


Doc no.: A3323904

File no.: 2022-00775



# Metal concentrations in seafood from the Port Pirie River estuary: human health risk assessment and risk management

EXTRACT 2022

Port Pirie Lead Investigation Group  
Scientific Services  
Health Protection and Regulation  
SA Health



Government  
of South Australia

SA Health



## Metal concentrations in seafood from the Port Pirie River estuary: human health risk assessment and risk management

Authors: Dr David Simon, Dr Carolyn Lewis, Dr Peter Bain and Razia Zariff

For further information and copies of the full report and Appendices please contact:

Health Protection and Licensing Services

SA Health

Email: [health:scientificservices@sa.gov.au](mailto:health:scientificservices@sa.gov.au)

Phone: 8226 7100

Web: [www.sahealth.sa.gov.au/portpiriefishing](http://www.sahealth.sa.gov.au/portpiriefishing)

**September 2022**

## Acknowledgements

The authors of this report would like to acknowledge a number of agencies and people who made significant contributions to this risk assessment:

- > SA EPA:
  - Sam Gaylard and Andrew Solomon for survey design and Spencer Gulf expertise
  - M. Nelson (pers. comm 2022) for providing additional unpublished data from the Gaylard et al. (2011) study at a level of detail that has allowed determination of statistical measures required to prepare comparative chronological visualisation
  - T. Corbin (pers. comm 2022) for providing additional unpublished data from the Corbin (2004) study at a level of detail that has allowed determination of statistical measures required to prepare comparative chronological visualisation.
- > SARDI – Stephen Pahl, Paul Rogers, Graham Hooper and Michael Drew for coordination of seafood sample preparation and analysis.
- > PIRSA – Gavin Begg, Matthew Bansemer, Shane Roberts and Paul Dowsett for provision of the 2020 seafood survey and local fishing expertise.
- > NSW EPA – Kate Langdon and Janina Beyer, Principal Technical Advisor, Chemicals and Pesticides, Regulatory Practice and Environmental Solutions Division and Kate Langdon – for experience and expertise relating to Lake Macquarie seafood health risk assessment.
- > FSANZ – Dr Katherine Bathgate, Scientific Officer, International and Dietary Exposure Assessment – for providing Australian seafood consumption data.

### IMPORTANT DEFINITIONS OF TERMS USED THROUGHOUT THIS REPORT

**General population:** All mentions of 'general population' in this report refers to population group containing non-pregnant adults and children aged 5 years and above.

**Diet limits:** All mentions of 'diet limits' in this report refers to the maximum number of standard serves (100g of cooked seafood) of recreationally caught seafood from Port Pirie River estuary and surrounding waters if consumed per week would not exceed the health-based guidance value for cadmium, lead or other metals assessed.

## Plain language summary

Finfish, crabs, mussels and razorfish taken by recreational fishing from the Port Pirie River estuary and surrounding waters contain levels of lead and cadmium metals above food safety guidelines. This is not unexpected given the long operation of the lead-zinc smelter and previous reports of significant contamination of the river sediment and marine animals that has been documented since the mid-1970s.

Lead and cadmium metals are harmful to health especially the function of the nervous system and kidneys. Given the results of this report, it is recommended that exposure to these metals is prevented or kept as low as possible. Young children and people who are pregnant or considering pregnancy are extremely vulnerable to harm from lead.

The greatest overall risk of lead and cadmium harm was assessed from eating seafood species tested from Zone 1. Specifically, crabs and mussels from Zone 1 as well as razorfish from Zone 2 of the current fishing closure area were the most contaminated seafood tested during the 2020 survey. This is because these species live on the bottom of the river where the metal levels in sediments are high. Therefore, it is recommended that **crabs and mussels from Zone 1 and razorfish from Zone 1 and Zone 2 should not be eaten by anyone or used in cooking.**

Other types of seafood including squid were not tested in the 2020 seafood survey but previous studies indicate they can also accumulate metal pollution..

The risk may be higher for some people if they eat this seafood including people who have chronic health conditions like diabetes and kidney disease, people who regularly eat more recreational catch than most and people who work with cadmium and lead in their occupation or hobbies.

The health risk assessment reported in this document shows that the lead and cadmium risk identified can be avoided by not eating seafood caught in these areas - this decision is **most important for young children and people who are pregnant or planning pregnancy who should avoid eating all types of seafood caught in the Port Pirie River estuary and surrounding waters because of the raised lead and cadmium levels.**

## Abstract

In 2020, various seafood species popular with recreational fishers were sampled from the Port Pirie River estuary and surrounding waters and tested for a range of contaminants. Initial screening of results against relevant standards found mercury and inorganic arsenic levels in all seafood tested were below these standards. However, average and or maximum levels of lead and cadmium above relevant standards were identified in some seafood groups sampled at certain locations, warranting further investigation of potential health risk from consuming these species. This is not unexpected given the long operation of the lead-zinc smelter and previous independent reports of significant contamination of the river sediment and marine animals since the 1970s.

To further investigate screening results, a site-specific risk assessment was done using lead exposure modelling and cadmium risk quotient calculations, incorporating estimated daily background metal exposure. This assessment examined worst-case exposures to account for higher-than-average seafood consumers and vulnerable population groups. Risk assessment confirmed the metals, sites of concern and seafood groups identified by initial screening that would have a high likelihood of unacceptable health risk if ingested. It also detected some additional seafood groups not previously flagged that had unacceptable risk when accounting for vulnerable population groups and additional background exposure sources. While there is a recognised monthly tolerable level for cadmium exposure, there is no safe threshold for lead exposure. Therefore, modelling explored the impact of

## OFFICIAL

seafood ingestion on average blood lead levels particularly for young children and pregnant people and their unborn babies.

While this assessment found a similar risk of cadmium exposure from seafood ingestion for people living in Port Pirie as those living elsewhere where there is likely to be a lower background exposure to cadmium, people living in Port Pirie would have a higher risk from additional lead exposure from ingesting recreationally caught seafood than people living elsewhere. This is due to a higher background exposure to lead from contamination of their living environment resulting in their blood lead levels being typically higher than the national average.

Based on the outcomes of the assessment, the following actions are recommended to manage risk:

- > Zone 1: crabs, mussels and razorfish caught in Zone 1 of the current fishing closure should not be consumed by anyone to avoid harmful lead and or cadmium exposure.
- > Zone 2: razorfish caught in Zone 2 of the current fishing closure should not be consumed by anyone to avoid harmful lead and or cadmium exposure.
- > Barrow Beach: razorfish caution should be exercised to avoid or minimise consumption by everyone to avoid harmful lead and cadmium exposure.
- > In addition:
  - People who are pregnant or planning pregnancy and young children under 5 years of age should not consume any seafood caught in these areas to avoid lead and cadmium exposure.
  - All other people should be aware that while consuming typical amounts of finfish caught in Zone 1 and finfish, crabs and mussels caught in Zone 2 is considered tolerable, caution should be exercised to avoid or minimise consumption because this seafood contains levels of cadmium that can accumulate in the body over a lifetime and levels of lead that may pose a risk for some people.

Precautionary measures in assessment methodology were taken to mitigate the extent and variability of dietary habits, and metal contamination in seafood groups as well as potentially limited representation in the 2020 survey of seafood species regularly consumed.

**The findings of this assessment and the public health advice issued to manage risk from ingestion apply to recreational fishing in the specified areas and do not apply to commercial or recreational fishing outside of these locations.**

## Executive summary

- > A report published by the University of South Australia (2020) indicates that the levels of pollutants in marine and estuary sediments in the Port Pirie River estuary and Germein Bay exceed national sediment quality guidelines. The report defines two zones where sediment contamination levels are of concern.
- > In response to public health concerns raised by the sediment quality findings, on the 15 September 2020, PIRSA issued a temporary fishing closure pursuant to section 79 of the *Fisheries Management Act 2007* in the two zones of concern (Zone 1 and Zone 2) as a precautionary measure to allow for the investigation that is the subject of this report (Appendix A: Figure A-1). On 14 September 2021, PIRSA extended this closure until 15 September 2022 to allow the development of risk management strategies informed by this investigation (PIRSA, 2021).
- > The EPA and PIRSA surveyed seafood species from the fishing closure area (and Barrow Beach north of the closure which has greater numbers of razorfish to improve the available sample size) during two fishing events between October and December 2020 (Appendix B: Figure A-2). This survey was conducted to determine the metal levels in finfish, crabs, mussels and razorfish within the closure zones to underpin the need (or otherwise) for public safety arrangements to restrict the consumption of aquatic resources taken in the Port Pirie River area.
- > Two hundred and sixty-nine individual and composite samples were sent for analysis of the levels of the metals lead, mercury, arsenic (inorganic), cadmium, selenium, copper and zinc.

### Part 1: screening assessment

- > The survey results were screened against the following criteria that were selected in a prioritised manner. That is where an Australian health-based food safety standard (maximum level of contaminant permitted – ML) was available, it superseded other criteria, then in the absence of an Australian criteria an international criteria (European Union - EU) was used and in the absence of any food standard then an Australian generally expected level (GEL) was used:

Seafood group	Part 1 screening criteria						
	Maximum levels of contamination (ML)						
	(mg/kg wet weight)						
	Lead	Arsenic (inorganic As)	Cadmium	Mercury (total Hg)	Copper	Zinc	Selenium
Finfish	0.5	2	0.05	0.5	2	15	2
Crustaceans	0.5	2	0.5	0.5	20	40	1
Molluscs	2	1	2	0.5	30	290	1

- > Findings:

#### All zones tested

- Mercury and inorganic arsenic levels in all seafood tested were below screening criteria.
- Average and or maximum levels of selenium, copper, zinc in some species tested exceeded screening criteria.

#### Zone 1

- Average and or maximum levels of lead and cadmium in all seafood groups tested in Zone 1 exceeded screening criteria.

#### Zone 2

- Average and or maximum levels of lead and cadmium in razorfish tested in Zone 2 exceeded screening criteria.

While finfish, crabs and mussels caught in Zone 2 are considered for the most part not to exceed screening criteria for lead and cadmium, all species tested contain some level of lead.

#### Barrow Beach

- Maximum levels of lead and cadmium in razorfish tested at Barrow Beach (north of Zone 2) exceeded screening criteria.

- > Metal concentrations detected in the 2020 seafood survey were comparable to independent research done over the past five decades which indicates that contamination in seafood species is expected to persist into the future. This validation of historical research, recent sediment quality findings, and exceedance of food safety guidelines justified a comprehensive assessment of site-specific health risk.

### Part 2: site-specific risk assessment

- > Potential health risks for vulnerable population groups were assessed for seafood identified to exceed the Part 1 screening criteria using:
  - Health-based guidance values (HBGVs) to assess cadmium risk (amount of cadmium consumed exceeds the **provisional tolerable monthly intake (PTMI) value of 25 micrograms per kilogram body weight**) and lead risk (blood lead level - BLL) caused by lead consumption exceeds **the Australian lead exposure investigation BLL of 5 micrograms per decilitre**).
  - Maximum cadmium and lead concentrations detected in each seafood group in the 2020 survey to assess worst-case exposure from seafood consumption.
  - Site-specific background exposure inputs to account for other sources of exposure to lead and cadmium for people (e.g. environmental contamination).
  - The upper level of seafood consumption by Australians (provided by Food Standards Australia New Zealand - FSANZ) to ensure risk management protects high seafood consumers such as recreational fishers and their families.

- > Findings:

#### All zones tested

- Consuming the most contaminated animals in all seafood groups caught at all testing locations poses an unacceptable risk of harm to children and unborn babies from lead exposure – this risk is higher for people living in Port Pirie where children under 5 years of age already have BLL above the national exposure investigation BLL.
- The highest concentrations of lead and cadmium of all species from all sampling locations were detected in crabs and mussels from Zone 1 and razorfish from Zone 2. Consequently, consumption of these species taken from these zones has the highest level of overall risk to health for all people from harmful cadmium and lead exposure.
- The high levels of contamination of these species in these locations are unsurprising based on the results of the 2020 University of Adelaide study of sediment metal levels and that crabs and molluscs are bottom-dwelling animals.



Zone 1

- Consuming very small amounts (less than one standard serve (100 grams) per month) of the most contaminated **crab or mussels** is an unacceptable risk for all people of significant increase in BLL above the national exposure investigation BLL. Consuming very small amounts (less than one standard serve per month for young children and two-three serves per month for other population groups) of the most contaminated **crab or mussels** will exceed the tolerable cadmium intake.
- Consuming very small amounts (less than one standard serve per month) of the most contaminated **finfish** is an unacceptable risk of increasing BLL of unborn babies above the national exposure investigation BLL and consuming more than three standard serves per week will exceed the tolerable cadmium intake for young children.
- Consuming more than two standard serves per week of the most contaminated **finfish** can increase BLL of the general population above the national exposure investigation BLL.

Zone 2

- Consuming very small amounts (less than one standard serve per month for young children and two-three serves per month for other population groups) of the most contaminated **razorfish** will exceed the tolerable cadmium intake and is an unacceptable risk of significant increase in BLL of all people above the national exposure investigation BLL.
- Consuming small amounts (less than two standard serves per month) of the most contaminated **mussel** is an unacceptable risk of increasing BLL of unborn babies above the national exposure investigation BLL and consuming more than two standard serves per week will exceed the tolerable cadmium intake for young children.

Barrow Beach

- Consuming very small amounts (less than one standard serve per month) of the most contaminated **razorfish** will exceed the tolerable cadmium intake for young children and is an unacceptable risk of increasing BLL of unborn babies above the national exposure investigation BLL. Consuming more than one standard serve per week of the most contaminated **razorfish** will exceed the tolerable cadmium intake for the general population and can increase BLL above the national exposure investigation BLL.
- > Risk assessment confirmed the findings of the screening assessment and identified additional harmful lead and cadmium exposure associated with consuming some seafood species that were not previously flagged when accounting for vulnerable populations and background metal exposure.

### Part 3: health risk management

- > The following risk management actions are recommended for people who regularly consume seafood caught in the Port Pirie River estuary and surrounding waters:

#### All zones tested

- All people are advised that consuming recreationally caught seafood from all zones tested is a readily avoidable source of toxic metals and people can avoid this risk to themselves and their families by deciding not to consume.
- Young children and people who are pregnant or considering pregnancy are particularly vulnerable to harm from lead exposure. There is no safe threshold for lead exposure and these people are advised not to consume any seafood caught in Zone 1, Zone 2 or Barrow Beach to protect their health.
- These actions recommended to manage cadmium and lead risks in seafood caught in all zones also protect people from excessive intake of other metals (selenium, copper, zinc) detected that were identified to exceed GELs for Australian seafood.
- Cephalopods (e.g. squid, octopus and cuttlefish) and other crustaceans (e.g. sand crabs) were not sampled in the 2020 seafood survey, but caution should be exercised because there is evidence that these species can accumulate metal contamination in the same way as the tested species and there has been historical detection of elevated lead and cadmium levels in cephalopods and prawns in the region.

#### Zone 1

- All people are advised not to eat crabs, mussels or razorfish taken from Zone 1 to avoid cadmium and lead exposure above health guidelines.
- Young children and people who are pregnant or considering pregnancy are advised not to eat finfish, from Zone 1 to avoid cadmium and or lead exposure above health guidelines.
- Fishing in Zone 1 is considered tolerable for other people (i.e. non-pregnant adults and older children) with the knowledge that this seafood contains lead and there is no safe threshold for lead exposure. More than two standard serves per week can increase BLL above the national exposure investigation BLL.

#### Zone 2

- All people are advised not to eat razorfish taken from Zone 2 to avoid lead and or cadmium exposure above health guidelines.
- Young children and people who are pregnant or considering pregnancy are advised not to eat finfish, crabs, mussels and razorfish taken from Zone 2 to avoid cadmium and or lead exposure above health guidelines.
- Fishing, crabbing and mussel collecting in Zone 2 is considered tolerable for other people (i.e. non-pregnant adults and older children) with the knowledge that this seafood contains low levels of lead and there is no safe threshold for lead exposure. More than two standard serves per week can increase BLL above the national exposure investigation BLL.

#### Barrow Beach

- Young children and people who are pregnant or considering pregnancy are advised not to eat razorfish taken from Barrow Beach to avoid cadmium and lead exposure above health guidelines.
- Other people (i.e. non-pregnant adults and older children) should be advised that eating more than one standard serve per week of razorfish taken from Barrow Beach

will expose them to levels of cadmium and lead above health guidelines and caution should be exercised to avoid or minimise consumption.

### Additional information

- > The findings of this assessment and actions recommended to manage identified risks apply to recreational fishing in the specified areas and **do not apply to commercial or recreational fishing outside of these locations (except Barrow Beach)** given that the Federal Government (Department of Agriculture, Fisheries and Forestry) analyse fish for heavy metals outside the closure areas to support trade and market access.
- > People living outside Port Pirie would generally have a lower day-to-day background exposure to cadmium and lead from their living environments and lower BLL than most local residents.<sup>1</sup> While this risk assessment found a similar risk of cadmium exposure and a minor lessening of risk of lead exposure for people eating seafood caught in the Port Pirie River estuary and surrounding waters who live outside of Port Pirie, even occasional consumption potentially increase BLL above the national exposure investigation BLL and can contribute to irreversible damage to kidney and nerve function that can persist over a lifetime. Therefore, the recommended risk management actions are relevant to all recreational fishers regardless of residential location.
- > People who regularly eat more recreationally-caught seafood than average Australians (higher metal dose), people that are exposed to metals in their work or hobbies (higher background exposure to metals) and people with chronic health conditions like diabetes and kidney disease (more vulnerable to the toxic effects of metals) can be at greater risk from eating recreationally-caught seafood from this area.
- > Precautionary measures are built into the methodology of this risk assessment that provide a high level of confidence that these risk management actions are protective of recreational fishers and their families from cadmium and lead health risks that may result from consuming recreationally caught seafood in Port Pirie River estuary and surrounding waters. These measures include assessing daily consumption of seafood containing the maximum concentration of metals detected in the 2020 survey at high rates of seafood consumption. Key methodology decisions made by SA Health risk assessors are presented in Appendix S: Table A-35. These measures were taken to mitigate certain identified data limitations.
- > Independent expert review has deemed that while considered conservative for the general population, the precautionary approach taken is justified to protect the health of vulnerable population groups from toxic effects because:
  - there is no safe threshold of exposure such as the health effects of lead
  - international guidelines for managing lead risk (e.g. USA: 3.5 µg/dL) are lower than the current Australian exposure investigation BLL of 5 µg/dL
  - this approach compensates for inherent uncertainties within the risk assessment process that include the actual concentration of metals in seafood eaten (including from season to season), the actual quantity of each species in individuals' diet, the actual rate of seafood ingestion of individuals and the potential for increased sensitivity and higher background exposure to metals of a potentially significant proportion of the local community.
- > The authors revised this report after independent expert review to implement its recommendations. Revisions included minor text additions indicated by \*reviewer comment, and removal of an interim Part 4 - Risk Communication, that contained preliminary translation of risk management recommendations into public advice. This was done to enable the finalisation of this

---

<sup>1</sup> People living in Broken Hill, Mount Isa and other industrial locations where lead or cadmium are used could have a similar background exposure to these metals Port Pirie residents.

report so it could be used to inform the future development of a targeted and consultative communication strategy.

## Recommendations and future considerations

The authors recommend that consideration be given to:

- > Considering and consulting on potential implications of recommended risk management actions on the local community, health, tourism, recreation and sustainable economies. and look to strategies used elsewhere in Australia (e.g. Derwent River and Lake Macquarie) for guidance on the most appropriate mechanism to handle these impacts.
- > Considering and consulting on mechanisms with local stakeholders to inform the local Port Pirie community, as well as visitors to the area about health risks and the recommended risk management actions to minimise exposure to lead and cadmium from eating locally-caught seafood using simple messaging appropriate for different needs of each target audience.
- > Recognising that:
  - Seasonal availability determines the likelihood of recreational fishers obtaining enough catch of a particular seafood group to exceed the average and high seafood consumption rates that underpin this risk assessment.
  - A level of risk remains that is unable to be completely prevented by recommended risk management actions due to:
    - Identified challenges to communicating metal exposure risk – in particular, a potential degree of lead message fatigue in the community which may result in vulnerable populations being exposed to harmful levels of cadmium, the complexity of the risk matrix for three population groups and four seafood types in three different locations and the public perception of seafood safety if temporary ban restrictions are lifted or changed.
    - The dietary basis of the recommended risk management actions is based on the standard serving size and weekly seafood consumption used in Australian Dietary Guidelines but risk management advice is less protective if people eat more than 100 grams of seafood in a meal.
    - Seafood consumption data limitations require that risk for children aged 5-15 years was assessed in the same way as adults despite the metal dose (intake per kg of bodyweight) being likely to be higher– precautionary measures and the conservative nature of the risk assessment aim to address this limitation as much as possible.
- > Considering integration of the findings of this risk assessment with future investigations of additional background exposure sources of metals such as recreational water usage and occupational exposure that could affect people consuming seafood from the Port Pirie River estuary and surrounding waters who live in Port Pirie and elsewhere.
- > Considering future sampling of other species popular for recreational fishing including cephalopods (such as squid and octopus), other crustaceans (such as sand crabs), and other popular recreational finfish species (such as kingfish, bream and mullet) that may accumulate metals to different extents or in different ways to the species surveyed as well as further sampling of the surveyed species in different seasons and at different maturities. Future sampling was suggested to be prudent by independent expert review.

---

## For more information

**Scientific Services Branch  
Public Health Services  
PO Box 6, Rundle Mall  
Adelaide SA 5000  
Telephone: 08 8226 7100  
[www.sahealth.sa.gov.au](http://www.sahealth.sa.gov.au)**

Public-I1-A1



[www.ausgoal.gov.au/creative-commons](http://www.ausgoal.gov.au/creative-commons)