Torres Strait TRL 2015 Pre-season Population Survey – 2016 March Update

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CSIRO Oceans and Atmosphere Flagship

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1. Introduction

The results of the 2015 pre-season survey were presented at the combined TRL RAG & TRLWG meeting on 14 December 2015, to provide stakeholders with the updated stock assessment and the revised recommended biological catch for 2016. This paper provides updates on size/age distribution of the 2015 recruiting (1+) year-class, long-term seabed habitat monitoring and long-term water temperature monitoring with discussions on impacts on the TRL population.

The 2015 pre-season (November) survey of the Torres Strait lobster population was conducted during 16 -28 November 2015 by four CSIRO staff, using the vessel M.V. *James Kirby*. A total of 78 sites (Figure 1) were surveyed by divers and each site was re-located accurately using portable GPS. Measured belt transects (500 m by 4 m) were employed as the primary sampling unit, as they were found to give the greatest precision (p=SE/Mean) of lobster abundance. Transect distance was measured, to the nearest metre using a Chainman® device. At the completion of each transect divers recorded; the number of lobsters caught, the number and age-class of those observed but not caught, depth, visibility, distance swum, numbers of pearlshell (*Pinctada maxima*), crown of thorns starfish and holothurian species observed, and percent covers of standard substratum and biota (including seagrass and algae species) categories. The sampled lobsters were measured (tail width in mm), sexed and moult staged to provide fishery-independent size-frequency data.

Three additional 50 m photo-transects were conducted at eight reef-edge sites (Figure 1) to benchmark coral cover given the anticipated coral bleaching event in April/May 2016. This bleaching event has now eventuated, starting in mid-February, as a result of anomalous high water temperatures. The likely short-term and longer-term impacts on the TRL fishery are discussed below.

2. Results

TRL distribution and abundance

The distributions of recently-settled (0+), recruiting (1+) and fished (2+) lobsters (Figure 2) were similar to those recorded during previous pre-season surveys (eg. Appendices A & B show 2014 & 2015 distributions of 0+ and 1+ lobsters respectively), except recruiting lobsters were significantly more abundant at several of the southern sites. Recently-settled lobsters were observed mainly along the western margin of the fishery, as per previous pre-season surveys. Fished lobsters were rarely observed, as the vast majority of fished lobsters would have emigrated from Torres Strait during August/September.

As the 2015 pre-season survey involved a reduced number of transects (78) from previous surveys (>130), four alternative methods were used to calculate annual indices of abundance between 2005 and 2015. These options are described in Table 1. The resulting indices are shown in Figure 3, which highlights that the long-term trends using data from the mid-year only (74) transects are generally consistent with trends using data for all sites and sub-sets of sites. As discussed previously, this strongly indicates that transitioning to smaller scale pre-season surveys will not interrupt the time series collected to date. Nevertheless, additional industry run surveys would increase precision of the estimates and provide even greater confidence in the estimates of annual recruitment strength. This is highlighted by the increased precision of the abundance indices generated using all sites in comparison to the mid-year only indices (Figure 4).

The 2015 index of recruit abundance was the highest recorded, although not significantly higher than the 2006 and 2014 levels. The high index was mainly due to anomalous levels recorded in the Kircaldie_rubble, South-east and TI_bridge stratums (Figure 5). In contrast, a record low level of abundance was recorded in the large Mabuiag stratum and recruitment was also low in the Buru stratum. The seabed habitat at several transects in these strata had been impacted by the incursion of sand waves, and this observation was corroborated by commercial fishers. Nevertheless, the high overall abundance of recruiting (1+) lobsters suggested that the 2016 stock would again be above average.

The pattern of densities of recently-settled (0+) lobsters amongst stratums (Figure 6) was similar to that observed during all previous years, although density in the Mabuiag stratum was significantly lower than in 2014. Further, the abundance of 0+ lobsters was highest in the Mabuiag stratum in most pre-season surveys. Overall the abundance of 0+ lobsters has been similar during the past four pre-season surveys.

Although all 0+ lobsters observed during the pre-season surveys are recorded it is not known how many are missed due to their small size and cryptic behaviour. Nevertheless, if the percentage of lobsters observed has remained constant throughout the study period, the density indices should be a reliable indicator of relative recruitment strength. As for recruiting lobsters, additional future industry-run surveys could provide greater certainty about strength of the 0+ year-classes, and even earlier forecasting of stock size and TAC.

The low abundance of both 0+ and 1+ lobsters in the northern strata is of concern for the local fishers, and particularly if the cause of the low abundance persists. As the Mabuiag stratum has been a key habitat for recently-settled lobsters in the past, future recruitment and stock would be impacted by persistent poor habitat. However, sand incursions have caused habitat destruction, seagrass die backs and reduced lobster abundance in the past and it is hoped that the impacts are transient.

The current coral bleaching event may also impact on the seabed habitats in western Torres Strait, particularly the reef-edge communities. The possible flow on impacts of this event are discussed briefly below.

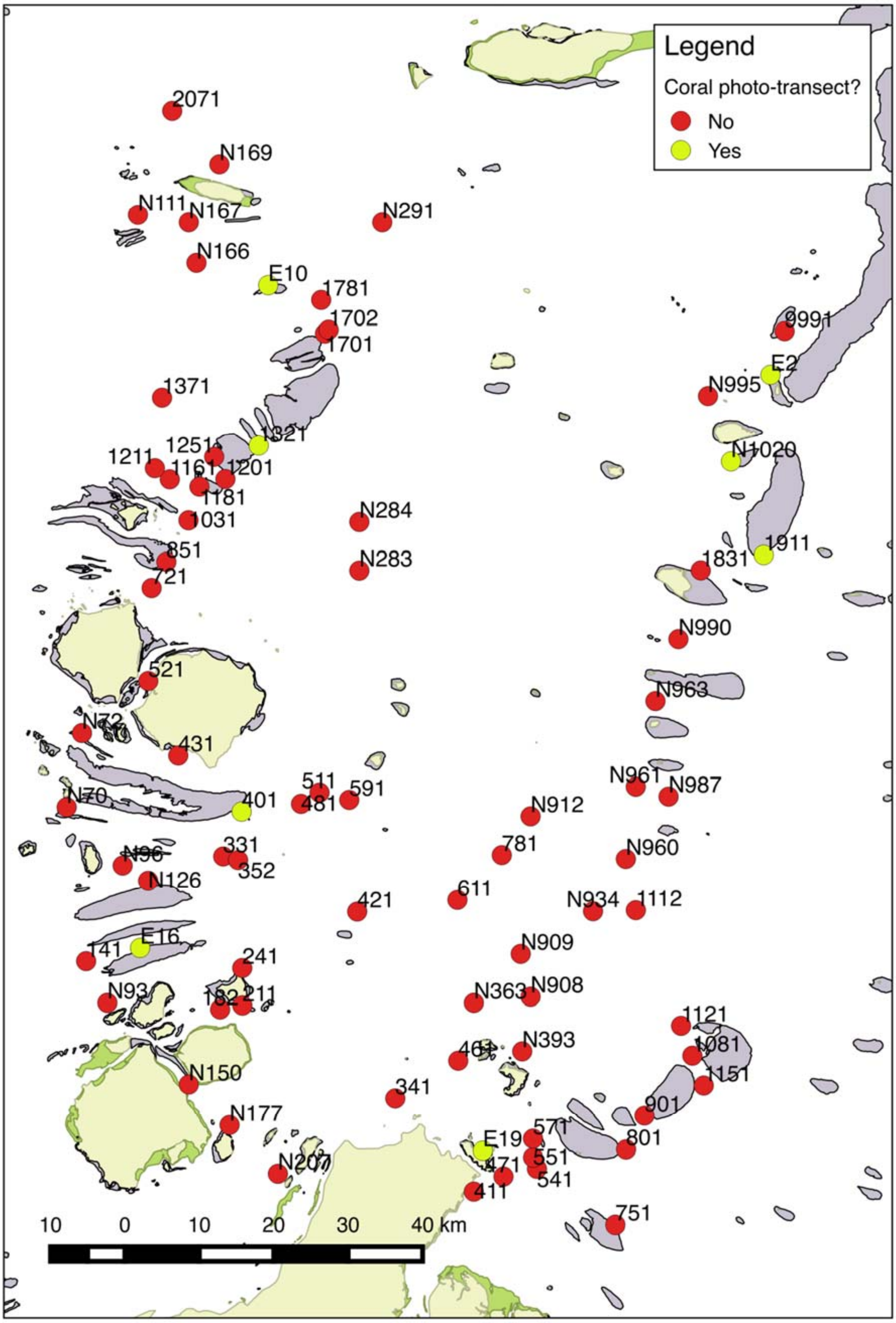

Figure 1. Map of western Torres Strait showing sites surveyed during the 2015 TRL pre-season population survey. Additional coral monitoring transects were conducted at sites marked yellow.

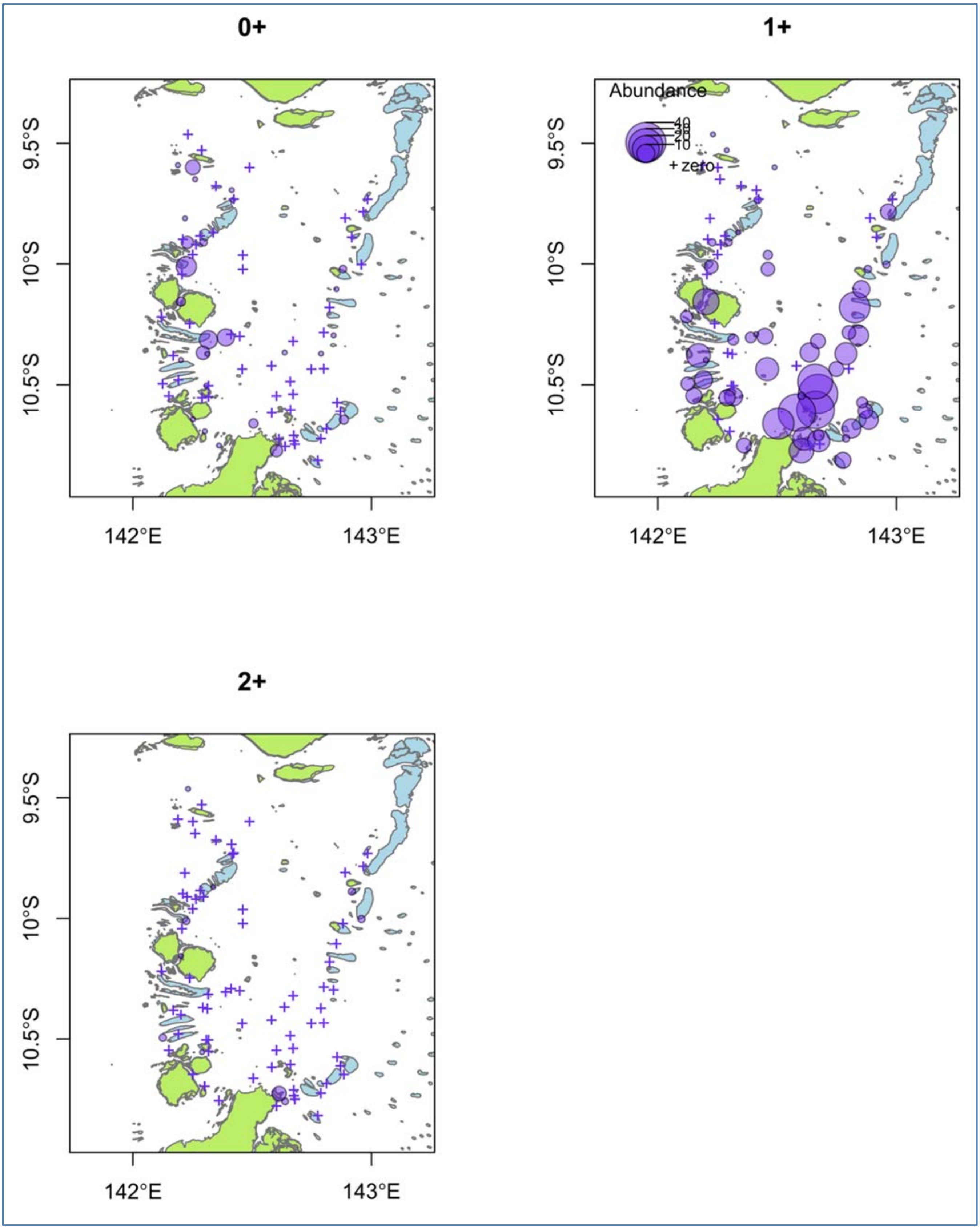

Figure 2. Density of recently-settled (0+), recruiting (1+) and fished (2+) ornate rock lobsters (*Panulirus ornatus*) recorded during the 2015 pre-season population survey in western Torres Strait.

Table 1. Description of the four options used to estimate ornate rock lobster (*Panulirus ornatus*) abundance indices from pre-season population surveys conducted in Torres Strait between 2005 and 2015.

Pre-season Index Option	Number of Strata	Description
1a. ALL SITES	7	All transects for all years utilised
1b. ALL SITES excluding Buru	6	All transects for all years utilised, excluding those from the Buru stratum
2a. MID_YEAR ONLY SITES	7	All mid-year transects (74) utilised
2b. MID_YEAR ONLY SITES- common across all years	6	All common transects utilised; equal number in each year

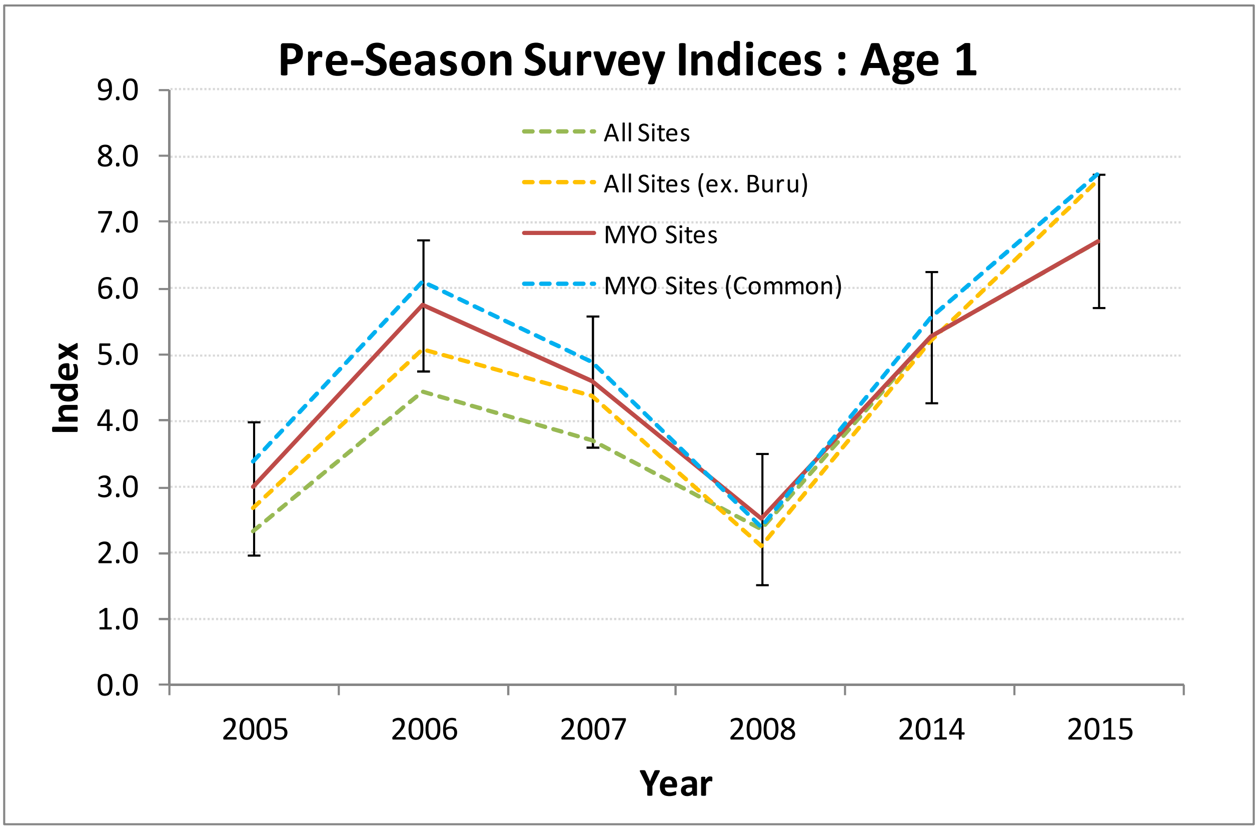

Figure 3. Four comparative indices of abundance of recruiting (1+) ornate rock lobsters (*Panulirus ornatus*) recorded during pre-season surveys in Torres Strait between 2005 and 2015 (note surveys were not done during 2009-2013). Error bars of MYO indices represent standard errors.

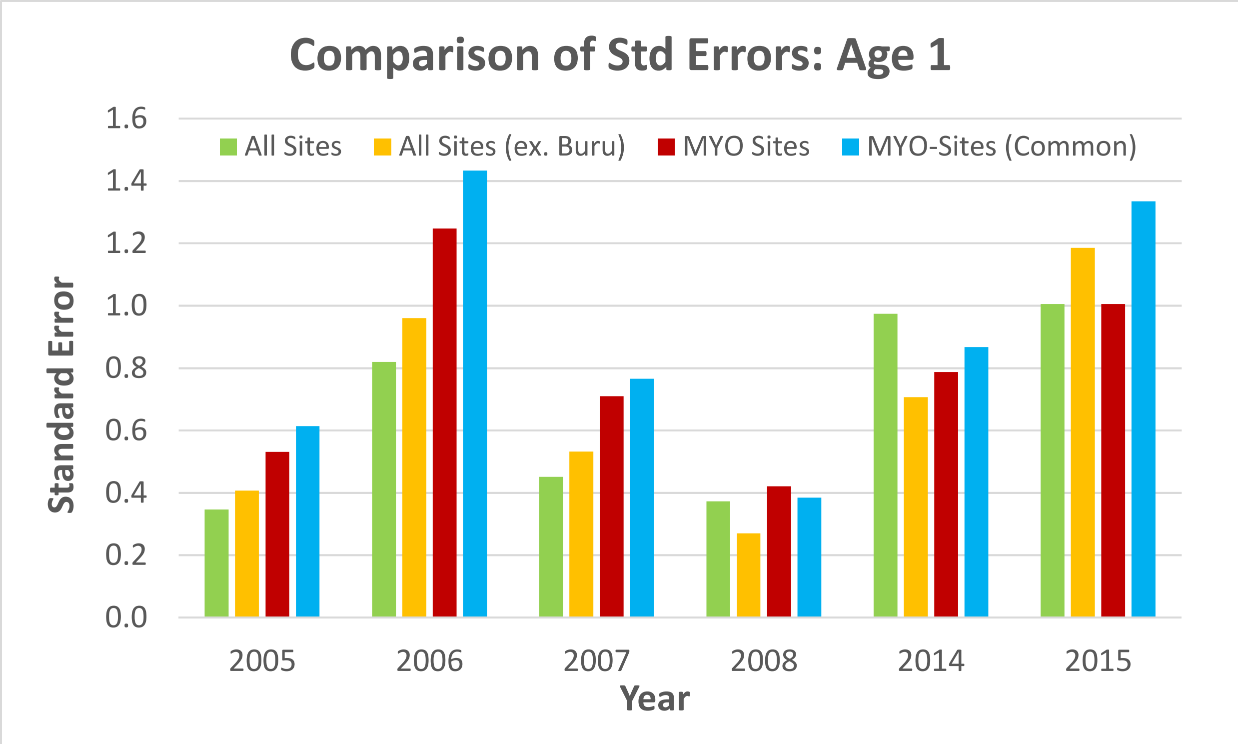

Figure 4. Comparative standard errors for four indices of abundance of recruiting (1+) ornate rock lobsters (*Panulirus ornatus*) recorded during pre-season surveys in Torres Strait between 2005 and 2015 (note surveys were not done during 2009-2013).

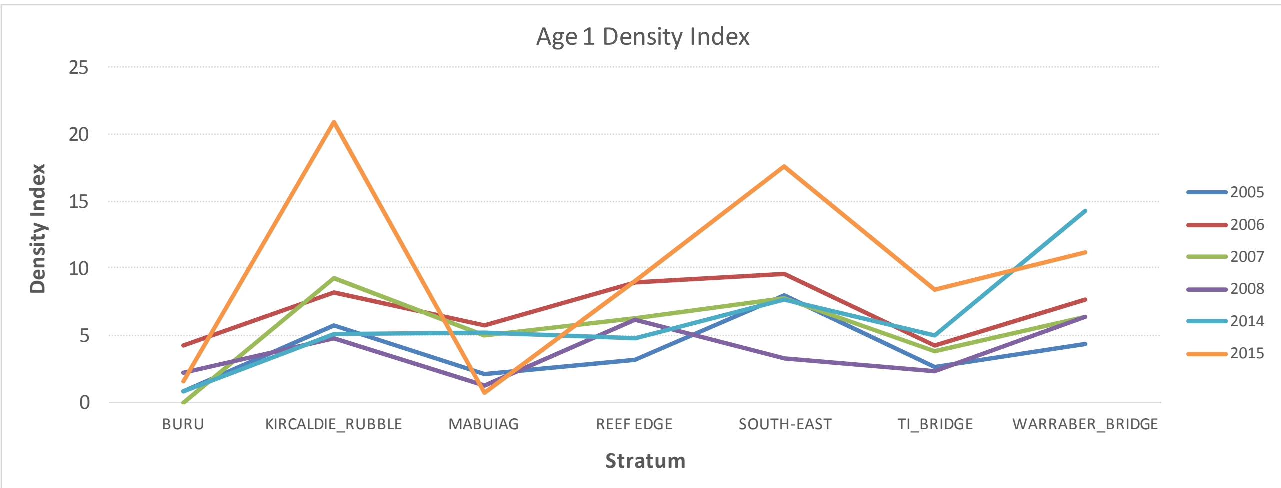

Figure 5. Comparative indices of abundance of recruiting (1+) ornate rock lobsters (*Panulirus ornatus*) recorded in each sampling stratum during pre-season surveys in Torres Strait between 2005 and 2015 (note surveys were not done during 2009-2013).

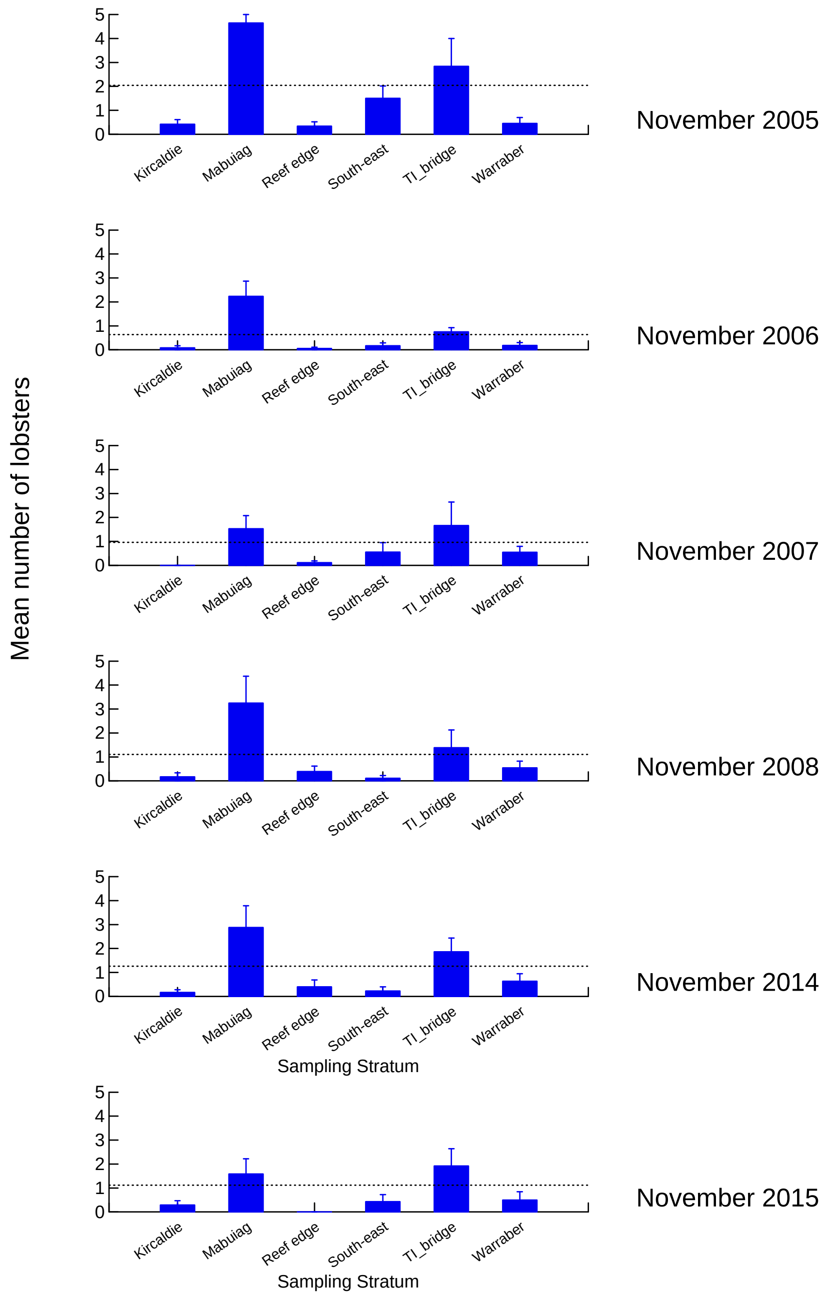

Figure 6. Density of recently-settled (0+) ornate rock lobsters (*Panulirus ornatus*) recorded during pre-season population surveys in western Torres Strait between 2005 and 2015 (note surveys were not done during 2009-2013). Dashed lines indicate overall density of 0+ lobsters.

Comparisons of abundance indices

As the fishery transitions to a QMS it is important to monitor the effectiveness of new population survey protocols in continuing the 27 year stock status time series established since 1989.

The relationship between recruiting (1+) lobster indices recorded from mid-year and pre-season surveys in the same years is shown in Figure 7. Although comparisons are only available for five years it is not surprising that the relationship is highly significant (R^2=0.97), given that the surveys were conducted only four months apart (June and November). Nevertheless, it is important that this relationship is maintained as management moves to a QMS reliant on indices from a pre-season population survey only.

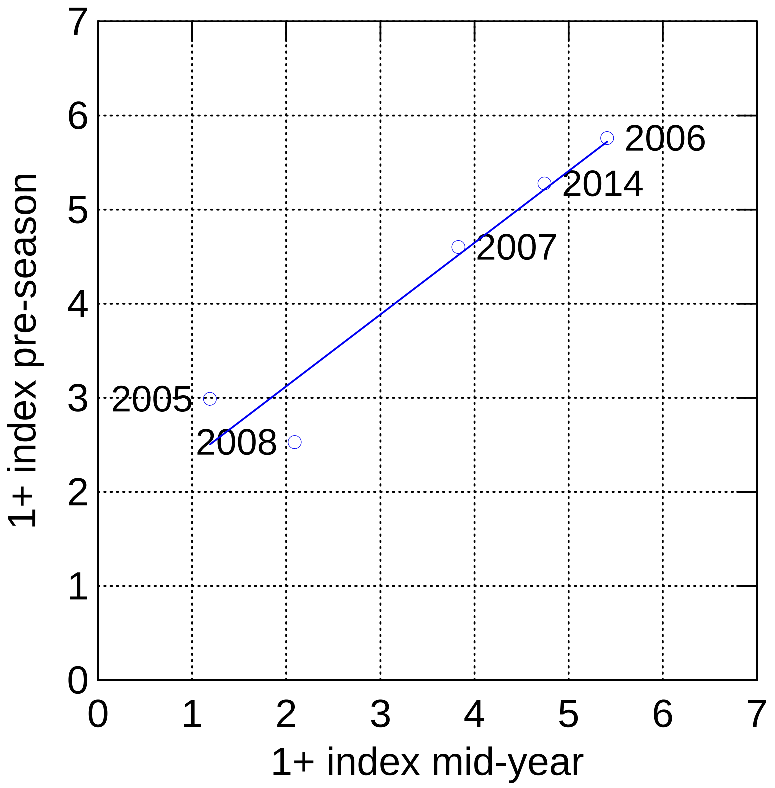

Figure 7. Relationship between recruiting (1+) lobster abundances indices recorded from mid-year and pre-season surveys for years 2005-2008 and 2014. Line denotes the linear regression (R^2=0.97).

The phasing out of mid-year surveys, in favour of pre-season surveys conducted closer to the fishing season opening has meant that no fishery-independent index of fished (2+) lobster abundance will be available. However, the availability of comprehensive TVH catch and effort data since 1994 has allowed comparison of the survey and CPUE indices in the same years (Figure 8). The relationship between these indices is highly significant (p=0.000) providing confidence that for future stock assessments the CPUE data will be a reliable proxy for 2+ and subsequently breeding stock abundance. Further, the recent data (>2010) has provided a range of stock sizes (most notably 2011) and the long-term significant relationship holds.

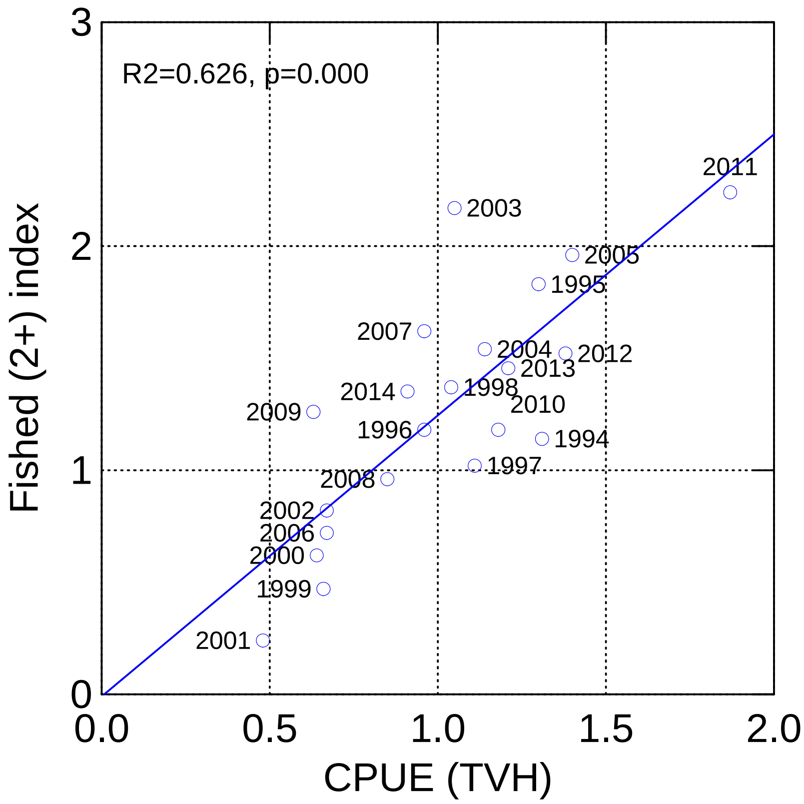

Figure 8. Relationship between CPUE indices for the TVH sector and fished (2+) indices recorded from mid-year surveys for years 1994 to 2014. Line denotes the linear regression (R^2=0.626).

Size/Age Distribution of Sampled Lobsters

The size distribution of lobsters sampled during the 2015 pre-season survey was similar to those recorded in previous years (Figure 9), except there was a decrease in the percent composition of legal-size lobsters. The modal size of recruiting (1+) lobsters recorded in 2015 was low and comparable to 2007 and 2014 levels.

Long-term Torres Strait Seabed Habitat Monitoring

The trends in percent cover of seabed substrates recorded during mid-year population surveys between 1994 and 2014 showed a relatively consistent composition of sand/mud (Mean 56 %), declining composition of rubble (Mean 13%) and an increasing composition of hard substrate which includes consolidated rubble and limestone pavement (Mean 29 %, Figure 10). Seagrass cover increased steadily during 2000 to 2010, and has remained above the long-term average since then Interestingly algal cover showed a steady decline throughout the period studied from ~20% to ~10%.

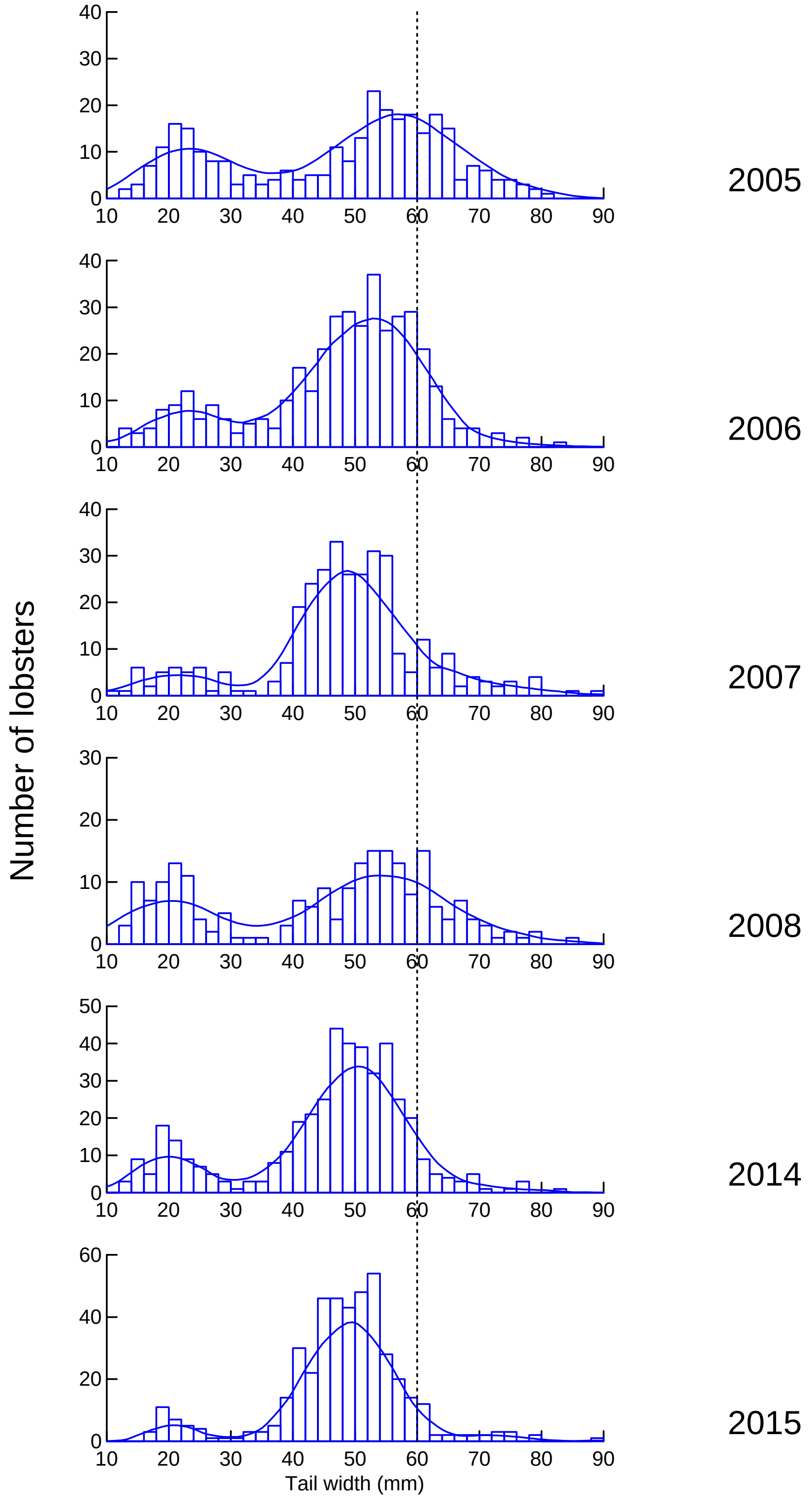

Figure 9. Length frequency distributions of lobsters (*Panulirus ornatus*) sampled during pre-season population surveys in Torres Strait in 2005-2008, 2014 and 2015. The dotted line represents the minimum legal size (90 mm CL ≈ 60 mm tail width).

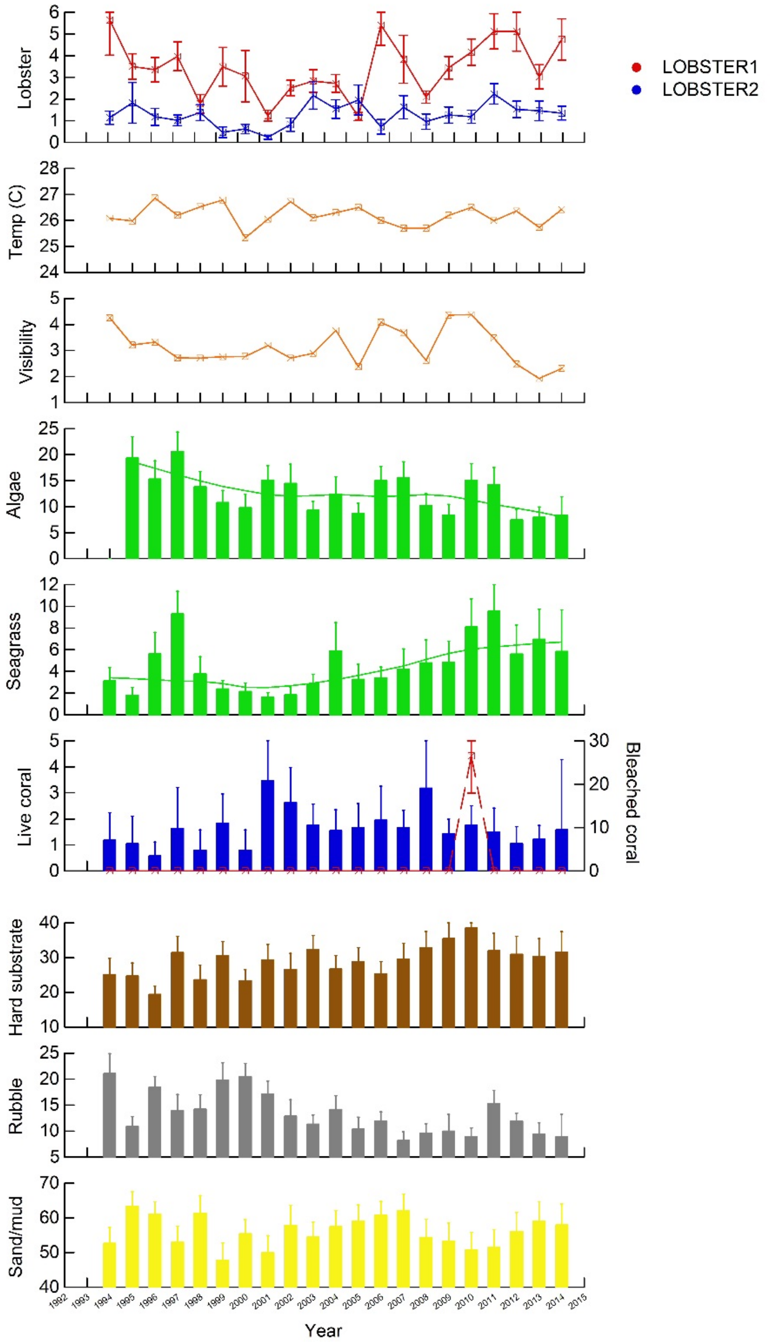

Figure 10. Mean percent covers of abiotic and biotic categories and lobster (*Panulirus ornatus*) indices recorded during mid-year population surveys in Torres Strait during 1994 to 2014. Error bars represent standard errors.

Although sand incursions were recorded at a numbers of transects during the 2015 pre-season population survey, the overall cover of sand at repeated sites was the lowest recorded (Figure 11). Further, the distribution of seabed substratums recorded in 2014 and 2015 wase similar with no clear evidence of regional incursions of sand (Appendix C). Nevertheless, sand wave movements in Torres Strait have been rapid and continual to date and seabed communities are well adapted to these incursions in any case. Further, seagrass and algal cover estimates were above the long-term average suggesting any sand incursions had not impacted the floral communities at the transects surveyed.

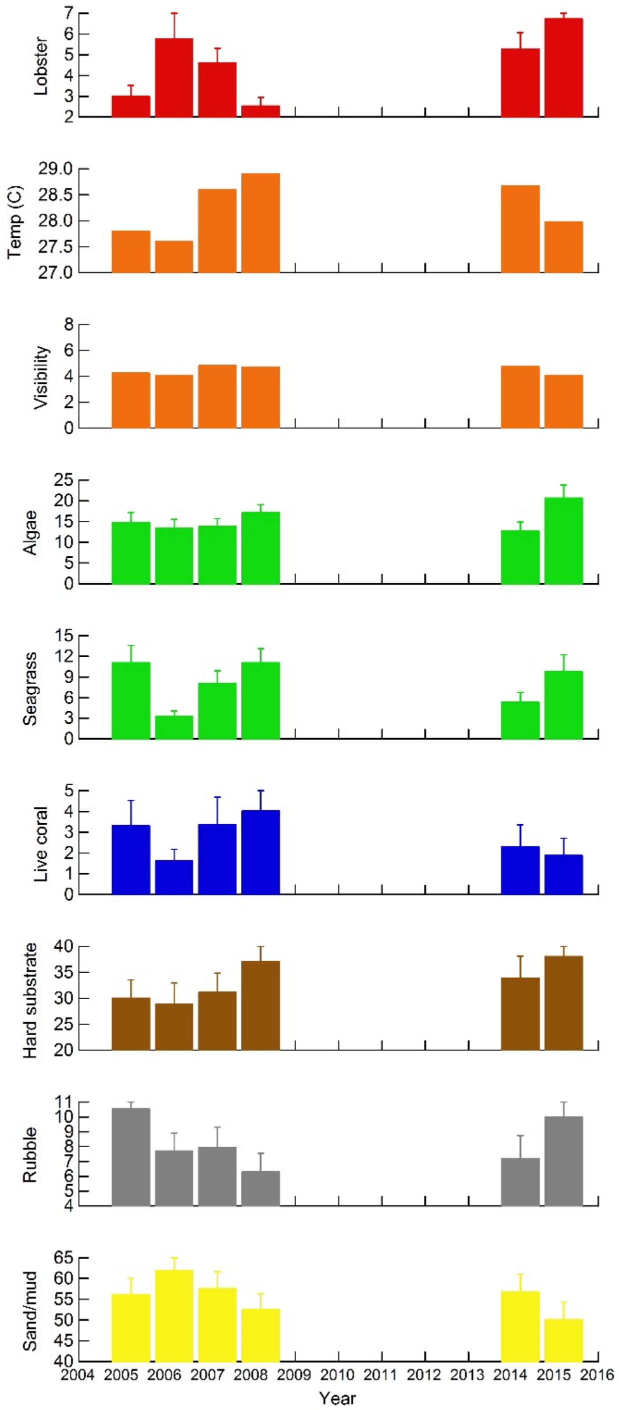

Figure 11. Mean percent covers of abiotic and biotic categories and lobster (*Panulirus ornatus*) indices recorded during pre-season surveys in Torres Strait during 2005 to 2015. Error bars represent standard errors.

Long-term Torres Strait Water Temperature Patterns

Whilst there has been considerable research on the impacts of changing climate on Australia's temperate lobster fisheries, for example the effects of warmer water temperature on western rock lobster (*Panulirus cygnus*) recruitment (de Lestang et al. 2014), little is known of the impacts on tropical lobsters. Projected climate conditions to 2030 suggest that whilst higher temperatures may increase egg production and growth of TRL, juvenile mortality will likely increase (Norman-Lopez et al. 2013). The perceived impacts are largely speculative due to the consistency of the recent climate, and hence the lack of range in impacting variables such as water temperature, sea level rise, ocean currents and rainfall. However, as per the recent dramatic decline in recruitment of *P. cygnus*, and reduced catch, changing conditions can be significant and provide valuable evidence for forecasting likely impacts on populations and catch.

The Southern Oscillation Index (SOI) has declined recently to a 10 year low in 2016 (Figure 12), continuing El Nino conditions throughout eastern Australia. As a result there was a high likelihood that eastern Australia would see above average sea temperatures, and this has occurred throughout northern Australia.

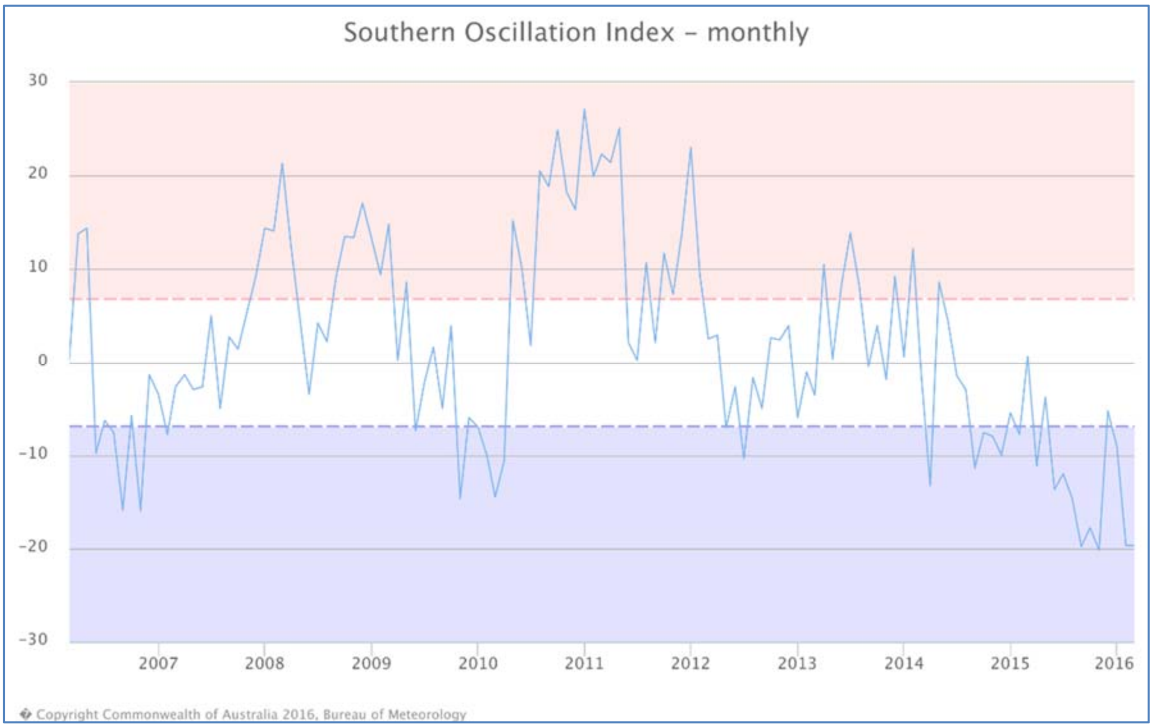

Figure 12. SOI indices recorded during 2006 to 2016; source Bureau of Meteorology.

Water temperature recorded at Thursday Island during 2012 to 2016 was generally consistent with the long-term trend (Figure 13) but since mid-February 2016 there has been a significant increase with temperatures well above average. The impacts of elevated water temperature have been exacerbated by reduced wind strength over the same period (Figure 14), which causes still conditions particularly in shallow water.

As a result of these conditions there have been reports of coral bleaching around Thursday Island, and it is likely that corals throughout western Torres Strait will be affected, as they were during the

2010 bleaching event (Appendix C). However, the impacts on the full range of key lobster habitats are less obvious.

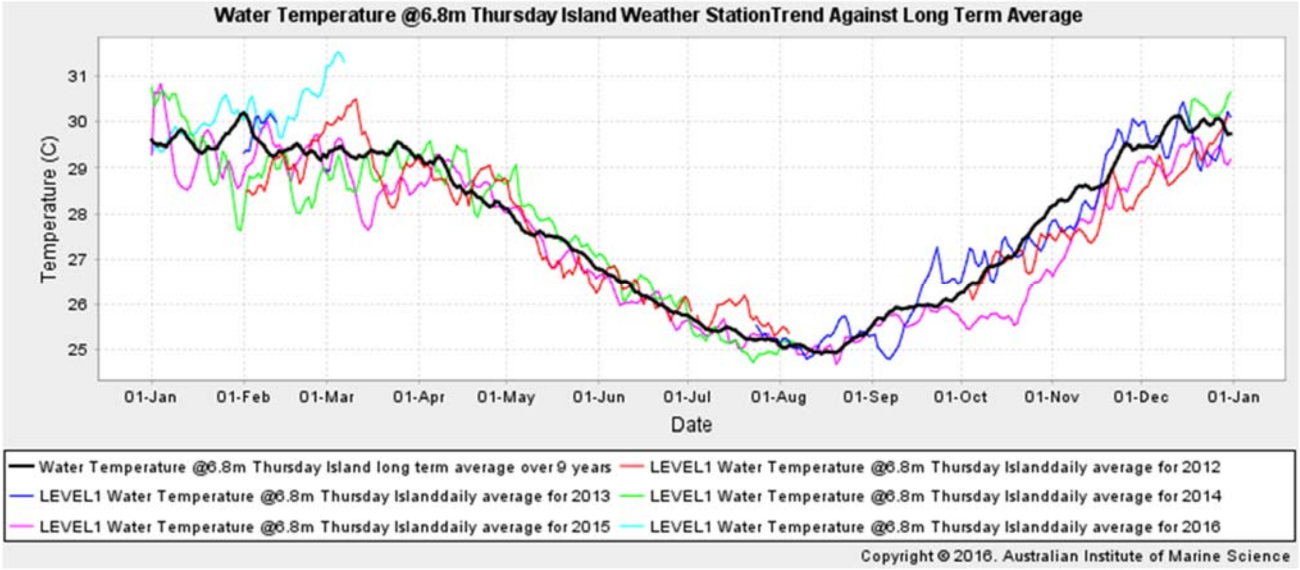

Figure 13. Water temperature recorded at 6.8m depth at Thursday Island during 2012 to 2016, against the long-term average. Source: AIMS/NERP. The black line represents the long-term average.

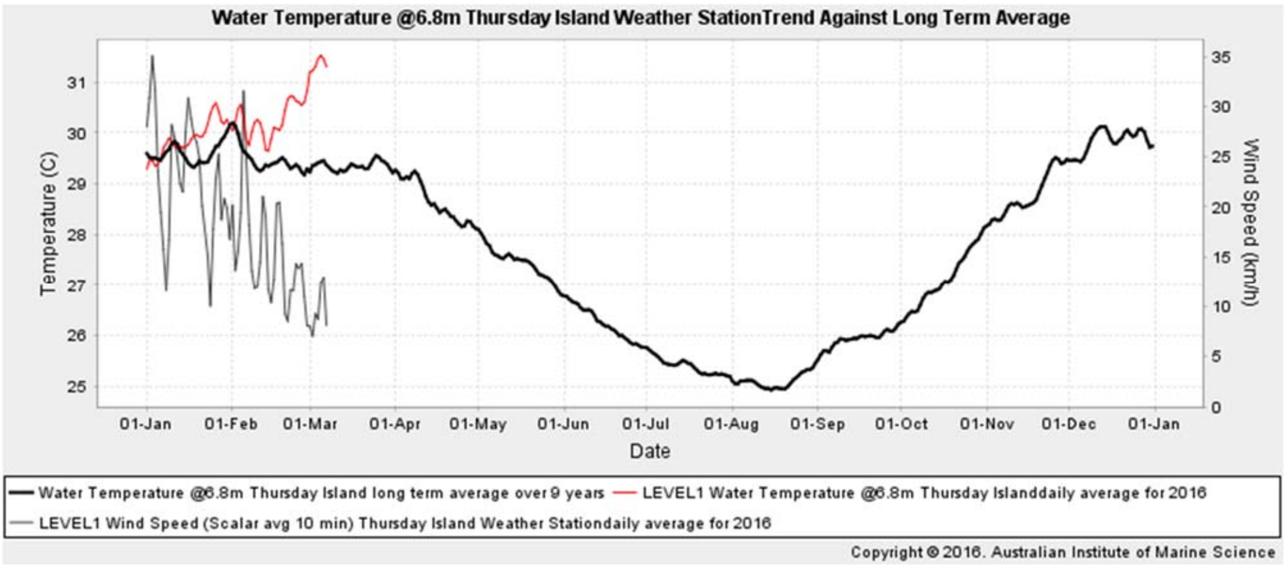

Figure 14. Water temperature and wind speed recorded at Thursday Island during 2016 against the long-term average. Source: AIMS/NERP.

As noted above, the long-term trends in water temperature in Torres Strait have been remarkably consistent with the exception of the spike observed in March 2010 (Figure 15), which resulted in the widespread coral bleaching. Fortunately, in 2010 water temperature returned to the normal seasonal cycle shortly after this spike and there was some evidence that there was minimal impact on the TRL population in that 2011 saw record catches and catch rates.

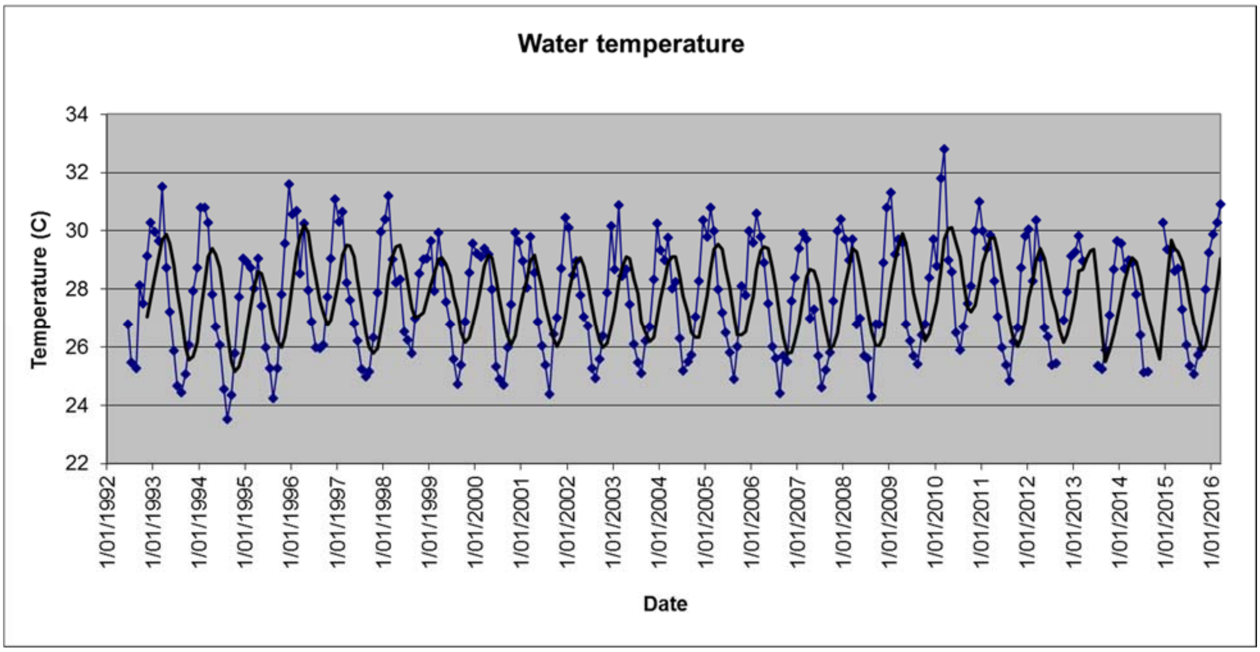

Figure 15. Water temperature recorded at Thursday Island during 1992 to 2016 from combined sources; CSIRO loggers 1992-2011, AIMS/NERP weather station 2012-2016.

Impact of elevated water temperature on held and wild lobsters

The impact of elevated water temperature on lobsters held in sea cages was clearly evident in early 2011 when high mortalities were recorded in Torres Strait, and subsequently at holding facilities. The impact was exacerbated by the high stocking densities in that year as a result of abundance well above average (eg. total Australian catch was 700 t). Notably in the previous year, when higher temperatures were recorded but catch rates were much lower (460 t), high mortality rates were not recorded in sea cages. The primary impact of elevated temperature on lobsters is the reduction in dissolved oxygen and the subsequent physiological effect on lobsters resulting in weakness and death (Paterson et al. 1997). These impacts can be ameliorated to some extent by increasing water flow, but invariably this is simply not possible and in any case high stocking densities result in increased dead space in tanks.

Ironically higher water temperatures are generally conducive for high growth rates in lobsters (Jones et al. 2001), and hence the 2016 year-class would be expected to grow faster than previous cohorts in the wild. This effect is obviously countered by density-dependent effects (for example competition for food) for years like 2016 when lobster abundance is above average. Nevertheless, given that recent high stocking density combined with high water temperature has resulted in significant mortality there is a case for reducing current fishing effort and accessing these lobsters later in the season when water temperatures are lower. This occurred to some extent in 2011 and resulted in high sustained catch rates throughout the fishing season. Further, it is possible that there may be a productivity bloom as a result of sustained high temperatures for seabed habitats including seagrass meadows and mussel beds, which may further enhance growth and survival of lobsters.

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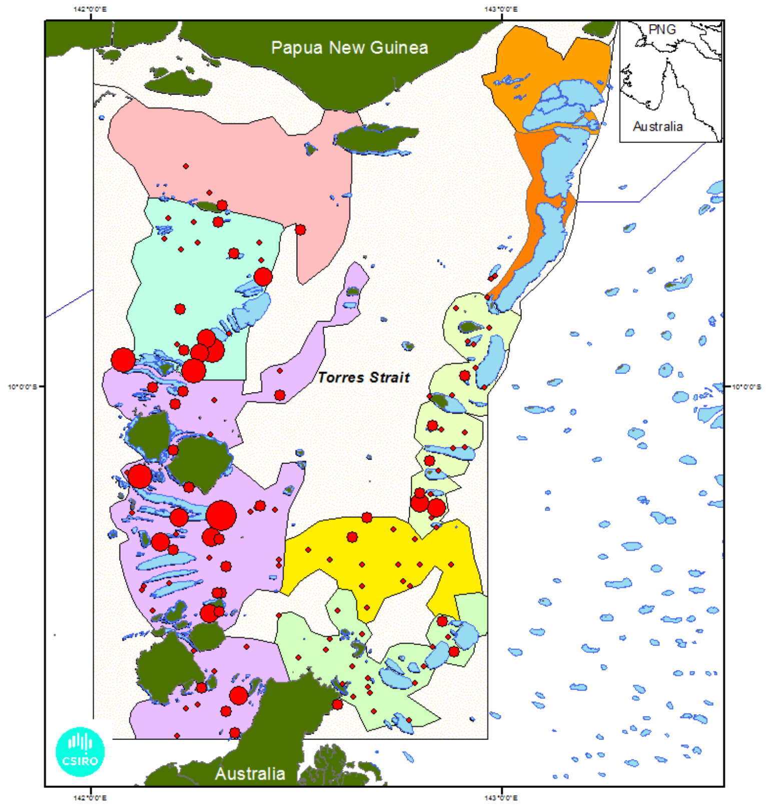
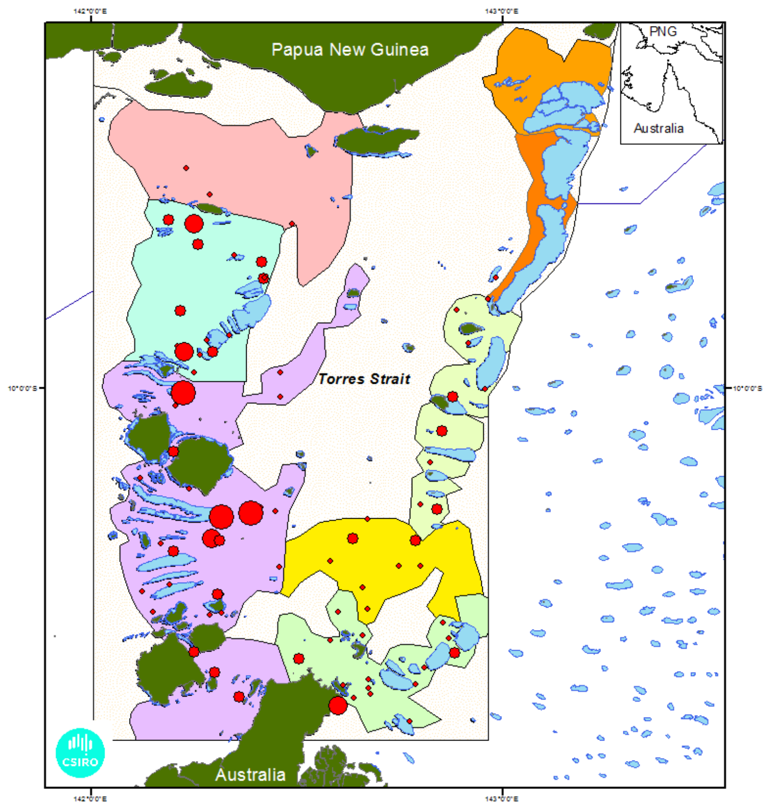
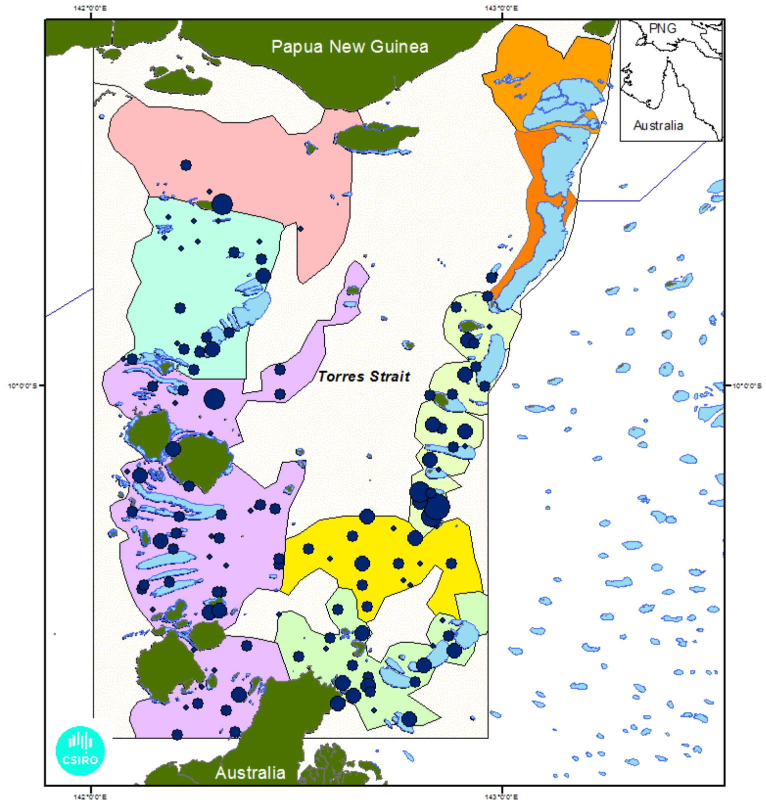
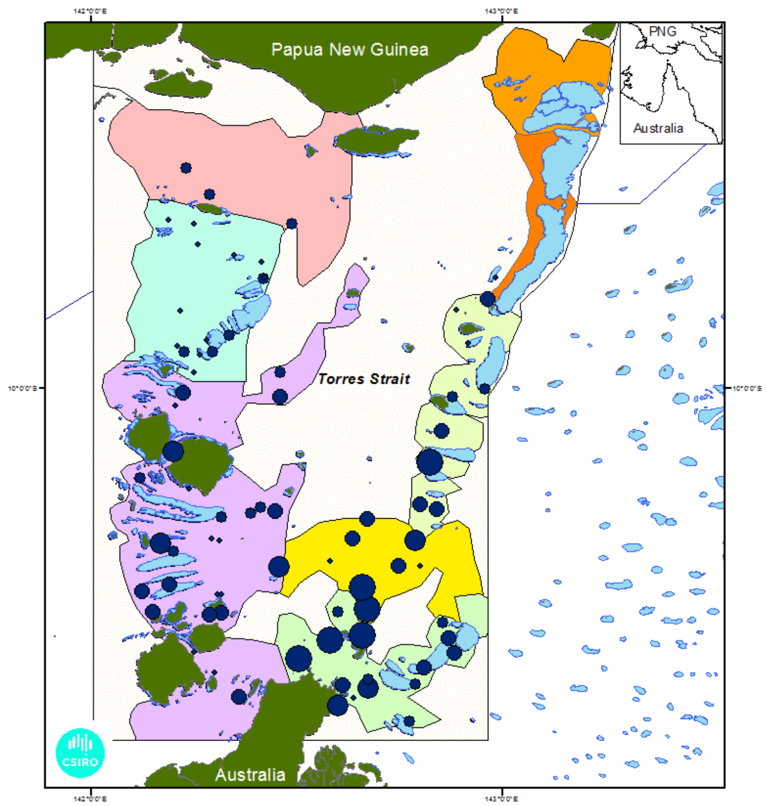
Appendix A. Density of recently-settled (0+) ornate rock lobsters (*Panulirus ornatus*) recorded during the 2014 (top pane) and 2015 (bottom pane) pre-season population surveys in western Torres Strait.



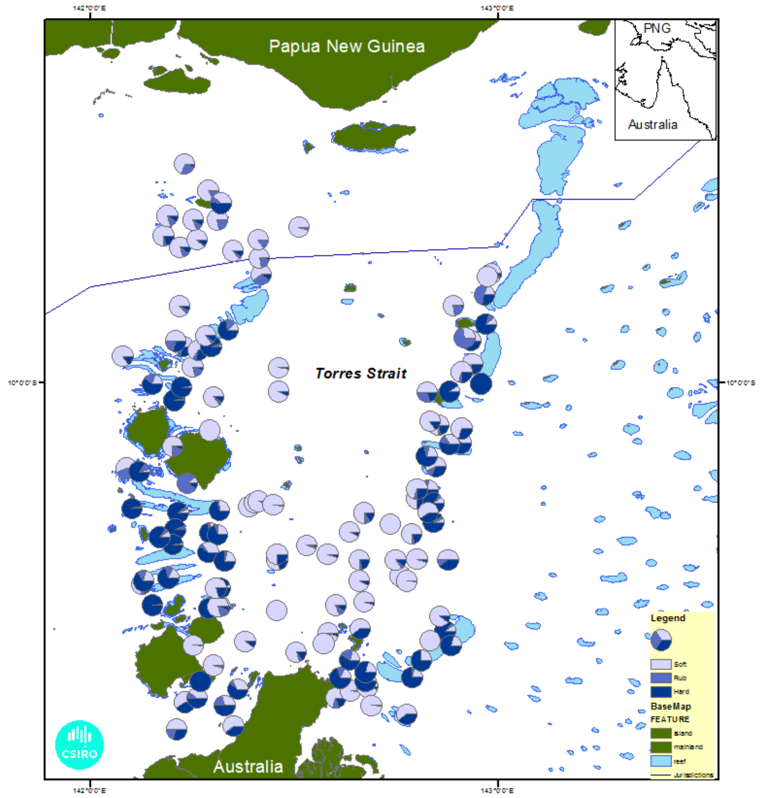


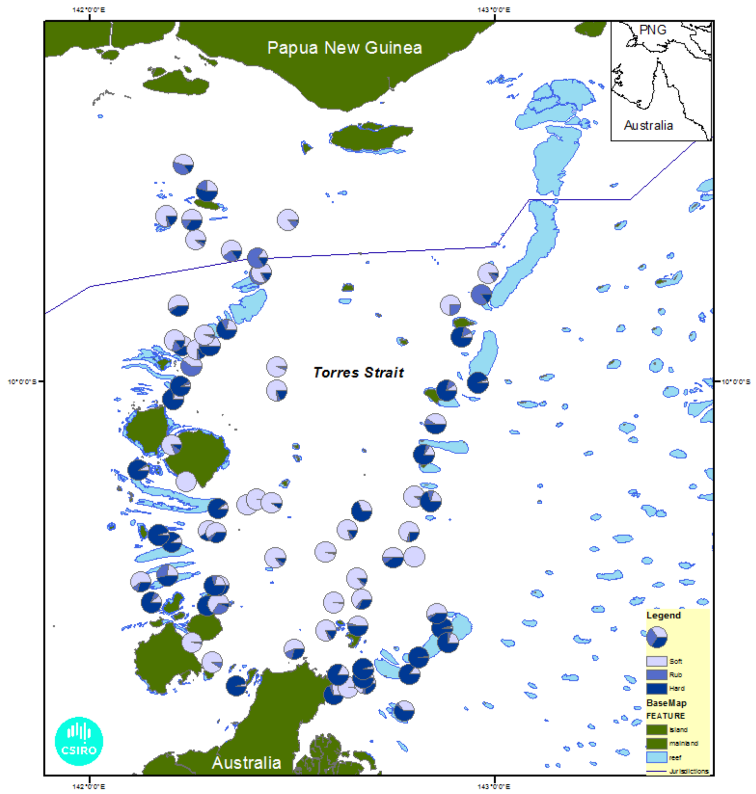
Appendix B. Density of recruiting (1+) ornate rock lobsters (*Panulirus ornatus*) recorded during the 2014 (top pane) and 2015 (bottom pane) pre-season population surveys in western Torres Strait.





Appendix C. Distribution of seabed substratums recorded during the 2014 (top pane) and 2015 (bottom pane) pre-season population surveys in western Torres Strait.





Appendix D. Percent coral cover bleached recorded during the 2010 mid-year lobster (*Panulirus ornatus*) population survey in western Torres Strait.