



Australian Marine Sciences Association Inc.

ABN: 35 279 182 164  
Email: [REDACTED]  
Website: [www.amsa.asn.au](http://www.amsa.asn.au)

Senate Standing Committees on Environment and Communications  
PO Box 6100  
Parliament House  
Canberra ACT 2600  
[ec.sen@aph.gov.au](mailto:ec.sen@aph.gov.au)

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Dear Committee Members,

**Re: Submission to Senate Inquiry on Climate-related Marine Invasive Species.**

The Australian Marine Sciences Association (AMSA) welcomes the opportunity to provide input to the Senate Inquiry on climate-related marine invasive species. AMSA is Australia's largest professional association of marine scientists, with more than 700 members including many ecologists and fisheries scientists. For over 60 years, AMSA has promoted all aspects of marine science in Australia. AMSA has a long history of providing independent, evidence based, advice to government, industry and other key marine environmental stakeholders on a wide range of marine science issues. All of our submissions are publicly available here: <https://www.amsa.asn.au/submissions>.

This submission has been prepared after invitation to all our Members to contribute and draws on material in AMSA's [position paper on climate change](#) and its [position paper on marine protected areas](#).

Please feel free to contact me at the details below for further information.

Kind Regards

**Prof Chris Frid**  
President | Australian Marine Sciences Association  
[REDACTED]  
[www.amsa.asn.au](http://www.amsa.asn.au)

## **Australian Marine Sciences Association Submission to Senate Inquiry on Climate-related Marine Invasive Species**

### **List of Recommendations**

1. Recognize *Centrostephanus rodgersii* (black or long-spined urchin) as a native species within its historical range in New South Wales . The species is shifting its range southwards and in doing so is creating new habitats in Tasmania;
2. Prioritize region-specific research to understand predator-prey dynamics in ‘urchin barren’ habitats;
3. Recognise sea urchin barrens as a natural habitat important for biodiversity in New South Wales;
4. Ensure that sanctuary (no-take) zones are maintained with no sea urchin removals;
5. Prioritize research and management actions to ensure the sustainable harvest of *C. rodgersii*, which is a finite resource; and
6. Recognize that synergistic effects of anthropogenically induced climate change such as warming waters, increased storm action and freshwater influx which are highly deleterious to macroalgal forests and can compromise restoration efforts.

### **Executive Summary**

Facilitated by anthropogenic climate change, specifically ocean warming and intensified southerly flow of the East Australia Current, the sea urchin *Centrostephanus rodgersii* (black or long-spined urchin) has extended its range from its historic centre in New South Wales southwards into Tasmania. As urchins eat seaweed, arrival of this species in Tasmania has been at the expense of kelp habitats. There is considerable interest in controlling these range extensions and sea urchin control is an emerging field of research with actions including augmentation of sea urchin predators (by introduction of lobsters and facilitating the presence of predators in sanctuary zones) and urchin culling schemes. Recent research suggests that these actions may not be effective with control of urchins by predators being overstated in Tasmania, and possibly also in NSW. There has also been targeted development of the Tasmanian sea urchin fishery. Synergistic climate-mediated effects of storms and marine heatwaves which are also deleterious for kelp have rarely been considered in kelp-loss models and future work should include these factors. As the ecological and evolutionary patterns of *C. rodgersii* differ across its native and extended ranges, it is crucial that the approaches adopted to manage this species be based on location specific evidence.

### **Background**

Sea urchins are ecologically important as herbivorous grazers (Mann 1982, Ling et al. 2015, Ling and Keane 2018, Cresswell et al. 2022). They eat a range of plant and invertebrate food sources and when they occur in high densities, their feeding can create macroalgal-free ‘urchin barren’ habitats (Filbee-Dexter and Scheibling 2014, Ling and Keane 2021). Barrens typically have a cover of crustose coralline, turfing and filamentous algae and have a distinct biodiversity (Ayling et al. 1981, Underwood et al. 1991, Kingsford 2002). As ecosystem productivity can be lowered when sea urchins turn kelp habitats into barrens (Ling et al. 2015, Kawamata and Taino 2021), limiting sea urchin populations has become an issue in marine management. Various strategies seeking to mitigate effects of urchin grazing and protect kelp stocks have been employed, with mixed results.

Developing ways to mitigate urchin grazing in Tasmania is seen as important, because climate driven ocean warming and the intensifying southerly flow of the East Australia Current (Philips et al., 2022) has facilitated range extension of the sea urchin *Centrostephanus rodgersii* (black or long-spined urchin) from its native range in New South Wales (NSW) to Tasmania with consequent effects on the receiving ecosystem (Fogarty and Pecl 2021, Ling and Keane 2021, Byrne et al. 2022, Cresswell et al. 2022). Due to the warming of Tasmanian waters *C. rodgersii* can now prosper in the region (Byrne et al., 2022). This range extension has caused great concern and prompted research and management action (Ling and Keane 2021, Cresswell et al. 2022)

The situation in Tasmania has prompted a vilification of *C. rodgersii* in other states. In NSW it is not clear that this is warranted in ecosystems where barrens are a representative and stable natural habitat (Filbee-Dexter and Schiebling 2014, Glasby and Gibson 2020). A blanket-approach to management of the sea urchin is unlikely to be equally effective in all regions as outcomes are influenced by the ecology of urchin and kelp species found there, and these differ temporally and spatially (Trowbridge et al. 2019, Glasby and Gibson 2020, Byrne et al. 2022, Davis et al. 2022<sup>b</sup>). It remains unclear how much of the kelp loss seen in eastern Australia can be directly ascribed to grazing by *C. rodgersii*. Climate-driven effects of regional ocean warming, storm action and freshwater influx are additional stressors which kill kelp individually or in combination (Fogarty and Pecl 2021, Davis et al. 2022<sup>a</sup>, Davis et al. 2022<sup>b</sup>) and which can hamper kelp-restoration efforts (Morris et al. 2020, Fogarty and Pecl 2021). The role of climate change stressors seem not to have been fully considered in kelp dynamics models as a contributing factor in the decline of kelp, compared to models focused on urchin grazing (Ling et al. 2009, Ling et al. 2015, Layton et al. 2020). Overall, while it is clear that urchins are conspicuous herbivores that can create and maintain barrens habitat, they may have been unfairly targeted in NSW where barrens are a long-stable representative habitat and natural state (Trowbridge et al. 2019, Glasby and Gibson 2020, Davis et al. 2022<sup>a</sup>, Davis et al. 2022<sup>b</sup>).

Recent results from experiments in NSW and Tasmania have identified the need for future urchin management schemes to include a wider range of considerations (Glasby and Gibson 2020, Day 2020, Day et al. 2021, Davis et al. 2022a, Davis et al. 2022b, Smith et al. 2022). These include recognition that: (1) for many areas of Australia, urchin barrens are a natural state which exists within a habitat mosaic with other habitats like kelp, cunjevoi and seagrass. (2) desirable outcomes for different regions of Australia will be different and (3) these managed responses need to be developed on a case-by-case, location specific, basis.

In Tasmania, management strategies to combat the formation of barrens have been employed including (1) divers removing sea urchins by hand (Ling et al. 2010, Sanderson et al. 2015), (2) enhancing wild predator populations by actively transplanting predators reared in captivity into areas ostensibly affected by urchins (Redd et al. 2014, Ling and Keane 2021), (3) encouraging populations of natural urchin predators (such as lobsters and large fish) in sanctuary zones through implementation of no-fishing zones (Barrett et al. 2009, Edgar and Stuart-Smith 2009, Perkins et al. 2015) and (4) commercial harvest of urchins (Keane et al. 2019, Cresswell et al. 2021, Ling and Keane 2021). The efficacy of these strategies is mixed. The commercial fishery of urchins has limited grazing in some areas in the short term. However, the dispersal of the larval urchins from NSW into Tasmania is favoured under climate projections (Ling et al. 2009, Fogarty and Pecl 2021, Byrne et al. 2022) and so will, to some extent, offset fishery removals. No significant decrease in *C. rodgersii* biomass in Tasmania has been seen in ~15 years of fishing (Cresswell et al. 2019, 2020 and 2021). The results of augmentation of lobster populations as a control measure is also uncertain as the lobster in Tasmania does not appear to focus on sea urchins as prey (Smith et al. 2022<sup>a</sup>).

### ***Urchins in their historic native range***

In NSW urchin barrens typically cover ~50% of nearshore areas (Andrew and O'Neill 2000) and have been stable for some time (Glasby and Gibson 2020). When 'urchin barrens' habitats were first described in 1981 the term 'coralline flats' was used initially, due to their close association with crustose coralline algae (Ayling

1981) which supports a range of vertebrate and invertebrate species (Coleman et al. 2019; Curley et al. 2002). Importantly, the barrens habitat in NSW supports a broad diversity of dependant species and have been shown to support higher species diversity than adjacent kelp areas (Curley et al. 2022).

Recently, it has been suggested that overfishing of sea urchin predators has resulted in an increase in sea urchin populations in NSW (Layton et al. 2020). However, the predator-prey dynamics for sea urchin populations in NSW are not well understood, and much has been assumed from work in other locations (Ling et al. 2015, Ling et al. 2019). The need for management intervention in NSW, where barrens are part of the natural mix of habitats and urchin predators are abundant in marine sanctuary zones including barrens, is not pervasive (Edgar et al. 2011, Coleman et al. 2015, Harasti et al. 2015, Lee et al. 2015, Day 2020, Knott et al. 2021).

In NSW, barrens areas maintained by *C. rodgersii* exist as part of a natural habitat mosaic along with kelp, cunjevoi, coral, seagrass and rock along the coast in parallel with long-standing (> 20 years) protection of a suite of urchin predators including the eastern rock lobster (*Sagmariasus verreauxi*), eastern blue groper (*Achoerodus viridis*) and pink snapper (*Chrysophrys auratus*) in Jervis Bay (Barrett et al. 2006, Barrett et al. 2008<sup>a</sup>) Batemans Bay (Barrett et al. 2008<sup>b</sup>) and Port Stephens (Davis et al. 2015). Recent work in NSW (Day 2020, Day et al. 2021) suggests while *Sagmariasus verreauxi* is abundant, this lobster does not often eat *C. rodgersii* in the wild (Jeffs et al. 2013, Montgomery and Liggins 2013, Woodings et al. 2021). Therefore, while NSW sanctuary zones effectively conserve many species that prey on *C. rodgersii*, like *A. viridis* and *C. auratus*, none of the predicted transitions from barrens to macroalgae has been seen in the reserves (Coleman et al. 2015, Harasti et al. 2015, Lee et al. 2015, Malcom et al. 2016; Knott et al. 2021).

### ***Urchins in their extended range***

Recently it has been suggested that if the larval load of *C. rodgersii* dispersing to Tasmania from the Australian mainland could be stemmed by controlling urchin populations in NSW, then the climate-driven range extension of this species would be controlled more. Controlling urchin populations by hand-removal of urchins by divers can be successful (Miller and Shears 2022, Miller et al. 2022) but is a 'high effort' for 'little gain' approach, which is labour intensive, environmentally invasive and has inherent operational limitations associated with diver safety and the scale at which this work can be performed is severely limited in context with the vast populations of *C. rodgersii* and seasonal larval load in NSW. Recent work has shown that hand removal of urchins by divers is effective only at the local scale (Sanderson et al. 2015). *C. rodgersii* is a highly fecund species (Byrne and Andrew 2013) such that it does not require many adults to maintain the larval load. There is also an ethical issue associated with this approach. By what "right" do we remove a species from its natural range in order to interrupt an essentially "natural" response to changing environmental conditions. It is possible that such large-scale manipulation of a species in its natural range would be in contravention of the spirit, if not the letter of the Convention on Biological Diversity.

In Tasmania, transplanting captive-reared southern rock lobster (*Jasus edwardsii*) into *C. rodgersii* affected areas has limited grazing by urchin populations in the short-term (Ling and Keane 2021, Cresswell et al. 2022). These experiments used only large *J. edwardsii* transplanted into places with limited urchin abundance (Smith et al. 2022<sup>a</sup>). Other lobster translocations have shown a change in lobster diets towards eating sea urchins before and after transplantation into sanctuary zones (Redd et al. 2014). While this is a developing field of research, it is unlikely that such management actions could realistically (economically) be scaled up to the level of whole ecosystems (Trowbridge et al. 2019, Sanderson et al. 2015, Shears and Babcock 2002). Further, for *C. rodgersii* whether this can even be achieved is uncertain and it is not known whether short-term changes will be maintained long-term as barrens are known to operate over decadal and multi-decadal timeframes (Trowbridge et al. 2019, Glasby and Gibson 2020).

It is crucial that sanctuary zones are maintained into the future as these are effectively ecological experiments which will contribute to the development of evidence-based management decisions with

respect to the barrens-macroalgal dynamic. This is a key research area as fundamental unknowns remain about urchin barrens in Australia, including whether urchin populations are unregulated due to a lack of predators in the first place (Lee et al. 2015, Trowbridge et al. 2019, Day et al. 2021, Davis et al. 2022b). Further, while culling urchins has been effective in the short term, it is not considered a feasible long-term solution (Sanderson et al. 2015, Morris et al. 2020). Since urchins are a high value product when processed for their roe (Blount et al. 2017, Baulch 2019) harvest of sea urchins is being considered to determine the viability of commercial exploitation to limit their numbers.

The situation unfolding in Tasmania with *C. rodgersii* is different to what has been observed in NSW nearshore ecosystems. These two ecosystems will require different management strategies, and this is rarely acknowledged when strategies are being developed.

### **Harvesting sea urchins**

Populations of *C. rodgersii* offer opportunities for sustainable commercial harvest of urchin roe, which is a high-value product for international markets (Blount et al. 2017, Baulch 2019). Despite descriptions of *C. rodgersii* in Tasmania as an invasive species which causes negative ecosystem effects (Ling et al. 2009, Ling and Keane 2018, Ling and Keane 2021) recent commentary more appropriately describes *C. rodgersii* as a native species extending its range south (Cresswell et al. 2019, 2020, 2022). Although the recent report states that no significant reduction in urchin populations has been achieved in Tasmania with ~15 years of fishing *C. rodgersii*, augmenting the fishery through the subsidy scheme in Tasmania has resulted in the development of a novel fishery which is a net-positive both financially (Johnson et al. 2005, Sanderson et al. 2015, Cresswell et al. 2022) and socially (Carr and Minshul 2020, Campus 2022). Importantly, development of a sea urchin fishery offers the opportunity for indigenous communities to be stakeholders in commercial fishing.

The quality of sea urchin roe is significantly higher in kelp habitats compared to barrens such that these are the most valuable stock for commercial divers (Eurich et al. 2014, Ling and Keane et al. 2018, Ling and Keane et al. 2021, Cresswell et al. 2020). Therefore commercial harvesting does not contribute to the removal of urchins from barrens. Certainly, there is some overlap and commercial divers have contributed to controlling urchin barrens at small scales by removing urchins from the area they work in (Sanderson et al. 2015, Morris et al. 2020). To date, harvesting urchins commercially in NSW (Blount and Worthington 2002) or culling *C. rodgersii* in southern states (Tracey et al. 2014) has not impacted the larval flow into Tasmania, nor has commercial harvest in Tasmania reduced urchin populations there (Cresswell et al. 2019, 2020, 2022).

### **Climate Change**

Climate change related stressors have been shown to cause wide spread mortality of macroalgal forests (Davis et al. 2022<sup>a</sup>, Davis et al. 2022<sup>b</sup>). These climate-mediated effects include (1) increased freshwater influx associated with increased storm action killing marine plants (Davis et al. 2022<sup>a</sup>), (2) increased storm action directly ripping attached kelp from the sea floor (Davis et al. 2022<sup>a</sup>, Davis et al. 2022<sup>b</sup>) and (3) ocean warming and marine heatwaves causing thermal mortality of kelp (Fogarty and Pecl 2021, Ling and Keane 2021, Cresswell et al. 2022). In addition to being an additional factor contributing to kelp forest loss (Carnell et al. 2020, Cresswell et al. 2022, Davis et al. 2022<sup>a</sup>, Davis et al. 2022<sup>b</sup>), these impacts can hamper kelp restoration efforts and even make restoration impossible in some areas (Morris et al. 2020). The heating of regional waters has been intense in Tasmania leading to mortality of kelp (Mabin et al. 2019).

Moving forward, it must be recognised that climate-related phenomena contribute to the formation and persistence of macroalgal free areas of the sea floor, not all 'urchin barrens' have been caused by urchins alone (Trowbridge et al. 2019, Davis et al. 2022<sup>a</sup>, Davis et al. 2022<sup>b</sup>). Increasing seascape variability has been shown along the path of the rapidly intensifying East Australian Current (EAC) Southern Extension in

southeast Australia, a hotspot of ocean warming and ecosystem tropicalization (Phillips et al. 2022). The potential exists for the macroalgal free habitats attributed to *C. rodgersii* in Tasmania and Southern NSW are, at least in part, climate-mediated phenomena and that grazing urchins may be the symptom and not the sole cause (Davis et al. 2022<sup>a</sup>, Davis et al. 2022<sup>b</sup>). The extent of kelp loss directly attributable to *C. rodgersii* remains unclear (Carnell et al. 2020, Cresswell et al. 2022, Davis et al. 2022a, Davis et al. 2022b).

Recent work suggests that urchin populations and the associated barrens grow and recede naturally on decadal or multi-decadal timeframes and that these changes scale with ecosystem productivity and sea temperature (Johnson et al. 2005, Trowbridge et al. 2019, Glasby and Gibson 2020). This is attested to by the relative stability of barrens habitats in NSW, fluctuations of the kelp-barrens mosaic involving *Strongylocentrotus purpuratus* (purple sea urchin) in California and *S.droebachiensis* (green sea urchin) in Norway where grazing urchin populations have undergone die-offs associated with high urchin population density, food limitation and disease (Smith et al. 2022<sup>b</sup>).

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