Fact Sheet: Intertidal rocky shores

Phase of learning
Years 5 - 6, Years 7 - 8, Years 9 - 10, Senior Secondary (Years 11-12)

WA Curriculum

Region
North Coast, Gascoyne Coast, West Coast, South Coast, Indian Ocean Territories

Summary
Reefs provide a foundation for many plants and animals, supporting a great diversity of marine organisms that rely on the reef for food, protection, shelter and somewhere to reproduce. Reefs create a natural buffer to strong winds and waves that would otherwise erode the coastline.

In WA, reefs can be broadly divided into two groups – limestone reefs and coral reefs (generally found in tropical climates).
Limestone reefs along the Western Australian coast (Figure 1) have taken thousands of years to develop. They have been created from calcium carbonate deposits resulting from organic matter such as skeletal remains and shells that have been compressed and hardened over time. Over thousands of years, waves wear away limestone to form reef platforms, broken up by rock pools.

The intertidal zone, also known as the littoral zone, is that area between the high tide mark and low tide mark. Intertidal zones may be rocky, sandy or mudflats. The intertidal zone can be divided the following ‘sub-zones’ – the spray zone, upper intertidal zone, mid intertidal zone and the lower intertidal zone (Figure 2). It is an area that is constantly changing, as the water moves in and out with the tides.

The spray zone, also known as the supra-littoral zone, is above the high tide mark and, as its
name would suggest, is kept damp through wave splash. This is the highest zone on the shore of true marine life. Organisms surviving in this environment include barnacles, limpets and periwinkles.

The upper intertidal zone is only covered by water at high tide and is a highly saline environment. Algal growth in this area is usually quite minimal, due to its long periods without water. Most algal growth present is green, usually *Ulva* (sea lettuce). This zone is characterised by animals such as barnacles, limpets, chitons, crabs, mussels, sea stars and periwinkles.

The middle intertidal zone is regularly covered by water. Seaweeds begin to become more prominent in this area. Animals present in this area include anemones, barnacles, crabs, mussels, sea stars, gastropods and sponges.

The lower intertidal zone is usually submerged, only being exposed at very low tides. As a result, it contains the greatest biodiversity within the intertidal zone. Organisms inhabiting this zone are less tolerant to extreme changes in temperature, salinity and cannot withstand long periods without water. This zone is characterised by large brown algae, such as kelp.

Figure 2. Different zones of the intertidal. (Image: © DPIRD)

Animals found in the lower intertidal zone include encrusting sponges, sea anemones, abalone, sea stars, crabs, sea cucumbers, gastropods and sea urchins. Small fish may also inhabit this area. The lower intertidal zone is quite well protected from big predators, such as large fish, due to wave action that occurs in it and the water still being relatively shallow.
The intertidal zone is home to many species of animals and plant-like organisms. Many of the animals are invertebrates (animals without a back bone), including limpets, snails, mussels, barnacles, sea anemones, sea urchins, sea stars and crabs. It is also an area where many organisms are preyed upon by sea birds and fish.

The intertidal zone is a harsh environment for organisms to live for a variety of reasons. Intertidal organisms must withstand being out of the water and exposed to air; wave action can wash away or dislodge animals; the temperature range can be quite extreme; and some areas such as rock pocks may be highly saline, due to high levels of evaporation. As a consequence of these environmental conditions, organisms in this zone have a variety of adaptations to enable them to survive.

Organisms exposed to air must be able to prevent (or tolerate) desiccation (drying out). As a result, many organisms living in this harsh environment have a protective covering, such as a shell. Some animals, like barnacles and mussels, can completely seal their shell. Others, like limpets (Figure 3), have a shell with an opening and thus clamp themselves to a substrate in the intertidal zone to seal the opening.
The shells are produced by taking in minerals from the environment. Molluscs are able to create calcium carbonate, which is secreted by specialised shells within the mantle to create their shell. As the mollusc grows, the shell thickens to ensure that it stays strong for its size. Some molluscs also have an iridescent internal layer of nacre (mother of pearl) that protects their soft flesh from damage.

Some organisms use mucus to create a seal. Animals such as periwinkles and turban snails possess a shell plate, called an operculum, which is used to close-off the opening to their shell, in a similar manner to a door (Figure 4).
Intertidal zones can be quite high energy environments, where waves may be consistently pounding the area with considerable force. Both marine animals, algae and plants that live in it must be able to withstand the conditions. Algae possess a root-like structure called a holdfast that they use to anchor themselves to substrates in the zone (such as rocks or shells of other organisms). Barnacles attach themselves to substrates by exuding a strong natural ‘glue’, while mussels use their byssal threads (long, fine, silky threads which they secrete) in a similar manner. Mobile animals, such as limpets and chitons, use their strong muscular ‘foot’ to cling onto the reef during heavy wave action. Animals in more exposed locations tend to have thicker shells (e.g. turban snails) than those in sheltered locations (e.g. pipis). Likewise, many intertidal organisms, such as barnacles, limpets and chitons, have low profiles, lying close to the rocks.

The salinity across the intertidal zone can be quite variable, depending on the amount of rainfall and the rate of evaporation of the water. During rainy periods, the water in the intertidal zone will become less salty, as it is diluted by rain. On warmer dry days, as water evaporates, the intertidal zone, particularly in rock pools, may become highly saline. Organisms that inhabit rock pools can usually withstand relatively large changes in salinity.
Animals in rock pools (Figure 5) and in the high tide zone are also exposed to greater variations in temperature and have a variety of adaptations to deal with this. Some animals in rock pools will take shelter under algae, out of direct sunlight.

**Figure 5. Coastal rock pools on the south coast of Western Australia.**

Sessile animals in an intertidal environment are restricted in when they can feed. Most are filter-feeders and thus are unable to feed when the tide is out (i.e. no water is present). Animals that are not filter feeders are also restricted in their ability to find food when the tide is out. Many are grazers, feeding on algae on the rocks, and seek shelter from the elements and predators at low tide.

Despite all of the challenges facing organisms living in the intertidal zone, one of the biggest limiting factors, particularly for sessile organisms, is the availability of unoccupied space.
Colonisers take over any occupied space quickly, so the ones remaining attach to each other. In rocky intertidal areas, getting unoccupied space translates to having an effective means of dispersal of larvae or spores. Many species disperse their larvae or spores which settle on the rocks so as to colonise open space. Having acquired space, species must be good at either holding on to it, or reproducing rapidly to disperse its young into the next available space. Rather than colonising open space, some organisms, such as barnacles, take over space that is already occupied.

In addition to the environmental challenges that organisms living in the intertidal zone face, one of their greatest threats is humans. People exploring intertidal areas cause damage to the intertidal zone by accidentally stepping on organisms and their habitat, and sometimes removing organisms altogether for food or other purposes. Coastal development can also pose a threat to inhabitants of the intertidal zone as run-off may introduce contaminants to the environment.

Adaptations in organisms

An adaptation is a characteristic that helps an organism survive. Adaptations are either structural (body form), functional (physiological), or behavioural.

Structural adaptations

Many marine animals have developed specialised body parts for avoiding predation. These parts include body covering, camouflage, skeleton, appendages, and mouth parts.

Many molluscs, such as scallops, mussels and oysters, as well as crustaceans, such as lobsters and crabs, have armour to protect their soft bodies. Many animals with armour are slow-moving. Fish have scales which act as a thin armour.
Figure 6. The spines of a sea urchin are an example of a structural adaptation in the intertidal zone.

Some animals, such as stone fish and sea urchins, have spines which make them harder to swallow, look bigger, and harder to remove from their environment (Figure 6).

Many marine species use camouflage to escape predators. Stone fish, octopus and cuttlefish are masters of this art. The colouration of many fish, including sharks and rays, having dark upper surfaces and lighter lower surfaces, is called counter-shading and helps them to avoid detection. Seahorses and sea dragons (Figure 7) look physically similar to various seaweeds and seagrass.
Leafy sea dragons look physically similar to seaweeds which is a form of camouflage.

The mouth, or mouth parts, of an organism indicate what it feeds on and how. Seahorses and butterfly fish have elongated, tubular-shaped mouths to pick at or suck small food. Sea stars have their mouth on the underside of their body, which they move over their food and ingest it. Chitons and other molluscs have a specialised mouth-part called a radula that is used to scrape food (usually seaweeds) off tough surfaces such as rocks.

**Physiological (functional) adaptations**
Functional adaptations in marine organisms include buoyancy control, production of toxins and reproductive methods.

Many fish have an air bladder, called a swim bladder, which allows fish to float at different depths. Other organs that assist in the buoyancy of marine animals include: an oily liver in sharks; light cuttlebone in cuttlefish; the pen in a squid (a feather-shaped internal structure in a squid that supports its mantle); and algae, such as *Sargassum* (Figure 8), which have air-filled
bladders to keep them afloat.
Figure 8. Sargassum, a type of brown algae, has air-filled gas bladders to keep the fronds afloat. (Image: Carina Lancaster)

Many marine organisms produce toxins that makes them either poisonous to eat, or venomous if injected or bitten. Boxfish and toadfish (blowies) are poisonous if eaten, while stonefish, blue-ringed octopus, cone shells and sea snakes are all venomous if stung or bitten.

Some marine organisms reproduce internally, whilst others reproduce externally. Those that reproduce externally, such as many fish, sea stars and corals, must produce large numbers of sperm and eggs to ensure continuation of the population, as many of them will not survive.

Some species of shark, such as great white sharks, reproduce internally, ensuring new brood stock survive. Species reproducing in this manner are less likely to reproduce in large numbers.

**Behavioural adaptations**

Behavioural adaptations are the actions (behaviours) that organisms do to protect themselves from predation. These adaptations include schooling, social organisation, communication and territoriality.

The schooling behaviour of many species of fish is a well-known behavioural adaptation. Large groups of fish swim together as one unit, thus increasing the chance of survival as it is harder for a predator to fix onto one fish.

Many organisms live together in groups to enhance their chances of survival. In some cases, the organisms are physically joined, such as in corals (Figure 9), ascidians and bluebottles. This
A grouping of organisms is called a colony.

**Figure 9. A colony of coral polyps – a coral reef.**

Many marine animals communicate through sounds for defence, attack, reproduction and establishing their position in the hierarchy. Dolphins and lobsters use clicking noises, and fish make sounds by rubbing together body parts.

Some species, or individuals, such as damselfish, may defend an area that they have claimed as their territory. Establishing a territory can be beneficial to members of the species, as it can reduce fighting and competition for resources.
Food chains

The interaction between organisms within a community of different plants and animals is quite varied. One of the most obvious examples of this interaction is the feeding relationships.

In order to survive, every living organism needs some form of energy (food). A food chain is a simple representation of the feeding relationships between species within a habitat or ecosystem. It depicts the transfer of food energy and matter from one organism to the next – from producers (algae and plants) through a succession of plant-eating and animal-eating consumers to decomposers.

Energy transfer is illustrated through the use of arrows in the direction of energy flow. The primary energy source in any food chain is the Sun. The amount of energy in a food chain is greatest at the bottom or base of the chain (i.e. the Sun) and smallest at the top of the food chain (i.e. the apex predator).

Animals that directly eat primary producers are called primary consumers. Primary consumers are eaten by secondary consumers; secondary consumers are then eaten by tertiary consumers; and so on. The top of the food chain always ends with a top or apex predator – an organism that has only a few natural predators (such as humans).

Plants and algae manufacture their own food using photosynthesis hence they are called primary producers. It is in this way that the energy from the Sun powers the base of the food chain.

Consumers are animals that cannot manufacture their own food and so need to consume other organisms for energy. Animals that eat primary producers (like plants) are called herbivores. Animals that eat other animals are called carnivores, and animals that eat both plants and other animals are called omnivores.

Detritivores (or decomposers) are organisms that break-down and feed on dead and decaying organic material, recycling it back into the ecosystem as energy and nutrients for primary producers to use again.

Food webs

Food chains are simplistic representations of the relationships of living organisms in an ecosystem. Most consumers feed on many species and, in turn, are fed upon by other species. A food web is a number of interconnected food chains, displaying the flow of energy and matter in an ecosystem.

There are very complex interactions taking place in food webs, with the survival of one organism dependent on the survival of another. Any changes or shifts within an ecosystem can have flow-
on effects for other organisms in the complex network of the food web. In extreme situations, the whole balance of the food web can be altered.

A number of things can alter reef platform food webs, for example:

- Removal of key species can cause a ripple effect throughout the food web.
- Habitat destruction or alteration that can affect the population and diversity of marine animals in the area.
- Variability in natural competition between different types of animals.
- Natural and climate change-induced variability in nutrient availability for marine food webs.
- Low oxygen levels, dramatic water temperature increases and pollution events.

References

Amalfi, C., 2005, ‘Limestone Kingdoms of Western Australia’, Western Fisheries, December, p. 8.


The Intertidal Zone http://www.enchantedlearning.com/subjects/ocean/Intertidal.shtml [06 February 2020].

Vocabulary

Byssal threads
Strong fibres secreted by mussels for attachment.

Desiccation
The dehydration of an organism.

Ecosystem
A complex set of relationships among the living resources, habitats and residents of an area.

**Filter feeder**

An animal that strains food such as plankton from water using a sieve-like structure in its mouth.

**Holdfast**

The root-like portion of macroalgae that holds the algae to the substrate.

**Intertidal zone**

Between high and low water marks that is periodically exposed to air.

**Invertebrate**

Animal without a backbone.

**Larvae**

The immature form of animals which undergo metamorphosis (a change in form) before becoming a juvenile or adult.

**Operculum**

Any covering flaps or lid-like structures in organisms, such as the gill cover in many fishes.

**Sessile**

Plants or animals that are permanently attached to a surface.

**Spore**

The asexual structure produced by some algae.

**Substrate**

The layer immediately underneath something or to which it is attached.
Related resources

Lesson: Introduction to the Intertidal
Presentation: Inhabiting the Intertidal
Presentation: The Intertidal Zone - a reef platform
Teacher Guide: Intertidal Investigation