Wildlife Health Australia

# Australian marine mammals and biotoxins

# Fact sheet

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## Introductory statement

Marine biotoxins produced by harmful algal blooms are a significant and growing global threat to the health of humans and other mammals, including marine mammal species (Bossart 2011). Biotoxins have been associated with mass morbidity and mortality in numerous cetacean and pinniped species (Reyero et al. 1999; de la Riva et al. 2009; Fire et al. 2011; Broadwater et al. 2018). Biotoxins are the third leading cause of wildlife mass mortalities globally (Fey et al. 2015). Conservation management of Australian marine mammals requires knowledge as to whether biotoxins are a cause of morbidity and mortality in these species. Marine mammals may act as sentinel species for biotoxins of possible human health concern. Fluctuations in the incidence of marine mammals affected by biotoxins can indicate changes in marine ecosystem relationships and can be used as a measure of ecosystem health. See Broadwater et al. (2018) for a comprehensive global review of this topic.

## Aetiology

The range of biotoxins produced by harmful algal blooms (HABs) is extensive (Landsberg 2002; Broadwater et al. 2018). About 200 species of microalgae are known or suspected to have the potential to produce biotoxins harmful to aquatic organisms. Some of the biotoxins of potential significance to marine mammal health and the microalgae that are known to produce them are:

- Brevetoxins (dinoflagellate *Karenia brevis*)
- Saxitoxins (dinoflagellates *Gymnodinium catenatum, Pyrodinium bahamense*, and *Alexandrium minutum*)
- Okadaic acid (dinoflagellates of *Prorocentrum* and *Dinophysis* spp.)
- Domoic acid (diatoms of *Pseudo-nitzschia* spp.)
- Microcystins (*Cyanobacteria* spp.)

## Natural hosts

Biotoxins have the potential to be harmful to marine invertebrates, fish, reptiles, birds and mammals. Species susceptibility to biotoxins is known to vary at higher taxonomic levels but would not be expected to vary between marine mammal species. Variation in the incidence of toxicity is believed to relate to exposure which is influenced spatially and by foraging patterns (Bargu et al. 2010).

## World distribution

Microalgae are ubiquitous in the marine environment but the distribution of individual species (including those known to potentially produce biotoxins) is influenced by factors including sea temperature, nutrient availability, salinity, currents and anthropogenic influences. Mortality events of aquatic animals due to biotoxins have been recognised world-wide. However, investigations of marine mammal morbidity and mortality events have generally only recently included analysis for biotoxins. Most reports of biotoxicity in marine mammals are from the Northern Hemisphere. Biotoxicity was suspected in a mass mortality of over 800 common dolphins (*Delphinus capensis*) in Peru. A study of South American pinnipeds in Peru found evidence of exposure to saitoxins, okadaic acid and domoic acid (Fire et al. 2017)

## Occurrences in Australia

Okadaic acid and microcystin-producing marine microalgae are known to be present in Australian waters (Arthur et al. 2006; Takahashi et al. 2008). No instances of morbidity or mortality associated with biotoxins have been reported for Australian marine mammals, although there is a hypothesis that domoic acid toxicity may contribute to cetacean mass stranding events in Tasmanian waters (Nash et al. 2017; Blyde 2019).

## Epidemiology

Marine mammals are typically exposed to harmful concentrations of toxic algae when environmental conditions favour `blooming' whereby the algal species dominate the food web. Filter feeders and planktivorous fish take up toxic algal cells directly from the water column and many retain the toxins in their viscera. Marine mammals that feed on fish or invertebrates become intoxicated when consuming prey species. Herbivorous marine mammals ingest algae present on the surface of their preferred food plants. Some species of algae release toxin into the surrounding water which may be concentrated by filter feeders. Biotoxins consumed at lower trophic levels may become transformed by their hosts into compounds of increased toxicity to higher trophic levels (Landsberg 2002). It is apparent then that a combination of fluctuating environmental factors and foraging strategies will determine the likelihood of exposure of marine mammals to biotoxins (Bargu et al. 2010).

## Diagnosis

Diagnosis requires demonstration of biotoxins in gastric and intestinal contents and/or tissues at concentrations known to be significant in other mammalian species

## Differential diagnoses

Other causes of sudden death in large numbers of marine mammals include acute viral (e.g. morbilliviruses, influenza viruses) and bacterial (e.g. *Campylobacter* spp.) infections. Of interest is the potential for chronic

low level exposure to biotoxins to influence cognition and immune function in affected animals. Therefore, investigations of stranding events and ill-health in marine mammals should include consideration of biotoxin analysis.

## Clinical signs and pathology associated with biotoxins in marine mammals

| Biotoxin | Clinical Signs | Pathology | References |
|---|---|---|---|
| Domoic acid | Seizures, disruption of cognitive process, abortion, sudden death | Hippocampal vacuolation, neuronal necrosis, ophthalmitis, myocardial necrosis placental necrosis, foetal brain oedema | Silvagni et al. (2005); Ramsdell and Zabka (2008); Nash et al. (2017) |
| Brevetoxins | Sudden death. Immune dysfunction? | Severe, multi-organ congestion, pulmonary oedema &haemorrhage, meningitis | Landsberg (2002); Fire et al. (2008) |
| Saxitoxins | Sudden death. Prior to death incoordination, paralysis | Pulmonary congestion and oedema | Reyero et al. (1999); Landsberg (2002) |
| Microcystins | Sudden death | Hepatic necrosis and haemorrhage | Landsberg (2002); Miller et al. (2010) |
| Okadaic acid | Sudden death? | None reported for marine mammals | Landsberg (2002); Fire et al. (2011) |

## Laboratory diagnostic specimens

- Tissue samples (liver, brain, lung, kidney) frozen
- Gastric contents frozen
- Intestinal contents frozen

## Laboratory procedures

- Mass spectrometry coupled with liquid chromatography (domoic and okadaic acid, microcystins, saxitoxins)
- Radioimmune assay (brevetoxins)
- Enzyme-linked assay (brevetoxins)

## Surveillance and management

Wildlife disease surveillance in Australia is coordinated by Wildlife Health Australia. The National Wildlife Health Information System (eWHIS) captures information from a variety of sources including Australian government agencies, zoo and wildlife parks, wildlife carers, universities and members of the public. Coordinators in each of Australia's States and Territories report monthly on significant wildlife cases identified in their jurisdictions. NOTE: access to information contained within the National Wildlife Health Information System dataset is by application. See the WHA website for more information: www.wildlifehealthaustralia.com.au/ProgramsProjects/eWHISWildlifeHealthInformationSystem.aspx#requests

There are no reports of biotoxicosis in Australian marine mammals in the national wildlife health information system eWHIS.

## Research

The potential role of biotoxins in Australian marine mammal morbidity and mortality is unknown. Investigations into marine mammal mortality events including cetacean strandings, should include the collection of samples suitable for biotoxin investigation.

## Human health implications

There are no public health risks from by marine mammals in regards to biotoxins unless tissues from intoxicated animals are consumed. However, in the event that algal blooms harmful to marine mammals are identified in Australian waters, public health authorities may have interest in the incidence of such intoxications given harvesting of wild fish and invertebrates for human food is still common.

## Conclusions

Biotoxins are known to have the potential to adversely affect health of marine mammals. There is little information on the possible impact of biotoxins on the health of Australian marine mammals. Investigations into marine mammal mortality events should include the collection of samples suitable for biotoxin analysis.

## References and other information

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## To provide feedback on this fact sheet

We are interested in hearing from anyone with information on this condition in Australia, including laboratory reports, historical datasets or survey results that could be added to the National Wildlife Health Information System. If you can help, please contact us at admin@wildlifehealthaustralia.com.au.

Wildlife Health Australia would be very grateful for any feedback on this fact sheet. Please provide detailed comments or suggestions to admin@wildlifehealthaustralia.com.au. We would also like to hear from you if you have a particular area of expertise and would like to produce a fact sheet (or sheets) for the network (or update current sheets). A small amount of funding is available to facilitate this.

## Disclaimer

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