Australian Government

National Land & Water Resources Audit

An initiative of the Australian Government

ESTUARINE, COASTAL AND MARINE HABITAT INTEGRITY

INDICATOR HEADING

Estuarine, coastal and marine habitat condition

INDICATOR GUIDELINE

Toxicant concentrations

Toxicant concentrations

Recommended by the Audit for further consideration

This version of the guideline has been developed through the National Land and Water Resources Audit and was informed by expert review and broad consultation on national indicators via national coordination committees and their associates. Version 1 – June 2008 does not yet have the final endorsement of any jurisdiction. The document is for guidance only and is presented to provide a basis for on-going discussion. It may require further consideration by a jurisdictional based reference group before national endorsement.

Status of indicator agreement

The National Land & Water Resources Audit (the Audit) coordinates the collation of data to support reporting on natural resource condition required under the National NRM Monitoring and Evaluation Framework (National M&E Framework).

The National M&E Framework identifies three requirements for monitoring natural resource condition:

- a set of resource condition indicators to measure progress toward the agreed national outcomes on a medium and long term basis
- a set of indicators for monitoring community and social processes relevant to or affected by NRM programs, as well as measures of the adoption of sustainable development and production techniques
- contextual data pertinent to the indicator being considered.

The Audit Advisory Council has agreed to a process for achieving a practical set of indicators under the National Monitoring and Evaluation Framework.

This process is to:

- obtain on-going **recommendations** from the relevant **National Coordination Committees** for each thematic area (including "Matters for Target") on appropriate indicators, protocols and information needs
- seek **endorsement** from the **Audit Advisory Council** that the indicators and protocols can be implemented at the national, state / territory and regional levels
- seek **agreement** from the Natural Resource Policies and Programs Committee (**NRPPC)** (or the Marine and Coastal Committee –**MACC**- for Estuarine, Coastal and Marine) that the indicators will be used and promoted by jurisdictions to underpin evaluations of NRM initiatives.

The NRPPC and MACC report to the Natural Resource Management Ministerial Council (NRMMC).

Introduction

This suite of "indicator guidelines" is relevant to the Estuarine, Coastal and Marine Habitat Integrity Matter for Target.

Two indicator headings are identified:

1. Estuarine, coastal and marine habitat extent and distribution
2. Estuarine, coastal and marine habitat condition.

Initially, 31 potential indicators were developed to measure the effect of the stressors on ecosystem condition (physical/chemical and biological) and habitat extent (Scheltinga et al., 2004). These indicators were reviewed at a national workshop (Souter and McKenzie, 2006) and further refined to 19 nationally agreed indicators (Table 1).

Drawing on a series of state/territory trials and national consultations; the documentation for the indicators has been modified from a "protocol" format that sought to define both measurement standards and reporting (information) products to one that presents "guidelines" for the collection and storage of monitoring data.

> These "indicator guidelines" should be used as standards for the collection, collation and storage of data in order to assist NRM service providers and community groups make observations that can potentially be pooled and re-used at a later date.

Ten ECM indicators were prioritised and guidelines have been developed through extensive consultation and reviewed by key experts in the field.

Table 1. Nationally agreed ECM Resource Condition Indicators. Indicators prioritised for documentation and included in this document are shown with an asterisk.

Indicator heading	Indicator
Estuarine, coastal and marine habitat extent and distribution	1. Extent and distribution of key habitat types*
Estuarine, coastal and marine habitat condition	Biological condition 2. Algal blooms 3. Animal or plant species abundance* 4. Chlorophyll a* 5. Coral bleaching 6. Mass mortality events 7. Pest species (number, density, distribution)* 8. Targeted pathogen counts 9. Vertebrates impacted by human activities Physical/chemical condition 10. Dissolved oxygen* 11. Nutrients* 12. pH 13. Presence / extent of litter (marine debris)* 14. Salinity (EC) 15. Sedimentation/erosion rates* 16. Shoreline position 17. Temperature 18. Toxicants (in water / sediments / biota)* 19. Turbidity / water clarity*

Toxicants

Matter for target:

Estuarine, coastal and marine habitat integrity

Indicator heading:

Estuarine, coastal and marine habitat condition

Indicator name:

Toxicant concentrations

This document presents the recommended monitoring guidelines for sample collection, analysis, collating and reporting information on toxicant concentrations for national, state/territory and regional applications.

1. Definition

This indicator documents the concentration of toxicants in biota collected from estuarine, coastal or marine ecosystems and in the surface sediments of these systems, and the concentration of water-soluble toxicants in waters from these systems collected via passive samplers.

AIM: To determine the concentrations of high-risk toxicants in the sediments, waters and biota in the major functional areas of estuarine or coastal waters and compare with local guidelines.

INDICATOR 1: Concentrations of toxicants in sediments of an estuarine or coastal waterbody.

INDICATOR 2: Concentrations of toxicants in waters of an estuarine or coastal waterbody.

INDICATOR 3: Concentrations of toxicants in biota of an estuarine or coastal waterbody.

2. Rationale

Toxicants are chemicals that harm animals or plants. They can be natural (eg metals such as zinc and copper) which are essential for life but become toxic at high concentrations or unnatural (ie man-made substances such as pesticides). A list of potential toxicants is provided in the Water Quality Guidelines (ANZECC/ARMCANZ, 2000a).

Excerpt from the guidelines for State of the Environment reporting (Ward et al.*, 1998):*

> Chemical residues and industrial chemicals are found in estuaries and bays near the major urban and industrial agglomerations, and potentially near regions of intensive agriculture. However, most marine and estuarine waters have low concentrations of these residues, and so measurements by traditional bulk water chemistry techniques are time consuming, laborious and expensive. Oysters, mussels and other taxa have been used to monitor the water column [concentrations] of many chemicals, and represent an early

> warning device to detect the spread of unpredicted residues into otherwise uncontaminated areas. Measurement [concentrations] of contaminants in natural biological tissues is also a useful way to track long-term trends in concentrations of most contaminants in marine and estuarine systems, and complements measurements of total concentrations made in sediment systems.
>
> Unlike sediments, living organisms 'see' only the biologically available fractions of pollutants in waters and sediments. These may be dynamic (that is, pollutants may move from non-available to available fractions), and since we have only very limited understanding of how this process operates for most pollutants, biological sentinel accumulators must be used to assess the extent to which total environmental levels of contaminants are biologically active. This is achieved by measuring their body burdens of the individual chemical residues. Overseas programs such as Mussel Watch have been used successfully to evaluate distribution and changes in pollutants (NOAA, 1986; O'Connor, 1992).
>
> Pollutants commonly accumulate in sediments and are a starting point for contamination throughout the food chain, potentially damaging marine life and affecting human health. Measurement of sediment concentrations of contaminants is a useful way to track long-term trends in concentrations of most contaminants in marine and estuarine systems. These concentrations indicate the extent and magnitude of the pressure imposed by contaminants on the flora [plants] and fauna [animals] of the shallow-water ecosystems.
>
> Most toxicants find their way into the surface sediments of contaminated waterways after various periods (sometimes brief) in the water column.

An advantage of monitoring toxicants in biota (bioaccumulation) compared to in water is that toxicants are often introduced into the system as a result of an isolated event and therefore concentrations in the water column may be too low to be measured some of the time or not routinely measured.

Many organisms can regulate the uptake of contaminants, especially metals. Some toxicants can be biotransformed once accumulated.

Toxicants in biota may be harmful to the biota themselves or to humans who consume them. Toxicants in biota is an important indicator for 'state of the environment' reporting (see the following indicators: 'seafood quality (contaminants)', 'sentinel accumulator program' and 'seabird eggs (contamination)' (Ward *et al*., 1998)).

Sediment toxicants (see 'sediment quality (contaminants)') is an important indicator for 'state of the environment' reporting (Ward *et al*., 1998), and was used as one determinant of sediment quality in the National Estuary Assessment (stage 2: modified estuaries) completed for the National Land and Water Resources Audit (NLWRA, 2002).

Toxicants can have a local or more widespread impact depending on the chemical involved. Some readily bind to sediments whereas others are highly water-soluble and can be dispersed over large areas. The impact may also vary over time with some breaking down rapidly over a matter of days whereas others, such as DDT or metals, may last years or decades. Toxicant additivity, antagonism and synergism are also important factors to consider when determining the possible impacts of particular toxicants on the organisms of a waterway. However, little is known about these aspects of toxicant interactions, and additivity is usually assumed.

For further information on toxicants including a detailed explanation of what toxicants are, the sources of toxicants, environmental significance of toxicants, and coastal habitats susceptible to toxicants see the OzCoast and OzEstuaries website (http://www.ozcoasts.org.au/indicators/toxicants.jsp).

3. Monitoring methodology

Before any samples are taken the laboratory that will perform the analysis must be contacted and the monitoring methodology discussed.

3.1 Monitoring locations

Toxicants in biota, sediments and waters are monitored at a number of sites where toxicants are thought to be a threat and at control sites for comparison. Sampling should occur when the peak loads of toxicants are expected (eg in the first flush/run-off after pesticides have been applied to crops).

3.2 Monitoring frequency required

The frequency of monitoring toxicants in biota, sediments and waters will depend on the program; in general this is annually, or when there is cause for concern. However, contaminants in biota and waters should be monitored more frequently than annually. Annual monitoring of waters may miss events or seasonal inputs. Monthly is usual in monitoring programs, or after runoff events (see ANZECC/ARMCANZ (2000b) Guidelines for Water Quality Monitoring and Reporting). Changes to sediment concentrations are slow and may be barely detectable annually, thus may require a longer monitoring frequency.

3.3 Data measurement method

Due to the technical nature of toxicant sample collection and analysis it is important that appropriate experts are consulted before designing a toxicant monitoring program. Specific guidance is provided in the ANZECC/ARMCANZ (2000b) Guidelines for Water Quality Monitoring and Reporting. All samples should be analysed at a NATA-accredited laboratory. Following is a simplified preliminary guide to sampling.

Toxicant concentration in biota

‘Experimental’ testing: at the designated site, three individual bags of oysters, containing 10 oysters each, are attached to buoys and lowered to a depth of approximately 1 m. Oysters used must be clear of any toxicants. Oysters are exposed to the ambient water conditions for eight weeks., Remove the oysters’ soft tissue and blot dry. Pool the 10 tissue samples of each original sampling site bag to form one composite sample. Thus you will have three replicate samples from each site. Freeze each composite sample or transport on ice to the laboratory..

‘Natural’ testing: at the designated site, collect several samples of a particular test species (eg fish, oysters, mussels, crabs). Species that do not move too much (ie sedentary species) are better as they are more likely to have become contaminated at that site. Samples should be frozen or transported on ice to the laboratory.

Toxicant concentration in sediments

At each of the designated sites, three surface sediment samples (0–5 cm depth) are taken using a plastic core tube in a manner so as to not contaminate samples. Fine sediments (muds) must be sampled (this may be from a ‘sandy’ area where new deposition of fines is occurring). Samples should, where possible, be taken from deposition zones at left bank, right

bank and midstream locations. All three samples are then pooled in a plastic container and mixed thoroughly before a subsample is removed and placed into an appropriate sample container.

Pesticide concentrations: sediment samples are placed into 375 mL solvent-washed glass jars and immediately chilled on ice before being frozen when possible. Samples should be sent to the laboratory as soon as possible.

Metal concentrations: sediment samples should be collected in 1 L clean containers or sturdy plastic bags. Samples should be frozen and be stored for a maximum of seven days before being sent to the laboratory.

Toxicant concentration in the water column – passive samplers/grab samples

Metal concentrations in water: water samples should be collected in 375 mL acid-washed polyethylene or Teflon containers. Samples should be frozen and stored for a maximum of seven days before being sent to the laboratory for analysis.

[BT]'Grab water samples provide a snapshot of contaminant concentrations at the time of sampling. Passive samplers, which are placed in a waterway over a number of weeks or months, provide an average contaminant concentration over the period of deployment.

Passive samplers can provide a time integrated water concentration because they sample continuously during the deployment period. The reason trace level contaminants can be detected is because the samplers are deployed for X amount of days, during which time they collect contaminants and sample or 'clear' a certain volume of water. This amount typically far exceeds what could be collected in a grab sample. This means that contaminants can be detected at lower concentrations than is possible with grab sampling" http://www.epa.qld.gov.au/environmental_management/land/binary_remediation_project/epa_water_sampling_program__postbinary_fire_incident.

For organic contaminants:

Excerpt from National Research Centre for Environmental Toxicology (EnTox) – Passive Sampling Guidelines (EnTox, 2007):

> Semipermeable Membrane Devices (SPMDs), Polydimethylsiloxane (PDMS) and Empore Disk® (EDs) are used for passive monitoring and detection of organic [contaminants] in water. A new device – the Plaster Flow Monitor (PFM) is often deployed alongside them to obtain a measure of the surrounding water flow to determine the sampling rate of the passive samplers. Samplers are prepared and loaded into their field deployment cases in the EnTox laboratory. This is to minimise handling time and exposure in the field, consequently reducing risk of contamination.
>
> **SPMDs**
>
> The SPMD is suited for detection of non-polar organic [contaminants] such as organochlorine pesticides ([e.g.] dieldrin, DDT). The samplers are deployed in stainless steel devices that protect the membranes and limit water flow. Cages with SPMDs attached are sealed in tin cans and kept chilled to prevent passive sampling of air and degradation due to direct light.
>
> Due to the sensitivity of SPMDs to air and light, it is important to minimise the length of time the samplers are exposed. At the site the stainless steel cage

is quickly transferred from the can to the water in such a way to minimise the time the samplers are in open air. Exposure time during retrieval should likewise be minimised. [A typical deployment time is 30 days.]

PDMS

PDMS strips can provide information about a wide range of [contaminants] including non-polar polyaromatic hydrocarbons (PAHs) and relatively polar compounds such as organic pesticides and other herbicides. Use of PDMS as a passive sampler is fairly recent and EnTox is continuing to calibrate the samplers for a broad range of contaminants. The samplers are deployed in stainless steel devices that protect the membranes and limit water flow. The cages with PDMS strips attached are sealed in tin cans and kept chilled to prevent passive sampling of air and degradation to light during transport.

Due to the sensitivity of PDMS to air and light, it is important to minimise the length of time the samplers are exposed. At the site the stainless steel cage is quickly transferred from the can to the water in such a way to minimise the time the samplers are in air and light. Exposure time during retrieval should like-wise be minimised. PDMS samplers are usually deployed in the same stainless steel deployment cage as used for SPMDs.

EDs

The ED sampler is suited for monitoring the more polar organic compounds such as herbicides and anti-foulants. The disks are deployed in a custom made white Teflon device for protection and to control uptake of compounds and minimise bio-fouling. They are usually deployed for approximately 30 days, however they can be adapted for shorter or longer deployments if required by modifying the membranes sealed in the cases.

EDs are transported to deployment sites with distilled water sealed inside to prevent the disc drying or sampling during transport. The EDs should not be allowed to become dry. They should always be filled with site water or distilled water. They have a removable transportation cap that is replaced with a deployment top ring before being placed in the water. The cap should be kept wrapped in clean alfoil so it can be used for retrieval of the samplers.

Transport and Storage

During transport it is good practice to maintain the passive samplers at a low temperature (ideally between 4-6ºC). This is to prevent degradation of the samplers and accumulation of contaminants during transport. The ED samplers should ideally be transported with the lid facing upwards; this ensures the samples remain wet in event of air bubbles or a leaking lid.

Important Points

Deployment and retrieval:

- Minimise exposure of SPMD and PDMS samplers to air. It is important to be set up and ready to get the samplers into the water quickly BEFORE you open the sealed cans.

- Minimise exposure of samplers to direct sunlight. Photo-degradation of

standards and compounds occurs in samples exposed to direct sunlight; this can have a severe impact upon sampling results.

- Powder free gloves should be worn when handling samplers. Do not wear hand lotions, perfumes, insect repellent or powdered gloves. Suitable gloves are provided with your field kit.

- Record your deployment and retrieval dates on the Deployment Record form. This is very important as we need them to calculate the concentration of compounds in the water.

Storage:

- Store the samplers in a cold room or refrigerator. This prevents the samplers from degrading or accumulating unwanted compounds before deployment.

- Re-freeze ice-bricks to transport with samplers.

- It is best to deploy samples ASAP. And also to return them to EnTox ASAP after you have retrieved them. If in a fridge, samplers do have a storage life of about 3-4 weeks, however it is best to minimise time between preparation and extraction.

For further information contact EnTox (www.entox.uq.edu.au).

3.4 Data collation / calculation method

Analytical data for a specific site should be collated over the study period and the median value calculated and compared against the relevant guidelines.

3.5 Data storage and management

Data should be stored by state/territory agencies and by the collectors (if different) of the data. If possible, the public should have access to the data (and report summaries) through a website hosted by state/territory government.

3.6 Data analysis and interpretation

Excerpt from the guidelines for State of the Environment reporting (Ward et al.*, 1998):*

> Rather than use concentration criteria to determine when concentrations are acceptable, we need to rely mainly on an assessment of trajectory to evaluate the level of stress imposed by contaminants. For synthetic chemicals, concentrations should be trending downwards, hopefully to near-zero, while for natural materials they should be close to natural background concentrations and not trending upwards. Locations that do not fit these objectives may be in most need of remedial action.
>
> Change can only be detected against a baseline of existing or historic data, and then only with many caveats about collection and analysis techniques. Laboratory techniques have become increasingly sophisticated in the last decade, and data from earlier times are usually highly questionable. So full documentation of procedures, quality assurance and controls is critical if the currently collected data are to be useful.

Excerpts from OzCoast and OzEstuaries (http://www.ozcoasts.org.au/indicators/toxicants.jsp):

> Many toxicants reaching estuaries have a high affinity for fine-grained sediment. The concentrations of some toxicants are therefore controlled to a certain extent by processes governing sediment transport and deposition. In tide-dominated waterways (e.g. deltas, estuaries and tidal creeks), flanking environments are the main traps for fine sediments, and these include mangroves (Harbison, 1986), saltmarsh areas (Lee and Cundy, 2001) and intertidal flats (Lee and Cundy, 2001). Fine sediments also accumulate in mangroves, saltmarsh and intertidal flats in wave-dominated coastal waterways (e.g. estuaries and strandplains/coastal lagoons), but the central basin is usually the main sink. The baffling of water movement by seagrass leaves can also cause fine sediments and toxicants to deposit in seagrass meadows. Physical disturbance of these habitats (e.g. dredging, reclamation, erosion and re-suspension) can remobilise toxicants from the sediments into the water column (Lee and Cundy, 2001).
>
> DOM [dissolved organic matter] can enhance the solubilities of some [metal and] organic [contaminants] and pesticides (Chiou *et al*., 1986), and this might be important in areas where there is lots of decaying vegetation.
>
> There are still many challenges to understanding the fate, transport and interactions of contaminants in marine systems. In particular, more information is needed on contaminant concentrations and processes governing their distribution in Australian coastal environments. Section 8.5.3 of the ANZECC Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000a) lists several other deficiencies in knowledge.

Information provided in OzCoast and OzEstuaries on 'pesticide hazard' (http://www.ozcoasts.org.au/indicators/pesticide_hazard.jsp), 'industrial point source hazard' (http://www.ozcoasts.org.au/indicators/industrial_pnt_src_hazard.jsp) and 'stormwater discharges' (http://www.ozcoasts.org.au/indicators/stormwater_discharges.jsp) is useful for assessing toxicant risk from agricultural and/or urban and industrial sources.

3.7 Reliability, validity and quality assurance

Quality assurance and control measures are important to minimise avoidable errors in the data and give more confidence in the data collected and conclusions made. Individuals collecting the data must have had adequate training in sample collection. Instrument calibration and/or laboratory quality assurance should be regularly examined and recorded.

3.8 Metadata

Metadata documentation should be completed for all datasets (see Appendix A). The metadata statement should be consistent with current ANZLIC standards, which now complies with ISO 19115.

See the following web site for the Metadata Profile:
http://www.osdm.gov.au/ANZLIC_MetadataProfile_v1-1.pdf?ID=303

For the Metadata Guidelines see:
http://www.osdm.gov.au/ANZLIC_MetadataProfileGuidelines_v1-0.pdf?ID=397

4. Reporting / information products

4.1 Audiences

Regional natural resource managers will be the main audience for information on specific estuaries and coastal waters. State and federal managers will be more interested in the collation of information into regional summaries/reports.

4.2 Products

At the smallest reporting concentration (ie at the site scale), toxicant concentrations are probably most easily represented in tables, graphs (against time) or box plots showing the median and 20th and 80th percentiles for the location. Box plots are an easy way to visually compare the data with reference data (ie baseline values, local guideline values). Once sufficient information on toxicant concentrations is available for a location, it will be possible to produce graphs or tables showing trends/change and their statistical significance. These trends can then be reported as an estimate of change. At a higher level, the percentage of animals/plants containing detectable concentrations of toxicants, or numbers of site in which toxicant concentrations exceed guidelines (eg Water Quality 'trigger' values – 'Queensland Water Quality Guidelines', 2006; ANZECC/ARMCANZ, 2000a) could be reported..

The percentage of seafood which contains a contaminant at concentrations that exceed the maximum recommended limits for consumption should be reported..

When reporting at an estuary or larger scale then toxicant concentrations should be reported against the scoring categories in Tables 1–6.

Table 1. Scoring categories and indicator values for toxicants (metals) in the water column as an indicator of estuarine condition.

Condition indicator: toxicants in the water column											
Condition score	**Indicator values (µg/L)**										
	Ag	**Cd**	**Co**	**Cr III**	**Cr IV**	**Cu**	**Hg** (inorganic)	**Ni**	**Pb**	**TBT** (as µg/L Sn)	**Zn**
Excellent	<0.8	<0.7	<0.005	<7.7	<0.14	<0.3	<0.1	<7	<2.2	<0.0004	<7
Good	0.8-1.4	0.7-5.5	0.005-1	7.7-27.4	0.14-4.4	0.3-1.3	0.1-0.4	7-70	2.2-4.4	0.0004-0.006	7-15
Fair	1.5-1.8	5.6-14	2-14	27.5-48.6	4.5-20	1.4-3	0.5-0.7	71-200	4.5-6.6	0.007-0.02	16-23
Poor	1.9-2.6	15-36	15-150	48.7-90.6	21-85	4-8	0.8-1.4	201-560	6.7-12	0.03-0.05	24-43
Very poor	>2.6	>36	>150	>90.6	>85	>8	>1.4	>560	>12	>0.05	>43

Source: ANZECC/ARMCANZ, 2000b. Values based on 'level of protection (% species)' of 99%, 95%, 90%, 80%.

Table 2. Scoring categories and indicator values for toxicants (pesticides) in the water column as an indicator of estuarine condition.

Condition indicator: toxicants in the water column					
Condition score	**Indicator values (µg/L)**				
	Endosulfan	**Endrin**	**Chlorpyrifos**	**Temephos**	**Other pesticides**
Excellent	<0.005	<0.004	<0.0005	<0.0004	None detected
Good	0.005-0.01	0.004-0.008	0.0005-0.009	0.0004-0.05	
Fair	0.011-0.02	0.009-0.01	0.01-0.04	0.06-0.4	Trace concentrations

					detected
Poor	0.03-0.05	0.011-0.02	0.05-0.3	0.5-3.6	
Very poor	>0.05	>0.02	>0.3	>3.6	Significant concentrations detected

Source: ANZECC/ARMCANZ, 2000b. Values based on 'level of protection (% species)' of 99%, 95%, 90%, 80%.

Table 3. Scoring categories and indicator values for toxicants (metals) in the sediments as an indicator of estuarine condition.

Condition indicator: toxicants in the sediments											
Condition score	**Indicator values (mg/kg dry weight)**										
	Ag	**As**	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Sb**	**TBT** (µg Sn/kg dry wt)	**Zn**
Excellent	<1	<20	<1.5	<80	<65	<0.15	<21	<50	<2	<5	<200
Good											
Fair	1-3.7	20-70	1.5-10	80-370	65-270	0.15-1.0	21-52	50-220	2-25	5-70	200-410
Poor											
Very poor	>3.7	>70	>10	>370	>270	>1.0	>52	>220	>25	>70	>410

Source: ANZECC/ARMCANZ, 2000b. Values based on ISQG-Low and ISQG-High trigger values.

Table 4. Scoring categories and indicator values for toxicants (pesticides) in the sediments as an indicator of estuarine condition.

Condition indicator: toxicants in the sediments						
Condition score	**Indicator values (mg/kg dry weight)**					
	Total DDT	**Chlordane**	**Dieldrin**	**Endrin**	**Lindane**	**Other pesticides**
Excellent	<1.6	<0.5	<0.02	<0.02	<0.32	None detected
Good						
Fair	1.6-46	0.5-6	0.02-8	0.02-8	0.32-1	Trace concentrations detected
Poor						
Very poor	>46	>6	>8	>8	>1	Significant concentrations detected

Source: ANZECC/ARMCANZ, 2000b. Values based on ISQG-Low and ISQG-High trigger values.

Table 5. Scoring categories and indicator values for toxicants (metals) in biota as an indicator of estuarine condition.

Condition indicator: toxicants in biota							
Condition score	**Indicator value (metals; maximum value for any sample; mg/kg dry weight)**						
	Hg (molluscs, crustaceans, or fish)	**Pb (fish)**	**Pb (molluscs)**	**Cd (molluscs)**	**Inorganic As (crustaceans or fish)**	**Inorganic As (molluscs or seaweed)**	**'Natural' toxicants**
Excellent	<0.25	<0.25	<1	<1	<1	<0.5	None detected/detected at reference concentrations
Good							
Fair	0.25-0.5	0.25-	1-2	1-2	1-2	0.5-1	Trace

		0.5					concentrations detected/slightly above reference
Poor							
Very Poor	>0.5	>0.5	>2	>2	>2	>1	Significant high concentrations detected

Source: FSANZ, 2007. Food Standards Australia New Zealand website. http://www.foodstandards.gov.au/thecode/foodstandardscode.cfm. FSANZ has set maximum concentrations for some toxicants in seafood as part of the Australia New Zealand Food Standards Code. These maximum limits (presented here against condition 'very poor') are related to human consumption risk and are not related to the health of the individual seafood organism (or 'ecological health').

Table 6. Scoring categories and indicator values for toxicants (pesticides and non-metals) in biota as an indicator of estuarine condition.

Condition indicator: toxicants in biota									
Condition score	**Indicator value (pesticides and non-metals in crustaceans, molluscs or fish; maximum value for any sample; mg/kg)**								
	Aldrin and Dieldrin	**Chlordane**	**DDT**	**BHC (not Lindane) Sum of isomers of 1,2,3,4,5,6-Hexachlorocyclo-hexane**	**HCB Hexachloro-benzene**	**Lindane**	**Heptachlor**	**Poly-chlorinated biphenyls (total) (for fish only)**	**Other extraneous chemicals†**
Excellent	<0.05	<0.025	<0.5	<0.005	<0.05	<0.5	<0.025	<0.25	None detected
Good									
Fair	0.05-0.1	0.025-0.05	0.5-1	0.005-0.01	0.05-0.1	0.5-1	0.025-0.05	0.25-0.5	
Poor									
Very Poor	0.1	0.05	>1	0.01	0.1	>1	0.05	>0.5	Detected

Source: FSANZ, 2007. Food Standards Australia New Zealand website. http://www.foodstandards.gov.au/thecode/foodstandardscode.cfm. FSANZ has set maximum concentrations for some toxicants in seafood as part of the Australia New Zealand Food Standards Code. These maximum limits (presented here against condition score 5) are related to human consumption risk and are not related to the health of the individual seafood organism (or 'ecological health').

†The following extraneous chemicals are listed in the Australia New Zealand Food Standards Code and according to *Standard 1.4.2* their residues should NOT be found in crustaceans, molluscs or fish: Endosulfan, Dicofol, Fenarimol, Quintozene, Azamethiphos, Azinphos-ethyl, Azinphos-methyl, Coumaphos, Demeton, Diazinon, Dichlorvos, Dimethoate, Disulfoton, Dithianon, Ethion, Ethoprophos, Famphur, Fenamiphos, Fenchlorphos, Fenitrothion, Fenthion, Formothion, Maldison, Methamidophos, Methidathion, Mevinphos, Naphthalophos, Omethoate, Parathion-methyl, Phorate, Phosmet, Pirimiphos-ethyl, Pirimiphos-methyl, Prothiophos, Pyrazophos, Sulprofos, Temephos, Tetrachlorvinphos, Thiometon, Tributylphosphorotrithioate, Trichlorfon, Vamidothion, Mancozeb, Metiram, Propineb, Thiram, Zineb, Ziram, 2,4-D, Diclofop-methyl, MCPA, MCPB, Picloram, Aldicarb, Bendiocarb, Carbaryl, Iprodione, Methomyl, Oxamyl, Phenisopham, Promacyl, Promecarb, Propoxur, Thiobencarb, Diuron, Fluometuron, Linuron, Methabenzthiazuron, Thidiazuron, Parbendazole, Thiabendazole, Benomyl, Carbendazim, Thiophanate, Thiophanate-methyl, Ametryn, Atrazine, Cyanazine, Metribuzin, Prometryn, Propazine, Simazine, Terbutryn, Metolachlor, Propachlor, , Chlormequat, Diquat, Paraquat, Captan, Ethylene dibromide (EDB), Ethylene dichloride, Methyl bromide, Trichloroethylene, Fenbutatin Oxide, Cypermethrin, Deltamethrin, Fenvalerate, Permethrin, Pyrethrins,

Etridiazole, Dithiocarbamates, Mancozeb, Metham, Metiram, Propineb, Thiram and Ziram.

4.3 Confidentiality

Data confidentiality is the responsibility of the data custodian.

4.4 Data collation/calculation method

The development of regional summaries/reports for state and national managers will require the collation of local datasets. Scoring categories provided for local scoring (Tables 1–6) can also be used for scoring at a regional level.

4.5 Data analysis, integration and interpretation information

Any national/regional level information products (ie interpreted products) need to be linked to the regional/local information that was used to create them (ie to the relevant state/territory and regional databases/information systems). Any specific methodologies, assumptions, additional data and changes in confidence in the interpreted products need to be stated.

4.6 Data access and storage

National level products should be developed with the needs of the various stakeholders in mind. Data access and storage for national level products should be through a nationally known and recognised web site such as 'OzCoast and OzEstuaries'. Links should then be made to state/territory and regional web sites to access the underlying products/datasets.

4.7 Product definition statement

Each product should have a product definition statement. The metadata statement referred to in 3.8.

5. Current national activities

There are no national activities related to toxicant monitoring.

The National Pollutant Inventory (NPI) is a programme implemented by federal, state and territory governments to provide free information about substance emissions in Australia. It reports emission estimates for 93 toxic substances as well as the source and location of these emissions (http://www.npi.gov.au/).

6. Future development

More relevant (ie at least state/territory) toxicant guidelines need to be developed.

7. Links to other indicators

Animal or plant species abundance (indicator)

8. Further information

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9. Glossary

Additivity – Where the combined effect of two or more chemical substances is equal to the sum of the effects of each substance.

Ambient – prevailing (normal or typical) conditions.

Antagonism – Where the combined effect of two or more chemical substances is less than the sum of their individual effects.

Baseline data – Information collected to form a reference set for comparison of a second set of data collected at a later time; used to interpret changes over time usually after some condition has changed.

Bioaccumulation – The process by which the concentrations of toxic chemicals gradually

increase in living tissue.

Biota – All the organisms, including animals, plants, fungi, and microorganisms, found in a given area.

DDT – Dichloro-Diphenyl-Trichloroethane. A chlorinated hydrocarbon insecticide now banned in many countries.

ED – Empore Disk®

EnTox – National Research Centre for Environmental Toxicology

NATA – National Association of Testing Authorities. A laboratory accreditation organisation that evaluates and audits the capability and technical competence of accredited laboratories.

Non-polar – A non-polar molecule has an even distribution of positive and negative charges.

Passive – Not active (ie no energy required)

PDMS – Polydimethylsiloxane

PFM – Plaster Flow Monitor

Polar – A polar molecule has a negative charge on one side and a positive charge on the other.

SPMDs – Semipermeable Membrane Devices

Synergism – Where the combined effect of two or more chemical substances is greater than the sum of their individual effects.

Toxicant – Any chemical or mixture of chemicals that has the potential to cause acute or chronic adverse effects in animals or plants (ie presents a risk of death, disease, injury, or birth defects in organisms that ingest or absorb it).

Appendix A: Metadata statement

Monitoring program	The name of the monitoring program
Custodian of data/Contact	The business name and address/contact details of the custodial organisation or responsible party
Summary of program	A brief narrative summary of the program
Geographic extent	The ordinary name(s) of the locations where the data was collected (ie study area)
Indicators monitored	List of all indicators monitored
Method of data collection	Summary of the methods used to collect the data
Past/future sampling	Description of when sampling started, how often it occurred, when it will finish
Quality assurance	Description of the quality control/assurance procedures used
Data access	1) Location: Where and how the data is stored. If it can be accessed remotely (ie from a website) 2) Format in which dataset is stored and available 3) Any restriction or legal prerequisites that may apply to access and use the data
Other comments	Any other comments
Information source(s)	Where information on the program can be found (eg reports, literature, websites)
Date metadata created	Date when the metadata record was created