Government of **Western Australia**
Department of **Fisheries**

Decline in juvenile (puerulus) settlement in the western rock lobster fishery in Western Australia: management adaptation to climate change

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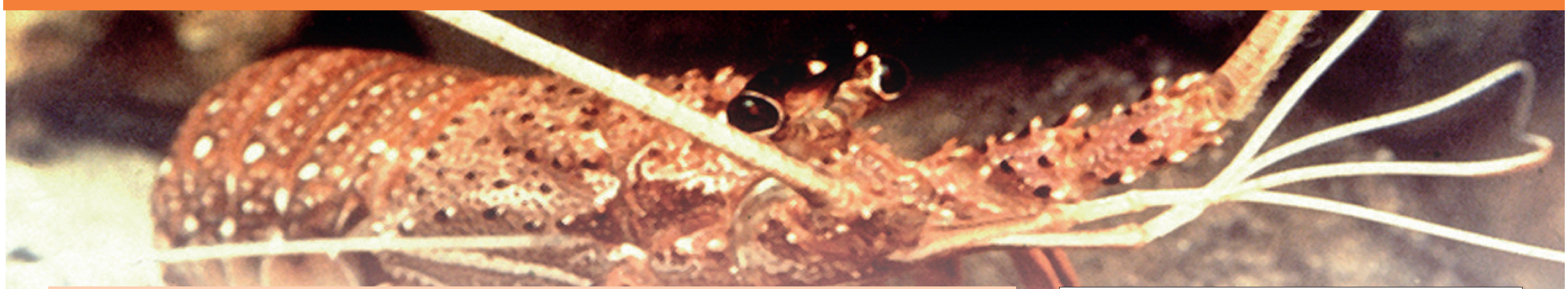

The western rock lobster (*Panulirus cygnus*) fishery is one of the best fisheries in Australia to examine effects of climate changes because its long time series of data allows fishery trends and their sensitivity to environmental conditions to be determined. Its location on the south-west coast of Australia has been identified as one of the global hotspots of long-term increases in water temperature (Fig. 1) and is also affected by a long-term reduction in winter storms. These environmental trends are projected to continue.

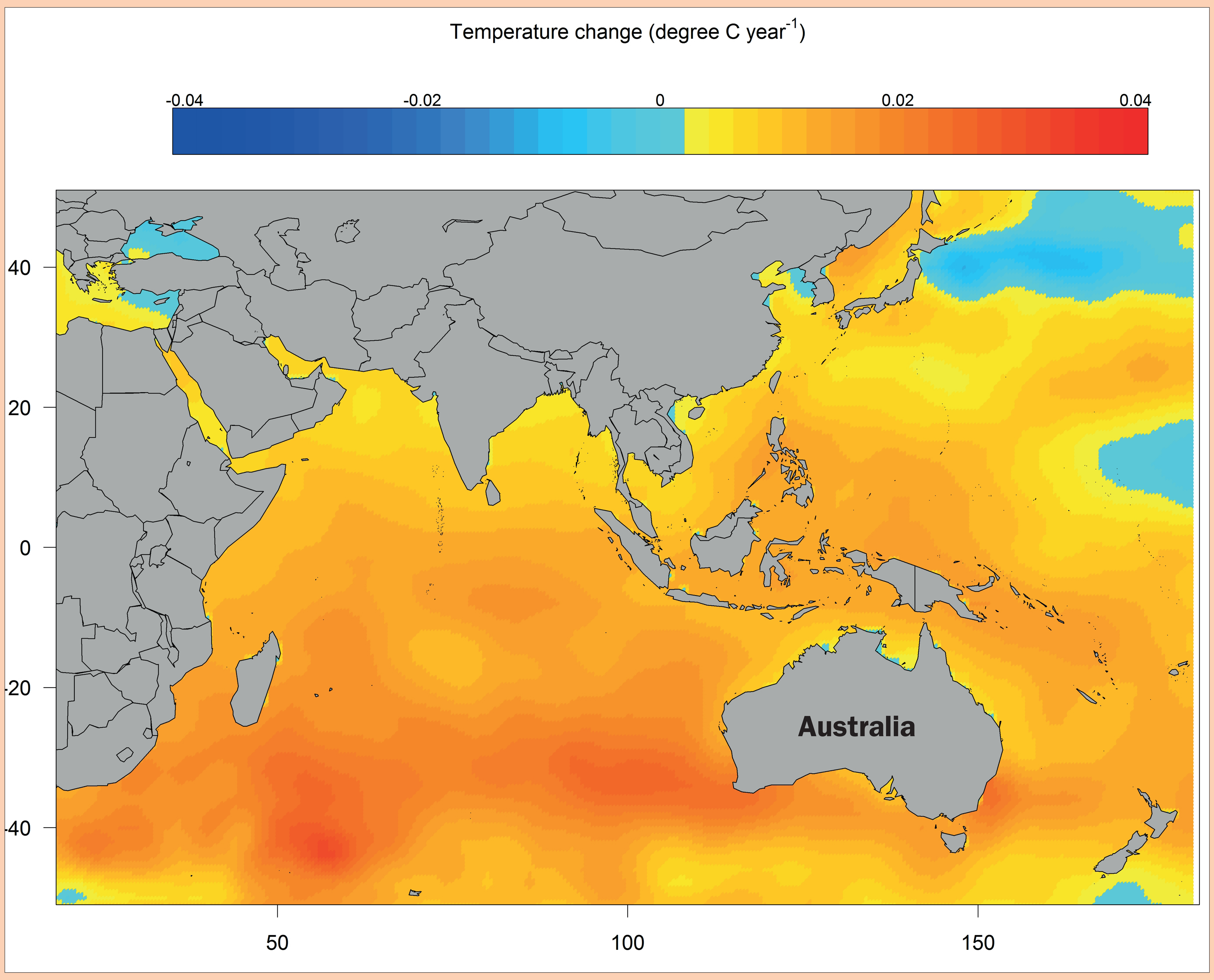

Fig. 1. Annual rate of water temperature (°C) increases in the Indian Ocean during 1950-2014.

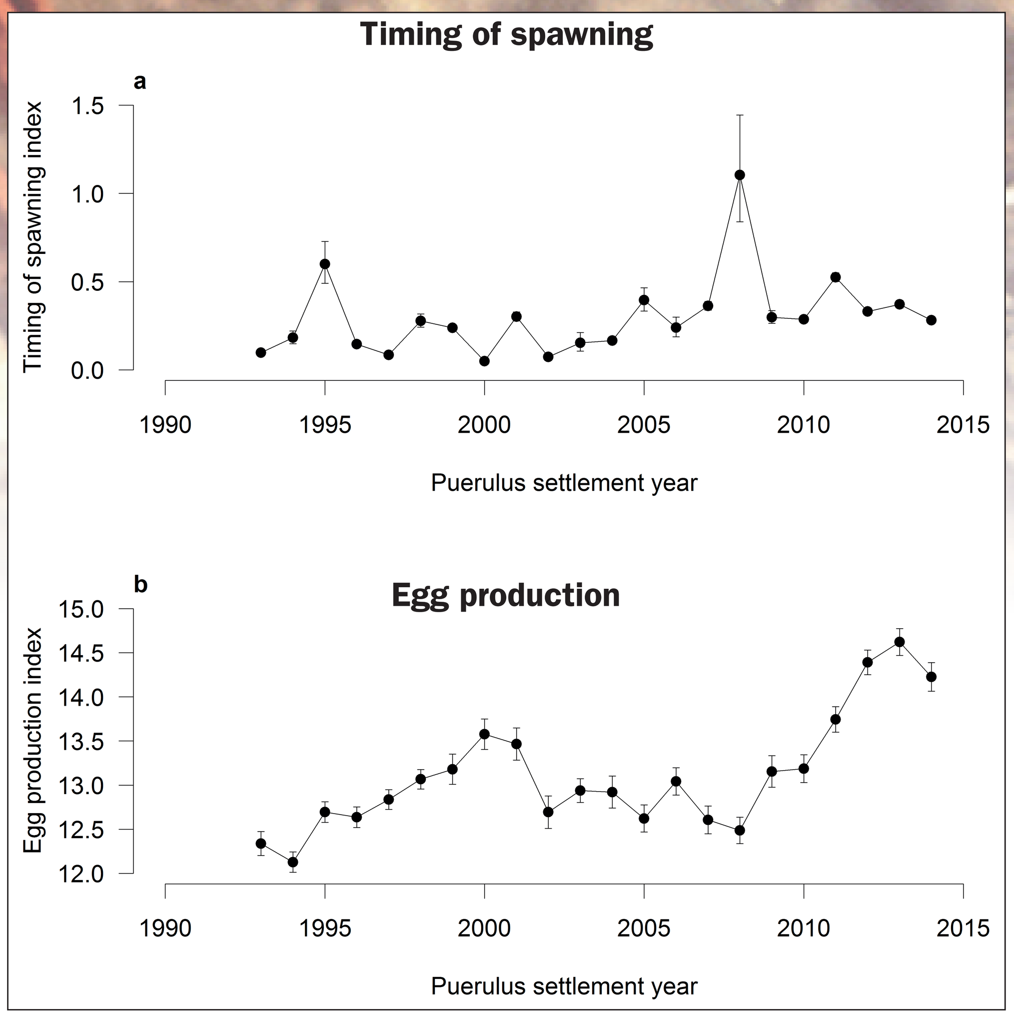

Fig. 3. (a) Standardised mean (and 95% C.L.) timing of spawning between 1992 and 2014. (b) Standardised mean (and 95% C.L.) egg production from a breeding stock survey.

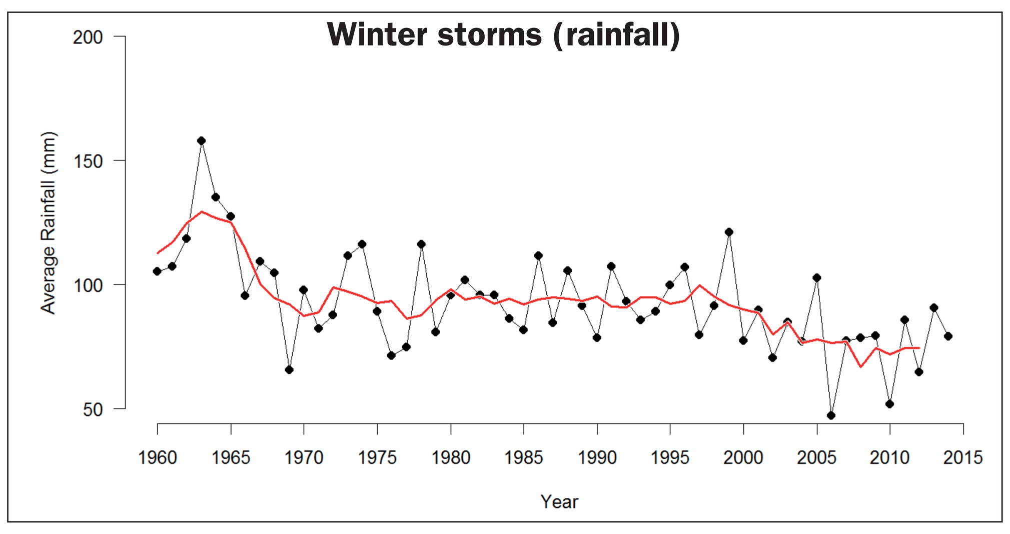

Fig. 4. Time series of coastal May-October rainfall with a 5-year moving average.

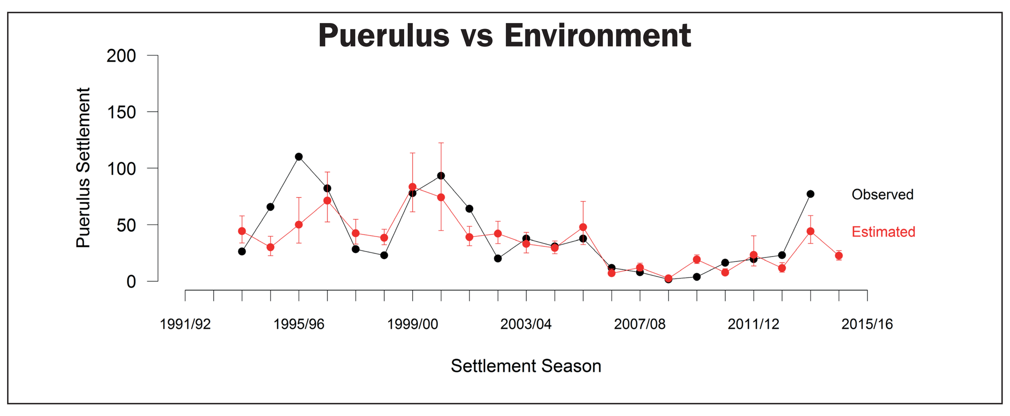

Fig. 5. Observed (black) and estimated ± 1 s.d (red) standardised puerulus settlement between 1993/94 and 2013/14 seasons.

Puerulus settlement

Numbers of puerulus (post-larval stage) rock lobster along the coast has remained well below average for 7 consecutive years (2006/07 to 2012/13) with 2008/09 being the lowest in over 40 years (Fig. 2).

Puerulus abundance is important in the stock assessment and management of the fishery as it is a reliable predictor of commercial lobster catches 3-4 years later. A strong Leeuwin Current during the early larval phase (associated with warm water temperatures) and strong winter/spring storms has historically been associated with above-average numbers. However these factors were not able to explain the recent downturn as low settlement numbers occurred despite a strong Leeuwin Current in 2008 and 2011.

The decline in abundance has been particularly obvious during the early part of their normal settlement season, August-October, which has traditionally been a period of good settlement.

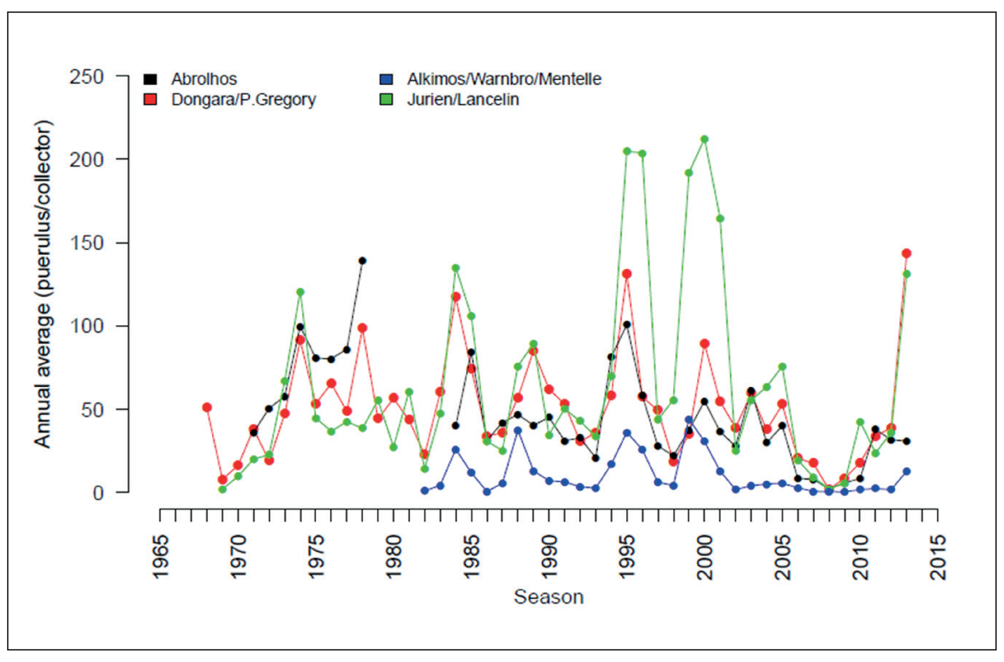

Fig. 2. Puerulus settlement time series from 1968/69 to 2013/14 in four regions; (Dongara/Port Gregory, Abrolhos, Jurien/Lancelin and Alkimos/Warnbro/Mentelle).

Cause of reduced puerulus settlement: match-mismatch

Successful settlement of puerulus appears related to a number of factors, which must all combine for good numbers to settle each year, these include the timing of the adults reproductive cycle, winter storm fronts and offshore water temperatures.

The timing of spawning index increased during the mid-2000s reflecting an earlier start to spawning, reaching its maximum in 2007 (Fig 3a). This 2007 spawning season resulted in the record-low 2008/09 settlement. The majority of years when the timing of spawning was early have occurred since 2004 and are associated with warmer bottom water temperatures at the start of the spawning cycle.

The winter (May-October) rainfall time series showed that the three lowest rainfalls in 50 years have occurred since 2006 (Fig. 4). This decline is part of a long-term trend in the south-west of Australia which is expected to continue.

The optimum puerulus-environment model (spawning time, rainfall and water temperature during the early larval phase) explained 71% of the variation in puerulus settlement, including the recent 7-year decline and the increase in 2013/14 (Fig. 5).

The early spawning combined with the reduced storm activity during the larval phase may have created a mismatch during its 9-11 month larval phase with the peak in food availability and/or larval transport mechanism back to the coast, as per the 'match-mismatch' hypothesis.

Management adaptation

This fishery produced a significant pro-active management adaptation response to the decline in recruitment abundance before these puerulus year-classes grew to legal size and entered the commercial fishery. These responses included a significant reduction in fishing effort (~70%) since 2008/09. This resulted in breeding stock being protected (Fig. 3b) from the effects of heavy fishing on the low recruitment as well as achieving a carry-over of legal lobsters into the poor year-class years. The fishery moved to a catch quota system in 2010 with maximum economic yield as its target which has provided increased resilience for the stock.

This fishery demonstrated the ability of research, management and industry to react quickly to changing abundance and highlights the value of (a) reliable pre-recruit abundance for early detection of changes; (b) environmental time series to assess the cause of the abundance decline; and (c) having a harvest strategy which enabled an early management adaptation response before fishing took place on the poor year classes.

Further reading

de Lestang et al. (2014) What caused seven consecutive years of low puerulus settlement in the western rock lobster fishery of Western Australia? ICES Journal of Marine Science, doi: 10.1093/icesjms/fsu177.

Caputi, N., S. de Lestang; C. Reid; A. Hesp; J. How (2015). Maximum economic yield of the western rock lobster fishery of Western Australia after moving from effort to quota control. Marine Policy 51 452–464. http://dx.doi.org/10.1016/j.marpol.2014.10.006

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