
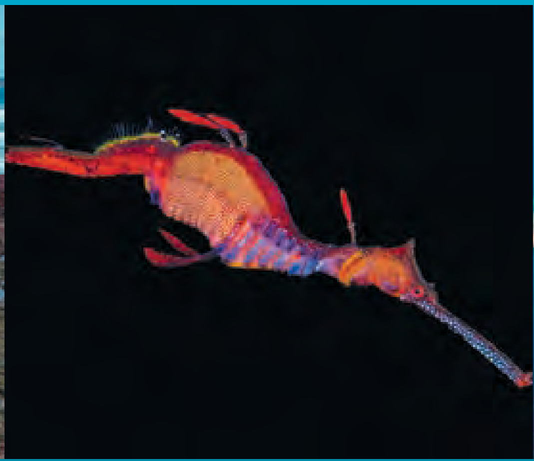


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Technical Compendium to the Sea Search Manual

March 2017

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Parks Victoria Technical Paper Series No. 98

Technical Compendium to the Sea Search Manual

Jacqui Pocklington
Steffan Howe

The University of Melbourne & Parks Victoria

March 2017

Executive summary

A review of the Sea Search program was undertaken to improve its ability to meet a range of key requirements for Parks Victoria including data for marine protected area management and a wider range of activities to suit different interest levels and ability among volunteers. The Sea Search Manual (Brown *et al.* 2013) covers in detail the practicalities of each of the new and modified Sea Search methods and is aimed at the Parks Victoria rangers and volunteers involved in Sea Search activities. This report is focused on the background to the method development, the questions able to be explored and tested by different methods, considerations for the success of the program, sampling design rationale and statistics. To prevent repetition reference is given to the Sea Search manual for information on each method.

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Introduction

What is Sea Search and why do we need it?

Victoria's marine national parks and marine sanctuaries were established in 2002 as part of a system of marine protected areas (MPAs) to provide for conservation of the state's unique and diverse marine ecosystems. These no-take areas protect both living organisms and the physical environment upon which they depend while providing for a range of human activities and uses. Some organisms live permanently within the boundaries of these reserves, while more mobile animals may spend only a portion of their lives as juveniles, or as adults, to breed, feed and shelter. Marine protected areas may in some cases also act as a source of larvae, seeds and spores that disperse to, and replenish, outside areas.

As the managers of these important marine areas, Parks Victoria establishes goals for improving the condition of the natural assets within MPAs and seeks to reduce the level of threats to identified values. To measure progress against achieving these goals, up-to-date information about the abundance, distribution and health of marine plants and animals inside the boundaries, as well as an understanding of the nature and effects of any threats to the natural values of these areas, is required. Monitoring – defined as repeated measurements or observations of something over time – is a way of collecting this information.

How does it work?

Many species of marine animals and plants contribute to the creation of healthy, functioning marine ecosystems – for example by creating habitats (e.g. mangroves, seagrass and algae) or influencing the presence and abundance of other species through competition and predation (e.g. seals, marine snails, fish and crabs). Parks Victoria has worked with marine scientists and other experts to identify important natural values in marine national parks and marine sanctuaries and the threats to these values (Parks Victoria 2011, Carey *et al*. 2007a, b). Information about how these natural values change through time (i.e. baseline information) is collected through both contracted and community monitoring. Natural baselines provide the background information against which the nature and magnitude of potential human impacts can be determined. Monitoring sites inside protected areas are identified by Parks Victoria rangers in consultation with scientists, drawing on information from previous investigations in the region and relevant studies conducted elsewhere.

The purpose of Sea Search is not simply to compare the performance of protected and outside areas, but is primarily about monitoring the condition of marine habitats across the state-wide system of marine protected areas and to contribute this information in a way which allows for an assessment of the improvement in natural values or reduction of threats in the MPAs.

Sea Search can be undertaken in a range of habitats (see Table 1), though the current focus is largely on two main habitat types: intertidal reefs, and seagrass beds. Depending on their availability and expertise, volunteers can select easy, moderate or difficult monitoring tasks within their marine national park or marine sanctuary. More than one method can be undertaken at the same, or different, times. Methods suitable for each marine national park and marine sanctuary are listed in Appendix 1[1]. For the purposes of brevity, marine national parks and marine sanctuaries are collectively referred to as *marine protected areas* in the remainder of this document.
This review builds on the significant work previously undertaken through Deakin University to establish Sea Search in Victoria (Koss *et al*. 2005 Parks Victoria technical series No. 16-19).

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1. This is not a list of monitoring priorities across the MPA system, but rather an indication of where the various methods could be used.

Quality Assurance and Quality Control (QAQC)

To ensure the data collected (most relevant for quantitative methods) can be used to inform management, quality assurance and quality control of the data collection needs to happen in the field and when data is entered into the computer. If data sheets are not completed, species are incorrectly identified or incorrectly counted/measured the data is not likely to be useful and could even lead to incorrect conclusions about what is happening in the MPA. There are ways of improving data quality and many of these are outlined by Rebecca Pirzl in an internal report to Parks Victoria (2010). Regular training and refresher courses on data collection and species identification can improve data quality, but these will be subject to available program resources. Easy ways to improve data quality in the field include nominating a person as the QAQC person who does spot checks on people recording data to see if they get the same species and counts, and checking that data sheets are fully complete before volunteers start collecting data in (for instance) a new quadrat. The database being developed for Sea Search data will include some automatic checks or tips on data entry to prevent error (e.g. that total % cover estimates for each quadrat should add up to 100%).

Technical Review

Many of these methods are new and will require regular review (especially statistical power analysis) once enough data has been collected to assess their ability to answer questions of interest to Parks Victoria. It is very important that methods are not altered until an official review has been completed as this would compromise the ability for any changes through time to be detected.

What happens to the information collected through Sea Search?

Sea Search data for each marine reserve is entered into an excel spreadsheet (or database once available) by Parks Victoria staff with assistance from volunteers. This information is checked, graphed and statistically analysed where possible, to determine patterns and trends in the natural value or activity in question. It is vital that surveys are completed and datasheets are filled out correctly so that there are no gaps in the data. Data gaps can reduce the statistical confidence in the data when testing questions and can even make it impossible to test questions at all.

Other types of information, such as photos, video, comments and observations are also systematically stored so they can be used to identify changes over time and potential impacts. Quadrat photos can be analysed with the aid of image analysis software Coral Point Count (CPCe, Kohler and Gill, 2006) so that the density of algae, mat-forming invertebrates, seagrass, and seagrass epiphytes is recorded. Threatening processes observed by Sea Search participants are investigated and responded to where necessary.

Sea Search information will be used to track the health of important natural values and will feed directly into the management of marine protected areas. Sea Search methods complement the scientific monitoring commissioned by Parks Victoria. Marine monitoring data is used in reporting on the status and condition of marine protected areas. It is intended that Sea Search data and images will contribute to the development of report cards which give a rating to the condition of marine natural values (habitats and species) inside protected areas.
The objectives of the Sea Search program include:

- Community engagement
- Establishing a sense of stewardship and increased awareness of marine values
- Collecting data to inform management - characterising plant and animal communities in each habitat by providing data on populations, population size structure of common and potentially impacted species and biological structure
- Determining the nature and magnitude of natural changes, species populations and communities over time
- Detecting impacts of threats on plant and animal populations and communities in MPAs

Permit requirements

All Sea Search activities are carried out under appropriate research permits held by Parks Victoria (issued by Department of Environment, Land, Water and Planning), these permits must be carried at all times during a Sea Search activity and permit conditions followed. If there are research activities you would like to carry out related to Sea Search that aren't part of an organised Sea Search event, or a Sea Search activity you can do alone (e.g. Species Checklist) you will also need to follow permit requirements. You can speak to the Parks Victoria ranger that delivers your local Sea Search program about permits and the associated requirements, such as letting the ranger on duty know of your planned activity in advance.

Table 1: Sea Search Method Summary

		Qualitative			Quantitative	
		METHODS FOR ALL HABITATS			ROCKY INTERTIDAL SPECIFIC	SEAGRASS SPECIFIC
Easy		1.1 Fixed Point Photos	1.2 Species Image Library	1.3 Sea Search Patrol		
Moderate					2.1 Cover Quadrats (algae and invertebrates)	3.1.1 + 3.2.1 Quantifying condition (rapid)
						3.3.1 + 3.3.2 Boundary Monitoring
Difficult					2.2 Counting snails and other mobile creatures*	3.1.2 + 3.2.2 Quantifying condition (detailed*)
					2.3 Catch per unit effort – snail and limpet sizes	

*this method must be done in addition to preceding methods e.g. 2.3 must be done only in addition to 2.1 and 2.2 not by itself.

Easy: Can be done by new volunteers
Moderate: Can be done by volunteers with some experience and training
Difficult: Can be done by experienced volunteers with relevant training

1. ALL HABITATS

The Sea Search monitoring activities in this section can be undertaken in any habitat within a Marine Protected Area. These habitats include beaches, intertidal habitats and shallow subtidal habitats. Methods 1.1 and 1.2 are easily done on shore, whereas methods 1.2 and 1.3 may also be done while snorkelling.

1.1 Fixed Point Photos

What

Repeat photos of habitats at the same geographic location over time can be a useful tool for detecting changes in habitat area and condition.

Why

Having a visual record from a fixed point can illustrate seasonal and long-term variations in the cover of algae, extent of seagrass or the expansion of a mangrove forest. Because these variables can change in response to human impacts, having this visual information enables managers to assess at a landscape-scale whether the condition of intertidal habitats is remaining constant, improving or declining.

This monitoring activity is designed to answer the question:

- **What are the broad changes in habitats that occur over time within the Marine National Park or Marine Sanctuary?**

Notes:

- Include permanent landmarks in your photos if possible.
- Refer to these photos each time to make sure you take your next set of photos from the same place each time.
- Multiple sites may be used for larger Marine Protected Areas.

When

This method is usually best for intertidal habitats during predicted low tide.

Where

Anywhere inside your marine protected area, but images must be collected from the same location and in the same direction for each survey point.

1.2 Species Image Library

What

Capturing images of all life forms of marine life in marine protected areas using digital cameras.

Why

Marine protected areas contain an abundance of plant and animal species, some of which are well known - many of which are not. In order to understand and conserve the biodiversity within protected areas, more information is needed. Your images will help document the diversity within parks and assist in developing identification guides.

Photos of previously unknown species at a location may reflect the limited surveys of the area or may indicate that a new species has arrived. This can important information for park management. Photos and movies of marine life can show others the unique marine life inhabiting Victoria's cool water habitats and through raising awareness can assist in their protection.

This monitoring activity is designed to answer the question:

- **What are the types of animals and plants that are found within the Marine Protected Area?**

When

During predicted low tide for intertidal areas, or predicted mid-high tide for subtidal habitat.

Where

Anywhere inside your marine protected area.

1.3 Sea Search Patrol

What

Observations of human activities, pollution, litter, marine pests and range expanding species in Marine Protected Areas.
Sea Search participants can make a valuable contribution to the conservation of marine protected areas through regular Sea Search surveillance patrols. Information recorded by observers can help identify potential threats at an early stage so that managers can take quick action. By being present you may also witness biological features or events that tell us more about marine species and ecosystems.

Why

Coastal and marine habitats can be threatened by human activities, marine pests, the arrival and establishment of warm-water species, pollution and litter. Even in areas where regulations prohibit fishing, collection and disturbance, these activities may still occur. Marine protected areas can have high visitor numbers with people engaged in a range of activities, depending on the location and ease of access.

Gathering regular information on the number of people and what they are doing can help marine managers identify whether particular types of activities are having a negative effect on resident plants and animals. For instance, disturbance by dogs impact shorebirds (e.g. the Hooded Plover) and seabirds.

The introduction of exotic marine pests into Australian waters is a major environmental issue. The larvae and spores of marine animals and plants can be transported in the ballast water inside ships from international ports, while adults and juveniles hitchhike on hulls, propellers and sea chests. Once in Victorian waters, these introduced pests grow and reproduce, sometimes with deleterious consequences for resident natives through competition for space and food, or predation.

Once established, marine pests are extremely difficult to eradicate so government strategies for dealing with pest species are largely focused on prevention, rather than control. Early detection of pest incursions however can assist with containment in certain circumstances, particularly when densities are low (Whitehead 2008). Efforts should, however, be concentrated on preventing their spread in Victorian coastal waters via boating, fishing, recreational and aquaculture gear.

Unfortunately, marine pests occur inside some marine protected areas. Where present, monitoring pest abundances can contribute to our understanding of potential shifts in community structure (i.e. from native species to introduced species). This information is needed by park managers when assessing the condition and performance of marine protected areas. Gathering information on possible seasonal fluctuations in pest numbers may in future assist with localised control. Validated data may also be made available to other state and commonwealth agencies to improve management of pest species in Australia. Sea Search participants may be the first to raise the alarm if new pest species are appearing inside marine protected areas.

The National Introduced Marine Pest Information System (NIMPIS) provides information on the biology, ecology and distribution (international and national) of marine pest species. It includes known species that have been introduced to Australian waters and species that are considered to pose a potential of future introduction. Sea Search monitoring can be used to track the abundance of known pests inside marine protected areas, as well as searching for some of the more conspicuous species that NIMPIS lists as posing a high risk if established.

In addition to unwelcome international marine pests, warm water marine species from the east coast of Australia are being observed further south, most likely in response to climate change-related ocean warming and intensification of the East Australian Current (EAC). For example, the long-spined sea urchin, *Centrostephanus rogersii*, historically found in NSW and parts of eastern Victoria has now become abundant in Tasmania, and through excessive grazing has created algal 'barrens.' The consequence of the southward migration of other northern species on cool-water adapted Victorian fish, invertebrates and plants is currently unknown. Sightings of uncommon species (species thought to be outside of their natural range) are being recorded through projects such as Redmap in Tasmania. Similar observations in Victoria may assist managers to identify if range expansion is occurring in Victoria and therefore to predict possible impacts on resident marine species.

Sea Search participants may be the first to record the presence of native species outside their natural range. Regular monitoring over time will help determine if their distribution is within the range of natural variability or indicative of a more recent geographic expansion. It is anticipated that this information will be added to the Redmap database as part of a national program to map the dynamics of marine populations in response to climate change.

This monitoring activity is designed to answer the questions:

- **What are the types of human activities and uses that are happening within the Marine Protected Area?**
- **Is there any pollution or litter within the Marine Protected Area?**
- **Are there any marine pests or native range expanders arriving in the Marine Protected Area?**

When

The best time to do these surveys especially for human use information includes weekends, public holidays, school holidays, and good weather (e.g. sunny days). If possible, try to do your survey at the same time of day (between 1pm and 3pm is best) and or the same low tide period as previous surveys. The more often you do these surveys the more information is gathered.

Where

Across the entire Marine Protected Area, or at multiple sites within (make sure to record where they are for future visits). Each time you visit try and cover a similar area.

2. ROCKY INTERTIDAL

Intertidal rocky reefs are found in many of Victoria's marine protected areas. Exposed to air at low tide and covered by seawater at high tide, intertidal reefs support diverse and unique combinations of plants and animals that have evolved to survive in this dynamic environment. Basalt, limestone, granite, and other rock types act as anchors on which algae attach and where invertebrates flourish. With the advancing tide, nearby fish move onto the reef to feed and shelter, while birds make the most of the low tide to forage.

Intertidal reefs are a great place for people to discover the fascinating marine life inhabiting the land-sea interface, but their popularity and exposure to human impacts also threatens the biodiversity of rocky shores. Human activities such as collection, fishing, trampling and rock turning can remove and injure animals and destroy the algal habitat on which they depend. Pollution, marine pests and climate change impacts (sea level rise, increased temperatures and altered seawater acidity) also threaten these habitats and organisms.

Long-term monitoring data for the biological assets on intertidal reefs is needed to understand the natural variability in population fluctuations. This in turn enables park mangers to identify, and act on, potential impacts. Significant intertidal reef habitats are found in many of Victoria's marine protected areas. Monitoring specific natural values such as algal cover and gastropod numbers at different locations will provide a picture not only of patterns of abundance and cover inside individual marine national parks and marine sanctuaries but across the state-wide system of marine protected areas.

Sea Search monitoring methods for intertidal reefs are:

2.1 Cover quadrats - Algae and Sessile Invertebrate Cover……Difficulty rating **– Moderate**
2.2 Counting Snails and Other Mobile Creatures……………………Difficulty rating **– Difficult**
2.3 Snails and Limpets - Catch Per Unit Effort……………………......Difficulty rating **– Moderate**

Difficult methods can only be done in conjunction with the relevant moderate methods (e.g. 2.1+2.2).

Detailed intertidal reef survey methods can be used in conjunction with general surveillance and monitoring methods detailed in section 1: **1.1** *Photo fixed point photos,* **1.2** *Species image library* and **1.3** *Sea Search Patrol.*

Site Layout

Animals can be distributed at different heights on the shore (in relation to the water's edge) according to the duration for which they are exposed during each low tide and interactions between species. The *lower intertidal zone* is only exposed to air on very low tides while the *mid intertidal zone* is regularly exposed and submerged by average tides. The *upper intertidal zone* is only covered by very high tides but on shores exposed to heavy wave action, the upper intertidal zone is also influenced by waves and sea spray – meaning that the intertidal region can extend above the high tide line.

To ensure that all species of interest are recorded, Sea Search surveys are done in the two zones where most of these are found - the *mid intertidal* zone and *lower intertidal* zone. In general, the mid intertidal is dominated by mussels, limpets and snails while the lower intertidal is dominated by algae, anemones and other invertebrate inhabitants (Figure 1). As distinct "zones" are not always obvious, Parks Victoria rangers will investigate and determine which zone(s) will be surveyed at each location prior to the commencement of monitoring. The location of each zone is marked using landmarks and GPS way points.

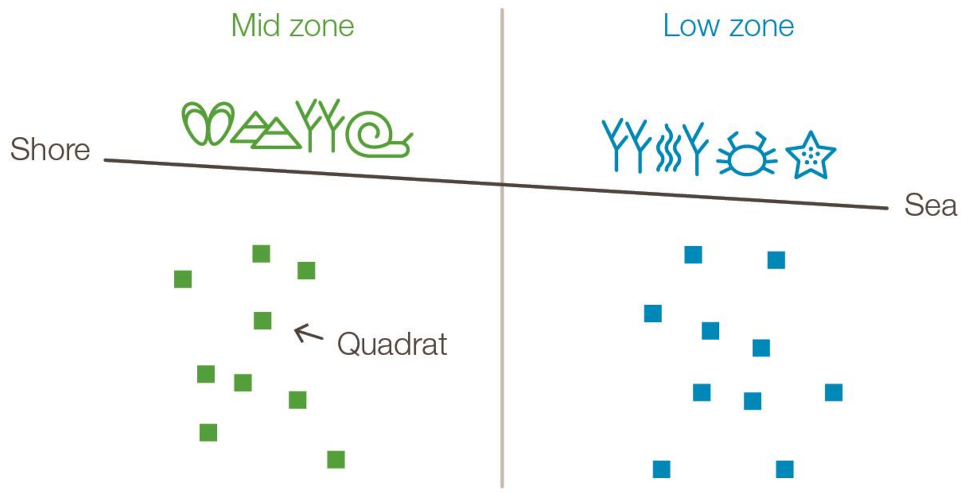

Figure 1: Illustration of how each sampling site is arranged within the "zones" on the shore. The mid zone is dominated by grazing (e.g. limpets and snails) and filter feeding (e.g. mussels) invertebrates and the low zone is dominated by macroalgae and mobile (e.g. crabs, seastars, snails) invertebrates. The High zone is not shown and is dominated by the blue periwinkle *Austrolittorina unifasciata*.

Quadrats (sometimes referred to as sampling replicates) are sampled in each zone at each site (see Figure 2).

- The ranger will have the quadrat placements (which have been randomly allocated by the Parks Victoria Research Branch) saved into a gps unit and drawn on a map.
- Using the gps unit and a map of the location the ranger will place numbered quadrat placement markers within each zone.
- Volunteer pairs or groups will be assigned a set of quadrats to photograph/sample (e.g. group 1 may sample quadrats 1-5, group 2 may sample quadrats 6-10).

Figure 2: Illustration of how quadrats may be arranged in each of the "zones" within a location.

Timing

Sea Search groups should undertake monitoring on a regular basis allowing for seasonal changes to be recognised, ideally for well organised groups regular quarterly monitoring could be scheduled within each season. This will provide not only useful data but also contribute to the development and improvements in the monitoring skills of the group. It is important that monitoring is regular and if done seasonally mid-season is best.

Field work should be done when low tide is predicted at 0.4 m or lower for most sites along the Victorian coastline. Participants should be on site around 1.5 - 2 hours before low tide. Ideally surveys should be completed before, or as, the tide comes in with participants leaving the reef well before sites are covered with water.

2.1 Cover quadrats - Algae and Invertebrates (field or photo)

What

Intertidal and subtidal reefs in Victoria's marine protected areas are home to some of the most diverse algal (seaweed) assemblages in the world. Numerous forms of brown, red and green algae cover the intertidal zone and provide habitats for many marine animals as well as acting as a source of food and nutrients. Along with algae, mats of invertebrate animals such as mussels, barnacles, calcareous tube-building worms and ascidians (sea squirts – cunjevoi) also provide important habitat for other organisms. They trap water, provide microhabitats, and can repel or encourage other reef species to settle.

Most species of algae grow at the lower edge of intertidal reefs because areas higher up get too hot and dry. Invertebrate animals that form dense covers can live higher up on the reef platform because they are protected from drying out by their shells, plates or tubes.

Why

Sea Search monitoring of intertidal algae and animal covers can help keep track of the health of rocky reef habitats. Photo records provide a useful way of building up a picture of changes that occur within these areas over time. Taking photos over a number of seasons and years will help determine if these changes are within normal limits, or if they indicate a decline or recovery in the condition of the habitat. Images can be analysed on a computer with software that can digitally impose point intercepts over the image allowing the user to quantify the area covered by each species (e.g. *Hormosira banskii*) or functional group (e.g. coralline turf). This information can then be statistically analysed to determine if changes in community composition are significantly different or within limits of normal variation.

This monitoring activity is designed to answer the questions:

- **How does the cover of algae (especially the habitat forming species *Hormosira banksii)* vary in the marine protected area over time?**
- **How does the cover of aggregating invertebrates (e.g. worms) vary in the marine protected area over time?**
- **How does the cover of green algae (e.g. *Ulva*) that may respond to increased nutrients vary in the marine protected area over time?**
- **How does the cover of sand vary in the marine protected area over time?**

When

Parks Victoria staff will assist in identifying suitable monitoring sites and determining the survey frequency. More Information on monitoring frequency and site layout for intertidal reef surveys can be found in the Introduction.

Where

The same fixed sites are used for all intertidal reef survey methods.

How

Cover quadrats can be done immediately prior to mobile invertebrate counts done in 2.2. Alternatively, cover quadrats can be done on their own in mid and lower intertidal zones. This method also complements fixed point photos detailed in 1.1 where an image is taken from a point(s) on shore at regular time intervals in order to record landscape-scale changes.

This method is the most important for monitoring rocky shores as it's the most accurate for non-scientists, requires the least amount of training and tells us a lot about any changes in condition to the reef.

If only taking photos in the field, they will need to be analysed on the computer later, using image analysis software (Coral Point Count (CPCe), Kohler and Gill 2006) to determine the proportion of each sort of cover (e.g. brown algae, coralline turf, or sand etc.) in the quadrat. A cover category file to use for analysis can be obtained from the Parks Victoria ranger that delivers your local Sea Search program. This image analysis generates data that can be analysed statistically to answer the monitoring question.

2.2 Invertebrate Abundance

This method is the most popular with volunteers but is not quite as important as cover quadrats for picking up changes in reef condition. The skill involved in accurately identifying species and counting abundance requires considerable training and practice so this method has the highest possibility of error. Invertebrate abundance has also been shown to vary considerably at both spatial and temporal scales making it hard to pick up changes unless long-term data is available. This method has been retained partly due to its previous inclusion in Sea Search and the current Intertidal Reef Monitoring Program to allow continuity.

What

Intertidal reefs in Victoria's marine protected areas are home to unique cool-water species of mobile marine invertebrates such as snails (gastropods), sea stars and urchins - many of which are found nowhere else in the world. These mobile marine invertebrates are often the most conspicuous animals on reefs and are found sheltering in algae and crevices, weathering the waves on rocks, and submerging themselves in rock pools. Surveys on the reef are done by counting the abundance of a number of common snail and limpet species in replicate 50 cm x 50 cm quadrats at sites within the marine protected area.

This activity should only be done in conjunction with 2.1 *Cover quadrats* and you may want to also do 2.3 *Snails and Limpets - Catch Per Unit Effort*.

Why

Sea Search monitoring of common invertebrate species will enable managers to keep track of the health of rocky reef habitats. The abundance of mobile invertebrates may naturally rise and fall in response to pressures such as food availability, predation or disturbance by storms. Monitoring over a number of years and seasons will help determine if changes occurring in populations inside marine protected areas are within normal limits, or if they indicate that human impacts such as illegal collection may be occurring. Monitoring may also show that an improvement or recovery is taking place.

This monitoring activity is designed to answer:

- **How does the abundance of some key species of mobile invertebrates change in the marine protected area over time?**
- **Are there any indications of human impacts such as illegal collection on invertebrate populations?**

When

Parks Victoria identifies suitable monitoring sites and determines the survey frequency.

Where

The site layout is the same as for method 2.1 (see Figures 1 and 2). If doing cover quadrats simultaneously with 2.2, record the cover/take a photo before the mobile invertebrates have been counted.

2.3 Snails and Limpets – Catch Per Unit Effort (CPUE)

What

Marine snails and limpets belong to a group of invertebrate animals known as gastropods. Ten minute searches are done for separate species of common gastropods in the intertidal zone of marine protected areas. This method focuses on gastropods that are known to be impacted by human collection, and compares them to 'control' (non-targeted) gastropods within the marine protected area. Searching for a set period of time measuring size and abundance of species gives you a "catch per unit effort" rather than a measure of abundance for a set area. This gives us an estimate of how common a species is on the reef (as less common species will take longer to find than common species). Size measurements provide information about natural fluctuations in populations and a reference against which potential impacts can be measured.

Why

Gastropods are important in food webs – acting as prey for larger animals such as birds, fish and octopus, and influencing the types and amount of algae growing on rocky shores. Many species are herbivores, while others are predators or scavengers. Because they are not very mobile, most gastropods are easy to spot and capture, with some species taken as bait, for human consumption or by shell collectors. Studies in Australia and overseas have shown that populations can be severely depleted by human collection and species may be permanently lost from an area. Loss of key gastropod species can have flow on community effects - leading to changes in the abundance or cover of other species. People often take the biggest snails or limpets – leaving behind the small ones that may not yet be reproductive and are more vulnerable to physical stress and predation. In addition to being protected inside the boundaries of marine national parks and marine sanctuaries, all other gastropod (snail like) molluscs such as abalone, snails, limpets and periwinkles are protected in the intertidal zone across Victoria down to 2 m depth. Collection of both live animals and shells is prohibited inside marine protected areas.

The abundance and sizes of intertidal gastropods may naturally vary through time and between places depending on the physical environment, and understanding this natural variability can help identify impacts that may occur. Comparing the size and abundance of gastropod species that are targeted (i.e. they are a preferred species for collection) to non-targeted species can help determine if gastropod populations are being impacted by human collection. If snail species are found to be smaller than the control species at some locations, it may indicate disturbance to these species.

Although the life histories of the control/target species may not match, they are considered to be in similar functional groups (e.g. grazing gastropods, predatory/scavenging whelks) so natural disturbance and changes in food availability at the sites should vary in a similar way. Some changes that might affect size outside the scope of these methods include recruitment (control and target species can reproduce at different times therefore a size class may be produced). The minimum size to be recorded goes some way to addressing this by excluding new recruits which are likely to be more numerous on a seasonal basis (Keough *et al.* 2007).

The questions addressed in this monitoring method is:

- **What is the size range of common species of gastropods inside marine protected areas, and how does this vary over time?**
- **Are the abundances and sizes of targeted and non-targeted species different?**

Table 2: List of intertidal snail and limpet species for timed searches and sizes (Keough *et al.* 1993). If possible, match a target species to its control (match the colour).

Targeted by humans		Min. size	Not commonly targeted "Control species"		Min. size
Limpet	*Cellana tramoserica*	14mm	False Limpet	*Siphonaria diemenensis/zelandica*	4mm
Top Shell	*Austrocochlea constricta/porcata**	14mm	Striped-mouth Conniwink	*Bembicium nanum/melastomum**	8mm
Warrener	*Turbo undulatus*	4mm			
Black Nerite	*Nerita atramentosa*	4mm			
Dog Winkle	*Dicathais orbita*	4mm	Lineated Cominella	*Cominella lineolata*	4mm
			Wine-mouthed Lepsiella	*Lepsiella vinosa*	4mm

**Austrocochlea* and *Bembicium* are represented by different species on the open coast than in the north of the bays. On the coast, *A. constricta* and *B. nanum* are more abundant, while bays tend to have more *A. porcata* and *B. melastomum*. Please note that there are also other species of these two genera so use your identification books/sheets to check if you are unsure.

When & Where

Catch per unit effort should only be done in conjunction with cover and invertebrate abundance quadrats (2.1 and 2.2) as these provide the highest priority data. Catch per unit effort can be undertaken within the same location as quadrat sampling (so long as you are not disturbing other volunteers collecting quadrat data at the same time). The best way to do this is to have most of the volunteer team focusing on cover and invertebrate abundance quadrats and one pair can take a break from quadrat sampling for ten minutes to record one species. They then return to quadrat sampling and another pair measure the control species and so on. Unless there is a particularly large team of volunteers it won't be possible to do all three rocky shore methods on the same occasion.

3. SEAGRASS BEDS

Seagrasses are marine flowering plants that can form lush beds supporting a diversity of animals. Most seagrass species are found in bays and inlets in sheltered conditions but some species are found on open rocky coasts.

Seagrasses play a critical role in providing habitat for a wide range of species including many juvenile fish, a diverse range of invertebrates and important feeding areas for birds. Seagrasses play a key role in binding soft sediments and preventing coastal erosion. Many commercial and recreational fisheries depend on healthy seagrass meadows because they are important nursery areas for young fish. They also play a role in nutrient cycling, producing oxygen and carbon sequestration.

Throughout the world seagrass meadows are in decline, with implications for biodiversity and fisheries. Water quality is vital to the health of seagrasses and the many species of fish, birds, crustaceans and other invertebrates that depend upon them. Some of the threats to seagrass beds include pollutants and nutrients originating from the land and sea, coastal development, dredging and physical damage from boat anchors, propellers or trampling. Marine pests, climate change and overfishing also threaten seagrass habitats and the animals and plants that live within them.

Seagrass species commonly encountered in the intertidal and shallow subtidal zones in Victoria are *Zostera muelleri (Eelgrass - intertidal)*, *Z. nigricaulis (Eelgrass- subtidal), Amphibolis antarctica* (Wire Weed or Sea Nymph), *Halophila australis* (Paddle Weed) and in Corner Inlet – *Posidonia australis* (Broad-leaf Seagrass) which tends to grow in deeper water than the previous species.

There are two main quantitative methods within the Sea Search program to assess the health of seagrass in Victoria's marine protected areas, which quantify both the seagrass bed as a whole (Quantifying Seagrass Condition) and the edges of the seagrass bed (Seagrass Boundary Monitoring). Both these methods work together at assessing any changes in the seagrass in terms of general site health (e.g. increases in epiphytic algae growth), and whether the seagrass bed is expanding or contracting[2]. The seagrass specific methods are arranged by site size: small and large, as the measurements collected are the same but the configuration of the sampling units within the sites differs by site size.

Quantitative (counting and measuring) seagrass methods should be done at specific locations in an MPA (e.g. Jawbone Marine Sanctuary) or at multiple sites within a location if there are large continuous areas of seagrass (e.g. Corner Inlet). Seagrasses are sensitive, fragile plants that are damaged by trampling. Any monitoring should be done with minimal impact and in consultation with Parks Victoria rangers. Because of their inaccessibility and vulnerability to disturbance, some seagrass meadows may not be suitable Sea Search sites. Identifying and establishing sites, including the installation of semi-permanent markers and labels, is the responsibility of the park ranger and can only be carried out under permit. Sites of representative habitat should be identified by Parks Victoria staff in each study area based on scientific advice, local knowledge and the size of the seagrass meadow inside the reserve.

Sea Search monitoring methods for seagrass meadows are:

3.1 **Small Sites (usually Marine Sanctuaries)**
3.1.1 Quantifying seagrass condition - Rapid method — Difficulty – **Moderate**
3.1.2 Quantifying seagrass condition - Detailed method — Difficulty – **Difficult**
3.3.1 Seagrass boundary monitoring — Difficulty – **Moderate**
3.2 **Large Sites (usually Marine National Parks)**

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[2] Methods have been adapted from Seagrass-Watch (McKenzie *et al.* 2001) and Port of Melbourne Corporation Seagrass Monitoring Program with reference to previous Sea Search seagrass methods (Koss *et al*. 2005).

3.2.1	Quantifying seagrass condition - Rapid method	Difficulty - **Moderate**
3.2.1	Quantifying seagrass condition - Detailed method	Difficulty – **Difficult**
3.3.2	Seagrass boundary monitoring	Difficulty – **Moderate**

Difficult methods can be used in conjunction with easy methods. If these methods are used, they should be used with the relevant moderate methods. They can also be combined with general surveillance and monitoring methods detailed in section 1: **1.1** *Photo fixed point photos,* **1.2** *Species image library* and **1.3** *Sea Search Patrol.*

3.1 and 3.2 Quantifying Seagrass Condition

Site Layout

There are two recommended quantitative Sea Search methods for assessing seagrass condition depending on the size of the seagrass meadow:

1) Small location method (shore based) – changes through time.
   Quadrats placed randomly around fixed GPS points (Figure 3) across the entire location or within species zones where present (e.g. *Z. nigricaulis* 'zone', *Z. muelleri* 'zone')
   - The number of quadrats to be sampled at each site and the random placement of these quadrats will be determined by Parks Victoria after an initial site assessment.
   - Future monitoring will involve simply going to these predetermined places using a GPS.

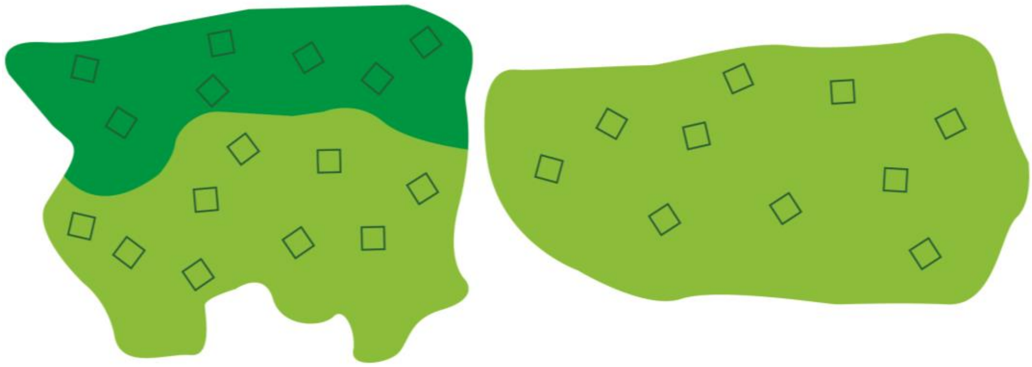

Figure 3: Diagram showing possible quadrat arrangement within sites. Left diagram shows a site with 2 dominant seagrass species. The number of quadrats and locations are indicative only.

2) Large location method (usually boat based) – examines changes between sites and through time
   Quadrats placed randomly around fixed GPS points within multiple sites of fixed size (e.g. 20 m x 20 m) across the entire location (see Figures 4 and 5).
   - The number and location of sites will be predetermined by Parks Victoria.
   - The quadrat placement will be haphazard within each site.
   - GPS and aerial images can assist in re-locating sites, as can drawing a simple diagram including relevant land marks, and taking digital photos of the site.

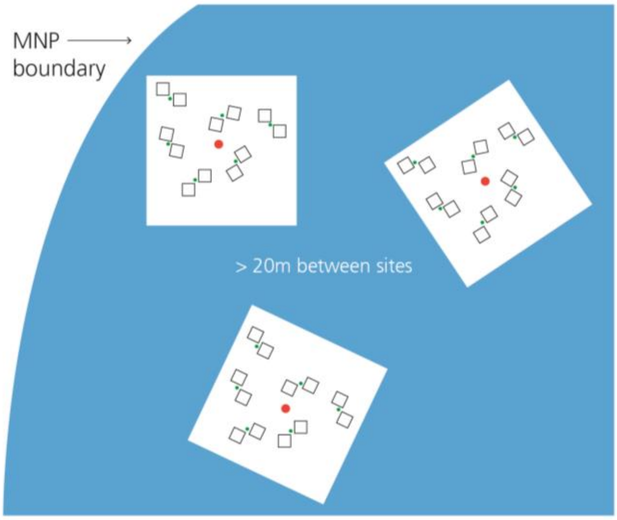

Figure 4: Diagram showing large site set up. Red dot indicates permanent marker/centre of site, blue squares indicate quadrat placement for sampling.

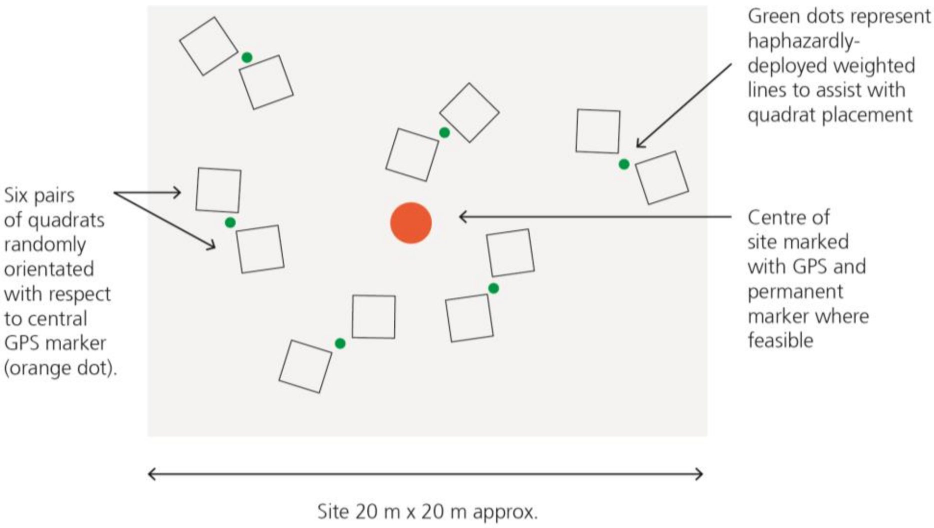

Figure 5: Random site design for Sea Search seagrass monitoring, ideally suited for large subtidal seagrass beds.

Timing

Ideally sites for quantifying seagrass condition should be monitored seasonally. This is because plant growth and cover can vary between cool months and hot summer conditions. It is important that monitoring is done around the same time each year – even if monitoring less than every season.

For subtidal seagrass, surveying at mid-high tide would be preferable. For intertidal and shallow-subtidal seagrass, field work should be done when low tide is predicted at 0.4 m or lower. Participants should be on site around 1.5 - 2 hours before low tide. Ideally surveys should be completed before, or as, the tide starts to come in with participants leaving well before sites are covered with water.

3.1.1 and 3.2.1 Quantifying Seagrass Condition (Rapid)

What

Participants walk, wade, or snorkel over intertidal and shallow subtidal seagrass beds and using a combination of measures and observational assessments to assess seagrass health (e.g. measures = seagrass cover; observational assessment = rapid epiphyte load estimate). Using quadrats as a sampling unit, participants score seagrass cover, cover of macroalgae (e.g. *Caulerpa* spp) and sediments, and epiphyte load. Any reproductive structures such as flowers and seeds are noted.

Why

The rapid method (moderate) provides information on some key indicators of seagrass health and condition (and may alert us to large scale changes e.g. loss of seagrass, increase in epiphyte loads etc.). Seagrass percentage cover is an important measure of habitat health. Dense stands of healthy seagrass provide different habitat than sparse or patchy seagrass for a variety of animals and algae. In addition to supporting biological diversity, dense seagrass is more effective at slowing currents than sparse meadows making it a more effective coastal buffer against tides and waves. Occasionally macroalgae such as *Caulerpa* spp. can also be an important habitat forming component of some seagrass beds (French *et al.* 2014).

Algae commonly found growing on seagrass leaves are known as 'epiphytes' or 'epiphytic algae'. Epiphytes are naturally occurring and provide food for a range of grazers such as marine snails. Increased nutrients in the surrounding water from human sources such as agriculture and sewage may increase the growth of epiphytes beyond naturally-occurring levels, and may favour certain types of nutrient-loving epiphytes. Dense epiphytes can impair and kill seagrass through smothering and blocking sunlight to leaves.

The quantifying seagrass condition rapid method (moderate) is designed to answer the questions:

- **How does seagrass condition (cover, epiphyte presence) vary over time inside the marine protected area? E.g. is seagrass becoming more/less dense?**
- **How does seagrass condition vary within large sites (where surveys are implemented in large sites)?**
- **Can indicators of seagrass reproduction be seen, and at what time of year do they appear?**

When

Sites should be surveyed seasonally where possible. At a minimum the rapid method should be carried out seasonally, and if carrying out the detailed method (only if groups wish to and have built up their experience level) this could be carried out in spring or summer when weather may be better for longer surveys.

Where

Initial site selection and survey design is undertaken by the Parks Victoria Research Section in collaboration with rangers. Using existing aerial photos and habitat maps suitable sites are identified. Sites are marked with GPS way points and navigational markers or landmarks where possible. Small sites will have maps created and waypoints for quadrat placement will be made available. Large sites may also be marked with subsurface plastic star pickets and attached labels and/or buoys acting as markers for relocating sites during sampling.

3.2.1 and 3.2.2 Quantifying Seagrass Condition (Detailed)

What

Participants walk, wade, or snorkel over intertidal and shallow subtidal seagrass beds and using a combination of measures and observational assessments to assess additional measures of seagrass health (e.g. measures). Using quadrats as a sampling unit, participants measure canopy height and shoot density, and count and identify animals.

Why

Detailed condition (difficult) involves recording other measures in addition to those assessed using the Rapid methods and provide information about the nature of the seagrass habitat (i.e. canopy height and shoot density) and abundance of common fauna.

We measure both shoot numbers and length (or canopy height) to get a picture of the habitat that is provided by the seagrass. For instance, few very long seagrass shoots may provide a similar understorey habitat (e.g. light conditions for fauna) as shorter more densely aggregated seagrass shoots. Shoot density is also a good indicator of health of *Posidonia australis* seagrass (Eric Paling pers. comm.), but for narrow leaf species it is more difficult to count and isn't as good an indicator of seagrass health (hence a randomly selected sub-quadrat is used for shoot counts of narrow leaf species).

Many species of fish, crustaceans, bivalves, gastropods and worms live on, amongst and below seagrass shoots. Recording the animals living in the seagrass provides useful information about the types and abundances of seagrass inhabitants, and improves our understanding of the biodiversity protected in marine protected areas. Grazers such as marine snails may feed on epiphytes on seagrass so measuring snail abundance can help us understand the role they play in maintaining epiphyte loads.

The quantifying seagrass condition detailed method (difficult) is designed to answer the questions:

- **How do seagrass measures (canopy height, shoot density) vary over time inside the marine protected area and how do they relate to percentage cover (see Rapid methods)? E.g. is seagrass growing longer?; is seagrass shoot density becoming more sparse?**
- **How does seagrass condition vary within large sites (where surveys are implemented in large sites)?**
- **What types of animals are found in seagrass beds, and how do the types and abundances of these animals vary over time? How does marine snail grazer abundance vary with epiphyte loads (see Rapid methods)?**

When

Sites should be surveyed seasonally where possible. At a minimum the rapid method should be carried out seasonally, and if carrying out the detailed method (only if groups wish to and have built up their experience level) this could be carried out in spring or summer when weather may be better for longer surveys.

Where

Initial site selection and survey design is undertaken by the Parks Victoria Research Section in collaboration with rangers. Using existing aerial photos and habitat maps suitable sites are identified. Sites are marked with GPS way points and navigational markers or landmarks where possible. Small sites will have maps created and waypoints for quadrat placement will be made available. Large sites may also be marked with subsurface plastic star pickets and attached labels and/or buoys acting as markers for relocating sites during sampling. Further description of the site layout is given in the following sections.

3.3.1 and 3.3.2 Seagrass Boundary Monitoring

The Sea Search Boundary methods differ slightly between smaller seagrass beds (<100 m across) and larger seagrass beds (>100 m). The methods are explained in detail in the Sea Search Manual (Browne *et al*. 2015). The information provided below is relevant to both small and large seagrass beds.

What

Participants measure the distance of the inner and outer edges of the seagrass meadow from a fixed point. Monitoring the deep and shallow boundaries of seagrass meadows over time can show whether a seagrass meadow is expanding, contracting or moving; and so provide a measure of seagrass health inside marine protected areas. Monitoring the movement of species dominance (e.g. *Zostera nigricaulis* expanding shoreward into areas previously dominated by *Zostera muelleri*) across the seagrass bed can also tell us about changes to local hydrology and sea level rise.

The edge boundary of a seagrass bed is not always clearly delineated and edges are naturally dynamic with leaves growing and dying off. For this reason, the 'edge' here is defined by two measures that both need to be recorded:

a) The appearance of the first/last (outermost) leaf; and
b) Where a hand placed flat on the sediment touches at least 2 separate shoots.

When assessing the dominant species boundary in the absence of a discrete change in species (e.g. distinct change visible to the centimetre or distinct sand barrier) record the boundary as where a hand placed flat on the seagrass touches 50% of each species. Monitoring the outer boundaries of more extensive seagrass beds requires boat access and participants to snorkel and/or scuba dive.

These measures are supplemented with a written description of the edge as well as photo points looking along the zone or edge boundary where possible.

Why

Seagrasses create habitats for a range of species, sequester carbon, stabilise sediment and are primary producers. The extent of seagrass is influenced by natural processes such as seasonality, light availability, water depth (which may be affected by sea level rise), sediments and hydrodynamics but it can also be affected by impacts such as water pollution (including turbidity), physical disturbance (e.g. trampling, anchor scar) and sediment burial (e.g. run-off). Different seagrass species may naturally be found at different depths but a reduction in the amount of light penetrating the water may alter their distribution. Light can be blocked by sediments in the water from land runoff or dredging (turbidity) or overgrowth of some nutrient-loving algae (epiphytes) in response to excess nutrients from agriculture and sewage. Damage to seagrass beds can occur as a decline in overall growth or even death of entire areas, retreat of boundaries and fragmentation.

Repeated measurements made over time of the distance (and depth) of seagrass boundaries from a fixed point(s) can reveal if seagrass is expanding or decreasing in a seaward and landward direction. Note that these methods are intended for seagrass within approximately 100 m of the shore and at times the deeper edge may only be accessible by snorkel from shore. Monitoring outer edges from shore is only possible in smaller patches. For more extensive seagrass beds, the outer boundary may require boat access.

This monitoring activity is designed to answer the questions:

- **Are the seaward and landward boundaries of the seagrass meadow expanding or contracting?**
- **Is the direction of change constant, or is it variable (i.e. some years advancing landwards, some years retreating)?**

- **Are species zones moving? E.g. are subtidal species (e.g. *Zostera nigricaulis*) moving landward? (Potential indicator of sea level rise or change in water clarity)**

When

This method should be conducted annually within the same season each time.

Where

Initial site selection and survey design is undertaken by the Parks Victoria Research Section in collaboration with rangers. Using existing aerial photos and habitat maps suitable sites are identified. Sites are marked with GPS way points and navigational markers or landmarks where possible. Large sites may also be marked with subsurface plastic star pickets and attached labels and/or buoys acting as markers for relocating sites during sampling. Small sites will have maps created and waypoints for boundary maker placement will be made available. Further description of the site layout is given in the following sections.

Resources

- See the Seagrass Watch manual for per cent epiphyte conversion when entering in data: http://www.seagrasswatch.org/longterm_monitoring/Epiphyte_matrix.pdf

Acknowledgements

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Appendices

Appendix 1: Location of Marine National Parks and Marine Sanctuaries with possible Sea Search methods (shaded). Habitat relevant methods are listed as present where they cover a significant proportion of the reserve.

Marine National Parks and Marine Sanctuaries	All Habitats	Intertidal Reef	Seagrass
Cape Howe Marine National Park	1.1, 1.2, 1.3	2.1, 2.2, 2.3	
Point Hicks Marine National Park	1.1, 1.2, 1.3	2.1, 2.2, 2.3	
Ninety Mile Beach Marine National Park	1.1, 1.2, 1.3		
Corner Inlet Marine National Park	1.1, 1.2, 1.3		3.1, 3.2, 3.3
Wilsons Promontory Marine National Park	1.1, 1.2, 1.3	2.1, 2.2, 2.3	
Bunurong Marine National Park	1.1, 1.2, 1.3	2.1, 2.2, 2.3	
Churchill Island Marine National Park	1.1, 1.2, 1.3		3.1, 3.2, 3.3
French Island Marine National Park	1.1, 1.2, 1.3		3.1, 3.2, 3.3
Yaringa Marine National Park			3.1, 3.2, 3.3
Port Phillip Heads Marine National Park (Swan Bay)	1.1, 1.2, 1.3		3.1, 3.2, 3.3
Port Phillip Heads Marine National Park (Mud Islands)	1.1, 1.2, 1.3		3.1, 3.2, 3.3
Port Phillip Heads Marine National Park (Point Nepean)	1.1, 1.2, 1.3	2.1, 2.2, 2.3	
Port Phillip Heads Marine National Park (Point Lonsdale)	1.1, 1.2, 1.3	2.1, 2.2, 2.3	
Point Addis Marine National Park	1.1, 1.2, 1.3	2.1, 2.2, 2.3	
Twelve Apostles Marine National Park			
Discovery Bay Marine National Park			
Beware Reef Marine Sanctuary	1.1, 1.2, 1.3	2.1, 2.2, 2.3	
Mushroom Reef Marine Sanctuary	1.1, 1.2, 1.3	2.1, 2.2, 2.3	
Ricketts Point Marine Sanctuary	1.1, 1.2, 1.3	2.1, 2.2, 2.3	
Jawbone Marine Sanctuary	1.1, 1.2, 1.3	2.1, 2.2, 2.3	3.1, 3.2, 3.3
Point Cooke Marine Sanctuary	1.1, 1.2, 1.3	2.1, 2.2, 2.3	3.1, 3.2, 3.3
Barwon Bluff Marine Sanctuary	1.1, 1.2, 1.3	2.1, 2.2, 2.3	
Point Danger Marine Sanctuary	1.1, 1.2, 1.3	2.1, 2.2, 2.3	
Eagle Rock Marine Sanctuary	1.1, 1.2, 1.3	2.1, 2.2, 2.3	
Marengo Reefs Marine Sanctuary	1.1, 1.2, 1.3		
The Arches Marine Sanctuary			
Merri Marine Sanctuary	1.1, 1.2, 1.3	2.1, 2.2, 2.3	

Appendix 2: Notes on sampling design rationale and statistical design for quantitative methods

Rocky Shores Methods 2.1, 2.2

Sampling has been stratified into mid and low "zones" on the shore to reduce "statistical noise" caused by differences in species assemblages that naturally vary between these areas.

The use of randomly allocated quadrat placement rather than using designs such as transects or blocks increases sampling units (n) across the zone to improve estimates of species richness and abundance through time. This is the most efficient way to increase sample size while reducing set up time during low tide.

Statistics can follow changes through time (repeated-measures)

Seagrass Methods 3.2, 3.3

Small sites
Sampling has been stratified by species (e.g. *Zostera nigricaulis*, *Zostera muelleri*) to reduce "statistical noise" caused by differences in measurements that vary due to species (e.g. *Z. muelleri* doesn't grow as long as *Z. nigricaulis*). This is the most efficient way to increase sample size while reducing set up time during low tide.

Statistics can follow changes through time (repeated-measures).

A randomised block design has been used for large sites to allow for comparison between sites and through time. This is also more efficient logistically.

Statistics can follow changes through time (repeated-measures) and between sites.

Statistical Review

- Power analysis should be done once data has been collected to ensure there is sufficient replication.
- Suggest this is done 12 months after beginning of data collection or after 4 sampling intervals, though this may be too short where seasonal variation is high

Design rationale follows:

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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.

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