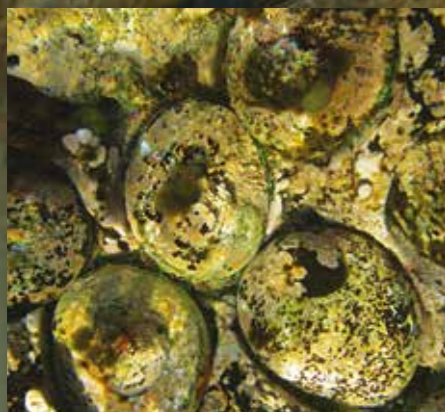


□ Life on the edge:
intertidal reefs of the
Marmion and Shoalwater Islands
marine parks

□ Many people are familiar with the intertidal rocky reefs along Perth's beaches as places to fossick among tide pools during the calm low tides of summer, or watch powerful waves crash onto the shore during winter storms. Others may visit these reefs to collect abalone during the recreational fishing season, or to indulge in a spot of line fishing. Very few people, however, realise that these reefs also support complex assemblages of algae and animals, many of which are specially adapted to live in these characteristically harsh environments perilously positioned between land and sea.

by Alan Kendrick,
John Huisman and
Michael Rule



The Perth area has a magnificent coastline of white sandy beaches interspersed with limestone outcrops and headlands that extend offshore as a series of islands, emergent rocks and shallow reefs. This distinctive coast is geologically recent, having been formed in the past 10,000 years by sea level changes and the accretion, and subsequent erosion, of relictual dune systems that now form rocky features such as Cape Péron and Penguin, Garden and Carnac islands, and the complex offshore limestone reefs that lie roughly parallel with the coast.

Centuries of relentless wave action has sculptured many of these intertidal and shallow reef platforms into distinctive shapes. While isolated offshore patch reefs typically form a flat platform, those adjacent to rocky shores are commonly eroded into a flat reef platform backed by an undercut or 'notched' cliff on the landward side. The platform width varies markedly; those at Rottnest Island can be more than 50 metres wide and are typically larger than those on the adjacent

mainland. The reef platforms vary in structure from being relatively level to very irregular due to the presence of gutters and rockpools. The seaward platform edge is frequently raised into a rim, beneath which the reef falls away in a vertical or undercut face to the seabed below.

Intertidal reefs are difficult places to live. In calm weather, falling tides can leave them exposed above the water level for several hours at a time, and they can be subjected to temperatures significantly above or below that of the receding water. On a hot summer day, desiccation and heat stress can kill many organisms, while during winter storms the same reefs can be pounded

by large waves, which can strip away seaweeds and dislodge many animals. The typical seasonal build-up and erosion of sand along the coast can also periodically bury shoreline reefs and smother many of the organisms living on them. Despite such disturbances and destructive events, intertidal reefs are typically fertile environments crowded with algae and animals of various forms. For many years marine scientists have been studying these fascinating habitats.

The unique habitats and biological assemblages of these distinctive reef structures have been identified as key ecological values in the Marmion and Shoalwater Islands marine parks, which are located adjacent to Perth's busy metropolitan coast. Scientists from the Department of Environment and Conservation's (DEC's) Marine Science Program and WA Herbarium, together with marine park staff from DEC's Swan Coastal District, have been undertaking research since 2009 to better understand these communities.

In addition to documenting the composition of algal and invertebrate communities on shoreline and offshore intertidal reefs, this work will contribute to long-term monitoring and management of these habitats in both marine parks.

Life on the reef

The potential for organisms to dry out when receding tidal water levels expose them to the sun and air, combined with the effects of wave action, are major factors that influence what plants and animals can live on intertidal reefs, and exactly where on the reef platform they can occur. As anyone familiar with the coast will know, the ebb and flow of the tides can fluctuate considerably. Tides are caused by the gravitational pull of the moon and, to a lesser extent, the sun. When the sun and moon form a straight line with the Earth (at a new moon or full moon), this force is at its greatest and the tides will be at their largest range. These extreme tides are called 'spring' tides and they expose

areas of the reef that usually remain submerged. Conversely, the smallest tides, known as 'neap' tides, occur when the moon is at right angles to the Earth-sun axis, as the gravitational pull of the sun dampens that of the moon. Overlaying these varying, but essentially predictable, patterns are the effects of local and regional weather. Onshore winds, a regular feature of the Perth coast, can often have a marked effect on the tidal level by pushing the water onto the shore.

A notable feature of nearly all intertidal reef communities is zonation, which is linked to tidal cycles and refers to the patterns by which organisms are vertically distributed on the shore. As the tide recedes, various parts of the reef platform are exposed to the air for longer or shorter periods. The upper intertidal is the first to be uncovered and remains exposed for the longest, as it is also the last to be inundated again by the incoming tide. Conversely, the lower intertidal is exposed for only a short period. Based on this degree of exposure, biologists divide the reef into

several zones. The uppermost, known as the supra-littoral, barely qualifies as intertidal as it is typically only inundated by large waves and the highest of tides; its moisture is more usually derived from sea spray. This zone supports only a few hardy species of cyanobacteria, barnacles and molluscs. Common in this zone around Perth is the small blue periwinkle (*Austrolittorina unifasciata*). Animals living in this zone typically have a tough, desiccation-resistant shell and exhibit physiological and behavioural adaptations that further retard water loss, such as congregating in crevices and shady areas where a moist microclimate reduces the impact of exposure. The degree of tidal inundation then typically increases below this relatively dry zone, such that the lowest (or sublittoral) fringe of the reef is only occasionally exposed during the lowest of tides.

Being inundated for longer periods, the reef flat itself may support dense algae, such as *Sargassum*, and many small crustaceans, echinoderms and molluscs that live among this algal canopy and



● Marmion and Shoalwater Islands marine parks



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Main Cape Péron in Shoalwater Islands Marine Park.

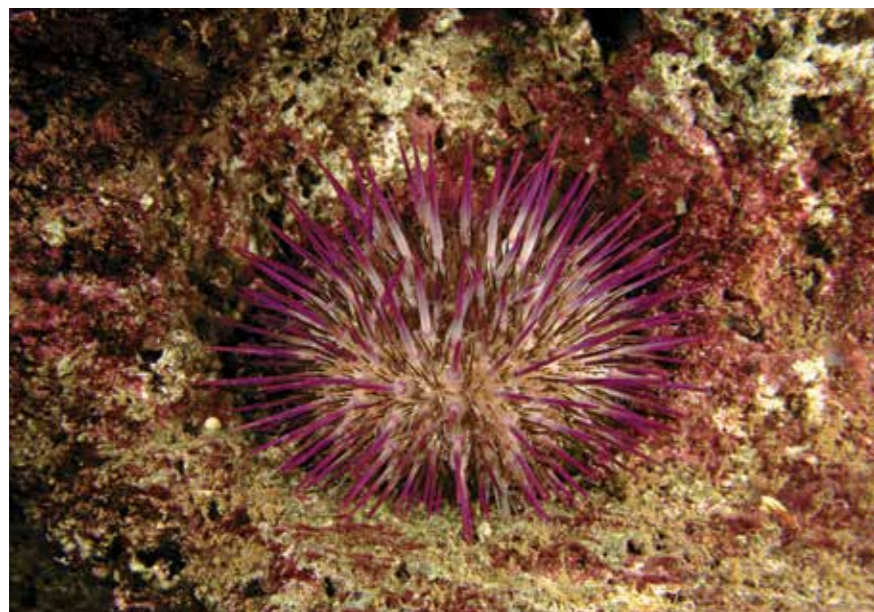
Insets (left) Roe's abalone; (middle) a pair of sea anemones; (right) a sea hare.

Above An eleven-armed starfish.

Left An early morning reef survey in Marmion Marine Park.

Photos - John Huisman/DEC





in the shelter provided by rock pools and crevices in the rock. However, just occasionally, when very low tides occur on a particularly hot and still summer day, these areas of the reef may experience massive mortalities as algae and invertebrates are exposed to intolerable drying and/or heat. While it is distressing to see such events occur, they are entirely natural and the reefs are soon recolonised by a suite of similar organisms.

The seaward crest of the intertidal reef is that part most subject to wave action, and is typically the realm of a relatively few species that can tolerate such high-energy conditions. Here, the cover of foliose seaweeds is often considerably reduced and the reef is covered with encrusting calcified algae, which appear as a light pink coating on the rock surface. The fauna is dominated by robust grazing molluscs, such as Roe's abalone (*Haliotis roei*), limpets and chitons that are able to cope with the rough conditions by adhering strongly to the rock surface. While the diversity of organisms on the seaward crest may be low, these molluscs happily live in very high densities and hundreds of individuals per square metre have been recorded.

Intertidal reefs

Surveys currently being carried out on intertidal reefs of the Marmion and Shoalwater Islands marine parks have so far recorded more than 100 species of algae, and more than 100 animal species. The most conspicuous algae is the large brown *Sargassum*, which can dominate the lower intertidal reef platforms, particularly during periods when plants are reproducing. Several algal species, such as the sea lettuce

Top left The outer edge of an intertidal reef.
Photo – Michael Rule/DEC

Centre left A high density of red waratah anemones and coralline algae-covered limpets.
Photo – Alan Kendrick/DEC

Left A purple sea urchin.
Photo – John Huisman/DEC

Right A shoreline intertidal reef in Shoalwater Islands Marine Park.
Photo – John Huisman/DEC

Ulva, occur on all of the reefs, but each reef also has a unique assemblage of species, possibly as a result of small variations in physical conditions such as the degree of exposure, or differences in the type and number of herbivores. The presence of rare species, such as the delicate feathery Struve's weed (*Struvea plumosa*), may be due to the entirely chance settlement of the alga's reproductive bodies on a piece of suitable habitat in the short period after they had been released from the parent. Most of the animals recorded have been molluscs and echinoderms with lesser numbers of crustaceans such as crabs and barnacles. The most prominent invertebrates inhabiting these metropolitan area reefs are large gastropods such as the turban shell (*Turbo torquatus*), Roe's abalone and the predatory cart-rut shell (*Dicathais orbita*), so named because of the distinct ridges in the shell. The most conspicuous echinoderms are the eleven-armed starfish (*Coscinasterias muricata*) and the purple sea urchin (*Heliocidaris erythrogramma*). Although also quite abundant, the six-armed starfish (*Meridiastra occidentalis*) typically remains well camouflaged within holes and crevices.

Despite the obvious nature of these larger animals, the most abundant molluscs on Perth's rocky shores tend to be much smaller and less obvious to the eye. The top shell (*Cantharidus pulcherrimus*) and dove shell (*Pyrene bidentata*) can live in very high densities among algae on the reef platform, while periwinkles such as *Austrolittorina unifasciata* and *Echinolittorina australis* can be abundant on rocks high on the shore. Several limpet species, including the ribbed limpet (*Patelloida alticostata*), can occur in very high densities towards the exposed seaward edge of the reef, although their shells are often well camouflaged under a covering of coralline algae. Another animal that can be found in extremely



high numbers on Perth's intertidal reefs is the bright red waratah anemone (*Actinia tenebrosa*), which often occurs in the same exposed habitats as limpets and abalone.

Research by DEC has also found that particular species inhabit even the small pockets of sand that accumulate in hollows and rock pools on intertidal reefs. Here, burrowing molluscs such as the pontifical cone (*Conus dorensis*) and the western creeper (*Rhinoclavis biturberculata*) are found only by digging into the sand. Occasionally the lighthouse shell (*Campanile symbolicum*) can also be found in these pools. This relatively large shell is endemic to the south-west of Western Australia, and is the sole extant species of a group that

was more diverse and widespread in the geological past.

Interestingly, this research has also found that intertidal reef communities in the Marmion and Shoalwater Islands marine parks are quite different. Reefs in Marmion Marine Park tend to support higher numbers of limpets and abalone, while those in Shoalwater Islands Marine Park tend to have more sea stars and sea urchins. This may be a consequence of the reefs being more exposed to wave action at Marmion than at Shoalwater Islands.

What's the future?

Perth enjoys the enviable position of having a relatively healthy coastal ecosystem in close proximity to a

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Top right DEC researchers at Cape Péron in Shoalwater Islands Marine Park.
Photo – John Huisman/DEC

Below A shore crab (*Leptograpsus variegatus*).
Photo – John Huisman/DEC

contaminated with nutrients or other pollutants from the city into coastal waters. Among the most obvious of these impacts in the Perth area is recreational fishing for Roe's abalone, when many people wade onto the intertidal reefs during the short periods when the activity is permitted by the Department of Fisheries.

Perth is also fortunate in having well-developed systems to ensure the conservation and sustainable management of its coastal marine biodiversity. The Marmion and Shoalwater Islands marine parks are managed by DEC to protect this resource, while the Department of Fisheries ensures that the take of species such as Roe's abalone and other fisheries remain sustainable. By taking care when visiting Perth's intertidal reefs, everyone can assist in their protection. Step carefully to avoid crushing delicate animals and adopt

a 'look but don't touch' approach to avoid disturbance where you can. Be particularly aware of what activities are permitted by fishing regulations and marine park zoning. The surveys described are part of DEC's statewide research and monitoring programs that assist in managing our marine parks and reserves and threatened marine fauna. Such work will help to ensure that Perth's biologically diverse intertidal reefs will remain a source of wonder for generations to come.

major population centre. However, the sheer number of people that live near and recreate on this coastline creates pressure on easily accessible intertidal reefs. These pressures may be direct, such as fishing, or indirect, such as the discharge or seepage of water



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