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Sea Search: Community-Based Monitoring of Victoria's Marine National Parks and Marine Sanctuaries

Intertidal Rocky Shore Monitoring

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Parks Victoria Technical Series No. 17

Sea Search: Community - Based Monitoring of Victoria's Marine National Parks and Sanctuaries

Intertidal Monitoring

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March 2005

Parks VICTORIA

FOREWORD

The establishment of Victoria's Marine National Parks and Sanctuaries in 2002 has created a world-class system to conserve Victoria's unique and diverse marine environment. To foster and encourage community stewardship for a marine protected area, Parks Victoria and Deakin University have developed a set of three technical series which will allow your community group to monitor your marine national park or sanctuary. The name given to this series set is Sea Search and focuses on community-based monitoring. This will encourage community interest in protecting its local marine area. Through community-based monitoring, a network of community monitoring groups can be established along the Victorian coastline.

Each technical series focuses on a specific marine habitat type and includes:

Seagrass Monitoring – Technical Series 16

Intertidal Monitoring – Technical Series 17

Subtidal Monitoring – Technical Series 18

This set of technical series will allow your community group to learn about the animals and plants in your marine protected area in addition to applying scientific knowledge to obtain important biological information. Participation in long-term monitoring will allow your group to accumulate biological data which will provide information on the environmental status of your marine protected area.

By engaging in monitoring, your community group has an active role in management. Active involvement and participation by your community group will increase local knowledge and awareness of the marine protected area and add value to the operations of the management agencies.

Data collected by your community group can be used to provide management authorities with quality advice. Your group has an important role in achieving the objectives of marine national park and sanctuary management. Community-based monitoring will allow you and your group to connect further with the marine environment and enjoy the wonders of Victoria's unique marine plants and animals.

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1.0 INTRODUCTION TO COMMUNITY- BASED MONITORING

1.1 What is community-based monitoring?

The system of Marine National Parks (MNPs) and Marine Sanctuaries (MSs) in Victoria provides the ideal opportunity for community groups to partake in community-based monitoring projects.

Community-based monitoring allows Friends and community groups to be interactive with their MNP or MS. It allows groups to conduct meaningful scientific surveys and collect biological information whilst having fun at the same time. All volunteers will learn new techniques and increase their knowledge of the marine plants and animals found in their marine protected area (MPA). Community-based monitoring is flexible and volunteers can choose when and where they would like to survey their marine habitat.

Biological information collected by community groups will assist in the management of Victoria's MNPs and MSs. Monitoring of Victoria's MPAs will allow community groups to develop awareness and to raise the profile of natural, cultural and social values of MPAs among the public. Community involvement can also build custodianship of an area and help communicate findings back to the broader community. Community-based monitoring of Victoria's MPAs is therefore valuable to management from both an ecological and social perspective. Community participation in activities allows communities and individuals to recognise that they have an important role in achieving the objectives of MNP and MS management (Parks Victoria 2003).

Figure 1.0 Marine Care – Ricketts Point Friends volunteers undertaking intertidal monitoring at Ricketts Point Marine Sanctuary, Victoria. (Image: R. Koss)

1.2 What does monitoring mean?

Monitoring is the repeated observation of a system, such as rocky shores, usually to detect change (McKenzie & Campbell 2002). The type of methods utilised in monitoring will vary the accuracy and detection of change in a system. It is important that the methods in a monitoring program are designed to quantify the causes of change for a particular site. *(See Section 4.0 for information on intertidal monitoring methods.)* Monitoring can focus on a particular organism or habitat, with additional information on environmental conditions. A successful monitoring program examines a specific environmental concern (McKenzie & Campbell 2002). Monitoring programs will be able to detect disturbance and will distinguish such disturbances from natural variation (Roob 2003). Many of the field techniques and analytical protocols employed in modern temperate reef ecology originated from previous intertidal studies (Creese & Kingsford 1998).

There are several features of the intertidal rocky shore which make it an ideal location to undertake monitoring. At low tide, rocky shores are readily accessible from land (which is not the case in many marine habitats). There are numerous organisms, either sessile or slow moving, which can be easily seen. The types of organisms found on intertidal rocky shore are diverse allowing an understanding of entire natural assemblages rather than randomly chosen groups (Underwood 1994). These organisms display varying physiological, behavioural and visual characteristics to adapt to the extreme physical factors of their environment (Underwood 1994). Due to competition for space and food on the rocky intertidal shore, there are a variety of interactions which are influenced by the environment.

The most efficient and appropriate monitoring parameters are chosen to enable the minimal monitoring effort required to detect change which are statistically and biologically meaningful. *(See Section 4.2 for information about choosing intertidal monitoring sites.)*

Biological and physical elements which are to be noted during intertidal zone monitoring include: invertebrate species counts; measurement of invertebrate shell length for the five most common species; point count for algae; point count for some sessile invertebrates; substrate type; air temperature; and cloud cover *(See Section 4.10 to find out what to count during monitoring)*.

The method of collecting data is dependent on the expected use of the data. Accuracy and precision of data collection is a requirement for accountability in coastal management decisions (Hart & Edmunds 2004). This in turn has created a need for statistical rigour in the design of sampling programs for monitoring of environmental impacts (McKenzie & Campbell 2002). Any impacts caused by human activities can then hopefully be separated from any natural variation within the system.

To find out the closest Victorian MNP or MS which your community group can monitor, contact the Parks Victoria Customer Service line on **13 19 63** or visit their website at www.parkweb.vic.gov.au and click on Marine & Coasts.

1.3 What are the objectives of intertidal rocky shore monitoring in Victoria?

The primary objectives for environmental research and monitoring programs related to protected area management are to provide information on the status of natural values and threatening processes, and to determine the nature and magnitude of trends over time (Parks Victoria 2003). This will, in turn, provide increased knowledge, understanding of change, bench marking and provide vital signs to assist with management of these areas (Parks Victoria 2003).

The principal objectives for intertidal rocky shore monitoring in Victoria are:

1. to characterise intertidal plant and animal communities on each reef by providing data on populations, population size structure of common and potentially-impacted species and biological structure

2. to identify important variation in intertidal plant and animal species and communities spatially across reefs

3. to determine the nature and magnitude of natural changes, species populations and communities in the intertidal over time

4. to detect impacts of threats on intertidal plant and animal populations and communities compared to reference sites. *(See Section 4.4 to find out what a reference site is.)*

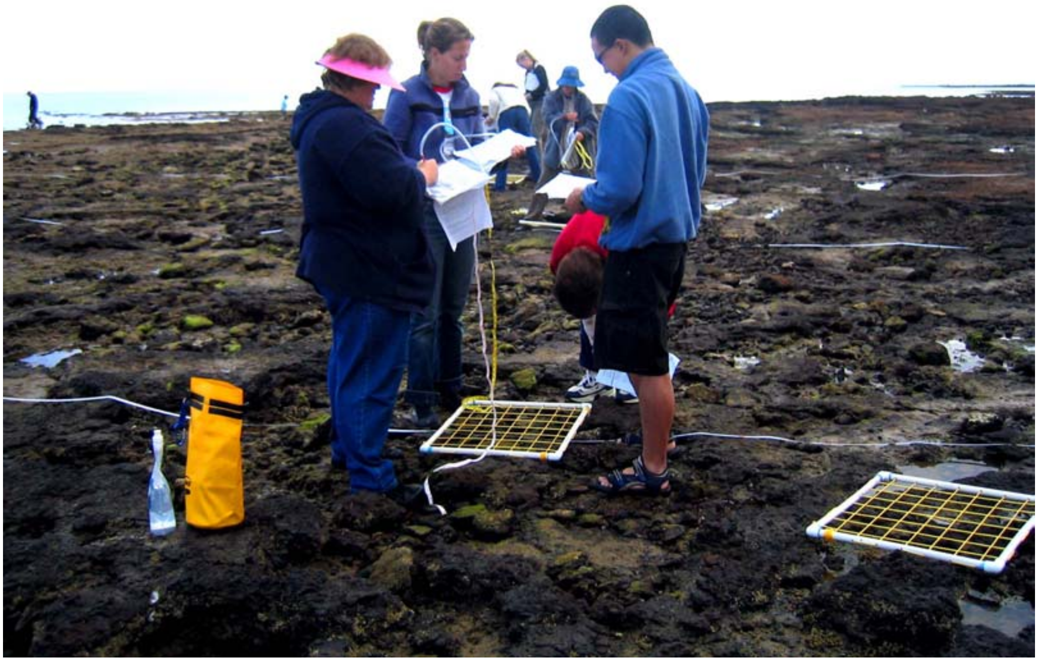


Figure 1.1 Marine Care - Ricketts Point volunteers consulting on species identification during an intertidal survey at Ricketts Point Marine Sanctuary, Victoria. (Image: R. Koss)

2.0 ALL ABOUT THE INTERTIDAL ZONE

2.1 Where is the intertidal zone located?

Intertidal habitats are found around the edges of landmasses (Fairweather 2003). The intertidal zone is the region of coast between the extreme high- and low-tide marks and is often called the littoral zone (Quinn *et. al*. 1992). The intertidal zone is exposed at low tides and covered during high tide. The marine habitats that are rarely exposed to the air at low tide are termed subtidal or sublittoral (Quinn *et. al*. 1992).

The intertidal zone is influenced by two processes. The first process is the regular rise and fall of the tide due to the earth-moon rotation and takes place approximately every 28 days (Underwood & Chapman 1995). This rotation creates a gravitational force between the moon and the earth. The second process is the cyclic neap and spring tides (Underwood & Chapman 1995). The neap tide does not go out as far and does not rise as high on the shore. The spring tide is the large tide, where at high-tide shores can be covered by water so that no sand or rock can be seen, and during low tide the lowest part of the intertidal zone can be exposed. This cycle is caused by the gravitational force of the sun. As the moon rotates around the earth, it comes into alignment with the sun creating a larger gravitational force between the earth, sun and moon (Underwood & Chapman 1995). In Victoria the intertidal zone experiences two high and low tides (diurnal cycle) daily.

Wave action in conjunction with tides, also influences the intertidal zone. Wave action varies from place to place, and therefore can shape the habitat found in the intertidal zone (Underwood & Chapman 1995). Due to these two major physical factors, tides and waves, the habitats on rocky coasts vary from low to high on the shore and from wave-exposed to sheltered coastline (Underwood and Chapman 1995).

2.2 How is the intertidal zone defined?

A useful way to define the intertidal zone focuses on four environmental factors. These four factors can be used at any specific location to describe any intertidal habitat and how they affect the populations and communities of plants and animals found there (Fairweather 2003).

Depth

The depth gradient ranges from the supratidal (splash zone or high tide) to the lowest part of the tidal range (Fairweather 2003). This gradient determines how much of the habitat is out of the water during a tidal cycle, where the highest point on the shore is exposed for a lengthier period of time. The physical stress of air exposure increases as you go up the shore. Most animals and plants found in the intertidal zone are adapted to the marine environment and require wetting by the ocean. They have varying adaptations to minimise water loss.

Exposure to water movement

Exposure to water movement relates to the degree of water motion created from waves, currents and tides (Fairweather 2003). As mentioned in Section 2.1, wave action and tidal cycles can vary from place to place, from exposed to protected areas and high to low intertidal zones.

Salinity

Salinity refers to how salty the water is. This can vary from brackish (2 parts per thousand salinity) in most estuaries, through to seawater of the open coast (35 parts per thousand salinity) to hyper-saline (100 parts per thousand salinity) found in standing pools of water on rock platforms or mudflats, where evaporation is extreme and prolonged (Fairweather 2003).

Particle size

The particle size refers to composition of the substrate and varies from massive bedrock (platforms, seawalls, cliffs) to the finest clays (Fairweather 2003). There is a major distinction between erosional (e.g. bedrock, boulders, cobbles, gravels) and depositional (e.g. sands, mud, some clays) shores (Fairweather 2003).

2.3 The rocky shore as an intertidal zone habitat

Rocky foreshores are often found along the Victorian intertidal zone. These habitats are more variable than other coastal habitats and are dependent on the geological character of the coast (Lewis 1978). This can range from steep, inaccessible cliffs to wide, gently sloping platforms; from fringing islets to long, narrow islets; and from smooth, uniform slopes to irregular masses or extensive boulder beaches (Lewis 1978).

Rocky shores are defined as hard substratum of geological origin, usually resulting from bedrock outcropping or very large particles, like boulders (Fairweather 2003). Intertidal platforms, cliffs, benches and cobble beaches are all examples of rocky shores where wave exposure (*See Section 2.1 for more information about wave exposure*) can vary from rough to calm and sheltered. These habitats are found in all climates, but are especially prominent in temperate zones (Fairweather 2003).

The most general rock habitat is the broad expanse of rock platform itself (Underwood & Chapman 1995). The evolution of rocky shore platforms relates to sea level changes and the recession of cliffs into shores, so that existing shore platforms may have been derived from earlier and higher shore platforms (Bird 1993). Platforms are shaped by the action of waves over many years. For example, where the rock is soft (sandstone or shale), platforms tend to be broad with a steep drop-off to the sea where even low-tide waves can have an effect (Underwood & Chapman 1995). Harder rocks, such as basalt or granite, are not as affected by wave action (Underwood & Chapman 1995).

Two major types of habitats can be found on the rocky shore platform: rock pools and boulder fields. Rock pools are formed on platforms where boulders have been swirled around by waves and eventually make a depression in the shore surface (Underwood & Chapman 1995). They are most often found on sandstone platforms or where wave action is strong enough to move boulders. Sheltered rock platforms do not have as many rock pools. Rock pools are permanently filled with water, even at low tide, which provides shelter for many marine animals and plants during this period.

Intertidal boulder fields are found where wave action is not sufficiently strong enough to move away rocks (Underwood & Chapman 1995). There must be enough water movement to prevent sand smothering the rocks and thereby forming a beach. The undersides of boulders create damp and dark environments where many marine animals, unable to survive in open areas of rock platforms, live (Underwood & Chapman 1995).

The rocky shore can be divided into typically three major zones *(See Figure 2.0 for a visual description of the rocky shore)*; supralittoral fringe (high-zone); eulittoral midzone (mid-zone); and, sublittoral fringe (low-zone) (Stephonson and Stephonson 1972; Fairweather 2003). Some of these zones can be further subdivided, for example, between the upper and lower portions of the eulittoral zone. This terming of zones allows intertidal biologists around the world to describe where they work in the vertical gradient of the intertidal zone. *(See Section 2.2 for information about depth gradients of the intertidal zone.)* (Fairweather 2003). This does not represent how intertidal animals and plants are found in the intertidal zone. Previous scientific concepts arranged specific animals and plants to a particular area of the intertidal zone (Fairweather 2003). The current scientific theories suggest that animals and plants found in the intertidal zone are not determined by the specific area of the intertidal zone, but rather that different processes *(as described in Section 2.2)* can affect the distribution of plants and animals.

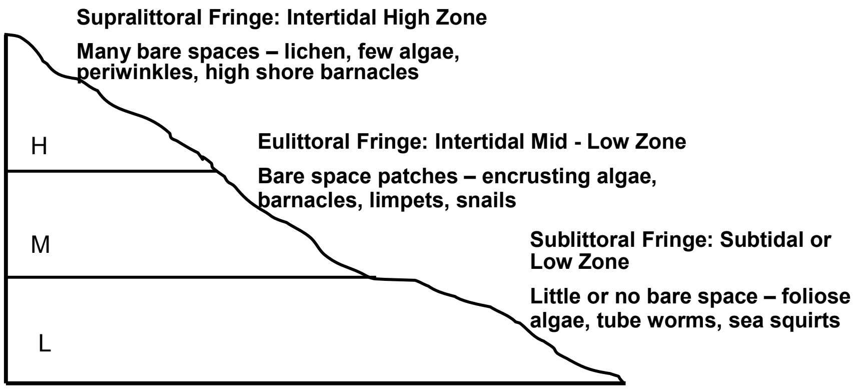


Figure 2.0 The basic division of the intertidal rocky shore into three zones: High- zone; Mid-Zone and Low-Zone (Adapted from Fairweather 2003).

A

B

Figure 2.1 Examples of Intertidal rocky shores: A) at Black Rock, Victoria, and B) Ricketts Point Marine Sanctuary, Victoria. (Images: K. Miller)

2.4 What is life like for plants and animals on the intertidal rocky shore?

The intertidal area is a difficult habitat to survive due to the daily rise and fall of the tides and wave exposure. For parts of the day, at high tide, marine plants and animals are completely covered by water and in between, they are exposed to air, wind and sunlight during low tide. Exposure to the physical elements such as high temperature and bright sunlight can lead to desiccation (drying out). The length of exposure to the physical elements is dependent on the organism's position in the intertidal area. Flora and fauna, which are found in the supralittoral fringe (high-zone), must cope with longer air exposure than those found in the sublittoral fringe (low-zone). Tidal fluctuations between neap and spring tides can cause the supralittoral fringe to be exposed to the air several days at a time, whilst the sublittoral fringe can be covered by water and have no exposure to air (Underwood & Chapman 1995). From the bottom to the top of the intertidal zone, there is an increase in stress of physical conditions during low tide (Underwood & Chapman 1995).

On wave-exposed coasts, the force of waves can make living on the intertidal area difficult. The types of animals and plants found on wave-exposed coasts, compared to sheltered coastlines, will tend to be different (Underwood & Chapman 1995). Sessile animals and seaweeds (non-moving organisms) glue themselves to the substratum and are generally found in wave-exposed areas. Delicate seaweeds and animals tend to be restricted to non-exposed areas (Underwood & Chapman 1995). Due to the dynamic and physical factors of the intertidal rocky shore, animals and seaweeds interact with one another in many complex ways. The rocky shore as a habitat is not constant due to the life-style and ecology of the animals and plants (Underwood & Chapman 1995).

A  B 

Figure 2.2 A) Associate Professor Geoff Wescott, Deakin University, presenting an intertidal seaweed and animal identification session to Marine Care – Ricketts Point volunteers as part of their training session. **B)** Marine Care – Ricketts Point Friends group undertaking intertidal monitoring at Ricketts Point Marine Sanctuary. (Images: R. Koss)

3.0 MARINE PLANTS AND ANIMALS FOUND ON INTERTIDAL ROCKY SHORES

3.1 What type of marine plants are found on the intertidal rocky shore?

The term 'seaweed' is often used when describing plants which inhabit the intertidal zone. Seaweeds are algae: structurally simple plants without roots, stems, or leaves, and have primitive methods of reproduction (Fuher *et. al*. 1988). Seaweeds, with seagrasses, are the major primary producers of intertidal areas. They are eaten by many marine animals, and therefore make up the basis of many food webs (Fuher *et. al*. 1988).

There are four main environmental factors which influence algal growth and distribution in the intertidal area (Womersley & King 1995):

dynamic factors - tide, water movement, wind

physical factors - light, sea and air temperature, humidity, rainfall, substratum

chemical factors - salinity, nutrients, gas availability, pH, pollution

biotic factors - competition for space, light and nutrients, grazing/predation, epiphytic, symbiotic relationships.

The combinations of all these factors vary on a daily, weekly and monthly basis.

There are three major forms of algae living on the rocky intertidal shore (Underwood & Chapman 1995).

Encrusting algae: Usually found on the supralittoral zone and decreases towards the sublittoral of the intertidal zone. The appearance is flat and very tightly stuck down to the surface. Due to the high levels of calcium in the plant structure, they can be either hard and crunchy or tough and leathery when touched.

Foliose algae: These seaweeds are usually upright and form branches which vary in length. They grow in the sublittoral in very dense patches. Some are tough and wiry, while others are soft and flexible. The many branches often provide shelter for smaller animals to live in.

Canopy-forming algae: These algae are taller, where the fronds can stand up in the water column above the shore at high tide or be draped along shore at low tide completely covering other plants and animals which live there. They are usually found in small densities starting in the eulittoral, with greater densities in the sublittoral.

Although there are many forms of algae, there are three major groups and two less conspicuous groups based on the forms of colouration.

Green algae: Chlorophyta are characterised by their green colour due to their chlorophyll pigments which assist in the capture of sunlight for photosynthesis (Womersley 1984). Shades can range from yellow-green to dark- or black-green. There are fewer species of green algae, which are smaller in size and form than the reds and browns (Fuher *et. al*. 1988). Many are tolerant of extreme environmental conditions and can be found in the supralittoral zone. They are able to colonise new or cleared surfaces rapidly (Fuher *et. al*. 1988).

Chlorophyll is the pigment found in plant cells and acts as a receptor of light energy for photosynthesis, which uses the light energy to create chemical reactions and form chemical bonds with carbon dioxide and water. Through photosynthesis, most plants are able to produce energy to assist in growth.

Brown algae: Phaeophyta are light- to dark-brown in colour due to the fucoxanthin (brown pigments) which cover the green chlorophylls (Womersley 1984). Colours range from pale-olive or yellow-brown to almost black and inhabit the sublittoral fringe of rocky shores (Fuher *et. al*. 1988). The brown algae vary in form and size, with many of the common species unique to Australia (Fuher *et. al*. 1988).

Red algae: Rhodophyta vary in shades of red due to the phycoerythrin (red protein pigments) (Womersley 1984). Phycoerythrin can easily be destroyed by high light intensity resulting in a decreased brightness of the red colour (Womersley 1984). This algae group possesses the greatest number of species of all the algae groups. Most inhabit the subtidal zone and are endemic to southern Australia (Fuher *et. al.* 1988). A few occur on the intertidal, usually in rock pools and under ledges and appear yellow to brownish-red in colour (Fuher *et al*. 1988).

Blue-green algae: Cyanophyta are often small and less conspicuous than the larger groups, but are prominent in the intertidal (Fuher *et. al*. 1988; Womersley 1984). They are able to cover extensive areas of the rocky intertidal where many of the main algae groups cannot grow. The blue-green colour is due to the accessory blue-green photosynthetic pigments (Womersley 1984).

Phytoplankton: Chrysophyta is a less conspicuous algae group consisting of many phytoplankton groups. It also includes the genus *Vaucheria* in the macroalgae group, which consist of entangled slender filaments, which form green mats (Womersley 1984).

There are many different forms of algae found on the intertidal rocky shore and they can be summarised in the following forms and groups:

Three forms of algae: Encrusting, Foliose and Canopy

Five groups of algae: Green, Brown, Red, Blue-Green and Phytoplankton.

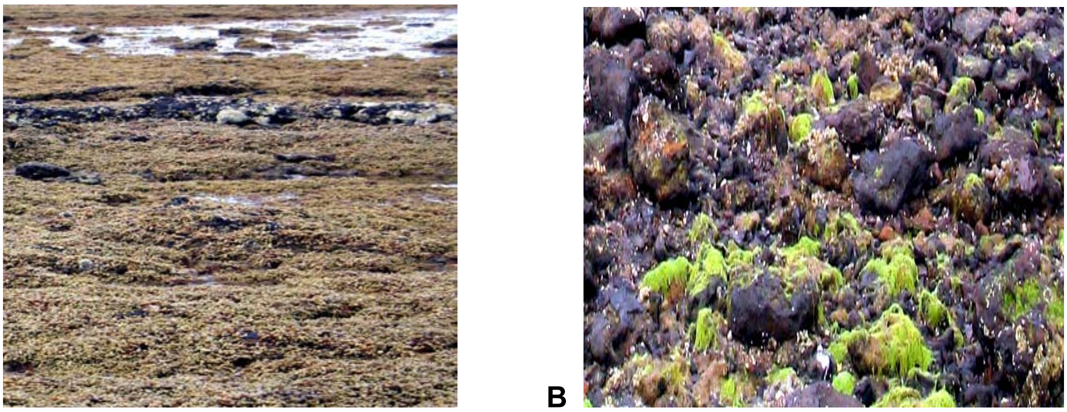


Figure 3.0 Intertidal seaweeds A) Neptune's necklace, *Hormosira banksii*, and B) Filamentous green alga, *Enteromorpha sp*.

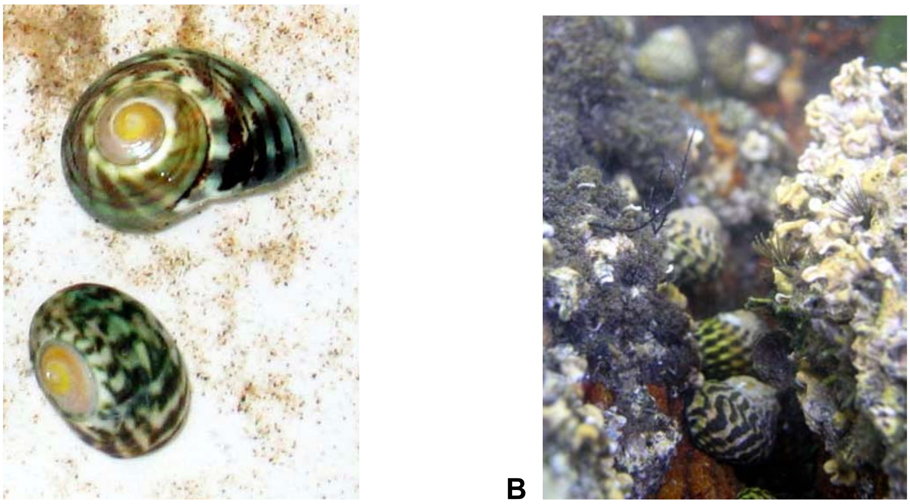
3.2 What are the different types of marine animals found on the intertidal rocky shore?

Most animals found in the intertidal zone are usually restricted to this band of shoreline (Creese & Kingsford 1998). Many of these animals fall into a large group called invertebrates. An invertebrate is any animal whose nerve cord is not enclosed in a backbone of bony segments (Purves *et. al*. 1992). On the intertidal rocky shore, the invertebrates can be subdivided into two major groups: mobile invertebrates, and sessile (non-mobile) invertebrates.

Mobile Invertebrates

This group includes animals such as snails, limpets, sea urchins, chitons and other herbivorous grazers. An herbivorous grazer feeds solely on plant matter. There are many species occurring along the Victorian coastline, but there are many similarities in the sorts of animals that you find at different levels of the shore (Underwood & Chapman 1995). As you go down the shore from the supralittoral, the top is usually covered by small snails. They are generally termed the littorinids, and are small, light in colour (sometimes blue) and usually extremely abundant (Underwood & Chapman 1995). The littorinids are grazers and feed on blue-green algae or other algal species (Underwood & Chapman 1995).

Larger snails, with a width ≥ 2-3 cm, are more apparent in the eulittoral zone (Underwood & Chapman 1995). These snails graze on microscopic stages of the algae life cycle and larger foliose algae. Snails at this mid-shore-level are more active, even at low-tide, around pools of water (Underwood & Chapman 1995).



A B

Figure 3.1 Common snails in Victoria's intertidal zone, A) the Warrener or Turbo, *Turbo undulatus*, and B) in between the rocks the topshell, *Austrocochlea concamerata*. (Images: R. Koss and J. Stevenson)

Limpets occur in great variety along the coast and are all grazers, feeding on either microscopic or larger algae and are closely related to other snails (Underwood & Chapman 1995). Limpets have a very broad foot on the under-surface of their body which allows them to cling tightly on to rocks when they are exposed to waves.

Sea urchins possess tube feet, like the sea star, but walk about mostly on their spines. The appearance of the sea urchin is of a bowl-like shell with a mouth on the under-surface (Underwood & Chapman 1995). The spines protect it from predators. Sea urchins are grazers and use their hard jaw plates, located in their mouths, to scrape away at algae fronds or encrusting algae on hard substrates (Underwood & Chapman 1995). Sea urchins are found in deep areas of rock pools or in the sublittoral at low tide.

Other herbivorous grazers include chitons. They have a shell formed of eight plates and a broad foot, which, like the limpets, allows them to stick tightly to rocks. They are grazers feeding on microscopic algae and can usually be found under boulders.

The other type of snail found on the rocky intertidal are the predatory snails, such as the whelk. The whelk actively seeks out prey. This is done by using a special tube called the siphon, which sticks out in front of the animal as it crawls along (Underwood & Chapman 1995). This siphon can be moved from side to side, and by using it as a nose it can smell out its prey. When water passes over the siphon, the whelk is able to pick up the prey's smell and the direction it is coming from. The whelk will drill a hole through the shell of their prey to obtain the animal for food. That is why the predatory whelk has a groove in the opening of the shell where the siphon comes out (Underwood & Chapman 1995). This feature is prominent on most predatory snails and can be used to distinguish between herbivorous and carnivorous snails (*See Figure 3.2 to find out the difference between a predatory and herbivorous snail.*)

Figure 3.2 The predatory snail, *Cominella lineolata*, commonly known as the Lineated cominella or Checker board snail for its chequered appearance, on the left side. Notice the siphon groove on the bottom left of the shell and the oval opening typical of a predatory snail. The herbivorous (grazers) snail, *Turbo undulatus*, commonly known as the Turban shell, on the right side of the image. Notice the round opening of the shell which is typical for herbivorous snails. (Image: R. Koss)

Seastars have a star-shaped or pentagonal body with five or more arms (*See Figure 3.3 for examples of native seastars*). Each arm contains part of the digestive system and the gonads on the internal side wall (Edgar 1997). The underside of the arm is lined by sensitive tube feet which are usually protected by a series of spines (Edgar 1997). The tube feet are usually pointed with a suction disc at the end allowing them to grip onto solid surfaces. This enables the animal to move about and capture prey (Edgar 1997). The mouth of the seastar is found on the central under-surface of the animal. The seastar can throw out a thin sack-like stomach through its mouth. The stomach covers the prey where it can partially digest food outside the body (Edgar 1997).

A  B 

Figure 3.3 Native Seastars: A) the Eleven armed seastar, *Coscinasterias muricata*, and B) a bright orange seastar, *Uniophora granifera*. (Images: R. Koss)

Some crabs are predators, feeding on smaller invertebrates. During the day, many take refuge between and under rocks so as not to be seen by birds and other predators. The head is made up of six fused segments, a thorax (body) with eight segments, and an abdomen with six or seven segments (*See Figure 3.4 for an example of a crab*) (Edgar 1997). Crabs generally have a forked first antennae and a pair of compound eyes which may be stalked or directly attached to the head (Edgar 1997).

Figure 3.4 The pebble crab, *Dittosa laevis*, found in the intertidal zone of Swan Bay, Victoria. (Image: A. Bunce)

Amphipods are a large group of animals with about 8000 named species. Their appearance is of a flattened body, from side to side, with small gills attached to the base of the legs. Often the first antenna has a small side branch (Edgar 1997). The size ranges from 1-5 mm. Some are found on individual algae and there is a small group which is adapted for living in the sediment.

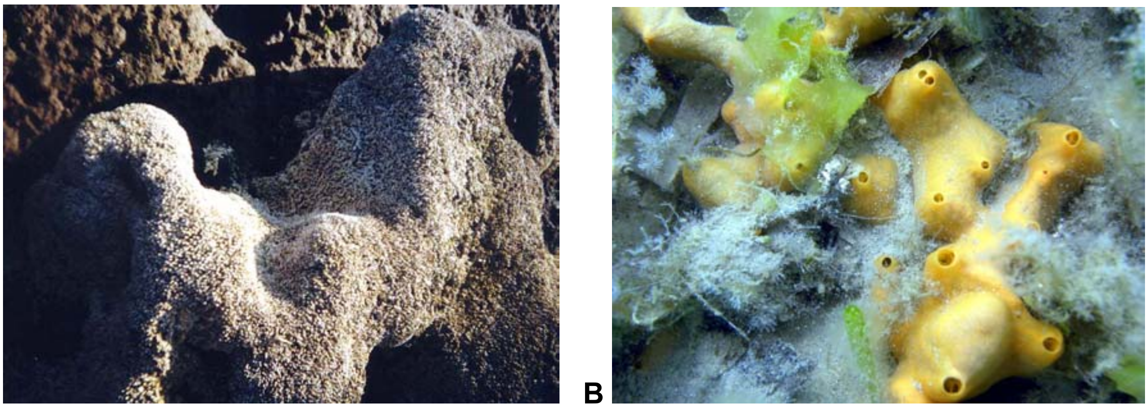
Isopods are flattened from top to bottom and therefore can be distinguished from amphipods. They can usually be found in little or big pools of water and are known as 'sea lice' (Edgar 1997).

Sessile Invertebrates

Sessile invertebrates are attached permanently to a substrate and cannot move from this position. Sessile animals include mussels, oysters, barnacles, tube worms and sea squirts. Animals such as mussels and oysters are abundant on intertidal platforms and are named bivalves. Animals known as bivalves have two hinged shells (valves). Mussels attach to the shore by strong filaments which are produced by the foot of the animal and stick out through the shell (Underwood & Chapman 1995). Oysters stick to surfaces by using a glue, which acts like cement, on one side of their shell (Underwood & Chapman 1995). Spaces between mussel and oyster groups provide shelter for smaller animals. By filtering large quantities of water, bivalves feed on small animals and particles found in the water column. The water is pulled through the gills which act as a sieve, selecting out small animals and particles from the water, and hence this group of animals is given the term *filter-feeders* (Underwood & Chapman 1995).

Barnacles are also filter-feeders. They are small animals which live inside a shell that are cemented tightly to a rock surface. Once a barnacle has settled on a surface, it will never move (Underwood & Chapman 1995). Barnacles use an elaborate system of modified appendages to filter small animals out of the water column (Quinn *et. al.* 1992). Barnacles can be found on protected and wave-exposed reefs, ranging from the supralittoral to the sublittoral zones.

Tube worms, such as *Galeolaria caespitosa*, (*See Figure 3.5 to see an example of tube worms*) use their tentacles (usually black in colour) to filter out food particles from the water at high-tide (Quinn *et. al*. 1992). During low-tide the tentacles are pulled back into the tube. *G. caespitosa* have small, white shells and can be densely packed together to form mats on the sublittoral fringe. They are often seen forming mats over the tops and sides of rocks. Other filter-feeding worms on the intertidal shore are less numerous and conspicuous than *G. caespitosa.*



A B

Figure 3.5 Intertidal sessile invertebrates**, A)** known as Galeolaria worms, *Galeolaria caespitosa*, and **B)** a colonial orange sea squirt (Images: R. Koss and J. Stevenson)

Sea squirts are found along the sublittoral zone where they are able to filter-feed at high tide. The outer layer is tough and leathery, ranging in colour from pinks and dark reds to black. Often they are covered by encrusting green and brown algae (Quinn *et. al.* 1992). They stick to the substrate by a tough calcareous base and filter-feed by pumping large quantities of water through their bodies via the two siphons found at the top of the animal (Underwood & Chapman 1995). If the siphons are touched or pushed, squirts of water are released.

3.3 What are the possible human impacts on the intertidal zone?

Although coastal areas are influenced by natural processes such as storms, erosion and deposition of sands and substrates by wave and tide action, the natural pattern of adjustment is increasingly influenced directly and indirectly by human activities (Woodroffe 2002). Occasional natural catastrophic events such as cold winters, hot summers, extreme storms and toxic algal blooms also occur (Thompson *et. al.* 2002). Rocky shores are also influenced strongly by offshore and near-shore processes such as upwellings and freshwater inputs from nearby flooded rivers (Thompson *et. al.* 2002).

Intertidal shores are usually the most accessible of marine environments for the general public and researchers (Creese & Kingsford 1998). This can have drawbacks in terms of impact, due to human activities. Humans are increasingly common sources of disruption of intertidal areas in Australia (Underwood 1994). Some of these impacts are described below.

Harvesting

Direct effects include harvesting intertidal organisms such as sea urchins, snails, bivalves and crabs for eating or use in bait (Creese & Kingsford 1998). Fishing from the intertidal rocks is a popular recreational activity and consequently there has been harvesting for food and bait on rocky coasts (Underwood 1994). Studies of intertidal organisms being taken from intertidal reefs in south eastern Australia, have led to changes in reef ecology (Creese &

Kingsford 1998; Keough *et. al*. 1993). Humans should be considered as strong predators in intertidal systems with their predatory activities causing numerous direct, indirect and subtle effects on the structure and dynamics of intertidal communities (Castilla 1999; Shoeman *et. al.* 2000).

Trampling

Human trampling can disturb the intertidal habitat (Keough & Quinn 1998). Different forms of recreational activities, such as access to the sea for SCUBA or snorkelling, and tourism and educational visits, can have cumulative trampling effects over time (Thompson *et. al.* 2002). Trampling, associated with harvesting, can also contribute to these disturbances. These impacts can be particularly heavy in conservation areas where public access is encouraged to promote awareness of marine wildlife (Thompson *et. al.* 2002). Human use and activity on the rocky intertidal zone acts directly upon adult life stages of the marine plants and animals (Lewis, 1978).

Pollution

Pollution can affect marine organisms at the very simplest level of biological organisation through cellular processes, to changes at the ecosystem level. Pollutants such as oils and dispersants, sewage, urban runoff, pesticides, landfill leachate, antifouling paints or heavy metals, and PCBs can decrease abundance and/or species diversity, reduce reproductive output, and cause behavioural changes (Creese & Kingsford 1998; Thompson *et. al.* 2002). Filter-feeding bivalves on rocky shores may pose a threat to public health through accumulating toxins and incubating diseases such as gastroenteritis from faecal pollution (Creese & Kingsford 1998).

Eutrophication and Algal Blooms

Eutrophication is the product of high nutrient loads entering the marine environment, usually from waste water discharged from sewer treatment works or run off from phosphate fertilised agricultural land (Roob 2003; Thompson *et. al*. 2002). High concentrations of nutrients cause microalgae blooms, which attach to, and shade, macroalgae. With a reduced amount of light, algae are not able to photosynthesise effectively. The reduction in photosynthesis causes a reduction in plant metabolic rates leading to eventual death of the macroalgae on the intertidal shore. Intertidal habitats are particularly susceptible to eutrophication due to many drains and stormwater outfalls which release a variety of pollutants and chemicals from urban streets into the intertidal zone. This situation can be compounded when there are accidental oil and chemical spills from industrial sources which end up in stormwater drains and often wash up on to intertidal zones.

Introduced Species

Accidental or deliberate introduction of species either as a consequence of transporting stocks for aquaculture, via release of ballast water from ships or from fouling on the underside of ships, can lead to dramatic effects on the native species (Thompson *et. al.* 2002). The arrival of non-local species represents one of the most important threats to the intertidal habitat, especially for native species which have no natural defence mechanisms to introduced pathogens or predators. Unlike pollution and harvesting, introductions of exotics are irreversible (Thompson *et. al*. 2002).

4.0 HOW TO MONITOR INTERTIDAL ROCKY SHORES IN VICTORIA'S MARINE NATIONAL PARKS AND MARINE SANCTUARIES

4.1 Safety procedures to follow before initiating intertidal monitoring

In each community group, one volunteer must be nominated to act as the supervisor of the intertidal monitoring group. This person will be responsible for contacting the Parks Victoria Ranger, organising dates for monitoring, assessing weather forecasts prior to the day of monitoring and organising and checking that each volunteer is fit and has the appropriate equipment and attire to proceed with monitoring. The following safety procedure is the checklist which the nominated supervisor must follow prior to monitoring.

1. Setting an appropriate date/s for intertidal monitoring can be done in consultation with the Parks Victoria Regional Ranger. This will provide an appropriate amount of time for the Park Ranger to organise volunteer insurance, time log forms and monitoring equipment. To contact a Parks Victoria Ranger for your MNP or MS, call **13 19 63** and ask to be connected to the office associated with your MPA. Once dates have been set, the appropriate Fisheries personnel for the region should be notified by ringing the Departments of Environment and Sustainability and Primary Industries Service (DPI & DSE) Centre on **13 61 86**. There are no seasonal restrictions for undertaking monitoring, but be aware that during winter months seawater and air temperatures can be cooler.

2. The night prior to, and on the morning of, intertidal monitoring, assess the weather forecast, tidal movement and sea conditions. This can be done by checking the Bureau of Meteorology via the website: http://www.bom.gov.au/weather/vic/

3. Notify all volunteers to meet in one specific location before embarking on the monitoring. This ensures that no volunteers become lost.

4. The monitoring supervisor must take a head-count of all volunteers and ensure that each volunteer signs and dates the Parks Victoria Volunteer Insurance and Time sheets prior to proceeding with intertidal monitoring. These can be obtained from your local Parks Victoria Ranger.

5. Ensure that all volunteers are wearing adequate clothing and footwear. Shoes must be sturdy, with a solid sole and a good grip. Protection against the hot elements such as a hat, sunscreen, sunglasses and water bottle is necessary. If rain is predicted, ensure adequate wet-weather gear such as a jacket or plastic poncho and a change of dry clothes is available.

(*See Appendix 4 for a complete checklist of personal and scientific equipment required for intertidal monitoring*).

6. A current first aid kit must be at the monitoring site.

7. Ensure that all volunteers are aware of dangerous marine animals such as the blue-ringed octopus, sea jellies and cone shells.

8. Be aware of a sudden change in weather conditions and use common sense to stop monitoring if the situation looks dire.

9. Ensure that at least one volunteer acts as a lookout for sudden large waves or changes in weather conditions.

10. An operable communication device, such as a mobile phone, should be present during each monitoring session.

4.2 How to select intertidal rocky shore monitoring sites in Victoria's Marine National Parks and Sanctuaries

Mapping programs have been performed by Primary Industries Research Victoria Marine and Freshwater Systems (PIRVIC – MFS) and the Department of Sustainability and Environment (DSE) over the past five years. Reports, maps and geo-spatial databases are now available for most areas around Victoria's coastline.

Using the MAFRI and DSE reports and maps, long-term rocky shore monitoring sites in Victoria's MPAs can be chosen. With the assistance of a Parks Victoria Ranger, the rocky shore sites chosen by volunteers can complement other reports and datasets used to predict threats and identify impacts.

If no previous report or mapping programs have been undertaken in an MPA monitoring region, consultation with the local Parks Victoria Ranger may assist in determining the best monitoring sites. (*Phone 13 19 63 to contact the Parks Victoria Customer Centre*)

Monitoring site selection should represent the intertidal rocky shore community for the MPA and the threats and impacts which can determine organism distribution. Site selection should also incorporate the range of habitats used by the flora and fauna and should not be logistically difficult to revisit. Ensure that the rocky shore is the dominant habitat of the MPA site. A research permit is required before any monitoring can take place. The research permit form can be obtained through DSE. A research permit application can be done in conjunction with a Parks Victoria Ranger for the MPA.

Monitoring sites in Victoria's MNPs and MSs should not be permanently marked with pickets or any other structure. The use of a Global Positioning System (GPS) in conjunction with a

Parks Victoria Ranger, will give co-ordinates for monitoring sites for long-term monitoring (*See Appendix 1 for information on GPS Guide*).

Monitoring sites within each MNP or MS are to be selected on the basis of (Hart & Edmunds 2004):

- the availability of intertidal rocky shore
- exposure to potentially threatening processes.

The process of selecting a monitoring site in an MNP or MS is as follows (Hart & Edmunds 2004):

1. Intertidal rocky shores of substantial size within the marine national park and sanctuary are selected.

2. If there is only a small area of intertidal rocky shore, then monitoring occurs on the safest area available.

If there is a single large rocky shore (>200 m), or multiple rocky shores within an MNP or MS, then monitoring should occur in areas that are likely to be exposed to the main threatening processes identified for that specific MPA. These processes include: high visitation causing disturbance to the flora and fauna by trampling, illegal collection of intertidal flora and fauna, changes to nutrient inputs, and freshwater inputs. Monitoring can have a different focus at separate intertidal rocky shores (e.g. to detect if an impact is occurring due to a specific threat, or to detect a change in flora and fauna populations over time).

4.3 What is a reference site and why should it be included in intertidal rocky shore monitoring?

Intertidal monitoring studies should be designed so that seasonal changes are not confused with changes caused by human impacts. Any impacts caused by human activities can then be separated from any natural variation within the intertidal habitat. There are many sources of natural and human-induced variation in a habitat which need to be considered in a monitoring design.

In an intertidal rocky shore monitoring program it is important to measure as many sites as possible within the MNP or MS. This will ensure that trends or patterns are representative of the whole MPA. A reference site is a monitoring site outside of the MNP or MS. The reference site must be similar to sites within the MPA by having the same dominant type of rocky substratum. In order to assess whether intertidal rocky shores and associated marine animal and plant assemblages are changing due to the habitat being protected, areas which are not protected must also be assessed. Over the long-term, patterns in variation can be detected in both protected and unprotected rocky shore intertidal habitats. If the variation is due to natural causes, this will be reflected in both protected and non-protected rocky shore intertidal habitats over time. However, if a trend is occurring, for example, in protected intertidal rocky shores and this is not seen in unprotected intertidal rocky shores, then an assumption can be made that protecting an area may cause this variation. For example, in an MPA the number of a specific species of snails may be greater than the same species of snail found in the non-MPA. This could imply that creating an MPA has protected this snail species from possible human-induced impacts.

If possible, it is important that each monitoring program has at least two reference sites. This of course will be dependent on intertidal rocky shore habitat availability outside the MPA. Reference sites can be chosen in conjunction with a Parks Victoria Ranger. (*Call 13 19 63 to find out the Parks Victoria Ranger for your MPA.*) By monitoring the MPA and reference sites over a long time-period, more trends can be identified and supported by the collected data.

Monitoring for impacts or changes in rocky shore communities requires monitoring of intertidal rocky shores within the MNP or MS, as well as reference locations. Reference sites are chosen by the following process (Hart & Edmunds 2004):

Identify intertidal rocky shore areas outside the MNP or MS. Most reference sites will be within the general vicinity of the MPA.

If the intertidal rocky shore outside the MNP or MS is limited in size, then the reference site will be on this limited amount of rocky shore. The substrate type and environmental conditions should be matched as closely as possible to the site within the MPA.

If there are multiple areas of intertidal rocky shore outside the MNP or MS, then the reference site should occur on the area of rocky reef that is most similar to the monitoring location within the MPA. The ideal reference site would have similar physical conditions such as substratum type and area, vertical gradients, exposure to wind, waves, currents and freshwater input. The reference site should also have similar marine plant and animal community structure.

If the focus of monitoring at a rocky shore in an MNP or MS is to detect if an impact is occurring because of a specific threat (e.g. trampling) then the reference site should be chosen so that the main difference between the rocky shore in the MPA and the reef at the reference site is the level of exposure to the threat.

Figure 4.0 Ricketts Point Marine Care volunteers monitoring at the Black Rock reference site, Victoria. (Image: K. Miller)

4.4 How often should intertidal monitoring be conducted?

There are no set rules as to how often your group should monitor your MPA and reference sites. During summer the weather is warmer and more desirable to work in, or next to, the water. Winter poses the problem of cooler air and water temperatures, where thicker and warmer clothes are needed. The frequency of monitoring is dependent on your community group and time commitments for each individual volunteer. It is also sensible to recognise that some volunteers may not wish to partake in intertidal monitoring during the winter months due to the cooler weather.

There could be seasonal effects on the distribution and types of animals and plants found on the rocky intertidal. For example, some seaweeds grow in greater densities during Spring and die back during Summer. This is a natural seasonal variation. Over time it is important to identify this as a natural trend. However, human-induced impacts may not show the same fluctuating trends through time. There may be changes to intertidal shores occurring slowly over time, or it may be a large scale impact which can take place within a few weeks. In order to not make the wrong assumptions, it is best that monitoring take place each season if possible at both MPA and reference sites. (*See Section 4.4 for details of selecting a reference site.*) It is possible to choose sampling dates with the Parks Victoria Ranger (*See Section 4.1 for Parks Victoria contact details*) who may recommend certain periods during each season which may produce favourable conditions for intertidal monitoring.

4.5 What equipment is needed to set up an intertidal rocky shore monitoring site?

Materials and Equipment

- 7 x 100 m fibreglass measuring tapes (transect lines)
- Compass or a GPS (Global Positioning System) (See Appendix 1 for further information on how to use a GPS.)
- Map of site (if available)
- Waterproof data sheet (See the Sea Search website www.parkweb.vic.gov.au/seasearch to download the intertidal monitoring sheet), clipboard, pencil, and rubber bands to hold the data sheets in place.
- Field summary sheets (See Appendix 3 for summary sheets to assist you during monitoring).
- 0.25 m^2 (50 cm x 50 cm) quadrats divided into a grid of 7 x 7 perpendicular wires, giving 50 regularly-spaced points. (*See Figure 4.8 in Section 4.10 to view a 50 point quadrat*).
- 1 m fibre glass measuring tapes
- 5 x 15cm plastic rulers
- Knee pads or a piece of foam to protect the knees whilst kneeling on the rocky substrate.

The methods used for monitoring the intertidal rocky shore, have been adapted from the Standard Operational Procedure for Intertidal Reef Monitoring by Australian Marine Ecology (Hart & Edmunds 2004) commissioned for Parks Victoria.

4.6 What are baselines and how do I establish them at the intertidal rocky shore monitoring site?

A baseline establishes the upper- and lower-shore limits of your monitoring area in the intertidal zone. (*See Figure 4.1 for a diagram of upper and lower shore baselines.*) The area between the high- and low-shore baselines is considered to be the monitoring sampling area. The baseline is established by using a 100 m measuring tape. The steps below detail how to establish the upper and lower baselines at your monitoring site.

A single intertidal monitoring survey should occur at a single reef during a single low tide.

At the chosen monitoring site, identify the high- (supralittoral zone) and low- (sublittoral zone) shore regions. On vertically-sloping shores, the high-shore corresponds to the area that is submerged for the shortest period of time during high tide.

Transects lines are used to create the high- and low-shore baselines. The baselines can extend for a distance less or equal to 200 m. When laying out the baselines, try to minimise the impact on the monitoring area by walking carefully over the substrate.

A transect line is reeled out along the high-shore. The 0 m position is on the right-hand-side of the transect line when looking towards the sea. This is called the high-shore baseline.

At the low-shore, a transect line is laid out at the estimated low tide level mark. This is called the low-shore baseline. Like the high-shore baseline, the 0 m position starts at the right side of the transect line when looking out to sea.

Record the GPS position at 0 m and end position of both baselines. If a GPS unit is not available, use a compass bearing to the nearest landmark feature.

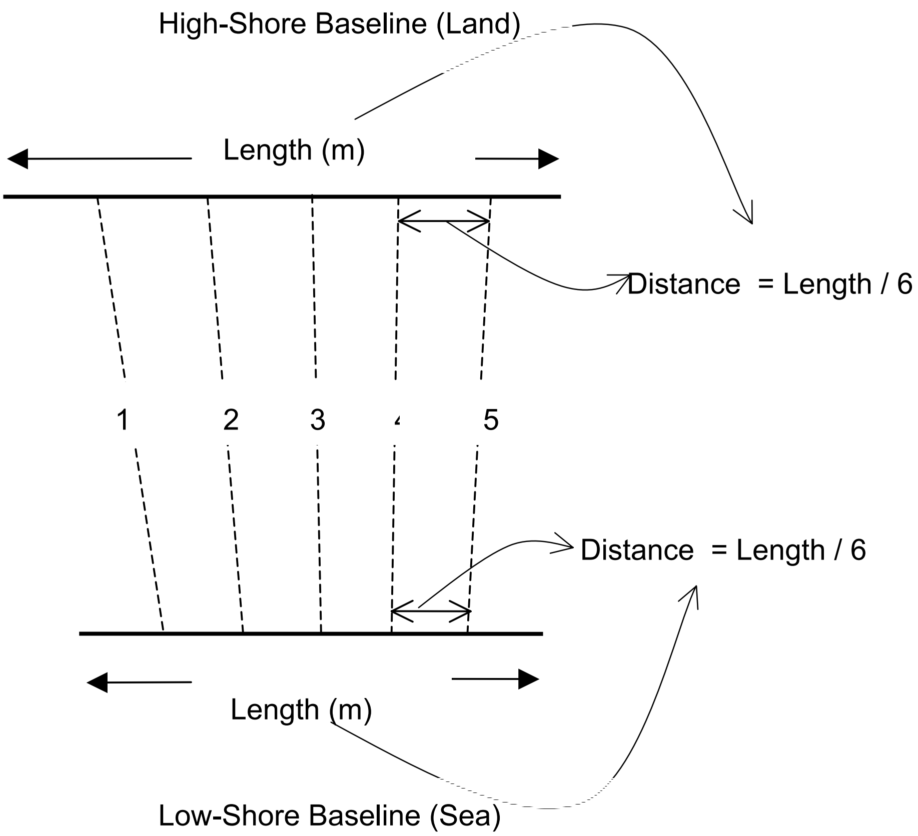


Figure 4.1 Intertidal rocky shore monitoring site with high shore and low shore baselines, incorporating transect lines 1-5. The position and distance between transects along the baseline can be derived by dividing the baseline by 6.

4.7 How to set out transect lines between the high- and low-shore baselines

Each of the five fixed transects run from the high- to low-shore baseline and are positioned across the intertidal area which is to be monitored. (*See Figure 4.1 for a diagram displaying the outlay of the transect lines.*) Transect 1 is the furthest to the right side and Transect 5 is the furthest to the left side when looking out to sea at the high-shore baseline.

To determine the start of each transect line along the high-shore baseline, divide the total distance of the high-shore baseline by six. This number is the distance (in metres) that each transect line will start along the high-shore baseline.

To determine the end of each transect line along the low-shore baseline, divide the total distance of the low-shore baseline by six. This number is the distance (in metres) that each transect will finish at the low-shore baseline.

Once these positions are established, Transect line 1 is to be reeled out starting at the specific distance in from the 0 m position of the high-shore baseline and will be moved towards the required spot on the low-shore baseline. (*See Figure 4.1.*) For example, if the high-shore baseline is 180 m long, then the start of each transect line will be placed every 30 m. Transect 1 will be 30 m along the measuring tape from the 0 m start position. If the low-shore baseline is 90 m long, then Transect 1 will finish at 15 m from the 0 m position on the low-shore baseline. When setting out the transect line, minimise the impact on the monitoring area by walking carefully over the substrate.

Transects 2-5 start at the designated distances along the high-shore baseline. To continue with the example in Step 5, Transect 2 would start 30 m along from Transect 1, that is, Transect 2 would start at 60 m and end at 30 m on the low-shore baseline.

The lengths of the high- and low-shore baselines may be different. Therefore, the transect layout may appear fan-shaped. (*See Figure 4.1 for this fan-shaped appearance.*)

Figure 4.2 Marine Care – Ricketts Point volunteers collecting data for the first quadrat along transect line 3 at Ricketts Point Marine Sanctuary, Victoria. (Image: R. Koss)

4.8 How to select a monitoring location along the transect line

Five quadrats are monitored for each transect line (*See Figure 4.3 for monitoring positions along the transect line*). Quadrats are randomly placed within each 2 m x 2 m sampling location (*See Section 4.9 for more details about random quadrat positions*).

1. Monitoring locations 1 and 5 are indented 1 m from the high- and low-shore baselines respectively.

2. The distance between sampling locations one and five is measured.

3. This distance is divided by 4. The resulting figure is the distance that sampling locations three to four are situated. For example, if the distance between sampling locations one and five is 20 m, then sampling locations two to four are 5 m apart.

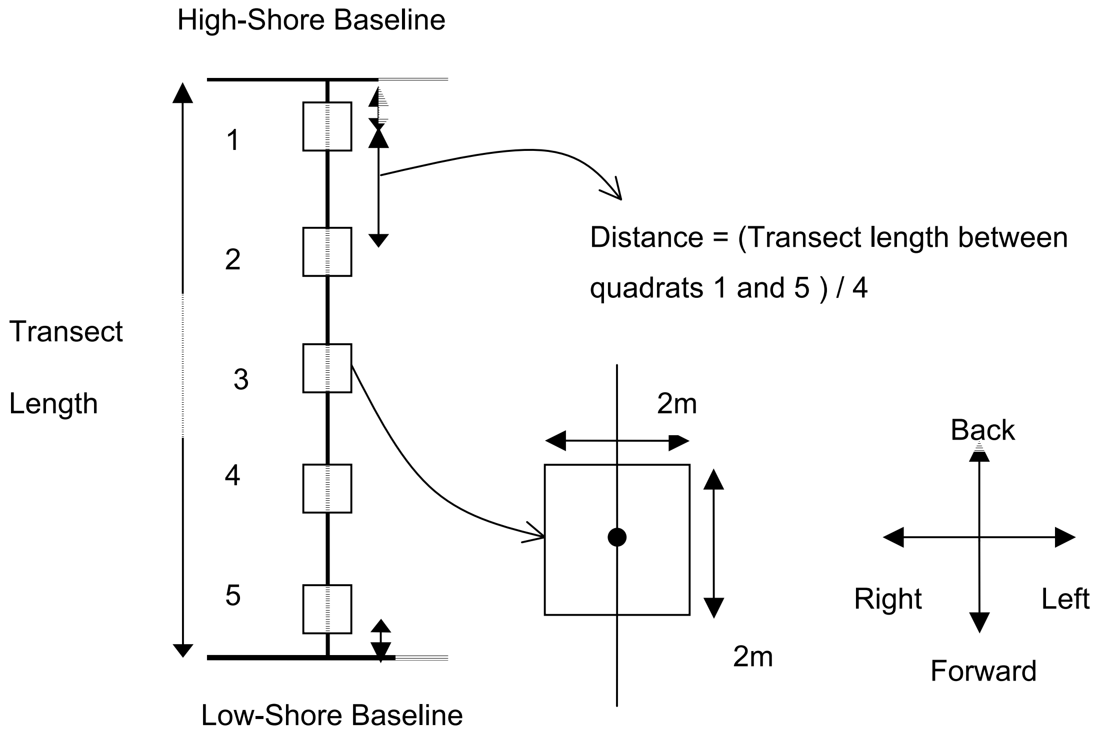


Figure 4.3 Sampling positions along the transect line. Random quadrat positions are derived using random numbers and directions (Appendix 2) from the central sampling location.

Figure 4.4 Marine Care – Ricketts Point volunteers collecting data at random quadrat positions along the transect line at the reference monitoring site, Black Rock, Victoria. (Image: K. Miller)

4.9 What are random quadrat positions and how are they selected?

Why does intertidal rocky shore monitoring require random quadrat positions?

The idea of random data collection is an important component in any scientific ecological monitoring. This decreases any biases in data collection and ultimately the final results. In order for no biases to be represented in the data collection, quadrat positions must be chosen in a random fashion.

How to choose random quadrat positions.

Quadrats should be randomly positioned within each 2 m x 2 m sampling location. (*See Figures 4.3 and 4.5 for guidance on how to place the random quadrat positions.*)

A set of random numbers determines the position that the quadrat is placed in the 2 m x 2 m area. In Appendix 2, numbers ranging from 0 to 100 (in multiples of tens) with the words forward or right, or back and left, written next to the number, can be found. These numbers are to be cut into equally-sized pieces. These pieces are placed into a hat or bag and two pieces of paper are selected. These two numbers, with the words, are the position points for the quadrat from the central location on the transect line. For example, a set of random numbers may be *60 FORWARD or RIGHT* and *80 BACK or LEFT*. Each number represents a measurement in centimetres and the word represents the direction moved in relation to the transect line.

At the central location of the 2 m x 2 m sampling area, use the first number and word to move backwards or forwards along the transect line from the central position, that is, the distance found in Section 4.8. For example, if you selected *60 FORWARD*, move 60 cm forwards towards the low-shore baseline. If *60 BACKWARD* is the first number and word, move 60 cm backwards, towards the high-shore baseline.

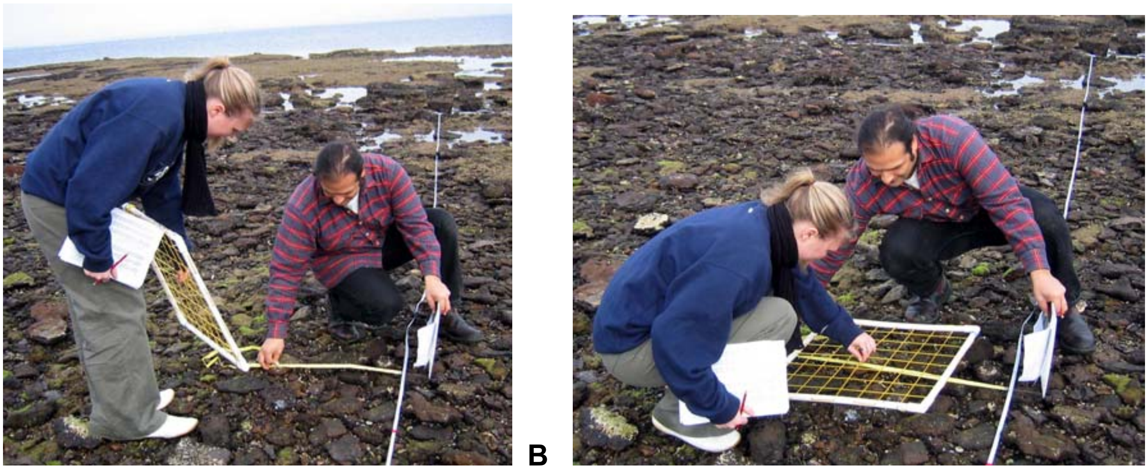
The second number and word selected, corresponds to the distance moved either to the right or left of the position in Step 3. Use the 1 m fibreglass measuring tape to find the exact position. For example, if the second number and word is *80 LEFT*, move 80 cm left of the transect line when looking at the sea. If the number and word is *80 RIGHT*, move 80 cm to the right of the transect line when looking at the sea.

At this final position, place the central part of the quadrat on the substrate.

If the quadrat position happens to occur in a rock pool or a different substrate type, for example, sandstone rather than basalt, or on a large vertical crevice which is greater than 50 cm, the quadrat must be moved to the closest area of the dominant substrate type. Measure the distance of the new sampling location and note this on the datasheet. This is done for two reasons. If the rock pool or crevice is deep, the animals and plants cannot be sampled efficiently. In addition to this, we want to decrease the impact or the amount of disturbance we have on the intertidal environment.

For data collection to be efficient, selecting the number and word is best done the day or night prior to monitoring by the intertidal monitoring supervisor with assistance from other volunteers. Once two random numbers are selected and noted on the datasheet, they are replaced back into the bag or hat before numbers are selected for the next quadrat position.

It is fine for two quadrats to have the identical sets of numbers chosen, provided the numbers were chosen at random and were in accordance with the above instructions.



A **B**

Figure 4.5 Marine Care – Ricketts Point volunteers position the quadrat. **A**) Measuring the distance from the transect line, and **B**) Placing the central point of the quadrat at this position distance. (Images: R. Koss)

4.10 What types of information need to be recorded?

Five sets of data are to be collected from each quadrat along each transect line and include:

1. Mobile invertebrates
2. Mobile invertebrate shell length
3. Macroalgae and aggregate sessile invertebrate point cover
4. Rocky shore habitat
5. Essential information.

It is important to first count the number of mobile invertebrates. Some mobile invertebrates, such as crabs, move quickly if disturbed and out of the area of the quadrat. There is no order for recording the other data sets.

Mobile Invertebrates

The density of mobile invertebrates and some sessile invertebrates, such as sea anemones, is measured by counting individuals within the 0.5 m x 0.5 m quadrat. All observable individuals on the rock surface, within small crevices and algal fronds are counted. To ensure that monitoring has minimum impact over time, rocks are not overturned or disturbed when counting individuals.

Starting at the top left corner, count downwards along the column. At the bottom of the column, move to the next column on the right and count upwards. Continue counting all individual species in this manner.

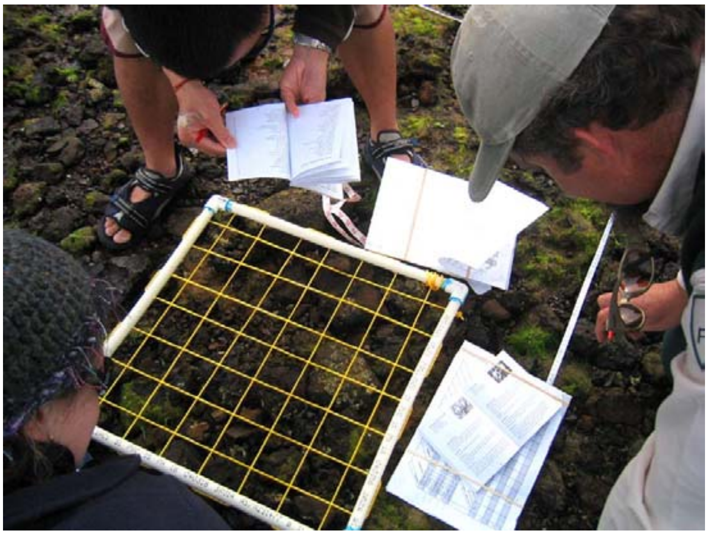


Figure 4.6 Marine Care – Ricketts Point volunteers and Parks Victoria Ranger, Peter Johnston, collecting monitoring data with the aid of identification guides.

Mobile Invertebrate Shell Length

The shell length of the five most commonly collected species used for bait or food, such as *Cellana tramoserica* and *Austrocochlea constricta* are measured. This is done to identify changes over time in the size structure of commonly collected species, which may indicate impacts on populations due to illegal shellfish collecting. Data collected also provides general information on population size structure and recruitment dynamics. Non-collected species such as *Siphonaria diamenensis*, *Cominella lineolata* and *Bembicium nanum* acts as a control. Collection of shell lengths is best done after counting individual invertebrate as set out in Step 1 above.

To identify other commonly collected invertebrates in your MPA and reference site, contact your Parks Victoria Ranger *(Parks Victoria Customer Service Centre 13 19 63)*

The first five individuals of each specie seen in the quadrat are measured for shell length.

Herbivorous snails (*See Figure 4.8 to see how to measure the shell length*) are measured across the width on the underside of the shell. Turn the shell over carefully, so as not to harm the animal, and using the ruler measure the width on the underside of the shell.

Predatory gastropods (*See Figure 4.8 to see how to measure the shell length*) are measured from top to the bottom (end of siphon groove), on the underside of the shell. Turn the shell over carefully, so as to not harm the snail, and using the ruler measure the length of the underside of the shell.

Ensure that all animals measured are placed back in the same location which they were taken from.

Some snails such as limpets are difficult to remove from the substratum. To decrease any harm and stress for the animal, it is much simpler to measure the length of the shell while it is attached to the substratum.

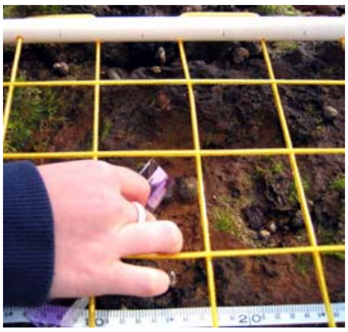
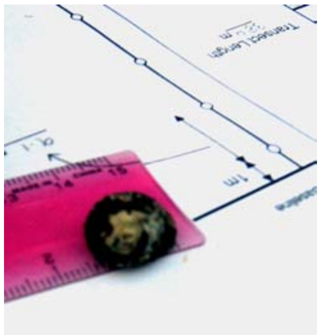
A  **B**  **C** 

Figure 4.7 Measurement of shell lengths. **A)** Limpets are difficult to remove from hard substratum and therefore should be measured with the ruler while the limpet is still attached to the rock. **B)** The herbivorous snail *A.constricta*, can be easily measured when handled carefully as to not cause any harm to the animal. **C)** Measurement of *A.constricta* across the width of the shell.

Figure 4.8 The shell of the predatory snail is measured across the length from the bottom of the siphon groove to the top pointed part of the shell as demonstrated by the red line on the snail *Cominella lineolata*. The shell of the herbivorous snail is measured across the width from the bottom of the shell opening to the other side of the shell as demonstrated by the red line on the snail *Turbo undulatus.*

Macroalgae and Aggregate Sessile Invertebrates Point Cover

The $0.25m^2$ quadrat is divided into a grid of 7 x 7 perpendicular wires, giving 49 regularly - spaced points. By including the bottom right corner of the quadrat, the number of intersecting points is 50. Cover is estimated by counting the number of points falling directly above each species (*See Figure 4.9 for a diagram on how to count point cover*).

Stand in front of the quadrat. When looking down on to the quadrat, the 50 intersecting points fall directly over the organisms.

Using the intersections and the bottom right corner point, count how many points cover each species of algae and aggregate sessile invertebrates. Aggregate sessile invertebrates such as the polychaete worm, *Galeolaria caespitosa*, and the blue mussel, *Mytilus edulis planulatus,* are measured using the point cover method.

Fluctuations in species numbers may indicate changes in nutrient loadings affecting intertidal areas. Species that may respond include the algae *Hormosira banksii, Ulva rigida, Cladophora subsimplex, Capreolia implexia, Ceramium flaccidum* and *Corallina officinalis*. If these species are present in the quadrat but do not fall under any points, a side note of their presence is recorded on the datasheet.

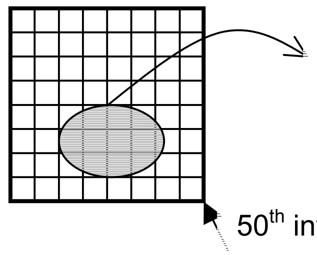


Figure 4.9 Point count of macroalgae and aggregate sessile invertebrates utilising the 50 intersecting point count.

Rocky Shore Habitat

For each random quadrat position, record the type of microhabitat. These include:

H – horizontal surface, flat and rock top

P – rock pool (if the water depth is greater then 20cm)

R – rocky rubble and cobble

S – sand

V – vertical surface, rock side and crevice.

Essential Information

There are a number of important qualitative sets of data which need to be noted at the time of monitoring. These include:

name of volunteer

date of monitoring

start and end time of monitoring

temperature

site (GPS co-ordinate or compass bearing to a geological feature on the land)

transect number

type of day (e.g. overcast, sunny, few clouds).

4.11 What to do if you think you have found a marine pest

If you suspect you have seen a marine pest, you should report it to the Department of Sustainability and Environment Customer Service Centre on **13 61 86**. It is important that you have all information corresponding to the animal or plant available. This includes a description of the animal or plant and its approximate size, the location where you saw the pest, the date and time of siting and the number of individuals seen. At the bottom of the intertidal monitoring sheet there is room for making notes on any marine pests sited.

4.12 Procedures and what should be done after completing an intertidal monitoring session

Once all monitoring has been completed, the monitoring group's supervisor must do a head count to check that all volunteers are present. This is very important, especially if intertidal monitoring sites are near exposed coastlines.

Ensure all equipment has been collected and nothing has been left behind at the monitoring site.

Once on land, each volunteer must check that their datasheet has been filled in and all numbers are clear and legible. Volunteers must check figures for discrepancies and anomalies with errors corrected and/or annotations added, if necessary. Ensure that all essential information (*See Number 5 in Section 4.10*) has been completed. Place all datasheets into a folder or envelope, where they will not be lost, which will be the responsibility of the group's monitoring supervisor.

Once on land, wash transect lines, quadrats and underwater slates in fresh water. This assists in removing any excess sand or mud. Ensure the equipment is dry before placing in storage.

The group's monitoring supervisor with assistance from other volunteers can place new datasheets on the underwater slates and sharpen pencils in preparation for the next intertidal monitoring. This can be done at home or at the car park after the completion of monitoring.

At home, the group's monitoring supervisor with assistance from other volunteers, can enter the data into a computer Excel worksheet (*See Section 4.13*) and save the data.

Figure 4.10 Marine Care – Ricketts Point volunteer reeling up a transect line on completion of the monitoring at Ricketts Point Marine Sanctuary, Victoria. (Image: R. Koss)

4.13 How to enter intertidal monitoring data onto an Excel worksheet

The intertidal monitoring data must be entered on to a Microsoft Excel spreadsheet and saved as soon after the completion of an intertidal monitoring session. This ensures that the valuable monitoring information is not lost. The following data entry procedures are relatively simple and guide you in entering the data. By following the Excel data template *(the Excel data template can be downloaded from the Sea Search website www.parkweb.vic.gov.au/seasearch)* it will allow your group and management authorities to analyse the data without needing to transform the data layout.

1. Open a new Microsoft Excel worksheet.

2. The first sheet (see the tabs on the bottom of the Excel sheet) is for quadrat data.

3. Type the word 'Transect' at the top of the first column.

4. Move to the top of the second column and type the word 'Quadrat'.

The additional columns will be labelled according to intertidal species names monitored for counts and percentage cover in the quadrat *(See Steps 1 and 3 in Section 4.10)*. The species names can be abbreviated for ease of data entry. Each column will be for a separate species.

5. Type in the count number for each animal according to the transect and quadrat number.

Once all species counts and percentage cover have been entered, save this spreadsheet according to the site name and date. For example, if monitoring took place at Ricketts Point MS on June 6 2004, then you can save the sheet as RP06062004. At the bottom left of the spreadsheet there is a tab with sheets named Sheet one, Sheet two and Sheet three. The species count data has been saved on Sheet one. Click on Sheet two, which will open a new spreadsheet. Sheet two is still recognised and saved under the same file name. Sheet two is for species shell lengths.

1. Type the word ‘Transect’ at the top of the first column.

2. Move to the top of the second column and type the word ‘Quadrat’.

3. Move to the top of the third column and type the word ‘Length’.

4. The additional columns will be labelled according to the five most common invertebrate species chosen for shell length measurement. Each column will be for a separate species.

5. Type the length for the specific intertidal species corresponding to the transect and quadrat number.

Press the Save function every five minutes during data entry.

Monitoring data stored as an Excel spreadsheet can be easily reproduced and used for analysis. Long-term monitoring may or may not display trends which can be easily seen by using graphing and statistical applications in the Microsoft Excel software package. A copy of your group’s monitoring data can be saved on to a disk or CD and sent to the Parks Victoria Ranger who assisted your community group intertidal monitoring or a ranger responsible for the management of your MPA (*Ring Parks Victoria on 13 19 63*).

GLOSSARY

Abdomen	A segmented section of the body located behind the thorax.
Adaptation	A particular structure, physiological process, or behaviour that makes an organism better able to survive and reproduce.
Algae (plural)	A photosynthetic, plant-like single- or multi-cellular organism.
Carnivore	An organism that feeds on animal tissue.
Desiccation	To dry up or caused to dry up.
Diurnal Cycle	A daily cycle of two high and low tides.
Gonad	The testis or ovary.
GPS	Global Positioning System
Grazer	An animal which feeds on vegetable tissue from herbaceous plants.
Habitat	The environment in which an organism lives.
Herbivore	An animal which eats plant tissue.
Intertidal	The region of coast between the extreme high and low tide marks.
Littoral	Another term used to define the intertidal zone.
MNP	Marine National Park
MPA	Marine Protected Area
MS	Marine Sanctuary
Salinity	A measure of dissolved salt concentration in water.
Sessile	Attached; not free to move about.
Sublittoral	The low-zone which is usually covered with water at low and high tides. Another term used to define the subtidal zone.
Substratum	A base which a sessile animal or plant is fixed.
Subtidal	The low-zone which is usually covered with water at low and high tides.
Supralittoral	The upper-zone of the intertidal which has the longest period of exposure to

	air during low tide.
Supratidal	The splash area of the intertidal zone.
Temperate	Having a moderate climate.
Tide	The rise and fall of the ocean's water relative to the earth-moon rotational cycle.
Thorax	The central section of the body consisting of several segments behind the head and in front of the abdomen.

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APPENDIX 1 – GPS GUIDE

A complete GPS Guide can be downloaded from the Parks Victoria Website:

http://www.parkweb.vic.gov.au/1park_display.cfm?park=256

What is a coordinate system / datum?

In order to translate from the coordinates on a map or chart to a location on the ground using a handheld GPS, there are several important steps that must be understood.

A coordinate system is a set of infinite lines that divides the earth up into sections for the purpose of map reading. Victoria is divided into two separate zones: zones 54 and 55. These zones relate to the Universal Transverse Mercator projection used by many countries to map the earth.

A datum is a best fit model of the earth's surface. In 2000, the Geocentric Datum of Australia (GDA-94) replaced the Australian Geodetic Datum 1966 (AGD-66) as the standard for all of Australia. It was chosen because it is directly adaptable to the World Geodetic System 1984 (WGS-84) which is used world-wide for GPS receivers. Prior to this, AGD-66 was widely used, and provided a best fit model for Australia *only*. Although GDA-94 in current industry standard has maps/charts made prior to 2000, they list coordinates relative to AGD-66.

There are two coordinate systems used in Australia to match these datums. They include MGA-94 (Map Grid of Australia) for the GDA-94 datum and AMG-66 (Australian Map Grid 1966) for AGD-66 datum.

Latitudes and Longitudes can be displayed in a variety of formats. The most widely adopted for general maps, are Degrees, Minutes and Seconds. The best way to understand this system is to simply considerate it like a clock. The world is broken up into 360 degrees and each degree can be thought of as an hour. Each degree is broken up into 60 minutes and each minute is broken up into 60 seconds.

Latitudes and Longitudes can also be expressed in Degrees, Minutes and Decimal Minutes. This is generally only used in Victoria for nautical charts. The difference between this and the previous method, is that each degree is still broken into 60 minutes, however, each minute, instead of being divided into sixty seconds is divided up into hundredths. In order to correctly chart Marine National Park coordinates onto a nautical chart this needs to be understood. All GPS receivers will convert between these two display formats.

In order to find your ground location on a map using a GPS receiver, it is important to understand to which Datum your GPS receiver is set, what projection your map is and in which format your coordinates are expressed. If it is set incorrectly, position differences of up to several hundred metres will occur.

How to find marine national parks and sanctuaries using your GPS receiver

It is important to familiarise yourself with your GPS receiver and more importantly, the accuracies attainable. Being able to switch between coordinates systems and datums is also useful, as not all maps or coordinates give positions in the same format. Latitude and Longitude are usually provided in the geodetic datum on which GPS is based (WGS-84).

GPS is not precise. The design of the system ensures that the average member of the public can achieve a reasonable accuracy with their GPS receiver, without locating a definitive 'X marks the spot' position.

It is, however, still possible to reduce the error of the position to less than 10-15 metres by ensuring that:

the coordinate system and datum in the receiver are correct

the GPS receiver is in Differential mode.

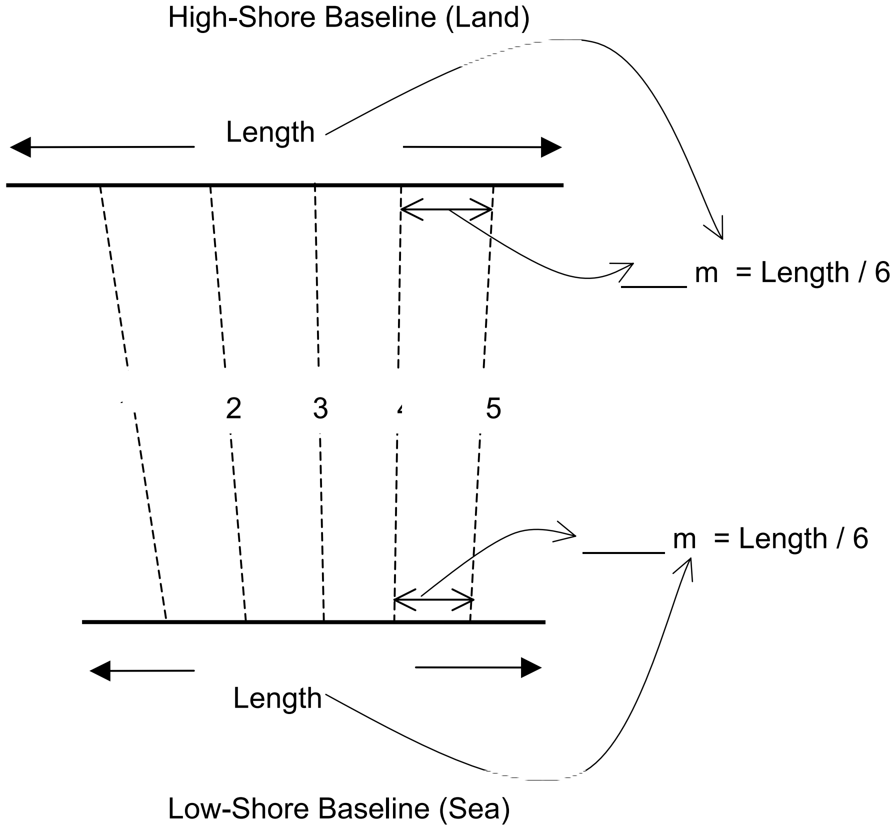
Differential GPS uses a known position on the earth and makes corrections to the GPS coordinates for that same position. These corrections are then applied to your GPS receiver, guaranteeing that the error in your position is minimised.

APPENDIX 2 – RANDOM QUADRAT PLACEMENT NUMBERS

Random quadrat placement numbers and directions as needed in Section 4.9. Use scissors to cut into equally-sized pieces.

0 cm FORWARD OR RIGHT	**0 cm BACK OR LEFT**
10 cm FORWARD OR RIGHT	**10 cm BACK OR LEFT**
20 cm FORWARD OR RIGHT	**20 cm BACK OR LEFT**
30 cm FORWARD OR RIGHT	**30 cm BACK OR LEFT**
40 cm FORWARD OR RIGHT	**40 cm BACK OR LEFT**
50 cm FORWARD OR RIGHT	**50 cm BACK OR LEFT**
60 cm FORWARD OR RIGHT	**60 cm BACK OR LEFT**
70 cm FORWARD OR RIGHT	**70 cm BACK OR LEFT**
80 cm FORWARD OR RIGHT	**80 cm BACK OR LEFT**
90 cm FORWARD OR RIGHT	**90 cm BACK OR LEFT**
100 cm FORWARD OR RIGHT	**100 cm BACK OR LEFT**

APPENDIX 3 - INTERTIDAL MONITORING FIELD SUMMARY SHEET



The baselines are positioned along the high water and low water marks, with a maximum length of 200 m.

5 transects are spread evenly across the baselines and are indented from the ends.

The indents and the gaps between transects are 1/6th the length of the high- and low- shore baselines.

Quadrats and sampling locations

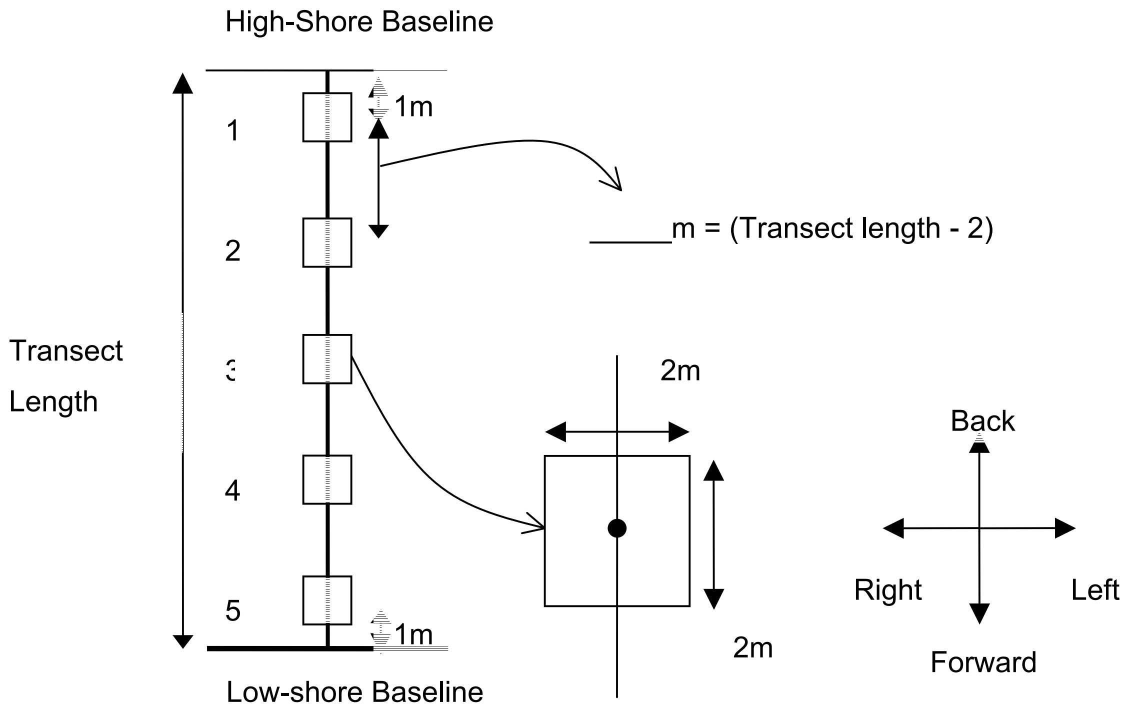
Transects are divided into five equally-spaced sampling locations.

These are numbered 1 through 5, beginning at the high-shore baseline.

Each sampling location is 2 m x 2 m giving an area of 4m^2.

The 1st and 5th sampling locations are indented 1 m from the baselines.

The gap between the sampling locations 1 and 5 is divided by 4 to give the distance for sampling locations 3 to 4.

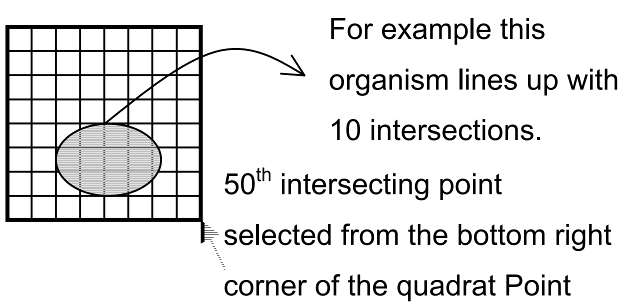


Within each sampling location, a 0.5 m x 0.5 m quadrat is randomly placed according to the following directions: Looking out to sea, start at the centre of the sampling location. Simply follow the directions on the data sheets for where to put the middle of the quadrat. (e.g. 20 cm forward, 30 cm right, or, 60 cm back, 90 cm left, etc.)

Measurements

Identify and count all the animals and plants in the quadrat.

If it is hard to count actual numbers of organisms (e.g. algae or mussels), then count the number of times the organism falls under one of the 50 intersection points on the quadrat (49 + the bottom right corner).



Measure five individuals per quadrat (if they are there) of each of the five 'common' gastropods listed.

APPENDIX 4 – PERSONAL/SCIENTIFIC EQUIPMENT SHEET

Personal and Scientific Equipment Summary Sheet to be checked by the supervisor of the monitoring group as outlined in Section 4.1.

PERSONAL EQUIPMENT	Tick	SCIENTIFIC EQUIPMENT	Tick
Each volunteer has protective shoes with a solid sole or dive boots.		7 x 200 m measuring tapes	
Each volunteer has a hat, sunscreen and sunglasses.		5 x 0.25 m^2 quadrats	
Each volunteer has a water bottle with water.		GPS or compass	
Each volunteer has wet weather gear if rain is predicted.		Waterproof datasheets, underwater slates, pencils, rulers and rubber bands.	
Each volunteer has adequate clothing to protect against the elements.		Map of site (if available)	
A current First Aid Kit for the whole group.		Field summary sheet	

Parks Victoria is responsible for managing the Victorian protected area network, which ranges from wilderness areas to metropolitan parks and includes both marine and terrestrial components.

Our role is to protect the natural and cultural values of the parks and other assets we manage, while providing a great range of outdoor opportunities for all Victorians and visitors.

A broad range of environmental research and monitoring activities supported by Parks Victoria provides information to enhance park management decisions. This Technical Series highlights some of the environmental research and monitoring activities done within Victoria's protected area network.

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For more information contact the **Parks Victoria Information Centre** on **13 1963**, or visit **www.parkweb.vic.gov.au**

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