VOLUME TWENTY TWO SEPT 2009 NUMBER TWO

The Lobster NEWSLETTER

ANNOUNCEMENTS

INTERNATIONAL CONFERENCE: UPDATE
"RECENT ADVANCES IN LOBSTER BIOLOGY, AQUACULTURE AND MANAGEMENT" (RALBAM 2010)
January 5 – 8, 2010, Chennai
National Institute of Ocean Technology Chennai, India

The RALBAM 2010 website has been updated and now registration and abstract submission can be done online. Climate change impact is added as one of the themes and Dr. Stewart Frusher of Tasmania Aquaculture and Fisheries Institute, Hobart, Australia will be chairing the session. We are happy to announce that Professor Bruce Phillips has consented to be one of the editors for the publication of proceedings.

Themes: Fishery; Conservation and management; Ecosystem interactions; Climate change impact; larval distribution / settlement / larval studies; Aquaculture and enhancement; Post harvest practices; Physiology, Nutrition and Health: Biotechnological innovations.

Registration: Registered participants will have the privilege of attending all scientific sessions, tea, lunch, Dinners and local tour and will receive conference materials. The registration fees for various categories are:

Foreign delegates	**Indian Delegates**:
Early Registration (31 Oct. 09): US $ 250	Registration fee: Rs. 5000
Late Registration (after 31 Oct.09): US $ 300	Student Registration fee: Rs. 2000
Registration fee for spouse: US $ 100	
Student registration fee: US $ 100	

Call for abstracts: All contributors for oral and poster presentations are required to submit abstracts in English. The abstract should be clear, descriptive and not longer than 400 words saved in MS Word, 12 point (Times New Roman). The text should be in single-column format. Last date for receipt of abstract is **15 November 2009**. The acceptance of abstract would be intimated to the authors by **30 November 2009.** Full paper has to be submitted at the time of the conference before presentation.

The Venue: The Conference will be conducted at the conference Centre of NIOT in the outskirts of Chennai 15 km away from the City Centre.

Travel and Accommodation: Chennai city has a number of Hotels and restaurants providing decent accommodation to suit the requirements of varied interests. Local transport will be provided for all delegates staying in Hotels in City Centre to attend the conference.

Visit to Gulf of Mannar Biosphere Reserve: The Gulf of Mannar Biosphere Reserve (700 km south of Chennai) in the Southeast coast of India is the first Marine Protected Area in Southeast Asia. Krusadi Island, one of the 21 uninhabited islands in the reserve is often described as a "Biologists paradise" due to its rich species diversity. It is the only place in the world where the prochordate, *Belanoglossus* is found. This Reserve is a natural habitat for all the six species of spiny lobsters and the slipper lobster, *Thenus orientalis* that are commercially exploited in India. The Gulf of Mannar Biosphere Trust, which manages the Reserve, invites lobster experts attending RALBAM 2010 at Chennai to visit the Reserve and offer their valuable suggestion to manage the lobster fishery in the Reserve. Contact the conference secretariat (ralbal@niot.res.in) for further details.

For more details, visit the website www.niot.res.in/ralbam/home.htm.

Contact Organizing Secretaries : Dr. M. Vijaykumaran/Dr. R. Kirubagaran, Ocean Science and Technology for Islands (OSTI), NIOT, Pallikaranai, Chennai – 600100, India. Ph: +91 44 66783418; 66783419, FAX: +91 44 66783430; 22460645, E mail: ralbam@niot.res.in; vijay@niot.res.in

The 9th International Conference and Workshop on Lobster Biology and management in Bergen, Norway, 19-24 June 2011

Two more years to go!

In the mean time, we invite you to send us ideas for special topics.

The demands and challenges are changing, due to various reasons, for instance climate change and new management schemes.

Any suggestions will be welcome and assessed.

Suggestions to be e-mailed to:

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RESEARCH NEWS

Trap behaviour of the Western Rock Lobster

From: Natalie Toon and Neil Loneragan

Research on the behaviour of the western rock lobster *Panulirus cygnus* in response to commercial fishing traps (referred to as pots in WA) is currently underway at Murdoch University in Western Australia. Although a great deal of research has been completed on this species and the fishery; limited research is evident on their behaviour, particularly with reference to traps (Cobb 1981; Jernakoff and Phillips 1988). Fishers have long been planning their fishing activities on how lobster catches will respond to varying environmental conditions. They have developed many theories on when you should or should not fish and on what exactly a lobster does throughout the day and night. This research aims to help shed light on some of those theories and questions.

The project investigates the catchability of the western rock lobster by observing their behaviour around commercial fishing traps. Video systems were developed and used to study behaviour in both the "natural" environment and within large aquariums to observe the behaviour of *P. cygnus* under varying conditions. Similar studies have examined the behaviour of lobsters around traps for the American lobster, *Homarus americanus* (Jury *et al.* 2001) and the southern rock lobster, *Jasus edwardsii* (Green 2002; Mills *et al.* 2005). Our current knowledge on the movements of *P. cygnus* around commercial traps has been through tracking studies and catch rate analysis. These studies have shown that lobsters are nocturnal, may travel up to 120 m to enter a trap and may leave a trap before morning (Chittleborough 1974; Jernakoff and Phillips 1988), and that their catch rates fluctuate with swell and lunar cycle (Srisurichan *et al.* 2005).

Video recordings of lobster behaviour around traps were made at the Houtman Abrolhos Islands, approximately 70 km's off the mid west coast of Western Australia. The Houtman Abrolhos consists of 122 low lying islands with surrounding coral reef. The lobster fishery at these islands is only open for 3 months of the year (March to June) and yields approximately 1,600 tonne of *P. cygnus* each year. Three cameras were attached to the sides and top of a commercial fishing trap, and deployed with a system in an underwater housing that could record the video footage remotely for up to 24hrs (Figure 1). The design was very similar to operating double gear for commercial traps and fished similar to commercial traps in the same area. The video was able to record lobsters entering and exiting the top entrance of the trap, as well as approaching and retreating from the side of the trap. Observations were undertaken over varying water temperatures and on different lunar phases.

In the aquariums lobsters were observed by a Closed Circuit TV system, similar to a standard security system (Figure 2). Observations of behaviour were made at varying water temperatures, simulated lunar light phases and different lobster sizes. The general hypothesis with these observations is that lobsters will be more catchable when they spend more time around, on and within the trap, and this will provide an indication of when they are more catchable in the field. From previous studies and fishers observations, we believe that they will be more catchable when the water is warmer, by increasing their metabolism, activity and feeding rates; when there is less light for example at a new moon, increasing their chance of predator avoidance; and if the lobsters are of a smaller size.

A range of behaviours have already been observed, such as "on the trap", "within the trap", "entering" and "exiting" the trap, and "within the area of the trap" (Figure 3). Lobsters appear to readily enter and exit the traps through both the neck and escape gaps at their own will, both in the natural environment and within the laboratory experiments. In the laboratory, some lobsters showed odd behaviours and appeared to have a personality all of their own. The video analysis of both aspects of this study is ongoing and the results should be appearing within the next six to twelve months.

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Figure 1. View of a camera attached to the side of a commercial trap at the Houtman Abrolhos Islands, May 2008.

Figure 2. Commercial trap in aquarium with lobsters. Note that all lobsters were marked individually

Figure 3. Security footage of the camera above the trap in the aquariums, with three lobsters on the trap and 1 within the trap.

Sea-ranching adult southern rock lobsters

From: Arani Chadrapavan, Bridget Green, Caleb Gadner, Adrian Linnane, David Hobday

Spatial differences in the market traits and growth rates of *J. edwardsii* have resulted in differences in biomass levels, egg production, and fishing effort between deep and shallow-water regions of the southern rock lobster (*Jasus edwardsii*) fisheries in Tasmania, South Australia and Victoria. But, despite the heterogeneity in the biological traits there is no spatial resolution in the current quota management of these fisheries. Deep-water southern rock lobsters characterised by pale, shell colouration and slower growth rates have less market value for the Asian live lobster market than inshore, red coloured, fast-growing *J. edwardsii*, and the fishing industries are looking for new management directions to increase yield and exploitable biomass. Consequently, we undertook a large-scale translocation and sea-ranching experiment to determine if moving adult *J. edwardsii* had potential to ameliorate some of the mismatch between the biology and management of the resource, and increase the value of the slow-growing pale sub-population.

Large-scale sea ranching operations in Tasmania began in 2005, which involved the capture, tagging and translocation of pale, slow-growing deep-water lobsters (~30, 000) into 10 shallow-water reefs along 3 degrees of latitude on the east and south-east coast of Tasmania. Within 12 months after translocation and after their first moult event, all translocated lobsters had changed from a pale to bright red colour, showed increased growth and enhanced body condition.

Pale coloured deep-water (right) and a red shallow-water *Jasus edwardsii*

Change in appearance

Colour: Catch sampling data revealed red shell colouration of *J. edwardsii* to decrease with depth across its distribution in south-east Australia (Chandrapavan *et al*, 2009). Differences in the three market colour categories of red, pale and white were also quantified on an RGB scale from digital macro photos. Colour of translocated lobsters was subsequently assessed at ~2 monthly intervals after translocation, which showed shell colouration had changed from a pale/white colour to the more marketable red colour of inshore shallow-water lobsters within one moult (Figure 1).

Body shape: There was considerable spatial variation in the body-shape traits, with deep-water lobsters exhibiting longer walking legs than shallow-water lobsters and significant differences in the tail area between deep and shallow-water males. However changes in body-shape were not significant after the first moult in translocated lobsters but we expect these changes to occur over several moults.

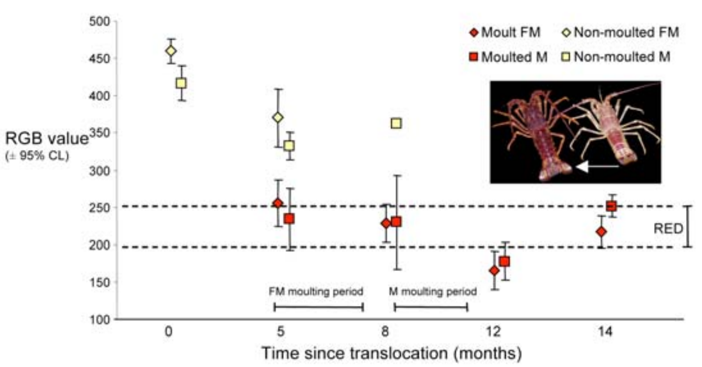

Figure 1. Change in the red colouration of the tail region of moulted and non moulted translocated males (M) and females (FM).

Change in diet: We assessed the nutritional condition of translocated, male, deep-water lobsters before and 12 months after translocation through variations in the lipid and fatty-acid profiles of the digestive gland and muscle tissue. A change in the diet of translocated lobsters was evident though fatty-acid compositions (Figure 2) while the most interesting outcome was the 30% increase in the mean omega-3 long-chain PUFA content (especially EPA) in the muscle tissue of translocated lobsters which enhances its overall nutritional value (Chandrapavan *et al*. 2009).

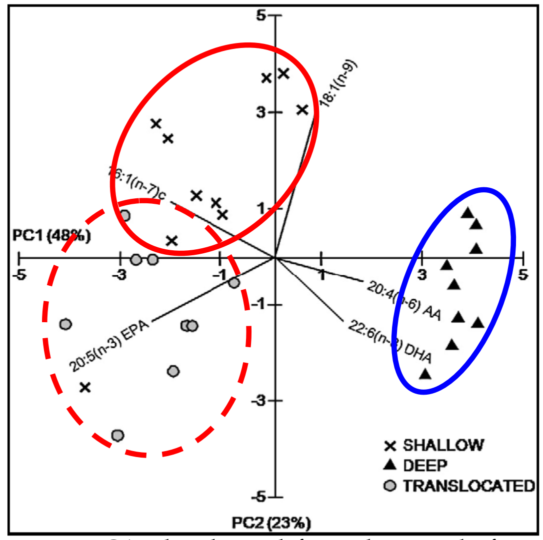

Figure 2. PCA plot derived from the muscle fatty-acid profiles of shallow, deep and translocated lobsters.

Change in growth: Growth of translocated lobsters in the 2 years following release was compared with the growth of the resident lobsters at the deep-water capture site and resident shallow-water lobsters at the release site. Translocated male lobsters grew faster than resident deep-water lobsters but did not quite match the growth of resident shallow-water males at the release site. Deep-water female growth was very slow at < 1mm per annum, and translocation increased this growth rate dramatically, with growth increments of some size classes greater than resident shallow-water females (Figure 3).

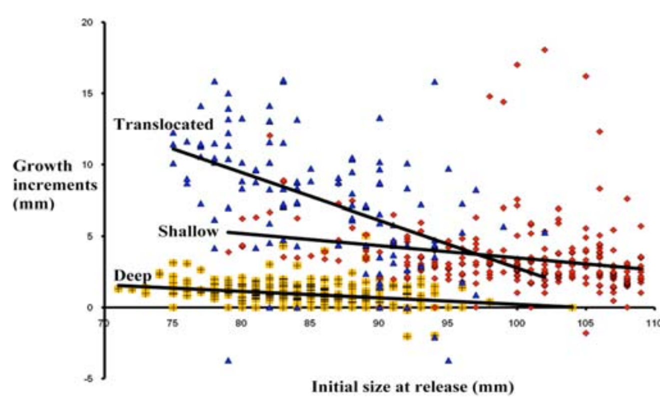

Figure 3. Differences in the mean growth increments of resident deep-water (yellow) and shallow-water (red) female lobsters and the growth increments of translocated females (blue) after the first moult event.

So far, results from the experimental translocations highlight its potential as a spatial management tool to improve the value and yield of the fishery. The southern rock lobster fishing industries may be heading in a new direction, pending a comprehensive economic and biological assessment in the final phase of the project. We hope to report on the other outcomes of this study in upcoming issues.

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Understanding shell colour changes in "white" western rock lobsters.

From: Nicholas M. Wade

Introduction:

The Australian western rock lobster, *Panulirus cygnus*, undergoes a characteristic change in colour from deep red to pale pink (known as "whites") that coincides with a mass offshore migration (George, 1958). The pale colour results in a significant annual loss for the industry, and attempts have been made to understand the triggers for this colour transition or whether "whites" can be rapidly returned to "reds" (Melville-Smith *et al*., 2003). In this study, we looked for any morphological, biochemical and genetic differences that may help explain this colour phenomenon.

Basic Morphology and Chomatophores

Similar to previous observations, we could not find any morphological differences between "reds" and "whites". Shell patterning was identical apart from the depth of colour itself. The hepatopancreas of "whites" was generally much darker in colour (not shown), perhaps due to an increase in carotenoids storage during this colour phase, although this difference could not be quantified. In regions of the body that contained chromatophores (particularly the tail), they were visibly constricted in "whites" (Figure 1). What role these chromatophores in the underlying epithelium are playing requires further study, although they are not visible through the thick calcified exoskeleton. Unlike prawns where chromatophores are easily visible, these hard-shelled animals are unable to rapidly modify their colour in response to environmental cues (Melville-Smith *et al*., 2003) and the initial appearance of "whites" does not appear to be in response to either diet or background substrate colour (Wade *et al*., 2008).

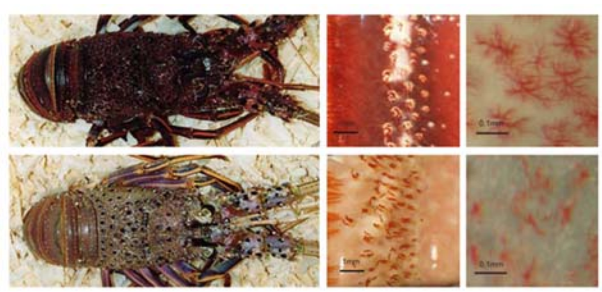

Figure 1. Although the basic morphology of wild caught "reds" was indistinguishable from that of "whites", striking colour differences were evident across all parts of the animal that were also reflected by the chromatophores in the underlying epithelial tissue.

Extractable Shell Colour

Coloured compounds could be efficiently extracted from ground shell material, and were shown to be virtually absent in the shells of "whites" (Figure 2). This was consistent with previous measurements of total carotenoids in the shell (Wade *et al*., 2005). The majority of extracted colour from "red" shells was present in the 50% and 65% ammonium sulphate purification cuts, with virtually none from similar amounts of material from "white" shells. In either case, there was very little colour remaining in the insoluble material, and the colour of this material was similar for both "reds" and "whites". This remaining colour may represent a fraction that is permanently bound in the exoskeleton. Despite the visible differences in chromatophore dispersal beneath the shell, it was not possible to extract and quantify coloured proteins from the epithelial tissue.

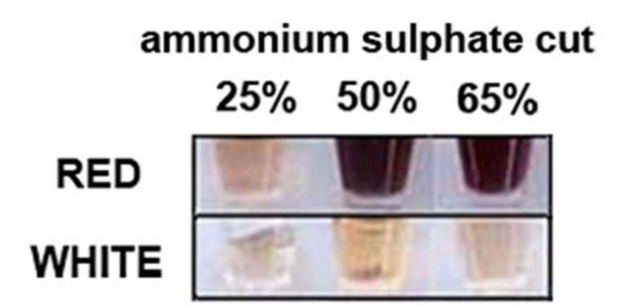

Figure 2. Extraction of soluble colour from ground shells and crude separation using ammonium sulphate showed there was very little colour present in "white" shells, compared with the colour taken from "red" shells.

Expression of Colour Genes

Colouration in lobsters is due to a carotenoid called astaxanthin in combination with a protein known as Crustacyanin (CRCN). The genes encoding this protein have been shown to be unique to crustaceans, meaning that lobsters, crabs and prawns have a unique way of making themselves colourful (Wade *et al*., 2009). Two CRCN genes, known as CRCN A1 and A2, have been identified in the western rock lobster. Using semi-quantitative PCR, these genes were detected in the tissue beneath the exoskeleton, with CRCN A1 expression slightly higher than that of CRCN A2 (Figure 3). We could also observe that CRCN expression was lower in "whites" than in "reds", when compared with the expression level of the 16s control gene. How these different levels of gene expression are being generated or maintained remains a mystery, however, these results provide a timely reminder that there is a large genetic component to crustacean shell colour formation and regulation.

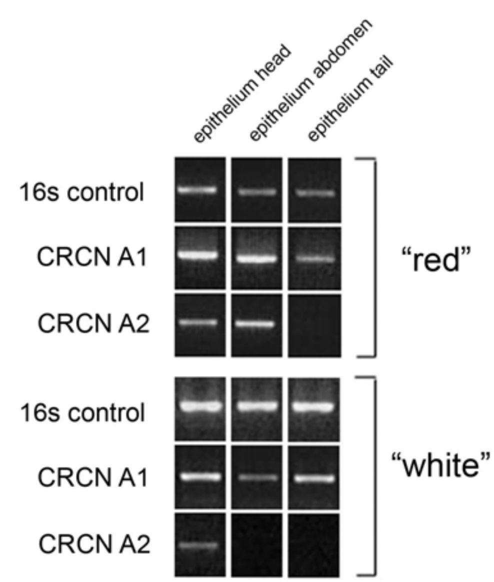

Figure 3. Semi-quantitative PCR was used to detect the Crustacyanin (CRCN) genes from tissue beneath the exoskeleton in both "red" and "white" lobsters. When compared to the 16s control gene, overall CRCN expression was lower in "whites" compared with "reds"

Conclusions

The colour we observe in "white" western rock lobsters would appear to be a combination of morphological (quantity of pigment molecules) and physiological (chromatophore dispersal) colour mechanisms. Morphological changes in gene expression and CRCN protein abundance in the shell must coincide with the moult to the paler coloured migratory "whites". The timing, speed and intensity of this colour change strongly suggest that it is genetically regulated, although the original cues or trigger that generates this genetic response may be environmental.

We know that the physiological responses to external cues such as background colour is slow in hard-shelled species, however, we show here that this may play a role in preserving the pale colour in these animals during their migration across large sections of light coloured sand. The variation in physiological response may also explain some of the colour variation seen across animals during their "white" phase. Regardless of how it appears, the colour transition from dark "red" to the pale "white" during the migration of this species provides an excellent model to understand the genetic factors regulating crustacean shell colour.

This work formed part of Nick Wade's PhD thesis at the University of Queensland entitled "Crustacean Shell Colour Formation and the White Phase of the Western Rock Lobster, Panulirus cygnus". Nick is currently working on gender, sex determination and fertility control in crustaceans at CSIRO Marine and Atmospheric Research, Cleveland, Australia. (Nick.Wade@csiro.au)

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Molecular Identification of *Panulirus homarus* by restriction fragment length polymorphism of mitochondrial cytochrome oxidase I gene

From: G. Dharani, G. Annapoorna Maitrayee, S. Karthikayalu, T.S. Kumar, M. Anbarasu and M. Vijayakumaran

Phyllosoma larvae of palinurids and scyllarids are widely distributed in temperate and tropical seas and it is often difficult to identify them to the species level. Both direct and indirect methods have been employed to identify phyllosma larvae from plankton collections. In the direct method, eggs hatched in captivity or larvae caught at sea are cultured to post larvae while the indirect method relies on the identity of species present as adults in the region and deducing the probable phyllosoma identity based on adult distribution and abundance and by comparing it with the morphology of the larvae in published accounts (see Sekiguchi *et al*. 2007). The life cycles of only few species of palinurids and scyllarids have been completed and larval stages described for direct identification of phyllosomas. Phyllosomas of nearly 57 species of scyllarids are described based on the adult phase, but only 30 have been reliably identified with adults of scyllarid species (Sekiguchi *et al*., 2007). Identification of phyllosomas of tropical Palinurids from plankton collections is still more complicated as it is often a multispecies fishery with more than two or three species dominant among the catch. Further, no distinct morphological differences could be observed in hatchery reared early phyllosomas of four species of spiny lobsters, *Panulirus homarus*, *P. ornatus*, *P. polyphagus* and *P. versicolor* (Vijayakumaran *et al*., 2004).

Species level identification of puerulus and nistos of palinurids and scyllarids in wild collections are also difficult, though not as complicated as phyllosomas identification. Recently, molecular methods have been used for definite identification of species or for identifying sub populations in a region. Molecular identification of lobsters using Amplified Fragment Length Polymorphism (AFLP), Restriction Fragment Length Polymorphism (RFLP) or nucleotide sequencing analysis is well documented in temperate species, while in tropical spiny lobsters, particularly in Indian waters, such analysis are not reported.

In India, the National Institute of Ocean Technology (NIOT), Chennai introduced farming and fattening of spiny lobsters in sea cages in the south east coast of Tamil Nadu. Large number of puerulii are attracted to lobster cages as well as to seaweed (*Kappaphycus alwarazi*) culture rafts and cages in the nearby areas (Vijayakumaran *et al*., 2009). The puerulii from sea cages in India were predominantly of single species (*P. homarus*), though they were often mixed with other species like *P. ornatus* and *P. polyphagus*. The transparent puerulii larvae are delicate in nature and are difficult to identify before they complete initial moults. The present work was aimed to identify the phyllosoma and puerulus of *P. homarus* by employing polymerase chain reaction-restriction fragment length polymorphism of the cytochrome oxidase I gene (COI).

Sample collection

Adult *P. homarus*, berried *P. homarus*, and puerulii were collected from the lobster culture cages in Tharuvaikulam, (8° 53′ N: 78° 10′ E), Tamil Nadu. Samples of eggs, abdominal muscle of puerulus, and adult were collected carefully and preserved in 95 % ethanol. The berried lobsters were transported and maintained at the seafront laboratory of NIOT at Neelankarai, Chennai and phyllosoma larvae, were collected and preserved after hatching.

Molecular analysis

Genomic DNA was extracted from the egg, whole phyllosoma, and the abdominal muscle of puerulii and adults. A fragment of mitochondrial cytochrome oxidase I (COI) gene, was amplified by polymerase chain reaction (PCR) using a modified primer COI65F-5´-GGAGCTTGAGCTGGAATAGT-3´ and COI1342R-5´-GTGTADGCRTCTGGRTARTC- 3´ (Seinen Chow et al., 2006a). Restriction digestion was performed with Alu 1, Taq 1, Bsp1I, RsaI & HhaI as 20µl reaction mixture.

Molecular identification

A portion of mitochondrial gene COI was amplified using the modified primer (Seinen Chow et al., 2006a) at 52.5°C. The size of amplified fragment of COI gene was estimated to be approximately 1300 base pair (Figure 1). Out of the five restriction endonucleases used (AluI, TaqI, BspLI, RsaI & HhaI), four were found to have recognition site. TaqI, BspLI, and AluI had maximum restriction sites in amplified COI fragment. The restriction endonucleases, TaqI & BspLI, had three restriction sites and yielded a fragment size of approximately, 150, 300, 360, and 490 and 120, 260, 320, 600 bp respectively. AluI had four restriction sites and yielded five fragments of approximately 100, 180, 200, 250 and 300 bp. RsaI has single restriction site and yielded two fragments of approximate 600 and 700 bp and Hha1 has no restriction site (Figure 2). TaqI restriction profile of the egg, phyllosoma and peurulus larvae were similar to that of adult *P. homarus* (Figure 3).

Mitochondrial gene Cytochrome c Oxidase subunit 1 was taken for the species identification, because, COI has been used extensively in determining relationships among arthropods and establishing the phylogeny of the species, shrimp (Maggioni *et al*., 2001; Lavery *et al*., 2004), crab (Harrison, 2004) and spiny lobster (Ptacek *et al*., 2001; Seinen Chow *et al*., 2006a; Seinen Chow *et al*., 2006b). It exhibits enough sequence diversity to enable discrimination at the species level and broad-range primers are available for amplification of COI from diverse invertebrate and vertebrate phyla (Folmer *et al*., 1994).

The important outcome of the present investigation is the fact that TaqI restriction profile of the egg, phyllosoma and peurulus larvae were similar to that of adult *P. homarus*. No polymorphisms were recorded within the individuals of adult *P. homarus* studied and distinct restriction patterns were recorded in the all life stages. Mitochondrial DNA sequence is considered to be the most powerful approach to resolve taxonomic uncertainties. Particularly, RFLP based methods have become conventional practice for identifying fish and crustacean species at all stages of the life cycle (Seinen Chow *et al*., 2006a; Seinen Chow *et al*., 1993). The results of the present study clearly indicate that restriction enzyme TaqI, can be used to identify and distinguish *P. homarus* phyllosomas and puerulii from those of other lobster species. Further investigation on samples from wide geographical areas and sequence alignment will provide insight on the genetic structure of Indian spiny lobster *P. homarus*.

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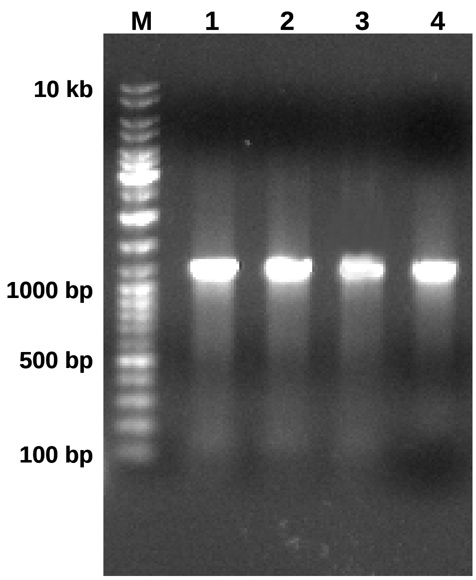

Figure 1**.** Agarose gel electrophoresis, M-100bp-10kb DNA ladder, 1-4 PCR products of COI of adult *Pa. homarus*, puerulus, phyllosoma and egg.

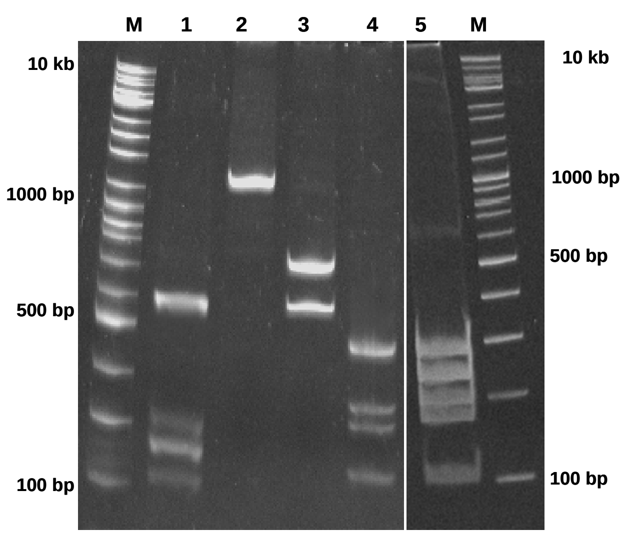

Figure 2. DGGE of COI, M-100bp-10kb DNA ladder, Lanes 1- 5 PCR-RFLP of COI of adult *Pa. homarus* digested with BspLI, HhaI, RsaI, TaqI and AluI.

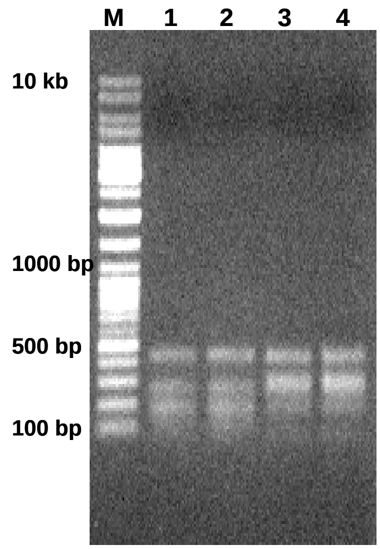

Figure 3. Agarose gel electrophoresis, M-100bp-10kb DNA ladder, 1-4 Taq I RFLP of COI of adult *Pa. homarus*, puerulus, phyllosoma and egg.

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Gleaning for lobsters from coral reefs in South Sinai, Egyptian Red Sea coast

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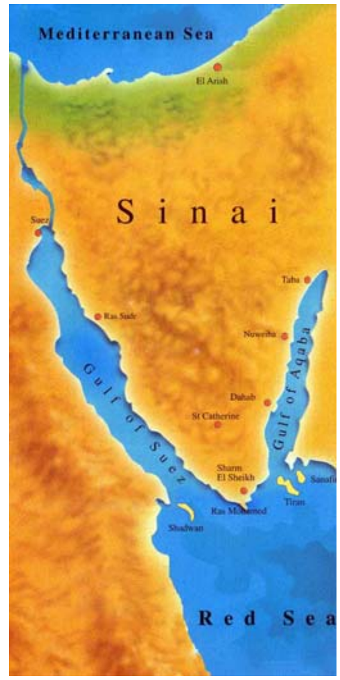
Sixteen species of lobsters representing three families have been reported from the Red Sea (Vine 1986). Not all lobsters are of equal importance on coral reefs. The Nephropidae or 'clawed' lobsters, which include *Enoplometopus occidentalis*, are not fished on reefs. However, The Palinuridae comprising the spiny or "rock" lobsters, support important reef fisheries. Three species of spiny lobsters are known to occur in the Red Sea. *Panulirus penicillatus*, *Panulirus versicolor* and *Panulirus ornatus*. Along the South Sinai coasts, *Panulirus penicillatus* is the most common spiny lobster; it is fished on exposed reefs close to deep water and has been reported to favour offshore reefs with clear water and high wave action (Munro 2000). Palinurids in general have been reported to live communally, grouped together in dens or other suitable shelter (Berry 1971). The Scyllaridae or the "slipper lobsters" comprise six species - *Thenus orientalis*, *Scyllarus ragosus*, *S. gibberosus*, *S. lewinsohni*, *S. pumilus* and *Scyllarides tridacnophaga.* The last is the second most common species found in the Gulf of Aqaba and it occurs in shallow water among coral boulders. These two most common species support important reef fisheries in this area.

The fisheries of lobsters in the Gulf of Aqaba are entirely artisanal and do not depend on major capital investment. As well as their economic importance, spiny lobsters are top predators and potential "keystone" species in the reef ecosystem. As such they can exert major influence on the population structure of their invertebrate prey (Edgar 1990) and may have direct or indirect effect upon the community structure. Their removal may have unpredicted effects upon the ecosystem (Hartnoll, 2001).

In South Sinai, Bedouin women have traditionally been regular providers of seafood for the family through their continuous reef gleaning action. The collection of octopus, sea cucumbers and other invertebrates is still an interesting subsistence activity for Bedouin women in this area. Men's contribution, however, is mainly in catching those species that require effort beyond the reef. Fishing lobsters is therefore the domain of Bedouin men since it requires night fishing. Due to the large value of these organisms recognized by the Bedouin, they are now seldom used for their consumption. The expansion in tourism and hotel development in the Gulf of Aqaba has led to the existence of a strong and growing demand for lobsters. Bedouin fishermen have therefore a ready and often unsatisfied local market for their catch.

Activities that are likely to damage habitats or reduce biodiversity in South Sinai area are now regulated by the Egyptian Environmental Affairs Agency (EEAA) staff in cooperation with concerned Bedouins. Routine patrols are conducted within the area of Gulf of Aqaba for regular checking of the night-time fishing operations. Members of the enforcement team of the (EEAA) have been successfully monitoring the fishing for lobsters; however, their role is confined to examining the harvest and returning the undersized animals back to the sea (minimum landing size unknown) as well as preventing the landing of ovigerous females. There is evidence that the two gleaned species are seriously exploited as indicated by the observations of the EEAA team. The appearance of female lobsters bearing extruded eggs at unusually small sizes suggests that there is a growth over fishing on these crustaceans. Early maturation of females is known as an appropriate response when the population experiences heavy fishing pressure (Waddy & Aiken, 1991).

Bedouins glean the reef for lobsters in several areas beyond their place of residence. Ninety Five percent of the fishermen are residents of Dahab, however, they fish lobster from Nabq, Abou Galoum, Elsheheira, Sanafer Island, and Abou Zabad. They operate without licenses because they consider fishing as their traditional occupation. Since it requires regular skin diving, fishing lobsters is a job only practiced by Bedouin young men (aged 18-25 years old). The number of family members involved in gleaning ranges from one to two, most of them possesses a diving suit. Gleaning is carried out all year round; however, fishermen do not operate everyday. Gleaning takes place only during moonless nights particularly within the 20th – 5th of the Arabic month. It commences one hour after sunset and lasts for a period of one to four hours. Fishing operations depend very much on the condition of the sea. Gleaning could be for only 7 days in cold winter days whereas in summer it might continue for the whole two weeks of fishing. Due to heavy gleaning in some areas and to the obvious decline in the numbers of lobsters in the past few years, fishermen have extended their activities to areas where the populations are still intact or undamaged such as Tiran Island. Gleaning takes place mainly in the area of the reef flat (depth 50 cm) and reef edge (depth 3-12 m). Fishermen observe lobsters to occur either solitary or in groups, and capture them manually using torches as the source of light. Once a lobster is located, the fisherman aims the light at its eyes so that it remains stationary and then collects it by hand. Two species are being gleaned - the spiny lobster *Panulirus penicillatus* and the slipper lobster *Scyllarides tridacnophaga*. The former is the main target while the latter is taken incidentally (though surprisingly it is considered much tastier). Average sizes are 20-80 cm (total length) and 20-50 cm for the two species respectively. The number of individuals caught per fisherman per session ranges from 3-15.



Map of South Sinai showing the gleaning areas.

Fishermen are unable to differentiate between sexes unless females are berried. Females bearing extruded eggs appear in the catch during summer, while juveniles are observed during autumn. The ratio of males to females per catch is 4:1. There are no specific landing sites for fishermen and the catch does not get sorted by sex. Selling is either direct where fishermen deliver lobsters straight to restaurants and hotels or through a dealer in case of long distance sales. The whole catch (comprising both species) gets sold per kilogram, not by the piece and the price is as high as LE 150 per kilogram.

Law number 124, issued by the Egyptian fishing authorities, states that in case of illegal fishing the boat, the harvest and the gear must be promptly seized. The harvest and the gear are sold on the spot to members of the coast guards while the fate of the boat is left to be decided by the court. Furthermore, there is a closed season for lobster fishing, which currently runs over summer in the protected area of Nabq. Nevertheless, further protection is still needed for the conservation of this valuable crustacean. Proper assessment of the impact of reef gleaning activity by Bedouin men on the population of lobsters in this area should be carried out. A program for the conservation of lobsters must be established and come into effect as soon as possible and should be managed under the fisheries authorities.

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Spatial differences in size of maturity within southern rock lobster (*Jasus edwardsii*) in South Australia.

From: Adrian Linnane, Shane Penny, Peter Hawthorne and Matthew Hoare.

The annual commercial catch of southern rock lobster in South Australia is ~2,400 tonnes, representing ~60% of the total landings from the south-eastern Australian region. The fishery is divided into a Northern and Southern Zone, which are each sub-divided into Marine Fishing Areas (MFAs) for management purposes (Figure. 1). The majority of the catch comes from the Southern Zone (SZ) which currently has a total allowable commercial catch of 1,770 tonnes. Fishing is permitted from October to May inclusive and a minimum legal size (MLS) of 98.5 mm carapace length (CL) for all rock lobsters has been in place in the zone since 1970.

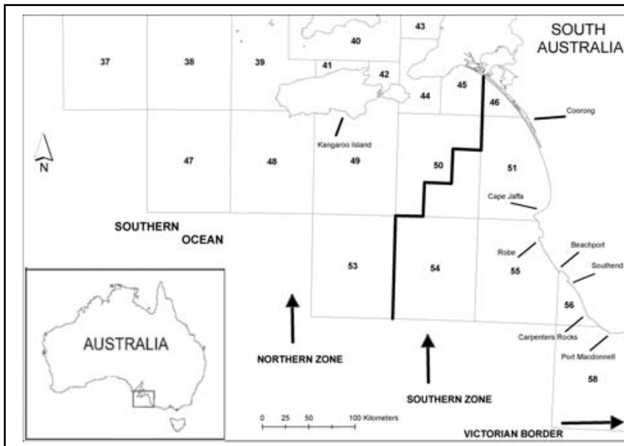

Figure 1. Map showing the Northern and Southern Zones of the South Australian rock lobster fishery. Numbers show location of marine fishing areas (MFAs). MFAs 51 and 55 represent the North Southern Zone (NSZ) while MFAs 56 and 58 make up the South Southern Zone (SSZ).

Data used to estimate size of maturity (SOM) came from two sources. The first was a fishery-dependent catch sampling program undertaken in four MFAs where ~ 99% of the commercial catch is taken annually i.e. MFAs 51, 55, 56 and 58. In place since 1991, fishers are requested to count, measure (mm CL), sex and record the reproductive condition of lobsters from up to 3 research pots per fishing trip. Despite an extensive dataset, the majority of records come from inshore grounds (< 60 m depth) and thus, information on SOM can be spatially limited. However, in 2007, a translocation study in the SZ (see article by Arani Chandrapavin *et. al.*) also provided a unique opportunity for the collection of biological data from offshore sites (> 100 m depth).

Figure 2. Ovigerous female southern rock lobster (Jasus edwardsii).

Data from all female lobsters were pooled according to capture depth and MFA. A female rock lobster was categorised as "sexually mature" if it possessed either eggs (Figure 2) or ovigerous setae (Wenner *et al.*, 1974). The percentage of sexually mature female rock lobsters was plotted against carapace length in each 1 mm CL size class and then fitted, using a SAS non-linear modelling procedure, to the logistic equation:

$$P_m = \frac{1}{\left[1 + e^{(a - b.CL)}\right]}$$

where P_m is the proportion of mature female rock lobsters, *CL* is the carapace length, *e* is the inflexion point of the curve and *a* and *b* are constants.

The size at which 50% of female rock lobsters were sexually mature (L_{50}) varied spatially from south to north and between inshore and offshore sites. Within the southern regions of the fishery (MFAs 56 and 58), L_{50} occurred at 92.3 mm CL (Figure 3). Based on the size frequency of commercial catch landings, this suggested that ~ 42% of lobsters in the commercial catch were under the MLS of 98.5 mm CL but above the L_{50} estimation. Within the northern region of the SZ (MFAs 51 and 55), the L_{50} occurred at 104.1 mm CL. Based on commercial catch landings this indicated that approximately 20% of lobsters above the MLS of 98.5 mm CL in the commercial catch were under the L_{50} estimation.

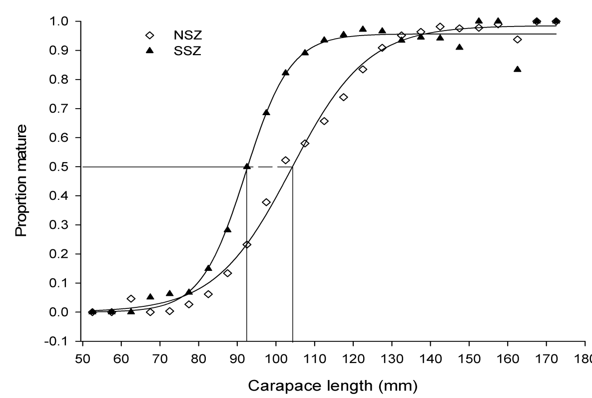

Figure 3. The L_{50} logistic curves for the proportion of mature female rock lobsters as a function of carapace length sampled from the North Southern Zone (NSZ; MFAs 51 and 55)) and South Southern Zone (SSZ; MFAs 56 and 58) regions of the South Australian rock lobster fishery.

Differences between inshore and offshore sites were compared in MFA 55 only. Within the inshore grounds, L_{50} occurred at 103.3 mm CL suggesting that approximately 21% of inshore lobsters in that region were above the MLS of 98.5 mm CL are under the L_{50} estimation. Within the offshore grounds, L_{50} occurred at 68.4 mm CL indicating that 63% of offshore lobsters in the commercial catch were under the MLS.

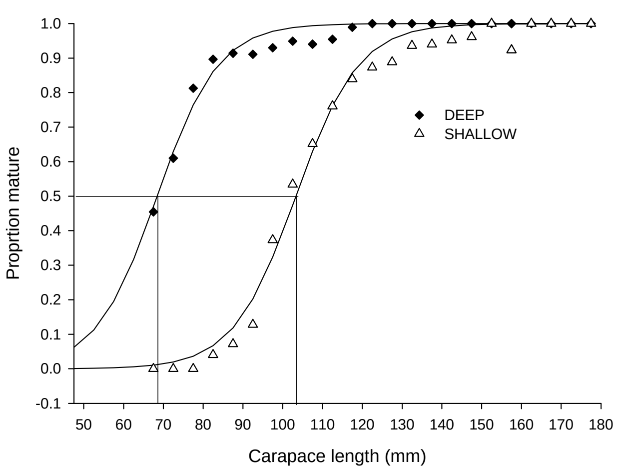

Figure. 4. The L_{50} logistic curves for the proportion of mature female rock lobsters as a function of carapace length sampled in deep (>100m) and shallow (<60m) water sites of MFA 55 in the South Australian rock lobster fishery.

Spatial differences in SOM appear to be influenced by a range of factors including temperature (Annala and Bycroft, 1987), growth rates (Hobday and Ryan, 1997) density dependence (Beyers and Gosen, 1987; MacDiarmid, 1989) and food availability (Melville-Smith *et al.*, 1995). In south-eastern Australia and New Zealand, SOM for *J. edwardsii* increases with latitude ranging from 41 mm CL in southwest Tasmania (Gardner et al., 2006) to ~122 mm CL in New Zealand (Annala *et al.*, 1980; MacDiarmid, 1989). Estimates from South Australia are closest to intermediate figures from Victoria where the SOM of 90 mm CL recorded in the Western Zone of Victoria (Hobday and Ryan, 1997) is comparable with that of 92.3 mm CL from the southern regions of the fishery. In conclusion, the spatial differences in SOM here indicate that a review of size limits may be required if this management tool is to be utilised on a fine-scale regional basis within the SZ rock lobster fishery of South Australia.

Figure 5. Peter Hawthorne collecting size of maturity data in the SZ rock lobster fishery.

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FISHERIES & AQUACULTURE UPDATES

Low puerulus settlements in the western rock lobster fishery

From: Rhys Brown, Simon de Lestang, Peter Stephenson and Nick Caputi

After almost a decade of good to average puerulus settlements, below average and very low settlements were observed in the western rock lobster fishery of Western Australia in 2006/07, 2007/08 and 2008/09.

There are two major research and management issues associated with the series of low settlements: (a) the cause of the low settlement and the research programs examining this; and (b) the management measures required to deal with the effects of the low settlement.

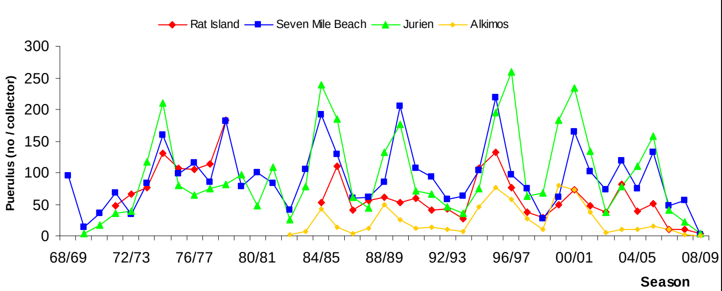

Figure 1. Puerulus settlement at four main sites on the Western Australian coast.

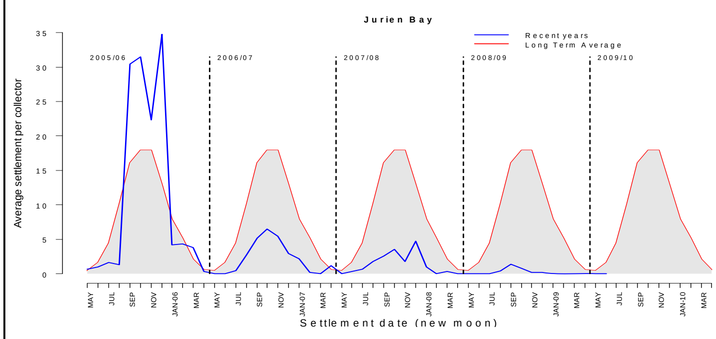

Figure 2. Jurien Bay as a detailed example of the monthly puerulus settlement over the past four seasons. The 2009/10 settlement season commenced in May 2009.

Further information on puerulus settlement data and collection sites can be accessed at: http://www.fish.wa.gov.au/docs/pub/PuerulusSettlement/index.php?0405.

This information is updated monthly.
General background information on the western rock lobster fishery can be found at: http://www.fish.wa.gov.au/docs/esd/esd004/index.php?0706

The latest annual report on the fishery can be found in the West Coast Bioregion section of the State of the Fisheries 2007/08 at: http://www.fish.wa.gov.au/docs/sof/2007/index.php?0706

These low settlements will have a major impact on the catch of rock lobsters three and four years after settlement, commencing in the non-migrating 'reds' (March-June) fishery of 2009/10. If management actions were not taken to significantly reduce exploitation on the rock lobster stocks they also have the potential to result in much lower breeding stock levels four to six years after settlement, as shown in Figure 3.

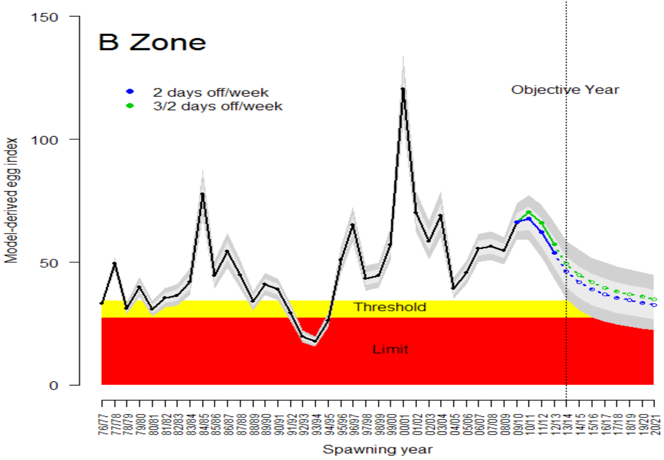

Figure 3. The northern coastal zone (Zone B) as an example of the model derived egg production index. Solid lines represent estimates based on known levels of puerulus settlement to date and different management scenarios. Dotted lines represent the continuation of these effort scenarios assuming future puerulus settlement remains at 2008-09 levels (i.e. extremely low, which is the worst case scenario). The light and dark grey areas represent the 75 and 90% confidence regions around the estimates.

The current understanding of the influence of environmental factors (as measured by ocean temperature and wind conditions) on the last three puerulus settlements seasons is that:

* the below average settlement of 2006/07 was explained by environmental factors (water temperature and wind) at all settlement sites,
* the very low settlement of 2007/08 was not well explained by the environmental factors at most settlement sites, and
* the extremely low settlement of 2008/09 was not explained by the environmental factors at nearly all the settlement sites, in fact it went against the previous trends, based on the environmental conditions, i.e. settlement should have been average or better.

Due to the uncertainty of the cause(s) of the low puerulus settlements, particularly 2008/09 (e.g. as yet unknown environmental factor(s) and/or breeding stock effect), a risk assessment workshop was undertaken on 1 and 2 of April 2009.

The western rock lobster fishery is data rich, with important data sets going back 40 years[1]. The factors covered at the workshop included lobster biology and life history (particularly breeding biology and larval stages), stock status (particularly puerulus settlement and breeding stock levels), increases in fishing efficiency, environmental factors affecting puerulus settlement, climate change effects on the fishery and aspects of physical and biological oceanography relevant to the different rock lobster life history stages and measurement error by the puerulus collectors.

The main concern regarding the recent low puerulus settlements was that the current long standing relationship between puerulus recruitment and environmental conditions (using sea temperature and wind conditions), which had previously provided a good explanation of the variations in settlement (Caputi *et al*. 2001), did not adequately explain the recent settlement patterns, particularly the very poor settlement of 2008/09. The uncertainty regarding the cause of the low settlements represents a high risk to the fishery.

The workshop focused on examining the 'likelihood' of factors that could have caused the decline in puerulus settlement. The workshop concluded that the decline could have been caused by changes in environmental conditions and productivity in the eastern Indian Ocean, or a decline in the abundance of the rock lobster breeding stock, particularly in the northern region of the fishery, or a combination of these two factors.

[1] For example, catch and fishing effort from 1944/45, research log book data from 1963/64, puerulus settlement from 1968 and commercial catch monitoring from 1974. A detailed description of the data bases used to assess and model the fishery are available at Hhttp://www.fish.wa.gov.au/docs/frr/frr180/index.php?0401

Some of the most important points arising from the workshop were:

- Probability that the cause of the low puerulus settlements were due to:

Puerulus collectors (changing fibres, interference, settlement occurring in deep water where there are no collectors) – less than 2%.

Short-term environmental change – 10% to 35%.

Long-term environmental change – 35% to 75%.

Breeding stock decline – 10% to 35%.

Combination of long-term environment and breeding stock – 35% to 75%.

- Long-term environmental changes have been occurring in the eastern Indian Ocean, but the mechanisms by which they may be affecting puerulus settlement are, as yet, uncertain.

- Possible short-term environmental changes, i.e. anomalies in the Indian Ocean Dipole (IOD) and the lack of westerly (onshore) winds in August 2008, could have affected the 2008/09 puerulus settlement.

- It was identified that there had been three consecutive positive IOD over 2006-2008 which is unusual and for the first time in 2008 there was a positive IOD associated with the La Nina conditions in the Pacific which has an influence on the strength of the Leeuwin Current and the puerulus settlement.

- Preliminary results from oceanographic modelling suggest that, under certain environmental conditions, breeding stock areas in the north of the fishery could play a more important role in successful puerulus settlement than areas in the south. However this needs to be examined further as the model is still under development.

- Breeding stocks overall appear to be within historic ranges, however in the far north of the fishery – Big Bank and the northern Abrolhos – the abundance appears to have declined.

- If the environmental conditions this year, 2009, are average or favourable for puerulus settlement and it still remains very low, the likelihood that it was caused by breeding stock depletion (i.e. a stock and recruitment failure) would increase.

A number of research projects have been initiated to examine some of these issues to try and understand the cause of the low settlement.

From a stock and fishery perspective, managers and fishers do not have control over the environmental factors that impact puerulus settlement, however they do have the ability to significantly influence the abundance of the breeding stock. Therefore, the Risk Assessment Panel was strongly of the view that managers and fishers should take significant short and long-term action to protect the breeding stock (BS) and to increase the level in areas that have been depleted[2], particularly in the northern region[3].

The reductions in fishing effort/exploitation, which commenced in 2008/09, should be continued in 2009/10 and into future seasons to maintain breeding stocks at or increase them to 'safe' levels.

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[2] The area south of Lancelin in Zone C and near the Abrolhos Is. is not considered to be critical as it is estimated to have adequate to good levels of BS.

[3] Big Bank and the northern Abrolhos are considered particularly important northern BS areas to protect.

By significantly improving the abundance of the breeding stock in the areas identified as being currently depleted, the risk that it could be a critical factor causing the low puerulus settlements, should be virtually eliminated. An important aspect of reducing exploitation will be to ensure measures are implemented to protect the BS from being the focus of additional heavy fishing pressure, due to the significant decline in new recruits (legal size, immature lobsters) to the fishery that will be experienced for at least the next four seasons. Significantly reduced exploitation will also allow more lobsters to survive the vulnerable 'whites' migration period (November-February) and replenish the deepwater breeding grounds.

SUSTAINABILITY OBJECTIVE FOR THE FISHERY

The sustainability objective for management (based on low or very low puerulus settlements for the foreseeable future, see Figure 3 above) is to keep the rock lobster breeding stocks in each of the three zones of the fishery above their threshold levels for at least the next five seasons with 75% probability and above their limit levels with 90% probability. Therefore, any management package adopted for the 2009/10 season must at least meet these criteria.

In the previous season (2008/09), effort reductions of about 35% were imposed during the migrating part of the fishery (November-February) and about 50-60% during the non-migrating part (March-June). These management actions reduced the actual catch taken from the previously predicted level of 9200 t to below 7800 t. Further reductions are likely to be required for 2009/10 to meet the sustainability objective and ensure there are significant carryovers into the low catch years of 2010/11 and 2011/12. Other objectives may also be considered. The Minister is expected to announce his decision on the management package for 2009/10 in the coming weeks.

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