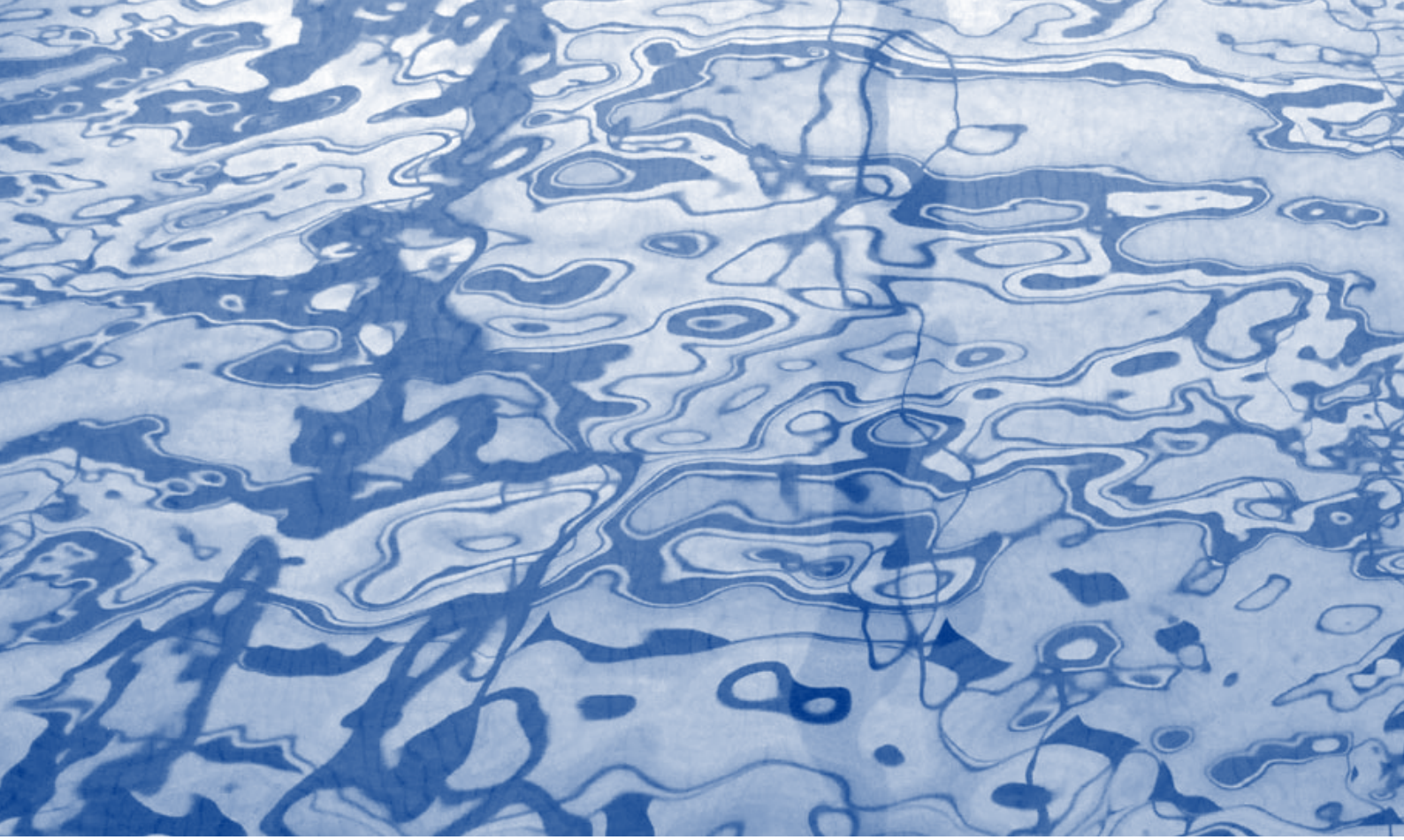
Torres Strait rock lobster

Research to support allocation of indigenous and commercial catch in the Torres Strait tropical rock lobster Panulirus ornatus *fishery*



Torres Strait rock lobster

Research to support allocation of indigenous and commercial catch in the Torres Strait tropical rock lobster Panulirus ornatus *fishery*

Darren Dennis[1], Jim Prescott[2], Yimin Ye[1], Tim Skewes[1]

1 CSIRO Marine Laboratories, PO Box 120, Cleveland, QLD 4163 Australia, Darren.dennis@csiro.au;

2 Australian Fisheries Management Authority, PO Box 376, Thursday Island, QLD 4875 Australia Jim.Prescott@afma.gov.au

Table of contents

Abstract	v
Introduction	1
Fishery-independent population surveys	5
"hookah" diver versus free-diver catch rates	7
Local depletion of traditional "home" reefs	9
Conclusions	13
References	17

Abstract

The Torres Strait tropical rock lobster fishery is shared between Australia and Papua New Guinea, and the Australian sector is managed by the Protected Zone Joint Authority (PZJA). In Australian waters the fishery is further sub-divided into the indigenous (islander) and non-islander sectors and managed to maximize the opportunities for the traditional inhabitants. To this end expansion in participation is limited to traditional inhabitants.

In Torres Strait ornate rock lobsters *Panulirus ornatus* are taken exclusively by diving, and trawling for lobsters was banned in 1984. About 500 licensed islander fishers based at the many island communities operate from small (<6 m) dinghies. The non-islander sector consists of about 21 freezer boats (7-20 m), each with 1-7 small tenders operating from it. Hence, the non-islander sector is more mobile and more readily able to maintain catch rates by moving between areas.

The fishery is currently managed by input controls supported by annual stock assessments based on fishery-independent population surveys conducted since 1989. Historical (prior to 1996) estimates of exploitation indicated that the combined catches of the islander and non-islander sectors were below sustainable levels. Catch rates of traditional free-divers were shown to be unaffected by higher catches made by divers using hookah equipment and research showed that small hookah exclusion zones around islands could conserve the traditional island-based catch.

More recently, with increasing stock abundance the ratio of islander to non-islander catch is falling, prompting effort reduction in the non-islander sector. New quota management, including a 50:50 share for islanders and non-islanders may simplify the allocation of catch, but a new suite of complications may arise

Introduction

In Australia, the ornate rock lobster *Panulirus ornatus* supports a small but locally important commercial fishery in Torres Strait. The fishery, currently worth ~$A12 million annually, is shared by Australia and Papua New Guinea and is a major source of income for Torres Strait traditional inhabitants. For these reasons the Torres Strait lobster population has been the focus of biological and fishery research carried out by the CSIRO and PNG Fisheries during the past two decades. Early research focussed on documenting the biology of the ornate rock lobster including: reproduction and migration (Moore & MacFarlane, 1984; Macfarlane & Moore, 1986; Bell *et al.* 1987, Trendall & Prescott, 1989, Dennis *et al.* 1992), diet (Joll & Phillips, 1986), genetic stock structure (Salini *et al.* 1986) and stock distribution (Prescott & Pitcher, 1991). With increasing catches during the 1990s the focus of research changed to assessment of the status of the stock and the impact of islander and non-islander fishery sectors. This research aimed to provide managers with the information required to manage these sectors of the fishery through input controls including; minimum size, seasonal closures, gear restrictions and effort reductions. In 2005 the PZJA moved to a 50/50 share of Australian commercial entitlements between Torres Strait Islanders and non-islanders in all Torres Strait fisheries. New research is underway to allow sustainable allocations to the islander and non-islander sectors of the fishery; including pre-season stock abundance surveys.

This paper presents an overview of the outcomes of past research conducted by CSIRO to support sustainable management of the shared Torres Strait lobster fishery, including two case studies, and describes future research needed to allocate sustainable catches to the islander and non-islander sectors under a new quota management system.

Torres Strait Lobster Fishery

The Torres Strait lobster fishery extends from the north-east tip of Australia to south-west Papua New Guinea and is managed by the two countries in

accordance with the Torres Strait treaty signed in 1985. The treaty established the Torres Strait Protected Zone (TSPZ). The commercial fishery in Torres Strait began in the late 1960s, after a processing factory was established on Thursday Island.

As ornate rock lobsters in Torres Strait waters do not enter baited traps, they are taken by divers with spears or are caught alive with hand-held nets. Divers generally work in pairs from small dinghies and either free-dive or use a 'hookah' that supplies compressed air from the surface. Free-divers work in waters to about 5 m deep, while hookah divers work in waters to around 25 m. This species was also taken by trawling prior to 1984 when a ban was placed on this practice to conserve emigrations of breeding lobsters. The fishery was based solely on frozen lobster tails, sold on the domestic and overseas (mainly the United States) markets, until the mid-1990s. Subsequently, the trade in live lobsters has continued to grow with established domestic and export markets for them.

The commercial diver fishery is comprised of two sectors; islander fishers and non-islander fishers. Islander fishers operate from small (<6 m) dinghies and are based on one of the many island communities. Islander fishers are required to hold a Traditional Inhabitant Boat (TIB) licence to fish commercially in the Torres Strait, and sell their catches to a shore-based processor. Most non-islander fishers operate from licensed primary vessels, each with a small number of tender vessels (< 6 m) working from it. Catches are stored onboard, either frozen or live, for several days and unloaded to a shore-based processor or mother-ship. There are a small number of islander divers working on the primary vessels.

The annual catch of ornate rock lobster by islander and non-islander divers combined in Torres Strait during the past two decades ranged from 120 t to 800 t (whole weight) and averaged 480 t, whilst PNG divers averaged about 170 t. Annual catches trended upwards through the 1990s, but declined dramatically during 1999 to 2001, raising concerns that the fishery was unsustainable. However, since then stock abundance has increased steadily and recent catches are above the long-term average.

Fishery Management

The Australian Torres Strait lobster fishery is managed by the Australian Fisheries Management Authority (AFMA) under the Protected Zone Joint Authority (PZJA). The fishery is managed to conserve the stock and to maximise the opportunities for traditional inhabitants. There are currently about 500 TIB licensed vessels and 21 primary vessels with a total of about 80 attached tenders operating in the fishery.

Until recently there was no specific allocation of catch to the islander and non-islander sectors in either Australia or PNG, but expansion was reserved to islanders. The PZJA capped the number of licences in the non-islander sector and a boat replacement policy was implemented to prevent effort creep. During the 1990s the fishery was managed by ensuring a conservative "escapement" of 75%. To meet this target a minimum size of 100 mm tail length and a ban on "hookah" equipment during October-November were introduced, in addition to limiting the fishing method to diving. However, as a response to a dramatic stock decline during 1999-2001 new management that was shown to be sustainable under a CSIRO fishery model was implemented in 2002. Current controls include a seasonal ban on all fishing during Oct-Nov and a ban on the use of 'hookah' equipment during Dec-Jan and a minimum size of 115 mm tail length or 90 mm carapace length. The conversion from frozen tail to live product was actively encouraged by management as each live animal is about two times more valuable than its frozen tail. During 2003-2005 non-islander tender effort was reduced by 30% in an attempt to maintain catch in this sector at a level that would result in a total catch under estimated maximum sustainable yield (640 t whole weight, Ye *et al*, 2004).

Fishery-independent population surveys

Until 2003 there was no comprehensive monitoring of catch and effort in the Torres Strait lobster fishery and annual catch data was gained from shipping companies carrying product out of Torres Strait. Hence, there was no reliable information on stock abundance. In 1989, absolute lobster abundance in Torres Strait was estimated by CSIRO and PNG DFMR using visual census of 542 sites distributed over the ~25,000 km^2 area of the fishery (Pitcher et al., 1992). In that year there were between 11-17 million lobsters in Torres Strait, of which about 8 million were legal size. The estimated stock size was 2200 to 3350 t tail weight, which was about ten-fold greater than the annual catch of ~250 t. This initial assessment suggested that the lobster population in Torres Strait could support the fishing effort at that time and that the population would likely support much higher exploitation by both islander and non-islander sectors, provided stock abundance remained at similar levels.

Following the 1989 lobster stock survey AFMA funded annual fishery-independent population monitoring, to be referenced against the 1989 stock benchmark. Since 1989, monitoring of the lobster population has continued at a sub-set of 100 (1990-1995) or 82 (1996-2005) of the 542 sites used in 1989, to determine the relative abundance of the recruiting and fished year-classes (1+ and 2+ years old respectively). A benchmark survey, involving 375 sites, was conducted in 2002 to update the information gained during the 1989 survey. Fishery-independent surveys have been conducted by CSIRO during May/June each year between 1989 and 2005. In addition, a pre-season survey involving 154 sites was conducted in November 2005, to provide current information on recruit abundance and allow forecast of future stock.

The fishery-independent surveys involve divers counting and collecting lobsters during timed swims at each site located throughout central and western Torres Strait. The abundance and size distribution data from the annual surveys were used to calculate fishery independent indices of the

relative abundance of the recruiting (1+) and fished (2+) year-classes (Figure 1). The abundance indices are compared with, and corroborated by CPUE information recorded during island-based commercial catch monitoring.

An abrupt decline in abundance of recruiting (1+) lobsters during 1999-2001 raised concerns about the sustainability of this fishery, particularly given the low stock levels in the same years. New management was implemented in 2002 in the Torres Strait fishery to allow the stock to recover to historical level.

The relative abundance indices were compared with indices from previous years and provided information on the relative strength of both year-classes and forewarning of trends in future stock size.

Figure 1. Numbers of 1+ (open bars) and 2+ (filled bars) lobsters seen during annual surveys of the Torres Strait lobster population between 1989 and 2005. Error bars represent standard errors.

The stock (2+) abundance indices, used as a proxy for relative abundance of the breeding population, compared with the recruit (1+) abundance indices 2 years hence, provided information on the Stock-Recruitment (SR) relationship. The SR relationship is a critical component of the updated dynamic fishery model used to assess the status of lobster stocks in Torres Strait.

"HOOKAH" DIVER VERSUS FREE-DIVER CATCH RATES

Traditional fishing for lobsters was by free-diving or night spearing in shallow waters surrounding the many Torres Strait reefs. During the late 1980s, with increased participation and catch, many divers embraced the use of "hookah" systems (small petrol-driven compressors) to extend their fishable depth and bottom time. However, many islander fishers continued to free-dive around their "home reefs" during traditional and commercial fishing and in the mid-1990s concern was raised that "hookah" fishing may be impacting the catch rate of free-divers.

In 1988 CSIRO began commercial catch monitoring at Mabuiag and Badu Islands to provide AFMA with information on the indicative trends in catch and effort of the island-based fishery. Annual monitoring was conducted over 4 weeks in June/July until 2001 to coincide with annual fishery-independent population surveys. As part of the island-based monitoring the fishing method used was recorded for subsequent statistical analysis and this data allowed a comparison of trends in the CPUE of islander free-divers and "hookah" divers.

A total of 1121 records of daily catch and effort were available for the comparison of free-dive (514 records) and "hookah" (607 records) CPUE (kg/diver/hour). The effect of fishing method was tested using an ANOVA (SAS software) which accounted for year, diver and the number of divers per dinghy. The CPUE of "hookah" divers was significantly higher than that of "free divers", overall by 48%. However, there was no widening of the gap between the two methods over time (Figure 2), suggesting that "hookah" divers were not adversely affecting the catch rates of free-divers.

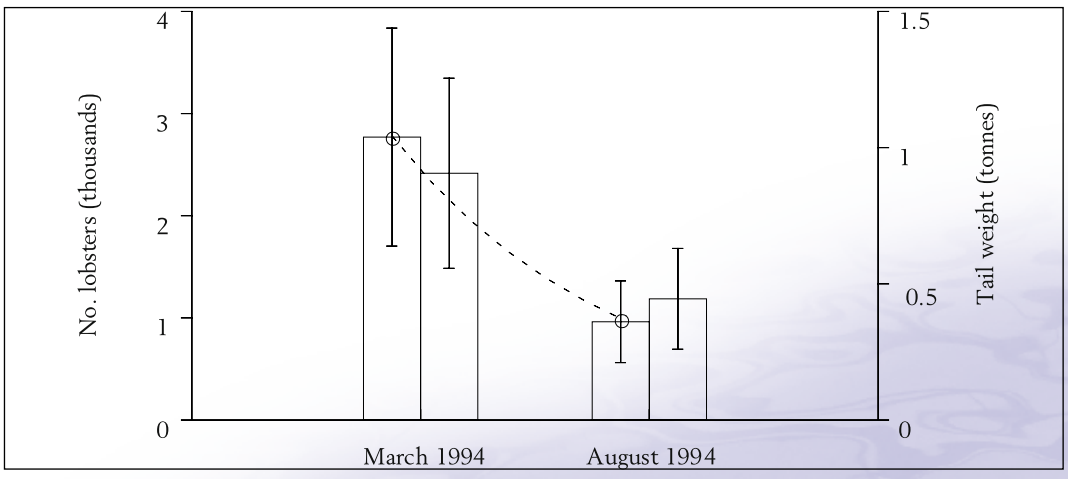
Figure 2. The catch rate of lobsters (kg/diver/hour) for Torres Strait hookah divers (open bars) and free divers (filled bars) based at Badu/Mabuiag Island (error bars are 95% C.I.). The results of two-way ANOVA (year by method) is shown.

Local depletion of traditional "home" reefs

In 1993 concern was again raised about the impact of "hookah" diving on the catch rates of islander free divers. Torres Strait Islanders became concerned about non-islander "hookah" divers taking lobsters in deep water close to their traditional "home" reefs. This concern lead to a study by the CSIRO to determine when and how lobsters moved from deep water onto a shallow reef-edges fished by local islanders. The study was conducted at Warraber Island in central Torres Strait, which has a small but locally important fishery.

Divers counted and measured lobsters on the shallow reef-edge and nearby deep grounds, during a pilot study in August 1993 and at the start (March) and end (August) of the main fishing season in 1994. The number of lobsters caught on the shallow reef during that time was estimated from freezer records and interviews. In 1994 fishing and natural mortality accounted almost exactly for the change in numbers of lobsters on the "home" reef-edge, suggesting that very few lobsters moved onto the reef-edge between March and August (Figure 3).

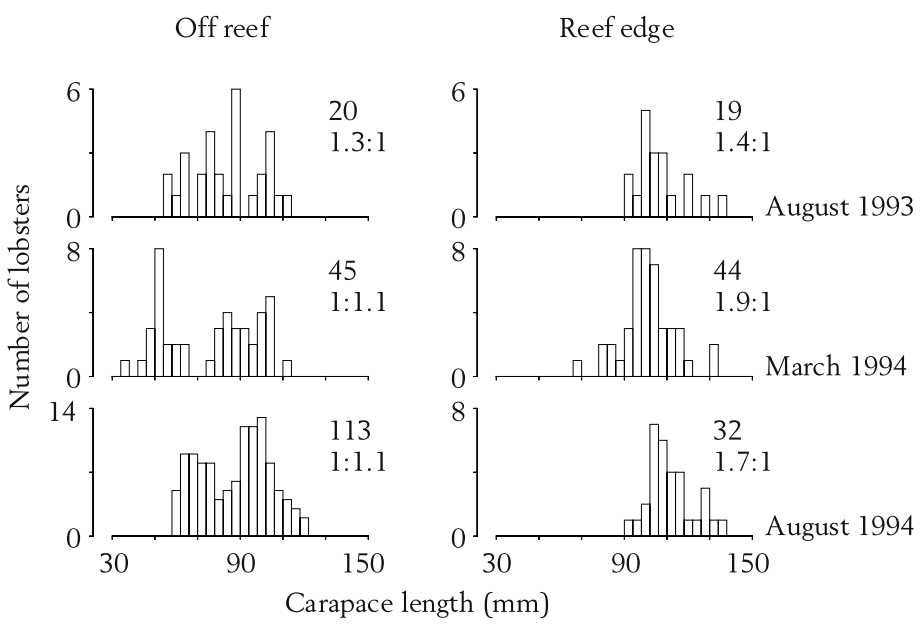
Figure 3. Number (open bars) and tail weight (filled bars) of lobsters on the reef-edge at Warraber Island in March and August 1994. The dashed line shows the decline in numbers that would be expected due to natural mortality and fishing by islanders.



However, lobsters had to move onto the reef-edge at some time to replace those lost to fishing and from natural causes. The reef-edge population was comprised almost entirely of large (>90 mm CL) lobsters, whereas the off-reef population was comprised of small (1+ year old) and large (2+ years old) lobsters (Figure 4). Nearly all large (2+) lobsters migrate at the end of the main fishing season (Skewes *et al.* 1994), leaving small (1+) lobsters. Some of these small lobsters subsequently move up onto the reef-edge during summer.

As most of the legal-size lobsters off the reef-edge would migrate at the end of the fishing season, and would not move onto the reef-edge, fishing for legal size lobsters in deep water next to the reef-edge would usually have little effect on the reef-edge fishery. In addition, the small lobsters that do recruit to the reef-edge are protected by the minimum size limit and the seasonal ban, which at the time of this study covered October-November.

Figure 4. Size-frequency distributions of lobsters sampled off the reef and on the Warraber Island reef-edge on three sampling occasions in 1993 and 1994. Numbers on each graph are number sampled and sex ratio (M:F).



In some years when large (2+) lobsters are scarce, commercial fishers catch a greater proportion of 1+ lobsters, which could reduce the number available to move up onto the reef-edge. To prevent this happening it was recommended that "hookah" fishers should not fish within 2 km of the reef-edge. The surveys showed that this off-reef area contained about ten times more 1+ lobsters than would be needed to fully replenish the reef-edge, after the migration (Table 1).

Table 1. Estimates of the number of lobsters within 2 km of the Warraber Island reef-edge and on the reef-edge during three separate sampling occasions in 1993, 1994 from diver survey counts.

	Stock estimate (# lobsters) and 95% CI		
Habitat	Pilot (August 1993)	1st survey (March 1994)	2nd survey (August 1994)
Off-reef	39618 ± 18620	32839 ± 11645	36884 ± 11518
Reef edge	3719 ± 1603	2770 ± 1067	962 ± 400

Conclusions

This study showed that few lobsters move onto the reef-edge during the main fishing season and those that did move onto the reef-edge were protected by minimum size and a seasonal "hookah" ban. Hence, the impact of "hookah" fishing in the vicinity of the reef-edge fishing grounds was likely to be small. Nevertheless, by conserving the off-reef lobster population within 2 km of the Warraber Island reef-edge a surplus of lobsters would be available to replenish the reef-edge.

Recent Islander and non-islander catch

Prior to 1997 there was no compulsory logbook program to monitor the Torres Strait lobster catch and effort, although some primary vessel owners completed logbooks voluntarily. Total annual catch was obtained from shipping records. In 1997 AFMA logbooks became compulsory for operators of primary vessels and this program allowed comprehensive monitoring of the non-islander sector's catch and effort. In 2003 a docket book system was implemented by AFMA for shore-based freezers to cover the islander catch and effort. This program has subsequently allowed comprehensive monitoring of all sectors of the fishery, except the traditional non-commercial sector, which is relatively small.

Recent recovery and entry of historical catch data from shore-based freezers by AFMA has allowed a comprehensive assessment of the total catches of the islander and non-islander sectors since 2001 (Table 2). The annual catches have increased dramatically since the record low in 2001, following the trend in increased stock abundance (Figure 3). The increasing stock abundance saw an eight-fold increase in the non-islander sector catch whilst there was only a three-fold increase in the islander sector catch over the same period. The islander sector has accounted for 25-43% of the total over the past four years and the recent decision by the PZJA to allocate 50% to each sector will see islander fishers allocated a greater share.

Table 2. Commercial catches of lobsters from the islander and non-islander sectors of the Torres Strait lobster fishery between 2001 and 2005.

	Lobster catch (tonnes whole)			
Year	Non-islander sector	Islander sector	Total	% Islander sector
2001	70	53	123	43
2002	144	65	209	31
2003	350	118	468	25
2004	465	257	722	36
2005	523	370	893	41

FUTURE RESEARCH TO SUPPORT SECTOR CATCH ALLOCATIONS

A decision by the PZJA in July 2005 to move to a 50/50 share of Australian entitlements between Torres Strait Islanders and non-islanders means that new research will need to be implemented to support the quota management system (QMS). The main objective of research under the new system will be to provide forecasts of stock abundance so that sustainable sector allocations can be made. The PNG sector will be included in this allocation adding complexity to the new management system.

To provide effective information on fishery recruit (1+) abundance the annual population surveys will be moved from mid-year (May/June) to pre-season (November) and the first of these surveys was undertaken in 2005. At the time of the pre-season survey the population is comprised almost entirely of one year-class, which is subsequently fished in the following year until August/September when this year-class emigrates to breed. Hence, the estimate of abundance from the pre-season survey must be precise to ensure the sector quota allocations are below maximum sustainable yield. The allocations will also be determined using predicted natural mortality, which has been extremely variable in the past ($M \approx 0.4 - 0.8$). In addition, the sector allocations must account for catch sharing with PNG, as outlined under the Torres Strait Treaty.

Most importantly the success of the quota management system will rely heavily on timely and effective monitoring of the sector catch and effort. The quota management system will for the first time increase the likelihood of fishers under-estimating their catch, and there will be far greater need for catch validation by AFMA. Also for the first time there will be a need to apportion the sector quotas amongst individual fishers or licences, and this process will be determined by an independent allocation advisory panel. In the non-islander sector this will likely occur through an open tender process. However, in the islander sector this may occur at an island community level, and such a system will likely lead to new complications for this fishery, particularly in years of low stock abundance.

In any case the new quota management system will now set a definite limit on catch, rather than effort, in this fishery. Given that the islander sector has accounted for only about 40% of the total catch in the past the new challenge will be to ensure this sector takes near its allocation.

References

Bell, R.S., Channells, P.W., MacFarlane, J.W., Moore, R., Phillips, B.F. 1987. Movements and breeding of the ornate rock lobster, *Panulirus ornatus*, in Torres Strait and the northeast coast of Queensland. *Aust. J. Mar. Freshw. Res.*, 38: 197-210.

Dennis, D.M., Pitcher, C.R., Skewes, T.D., Prescott, J.H. 1992. Severe mortality of breeding tropical rock lobsters, *Panulirus ornatus*, near Yule Island, Papua New Guinea. *J. Exp. Mar. Biol. Ecol.*, 162: 143-58.

Joll, L.M. & Phillips, B.F. 1986. Foregut contents of the ornate rock lobster *Panulirus ornatus*. Pp. 212-217. In: Haines, A.K., Williams, G.C. & Coates, D. (eds.) *Torres Strait fisheries seminar, Port Moresby, 11-14 February 1985*. Australian Government Publishing Service: Canberra.

MacFarlane, J. W., and Moore, R. (1986). Reproduction of the ornate rock lobster, *Panulirus ornatus* (Fabricius), in Papua New Guinea. *Aust. J. Mar. Freshw. Res.*, 37: 55-65.

Moore, R. & MacFarlane, W. 1984. Migration of the ornate rock lobster, *Panulirus ornatus* (Fabricius), in Papua New Guinea. *Australian Journal of Marine and Freshwater Research*, 35: 197-212.

Pitcher, C.R., Skewes, T.D., Dennis, D.M. & Prescott, J.H. 1992. Estimation of the abundance of the tropical rock lobster, *Panulirus ornatus*, in Torres Strait, using visual transect survey methods. *Mar. Biol.*, 113: 57-64.

Pitcher, C.R., Dennis, D.M. & Skewes, T.D. 1997. Fishery-independent surveys and stock assessment of *Panulirus ornatus* in Torres Strait. *Mar. Freshw. Res.*, 48: 1059-1067.

Prescott, J. H. & Pitcher, C. R. 1991. Deep water survey for *Panulirus ornatus* in Papua New Guinea and Australia. *Lobster Newsl.*, 4(2): 8-9.

Salini, J., Rintoul, G., Shaklee, J.B. & Phillips, B.F. 1986. An electrophoretic analysis of stock structure in the ornate tropical rock lobster, *Panulirus ornatus*. Pp. 218-232. In: Haines, A.K., Williams, G.C. & Coates, D. (eds.) *Torres Strait fisheries seminar, Port Moresby, 11-14 February 1985*. Australian Government Publishing Service. Canberra.

Skewes, T.D., Pitcher, C.R. & Trendall, J.T. 1994. Changes in the size structure, sex ratio and moulting activity of a population of ornate rock lobsters,

Panulirus ornatus, caused by an annual maturation moult and migration. *Bull. Mar. Sci.*, 54: 38-48

Skewes, T.D., Dennis, D.M., Pitcher, C.R.. & Long, B.G. 1997. Age structure of *Panulirus ornatus* in two habitats in Torres Strait, Australia. *Mar. Fresh. Res.*, 48: 745-750.

Trendall, J.T. & Prescott, J.H. 1989. Severe physiological stress associated with the annual breeding emigration of *Panulirus ornatus* in the Torres Strait. *Mar. Ecol. Prog. Ser.*, 58: 29-39.

Ye, Y., Pitcher, C. R., Dennis, D. M., Skewes, T. D., Polon, P. K., Kare, B., Wassenberg, T. J., Haywood, M. D. E., Austin, M. D., Koutsoukos, A. G., Brewer, D. T., Bustamante, R. H. & Taranto, T. J. 2004. Benchmark abundance and assessment of the Torres Strait lobster stock. *CSIRO Mar. Res. Final Rep.* pp 79.