

# Toxic *Alexandrium minutum* in the Swan Canning Estuary: control, toxins and management implications

DBCA collaborative partnership with Murdoch University, Dept of Health and Dept of Primary Industries Resources and Development.

Summary by: Dr Cherono Sheilah Kwambai and Dr Jeff Cosgrove

Contacts: jeff.cosgrove@dbca.wa.gov.au; s.kwambai@murdoch.edu.au; rescience@dbca.wa.gov.au

## Background

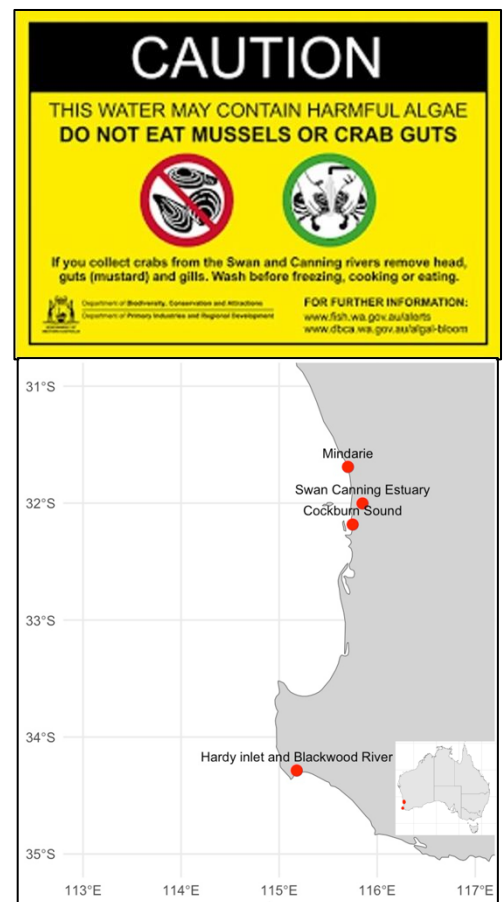
In Western Australia, blooms of the harmful alga, *Alexandrium* spp., have increased in both frequency and severity over the past decade. *Alexandrium* produces paralytic shellfish toxins (PSTs) that bioaccumulate through the food web, contaminating shellfish, crustaceans, fish, and seabirds<sup>1</sup>. Human consumption of contaminated seafood can cause paralytic shellfish poisoning, a potentially fatal illness, even when algal cell concentrations are low.

Algal blooms can also have significant economic, ecological, and socioeconomic implications. In Western Australia, two major blooms occurred in the Swan Canning Estuary in 2019–20, causing disruption to both recreational and commercial fisheries. At the peak of these events, saxitoxin levels in blue swimmer crabs (*Portunus armatus*) reached levels of 1700 µg/kg, and 8800 µg/kg in mussels (*Mytilus galloprovincialis*)<sup>2,3</sup>, exceeding the regulatory guideline of 800 µg of saxitoxin per kg for paralytic shellfish toxins in bivalves. While there have been several *Alexandrium* spp. detections in Western Australia (Figure 1). The Swan Canning bloom events highlighted the urgent need to develop rapid monitoring approaches for fishery risk assessment and reliable control strategies.

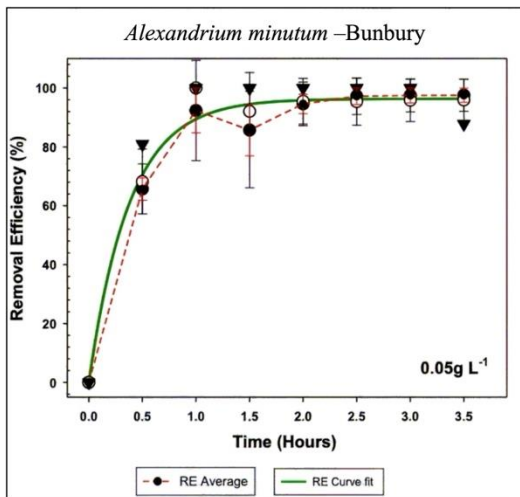
To address these issues, research<sup>4</sup> was undertaken with four main objectives: (1) Trial modified clays to remove *Alexandrium* from the environment; (2) Apply molecular tools to genetically identify and determine the toxicity of a local *Alexandrium* spp. strain; (3) Evaluate a modified liquid chromatography / mass spectrometry method (HILIC-MS/MS) to measure toxins in crabs; and (4) Examine the effect of freezing, thawing and boiling crabs on paralytic shellfish toxins quantity and distribution in blue swimmer crab tissue and cooking broth.

## Findings

Small scale controlled experiments applying very low concentrations of kaolinite clay modified with poly-alum-chloride (KPAC) to *Alexandrium minutum* cultures achieved up to 100% algal removal within two hours (Figure 2). In contrast, treatments using natural kaolinite clay only reached a maximum of 85% algal removal over a longer period. Furthermore, the ability of natural kaolinite clay to remove algae declined after the initial peak, occasionally failing to remove any *Alexandrium* cells over time. High algal cell removal



**Figure 1:** Warning signs applied during Swan Canning bloom events (above); map showing reported locations of *Alexandrium* spp. detections around Western Australia (below).



**Figure 2:** Percentage removal of *Alexandrium* cells with KPAC clay.

efficiency observed with KPAC in salt water, suggests substantial real-world operational advantages of this modified clay and value in additional testing in larger and more expansive natural water environments<sup>5</sup>.

Molecular analysis of water taken from the Swan Canning estuary identified a non-toxic *A. minutum* strain<sup>i</sup>, thus species presence alone does not necessarily indicate toxicity. Molecular testing and/or toxin testing is therefore essential for bloom assessment and response.

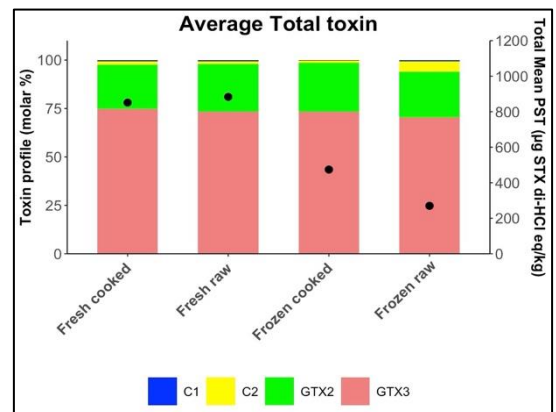
A HILIC-MS/MS method was developed and validated for reliable quantification of paralytic shellfish toxins in crab flesh, water and *A. minutum* cells. This analytical capability offers a key tool for public health risk assessment. The method also identified the types of individual toxins present, allowing characterisation of toxin profiles and estimation of overall toxicity.

When blue swimmer crabs were fed pellets containing paralytic shellfish toxins (PST), these accumulated exclusively in the hepatopancreas. Freezing and thawing significantly reduced toxin concentrations in these tissues, through flushing (Figure 2). However, cooking (boiling) did not alter toxin levels or the internal organs impacted. No PSTs were detected in cooking broth. These findings are critical for assessing the potential human health risks of consuming crabs obtained during an *Alexandrium* bloom event.

## Management implications

This study enhanced understanding of *Alexandrium* monitoring approaches, control and paralytic shellfish toxin uptake in blue swimmer crabs. Key implications include:

- Increased capacity of molecular and toxin assessment methods for improved algal monitoring and seafood risk assessment during bloom seasons.
- Identification of a modified clay as a promising bloom mitigation tool, worthy of additional trials.
- Data to support current public communication messaging that the risk of paralytic shellfish poisoning can be minimized by removing and disposing of crab guts (including the hepatopancreas) prior to cooking or freezing and consumption.



**Figure 3:** Total PST concentrations (black dots) and % toxin contribution in crab hepatopancreas, before and after freezing, thawing, and boiling.

Effective consideration of these findings into coastal and fisheries management frameworks will be important for monitoring and managing harmful algal blooms, while supporting sustainable recreational and commercial fisheries.

## Further information

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2. Band-Schmidt, C. J., & Rodríguez-Gómez, C. F. (2022). *Proceedings of the 19th International Conference on Harmful Algae, La Paz, B.C.S. Mexico*. Mexico. International Society for the Study of Harmful Algal Blooms.
3. Traylor, K., & Cosgrove, J. (2021). Blooming surprise: Toxic algal blooms in Perth rivers Landscape, 50(52), 50-52.
4. Kwambai, C. S. (2025). Toxic *Alexandrium minutum* and blue swimmer crabs: Toxin dynamics, impacts and implications for public health, monitoring and management. PhD thesis, Murdoch University.
5. Kwambai, C. S., Ennaceri, H., Lymbery, A. J., Laird, D. W., Cosgrove, J., & Moheimani, N. R. (2025). Effectiveness of kaolinite with and without polyaluminum chloride (PAC) in Removing Toxic *Alexandrium minutum*. *Toxins*, 17(8), 395. <https://doi.org/https://doi.org/10.3390/toxins17080395>

<sup>i</sup> Castledare site (CASMID) Canning River, collected 6<sup>th</sup> February 2024