THE NON-TRAWL CAPTURE OF PRAWNS: THE COMMERCIAL FEASIBILITY OF TRAPPING

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Summary

Prawn trawling in Australia is faced with several problems, on economic, social and environmental fronts. Trawling is fuel-intensive and economic performance is thus sensitive to fuel price movements. Because prawn trawling produces a high ratio of by-catch, ecological, conservation and social concerns about the impact of prawn trawling are growing. Non-trawl methods could provide economic flexibility and, by taking less by-catch, reduce the problems caused by high by-catch and discarding levels.

There are published accounts of trapping penaeid prawns in Australia and economic analyses suggested that trapping had economic potential. Prawn trapping was examined as a potential additional fishing method for Australia's prawn fisheries. Baited traps on long-lines were set on trawl grounds in the western Gulf of Carpentaria to test trap type, bait type, soak times and location as factors in trapping rates of the tiger prawns, *Penaeus esculentus* and *P. semisulcatus*. Concurrent trawls indicated sites of relative abundance for setting traps and gave information on prawn species, abundance, sex and size composition.

Only two individual brown tiger prawns, *Penaeus esculentus*, and two of the small penaeid *Trachypenaeus fulvus* were trapped in 945 trap lifts. It was concluded that the low catch rate depended mostly upon variables not tested.

In small experiments in an aquaculture pond, York prawns, *Metapenaeus eboracensis* were readily trapped but there was some evidence of a decline in catchability as barramundi, *Lates calcarifer*, in the pond grew. It is suggested that agonistic encounters between the prawns and the fish were partly responsible for this decline.

The results show that, if prawn trapping is to be developed as a fishing method, the ecological conditions under which catches of penaeids with traps are predictable - the "right time and right place" - need to be defined. Only then can gear development and economic evaluation realistically proceed. It is suggested that in future experimentation, large prawns should be targeted over a range of depth and seasonal conditions.

There remains considerable incentive to develop non-trawl harvest methods for prawns. Because prawns have historically been trapped, it is recommended that the first step in future research should be the duplication of the historical experiments, followed by photographic studies of the behavioural ecology of prawns with respect to traps. Opportunistic experimentation to provide observations, and laboratory and pond experiments to increase trapping power of trapping operations are also recommended.

Introduction

Background to the research project

Funding was sought to examine prawn trapping as an additional fishing method for Australia's prawn fisheries, particularly for the Northern Prawn Fishery (NPF), on the basis that it might provide economic flexibility for these fisheries and alleviate some of the environmental and sociological problems they face.

At the time the work was initiated, Australia's valuable prawn fisheries were facing various economic difficulties. They were close to full exploitation, with sustained increases in catches unlikely (Bowen and Hancock 1985). Excess fishing capacity was a common management problem. Aquaculture was providing an ever-increasing proportion of world prawn production, suppressing prices, and the outlook was that these trends would continue. The ecological and environmental impacts of trawling were regarded with increasing concern.

These needs are still apparent. Disease outbreaks have curtailed prawn production from aquaculture, and demand and prices for prawns are buoyant; farmed prawns will in the long run, however, make inroads on prices by meeting demand. In the NPF, a major and expensive reduction in the fleet has been put in place, to improve profitability of remaining operators and avoid overfishing. Should prawn prices decline, fuel prices increase, and fishing power continue to increase with technology, profitability will be eroded and stock viability will be difficult to ensure. Only the urgency rather than the need for economic flexibility has declined.

Concerns over ecological and environmental impacts of trawling have not diminished. In fact, the current focus on ecologically sustainable development, continuing concerns over the trawl mortality of turtles, conflict between resource users and the potential of large marine reserves, have amplified the importance of this aspect.

The need for research into alternative fishing methods thus remains. The economic feasibility of trapping would rely on maximised catch quality, reduced fuel costs and might require smaller capital investment, all offsetting the probable loss in catch volume and revenue relative to trawling. The possible merits of an additional fishing technique for Australia's prawn fisheries are outlined in detail in the application for funding made to the FRDC (Appendix 3).

Racek (1955, 1957) trapped prawns off the coast of New South Wales, but apart from a brief report from Indonesia (Barus 1989) and anecdotes, there is little information available on the technique. Buckworth and Cann (1992) modelled the economics of a small prawn trapping operation working in the NPF. While limited by a lack of available information on catch rates, baiting etc, they suggested that a non-trawl method such as trapping could be economically viable.

Several perceived ecological/environmental benefits would also flow from the use of traps relative to trawls, due to the more selective nature of traps and their passive action. These include reduction in by-catch, regulation of gear design, and locations of timing of fishing to manipulate population size structure. In contrast, trawling is extensive, destructive of habitat, and requires considerable fuel.

This report describes trials in which both trawling and extensive trapping operations were conducted, to provide input for economic models, and to begin the development of gear designs and fishing techniques, stimulate methodological ideas, and identify future research strategies.

Although trawls were used to pinpoint areas of relative prawn abundance, catch rates with traps were very low and most objectives of the research could not be met. In this report I have tried therefore, to provide experimental and methodological detail as a guide to future experimentation. Three appendices provide detail on different aspects of the work. Appendix 1 is in the form of an article for publication in a scientific journal, describing the comparative trawling and trapping experiments conducted at sea. Some additional trials conducted in an aquaculture pond (not part of the original project design) are reported in Appendix 2, and the application for funding of the work is included as Appendix 3.

Project objectives

1. To examine the effect of combinations of trap design, baits and setting periods on catch rates from traps.

2. To evaluate the commercial feasibility of prawn trapping operations.

3. To examine the size selectivity of trap designs, particularly in comparison with catches of small prawns by otter trawls.

4. To ascertain and evaluate differences in quality between trapped and trawled prawns, with particular reference to those destined for export alive.

The research problem

An economic model (Buckworth and Cann 1992) indicated that a profitable prawn trapping operation would require smaller catches than from trawling operations, relying on high unit value and reduced operational and capital costs. Penaeid prawns can be caught in traps: offshore stocks of eastern king prawns, *Penaeus plebejus*, giant tiger or leader prawns, *P. monodon* and brown tiger prawns, *P. esculentus* were located with traps (Racek 1955, 1957) and Barus (1989) trapped *P. merguiensis*, *P. monodon* and *Metapenaeus ensis* in inshore Indonesian waters. Baits can also be used to attract *Penaeus* prawns (Whitaker *et al.* 1992), and pandalid, caridean and deepwater penaeids are readily trapped (King 1981; Moffitt and Polovina 1987). In the NPF, there are contrasting anecdotal reports of success/failure of trapping prawns. However, the scarcity of information on trapping of prawns, particularly those in the valuable genera *Penaeus* and *Metapenaeus*, limited the applicability of economic modelling.

In pilot trials (Buckworth 1993), no prawns were caught but, because no other techniques (eg beam trawling) were used to establish prawn abundance, no conclusions about the utility of trapping could be made.

The central problems were therefore to verify that prawns can be taken with traps, identify which methodological factors (eg trap design, baits) affect trapping success, and define conditions under which catchability is highest.

Methods and results of the research

Most methodological details and experimental results are provided in Appendices 1 and 2. In this section, I provide an overview and additional detail on the planning, methodology and conduct of the experiments.

The operational objectives were to firstly, identify a set of circumstances under which prawns could be trapped, secondly, to test the effects of different factors on catch rates, and then provide the other information required in the project objectives.

The strategy adopted for these trials was to use trawling (both with the main gear and try gear) to identify areas of prawn abundance, then set traps in these areas, and test the effect of various factors on trapping rates. Trawls were also to provide information for comparison with trapping operations - relative amounts, composition and quality of prawn catches.

The operators of the NPF-endorsed trawler *Glen Eagle* offered the use of their boat and crew on the arrangement that fuel would be paid for and that they would be able to keep any product; funds were not available for full charter of a vessel.

Habitats, trap types, baits and soak times were identified as probable factors affecting catch rates achievable with traps. Operations were centred in the Groote Eylandt region of the western Gulf of Carpentaria, an area of historical high trawl catch rates for tiger prawns and well known as a research site (see Fig. 1, Appendix 1). Within the area, sites were chosen to provide contrasting species compositions, related to habitat (Somers *et al*. 1987) and contrast in the level of fishing to which the areas have been exposed. The experimental design proposed was basically a randomized blocks design, with Trap Design and Bait Type as orthogonal factors, with replication, nested within longlines, nights and locations. By numbering traps and lines individually, the ability to subject results to *post hoc* statistical analyses (runs tests etc) was also included.

Four trap types (see Fig. 2, Appendix 1) were chosen on the basis of availability, ease of construction and to incorporate different design features. As suggested in previous work (Buckworth 1993), entrances were relatively small to reduce entry of large by-catch items, and no tangle panels were included. The type A trap (see Appendix 1 for figures) was similar to Racek's (1955) traps, but used an entrance that it was felt would be more easily standardized than a slot cut in the birdwire covering of the trap (as Racek used).

A cylindrical trap with a large funnel entrance in one end of the cylinder, type B was the only trap designed to roll in the current flow, so that the scent plume from the bait would direct prawns to the funnel. Type C was a shorter cylinder, designed to rest on one of the ends, and similar to crab traps used in the North Atlantic, was notable for its ease of construction. The same funnel entrance as in type A was used, but placed so that it would be very near to the substrate when set.

The scampi trap, type D, was the only design which used two entrances, and because of the funnel construction, a large part of the area presented by the trap led to the entrances. These traps were covered in trawl netting rather than birdwire and required much more labour in covering the traps and constructing the entrances than the other traps. However they were much easier to handle than the other designs and ultimately more durable because the bird wire tended to be brittle.

Traps were individually numbered with PVC cattle ear tags.

A wide variety of baits were used (Appendix 1), to identify if possible a bait or baits that were markedly more successful than others. Bait amounts were standardized at 100g, again to reduce potential variance, arising from differences in bait amount. To this end, and to reduce labour at sea, baits that were available in Darwin (squid, horse, liver, chicken and pilchards) were pre-packed and frozen.

Traps were attached to long-lines with 1 m snoods, at about 15 m spaces. The order of traps was randomized during the first few nights; however, when it became clear that the pressing objective was to identify trap, bait and location combinations that trapped prawns, trap order was systematised. The order of baits within trap designs was randomized. The number of traps that could be set was constrained by the work required to maintain the order of traps and baits, and by the work space available on the rear deck of the small NPF trawler (with a large brine tank that is typical of NPF vessels).

A range of soak times was provided by, on most nights, retrieving the lines of traps in reverse order - so that the last traps set were the first recovered.

Trapping operations were readily carried out from the small trawler. Space restrictions were imposed by a work deck set up for trawling, processing and storage, and visibility from the wheel house made precise manoeuvring during trap retrieval difficult at times. Little modification would be required to overcome these problems in a vessel dedicated to both fishing techniques. Use of snatch blocks and the trawl winch niggerheads for setting and retrieval of the trap long lines meant that no modification of the vessel was necessary; installation of a pot hauler would, however, be necessary for more extensive work.

Some seasonal and life history contrast was included in the original project design by planning for two comparative trawling/trapping experiments (sets of experiments to be held in March and June/July). The very low catch rate produced in the March series, and the lack of an available vessel, meant that the program was terminated after one cruise.

Only two small tiger prawns (*P. esculentus*) and two hardback prawns (*Trachypenaeus fulvus*) were trapped, despite an overall trawl catch rate of 15.1 (2.4 s.e.) kgh^{-1} (see Appendix 1).

Extent to which objectives were achieved

The first objective was only partially achieved: the catch rate with traps was so low that the specified factors could not be evaluated. Some indication was, however, made of what conditions might be necessary for prawns to be trapped.

With the very low trapping rates reported here, trapping could not be an economically viable fishing method (a hundred-fold increase in the trapping rate, at least, would be required). However, conditions may yet be defined under which the method could be applied profitably. The funded research defined some future research directions.

The underlying requirement for achievement of the other objectives was to catch sufficient prawns with traps and hence these objectives could not be addressed. With the very low trapping rate, the planned quality comparisons could not be carried out. However it is of interest that the prawns which were trapped were alive, and that of the nine live prawns used to bait the traps, all but one were recaptured alive.

Difficulties encountered

The major difficulty encountered was in obtaining a vessel for the comparative trawling and trapping experiments. This made planning difficult (for example, predicting what modifications to vessel hydraulics would be required if it were necessary to install a pot hauler), and meant that only one set of experiments could be undertaken.

Discussion and Recommendations

Detailed discussion of the results is provided in Appendices 1 and 2. The essential conclusion of the research presented here is that development and application of prawn trapping as a fishing method depends upon predicting "the right time and the right place" at which prawns can be trapped: the correct range of ecological conditions needs to be defined. Testing of gear designs and baiting could improve catching power but would have little advantage until such time as prawns could be predictably trapped.

Recommendations:

The incentives to develop non-trawl methods to catch prawns remain, and the following recommendations for the development of trapping are made:

1. The trapping methodology, including locations and times, used by Racek (1955, 1957) should be duplicated in an experiment to ascertain whether prawns can still be trapped at those sites using his methodology, and if successful, to use this as a starting point to define conditions under which prawns can be caught;

2. Where field conditions are suitable, use of video or timelapse photosequence should be made to study the behaviour of prawns near and in traps (observations could be extended to behavioural experiments). Trapping methodology might be modified and tested as a consequence;

3. Opportunistic experimentation with traps over a wide range of times and sites, to generate observations. Testing of traps at deeper water sites of known prawn concentrations is probably the most important of these;

4. Use of laboratory and pond experiments to improve trap design and baiting methodology, with field validation.

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Appendix 1. Article for submission to a scientific journal.

Traps Catch Few Penaeid Prawns in the Gulf of Carpentaria: Why?

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Abstract:

Prawn (shrimp) trawlers use a great deal of fuel and a produce a high ratio of by-catch, leading to ecological, conservation and social concerns. Non-trawl methods could provide economic flexibility and, by taking less by-catch, reduce the problems caused by high by-catch and discarding levels.

Baited traps on long-lines were set on trawl grounds in the western Gulf of Carpentaria, Australia, to test trap type, bait type, soak times and location as factors in trapping rates of the tiger prawns, *Penaeus esculentus* and *P. semisulcatus*. Concurrent trawls indicated sites of relative abundance for setting traps and gave information on prawn species, abundance, sex and size composition.

Only two individual brown tiger prawns, *P. esculentus* , and two of the small penaeid *Trachypenaeus fulvus* were trapped in 945 trap lifts. It was concluded that the low catch rate depended mostly upon variables not tested. The results show that, if prawn trapping is to be developed as a fishing method, the ecological conditions under which catches of penaeids with traps are predictable, need to be defined. Only then can gear development and

economic evaluation proceed. It is suggested that in future experimentation, large prawns should be targeted over a range of depth and seasonal conditions.

Introduction

Prawn (shrimp) trawlers use a lot of fuel relative to the target catch, and are non-selective in what they catch. Consequently, the profitability of prawn trawling operations is sensitive to fuel costs, and typical by-catch: prawn ratios are 10:1 or more in tropical and subtropical fisheries (Andrew and Pepperell, 1992).

Several ecological, conservation and social issues are prompted by the large quantities of by-catch which, in most industrial fisheries, are discarded. Trawling and subsequent discarding may create conflict between resource users by destroying juveniles or baitfishes of commercially or recreationally important fish species (Hill and Wassenberg, 1990). It may engender changes in faunal composition (Harris and Poiner 1991), or impact on species important to conservation, such as sea turtles (Henwood and Stuntz 1987; Poiner *et al.* 1990). These concerns have been addressed in part by management measures (eg closures, Somers, 1990) and trawl efficiency devices (reviewed by Andrew and Pepperell, 1992). Non-trawl harvesting methods for penaeid prawns could alleviate some of these problems and provide additional economic flexibility (Buckworth and Cann, 1992). However they have received little research attention in all but essentially artisanal fisheries (eg Whitaker *et al.* , 1992).

Deep water caridean and penaeid prawns may be trapped (King, 1981; Moffitt and Polovina, 1987). In many artisanal fisheries, penaeids are taken in fixed traps in the inner littoral zone, and in baited pots in culture ponds (Vendeville, 1990). Penaeids are attracted to baits (Whitaker *et al.* ,1992) and there are frequent anecdotal accounts of prawns entering crab pots (I. Knuckey, NT Department of Primary Industry and Fisheries, pers. comm.). Only Racek

(1955, 1957) and Barus (1989), however, have published accounts of trapping of the valuable *Penaeus* and *Metapenaeus* species, in habitats usually fished by trawling. It has thus been established that penaeids are attracted to baits and can be trapped, but it has yet to be defined under what circumstances prawn trapping would be a reliable fishing method, and would be profitable.

Buckworth and Cann (1992) suggested that prawn trapping might be an economically feasible fishing method for Australia's Northern Prawn Fishery (NPF), by maximising catch value compared to operational costs. The NPF extends across the continent's northern tropical coast, between 127^{o} E and 142^{o} E. Much of the fishing effort is directed toward the tiger prawns, *Penaeus esculentus*, and *P. semisulcatus*. These prawn are not strongly aggregating species (Penn 1984) and they are usually fished by fuel-expensive pattern trawling in tows of about 2-3 hours. Annual landings are 3-4000 t (Robins and Somers, 1994) and 97% of the 40000+ t of by-catch is discarded (Pender *et al.* , 1992). The tiger prawns are therefore target species for which alternative methods might have good economic potential compared to trawling, but the information to make a realistic evaluation has not been available (Buckworth and Cann, 1992).

In this article I describe experiments designed to provide information for such an evaluation, but report that so few prawns were taken at sea with traps, that the evaluation could not be made. In order to define the direction of future experimentation, I examine the possible reasons for the poor trapping rates, and conclude that the main requirement is the identification of the ecological circumstances in which prawns will enter traps.

Materials and Methods

Experimental strategy

The general strategy adopted was to set traps in areas of prawn abundance, identified using trawls and try gear (a small monitoring trawl towed in front of the main gear), then to evaluate factors affecting prawn trapping rates. Factors addressed related to habitat (represented by different locations) and trapping methodology. Trap type and bait type were incorporated in an experimental design as orthogonal factors, nested in long lines and night (location) fished. Trawls also provided information on catch rates, species and size composition of prawns.

Study Area

All trapping and trawling operations were in the western Gulf of Carpentaria, in the vicinity of Groote Eylandt (Fig. 1), an important fishing area for both *P. esculentus* and *P. semisulcatus* (Buckworth, 1985; Somers, 1987). Trawl and trap sites were chosen to provide contrast in the main tiger prawn species caught, a range of bottom types, heavily fished vs unfished areas, and included a depth range of 5 - 30 m.

Trapping and trawling operations were carried out over 10 -20 March 1993, from a 19 m otter trawler. The vessel was twin-rigged, towing Florida Flyers with headropes each 16.2 m, and with codends of 50 mm stretched mesh. Try gear was a 3.6 m otter trawl.

Traps, baits and deployment

Four trap designs were used (Fig. 2). Designs A, B and C were covered in light galvanised wire netting (15 mm across the mesh). Design A was similar to traps used by Racek (1955, 1957), with a rectangular frame of hardwood but was smaller and differed in using an entrance funnel (a flattened tube of plastic mesh) rather than a slot formed in the netting cover. Designs B and C were both cylinders framed from mild steel rod (6 mm dia.). In design B the entrance was in one of the circular ends and consisted of a netting cone ending in a steel ring (50 mm dia.). An entrance similar to that chosen for design A was placed into the side of design C. In trap designs A, B and C, access for baiting and removal of catch was provided by hinged sections in the wire covering. Design D was a Scottish scampi creel, with a rectangular galvanised steel frame covered in light trawl netting. Funnel entrances were formed in two of the side panels by sewing polypropylene rings into the netting, and drawing them toward the centre of the trap using twine. One end panel was hinged to form a door for baiting and for removal of catch. The A traps were ballasted with 3 kg of steel chain; the other trap types were negatively buoyant and so were not weighted.

Chopped baits (Table 1) of about 100 g were packed in light mesh bags and wired into the centre of the traps. Light sticks (Cyalumes) wrapped in red cellophane were also added to 20 traps on 18 Mar. Also on this date, live *P. semisulcatus* were added to nine traps, in a small test of whether prawns entered and left traps, or whether predation on prawns within traps might be significant. Captured in a try shot, the prawns were maintained in a tank of continuously flowing water until placed within the traps at setting.

Traps were clipped to long lines with 1 m snoods, on long-lines, each with up to 44 traps spaced at intervals of 15 m . These were set across the tide to maximise the width of the scent plume from baits. Tiger prawns are mostly active at night (Somers *et al*.., 1987) and so traps were usually set in full darkness and retrieved around dawn. On the first day of the experiments, however, a line of traps was set over the day, as a gear trial. Soak time was varied, with the last line of traps set usually being the first retrieved, to maximise the range for this factor (from 21 min. to 12.5 h). Traps were, nevertheless, usually set for periods exceeding 10 hours. Not all trap designs or bait types were used each night (Table 2). Over the nights of 10 - 13 March 1995, trap designs were ordered randomly within longlines but were set systematically on the later dates. Bait order within trap designs was randomized. Prawn catches from traps were recorded. By-catch was recorded from many trap lifts.

trawling

Trawls were usually around 120 min duration (range: 60-210 min). Trawl runs were chosen on the basis of the master's experience in the area and the results of try shots, and were as close as practicable to trap sites.

Samples of commercial species of prawns were taken from representative trawls, species, sex and carapace lengths (CL mm) recorded.

Results

In 945 trap lifts (Table 1), only two commercial prawns were taken with the traps: one small *Penaeus esculentus* was trapped on each of March 13 and 14, at Site 2. Both were males, with CL of 16 and 23 mm respectively, and were alive at trap retrieval. The first was taken in a design B trap, baited with squid. The second was caught in a design D trap, with chopped fish. Two individuals of the small, non-commercial species *Trachypenaeus fulvus* were also taken, at Site 2, on March 14 and 18, in a design A trap baited with scallop, and in a B trap baited with squid, respectively.

The tiger prawns placed in the traps on 7 Mar remained when the traps were retrieved, with only one found dead.

Tiger prawns were the dominant prawns in the trawl catches. Catch rates for a night's trawling ranged between 4.8 (± 0.4 s.e.) kg h^{-1} and 36.5 (± 0.2 s.e.) kg h^{-1}, with a mean of 15.1 (± 2.4 s.e.) kg h^{-1} (Table 2). Endeavour prawns

(*Metapenaeus endeavouri*) were caught in most tows, but at the much lower rate of 2.0 (± 0.4) kg h^{-1}. Occasional individuals of other commercial penaeid species, banana prawns (*P. merguiensis*), giant tiger prawns (*P. monodon*) and king prawns (*P. latisulcatus* and *P. longistylus*) were also trawled.

Most (65.4%) tiger prawns were *P. esculentus*. However, the species composition of tiger prawns varied with site: *P. esculentus*. was the dominant species at Sites 1, 3 and 5, comprising 98.9%, 99.4%, and 89.0% of tiger prawn catches, respectively, while at Sites 2 and 4, *P. semisulcatus* was 69.6% and 69.7% of tiger prawn catches. Although the red endeavour prawn *M. ensis*, is a major part of NPF endeavour prawn catches, this species was not observed in catches in this study.

Most prawns trawled were relatively small, mostly graded commercially at 20-30 count per pound (whole), with overall mean CL (± s.e.) for *P. esculentus*., *P. semisulcatus* and *M. endeavouri* being 30.8 (± 0.1) mm, 28.0 (± 0.17) mm, and 29.8 (± 0.29) mm, respectively.

By-catch in traps was usually alive, and consisted mostly of small fish (Theraponidae, Scolopsidae and juvenile Lutjanidae) and crabs (Portunidae, Xanthidae and Grapsidae). Swim bladders of the fish were not usually distended and they were able to dive easily when the traps were emptied.

Isopods (Family Cirolanidae; Northern Territory Museum and Art Gallery registration number NTMCr011314) were observed in retrieved traps at most sites in small numbers; at Site 1, however, isopods were so abundant that they destroyed baits in < 1 h, so that any future trapping operations at this site would depend upon techniques to prevent isopod access to baits.

Discussion

So few prawns were taken in my trapping experiments, that evaluation of the traps or bait type, or refinement of economic models, is not possible. The value of the work lies in defining potential research directions, by examining why so few prawns were trapped.

Trapping rates might be very low if prawn density were low, if baits were not attractive, or if trap designs restricted entry or didn't retain prawns. However each of these aspects was addressed by the experimental strategy.

Traps were set in the areas of relative abundance of prawns, established by trawls, with replication to overcome patchiness in their distribution. If patchiness alone were the problem, occasional instances of large individual catches would be expected in over 900 trap lifts. The probability of trapping success must increase with prawn density and it is worthy of note that the prawns trapped were at Site 2 where maximum trawl catch rates were achieved.

Baits are used to attract penaeids in some cast net fisheries (Whitaker 1992). I used a wide range of baits, including those reported as effective in capturing *P. esculentus* , *P. carinatus* (=*P. monodon*) and *P. plebejus* (horse, liver: Racek, 1957) and *P. merguiensis, P. monodon* and *M. ensis* (chopped fish, shark: Barus, 1989). Racek (1955, 1957) successfully used traps similar to design A. All designs caught a range of by-catch species, and the traps retained the live prawns which were added to them. In pilot experimentation in large tanks and ponds, individuals of various *Penaeus* and *Metapenaeus* species entered and were retained by traps of designs A, B and C, baited with squid (Buckworth, unpublished data). The baited traps were capable of capturing and retaining prawns.

It must be concluded that the very low trapping rate depended little on the efficiency of the traps or the attractiveness of the baits, compared to factors untested by the present work.

Low catchability with respect to traps in the present study could be related to prawn size and ecological conditions, in particular those such as food availability and the abundance of predators or competitors . Prawns tend to move into deeper water as they grow (Garcia and Le Reste, 1981), and ecological conditions change with depth, so the two factors are confounded. Low catchability could represent changes in the behavioural ecology of prawns with size: nutritional requirements and feeding behaviour may change with growth and reproductive maturity. A shift in behavioural ecology occurring with a combination of size and depth, so that prawns scavenge more or become less wary of predation, would explain why Racek (1957) trapped *P. esculentus* , *P. monodon* and *P. plebejus* , in deep water (>100 m), but had no success in shallow water. The prawns he trapped in deep water were invariably large and mostly female. Barus (1989) trapped prawns in shallow water (2-10 m), with very variable catch rates, but did not report size or sex composition. The density of large prawns trawled in the present study was relatively low and the depths fished necessarily reflected the seasonal distribution of the tiger prawn species (Somers *et al*., 1987).

Despite the low trapping rate reported, the environmental, economic and social incentives to develop non-trawl prawn fishing methods remain. Because penaeids are usually trawled, there is limited information available on prawns' behavioural ecology that can be applied in other fishing methods. The work presented here suggests that the development of trapping as a fishing method cannot proceed until there is definition of the ecological conditions under which penaeid prawns are catchable with traps; only then could experimentation produce efficient trap design and baiting practices. Clearly, conditions to be examined are those in which the density of large prawns is reasonably high, and over a range of depth and seasonal conditions.

Acknowledgments

I am especially grateful to Ric and Richard Richter as Master and crew, and to Mary Richter, Carol and Kim Bowers as operators, who provided their trawler *Glen Eagle*, for these experiments. Dr A A Racek and Mr Bill West provided information on their experiences with trapping prawns. Drs Steve Kenelly and Steve Montgomery of the NSW Fisheries Research Institute assisted with information and experimental planning. Charles Bryce, Richard Mounsey and Neville Gill of the Fisheries Division assisted with trap construction and field work. August Stevens, of the Department of Correctional Services, organized for assistance in trap construction. Allan Findlay, of Emperor Seafoods P/L provided the design and materials for construction of the scampi creels. Karen Coombs of the NT Museum and Art Galleries, Darwin, provided taxonomic assistance. Yan Diczbalisand Ian Knuckey provided valuable review of the manuscript. I am grateful for the support of the Fisheries Division, in particular Messrs. Darryl Grey and Richard Slack-Smith. Partial funding for this project was from the Fisheries Research and Development Corporation, Project 92/10.

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Figure 1

The study area in the western Gulf of Carpentaria, showing locations of experiments.

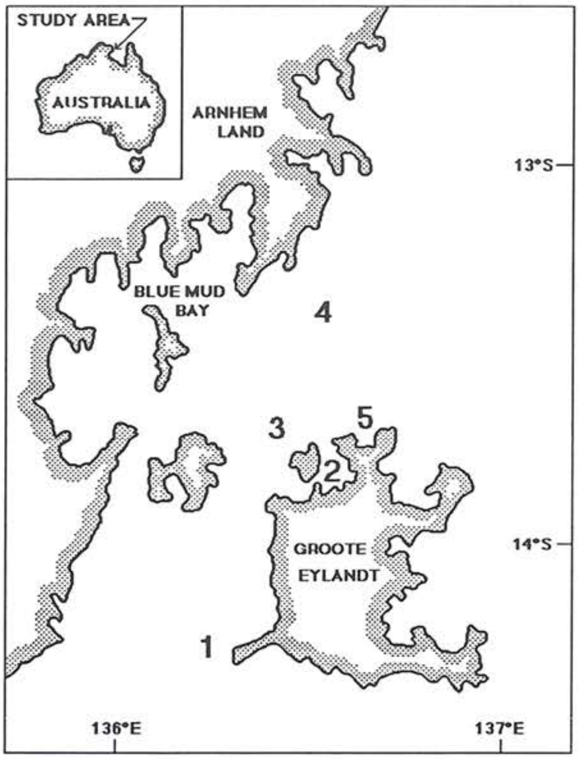

Figure 2

Construction details of traps used in the trapping experiments. Letters indicate trap designs described in the text. All measurements are mm.

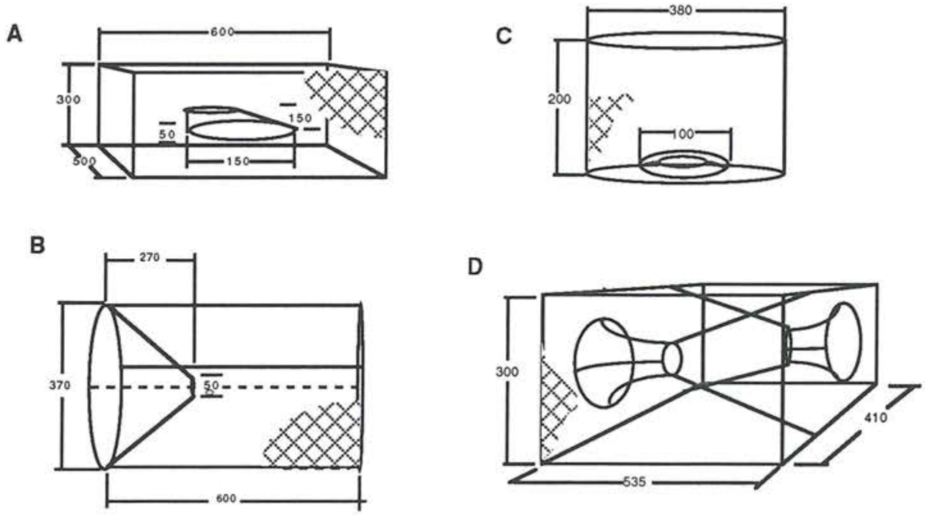

Table 1

Baits used in trapping experiments

Bait	Species	No. sets
Pilchard	*Sardinops neopilchardus*	150
Chicken necks		142
Squid	*Loligo spp.*	142
Horse		134
Liver (bullock)		122
Fish	*Caranx, Sillago and Leiognathus spp.*	64
Cuttlefish	*Sepia sp.*	54
Prawn	*Metapenaeus endeavouri, M. ensis*	35
Saucer scallop	*Amusium pleuronectes*	32
Shark	*Carcharinus spp.*	23
Ray	*Dasyatis sp.*	16
Crab	*Portunus pelagicus*	14
Octopus	*Octopus*	9
Bug (slipper lobster)	*Thenus orientalis*	8
Total		945

Table 2

Numbers and types of traps used, and trawl catches and catch rates, for prawn trapping and trawling experiments

Dates (March)	Site	Traps no. set	types	Trap hours*	Tiger Prawn Trawl catch kg	trawl rate (s.e.) kg/h
10	1	44	A,B,C,D	404.8	114	19.0 (0.2)
11	1	108	A,B,C,D	1554.1	160	16.0 (1.4)
12	1	144	A,B,C,D	688.7 a		
13	2	37	A,B,C,D	388.5	256	36.5 (8.4)
14	2	180	A,B,C,D	1463.8 a		
15	3	72	A,B,C,D	822.6	41	7.4 (1.6)
16	4	144	A,B,C,D	1738.8	40	5.2 (0.2)
17	5	72	A,B,D	855.7	44	4.8 (0.4)
18	2	72	A,B,D	818.6	102	12.3 (1.3)
19	2	72	B,D	794.2	65	7.8 (0.3)
totals		945		9529.8	822	15.1 (2.4)

* No. traps X soak time

Appendix 2

Tests of Trap Types and Baits on Trapping Rates of *Metapenaeus eboracensis* in an Aquaculture Pond.

Introduction

The very low capture rate of prawns in experiments at sea raised several questions about the relative importance of several factors in prawn trap capture rates, including trap designs, baits and ecological factors (such as the presence of predators, or whether or not prawns are hungry). Pond experiments may provide observations and hypotheses for testing at sea, such as the utility of various design features, or the preferences of prawn species for different baits.

In this note I describe a small series of experiments conducted in an aquaculture pond (The Fish Farm, 12° 21' S 131° 02' E) at the mouth of the Howard River, near Darwin. A dense population of small prawns, *Metapenaeus eboracensis*, was observed in the pond. They had presumably entered the 200m X 400m X 1.5m seawater-filled pond as larvae when it was filled. The pond had been stocked with barramundi (*Lates calcarifer*) larvae on 9 Mar 1993 but the owner believed the barramundi survival rate to be very low. Despite initial success with the traps, catch rates dropped to a very low level. I conclude that this was due to some combination of lower prawn numbers due to predation on the prawns by the barramundi, and to agonistic encounters between the species.

Methods

Initial trials in the pond with traps (types B and D) baited with squid indicated that the *M eboracensis* were catchable with the traps, and that there were possible differences in catch rates between the designs. Occasional catches were also made with unbaited traps.

All trap experiments in the pond tested catch rates of prawns against the factors trap type (type B, type D) and bait (levels differed between experiments), in a factorial experimental design with the order of trap type, and order of baits within trap type, both randomized.

Sixteen traps were set in the pond on 30 Apr 1993, and catch rates tested against trap type and baits (Experiment 1). Baits were zero bait and squid.

A further factorial experiment (Experiment 2) was conducted, with four levels of bait (zero, squid, liver and pilchard) and the two trap designs, with three replicates of each combination, all nested within three consecutive nights (17-19 May 1993).

In experiment 3, 24 traps were set as in experiment 2, on each of the nights 1 and 2 June 1993.

Results and Discussion

Initial trials during April and May 1993 indicated that the *M eboracensis* in the pond could be trapped, with juvenile barramundi as an occasional by-catch.

In Experiment 1, transformed (log(x + 1)) catches differed significantly between bait types ($F_{1,12} = 5.34$, $P<.05$) but there was no significant difference between trap type, and the interaction was not significant($F_{1,12} = 2.27$, $P> 0.1$ and $F_{1,12} =3.11$, $P> 0.1$, respectively). By leaving some traps unbaited, a measure of the maximum variability expected between bait type was produced.

Although Experiment 2 had many more replicates and potentially, more statistical power (as predicted from Experiment 1), only five prawns were trapped over the three nights (72 trap nights), while 23 barramundi were taken.

The low trapping rate improved only slightly in Experiment 3, with 11 prawns produced in the 48 trapnights.

Five sweeps of a small drag net (10m X 2m X 10 mm stretched mesh) on 24 May 1993 produced a total of 6 prawns and 70 barramundi, which ranged in size 140 - 171 mm (fork length). Several prawns were seen to pass through the meshes of the net. Six randomly sampled barramundi were dissected. Two had prawn antennae protruding from their mouths, and all had prawns (up to 5) in their stomachs, suggesting that the fish were actively feeding on the prawns.

The decline in prawn catch rates over the less than three weeks between April and mid May appeared to coincide with an increase in the activity (and given their age) size of the juvenile barramundi in the pond. Reduction in prawn numbers could certainly have occurred due to increasing predation by the fish as they grew. As the small netting trial indicated, the barramundi had been feeding on the prawns, but prawns still appeared to be abundant in the ponds. Agonistic encounters between the prawns and barramundi, preventing the prawns from entering the traps may also have reduced the trapping rate. The relative importance of declining abundance and agonistic encounters in the reduced catch rate cannot be quantified.

FISHERIES RESEARCH AND DEVELOPMENT CORPORATION
NEW APPLICATION FOR GRANT

SECTION 1 - PROJECT TITLE

Non-trawl Capture of Prawns: the Commercial Feasibility of Trapping.

SECTION 2 - KEYWORDS

Trapping, prawns, economics, environment.

SECTION 3 - OBJECTIVES

1. To examine the effect of combinations of trap design, baits and setting periods on catch rates from traps.

2. To evaluate the commercial feasibility of prawn trapping operations.

3. To examine the size selectivity of trap designs, particularly in comparison with catches of small prawns by otter trawls.

4. To ascertain and evaluate differences in quality between trapped and trawled prawns, with particular reference to those destined for export alive.

SECTION 4 - JUSTIFICATION

The need for the research:

The proposed research is to evaluate the commercial feasibility of prawn trapping operations as an additional method for taking prawns in Australian fisheries. An economic model (Attachment 2) suggests that while catches from trapping will probably be smaller than from trawling, the operation may be profitable because operational and capital costs are markedly reduced. If prawn trapping can be developed as a commercial fishing method, it could be of considerable benefit to the Australian fishing industry, for economic, social and environmental reasons. These are detailed below.

Economic and social considerations:

Australia's prawn fisheries are very valuable, landing about 17000 t in 1989, mostly exported and worth about $170 M (Battaglene 1990). However, most of these fisheries are experiencing economic difficulties. All are now limited entry fisheries and schemes to remove excess fishing capacity are a common feature of their management strategies, with the basic objectives of improving profitability whilst ensuring stock maintenance. Most of Australia's prawn fisheries are close to full exploitation and sustained increases in catches, producing major economic improvements, are unlikely (Bowen and Hancock 1985).

Over-capitalization is the underlying cause of poor economic performance in Australia's most valuable prawn fishery, the Northern Prawn Fishery (NPF; Hayes and Pascoe 1988). It has been exacerbated in recent years by an increasing supply of aquaculture produced prawns entering the world market, and high interest rates and fuel costs. In the NPF, a major reduction in the fleet is underway, to ensure profitability of remaining operators. Such management options have drawbacks: the proposed compulsory removal of units has considerably inflated their trading value (the individual capitalization of purchasers thus increasing), an oversupply of hulls has been created and unemployment among fishermen is growing. There are growing concerns about the dwindling opportunities available for young fishermen (D. Dunstan, NT Fishing Industry Council, pers. comm.). If the trends which have created the economic problems continue (ie over-capitalization, increasing costs, poor prices), then fleet reduction will prove to be a respite, not a solution. Avenues by which the profitability of operators could be enhanced, but without the economic and social consequences entailed by major fleet reductions, should thus be explored. The use of different catching techniques to improve quality, reduce costs and thus increase profitability has seldom been addressed.

Prawn trapping, if commercially feasible, would have several operational and management benefits:

- Maximize quality of catch, with the opportunity to exploit a high-value market for large or live prawns;
- Considerable reduction in fuel costs;
- Smaller capital investment required - operations could be performed from smaller vessels;
- Trapping could be conducted on rough ground or new grounds where trawling has not been feasible;

- By manipulating trap design (eg mesh sizes and entrances), and with seasonal and area closures, selectivity of the gear could be used as an aid in stock management;

- There is a potential use of trawler by-catch for bait; and

- Conversion to trapping operations could be offered as an alternative to licence buy-back as a management option. .

The lack of species selectivity and the impact on benthic communities by demersal trawls have generated considerable international concern. Conflict occurs from the capture of juveniles of other commercially or recreationally important species. Habitat and community changes have been demonstrated (Young and Sainsbury 1985) but are poorly understood. In contrast, trapping for fish has little impact on the physical environment and non-target communities (Moran and Jenke 1989). Mortalities due to prawn trawling are alleged to be a major problem in the conservation of sea turtles in some areas (Poiner *et al.* 1990) and have led to the restriction and probable closure of some valuable fisheries in North Carolina and Florida (Klima, US National Marine Fisheries Service, pers. comm.). Modifications to trawls that effectively avoid capture of turtles and reduce other by-catch, whilst maintaining prawn catch rates, have yet to be demonstrated. The US Government has recently restricted imports of prawns to those taken with "turtle friendly" gears.

In contrast to demersal trawls, prawn trapping could have considerable environmental advantages:

- With the massive reduction in by-catch, turtles and dolphins would not be taken, wastage would be minimal and few juveniles of species important to other fisheries, including recreational fisheries would be caught - thus reducing conflict;

- Degradation of demersal habitats would be considerably reduced; and

- There would be a large reduction in the amount of fuel burnt.

There will be increasing pressure from conservation groups to include more sections of coastal waters in marine parks. Passive fishing methods, being more consistent with the principles of park management, have a greater chance of being permissible under the management plans of these parks.

There are trap fisheries for scampi (*Nephrops* spp.) and various pandalid prawn species in the North Atlantic, and there have been successful trials of traps for capture of deepwater prawns at several Pacific sites (eg King 1981; Moffitt and Polovina 1987). Baits are used to attract prawns in some Indian cast net fisheries (Suseelan 1975) and in amateur fisheries for school prawns, *Metapenaeus dalli* in the Swan River (J. Penn, pers. comm.). York prawns, *Metapenaeus eboracensis*, are frequently taken in mud crab pots in the Northern Territory (Mounsey, pers. comm.). Large catches of western king prawns, *Penaeus latisulcatus* are occasionally taken by sand crab fishermen in the South Australian Gulfs (N. Carrick, pers. comm.). Offshore stocks of eastern king prawns, *P. plebejus* and brown tiger prawns, *P. esculentus* were located with traps (Racek 1955, 1959) but were subsequently developed as trawl fisheries.

There is thus enough evidence that penaeid prawns are attracted to baits and will enter pots. However, a search of the literature has revealed no assessments of trapping in inshore penaeid fisheries. Some ad hoc trials of trapping for prawns have been conducted by fishermen with apparently little success. However, few fishermen have the time or resources to conduct the structured series of trials required to evaluate the method properly, as exemplified by the successful development of the NT fish trap and drop-line fisheries. Despite ad hoc trials by fishermen, over decades, the fishery was not developed until the implementation of a program involving tests of trap designs, baits, deployment methods, fishing areas, handling techniques, economic analysis and marketing.

An economic analysis (attached) suggests that trapping is commercially feasible. This could be especially true if the niche market for live prawns is exploited (Goodrick and Patterson, in prep.). However, for values of many of the variables used in the model, only reasonable guesses could be used. Trials are required to provide a realistic analysis.

If prawn trapping is feasible, the chief beneficiaries will be operators, who will be provided with an economically attractive alternative to trawling.

There is no similar research being undertaken in Australia.

Industry support: The Northern Territory Fishing Industry Council has given its support for this proposal, and that of the Research Committee of the Northern Prawn Fishery Management Advisory Committee has been sought.

Performance Criteria: Success of the research will be indicated by the provision of realistic measures for economic analysis. If the analyses indicate that profitable prawn trap fishing is possible, then further experimentation and trial fishing may be warranted.

The ultimate test of success of this program will be if trapping is adopted as an alternative to trawling in some of Australia's prawn fisheries.

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SECTION 5 - PROPOSAL IN DETAIL

(a) Plan of Operation

(i) Method of Procedure

The work for which funding is requested is Stages 3 and 4 of a five stage program directed at developing a prawn trapping methodolgy, evaluating its commercial feasibility, then monitoring commercial application should it eventuate (Attachment 1).

Each stage will entail trials at sea using both trawling and traps, deployed from a chartered trawler, to capture prawns. All trials will provide information for economic analysis. This will be similar to that used to evaluate fish trapping by Cann and Mounsey (1990), upon which the preliminary analysis (Attachment 2) was based.

The trials will be conducted in the western Gulf of Carpentaria, in the vicinity of Groote Eylandt (Fig. 1). As indicated by log book data, this is one of the most important areas for tiger prawns in the NPF (Somers and Taylor 1981; Trainor 1989) and the fishing grounds have been the site of extensive research. Trawl runs, species and seasonal size composition and movements of prawn stocks in the area are well known. The tiger prawns are non-schooling species (as are king and endeavour prawn species). They are usually fished by fuel-expensive pattern trawling and are therefore target species for which trapping may have good economic potential relative to trawling.

All the experiments are to be conducted in early 1993, during the NPF closure period. This will obviate conflict between the trapping experiments and commercial trawling in the area, and will provide potentially cheaper charter costs. It is a period when a large size range of prawns are available for capture (Grey and Buckworth 1983; Buckworth 1985; Somers *et al.* 1987), and the experiments will thus supply information on the size selectivity characteristics of different trap designs.

Concentrations of prawns will be located using commercial trawling gear, in areas where either or both of the tiger prawn species (*P. esculentus* and *P. semisulcatus*) are expected. Standardized trawls will be used as an index of abundance that can be compared to catch rates from trapping experiments. Fuel consumption will be monitored throughout the trials.

Traps will be deployed on a long line(s), the basic design described by Mounsey 1987. It is intended to use 100 traps, with combinations of five trap designs and five baits. The basic statistical design is thus a replicated, randomized blocks experiment.

Stage 3, to be conducted in February 1993, will entail two cruises. The first cruise of up to five days will be for gear trials, developing the appropriate procedures for deploying the traps from the trawler. The second cruise, of seven days, is to provide information for the assessment of the commercial feasibility of prawn trapping. It will include trap design/bait trials and comparison of trap catch rates with those of standardized trawls.

Stage 4, in March 1993, will be based on a seven day cruise. This will examine the effect of soak time on catch rates, and will provide additional experiments on trap/bait combinations and trap/trawl comparisons.

The quality of trawled and trapped prawns will be examined throughout the experiments. On-board examinations will include the proportions of live animals taken, and inspection against Department of Primary Industry and Energy Export Inspection standards. Further trials will be directed at assessing the potential for trapped prawns in the market for live prawns

Trawled and trapped prawns will be handled on board for either of two periods,15 minutes or 1 hour, before being snap frozen. These samples will be sent to the IFIQ laboratories in Brisbane for determination of lactic acid and purine nucleotide concentrations. On-board handling will be the same for each capture treatment, and will be varied within each treatment to to check the effect of post-harvest handling on the parameters being measured.

(ii) Facilities Available

The Research Branch of the Northern Territory's Fisheries Division has laboratories, freezers and office space in Darwin, including computing facilities. Commercial accommodation will be sought at Groote Eylandt (our field station there has been sold).

The Queensland Department of Primary Industries, International Food Institute of Queensland (IFIQ) has analytical laboratories suitable for the analysis of seafood quality.

(b) Supporting Data

(i) Previous Work in This or Related Fields

The Fisheries Division of NT Department of Primary Industry and Fisheries (NT DPIF) has previously been involved in several programs relevant to the proposed research. Mr. Grey and Mr. Buckworth have been involved in several projects throughout the 1980's to monitor prawn stocks or to examine aspects of their biology (eg Grey and Buckworth 1983; Buckworth 1985, 1988). Mr Willing has been involved with programs to examine prawn fishery by-catch (Pender and Willing 1989; Ramm *et al.* 1990) and is presently engaged in an examination of the Joseph Bonaparte Gulf prawn fishery (Buckworth and Willing 1990). Mr. Mounsey has been involved in the development of several fishing gear applications and initiated a deepwater prawn trap fishery off Dominica (Mounsey 1987). He designed and built the environmentally-friendly "Julie-Anne trawl" (Mounsey and Ramm 1991). This project, for which the Department of Primary Industry and Fisheries received a 1991 Nabalco Land Care NT Award, has elicited acclaim from both fishermen and conservation groups. The Department's Economics Section developed the preliminary economic analysis of prawn trapping operations, and has assisted with economic evaluations of several Northern Territory fisheries (eg Cann and Ramm 1988; Cann and Mounsey 1990). The Fisheries Research Branch gas also been involved in comparison of fish trap designs and the behaviour of fish during trapping operations (Coleman and Ramm, in prep.).

The analytical Services and Research and Development Sections of IFIQ have considerable expertise in seafood quality research drawn from past and current research (eg. Williams *et al* 1991). Bruce Goodrick (Seafood Technologist) and Brian Paterson (Crustacean Physiologist) are currently developing on-board handling techniques for export of live prawns and are studying the symptomd of capture stress shown by prawns (FIRTA 91/71) following from their research on live transport of penaeid prawns (Goodrick and Paterson in prep.). Lactate accumulation and purine nucleotide degradation occurs in living prawns during handling and these parameters provide a convenient means to evaluate the stress associated with different methods of capture (Paterson and Goodrick 1991 and in prep.)

SECTION 6 - RESEARCH PRIORITY

Aspects of this project fall into several of the priorities identified by FIRDC's 5 year plan:

Economic Assessment. The program provides data for the appraisal of a fishing method which might provide a profitable alternative to trawling in some parts of the fishery, and thus increases management options;

Avoidance of Conflict Between Resource Users. Considerable reduction in the volume of by-catch compared to trawling would reduce the impact of the prawn fisheries on the juveniles of species taken commercially elsewhere, and on species of recreational value;

Environmental Changes. By reducing the volume of by-catch, damage to fish resources and changes to demersal assemblages would be minimised and marine mammals and reptiles would not be taken. Trapping would avoid the habitat degradation associated with trawling. There would be a considerable reduction in the fuel burnt to harvest the resource.

SECTION 7 - TRANSFER OF RESULTS TO INDUSTRY

In addition to articles for Australian Fisheries, Professional Fisherman and NPF Info Notes, it is intended that the results of the experiments will be distributed to fishermen informally using handbills and word of mouth. This will be a part of the Division's usual extension and liaison activities. Presentations will be made at the 1993 and 1994 Fisheries Division Research and Development Seminars (a series to be initiated in January 1992, as a means of providing research information to industry), at the 1994 NPF Workshop, and at other industry meetings wherever feasible. Information will be distributed to Fisheries agencies in other states for further dissemination.

PROFORMA 'A'

FOR NEW APPLICATIONS

SECTION 8 - PREDICTED COMMENCEMENT & COMPLETION DATE

Commencement Date 1 / 7 /92

Duration of Project: one year *Completion Date:* 30 / 6 / 93

SECTION 9 - REQUESTED BUDGET

Item	Requested 1992-93 $
Salaries & Wages	26065
Operating Expenses	54343
Travel Expenses	8892
Capital Items	7000
TOTAL	96300

SECTION 10 - FUNDS SOUGHT FROM OTHER SOURCES

An application has been submitted to the Northern Territory Fishing Industry Research and Development Trust Account Committee for funding of preliminary trapping trials

Amount Requested: **$4794**

SECTION 11 - FINANCIAL CONTRIBUTION OF APPLICANT

Salaries	
Biologist (Leader) - 20%	8360
Senior Gear Technologist - 5%	1875
Technical Officer - 5%	1661
Contract T.O. (6 months) - 100%	17755
Quality Control Officer - 7%	2537
Economist - 3%	1532
Biometrician -3%	1348
Supervisors - 4%	2082
Proportional on-costs for Dept staff	7437
Sub-Total	**44587**
Operating Costs	
Trap Design and Construction	200
Consumables, video batteries, diskettes etc.	200
Sub-Total	**400**
TOTAL: Applicant's contribution	**$44987**

SECTION 12 - DETAILED BUDGET

Expenditure is broken down into that requested for each phase.

		Estimates for 1992/93 $
Salaries		
Technical Officer, to be appointed (1/1/93 to 30/6/93)		
Salary/Wages		17755
Leave Loading		295
N.T. Allowance		515
Over-time (for 3 officers in field) 300 hrs		7500
Total salaries		**26065**
Travelling Costs		
Fares -Darwin-Groote return 6 @ $664		3984
-Darwin-Cairns return 1 @ $808		808
Allowances: TA	Groote 50 @$70	3500
	Cairns 5 @ $120	600
Total travel		**8892**
Operating costs		
On-costs		
payroll tax		1810
workers compensation		532
superannuation		3551
sub-total		**5893**
Vessel charter	20 days @$2000/day	40,000
NB This cost will be offset by sale of product		
Freight & storage		400
Traps		1500
Longline and snood ropes, clips		400
Bait		600
Cartons and packaging		250
Tape recorders, tapes, batteries, calipers		200
Sampling bags, trays, stationery, diskettes		100
Chemical analysis costs (IFIQ)		5000
Total operating		**54,343**
Capital costs		
Pot hauler		7000
Total capital		**7000**
TOTAL REQUESTED		96300

Date of compilation of financial data: 7/1/92

SECTION 13 - ORGANISATION

Head Responsible for Project Mr R J Slack-Smith
Name of Organization:
Fisheries Division, N T Department of Primary Industry and Fisheries
Address
GPO Box 990
City: Darwin **State:** Northern Territory
Postcode: 0801
Telephone 089-897673 **Fax** 089-813420
Telex: AA 85240

SECTION 14 - PROJECT SUPERVISOR

Name R C Buckworth
Address
GPO Box 990
City: Darwin **State:** Northern Territory
Postcode: 0801
Telephone 089-897608 **Fax** 089-813420
Telex AA 85240

SECTION 15 - STAFF INVOLVED ON PROJECT

NT Fisheries			
R C Buckworth	MSc	Project leader	20%
R Mounsey		Gear technologist	5%
N W Gill		Technical officer	5%
to be appointed		Technical officer	50% ie 6 months
A Mikolaczyk		Quality control	
TBA	BAgEc	Economist	3%
I Cook	PhD	Biometrician	3%
R J Slack-Smith	BSc	Advisory	2%
D C Ramm	PhD	Advisory	2%
IFIQ			
B Goodrick	PhD		10%
B Paterson	BSc		10%
Technician			5%

SECTION 16 - ADMINISTRATIVE CONTACT

Name Ms A Walmsely
Address
Department of Primary Industry and Fisheries
GPO Box 990

City: Darwin State Northern Territory Postcode: 0801
Telephone 089-894210 Fax 089-813420
Telex AA 85240

FINANCIAL INFORMATION

(i) **Industry Contribution**

No funds are being sought from the fishing industry.

(ii) **Justification of Information in**

Salaries: •Technical Officer (T2 grade) is to be dedicated to the project. Overtime estimates are indicative of up to 40 hours each (including weekend work) for three officers for each of the experimental cruises. Trawling for tiger prawns is most effective at night and it is anticipated that the work load would be heavy, to make the most of the opportunity of a chartered vessel.

Relative priority: Essential.

Travel: •Groote Eylandt is a major area of the Northern Prawn Fishery for both species of tiger prawns, and species composition and catch patterns are very well known. Airfares are for a scientific and technical staff and the gear technologist to work on each experimental cruise.

Relative priority: Essential

Operational: •Vessel charter - A trawler is necessary to the program to indicate relative catch rates of prawns and to provide suitable work conditions and accommodation. The Master of the charter vessel would have to be familiar with the trawl runs in the area. Use of an NPF-endorsed vessel provides the opportunity of selling the product and returning the proceeds to FIRDC. In a FIRTA-funded program (Western Gulf of Carpentaria Closure Study) conducted over 1982-83, NT Fisheries Division recouped and returned 30% of the funds granted for charter costs. A catch of up to 500 kg of tiger prawns (worth about $8000) would be reasonable for each charter period, and should be considered with the charter cost. The Fisheries Division's largest research vessel, the *FV John Lake*, is not large enough to undertake the commercial scale trawling and trapping program planned. As the project has application throughout Australia's prawn fisheries, Commonwealth funding is appropriate.

Relative priority: Essential

•Traps -Construction costs for the traps required for experiments, including spares, are indicated.

Relative priority: Essential

(iii) FIRDTF First Payment $48,150

(iv) Commercial Assessment

There is no confidential or unpublished information associated with the project which could be regarded as intellectual property, or relates to patents

NTDPIF has made an initial contribution in the preparation of the preliminary economic model. FIRDC has not made a previous contribution of funds.

Funds are not sought for any related projects.

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ATTACHMENT 1

The Commercial feasibility of prawn trapping

Research to be undertaken by Fisheries Division, Department of Primary Industry & Fisheries

Timing: *September 1991 - June 1993*

The program is divided into several stages. Each is dependent upon the success of preceding trials

Stage 1. Ad hoc trials

Funding: NT Fisheries Division (salaries, operational costs)

- Building/acquisition of a small number of traps and designs.
- Opportunistic trials to develop handling techniques, baits etc.

It is the view of the NT's Fisheries Division that prawn trapping has the potential to improve profitability and employment in the NPF, which would have direct benefit for the NT. It requires some experimentation to assess whether or not it should be developed as a management option for the fishery. The responsibility for management of the fishery lies with the Commonwealth. However the Fisheries Division believes the proposed research has sufficient merit that it will fund the ad hoc trials. The amount of funding has not been explicitly identified, as material for some trap construction is on hand, and the ad hoc trials will be carried out during other research activities. These will continue between other trials, and will possibly include comparisons with trawling when gear trials are being conducted.

Stage 2. Pilot Studies - North West Bay

Funding: NTFIRDTA (travel, operational costs, overtime, vessel hire), Fisheries Division (salaries, support)

- Trap and bait trials in North-West Bay.

North-West Bay at Groote Eylandt historically provided high catch rates of prawns of several species, before its closure to fishing to protect small prawns. It is sheltered and easily accessible from Bartalumba Bay. There is no suitable study site more accessible to Darwin. It is thus the best available study site for proving that capture of prawns with traps is feasible, and testing some trap and bait combinations. Charter of a small boat - at the minimum a 16' dinghy - is required.

Stage 3. Comparison of catch rates with trawls

Funding: FRDC (salaries, overtime, travel, operational costs) , Fisheries Division (salaries, support)

- Trials comparing catch rates of traps with trawls.
- Trap and bait trials.

FRDC funding is to be sought for this work. These will be conducted during February 1993 and will require charter of a prawn trawler, to both establish availability of prawns, and provide trawl/trap comparisons. Establishing relative capture rates between trawls and trapping operations on a near-commercial scale will develop the methodology of trapping, as well as providing information for economic modelling and examination of the size selectivity of different designs. The performance of different trap/bait combinations will be monitored.

Stage 4. Extensive trials: comparison of catch rates with trawls, size selectivity experiments, quality of trapped vs trawled prawns for live export.

Funding: FRDC (salaries, overtime, travel, operational costs) , Fisheries Division (salaries, support)

- Trials comparing catch rates of traps with trawls.
- Trap and bait trials.
- The effect of soak time on catch rates.

Stage 4 is set of extensive experiments for which FIRDC funding is to be sought. To be conducted in March 1993, these will be directed at further examining trap design/bait/deployment variables and relative capture rates of small prawns by trawl and trap. By including various trap designs, bait types and soak periods, further information for the economic analysis will be provided.

- Trials comparing quality between trawl and trap caught prawns.

Premium quality markets, in particular live-export, are perceived to be a potentially lucrative niche that trapped prawns may fill. The survival and continued quality of prawns for export is critically dependent upon the levels of stress to which they have been subjected. Trials at sea and in the laboratory with the collaboration QDPI International Food Institute of Queensland (IFIQ) staff will examine relative quality of trap and trawl caught prawns.

Stage 5. Commercial application: monitoring

- If commercial feasibility of trapping for prawns is demonstrated, it is appropriate that the development of this sector of the fishery is monitored. Given that they are critically dependent upon results of the previous stages, details for this stage of the program are not given.

ATTACHMENT 2

ASSESSMENT OF POTENTIAL FOR PRAWN TRAPPING

The model described by Cann and Mounsey (1988) was used to provide a preliminary assessment of the economics of prawn trapping. In this analysis, it was necessary to make assumptions about several aspects of the operation and rough estimates were made for several parameters. The number of traps that can be deployed is dependent on the crew/vessel combination and was set at 500 in this analysis. The price of fuel has been slightly inflated, at 43 c/l, to account for costs which have not been identified. The price of $15 kg assumes that average quality of the catch is very high.

The main parameter to be tested by the proposed research is catch rate per trap. Accordingly, Table 1 summarizes the effect of varying the catch rate per pot on the modelled commercial operation. All other inputs were as specified in the summary of the model presented below.

Table 1. Output of the feasibility model for various prawn catch rates.

Catch rate (kg/set)	0.09	0.10	0.125	0.15	0.175	0.20
Profit ($)	-12503	753	33891	67029	100166	133304
Annual return to capital (%)	-5.6	0.33	15.1	29.8	44.5	59.3

A summary of the model,with all inputs and major output features, for a catch rate of 0.1 kg of prawns /trap/set, is presented below. With all other factors fixed this the approximate "breakeven" catch rate.

N.T. FISHING FEASIBILITY MODEL - TRAPPING/DROPLINING

1. FISHING STRATEGY

Days per trip	15
Days steaming and in port	2.5
Maximum days fished per year	270
Percentage down time (breakdowns, bad weather etc	10

2. CAPITAL

Item	Starting value	Life	Salvage Value %	R&M	% R&M
	($)	(years)	($)	per trip	per year
Boat	200000	8	150000	0.0	6.0
Gear	5000	2	2500	3.0	0.0
Vehicles	20000	8	8000 ***	5.0	

No. of years between major refits ? 2 years
No.of years to next major refit ? 2 years

Interest rate on alternative investments ? 15 %

3. FUEL & LUBRICANTS

Fuel Usage per Boat	Consumpt'n (L/hr)	Hours run (per day)
Main - catching	18	12
- steaming	100 ****	
Auxilliary - on grounds	7	24
- steaming	7	24
- in port	7	12

Hours steaming to and from port ? (hours each way)	12 hours
Fuel Cost ?	43 cents/litre
Fuel Capacity ?	10000 litres/trip

4. LABOUR

Based on 3 crew, with 25% of catch value to the crew

5. MARKETING COSTS

Packaging ? 10 cents/kg

6. OTHER COSTS

Bait - kg/trap/day ?	0.20 kg
- price/cost ?	1.00 $/kg
Berthing & Wharfage Charges ?	2900 $/year
Licence/Registration/Survey Charges ?	400 $/year
Insurance ?	8000 $/year
Sundry Costs ?	7500 $/year

7. REFRIGERATION CAPACITY

Freezer Capacity ? 3 tonnes

8. COMPOSITION OF CATCH AND PROCESSING STRATEGY

It is assumed that prawns are 100% of the catch, that these are all frozen whole, and that there is a 2% loss by weight in handling.

Quantity Caught per Day (kg)

Species	landed weight	frozen
Prawns	50	49

9. PRICES

Prices ($/kg)	|	WHOLE	|
Species	frozen	fresh in brine	chilled on ice
Prawns	15.00	0.00	0.00

Average Price = $ 15.00 /kg

10. CATCH STATISTICS

Kilograms of prawns caught per trap per set ?	0.1
No. of traps ?	500
No. of sets per day ?	1
No. of trips per year =	17
Maximum no. of days spent fishing per trip =	14.5
Average no. of days spent fishing per trip =	13.1
Number of days spent fishing per year =	227
Total landed weight caught per trip =	653
Total processed weight caught per trip =	639
Total landed weight (tonnes) caught per year =	11
Total processed weight (tonnes) caught per year =	11

11. QUANTITY OF FISH CAUGHT PER YEAR (kg)

|	WHOLE			|	TRUNKS
Species	frozen	fresh in brine	chilled on ice	frozen	fresh in brine
Prawns	11139	0	0	0	0
Total	11139	0	0	0	0

12. VALUE OF FISH CAUGHT PER YEAR ($)

|	WHOLE	|	TRUNKS		
Species	frozen	fresh in brine	chilled on ice	frozen	fresh in brine
Prawns	167082	0	0	0	0
Total	167082	0	0	0	0

13. ANNUAL COSTS AND RETURNS

ANNUAL INCOME: 167082

CASH COSTS:	$	% of cash cost
Fuel & Lubricants		
- fuel- fishing	20527	13.0
- steaming to and from grounds	17977	11.4
- auxilliary	18309	11.6
- lubricants	2841	1.8
subtotal	59654	37.9
Labour		
- wages - master	0	0.0
- crew	0	0.0
- shares of catch	33416	21.2
- labour on-costs	0	0.0
- food	0	0.0
subtotal	33416	21.2
Repairs & Maintenance		
- boat (incl. allowance for major refit)	18000	11.4
- gear	2613	1.7
- vehicle	1000	0.6
- other	0	0.0
subtotal	21613	13.7
Marketing		
- packaging	1114	0.7
- ice/ice packs	0	0.0
- freight	0	0.0
- commission	0	0.0
subtotal	1114	0.7
Other Cash Costs		
- cold storage	0	0.0
- ice (on board)	0	0.0
- bait	22732	14.4
- berthing & wharfage	2900	1.8
- licence/rego/survey	400	0.3
- insurance	8000	5.1
- sundry	7500	4.8
subtotal	41532	26.4
Total Cash Costs	157329	99.3

NON-CASH COSTS:

		$	% of non-cash costs	% of total costs
Interest on Capital (at 15 %)				
(average value)	- boat	26250	69.2	13.7
	- gear	563	1.5	.3
	- vehicle	2100	5.5	1.1
	- other	0	0.0	0.0
	subtotal	28913	76.3	15.1
Depreciation				
	- boat	6250	16.5	3.3
	- gear	1250	3.3	.7
	- vehicle	1500	4.0	.8
	- other	0	0.0	.0
subtotal		9000	23.7	4.7
Total Non-Cash Costs		37913	100.0	19.8

TOTAL CASH & NON-CASH COSTS =	195242
ANNUAL CASH SURPLUS = (income - cash costs)	9753
ANNUAL PROFIT/LOSS = (income - cash costs - depreciation)	753
SURPLUS OVER BREAKEVEN COST = (income - cash costs - non-cash costs)	-28160
ANNUAL RETURN TO CAPITAL = (annual profit/loss divide by) (starting value of capital x 100)	**0.33 %**

14. SENSITIVITY ANALYSES

FISH PRICES
(% change)

	-20 %	-10 %	0	+10 %	+20 %
SURPLUS OVER BREAKEVEN COST	-61576	-44868	-28160	-11452	5257

FUEL PRICE
(cents per litre)

	33	38	43	48	53
SURPLUS OVER BREAKEVEN COST	-14947	-21554	-28160	-34766	-41372

LABOUR COSTS
Percentage of catch value to crew (%)

	20.00	22.50	25.00	27.50	30.00
SURPLUS OVER BREAKEVEN COST	-28160	-32337	-36514	-40691	-44868