IEC Water Quality sub-index

Index of Estuary Condition

The Index of Estuary Condition (IEC) integrates information for five key aspects of estuary condition: Physical Form, Hydrology, Water Quality, Flora and Fish. These sub-indices are aggregated to provide an overall 'snapshot' measure of environmental condition at the time of monitoring.

Water quality influences most ecological and biogeochemical processes that support estuary ecosystem structure and function. Many estuarine organisms, such as submerged plants and fish, are also directly affected by water quality. Consequently, most programs monitoring estuary condition include measurements of water quality.

Water quality sampling was done in spring, summer and autumn as this timing corresponds to: 1) critical growth periods for submerged vegetation that need light to grow, 2) periods of elevated precipitation and potential runoff that can affect water quality and primary production, and 3) high pelagic phytoplankton concentrations (a contributor to turbidity). Sampling focused on the middle and upper zones of estuaries in an attempt to characterise impacts of catchment-based threats.

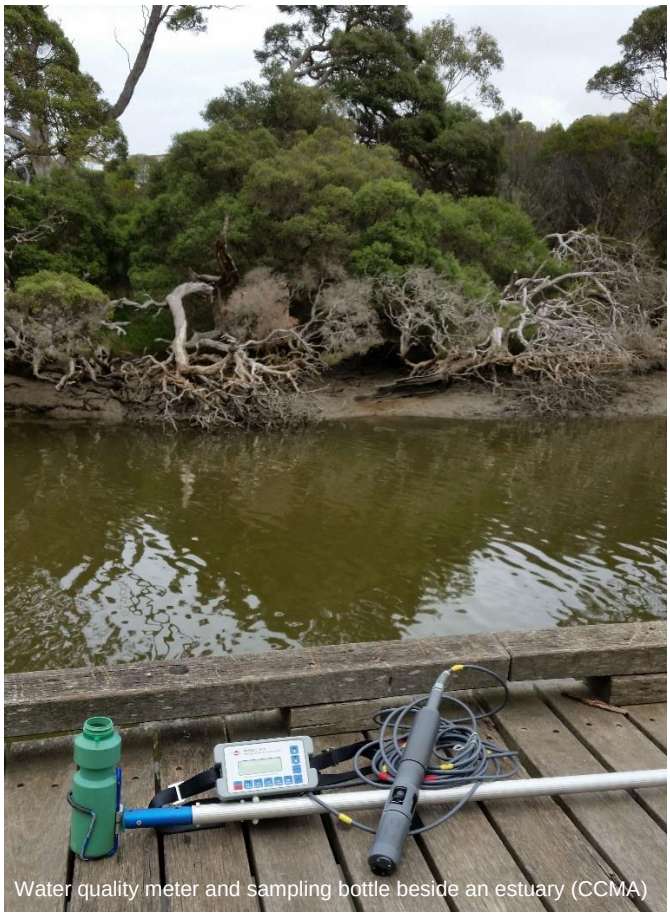
The IEC Water Quality sub-index has two measures:

1. Turbidity
2. Chlorophyll *a*

Turbidity

Turbidity is the degree to which light is scattered by particles suspended in a liquid. It is an important characteristic of the water column in estuaries because the depth of light penetration is a critical limiting factor in the type and extent of benthic vegetation. Elevated sediment inputs to estuaries increase turbidity, with repercussions for primary and secondary production. Turbidity is readily measured, provides a reasonable proxy for assessing the availability of light at depth, and can be considered an aspect of the physical condition of estuary waters.

Data from the middle and upper zones of estuaries were used in the calculation of the Turbidity measure, as these data are more likely to reflect impacts of catchment-based threats than data from the lower estuary zone. Using turbidity data from the lower zone for comparisons among estuaries is perilous in open estuaries because tidal amplitude will greatly influence turbidity values. Although tidal amplitude strongly influences estuary structure and function, it is an intrinsic characteristic of each estuary, whereas the focus of the IEC is on capturing impacts of anthropogenic pressures and stressors on estuary condition.



Water quality meter and sampling bottle beside an estuary (CCMA)

IEC Water Quality sub-index

Chlorophyll *a*

Anthropogenic land use usually increases inputs of nutrients to estuaries, and these inputs can be influenced by modified hydrology. Elevated nutrient inputs to estuaries can disrupt ecological processes such as primary production, nutrient cycling, energy transfers across trophic levels, and dynamics of consumer species. Pelagic primary producers (e.g. phytoplankton) and benthic plants capable of rapid nutrient uptake (e.g. macroalgae) respond quickly to nutrient enrichment.

Chlorophyll *a* is the critical pigment used during photosynthesis by phytoplankton. It is a common proxy metric for representing primary production in estuaries and other water bodies, often assessed in monitoring programs as a measure of condition representing anthropogenic eutrophication (nutrient enrichment).

Standardising water quality scores

For both Turbidity and Chlorophyll *a*, scores were determined in the context of compliance with appropriate standards. The proportion of values for either measure that exceeds the standard (i.e. non-compliance) provides a measure of condition based on water quality. However, these standards are being used to contextualise observed values in terms of ecological relevance, rather than to report on compliance with the standards per se.

The IEC uses the objectives for riverine estuaries set out in the State of the Environment Protection Policy (Waters) (2018) as the defined compliance value for the calculations of these two measures. These compliance values are based on the 75th percentile of observed values from a long-term dataset held by EPA Victoria, and are 10 NTU for turbidity, and 3 µg/L for chlorophyll *a*. The non-compliance values can range from 0 (i.e. all observed values are compliant) to 1 (i.e. all observed values are non-compliant). For estuaries where non-compliance was detected (i.e. the non-compliance value exceeded zero), the distance value describes the distance of an observed value that lies between the defined compliance value and the worst-expected value (98th percentile value), and is a measure of the magnitude of non-compliance.

Metric value = √(non- compliance value x distance value)

Table 1: Scoring criteria for Turbidity and Chlorophyll *a*

Metric values Turbidity	Metric values Chlorophyll *a*	Score
0	0	5
>0 – 0.18	>0 – 0.11	4
>0.18 – 0.31	>0.11 – 0.18	3
>0.31 – 0.6	>0.18 – 0.36	2
>0.6	>0.36	1

Calculating the Water Quality sub-index

Water Quality score = (((Turbidity score + Chlorophyll a score) – 2) x 9)/8 + 1

State-wide condition assessment programs provide information about the overall environmental condition of Victoria's waterways and are vital for guiding state and regional planning. The current approach is to rotate these assessments among estuaries, wetlands, and rivers at the long time-frames (10 years or more) expected for changes in condition at the broad spatial scales assessed, and in response to changes in threats, management regimes or environmental contexts. In the intervening periods, planning and management will be informed by targeted monitoring of key aquatic values and threats at specific waterway assets, evaluations of the effectiveness of management interventions, and strategic research to fill critical knowledge gaps.

For further details for IEC methods see:
DELWP (2021). Assessment of Victoria's estuaries using the Index of Estuary Condition: Background and Methods 2021.

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