Isolation of oceanic and coastal populations of the harvested mother-of-pearl shell *Tectus niloticus* in the Kimberley

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WAMSI Kimberley Marine Research Program

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Front cover images (L-R)

Image 1: Satellite image of the Kimberley coastline (Image: Landgate)

Image 2: Small biopsy samples were taken non-lethally from the foot of trochus (Tectus niloticus) during fieldwork in the Kimberley and on offshore atolls. (Image: Zoe Richards, Curtin University)

Image 3: Humpback whale breaching (Image: Pam Osborn)

Image 4: Trochus (Tectus niloticus) is a harvested mollusc that is abundant on some intertidal reefs in the Kimberley, and throughout the Indo-Pacific. (Image: Zoe Richards, Curtin University)
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Executive Summary

This report focuses on “trochus” or “mother of pearl shell” *Tectus niloticus*, which is a large harvested gastropod mollusc common on intertidal reefs in the Kimberley and the wider Indo-Pacific. This species was selected as a model for a study of connectivity in molluscs because it has a short larval life-history (3-5 days), which is typical of species whose recruitment is primarily local and they are prone to over-harvest. Over-harvest of *T. niloticus* has been documented throughout its range, and it’s been argued that placement of reserves adjacent to harvested regions would be an effective way to sustain the species. However, the unique complexity and power of the Kimberley hydrodynamic environment potentially enlarges the scale of recruitment and/or creates spatially complex dynamics that may be relevant to harvest management in the region.

*T. niloticus* is also unusual because it is present on both coastal Kimberley reefs and oceanic atolls at the edge of the Australian continental shelf margin. Oceanic and coastal reefs have profoundly different faunal diversity, and biogeographers have speculated on whether this can be attributed to their pronounced environmental differences or to hydrodynamic isolation. However, the scarcity of species common to both environments has meant that this hypotheses remains untested. Oceanic populations are also harvested by Indonesian artisanal fishers, and there is a need to understand how oceanic reefs depend on recruitment and genetic variation from reefs elsewhere.

Samples from 514 *T. niloticus* individuals were collected from 16 “coastal” sites in the Dampier Peninsular and Buccaneer Archipelago as well as the “oceanic” sites the Rowley Shoals and Scott Reef. We employed a genotype-by-sequencing approach to characterise genetic diversity within and between these sampling sites. Custom bioinformatics pipelines were developed to analyse this large dataset. After quality control filtering, 5,428 single nucleotide polymorphisms (SNPS) were available for analysis.

Insights into broad-scale genetic structure between coastal and oceanic sites

Significant genetic sub-division was evident between the oceanic sites (the Rowley Shoals and Scott Reef) and the coastal sites (distances c. 500 and 300 km respectively). Significant genetic sub-division was also evident between the two oceanic sites (distance c. 400km), but it was approximately 25% of the magnitude of the oceanic – coastal sites comparison. Evidence for significant adaptive genetic differences between the coastal and oceanic sites was indicated by the presence of a sub-set of highly divergent “outlier” genetic loci.

This means that oceanic *T. niloticus* populations are genetically and demographically independent from coastal populations and from each other. The closer affinity of oceanic populations to each other than to coastal populations reflects irregular connectivity on evolutionary timescales under the influence of the Indonesian Flow-Through and derivative currents. Different environmental conditions on oceanic and coastal reefs are also driving adaptive divergence between *T. niloticus* populations.

Insights into fine-scale genetic structure within the coastal Kimberley

Negligible genetic sub-division was evident among the Dampier Peninsular-Buccaneer Archipelago coastal sites (distances ≤ 75km), and what sub-division was recorded could not be attributed to geographic distance nor modelled oceanographic connectivity.

*T. niloticus* inhabiting reefs on the Dampier Peninsular and Buccaneer Archipelago form a single highly-mixed genetic unit, and are highly demographically inter-dependent. This is likely due to their high and continuous reproductive output in combination with the extreme hydrodynamic mixing experienced in the region.
Implications for management at a broad-scale

Management of *T. niloticus* at the Rowley Shoals, Scott Reef, and other oceanic shoals should treat each as being effectively isolated on the ecological timeframes relevant to harvest management. Recruitment from outside will not replenish over-harvested stocks even within tens of years. Occasional recruits will be drawn from other offshore shoals, and possibly Indonesia, and will contribute genetic diversity rather than offsetting over-harvest. Potential supplementation of populations should recognise that coastal *T. niloticus* populations may be mal-adapted to oceanic conditions.

Implications for management at a fine-scale

Management of *T. niloticus* on the Dampier Peninsular and Buccaneer Archipelago should treat the region as being effectively a single stock on the ecological timeframes relevant to harvest management. Over-harvested sites within this region will be replenished with recruits from neighbouring sites within years, assuming they exist, and allowing for the slow growth of the species.

Residual knowledge gaps

This investigation had a limited spatial scope in comparison to the broad Indo-Pacific range of *T. niloticus*, capturing the south-westernmost part of its range. Indeed, even within the Kimberley region, the region of high density in the Buccaneer Archipelago is disjunct from other high density populations in Australia, Indonesia and on offshore atolls. The broad distribution of *T. niloticus* in the tropical Indo-Pacific incorporating a diversity of reef types and hydrodynamic conditions means that it is unlikely that the spatial scale of genetic structure will be reflected throughout its range. Considering the economic and cultural significance of the species to many people, a broader investigation of population structure in *T. niloticus* and its biophysical drivers deserves consideration.

Please Note:
The details of this report are currently subject to a journal publication process. For more information contact the author: Dr Oliver Berry, CSIRO Oceans and Atmosphere. oliver.berry@csiro.au.