Senate Standing Committees on Environment and Communications
PO Box 6100
Parliament House
Canberra ACT 2600
ec.sen@aph.gov.au

Dear Senate Standing Committees on Environment and Communications,

I welcome the opportunity to comment on the *Senate Inquiry on Climate-Related Marine Invasive Species*. I am a PhD candidate at the University of Sydney researching the ecology, thermal biology, larval biology, and taxonomy of echinoderms, with a particular focus on sea urchins on the southeast coast of Australia.

Firstly, I would like to address the use of the term invasive species with respect to the sea urchin *Centrostephanus rodgersii* on the Great Southern Reef. Although climate change driven warming and intensification of the East Australian Current in southeast Australia has led to the range extension of *C. rodgersii* into Tasmania, The Great Southern Reef is an expansive habitat and within its extent in NSW and Victoria *C. rodgersii* is a local **native** species. My submission will focus on NSW where *C. rodgersii* is a native species and where my research and knowledge are focussed.

(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;

With respect to potential damage and risk to biodiversity within NSW, the barrens habitat is a stable alternate state that supports a unique biodiverse marine community (Coleman and Kennelly 2019; Glasby and Gibson 2020). In fact, at the microscopic scale of biodiversity, diversity in sea urchin barrens is comparable to that in kelp forests (Coleman and Kennelly 2019). As such, the mosaic / patchy habitat of kelp forests interspersed with barrens that characterises the NSW seascape, supports a vast biodiversity. Further, a comprehensive biodiversity assessment for the barrens' habitat has not been undertaken, and as such, there may be under described groups of marine organisms (e.g., many invertebrate groups) in barren habitats that have not been discovered. As such, without an accurate biodiversity assessment led by expert taxonomists, alteration of these habitats by management actions may risk the loss of local biodiversity before we knew it existed.

It is important that targeted research is undertaken to understand the role that C. *rodgersii* plays in shaping the NSW seascape before any management actions are implemented. *Centrostephanus rodgersii* is a sea urchin in the family Diadematidae. It is well known and documented that Diadematidae sea urchins shape the ecosystems they inhabit by grazing turfing algae. For example, the collapse of coral reefs in the Caribbean during the 1980s can be attributed solely to the mass die-off of *Diadema antillarum* (Hughes 1994). There is limited data suggesting that the extent of *C. rodgersii* barrens have increased in NSW (Glasby and Gibson 2020) and in 50 years of observations, the majority of barrens in NSW have not increased in extent. This emphasises the stability of *C. rodgersii* populations in NSW and the need for decadal scale monitoring to understand the dynamics of the kelp-urchin barren cycles of NSW (Glasby and Gibson 2020). Before this is understood, any management actions in NSW may disrupt the stability of these ecosystems.

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

In NSW, while the largely stable state of urchins-kelp dynamics cautions against uninformed management actions or removal of *C. rodgersii*, the situation in Tasmania is different. In Tasmania, it

is evident that the range extension of *C. rodgersii* is a threat to local biodiversity. There are options to mitigate the effects of *C. rodgersii* grazing in Tasmania that do not involve culling. The promotion of sea urchin predators through the expansion of no take zones, can assist in controlling *C. rodgersii* populations. As has been demonstrated in Pacific Northwest, the promotion of predation can facilitate the recolonisation and establishment of kelp in areas overgrazed by sea urchins (Duggins 1980). Further, the establishment of a sea urchin fishery that utilises barrens urchins, such as the model employed by Urchinomics (https://www.urchinomics.com/) would allow for marketable roe sourced from barrens urchins. However, as with all sessile invertebrate fisheries, caution must be taken to ensure sustainable harvest practices.

Culling should be the last option, if one at all. Echinoderms (sea urchins, sea stars and sea cucumbers) are a boom-bust phyla, meaning they are characterised by population fluctuations and complex population dynamics (Uthicke et al. 2009). As we have seen with Crown of Thorns Starfish (COTS) (*Ancanthaster planci*) and *Asterias amurensis*, the culling of echinoderms that do not have well understood population biology can be very expensive and labour intensive, with limited success. If we do not understand the dynamics between larvae, juveniles and adults, culling adults may simply promote the colonisation of more larvae, or free up space for more juveniles as has been observed for the sea star *Marthasterias glacialis* (Byrne et al. 2021) and is likely for juveniles of COTS (Deaker et al. 2020). This possibility cautions strongly against uninformed management action and any management actions or removal of *C. rodgersii* needs to be underpinned by rigorous research and knowledge of this species biology.

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

It is not possible to stop the spread of *C. rodgersii*, it is a highly abundant species over a vast geographic extent in NSW, it extends into deep water and is a highly fecund. (Byrne and Andrew 2013). Any culling operations in NSW are unlikely to stem larval supply and would be a misdirected use of federal funding.

(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);

Regarding restoration options, it must be acknowledged that climate change is the driver of the range expansion of *C. rodgersii* into Tasmania and should be a significant consideration when undertaking restoration. Southeast Australia is a global warming hotspot (Hobday and Pecl 2014) and any restoration efforts will be challenged by ocean warming and increased storm activity. *Macrocystis pyrifera* is sensitive to increases in temperature and *Eklonia radiata* forests are sensitive to increased periods of low salinity during storm activity (Davis et al. 2022). As such, any restoration may be undermined by climate change driven ocean warming and increased storm activity if this is not a key consideration in the design of restoration efforts.

Sea urchins cannot be blamed for ocean warming, and even if populations of *C. rodgersii* are reduced, millions of dollars of investment and time will be misdirected because ecosystems dominated by *M. pyrifera* and *E. radiata* will still be at risk from global climate change. As such, restoration efforts focussed on mitigating the impacts of climate change warrant as much attention as addressing the range expansion of *C. rodgersii*.

Emily McLaren

References

Byrne M, Andrew N (2013) Centrostephanus rodgersii. In: Developments in Aquaculture and Fisheries Science. Elsevier, pp 243–256

Byrne M, Minchin D, Clements M, Deaker DJ (2021) The Waiting Stage, Prolonged Residency in Nursery Habitats by Juveniles of the Predatory Sea Star *Marthasterias glacialis*. The Biological Bulletin 241:219–230. doi: 10.1086/715843

Coleman MA, Kennelly SJ (2019) Microscopic assemblages in kelp forests and urchin barrens. Aquatic Botany 154:66–71. doi: 10.1016/j.aquabot.2019.01.005

Davis TR, Larkin MF, Forbes A, Veenhof RJ, Scott A, Coleman MA (2022) Extreme flooding and reduced salinity causes mass mortality of nearshore kelp forests. Estuarine, Coastal and Shelf Science 275:107960. doi: 10.1016/j.ecss.2022.107960

Deaker DJ, Agüera A, Lin H-A, Lawson C, Budden C, Dworjanyn SA, Mos B, Byrne M (2020) The hidden army: corallivorous crown-of-thorns seastars can spend years as herbivorous juveniles. Biol Lett 16:20190849. doi: 10.1098/rsbl.2019.0849

Duggins DO (1980) Kelp Beds and Sea Otters: An Experimental Approach. Ecology 61:447–453. doi: 10.2307/1937405

Glasby TM, Gibson PT (2020) Decadal dynamics of subtidal barrens habitat. Marine Environmental Research 154:104869. doi: 10.1016/j.marenvres.2019.104869

Hobday AJ, Pecl GT (2014) Identification of global marine hotspots: sentinels for change and vanguards for adaptation action. Rev Fish Biol Fisheries 24:415–425. doi: 10.1007/s11160-013-9326-6

Hughes TP (1994) Catastrophes, Phase Shifts, and Large-Scale Degradation of a Caribbean Coral Reef. Science 265:1547–1551. doi: 10.1126/science.265.5178.1547

Uthicke S, Schaffelke B, Byrne M (2009) A boom–bust phylum? Ecological and evolutionary consequences of density variations in echinoderms. Ecological Monographs 79:22.