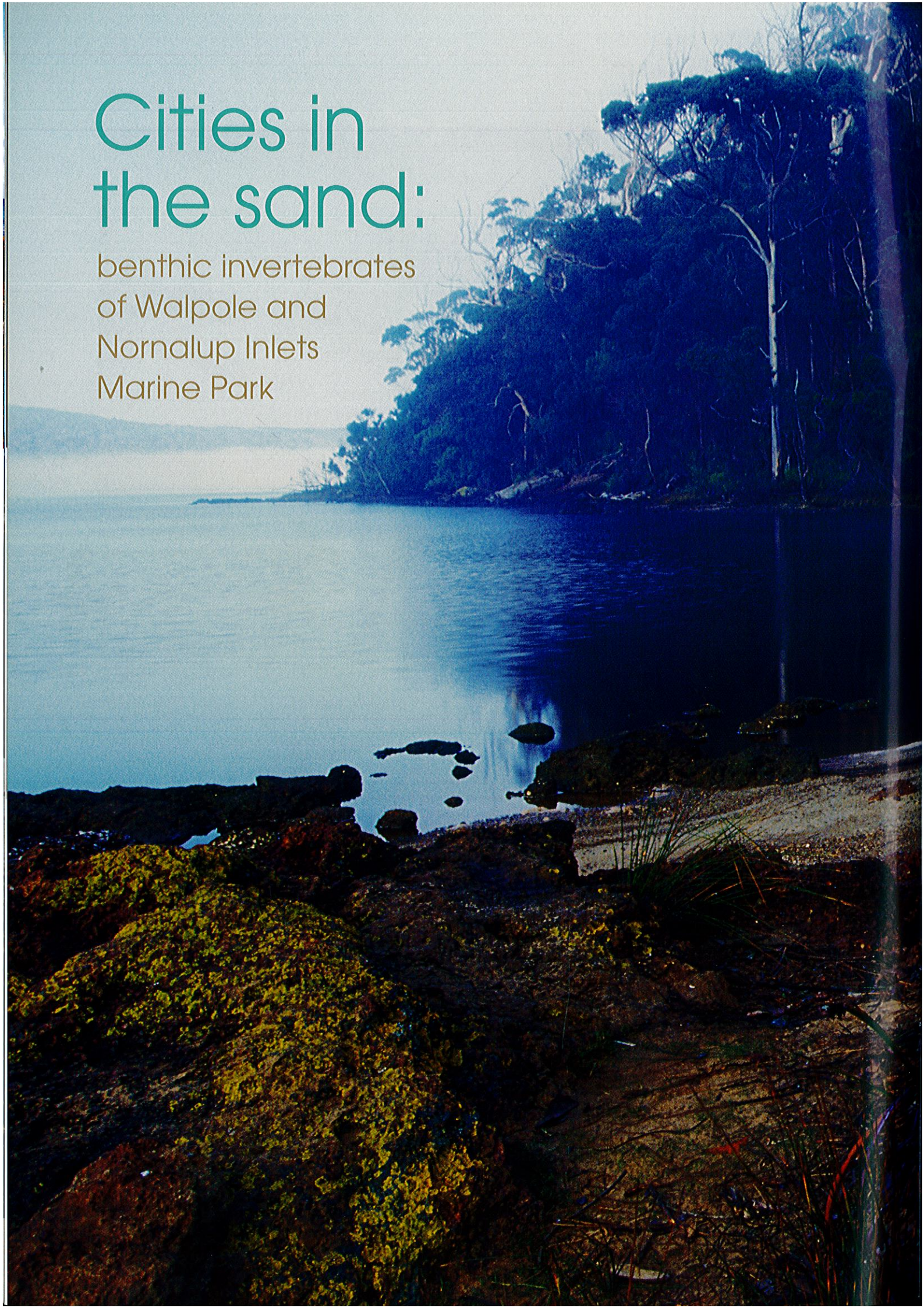
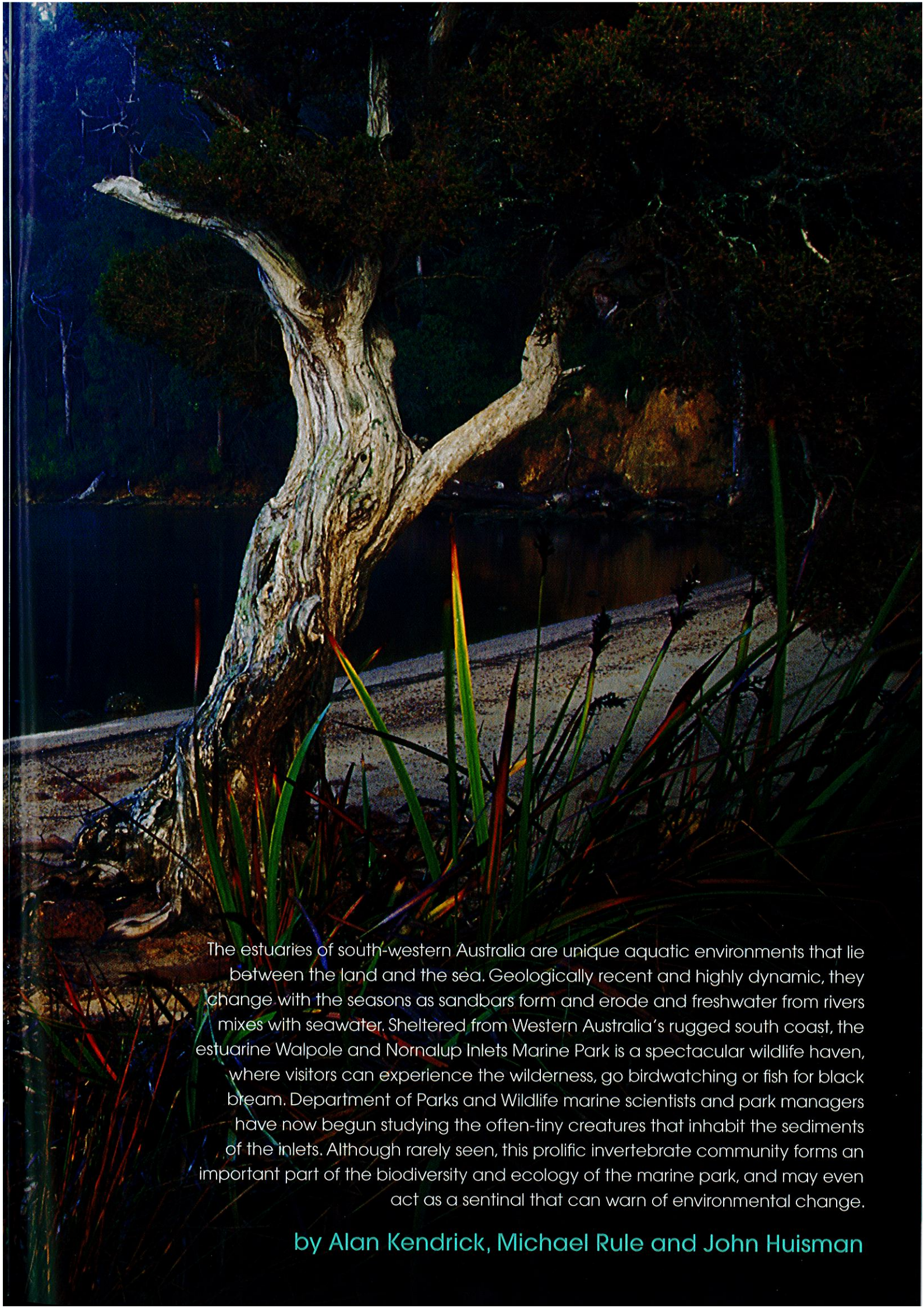
Cities in the sand:

benthic invertebrates of Walpole and Nornalup Inlets Marine Park



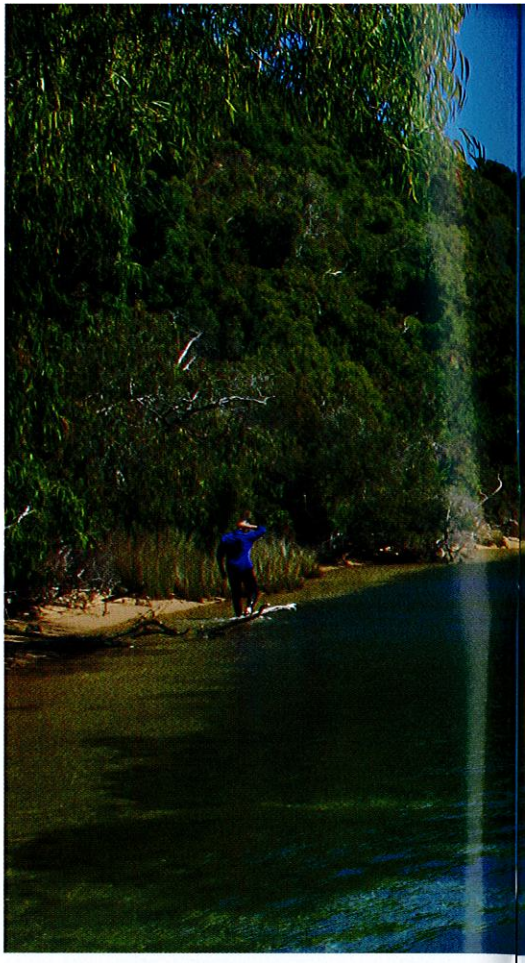


The estuaries of south-western Australia are unique aquatic environments that lie between the land and the sea. Geologically recent and highly dynamic, they change with the seasons as sandbars form and erode and freshwater from rivers mixes with seawater. Sheltered from Western Australia's rugged south coast, the estuarine Walpole and Nornalup Inlets Marine Park is a spectacular wildlife haven, where visitors can experience the wilderness, go birdwatching or fish for black bream. Department of Parks and Wildlife marine scientists and park managers have now begun studying the often-tiny creatures that inhabit the sediments of the inlets. Although rarely seen, this prolific invertebrate community forms an important part of the biodiversity and ecology of the marine park, and may even act as a sentinal that can warn of environmental change.

by Alan Kendrick, Michael Rule and John Huisman

Few visitors walking along the shore or boating in the Walpole and Nornalup inlets would pay much attention to the expanse of sand and oozing black mud that makes up the seabed of the marine park. This is understandable; after all, what could possibly be interesting about sand and mud? Taking a closer look, however, reveals that these seemingly barren sediments actually provide habitat for a largely hidden invertebrate community that represents a significant proportion of the biodiversity of the inlets. Often tiny and rarely seen, these animals are ecologically important, as they process nutrients and provide a vital food source for larger animals such as fish and birds. For these reasons, benthic (bottom-dwelling) invertebrates are recognised as a key value of the marine park, and ensuring this community remains healthy is an important aim of environmental management.

Department of Parks and Wildlife (DPaW) scientists are now undertaking a detailed study of how benthic invertebrates are distributed within the inlets and how this community varies over time, particularly in relation to the seasonal environmental changes that typically occur there. In each season over the past three years, numerous samples of sediment containing invertebrates were collected around the inlets, using a core sampler in shallow water and a grab sampler in deeper basins. The core sampler is a wide cylinder that is pushed into the substratum to extract a core, while the steel-jawed grab sampler is lowered to the seabed on a rope and takes a 'bite' of the seabed when triggered from above. Many hours were then spent in the laboratory, sorting the tiny animals from the sediment and identifying them. This research has provided DPaW scientists with a new understanding of how these animals use the inlets, and builds upon earlier work undertaken by Western Australia's pioneering estuary researchers such as the late Ernest Hodgkin.



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Main Walpole and Nornalup Inlets Marine Park.
Photo – Brett Dennis/Lochman Transparencies

Below 'Grab' sampling in deeper waters in the marine park.
Photo – Michael Rule/DPaW

Unique estuarine environment

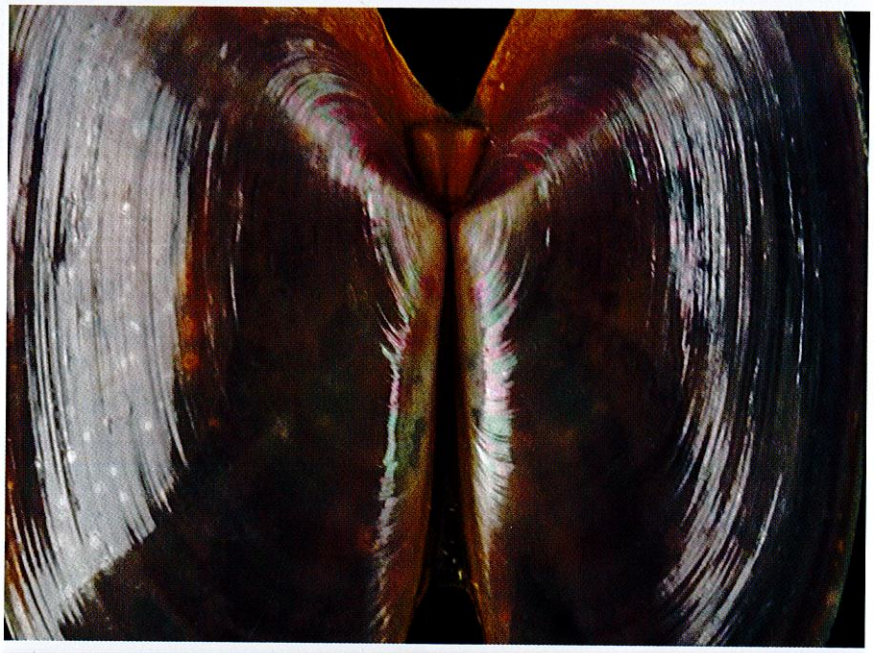
Estuaries are typically highly variable environments that form where a river meets the sea and creates a brackish water body. The environment that exists within an individual estuary depends on various factors, such as the underlying geology and climate of the region, and the tides and waves of the adjacent ocean. Estuarine water is typically marine-like in the lower reaches and becomes increasingly fresh as you move away from the ocean. These gradients, however, can change dramatically if large volumes of freshwater enter the estuary from surrounding catchments, or if they undergo extended periods without rain. In the absence of freshwater flows, many estuaries on exposed coasts are periodically closed from the sea by sandbars formed by wave action. These closures can lead to hypersaline conditions forming in the estuary until rainfall or human intervention again enables a connection to the sea. While providing attractive sheltered

Above Vegetation meets the water at Walpole and Nornalup Inlets Marine Park.
Photo – Michael Rule/DPaW

Right Conducting research in the marine park.
Photo – Alan Kendrick/DPaW

habitats for many organisms, few aquatic species can consistently tolerate the environmental gradients and seasonal changes that typically occur in estuaries. Mobile species often move in and out of the systems as conditions change, while fast-growing sedentary species may die and only re-colonise the estuary when suitable conditions return. For this reason, estuaries are typically dominated by high numbers of relatively few species compared to the adjacent ocean.

The Walpole and Nornalup inlets differ from most estuaries in Australia's south-west because they are not closed by a seasonal wave-formed sandbar and are therefore permanently open to the sea. This is probably due to the high rainfall in this part of WA and the presence of a large rocky headland adjacent to the ocean entrance that limits the influence of waves on the inlet entrance. The estuary comprises two connected basin inlets—the smaller Walpole and the larger Nornalup, which is connected to the sea by a narrow channel. The Frankland and Deep rivers discharge into the Nornalup Inlet, while the smaller Walpole River flows into the Walpole Inlet. The bottom of the shallow Walpole Inlet and the deeper basin of the Nornalup Inlet consist of fine, organically rich black silt that has accumulated in the inlets over many centuries. In stark contrast, the entrance channel and the large, shallow margins of the Nornalup Inlet consist of clean white sands. This study has found that, like many other estuaries, the benthic invertebrate community of the Walpole and Nornalup inlets is dominated by molluscs, crustaceans and polychaete worms.



Left Sandy Beach, Nornalup Inlet.
Photo – Len Stewart/Lochman Transparencies

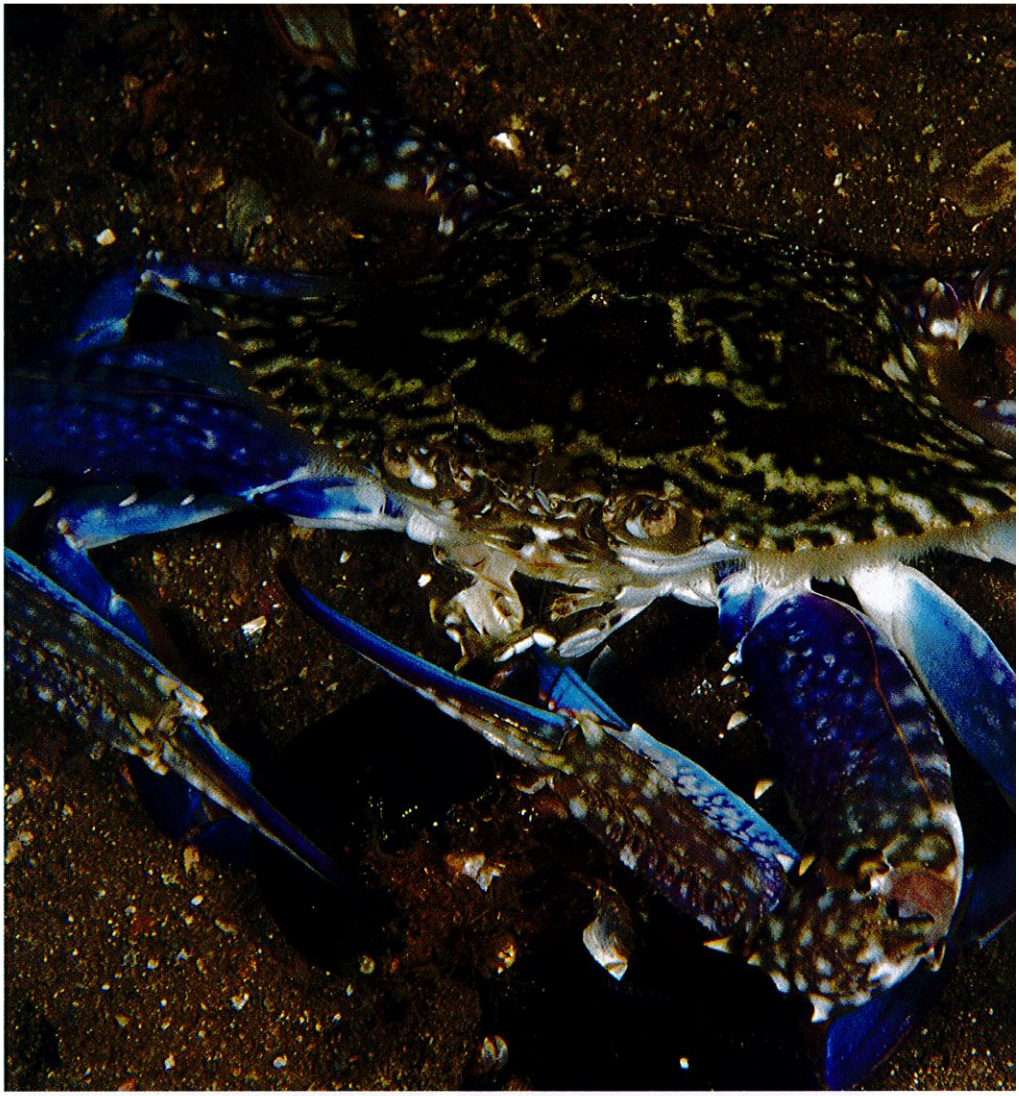
Centre left The bivalve *Soletellina alba*.

Bottom left The bivalve *Katelysia scalarina*.
Photos – John Huisman/DPaW

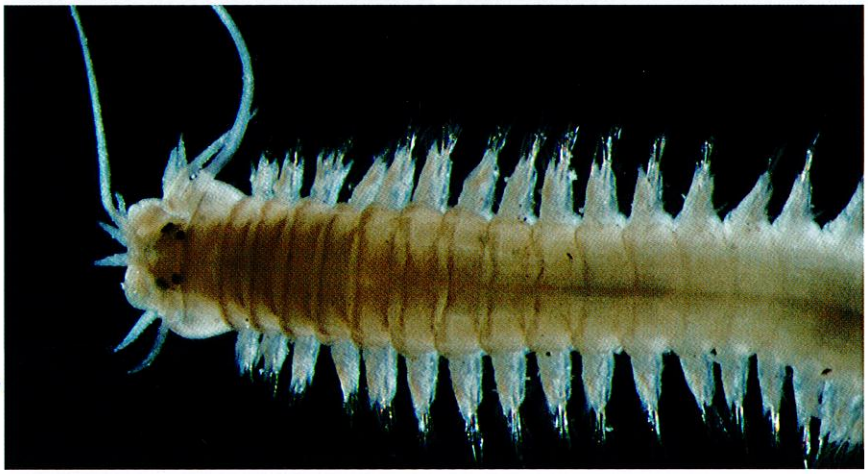
Molluscs

More than 20 species of molluscs were found in the inlets during this study, the most abundant of which were bivalves that burrow into the soft sand or mud sediments. Here they remain hidden from predators, often feeding on organic detritus drawn into an inconspicuous siphon that protrudes up into the water column. The most common of these was the four to five centimetre long sunset shell (*Soletellina alba*), so named because of the pale ray-like stripes on the shell. While *S. alba* was commonly found burrowing into the clean shallow sands around the Nornalup Inlet and in the entrance channel, other relatively common bivalve species occupied different habitats. The round white lucinid bivalve *Wallucina assimilis* was mostly found buried among the rhizomes of the ephemeral seagrass *Zostera polychlamys* in or near the entrance channel, while the translucent and fragile *Theora lubrica* was found only in the silty mud of the deeper inlet basin. Originally confined to shallow muddy habitats across eastern Asia, *Theora* is thought to have reached Australia and other locations around the world in ballast water or on fouled vessel hulls.

More visible than the burrowing bivalves and quite common in the inlets is the dog whelk *Nassarius burchardi*, which grows to about one centimetre long and lives on the sand surface. These scavengers can often be seen aggregating near potential food such as dead fish. A more unusual mollusc is the sea slug *Philine angasi*, which is five to six centimetres long with pale fleshy lobes on its body and a delicate internal shell that is not visible. *Philine* was most common in the deeper silty habitats of the inlets, where it preys on other molluscs.



Right Blue swimmer crab.
Photo – Alex Steffe/Lochman Transparencies



Below right A polychaete worm.
Photo – John Huisman/DPaW

Crustaceans

While the large blue swimmer crab (*Portunus pelagicus*) may be the most visible crustacean in the inlets, by far the most common are tiny species such as amphipods, isopods, copepods and mysids that rarely exceed five millimetres in length. What they lack in size, these tiny crustaceans make up in numbers and they can occur in very high densities in some habitats. Benthic-dwelling species, such as the common estuarine amphipods *Melita* and *Corophium*, anthurid isopods and harpacticoid copepods, may live in sediments or among the shelter provided by algae fronds or seagrass leaves. Other small crustaceans, such as the shrimp-like mysids, swarm in the water just above the seabed.

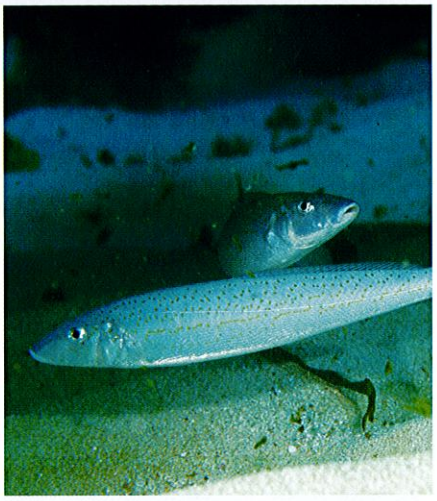
Polychaete worms

Polychaetes are very diverse and often highly specialised worms that can inhabit estuarine and marine sediments in very high numbers. Although related to humble terrestrial earthworms, the segmented bodies of polychaetes can be elaborately adorned with bristles, tentacles and lobe-like appendages called parapodia. Polychaetes can be either errant (free moving) or sedentary, in which case they often live within a secreted tube buried in the sediment. Some polychaetes are predatory carnivores with powerful jaws, while others digest organic material from ingested mud and sand, or filter organic particles from the water with complex frond-like mouthparts.

The two most abundant polychaete worms in the Walpole and Nornalup inlets are relatively nondescript species that are common in estuarine sediments. The earthworm-like capitellid *Heteromastus* is most abundant in the organically enriched muddy basins, while the orbiniid *Scoloplos normalis* is more commonly associated with sandy sediments. Other polychaetes that occur in sandy habitats of the inlets are the opheliid *Armandia*, the spionid *Pseudopolydora kempi* and the nereidid *Simplisetia aequisetis*, which was particularly common at some locations within the Walpole Inlet.

More unusual residents

Less common members of the benthic invertebrate community of the inlets include sediment-dwelling worms with evocatively descriptive names such as peanut worms (sipunculids), ribbon worms (nemerteans), round worms (nematodes) and flatworms (platyhelminths). These small worms are not segmented like polychaetes, and some have an amorphous, blob-like appearance. Interestingly, some insect larvae also occur in the inlet waters, and the most abundant of these are chironomid midges, which can be common among algae and seagrass. As adults, these midges swarm near the water and lay their eggs on vegetation at the water surface.



Above Tranquil scenes in Walpole and Nornalup Inlets Marine Park.
Photo – Michael Rule/DPaW

Far left An amphipod.
Photo – John Huisman/DPaW

Left King George whiting.
Photo – Eva Boogaard/Lochman Transparencies

Research informs management

This study has markedly increased knowledge of the benthic invertebrate community in the marine park. While dominated by about 20 very abundant species, more than 100 different invertebrate species have been identified so far. This is a higher diversity than had previously been recorded in the inlets, which may simply reflect the fact that more sampling was conducted in this study. The large number of invertebrate species in the inlets is probably due to the strong marine influence caused by the permanently open entrance to the sea. This oceanic influence may also explain why some species that are common in nearby estuaries, such as the small bivalve *Arthritica semen*, appear to be far less abundant in this estuary.

Understanding the ecological significance of this community is just as important as documenting its composition. Many small invertebrates feed on organic material derived from decomposing algae, seagrass and other animals, which they collect by foraging within the sediment, on the seabed, or by filtering particles of food from the water. In this manner, small invertebrates recycle nutrients before they, in turn, become prey for the larger animals that inhabit the estuary. Benthic invertebrates are an important food source for many fish that inhabit the inlets, such as black bream (*Acanthopagrus butcheri*) and King George whiting (*Sillaginodes punctata*). Many fish begin eating small prey, such as amphipods and polychaetes, when they are juveniles, before progressing to larger prey items such as bivalves and shrimps as they grow. The numerous stingrays that live in the Walpole and Nornalup inlets leave characteristic circular pits in the sediment where they have foraged for benthic invertebrates. At low tide, pied oystercatchers (*Haematopus longirostris*) can be seen on exposed sand banks using their long beaks to probe for bivalves.

Importantly for management, benthic invertebrate communities can be sensitive indicators of environmental change. As outlined above, estuaries vary naturally, and part of this research has been devoted to identifying how these invertebrates respond to the changes in salinity and temperature that may occur seasonally, depending on when river flow is greatest. Understanding such natural variation is important in relation to recognising possible additional changes caused by human impacts. Estuaries are extremely susceptible to human impacts, such as pollution and elevated nutrient levels,

Right Pelicans in Walpole and Nornalup Inlets Marine Park.
Photo – Michael Rule/DPaW

Centre right Pied oystercatcher.
Photo – Alan Kendrick/DPaW

Bottom right Walpole and Nornalup Inlets Marine Park is known for its scenic beauty.
Photo – Michael Rule/DPaW

because they are often a focus for urban development and are influenced by run-off from surrounding catchments. While some of WA's temperate estuaries exhibit obvious impacts of this kind, such changes can also be quite subtle and occur slowly over time. In these instances, variations in the benthic invertebrate community can alert managers that changes are taking place. For example, some species, such as the capitellid polychaete *Capitella capitata*, respond quickly to nutrient enrichment and can be very abundant in eutrophic (nutrient-rich) environments.

Following this research, DPaW scientists and local marine park staff will implement a long-term program to periodically monitor benthic invertebrates and other key values of the marine park. It is anticipated that community volunteers will have the opportunity to take part in this work. This monitoring will enable managers to assess the condition of the marine park and the way it varies over time, to determine if changes need to be made in how the park is managed. The Walpole and Nornalup inlets comprise one of south-west WA's most intact estuarine systems, and their high ecological and social values led to the estuary becoming a marine park in 2009. This and other research being undertaken by DPaW marine scientists and management staff is helping to better understand the hidden occupants of the inlets' cities in the sand. Research and monitoring play a key role in building our understanding of the ecology of WA's diverse system of marine parks and reserves, and ensures that management continues to be guided by sound scientific knowledge.

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