Estuaries are transition zones where rivers meet the ocean, creating an environment with large seasonal fluctuations in temperature, salinity, and light. These difficult growing conditions provide some unique challenges for seagrasses. In southwest Australia, estuaries are usually closed by a sand bar at the mouth, cutting them off from the ebb and flow of the tide for long periods. Winter rains flow down-river into the estuaries, raising the water level until it breaks through the sand bar. Seawater then starts to flow in and out with the tide until movement of sand along the beach by waves will once again close the sand bar, usually in late summer. Because of these seasonal changes, only a few types of seagrass such as *Ruppia*, *Halophila*, and *Zostera* grow in these estuaries. However, they are very important as they provide shelter and food for many species of fish, crabs, shellfish, and prawns.

Estuaries are often surrounded by Melaleuca wetlands, which add tannins to the water, resulting in a characteristic orange colour.

A *Ruppia megacarpa* flower with four main pollen sacs surrounding eight female carpels (large pollen sacs approximately 2 mm) (middle). The mouth of Wilson Inlet, one day after opening of the sand bar, showing the estuary water flooding out into the ocean (bottom).

**Rarely open estuaries**

- To the east of Cape Leeuwin, annual rainfall decreases. As there is less water flowing into the estuaries, the sand bars at the mouth of the estuaries are very rarely open (e.g., Dempster Estuary).

**Permanently open estuaries**

- Oyster Harbour

Southwest estuaries

Management issues

**Agricultural inputs**

Southwest estuaries are heavily impacted by agricultural activities, especially nutrient enrichment and increased salinity through loss of riparian vegetation and erosion due to catchment clearing. Nutrients cause blooms of algae which, along with increased sediment inputs, reduce light and can eventually lead to seagrass die-off.

**Urban expansion**

People enjoy living close to the water and, as a result, there is an increase in nutrients flowing into estuaries, e.g., from fertilised lawns. There is also high nutrient pressure from the sewage produced from large populations. These increased nutrients can lead to excess microbial and macroalgal growth, resulting in seagrass die-off.

**Estuaries with maintained permanent openings**

Some southwest estuaries have a managed, permanent opening to the ocean to reduce the effects of high nutrient input and improve boat access. However, these openings permanently change the ecology of habitats within the estuary and surrounding wetlands. Construction of associated developments may also impact seagrasses.

**Management responses**

**Better catchment management**

To reduce inputs to estuaries, changes need to be made in the catchment. Re-vegetation and fencing of streams will reduce erosion and slow water flow into the estuary, reducing sediment and nutrient inputs.

**Better wastewater and surface water management**

Reducing nutrient delivery from urban areas to estuaries can be achieved by improving sewage treatment, avoiding use of septic systems, and minimising impervious surfaces to reduce overland flow.

**Consideration of habitat changes**

Monitoring of habitat changes resulting from permanent openings and the effects of construction is essential to assess long-term effects on seagrass. Other issues such as nutrient inputs should also be effectively managed.