Journal of the Marine Biological Association of the United Kingdom

cambridge.org/mbi

Marine Record

**Cite this article:** Linnane A, McLeay L, Doubell M (2023). Westward range expansion of the eastern rock lobster (*Sagmariasus verreauxi*) in Australia. *Journal of the Marine Biological Association of the United Kingdom* **103**, e39, 1–4. https://doi.org/10.1017/S0025315423000309

Received: 16 January 2023
Revised: 4 April 2023
Accepted: 24 April 2023

**Keywords:**
Climate change; eastern rock lobster; fisheries; range expansion

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# Westward range expansion of the eastern rock lobster (*Sagmariasus verreauxi*) in Australia

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## Abstract

The eastern rock lobster (*Sagmariasus verreauxi*) inhabits the east coast of Australia from southern Queensland to the South Australian border including Tasmania, with the highest abundances found in New South Wales. Changes in strength, duration, and intensity of the eastern Australian current have expanded the species range southward but until recently, records of the species in western regions of south-eastern Australia were rare. Here, we report the first ever verified records of *S. verreauxi* in the northern zone rock lobster fishery of South Australia, which are the most westerly records ever documented in terms of overall distribution for this species. We hypothesise that two westward flowing systems, the offshore Flinders current and the inshore coastal current may be possible mechanisms for larval transport.

## Introduction

In Australia, the eastern rock lobster (*Sagmariasus verreauxi*) inhabits rocky reef and sand/mud substrates in depths ranging from 1 to 200 m from southern Queensland to the South Australian border, including Tasmania (Figure 1) (Montgomery and Liggins, 2013). Highest abundances are found along the New South Wales coastline where the species supports both commercial and recreational fisheries. The commercial fishery is managed using a range of controls including a total allowable commercial catch (TACC). The fishing season extends from 1 August to 31 July, with the TACC for the 2021/2022 season set at 180 t (Liggins *et al*., 2021).

The spawning stock of eastern rock lobster is spatially distinct being limited to the north coast of New South Wales (Montgomery and Craig, 2005). Spawning occurs from September to January (Booth, 1984) with phyllosoma undergoing 17 stages of larval development over a 9–12-month period (Kittaka, 1994) before settling as puerulus into inshore reef habitat along the entire New South Wales coastline. Notably, the eastern rock lobster is also found in New Zealand, and while earlier research indicated minimal larval connectivity (Brasher *et al*., 1992; Ovenden *et al*., 1992), more recent studies suggest genetic homogeneity across the Tasman Sea encompassing both Australian and New Zealand populations (Woodings *et al*., 2018).

Within South Australia, lobster fishing occurs exclusively for southern rock lobster (*Jasus edwardsii*). The fishery is divided into two zones for reporting and management purposes, the northern and southern zones (Figure 1), which at the start of the 2021/2022 seasons had TACCs of 1246 t and 296 t, respectively (Linnane *et al*., 2021*a*, 2021*b*). Most of the catch is taken from October to May with a minimum legal size of 98.5 mm carapace length (CL) in the southern zone and 105 mm CL in the northern zone. As with the eastern rock lobster, commercial fishing can only be undertaken by using baited traps. The southern rock lobster fishery is South Australia's most valuable fishery resource with a gross value of production in the 2020/2021 season of AUS$83 million (BDO EconSearch, 2022*a*, 2022*b*).

Reports of eastern rock lobster being landed in South Australian waters are extremely rare, being primarily limited to a few individuals caught in the southern zone, off Port MacDonnell at the southernmost end of the distribution range within the southern zone fishery (Figure 1). However, over the past three fishing seasons, reports of eastern rock lobster being caught in South Australia have increased. Notably, some reports have been from regions west of Port MacDonnell from areas where *S. verreauxi* have not previously been observed. This study reports on three verified westerly specimens caught during the 2021/2022 South Australian southern rock lobster fishing season. This includes the first ever reporting of eastern rock lobster in the northern zone of South Australia's southern rock lobster fishery.

## Materials and methods

### At-sea catch sampling

The three eastern rock lobster specimens were recorded as part of a southern rock lobster at-sea catch sampling programme that has been undertaken in South Australia since 1991 in collaboration between commercial fishers and scientists from the South Australian Research and Development Institute (SARDI). The aim of the programme is to provide temporal and spatial stock assessment data relating to the catch of legal and undersized lobsters as well as information on bycatch species.

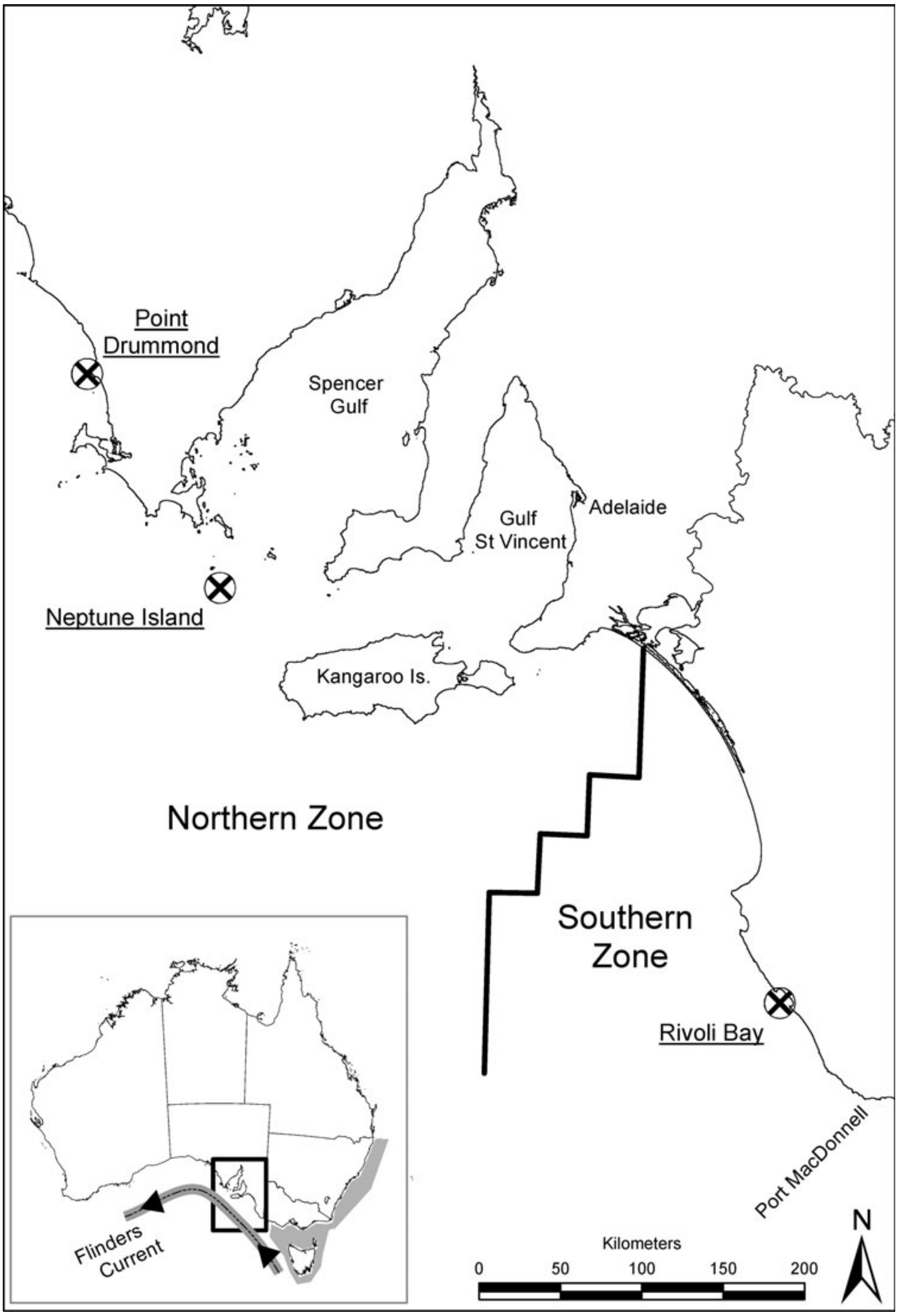


**Figure 1.** Map showing the location of eastern rock lobster specimens caught in South Australia during the 2020/2021 fishing seasons at Rivoli Bay, the Neptune Islands, and Point Drummond. Shaded area (inset) shows the normal range distribution of the species.

Participating fishers record the contents from up to three traps daily which is supplemented by SARDI scientific observers who undertake routine onboard sampling trips and record information from all traps. Data recorded from each trap include (i) number of legal and undersized lobsters; (ii) lobster sex as determined by position of the gonopores (at the base of the third pereiopods in females and fifth pereiopods in males); (iii) lobster size; (iv) reproductive condition of females, e.g. ovigerous or sexually immature; (v) identification and number of all bycatch species; and (vi) latitude, longitude, and depth of each trap sampled.

Fishing is undertaken using steel-framed traps which are generally baited with either Australian salmon (*Arripis truttaceus*), blue mackerel (*Scomber australasicus*), barracouta (*Thyrsites atun*), or carp (*Cyprinus carpio*). Traps are set overnight and hauled at first light. On capture, photographs of each *S. verreauxi* specimen were taken onboard the commercial fishing vessel and sent to SARDI in Adelaide, South Australia for visual identification.

## Results and discussion

One *S. verreauxi* was captured at Rivoli Bay in the southern zone fishery while two were recorded in the northern zone fishery at North Neptune Island and Point Drummond (Figure 1). All three specimens were male, ranged in size from 122 to 160 mm CL, and were caught in depths ranging from 4 to 22 m (Table 1 and Figure 2). Specimens caught at Neptune Island and Point Drummond

**Table 1.** Details of three *Sagmariasus verreauxi* specimens caught during the 2020/2021 South Australian rock lobster fishing season (CL, carapace length)

| Date | Location | Sex | Depth (m) | Size (mm CL) |
|---|---|---|---|---|
| November 2021 | Point Drummond | Male | 22 | 152 |
| November 2021 | Neptune Islands | Male | 18 | 122 |
| April 2022 | Rivoli Bay | Male | 4 | 160 |

represent the first verified observations of *S. verreauxi* in the northern zone fishery of South Australia and are the most westerly records ever documented in terms of overall distribution for this species.

Range expansion and changes in distribution due to climate change are well documented for numerous oceanic species globally (Poloczanska *et al.*, 2013; Pecl *et al.*, 2017; Pinsky *et al.*, 2021). Within Australia, the south-east region is considered a climate change hotspot where southward latitudinal shifts in species distribution have been documented for a variety of reef-dwelling organisms (Pecl *et al.*, 2009; Last *et al.*, 2011; Gervais *et al.*, 2021). These shifts are strongly influenced by known changes to the eastern Australia current (EAC), which has increased in terms of strength, duration, and frequency of southward incursion (Ridgway, 2007) resulting in the transportation of larvae from northern regions southward into Tasmania (Ling *et al.*, 2008; Johnson *et al.*, 2011).

One such species is *S. verreauxi* which is now identified as being resident in Tasmanian waters (Pecl *et al.*, 2009; Robinson *et al.*, 2015). Within New South Wales, the species has a natural north-to-south recruitment pattern (Montgomery and Craig, 2005), which facilitates the natural movement of larvae from the region into Tasmania as the EAC extends further south. While the process for the range extension of *S. verreauxi* southward is relatively understood, less is known about its expansion westward.

The connectivity of ocean currents from Australia's western and eastern coastlines with the southern shelf has potential implications for influencing species distributions (Griffin *et al.*, 2001; Coleman *et al.*, 2013). The predominant current along the south coast of Australia is the Leeuwin current which flows south along the west coast of Australia and extends eastwards into the Great Australian Bight principally during the Austral autumn and winter (Griffiths and Pearce, 1985; Church *et al.*, 1989). In the east, the Flinders current (FC) (Figure 1) transports subsurface water westwards along the southern shelf of Australia (Middleton and Cirano, 2002). The FC has the potential to transport larvae from the south and west coasts of Tasmania westward into South Australia (Griffin *et al.*, 2001; Middleton and Bye, 2007). In addition, a north-westward flowing nearshore coastal current (CC) associated with south-easterly winds prevalent during the Austral summer is also expected to connect Bass Strait and western Victorian coastal waters with the southern zone and the south coast of Kangaroo Island (Rochford, 1957; Middleton and Bye, 2007). Both the FC and CC are linked with the occurrence of summertime upwelling events along the southern shelf of Australia (Kämpf *et al.*, 2004; Middleton and Bye, 2007) and provide a possible mechanism for eastern rock lobster larval transport between Victoria and South Australia. Connectivity between Tasmania and South Australia has been confirmed through stable isotope analyses (Richardson *et al.*, 2019), particularly during upwelling seasons, providing further evidence for a possible larval transport mechanism between the two regions.

The occurrence of eastern rock lobster in South Australia suggests a change in environmental factors allowing settled larvae to survive through to adulthood. The normal temperature range of *S. verreauxi* in New South Wales is approximately 14.5–21.5 °C while that of southern rock lobster in south-eastern Australia tends to be cooler at approximately 9–21 °C (Holthuis, 1991). However, while investigating temporal changes in size at sexual maturity in *J. edwardsii*, McLeay *et al.* (2019) highlighted high rates of increase in sea-surface temperature within South Australia since 1991. This suggests that local environmental conditions within South Australia are now favourable to eastern rock lobster settlement, survival, and maturity, to adult stages.

Finally, the local ecological impacts of *S. verreauxi* expansion into South Australia remain largely unknown. Early research, however, indicates that *J. edwardsii* may be more dominant than *S. verreauxi* in direct food competition and that this dominance is sustained under a wide temperature range (Twiname *et al.*, 2022). Given the importance of the southern rock lobster fishery to South Australia, further research is warranted on the competitive interactions of *S. verreauxi* with *J. edwardsii*, as well as the broader ecological consequences of eastern rock lobster range expansion.

Analyses of oceanographic information available through the Integrated Marine Observing System (IMOS) series of National Reference Stations (http://imos.org.au/), which are deployed to monitor ocean climate in Australian coastal ocean waters, coupled with cross jurisdictional fishery monitoring data, may assist in predicting range shifts of marine species such as eastern rock lobster and any ecological impacts under the influence of climate change.

**Acknowledgements.** We thank South Australian commercial rock lobster fishers Richard Leech, Les Polkinghorne, and Ros Brown who reported the eastern rock lobster specimens. We acknowledge SARDI rock lobster fishery observers Douglas Graske, Andrew Hogg, and Peter Hawthorne.

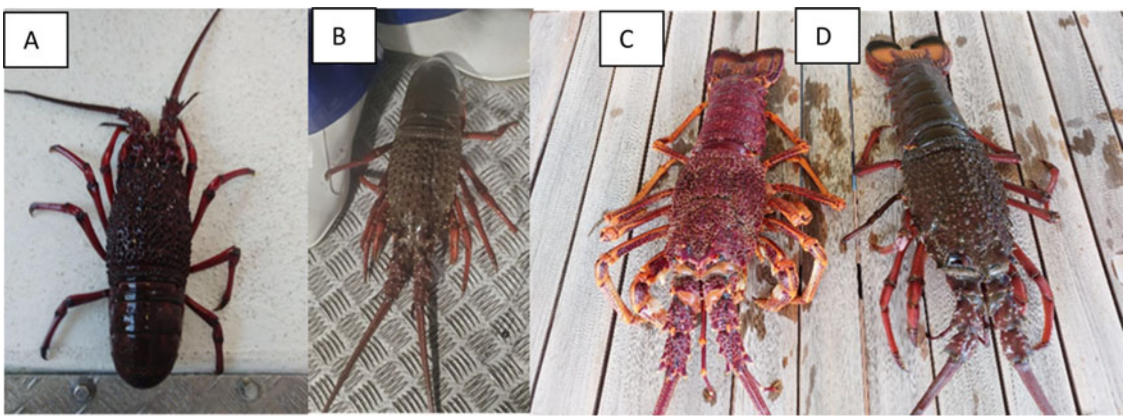


**Figure 2.** Specimens of eastern rock lobster *Sagmariasus verreauxi* caught at Neptune Islands (A) and Point Drummond (B) in South Australia. Specimen of *Jasus edwardsii* (C) is included for comparison with *S. verreauxi* caught at Rigoni Bay (D).

https://doi.org/10.1017/S0025315423000309 Published online by Cambridge University Press

**Author's contribution.** A. L. and L. M. recognised the importance of these observations and wrote the first draft of the manuscript; A. L. and L. M. morphologically verified the identity of *Sagmariasus verreauxi* specimens; M. D. provided oceanographic expertise; all authors contributed to the refinement of the final manuscript.

**Financial support.** This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

**Competing interests.** None.

## References

**BDO EconSearch** (2022*a*) Economic and social indicators for the South Australian northern zone rock lobster fishery, 2020/21. A report for The Department of Primary Industries and Regions. 86 pp.

**BDO EconSearch** (2022*b*) Economic and social indicators for the South Australian southern zone rock lobster fishery, 2020/21. A report for The Department of Primary Industries and Regions. 81 pp.

**Booth JD** (1984) Movements of packhorse rock lobsters (*Jasus verreauxi*) tagged along the eastern coast of the North Island, New Zealand. *New Zealand Journal of Marine and Freshwater Research* **18**, 275–281.

**Brasher D, Ovenden J, Booth J and White R** (1992) Genetic subdivision of Australian and New Zealand populations of *Jasus verreauxi* (Decapoda: Palinuridae) – preliminary evidence from the mitochondrial genome. *New Zealand Journal of Marine and Freshwater Research* **26**, 53–58.

**Church J, Cresswell G and Godfrey J** (1989) The Leeuwin current. In Neshyba S, Mooers C, Smith R and Barber R (eds), *Poleward Flows Along Eastern Ocean Boundaries*. New York, NY: Springer, pp. 230–254.

**Coleman MA, Feng M, Roughan M, Cetina-Heredia P and Connell SD** (2013) Temperate shelf water dispersal by Australian boundary currents: implications for population connectivity. *Limnology and Oceanography: Fluids and Environments* **3**, 295–309.

**Gervais CR, Champion C and Pecl GT** (2021) Species on the move around the Australian coastline: a continental-scale review of climate-driven species redistribution in marine systems. *Global Change Biology* **27**, 3200–3217.

**Griffin DA, Wilkin JL, Chubb CF, Pearce AF and Caputi N** (2001) Ocean currents and the larval phase of Australian western rock lobster, *Panulirus cygnus*. *Marine and Freshwater Research* **52**, 1187–1199.

**Griffiths R and Pearce A** (1985) Instability and eddy pairs on the Leeuwin current south of Australia. *Deep Sea Research Part A. Oceanographic Research Papers* **32**, 1511–1534.

**Holthuis L** (1991) Marine lobsters of the world. An annotated and illustrated catalogue of species of interest to fisheries known to date. FAO Fisheries Synopsis No. 125, Vol 13. FAO, Rome.

**Johnson CR, Banks SC, Barrett NS, Cazassus F, Dunstan PK, Edgar GJ, Frusher SD, Gardner C, Haddon M and Helidoniotis F** (2011) Climate change cascades: shifts in oceanography, species' ranges and subtidal marine community dynamics in eastern Tasmania. *Journal of Experimental Marine Biology and Ecology* **400**, 17–32.

**Kämpf J, Doubell M, Griffin D, Matthews RL and Ward TM** (2004) Evidence of a large seasonal coastal upwelling system along the southern shelf of Australia. *Geophysical Research Letters* **31**, L09310.

**Kittaka J** (1994) Culture of phyllosomas of spiny lobster and its application to studies of larval recruitment and aquaculture. *Crustaceana* **66**, 258–270.

**Last P, White W, Gledhill D, Hobday A, Brown R and Edgar G** (2011) Long-term shifts in abundance and distribution of a temperate fish fauna: a response to climate change and fishing practices. *Global Ecology and Biogeography* **20**, 58–72.

**Liggins GW, Miller M and Ballinger G** (2021) *Resource Assessment: Eastern Rock Lobster (Sagmariasus verreauxi)*. NSW Department of Primary Industries, Sydney.

**Ling SD, Johnson C, Frusher S and King C** (2008) Reproductive potential of a marine ecosystem engineer at the edge of a newly expanded range. *Global Change Biology* **14**, 907–915.

**Linnane A, McGarvey R, Feenstra J and Graske D** (2021*a*) Northern zone rock lobster (*Jasus edwardsii*) fishery status report 2020/21. Status Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000714-15. SARDI Research Report Series No. 1113. 21 pp.

**Linnane A, McGarvey R, Feenstra J and Hawthorne P** (2021*b*) Southern zone rock lobster (*Jasus edwardsii*) fishery status report 2020/21. Status Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000715-15. SARDI Research Report Series No. 1112. 18 pp.

**McLeay LJ, Doubell MJ and Linnane AJ** (2019) Spatial and temporal variations in female size at maturity of a southern rock lobster (*Jasus edwardsii*) population: a likely response to climate change. *PLoS ONE* **14**, e0225144.

**Middleton JF and Bye JA** (2007) A review of the shelf-slope circulation along Australia's southern shelves: Cape Leeuwin to Portland. *Progress in Oceanography* **75**, 1–41.

**Middleton JF and Cirano M** (2002) A northern boundary current along Australia's southern shelves: the Flinders current. *Journal of Geophysical Research: Oceans* **107**, 3129.

**Montgomery S and Craig J** (2005) Distribution and abundance of recruits of the eastern rock lobster (*Jasus verreauxi*) along the coast of New South Wales, Australia. *New Zealand Journal of Marine and Freshwater Research* **39**, 619–628.

**Montgomery SS and Liggins GW** (2013) Recovery of the eastern rock lobster *Sagmariasus verreauxi* off New South Wales, Australia. *Marine Biology Research* **9**, 104–115.

**Ovenden J, Brasher D and White R** (1992) Mitochondrial DNA analyses of the red rock lobster *Jasus edwardsii* supports an apparent absence of population subdivision throughout Australasia. *Marine Biology* **112**, 319–326.

**Pecl GT, Araújo MB, Bell JD, Blanchard J, Bonebrake TC, Chen I-C, Clark TD, Colwell RK, Danielsen F, Evengård B, Falconi L, Ferrier S, Frusher S, Garcia RA, Griffis RB, Hobday AJ, Janion-Scheepers C, Jarzyna MA, Jennings S, Lenoir J, Linnetved HI, Martin VY, McCormack PC, McDonald J, Mitchell NJ, Mustonen T, Pandolfi JM, Pettorelli N, Popova E, Robinson SA, Scheffers BR, Shaw JD, Sorte CJB, Strugnell JM, Sunday JM, Tuanmu M-N, Vergés A, Villanueva C, Wernberg T, Wapstra E and Williams SE** (2017) Biodiversity redistribution under climate change: impacts on ecosystems and human well-being. *Science* **355**, eaai9214.

**Pecl G, Frusher S, Gardner C, Haward M, Hobday A, Jennings S, Nursey-Bray M, Punt A, Revill H and van Putten I** (2009) The east coast Tasmanian rock lobster fishery – vulnerability to climate change impacts and adaptation response options. Report to the Department of Climate Change, Australia, 116 pp.

**Pinsky ML, Fenichel E, Fogarty M, Levin S, McCay B, St Martin K, Selden RL and Young T** (2021) Fish and fisheries in hot water: what is happening and how do we adapt? *Population Ecology* **63**, 17–26.

**Poloczanska ES, Brown CJ, Sydeman WJ, Kiessling W, Schoeman DS, Moore PJ, Brander K, Bruno JF, Buckley LB, Burrows MT, Duarte CM, Halpern BS, Holding J, Kappel CV, O'Connor MI, Pandolfi JM, Parmesan C, Schwing F, Thompson SA and Richardson AJ** (2013) Global imprint of climate change on marine life. *Nature Climate Change* **3**, 919–925.

**Richardson L, Middleton J, Kyser TK, James NP and Opdyke B** (2019) Shallow water masses and their connectivity along the southern Australian continental margin. *Deep Sea Research Part I: Oceanographic Research Papers* **152**, 103083.

**Ridgway KR** (2007) Long-term trend and decadal variability of the southward penetration of the East Australian Current. *Geophysical Research Letters* **34**, L13613.

**Robinson LM, Gledhill DC, Moltschaniwskyj NA, Hobday AJ, Frusher S, Barrett N, Stuart-Smith J and Pecl GT** (2015) Rapid assessment of an ocean warming hotspot reveals 'high' confidence in potential species' range extensions. *Global Environmental Change* **31**, 28–37.

**Rochford D** (1957) The identification and nomenclature of the surface water masses in the Tasman Sea (data to the end of 1954). *Marine and Freshwater Research* **8**, 369–413.

**Twiname S, Fitzgibbon QP, Hobday AJ, Carter CG, Oellermann M and Pecl GT** (2022) Resident lobsters dominate food competition with range-shifting lobsters in an ocean warming hotspot. *Marine Ecology Progress Series* **685**, 171–181.

**Woodings LN, Murphy NP, Doyle SR, Hall NE, Robinson AJ, Liggins GW, Green BS, Cooke IR, Bell JJ and Strugnell JM** (2018) Outlier SNPs detect weak regional structure against a background of genetic homogeneity in the eastern rock lobster, *Sagmariasus verreauxi*. *Marine Biology* **165**, 1–17.