Indicators of estuarine condition and thresholds of potential concern (TPC)

What we found

Indicators of estuarine condition

Indicators for monitoring Tasmanian estuaries, coastal and marine environments were recommended in The Tasmanian Indicator Compendium (Mount et al. 2006) and summarised by Crawford (2006), including monitoring methods. The specific indicators to be monitored are determined by the objectives of each monitoring program. A range of indicators are required and it is recommend that stressors such as nutrients or turbidity, as well as ecological response indicators such as chlorophyll a, are monitored. If a response is detected, the likely causes can then be traced back via the stressors.

Indicators recommended for monitoring Tasmanian estuarine and coastal waters

- Temperature
- Salinity
- Dissolved oxygen (especially bottom waters)
- Turbidity
- Chlorophyll-a
- Habitat extent
- Animal and plant species abundance
- Shoreline position
- Nutrients in the water column
- Toxicants
- Pathogens
- Algal blooms
- Mass mortalities
- Litter
- Invasive species

These indicators include some that are readily measured by the community because they are on site to record unusual events, such as algal blooms or mass mortalities, and minimal training is required, whereas others require considerable experience, funding and specialist interpretation. For smaller estuaries, photographs taken at low tide from the exact same locations over a period of time can provide important information on habitat change, such as increase in sediment or nuisance macroalgae. In order to interpret the condition of an estuary using the indicators listed above, we recommend other contextual data are collected to aid our understanding of their vulnerability to human-induced change. These include bathymetry and basic hydrodynamics (tidal range, tidal prism and flushing rate) and entrance state.

When and where to monitor

The Estuarine Decision Tree (Fact Sheet 16) helps to identify the sensitivity of an estuary to human impact by classifying estuaries according to their rate of flushing. It also indicates where and when to monitor by identifying for each flushing class the time and location that the estuaries are most vulnerable, e.g. well flushed estuaries during low river flows over summer in the upper estuary. Generally a biological response, such as increased algal production, is more likely in summer when hours of daylight are longer and water temperatures are higher.

Monitoring, in particular for compliance purposes, requires a sufficient number of samples to be collected to be able to statistically demonstrate that a change in condition has occurred. There are numerous publications on sampling design, including the Australian and New Zealand Environment Conservation Council (ANZECC) (2000). However, in practice sufficient funds are often not available to sample at the required intensity, especially in smaller estuaries, and a trade-off between the statistical validation and available budget often occurs. In these instances, signs of deteriorating condition should trigger additional sampling.

Thresholds of Potential Concern (TPC)

Threshold values, often called ‘trigger values’, are values that signal that the environmental health is deteriorating to an unacceptable level, as determined from available data and previous knowledge. We have called these decision points ‘Thresholds of Potential Concern’ (TPCs, Gillson & Duffin 2007) as ‘trigger value’ has specific meaning in the national water quality ANZECC (2000) guidelines. The TPCs are our best estimate from the data available that environmental conditions are deteriorating and further assessment is required to determine whether the changes in conditions are temporary or are being sustained, and what is the likely cause of impact.

We have developed TPCs for the indicators of estuaries classified as well flushed and as poorly flushed. Thresholds for intermittently open and closed estuaries are more difficult to quantify because of the major fluctuations in their physical characteristics and there is insufficient data for these systems.

ANZECC Guidelines for Fresh and Marine Water Quality (2000) for estuaries in southeastern Australia have previously been used as default trigger values for Tasmania (i.e. a single value for all Tasmanian estuaries for each indicator). Our data suggest that these ANZECC trigger values are not suitable for all Tasmanian estuaries, especially well flushed systems. Importantly our data also show that the trigger values and subsequent interpretation will vary depending on where and when the sample is collected. Therefore, we have developed thresholds that differentiate between locations and times that are likely to respond differently. Additionally, our results highlight the importance of using both pressure-state indicators as well as ecological or value indicators in a monitoring program, e.g. nutrients and chlorophyll a.

Implications for managers and policy-makers

These estuarine indicators and TPCs provide a means for managers to interpret estuarine condition data that have been collected as part of estuarine health assessments. The TPCs provide a warning to managers that the estuary may be...
undergoing significant negative impact and that further assessments are required to determine whether this change in condition is a long term trend and if so, what is causing the change and can mitigation measures be implemented. Preferably managers will have already identified, as part of the establishment of the monitoring, evaluation and reporting process, the management actions that would be imposed to reverse the decline in condition.

How we did it

The median value (50th percentile) was used to set TPCs and expert opinion has then been used to further evaluate the suitability of these threshold values. Methods commonly used to determine trigger values include expert opinion and the 50th and 20th percentiles in reference estuaries (ANZECC 2000). Where there are few reference estuaries, the 25th percentile of all data from a range of estuaries has been recommended (US EPA 2000). In Tasmania an insufficient number of estuaries in each flushing class remain in near pristine condition to be used as reference sites and few estuaries have been routinely monitored for 24 months as recommended by ANZECC guidelines. However, most estuaries are not as degraded as those in the USA and the 25th percentile provided values that were too low.

Estuarian data collected in several monitoring programs were combined and classified according to the Estuarine Decision Tree. Location in well flushed estuaries was determined from position in the estuary and salinity of <25 or >25; upper and middle estuary sites were combined as they demonstrate similar responses. Poorly flushed estuaries were classified according to whether freshwater inflow was base flow or a flood event, determined by salinity >10 or <10, respectively. They were also grouped according to location; upper and middle site data were combined during flood events because they demonstrate similar responses, but floods were rarely sufficiently large to result in salinities <10 in the lower estuary. During base flows, however, the middle and lower estuary showed similar results whereas the upper estuary had the least flushing and greatest signs of deteriorating conditions.

TPCs for other indicators, including habitat extent and animal and plant species abundance, are currently under development. Habitat extent is determined by mapping the habitats (SeaMapTasmania www.utas.edu.au/tas/seaemap). Animal and plant species abundance in estuaries has mostly been assessed using infaunal macroinvertebrate assemblages; they are a useful integrator of estuarine condition because they are generally long-lived and immobile. Toxicants and pathogens are usually only monitored for specific purposes and assessed according to ANZECC guidelines.

References


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- five research institutions – University of Tasmania, Australian National University, RMIT University, Charles Sturt University and CSIRO; and
- state land management agencies in Tasmania and Victoria – the Tasmanian Department of Primary Industries, Parks, Water & Environment, Forestry Tasmania and the Victorian Department of Sustainability & Environment.

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