Cooperative Research Centre for Coastal Zone, Estuary & Waterway Management

Contaminants in Port Curtis: screening level risk assessment

Executive Summary

May 2005

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Coastal CRC Phase 1 PC5 Project

Port Curtis Contaminant Risk Assessment Team

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Authors

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A large portion of this report is based on the Masters thesis by Mary-Anne Jones (Jones 2003).

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Executive Summary

Background

The Port Curtis estuary, one of the Coastal CRC's three key study areas, has a well-developed and expanding industry within its catchment. It is also one of Australia's leading ports which is located adjacent to the World Heritage-listed Great Barrier Reef Marine Park. As a consequence of increasing population and industrial activities, the Port Curtis estuary is expected to receive increasing quantities of contaminant inputs from diffuse sources (e.g. urban run-off) and point source discharges (e.g. industrial effluents). Sources of chemical stressors are many and multiple contaminants are likely to be transported to the estuary by air and/or water. It is important to objectively assess the risks posed by these contaminants in order to ensure effective management. To date, there have been few published studies describing contaminant distributions in Port Curtis.

This report comprises a human and ecological screening level risk assessment focussed on key contaminants in the Port Curtis estuary. The principle aims of the project were to:

(i) Review and collate the existing physical, chemical and biological data with particular reference to contamination of sediments, waters and biota.

(ii) Identify data gaps and collect new contaminant data for waters, sediments and biota.

(iii) Identify contaminants that pose a risk to humans and the environment, by undertaking a screening level ecological risk assessment (SLERA) and a human health risk assessment (HHRA) using the combined data sets.

(iv) Outline future research needs.

A risk assessment framework developed by the USEPA (1998) was utilised. Conceptual models were developed to assist with planning and design of the study. For the SLERA, the study area was divided into seven geographical zones. Following a systematic screening process, aluminium (Al), arsenic (As), cadmium (Cd), copper (Cu), chromium (Cr), iron (Fe), mercury (Hg), nickel (Ni), lead (Pb), selenium (Se), zinc (Zn), fluoride, cyanide, polycyclic aromatic hydrocarbons (PAHs) and tributyltin (TBT) were the contaminants examined in detail in the SLERA. Contaminant concentrations were measured in water, sediments and in biota including seagrass (*Zostera capricorni*), oysters (*Saccostrea* spp), and mud whelks (*Telescopium telescopium*). For the HHRA, concentrations of aluminium, arsenic, cadmium, copper, chromium, iron, mercury, nickel, lead, selenium, and zinc were measured in fish and shellfish likely to be consumed by humans, namely, barramundi (*Lates calcarifer*), sea mullet (*Mugil cephalus*), mud crab (*Scylla serrata*) and banana prawns (*Penaeus merguiensis*). Tributyltin was measured in the edible flesh of mud crab.

The compiled data for water, sediment and biota concentrations was assessed against assessment endpoints. For waters and sediments, the chosen endpoints were the latest Australian water and sediment quality guidelines (ANZECC/ARMCANZ 2000). The observed contaminant concentrations in biota at study sites were compared with benchmarks derived from concentrations in biota at control sites and from the literature. The ability of biota to integrate fluctuating concentrations of metals over time and to reflect exposure via dietary uptake allowed a thorough investigation of the exposure of biota to contaminants in the Port Curtis estuary.

For the screening level HHRA, chronic daily intakes (CDIs) of contaminants by adults and children consuming seafood from this region were compared to threshold toxicity values set by regulatory agencies (ATSDR 2001). To account for additivity of other chemicals, a hazard quotient greater than 0.1 indicated a contaminant of potential concern (COPC).

Conclusions

The following contaminants of potential ecological concern were identified:

- TBT in waters.
- Arsenic, TBT and naphthalene (based on limited historical data) in sediments.

Particulate arsenic and naphthalene may be derived from natural sources within Port Curtis (e.g. oil shale deposits). The main sources of tributyltin are commercial shipping and historically, the leisure boats that utilise the area. TBT contamination is a problem affecting all large commercial ports. TBT concentrations are expected to decline in Port Curtis over the next decade as this antifoulant is completely phased out worldwide.

The concentrations of dissolved metals in waters of the Port Curtis estuary were below levels of regulatory concern. However, the concentrations of dissolved copper, nickel, lead and zinc were elevated relative to concentrations at pristine coastal water sites in Australia. The reasons for these elevated concentrations may be industrial discharges or natural inputs of metals from local geological formations.

The concentrations of metals in sediments were generally below levels of regulatory concern. However, arsenic, chromium and nickel concentrations were consistently above the ANZECC low interim sediment quality guidelines at many sites which does not necessarily imply deleterious effects but is a ‘flag’ for further investigations. The concentrations of chromium and nickel were comparable to those at control sites indicating natural sources. Arsenic concentrations however, were consistently above background. Further studies are required to determine the sources of particulate arsenic.

The concentrations of aluminium, arsenic, copper, chromium, iron, mercury, nickel, selenium and zinc were significantly enriched in marine biota sampled within Port Curtis relative to organisms at reference sites. This indicates that marine organisms living in Port Curtis are exposed to higher metal concentrations (as compared to pristine coastal locations). This does not necessarily imply adverse effects resulting from exposure to elevated concentrations. Further studies are required to investigate whether organism health is impaired by these increased body burdens of metals.

The spatial analysis conducted as part of the SLERA indicated that the Calliope River and mid-harbour regions of Port Curtis contain the highest concentrations of contaminants.

The HHRA identified mercury concentrations in large barramundi as a potential concern for the health of adult and child populations likely to consume fish from this area. It should be noted that this is a general public health issue affecting most regions of Australia and is not exclusive to Port Curtis.

Recommendations

Although the concentrations of the contaminants studied were below levels of regulatory concern in both waters and sediments, the study has flagged a number of areas that require further study and possible management actions:

The sources of contaminants that are bioaccumulated by organisms in Port Curtis should be identified. Further field surveys conducted over a wider geographical area and scenario modelling of contaminant dispersion using the recently developed hydrodynamic model of Port Curtis (Herzfeld *et al.* 2003) may allow the differentiation of natural versus anthropogenic sources of metals and help resolve these issues.

The sources of particulate arsenic and naphthalene in benthic sediments should be elucidated. It is highly likely that both contaminants originate from natural sources. Given its intrinsic solubility, the concentration of naphthalene in the water column should also be measured.

The ecological health of organisms that have increased metal burdens should be evaluated. This is best achieved by measuring sublethal stress indicators such as enzyme biomarkers in selected organisms.

The impact of butyltin antifoulants on Port Curtis should be evaluated by measuring the incidence of imposex in gastropods. This is the most reliable and sensitive indicator of exposure.

A screening level risk assessment of organic contaminants which were not covered in this study, should be conducted. In particular, the risks associated with dioxins and PCBs, which were identified as potential chemical stressors in this study, should be evaluated.

The role of pulse events (e.g. storms and dredging) which may result in periodic introduction of contaminants and sediments from the surrounding catchment area should be evaluated. Current risk assessment protocols are directed at understanding the effects of steady state contaminant exposure on organisms.

Further work is required to understand the factors leading to the bioaccumulation of mercury by barramundi (e.g. sources of mercury, fish size and age). Additional survey work is required to determine if other piscivorous fish are also high accumulators of mercury. Similar to health advisories at other locations, high risk groups e.g. pregnant women, should limit their consumption of top predator fish such as barramundi to prevent potential detrimental effects of mercury on the foetus.