1. GENERAL INTRODUCTION

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1.1 Torres Strait

1.1.1 Geography

Torres Strait is a tropical body of water lying between the tip of the Cape York peninsula and the south coast of Papua New Guinea and bordered on the east and west by the Coral Sea and Arafura Sea respectively (Figure 1). The strait is shallow, usually less than 15 m deep. It extends 100 km north-south and 20 to 60 km east-west (Wolanski 1986). This region has extensive coral reefs, numerous coral cays and some continental islands. There are more than 70 islands throughout the Straits' 8 000 km² sea area. Seventeen of these are inhabited by Islander communities (Bain 1986). The largest reefs in Torres Strait are the Warrior Reefs which extend for 65 km roughly north-south, bisecting the region and separating the Coral Sea to the east from the Arafura Sea to the west. Torres Strait is separated from the deeper waters of the Coral Sea by a ribbon of reefs which are a continuation of the outer Great Barrier Reef. Immediately to the east of the Warrior Reefs is the Great North East Channel. This channel is 20-40 m deep and continues as far as Papua New Guinea making it important as an international shipping route. It is this region where most of the Torres Strait fisheries are located (Anon. 1987a).

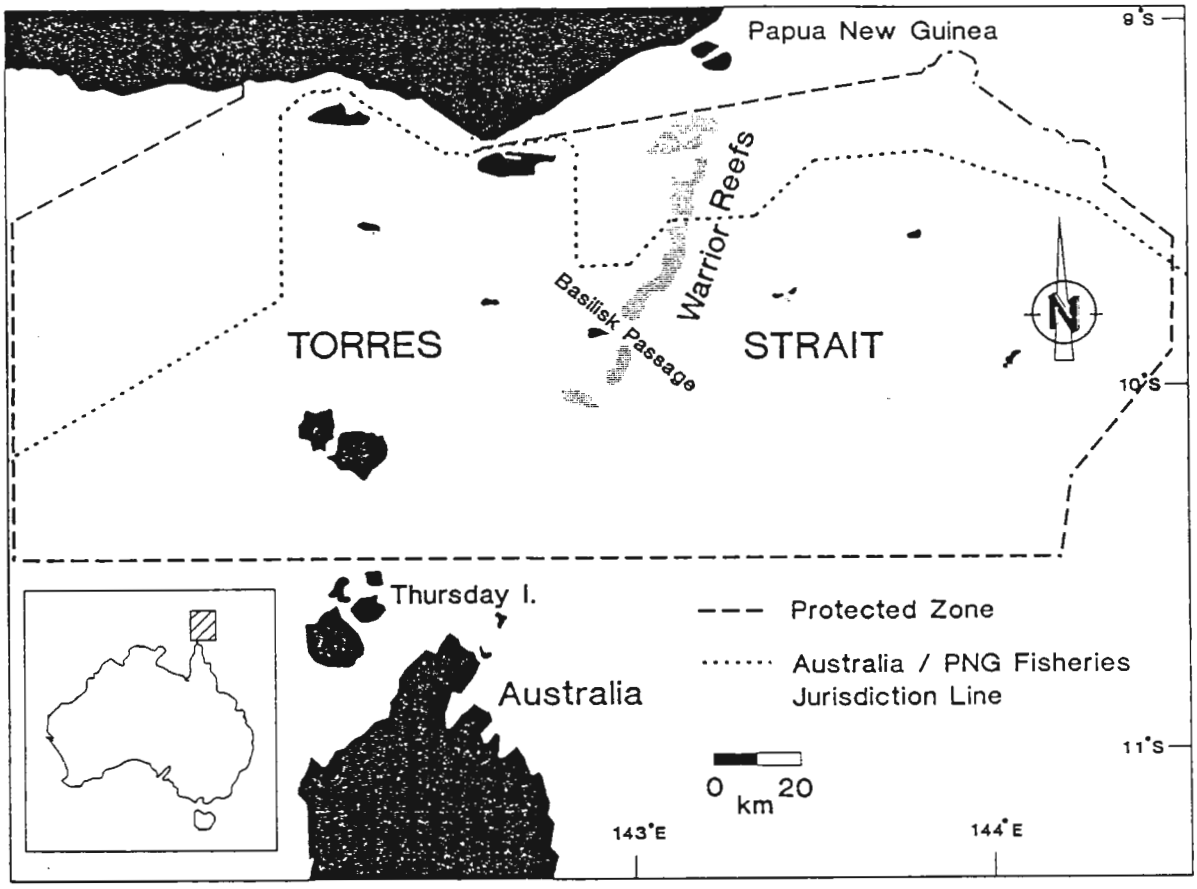

Figure 1. Torres Strait Protected Zone and Fisheries Jurisdiction Line.

1.1.2 Winds

The seasonal fluctuations of the winds in Torres Strait are comprised of the south-east trade winds from April to November and the northerly monsoon from December through to March (Wolanski 1986). For the eight months between April and November the wind is predominately (about 90% of the time) from the east-south-east. For 66% of this time the wind is greater than 20 knots (Anon. 1987a). During the other four months of the year, December-March, the monsoonal winds have a north-westerly component and are generally (about 70% of the time) less than 20 knots.

1.1.3 Rainfall

The two patterns of wind circulation are correlated with well defined wet and dry seasons in this region. The wet season corresponds to the Northwest Monsoon period and the dry season corresponds to the period when the Southeast Trade winds influence the entire Queensland coast (Brandon 1970). As a consequence Torres Strait receives 70% of its rainfall between January and March and is comparatively dry for the rest of the year (Brandon 1970).

1.1.4 Sediments and currents

Sediments and currents were reported extensively by Harris, Schneider and Baker (1988). In general, sediments of Torres Strait are in the category of very muddy sands, that is, they have a relatively low content of mud (< 40%, Harris 1988). There is no reported net current through Torres Strait. The currents that are present are swift (up to 1.0 m^{-1}) and strongly tidal (Wolanski 1986). These currents alternate eastward then westward and bear some correlation with sea level differences between the Arafura Sea and the Coral Sea, as well as with the east-west wind component (Anon. 1987a).

1.1.5 Temperature and salinity

Shallow depths, strong winds and currents ensure that the waters of Torres Strait are well mixed with respect to temperatures and salinities. Salinities in the Great North East Channel range from 31.5 to 36.0 gl^{-1} (Somers *et al.* 1987) depending on the degree of freshwater intrusion from the considerable river discharge into the Gulf of Papua from the Fly River, Papua New Guinea. Surface sea temperatures range from about 25°C to 30°C.

1.1.6 Seagrass meadows

Seagrass beds act as nursery grounds for juvenile prawns (Coles and Lee Long 1985; Staples *et al.* 1985 and Coles *et al.* 1987). Extensive seagrass beds occur throughout Torres Strait around the coasts of the continental islands; on reef flats; and lagoons of the atolls and reefs and; in the shallow open ocean of the northwestern Torres Strait. It is believed that only a small proportion of these beds formeffective prawn nursery grounds, therefore it is essential for the long-term survival of the prawn stocks and fishery that these areas are not damaged.

1.1.7 Relationship between physical and environmental parameters and prawn stocks

Information on the physical and environmental parameters (temperature, sediment, salinity, currents and seagrass beds) of Torres Strait allow a better understanding of prawn behaviour with regard to distribution, spawning and recruitment patterns. Knowledge of these parameters is essential to the implementation of useful management strategies for the fishery. Awareness of seagrass nursery areas is an important aspect in the management of commercial prawn fisheries. Samples of prawn populations in nursery areas can provide a measure of the success of spawning females, as well as the timing of juvenile prawns moving to the fishing grounds.

1.2 History of Commercial Fishing in Torres Strait

Prior to European colonization of Torres Strait in 1800, the indigenous Torres Strait island people were already dependent on its marine resources such as marine turtles, dugong, reef fishes, molluscs and other invertebrates as a protein source. Trading in beche-de-mer fishing commenced in the late 1700's in this region (Shelley 1986). Wide commercial interest in the marine riches of Torres Strait first occurred with the discovery of substantial quantities of mother-of-pearl shell in 1868 (Colgan 1988). Trochus shell harvests began in 1912 (Nash 1986). Prior to the Second World War, an Australian troll fishery for mackerel existed in Torres Strait waters (McPherson 1986). During the war an Australian Army fishing unit was established at Thursday Island to supply mackerel, *Scomberomorus commerson,* to troops stationed in the area.

It was this unit that first assessed the rock lobster *Panulirus ornatus* resources of the Torres Strait. Many attempts to establish a commercial rock lobster fishery were unsuccessful during the 1950's and 1960's. In 1969, the first seafood processing factory, Norshrimp Pty Ltd, opened and this provided the much

needed facilities for this fishery to succeed (Channells 1986). With the establishment of Norshrimp Pty Ltd commercial prawn trawling also commenced in Torres Straits (Channells *et al.* 1988) and this has become one of the major fisheries for the area, with an average annual catch of 1 000 t, worth $14M(based on the 1988 average price for all species of prawns, P. Channels, Australian Fisheries Service pers. comm.).

1.3 History of the Torres Strait Prawn Fishery

There have been vast improvements in the operational efficiency of vessels in this fishery and an explosion in the number of vessels participating since 1974, when five prawn trawlers were based at Thursday Island. By the 1980's, fuel barges were moored for at least part of the year at the Yorke Islands allowing refuelling on the trawling grounds. Regularly scheduled small aircraft and even helicopter services to many Torres Strait communities allows easy access to supplies, spare parts, replacement crew and mail. Improvements in radio telephone services and the placement of telephones at many communities allows vessels to arrange supplies and repairs, and to sell their catches without delays. Mothership operators now buy prawns on the fishing grounds removing the necessity for trawlers to unload at Thursday Island or at any other port.

The Torres Strait Prawn Fishery has experienced an increase in technical innovations as have other fishing ventures in Australia. Greatly improved radar, depth sounders and sonar have enhanced the safety and the effectiveness of operations. Vessel construction and engine horse-power improvements have also occurred combining to increase the overall efficiency and endurance of fishing operations.

There were about 604 vessel masters and 453 vessels licensed to operate in Torres Strait by 1986 (Anon. 1987b). Many of these operators did not use their option to fish in Torres Strait and in 1986 only about two dozen vessels operated in Torres Strait throughout the fishing season, though in some months, nearly 70 individual vessels were recorded as fishing in this region.

The fishery is a mixed penaeid prawn trawl fishery, with *Penaeus esculentus,* brown tiger prawn, and *Metapenaeus endeavouri,* endeavour prawn, comprising about 90% of the catch. *Penaeus longistylus,* red spot king prawn, makes up the balance of the commercial catch.

1.4 Management of the Torres Strait Prawn Fishery

The Torres Strait Treaty, delimits the fisheries and seabed jurisdicitions of Australia and Papua New Guinea. Following ratification of the Torres Strait Treaty in 1985, the Torres Strait Protected Zone was declared (Figure 1). This zone consists of areas in which Australia and Papua New Guinea have jurisdiction over 'swimming' fish and sedentary species. The purpose of this zone was to recognize and protect the life and livelihood of the traditional human inhabitants, including their traditional fishing (Haines 1986). The Treaty facilitated the joint management of commercial fisheries within this zone by Australia and Papua New Guinea. The prawn fishery was amongst six fisheries initially nominated under Article 22 of this Treaty for co-operative management. Annual quotas or total allowable catches (TACs) were established for each 'Article 22' fishery to faciliate catch sharing between Australia and Papua New Guinea.

Management of the Torres Strait Prawn Fishery as a separate and distinct fishery from the Northern Prawn Fishery and the Queensland East Coast Fishery is only a recent development. Prior to the Torres Strait Treaty between Australia and Papua New Guinea, this fishery had been treated as a part of the Queensland East Coast Fishery.

Initially the fishery was small in scale and the few management measures employed were not determined by state or federal government but by the majority of the operators involved in the fishery. These measures included resting some trawling grounds until catches improved (spatial closures) and to stop trawling at certain times of the year to protect the small prawns entering the fishery (seasonal closures). At present both spatial and seasonal closures are used as management tools in Torres Strait.

1.4.1 Spatial closures

The permanent closure of an area which serves as a nursery to juvenile prawns and contains few individuals of preferred harvest size has been effectively employed in other fisheries throughout the world (Gulland and Rothschild 1984).

In October 1981, the fishing grounds to the west of the Warrior Reefs were closed to trawling under Commonwealth legislation at industry request. Industry participants believed that large catches of small, non-commercial-sized *P. esculentus,* (the most important species in the fishery) were being taken in this area.

In July 1987, an area immediately to the east of southern Warrior Reef, in the Basilisk Passage area (Figure 1), was also closed to prawn trawling all year round. Industry participants sought this closure because they believed that prawns taken in this area were generally less than optimum-sized and often 'soft and broken' (poor quality).

Another area closure implemented in Torres Strait was the absolute closure of western Torres Strait to fishing in 1988, to allow for the potential redevelopment of the pearling industry. This ban was put in place to protect prospective pearl shell beds from substrate disturbance (Anon. 1989).

1.4.2 Seasonal closures

Seasonal closures have been used effectively to select the size at first harvest in prawn stocks where there is a seasonality of recruitment into the fishery (Gulland and Rothschild 1984). Based on scientific studies by CSIRO and industry support, seasonal prawn closures that had become routine in the Gulf of Carpentaria were introduced to the north-east coast of Queensland. Although the Torres Strait Prawn Fishery is legally distinct from the two adjacent fisheries, management of this fishery has been run in parallel with the Queensland East Coast Prawn Fishery. Consequently the Torres Strait Prawn Fishery closures mirrored those of the East Coast Prawn Fishery.

The first seasonal closure to prawn trawling in the Torres Strait and East Coast Fisheries extended from January 1 to February 28, 1985, coinciding with the time when fishermen thought that small, less valuable prawns recruited into the fishery. The timing of this closure was based on information from two sources. Firstly, experienced commercial operators, indicated times of the year when trawl catchescontained a large proportion of juvenile prawns and, secondly, data had been collected by QDPI Fisheries Research Branch on the timing of prawn life cycles (Coles *et al.* 1985). As a management measure, the closure was markedly successful. In the absence of trawling, there was an increase in the total number and weight of commercially important prawns (Coles *et al.* 1985).

A similar rationale was used to establish a prawn closure the next year from 13 December, 1985 to 28 February, 1986. At the start of the 1986-87 season, however, there was no prawn closure on the east coast of Queensland, and consequently in Torres Strait. This was at the request of some sections of the industry, particulary northern-based operators. They believed that the previous year's closure had aggregated effort into the first months of fishing causing a 'pulse fishing' effect (Queensland Commercial Fishermen's Organisation consultations). Some northern operators affected by the closure believed that southern operators, whose home grounds were not part of the closure, should not participate on an equal basis when the season opened following the closure (Beurteaux 1987). Though agreement was not reached on a license scheme to address this concern, urgings from research scientists from QDPI, and an underlying belief as to the value of closures by commercial operators, allowed a closure to be reintroduced the following year from 15 December, 1987 to 1 March, 1988.

In 1989, the Torres Strait closure period was from December 23 to April 15, north of 10° 13'S and from December 23 to March 7, south of this line. The lengthened closure period in most of Torres Strait reflected the general view of operators and researchers, that a longer closure further optimized prawn catch values whilst somewhat reducing fishing effort. The area to the south of 10° 13'S supports a *P. longistylus,* red spot king prawn fishery, of which the life cycle timing requires an earlier opening date.

1.4.3 Other management measures

Other management measures enforced on the Torres Strait Prawn Fishery include gear restrictions and closures to protect other fisheries such as the rock lobster and pearl fisheries.

In September and October of 1981, a ban was placed on daylight trawling of prawn trawlers for rock lobsters in Torres Strait. This restriction was designed to stop the targeting of migrating lobstersduring the day. This was expected to provide some relief to migrating aggregations, as trawlers would find relocating the aggregations difficult the following night (Williams 1986). This ban was later extended year-round and by 1988, no trawled rock lobsters could be kept by trawlers at any time. This ensured that the rock lobster fishery remained as a diver fishery, in an effort to allow the maximum opportunity for economic development of Torres Strait and adjacent areas of both Australia and Papua New Guinea (Anon. 1987b).

In July 1985, vessel size and gear limits were introduced to the Torres Strait Prawn Fishery, in line with similar restrictions already introduced on the Queensland east coast. Vessels had to be under 20 m in length and the total combined length of net headline and footrope could not exceed 88 m. This restricted both the size and the number of nets that could be used. These management measures successfully restricted the entry into the fishery of the larger boats that fished the Gulf of Carpentaria.

In 1988, vessels which had failed to prove a recent history of trawling in Torres Strait had their endorsements cancelled in an attempt to reduce 'latent' effort - the number of vessels that could potentially fish in Torres Strait in the future. Managers wanted to circumvent the possibility of over-fishing as the fishery was already considered to be over-capitalized (Anon. 1989). This action reduced the number of endorsed vessels from 421 to about 140. Further attempts to reduce the numbers of vessels have been unsuccessful to date. Other catch restrictive measures now in place are mesh-size restrictions and a total ban on daylight trawling.

As an Article 22 fishery under the Treaty, the prawn fishery of Torres Strait is required to determine a total allowable catch (TAC). The TAC is set annually and is currently set at 1 500 t (Anon. 1989). The TAC is a requirement of the Treaty, to be used as a basis of catch-sharing, and is not necessarily a measure aimed at biological conservation (Haines 1986). From 1990, Australia and Papua New Guinea are required to begin to progressivley implement the detailed catch-sharing provisions of the Treaty, with a view to full implementation from 1995. Enforcement of the catch-sharing arrangement has still to be effected.

TACs have been unsuccessful for prawn fisheries elsewhere in the world (Pope 1983). Prawns are short lived with a single cohort alive at one time. This, combined with high year-to-year recruitmentvariability, makes it imposible for managers to respond quickly enough to set new catch quotas. As an alternative management measure to TACs the use of effort quotas is currently being considered.

1.5 History of the QDPI Torres Strait Prawn Project

In July 1985, a Queensland state government-funded project was initiated to determine the recruitment patterns, movement and distribution of the commercial prawns comprising the Torres Strait Prawn Fishery. Industry required information on prawn growth and movement so as to increase the effectiveness of spatial and seasonal closures as management strategies. This was achieved by establishing the optimum times and areas for closures. Details on the numbers and distribution of juvenile prawns were also required to assist in the formulation of annual quotas or TACs required under the Torres Strait Treaty.

Staff were appointed in 1985, and general surveys of areas of seagrass in the region were completed. In September 1985, a commercial prawn trawler was chartered to establish initial sites for sampling. General sampling commenced in late January 1986.

The project's objectives are to:

1) determine the distribution and abundance of juvenile prawns in seagrass areas. (Section 4),
2) establish the timing and pathways of recruitment and migration of the prawns. (Section 5),
3) collate historical catch data and monitor commercial catch/effort. (Sections 2 and 3),
4) determine spawning periods. (Sections 5 and 6),

5) establish growth and mortality rates. (Section 7),
6) assist management in the rationalization of spatial and temporal closures, and
7) assist management in the formulation of optimum effort levels and of a TAC.

Information obtained from the study is also being used to develop computer models to simulate the effects of different management regimes (Section 12). Such developments have application to prawn fisheries outside Torres Strait and have already been applied to management of the Torres Strait Prawn Fishery (John Stewart, Torres Strait manager, Australian Fisheries Service pers. comm.).

1.6 Conclusion

This report represents a portion of three years research. Each objective has been addressed (as listed above) and has been presented in relevant subject categories. The sections fall into broad categories of Torres Strait Prawn Fishery, Sampling, Biology, Gear and Population Dynamics. As an interim report some subject matters have only been presented in part (Sections 4 - 7 and 12) while other sections have been presented in full (Sections 2 and 3 and 8 - 10 and parts of 11).

The information presented is specifically pertinent to *P. esculentus*, brown tiger prawn, as it is the most valuable component of the fishery. Information relevant to the other commercial species that comprise this mixed fishery will be documented in subsequent reports.

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