What next?

The ecosystem models help us understand the relationships between the physical and chemical features and ecological functions of Western Port. This will assist managers and stakeholders to take a holistic approach to planning and coordination of research and management.

Important gaps in the scientific understanding of Western Port marine ecosystems have been identified using these models. The challenge now is to identify the critical gaps in our knowledge and develop a coordinated and collaborative plan to address those gaps to ensure that Western Port can be managed for the benefit and enjoyment of the people of Victoria.

Building the ecosystem models

In cooperation with stakeholders and scientists, a series of models describing the whole-system understanding of the Western Port marine environment were developed (middle pages). These models communicate in a graphical way, the important physical, chemical and biological processes forming the foundation of the marine ecosystem in Western Port.

In many Australian estuarine environments, sediments, nutrients and hydrodynamics play key roles in driving and shaping the ecosystem; therefore the dynamics of these elements and processes affecting them are used as the basis of the conceptual understanding of Western Port.

The models will be updated as new science and knowledge of the Western Port ecosystems emerges.

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The full report, and copies of this brochure, can be downloaded from the Central Coastal Board's website.

CRC for Coastal Zone Estuary & Waterway Management · CSIRO · Central Coastal Board · Department of Sustainability and Environment Victoria · EPA Victoria · Melbourne Water · Port Phillip and Westernport Catchment Management Authority

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Victoria's Western Port Marine Ecosystems

Victoria's Western Port sustains a diverse range of human activities. Commercial activities include international and domestic shipping, fishing, tourism and aquaculture. Recreational activities are also an important element of the regional economy and include boating, fishing and aesthetic appreciation.

Western Port has been recognised internationally for its wetlands, which are listed under the Convention on Wetlands of International Importance. Significant seagrass, mangrove and saltmarsh communities exist within Western Port, which provide important habitats for a range of animals.

The Westernport catchment also supports a range of interests, including major industry (oil refinery, steel works), agriculture (cattle and sheep grazing, dairying, viticulture, poultry, nurseries, orchards), urban populations and conservation activities (community groups). Significant modifications have been made to the Westernport catchment, such as the draining and reclamation of the Koo-Wee-Rup swamp for agriculture.

Satellite image of Western Port - the embayment and its catchment. The brown coloured water represents shallow and turbid water over muddy tidal flats.

The Western Port Research Coordination Project

The ecological consequences of human activity in Western Port and its catchment are many and complex. The direct and indirect impacts have been manifested in several ways, including significant seagrass loss, declining fish stocks, degraded water quality and waterways, and loss of wetlands. Increased nutrient, sediment and toxicant loads from the catchment are key indicators and pressures upon Western Port.

This project was initiated because the stakeholders of Western Port were concerned about continuing impacts to the ecosystem and the potential economic consequences of those impacts in terms of paying for environmental repair or costs to activites dependent upon a healthy environment. A coordinated and cooperative approach is needed to address these impacts and manage Western Port through identifying priority research needs. Partners of this project are bringing together existing science to describe the Western Port marine environment and provide a whole-ecosystem picture of the important processes and elements of this embayment.

Western Port Marine Ecosystem Models

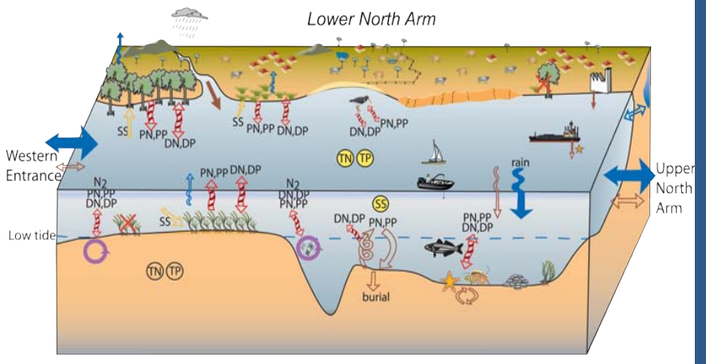
Western Port is a complex shape, containing two major islands and two entrances to Bass Strait. Different regions of the bay have different biophysical characteristics (landscapes, hydrology, sediment dynamics, etc.). To develop a scientifically robust and meaningful conceptual understanding of Western Port, the bay was divided into smaller basins with distinct biophysical properties (see Western Port whole ecosystem model below).
The waters of Western Port and its catchment are an interconnected system - the health of the catchment affects the health of Western Port. To properly manage Western Port, the links between the catchment and the bay need to be considered. Western Port covers an area of 680 km²; 40% is exposed mud flats at low tide. Western Port's coastline consists of cliffs, sandy beaches and mud flats with mangroves and saltmarshes.

Seventeen waterways discharge water from the Westernport catchment into the embayment. The major streams include the Bunyip, Bass and Lang Lang Rivers, which together contribute approximately 75% of the total freshwater inflow. These waterways deliver sediment to Western Port, originating from the erosion of gullies and stream banks in the catchment. Erosion of the shoreline in the Upper North Arm basin also contributes sediment to the bay. Because of the net clockwise direction of water flow within the bay, much of the sediment delivered into the north-east of the bay is transported into the Corinella and Rhyll basins where it is deposited. Water exchange with Bass Strait is high, particularly in the Western Entrance basin, because of the great width of the entrance. Water exchange via the Eastern Entrance (in the Rhyll basin) is much less.

Western Port whole ecosystem model

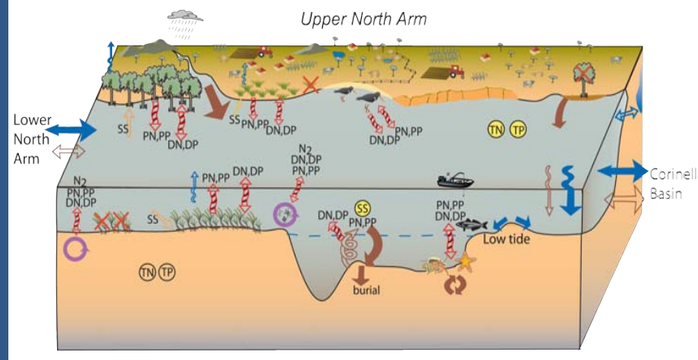
Key to the models. *The size of the arrows indicate the relative importance of the ecosystem process or element. Solid arrows indicate the importance is based upon existing knowledge. Hollow arrows indicate the importance is based upon 'best guess'. The amount of different ecosystem elements (eg seagrass) in the models is approximately representative of the actual amount present.*

- Intertidal seagrass (including benthic micro and macroalgae)
- Subtidal seagrass (including benthic micro and macroalgae)
- Seagrass
- Saltmarsh
- Mangroves
- Vegetation loss
- Rocks
- Planktonic fauna
- Benthic fauna
- Waterbirds and migratory birds
- Marine mammals
- Penguins
- Phytoplankton
- Grazing
- Industry
- Recreational and commercial fishing
- Recreational boating
- Commercial shipping
- Horticulture
- Tidal divide
- Marine National Park
- Water movement
- Net direction of movement
- High water mixing
- Sediments (coarse and fine)
- Sediment resuspension and deposition
- SS Sediments
- (SS) Water column concentrations of suspended sediments (SS)
- Nutrient & sediment movement
- Nutrient movement
- Microbial processing of nutrients
- DN, DP Dissolved nitrogen & dissolved phosphorus
- PN, PP Particulate nitrogen & particulate phosphorus
- N_2 Nitrogen gas
- (TN) (TP) Total nitrogen (TN), total phosphorus (TP) in the water column and/or sediments.



Lower North Arm Basin

The coastline here includes significant remnant mangrove and saltmarsh communities. Together with the intertidal seagrass beds, this vegetation is important for processing nutrients, trapping sediments and provides important habitat and food sources for marine fauna and birds. Although there are some naturally deep channels in this basin, much of the area is shallow intertidal mud flats. Water exchange is higher in the Lower North Arm than in the northeast of Western Port because of its closeness to the Western Entrance. The amount of catchment run-off is small compared to other basins in Western Port – more freshwater probably comes from rainfall directly into the basin. The land-based industries discharge small amounts of sediments and nutrients. The large international vessels visiting the port facility follow port procedures to reduce the risk of spreading marine pest through ballast water.

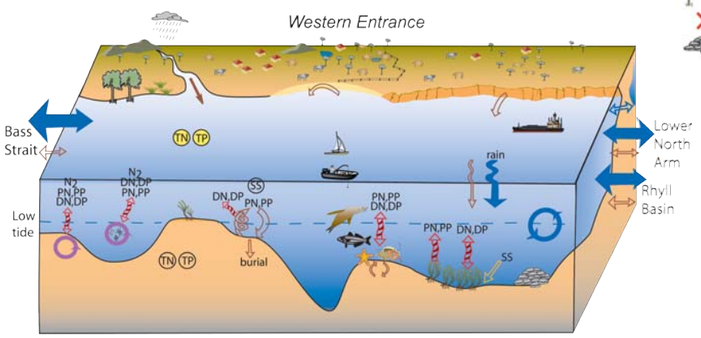


Upper North Arm Basin

Most of this area is intertidal mudflats with some seagrass, although large areas of seagrass have disappeared. Migratory waterbirds visit the saltmarshes and mudflats, nesting or searching for food. Catchment run-off is high, carrying with it high loads of sediments and probably nutrients. Large amounts of sediments also originate from erosion of foreshore banks, especially where mangroves and saltmarshes have disappeared. Many sediments settle to the bottom but resuspension of the sediments into the water is also high and the water is usually turbid. There is a net flow of water from this basin towards the Corinella basin and much of the suspended sediments are transported there. The nutrients in the water are higher than background levels but not above the national guidelines. The rates of water exchange are slow compared to other areas of Western Port and may be up to a couple of months duration.

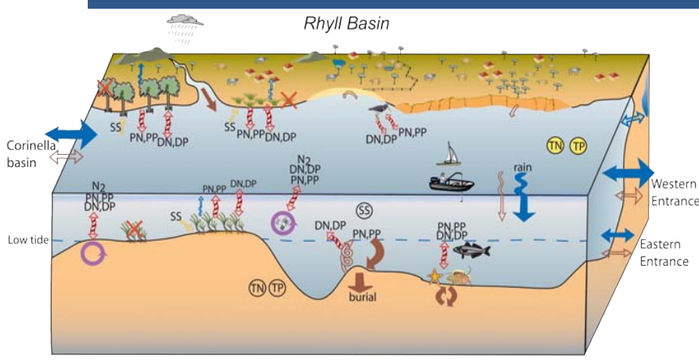
The key differences between the five basins of Western Port are summarised in the table below. The table shows the relative importance of some key factors defining each basin.

Basin	Inputs from adjoining catchment			Sedimentation rates within the basin	Tidal flushing
	Water	Sediment	Nutrients		
Western Entrance	Low-Medium	Low?	Low?	Low?	Very High
Lower North Arm	Low-Medium	Low-Medium?	Low-Medium?	Low - Medium?	Medium
Upper North Arm	High	High	High?	Medium - High	Low-Medium
Corinella	Low	Low	Low?	Very High	Low-Medium
Rhyll	Medium	Medium	Medium?	High	Medium



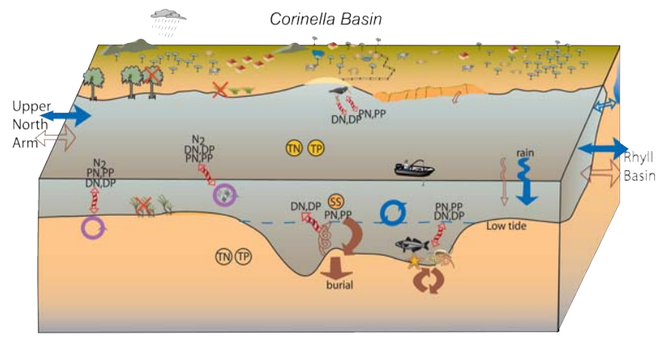
Western Entrance Basin

Water exchange in this basin is high due to the 10 km wide entrance to Bass Strait and the prevailing swell direction. Catchment run-off is low. Cliff erosion and the movement of sand along beaches contribute to the significant movement of sediment in Western Port. The high water flow means that little sediment is likely to settle in this basin. In the deeper areas healthy populations of subtidal seagrass such as *Amphibolis antarctica* are present – these seagrass beds play a role in nutrient processing, sediment trapping and provide food and habitat for fish and other fauna. Marine mammals, such as seals and dolphins, are often observed in this basin. The Western Entrance basin is a shipping channel for large vessels travelling to Hastings Port and is also commonly used for recreational activities such as boating and fishing.



Rhyll Basin

The Bass River discharges moderate volumes of water from the catchment in comparison to other basins in Western Port. Some pollutants, such as sediments and nutrients, are probably transported from the catchment to Western Port via this river. Some sediments originate from the erosion of cliffs and the foreshore. However, most sediments probably originate in the upper catchment, then are discharged into the Upper North Arm through major waterways and transported to the Rhyll basin through tidal water flows. Although there has been some historic loss of seagrass, some seagrass beds remain. Limited seawater exchange with Bass Strait occurs through the Eastern Entrance but most occurs through the Western Entrance.



Corinella Basin

No major waterways discharge into the Corinella basin – freshwater enters from rainfall into Western Port or from catchment run-off through the Upper North Arm basin. Without the direct discharge of waterways, the loads of sediments and nutrients from the adjoining catchment area are low. However, high loads of sediments from the upper catchment are transported here through the Upper North Arm. In the Corinella basin the rate of sediments settling to the bottom is high. The fauna that live in the sediment mix the upper layers moving some of the older sediments and nutrients to the surface. Resuspension of sediments into the water column is also high and the water is often turbid. Seagrass has been lost from this basin but some seagrass beds remain and more may be recovering. Mangroves and saltmarshes have also been lost from the coastline.