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A SUBMISSION FROM PARKS VICTORIA TO THE SENATE STANDING COMMITTEES ON ENVIRONMENT AND COMMUNICATIONS IN REGARD TO “CLIMATE-RELATED MARINE INVASIVE SPECIES”.

INTRODUCING PARKS VICTORIA:

Parks Victoria is a Victorian Government statutory authority appointed as managers of Victoria’s marine protected areas, which comprises a system of thirty marine protected areas that span the coastline of the entire state. These marine protected areas include thirteen Marine National Parks and eleven Marine Sanctuaries that are managed as highly protected (no-take) reserves and six multiple-use marine protected areas that allow some forms of commercial or recreational fishing.

Parks Victoria are also the managers of three Local Ports including Port Phillip, Western Port, and Port Campbell and are responsible within these waters for recreational boating and safe navigation whilst also managing assets including piers and jetties and some launching facilities.

Parks Victoria manages marine protected areas primarily to protect and preserve their biodiversity values whilst also providing opportunities for visitors to enjoy parks through recreational activities such as snorkelling and diving.

PARKS VICTORIA AND URCHIN MANAGEMENT:

Over the past two decades two species of native sea urchins have become overabundant in Victoria and present a significant management challenge for marine protected areas across the state.

In eastern Victoria Black-spined Urchins (*Centrostephanus rogersii*) have created extensive barrens on reefs within parks within as well as on many other reefs outside parks in the region (Beware Reef Marine Sanctuary and Cape Howe Marine National Park). Purple Urchins (*Heliocidaris erythrogramma*) have caused extensive loss of kelp communities within the three Port Phillip Bay Marine Sanctuaries (Ricketts Point, Jawbone, and Point Cooke Marine Sanctuaries) and seagrass beds (*Posidonia australis*) in south Gippsland’s Nooramunga Marine and Coastal Park.

Loss of suitable kelp or seagrass habitat within Victoria’s marine protected areas due to overgrazing of urchins is recognised as a major threat to maintaining marine biodiversity within these parks. Parks Victoria has worked with research partners and community organisations to manage impacts where possible and actively restore habitat through culling of urchins within parks.

These activities have been directed by approved Overabundant Native Animal Management Plans that are a requirement for control of native species within parks managed under the National Parks Act 1975.

This submission will largely focus on experiences and understandings gained in managing *C. rogersii* in marine protected areas managed by Parks Victoria in East Gippsland however will also reference work undertaken in the management of *H. erythrogramma* where relevant.

This work has formed a significant component of a broader investigation into impacts and management options for overabundant urchins in Victoria undertaken through a 2019 Department of Environment, Land, Water, and Planning Biodiversity Response Plan (BRP) funded project *Optimal management of overabundant sea urchins in Victoria* led by Professor Steve Swearer at the University of Melbourne, with partners including Parks Victoria and Deakin University. Other components of the BRP project that may be of interest to the Senate Subcommittee include mapping, development of dispersal models, development of a decision support tool, along with monitoring manuals and guidance.

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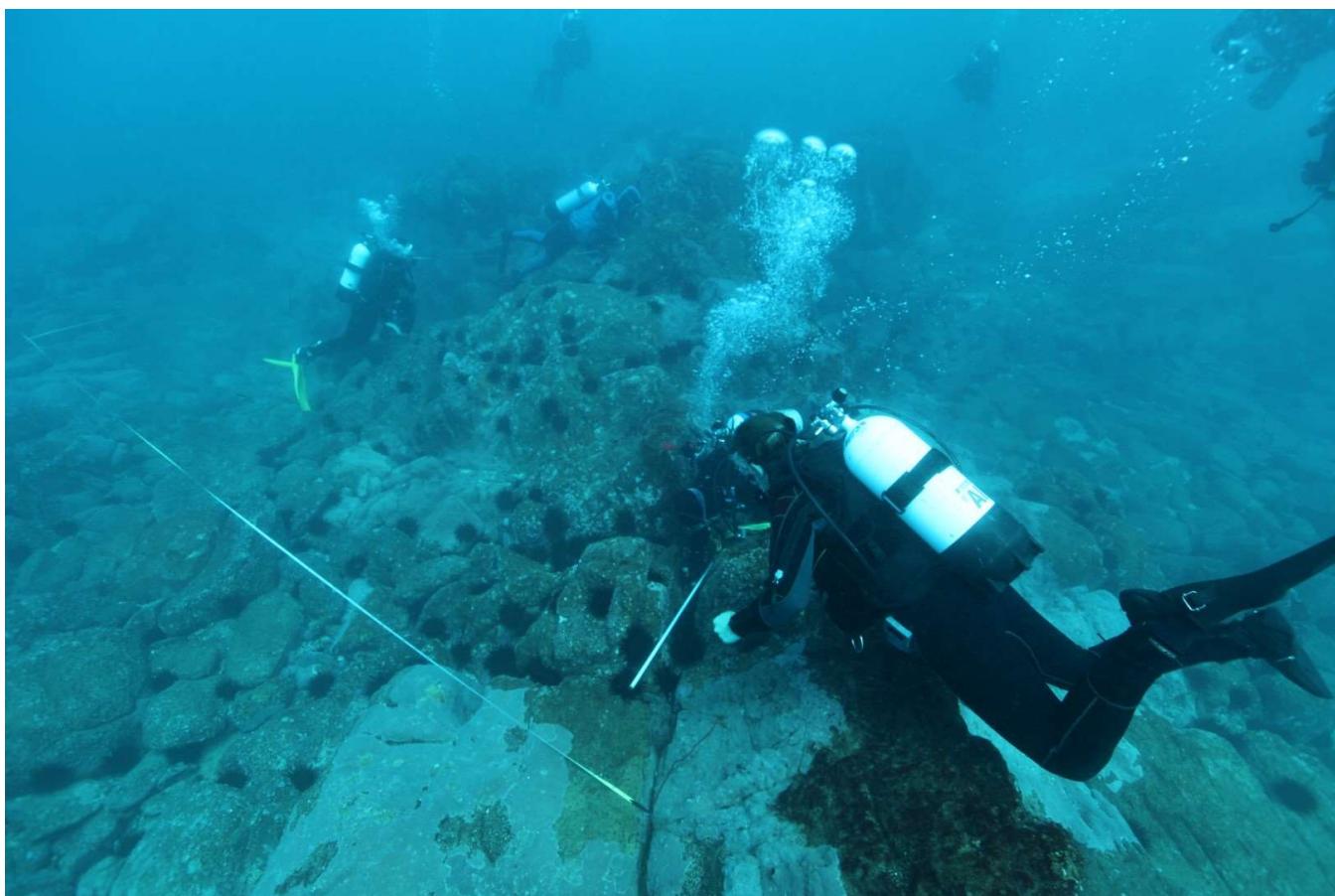
PARKS VICTORIA RESPONSES TO TERMS OF REFERENCE:

1. **Re:** (a) the existing body of research and knowledge on the risks for and damage to marine biodiversity, habitat and fisheries caused by the proliferation and range shifting of non-endemic long spined sea urchins;

BLACK-SPINED URCHINS (*Centrostephanus rogersii*) AND EAST GIPPSLAND'S MARINE PROTECTED AREAS.

Overabundant range-expanding native sea urchins including the Black-spined Urchin present a growing threat to marine biodiversity in Victoria. The distribution of *C. rogersii* was historically restricted to subtidal reefs along the coasts of New South Wales (NSW), eastern Victoria, and the Flinders Island Group in the Bass Strait however over the last few decades, the range of *C. rogersii* has expanded southwards to the east coast of Tasmania and westward along the coastline of Victoria towards Wilsons Promontory.

This phenomenon associated with the strengthening of the East Australian Current, bringing warmer water containing urchin larvae further southwards. Range expansion of the black-spined sea urchin is resulting in extensive kelp bed loss and barren formation with important consequences for biodiversity. Other range expanding species such as the Sydney Octopus (*Octopus tetricus*) also pose a significant threat to native mobile invertebrate species including southern rock lobster.



Black-spined Urchin, *Centrostephanus rogersii*, at Beware Reef Marine Sanctuary (Image: Mike Irvine)

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Overabundant Black-spined Urchins (*C. rodgersii*) have had a major impact on kelp communities across reefs with the three marine protected area in East Gippsland: Cape Howe Marine National Park, Point Hicks Marine National Park, and Beware Reef Marine Sanctuary, and have created extensive urchin barrens within these parks as well as on reefs outside of the parks.

Following are summaries of how *C. rodgersii* have impacted these three marine protected areas and the management approaches undertaken particularly at Beware Reef Marine Sanctuary to reduce their impact on parks values and restore kelp habitat.

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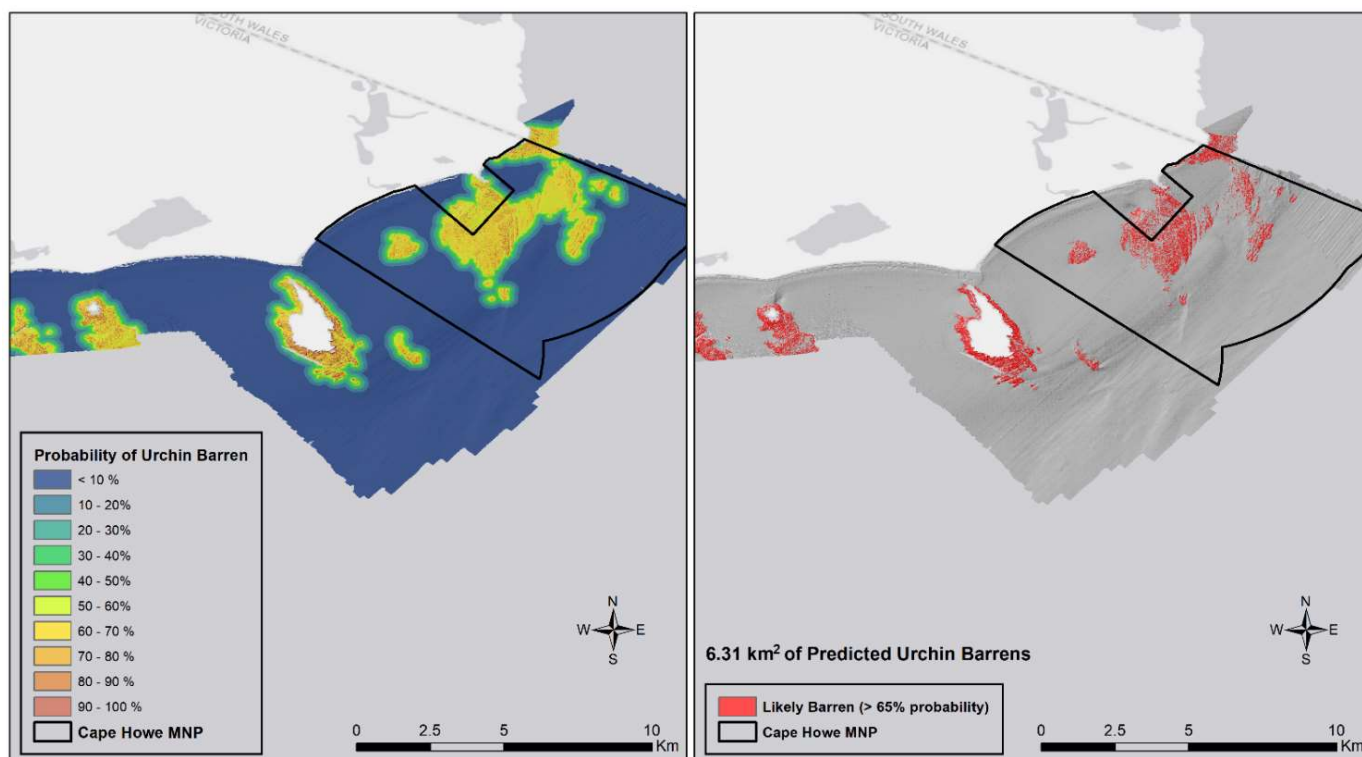
1. CAPE HOWE MARINE NATIONAL PARK:

Cape Howe Marine National Park is Victoria’s most easterly Marine National Park and is a representative area within the Twofold Shelf IMCRA Bioregion of Victoria.

Important natural values of Cape Howe MNP are its diversity of habitats including long sandy beaches, intertidal reef along its eastern shore, shallow and deep subtidal reefs, extensive subtidal soft sediment, and expansive areas of deep open water. Its rocky reefs have a complex structure, including eroded low-profile sandstone reef and high-profile granite reef. The shallow subtidal reef is dominated by a mixture of Crayweed (*Phyllospora comosa*) and bull kelp (*Durvillaea potatorum*), while the reef further offshore tends to be dominated by *P. comosa*.

This Park sits on the border of Victoria and NSW and given its location in relation to the East Australian Current is the marine protected area in Victoria most likely to be impacted by changes in water temperature due to climate change. On reefs within the park *C. rodgersii* can remove all erect algae creating urchin barrens which in this park are extensive and continue outside of the park boundaries into highly valued abalone fishing areas including Gunshot Reef which was excluded from the protected area on establishment to allow for fishing.

At Cape Howe Marine National Park surveys undertaken in early 2021 were used by Deakin University to inform predictive models for the extent of urchin barrens within the park which indicated that study area contains an area of likely urchin barrens of 6.3 km². The model found that highest probability of occurrence of *C. rodgersii* was on reef habitat, on more complex (sloping) terrain, in shallower depths, and in areas outside Cape Howe MPA. The probability of occurrence and predictive distribution of urchin barrens across the Cape Howe MNP and adjacent area are shown the figure below (from Whitmarsh et al, 2022, in prep).



Probability of occurrence of urchin barrens is shown in the right panel while the distribution of urchin barrens (based on >65% probability of occurrences is shown in the left panel).

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Culling of *C. rodgersii* to restore kelp forests at this location has been considered. However due to depth, remote location, cost, and the scale of barrens, no active management has been undertaken to date.

Illegal resource extraction (i.e. fishing) has been identified as a key threat to natural values in the park with illegal harvest of abalone having been an issue for many years, especially close to the NSW border. Abalone are a keystone species on subtidal reefs and illegal fishing has the potential to significantly impact on the health of these reefs. This can also compound the effect of Black-spined Urchins on abalone populations and subtidal reef systems.

Illegal fishing also has the potential to impact Southern Rock Lobster and Eastern Blue Groper populations which are predators of Black-spined Urchins and can help to mitigate the impacts of urchins on subtidal reefs. Anecdotal reports suggest rock lobster populations have declined in East Gippsland over the past few decades (possibly related to climate change) and illegal fishing has the potential to worsen this effect. Rock Lobster are also a keystone species on subtidal reefs and key predator of other mobile invertebrates.

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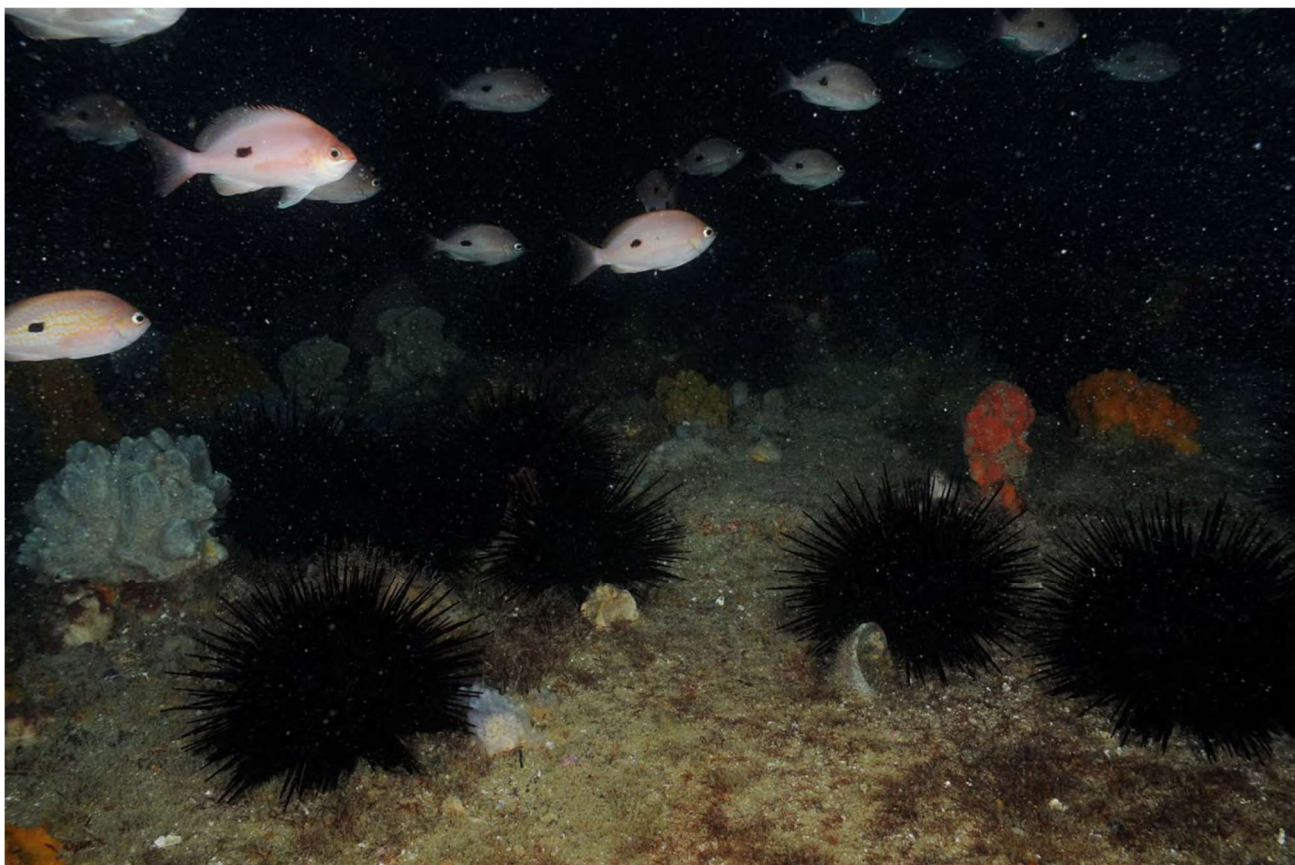
2. POINT HICKS MARINE NATIONAL PARK:

Point Hicks is one of three Marine National Parks in the Twofold Shelf marine bioregion, which also includes Ninety Mile Beach and Cape Howe Marine National Parks. Important natural values of Point Hicks Marine National Park are its granite intertidal and shallow and deep subtidal rocky reefs, sandy shores and open oceans that provide habitat for a diversity of marine flora and fauna species, including sessile invertebrates, algae, fish and transient whales.

An important characteristic of Point Hicks MNP is its canopy forming algae and small understorey algae. The stands of canopy forming algae are generally a mixture of Crayweed (*Phyllospora comosa*) and Golden Kelp (*Ecklonia radiata*) with the proportions of these two species varying according to the habitat, depth and location.

C. rodgersii occurs in Point Hicks Marine National Park and forms large grazing aggregations which denude the reef of erect algal species, forming barrens and these have been observed in the Marine National Park although have not been mapped as well as at Cape Howe MNP. Removal of large algae by *Centrostephanus* causes substantial changes to subtidal reef community structure.

Due to its remoteness and difficulty accessing no management of urchins at Point Hicks Marine National Park has been undertaken to date.



Black-Spined Urchins *Centrostephanus rodgersii* and Butterfly Perch *Caesioperca lepidoptera* in Point Hicks Marine National Park. Photo by Mark Norman, Museum Victoria.

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3. BEWARE REEF MARINE SANCTUARY:

Beware Reef is the only Marine Sanctuary in the Twofold Shelf Bioregion and covers 220 hectares and comprises a 1.5 km square around the isolated Beware Reef. The Park is a highly valued marine protected area located five kilometres offshore, south-east of Cape Conran in East Gippsland, Victoria, Australia. The exposed section of the granite reef emerges from a sandy seabed approximately 28m deep and rises to around one metre above the surface at low tide. The reef is 70m long above water and continues for 1km below sea level to the south-east.

The high diversity of marine flora and fauna make Beware Reef Marine Sanctuary a highly regarded scuba diving area and three historic wrecks, the Auckland, Ridge Park, and Albert San which also are important recreational diving venues in the Marine Sanctuary.

The temperate, clear waters of Beware Reef Marine Sanctuary provide habitat for an abundance of marine life. Parts of the reef are covered large brown algae forming kelp forests which in turn supports a wide range of smaller green algae, red algae, and many animals both in the canopy and on the sea floor. The exposed tip of the reef is a favourite resting spot for Australian Fur Seals. Where there is less sunlight deeper parts of the reef host a wide range of filter feeders including sponges, sea fans, sea tulips, sea whips and anemones. A wide diversity of fish is found on the reef and include boarfish, morwongs, trumpeters, wrasses, and sweep.

Important natural values of Beware Reef MS are its isolated intertidal and subtidal granite reef, extensive subtidal soft sediment, and open ocean that provide habitat for a diversity of marine flora and fauna species, including sessile invertebrates, algae, fish and transient whales. In the shallow subtidal (< 10m) the stands of canopy forming algae at Beware Reef Marine Sanctuary are generally Bull Kelp *Durvillaea potatorum* and Crayweed *Phyllospora comosa*, with a lesser contribution by the Golden Kelp *Ecklonia radiata*. Small red algae dominate the understory.

A subtidal reef monitoring program has been in place at Beware Reef Marine Sanctuary since 2005. This monitoring identified that although *C. rogersii* declined in abundance from 2006 to 2011, its numbers increased markedly to the highest recorded density in 2013.

From 2010 increasing populations of *C. rogersii* were being regularly reported by volunteers from the Friends of Beware Reef to Parks Victoria as have significantly impacted natural values of the Marine Sanctuary by overgrazing native algae creating large areas of barrens.

Friends of Beware Reef have been conducting Reef Life Surveys over the past 15 years which detail surveys of algae, fish, and invertebrates at Beware Reef Marine Sanctuary. The barrens at Beware Reef are thought to occupy up to 5% of the entire subtidal reef habitat based on visual field estimates.

Following assessment of options for managing urchins and completion of a Native Animal Management Plan for the site by Parks Victoria in 2016 culling of Black Spined Sea Urchins commenced in 2017 with some initial trials undertaken by Parks Victoria staff with the Friends of Beware Reef working together to assess the viability of localised volunteer management. The challenges of working at depth on SCUBA tanks meant, while there was some impact on urchin numbers within the trial, a greater level of control effort would be required to achieve the significant reductions in urchin numbers needed to restore overgrazed kelp forest.

In 2019 a project Optimal Management of Overabundant Sea Urchins in Victoria led by the University in Melbourne, in partnership with Deakin University and Parks Victoria, was established and was successful in gaining Biodiversity Response Planning (BRP) funding from the Department of Environment, Land, Water, and Planning. This project sought to fill key knowledge gaps in understanding of urchin biology, assist in the revegetation of barren reefs in marine protected areas by the removal of overabundant urchins, and to develop an urchin management plan to assist targeting of future on-ground action across the state.

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As the manager of Victoria's marine protected area funds allocated to Parks Victoria through this project were targeted towards on-ground actions to reduce urchin numbers in both East Gippsland targeting *C. rodgersii*, and also in Nooramunga Marine and Coastal Park in south Gippsland targeting a different species of urchin *Heliocidaris erythrogramma* that was creating urchin barrens in *Posidonia australis* seagrass beds.

At Beware Reef Marine Sanctuary these funds allowed for the engagement of specialist skilled contractors working using surface supplied air to undertake urchin culling over much larger areas of the reef that was previously possible using staff and volunteers.

This project aimed to focus culling of *C. rodgersii* initially from the largest barren on the NE side of Beware Reef Marine Sanctuary and progress to treat other barrens where feasible. Targeted culling has been shown to effectively reduce over-abundant densities of *C. rodgersii* in Tasmania. The barrens at Beware Reef are discrete and within depth ranges accessible to SCUBA diving, making them feasible for targeted culling.

The trials at Beware Reef focussed on reducing the density of *C. rodgersii* to below 0.2/m², to find out if this density allows recovery of the reef in areas as defined by the photo quadrats.

The densities found in one barren at Beware Reef in 2013 were approximately 4.5/m². In 2015 it was estimated that the population of urchins in the north-east barren of Beware Reef Marine Sanctuary to be around 10,000 individuals.

Monitoring the effects of management actions, to ensure they are having the desired response, and ensure there are no adverse impacts is a critical part of an adaptive management approach. Monitoring of both urchin numbers and changes in the cover of kelp is has been guided by *Monitoring urchin barrens before and after management: a standardised urchin barren monitoring manual* (Carnell, Critchell, Pocklington, McSkimming & Swearer (2020)). This manual was developed to provide directions for future urchin management in a range of habitats including both seagrass and reef system as well as dealing with both species of urchins that are overabundant in different parts of Victoria.

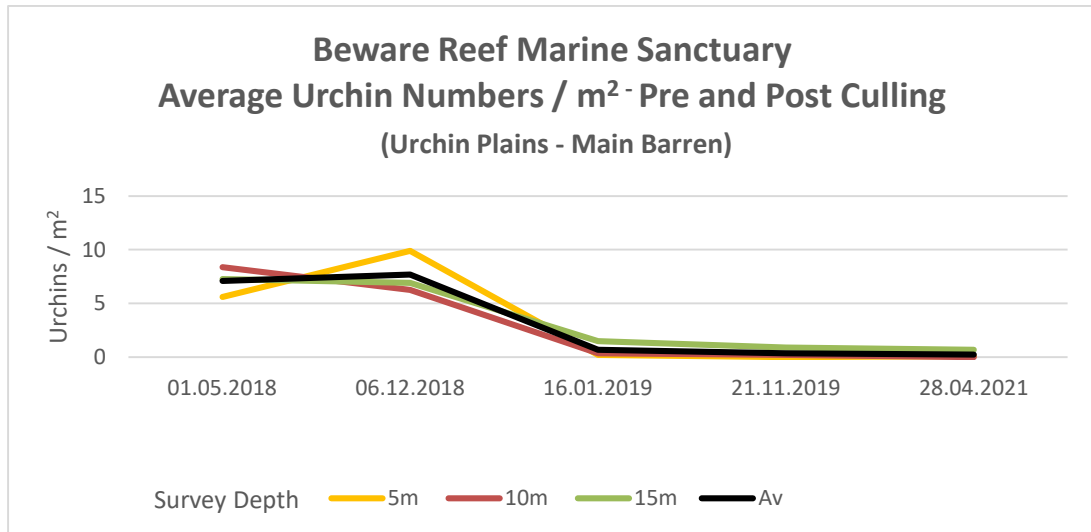
Photos were used to assess the numbers of urchins present although as the reef surface was uneven with many crevices or where kelp was present it was difficult to be able to see these in images. Images were also used determine the overall cover of kelp.

An initial survey was undertaken in April 2018 and determined that across the main barren area area urchin densities were high at an average of 7.1 urchins / m. In early December 2018, Parks Victoria conducted a pre-cull survey urchin density survey which showed a slight increase in urchin numbers. The survey urchin along three depth contours (5, 10 & 15 m) determined that across the area there was an average pre-cull urchin density of ~ 7.6 urchins / m².

Following the initial cull urchins were again monitored at this site in January 2019 and observed approximately a 90% reduction in urchin density from the pre-cull survey to the post cull survey. Some recruitment into the treated area from urchins that may have been at depth taking advantage of reduced competition in the 5 ½ weeks following the cull was reported. Maintenance culling was carried out in December 2019 to treat new arrivals and ensure that levels of urchin numbers remained sufficiently low to allow for kelp recovery.

Due to COVID restriction follow up monitoring was unable to be carried out until April 2021 however measures of urchin numbers indicated these stayed close to the projected densities for kelp recovery sought of 0.2 urchins / m². This was particularly notable at the 5- and 10-meter depths where kelp forests are most likely to be able to recover.

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Analysis of images pre and post culling has demonstrated effective restoration of kelp and other algal species at Beware Reef Marine Sanctuary. This was most pronounced in both 5 and 10m depth contours. At 15m kelp species are less likely to occur due to reduced light availability however some recovery of other brown algae as well as foliose red algae better suited to this depth were clearly observed.

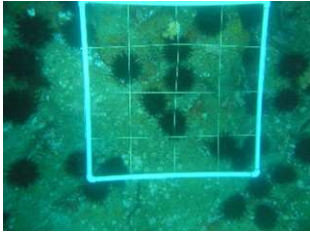
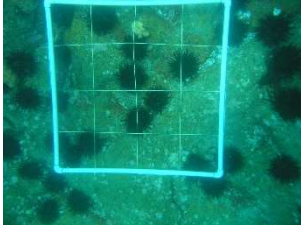
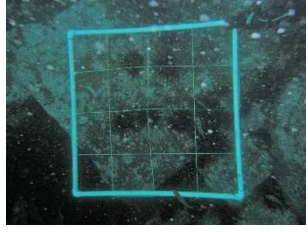
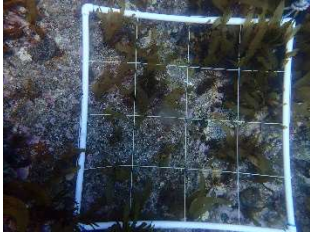
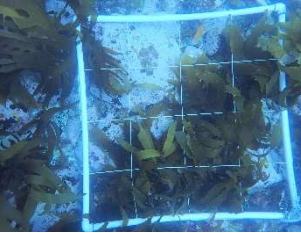
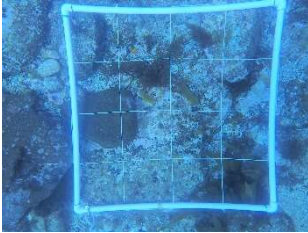



While the primary driver for undertaking this project has been to restore kelp it was also notable to see the increase in % cover of other algal species as well, particularly notable while the kelp plants were relatively small. Recovery of coralline algae enhances food availability for some grazing molluscs such as juvenile abalone that depend on these for their early growth.

This multiyear project has quantitatively shown large scale culling of urchins as a highly effective management approach for restoring what was formerly an urchin barren into a productive and diverse kelp forest ecosystem.



Kelp recovery on a former urchin barren after culling.

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Survey Dates	Transect Depth		
	5 m	10m	15m
December 18			
December 19			
April 21			

Sample images from surveys at Beware Reef Marine Sanctuary across each 5,10, 15 metre depth transect in December 2018, December 2019, and April 2021.

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2. Re: (b) management options, challenges and opportunities to better mitigate or adapt to these threats, and governance measures that are inclusive of First Nations communities;

- **Managing Overabundant Urchins by Culling:**

As discussed in the previous section and demonstrated through Parks Victoria's adaptive management at Beware Reef Marine Sanctuary active management of urchins through culling to allow for restoration of kelp forests is achievable and, where resources are available to support this, can achieve great results in recovery of algal communities.

A key component of success has been provision of adequate funding to engage contractors, obtained through the Biodiversity Response Planning funding for the project *Optimal management of overabundant sea urchins in Victoria* provided by Department of Environment, Land, Water, and Planning. This significantly enhanced capacity to undertake culling at scale, and when combined with follow up maintenance of treated sites clearly demonstrates it is possible to restore degraded reef ecosystems.

The management of overabundant urchins to protect high value assets, such as marine protected areas, is clearly achievable and will lead to strong recovery of algal communities but requires significant investment to achieve and may not be possible everywhere. In our experience costs for undertaking commercial culling of urchins within marine protected area are high at around \$5000 per day so targeted actions to where they are likely to have the best outcomes is critical.

To ensure that restored habitats persist ongoing culling programs to maintain low numbers of urchins will also be required noting that the resourcing for maintenance programs will be significantly less that what was required to achieve a significant knockdown in numbers required for habitat recovery. It is likely that this maintenance will be possible with local managers and volunteers carrying out this work.



A contractor at Beware Reef Marine Sanctuary with tool developed for controlling *C. rogersii*.
(Picture courtesy Kina Diving)

- **Partnerships for Urchin Management with Community Organisations:**

Community interest and support for management of urchins within marine protected areas has been strong and within Port Phillip Bay's three Marine Sanctuaries, in Nooramunga Marine and Coastal Park, and at Beware Reef Marine Sanctuary volunteers have played an important role in both identifying and reporting issues and well as participating actively in programs to reduce urchin numbers.

Parks Victoria actively encourages and supports citizen science programs and values the contributions volunteers make to data collection.

Volunteers from East Gippsland's Friends of Beware Reef Marine Sanctuary undertake regular monitoring using Reef Life Survey methods and initially identified the significant loss of kelp cover within the park and increases in Black-spined Urchin numbers and reported this to Parks Victoria. This clearly demonstrated the important role that volunteers can play in detecting and reporting changes to marine ecosystems they observe.

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After gaining approvals for an Overabundant Native Animal Management Plan for the site Friends of Beware Reef volunteers were also actively involved in undertaking baseline surveys and initial trials to assess the effectiveness of culling for kelp restoration. While having some localised benefits these trials demonstrated that the size of barrens was beyond the remit of volunteers alone and that commercial contractors would be better placed to achieve the targets required for restoration.

In Nooramunga Marine and Coastal Park Parks Victoria ranger staff worked with volunteers to undertake the initial culls of Purple Urchins in the park and removed more than 58,000 urchins during April and May 2017 at three barren sites. This number far outweighed the number of urchins removed through commercial fishing and reduced densities significantly.

Within Port Phillip Bay's Ricketts Point, Jawbone, and Point Cooke Marine Sanctuaries programs to restore kelp through reducing Purple Urchin numbers are currently getting underway with volunteers actively engaged in both monitoring sites as well as assisting where possible with culling. Recent funding to support kelp recovery from Department of Environment, Land, Water, and Planning has allowed for engagement of contractors to support volunteer culling efforts.



Volunteers at Ricketts Point Marine Sanctuary undertaking urchin culls.

Parks Victoria have also undertaken to actively build broad based community support for urchin programs through providing information, media, webinars, and in responding to queries. This builds social license and support for management.

- **Working with Traditional Owners:**

As a component of urchin management in Nooramunga Marine and Coastal Park opportunities to engage Gunaikurnai Land and Waters Aboriginal Corporation in urchin management and monitoring were identified and an invitation to contribute extended.

Gunaikurnai people have occupied, used, and managed coastal land and sea environments for many thousands of years include those areas that were dry land before the current sea level stabilised about 5,000 years ago.

A barrier to participation in urchin programs was in-water skills of Gunaikurnai Rangers so Parks Victoria's marine staff delivered a training program in snorkelling and underwater monitoring. This program was an important first step towards active involvement in future programs across Gunaikurnai sea country.



Parks Victoria and Gunaikurnai Rangers sharing marine knowledge and skills in Gippsland.

Agencies like Parks Victoria can build partnerships and collaborate with Traditional Owner to share knowledge and build capacity for managing sea country including management of overabundant urchins.

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- **Partnerships for Marine Restoration with Commercial Fishers:**

In south Gippsland's Nooramunga Marine and Coastal Park overabundant native Purple Urchins (*Heliocidaris erythrogramma*) have overgrazed meadows of the Broad-leaf Seagrass, *Posidonia australis*, creating several large barrens. An unprecedented massive settlement and recruitment of the urchin *Heliocidaris erythrogramma* has resulted in over-abundant populations establishing with up to 4ha of *Posidonia* meadows lost. Density surveys showed up to 173 urchins/m² at some site and serious potential for long term damage noting this as the first record of urchin overgrazing seagrass in Australia.

Following local interest in Parks Victoria's initial culling undertaken in May 2018, Parks Victoria, Victorian Fisheries Authority, and Seafood Industry Victoria initiated an expression of interest for Research Permits to collect and harvest the overabundant Purple Urchins in Nooramunga Marine and Coastal Park. Permits were issued for three 12-month periods to trial whether commercial collection could aid in management.

The Permit Objectives were to remove sea urchins from seagrass beds in Nooramunga Marine and Coastal Park to ensure the ongoing sustainability of the important seagrass meadows. The need to protect and restore seagrass is well understood by local fishers as it is a critical nursery habitat for fish that will contribute to their future catches.

Initial market reaction to the Corner Inlet urchins was positive selling at around \$8/kg helped by limited supply from other sources but this declined to \$2/kg below the price at which commercial fishing was viable (Note that commercial fishing is permitted within Nooramunga Marine and Coastal Park.)

Management of urchins by Parks Victoria culling and through commercial fishing has been effective in reducing densities to below target of 2 urchins/m² and has allowed for some recovery of seagrass in barrens.

While initially commercial fishing efforts to help achieve this target and reduce urchin numbers were substantial, the fall in price of urchins and the subsequent lack of fishing activity meant that this was not a reliable approach for managing urchin impacts in parks.

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3. Re: (c) funding requirements, responsibility, and pathways to better manage and co-ordinate stopping the spread of climate-related marine invasive species;

Funding: As discussed in regards the BRP Project at Beware Reef Marine Sanctuary adequate funding is required to effect reductions of urchin numbers to levels that will allow for kelp recruitment. At Beware Reef the relatively contained reef area impacted by urchins within the park and the high potential for restoration at key sites has allowed investment provided to be targeted to a site which has both high environmental and visitor values.

Given the extent of urchin barrens in Cape Howe and Point Hicks Marine National Parks significantly more resources would be required across these large parks to effect restoration. At these larger sites there would remain a much higher risks of reinvasion of restored sites if treatments were not of sufficient scale to knock down urchin numbers across the reef system and to prevent urchins moving from untreated surrounding areas into treated sites.

Responsibilities: The responsibility for managing overabundant urchins within marine protected areas clearly sits with Parks Victoria, while recognising the need and opportunities for strong collaboration with other stakeholders including funding bodies, researchers, and the broader community. In Victoria agencies including Department of Environment, Land, Water, and Planning (DELWP) have responsibility for management of marine values including reef system in areas outside of marine protected area. In developing long term solutions to managing overabundant urchins at Beware Reef Marine Sanctuary partnerships between Parks Victoria as the site manager and other sectors have been essential.

For this project these have included building strong relationships with community organisations that contribute to identifying issues and communicating these to site managers, with researchers for advice on management options and particularly in developing protocols for monitoring, with funding organisations to allow work at scale to be undertaken, and with professional contractors with the adequate skills and knowledge to implement effective and efficient culling programs.

Pathways to prevent urchin invasion: The vast expansion of range of *C. rogersii* into Victorian and Tasmanian waters over the past two decades is aligned with changes in sea surface temperatures and the improved survival of larvae and the strengthening of the East Australia Current into lower latitudes. Given the fecundity of urchins and the opportunities for dispersal over large distances by oceanic currents there are few practical means to prevent spread from areas with high urchin numbers.

In undertaking culling programs at high value locations such as at Beware Reef Marine Sanctuary it was initially observed that areas that had been treated were quickly invaded from surrounding areas. Follow up culls were required to eventually bring densities down to levels that support kelp recovery (< 2 urchins / m²).

In planned urchin management / kelp recovery programs being considered for Port Phillip Bays' Marine Sanctuaries, a focus for restoration will be establishing buffer areas surrounded treated sites to prevent reinvasion, and also targeting some culling toward sites that are identified through modelling as sources of recruits.

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4. Re: (d) the importance of tackling the spread of invasive urchin 'barrens' to help facilitate marine ecosystem restoration efforts (such as for Tasmanian Giant Kelp *Macrocystis pyrifera*);

In managing Victoria's marine protected areas Parks Victoria seek to maintain the cover, extent and connectivity of habitat forming algae that provide cover and food for a diverse assemblage of fish and macroinvertebrates in the subtidal reef ecosystems.

Our management of urchins at Beware Reef Marine Sanctuary and within Port Phillip's Marine Sanctuaries is primarily aimed at restoring kelp from locations where it has been lost due to overgrazing whilst also seeking to limit spread and further loss of kelp. In Nooramunga Marine and Coastal Park urchin culling has been undertaken primarily to prevent expansion of barrens within the *Posidonia* seagrass meadows whilst also allowing for restoration of seagrass.

Restoration of habitat at Beware Reef has focussed on reducing urchin numbers down to the point where they are not overgrazing emergent juvenile kelp. Based on research conducted in Victoria, Parks Victoria are working to try and achieve urchin densities of *Centrostephanus rodgersii* to below **0.2/m²** (Carnell and Keough 2106)

At sites within the Marine Sanctuary where this has been achieved and with urchin numbers remaining below these levels through maintenance culling, the consequent restoration of kelp in treated areas has been both comprehensive and relatively rapid with former barrens supporting a healthy kelp community within two to three years.

In Nooramunga Marine and Coastal Park barrens in seagrass formed by the smaller Purple Urchin *Heliocidaris erythrogramma* were expanding rapidly with urchin densities at the edge of barrens being as high as 173/m². Following targeted culling within these sites as well as removal of urchins through commercial fishing densities of urchins are now around 0.1 / m², which is well below the target density to allow for restoration of less than **2 urchins/m²**. Within the treated barrens while *Posidonia* is still to recover there has been good recruitment of another seagrass *Heterozostera nigricaulis* and ongoing monitoring will continue to track recovery.

Within Port Phillip's three Marine Sanctuaries management of overabundant urchins for restoration of lost kelp communities also aims to achieve densities of less than 2 urchins/m² and in some locations where this has occurred there is regrowth of macroalgae. Efforts to date in managing urchins within these parks has been focussed on limiting the spread of urchins into healthy habitat as well as restoration of kelp.

With the bay restoration of kelp is however further complicated by the presence of algal turfs that form on reefs in former barrens that can prevent juvenile kelp from establishing. Rapid colonisation of bare areas by invasive non-native algae including the large brown algae *Undaria pinnatifida* and the invasive red algae *Grateloupia turuturu* can also limit opportunities for native kelps to re-establish. Loss of mature kelp plants due to urchin overgrazing across large areas of the bay also limits sources of propagules for natural recruitment and where this is extensive alternate sources may need to be provided.



Juvenile kelp growing on a former urchin barren at Beware Reef Marine Sanctuary.

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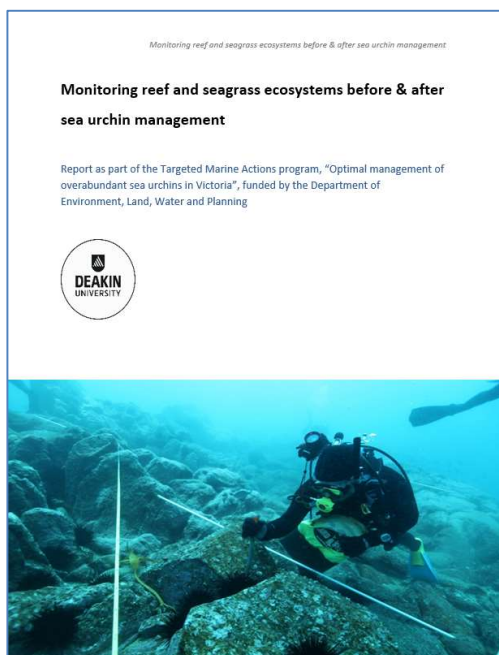
As part of a significant restoration programs within the Bay's Marine Sanctuaries getting underway in 2022 trials are planned of methods for both reducing algal turfs and for enhancing recruitment including using "green gravel" with small rocks "seeded" with kelp reared in the laboratory being placed in areas where natural recruitment is limited. These programs have been funded by the Department of Environment, Land, Water, and Planning and being led by University of Melbourne in partnership with Parks Victoria and others.

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5. Re: (e) any other related matters.

Some potentially useful internal publications and reports as well as some online resources on urchin management and monitoring may be of interest to the committee are listed here. These can be made available on request if useful.

- Parks Victoria (2021), Management of Overabundant Sea Urchins at Beware Reef Marine Sanctuary: Summary Report
- Parks Victoria (2018) *Centrostephanus rodgersii* (Black Spined Sea Urchin) Impact Management Plan for Beware Reef Marine Sanctuary.
- Parks Victoria (2018) *Heliocidaris erythrogramma* (Purple Sea Urchin) Impact Management Plan for Nooramunga Marine and Coastal Park.
- Parks Victoria (2021) *Heliocidaris erythrogramma* (Purple Sea Urchin) Impact Management Plan for Point Cooke Marine Sanctuary, Jawbone Marine Sanctuary, Ricketts Point Marine Sanctuary.
- Carnell, Critchell, Pocklington, McSkimming & Swearer (2020). Monitoring urchin barrens before and after management: a standardised urchin barren monitoring manual. Report to Department of Environment, Land, Water, and Planning.
- Online webinar: Searching for Urchin - <https://youtu.be/PQEse551b8w> . This webinar presentation includes a summary of recent research and monitoring on urchins in Victoria by Deakin University's Dr. Paul Carnell as well an overview of programs at Beware Reef Marine Sanctuary and in Port Phillip Bay Marine Sanctuaries with Parks Victoria marine rangers.



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References:

Carnell, P.E. and Keough, M.J. (2016) The influence of herbivores on primary producers can vary spatially and interact with disturbance. *Oikos* 125: 1273–1283.

Whitmarsh SK, Porskamp P, Tinkler P, Gray S, Ierodiaconou D, Sams MA and Young MA (In prep) An integrated monitoring program for Cape Howe Marine National Park, Parks Victoria Technical Series No 119, Parks Victoria, Melbourne.