

IEC Hydrology 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.

Estuaries are conduits through which the living and non-living entities in water can move between freshwater rivers and the marine environment. Hydrological connectivity is therefore a key feature of estuaries. Disruptions to this connectivity, via changes to either freshwater or marine inputs, can alter the fundamental nature of an estuary.

The IEC Hydrology sub-index has two measures:

1. Modification of Marine Exchange
2. Modification of Freshwater Inflows

Modification of Marine Exchange

The capacity for marine exchange in an estuary is a function of the channel's cross-sectional area and its connectivity to the marine environment. At estuary mouths, this is influenced by the relative balance between onshore sediment transport and ebb-tidal currents. The cross-sectional area of an estuary mouth is often altered by human activities. These activities include artificially opening and undertaking engineering works such as dredging and construction of training walls. In some cases, the entrances of intermittently closed estuaries have been engineered to remain permanently open. Changes in freshwater flows are also likely to alter the connectivity between estuaries and marine environments. The modification of hydrological exchange between estuaries and the marine environment can influence estuarine water quality, physical processes, geomorphology and floodplain inundation regimes, with repercussions for important ecological processes (e.g. organic matter breakdown, nutrient cycling) and biota. The metric used was different for intermittently and permanently opened estuaries.

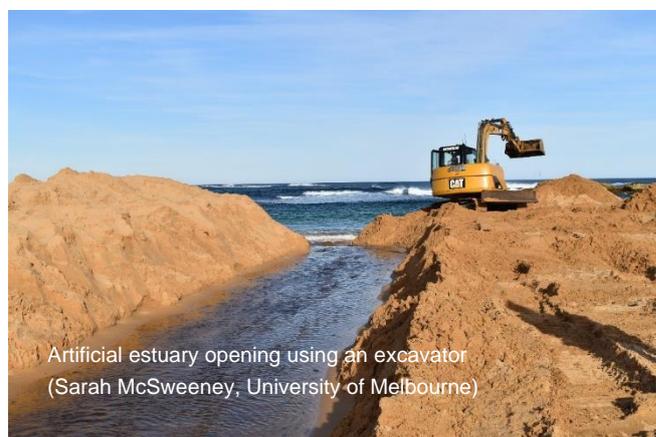
Percent Artificial Openings

In Victoria, ~90% of coastal estuaries intermittently close to the ocean. Entrance closure occurs during periods of low river flow where waves deliver sediment onshore to fill in the entrance channel. When closed, freshwater inflows influence environmental conditions within the estuary more than wave processes. Reopening occurs when the water level in the backing lagoon increases to overtop the berm and incise a channel at the estuary mouth. This typically occurs in response to high river flow or when ocean waves repeatedly wash over the berm.

To quantify the degree of modification to the natural opening regime of estuaries, the number of artificial openings was divided by the total number of known openings and converted to a percentage. Openings that occurred but whose mode was unknown were excluded from the calculation.

Table 1: Scoring criteria for Percent Artificial Openings metric for intermittently open and closed estuaries

% artificial openings	Score
0	5
1 - 50	4
51 - 74	3
75 - 99	2
100	1



Entrance Engineering Works

In permanently open estuaries, the calculation of Entrance Engineering Works was based on the occurrence and degree of constructed structures (i.e. training walls) and dredging at estuary entrances. These are typically aimed at increasing the cross-sectional area of estuary entrances to facilitate boat passage.

Table 2: Scoring criteria for Entrance Engineering Works metric for permanently open estuaries

Criteria	Score
Essentially natural marine exchange	5
Some modification of marine exchange: <ul style="list-style-type: none"> - at entrance, no entrance dredging, but engineered structures, or - artificially constructed entrance, or - major modification to marine exchange of the embayment or estuarine lake system into which the estuary enters 	3
Considerable modification of marine exchange: <ul style="list-style-type: none"> - entrance dredged, or - training walls present 	1

Modification of Freshwater Inflows

Modification of freshwater inflows to estuaries may alter: sediment and nutrient delivery; mixing of fresh and salt water layers; cues for significant life-history stages of biota, such as reproduction or migration; plus, entrance openings and connectivity with the marine environment.

The Modification of Freshwater Inflows measure is based on the volume of water that is stored within the estuary's catchment relative to the total volume of available runoff. The proxy metric Total Catchment Storage Volume was considered to be capable of distinguishing coarse differences in freshwater inflow modifications among Victorian estuaries, and is estimated using the volume of water storages within an estuary catchment. The proxy metric Water Availability was estimated using the Bureau of Meteorology's

Australian Water Resource Assessment Landscape modelled seasonal runoff (in winter and summer, see full report for details) across the catchment.

Table 3: Scoring criteria for Modification of Freshwater Inflows

Criteria	Score
No modification (0 - 0.0001% runoff intercepted)	5
Minor modification (>0.0001 - 5% runoff intercepted)	4
Moderate modification (>5 – 20% runoff intercepted)	3
High modification (>20 – 70% runoff intercepted)	2
Very high modification (>70% runoff intercepted)	1

Calculating the Hydrology sub-index

$$\text{Hydrology score} = (((\text{Modification of Marine Exchange score} \times 2) + (\text{Modification of Freshwater Inflows score} - 3) \times 9) / 17) + 1$$

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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