi-automated, alternative. Here we present the first application of MFQPCR to microbial processes in soil, evaluating the ecotoxicology of residual hydrocarbons in sub-Antarctic soils. Utilising existing primer sets, we developed a MFQPCR assay targeting the nitrogen cycle, hydrocarbon degradation and taxa, including bacteria and fungi. With as little as 6.7 nl reaction volumes, each chip has the capacity to quantify 14 genes across 30 samples in less than 5 hours, with costs per reaction less than half that of traditional qPCR. The FuelTox pipeline combines our MFQPCR assay with long-term in-situ mesocosms (114 weeks), fingerprinting (ARISA), factor-qPCR and multi-variate analysis, to assess the microbial ecotoxicology of hydrocarbons in soils. Utilising native soil and in-situ mesocosms, the Fueltox pipeline incorporates both environmental and biological variation, producing realistic assessments of toxicity. Additionally, due to the ability to quantify a large number of genes, MFQPCR is uniquely suited to a range of univariate and multivariate analyses, including those traditionally employed with larger organisms such as principal response curves (PRC). This method greatly reduces the complexity often associated with interpreting bacterial community responses, and produces results that are directly comparable with studies based on invertebrates and larger organisms. In our Macquarie Island case study with residual fuels, PRCs of MFQPCR-derived gene abundances revealed significant inhibition of the endemic microbial community in response to fuel spiking; with bacterial laccase-like and denitrification (nosZ, nirK & narG) genes the most sensitive. Unlike previous Macquarie Island studies with fresh fuel, we observed similar sensitivities over our entire spiking range of 50 – 10 000 mg/kg, with no stimulation of nosZ, alkB or nah genes, commonly associated with hydrocarbon degradation observed. By 69 weeks post-spiking we observed significant reductions in spiking compounds (54-99%) and most significantly the recovery of the microbial community to that prior to fuel spiking.

KEY WORDS
Microfluidic qPCR, Microbial Ecotoxicology, Mesocosms, Terrestrial, Residual Hydrocarbons, Sub-Antarctic
**3.3 SUSTAINABLE WASTE MANAGEMENT AND HUMAN HEALTH ISSUES**

Session Chairs: Dr Kathy Northcott & Erik Prochazka

Time: 13:20–15:00

**SAMPLING THE SH.. OUT OF AUSTRALIA ON CENSUS**

**AUTHORS**

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**ABSTRACT**

Systematic collection and analysis of wastewater has become an effective tool for estimating population use and abuse of a range of chemicals including illicit drugs, alcohol, pharmaceuticals, specific foods. By synchronising wastewater sampling in wastewater treatment plants (WWTPs) across Australia with the 2016 Census, we aim to develop a pioneering systematic Australia-wide program covering the Census week 2016 with the following objectives:

- Estimating national and catchment-specific per capita consumption of chemicals through analysis of influent wastewater and subsequent interpretation and extrapolation of data
- Estimating per capita release of chemicals via effluent and biosolids collected from the target WWTPs in Australia
- Measuring temporal and spatial trends for a wide range of chemicals and relating these to exposure, their use and/or population health and other outcomes (e.g., crime or hospital admission).
- Identifying potentially emerging chemicals in wastewater and assessing the use of wastewater analysis as a screening tool for hazard identification
- Providing guidance on assessment and prioritisation of policy responses to potential hazards to public health and the environment and for assessing markers of population health status
- Last but not least, by analysing the above data, the project will be able to assess co-factors that will allow accurate estimation of the population size contributing to the sampled wastewater.

**KEY WORDS**

Census; wastewater analysis; sewer epidemiology; WWTPs; population exposure
NEW WATER TREATMENT PLANT AT DAVIS, ANTARCTICA

AUTHOR
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ABSTRACT
Annex III of the Madrid Protocol outlines the obligations of national programs for waste disposal and management. Antarctic research stations generate a variety of waste, including liquid waste comprising human waste, waste from kitchens and bathrooms, and operational activities workshops. The Australian Antarctic Division has recently installed a new waste water treatment facility at Davis research station which has come on line at the end of the 2015–16 summer. This new facility will greatly improve the environmental outcome for this area. During the project’s second stage, an advanced waste water treatment plant with the capacity to produce potable water will be installed.
BIOACCUMULATION OF PFAS IN SEAFOOD FROM DIFFUSE AND POINT SOURCES

AUTHORS
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ABSTRACTS
Poly- and per-fluorinated alkyl substances (PFAS) are emerging contaminants that are receiving significant attention due to contamination at sites in Australia and abroad. Some of these substances are bioaccumulative and may present a risk to human and ecological health. A major pathway of PFAS exposure to humans can be consumption of contaminated seafood. This presentation contrasts PFAS concentrations in fish and prawns from Parramatta River (located in Sydney Harbour) with the same species from Fullerton Cove (located north of Sydney). The Parramatta River receives PFASs from diffuse urban sources, whereas Fullerton Cove receives PFASs via drains from contaminated land surrounding the Williamtown Airforce Base.

The species that were sampled as part of this work included Yellowfin Bream, Sea Mullet and School Prawns, which represent organisms at different trophic levels with different feeding habits. In Parramatta River, the concentrations of perfluorooctane sulfonate (PFOS) in fish and prawns were 0.1 – 6.1 and 11 – 18 µg/kg, respectively. In contrast, the concentrations of PFOS in fish and prawns sampled from Fullerton Cove were 0.3 – 19 and 9.6 – 25 µg/kg, respectively.

Persistent organic pollutants are generally bioaccumulated by aquatic biota with concentrations increasing at higher trophic levels, due to biomagnification. The results from this study illustrate the anomalous bioaccumulation of PFAS, since concentrations are higher in the lower trophic levels (i.e. prawns). This difference is due to the unique physico-chemical properties of PFASs.

Concentrations in fish were generally below the interim human health screening value for PFOS of 9.1 µg/kg recommended by RIVM (The Netherlands), whereas, concentrations in School Prawns frequently exceeded this value. Apart from PFOS, other PFASs detected in the Parramatta River samples were mainly long chain perfluorinated carboxylic acids, especially those with carbon chains of ten and above. In contrast, PFOS was the only PFAS frequently detected in the samples from Fullerton Cove. The results of this study show that both point sources and diffuse sources of PFAS may lead to concentrations in aquatic biota that exceed screening guidelines.

KEY WORDS
PFAS, PFOS, bioaccumulation, biomagnification, aquatic biota
GLOBAL GENE EXPRESSION CHANGES IN HUMAN SMALL INTESTINE EPITHELIAL CELLS FOLLOWING EXPOSURE TO SELECTED BROMO- AND CHLORO-DBPS

AUTHORS
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ABSTRACT
The process of disinfecting drinking water inadvertently leads to the formation of numerous disinfection by-products (DBPs). Some of these are mutagenic, genotoxic, teratogenic and/or cytotoxic, as well as potential carcinogens both in vivo and in vitro. In the current study we investigated changes in global gene expression (GE) in untransformed human small intestine epithelial cells (FHs 74 Int) after 4h exposure to six brominated (Br-) and two chlorinated (Cl-) members of various classes of DBPs: bromoacetic acid (BAA), bromoacetonitrile (BAN), 2,6-dibromo-¿-benzoquinone (DBBQ), bromoacetamide (BAM), tribromoacetaldehyde (TBAL), bromate, trichloroacetic acid (TCAA) and trichloroacetaldehyde (TCAL). Using whole genome cDNA microarray technology, we examined GE after exposure to DBPs at equipotent concentrations, determined significant changes in gene expression using statistical analysis (p ≤ 0.001, q ≤ 0.1), and investigated the influence of these genes on transcription factors and toxicity pathways via gene enrichment analysis. The tested Br- and Cl-DBPs showed specific differences in the induced changes in GE. While the GE profiles for Cl-DBPs were dominated by genes related to activation of oxidative stress-responsive Nrf2 and HSF1 pathways (i.e., upregulation of HMOX1, SRXN1, GCLM), the Br-DBPs induced GE response regulated predominantly by immune-responsive NF-Kb (i.e., upregulation of PTGS2, VCAM1, IL1B, IL24; downregulation of HMOX1, and GADD45A), however clearly indicating oxidative stress as a contributing factor. The apparent immunotoxicity observed after exposure to Br-DBPs adds to our current understanding of potential adverse effects related to exposure to disinfected drinking water.

KEY WORDS
Disinfection by-products; gene expression; toxicogenomics; microarray
IMPROVED TIME-INDEPENDENT SENSITIVITY ESTIMATES FOR ANTARCTIC SPECIES USING NO EFFECT CONCENTRATIONS

AUTHORS
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ABSTRACT
Toxicity tests incorporate exposure duration and concentration to assess the sensitivity of species to contaminants. “Critical effect concentrations” are quantitative estimates for the levels of effects or thresholds for toxicity. Of the three common types of critical concentrations, only two are in regular practice; the NOEC (No Observed Effect Concentration) and the EC/LCx (Effective/Lethal Concentration of x%). However, results of these measures are dependent on the exposure duration used. In contrast, the NEC (No Effect Concentration) is independent of exposure duration and provides a more robust estimate, yet its use is limited because of computational and mathematical difficulty. The NEC is particularly useful for species which are slow to respond to contaminant exposure, such as Antarctic biota, where low metabolic rates extend the required testing times. Lengthened exposure durations makes assessing sensitivity difficult with traditional, time-dependent, NOEC and EC/LCx metrics. The NEC is, therefore, preferable as it is defined as the concentration below which no effect occurs, regardless of exposure duration. However, the NEC model must be adjusted to account for common anomalies, such as control mortality and high variance of response at lower concentrations. Anomalies that are particularly prevalent in data from Antarctic species. Using our adapted model, we calculate NECs for a range of Antarctic species and compare the results to published NOEC and EC/LCx values. The extended test durations of Antarctic species and observations through time allow us to examine the usefulness of the time-independency of NEC values. It is expected that the adaption of NECs for Antarctic data will produce high reliability species sensitivity distributions and improve guideline derivation for high latitude Australian territories. The adapted NEC model we present here will also be of wider use to other regions for any data, including those with high-rates of control mortality.

KEY WORDS
NEC, critical effect concentration, exposure duration, guidelines
REVISED GUIDELINE VALUES FOR PESTICIDES DETECTED IN GREAT BARRIER REEF CATCHMENTS

AUTHORS
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ABSTRACT
At least 49 different pesticides have been detected in catchments that flow to the Great Barrier Reef (GBR) lagoon as a result of terrestrial runoff. Of these, only 12 have trigger values in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000) with eight of these having low reliability trigger values. Published ecotoxicity data were collated and screened for many of these detected pesticides, starting with those that pose a greater risk to the GBR. The newly revised derivation method that establishes species sensitivity distributions (SSDs) and freshwater and marine protective concentration (PCx) values was used to calculate guideline values (formally termed trigger values) as part of the national revision of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality. The resulting PCx values were submitted for consideration as new guideline values for the Australian and New Zealand Water Quality Guidelines and the Great Barrier Reef Water Quality Guidelines. To date, new guideline values for 13 pesticides have been derived by the authors for freshwater and/or marine ecosystem protection including: 2,4-D, ametryn, diuron, glyphosate, hexazinone, imazapic, imidacloprid, isoxaflutole, metolachlor, metribuzin, metsulfuron-methyl, simazine and tebuthiuron. New guideline values for a further 14 pesticides (11 herbicides, two fungicides and one insecticide) are due for submission by the end of December, 2017. This ecotoxicity data and the new water quality guideline values are also used in the multisubstance-potentially affected fraction (ms-PAF) method to determine mixture toxicity and ecological risk assessments for GBR catchments and the GBR lagoon. In addition, ecotoxicity data have been made available to multiple organisations and programs to provide consistent pesticide advice to stakeholders and support the Reef Water Quality Protection Plan. Here we present the new water quality guideline values for pesticides and discuss the key steps in their derivation using the revised method.

KEY WORDS
Pesticides, Great Barrier Reef, guideline values, water quality guidelines, trigger values
A REVISED WATER QUALITY GUIDELINE FOR COBALT IN FRESHWATERS

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ABSTRACT
Toxicant guideline values (GVs) are an integral component of most water quality management programs. The ANZECC/ARMCANZ Water Quality Guidelines (2000) (the Guidelines) represent the primary guidance in Australia and New Zealand for managing and regulating water quality. The Guidelines are presently being revised, and will include a new web-based platform that will enable the timely revision of existing GVs and inclusion of GVs for additional toxicants. Another key change to the Guidelines is that GVs can be derived and submitted by external parties. This contributed GV scheme presents opportunities for academia, industry and regulators to improve environmental management by revising or deriving GVs for a larger number of high priority toxicants.

Default GVs are used as Trigger Levels (TLs) in the Environmental Authority (EAs) to operate for most mining operations in Queensland. Exceedances of TLs 'trigger' further investigation and reporting. Given the reliance on default GVs in environmental compliance, it may be more appropriate for an operation to allocate resources to improving an existing, or deriving a new, default GV before undertaking site-specific investigations (i.e. for sites where there are no site-specific factors that would significantly affect toxicant bioavailability and therefore, toxicity). A contributed default GV is also likely to provide greater societal benefit, especially in an environment where funding for new GVs is scarce.

A review of the surface water compliance history at a metalliferous mine in North West Queensland identified low level exceedances of the default GV for cobalt as a common trigger for compliance reporting. The current national default Co GV of 1.4 mg/L was classified in 2000 as a low reliability value due to a lack of available data and its subsequent derivation using the assessment factor approach. This provided the impetus to examine whether sufficient data now existed to revise the value using the preferred species sensitivity distribution (SSD) approach. Chronic cobalt toxicity data for 20 species from 9 taxonomic groups were initially collated, with the quality assessment and data screening steps refining the dataset to 11 species from 7 taxonomic groups. Key decisions made during the data screening stage included excluding all converted chronic and NOEC data, excluding data where the species or testing conditions were not considered environmentally relevant, and selecting only the most sensitive response where a toxicity modifying factor (e.g. hardness) appeared to influence the results. A high reliability GV of 4.3 mg Co/L was subsequently derived. Progress made to incorporate the new GV into an EA amendment for a mine in Queensland and to contribute the value to the Guidelines will also be presented.

KEY WORDS
Cobalt, Water quality guideline, Species sensitivity distribution, Environmental management, Freshwater
DERIVATION OF A MARINE ARSENIC WATER QUALITY GUIDELINE VALUE

AUTHORS
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ABSTRACT
Water quality guidelines are an essential tool for conducting ecological risk assessments and yet there are many contaminants, such as arsenic (As), in our coastal marine waters for which there are no reliable guideline values (GVs) thereby limiting the assessment of their effects. Currently the ANZECC/ARMCANZ (2000) guidelines have an environmental concern level (ECL) of 2.3 µg/L for arsenite (AsIII) and a low reliability GV of 4.5 µg/L for arsenate (AsV). Both AsIII and AsV values were derived from a limited data set of chronic or adjusted chronic values with an assessment factor applied. This approach produced interim values with the view that as more data came to hand, these values would be updated to more reliable GVs. In this update, we have prioritised the derivation of a marine AsV GV based on its dominance in oxidized seawaters and the rapid oxidation of AsIII to AsV in surface sea waters. An AsV toxicity database was created by conducting chronic toxicity tests with 8 Australasian marine species representing 4 taxonomic groups (2 bivalves, 1 sea urchin, 3 green microalgae, 2 diatoms). Chronic effect concentrations (IC/EC10s) based on measured dissolved arsenic ranged from 15 µg/L to 19,000 µg/L, with the green microalga Chlorella salina being the most sensitive species tested. These data were supplemented with peer-reviewed and published literature values that were assessed and ranked for inclusion based on the quality assurance of the data. A species sensitivity distribution was modelled using BurriLOz Version 2.0 software to derive the final marine AsV GV that was markedly higher than the interim value. In addition, chronic AsV toxicity testing was conducted with seawater supplemented with phosphate and nitrate for the green algae, diatoms, mussel and sea urchin species to determine nutrient effects on AsV toxicity to biota. A consistent decrease of AsV toxicity with increasing nutrient concentration was observed for all species. This nutrient ameliorative effect on AsV toxicity is particularly important when designing, conducting and interpreting algal toxicity tests. The development of a reliable marine AsV GV will have high impact for industry and resource managers in assessing the ecological risk of AsV to marine biota.

KEY WORDS
Arsenic, water quality guideline, chronic toxicity testing, SSD, nutrients, algae, sea urchin, mussel, oyster, diatom
AMMONIA TOXICITY TO SIX TROPICAL SPECIES IN LOW PH WATERS, AND DERIVATION OF SITE-SPECIFIC WATER QUALITY GUIDELINES

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ABSTRACT
Ammonia is a contaminant of concern in surface waters, globally. Sources include anthropogenic uses such as, agricultural run-off, sewage and stormwater discharge, extraction of metals in the mining industry, production of pharmaceuticals and processing of crude oil that ammonia can enter the environment. In the present study, ammonia toxicity was assessed in the slightly acidic (~pH 6), soft waters (<10 mg L-1 CaCO3) of Magela Creek, Kakadu National Park, Northern Territory, Australia. This region is of high environmental significance, and is potentially at risk of ammonia contamination due to uranium mining related activities. Six local species were tested: Chlorella sp., Lemna aequinoctialis, Hydra viridissima, Moinodaphnia macleayi, Amerianna cumingi and Mogurnda mogurnda. Its environmental toxicity varies depending on the pH and temperature of the water. Throughout testing, test water pH was maintained at approximately pH 6, and temperatures between 27.5 to 30°C, dependent on species. Toxicity estimates were normalised, using well established algorithms (US EPA 2013), to pH 7 and 20°C. Normalised (pH 7, 20°C) international data for the chronic toxicity of ammonia compiled by the US EPA (2013) were combined with the normalised (pH 7, 20°C) toxicity estimates for the invertebrate and fish species from the present study into a species sensitivity distribution. Low effect chronic inhibition concentration (IC10) and acute lethal concentration (LC10) values for these species ranged between 1.8 to 66 mg L−1 total ammonia nitrogen (TAN). Of the local species tested, H. viridissima was the most sensitive and the fifth most sensitive in the international literature (based on comparisons between IC20 values at pH 7 and 20°C); while tests with M. mogurnda yielded the most sensitive acute toxicity estimate for a species of fish in the international literature. The macrophyte species, L. aequinoctialis, was the second most sensitive of the local species, based on chronic sensitivity. A 99% species protection guideline value of 0.48mgL−1 TAN was derived from the normalised test results. This value was adjusted using well-established algorithms for a range of temperatures and pH concentrations to establish a matrix of water quality guideline values between 0.62 to 0.03 mg L-1 TAN, encompassing a pH range of 6 to 9 and temperature range of 25 to 32°C. This allows the application of the ammonia guideline values to a range of surface water conditions.

KEY WORDS
Uranium mining, aquatic toxicity, ammonium
GLACIAL SUSPENDED SEDIMENT: CHARACTER, COMPOSITION AND ADSORPTIVE BEHAVIOUR IN THE WAITAKI CATCHMENT, NEW ZEALAND

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ABSTRACT
The dissolved concentrations of many toxic trace metals, nutrients and organic contaminants are strongly influenced by sorption-desorption processes on the surfaces of suspended sediment (SS). Because such pollutants are typically more bioavailable to aquatic biota in their dissolved form, the adsorption of trace contaminants and nutrients onto SS is an important process regulating their transport, availability and toxicity.

Glaciers produce huge volumes of sediment through the crushing of rock in alpine environments. Much of this sediment is extremely fine grained and suspends in melt-waters for extended periods. The freshly eroded surfaces of these sediments are both primed for chemical adsorption and susceptible to chemical weathering. These particles may play an important role in regulating water quality as glacier-fed catchments are subject to increasing levels of pollution and significant changes in runoff and sediment load resulting from glacial retreat.

The aim of this research is to determine the character, composition and behavior of glacial SS in the Waitaki catchment, a large alpine catchment in New Zealand that is fed by a number of the country’s most prominent glaciers. Five large hydroelectric lakes increase the residence time of SS to approximately 1-2 years, optimizing opportunities for particle characteristics to change. Comparisons have been made between the upper glacier-fed catchment (Aoraki/Mt Cook) and the lower, agricultural catchment. Changes in the mineralogical and morphological character of the SS with time have been detected, and include an increase in the proportion of clay minerals, aggregates and diatoms to feldspar and quartz minerals. The capacity of upper and lower catchment SS to adsorb copper, cadmium and phosphate has been assessed through adsorption and DGT experiments that will be discussed.

KEY WORDS
Glacial, Sediment, Sorption, DGT, Trace, Copper, Cadmium, Phosphate
BIOTURBATION INTENSITY: A POTENTIAL GAME CHANGER FOR SEDIMENT TOXICITY TESTING AND SEDIMENT REMEDIATION

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ABSTRACT
Globally, industrialisation and land use has put aquatic ecosystems under threat. Sediments are a sink for many contaminants which impact organism recruitment, benthic organism populations and the community structures present. Organism-sediment interactions modify physicochemical properties of sediments and influence the fate of contaminants (e.g. burial, degradation, fluxes). The interplay between how bioturbation activities influence the concentrations, forms and position of contaminants, and the exposure, bioavailability, toxicity and interactions between organisms, will influence the communities they can sustain and also the rate of natural recovery of contaminated sediments.

We investigated the impact of bioturbation intensity (No, Low and High) on contaminant exposure, bioavailability and toxicity (acute and chronic) in laboratory-based tests. Bioturbation was achieved by the addition of a single test organism species (Low), or both a test species and an additional active bioturbator species (the amphipod *Victoriopisa australiensis* (High)). Toxicity test endpoints comprised 28-day survival and metal bioaccumulation in the bivalve *Tellina deltoidalis* and 10-day survival and reproduction of the epibenthic amphipod *Melita plumulosa*.

The sediments studied comprised a variety of physical properties (silty/ low organic carbon (OC), sandy/ high OC) and contaminant classes (metals, hydrocarbons). Changes in metal-partitioning were observed in all tests, with the greatest changes occurring in high bioturbation treatments. In metal-contaminated sediments, higher bioturbation rates increased survival compared to non-bioturbated controls for both organisms (53 to 100% (bivalve), 42 to 93% (amphipod)), and increased reproductive output in *M. plumulosa* (3 to 65%). These trends correlated to the decrease in dissolved copper in the overlying waters. However, decreased reproductive output for *M. plumulosa* (44 to 23%) was observed in the highly bioturbated metal and hydrocarbon-contaminated sediment, correlating with the increased release of polycyclic aromatic hydrocarbons (PAHs) from the sediments. The research has highlighted the importance of considering natural disturbances such as bioturbation when assessing the fate and risk posed by sediment contaminants. Research is underway to enable better use of this information in improving rates of natural recovery of contaminated sites.

KEY WORDS
Bioassay, benthic invertebrates, contaminants, speciation, sediment quality guidelines, metal speciation, multiple stressors
PREDICTING THE FATE OF ORGANIC POLLUTANTS IN BREWSTER LAKE, NEW ZEALAND UNDER CLIMATE CHANGE SCENARIOS

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ABSTRACT
Glacial melting in cold ecosystems is projected to accelerate in the future due to increases in the mean surface temperature. This may result in the enhanced release of organic chemicals currently trapped in glaciers to the surrounding environment. This study was conducted at Brewster Lake, a high-alpine lake in the Southern Alps of New Zealand, which is mainly fed by meltwater from Brewster Glacier. A multi-media environmental chemical fate model was developed for Brewster Lake, using the chemical concentrations measured in air, stream water, and glacial meltwater as chemical input. The measured lake water and sediment concentrations were used for an independent validation of the model. During five field trips to Brewster Lake between March 2014 and April 2015, air was sampled by passive air samplers, water by high-volume water samplers, and sediment by a sediment corer. The model was used to understand current fluxes of organic pollutants in this proglacial lake and estimate future concentrations under two specific future climate scenarios expected for New Zealand and the Brewster Glacier catchment.

Endosulfan I, dacthal, chlorpyrifos, hexanechlorobezene, and triallate were detected in the air, water, and sediment during the one year course. Triallate exhibited the highest concentrations of 730 pg m⁻³ in the air during the autumn sampling period and 350 pg L⁻¹ in the lake water in June 2014. Endosulfan II and endosulfan sulphate were also found in lake water and sediment although no significant seasonal trend was observed. The model agreed well with the measured concentrations in the lake water and a sensitivity analysis showed that the chemical concentrations were most sensitive to lake temperature and the air-water partition coefficient (K_{AW}). Wet gaseous deposition was the main pathway for endosulfan I, dacthal, chlorpyrifos and triallate to enter the lake from air because of their low K_{AW}. Measured concentrations in air, glacial meltwater, and stream water were positively correlated with the lake water concentration. Under future climate change scenarios, the concentration peak caused by ice melt runoff occurred three months earlier, which is mostly due to the projected increase in air temperature.

KEY WORDS
Multimedia environmental model, alpine glacial lake, passive air sampling, high-volume water sampling, climate change
FORECASTING RISK OF RADIUM FROM FERTILISER IN NEW
ZEALAND AGRICULTURAL SOILS

AUTHORS
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ABSTRACT
Phosphate ore sources worldwide can contain high levels of uranium and its decay products, of which 226Radium (226Ra) is an important environmental contaminant. 228Radium (228Ra) from thorium decay may also be present but at lower activity concentrations. For many countries, the acid processing of phosphate ore to triple superphosphate removes 226Ra. In contrast, New Zealand generally uses single superphosphate and reactive phosphate rock to maintain crop yields. These fertilisers do not undergo acid processing, and 226Ra is retained in the applied product. The current study showed that significant activities of 226Ra are present in soils, ranging up to 1.6 kBq/kg, however 228Ra did not exceed 75 Bq/kg. Subsequently, analysis of 40 New Zealand soils, covering a range of land uses, showed activities of between 27-88 Bq/kg 226Ra and 21-102 Bq/kg 228Ra. Unexpectedly there was a strong correlation between the two radium isotopes. In 13 of the soils, all with very high phosphate levels, the speciation of 226Ra was determined, indicating that it largely remains immobile in the residual phase of the soil. Agricultural soil and crop pairings were analysed for 226Ra to establish transfer factors. For all food crops and some feed crops, the calculated transfer factors fall within 0.005-0.05 g/g, although certain pasture crops ranged up to 0.2 g/g. Dietary burden analysis indicates 226Ra and 228Ra exposure is largely through cereal grains. Soils and foliage from a fertiliser-contaminated site were analysed to establish if transfer factors vary across an increasing 226Ra soil activity gradient. Plant uptake did not increase with increasing soil activity concentrations. Future increases to the dietary ionising radiation dose can be forecast using the current fertiliser inputs of 226Ra. From this forecasting it is estimated it will take more than a thousand years to reach a dose requiring regulatory intervention.

KEY WORDS
Radium, Phosphate Fertiliser, Agricultural soils, Food and Feed Crops, Dietary exposure assessment
PREDICTORS OF PESTICIDE CONCENTRATIONS IN FRESHWATER TROUT – THE ROLE OF LIFE HISTORY

AUTHORS
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ABSTRACT
Concentrations of halogenated pesticides in freshwater fish can be affected by age, size, trophic position, and exposure history. Exposure history may vary for individual fish caught at a single location due to different life histories, e.g. they may have hatched in different tributaries before migrating to a specific lake. We evaluated correlations of pesticide concentrations in freshwater brown trout (Salmo trutta) from the Clutha River, New Zealand, with potential predictors including capture site, age, length, trophic level, and life history. Life history was determined from otolith strontium isotope ratios, which vary among tributaries in the region of our study. Variability in pesticide concentrations between individual fish could not be explained by capture site, age, length, or trophic level. However, hexachlorobenzene (HCB) concentrations were distinct in lake-based trout with different life histories. Additionally, one of the riverine life histories was associated with relatively high concentrations of total endosulfans. Linear models that included all potential predictor variables were evaluated and the resulting best models for HCB, chlorpyrifos, and total endosulfans included life history. These findings show that in cases where otolith isotope signatures vary geographically, they can be used to help explain contaminant concentration variations in fish caught from a single location.

KEY WORDS
Strontium isotopes, fish otoliths, Clutha River, hexachlorobenzene, chlorpyrifos, endosulfan
CELLULAR ENERGY ALLOCATION AND THE USE OF NEAR INFRA-RED SPECTROSCOPY FOR MEASURING STRESS RESPONSES IN COMMON AUSTRALIAN BIVALVE SPECIES

AUTHORS

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ABSTRACT

The function and sustainability of organisms, populations and ecosystems are driven by the input, use and transfer of energy. The storage and transfer of energy in organisms is influenced by environmental stress from physiochemical changes and contamination. Cellular Energy Allocation (CEA) is a measure of energy stores (protein, lipids and glycogen) versus energy consumption and provides a measure of organism response to stress. The capacity to rapidly assess CEA would provide a valuable tool to assess organisms’ responses to both physiochemical stressors such as temperature, salinity, pH and oxygen changes and anthropogenic influences. Near infra-red spectrometry (NIRS) quantitative modelling provides an approach that can provide high accuracy results with rapid results outputs and minimal sample preparation. In Australian estuaries, bivalves are a valuable monitoring species due to their filter feeding and sessile nature. This presentation will present an approach for a rapid energy determination method that assesses energy storage and use changes in bivalves resulting from physiochemical changes and metal contamination. NIRS models have been developed to assess energy stores for Saccostrea glomerata (Sydney Rock Oyster), Ostrea angasi (Flat Oyster), Mytilus galloprovincialis (Australian Blue Mussel), Crassostrea gigas (Pacific Oyster) and Anadara trapezia (Sydney Cockles).

KEY WORDS

Cellular Energy Allocation, Near infra-red spectroscopy, bivalve, oyster, cockle, mussel
INCLUDING SENTINEL ANIMALS ALONGSIDE ENVIRONMENTAL MONITORING IN AQUACULTURE PRODUCTION

AUTHORS
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ABSTRACT
It is difficult to routinely monitor the behaviour and health of thousands of individuals in aquaculture production systems. Consequently, aquaculture stock is typically monitored intermittently by direct physical inspection of a subset of individuals outside of their normal environment. The physical handling periods associated with these spot checks on welfare are themselves stress events, and any subsequent measurement or observation may be compromised. Another common practice is to utilise easily-measured, environmental parameters such as water temperature and quality (pH, oxygen level, nitrogen, turbidity) as a proxy for animal well-being. Environmental sensors are often relatively cheap and provide valuable insight into stock living conditions. However, they require regular cleaning and calibration, and importantly they do not provide any information concerning an animal’s view of its environment, behaviour or physiology which are key indicators of well-being. Here we present our sentinel aquaculture stock concept where the animal itself is integrated into an array of environmental sensors using the pacific oyster as a case study. Oyster heart rate and valve gape is measured on-farm alongside key environmental parameters including temperature, salinity, dissolved oxygen concentration and chlorophyll concentration. We present physiology coupled with environmental data from a commercial oyster lease. Ultimately, real-time physiological and behavioural cues from sentinel animals combined with environmental data will provide indicators that enable swift management actions that prevent stock and consequently profit losses. Using sentinel animals to improve decision support systems prevent stock loss and increase yield can help the overall sustainability and profitability of oyster and other aquaculture industries.

KEY WORDS
Aquaculture, sensor network, biologger, biosensor, biotag, monitoring, Farm management; Smart farm; Decision support, Heart rate; Valve activity
TIME TRAVELLING POISON: RAPID ANALYSIS OF BRONZE-AGE CONTAMINATION IN CENTRAL THAILAND AGRICULTURAL SYSTEMS

AUTHORS
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ABSTRACT
Ancient metalworking (copper, bronze and iron), began in Southeast Asia in the 2nd millennium BCE and played a key role in the social and economic transformation of the region. While the products of this technology are ubiquitous, evidence of actual metal working and smelting is often obscured in the modern landscape. In this work we examine the potential of portable X-ray fluorescence spectrometry to rapidly identify and map archaeological significant sites that sit within the current Central Thailand agricultural production system. We find that the technology can rapidly identify grossly contaminated sites, but precision decreases as values approach the regional background value of copper in soil, which makes the identification of sites with a small amount of copper enrichment difficult. In several instances we identify sites and samples within sites with total copper that grossly exceeds regional background concentrations (>10000 mg kg⁻¹). Using a specific site as a case study, we examine the relationship between this ancient copper contamination and current mobility of copper within a sugar cane/maize production system, and explore the capacity of pXRF to identify hotspots of copper contamination within a small site. We also examine the capacity of pXRF to rapidly assess the trace element concentrations in archaeologically significant sediment profiles, and show how this can value add to archaeological interpretations of past site use.

KEY WORDS
Portable X-ray fluorescence, copper, bronze-age smelting, archaeology
HYDROCARBON CASE STUDIES: ANOMALOUS RESULTS AND FALSE POSITIVES

AUTHOR
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ABSTRACT
Background/Objectives
CRC CARE has established the NEPM guidelines for the assessment of petroleum hydrocarbon contamination. These guidelines have calculated Health Screening Levels (HSLs) for different hydrocarbon fractions in different soil types or aquifer situations. The HSLs rest on a set of assumptions, including the presumption that the hydrocarbon contamination is ‘typical’ of hydrocarbon (i.e. petrol or diesel).

Approach/Activities
In this presentation we outline a number of case studies of samples collected from actual contaminated samples. Contamination levels were assessed using gas chromatography–flame ionization detection. This is a non-specific method that cannot determine the type of contamination.

Unusual chromatographic profiles were further analysed by gas chromatography–mass spectrometry to determine the compounds present. This data was then used to assess the applicability of the NEPM HSLs.

Results/Lessons Learned
While the HSL assumptions are robust enough for most contaminated sites, we show that there are times when blindly applying these assumptions without a real knowledge of the type of hydrocarbon contamination can lead to incorrect actions taken. A more robust approach is required for better decision making.

KEY WORDS
Hydrocarbons, NEPM, Health Screening Levels
DRAFT ANZECC AND ARMCANZ WATER QUALITY GUIDELINES FOR PFOS AND PFOA

AUTHORS
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ABSTRACT
The release of the Revised Methodology and Technical Rationale guidance documents (Warne et al, 2015; Batley et al, 2014) to derive Australian and New Zealand Water Quality Guideline Values for Toxicants represents a significant improvement to development of risk-based guidelines for protection of aquatic ecosystems in Australia. The authors will present their experience in developing draft aquatic guidelines for the emerging contaminants PFOS and PFOA (per- and poly-fluoroalkyl substances, PFASs) using the revised guidance. PFASs are complex contaminants. The understanding of the toxicology and environmental fate of PFASs is still emerging. Emerging or complex contaminants present challenges in determining ecotoxicological effects of ecological relevance and in selecting appropriate and defensive studies for use in environmental quality guidelines. The presentation will cover some of the data considerations and professional judgements made in selection of studies included in the draft guidelines with particular focus on chronic, endocrine and multigenerational effects. Comparison of the Australian and New Zealand approach and draft numeric limits for PFOS and PFOA will be made with water quality guidelines for PFOS and PFOA available in other jurisdictions.

KEY WORDS
ANZECC/ARMCANZ revisions; water quality guidelines; emerging contaminants; PFOS; PFOA
3.1 Metal Toxicity and Environmental Chemistry

Session Chairs: Assoc Prof Dianne Jolley & Timothy Coggan
Time: 13:30-15:10

THE EFFECT OF SEAWATER INUNDATION ON THE MOBILISATION OF TRACE METALS FROM A CONTAMINATED WETLAND SEDIMENT

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ABSTRACT
Freshwater wetlands provide a number of important ecosystem services, including the retention of contaminants like trace metals. This process occurs via the sequestration of dissolved metals by wetland sediments and the sedimentation of metal-containing particulate material. Freshwater wetland sediments are characterised by large amounts of decaying organic matter, which can provide a variety of sorption sites for trace metals. Unfortunately, many freshwater wetlands are located in coastal areas close to sea-level, placing them at risk from future seawater inundation due to storm surges and/or climate change-induced sea-level rise. To investigate the possible implications of seawater inundation on the geochemical processes controlling the mobility of trace metals in organic-rich wetland sediments, we performed a laboratory-based microcosm experiment using sediment taken from a moderately contaminated freshwater wetland. Microcosms containing homogenised sediment were assigned to one of three treatments: 1) control treatment, containing freshwater only; 2) low seawater, containing 10% seawater and 90% freshwater; and 3) high seawater, containing 50% seawater and 50% freshwater. Microcosms were incubated under anoxic conditions in an anaerobic chamber, and sacrificed and sampled at regular intervals over 30 days. The aqueous phase of each microcosm was sampled for pH, Eh, dissolved metals, TOC, sulfate, sulfide, and Fe2+. There were considerable differences in the extent of mobilisation of different trace metals with increasing seawater concentration. In general, metals more likely to be sorbed to organic matter via oxygen-containing ligands like carboxyl groups (i.e. harder lewis acids), such as Fe, Mn, Co, Ni and Zn, were rapidly released to the aqueous phase upon exposure to seawater, with a greater degree of mobilisation at higher seawater concentrations. In contrast, metals that tend to form complexes with sulfur-containing ligands like thiol groups (i.e. soft lewis acids), such as Cu, Cd and Pb, were more immobile with increasing seawater concentration. These findings indicate that the inundation of organic-rich wetland sediments with seawater can result in contrasting impacts on the mobility of different metals. Interpretation of this behaviour in the context of Hard-Soft Acid-Base (HSAB) theory provides a valuable framework for assessing the risk of metal mobilisation from wetland sediments under variable environmental conditions.

KEY WORDS
trace metals, mobilisation, speciation, wetlands, sediment
THE TOXICITY OF METAL MIXTURES TO ANTARCTIC MARINE ALGAE

AUTHORS
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ABSTRACT
Over one hundred years of anthropogenic activity in Antarctica has resulted in waste sites that continue to contaminate the near-shore marine ecosystem with metals. This contamination adversely affects the community structure and diversity of endemic microalgae. To prevent further contamination and facilitate the remediation of this unique environment, a robust framework of polar specific water quality guidelines are required. However, current protocols for toxicological assessment specify single contaminant exposures. Metals rarely exist singularly in nature and the toxic response of organisms to metal mixtures has shown to be varied. Thus, the toxicity of metal mixtures needs to be better understood to better inform guidelines.

This research developed an environmentally relevant test protocol that best reflected the natural conditions of the Antarctic marine environment. Five metals commonly reported as contaminants in Antarctic marine systems (Cd, Cu, Ni, Pb, and Zn) were used in growth inhibition tests. Single metal exposures used a gradient of increasing metal concentrations to derive modelled concentrations that inhibited population growth rates by 10% (EC10 values). Metal mixtures chosen for testing included an equitoxic mixture of the metals at their EC10 concentrations and mixtures of 10, 20, and 30 times the previously reported metal concentrations in a contaminated Antarctic bay.

In single metal exposures, by EC10 values copper was the most toxic metal followed by lead, cadmium, zinc, and nickel. In metal mixture exposures antagonistic and additive toxicity to the population growth rate was observed for the species Cryothecomonas armigera and Phaeocystis antarctica; but, synergistic toxicity was observed to sub-cellular physiological parameters, such as intracellular lipid concentrations. This research highlights that our water quality guidelines do not account for interactions between metal contaminants, which affect the overall toxicity of a contaminated environmental system.

KEY WORDS
Polar, BODIPY, metal mixture, multiple stressor
BLACK, WHITE OR CLEAR, DOES RIVER WATER TYPE AND DISSOLVED ORGANIC CARBON AFFECT TOXICITY OF NICKEL IN THE AMAZON BASIN?

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ABSTRACT
As anthropogenic processes encroach on many areas once untouched, such as the Amazon Basin, the relative risk that metals such as nickel pose to aquatic environments must be taken into consideration. The Amazon Basin in Brazil is characterised by three main freshwater types: black, white and clear, which differ in physico-chemical properties such as pH, ionic composition, total suspended solids and dissolved organic carbon (DOC) concentrations and quality. DOC quality depends on the source of the organic carbon to the aquatic environments and is often defined into two broad groups: allochthonous (terrestrially-derived, highly aromatic with a high molecular weight and containing high amounts of humic and fulvic-like components) and autochthonous (microbially-derived, less aromatic with low molecular weight and containing high amounts of fulvic and protein-like components).

This study investigated the toxicity of Ni to the fish cardinal tetra (Paracheirodon axelrodi) within the black (Rio Negro), white (Rio Solimões) and clear (Rio Tapajós) river waters during the wet and dry season both at pH 7 (representative of white waters) and pH 4 (representative of black waters). It also assessed whether differences in DOC quality influence Ni toxicity.

River water type, season and DOC quality was shown to significantly affect Ni toxicity to cardinal tetra (Paracheirodon axelrodi) with contrasting effects at pH 7 and pH 4. Toxicity of Ni decreased in the presence of allochthonous, aromatic humic-like DOC at pH 7 and increased at pH 4. This contrasting effect has implications for the management and risk assessment of metals such as Ni in naturally acidic waters such as the Rio Negro (Brazil) and wallum streams in Australia, commonly characterised by low pH, and high levels of allochthonous aromatic humic-like DOC. Importantly, results obtained from circumneutral waters may not be applicable for these unique systems and further research into the effects differences in DOC have in determining toxicity of metals is needed.

KEY WORDS
Dissolved organic matter, DOC, DOM, metal toxicity, tropical, Brazil
FILLING THE GAPS: NICKEL TOXICITY TO TROPICAL MARINE BIOTA

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ABSTRACT
Over two-thirds of the world’s nickel production is in tropical regions including Indonesia, the Philippines, Australia, New Caledonia, Brazil and Cuba. The mining, refining and smelting of lateritic ores can present many potential environmental risks, as with any such operations located in tropical regions of high ecological diversity. However, our current understanding of the toxicity of nickel to tropical biota is limited, largely due to the lack of ecotoxicity data with tropical species endemic to these regions. The Nickel Producers Environmental Research Association is currently leading a research program to develop and apply risk assessment tools to support the sustainable development of lateritic nickel deposits in the tropical region of South East Asia and Melanesia (SEAM). This research involves the compilation of exposure and effects assessment data for nickel in tropical marine waters, specifically in the SEAM region.

Key gaps for ecologically important tropical taxa of the SEAM region include corals, crustaceans, gastropods, bivalves and fish. The aim of this study was to investigate the sensitivity of tropical marine biota to nickel, with a focus on those species relevant to the SEAM region. Data produced from this study will contribute to the development of a reliable and ecologically relevant water quality guideline value for nickel in tropical marine waters.

Chronic nickel toxicity to two crustaceans (copepod and barnacle), one gastropod (snail) and three species of corals, native to the SEAM region was investigated. Toxicity tests were carried out at temperatures of 25-30 °C and a salinity of 35‰. Endpoints measured included 72-h development (from egg to copepodite), 96-h growth, 96-h metamorphosis and 5-h fertilisation success for the copepod, snail, barnacle and corals, respectively. Throughout all tests, water quality parameters were monitored and sub-samples were taken to measure total and dissolved (< 0.45 µm) nickel. The copepod was the most sensitive to nickel, followed by the snail and barnacle, with IC10 (10% inhibition concentration) values of 15, 65 and 67 µg Ni/L. Corals were relatively insensitive to nickel with effects observed at concentrations greater then 1 mg/L, with the exception of one species, Acropora aspera, with an IC10 value of 100 µg Ni/L. This study provides valuable toxicity data which can be used in the development of an ecologically relevant guideline value for nickel in tropical marine waters.

KEYWORDS
Tropical ecotoxicology, bioassay, invertebrates, species sensitivity distribution, ecological risk assessment
META IMPACTS ON EDIBLE BIOTA IN THE FINNISS RIVER ECOSYSTEM

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ABSTRACT
The Finniss River drainage basin is dominated by extensive wetland and estuarine environments for approximately 100–150 km downstream of the Rum Jungle mine (RJ). The sediment in these environments has been recognised as acting as efficient traps or sinks for transported pollutants. The Rum Jungle uranium/copper mine is one of the most comprehensively studied examples of the effects of Acid Mine Drainage (AMD) on a riverine environment. The majority of studies have focussed on monitoring and quantifying the release of metals in the mine vicinity, with little effort directed towards the metal pollutants further downstream.

This study investigated the fate of metal pollutants released from RJ into the Finniss River during its operation from 1954 to 1971 and since its closure and rehabilitation (1983–88). Lead isotopic ratios (207Pb/206Pb and 208Pb/206Pb) have been used to track the dispersion of mining products and 210Pb analysis was used to date downstream sediment cores. Samples affected by the legacy of RJ mining were characterised by highly radiogenic lead (low 207Pb/206Pb and 208Pb/206Pb) derived from uranium ores. Sediment data from 2015 found a possible second Pb isotope signature distinct to that from sediment taken in proximity to RJ. Tissue samples from the mussel Velesunio angasi noted elevated total Pb and Cu levels above the generally expected levels (GEL)’s of metal content in food provided by the Food Standards Australia New Zealand (FSANZ). This mussel species is considered bush tucker by the local Indigenous Walangurrminy community and in some cases eaten raw. In addition to sediment and biota, metal content of water and epiphytic algae were analysed. DGT’s were also deployed to detect the bioavailable metal content in the water column.

These complementary data sets will be used to assess the pathways of contaminants in an attempt to understand their implications for communities living along the Finniss River.

KEY WORDS
Lead Isotope, Copper, Biota, Bush Tucker, Velesunio angasi, DGT, Sediment, Water
MICROBIAL COMMUNITIES AS INDICATORS OF ANTHROPOGENIC AND NATURAL DISTURBANCES TO ANTARCTICA AND SUBANTARCTIC MACQUARIE ISLAND

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ABSTRACT
Environmental contamination due to human activities continues to threaten the health of Antarctic ecosystems. Currently, there is a lack of site-specific toxicity data for Antarctic and subantarctic soils on which robust guidelines for both contamination thresholds and remediation targets can be derived. This makes site sign-off and soil reuse following remediation problematic. In terrestrial Antarctica, microbes both dominate and drive soil processes. Therefore, the development of risk assessments that incorporate soil microbial communities and critical soil processes are essential for adequate protection of biota in the region. Through the analysis of pristine, hydrocarbon contaminated and actively remediated sites across subantarctic Macquarie Island and more recently Antarctica, we have begun to unravel the key drivers of microbial communities thriving in polar soils. Subsequently, next generation sequencing, qPCR and more recently microfluidic qPCR has been used to develop soil microbial community indices as indicators for both the development of ecotoxicology targets, and for monitoring of sites deemed as ‘clean’ following remediation. We will provide evidence that the structure and function of polar soil microbial communities can be restored to that present prior to site disturbance, following successful remediation in the region.

KEY WORDS
Ecotoxicity, soil, microbial communities, QPCR, hydrocarbons, Antarctic
NOT SO HOT UNDER THE COVERS: LESSONS FROM THE CASEY BIOPILES, ANTARCTICA

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ABSTRACT
It is widely known that low temperatures and low nutrient levels in polar soils present a significant barrier to the natural biological remediation of hydrocarbon contamination. The Casey biopiles represent the first time a large quantity of contaminated soil has been remediated in the Antarctic, with inorganic nutrients the only significant soil amendment.

Nitrogen, phosphorous and potassium were added as powdered/pelletal fertiliser during biopile construction to a C:N:P:K ratio of 100:10:1:2, and an average mass of 400 mg of nitrogen per kg of soil. Analysis of nitrogen within the biopiles over a four year period showed that the initial release of nutrients was very slow, due to a nine-month period before the soil was first turned and nutrients were available in the water phase. The poor initial mixing and low water content of the soils resulted in concentrations of between 11,000 and 30,000 mg of nitrogen per kg of soil-water. This is well in excess of concentrations deemed inhibitory for bioremediation. Despite this, hydrocarbon concentrations dropped rapidly in the first 2 years, and after 4 years had dropped to less than 1,000 mg/kg (C9-C40) total recoverable hydrocarbons. Preliminary microbial work shows potential recovery of the amoA gene, a sensitive indicator of PHC toxicity, however more research needs to be done to determine the residual toxicity of the biopile soils.

Current learnings about nutrient behaviour will be used when constructing future Antarctic biopiles, with the aim of increasing hydrocarbon degradation rates without the need to resort to heating the soil or the addition of non-native microbial amendments.

KEY WORDS
Hydrocarbon contamination; bioremediation; nutrient amendment; cold region; microbial assemblages
EFFECTS OF FREEZING AND THAWING ON THE COLLOIDAL METAL COMPOSITIONS IN SOIL INTERSTITIAL WATER

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ABSTRACT
A freeze-thaw event has been reported to affect the stability of soil aggregates or colloidal constituents, which could in turn change the bioavailability of nutrients, microbial activities and transport of contaminants in soils. Recent studies have showed that freezing and thawing of soils could increase the mobilization of colloidal metals. However, it was not clear if freeze-thaw process with low thawing temperatures could still significantly affect quantity and quality of colloidal metals through the phase transitions of soil interstitial water. In this study, the experiment was designed to decouple the freeze-thaw effect from the warming effect, and we investigated the effects of each treatment on the compositions of the colloidal (0.2 - 1.2 µm) metals in soil interstitial water. Temperate soil samples were incubated in a refrigerator at 2 °C for 4 weeks, and compared with the freeze-thaw treatment group which was frozen at -20 °C in the second week followed by thawing at 2 °C to study a freeze-thaw effect with minimal influence from the thawing temperature. The freeze-thaw group was compared with those incubated at 25 °C in the last week to investigate a warming effect. The laser induced breakdown spectroscopy (LIBS) technique was used to analyze the relative concentrations of the colloidal metals, which were grouped into two based on their distinct trends in response to the two treatments. Type 1 colloidal metal (Fe, Ca, Ba) contents decreased by the freeze-thaw treatment, but increased by the warming, whereas type 2 colloidal metal (Si, Mg, Al) contents decreased by the warming as well as by the freeze-thaw treatment. Only type 2 metals showed positive correlations with the amount of colloidal organic carbon. Because the freeze-thaw and warming treatments can result in the opposite effects on the colloidal metal compositions, the effects of a freeze-thaw event could be contradicting depending on the thawing temperatures.

KEY WORDS
Freeze-thaw event, colloidal metals, soil organic matter, laser induced breakdown spectroscopy (LIBS)
CHALLENGES FOR RISK ASSESSMENT IN DEEP SEA ENVIRONMENTS

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ABSTRACT
Marine pollution is of growing concern to the global community, and at the same time the risk of pollution from Submarine Tailings Disposal (STD) and developing deep sea mining activities is unprecedented. Such activities are predominately occurring in the tropical oceans of the world and there is much uncertainty about risk to food safety and food security.

Recent experiences in stakeholder engagement have highlighted the many gaps in knowledge needing to be filled, and approaches to assessment that need to be developed to better manage risk. Experience will be drawn from the South Pacific Region highlighting important issues specific to stakeholders. Discussions have identified:

1. Values of the deep sea
2. Concepts to develop
3. Tools and approaches to develop

These will be discussed and include identifying risk assessment tools for biodiversity, ecosystem services and functions, developing multiple lines of evidence approaches to predicting impacts, communicating risk, and developing protocols and procedures for assessment.

This work was part of a PACE-Net seed funding grant.

KEY WORDS
Deep sea, biodiversity, risk communication, multidisciplinary
ANTFOCE (ANTARCTIC FREE OCEAN CO2 ENRICHMENT — OCEAN ACIDIFICATION UNDER SEA ICE AND ITS EFFECTS ON BENTHIC COMMUNITIES)

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ABSTRACT
Free ocean CO2 enrichment systems (FOCE) were developed to address the need for in-situ experiments on community level responses to ocean acidification in natural benthic habitats. The antFOCE project was the first polar FOCE system and was used to run an 8 week experiment at Casey Station, East Antarctica, in early 2015. The aim was to determine the responses of Antarctic benthic communities under sea ice to ocean acidification at levels expected by 2100 under business as usual emissions scenarios.

The design consisted of 2 acidified benthic chambers (at 0.4 pH below ambient), 2 control chambers (at ambient pH) and 2 open plots (no chamber). Chambers were 2 m long x 0.5 X 0.5 m. Chambers were deployed on sediments in 14 m of water under 2.6 m of sea ice. The aims included: 1) Characterising physical and chemical environmental changes in water and sediments; 2) Examining community responses including sediment bacteria, microphytobenthos, meiofauna, and macrofauna, and hard substrata biofilms and macrofaunal communities; 3) Examining the response of key ecosystem processes including bioturbation and sediment nitrification; 4) Examining the vulnerability of some calcifying species.

The deployment and running of this highly complex experiment in such an extreme environment presented many challenges which required a range of innovations to overcome. The system performed to its specifications, maintaining an approximate 0.4 pH offset for most of the 8 week period. Occasional power failures and other technical difficulties saw the pH revert to background for short intervals during the experiment, increasing the variability of the pH treatment. The saturation state (Ω) fluctuated between 0.7 and 0.8 but also reverted to background (approx 1.7) during outages.

An overview of the system, its deployment and some preliminary results will be given, including effects on a range of benthic communities including microphytobenthos, sediment microbial and macrofaunal communities, and biofilms and encrusting invertebrates on hard substrates. We will also examine ocean acidification influenced biogeochemical changes in the sediment and how these may effect bioavailability of sediment bound metals, nutrients and other sediment physico/chemical parameters. These preliminary results indicate a potentially large range of future changes in Antarctic benthic ecosystems from ocean acidification.

KEY WORDS
Ocean acidification, benthic communities, Antarctica, field experiment
THE ESTABLISHMENT OF CLOSURE CRITERIA AS TARGETS FOR THE SUCCESSFUL REHABILITATION OF THE RANGER URANIUM MINE

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ABSTRACT
The Ranger Uranium Mine is surrounded by the World Heritage and Ramsar-listed Kakadu National Park, Northern Territory. In operation since 1980, the mining of ore ceased in 2012 with the exhaustion of resources from Pit 3. Milling of the ore can continue until 2021, with rehabilitation of the site being progressively undertaken and being scheduled to be completed by 2026. Hence, although the mine continues operations, it has already entered the decommissioning phase. The Ranger Environmental Requirements (ERs) articulate the environmental objectives to be achieved during operations and following closure. The primary environmental protection objectives focus on maintaining the World Heritage attributes of Kakadu and the ecosystem health of the wetlands, protecting the health of people living in the region, and the biological diversity and ecological processes in the region. While these are broad objectives for rehabilitation, it is a requirement for mine’s operator to propose specific Closure Criteria, which aim to quantitatively demonstrate these objectives have been met. Closure Criteria are the performance benchmarks against which the long term success and sustainability of rehabilitation will be measured. They are measurable and quantifiable and will be used as the basis for issuing of a close-out certificate. Closure criteria are being developed with advice from technical working groups under six themes: 1) Water and sediment 2) Radiation 3) Landform 4) Flora and Fauna 5) Soils 5) Cultural. These closure criteria are currently being developed collaboratively with the involvement of all key stakeholders and will draw on a depth of technical knowledge that has been generated over the decades of operation. This presentation will describe the challenges of deriving closure criteria and of determining if closure criteria will be met. Closure criteria may be a single measurement value, a range of values or a trajectory that demonstrates the ecosystem is heading towards a state that is agreeable to stakeholders. Specific examples will be presented to demonstrate these concepts, including the applicability of current operational environmental objectives and how these might be used in conjunction with modelling data to predict the achievement of closure criteria in future generations.

KEY WORDS
Mining, Closure, Water Quality Guidelines, Sediment Quality Guidelines, Rehabilitation, Environmental Quality Standards
EFFECTS OF COAL CONTAMINATION ON TROPICAL MARINE ORGANISMS

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ABSTRACT
Coal is a major export commodity of Australia and a large percentage of coal mined in Queensland is shipped through the Great Barrier Reef World Heritage Area (GBRWHA). Consequently, reef organisms such as corals, can be at risk from suspended and deposited coal particles that might result from ship loading or spill events. Coal particles and dust are physically abrasive, block light penetration into the water column and contain potentially toxic hydrocarbons and trace metals. Despite this risk, the effects of suspended and deposited coal on tropical marine organisms of high conservation value remains largely unknown, making accurate environmental impact assessments of coal contamination difficult. This study conducted a series of controlled experiments exposing three taxa abundant in the GBRWHA (the coral Acropora tenuis, the reef fish Acanthochromis polyacanthus, and the seagrass Halodule uninervis) to a range of suspended coal dust (< 63 µm) concentrations (0-275 mg/L) over 28 d. Results demonstrate that chronic coal exposure can cause considerable lethal effects on corals, and reductions in seagrass and fish growth rates. Coral survivorship and seagrass growth rates were inversely related to increasing coal concentrations (> 38 mg/L) and effects increased between 14 and 28 d, whereas fish growth rates were similarly depressed at all coal concentrations tested. This investigation provides novel insights into direct coal impacts on key tropical taxa for application in the assessment of risks posed by increasing coal shipments in globally threatened marine ecosystems.

KEY WORDS
Coal particles, contamination, Great Barrier Reef
ECOLOGICAL TOXIC EFFECT AND HUMAN HEALTH RISK OF REUSING METAL MINE WASTES

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ABSTRACT
With the current movement towards increasing reuse of solid wastes, it is necessary to understand leaching potentials of heavy metals from mine wastes and the subsequent environmental effects and human health risk in order to reuse mine wastes. This study investigated potential environmental effects and human health risk of reusing 5 different mine wastes (i.e., Z, J, M, Y, and H mine wastes) collected around South Korea with short-term leaching tests, long-term leaching test, toxicity tests, and human health risk assessment. Based on the Korea Standard Test Method for Solid Wastes (STM) and Toxicity Characteristics Leaching Procedure (TCLP), all the 5 mine wastes studied satisfied the standard levels given in the Korea Waste Control Act and USEPA region 3 regulatory levels, respectively, suggesting that they can be reused. Assuming that the leachates get into nearby water sources after reuse, the toxicities of the leachates were tested using Daphnia Magna, and the toxic unit (TU) values after 24 h and 48 h exposure were compared with the Korea Allowable Effluent Water Quality Standards (TU<1 for the Clean area and TU<2 for the Area 1 and Area 2, which depends on the administrative district). For example, the heavy metal concentrations and toxicity of the STM leachate from the Z mine waste sample met the Korea Allowable Effluent Water Quality Standards for all the areas (TU_{24 h}=0, TU_{48 h}=0.6), despite the high concentrations of heavy metals (45,424 mg As/kg, 2,293 mg Cd/kg, 2,671 mg Pb/kg, 14,851 mg Zn/kg). On the other hand, the toxicity of the STM leachate from the J mine waste sample, which had lower heavy metal concentrations than the Z mine waste, had TU values higher than 1, while the heavy metal concentrations met the standards. The long-term leaching test showed that the column eluent of the Z mine waste can have toxic effects as the TU values were greater than 1 for the eluent collected at L/S of 30. This implies that the long-term effect of reusing mine wastes need to be thoroughly assessed if mine wastes are to be reused. The human health risk assessment of reusing the Z mine waste was carried out using the bioavailable fraction of the heavy metals contained in the mine wastes (0.6% for As, 6.3% for Cd, 39.6% for Pb, 2.8% for Zn). The bioavailable fractions of heavy metals were determined by using the Solubility/Bioavailability Research Consortium method. For reuse in residential areas, carcinogenic risk (CR) was 4.9E-04, while non-carcinogenic risk (HI, Hazard Index) was 1.7E+01 for children and 1.5E+00 for adults. This indicates that there may be potential carcinogenic and non-carcinogenic risk when the Z mine wastes are reused in residential areas, because CR$$\geq$$1.0E-05 has carcinogenic risk and HI$$\geq$$1.0E+00 has non-carcinogenic risk. For reuse in industrial areas, CR was 9.7E-05 and HI was 1.0E+00. Considering human health risk from the reused Z mine wastes, reuse of the Z mine wastes in residential areas should be avoided. Overall, this study shows that not only the assessment of concentration-based standards but ecological and human health risk based assessment need to be carried out for safe and sustainable reuse of mine wastes.

KEY WORDS
Mine waste, Leaching, Human Health Risk, Toxicity
KEEPING IT CLEAN: SELENIUM UPTAKE IN PLANT PROTEINS DETERMINES SUITABILITY FOR MINE SITE REMEDIATION

AUTHORS
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ABSTRACT
Selenium (Se) has emerged as a contaminant in terrestrial and aquatic environments in many regions around the world as a result of mining and agriculture. Extensive research has concluded that Se is an essential micronutrient to humans, animals and some microorganisms but to date limited research has been conducted to determine the essentiality of Se to higher plants in respect to Se translocation and accumulation on a molecular level in Australia. We investigated 1) the effects of radiolabeled selenite and selenate (75Se) concentrations on patterns of translocation of selenium salts by whole plant autoradiography, 2) the quantity of the 75Se accumulated in DNA, RNA, lipids, carbohydrates, and various classes of proteins. The plants, Brassica rapa ‘Vitamin Greens’ and Helianthus annus ‘Dwarf Sunflower’ were grown in tissue culture growth media and harvested after 21 days of exposure to a range of increasing concentrations of selenite and selenate salts of 5-50µM and 10-100µM respectively, after which sub-lethal exposure concentrations were selected for further studies. The sub-lethal concentrations were 20µM of each selenium salt for Brassica rapa and 25µM of each selenium salt for Helianthus annus. Autoradiography displayed 75Se translocation of SeIV in relatively greater proportions in the roots than leaves and higher SeVI in the leaves than in the roots. Se was primarily bound to albumin, prolamin and glutelin proteins. These patterns of translocation coupled with further proteomic studies will assist in seleno-protein studies at a later stage to determine if Se is incorporated into specific proteins in these plants. The patterns of selenium translocation, its accumulation and possible phytovolatilization in plants have considerable implications on their suitability as tools for phytoremediation and biofortification

KEY WORDS
Selenium, Remediation, Mining
ASSESSMENT ON HUMAN AND ENVIRONMENTAL RISK FOR RECYCLED SLAG BALL: CONSIDERATION OF CHEMICAL AND PHYSICAL STABILITY

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ABSTRACT
Assessment on human and environmental risk is necessary for sustainable use of recycled slag ball, which is made by smelting and atomizing mine waste, waste red mud, and waste limestone. The extent of use of the slag ball can be determined on the basis of environmental risk which can be derived through chemical/physical stability tests. To evaluate the chemical stability of the slag ball Toxicity Characteristics Leaching Procedure (TCLP) was performed. Metal (As, Cd, Cr, Cu, Pb) concentrations in the leachate were under USEPA Region 3 regulatory levels. To evaluate the physical stability of the slag ball as the aggregates, soundness, density, water absorption, and bulk density were measured and the values were compared with the various kinds of quality standards for aggregates. According to the leaching test results use of the slag ball as aggregate is acceptable but specific extent of the slag ball as the aggregate can be determined with the physical stability test results. The study suggests chemical/physical stability test framework for evaluating recycled slag ball as aggregate to determine the extent of use in order for minimizing human and environmental risk.

KEY WORDS
Recycled Slag ball, Chemical stability, Physical Stability
**ARSENIC BIO-ACCESSIBILITY AND -AVAILABILITY IN ARSENIC CONTAMINATED SOILS: EARTHWORM, AND PHYSIOLOGICALLY-BASED AND SEQUENTIAL EXTRACTION INVESTIGATION**

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**ABSTRACT**

Historic arsenic (As) contamination of soils occurs throughout the world from mining, industrial and agricultural activities. In Australia, the control of cattle ticks using arsenicals from the late 19th to mid 20th century has led to some 1600 contaminated sites in northern New South Wales. In this study, the bioavailability of As in contaminated soils was assessed using 3 different approaches; bio-accumulation by earthworms (*Eisenia fetida*), 1.0 M HCl extraction- an operationally defined bioavailability test, and human bioaccessibility- an extraction test replicating gastric conditions (in vitro physiologically-based extraction test). Sequential extraction procedure was also employed in order to evaluate the chemical binding of As in the soils. Soil samples were collected from the As-contaminated cattle dip sites, along with pristine sites for comparison. The Earthworms were exposed to the As contaminated soils, and pristine soils sorbed with As in the laboratory. After seven weeks of exposure in soils in the dark, the earthworm tissue, cast and gut content was analysed for As. Findings show that historically contaminated soil As is strongly bound to the soils showing a lower degree of As bio-accessibility and –availability than freshly As sorbed soils. In all tests, the aging time was shown to be an important factor in determining the labile fraction of soil As. The arsenic bio-accumulation factor (BAF) for the earthworm is found to correlate positively with the human bio-accessible fraction (HBF). The potential use of both physiologically-based extraction tests and earthworms as complementary tools is explored as a holistic and multidisciplinary approach towards understanding risk at contaminated sites.

**KEYWORDS**

Arsenic, Contaminated soils, Bio-accessibility, Bio-accumulation, Exposure, Risk
USING GRAPHENE-BASED MATERIALS FOR REMEDIATION OF ARSENIC AND CADMIUM

AUTHORS
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ABSTRACT
Environmental contamination, aggravated by rapid urban and industrial growth, poses considerable risk to human and environmental health. Most contaminated sites contain a complex mix of contaminants (metals, metalloids, halogens, and organic chemicals), making remediation a challenge. Developing an efficient technology that can target multiple contaminant groups simultaneously is thus necessary to make remediation a cost-effective and technically viable exercise. Graphene, the latest addition to the nanocarbon family, has emerged as a ‘miracle material’ due to its extraordinary physico-chemical properties, and has been used innovatively in electronics, energy storage, biosensing, filtration, etc. Its high surface area and versatile surface chemistry offers pathways to engineer advanced formulations with the potential to bind a range of contaminants, making it an excellent candidate for development as a multi-mode adsorbent for remediation.

In this study, the sorption behaviour of two prepared graphene derivatives, graphene oxide (GO) and iron-modified graphene (FeG), towards two model environmental contaminants were evaluated. Cadmium (Cd), a metal that predominantly occurs in its free cationic form, and arsenic (As), a metalloid that commonly exists as arsenate anions in the environment, were selected since these contaminants are notorious for posing health risks to humans through intake of contaminated food and water.

Batch adsorption tests were conducted using spiked solutions to investigate the adsorption capacity of GO and FeG towards Cd and As respectively. Negatively-charged GO successfully adsorbed Cd, whereas positively-charged FeG adsorbed As. The influence of varying pH conditions and competing ions were investigated to provide insights on the adsorption mechanisms and implications for remediation. Data highlight the critical role of environmental factors (pH, presence of background ions) in adsorptive remediation by graphene-based materials. Results suggest that a GO and FeG composite material could potentially be used to enable treatment of multiple contaminant classes simultaneously, hence offering innovative alternatives to traditional remediation efforts.

KEY WORDS
Remediation; graphene; adsorption; arsenic; cadmium; competition
ROLE OF DIFFERENT ORIGIN MYCORRHIZA IN REMEDIATION AND IMPROVING MAIZE GROWTH IN SOIL WITH HIGH CONCENTRATIONS OF ARSENIC

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ABSTRACT
Arsenic (As) negatively affects the growth of plants, and at high concentrations can cause biomass decrease and inhibition of photosynthesis. Arsenic can enter the food chain via plant uptake and can be harmful to human health. Arbuscular mycorrhizas fungi (AMF) have a known role in enhancing plant growth and also minimising effects of toxins on plants. The effects of inoculating maize with AMF originating from soil contaminated with As and from a similar uncontaminated soil was investigated. Mycorrhizal inoculum including infected maize root, spores, and mycelium and rhizosphere soil was obtained by growing maize in a mixture of sand with As contaminated and also uncontaminated soil for 10 weeks. Maize was grown in a mixture of autoclaved uncontaminated soil: sand, 1:1 w/w, spiked with As at rates of 0, 5, 10, 25, 50, and 75 mg/kg. The mycorrhizal treatments received 100g of the inoculum which was mixed into the upper layer of the 1 kg substrate, while non-mycorrhizal treatments received 100g of autoclaved inoculum. With increased As concentrations in the soil, there was a reduction in maize growth (around 60% dry weight) and a significant increase in As concentration and uptake with decreased phosphorous (P) concentration and decreased mycorrhizal colonization (by about 35%). Inoculation with mycorrhiza significantly decreased As concentration and uptake, and increased (P) concentration in mycorrhizal plants compared with non-mycorrhizal plants. However, shoot dry weight was reduced by an average of 28% with Mycorrhiza. Dry and fresh shoot and root weight, and height of plants, were significantly greater in maize inoculated with mycorrhiza originating from contaminated soil (coM+) than mycorrhiza originating from uncontaminated soil (unM+) at 50 and 75 mg/kg As, while unM+ decreased As concentration in shoots and roots compare with coM+. Higher mycorrhizal colonization was found in maize inoculated with coM+. The translocation of As in maize was root > shoot > cobs. This study shows that growing maize with arbuscular mycorrhiza could alleviate As toxicity in contaminated soil, and at high As the origin of mycorrhiza can play an important role in remediation and toxicity to the plant.

KEY WORDS
As; Mycorrhiza; remediation; origin of mycorrhiza; As translocation in maize
ENVIRONMENTAL RISKS ARISING FROM ELEVATED ARSENIC AT AN ABANDONED GOLD MINE IN NEW ZEALAND

AUTHORS
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ABSTRACTS
At Prohibition mine, an abandoned gold mine on the West Coast of New Zealand, processing of the arsenopyrite-rich ore has given rise to arsenic (As) concentrations up to 40% w/w in the soil surrounding the roasting plant. This main area of contamination is currently being remediated. However, As is also elevated in soil outside this area, particularly in the vicinity of an old tailings dam to the west of the ore roasting plant. To assess the environmental risk arising from elevated As in this area, co-located soil and plant (manuka and grass) samples were collected from 10 locations, with three bulk soil samples collected for earthworm toxicity studies, and to examine As leaching. Arsenic concentrations ranged from 890 to 10,400 mg/kg in the collected soil samples, 0.22 to 4 mg/kg DW in manuka, and 6.9 to 24 mg/kg DW in grasses. Despite the high As concentrations in the soil, a synthetic precipitation leaching test gave As concentrations in leachate of only 0.02 to 0.6 mg/L. Earthworms, Eisenia andrei, were exposed to four As concentrations ranging from 1540 to 10,400 mg/kg over 28 days, with c. 50% mortality at the highest concentration. Effects on reproduction and As accumulation in the worms is currently being assessed.

KEY WORDS
Arsenic, worms, manuka, grass, mining
4.2 Fuels, oils and produced waters - Toxicity and Risk Assessment

Session Chairs: Dr Sharon Hook & Gabriella Macoustra
Time: 15:30–16:50

Behaviour of hydrocarbons from fuels in polar seawater and effects on the Antarctic amphipod Paramoera walkeri

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Abstract
As part of risk assessment of fuel oil spills in Antarctic waters, the sensitivities of Antarctic marine invertebrates to water accommodated fractions (WAF) is tested. One challenge in toxicity testing with petroleum fuel contaminants is the considerable loss of volatile hydrocarbons from test solutions over time. Static toxicity tests with fuels experience changing concentrations and compositions of treatments, therefore the use of a measured concentration at the start of a test will likely underestimate the sensitivity of organisms. An understanding of fuel behaviour in Antarctic waters is therefore required to estimate sensitivities of marine organisms to contaminants from fuels.

A further difficulty in estimating sensitivities of Antarctic marine invertebrates to fuel WAFs is the extended exposure durations necessary to account for the slower response of organisms at low temperatures, requiring renewal of test treatments to maintain optimal test conditions. A more accurate estimation of overall exposure concentrations can be gained by measuring hydrocarbons during tests and modelling total hydrocarbon content (THC) of WAFs through time to determine exposure concentrations. The rate of decay and subsequent renewal of hydrocarbons in test solutions is accounted for in modelling THC to derive point estimates. In addition, separation of THC into equivalent carbon number (ECN) ranges defined by approximate carbon numbers and boiling point allows some characterisation of these fuels and greater understanding of their potential toxicity in Antarctic conditions.

This approach was used in estimating the sensitivities of Antarctic marine invertebrates to WAFs of Special Antarctic Blend diesel, marine gas oil, and an intermediate grade of residual fuel oil. We describe the patterns of hydrocarbon losses during time series exposures at polar temperatures, including the relative proportions in ECN groups. In polar conditions, these fuels generate WAFs of high aromatic content that exhibit reduced evaporation over time, with proportions of these toxic contaminants persisting in WAFs for over 7 days.

Point estimates of the sensitivity of Antarctic amphipod Paramoera walkeri adults and juveniles to lethal (LC05 and LC50) and sub-lethal (unimpaired movement) (EC05 and EC50) concentrations of THC in three fuel WAFs were determined in exposures of up to 21d. These results contribute to comprehensive assessment of risks from fuel spills in the Antarctic marine environment.

Keywords
Fuel spills, water accommodated fraction, petroleum hydrocarbon, toxicity, Antarctic pollution
TOXICITY OF MECHANICALLY AND CHEMICALLY DISPERSED FUELS TO ANTARCTIC MARINE INVERTEBRATES

AUTHORS
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ABSTRACT
Human activities in Antarctica pose significant threats to marine ecosystems from hydrocarbon contamination from fuel spills, primarily as a result of shipping incidents. Significant hydrocarbon contamination has already occurred in Antarctic waters and the risks of incidents are rising as shipping associated with research and tourism in the area increases. Conventional fuel spill response methods are largely unsuitable in Antarctic conditions, however, chemical fuel dispersants may offer an alternative solution. Fuel dispersants are not currently used in Antarctica, due to the lack of information on their effectiveness and on their toxicity to Antarctic marine biota, preventing informed environmental cost benefit analyses for the management of marine fuel spills. Consequently, there is a need for scientifically robust data on the toxicity of fuels and fuel dispersants to Antarctic marine biota.

A range of Antarctic marine invertebrates were used in toxicity tests to investigate the relative sublethal and lethal responses of organisms of various life stages to physically and chemically dispersed fuels and fuel dispersants. Three fuels commonly used in Antarctica were tested: Special Antarctic Blend (SAB) diesel, marine gas oil (MGO) and an intermediate fuel oil (IFO 180); along with three fuel dispersants: Ardrox 6120, Slickgone LTSW and Slickgone NS. Fuel dispersants generally increased the toxicity of fuels to biota, different fuel and dispersant combinations had different impacts on test species and toxicity varied depending on dispersant type. Data generated from this work will assist in the development of effective fuel spill contingency plans for fuel spills in Antarctic waters.

KEY WORDS
Fuel, oil, hydrocarbon, Slickgone, dispersant, SAB
ECOTOXICITY AND TOXICITY IDENTIFICATION EVALUATION OF PRODUCED WATERS FROM OFFSHORE OIL AND GAS FACILITIES

AUTHORS
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ABSTRACT
Produced waters (PWs) from the offshore production of oil, gas and condensate are complex mixtures of oil/gas components, inorganic components as well as biocides and process chemicals added during the extraction process. Currently, PWs generated in off-shore locations are discharged directly into the ocean, where dilution is predicted to reduce their impact on the environment. Regulatory authorities require regular toxicity assessments of PWs to monitor the quality, toxicity and potential impact of PWs that are potentially discharged.

This study investigated the toxicity and chemical composition of PWs from eight offshore oil and gas facilities. Toxicity tests measured acute and chronic endpoints with tropical and temperate species including: microalgae (N. closterium and I. galbana), copepods (A. sinjiensis and G. imparipes), sea urchins (E. mathaei and H. tuberculata), oysters (S. echinata), Microtox (V. fischeri), and fish (L. calcarifer). Chemical characterisation of PWs included polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene and xylene, phenolic compounds, volatile organic acids, sulfide, ammonia and, metals and metalloids.

The chemical composition of the PWs varied considerably between sites and this was also reflected in the toxicity results observed with EC50 values of 0.26 – >90% and EC10 values of 0.016 – 51% with copepods and sea urchins consistently the most sensitive species. Generally, organic components of PWs (e.g. PAHs, TPHs) are assumed to pose the highest risk to biota. However, through the use of partial toxicity identification evaluation (TIE) studies with three sensitive toxicity tests (Microtox, copepods and sea urchins), removal of PAHs and TPHs from PW did not always correlate with a reduction in toxicity. In addition, the toxicity of PW after storage and treatment (by centrifugation to decrease the oil content) was greater than expected. This study confirmed that PW is unique in its composition and toxicity, likely due to factors including the type of resource being extracted (e.g. oil, gas), the geology at the source of extraction, age of the PW (e.g. following storage), and, the use of different process chemicals, biocides and/or water treatment technologies. Furthermore, upon release of PW to the ocean, dilution, oxidation, volatilisation and photodegradation can also significantly influence the toxicity and risk of PWs to marine biota in the receiving environment.

KEY WORDS
formation waters, marine, petroleum hydrocarbons, metals, DTA, TIE
AN INTEGRATED APPROACH TO MEASURING CHANGES IN FISH PHYSIOLOGY FOLLOWING SUBLETHAL EXPOSURE TO A LIGHT CRUDE OIL

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ABSTRACT
Assessments of impacts of oil exposure on fish have traditionally relied on biomarkers such as fluorescent biliary metabolites and EROD induction, which confirm exposure to oil, but do not identify or quantify ecological/physiological impacts. Other metrics, such as changes in tissues measured via histology or lipid class analysis, can provide direct indications of alterations in physiological processes leading to an adverse outcome, but the causative agent can be difficult to identify. The goal of this study was to link traditional metrics of oil exposure to physiological changes by using transcriptomics to identify linking pathways. Individuals of Spotted Dragonet (Repomucenus calcaratus), a benthic fish abundant in the study area, were exposed to 0, 0.5 or 2 mg/kg light crude oil contaminated sediments for up to 96 hours, to measure changes in the animal’s physiology caused by crude oil, then to clean sediment for another 96 hours to measure recovery. Biliary metabolites and EROD were chosen as exposure metrics, and lipid class profiling and histological examination of tissues were chosen as metrics for physiological impacts. The adverse outcome pathways linking the two were profiled using RNA-Seq based transcriptomic profiling. Our initial results indicate an increase in naphthalene and phenathrene, but not benzo[a]pyrene metabolites, and an increase in tissue damage at the highest concentrations used. The results will be used to inform the development of ecological monitoring strategies for exposure to oil, the impacts of exposure, and the recovery from exposure.

KEY WORDS
Oil, biomarkers, transcriptomics, RNASeq, adverse outcome pathways
**4.3 Emerging Ecotoxicological Methods**

Session Chairs: Dr Tom Cresswell & Amanda Dawson

**Time:** 15:30–16:50

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**CAN IMAGE RECOGNITION TECHNOLOGY BE USED TO PROPEL COPEPOD LARVAL DEVELOPMENT TESTS INTO THE 21ST CENTURY?**

**AUTHORS**

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**ABSTRACT**

World-wide, scientists still rely on direct microscopic examination methods first implemented over 100 years ago to assess larval development of invertebrates. With recent advances in digital technology, there is now an opportunity to radically modernise the way larval development is assessed. A number of instruments have been recently developed that use scanning and image recognition (SIR) technology to semi-automate the rapid identification, enumeration and measurement (e.g. size and shape) of plankton in water samples without the need for a microscope. We have trialled a zooplankton analyser that uses SIR and image analysis software (ImageJ, Plankton Identifier, Zooprocess) to identify and measure over 50 different metrics on tropical marine/estuarine copepods (*Acartia sinjiensis*) in chronic larval development tests. Traditional endpoints of egg hatching rate and larval development ratio achieved using microscope examination and SIR were almost identical ($R^2 = 0.97$). Additional sensitive endpoints made possible by SIR included: larval development index (LDI; based on the number of animals at each stage of development), biomass (three different surface area measurements, perimeter), and growth (length, width). These endpoints were based on measurements that had concentration-dependant responses to common toxicants, and were a sub-set of the full range of metrics provided by the software. In addition, measurements of shape such as circularity, elongation, symmetry and equivalent spherical diameter may help identify larval abnormalities. The new endpoints are similar to or more sensitive than the traditional endpoints and will be discussed in relation to copper, nickel and ammonia exposures. SIR technology provides a major opportunity to improve and modernise larval development tests for a range of species, but comes at a cost of increased data size and complexity. The implications of this and the future use of this technology as a research and routine toxicity testing tool will be discussed.

**KEY WORDS**

Calanoid, invertebrate, sub-lethal, Zooscan
DEVELOPMENT OF A CHRONIC WHOLE-SEDIMENT ALGAE BIOASSAY USING CHLOROPHYLL EXTRATIONS

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ABSTRACT
The use of a battery of whole-sediment toxicity tests is recommended when assessing the risks posed by contaminated sediments. Representing a vital component of sediment ecosystems, benthic algae are poorly represented globally in the range of organisms available for assessing the risk of chronic effects to benthic biota. The development of algal sediment bioassays has been challenging primarily due to the small size of the algal cells and the inferences caused by the sediment when quantifying cell density and cell health. Methods have been established that assess the inhibition of esterase activity after 24-h exposure of the marine species Entomoneis cf punctulata to whole sediment. While this acute toxicity test has been demonstrated to be relatively sensitive to hydrocarbon–contaminated sediments, the endpoint (enzyme activity) is only an indicator of potential effects on algal growth.

Measurements of chlorophyll a concentrations as a surrogate for cell density (algal populations) holds promise to overcome this issue. In this presentation, we describe the use of the benthic alga Nitzschia closterium for assessing chronic effects in whole sediments by measuring chlorophyll concentrations over 3 days. The spectrophotometric measurements of chlorophyll a concentrations after extraction with acetone proved to be a suitable surrogate for cell density in sediments. Issues associated with high background chlorophyll a measurements and poor absorbance signals were resolved through modifications to the test methods. The response of the algal growth bioassay will be demonstrated using a range of contaminated marine and estuarine sediments, and the results compared to established whole sediment bioassays (10-d Melita plumulosa reproduction bioassay, 10-d Nitocra spinipes reproduction bioassay and 24-h Entomoneis cf punctulata esterase activity bioassay).

KEY WORDS
Sediment, microalgae, chlorophyll a, toxicity, test development
DIURNAL ACTIVITY PATTERNS AS A SENSITIVE TOXICITY OUTCOME IN FISH

AUTHORS
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ABSTRACT
Behavioural responses are recognised as sensitive sub-lethal toxicity outcomes in fish and other aquatic animals exposed to various environmental pollutants. Variability amongst individual fish is one of the most common obstacles preventing the collection of statistically rigorous behavioural data. Standardised approaches for behavioural testing are also currently lacking, making it difficult to compare results between studies or gauge the relative importance of specific chemicals as behavioural toxicants. For behavioural testing to be effectively applied towards environmental monitoring, it is therefore necessary to develop robust and sensitive testing methods that yield information relevant for fundamental biological processes.

Many fish species exhibit circadian rhythms in their activity patterns, which are influenced by natural biotic and abiotic factors such as seasonal and daily changes in temperature and photoperiod. These rhythms are hypothesised to have evolved to coincide activity with peak timeframes for foraging success and predator avoidance. However, despite their ecological significance, few studies have explored such patterns as endpoints in ecotoxicology due to the absence of user-friendly tools for quantifying circadian rhythms.

A novel approach for quantifying diurnal activity patterns (DAPs) has recently been developed using small-bodied fish. Trials with mosquito fish (Gambusia holbrooki) reveal DAPs to be highly consistent between individual fish and also repeatable over time, thus providing robust toxicity information using comparatively fewer fish than most conventional toxicity bioassays. Experiments performed with treated sewage and various organic contaminants indicate high sensitivity using DAPs compared to other behavioural endpoints, and the method has been useful in identifying key compounds that may be driving sub-lethal toxicity in complex wastewater. More recently, the approach has been applied to study mixture toxicity with several common selective-serotonin reuptake inhibitor (SSRI) anti-depressants, and the results demonstrate significantly increased risk associated with mixtures of these compounds. Overall, DAPs represent a promising method to evaluate sub-lethal toxicity associated with emerging pollutants. Further work is now needed to standardise the methodology, evaluate responses with changes to basic water quality parameters, and explore the applicability towards in situ testing to achieve real-time environmental monitoring.

KEY WORDS
Toxicity; Behaviour; Circadian rhythm; Diurnal Activity Pattern; Sewage; Organic contaminant
SENSITIVE SPERM: A MEASURE OF HEAVY METAL TOXICITY IN THE MARINE ENVIRONMENT

AUTHORS
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ABSTRACT
Port Pirie in South Australia is the location of one of the largest lead smelting facilities in the world, which has been a long-term source of metal pollution into the Upper Spencer Gulf of South Australia. Marine sediments within the area have extreme elevations in the concentration of heavy metals: over 200-300 times greater than background levels for lead and zinc, and over 1000 times greater for cadmium. Recent plans to dredge the sediments within the area risk the resuspension and release of these contaminants into the water column where they have the potential to have toxic impacts to biota. Current approaches for ecotoxicological assessment of heavy metal pollution often involve assays that may take days to run, adding significantly to their costs. However, a recently developed method for assessing sperm motility holds some promise: a repeatable, sensitive and quick measure of the impact of changes in water quality on the reproductive function of marine organisms. Based on an easily measured rate of accumulation (and sticking) of motile sperm against clean surfaces, the advantages of this new method include its broad applicability to a diverse range of species and its brevity. However, the sensitivity of this method to heavy metal contamination is yet to be investigated and thus its potential role in ecotoxicological assessments remains unclear. This research aims to develop and test this new sperm motility based assay to produce a rapid and objective means of monitoring the impacts of heavy metal contamination to the marine environment.

KEY WORDS
Sperm; Toxicity; Ecotoxicology; Metals; Marine
NEW ZEALAND MUD SNAIL (AMPHIBOLA CRENATA) AS A BIOINDICATOR FOR ESTUARINE TRACE METAL CONTAMINANTS: LABORATORY STUDY USING MULTIPLE BIOMARKERS

AUTHORS
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ABSTRACT
Many estuaries are subjected to high levels of trace metal input from industrial, agricultural and domestic discharges. These discharges can result in decreased estuarine health and stress to estuarine organisms. Organisms that live in estuaries are often exposed to higher levels of contaminants than those in open coastal habitats because they are exposed not only water borne contaminants but are also closely associated with contaminated sediments. The endemic deposit feeding pulmonate gastropod, Amphibola crenata is widespread throughout New Zealand and is being assessed as a bioindicator of environmental conditions in estuaries. The acute (48 h) and chronic (21 d) biomarker responses of A. crenata to water born trace metal (Cd) exposure in the laboratory were measured. Snails were exposed to a range of cadmium concentrations (acute; 8, 16 and 32 mg Cd/L, and chronic: 0.2, 4 and 8 mg Cd/L). The biomarkers selected included trace metal content of individual tissues, physiological biomarkers and biochemical biomarkers in five body tissues (digestive and gonads, head and foot, rest of the body tissues). After 48 h of Cd exposure there was greater accumulation of Cd in digestive and gonad tissues compared with the head and foot tissues. Cd accumulation in all tissues increased with the exposure level. Haemolymph glucose and protein were significantly elevated (p < 0.001) whereas tissue glycogen and protein decreased significantly (p < 0.01) with increased Cd concentrations. Oxygen consumption exponentially decreased (p < 0.05) while ammonia excretion significantly increased (p < 0.01) with the increased Cd levels over the 48 h of exposure. Similarly, 21 d Cd exposure resulted in physiological and biochemical changes based on exposure level and time.

The observed high sensitivity of A. crenata physiological and biochemical endpoints to cadmium exposure, confirms that A. crenata is a good indicator of trace metal bioavailability.

KEY WORDS
trace metals, biomonitoring, bioaccumulation, physiological and biochemical assays
A META-ANALYSIS EVALUATING THE EVIDENCE OF A RELATIONSHIP BETWEEN AQUATIC POLLUTANTS AND LARVAL DEFORMITIES IN THE CHIRONOMIDAE FROM LABORATORY STUDIES

AUTHORS
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ABSTRACT
Chironomid larval deformities have been widely investigated as an aquatic pollution toxicity endpoint. Field chironomid surveys often show a spatial association between chemical contaminants and deformities, suggesting contaminants cause deformities. However, over 40 years of laboratory assays have not been able to confirm this causality; results are considered inconsistent across studies. Here, we present the results of a meta-analysis literature review of laboratory studies A) assessing whether trends across published assays were indicative of dose-response effects, B) characterising the inconsistency of results, and C) investigating whether experimental issues and publication bias were contributing to inconsistency and/or reducing confidence in results. Our meta-analysis of the most commonly assessed exposure chemicals suggested dose-response effects for lead; but not for cadmium, copper or zinc. However, we also confirmed significant inconsistency across studies. We found that the effects of mortality and extraneous stressors were potentially contributing to this inconsistency, and reducing confidence in most published results. We found no evidence of publication bias in the literature, suggesting that this is not a factor acting to reduce confidence in published results. Additionally, we present preliminary experimental data from our own laboratory assays.

KEY WORDS:
Chironomidae, deformities, aquatic ecotoxicology, pollution, causality, meta-analysis
INVERTEBRATES AS BIOINDICATORS AND BIOMARKERS FOR TRACE METALS AND OTHER CONTAMINANTS IN COASTAL AND FRESHWATER HABITATS

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ABSTRACT
Aquatic organisms are exposed to a changing conditions of salinity, irregular food supply, increased sediment loads and contaminants from adjacent catchments. Few studies have examined how environmental stressors, either individually or in combination affect marine invertebrates. We have examined how stressors affect the population structure, physiology, growth and health of common aquatic organisms, crustaceans, marine gastropods and bivalves from freshwater, estuarine and coastal areas. Mussels are widely used in monitoring programmes and our research confirms that green-lipped mussels are useful biomarkers for metal contaminants. Certain population parameters and growth rates of molluscs also reflect the environmental stressors with salinity and nutrient levels being most important. For example, high aquatic nutrient levels reduce shell growth in the mud snail. In the Canterbury region where trace metals levels in the sediments and water are generally low compared with some other regions of New Zealand, growth of cockles was independent of trace metal concentrations in the sediment. Low salinity exposure, however, reduced the growth rate in this bivalve but reproduction was not inhibited. These studies confirm the wide tolerance of molluscs to changing conditions in estuaries. Research on crustaceans has shown that amphipods are effective metal bioindicators of environmental conditions and our current research is investigating the effects of metals on freshwater crustaceans. Biomarker and bioindicator species reflect environmental conditions and in some species, population attributes can be used as bioindicators of contaminant inputs into aquatic habitats.

KEY WORDS
Metal toxicity, aquatic invertebrates, biomarker
BIOCHEMICAL EFFECTS IN JUVENILE TIGER PRAWNS (PENAEUS MONODON) AFTER INORGANIC MERCURY DIET EXPOSURE

AUTHORS
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ABSTRACT
It is known that methylmercury is the main toxic form of mercury, however little is understood about uptake pathways of different forms of this metal and subsequently toxicity to marine organisms. With the increasing use of mercury in artisanal mining operations large quantities of elemental mercury are entering marine systems and resulting in wide ranging exposure pathways and mercury species. In the present study, we investigated the effects of inorganic mercury on tiger prawn (Penaeus monodon) juveniles after dietary exposure for 4, 8 and 12 days. Commercial prawn feed was prepared by dosing with mercuric chloride at concentrations of 0.2 (low), 0.77 (medium), 1.41 (high) and 2.52 µg/g (higher) plus control. Juvenile P. monodon were fed daily during 4, 8 and 12 days. At the end of each exposure period and at the beginning of the experiment (0 days; background values) P. monodon were euthanized, biometry data collected and tissues (compound eyes, ventral nerve cord and muscle) were collected and stored at -80°C prior biochemical biomarkers (acetylcholinesterase – AChE; lipid peroxidation – LPO; glutathione S-transferase – GST; catalase - CAT) analysis. Additional muscle samples were collected for mercury analysis. AChE activities in both compound eyes and ventral nerve cord of exposed P. monodon showed a pattern of initial stimulation followed by a decrease in enzymatic activity, however results were not significant. Enzymatic activities and LPO from muscle tissues of P. monodon from low and medium treatments showed similar patterns to control, while samples from high and higher treatments did not show a clear pattern in all analysis. Although the mercury accumulation in muscle showed an accumulation pattern over time, it was not dependent on treatment. However, it was positively correlated to CAT activity and negatively related to AChE activity in muscle. The activity of these enzymes were also negatively correlated with each other. Furthermore, AChE activity in muscle was correlated with GST activity and carapace length. This study showed that a small amount of inorganic mercury present in feed can be accumulated by P. monodon, independently of its concentration, and changes in biochemical biomarkers can be observed as a result of the toxic effects of this metal.

KEY WORDS
Tiger prawn, mercuric chloride, acetylcholinesterase, oxidative stress
HEALTH STATUS OF SAND FLATHEAD (*PLATYCEPHALUS BASSENSIS*), INHABITING AN INDUSTRIALISED AND URBANISED EMBAYMENT, PORT PHILLIP BAY, VICTORIA AS MEASURED BY BIOMARKERS OF EXPOSURE AND EFFECTS

AUTHORS
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ABSTRACT
Port Phillip Bay, Australia, is a large semi-closed bay with over four million people living in its catchment basin. The Bay receives waters from the Yarra River which drains the city of Melbourne, as well as receiving the discharges of sewage treatment plants and petrochemical and agricultural chemicals. A 1999 study demonstrated that fish inhabiting Port Phillip Bay showed signs of effects related to pollutant exposure despite pollution management practices having been implemented for over a decade. To assess the current health status of the fish inhabiting the Bay, a follow up survey was conducted in 2015. A suite of biomarkers of exposure and effects were measured to determine the health status of Port Phillip Bay sand flathead (*Platycephalus bassensis*), namely ethoxyresorufin-O-deethylase (EROD) activity, polycyclic aromatic hydrocarbons (PAH) biliary metabolites, carboxylesterase activity (CbE) and DNA damage (8-oxo-dG). The reduction in EROD activity in the present study suggests a decline in the presence of EROD activity-inducing chemicals within the Bay since the 1990s. Fish collected in the most industrialised/urbanised sites did not display higher PAH metabolite levels than those in less developed areas of the Bay. Ratios of PAH biliary metabolite types were used to indicate PAH contaminant origin. Ratios indicated fish collected at Corio Bay and Hobsons Bay were subjected to increased low molecular weight hydrocarbons of petrogenic origin, likely attributed to the close proximity of these sites to oil refineries, compared to PAH biliary metabolites in fish from Geelong Arm and Mordialloc. Quantification of DNA damage indicated a localised effect of exposure to pollutants, with a 10-fold higher DNA damage level in fish sampled from the industrial site of Corio Bay relative to the less developed site of Sorrento. Overall, integration of biomarkers by multivariate analysis indicated that the health of fish collected in industrialised areas was compromised, with biologically significant biomarkers of effects (LSI, CF and DNA damage) discriminating between individuals collected in industrialised areas from observations made in fish collected in less developed areas of the Bay.

KEYWORDS
Port Phillip Bay, urban contamination, biomarkers, PAH bile metabolites, EROD, carboxylesterase, DNA damage, multivariate analysis
EVALUATION OF FISH AS POTENTIAL BIOINDICATORS OF ECOSYSTEM HEALTH IN A MAJOR COAL-PRODUCING REGION IN CENTRAL QUEENSLAND, AUSTRALIA

AUTHORS

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ABSTRACT

Within the Fitzroy Basin of Central Queensland, Australia, a major coal-producing region, environmental health monitoring is often focused on water quality monitoring, lacking biotic aspects such as fish community and health indicators. Thus, such monitoring may not always provide an in-depth picture of overall ecosystem health. Various fish community and health indicators were analysed for correlations with water and habitat quality variables (including physico-chemical parameters, sediment and dissolved metals, nutrients and pesticides) to investigate their potential for use as bioindicators. Preliminary results showed a number of fish community indicators were negatively correlated with increasing concentrations of water pollutants, but positively correlated with Australian Rivers Assessment (AusRivAs) habitat scores. Habitat scores were also negatively correlated with water quality variables, highlighting the importance of the physical habitat for maintaining suitable conditions to support fish species diversity. Out of 22 fish species collected, three common and abundant species had the greatest number of correlations with water quality variables; the Bony Bream Nematalosa erebi, the Eastern Rainbowfish Melanotaenia splendida splendida and the Western Carp Gudgeon Hypseleotris klunzingeri. Fulton’s condition factor (body-weight to length ratio) of M. s. splendida was negatively correlated with seven sediment metal concentrations, H. klunzingeri abundances were positively correlated with degradations in water quality variables and N. erebi abundances were negatively correlated with AusRivAs habitat scores. As H. klunzingeri and N. erebi are widely distributed throughout Eastern Australia, and M. s. splendida is distributed throughout tropical and subtropical Queensland, these species could have widespread potential as bioindicators of environmental health. Individuals of these three species were also analysed for metal concentrations within liver, viscera and full body tissue samples. Monitoring that includes fish indicators could lead to better understanding of pollutant bioaccumulation through the aquatic food chain, and better understanding of its impacts on the aquatic ecosystem as a whole.

KEY WORDS

Freshwater Fish, Environmental Monitoring, Bioindicators, Fish health, Metals Bioaccumulation, River Health
2.2 PESTICIDES/HERBICIDES - ECOLOGICAL RISK ASSESSMENT

Session Chairs: Assoc Prof Vincent Pettigrove & Maximillian Obinna Obiakor

Time: 11:00 - 13:00

BIOMARKERS TO ASSESS THE TOXICITY OF PESTICIDE MIXTURES TO THE YABBY CHERAX DESTRUCTOR

AUTHORS

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ABSTRACT

Organophosphate (OP) and carbamate (CB) pesticides are widely used in Australia and the combination of these pesticide groups are commonly detected in the aquatic environment. Both OP and CB pesticides are known as to inhibit the activity of cholinesterase and affect the behaviour of aquatic organisms. The toxicity of various individual OP and CB pesticides on aquatic biota has been reported in numerous research papers. However, information on the effects resulting from exposure to mixtures of these pesticides is still limited.

The yabby Cherax destructor is a native, edible crayfish found in freshwater habitats, including in agricultural areas where it is often exposed to these pesticides as a result of run off and spray drift. In this study, yabbies were exposed to three binary mixtures of two OP (chlorpyrifos, malathion) and one CB (methomyl) pesticides. Several biomarkers of exposure i.e. the activities of the enzymes Acetylcholine esterase (AChE), Butrylcholine esterase (BChE), ATPase and glutathione S-transferase (GST) were investigated to evaluate sublethal effects of these pesticide individually and as mixtures on yabbies. The effects of all binary combinations of chlorpyrifos (CF), malathion (MA) and methomyl (ME) on AChE, BChE, GST, and ATPase activity in yabbies varied depending on the ratio of the pesticide concentrations in the experimental mixtures. Based on the concentration addition model, the observed combined toxicity of the three binary mixtures of pesticides on AChE activity was estimated to show three different type of joint action, i.e. greater than additive, less than additive and synergistic. BChE activity in yabbies exposed to the binary mixtures was lower than in yabbies exposed to the pesticides individually, while gill ATPase activity and GST activity in the digestive gland and the gills was generally higher than when yabbies were exposed to the pesticides individually. We conclude that the sub-lethal toxicity of pesticide mixtures are complex and vary depending on the ratio of the mixtures and the different enzyme systems of the organism that are affected. These are important considerations in predicting the risk from pesticide exposure to non-target species in aquatic ecosystems.

KEY WORDS

Cherax destructor, organophosphates (OP), carbamate (CB), pesticide mixtures, biomarkers
DEVELOPMENT AND APPLICATION OF A MULTISPECIES MICROALGAL BIOASSAY TO ASSESS THE TOXICITY OF HERBICIDES IN NORTHERN QUEENSLAND CATCHMENTS

AUTHORS
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ABSTRACT
Agricultural land within the Great Barrier Reef Catchment Area has resulted in the contamination of surface freshwater ecosystems that flow directly into the Great Barrier Reef. These freshwater ecosystems provide a variety of ecosystem services and are valuable biodiverse tropical ecosystems. Intensive agriculture can result in varying combinations of nutrients, pesticides and total suspended solids, released in pulses following rain events. Yet environmentally relevant ecotoxicological data for herbicides and herbicide formulations is lacking for aquatic plants such as microalgae. Traditionally, microalgal toxicity tests utilise single species whereas microalgae occur as complex communities of multiple species. To date, no multispecies ecotoxicity tests with tropical microalgae have been developed.

This study developed an environmentally relevant toxicity test protocol for a multispecies growth rate toxicity test with three species of tropical green microalgae: Pediastrum duplex meyenii, Monoraphidium arcuatum, and Isolate 1b (possibly a Chlorella sp.). Flow cytometry was able to utilise the different fluorescence properties of each algal species to efficiently separate individual species within the algal mixture, and to determine the population growth rate of each species. The multispecies assay was used to assess the toxicity of four individual herbicides commonly detected in Northern Queensland Catchments; atrazine, diuron, hexazinone and imazapic. The most toxic herbicide was diuron (EC10 3.7–25 µg/L) followed by atrazine (EC10 3–250 µg/L), hexazinone (EC10 15 – > 500 µg/L) then imazapic (EC10 >1000 µg/L). Herbicide toxicity was not noticeably different when determined using individual species or the mixture of algal species. The P. duplex meyenii was consistently the most sensitive algal species, followed by M. arcuatum then Isolate 1b. Two commercial formulations (Barrage, 13.2% hexazinone and 48.6% diuron, and Diurex, 90% diuron) were also assessed along with river water samples from an impacted creek in Northern Queensland (Sandy Creek) and a reference creek (Tully Gorge) to determine the bioavailability and toxicity of herbicides in natural waters. Throughout each toxicity test, herbicide concentrations were measured using liquid chromatography-mass spectrometry. Herbicide toxicity to tropical microalgae, as individual herbicides, commercial formulations and at environmentally relevant concentrations in natural waters, will be discussed.

KEY WORDS
Photosystem II inhibitor; Great Barrier Reef Catchment Area; flow cytometry; multispecies
LETHAL AND SUBLETHAL EFFECTS OF THE HERBICIDE FLUAZIFOP-P-BUTYL ON THE SEAGRASS ZOSTERA NIGRICAULIS

AUTHORS
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ABSTRACT
Along Victorian coastlines the accepted management practice for control of the invasive grass Spartina anglica is through application of the herbicide Fusilade Forte® (active ingredient fluazifop-p-butyl). Concern has been raised as to whether spray drift and tidal transport of Fusilade Forte® applied near coastal waters is contributing to the loss of seagrass beds. Currently there is a dearth of information regarding the effects of fluazifop-p-butyl on Australian seagrass species, limiting our ability to determine risks of fusilade forte to seagrass health. In a lab study we exposed the subtidal seagrass Zostera nigricaulis to a range of concentrations of the herbicide Fusilade Forte® (0.01-10 mg L⁻¹ of active ingredient) for 7 days, followed by a 14 day recovery period in clean seawater. A number of lethal and sublethal effects were observed. After 7 days exposure, dark adapted photosynthetic efficiency (Fv/Fm) was significantly reduced at a concentration of 10 mg L⁻¹ fluazifopbutyl. Values for 7 day IC₅₀, IC₂₀ and IC₁₀ were calculated (0.95 mg L⁻¹, 0.65 mg L⁻¹ and 0.52 mg L⁻¹, respectively). Furthermore, at the end of the recovery period the 0.1 mg L⁻¹ and 1 mg L⁻¹ treatments experienced significant reductions in Fv/Fm relative to the control. At the completion of the experiment there was a significant increase in mortality in 10 mg L⁻¹ concentration compared to the control. Our research showed an effect of the herbicide Fusilade Forte® in a lab setting at relatively high concentrations, but these results should be considered in the context of actual concentrations experienced in the field. As plants were harvested mid-winter, these findings indicate vulnerability of Z. nigricaulis exposed to fluazifopbutyl during winter periods.

KEY WORDS
Fluazifop, PAM fluorometry, seagrass, Zostera nigricaulis, toxicity, Fusilade Forte, pesticide, herbicide, Spartina management
SUB-LETHAL EFFECTS OF THE HERBICIDE FLUAZIFOP-P-BUTYL AND THE ADJUVANT HASTEN ON SEAGRASSES

AUTHORS
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ABSTRACT
Spartina, an aggressively invasive grass, was introduced to saltmarshes and estuaries globally in an effort to assist with land reclamation. The ecological, social and economic costs associated with its continued spread have resulted in the development of eradication programs heavily reliant on herbicides. Due to its efficacy and toxicological properties, Fusilade Forte® (FF), applied alone or in conjunction with the adjuvant Hasten™, is the preferred Spartina management method in Australia. FF (active ingredient fluaazifop-P-butyl) is phytotoxic through the inhibition of acetyl coenzyme-A carboxylase (ACCase). The close proximity of seagrass meadows to Spartina infestations has raised concern regarding effects on this vital aquatic ecosystem from off-target herbicide drift. We undertook a study to understand risks to seagrasses from FF, alone or combined with Hasten. The study involved 1) hydrodynamic modelling to predict off-target transport of FF in the coastal embayment of Corner Inlet, Victoria; 2) a field-sampling program during and after Spartina spraying; and 3) laboratory experiments to assess toxicity of FF alone and combined with Hasten to the subtidal seagrass Zostera nigricaulis. Hydrodynamic modelling was used to select field-sampling sites from predictions of potential plume drift for up to 3-d post application. Field monitoring of FF 24-h post application detected a maximum fluaazifop-P concentration of 0.069mg/L ~2km from the shore. Laboratory experiments with FF ranging 0.01-10 mg/L indicated significant inhibition of photosynthetic parameters at concentrations ≥ 0.1 mg/L following 7-d exposure to FF and FF+Hasten. Z. nigricaulis photosynthetic responses recovered after 14-d in clean seawater in plants exposed to all treatment levels with the exception of those in the highest treatment (10 mg/L). In the laboratory experiment, the degradation of fluaazifop-P-butyl to fluaazifop-P occurs at a decreased rate in the presence of Hasten. To elucidate further the interaction between fluaazifop-P-butyl and seagrasses, samples of three seagrass species were collected during field monitoring and laboratory exposures to determine if any inhibition of ACCase activity is occurring. Outcomes from this study will provide a basis for discussing potential risks to seagrass habitats from ACCase-inhibiting herbicides and provide important data to guide approaches to Spartina management.

KEY WORDS
Spartina management, Seagrass, Zostera nigricaulis, Fluazifop, Herbicide, PAM fluorometry, Photosynthesis, Ecotoxicology
“AUSTRALIANISING” PESTICIDES ENVIRONMENTAL RISK ASSESSMENTS

AUTHOR
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ABSTRACT
Pesticides in Australia are regulated by the Australian Pesticides and Veterinary Medicines Authority (APVMA). Environmental risk assessments broadly follow methodologies applied internationally. These methods, when used in Australia, are generic in their nature with no specificity to Australian species, climates or geography.

Estimates of risk to birds and mammals are determined based on algorithms published almost 30 years ago.

In the case of mammals, the Department of the Environment (DotE) continues to apply a poorly correlated equation based on rats while the APVMA applies a eutherian mammalian equation. These equations do not represent energy requirements of marsupials particularly well. For smaller dasyurid marsupials that are insectivorous and may readily be exposed through agricultural settings, both equations under predict energy requirements and consequently will underestimate risk. For larger marsupials that are essentially from the macropod family and represent herbivorous browsers and grazers, the DotE equation underpredicts energy requirements and consequently underestimates risk.

When assessing risk to birds AEA assesses a number of different bird body weights and applies a more recent avian allometric equation, which results in slightly higher energy requirements being predicted for birds than the 1987 equations applied by the APVMA and DotE. The APVMA and Department of the Environment continue to apply default body weights as applied by the US EPA and PMRA. The three body weights assessed for birds are 20 g, 150 g and 1000 g. Australia has a large number of “bush birds” that have an insectivorous diet that are unlikely to be protected by such an approach due to many birds with body weights below 20 g. The range of body weights and diets being recommended will be presented.

For the aquatic compartment, runoff predictions can be made based on knowledge of soil profiles, geography, rainfall and streamflow unique to the areas being considered rather than relying on generic (and meaningless) default assumptions.

Development of appropriate software incorporating these improvements now allows more relevant environmental risk assessments to be performed for regulation needs in Australia in an efficient and consistent manner.

KEY WORDS
APVMA, Pesticides, Marsupials, Birds, Runoff, Risk Assessment
QUANTIFYING AND COMMUNICATING THE ECOLOGICAL RISK OF PESTICIDES FOR THE REEF WATER QUALITY PROTECTION PLAN

AUTHORS
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ABSTRACT
Forty-nine different pesticides have been detected in waterways discharging to the Great Barrier Reef (GBR) during the wet season from agricultural basins along the Queensland coast. The potential impact of pesticides on the resilience of the GBR in the face of climate change has been well documented. In response, the Reef Water Quality Protection Plan 2013 (Reef Plan) has set a long-term goal ‘to ensure that by 2020 the quality of water entering the reef from broadscale land use has no detrimental impact on the health and resilience of the Great Barrier Reef’. In recent years, Reef Plan’s pesticide reduction targets have been re-evaluated, progressing towards more ecologically relevant targets; first by incorporating mixture toxicity methods into the procedure, and now in the second stage, introducing methods of Probabilistic Ecological Risk Assessment (PERA). Through six years of pesticide monitoring data, obtained from more than ten Queensland basins, we analysed the patterns of exposure and risk of pesticides transported to the GBR lagoon to develop a multi-dimensional risk-based approach to quantify progress towards ecologically relevant targets, independent of the annual variability in river discharge. In addition, we aimed to ensure the approach: (1) was compatible with current methods for generating modelled pesticide data for Reef Plan (2013); and (2) balanced transparency with complexity, i.e. the methods were simple and easy to understand for stakeholders, but complex enough to address real-world processes of exposure and effects in the GBR’s riverine, coastal and marine ecosystems. PERA methods included the most up-to-date pesticide species sensitivity distributions (derived for the revision of the Australian and New Zealand Water Quality Guidelines) combined with the multi-substance potentially affected fraction (ms-PAF) method to include as many of the 49 detected pesticides in the risk calculations. The application of the method and its relevance across a wide range of catchment and climatic conditions, as well as its function as a communication tool will be discussed.

KEY WORDS
Pesticides, Great Barrier Reef, probabilistic ecological risk assessment, multisubstance-Potentially Affected Fraction, mixtures
DETECTION OF NOVEL BROMINATED FLAME RETARDANTS (NBFRS) IN THE URBAN SOILS OF MELBOURNE, AUSTRALIA

AUTHORS
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ABSTRACT
A range of brominated flame retardants (BFRs) have been incorporated into polymeric materials like plastics, electronic equipment, foams and textiles to prevent fires. The most common of these, polybrominated diphenyl ethers (PBDEs), have been subject to legislated bans and voluntary withdrawal by manufacturers in North America, Europe and Australia over the past decade due to long-range atmospheric transport, persistence in the environment, and toxicity. Early research has shown that replacement novel brominated flame retardants (NBFRs) are released to the environment by the same mechanisms as PBDEs and share similar hazardous properties. The objective of the current research was to characterize soil contamination by NBFRs in the urban soils of Melbourne, Australia. A variety of industrial and background land-uses were investigated with the secondary objective of determining likely point sources of pollution. Six NBFRs; pentabromotoluene (PBT), pentabromoethylbenzene (PBEB), hexabromobenzene (HBB), 2-ethylhexyl-2,3,4,5-tetabromobenzoxate (EH-TBB), bis(2,4,6-tribromophenoxy)ethane (BTBPE) and decabromodiphenyl ethane (DBDPE) were measured in 30 soil samples using selective pressurized liquid extraction (S-PLE) and gas chromatography coupled to triple quadrupole mass spectrometry (GC-MS/MS). NBFRs were detected in 24/30 soil samples with \( \Sigma_6 \) NBFR concentrations ranging from nd-385 ng/g dw. HBB was the most frequently detected compound (14/30), while the highest concentrations were observed for DBDPE followed by BTBPE. Electronic waste recycling and polymer manufacturing appear to be key contributors to NBFR soil contamination in the city of Melbourne. This research provides the first account of NBFRs in Australian soils and indicates that these emerging contaminants possess similar risks to land contamination as PBDEs.

KEY WORDS
Novel brominated flame retardants (NBFRs), persistent organic pollutants (POPs), land contamination
FINGERPRINTING STRATEGIES FOR SOURCE IDENTIFICATION OF POLY- AND PER-FLUORINATED ALKYL SUBSTANCES (PFAS)

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ABSTRACT
Poly- and Per-Fluorinated Alkyl Substances (PFAS) have received significant attention recently due to contamination at a number of sites in Australia and abroad. The issue of PFAS contamination is likely to become even more prominent as further contaminated sites are identified and any adverse impacts to human health and the environment become clearer.

The use of PFAS in aqueous film forming foam (AFFF) for firefighting has received the most attention, but PFAS are also used in a variety of industrial and household products, and consequently have been reported in sewage effluents, biosolids and landfill leachates. Reliable identification of PFAS sources will be useful in some instances for risk management decisions and potentially in legal cases.

Three potential analytical fingerprinting strategies are put forward for identifying sources of PFAS in contaminated material. The first relies on the LC-MSMS analysis of the commonly analysed suite of different chain length perfluorinated sulfonates and carboxylic acids, and fluorotelomers.

The second strategy uses an assessment of the ratio of linear to branched-chain PFAS, as has been suggested by a number of authors. This strategy is based on the fact that PFAS produced by electrochemical fluorination (as used by 3M prior to 2002) produces a mixture of linear and branched products, whereas telomerisation (used by other manufacturers including DuPont) produces predominantly linear products.

The final strategy is to use mass spectrometry as a qualitative tool to identify a range of PFAS precursor compounds. Precursors are generally PFAS with organic chains bonded to the PFAS, often by an amide functional group. These precursors are often present in products such as AFFF in significant concentrations and may present a useful diagnostic signature.

Examples will be presented of differing PFAS profiles using the commonly analysed suite of PFAS, based on different sources. A discussion of the potential for linear/branched analysis and precursor identification to provide more definitive conclusions will be included. Strengths and limitations of fingerprinting techniques will be discussed including consideration of differing fate/transport properties of linear and branched-chain PFAS, and precursor compounds.

KEY WORDS
PFAS, PFOS, fingerprinting, mass spectrometry
POINTING THE FINGER AT A POINT SOURCE. RELEASE AND FATE OF PFCS IN A SEMI-ARID ENVIRONMENT

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ABSTRACT
Perfluorinated compounds (PFCs) including perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) are a group of anthropogenic chemicals that are used in a wide range of applications, including non-stick coatings and aqueous film forming foams (AFFF). Their persistence, toxicity and bioaccumulation potential indicate both an ecological and human health risk. This risk for potential adverse effects has motivated a progressive phasing out of the use of PFCs in many applications, including in firefighting foams, since 2008 in most jurisdictions. However, frequent historical use of AFFFs has resulted in widespread soil, groundwater and surface water contamination, especially with PFOS and PFOA. Here we present an overview of information on the occurrence of PFCs in the environment in Australia, from publically-available sources. Specifically, we will explore and discuss sources and pathways of exposure, and evaluate how a relatively isolated point source can lead to widespread contamination and result in human exposure at the population level. This will include: (1) the presentation of measured concentrations of PFCs across a range of matrices covering soil, vegetation, animals and humans; (2) comparison of this data with controlled studies on transfer of PFCs across different media; and (3) an evaluation of potential pathways of exposure from point source to human. Finally, we present a conceptual model for the release of PFCs from a point source and discuss strategies to help with minimizing human exposure.

KEY WORDS
PFOS; perfluorinated chemicals; fate of fluorochemicals; groundwater; food chain; hydrology
PER AND POLY FLUORINATED ALKYL SUBSTANCES – WHERE ARE WE, ECOLOGICALLY SPEAKING?

AUTHORS
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ABSTRACT
Per- and poly-fluorinated alkyl substances (PFASs) are a high profile group of emerging contaminants worldwide. These chemicals have an extremely wide range of uses including some fire-fighting foams, metal plating processes, packaging, non-stick cookware and specialized garments, curtains and carpets. The characteristics of these chemicals lead to their widespread distribution in the environment and their accumulation in many organisms. As with other countries, work in Australia has identified a range of sites where these chemicals have been released into the environment, where they may pose a health or ecological risk.

This presentation will outline the Australian story to date including discussion of the key difficulties that have arisen in assessing ecological risks at PFAS contaminated sites. The key questions arising in these investigations include:

● Sources of variability in international guidelines and what important guidelines are we missing?
● Bioaccumulation for these chemicals doesn’t follow existing wisdom; how does this affect design of investigations and how we determine guidelines?
● Secondary poisoning versus direct toxicity and what do those extremely low draft screening values really mean?
● Endangered species (including wetland birds)?

The presentation will cover these key questions with reference to major contaminated sites in Australia (Williamtown, Fiskville, & Oakey).

KEY WORDS
PFAS, Risk Assessment, Persistence, Bioaccumulation, Risk Management
RISK-BASED ASSESSMENT, GUIDELINE DEVELOPMENT AND MANAGEMENT OF PFOS AND PFOA

AUTHORS

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ABSTRACT

Perfluorooctanesulfonate (PFOS) and perfluorooctanesulfonic acid (PFOA) have been identified as contaminants of emerging concern in Australia. They are known to be persistent, bioaccumulative and potentially toxic, and have been found to be present at concentrations of potential concern at a number of sites, particularly where there has been use of firefighting foams. Industry and public awareness of the presence of particularly PFOS and to a less extent PFOA is growing rapidly, with regular reporting of PFOS contamination in the media, with particular concern being raised regarding the risk that the contamination poses to the health of persons who may be exposed.

In general, there is limited and incomplete information surrounding the occurrence, fate and toxicity of PFCs in the Australian context, and criteria for protecting human health and ecological systems have not been established making it difficult to determine the risk that the contamination poses. Because of the persistence and difficulty of treating PFOS contamination, there is also considerable uncertainty about how such contamination can be treated.

CRC CARE is in the final stages of preparing guidance on the assessment, management and remediation of PFOS and PFOA. This work has involved a working group comprising representatives of regulatory agencies, industry and research organisations. It is intended that this guidance will assist practitioners, regulators and site owners to effectively assess, manage and remediate soil and groundwater contaminated with PFOS and PFOA, and will allow more appropriate remediation and potentially reduce the cost of managing contaminated soil and groundwater.

It is expected that guidance will be published mid 2016, and will be circulated for industry review.

In particular, information will be provided on:

(a) The extent and magnitude of PFC contamination in Australia, where known, and where significant data gaps in knowledge exist;
(b) The problem of many perfluorinated compounds and where assessment should focus;
(c) Impacts on beneficial uses, with a focus on soil, groundwater and receiving waters;
(d) Ecological and human health screening levels for soil and water that are available internationally, and the development of screening levels for application in Australia, particularly considering toxicity, bioaccumulation, bioavailability and persistence;
(e) Screening levels for water and sediment with respect to bioaccumulation in fish and acceptability for human consumption;

KEY WORDS
PFOS, PFOA, Marine Guidelines, Ecological Screening levels
BROMINATED FLAME RETARDANTS IN AIR AT TOOLIK LAKE, ARCTIC ALASKA

AUTHORS
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ABSTRACT
Brominated flame-retardants (BFRs) can be released from consumer products, resulting in accumulation in the surrounding environment and/or long-range transport to remote environments. We evaluated concentration changes in BFRs, including a suite of polybrominated diphenyl ethers (PBDEs) and 1,2-bis(2,4,6tribromophenoxy)ethane (BTBPE), in air at Toolik Lake, Arctic Alaska during the Northern Hemisphere summer of 2013. A high-volume active air sampler at the field station collected 2-day integrated samples and three flow-through air samplers collected 18-day integrated samples along a transect extending away from the field station. The BDE congeners associated with the penta-BDE commercial mixture (BDE47, -99, and -100) were the most frequently detected BFRs and were found at concentrations consistent with those reported for other Arctic sites. Gas-particle distributions were influenced by temperature and correlations between gas-phase concentrations and temperature suggested that either volatilization from local sources or re-emission from secondary sources (that is, re-volatilization of BFRs that had migrated northwards from distant sources) was important for the lower-brominated BFRs during the warmer months. Source indicator analysis suggested no single dominant geographic source of BFRs while results from the flow-through samplers indicated that the field station itself was not a significant source of BFRs.

KEY WORDS
Polybrominated diphenyl ethers (PBDEs), BTBPE, long-range atmospheric transport, high-volume air samples, flow-through air samples, source indicator analysis
DEVELOPMENT OF A 7 DAY CHRONIC TOXICITY TEST FOR LARVAL NORTHERN TROUT GUDGEON, \textit{MOGURNDA MOGURNDA}, USING SUB-LETHAL GROWTH ENDPOINTS

**AUTHORS**
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**ABSTRACT**

In the eriss ecotoxicology laboratory, a suite of local species has been routinely used to derive WQ GVs for two creeks adjacent to Ranger Uranium Mine, Magela Creek and Gulungui Creek, in Kakadu National Park. The current routine toxicity test for the Northern Trout Gudgeon, \textit{Mogurnda mogurnda}, is an acute 96-h exposure (using a survival endpoint). This test is typically a less sensitive indicator of toxicity than the chronic tests used for the other species in the suite. The acute data generated from this test is not ideal for WQ GV derivation as it does not represent the long term effects of the contaminant within the environment. Thus, there was a need to update the current method to a cost-effective, chronic test based on sub-lethal endpoints.

A 28 day chronic toxicity test for \textit{M. mogurnda} was previously developed using length and weight as sub-lethal endpoints (Cheng et al., 2010). This test detected responses to uranium (U) at lower concentrations than the acute test (i.e. 28 d chronic LC50, 1070 µg L\(^{-1}\); acute 96 h LC50, 1450 µg L\(^{-1}\) U) and found that dry weight was the most sensitive sub-lethal endpoint. The present study aimed to determine the feasibility of a 7 d larval growth toxicity test, as this is the minimum test length required for a test to be considered chronic in Australia and New Zealand (Batley et al., 2014, Warne et al., 2015). Larval growth rate, based on length as measured using a new stereomicroscope with digital image analysis software, was calculated at the end of the 7-d test period as well as dry weight. Fry were fed once daily from day three when the yolk sac became significantly reduced.

Tests to date have shown the 7-d test is far more sensitive compared to the 96-h survival test. Growth rate based on length is a sensitive and consistent endpoint, with an average IC50 for U of 616 µg L\(^{-1}\). When compared to the length endpoint used in the 28-d chronic test, growth rate based on length was 68% more sensitive (average IC10 of 270 µg L\(^{-1}\) U compared with 850 µg L\(^{-1}\) U). However, if we consider length as an endpoint between the two tests, they are comparable (7 d length IC10 = 905 µg L\(^{-1}\) U). The survival endpoint for the 7-d test (LC50 = 1210 µg L\(^{-1}\) U) was 17% more sensitive compared to the 96-h test (1450 µg L\(^{-1}\) U). The new test methodology with the addition of the growth rate endpoint may prove to be more sensitive following longer exposure durations. Weight has proved a difficult and unreliable endpoint, due to the young age and, thus, small mass of the fish (on average 0.166 mg in the controls).

This study highlights the importance of updating test methods based on available technology. With the improvement of image analysis and microscopic photography a new, more sensitive endpoint and a more cost effective and manageable chronic method for \textit{M. mogurnda} toxicity testing have been developed. This approach has enabled progression from outdated endpoints such as mortality and imbalance. Further investigations might involve assessing this new method across longer exposure durations.

**KEY WORDS**
Toxicity testing, Method improvement, chronic fish test, tropical ecotoxicology
**DEVELOPMENT OF AN ACUTE AND CHRONIC TOXICITY TEST FOR THE FRESHWATER MUSSEL VELESUNIO ANGASI AND AN ASSESSMENT OF AMMONIA TOXICITY**

**AUTHORS**

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**ABSTRACT**

Ammonia is used during the final stages of uranium processing at the Ranger mine, situated in the Alligator Rivers Region (ARR) of Northern Australia. Ammonia has been identified as a contaminant of potential concern due to 1) low-level residual concentrations in treated process water discharged into the environment, and 2) potential seepage from buried tailings and brines post 2026, once the mine has been rehabilitated. An interim Guideline Value (GV) for Total Ammonia Nitrogen (TAN) in freshwater of 0.7 mg/L has been derived from a Species Sensitivity Distribution of international data using a 99% species protection level and adjusted to locally-relevant pH and temperature. Local species ammonia toxicity testing has also been undertaken, and will be used to further refine the GV.

The freshwater mussel, *Velesunio angasi*, found throughout this region is an important food source for Aboriginal communities living downstream of the mine. Studies have shown freshwater mussels to be the most sensitive taxa to ammonia, and hence adequate protection of their early life stages needs to be considered in site-specific GVs. Consequently, the current project is developing toxicity testing methods for *V. angasi*.

An acute toxicity test (based on a 24-h survival endpoint) has been developed for the early life stage of *V. angasi* in order to assess the toxicity of ammonia. Survival was measured through a valve closure response when glochidia (larvae) were exposed to a NaCl solution at the end of the test. The pH was adjusted to 6.0 at the start of the test and the test temperature maintained at ~28°C to represent environmental conditions of the local creeks. Preliminary estimates using these data suggest that *V. angasi* is highly sensitive to ammonia with 24-h exposures to ammonium sulfate generating an LC50 of 9.02 mg TAN/L, and an LC10 of 3.5 mg TAN/L, which is the second lowest toxicity estimate for all tropical species, despite being an acute value. A chronic ≥14-d test method for *V. angasi* is under development using growth and survival endpoints and progress will be reported. Glochidia and juvenile mussels will also be exposed to other key mining contaminants and the acute and chronic toxicity estimates will be used to inform the site-specific GVs for the protection of species in the ARR.

These toxicity estimates may also be useful for the revision of the ANZECC/ARMCANZ Water Quality Guidelines.

**KEY WORDS**

Freshwater mussel, *Velesunio angasi*, ammonia, acute toxicity
HYPOXIA-INDUCED EPIGENETIC CHANGES AND TRANSGENERATIONAL REPRODUCTIVE DEFECTS IN MARINE MEDAKA

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ABSTRACT
Aquatic hypoxia arising as a result of eutrophication is a pressing global problem affecting aquatic ecosystems worldwide. Hypoxia causes major changes in fish species compositions, alterations in community structures, and reductions in biodiversity resulting in serious population declines and the extinction of sensitive species in marine and freshwater systems. Laboratory and field studies have shown that hypoxia can cause reproductive impairments in fish by inhibiting testicular and ovarian development, affecting sperm and egg production and quality, and reducing fertilization success. Recent data also indicated that hypoxia impairs reproductive functions by affecting specific steroid hormones and receptors along the hypothalamus-pituitary-gonadal axis. Here, we demonstrate that F0 marine medaka male fish (Oryzias melastigma) exposed to prolonged hypoxia can lead to decreased sperm motility and reproductive impairments in the F1 and F2 progenies. Epigenomic, transcriptomic and proteomic analyses further revealed that the observed transgenerational effects might be associated with differential methylation of TSSK1B, FOXP2 and EHMT2 in the F0 and F2 generations. Elevated expression of EHMT2 and H3K9me2 (epigenetic mark for gene repression) was observed in hypoxic F0, and F1 and F2 offsprings, which correlated with impaired spermatogenesis. Since the genes regulating spermatogenesis and epigenetic modifications are highly conserved in vertebrates, the findings from this study may provide important insights into possible transgenerational effects of hypoxia in higher vertebrates including humans.

KEY WORDS
Hypoxia, epigenetics, transgenerational, reproductive defects, marine medaka
EUKARYOTIC COMMUNITIES IN A DYNAMIC TROPICAL SALTMARW FLOODPLAIN, THE SOUTH ALLIGATOR RIVER, KAKADU NATIONAL PARK, AUSTRALIA

AUTHORS
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ABSTRACT
Forecasted climate change models predict that much of Northern Australia’s coastal habitats are in retreat due to saltwater intrusion (SWI). SWI brings with it ecological stress to a typically freshwater dynamic systems, yet little is known of the depth of the complexity of stress to the eukaryotic biodiversity of the floodplain. In this DNA-based approach, the composition of eukaryotic soil communities of the World Heritage-listed tropical floodplain, the South Alligator River (SAR), Kakadu National Park were studied. Metabarcoding (amplicon pyrosequencing) was used to compare soil eukaryote composition from 18 sites along the South Alligator floodplain. The eukaryotic communities that were subjected to regular episodic saltwater intrusion from tidal movement were measured using 18S rRNA gene metabarcoding, comparing across different floodplain morphology (FM) and River Zone (RZ) classifications. The community composition was significantly different between sites from the lower floodplain (closer to the river) compared with the upper (inland from the river) and backwater swamp (furthest from the river) areas of the floodplain. From the multivariate model, the environmental variables salinity, pH, elevation, inundation, total organic carbon (TOC%) and total phosphorus (P) were significantly (P<0.05) contributing to the biological composition, however, they only contributed to a small amount of the biological variation. This demonstrated that the eukaryotic communities sampled are determined by a combination of players driving the different FM and RZ community structures. It is not salinity alone that is determining community structure but rather a suite of factors.

KEY WORDS
Eukaryotes, climate change, saltwater, river zone, flood morphology
RNA-SEQ ANALYSIS OF ISIDORELLA NEWCOMBI EXPOSED TO COPPER

AUTHORS
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ABSTRACT
Advances in molecular technologies have greatly increased the potential for genomic methods to be incorporated into ecotoxicological monitoring and assessment. Sequencing of the transcriptome (RNA-seq) has advantages over traditional biomarkers of being able to detect the first response to contaminant exposure and detecting responses at a global level. This allows responses to be detected at the earliest possible time and provides insight into the condition of the organism through regulation of functional responses that are indicative of the level of stress the organism is experiencing. It also has the potential to show contaminant-specific transcriptomic profiles and detect novel functional pathways.

Despite huge potential, there are many challenges in establishing transcriptomics as an accepted and reliable means of assessing the response of organisms to contamination. These include the need to use non-model species, link transcriptional changes to biological functions and establish contaminant-specific transcriptomic footprints. The Australian endemic freshwater snail Isidorella newcombi is considered a pest in rice growing areas and is controlled with copper sulphate. It is also widely distributed and has potential for use as a biomonitor. In this study, I. newcombi was exposed to copper and RNA-seq was performed. Following alignment and annotation of transcripts data, quantitative analysis was conducted between copper exposed treatments and controls. Our study identified differential regulations of many genes and functional pathways, including copper ion binding regulatory functional pathway. We also assessed lysosomal destabilisation and observed that to be significantly higher in copper exposed organisms. We discussed the biological significance of the transcriptional changes including identifying genes, novel transcripts and pathways that show potential for use as biomarkers.

KEY WORDS
Transcriptome, Biomarkers, Gastropod, Mollusc, Gene expression
BUILDING A PREDICTIVE ADVERSE OUTCOME PATHWAY FOR MIXTURES OF ACETYLCHOLINESTERASE INHIBITORS TO ESTIMATE EFFECTS TO POPULATION SCALE ENDPOINTS

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ABSTRACT
Adverse outcome pathways (AOPs) are linear models that describe the interaction of a toxicant or toxicants with the molecular receptors, cellular processes, organ function and eventually the effects on the organism. Currently AOPs do not predict population scale effects. Current AOPs also do not address the issue of multiple stressors as found in the environment. This paper presents how to describe the AOP framework using a Bayesian network to describe the effects at each biological scale and how to derive the key parameters for estimating population dynamics. These population parameters are survival and timing to first reproduction, survivorship between age classes, and reproduction at each age class. Bayesian networks are parameterized to include molecular interactions including synergistic and antagonistic effects of multiple stressors. Age structured population models are used to incorporate ecological context including carrying capacity, density dependent or independent population control, and patch dynamics. Our pilot models are based on the effects of organophosphate acetylcholinesterase inhibitors to Chinook salmon singly and in mixtures typical of the Pacific Northwest. The extensive data on the types of acetylcholinesterase inhibitors, their concentrations, and spatial relationships serve as the basis of the modelling effort. The current results indicate that the AOP derived Bayesian networks serve as an effective cause-effect structure to organize information and to identify key uncertainties. Supported by USEPA STAR Grant RD-83579501.

KEY WORDS
adverse outcome pathways, Bayesian networks, acetylcholinesterase inhibitors, population scale effects
ASSESSING THE MICROPOLLUTANT BURDEN IN SMALL STREAMS IN THE RHINE CATCHMENT USING CHEMICAL ANALYSIS AND BIOANALYSIS

AUTHORS
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ABSTRACT
Micropollutants can enter the aquatic environment from both point sources, such as wastewater effluents, and diffuse sources, such as agricultural discharges. In this study the micropollutant burden in three small streams within the Rhine catchment, Switzerland, was assessed using a combination of targeted chemical analysis and bioanalysis. At all sites water samples were collected upstream and downstream of a wastewater treatment plant (WWTP) under low flow conditions, with wastewater effluent also sampled. The analysed chemicals included pharmaceuticals, pesticides and industrial compounds, with 405 chemicals targeted in total. Eleven bioassays comprising 13 different endpoints were applied, with the assays representing different stages of cellular toxicity pathways including xenobiotic metabolism, receptor-mediated effects and adaptive stress responses, as well as whole organism effects. At all sites the wastewater effluent had the highest chemical concentrations and observed effects, followed by the downstream sites, with the lowest chemical concentrations and effects in the upstream sites, which received no input of wastewater effluent. The fraction of wastewater effluent downstream was estimated based on chemical analysis and bioanalysis using a mass balance approach. The wastewater effluent was found to have a substantial impact on the micropollutant burden downstream. Though less contaminated, the upstream sites were far from pristine. Elevated concentrations of some pesticides were detected, suggesting that diffuse sources are still relevant in low flow conditions. Mixture toxicity modelling was applied to assess whether particular chemicals were driving the observed effect. In most cases, the detected chemicals could only explain a small fraction of the effect, which emphasises the importance of combining both chemical analysis and bioanalysis for water quality monitoring.

KEY WORDS
Wastewater effluent; Micropollutants; Mixture Modelling; Chemical Analysis; Bioassays
THE EFFECTS OF WASTEWATERS ON ROCK OYSTER SPECIES SACCOSTREA MORDAX: ASSESSMENT OF GENERAL AND REPRODUCTIVE HEALTH AND LARVAL DEVELOPMENT

AUTHORS

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ABSTRACT

The WA Environmental Protection Authority has expressed concerns about environmental contamination from a waste water treatment plant (WWTP) in the north of the State. There is a fear that contaminants from the WWTP are leaching into the marine environment from groundwater with potential general, reproductive and larval developmental impacts on local organisms. *Saccostrea mordax* (local rock oysters) were exposed to five increasing concentrations of post-chlorination WW from the WWTP (0.5%, 1%, 5%, 10% and 20%), two positive controls (copper and 17α-ethynylestradiol) and a negative control (0%). The WW did not impact the overall condition of the oysters, although there was some mortality at high exposure concentrations. Exposure to high concentrations of WW (>10%) significantly increased the proportion of oysters with destabilised lysosome membranes but did not disrupt the reproductive investment of the oysters. Exposure to WW at concentrations between 0.5%, 1% and 5% caused a significant increase in abnormal larval development and there was 100% mortality of larvae exposed to higher (10 and 20%) WW concentrations. Larvae of *S. mordax* in the immediate vicinity point that groundwater contaminated with WW enters the marine environment may experience high mortality and abnormalities. Mature populations of *S. mordax* are not expected to show signs of impact however, they may be affected at a cellular level. To fully understand the population level impacts at this location contaminant modelling around the outfall needs to be conducted.

KEY WORDS

Wastewater, *Saccostrea mordax*, multiple stressors
GLOBAL GUIDANCE ON LAND USE IMPACTS ON BIODIVERSITY INDICATORS IN LCA

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ABSTRACT
Objective: The life cycle impact assessment guidance flagship project of the UNEP-SETAC Life Cycle Initiative aims providing global guidance and building scientific consensus on indicators for assessing land use impacts on biodiversity.

Methods: Several tasks have been conducted during the last two years in order to achieve the purpose: 1) workshops where invited experts and stakeholders discuss and agree on recommendations for assessing biodiversity loss due to land use interventions, 2) critical review of the existing framework for Land Use impact assessment in LCA (Teixeira et al 2015), 3) Review of existing indicators in and out of the field of LCA in order to identify models of particular promise for further application and development (Curran et al 2016) and 4) Pellston WorkshopTM, where conclusions have been built in based on the previous work and the participation of selected experts in the area.

Results: Main results from the revision conducted showed that approaches in LCA nested within those from ecology and conservation. From the workshops conducted and review performed we concluded that an acceptable model should reflect both local measures of land use intensity and regional weighting reflecting vulnerability aspects. Finally, during the Pellston WorkshopTM the approach proposed by Chaudhary et al. (2015) has been provisionally recommend to assess biodiversity loss due to land use. The model links land use to species loss through the Countryside-SAR model and includes vulnerability scores expressed as ratio of threatened endemic richness with the total species richness hosted by the region.

Conclusions: The indicator proposed is recommended to be used in identification of potential hotspots analysis from LCA and not be used for comparative assertions and product labelling. In addition, guidance and recommendations to improve indicator have been suggested.
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ARSENIC CONTAMINATION - IMPACTS AND REMEDIATION

MAGNETIC BIOCHAR, BIOCHAR AND IRON FOR ARSENIC ACCUMULATION REDUCTION AND GROWTH ENHANCEMENT OF MAIZE IN ARSENIC –CONTAMINATED SOIL

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ABSTRACT

Magnetic biochar recently has gained interest in it capacity in pollutants sorption, however research on its influence on plant contaminant accumulation and also plant growth in contaminated soils is limited. In this study a pot experiment conducted to compare the influence of magnetic biochar (MB), nonmagnetic biochar and Fe on the accumulation of arsenic (As) in maize growing in arsenic contaminated soil, the growth of the maize and on mycorrhizal communities. Three rates of amendments were used (0, 5, and 15 g/kg soil) for MB, coconut activated biochar (nonmagnetic biochar) and Fe. The MB was developed by coating coconut activated biochar with magnetic Fe₃O₄ nanoparticles. The MB, nonmagnetic biochar and Fe were mixed with 1 kg arsenic contaminated soil: sand mix (1:1 w/w). After 10 weeks the maize plants were harvested with dry and fresh shoot and root weight obtained, and plant height and mycorrhizal colonization measured. The concentration of As and phosphorous (P) in the maize plants was also analysed. The results showed that the addition of all amendments resulted in a significant increase in plant growth (dry and fresh shoot, fresh root, plant height), and increased P concentration in maize shoot, but plant growth and P were maximum in MB treatment at 5g/kg. Nonmagnetic biochar at 5 g/kg increased As concentration in maize shoot, while both MB and Fe amended treatments at 5g/kg showed lower As concentration in maize shoot. Mycorrhizal colonization percentage was high (P<0.05) in all treatments, but in nonmagnetic biochar at 15mg/kg the percentage was higher than the other treatments. This study shows that magnetic biochar may have potential role in risk management for soil contaminated with As.

KEY WORDS

Magnetic biochar, biochar, arsenic, iron, arsenic-contaminated soil, mycorrhizal colonization
BIOMARKERS AND BIOINDICATORS

CELLULAR BIOMARKER RESPONSES IN AURELIA AURITA EXPOSED TO VARIOUS COPPER CONCENTRATIONS AS A NOVEL PELAGIC & ESTUARINE BIOINDICATOR

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ABSTRACT
Jellyfish are ubiquitous in marine systems, ranging from shallow bays and estuaries to great depths of pelagic areas. Due in part to the complexity of scyphozoan life histories, even slight changes in environmental factors can have an effect on fecundity, development and population fluctuations. Anthropogenic activities have been suggested as a major cause of increases in jellyfish. These include overfishing, eutrophication, and habitat modification. In addition, jellyfish, like other aquatic organisms, are exposed to a host of chemical contaminants in the ambient environment. Heavy metals, such as copper, are a major anthropogenic pollutant found throughout aquatic ecosystems. However, there are few accounts of copper contaminant effects on scyphozoans in terms of biochemical markers. This study evaluated a host of sub-lethal cellular biomarker assays combined with behavioral analyses to determine the effects of 48 hr. exposures to 5, 10, 25 and 50 ppb Cu concentrations on Aurelia aurita, the common moon jellyfish. No adverse effects were seen in medusae at 5 or 10 ppb. Results showed the lysosomal destabilization assay was the most sensitive assay when compared to glutathione and lipid peroxidation. Results for lipid peroxidation and total glutathione varied from exposure to exposure in both oral arm and bell tissues. Lipid peroxidation did not vary significantly as Cu concentration increased. Glutathione levels did increase as Cu concentration increased, suggesting that increased antioxidant capacity (glutathione) inhibited increased cellular damage by peroxidation of lipids. Behavioral differences were also observed as Cu concentration increased—decreased pulsation rate and a decline of suspension in the water column. Biochemical markers provide useful tools in determining molecular responses to contaminants that may have effects on A. aurita populations and are valuable for identifying species-specific sensitivities. These tests, coupled with behavioral analyses, can then further be used to assess ecological implications at the community and population levels.
FISH BIOMARKER RESPONSES AND ENDOCRINE ACTIVITY IN A SOUTH AUSTRALIAN CREEK RECEIVING TREATED WASTEWATER

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ABSTRACT
The discharge from wastewater treatment plants (WWTPs) potentially have major detrimental effects on the health of aquatic ecosystems. The rivers containing effluents are a complex mixture of compounds including pharmaceuticals and natural hormones and have previously be shown to interfere with normal reproduction development and function in exposed individuals. The aim of the present study was to determine the potential risk to fish health of a WWTP effluent discharged to a water system in the Adelaide Hills, South Australia. Adult Murray-Darling rainbowfish, Melanotaenia fluviatilis were exposed to effluent under controlled conditions in the field to determine if it induced reproductive disruption in the fish. The expression of selected estrogen-responsive genes (vitellogenin (VTG), estrogen receptors alpha (ERα), and beta subunits 1 and 2 (ERß1 and ERß2)) and two androgen receptors (ARα and ß) in brain, liver and gonads were determined in rainbowfish using quantitative reverse-transcriptase polymerase chain reaction (qRT-PCR). In vitro reporter gene assays (CALUX bioassays) were also used to screen water extracts for endocrine activity. Liver ERß1, ERß2 and the ARs gene expression were downregulated downstream from the WWTP outfall. There were no differences observed in the testes and brain. The ERß and AR CALUX bioassays showed only low levels of estrogenicity immediately downstream of the outfall, while androgenicity and anti-androgenicity were below detection limits and quantification limits, respectively. Together, these results suggest that the impact of the WWTP effluent on estrogenic and androgenic biomarkers in rainbowfish is low. There appear to be differences in biomarker expression in fish caged upstream from the WWTP that indicate some degree of contamination at these sites, possibly due to stormwater or other ephemeral inputs.

KEY WORDS
Estrogenic activity, androgenic activity, municipal wastewater, biomarkers
ECOLOGICAL RISK ASSESSMENT

PREDICTING RISK TO ESTUARY WATER QUALITY AND PATTERNS OF BENTHIC ENVIRONMENTAL DNA IN QUEENSLAND, AUSTRALIA USING BAYESIAN NETWORKS

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ABSTRACT
Risk assessment and predictive modelling can inform natural resource management by demonstrating stressor-response pathways and also quantifying the effects of stressors on selected endpoints. For this study, I used Bayesian networks and the Relative Risk Model to develop a multiple stressor risk assessment to predict risk to estuary water quality and patterns of benthic communities in a single integrated assessment. Similar to other coastal regions, Southeast Queensland (SEQ) is highly developed and nutrient and sediment loading from non-point sources are major stressors to water quality and biota. The combination of runoff from heavy rainfall, excess nutrients, phytoplankton blooms and a large supply of organic matter causes eutrophication with depressed oxygen levels and changes to aquatic communities. Water quality objectives have been developed to assess the condition of estuaries and guide management. Using Bayesian networks, I have built risk assessment models for three different estuaries in SEQ. The models estimate the probability of meeting water quality objectives in sub regions of the estuaries. In addition, I have also modelled the response of eukaryotic benthic communities to estuarine water quality and synthesized the endpoint response. The benthic community data was collected via metabarcoding techniques, where DNA is collected from environmental media (such as soil, sediment or water), sequenced and identified using online databases. I will be presenting the methodology of building the models, current findings, and future use of the models for adaptive management.

KEY WORDS
Risk assessment, Bayesian networks, water quality, environmental DNA
SEDIMENT CONTAMINATION IN WORLD HARBOURS: A REFLECTION OF SOCIAL-ECONOMIC DEVELOPMENT?

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ABSTRACT
Our aim is to establish the present, past and future trends in the environmental contaminant status of major world harbours and to identify how these environments relate to natural and anthropological pressures. To achieve this we will use the present-day status of Sydney Harbour estuary as a methodological template for assessment of other harbours—Guanabara Bay, Rio de Janeiro; Hong Kong Harbour, Hong Kong; Auckland harbours, New Zealand; Port of Vigo, Spain; Ravenna Harbour, Italy; Plymouth Sound and the Fal Estuary, UK; Heraklion Harbour, Crete; Dublin Harbour, Ireland; Port of Hobart, Tasmania and Darwin Harbour, Northern Territory, Australia; and Baltimore Harbour, Chesapeake Bay, USA. From each harbour and catchment a wide suite of data, such as physical, geological/geochemical, hydrological, socio-economical, etc, will be collated to obtain a concise understanding of each harbour and catchment. Sediment risk maps will be generated using ArcGIS for comparing adverse contaminant risk between the harbours, which may act as a catalyst for further research; potentially leading to the introduction of specific management measures. Within Sydney Harbour for example, data were available for 25 metalics and organic chemicals, each of which was classified according to its respective sediment quality guideline value (SQGs). SQG values include the Effects Range Low (ERL), the concentration below which adverse biological effects are seldom observed, and the Effects Range Median (ERM), the concentrations above which adverse biological effects occur frequently. Concentrations between ERL and ERM indicate intermediate, irregular biological responses. Individual chemicals, e.g. lead, were assessed for possible adverse biological effects by comparing concentrations at each site to the respective ERL and ERM values. Sediment risk was also determined for mixtures of contaminants using the mean ERM quotient (MERMQ) approach. Results were plotted using ArcGIS to obtain spatial distributions of sediment toxicant risk from both individual and mixtures of contaminants across a harbour in each respective class (metals, OCs, and PAHs). Lastly, MERMQs were combined to provide the cumulative risk of sediment toxicity from multiple chemical classes.

KEY WORDS
Global Harbours, Estuaries, Contamination, Sediments, Risk, GIS
EMERGING ECOTOXICOLOGICAL METHODS

EFFECTS OF NICKEL AND COPPER ON TROPICAL MARINE AND FRESHWATER MICROALGAE: DIFFERENT ISOLATES HAVE DIFFERENT SENSITIVITIES

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ABSTRACT
Increasing demands for metal resources and the expansion of mining in tropical regions increases the need for environmentally relevant water quality guidelines (WQG) as risk assessment tools. The development of WQGs for tropical regions is hindered due to limited ecotoxicity data with relevant species. Toxicity databases are well established for temperate species, however there is uncertainty around applying temperate data to tropical aquatic ecosystems due to their vast differences in climate, geochemistry and the evolutionary distinct biota. In this study we compare the sensitivity of temperate and tropical marine and freshwater microalgae to Cu and Ni.

Using chronic growth rate inhibition bioassays, the toxicity of Cu and Ni to four tropical microalgae were tested; two marine species, \textit{Isochrysis galbana}, and \textit{Ceratoneis closterium}, and two freshwater species \textit{Chlorella sp.} and \textit{Monoraphidium arcuatum}. The temperate marine isolate of \textit{C. closterium} (Port Hacking, Sydney) was also tested and toxicity values compared to the tropical isolate of \textit{C. closterium} (Coral Sea). Toxicity tests were carried out in natural seawater or synthetic softwater supplemented with nutrients (NO$_3^-$ and PO$_4^{3-}$) and Ni or Cu. Algae were washed, inoculated (10$^3$ cells/mL) into test flasks and incubated at 27°C (tropical) or 21°C (temperate). Algal growth rates were determined daily by flow cytometry over 72 h. Water quality parameters and metal concentrations (total and dissolved) were also measured.

Tropical freshwater microalgae were the most sensitive to Ni with growth rate inhibited by 10\% (IC10) at 26 \(\mu\)g/L. Tropical marine microalgae had IC10s of 377 (\textit{I. galbana}) and 2570 – 3130 \(\mu\)g/L (\textit{C. closterium}). The temperate isolate of \textit{C. closterium} was about ten times more sensitive to Ni (IC10 300 \(\mu\)g/L) than the tropical isolate. Experiments on tropical \textit{C. closterium} cultured in different media suggest that this increase in sensitivity is attributed to the algal isolate and not to differences in culture media. In contrast, Cu toxicity to freshwater and marine tropical microalgae was similar (IC10 0.67 – 1.8 \(\mu\)g/L). The temperate \textit{C. closterium} isolate was also of similar sensitivity (IC10 1.2 \(\mu\)g/L) suggesting that Cu toxicity to \textit{C. closterium} is not dependent on the isolate used. This study demonstrates the importance of using ecologically relevant species for WQG development and provides valuable ecotoxicity data for tropical species which was previously lacking.

KEY WORDS
Ni, copper, growth rate inhibition, bioassay, water quality guidelines, risk assessment tools
LOOKING BEYOND ESTROGENICITY: APPLICATION OF IN VITRO BIOASSAYS TO MEASURE ENDOCRINE ACTIVITY IN ENVIRONMENTAL WATERS

AUTHORS

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ABSTRACT

Much of the work on endocrine disruption from exposure to environmental contaminants has been carried out on the estrogenic axis, but several other hormones (such as androgens, progestagens, glucocorticoids, retinoids, thyroids, etc) also play a crucial role in the maintenance of homeostasis, sexual development, metabolism, growth and behavior. Substantially less information is available on these other endocrine endpoints, although it is becoming clear that these pathways can also be disrupted by exposure to environmental contaminants. Bioanalytical tools are finding increasing application as screening tools because the chemical causing the effect in the endocrine active sample may be unknown and/or difficult to quantify. This is particularly true for these less-studied endocrine endpoints, where the causative chemicals are often unknown. This project, funded by the Global Water Research Coalition (GWRC), had four main aims: 1) identify suitable bioassays for analysis of non-estrogenic endocrine activity in environmental waters, 2) develop and validate methods to extract a variety of endocrine-active compounds from water, 3) benchmark different bioassays to assess thyroid activity, and 4) measure endocrine activity in water samples (treated wastewater, surface and drinking water) from various countries (Australia, Germany, France, The Netherlands, South Africa and Spain). Results so far suggest that 1) mammalian reporter gene assays and cell proliferation assays are the most sensitive methods, but significant sample enrichment is still necessary to detect non-estrogenic endocrine activity in water samples based on current (often incomplete) knowledge. 2) Solid Phase Extraction (SPE) with a StrataX cartridge at pH 2 was the most efficient method to extract a variety of endocrine active compounds from different types of water samples, although extraction with C18 and Oasis HLB cartridges likewise were very efficient, 3) thyroid receptor reporter gene assays do not detect significant thyroid activity in environmental waters, and 4) other than some low estrogenic, glucocorticoid and progestagenic activity in a few samples, there was little endocrine activity detected in environmental waters.

KEY WORDS

Endocrine activity, environmental waters, high-throughput, in vitro bioassays, water quality
ENIRONMENTAL ANALYSIS AND MONITORING

COPPER DISTRIBUTION IN A RIVER SYSTEM THAT RECEIVES COAL MINE-AFFECTED WATER RELEASES IN THE FITZROY RIVER BASIN, CENTRAL QLD

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ABSTRACT
The Mackenzie River sub-basin in the Fitzroy Basin (Central Queensland) is a turbid river system associated with significant coal mining. Coal mine-affected water (CMAW) releases do not occur during low flow conditions. Copper (Cu) is one of the heavy metals found in CMAW. The median annual dissolved Cu concentrations in the Mackenzie basin during low flow conditions in 2010-2014, calculated from data reported by the Fitzroy Partnership for River Health, were 3.0, 2.0, 1.5 and 1.2 µg/L (n = 43–264), respectively, with concentrations for 3 years being greater than the ANZECC (2000) toxicant trigger value for Cu (1.4 µg/L) for slightly-moderately disturbed freshwater systems. This study sought to determine the potential bioavailability and the distribution of Cu in the Mackenzie River environment.

Two field trips were conducted: sediment core samples were taken in August 2014 and water samples in March 2015, both during low flow conditions and no recent CMAW releases. Three sites were sampled: one, in an upstream tributary, where no coal mining activity existed (called “Ref” site), and two downstream Mackenzie River sites (Site 5b and Site 6), that could receive cumulative mine-affected water releases, from numerous upstream coal mines. DGT-labile Cu (using DGT devices), total dissolved Cu (grab water samples filtered through 0.45µm at the site) and Cu in suspended particulate matter (retained on large diameter 0.45 µm filters, in field) were measured at each site. Triplicate DGT samplers were deployed for 48 h, and triplicate grab water samples were taken during deployment and retrieval of the DGT devices at each site.

There was no significant difference in the total dissolved Cu concentration at deployment vs at retrieval at the Ref site and at Site 6 (furthest downstream). The average dissolved Cu concentration over 48 h at these two sites were 0.91 ±0.10 µg/L and 1.6 ±0.26 µg/L, respectively. In contrast a significant difference in the Cu concentration at deployment vs at retrieval was observed at Site 5b (2.1 ±0.14 µg/L vs 3.2 ±0.42 µg/L). Total dissolved Cu at Ref site was below the ANZECC (2000) trigger value, whereas concentrations at downstream sites were greater than the trigger value. The time-averaged DGT-labile (or potentially-bioavailable) Cu concentrations were low overall, being greatest at Site 5b (0.37 ±0.04 µg/L) and similar at Ref site and Site 6 (0.20 ±0.09 vs 0.18 ±0.01 µg/L, respectively).

The Ref site had 4.3 mg/kg of particulate Cu on deployment and 1.3 mg/kg on retrieval; the respective values for Site 5b were 2.8 and 9.8 mg/kg, and for Site 6 were 1.2 and 2.1 mg/kg. Turbidity readings on retrieval were 27.4, 163 and 127 NTU at the three sites, respectively.

A 10-cm sediment core from Ref site and a 12-cm core from Site 6 were analysed; Site 5b had rocks and pebbles and was unsuitable for coring. Cu concentration (<60 µm fraction) in the 2-cm core slices from Ref site ranged from 16.9-37.7 mg/kg dry weight (dw), and in Site 6 from 19.5-28.3 mg/kg dw.

This preliminary study has demonstrated that total dissolved Cu in grab water samples may overestimate the potential impact of Cu on the aquatic environment. Cu distribution in different phases of the turbid Mackenzie River system indicated low bioavailable-Cu levels during low flow conditions. Comparative testing during CMAW releases is recommended. Cu concentrations (<60 µm fraction) in sediment cores were relatively low.

KEY WORDS
Environmental Analysis and Monitoring; Coal Mining; Fitzroy River Basin; Copper; DGT
ESTROGENS IN ESTUARINE WATER: ANALYTICAL VALIDATION AND FIRST DATA FOR A HIGHLY POPULATED COASTAL BRAZILIAN REGION

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ABSTRACT
Southeast is the Brazilian most populated region. Santos-São Vicente estuary, located there, includes c.a. 1.5 million inhabitants, one of the most important Brazilian petrochemical sites and the bigger harbor from Latin America. In this region, the sewage treatment is almost inexistent (covers c.a. 20% of all population), nevertheless there are not studies about the occurrence and environmental dynamics of estrogens or others endocrine disruptors there. On the other hand, the analytical reliability in environmental studies have been frequently neglected. Thus, this work presents a reliability evaluation for estrogens (EE2, E2 and E3) determination in marine water, using a method based in solid phase extraction (SPE) and HPLC-FLD analysis, statistical tools were used to accomplish the calibration curve, storage time of SPE cartridges after sample elution and matrix effects. The analytical validation process showed adequate selectivity, recovery (76-94%, for different concentrations of EE2, E2 and E3) and precision (RSD below 20%). The method detection limit for EE2, E2 and E3 was 10, 2 and 4 ng L⁻¹, respectively. Five analytical curves for each compound were used to evaluate the matrix effect wherein the standard solutions were prepared in solvent (acetonitrile, or on the SPE extract from artificial seawater (S=30) or in natural seawater). Additionally, for artificial and natural seawater, the standards were spiked to matrix before the SPE. All standard solution contained all the studied estrogens, at the same concentration, for each curve it was used six standards concentrations. Model fitting was done by linear regression models, using ANOVA. The results showed matrix effects for all estrogens, thus matrix-matched (natural seawater) analytical curves were used at the following method validation steps. SPE cartridges storage time (after sample loading) was studied for until 80 days, data demonstrated no significant differences for this period. Three sampling campaign were done at Santos-São Vicente estuary, in February 2014, February 2015 and June 2015. Estriol (E3) concentrations ranged ND-354 ng L⁻¹, estradiol (E2) ND-18 ng L⁻¹ while 17α-ethynylestradiol (EE2) was not possible to quantify in any samples (below method LOQ, ). Overall, the study indicated that the concentrations and spatiotemporal distribution for E3 in Santos-São Vicente estuary is influenced simultaneously by pollution sources and estuary hydrodynamics. In light of the possibility of risks for aquatic organisms, the high concentration of estrogens found in this marine ecosystem are of environmental concern.

KEY WORDS
Estriol, Estradiol, Estuary, Seawater, Santos
IDENTIFICATION OF METAL CONTAMINANTS FROM MULTIPLE AGRO-BASED ACTIVITIES IN THE TULLY RIVER CATCHMENT

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ABSTRACT
The Tully River catchment in North Queensland is home to a number of agro-based activities notably sugarcane and banana crop production. These activities, in addition to human settlement along the river, potentially contribute a range of contaminants to the river flow that may affect the surrounding ecosystem which includes a number of wetlands, mangroves and rainforests. A sampling program utilising a number of different analytical techniques was designed to identify possible metal contaminants along the river and develop environmental profile by incorporating soil analysis for toxic metals, rare earth elements (REE) and lead isotope ratios by ICP-QQQ, diffusive gradients in thin films technique (DGTs) for bioavailable toxic heavy metals, and grab water samples for total metal concentrations. The obtained data indicated elevated levels of heavy metals in sites adjacent to farming activities. The outcome of this study will provide an indication of the influence of anthropogenic activities on contaminants present and allow for more targeted monitoring of specific heavy metals at particular locations on the Tully River.

KEY WORDS
ICP-QQQ; heavy metals; DGT; REE; lead isotopes
MONITORING OF THE LOWER LAKES BASED ON THE ECOTOXICOLOGICAL ASSESSMENT OF SELECTED SITES

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ABSTRACT
Drought from 2007 to mid-2010 caused previously long-inundated sediments and subaqueous soils to be exposed around the margins of lakes Alexandrina and Albert in South Australia. This exposed acid sulfate soil (ASS) material became progressively oxidised over increasing depths in the soil profiles. The resultant formation of sulfuric materials (pH < 4) produced significant soil, water quality and ecological problems. Increased rainfall from March 2010 caused a rapid rise in water levels and inundation of the sulfuric materials into the Lower Lakes. The aim of this study was to perform an ecological assessment on whole sediment and pore water from Point Sturt North and Boggy Creek sites at Lower Lakes to provide a better understanding of ecotoxicity and potential impacts of recovered ASS. Subaqueous soil profiles were sampled from Point Sturt North (up to 67 cm with four distinct layers) and Boggy creek (up to 62 cm with five distinct layers). Whole sediment bioassays were conducted on each of these sediment sub-layers at different depths to assess their contribution towards toxicity. Laboratory cultured, second-instar midge larvae (Chironomus tepperi) were used for sediment toxicity assessment. Survival, growth, emergence and sex ratios were the endpoints used for sediment bioassays. Pore water collected from the subaqueous soils was also subjected to ecotoxicological assessment using Microbial Assay for Risk Assessment (MARA™) and a cladoceran (Ceriodaphnia dubia). Microbial toxicity of pore water varied from low to moderate. Metal concentrations in pore water from deeper cores were above the ANZECC/ARMCANZ guideline values at both sites. The ecotoxicological assessment of surface water, pore water and sediments at different depths at the two sites, four years after inundation, confirms that the contaminants generated at the ASS impacted sites, at deeper sediment depths, are potentially severely toxic to aquatic organisms. If this monitoring was undertaken during or straight after the water had returned, the surface sediments may also have posed this risk level to aquatic organisms.

KEY WORDS
Toxicity, Acid sulfate soils, Midge larvae, Pore water
PAHS, PCBS, OCS, TRACE METALS CONCENTRATIONS IN SAND FLATHEAD COLLECTED FROM PORT PHILLIP BAY, AUSTRALIA

AUTHORS
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ABSTRACT
Port Phillip Bay, Australia, is a typical urban embayment which hosts a population of over four million people on its catchment basin. The economical, political and ecological importance of the Bay has previously triggered management practices to regulate contaminant inputs and in the past two decades, short-term monitoring programs concerned with the deteriorating ecological health of the Bay have been established to measure contaminant levels in various environmental compartments including fish. Concentrations of polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides, PCB congeners (PCBs) and a suite of trace metals were determined in the skinless white muscle of sand flathead Platyecephalus bassensis collected at 6 locations in Port Phillip Bay during 2015 and compared to those measured in previous decades. No PAHs, organochlorine pesticides or PCBs were detected in the white muscle of sand flathead at any of the locations, however measurable levels of arsenic (As), copper (Cu), mercury (Hg), selenium (Se) and zinc (Zn) were detected at all sites. Only As and Hg exhibited regional difference in white muscle concentrations, with As present only in a non-toxic organic form (<8.0 mg/kg) and Hg concentrations (<0.30 mg/kg) measured at levels that are comparable to levels reported in reference sites in other studies. All contaminants detected in the (edible) white muscle of sand flathead collected in Port Phillip Bay in 2015 were below the recommended Australian Food Standards guideline values, and by world standards, the Port Phillip Bay sand flathead population is considered minimally contaminated. Furthermore, tissue contaminant concentrations appear to be decreasing over time, with all the levels measured in this study being lower than measured concentrations in previous studies within sand flathead from Port Phillip Bay.
HEALTH STATUS OF SAND FLATHEAD (*PLATYCEPHALUS BASSENSIS*), INHABITING AN INDUSTRIALISED AND URBANISED EMBAYMENT, PORT PHILLIP BAY, VICTORIA AS MEASURED BY BIOMARKERS OF EXPOSURE AND EFFECTS

**AUTHORS**

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**ABSTRACT**

Port Phillip Bay, Australia, is a large semi-closed bay with over four million people living in its catchment basin. The Bay receives waters from the Yarra River which drains the city of Melbourne, as well as receiving the discharges of sewage treatment plants and petrochemical and agricultural chemicals. A 1999 study demonstrated that fish inhabiting Port Phillip Bay showed signs of effects related to pollutant exposure despite pollution management practices having been implemented for over a decade. To assess the current health status of the fish inhabiting the Bay, a follow up survey was conducted in 2015. A suite of biomarkers of exposure and effects were measured to determine the health status of Port Phillip Bay sand flathead (*Platycephalus bassensis*), namely ethoxyresorufin-O-deethylase (EROD) activity, polycyclic aromatic hydrocarbons (PAH) biliary metabolites, carboxylesterase activity (CbE) and DNA damage (8-oxo-dG). The reduction in EROD activity in the present study suggests a decline in the presence of EROD activity-inducing chemicals within the Bay since the 1990s. Fish collected in the most industrialised/urbanised sites did not display higher PAH metabolite levels than those in less developed areas of the Bay. Ratios of PAH biliary metabolite types were used to indicate PAH contaminant origin. Ratios indicated fish collected at Corio Bay and Hobsons Bay were subjected to increased low molecular weight hydrocarbons of petrogenic origin, likely attributed to the close proximity of these sites to oil refineries, compared to PAH biliary metabolites in fish from Geelong Arm and Mordialloc. Quantification of DNA damage indicated a localised effect of exposure to pollutants, with a 10-fold higher DNA damage level in fish sampled from the industrial site of Corio Bay relative to the less developed site of Sorrento. Overall, integration of biomarkers by multivariate analysis indicated that the health of fish collected in industrialised areas was compromised with biologically significant biomarkers of effects (LSI, CF and DNA damage) discriminating between individuals collected in industrialised areas from observations made in fish collected in less developed areas of the Bay.

**KEY WORDS**

Port Phillip Bay, urban contamination, biomarkers, PAH bile metabolites, EROD, carboxylesterase, DNA damage, multivariate analysis
THE EFFECT OF SEDIMENT STRUCTURE ON THE DIVERSITY OF BENTHIC MARINE ANIMALS IN JAPAN

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ABSTRACT
Sediment contamination is well known to cause the degradation of diversity in marine benthic animals, however, the role of sediment structure on benthic biodiversity is equally important, although frequently overlooked or simplified in sediment monitoring programs. In this study, we analysed ecological data obtained from a wide area of Japan, including the industrialized port of Nagoya. The data included benthic community and sediment structure (e.g. grain size, water content, and total organic carbon (TOC)). Using generalized linear models and generalized linear mixed models derived from presence/absence data, we examined the relationships between the richness of macrofaunal taxonomic groups and sediment structure. Regardless of region, latitude, water depth, temperature or sampling method, the key explanatory variables associated with changes in biodiversity were water content, TOC, and the proportion of silt/clay. Using the Akaike information criteria to test a range of models, we consistently found that the best predictor of family richness for a range of taxonomic groups was water content, however, all three variables had the capacity to alter the compositional data. These findings emphasise the importance of including these in ecological surveys, and also the difficulties associated with separating the effects of natural and anthropogenic stressors in sediment monitoring programs.

KEY WORDS
Marine biodiversity, benthos, sediment quality, linear models
TOXICITY ASSESSMENT OF PULSED DISCHARGES OF ACID MINE DRAINAGE FROM THE HISTORIC BRUKUNGA MINE SITE

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ABSTRACT
The historic Brukunga Pyrite Mine is situated in the Adelaide Hills approximately 50 km east of Adelaide in the Mount Lofty Ranges. The Brukunga mine was operated from 1955 to 1972 to supply feedstock for sulfuric acid production to the South Australian fertiliser industry. After closure of the mine, increasing acid mine drainage (AMD), derived mainly from the mine tailings dam, was observed within the Dawesley–Bremer catchment zone. The aim of this project was to gain a better understanding of the toxicity of pulsed stormwater overflows of AMD from the historic Brukunga mine site on aquatic organisms using two lines of investigation: 1. Direct toxicity assessment of AMD in the laboratory using a cladoceran (Ceriodaphnia dubia), a freshwater shrimp (Paratya australiensis) and Microbial Assay for Risk Assessment (MARA™) for water management (e.g. dilution/neutralisation) at the Brukunga mine site; and 2. In-situ toxicity testing using the freshwater mussel (Velesunio ambiguus) for direct field assessment of organism effects from exposure to pulsed AMD events. Direct toxicity assessment showed that C. dubia was the most sensitive of the species tested with an EC10 at AMD 3.4\%, pH 7.7 and electrical conductivity 1252 µS cm\(^{-1}\); and an EC50 at AMD 6.2\%, pH 7.6 and electrical conductivity 1279 µS cm\(^{-1}\). In general, P. australiensis and bacteria species (MARA™) were less sensitive than C. dubia to AMD with an EC10 reduction in survival and bacterial function occurring at AMD 6.2-6.7\%, pH 4.5-4.6, and 1396-1460 µS cm\(^{-1}\). In-situ testing showed there was no decrease in total mussel mass, shell length or shell height compared to the controls and there was no significance difference (p>0.05) in selected metal concentrations (e.g. aluminium, cadmium, copper, iron, manganese and nickel) in mussel tissues compared to their controls, from pulsed AMD events at 24 hr, 1 or 4 weeks. Mussels may have modified their behaviour (e.g. closed or reduced the rate of opening) during pulsed AMD events to prevent/decrease uptake of metal laden acidic waters and potential adverse effects. These findings highlight the importance of examining multiple organisms from various trophic levels to gain a better understanding of the risks from stressors, such as AMD, to aquatic environments.

KEY WORDS
Acid mine discharges, Direct toxicity assessment, in-situ, Freshwater mussel
METAL TOXICITY AND ENVIRONMENTAL CHEMISTRY

SENSITIVITY OF AUSTRALIAN BASS AND SILVER PERCH TO ANTIMONY: EXPOSURE-DOSE-RESPONSE CHARACTERISTICS

AUTHORS

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ABSTRACT

Despite the increasing consumer-led applications of antimony (Sb), cumulative impact and response characteristics for site-specific fish species are rarely examined. We conducted acute semi-static studies to examine the response of indigenous Australian bass and Silver perch to different measured concentrations of Sb(III) (10.5 – 30.5 mg L⁻¹) and Sb(V) (95.9 – 258.7 mg L⁻¹). In addition to standard toxicological endpoints, the bioavailability and the effects of Sb on body ion regulation (Ca, K, Mg and Na) were investigated. Median lethal concentrations (LC50s) of 13.55 and 18.03 mg L⁻¹ for Sb(III) were recorded for Australian bass and Silver perch, respectively, and 165.33 mg L⁻¹ for Sb(V) in Australian bass. The LC50 could not be calculated for Silver perch exposed to Sb(V) by the model interpolations due to low response (the maximum exposure concentrations produced 40% mortality). An extrapolative value of 293.69 mg L⁻¹ was estimated, however, as the indicative LC50. Antimony species-specific effects were seen with exposure to both Sb oxidation states. The Australian bass showed similar mortality response to Sb(III) and Sb(V) as demonstrated by the linearity between their concentration-response curves (parallelism, $X^2 = 1.20$), while Silver perch responded differently to these species (parallelism, $X^2 = 0.10$). However, Sb(III) was more toxic to both fish species as indicated by the significant relative median potency values derived from the respective LC50s [0.08 and 0.06 Sb(III) and 12.20 and 16.60 Sb(V) for Australian bass and Silver perch, respectively]. The LR50s (total lethal Sb) of 77.68 and 26.63 mg kg⁻¹ dw were estimated for Sb(III), and 628.14 and 421.60 mg kg⁻¹ dw for Sb(V) exposure to Australian bass and Silver perch, respectively. Total Sb fish body residues showed strong dose-dependent bioconcentration factors (BCFs) for both Sb(III) and Sb(V) which increased with exposure, indicating that BCF might be an intrinsic property of Sb acute toxicity. No effects on whole-body Ca, K, Mg or Na were observed with exposure. This is the first time Sb toxicity has been examined using Australian native fish species and our predicted effect concentrations are lower than reported values for related standard indicator species. Thus, the effect data underpin the current knowledge that Sb risk assessment should depend on the toxicological profile of individual Sb species and suggest that sub-lethal exposure measuring specific tissue residues could help to better understand the toxicokinetic and toxicodynamic basis of Sb toxicity.

KEY WORDS

Sb(III); Sb(V); LC50; LR50; ion regulation; parallelism
A LABORATORY SIMULATION OF THE MIXING OF COAL MINE-AFFECTED WATER WITH FITZROY BASIN RIVER WATER

AUTHORS
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ABSTRACT
Coal mine-affected water (CMAW) releases contribute to the total wet season stream-flow in the Fitzroy River Basin. Using data from the QLD government ‘Fitzroy River’ website, the flow attributable to CMAW releases in the Mackenzie River sub-basin were calculated as 3.75% and 2.1% in the 2012-13 and 2013-14 wet seasons, respectively. This study used laboratory simulation to investigate the changes in copper (Cu) composition in river water when CMAW is released in the Mackenzie sub-basin.

CMAW was collected directly from a mine’s on-site holding dam. CMAW from this dam can be released into a Mackenzie River tributary when certain water quality and flow conditions are met. In April 2015 this tributary was dry, so river water was collected further downstream in the main trunk of the Mackenzie River.

Changes in water quality were monitored in eight different quantities of CMAW mixed with the river water (range = 0.2-10% CMAW). Electrical conductivity increased linearly with increasing % CMAW, whereas non-linear responses and possible chemical reaction (indicated by curve inflections) were observed for pH, TSS and alkalinity in the 0.4% and 2% mixtures.

Two 5L mixtures of 0.4% and 2% CMAW in river water were continually mixed at a constant speed for three days. Nine DGT samplers were placed in each mixture; temperature, EC and pH were monitored daily. A 30-mL aliquot for total dissolved Cu, a 50-mL aliquot for total alkalinity, and three DGT samplers, were removed from each mixture at three time points (24, 48 and 72 h). The suspended particulate matter (SPM) in the initial samples and final mixtures were collected and are being characterised.

Total dissolved Cu concentration in the mixtures was compared to the original waters (river water = 2.2 μg/L; CMAW = 0.97 μg/L). At t=0 h the 0.4% mixture had 1.7 μg/L of Cu, while the 2% mixture had 1.9 μg/L. After 24 h both mixtures had 2.1 μg/L. Cu concentration in the 0.4% mixture was 2.0 μg/L at 48 and 72 h. Cu concentration in the 2% mixture at t=48 h dropped to 1.6 μg/L. These changes over time may be significant for compliance monitoring during CMAW releases. Cu concentration in the SPM were: river water = 34 mg/kg, CMAW = 22 mg/kg, 0.4% CMAW = 34 mg/kg, and 2% CMAW = 30 mg/kg. Analyses of the DGT eluents are currently being verified.

It is noted that the composition of the original water samples could vary from day-to-day, site-to-site and mine-to-mine, depending on different climatic and operational conditions. Hence, it is recommended that this investigation be repeated numerous times, controlling different variables. The current method could be improved to more closely represent in-situ river mixing conditions.

Overall, the study provided a unique approach to determine the potential effects of releasing CMAW into the Fitzroy Basin river system. The preliminary findings were that Cu concentrations and other water quality parameters varied over the 72 hour mixing period. Cu concentrations were more variable in the 2% mixture. This indicates that the time of sampling and volume of release are important compliance monitoring considerations. This methodology could be applied or modified to study other toxicants of interest.

KEY WORDS
Metal toxicity and environmental chemistry; Coal mine-affected water releases; Fitzroy River Basin; Mixtures; Copper
THE AMELIORATIVE ABILITY OF AUSTRALIAN DISSOLVED ORGANIC CARBON TO REDUCE METAL TOXICITY IN FRESHWATER SYSTEMS

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ABSTRACT
Dissolved organic carbon (DOC) is a ubiquitous component in natural waters. It has been shown to play a significant role in the transport and fate of metals in freshwater systems due to its ability to bind and alter the speciation of metals, influencing their bioavailability. DOC is categorised as either allochthonous (terrestrially-derived) or autochthonous (water column-derived). Each aquatic system and surrounding catchment is distinct, contributing a unique combination of terrestrial- and water column-derived organic matter, and leading to variable amorphous DOC with complex and heterogeneous chemical compositions. This is significant as the ability of DOCS to bind metals has been shown to be very dependent on the source of the DOC. To date, there has been limited research to characterise DOC in Australian freshwater systems, information that is required if we are to include modifying factors in the development of national and local water quality guidelines for metals.

For the well-defined small compounds of DOC, i.e. amino acids and proteins, standard analytical methods can be used for characterisation. However, the majority of DOC is composed of highly heterogeneous humic substances that are functionally and operationally defined, requiring several isolation and analytical techniques, e.g. gas chromatography and electrophoretic methods, to be used in tandem to provide a comprehensive understanding of DOC. Given this, characterisation of DOC using standard analytical methods is extremely difficult and time consuming and therefore has limited applicability.

Measurement of optical properties, fluorescence and absorbance spectroscopy, of DOC has several advantages. It is a rapid technique that relies upon the ability of DOC to absorb light in the visible region due to the presence of aromatic functional groups. It provides information on key characteristics including their source, allochthonous versus autochthonous, aromaticity, molecular weight and the humic-like, fulvic-like and protein-like components. This has enabled better understanding of how DOC quality affects metal toxicity as these optical qualities have significant relationships with trends in toxicity.

Our study focuses on characterising DOC from Australian waters and examines how DOC quality affects metal complexation, speciation and toxicity to freshwater biota. This research will present an overview of the current literature, highlight gaps in our knowledge, and recommend strategies to address these gaps.

KEY WORDS
Dissolved organic matter, metals, humic substances, natural waters
TOXICITY OF NICKEL IN SEDIMENT TO TEMPERATE AND TROPICAL BIOTA

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ABSTRACT
Sediments from freshwater and estuarine-marine systems are often a significant reservoir for metal contamination resulting from anthropogenic activities. Major sources of contaminants range from diffuse urban runoff to point source inputs, such as those occurring from mining. The accumulation of nickel in sediments is of particular concern for tropical regions within the Asia-Pacific which are the dominant contributors to global nickel production (e.g. Philippines, Indonesia, Australia and New Caledonia), largely from extensive lateritic deposits. Currently no published nickel toxicity data exist for tropical benthic organism and limited data exist for temperate marine species relevant to the Asia-Pacific region. This creates uncertainty in terms of the risk that ongoing nickel mining may have on the organisms inhabiting sediments in the Asia-Pacific region. The aim of the current project is to improve our understanding of the role sediment geochemistry (e.g. particle size, organic carbon, acid-volatile sulphide, iron and manganese and carbonate content) plays in influencing nickel bioavailability and toxicity to tropical and temperate aquatic organisms. A major current limitation to this research is the absence of readily available tropical whole-sediment bioassays (acute or chronic). Therefore this project aims to develop a novel whole-sediment toxicity test protocol based on sublethal effects (e.g. growth, reproduction or behaviour) for a tropical benthic marine organism. The tropical burrowing whelk, Nassarius dorsatus is found in the Asia-Pacific region and has been selected for method development. This project will also apply established bioassays for Australian temperate marine amphipod and copepod species (Melita plumulosa and Nitocra spinipes) to generate sublethal effects data for nickel from sediment exposure. This research will provide much needed nickel toxicity data from sediment exposure for both temperate and tropical marine organisms to support the sustainable development of nickel mining in the Asia-Pacific region.

KEY WORDS
Nickel, sediment, tropical, marine, test development, bioavailability
NANO-RISK RESEARCH: TOXICITY OF MICRO POLLUTANTS

GRAPHENE NANOMATERIALS - FROM THE LABORATORY TO THE ENVIRONMENT – CHALLENGES, OPPORTUNITIES AND LIMITATIONS

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ABSTRACT
The value of the market for graphene nanomaterials (GNMs) for industrial and commercial use is predicted to reach $1.3 billion by 2023 (BBC Research, 2013). The extremely small size which gives novel properties to nanomaterials can be similar to that of important biological molecules, and there are scientific and community concerns over their potential environmental effects (Batley et al. 2012). The NMs can be emitted to the aquatic environment via the production line, transport, direct application (remediation) or through soils (landfills) (Boxall et al. 2007). In the environment, NMs (including GNMs) can undergo various physical and chemical transformations (Batley et al. 2012). Assessment and regulation of the environmental risks posed by GNMs is needed prior to widespread production and use, in order to avoid potential adverse environmental effects as has previously occurred for chemicals such as perfluorooctane sulfonate or polychlorinated biphenyls. A review of the scientific literature on ecotoxicology of GNMs identified important gaps in analytical methodologies and ecotoxicological testing protocols used to assess potential effects on aquatic biota. Assessment of any potential adverse effects on aquatic organisms is best assessed by use of species sensitivity distributions (SSDs). Herein, we present a preliminary SSD for the toxicity of GNMs to aquatic species. The results of this study will aid in developing an understanding the potential risks of GNMs in aquatic environments and contribute to derivation of future water quality guidelines for GNMs.

KEY WORDS
graphene, nanomaterial, ecotoxicology, water quality guideline
CELLULAR ACCUMULATION AND TOXICITY OF POLYSTYRENE PARTICLES IN OYSTERS, *CRASSOSTREA VIRGINICA*

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ABSTRACT
The global annual usage of plastics has increased dramatically over the last decade. Plastic polymers take on many forms with polystyrene being the fourth most common plastic material produced annually due to its many versatile applications. Consequently, there has been an increase in polystyrene wastes, much of which makes its way into waterways and oceanic habitats. While plastic debris has been shown to adversely affect many marine species as a result of ingestion and entanglement, little has been studied regarding the effects of micron- or nano-sized plastic particles on marine invertebrates. The potential for particle uptake and toxicity by hepatopancreas and gill cells of oysters, *Crassostrea virginica*, was investigated following *in vitro* and/or *in vivo* exposures to 10ppb, 50ppb, and 100ppb of either 50nm or 3um fluorescent polystyrene particles. Fluorescent microscopy techniques were used to evaluate the potential for intracellular particle accumulation. Microscopic analyses using epifluorescence indicated that both 50nm and 3um particles were present in both tissue types, but analyses using deconvolution microscopy revealed that the 50nm particles, but not the 3um particles, were intracellular. Toxicity analysis for cellular damage did not reveal any increases in lysosomal destabilization or lipid peroxidation as a result of exposure to the particles for these short term exposure times. This research demonstrates that oysters take up polystyrene particles from the water column and that particles in the nano size range can be internalized into hepatopancreas and gill cells.
CHANGES OF AQUEOUS TOXICITY OF SILVER SULFIDE NANOPARTICLES (AG2S-NPS) ENVIRONMENTAL TRANSFORMED FROM SILVER NANOPARTICLES (AGNPS)

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ABSTRACT
Silver nanoparticles (AgNPs) are among the most widely used engineered nanoparticles because of useful properties such as strong reactivity and antibacterial activity. But their strong toxicity has been demonstrated in several environmental species. Although AgNPs are the toxic materials, the researches have been mostly limited in the pristine forms. AgNPs are transformed to several forms in the environment, for example, silver sulfide nanoparticles (Ag2S-NPs) and silver chloride nanoparticle (AgCl-NPs). Ag2S-NPs are readily found in the environment and often observed in sewage sludge products, but their toxicity is poorly understood. In this study, PVP-coated AgNPs were transformed to Ag2S-NPs and sulfidation of AgNPs was verified using Transmission electronic microscopy and energy dispersive spectroscopy. Physicochemical properties of AgNPs and Ag2S-NPs such as hydrodynamic size, zeta potential and dissolved Ag ion were analysed. In particular, decrease of silver ion was observed in Ag2S-NPs compared to AgNPs. AgNPs and Ag2S-NPs were exposed to the several organisms including to larval zebrafish, water flea, alga and hydra and their aqueous toxicity changes were investigated.

KEY WORDS
Silver nanoparticles, silver sulfide nanoparticles, silver ion, aqueous toxicity
FATE, TRANSFORMATIONS AND TOXICITY OF NANOPARTICLES IN THE AQUATIC ENVIRONMENT

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ABSTRACT
There has been a proliferation of nanotechnology in recent times that has resulted in a multitude of nanoparticles being synthesised and functionalised. As the use of nanoparticles in nanomaterials increases there is an increased risk of them entering aquatic systems and exerting toxicity on the organisms therein. This study has involved a comprehensive review of current literature in an attempt to highlight the transformations, fate and toxic mechanisms of metal and metal-oxide nanoparticles in aquatic systems. One of the most important factors that influences metal nanoparticle behaviour and fate in aquatic systems is the types and concentrations of chemical constituents that comprise the aquatic matrix, which influence the nanoparticle bioavailability via processes such as dissolution, aggregation and sedimentation. Organism exposure to nanoparticles has been shown to result in a wide range of toxic responses in aquatic systems, including both direct ingestion and indirectly through adsorption to and physical damage to cell membranes, and generation of reactive oxygen species, which can disrupt cell membrane processes and cause oxidative damage. The toxicity of nanoparticles in aquatic systems can be mitigated or enhanced by a number of physico-chemical factors including pH, ionic strength, and the presence of chloride and dissolved organic carbon. Hence, there has been a significant effort by the research community to quantify the influence of nanoparticles on the toxicity of aquatic organisms. This study discusses the more important physico-chemical factors that have been reported for metal and metal oxide nanoparticles and identifies some of the knowledge gaps that currently impede nanoparticle regulation. Future research should consider nanoparticle exposure pathways in aquatic systems, including the use of natural waters and transformed or functionalised nanoparticles when performing ecotoxicological assessments of nanoparticles.

KEY WORDS
Physico-chemistry, sedimentation, ecotoxicity, aggregation, adsorption, dissolution
THE EFFECTS OF POLYDOTS ON CELLULAR HEALTH AND VIABILITY IN THE EASTERN OYSTER, CRASSOSTREA VIRGINICA.

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ABSTRACT
Polymer dynamic organic theranostic spheres (PolyDOTs) are currently being studied as a potential to be used in photothermal ablation treatment of cancer. If shown to be successful, these PolyDOTs could be mass-produced and it is expected that they, like any other engineered nanoparticle (ENP), will be found in the ambient environment. The specific PolyDOTs used in these studies are P3HT/BSe PolyDOTs and are activated to thermally ablate cancer cells by 808nm of near infrared light. The purpose of these studies is to investigate the potential toxicity of these types of hybrid nanoparticles to marine organisms. In order to investigate the potential of even greater toxicity (e.g. potentiation) due to solar exposure, which includes UV radiation, infrared radiation, and longer wavelengths of light, the PolyDOTs were exposed to the sun for 12 hours and effectively “charged”. Once charged, hepatopancreas and gill tissues from the eastern oyster (Crassostrea virginica) were exposed to various concentrations of both uncharged and charged PolyDOTs for 24 hours, and the effects of the PolyDOTs on lysosomal destabilization were analyzed using the Neutral Red assay, cell viability was analyzed using the MTT assay, and free radical damage was analyzed using the lipid peroxidation assay. Fluorescent deconvolution microscopy studies are being used to visualize particle uptake by oyster hepatopancreas cells. The lysosomal toxicity assays with in vitro hepatopancreas tissues exposed to PolyDOT particles showed that toxicity was potentiated when cells were exposed to charged particles compared to uncharged particles. The MTT toxicity assay showed that there were no statistically significant differences between the exposure groups when hepatopancreas tissues were exposed to charged or uncharged PolyDOTs. Preliminary data has provided evidence of increased toxicity in gill tissues based on the MTT assay. These types of studies are important for understanding the effects of ENPs on oysters, and for understanding the broader ecological impacts of ENPs on estuarine ecosystems.

KEY WORDS
PolyDOTs, nanoparticles, oysters, toxicity, hepatopancreas, and gill
TRANSFORMATION AND TOXICITY OF ZINC OXIDE NANOPARTICLES IN AQUEOUS SYSTEM: EFFECT OF NOM AND EPS

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ABSTRACT
ZnO nanoparticles (NPs) are a common type of ENMs and have been widely used in many applications. ZnO NPs have been affected a significant impact on the environment that have attributed their toxicity to both the NPs and the dissolved Zn ions. Influential factors of ZnO NPs are aqueous pH, ionic strength, nanoparticle size, natural organic matter (NOM) and extracellular polymeric substances (EPS). Above all, NOM and EPS have dominated transformation, fate and toxicity of ZnO NPs in aqueous environment. This study addresses the effects of both the transformation and toxicity of ZnO NPs in aqueous system by extending our work on transformation of ZnO NPs using organic matter to four additional NOM and EPS. The bare ZnO NPs powder (10-30 nm) were purchased from US Research Nanomaterials, Inc. Preparation of stock solution sonicated for probe ultra-sonication (pulse type, 30 min, 56 W) by ZnO 100 ppm and used within 2 hours. The size and surface charge were characterized by DLS (hydrodynamic diameter and zeta potential). Two of NOM isolates and two EPS were assessed, Suwannee River humic acid (HA), citric acid (CT), chitosan (CS), dextran (DT). The concentration of the NOM and EPS used in all experiments was 10 ppm as TOC. Toxicity test should be carried out after equilibrium of ZnO NPs during 24 hr and used Daphnia magna. In the presence HA, ZnO NPs decreased hydrodynamic diameter, zeta potential and dissolution for coating effect on the surface of ZnO NPs. In contrast to HA, effect of CT enhanced to dissolution of ZnO NPs. Effect of DT is negligible about transformation but observed to be coating. CS is no effect to transformation of ZnO NPs. The toxicity of transformed ZnO NPs in the presence NOM and EPS has inhibited than bare ZnO NPs. Because zinc ion dissolved ZnO NPs combined with NOM and EPS is complexation. Based on the overall results it can be concluded that free zinc ions played a key role in toxicity of ZnO NPs.

KEY WORDS
ZnO NPs, Transformation, toxicity, NOM, EPS
ECOTOXICITY OF BORON, BARIUM AND CRESOLS IN FRESHWATER: ADDRESSING DATA GAPS RELEVANT TO COAL SEAM GAS OPERATIONS

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ABSTRACT
Coal seam gas and other forms of unconventional gas are growth industries that present new challenges for managing environmental footprints, including impacts on water quality. There is a public perception that environmental harm may be caused by hydraulic fracturing chemicals and the disposal of contaminated produced waters (PW) that back-flow from wells. Produced waters are challenging to manage because they are saline, have a unique chemical composition dependent on the fracturing chemicals used and may contain contaminants of geogenic origin (including trace metals, radionuclides, hydrocarbons and phenols). In particular, determining the level of PW treatment required prior to disposal or reuse is problematic.

Comparison of contaminant concentrations to water quality guidelines (WQG) where they exist, indicates the potential risk to aquatic ecosystems; however, a lack of WQGs for elements such as barium and cresols (methylphenols), impedes the risk assessment for a wide range of contaminants present in PWs. Despite WQGs for boron in Australia and New Zealand (revised guideline of 0.95 mg/L) and Canada (1.5 mg/L) the toxicity of boron-based hydraulic fracturing chemicals including borax (sodium tetraborate), boric acid disodium salt and boric acid with 2-aminoethanol is lacking from environmental regulatory chemical assessments.

This study investigates the acute and chronic toxicity of boron, barium and cresols to sensitive freshwater biota including the microalga Chlorella sp., the cladoceran Ceriodaphnia dubia and the snail Physella acuta. The low solubility of barium influences the interpretation of toxicity to aquatic biota and requires consideration. The implications for site-specific water quality guidelines based on factors affecting the toxicity of barium and boron such as ionic composition, pH, hardness, solubility, precipitation and organic matter will also be presented.

KEY WORDS
Geogenic, hydraulic fracturing, guidelines, borax, barium, cresol, precipitate
**BIOREMEDIATING AGED PAH CONTAMINATED GASWORK SOIL USING COMPOSTING OF ORGANIC WASTE AMENDMENTS**

**AUTHORS**

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**ABSTRACT**

The efficacy of a range of organic waste amendments for the bioremediation of aged gaswork PAH contaminated soil through composting was investigated. Soil from an old gasworks site contaminated with PAHs (700 mg kg\(^{-1}\) total PAHs) was mixed at a 1:1 ratio with five different well matured manures; chicken, cattle, pig, sheep and horse manure, showing a range of different characteristics. An additional treatment of soil mixed with inorganic fertiliser was also prepared. Mixtures were kept at approximately 60% water holding capacity and aerated weekly under controlled conditions for 31 days. Total PAH concentration, C/N, pH, EC and the presence of microorganisms were assessed weekly. No significant PAH degradation was detected in any treatment. Total DNA extraction and PCR amplification of the 16S and 18S rRNA gene indicated that eukaryotic organisms were present in three treatments (cattle, sheep and pig manure) and prokaryotic organisms were present in two treatments (cattle and pig manure). Despite this, the treatments did not activate a microbial response as evidenced by any significant reduction in C/N ratios. A subsequent experiment using a mixture of soil, composted cattle manure (~14 weeks old) and wheat straw (2:1 and 4:1 mixture ratios) showed composting was evident via changes in C/N ratio, total compost mass and pH, however, still no significant degradation of total PAHs during 56 days of composting was observed. These experiments demonstrate the difficulties in applying bioremediation approaches to aged PAH contamination, with in particular the limitations imposed by PAH bioavailability. For these soils, more rigorous remediation strategies are required.

**KEY WORDS**

Mature manure amendment, compost bioremediation, polycyclic aromatic hydrocarbons, gasworks remediation
ARE HERBICIDES FROM SUGARCANE CROPS REACHING AND IMPACTING NEARBY MARINE TURTLE NESTS?

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ABSTRACT
The production of sugarcane is associated with the use of many different herbicides that can contaminate surrounding environments. Mon Repos, a major nesting beach for Australian marine turtles in Queensland, is adjacent to large sugarcane crops. A recent surface water quality survey detected many herbicides in a wetland located directly behind the nesting beach. This raised concerns that these chemicals could be reaching the nesting beach via surface or ground water and penetrating the nest environment of critically endangered marine turtles. This study investigated the potential and significance of this by analysing herbicides in sand at nest depth and nearby agricultural drains (using liquid chromatography-mass spectrometry), and measuring the toxicity of identified chemicals (and mixtures) on turtle cells. In total, 19 herbicides were identified, including 2,4-D, imazapic, metolachlor, ametryn, picloram, atrazine, isoxaflutole, diuron, metribuzin, fluroxypyr, imazethapyr, hexazinone, clopyralid, simazine, prometryn, triclopyr, propazine, tebuthiuron, and MCPA. In order to investigate the total combined effect of herbicides within each extract, imaging pulse amplitude modulation (IPAM) was used to measure the inhibition of photosynthesis in algae. Additionally, the toxicity of extracts and individual herbicides was tested on loggerhead turtle cells in vitro, in order to assess the significance of herbicide contamination on these threatened animals. Overall, the findings of this study indicated the potential impact of sugarcane crops on the health of Mon Repos turtle hatchlings. This can inform any management action necessary to protect turtles from exposure to herbicides.

KEY WORDS
Herbicides, cytotoxicity, marine turtles
RISK ASSESSMENT, ECOTOXICOLOGY AND REMEDIATION IN EXTREME ENVIRONMENTS

DEVELOPMENT OF BIOLOGICAL ACTIVATED CARBON COLUMNS FOR THE BIOREMEDIATION OF PETROLEUM CONTAMINATED WATER IN ANTARCTICA

AUTHORS

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ABSTRACT

During the 2015/16 summer season at Casey Station, Antarctica, a key activity in the response to a recent fuel spill was management of contaminated meltwater. Over 150,000 L of contaminated water was produced from meltwater during the initial clean up – a major volume for a remote location. In order to treat this water, activated carbon columns in a portable water treatment plant were used to adsorb the petroleum hydrocarbons from the migrating water streams. Over 4 m³ of granular activated carbon (GAC) were used at significant financial cost. In order to reduce the cost of treating hydrocarbon contaminated water, work is being performed to develop Biological Activated Carbon (BAC) to replace the GAC. This technology, adapted from municipal wastewater plants, uses the adsorptive properties of GAC to retain the mobile and recalcitrant components of petroleum hydrocarbons. Using this longer retention time and the incorporation of high-load, low-load cycling, indigenous Antarctic microbes inoculated into the column will be able to degrade the recalcitrant compounds and regenerate the activated carbon. This will have the benefit of extending the life activated carbon, while also reducing material costs.

Some limitations exist, however, in the development of BAC filters. Successful microbial attachment, proliferation and biofilm formation on the carbon particles is critical in developing a steady state operation. The adsorption/desorption profiles of different contaminants on activated carbon will also affect performance, dictating the bioavailability of the contaminants for successful bio-regeneration of the particles. The characteristics of different activated carbons will impact these processes, requiring the screening of different materials.

Here we present the performance of the contaminated water treatment plant during the 2015/16 season and show results from adsorption/desorption experiments on different carbons. We also develop a technique for culturing a hydrocarbon degrading community and inoculating the columns, to significantly accelerate the formation of BAC given the limited time frame during the summer melt season.

KEY WORDS

Remediation, bioremediation, biological activated carbon
DEVELOPMENT OF CONTAMINANT REMOVAL MATERIALS SUITABLE FOR IMPLEMENTATION IN COLD REGIONS

AUTHORS
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ABSTRACT
Contamination and challenging environmental conditions in remote locations such as Antarctica makes it necessary to develop innovative and fit for purpose technologies. One technology that has been widely applied is permeable reactive barriers. This technology relies on contaminant sorption materials that not only remove the contaminant from the aqueous phase, but also enables it to be degraded in-situ. Commercially available adsorbents do exist, but it has been found that these do not allow the contaminant to be microbial available in Antarctic conditions. Therefore, this project develops a new material based on the modification of zeolite.

Among existing methods, chlorosilane modification was selected as it can be attached to the zeolite surface via a stable covalent bond, which greatly enhances the hydrocarbon sorption behaviour compared with unamended zeolite. The Diphenoldechlorosilane (DPDSCI), which is attached to the zeolite surface in this study, has affinity to absorb hydrocarbons. Tests of DPDSCI modified zeolite included characterization (FT-IR; TGA), adsorption batch study and column tests (under 4°C and 20°C). Results from characterization studies showed the modification successful whilst data from batch study presented good toluene adsorption performance even under cold temperatures. The results from column tests indicated the material was stable and removed toluene from the mobile phase as well as possessing good regenerated ability. The performance of batch study and column tests would have significant implications for PRB design to treat contaminated water in cold regions.

KEY WORDS
PRBs, hydrocarbon sorption, modified zeolite
SUSTAINABLE WASTE MANAGEMENT AND HUMAN HEALTH ISSUES

CADMIUM AND ARSENIC IN SRI LANKAN FARM SOILS: AN ANALYSIS OF SOURCES, CHEMISTRY, THREATS AND BEST AVAILABLE TECHNIQUES FOR REMEDIATION

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ABSTRACT
Overuse of fertilizer and agrochemicals, combined with a suite of little controlled industrial activities, have resulted in metal (loid) contamination of cropland soils in many parts of the world with often serious impacts on human health and the environment. Here we review the situation in the North Central Province (the Dry Zone) of Sri Lanka which has one of the world’s highest incidents of chronic kidney disease (CKD). This is assumed to be induced by exposure to Cd and As with more than 20,000 reported related deaths. Pesticides and fertilizer used extensively in rice farming have been attributed as the most likely sources of the elevated As and Cd in groundwater and soils. The bedrock geochemistry is little understood and little systematic investigation of biogeochemical cycling and food chain transfers have been reported. Rice is the major dietary source of As and Cd in the Sri Lankan population and As and Cd in locally grown rice have been reported at 90-260 µg/kg and 10.0-92.5 µg /kg (on dry weight basis) respectively. The labile As in soils in the Dry Zone is generally high due to relatively high soil pH, salinity, and low Fe and Al. Cadmium is retained in soil by exchange reactions but in the presence of strong competitive cations such as Ca2+, which is more prevalent in the Dry Zone soils, Cd is weakly sorbed. In addition, with the varying water levels of the reservoirs during drier periods reducing conditions can change Cd solubility. There has been ongoing development of a variety of technologies to reduce the risk from the contaminated soils, but the co-contamination by Cd and As is a particular challenge for remediation. Many technologies currently available are prohibitively expensive and time-consuming but the use of biochar, compost and iron-rich materials appears to be promising.

KEY WORDS
CKD, Metals(loid)s toxicity, As and Cd Co- contaminated soils, Remediation measures
TERRESTRIAL ECOTOXICOLOGY

REMEDIAION OF PYRENE-CONTAMINATED SOILS USING BIOCATALYTIC REACTIONS WITH HEMOGLOBIN AND HYDROGEN PEROXIDE

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ABSTRACT
Waste railroad treated with creosote is contains Polycyclic aromatic hydrocarbons (PAHs) which is a carcinogen regulated by the appropriate regulating agencies in many nations, including the USA and Korea. Biocatalytic reaction catalyzed by hemoglobin can be effective at remediating pyrene-contaminated soils. This study was set to the effect of hydrogen peroxide and hemoglobin concentrations on biocatalytic degradation of pyrene using 0.01 g Hb/g soil and 0.03 g H₂O₂/g soil. Soil samples and the reactants were mixed in glass vials and the treatment proceeded for 24 hours. After 24 hours, soil samples were extracted using n-hexane and analyzed for pyrene concentrations using High performance Liquid Chromatograph (HPLC), injected into a Younglin YL9100 HPLC (Younglin Co., Ltd., Korea). The concentration of pyrene was decreased by biocatalytic reaction from 9.35(0.1) to 4.92(0.23) mg kg⁻¹. Reducing toxic effect of the pyrene-contaminated soils is as important as reducing the pyrene concentration in soils. Since the biocatalytic reaction could remove almost 50% amount of pyrene from soils, the changes in the toxic effects were determined after treatment. The toxic effects of the soil sample were evaluated in a Microtox® 500 analyzer (SDI). The EC50 value, the effective concentration of pyrene exhibiting 50% reduction in bioluminescence of V. fischeri, similarly by approximately from 45.78(8.89) to 42.1(0.96) g L⁻¹ after treatment. The toxic effects were compared with the toxic effects of the only H₂O₂ treatment soils, the EC50 value decreased by approximately 2 times lower after treatment 23.22(3.63) g L⁻¹. Pyrene concentration was similarly decreased by only H₂O₂ treatment. This study showed that biocatalytic reaction could pyrene removal in pyrene-contaminated soils. The pyrene removal by biocatalytic reaction also led to a reduced toxic effect.

This study was supported by the Korea Basic Science Institute (KBSI).

KEY WORDS
Biocatalytic reaction, Hemoglobin, Pyrene, Remediation, Toxicity
TOXICITY OF MIXTURES AND MULTIPLE STRESSORS

THE EFFECTS OF INCREASING TEMPERATURE AND SALINITY ON FRESHWATER GASTROPOD (*ISIDORELLA NEWCOMBI*): PLASTICITY IN RELATION TO CLIMATE CHANGE

AUTHORS

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ABSTRACT

Global Climate Change (GCC) is driving rapid changes in atmospheric temperature and freshwater salinity concentrations. Freshwater ecosystems are particularly vulnerable to GCC because of anthropogenic alterations, increasing demand, higher evapotranspiration rates, and inundation by rising sea levels. It is necessary to establish biomarkers to improve monitoring and management of freshwater ecosystems because they are valuable natural resource. Organisms are rarely exposed to just one source of environmental stress. Stressors commonly act on populations simultaneously, creating complex interactions with unexpected outcomes.

There is a lack of knowledge regarding the compounding or synergistic effects of changing salinity concentrations and other stressors such as temperature on freshwater organisms. An organism’s response to stress may be costly to its overall fitness and may produce a variety of measurable adverse effects. Increased temperature and changing salinity levels caused by GCC are expected to interact, decreasing freshwater species abundance and changing distributions.

Here we performed laboratory experiments on Australian native freshwater snail, *Isidorella newcombi* at different salinity and temperature treatment levels. The snail is abundant and widely distributed, making it a candidate to be used as a model species for exploring biotic responses to heat and salinity stress. To enable robust conclusions of the effects of climate related stressors on organisms a combination of assessment methods were used. Organism responses to stressors are rarely unilateral and evidence occurs at different biological levels. This study encompassed assays at a cellular and molecular level as well as mortality and fecundity observations. Measurements at organism level such as mortality when combined with cellular measures such as lysosomal membrane stability assays enabled strong conclusions to be drawn. Both mortality of snails and lysosomal membrane instability increased at higher temperature and salinity regimes. Our study revealed that the synergistic effects of temperature and freshwater salinity increases associated with GCC are likely to have increasingly adverse effects on the health of freshwater gastropods.

KEY WORDS

Global Climate Change, Multiple Stressors, Lysosomal Membrane Stability, Freshwater, Gastropod
TRANSPORT, FATE AND EXPOSURE MODELLING OF CHEMICALS

THE EFFECTS DIFFERENT ARSENIC SPECIES HAS ON RICE IN RELATION TO STRAIGHTHEAD

AUTHORS
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ABSTRACT
Straighthead is a physiological disorder in rice that results in sterile florets and poorly developed panicles leading to the head of the rice plant remaining upright when it reaches maturity. Extreme cases of straighthead can even result in the panicles and heads not forming resulting in a dramatic reduction in yield. In Australia alone this results production in losses of over $1 million per year. The exact cause of straighthead disorder is unknown, however, studies have revealed a strong correlation between the disease and elevated levels of arsenic within the plant and soil. It is still unclear how arsenic induces straighthead disease in rice.

The aim of this project is to shed light on arsenic and its role in straighthead disease. To improve our knowledge of the uptake and metabolism of different arsenic species, and the effect individual species has on the rice plants nutrient uptake, we grew rice hydroponically exposing plants to different concentrations and species of arsenic. The hydroponic set-up allowed maximum control over the species of arsenic being exposed to the rice, as well as giving us the ability to monitor the uptake of a range of nutrients by the plant. Preliminary results indicate that dimethyl-arsenic influences phosphate and silicon uptake by plants.

KEY WORDS
Rice, Arsenic, dimethyl-arsenic, Straighthead
WATER QUALITY GUIDELINES AND STATISTICAL METHODS

THE RELATIVE SENSITIVITY OF FRESHWATER SPECIES TO ANTIMONY: IMPLICATIONS ON WATER QUALITY GUIDELINES AND ECOLOGICAL RISK ASSESSMENT

AUTHORS
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ABSTRACT
Antimony (Sb) is listed as a priority pollutant in many jurisdictions because of its potential environmental and health concerns, yet its threat to aquatic biota is currently unclear. To date, due to data paucity, water quality guidelines (WQGs) for Sb are not well established and large uncertainty factors are commonly applied in derivation, which hinders robust ecological risk assessment (ERA). In this study, freshwater species sensitivity distributions (SSDs) for Sb(III) were constructed using available acute toxicity data generated from global and temperate regions. A tiered ERA approach, hazard quotients (HQs), was also applied for characterisation of risks of Sb concentrations in the freshwater environment. Since there were insufficient toxicity data of Sb(V) for SSDs’ constructions, the data of Sb(III) for an array of taxonomic groups were collected and used for SSDs’ constructions; 5% hazardous concentrations (HC5; 95 % of species being protected) were subsequently derived as threshold toxicity levels. For each SSD, multiple parametric and nonparametric fitting models were employed and compared; and the best fit one was determined and used for HC5 and its corresponding predicted no effect concentration (PNEC) derivations. The HC5 values for global and temperate SSDs were estimated as 781 and 976 µg L⁻¹ Sb(III), respectively, while the PNECs for the both datasets were 156 and 195 µg L⁻¹ Sb(III), respectively. Using a previous recommended temperate-to-tropic extrapolation factor of 10 for freshwater ecosystems, an interim PNEC for the tropics was estimated as 20 µg L⁻¹ Sb(III). While data for Sb(III) concentrations in natural waters are limited, the potential ecological risks posed by Sb(III) occurring in segments of Gediz River in Turkey and northern part of Pearl River in China would be classified in high and medium risk categories, respectively. Low ecological risks of Sb(III) were characterised (~90.5%) for some countries including USA, Japan, Poland, Spain, China, Germany, Bulgaria, Slovakia, Macedonia and Brazil. The ability to accurately derive WQGs and conduct ERAs may be limited, however, the results presented in this study facilitate and help illustrate the toxic effects of Sb(III) to freshwater species and their communities. In the future, more toxicity data need to be generated, especially for the tropics and also for Sb(V), in order to fill in data gaps and increase the certainties of the current results.

KEYWORDS
Antimony (SbIII), Freshwater ecosystem, Species sensitivity distributions (SSDs), Water quality guidelines (WQGs), Ecological risk assessment (ERA), Aquatic ecotoxicology
USING THE SEASIM FACILITY FOR ECOTOXICOLOGY – TESTING THE EFFECTS OF NI AND CU ON THE ADULT HARD CORAL ACROPORA MURICATA

AUTHORS
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ABSTRACT
Ecotoxicology using adult corals is challenging due to the highly sensitive nature of corals to water quality change. We used facilities at the National Sea Simulator (SeaSim) located at the Australian Institute of Marine Science, Townsville to set up flow through experiments to test the effects of nickel and copper on coral and associated microbiota.

Acropora muricata corals were collected from Trunk Reef (18° 18' 173'S 146° 52' 153'E) by SeaSim staff on the 7th June 2016. On board the boat and immediately after collection, fragments approximately 5-8cm were fixed to prefabricated aragonite plugs using superglue Xtra (Loctite Pty. Ltd) and placed in grow out trays. After six weeks acclimation in aquarium conditions at the SeaSim facility skeletal growth over the plugs was observed.

Experiments were set up in controlled lighting and under flow through (~2.8mL per min) conditions in 2.5 L experimental chambers on the 14th July 2016. The flow rate was set to create ~80-90% water exchange every 12 hours. The SeasSim chamber design included a magnetic stirrer and stirring mechanism to create water movement in the chamber to optimise coral health. Four replicate containers were used for each of the following doses; control, 50, 100, 500, 1000 µg/L Ni and 5, 20, 50, 100 µg/L Cu. Each chamber contained 3 coral fragments each for different analytical purposes (DNA/RNA analysis, metal analysis using ITRAX /Lazer ablation ICPMS, and for tissue extraction and digestion for ICPMS analysis). After 96 hours exposure coral fragments were collected and appropriately prepared and preserved for the various analysis.

Control treatments remained healthy throughout the duration of the experiment. After 36 h exposure, bleaching was observed in corals exposed to 50 and 100 µg Cu/L and 10000 µg Ni/L. At 96 h significant discoloration was observed in nickel treatments 500 and 1000 µg Ni/L. The poster will present new results from the latest analysis of this study.

KEY WORDS
SeaSim facility, coral, nickel, copper, tropical ecotoxicology
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CENTRE FOR AQUATIC POLLUTION IDENTIFICATION AND MANAGEMENT (CAPIM)

The Centre for Aquatic Pollution Identification and Management (CAPIM) is an interdisciplinary research organisation dedicated to the identification of water pollution, the assessment of its ecological impact and the development of cost-effective monitoring systems. CAPIM’s research informs waterway management policies and practices to achieve improved waterway health, greater biodiversity, and environmental and industrial sustainability.

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The National Institute of Water and Atmospheric Research (NIWA) is New Zealand’s leading provider of atmospheric, freshwater and marine research and applied science services. Our vision is “to enhance the benefits of New Zealand’s natural resources”. We undertake targeted research that helps New Zealanders benefit from the rich bounty of our natural environments, without compromising their profound ecological, recreational, cultural and spiritual value. We are a Crown Research Institute (CRI) and receive core funding from the Government to undertake research for the long-term benefit of all New Zealanders. We also make our science services available on a commercial footing to businesses that can benefit from our expertise, databases and facilities. We serve clients in many sectors, including pastoral farming, forestry, horticulture, transport, energy, marine fisheries and aquaculture.

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The Australian Institute of Nuclear Science and Engineering (AINSE) is an integral organisation for enhancing Australia’s capability in nuclear science and engineering by facilitating world-class research and education. AINSE offers a range of programs and services to its members including generous conference support, inspiring symposiums, Honours / Postgraduate scholarships and intensive education schools. These benefits aim to foster scientific advancement and promote an effective collaboration between AINSE members and ANSTO.
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The University of Newcastle is known nationally and internationally for delivering excellence in education, research and innovation – ranking in the top 3% of universities in the world. In partnership with government and industry we produce a strong performance in research and innovation on some of the world’s most complex challenges including health, energy and science. Our multi-disciplinary approach is supported by our flagship research institutes, the Hunter Medical Research Institute and the Newcastle Institute for Energy and Resources.

AUSTRALIAN ANTARCTIC DIVISION

Our Vision: Antarctica: valued, protected and understood.

The Australian Antarctic Division, based in Hobart, Tasmania, is a Division of the Australian Government’s Department of the Environment and Energy.

The Division is responsible for the advancement of Australia’s strategic, scientific, environmental and economic interests in the Antarctic by protecting, administering and researching the region.

We do this by leading, coordinating and delivering the Australian Antarctic Program – a program that reflects our strong national connection to Antarctica and our national Antarctic interests.

The Australian Antarctic Program is focused on conducting world-class science of critical national importance and global significance that delivers on Australian Antarctic policy and operational priorities.

This includes managing Australia’s presence and administering the Australian Antarctic Territory and the Southern Ocean, and the subantarctic Territory of Heard Island and McDonald Islands (HIMI) and their adjacent waters.

The Australian Antarctic Program utilises combined sea, air and continental transport capabilities to undertake wide-ranging marine, ice and aviation-based research activities, personnel transfer, station operation and resupply, and waste management and removal. Australia maintains three research stations on the Antarctic continent – Mawson, Davis, and Casey – and a subantarctic station on Macquarie Island.

All research stations are operated year round, but with minimal staff over the harsh winter months. The program relies on a cohesive workforce of Antarctic expeditioners supported by office based staff experienced in Antarctic policy, law, operations, medicine and science.

Australia also works closely with other countries’ Antarctic programs to operate cooperatively on the ice and at sea. The work undertaken by the Australian Antarctic Program enables Australia to maximise its influence in the Antarctic Treaty system.
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**ENVIRONMENT PROTECTION AUTHORITY**
EPA Tasmania’s vision is for a clean, healthy and sustainable environment. Our purpose is to protect and enhance the quality of the Tasmanian environment, balancing economic and social values, and the needs of future generations. Our activities focus on the assessment and regulation of large industrial developments, and the monitoring, analysis and reporting of environmental performance. Our work is based on sound scientific and evidence-based principles and we are committed to using the best available scientific and technological practice to monitor, analyse and report trends in environmental quality.

www.epa.tas.gov.au
THE ROYAL AUSTRALIAN CHEMICAL INSTITUTE

The Royal Australian Chemical Institute is a membership organisation for professionals working in the chemical science environment. It acts both as the qualifying body in Australia for professional chemists, and as a learned society promoting the chemical sciences and practice of chemistry. The organisation is 100 years old in 2017 and is celebrating the event by running a congress of conferences where 8 international chemical science related conferences are running side by side with the RACI’s national centenary conference where a single delegate fee allows access to all.

TECO MEDICAL GROUP

Swiss-based TECOmedical Group with subsidiaries in Germany, France and Benelux, is a leading provider of in-vitro specialty test systems in the areas of medical and veterinary diagnostic, biosafety and environmental testing. In addition TECOmedical develops and manufactures specialty biomarkers. In environmental testing, Vitellogenin is one of the core endpoints in screening and testing for endocrine disrupting chemicals. Our company provides Vitellogenin ELISA tests for estrogenic activity in fish, standardized to OECD Guidelines.

www.RACIcongress.com

www.tecomedical.com/en/ecotoxicology
HOTEL GRAND CHANCELLOR FLOOR LAYOUT
Image courtesy of Hotel Grand Chancellor
The Centre for Aquatic Pollution Identification and Management aims to identify and address the ecological impacts of pollution in water environments.

CAPIM is dedicated to the identification of water pollution, the assessment of its ecological impacts, the sourcing of pollutants and the development of cost-effective monitoring systems.

Based on a weight-of-evidence approach, our research informs water management policies and practices to achieve improved waterway health, greater biodiversity, and environmental and industrial sustainability.

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NIWA offers standard toxicity tests for freshwater and marine environments that are based on established, internationally recognised protocols. NIWA also carries out specialised projects to address environmental concerns and provide in-depth solutions.

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- resource consent compliance
- ecological risk assessment
- laboratory and field testing
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- contaminant bioavailability
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- ANZECC Guidelines
- product registration with EPA
- assessment of environmental effects (AEE)
- whole effluent toxicity testing (WETT)
- in-situ biomonitoring
- water, sediment and elutriate testing
- habitat preference surveys
- design/implementation of monitoring programmes
- pesticides/piscicides
- restoration and rehabilitation of aquatic organisms
- biomarkers – genetic integrity, stress proteins and enzymes
- stormwater/oil spill/mine leachate/dredge spoil toxicity

For more information visit: www.niwa.co.nz/our-science/freshwater/our-services/specialist-analytical-services/ecotoxicology-services or phone: 07 856 7026
National Institute of Water & Atmospheric Research Ltd, PO Box 11115, Hamilton, New Zealand.