DEPARTMENT OF
FISHERIES AND WILDLIFE
WESTERN AUSTRALIA



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# The Shark Bay Prawn Fishery (1970–1976)

BY

J. W. PENN and R. W. STALKER

1979

PERTH
WESTERN AUSTRALIA

Department of Fisheries and Wildlife

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PERTH, W.A.

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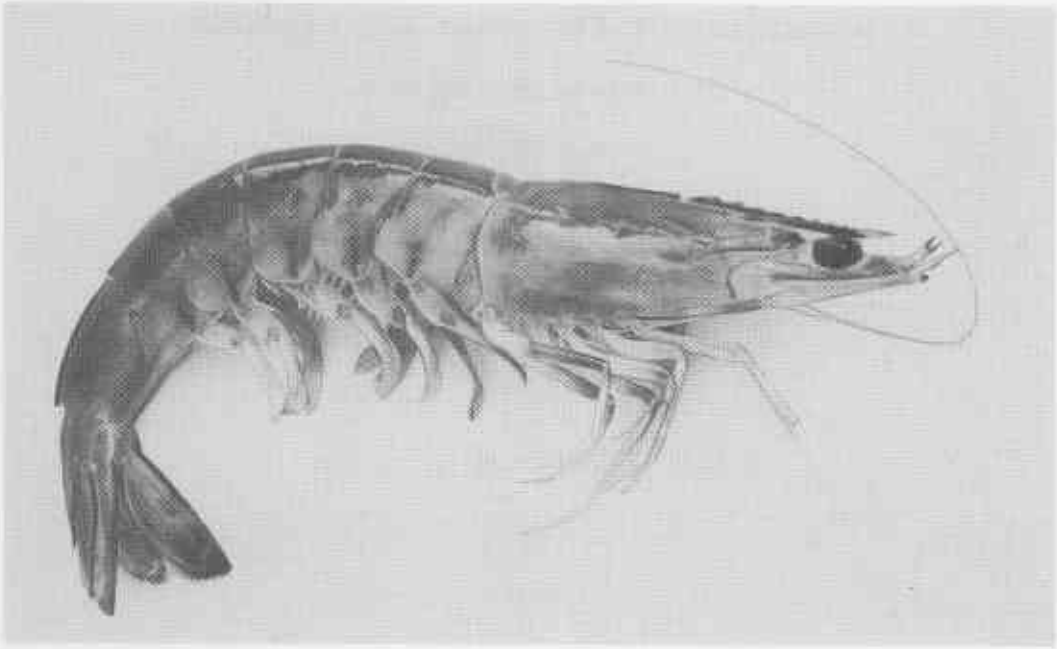
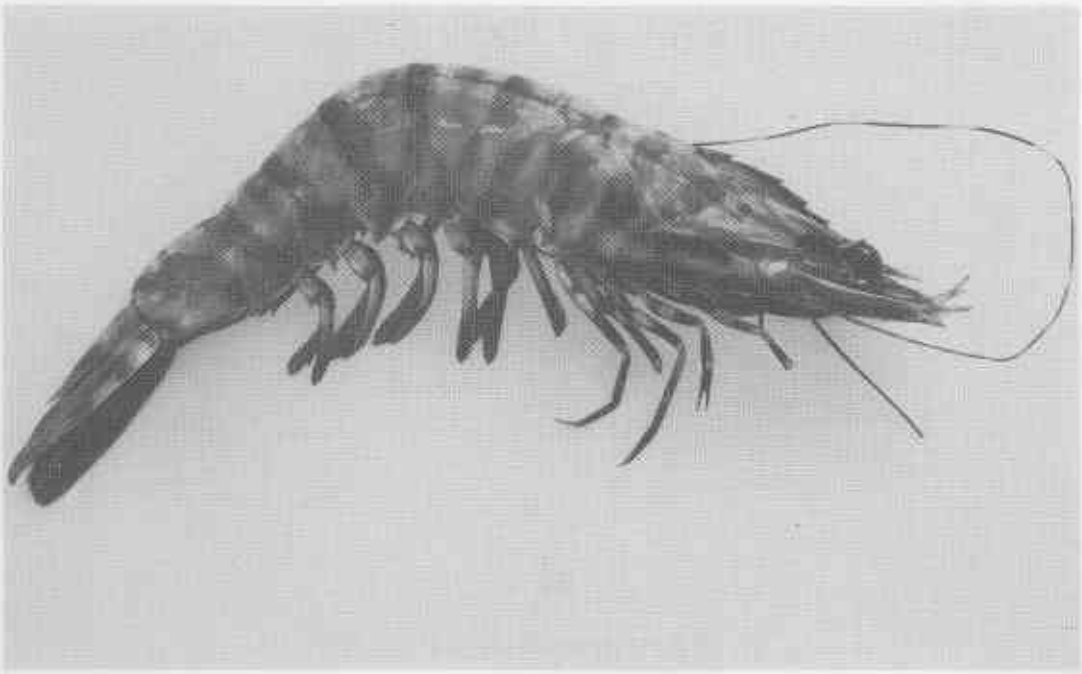
# FRONTISPIECE



Western king prawn (*Penaeus latisulcatus*)



Tiger prawn (*Penaeus esculentus*)

# FOREWORD

The Department of Fisheries and Wildlife research programme on the Shark Bay prawn fishery has a number of purposes, one of which is to provide members of the fishing industry with useful information about the fish stocks which they exploit.

To provide this information for fishermen in a readable form, the detailed data collected and presented in scientific publications has been condensed into this generalised account of the life histories of the two major prawn species taken in Shark Bay.

In addition, information on catching, handling and processing of the prawn catch has also been included to assist interested sections of the general public in understanding the way in which prawn fishing is carried out in Western Australia.

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# PLATES (CONT'D)

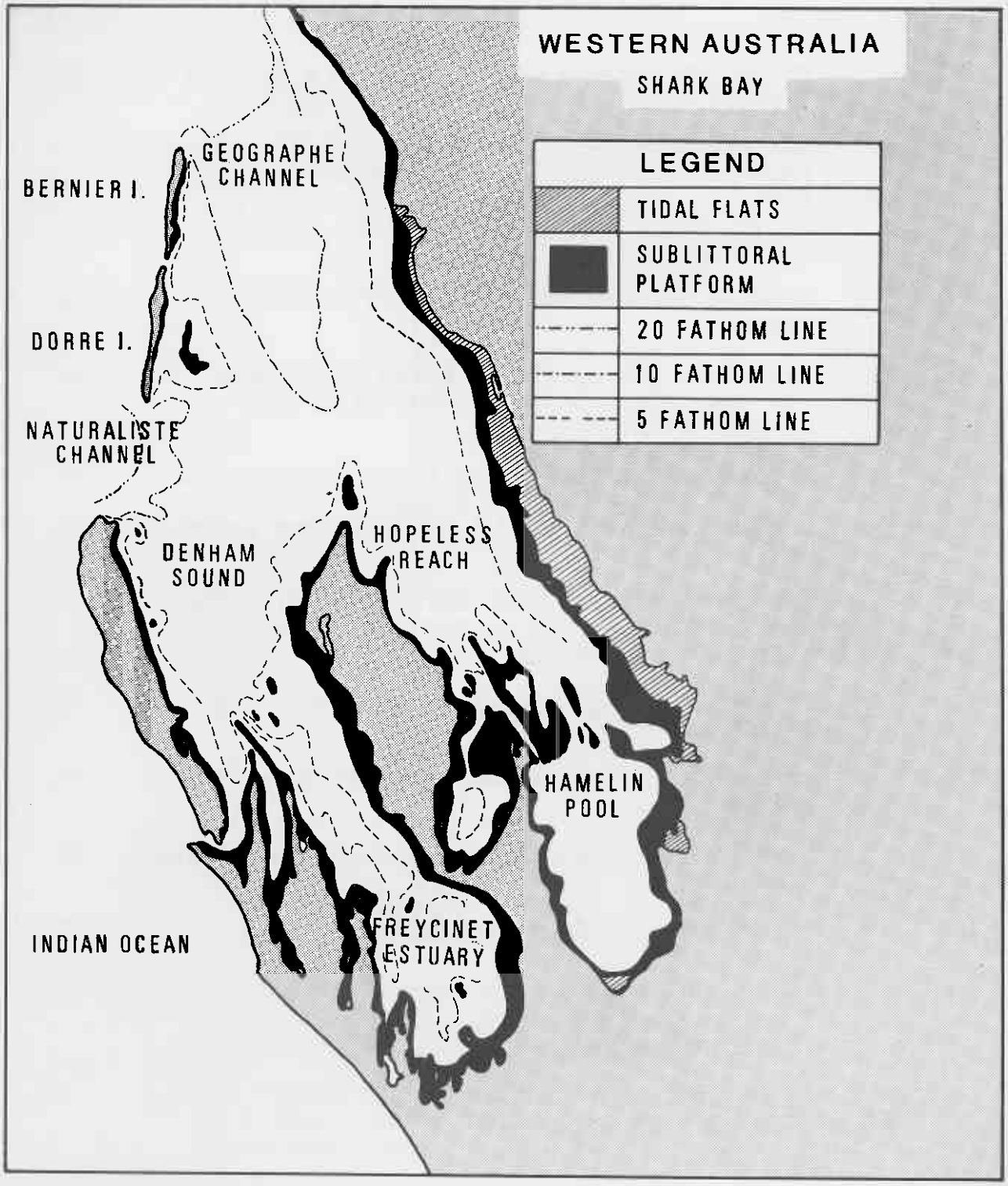


FIGURE 1: THE TOPOGRAPHY OF THE MARINE ENVIRONMENT OF SHARK BAY, WESTERN AUSTRALIA ADAPTED FROM LOGAN & CEBULSKI (1970).

*Dept. Fish. Wild. West. Aust. Rept. No. 38, 1-38*

# THE SHARK BAY PRAWN FISHERY (1970-1976)

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## I INTRODUCTION

The existence of prawn stocks in Shark Bay, Western Australia, has been known since 1904 when the sailing ketch "Rip" on charter to the Western Australian Government, trawled large quantities of prawns from the area between Bernier Island and the mainland, Gale (1905). Although the Fisheries research vessel "Lancelin" trawled potentially commercial quantities of prawns from Shark Bay in the early 1950's, it was not until 1962 that a regular fishery was begun.

Today the prawn stocks of Shark Bay support Western Australia's largest and most consistent prawn fishery, having an annual production currently exceeding 2 000 tonnes. The catch is dominated by two large species, (see frontispiece), the western king (*Penaeus latisulcatus*) which provides about two-thirds of the catch, and the brown tiger prawn (*Penaeus esculentus*) which makes up the remainder.

Since the inception of the fishery, management measures, aimed at rational exploitation of the stocks by controlling the number of fishing vessels, have been in force. To enable this management programme to work successfully, a continuous research programme involving intensive collection of catch and effort data from the fishing fleet and processors, in addition to biological studies, has been carried out.

The results of this research to the end of the 1969 season has been recorded previously in Slack-Smith, 1966, 1969, 1978. The purpose of this booklet is to describe the current fishing operation and to provide a description of the biology of the two commercial species of prawns caught in Shark Bay.

## II PHYSICAL CHARACTERISTICS OF SHARK BAY

Shark Bay is a large marine embayment (Figure 1) of approximately 13 000 square kilometres situated on the Western Australian coast between latitudes 24°30' and 26°45' south, about 900 kilometres north of Perth.

The islands bordering the bay and the sea floor itself, are exclusively of sedimentary origin, predominantly limestones and sandstones (Logan and Cebulski, 1970). Water depths increase to the north and west reaching a maximum of approximately 40 metres in the Naturaliste and Geographe channels. The waters of the Bay are influenced by semi-diurnal tides (two high waters per day) which have a maximum range of about 1.5 metres.

In the Shark Bay region the desert approaches the coast, and the rainfall is low, approximately 20cm/year, while the evaporation rate under the influence of the summer trade winds reaches approximately 220cm/year. This high evaporation rate, together with the extensive sand banks which slow water movements into the southern bayheads results in high salinity of up to 60-70 parts/thousand (twice as much salt as normal sea water) in areas such as Hamelin Pool, Figure 1. Also because of the desert climate, seawater temperatures in the shallows range from about 15°C in June/July to 35°C in February/March. The range offshore, away from the terrestrial climatic influences is reduced to approximately 21° to 25°C in August and May respectively.

Another physical feature of Shark Bay which is worthy of specific mention, because of its importance to the prawn fisheries, are the extensive shallow sand and weed banks which border much of the coastline. Most important of these are around the shores of Hopeless Reach where the banks extend from the coastline out to approximately 9 kms offshore. These sand and weed banks provide the major nursery areas for the commercial prawn fishery in the deeper waters of the Bay.

## III BIOLOGY OF COMMERCIAL PRAWNS

The life cycles of the two commercial species of prawns have been summarised diagrammatically in Figure 2 (western king prawns) and Figure 3 (brown tiger prawns). Additional details of each stage of the life cycle are included in the following text and are summarised in Table 1.

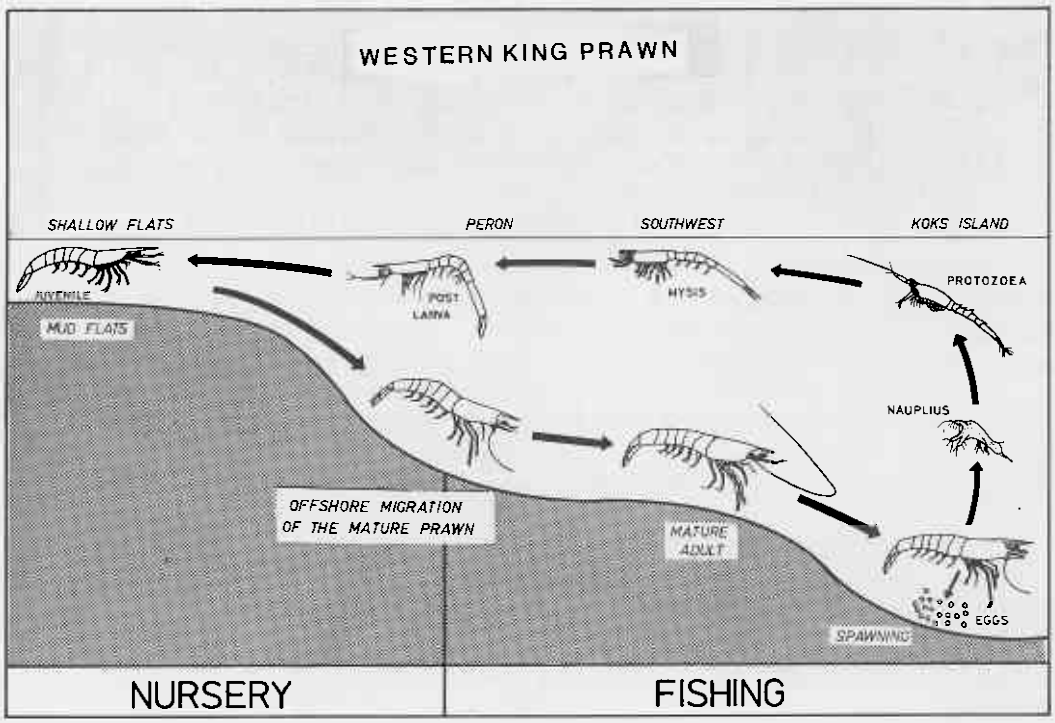


FIGURE 2: DIAGRAMMATIC REPRESENTATION OF THE STAGES IN THE LIFE CYCLE OF THE WESTERN KING PRAWN IN SHARK BAY.

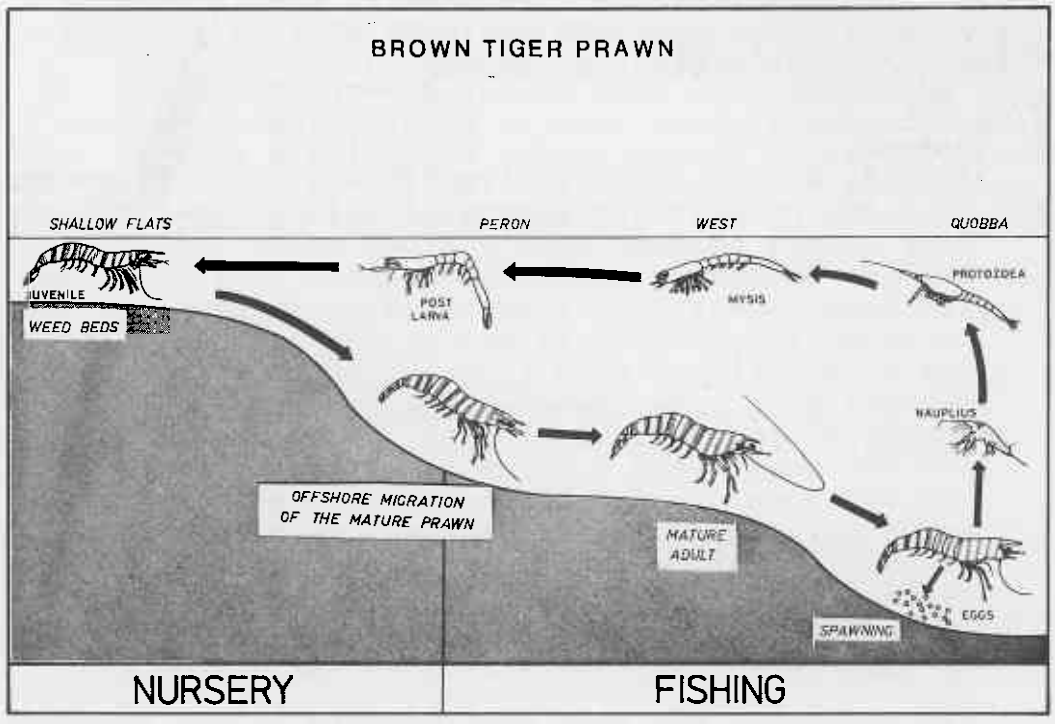


FIGURE 3: DIAGRAMMATIC REPRESENTATION OF THE STAGES IN THE LIFE CYCLE OF THE BROWN TIGER PRAWN IN SHARK BAY.

TABLE 1: GENERAL LIFE CYCLE OF W.A. PENAEID PRAWNS

| | Development Stage | Number of Moults* | Time |
|---|---|---|---|
| Planktonic larvae stages | Egg | - | 24-48 hours |
| | Nauplius | 6 | 2-5 days |
| | Protozoea | 3 | 6-10 days |
| | Mysis | 3 | 10-20 days |
| Settling stage | Post larvae | 8-10 approx. | 20-30 days |
| Benthic (bottom dwelling stages) | Juvenile (settled) | 15-20 approx. | 1-6 months |
| | Adult | 10-15 approx. | 6-18 months |

* All prawns cast off their outer shell at intervals throughout their life. This process called moulting occurs less frequently as the prawns grow larger and is also affected by temperature, i.e. during cold periods moulting is less frequent and growth is thereafter slower.

(a) Spawning

Studies of the reproductive biology of both western king and brown tiger prawns have shown that mating only occurs between hard shelled males and soft shelled (recently moulted) females. After mating the female ovary develops rapidly and the eggs are released into the water before the female moults again, normally within a period of about one month. Western king prawn females are able to spawn a number of times during a year, producing approximately 100 000 eggs (from a 130mm total length female) to 700 000 eggs (from a 225mm total length female) per spawning. Brown tiger prawns have similar spawning habits, producing approximately 50 000 eggs (from a 140mm long female) to 400 000 eggs (from a 220mm long female) per spawning. The numbers of eggs being released reaches a peak during Autumn and again in Spring although spawning occurs throughout all months of the year particularly in the northern area where large mature females are always present.

(b) Larval stages

At spawning the females swim near the bottom releasing the eggs which usually hatch within 24 hours. After hatching from the egg the larvae called nauplii (see Figure 2) swim freely in the water column but do not feed. During the nauplii stages the larvae utilise stored food from the egg, completing a series of six moults before development to the next larval stage. During the second larval stage, the larvae, now called protozoea, feed mainly on single celled algae (plants called diatoms) which are found free floating in the water column. Before developing to the third larval stage (mysis), the larvae undergo three protozoeal moults. During the mysis stage, the larvae feed on other small animals in the plankton while undergoing a further three moults before developing into post-larvae. At this stage the postlarvae still maintain a planktonic existence, feeding on small animals and moulting, while drifting with the water currents (Penn, 1975).

The process of larval development from nauplii to postlarvae generally takes from one to three weeks before the larvae are at the stage where they can settle onto the sea floor. If by this time the larvae have drifted to a suitable nursery area (i.e. shallow sand flats in the case of western king prawns or onto a seagrass bed for brown tiger prawns (Figures 4 and 5) they will settle to the bottom and continue to grow into juveniles, but if they settle onto an unsuitable habitat, then they will usually perish. At the time of settlement the postlarvae are approximately 10mm in total length.

(c) Juveniles

Once the postlarvae have settled on the nursery shallows they are regarded as juveniles. In Shark Bay juveniles of both species spend about three months growing to the size at which they migrate offshore and enter the trawl fishing grounds.

Investigation of the nursery requirements of each species has shown that juvenile western king prawns prefer to live in the area from just below low water mark to a depth of about 1 metre. This zone typically consists of fine silty sand with shell fragments and small clumps of fine algae. At night the juvenile prawns become active and move about foraging for food, e.g. small animals, detritus, etc. During this feeding activity the juveniles move about freely in the water column and often spread out into the intertidal zone returning to below the low water level to bury before dawn.

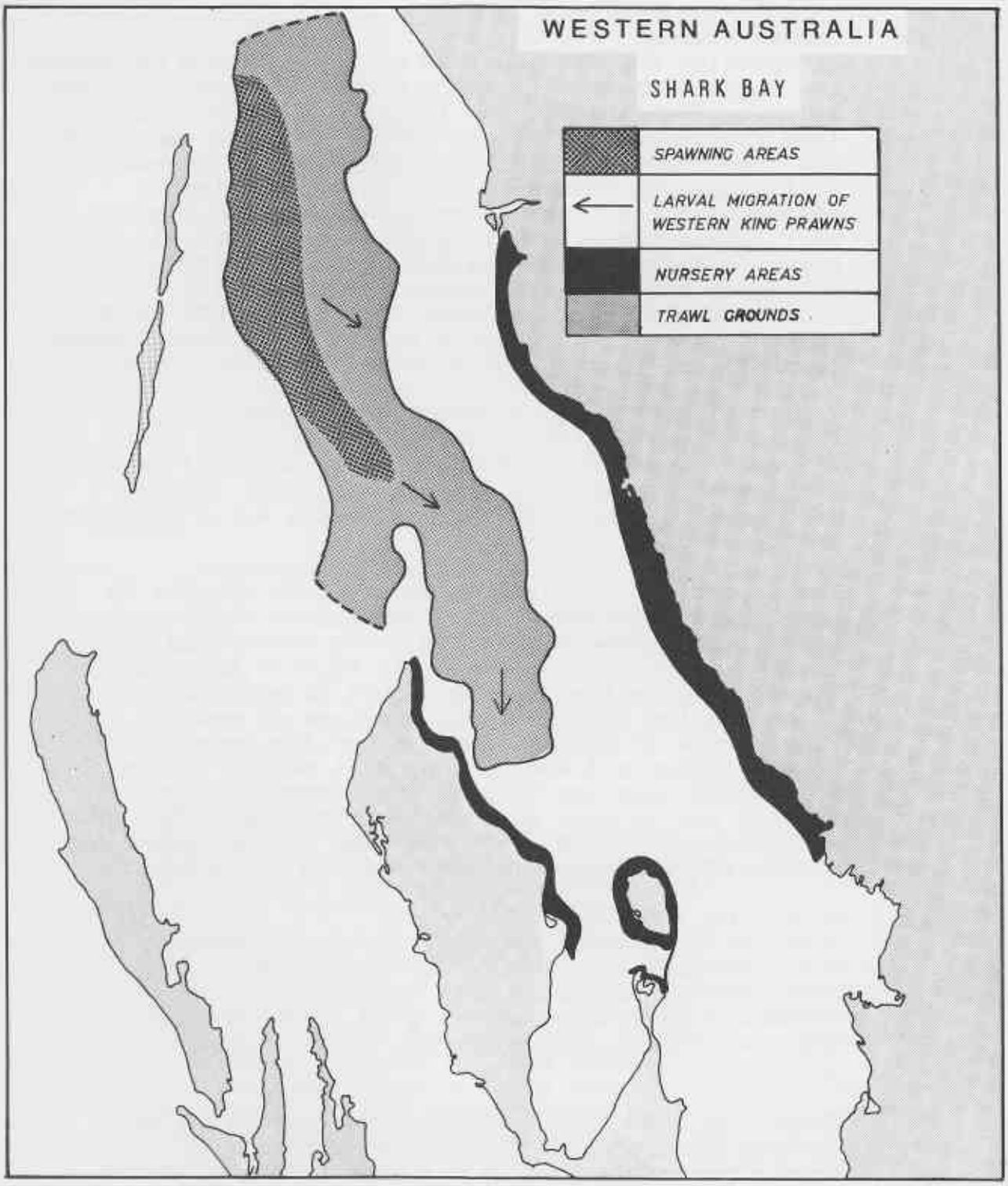


FIGURE 4: MAJOR SPAWNING AREA FOR THE WESTERN KING PRAWN AND THE DIRECTION OF LARVAL MIGRATION TO THE INSHORE SAND FLATS.

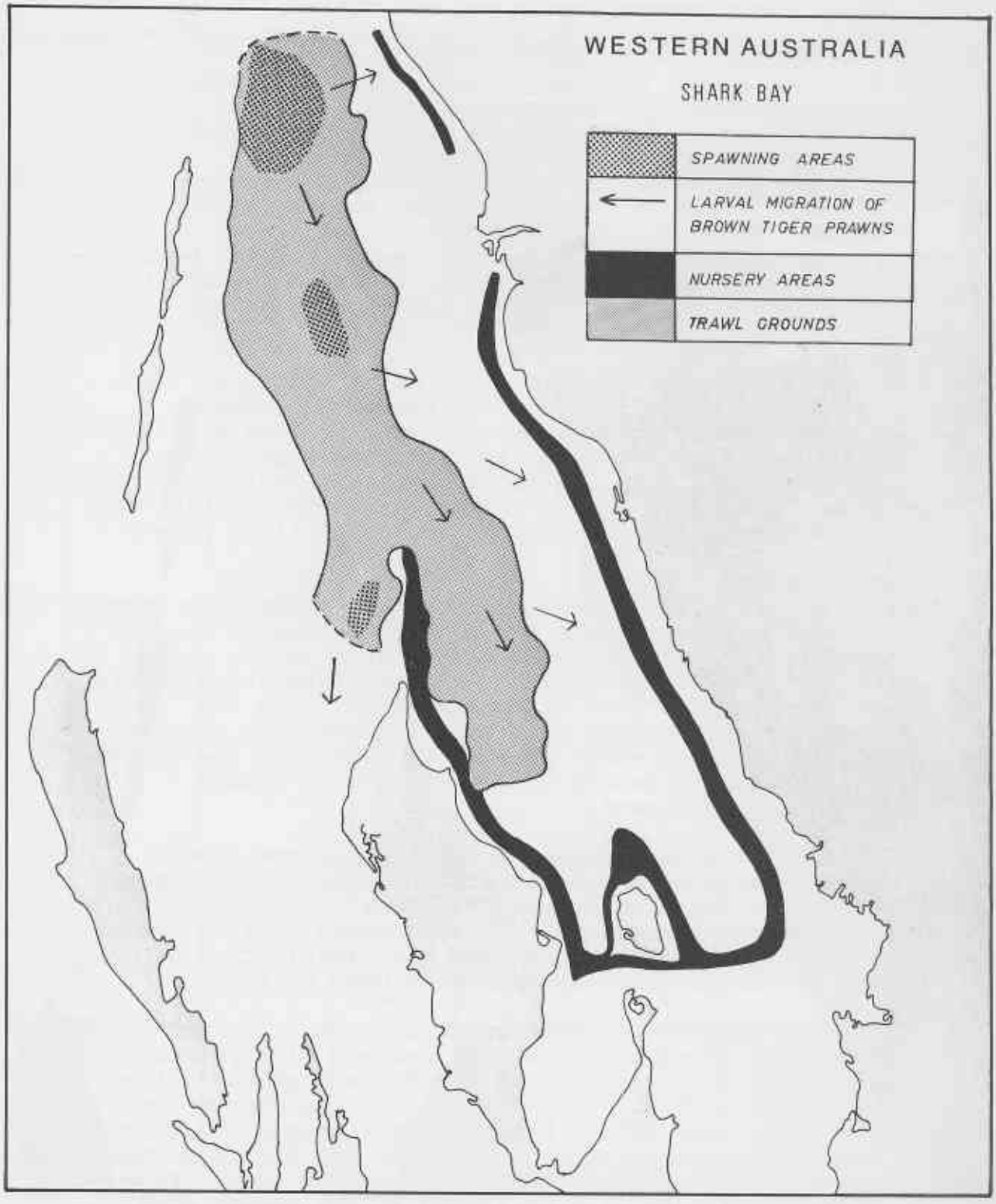


FIGURE 5: MAJOR SPAWNING AREAS FOR THE BROWN TIGER PRAWN AND THE DIRECTION OF LARVAL MIGRATION TO THE WEED BEDS.

In contrast to the western king prawns, the juvenile brown tiger prawns settle and are confined to the seagrass beds, which fringe the sand flats. This species prefers to inhabit the ribbon weed (*Posidonia sp.*) seagrass areas especially those where the grass is actively growing. An interesting feature of the juvenile brown tiger prawns in Shark Bay is that they take on the colour of the seagrass on which they are living, becoming green in colour with the normal brown bands. This colouration provides perfect camouflage until the juveniles leave the weed beds, at which stage the green colour fades to the adult pale grey colour leaving the brown bands as the conspicuous markings.

Juveniles of both species move off the inshore flats to the shallow edges of the trawl grounds in late Summer and Autumn each year. This migration coincides with the juveniles maturing physically, i.e. at sizes from 107 to 127mm total length (approx. 84/kg) for western king prawns, and between 101-121mm total length (approx. 80/kg) for brown tiger prawns.

(d) Adult Stock

Adult prawns are found throughout the trawlable area of Shark Bay from Cape Peron in the south to the Quobba Point and the Koks Island area in the north Figure 6. In addition a small separate stock occurs in the northern area of Denham Sound. On the infrequent occasions when trawling has been carried out in the deep water outside the Bay, the few prawns that have been caught were mostly large female western king prawns.

Since 1969 a continuous research programme aimed specifically at the adult stock has been undertaken using the research vessel "Flinders" and a number of commercial trawlers. Considerable data on the longevity, growth, migrations and distribution of the two major prawn species have been collected.

Tagging experiments conducted in the Koks Island area have shown that once the western king prawns reach the northern end of the Bay almost no further migration occurs. In addition the tag recoveries from this area over a period of six months indicate that these prawns survive in small but fishable quantities until they are approaching two years of age. From size composition data collected in the Quobba area it appears that brown tiger prawns follow a similar pattern to western kings with a small number of prawns surviving into their second year.

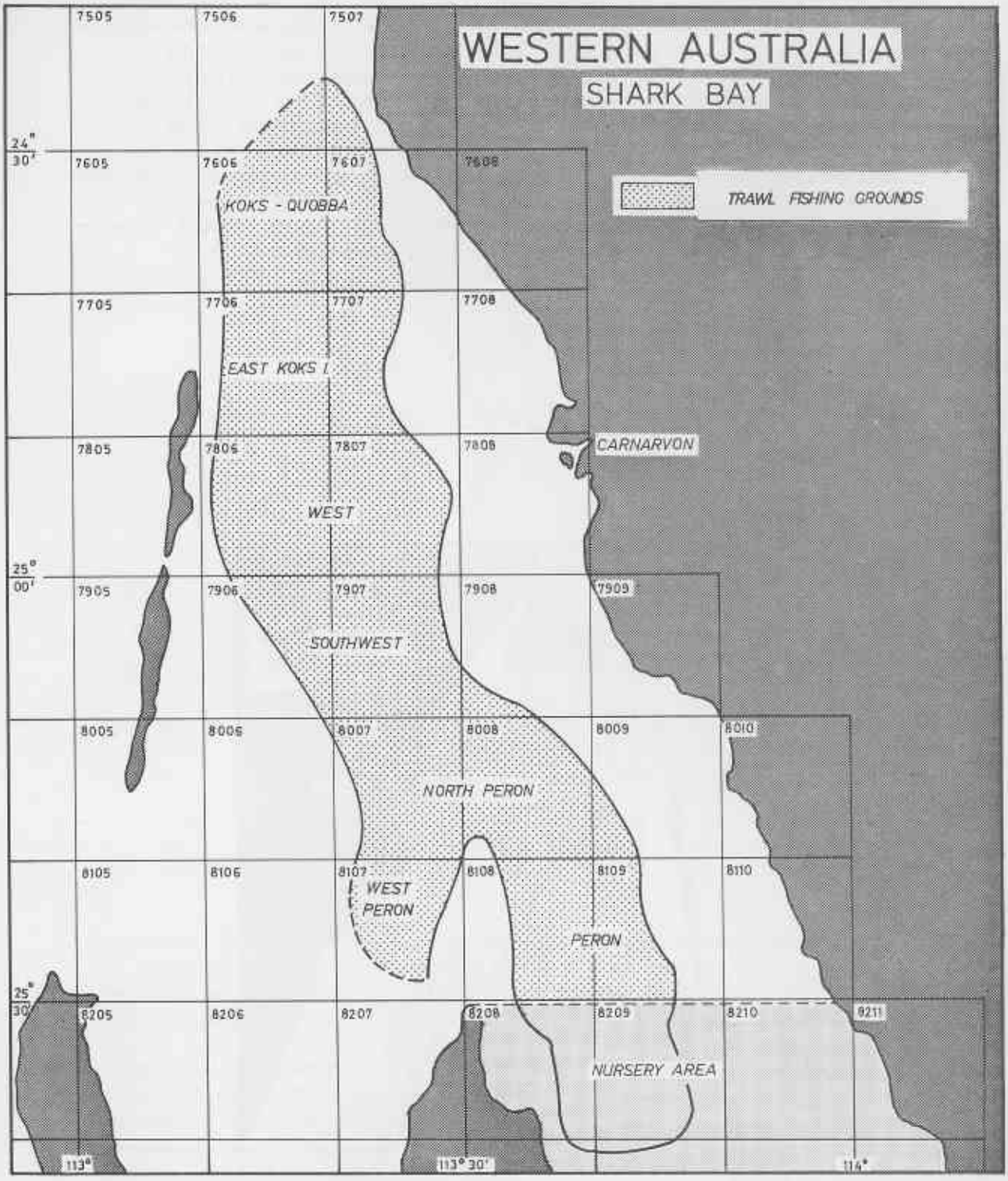


FIGURE 6: THE SHARK BAY TRAWL GROUND SHOWING THE MAJOR AREAS FISHED AND THE GRID BLOCKS USED BY FISHERMEN TO RECORD THE LOCALITY OF FISHING EACH NIGHT.

"Flinders" surveys covering the entire fishing area have provided data on the migration patterns which result in the accumulation of 1+ year old prawns in the northern area. From these surveys the average size and abundance of prawns in each area of the fishery has been used to illustrate the migration pattern for western kings (Figure 7) and brown tiger prawns (Figure 8). These data with the addition of a series of sampling runs from Cape Peron to Quobba at two monthly intervals on commercial vessels have also been used to produce average growth curves for prawn stocks. Approximate growth curves for western king prawns, Figure 9 and brown tiger prawns, Figure 10 have been presented to show the increase in mean size of each stock during 1974.

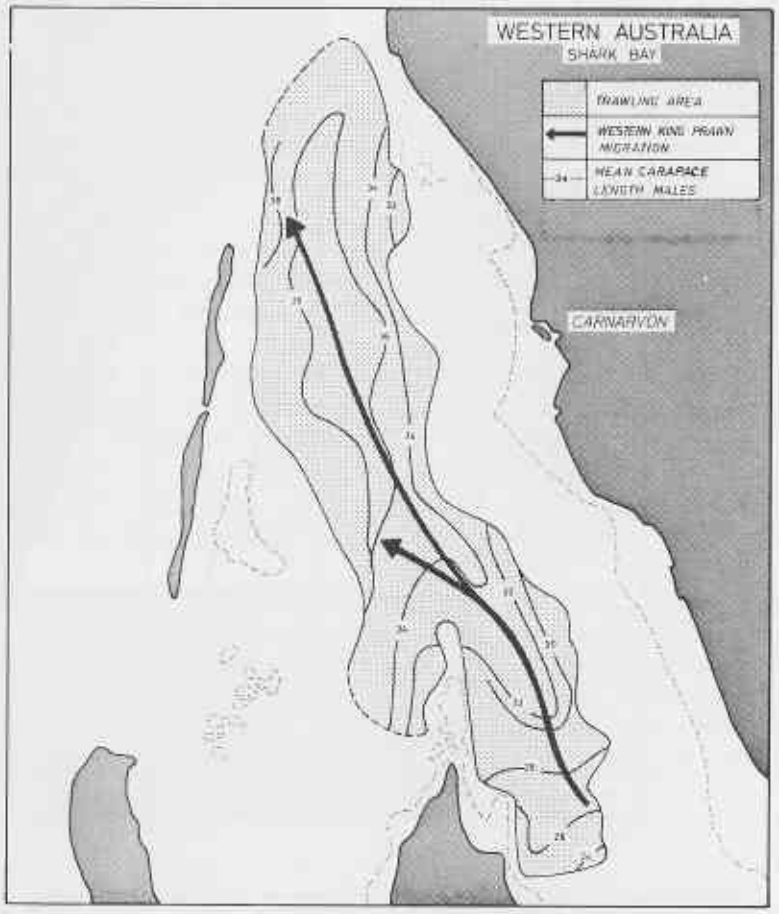


FIGURE 7: THE TYPICAL AVERAGE SIZE AND DIRECTION OF MIGRATION OF WESTERN KING PRAWNS ON THE SHARK BAY TRAWL GROUNDS IN AUTUMN.

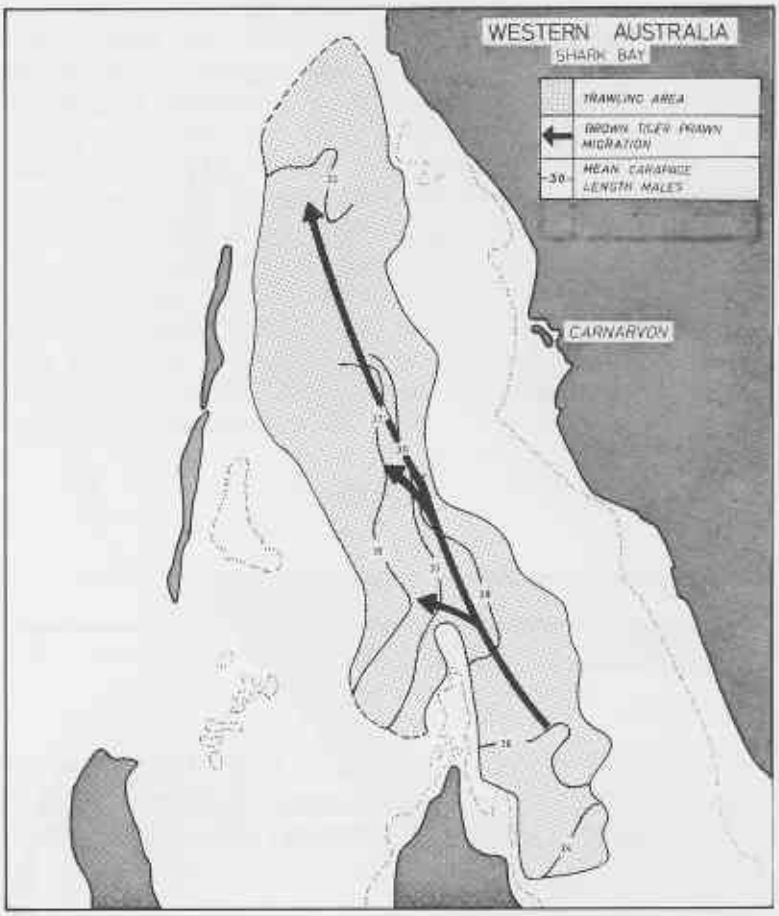


FIGURE 8: THE TYPICAL AVERAGE SIZE AND DIRECTION OF MIGRATION OF BROWN TIGER PRAWNS ON THE SHARK BAY TRAWL GROUNDS IN AUTUMN.

Another facet of the work on the adult stock has been to define the areas within Shark Bay which are inhabited by each species. Work to date has shown that brown tiger prawns occur consistently in areas where the sediment has a high mud content. In contrast the western king prawns are able to utilize coarser sediment areas probably because of their superior burrowing abilities. Figure 11 shows the areas of high mud content sediments in which the catch is dominated by brown tiger prawns - the remaining area contains predominantly western king prawns. These data have been used (Hall and Penn in press) to assess independently, the states of exploitation of the western king and brown tiger prawn stocks.

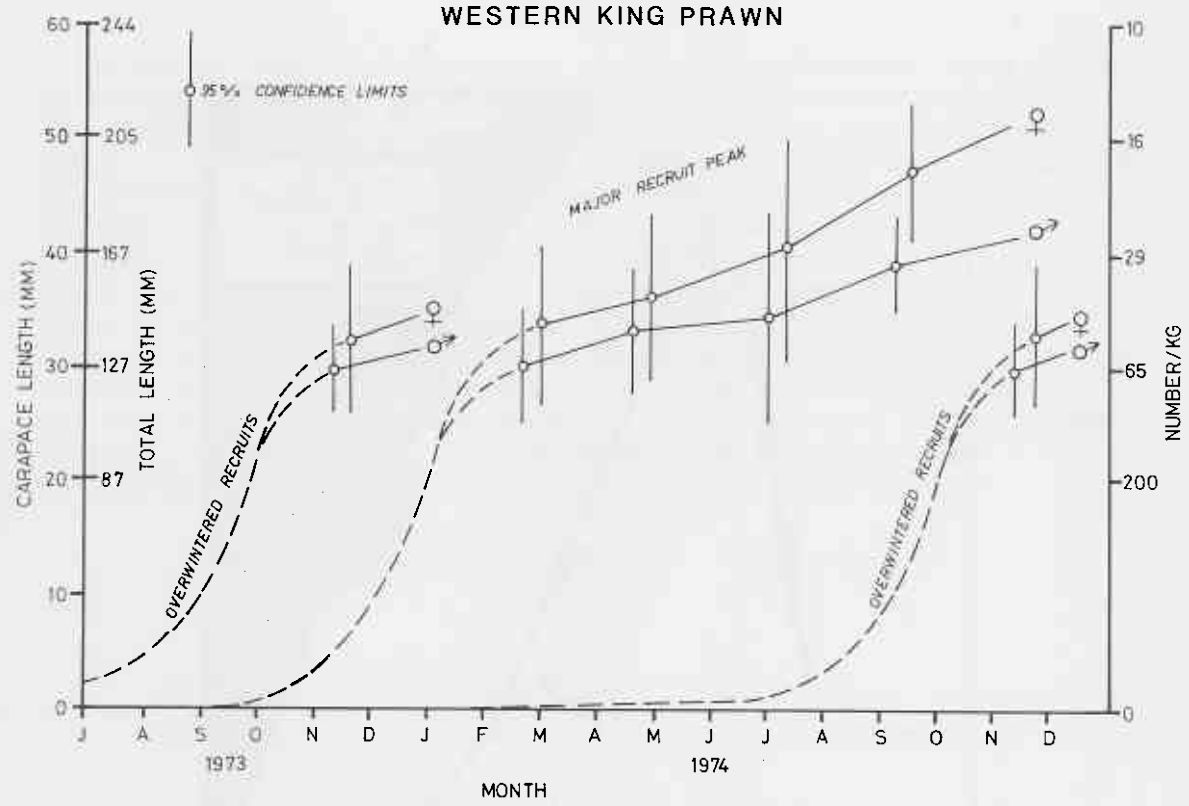


FIGURE 9: THE GROWTH CURVE FOR THE FISHABLE STOCK OF WESTERN KING PRAWNS DURING 1974 (THE GROWTH CURVE OF JUVENILES ESTIMATED).

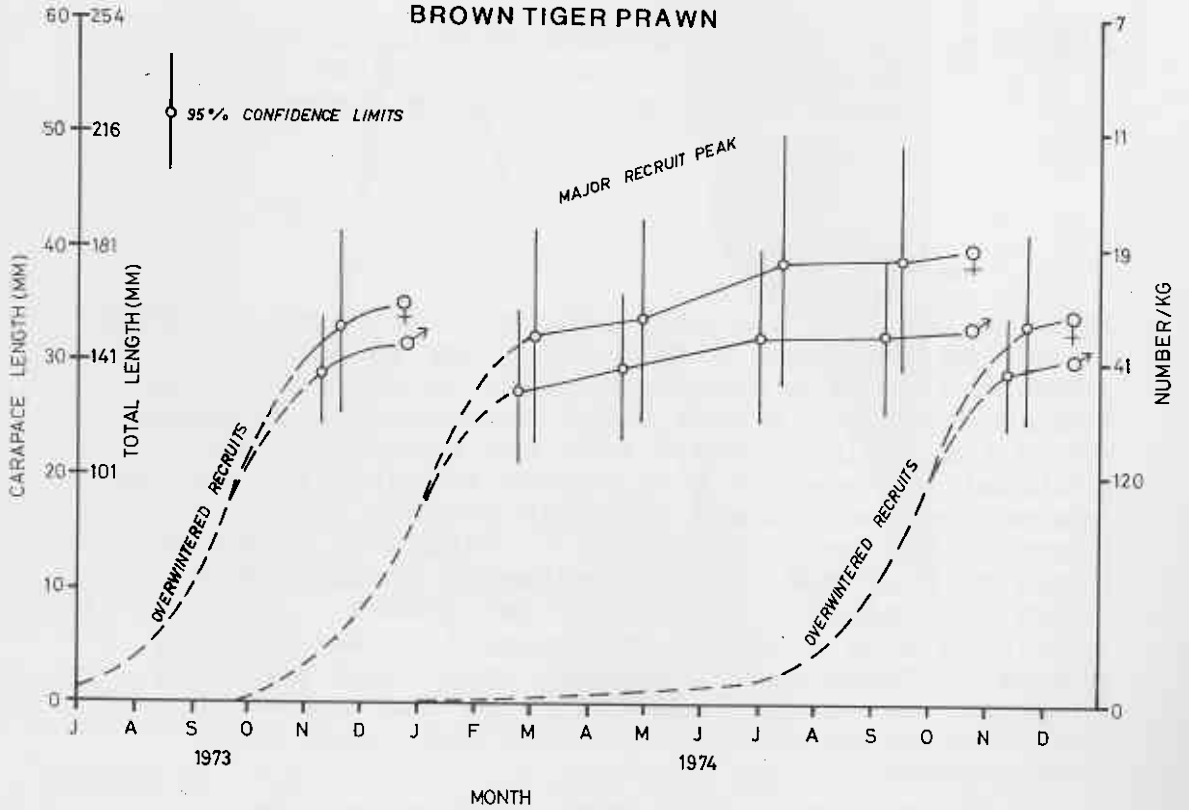


FIGURE 10: THE GROWTH CURVE OF THE FISHABLE STOCK OF BROWN TIGER PRAWNS DURING 1974 (THE GROWTH CURVE OF JUVENILES ESTIMATED).

The smaller fishing area in Denham Sound which has only recently become the subject of research surveys, has not been included in the stock assessment carried out to date because it contains a separate population. The western king prawns in the area are fished predominantly in the Spring and are equivalent in size to those found in the Koks Is. section of the main fishery. Recruitment to the area comes from the shallow untrawlable areas of Freycinet Estuary. In contrast to the western kings, the brown tigers recruited from the weed beds along the western shores of Denham Sound and Freycinet Reach move northward to the area to the west of Peron Flats where they occur predominantly at the same sizes and times as those in the Quobba area.

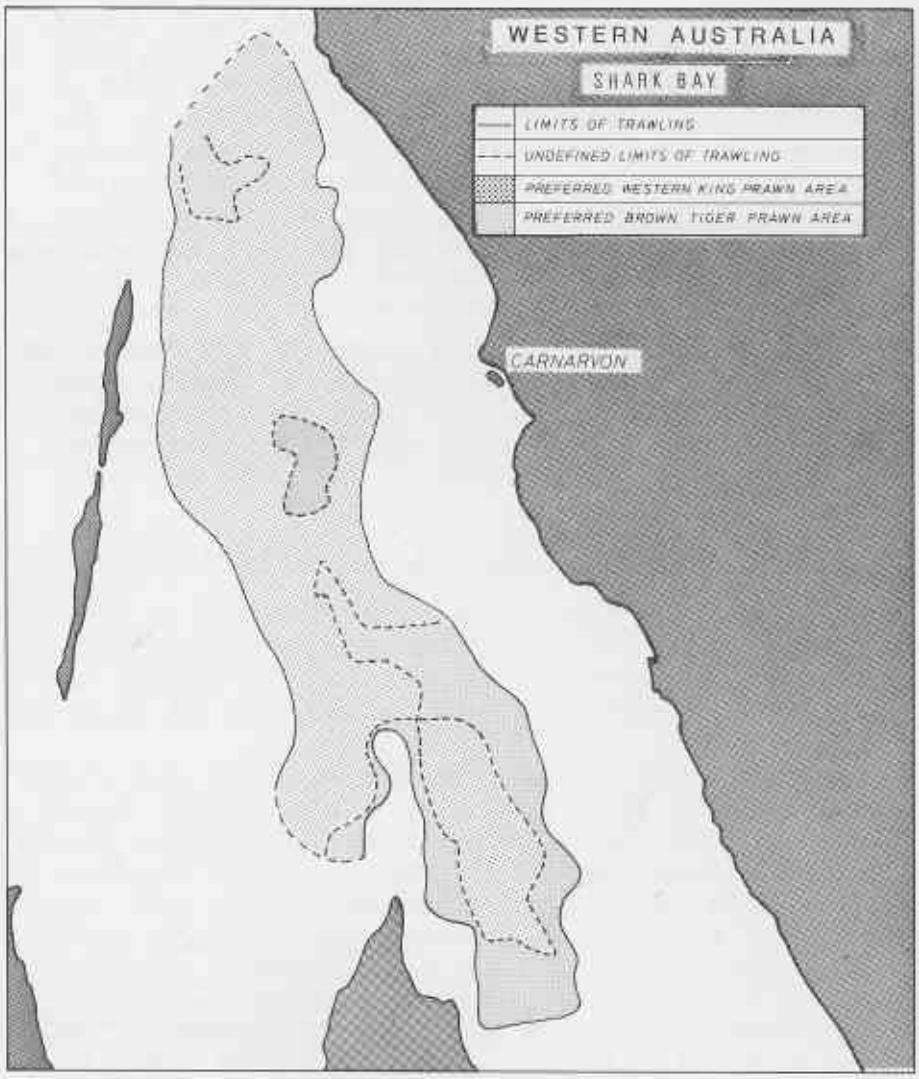


FIGURE 11: THE TRAWL GROUND SHOWING THE AREAS OF HABITAT FOR WESTERN KING AND BROWN TIGER PRAWNS.

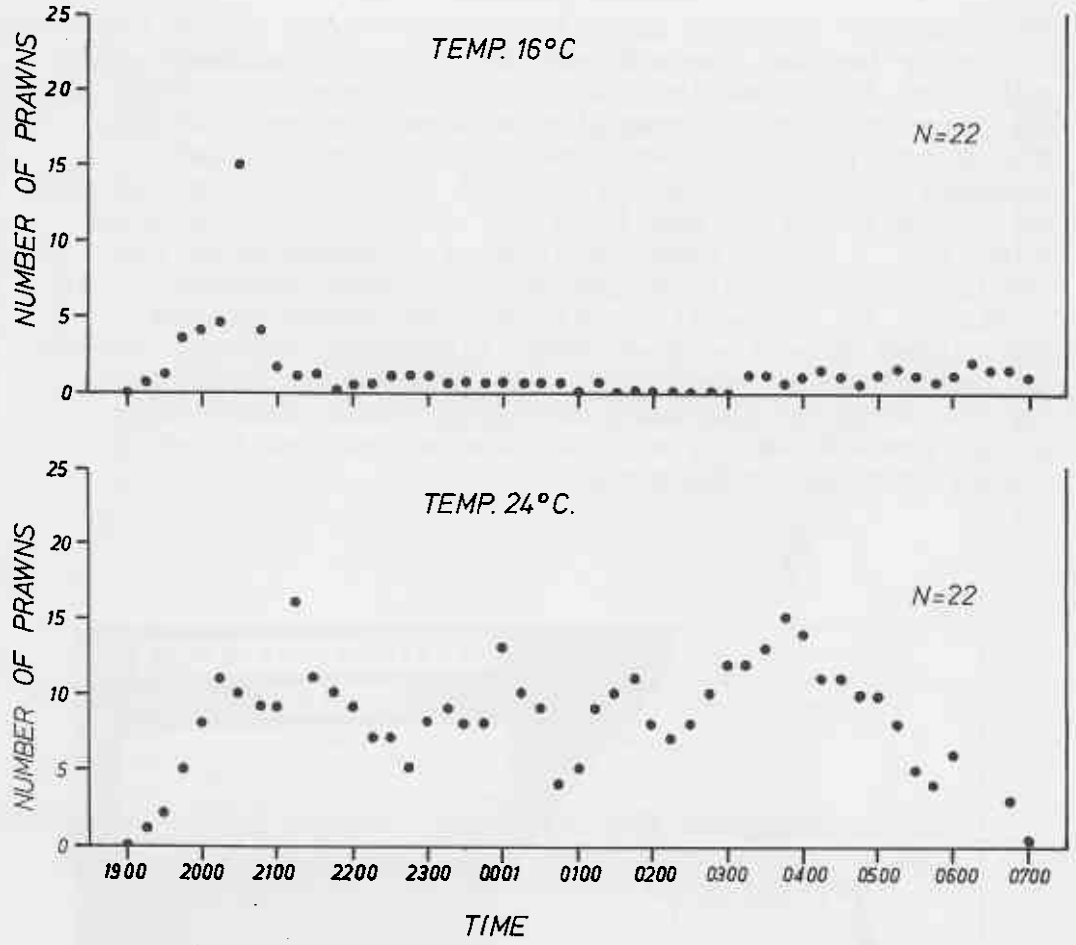


FIGURE 12: THE NOCTURNAL ACTIVITY OF WESTERN KING PRAWNS MEASURED BY THE NUMBER OF PRAWNS EMERGED AND FEEDING ABOVE THE SAND AT FIFTEEN MINUTE INTERVALS DURING THE NIGHT IN AQUARIA.

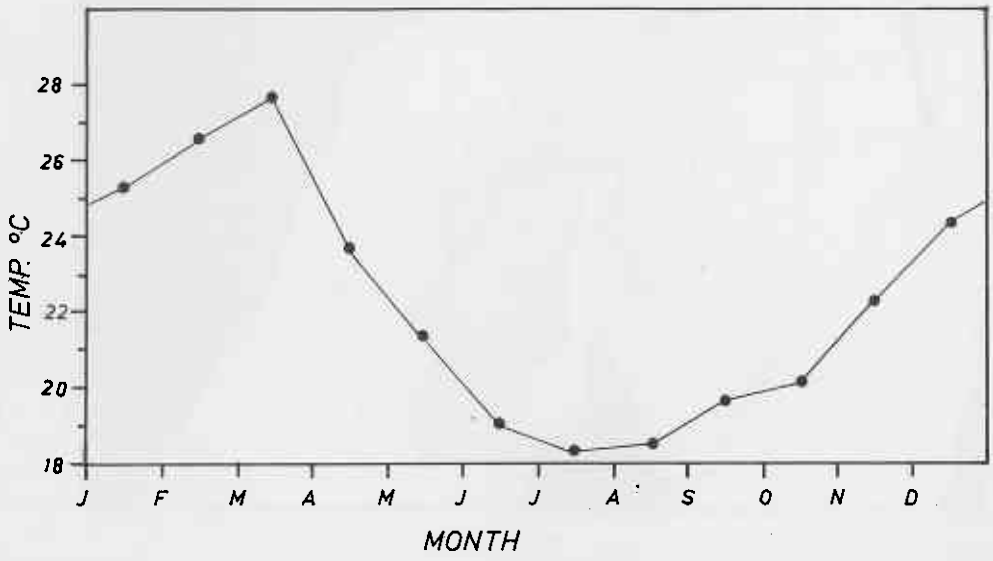


FIGURE 13: THE MEAN MONTHLY SEAWATER TEMPERATURE CYCLE OBSERVED AT THE MAIN JETTY, CARNARVON.

In addition to the field studies carried out in Shark Bay, research has been undertaken at the W.A. Marine Research Laboratories on the two major prawn species from Shark Bay. Time-lapse photography has been used to examine behavioural factors likely to affect the catch rates of prawns. This work has shown that western king prawns spend considerable periods at night buried in the bottom sediments where they would be almost untrawlable. The time spent inactive (buried) has been shown to be related to temperature, with the highest rates of activity occurring with maximum temperature. These results suggest that in the fishery the catch rates during the coldest times of the year are likely to underestimate the actual density of western king prawns present (Figure 12).

Brown tiger prawns have also been found to emerge from the bottom sediments at dusk but in contrast to the western king prawns all remain out during any period of darkness, regardless of temperature within their normal range. These results suggest that tiger prawns in a fishery are more easily exploited than king prawns, especially during the times of coldest water temperature. The mean monthly seawater temperature for the inshore waters of Shark Bay is shown in Figure 13.

These data are to be used to make adjustments to catch rate information from the fishery so that better estimates of the rates of exploitation of each species can be made.

## IV LOGBOOK COLLECTION OF CATCH DATA

To enable a limited entry management system in a fishery to be operated successfully, the catch of each species and the amount of fishing effort expended in taking that catch must be constantly and accurately monitored.

In Shark Bay this management data is collected via research log books (Figure 14), in which each skipper keeps a detailed record of his fishing operations. These log book records not only assist in the management of the fishery, but also provide each skipper with a permanent record of his fishing operations. This log book data is collected by the research staff, who remove the duplicate sheets from each book when the vessels are in port to unload. Additional data is also collected in the form of landed weights at each unloading and from measurements of weekly samples of prawns caught in each section fishery.

SKIPPER

# DAILY LOGSHEET

ORIGINAL

**Before commencement** of trawling, please indicate in the appropriate box which one of the species listed is your main fishing preference on this day.

| ✓ | King | Tiger | Banana | Endeavour | Scallops | No Preference |
|---|---|---|---|---|---|---|
| | | | | | | |

| Date of the Day Trawling Commences | Indicate Name of Vessel | Indicate the Fishing Ground and Area e.g. Quobba S.B. | Indicate Type of Net, Headrope Length and Single or Double Rig. | Indicate your position at the start and end of trawling from lights, prominent landmarks and radar |
|---|---|---|---|---|
| | | | | Start<br>End |

PLEASE INDICATE ANY CHANGE IN FISHING GROUND

WHEN KEEPING SCALLOPS, PLEASE RECORD THE NUMBER OF BAGS SAVED FROM EACH SHOT

| Block and Sub-block Fished | FISHING GROUND e.g. Peron S.B. | Shot Number | Start Time in 24 hour clock | Duration in Minutes | Depth of Trawl | | WEIGHT OF CATCH (kg) | | | | | | SCALLOPS (BAGS) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | PRAWNS | | | | | | | |
| | | | | | Start | End | King | Tiger | Endeavour | Banana | Coral | Total | | |
| | | 01 | | | | | | | | | | | | |
| | | 02 | | | | | | | | | | | | |
| | | 03 | | | | | | | | | | | | |
| | | 04 | | | | | | | | | | | | |
| | | 05 | | | | | | | | | | | | |
| | | 06 | | | | | | | | | | | | |
| | | 07 | | | | | | | | | | | | |
| | | 08 | | | | | | | | | | | | |
| | | 09 | | | | | | | | | | | | |
| | | 10 | | | | | | | | | | | | |
| | | 11 | | | | | | | | | | | | |
| | | 12 | | | | | | | | | | | | |
| | | 13 | | | | | | | | | | | | |
| | | 14 | | | | | | | | | | | | |
| | | 15 | | | | | | | | | | | | FREEZER BOATS— Number, weight and type of cartons or bags e.g. 10 kg cooked prawns or 45 kg bags whole scallops |
| Estimated Weight | | 98 | | | | | | | | | | | | |
| Landed Weight | | 99 | From your dockets, place in the appropriate columns the individual Landed Weights | | | | | | | | | | | |



FIGURE 14: RESEARCH LOGBOOK SHEET.

TABLE 2. - PRAWN LANDINGS - SHARK BAY - 1962-1976

| YEAR | WESTERN KING | | BROWN TIGER | | TOTAL (kg) | EFFORT (hrs) | BOATS* |
|---|---|---|---|---|---|---|---|
| | Catch (kg) | Catchrate (kg/hr) | Catch(kg) | Catchrate (kg/hr) | | | |
| 1962 | 104 806 | 43.3 | 46 758 | 19.3 | 151 564 | 2 420 | 4 |
| 1963 | 359 387 | 36.3 | 242 747 | 24.5 | 602 134 | 9 898 | 22 |
| 1964 | 505 568 | 36.2 | 406 633 | 29.1 | 912 201 | 13 960 | 26 |
| 1965 | 442 810 | 24.8 | 396 834 | 22.2 | 839 644 | 17 861 | 28 |
| 1966 | 261 236 | 13.6 | 406 458 | 21.2 | 667 694 | 19 211 | 29 |
| 1967 | 227 782 | 7.2 | 673 313 | 21.3 | 901 095 | 31 644 | 30 |
| 1968 | 413 900 | 11.4 | 499 326 | 13.7 | 913 226 | 36 379 | 29 |
| 1969 | 798 300 | 21.4 | 460 275 | 12.4 | 1 258 575 | 37 210 | 27 |
| 1970 | 1 042 706 | 21.4 | 732 181 | 15.0 | 1 774 887 | 48 667 | 32 |
| 1971 | 937 034 | 20.2 | 608 540 | 13.1 | 1 545 574 | 46 483 | 32 |
| 1972 | 1 382 796 | 26.8 | 369 143 | 7.2 | 1 751 939 | 51 522 | 31 |
| 1973 | 1 185 608 | 23.0 | 636 121 | 12.4 | 1 821 729 | 51 474 | 33 |
| 1974 | 1 432 625 | 27.6 | 667 708 | 12.9 | 2 100 333 | 51 814 | 32 |
| 1975 | 1 382 795 | 25.1 | 770 031 | 14.0 | 1 152 826 | 55 134 | 35 |
| 1976 | 1 510 839 | 24.6 | 771 416 | 12.6 | 2 282 255 | 61 340 | 35 |

* Maximum number of boats fishing during any month, but may be present for only a short period of the year.

The data in this table may be subjected to minor revision following more detailed analysis.

Information from these three sources are stored on computer file for processing into summaries of catch and effective effort which are then used to monitor levels of exploitation of each prawn stock. A summary of the basic catch and effort data collected for the Shark Bay fishery via the log book system is presented in Tables 2 and 3.

In addition to the data provided for management (see Hancock, 1974a & b for detailed account) the log books also provide the skipper of each vessel with a permanent record of his fishing operation.

TABLE 3: Prawn Landings Shark Bay 1976

| Month | Western King (kg) | Brown Tiger (kg) | Total (kg) | Effort (hrs) | Boats* |
|---|---|---|---|---|---|
| January | 3 924 | 5 081 | 9 005 | 247 | 7 |
| February | 109 786 | 62 115 | 171 901 | 4 844 | 32 |
| March | 275 637 | 142 487 | 418 124 | 8 354 | 34 |
| April | 335 216 | 240 527 | 575 743 | 8 641 | 35 |
| May | 258 088 | 176 453 | 434 541 | 9 528 | 35 |
| June | 189 631 | 91 060 | 280 691 | 9 157 | 35 |
| July | 114 239 | 36 134 | 150 373 | 7 416 | 35 |
| August | 71 386 | 7 073 | 78 459 | 4 798 | 33 |
| September | 85 039 | 5 467 | 90 506 | 4 656 | 30 |
| October | 45 984 | 4 565 | 50 549 | 2 836 | 25 |
| November | 21 909 | 454 | 22 363 | 863 | 10 |
| December | 0 | 0 | 0 | 0 | 0 |

* Maximum number of boats fishing during any month, but maybe present for only a short period of the year.

The data in this table may be subjected to minor revision following more detailed analysis.

# V FISHING VESSELS

The fishing fleet currently licensed to fish for prawns in Shark Bay consists of thirty five vessels (including three with provisional licenses for 1975-77), most of which have been built specifically for prawn trawling. These trawlers are generally of steel construction, although some older style wooden vessels are still in use.

The steel vessels built in recent times have ranged from 16 metres, which is about the smallest size vessel able to work in the Shark Bay sea conditions, to 23 metres which is probably about/or above the maximum size on economic criteria. These larger vessels have generally been constructed to take advantage of the ship building subsidy which is currently paid on vessels over 22 metres. Plates 1-4 show the four types of trawlers which have fished in Shark Bay from 1970-76.

The larger freezer vessels generally have a crew of four or five, comprised of a skipper, mate (second skipper), engineer, and one or two deck hands. The smaller brine storage vessels are usually worked by a crew of three but have also been operated successfully by a crew of two.

The skipper is usually paid a commission based on the quantities of prawns caught from which he pays the other crew members. Average catch per vessel per season is from 50-60 tonnes, with some vessels taking up to 100 tonnes of prawns in good years.

# VI FLEET FACILITIES

The fleet operates from two locations at Carnarvon. The eighteen vessels controlled by the local processing factory "Nor 'West Whaling Co." operate from the small jetty outside the Company's factory on Babbage Island. This anchorage, although not well protected from the weather, allows the catch to be offloaded directly into the factory. Plates 5 and 6 show the frozen prawns being unloaded and the train which takes the product into the factory. The remaining vessels currently use the newly constructed marina ( Plate 7) which provides shelter from the prevailing winds. In this marina the vessels are able to offload directly into freezer trucks (Plate 8) or brine storage bins which are used to transport the catch to other factories for processing.

Maintenance facilities for the Shark Bay fleet are presently (1976) restricted to mechanical repairs during the season, with all vessels returning to either Geraldton or Fremantle for slipping to allow hull maintenance and general refitting. Construction and major repairs to

trawling gear and nets is usually undertaken during the offseason, although in the case of Nor. West Whaling Co. vessels this work is carried out continuously at the Carnarvon factory (Plate 9). Minor repairs and maintenance of nets is however carried out aboard each vessel throughout the season (Plate 10).

## VII PROCESSING THE CATCH

Prawns caught by the Shark Bay fleet are processed in a number of ways. On board the vessels there are two basic storage methods. Firstly, the prawns may be held for up to six days in refrigerated brine in insulated tanks on deck (Plate 11), usually located under the sorting tray (Plate 12). Alternatively the prawns are packed into cartons and snap frozen before transfer to the vessel's freezer hold for storage until offloading up to a month later.

On board handling of the prawns may also include cooking (by boiling in seawater) before being frozen for storage in 10-14 kg cartons. This process of onboard cooking has become less common in recent years and is now only carried out on some of the individually owned vessels. These vessels cook small prawns (below the minimum export size) which are suitable only for the local or Eastern States market.

Once the prawns are landed they are either processed in the local factory or transported to processing factories in the Perth metropolitan area. At the processing factories the prawns for export are packed into 2 kg blocks of either green (uncooked) tails, (Plate 13) or whole green prawns, i.e. most brown tiger prawns are frozen whole for export to the Japanese market (Plate 14).

In addition to the conventional processing by manual heading of the prawns (Plate 15) the Carnarvon factory has also recently begun to use a mechanical peeling and deveining machine to produce a prawn flesh pack. This machine is used mostly on broken shelled reject prawns and small prawns not suitable for the export market, and has also been found useful for shelling endeavour prawns, which, because of their lower market value, are not economic to process by hand. A photograph of the peeling machine is included in Plate 16.

In the export packs all prawns are graded into size categories with the majority of western king prawns being in the range of 40-55 tails per kg, and the majority of tiger prawns being packed at 36-44 tails per kg. To enable the grade category data to be used scientifically, a series of tables have been prepared converting numbers per kilogram to actual sizes of prawns (Penn and Hall, 1974).

## VIII FUTURE RESEARCH

Monitoring of the catch, and the effort expended on the prawn stocks will continue as part of the ongoing management of the Shark Bay limited entry fishery. This monitoring will involve the continued use of logbooks and the associated factory sampling to measure the size of prawns taken in each area of the fishery.

Biological research will continue with the major emphasis on recruitment, both to the fishery and the nursery areas. The nursery programme which has already begun, will seek to define the juvenile habitats and areas of these habitats available in Shark Bay. Once the nursery areas have been defined, the environmental factors which could affect survival of juveniles will be investigated as a long term project. In addition to the field studies, the existing laboratory programme to determine the behavioural factors affecting catch rates of both western king and tiger prawns will be continued at the W.A. Marine Research Laboratories.

## IX ACKNOWLEDGEMENTS

The authors wish to thank all those members of the Shark Bay fishing industry who have willingly assisted in the research programmes since the inception of the fishery. The authors also wish to thank Dr. D.A. Hancock and Mr. R. Lenanton for their constructive criticism of the manuscript, and Messrs. P. Wood, B. Bartley, G. Lymn and K. Marshall for their assistance with collecting data and the photographs.

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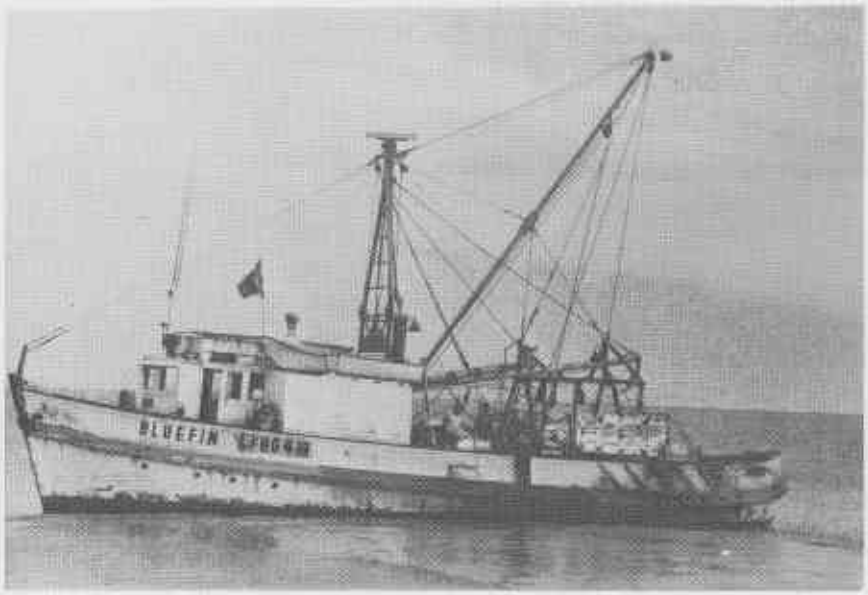

PLATE 1: THE TRAWLER 'BLUEFIN' A WOODEN HULLED VESSEL CONVERTED FOR PRAWN TRAWLING IN THE EARLY YEARS OF THE SHARK BAY FISHERY.

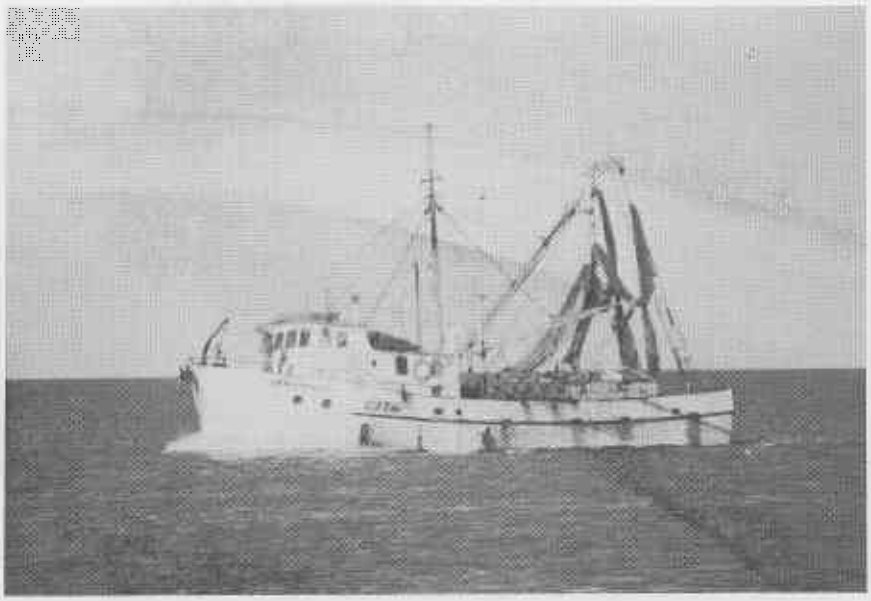

PLATE 2: THE "RIVER CLASS" TRAWLER 'N.W. FORTESCUE' IS A STEEL VESSEL DESIGNED SPECIFICALLY FOR PRAWN TRAWLING.

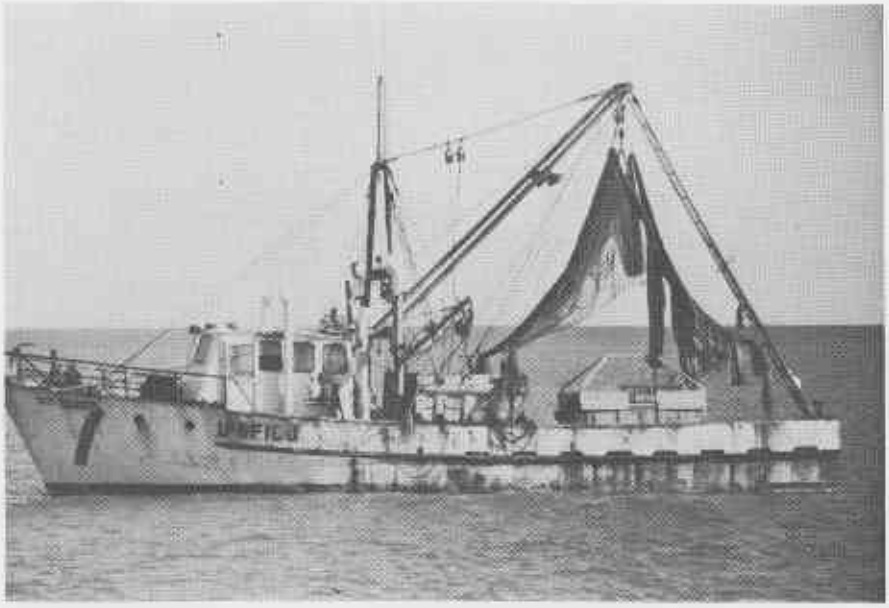

PLATE 3: THE "NOR CLASS" TRAWLERS ARE THE SMALLEST STEEL VESSELS OPERATING IN SHARK BAY.

PLATE 4: "SENHORA DE FATIMA" WAS THE LARGEST TRAWLER THAT FISHED IN SHARK BAY FROM 1971 TO 1974.

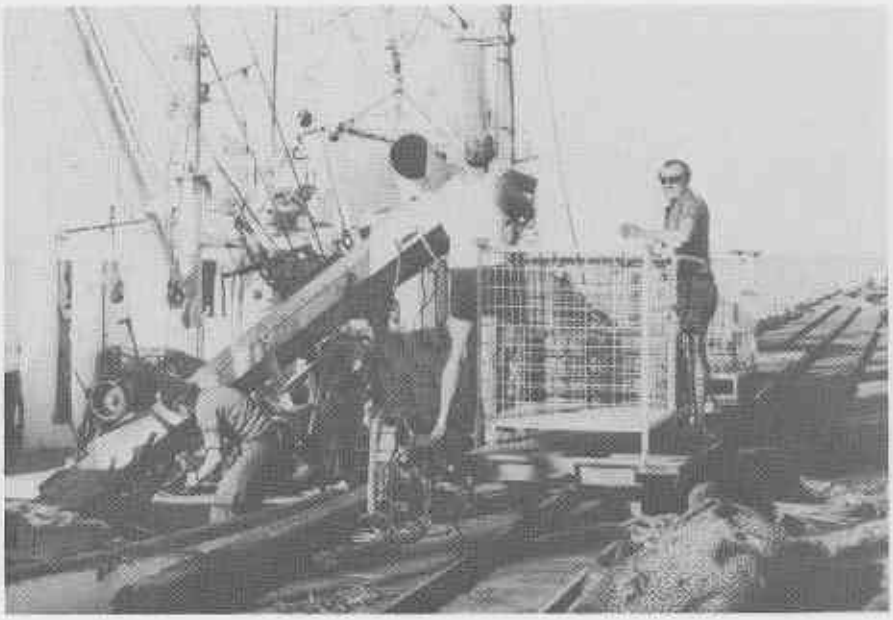

PLATE 5: UNLOADING CARTONS OF PRAWNS FROM A FREEZER TRAWLER AT THE N.W. WHALING CO. JETTY.

PLATE 6: THE UNLOADED CATCH OF PRAWNS IS TRANSPORTED FROM WHARF TO THE NEARBY FACTORY PROCESSING LINE.

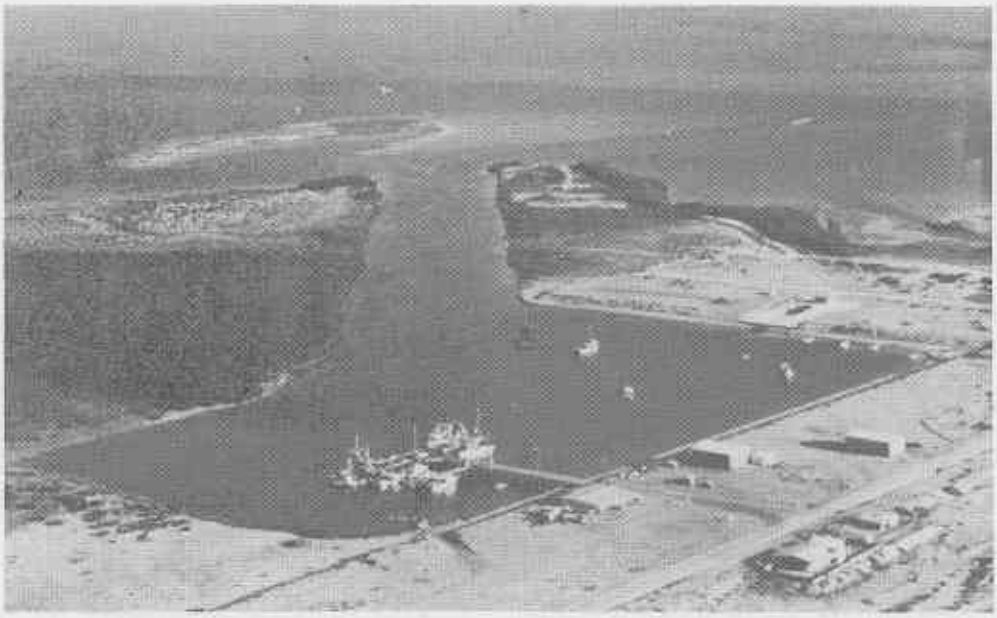

PLATE 7: CARNARVON MARINA.

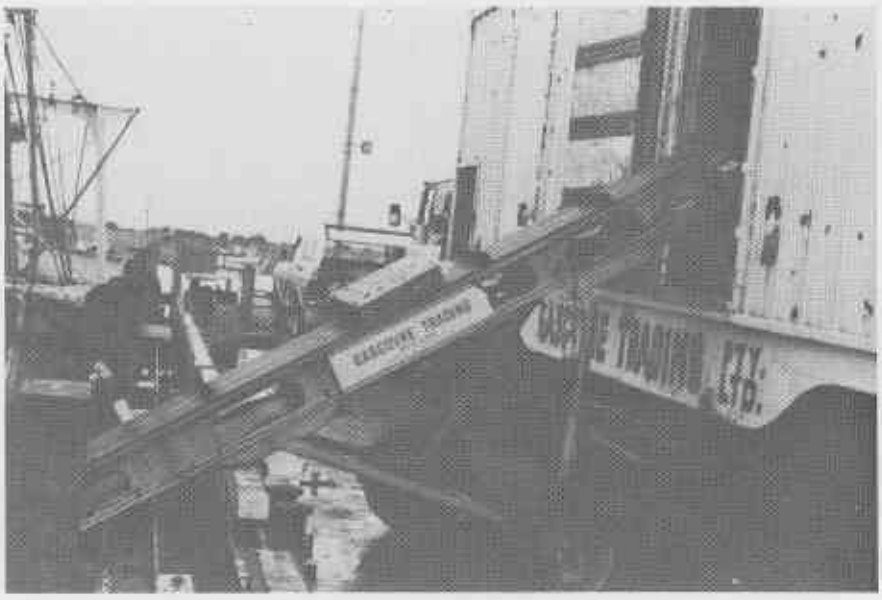

PLATE 8: TRAWLER OFFLOADING PRAWNS TO A FREEZER TRUCK.

PLATE 9: MAKING UP AND REPAIRING PRAWN TRAWL NETS FOR N.W. WHALING CO., AT THE CARNARVON FACTORY SITE.

PLATE 10: FISHERMEN REPAIRING NETS ABOARD A TRAWLER.

PLATE 11: UNLOADING PRAWNS FROM A REFRIGERATED BRINE TANK.

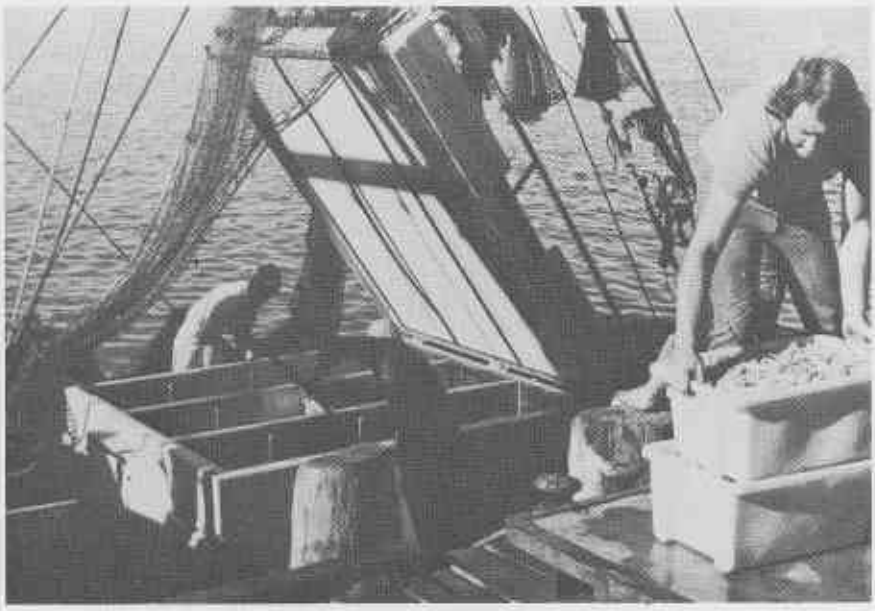

PLATE 12: VIEW OF A REFRIGERATED BRINE TANK WITH THE SORTING TRAY LIFTED TO PROVIDE ACCESS FOR THE UNLOADING OPERATION.

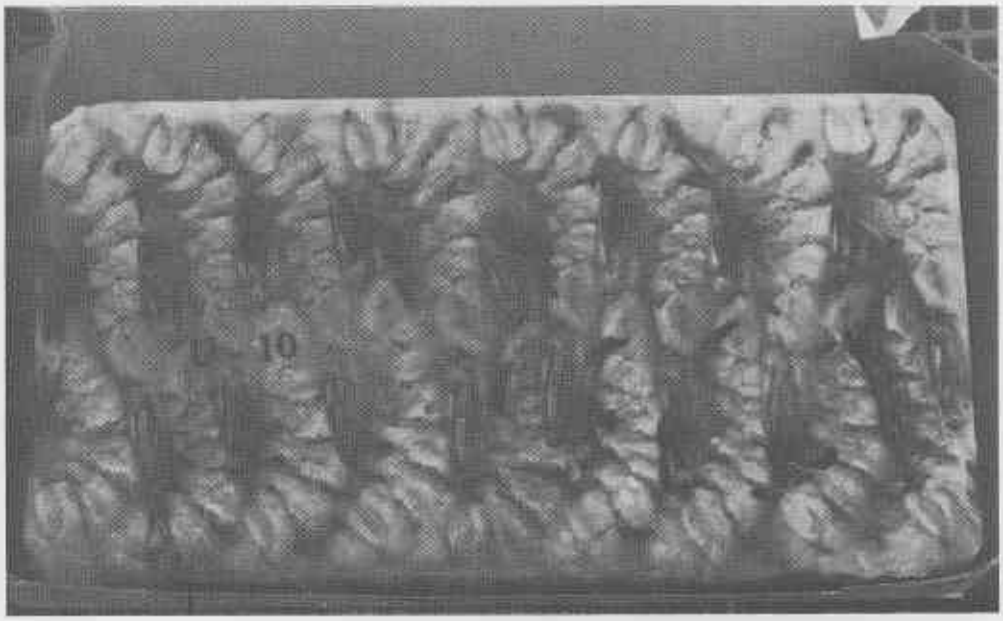

PLATE 13: EXPORT CARTON OF FROZEN BROWN TIGER PRAWN TAILS.

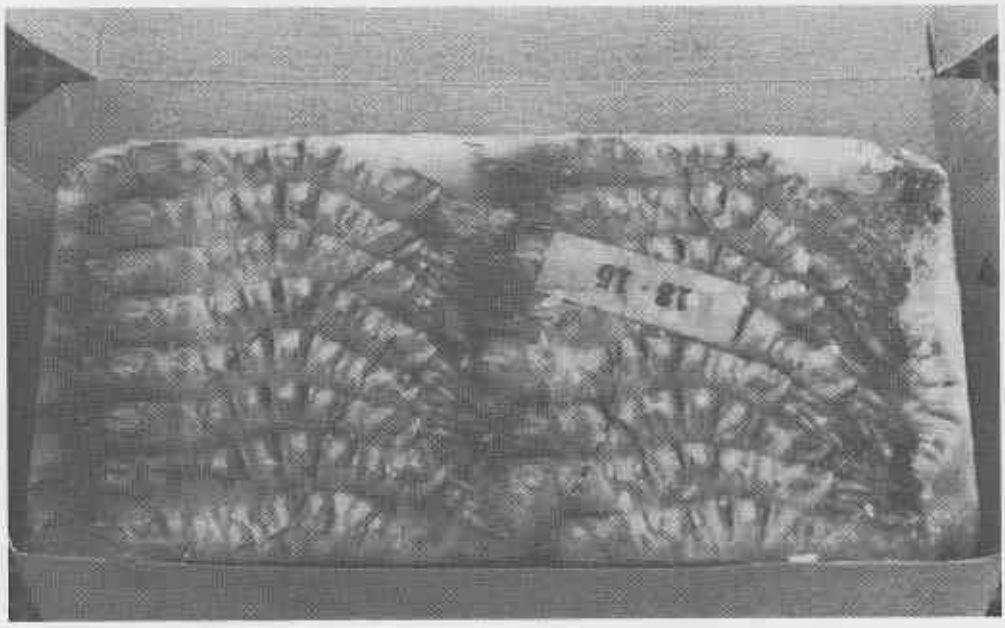

PLATE 14: EXPORT CARTON OF FROZEN WHOLE BROWN TIGER PRAWNS.

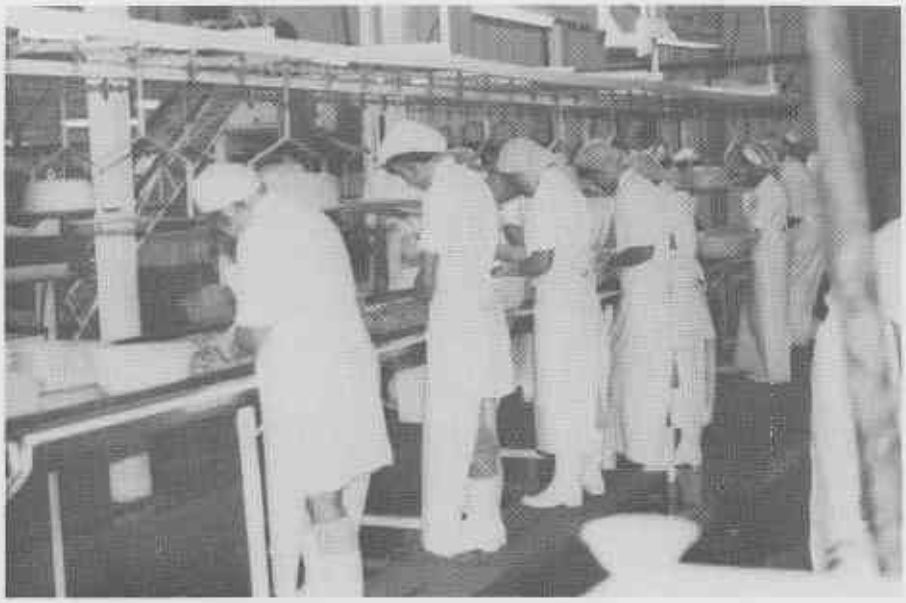

PLATE 15: HEADING THE PRAWNS AT THE FACTORY PROCESSING LINE.

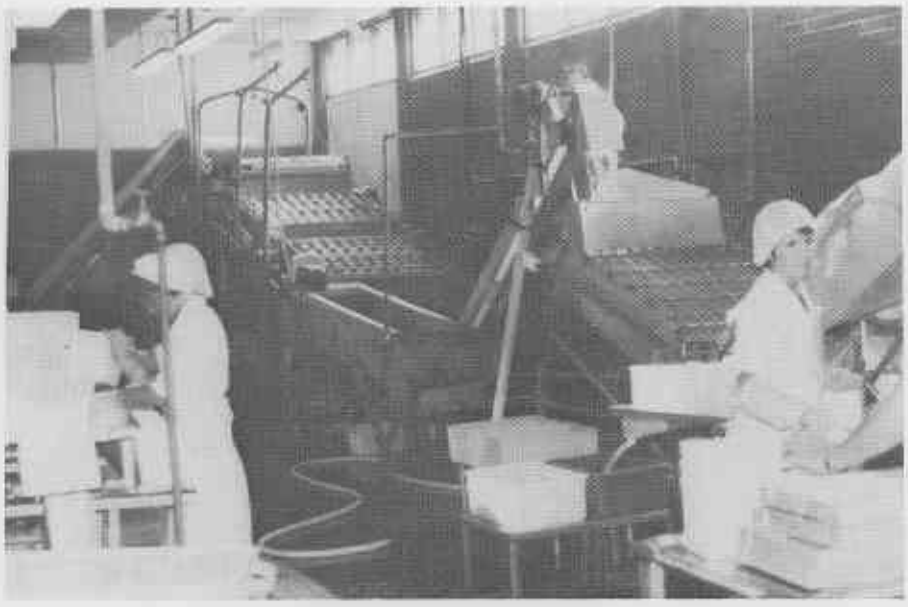

PLATE 16: THE AUTOMATIC PRAWN PEELING MACHINE.