WAT

LESCHENAULT INLET FISHERIES AND MANAGEMENT SEMINAR

Waterways Commission
Report No. 17
June 1990

184 St. George's Terrace, Perth W.A. 6000

LESCHENAULT INLET

FISHERIES AND MANAGEMENT SEMINAR

ISSN 0814 6322
ISBN 0-7309-3890-5

LESCHENAULT INLET FISHERIES AND MANAGEMENT SEMINAR

THURSDAY - 13 OCTOBER 1988

LORD FORREST HOTEL - BUNBURY

CONTENTS

INTRODUCTION

The Leschenault Inlet is the Bunbury districts biggest inland waterway, and is facing a potential environmental crisis.

The threat to the health and quality of the waterway stems from three principal sources.

Firstly, increased boating and fishing, and recreational use of estuary and foreshores.

More information is required on the effects of the abuse of inshore waterways fishing regulations, the impact of netting by professionals and the damage to shallows from boating, wading and prawning.

There is also still much to learn about the migratory, feeding and breeding habits of the estuarine waterbird species and the effects of human activity on those waterbirds.

Secondly, significant fertiliser inflow from surrounding farmland, have the potential to cause very serious problems with algae growth. The Inlet seems to have been protected from uncontrolled algal growth problems to date by the effects of tidal flushing through the Cut, however, any significant increase in nutrient inflow may cause the onset of problems similar to those being experienced at Mandurah in the Peel Inlet and Harvey Estuary.

Thirdly, industrial and domestic wastes can have a direct and drastic effect upon the waterway environment, and it is essential that future industrial development near the Collie and Preston rivers and Bunbury inner harbour do not involve harmful discharges into the inlet waterway.

Inevitably, the future expansion of the South West will mean increased competition for a limited inlet fishing and recreational resource.

The priorities we set for the future of the waterway should be decided by the whole community.

The purpose of this seminar, is to provide you with a description of the biology of the waterway environment, a summary of the pressures being placed upon the waterway, and the management objectives and methods; and to have a forum for you, the community, to have input into the conservation and enhancement of our waterway environment.

Sir Donald Eckersley, OBE
CHAIRMAN
LESCHENAULT INLET MANAGEMENT AUTHORITY

OPENING

This Seminar is important because it highlights the fact that there is a high degree of awareness within Government and the scientific community that the Swan Coastal Plain is indeed at risk.

I also want to emphasise that if there are problems with the coastal plain and its inlets, then there are problems for us all, and not just one specific group, whether they be the inlet management authority, fishermen, boat owners, farmers, or even government departments.

The Leschenault Inlet itself is the biggest recreational area of water near Bunbury and it is still in a healthy state, when compared with other inlets on the Swan Coastal Plain. However, it is facing increasing demands from a variety of sources. The population of the South-West between 1981 and 1986 grew by 16.7 per cent, compared with the overall Western Australian growth rate of 10.5 per cent.

Growth rates in Australind and Eaton show that there is a big expansion of population in the Leschenault Inlet catchment.

There are also the impacts of industrial development, farming practices and the fishing industry.

The recently released South West Strategy places high priority on the environment, particularly the need to identify environmentally critical areas of river and estuarine catchment and develop integrated management programmes for those catchments.

The strategy also highlights the need to ensure that the effect of pollution on certain estuarine habitats is recognised and that action is taken to protect affected fish breeding grounds.

We already are seeing some headway in making sure that these needs are being met.

For example, the SCM plant's new Kemerton complex has removed one of the pressures being placed on the estuary.

The change in SCM's processing technology means that the Leschenault peninsula can be phased out as a dumping ground for the waste material generated by the plant.

That, in turn, has allowed the area to be rehabilitated and turned into a coastal park for the benefit of residents and visitors to the region.

Other changes that will have an impact on protecting the inlet include changed fertiliser practices, particularly for farmers in the Brunswick, Preston and Collie river catchments.

The Department of Agriculture has developed a fertiliser prediction model to help plan optimum fertiliser strategies.

For example, one problem that the department found in the Peel/Harvey catchment, which no doubt applies in the Leschenault, is that farmers were applying superphosphate on sandy soils, not so much for the phosphorus, but for the sulphur content.

This practice has dangers for the water quality of the inlet, and clearly most stop.

As well, the department, in association with CSBP, developed a slow release fertiliser for coastal soils as part of the overall plan to reduce the amount of phosphorus leaching into waterways.

With this product and other fertiliser strategies farmers have adopted, we have achieved cuts of 30 per cent in the amount of phosphorus applied to the Peel catchment over three years, without reducing agricultural productivity.

Unfortunately, CSBP no longer manufactures the compound, but through the Government's Integrated Catchment Management Policy Group, I will be initiating discussions with the company as we believe that CSBP does have a role to play in regard to this environmentally sensitive issue.

Farmers in the Leschenault catchments should not wait until they cause pollution in the inlet, but rather, should begin the change now so that future problems will be minimised, or even avoided.

The recreational and commercial fishing sectors do compete for the Inlet resource and, consequently, the Government recognises that some scaling down of the commercial activity in the estuaries will be necessary to allow for an increase in recreational fishing.

Commercial estuarine fishing licences are not transferable, and the number of these licences will be reduced as fishermen leave the industry.

In my opening remarks I suggested that the problems of areas such as coastal estuaries were not the domain of any single group, but rather were a community responsibility.

The preservation of the integrity of the inlet is important, not only in an environmental sense, but also socially, as it will become a much greater feature of Bunbury, particularly with the opening of the Koombana bridge and new entrance into the city.

I am optimistic about the future of the inlet, as I believe that we do have many of the solutions at hand and that with cooperation with all land and water users in the catchment, we can prevent a repeat of the problems that have affected other estuaries.

The Hon. Julian Grill, MLA
Minister for the South West,
Fisheries and Agriculture.

SUMMARY

by

DR R GEORGE

This whole seminar has been so interesting that it has been most difficult to compose this summary during the speakers' addresses.

Each speaker is to be highly commended, as they have given the enthusiastic audience so much good data on the various aspects that make the whole Estuary what it is.

The multitude of questions from the audience have shown the concern by the public, particularly about the crabs and the fish for recreational and commercial purposes. But the longer term problems, like the effects of increasing industrial developments, aquaculture, mosquito control, environmental changes like greenhouse, ozone layer and Leeuwin current, are certainly taxing our panel of absolute answers.

The real question to which virtually all speakers implied was "How does this estuary system work?" If we fully understood all the various influences that daily, seasonally and annually act on the estuary, we would have less concern. Most speakers made comparisons between the many coastal estuaries of our South West and showed that we do know quite a lot - but do we know enough? Current research seems to be oriented directly towards finding out what manner of 'things' get into the catchments of our rivers and streams and then we want to know just what effects these have on the total health of the estuaries.

It is obvious that we must maintain and correct the estuary systems, but we also know that "there is nothing more certain than the uncertainties produced by change".

A team effort is essential and we have seen how the Waterways Commission has selected the various members of its team to form a strong unit. We must win the fight.

The Four Corners Video we saw at lunch is proof enough that these events must not happen in Western Australia. We have been warned, let's act on that warning. We must win! To come second means we will never get the chance to even compete again!

BIOLOGY OF THE ESTUARY - THE FOOD WEB

N.R. LONERAGAN

School of Biological and Environmental Sciences

Murdoch University

Murdoch, Western Australia 6150

The physical environment of an estuary has an important influence on the animals and plants found in estuaries. Estuaries receive inputs of marine water from the ocean and fresh water from the rivers which flow into the estuary. One of the features of all estuarine systems in south-western Australia is that they are highly seasonal in terms of freshwater inputs. Nearly 60% of the annual rainfall and 90% of riverflow in this region occurs in the winter months between June and August (Fig. 1). The initial rainfall in May doesn't cause an immediate increase in river flow (Fig. 1) because this rainfall is absorbed by the soils in the catchment. During the time of high rainfall and high river flow, several characteristics of the water within the estuary such as salinity, nutrient levels and the amount of light transmitted through the water column also change dramatically.

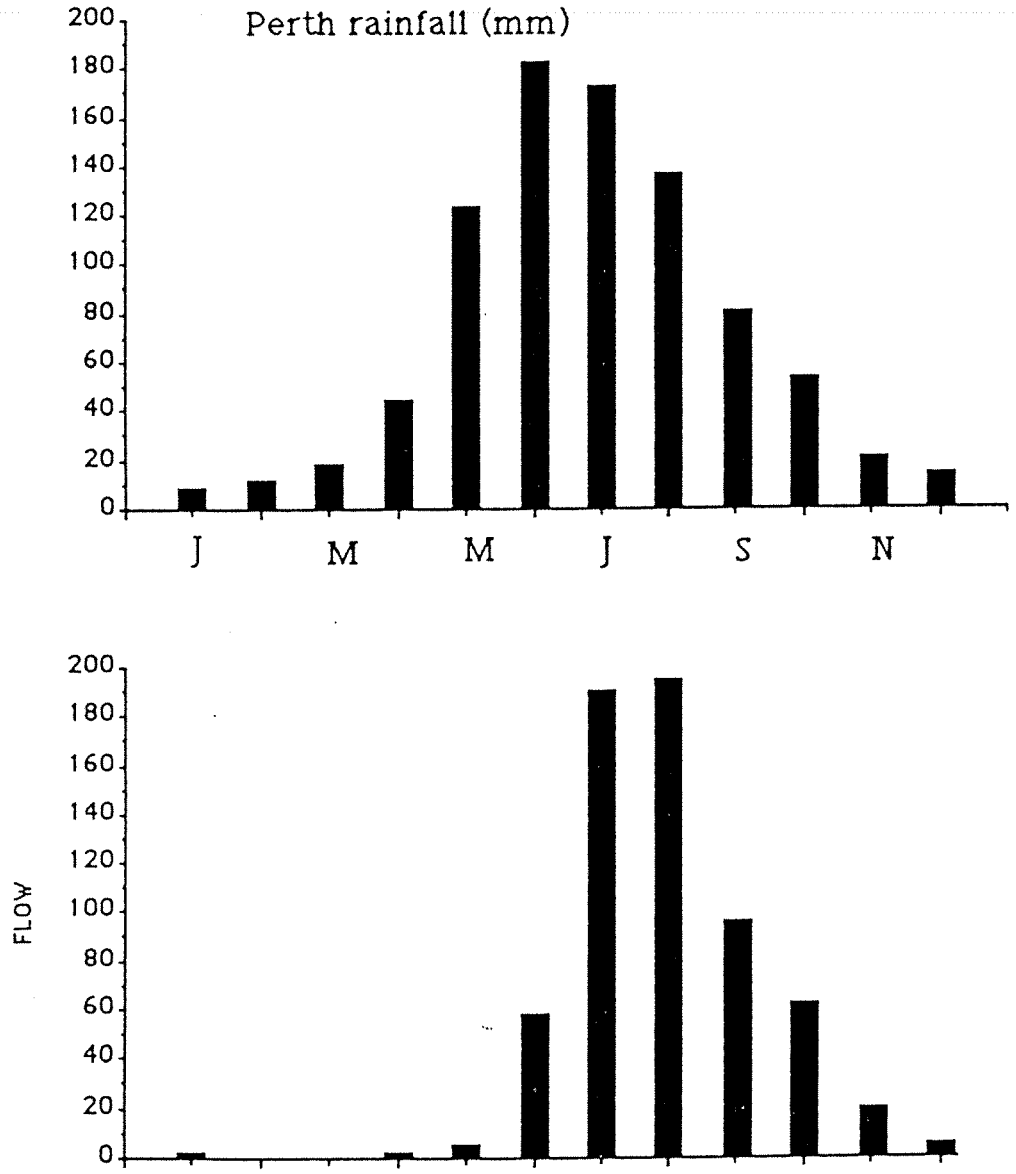


Figure 1. Rainfall and riverflow for the Perth region.

The salinity of the water, i.e. the amount of dissolved salts, has an important influence on the animals and plants found in the estuaries. Estuarine animals and plants fall into several broad categories according to their tolerance to changes in salinity:

1. Marine species - (a) animals which are very tolerant of large changes in salinity (marine - euryhaline, e.g. sea mullet):

   (b) animals which tolerate only small changes in salinity (marine - stenohaline, e.g. leatherjackets), and hence are usually found only near the mouth of the estuary.

2. Estuarine species - species which are able to complete their life cycles in the estuary (e.g. black bream).

3. Freshwater species - those animals which generally live in the upper reaches of estuaries (e.g. pygmy perch); and

4. Migratory species - animals which pass through the estuary to breeding areas in the rivers (anadromous, e.g. Perth herring), or ocean (catadromous, e.g. eels),

The salinity of oceans waters is about 35 parts per thousand, which is the salinity we would expect near the Cut of Leschenault Inlet for most of the year (Fig. 2). Within the basin of Leschenault Inlet the salinity is likely to vary throughout the year. In this region, salinities probably increase to very high levels in the late summer and autumn months due to the evaporation of water and very little freshwater input. During the winter months, however, there is likely to be a dramatic decline in salinity levels, to between 10 and 20 parts per thousand (Fig. 2). The salinity in the Collie River is also highly seasonal but it is unlikely to exceed 25 parts per thousand.

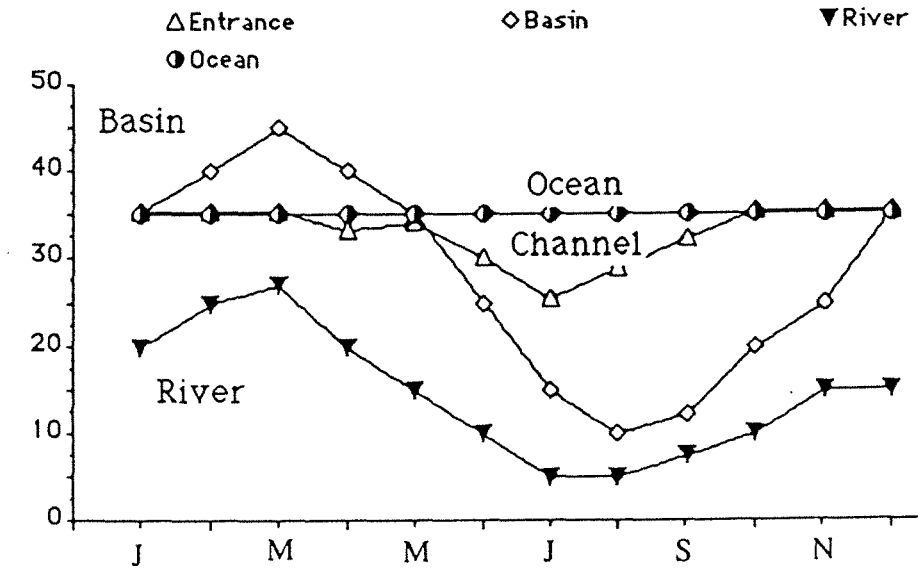


Figure 2. Hypothesized changes in salinity for different regions of the Leschenault Inlet.

The changes in salinity of the water in an estuary limits the number of species that are able to reside within an estuary. Most of the species found in estuaries are marine species which breed in the ocean and use the estuary at some stage of their life cycle. In general, estuaries tend to have fewer species than the ocean, but the number of animals and biomass of plants found within estuaries can be very high.

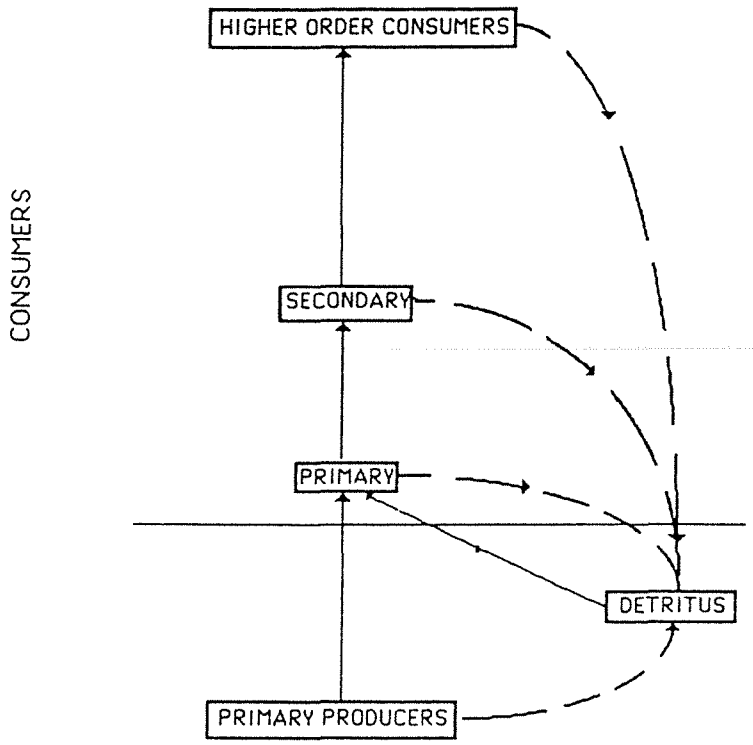


Figure 3. Generalised food web for an estuary.

A generalised scheme for an estuarine food web is shown in Fig. 3. At the base of the food chain are the primary producers. These are the plants which utilise nutrients, light and temperature to grow. Dead and decaying organic matter or detritus is also at the base of the food web. Detritus is formed from either plant or animal matter and is colonised by bacteria and fungi. It can be an important source of food for some fish (Fig. 4).

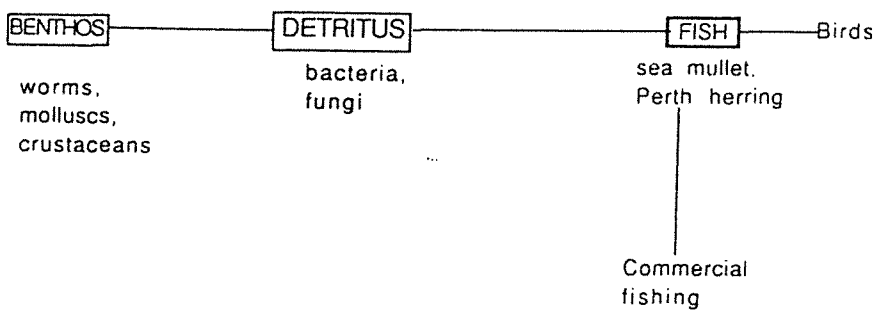


Figure 4. Detritus based food web.

One of the primary producers within the estuary are the microscopic plants called phytoplankton (Fig. 5). Diatoms, although very small, are an important part of the phytoplankton. They are the first group of plants to utilise the nutrient rich water, resulting from high river flow in winter. Diatoms are able to reach very high densities and when they die, they fall to the bottom as detritus. In this way they contribute to the nutrient pool within the sediment and thus "trap" some of the nutrients in the estuary. Another form of phytoplankton found within estuaries are the blue-green algae, which can also reach very high densities and cause quite extensive problems for the animals within the estuary.

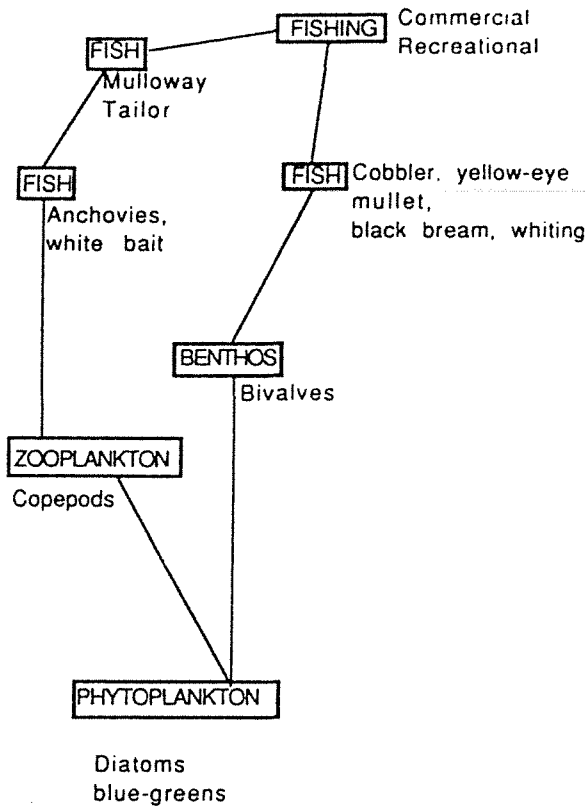


Figure 5. Phytoplankton based food web.

The second major group of primary producers within our estuaries are the seagrasses. One of the densest seagrasses in the Leschenault Inlet is the paddle-weed, Halophila. Sea grasses are attached to the bottom of the estuary by a root system within the sediment. This enables them to use the nutrients which are stored in the sediments. Although not many species of fish feed directly on seagrasses, these plants play an important role in the estuary because they stabilise the sediments and provide living space for small fish and other animals. Growth of seagrasses is highly seasonal with virtually no growth during winter and fast growth in summer. This can result in extensive seagrass areas being formed in the summer months.

Macroalgae, or large algae, are the third group of primary producers in the estuary (Fig. 6). Macroalgae differ from the seagrasses because they are able to obtain nutrients from the water column. When nutrient levels are high, macroalgal growth can become very profuse. This situation has occurred in the Peel Inlet where extensive areas of the estuary can be covered in macroalgae. Vast amounts of macroalgae growing in an estuary can cause many problems for animals and other plants within the system.

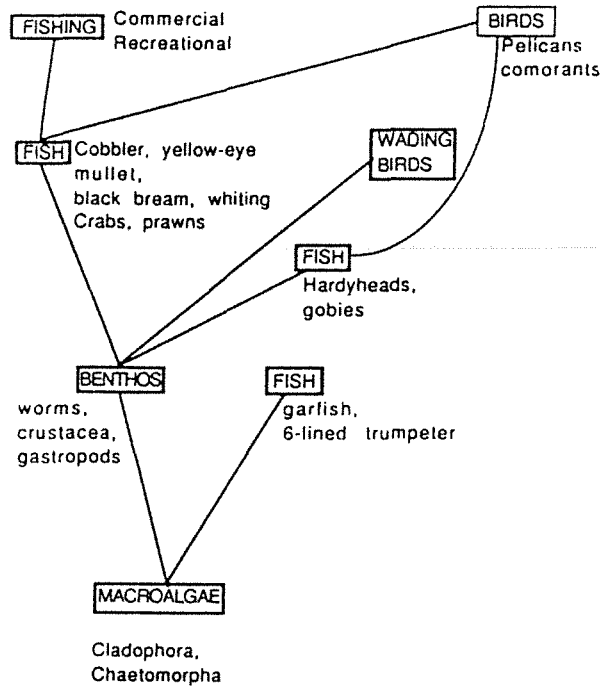


Figure 6. Macroalgae based food web.

Primary consumers are animals which feed directly on the plants or detritus (Fig. 3). Examples of primary consumers include small animals living in the water column (zooplankton, e.g. Gladioferens) and bottom dwelling (benthic) animals such as molluscs (e.g. mussels and other bivalves) and polychaete worms (Figs 3, 5-7). In the Peel-Harvey and Leschenault estuaries only two species of fish, the six lined trumpeter (Pelates sexlineatus and the garfish (Hyporhamphus melanochir), have been found with substantial amounts of plant matter (mainly macroalgae) in their intestines. Black swans in the Blackwood River system feed extensively on the seagrass Ruppia. Primary consumers which feed predominantly on detritus include the commercially important sea mullet (Mugil cephalus and Perth herring (Nematalosa vlaminghi), and also the shrimps and the school and king prawns (Fig. 4).

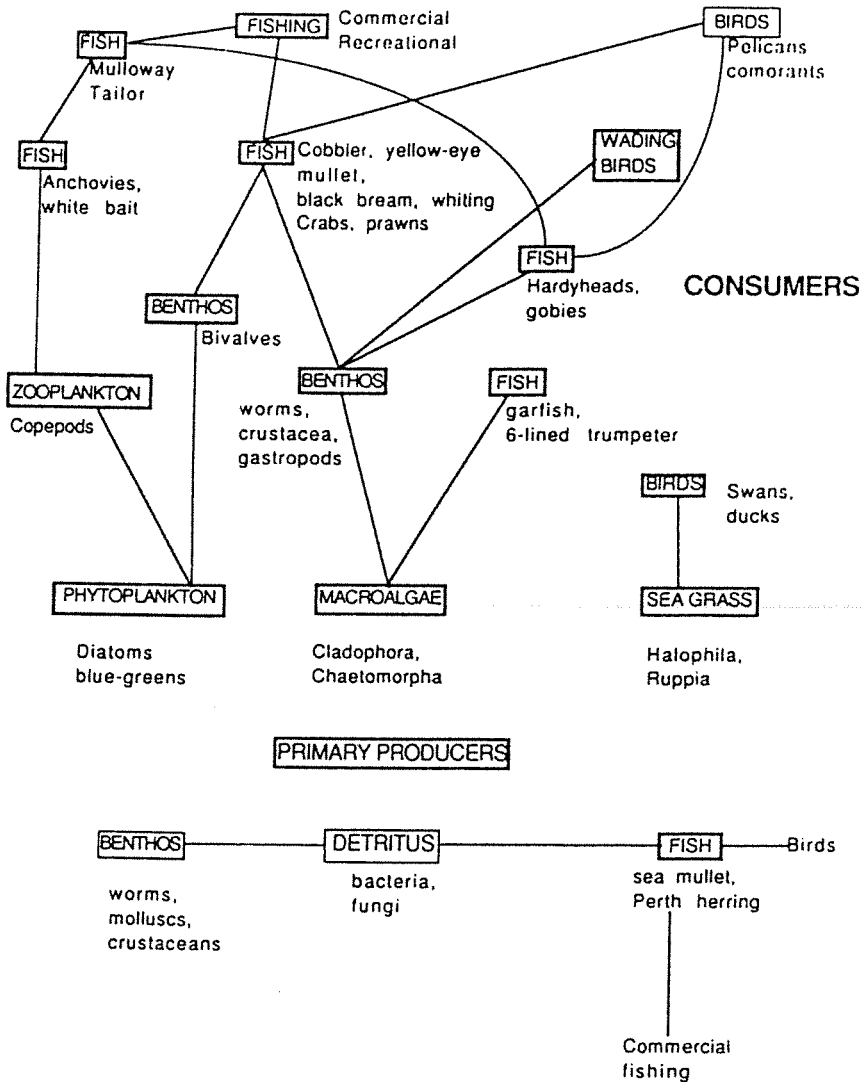


Figure 7. Interactions of the components of a food web for an estuary.

Secondary consumers are animals which feed on the primary consumers. In the estuary this group is represented by some species of predatory zooplankton (e.g. Sulcanus), gastropod molluscs (e.g. Nassarius) and polychaete worms (Figs 5, 6, 7). Many species of fish are secondary consumers, including the commercially important cobbler (Cnidoglanis macrocephalus) and yellow-eye mullet (Aldrichetta forsteri), the recreationally important whiting (Sillago) and black bream (Acanthopagrus butcheri), and small fish such as gobies and hardyheads (Figs 6, 7). Polychaete worms, amphipods (benthic crustaceans), bivalve molluscs and copepods (planktonic crustaceans) are some of the items eaten in varying amounts by the above fish (Fig. 7).

The animals at the next level of the food web feed predominantly on the secondary consumers and are termed tertiary consumers (Figs 3, 7). Included in this category of consumer are fish such as mulloway (Angyrosomus hololepidotus), tailor (Pomatomus saltatrix) and flathead (Platycephalus), and birds such as pelicans and cormorants. The above species feed largely on small fish (gobies and hardyheads), shrimps and prawns. People are major consumers of the larger fish, prawns and crabs, which are either commercially or recreationally important.

Every stage in the food web is extremely important to the health and quality of the estuarine environment and its biota. In the Peel-Harvey estuary, increasing nutrient enrichment in the 1960's and 1970's has dramatically altered the balance of the food web. Initially this resulted in massive growth of macroalgae in the estuary which was associated with increased commercial fish catches. More recently, blooms of the blue-green alga Nodularia, have disrupted the diatom-zooplankton-fish pathway during the spring-summer months. Another consequence of the interactions between the different levels of the estuarine food web is that pesticides, heavy metals and other toxins can be concentrated up the food chain so that dangerous levels may be accumulated in higher order consumers.

THE BIOLOGY OF ESTUARINE STOCKS OF CRABS AND PRAWNS

Speaker: Dr. J.W. Penn
Chief Research Officer
Western Australian Marine Research Laboratories.

Detailed information on the biology and fishing of blue manna crabs (Portunus pelagicus) in Western Australia is available from previous studies in Leschenault Inlet (Dr. T. Meagher - UWA), Cockburn Sound (Dr. J. Penn - Fisheries Department, W.A. Marine Research Laboratories) and Peel-Harvey Estuary (Professor I. Potter - Murdoch University). The information from these studies is summarised in the Western Australian Fisheries pamphlet on crabs which was distributed at the seminar.

Blue Manna crabs have a wide distribution occurring from South East Africa through South East Asia to Japan and down to Australia and Islands of the South West Pacific. They occur around most parts of Australia and are particularly abundant in the South West of Western Australia. Large male blue manna crabs have been reported by fishermen up to 840mm from tip to tip across the nippers and up to 1kg in weight. Females have generally smaller claws but a relatively larger body and are distinguished from males by the wide abdominal flap on the underside and the sandy brown colour of the carapace.

Blue manna crabs and other crustaceans all grow through the process of moulting (casting of the shell). Before the animal moults a complete new shell forms under the old. At the moult the animal absorbs water after casting the shell and swells to a larger size before the new shell hardens, which takes a few days. Moulting occurs frequently (each month) when the crabs are small, but occurs annually once the crabs have matured. Large adult male crabs tend to all moult in the mid summer and large females usually moult one or two months later.

The major breeding stock for the crabs in the south west is in the ocean or coastal embayments such as Cockburn Sound and Geographe Bay. Females produce up to 2 million eggs per spawning mostly over summer and may produce 2 batches of eggs per year. After hatching the larvae pass through a number of development stages over a period of four to six weeks during which time they may drift considerable distances, of 80 or more kilometres off or along the coast.

Small crabs settle back onto the coastline and actively migrate into estuaries, such as Leschenault Inlet, which provide ideal growing conditions during the summer months. Growth is rapid with crabs becoming sexually mature at about 1 year of age, however, they do not reach legal size until 1½ to 2½ years of age. This allows significant spawning to occur before crabs reach legal size and are subject to fishing pressure. During growth to maturity, juvenile crabs often move out of the estuaries in winter when the salinity is reduced and return again in summer when the freshwater flow ceases.

The success of crabbing in estuaries and the ocean varies due to three main factors.

1) The numbers of crabs migrating or being recruited into the particular area or estuary.

2) The level of activity and feeding of the crabs, which is affected by temperature and the process of moulting.

3) The previous fishing pressure in the particular area.

Movements of crabs into or out of estuaries and hence stock levels are therefore influenced by the severity of the winter rainfall. Low rainfall allows more crabs to remain in the estuary during winter and can result in better than average catches in the following summer. Temperature also affects the catchability of crabs. Males are more catchable than females at low temperatures and both sexes are hungry and easier to catch after moulting. These factors result in males being caught earlier in the season leaving more females to be caught in the latter part of the summer. Because crabs become legal size at an early age, each estuary effectively has an annual crop of crabs which is replenished from recruitment from the oceanic breeding stocks. Essentially all of the legal size crabs in the estuaries are taken by fishing by the end of each summer. The ocean stocks are, however, more widely dispersed and more animals survive to spawn and replenish the stocks. As increasing numbers of people use our estuaries for fishing, the available crab stocks will be taken more rapidly each season with the result that individual fishermen can expect to obtain a lower catch per day in the future.

Estuarine king prawn stocks follow a similar life history to the crabs in south west estuaries. Spawning and development through the larval stages occurs over a period of about 2 weeks in the ocean, with post larval prawns entering the estuaries during the spring and summer. Growth is very rapid with the prawns reaching a good fishable size by the end of the summer. King prawn fishing occurs when prawns migrate out of the estuary on ebb tides in the evenings during autumn. Like crabs, the prawns are an annual crop in the estuary, which can be heavily fished without affecting appreciably the offshore breeding stocks. Estuaries such as Peel Inlet also contains stocks of smaller river prawns which complete their entire life history in the estuary. Detailed information on both the crabs and prawns is available in the pamphlet series produced by the Department of Fisheries and available from Fisheries Department offices.

IMPACT OF FISHING ON ESTUARINE STOCKS

Dr. R.C.J. Lenanton
Western Australian Marine Research Laboratories
PO Box 20, North Beach, Western Australia 6020

ABSTRACT

Individuals of a species found in estuaries can, depending on the particular species being considered, comprise an entire stock, or be part of a stock which is also distributed in the adjacent marine environment.

Most of the species commonly caught in estuaries, however, breed at sea and use both the inshore marine environment, and the estuary as a nursery area.

Individuals from an estuary, from a stock, which is distributed both in the estuary and the adjacent inshore marine environment mix with those individuals from the marine environment, mostly by either being forced into the adjacent sea during the winter period of freshwater flushing, or by actively migrating to sea to spawn, summer for crabs and prawns.

The extent to which those stocks are distributed along the coast is a function of both the degree to which both eggs and larval (pre-metamorphosis) stages, and the juvenile and adult (post-metamorphosis) stages move.
Thus species such as cobbler (Cnidoglanis macrocephalus), with restricted pre- and post-metamorphosis movement, could be expected to be composed of many small coastal stocks.
Species such as Australian salmon (Arripis truttaceus), however, provide a good example of the other extreme.
Here, larvae are distributed widely throughout southern Australian coastal nursery areas by the Leeuwin current, while adults actively migrate in the reverse direction to spawn in the waters off south-Western Australia.

A convenient way to review the impact of fishing on estuarine stocks is to review the impact of the four forms of overfishing. i.e. recruitment overfishing, growth overfishing, ecosystem overfishing and economic overfishing.

Recruitment overfishing occurs when fishing reduces the parent stock to the point where subsequent levels of recruitment to the fishery are impared. Whether or not heavy fishing pressure within an estuary has the potential to cause this type of overfishing, depends primarily on the proportion of the stock being subjected to this intense fishing pressure.

Growth overfishing occurs when fish are caught before they have a chance to grow to optimum size. This usually occurs if fishing pressure is too intense on fish immediately above the legal minimum size.
This type of overfishing is common in our coastal recreational fisheries.

Ecosystem overfishing occurs when a prominent species in a multispecies fishery is depleted, and the loss is not compensated for by the increase in biomass of other exploited species. Presently this is not thought to be a problem in Western Australian estuaries.

Economic overfishing, which occurs when fishing effort exceeds the level needed to maximise the profit from the fishery was commonplace during the early history of these estuarine fisheries.

Angler catches of most of the recreational target species are greater than commercial catches of those species.
Falls in individual angler catch rates are, in the main, a reflection of reduced levels of stock abundance resulting from increased levels of recreational fishing pressure.

However, increasing competition between angling gear used to exploit the resource, available at popular fishing locations, is thought to be depressing actual catch rates below those levels expected from most recreationally exploited stocks. i.e. at popular angling locations, there is often excessive amounts of gear being used to take the fish available at that time.

There is also overcrowding and interference at these locations, which causes conflict and a further reduction in the effective fishing effort being expended.

The average catch per unit of effort (CPUE) of a commercial fleet is the best available index of the abundance of stocks targetted by commercial fishermen. However, many factors other than stock abundance, such as market demand, and fishermen behaviour, can influence CPUE, particularly over the short-term.

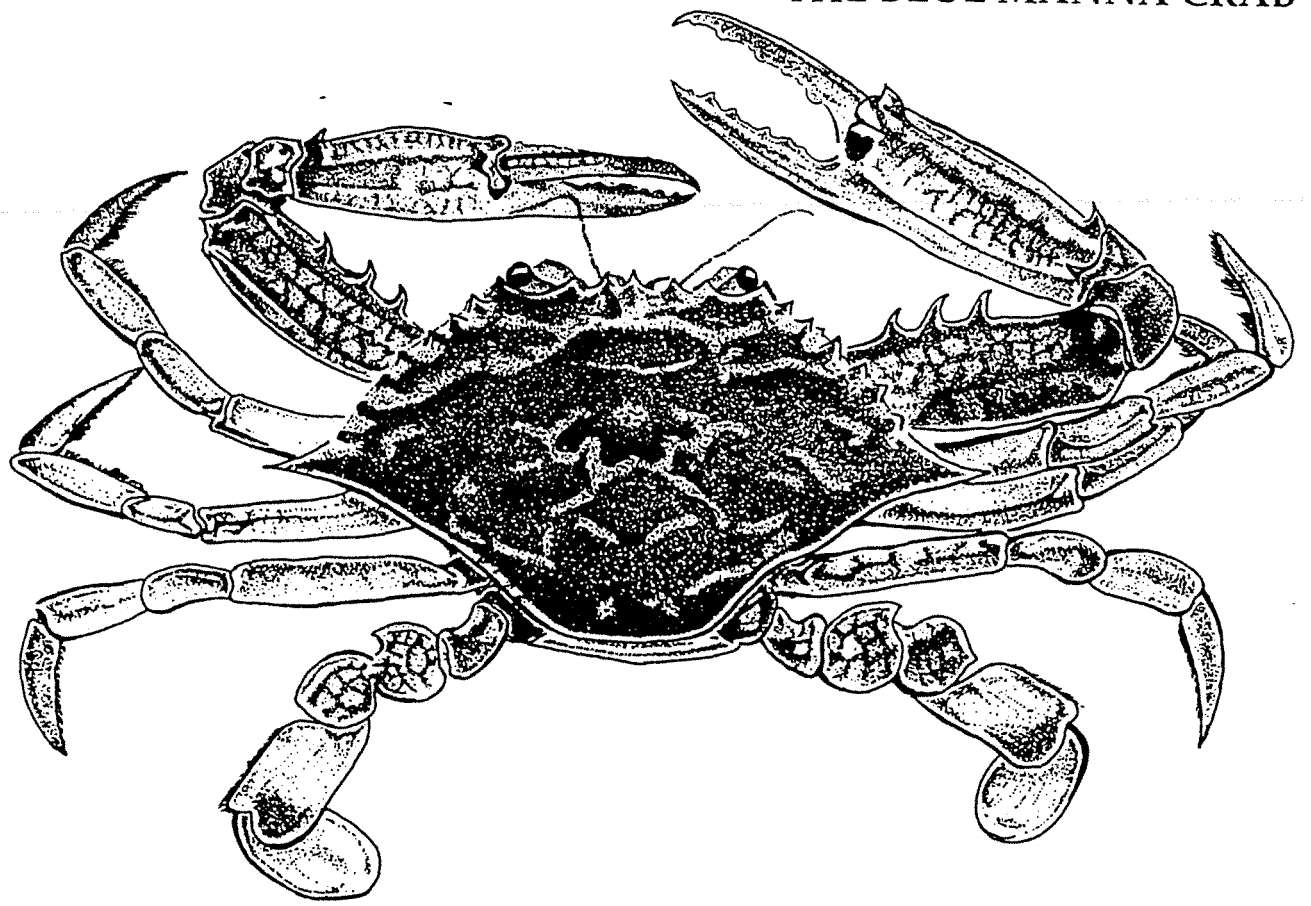
Thus, a long time-series of CPUE probably provides the best available index of the state of an estuarine stock.

FISHING W.A.

Fisheries Department of
Western Australia

LEAFLET No 7, 1988

THE BLUE MANNA CRAB



The blue manna crab is the best-known edible crab in Western Australia. It is aptly named after the biblical "manna from heaven" for its delicate taste. Crabbing is a popular activity for holiday-makers in the south-west, especially at Mandurah and Bunbury, and commercial fishermen supply restaurants and local fish shops.

Description

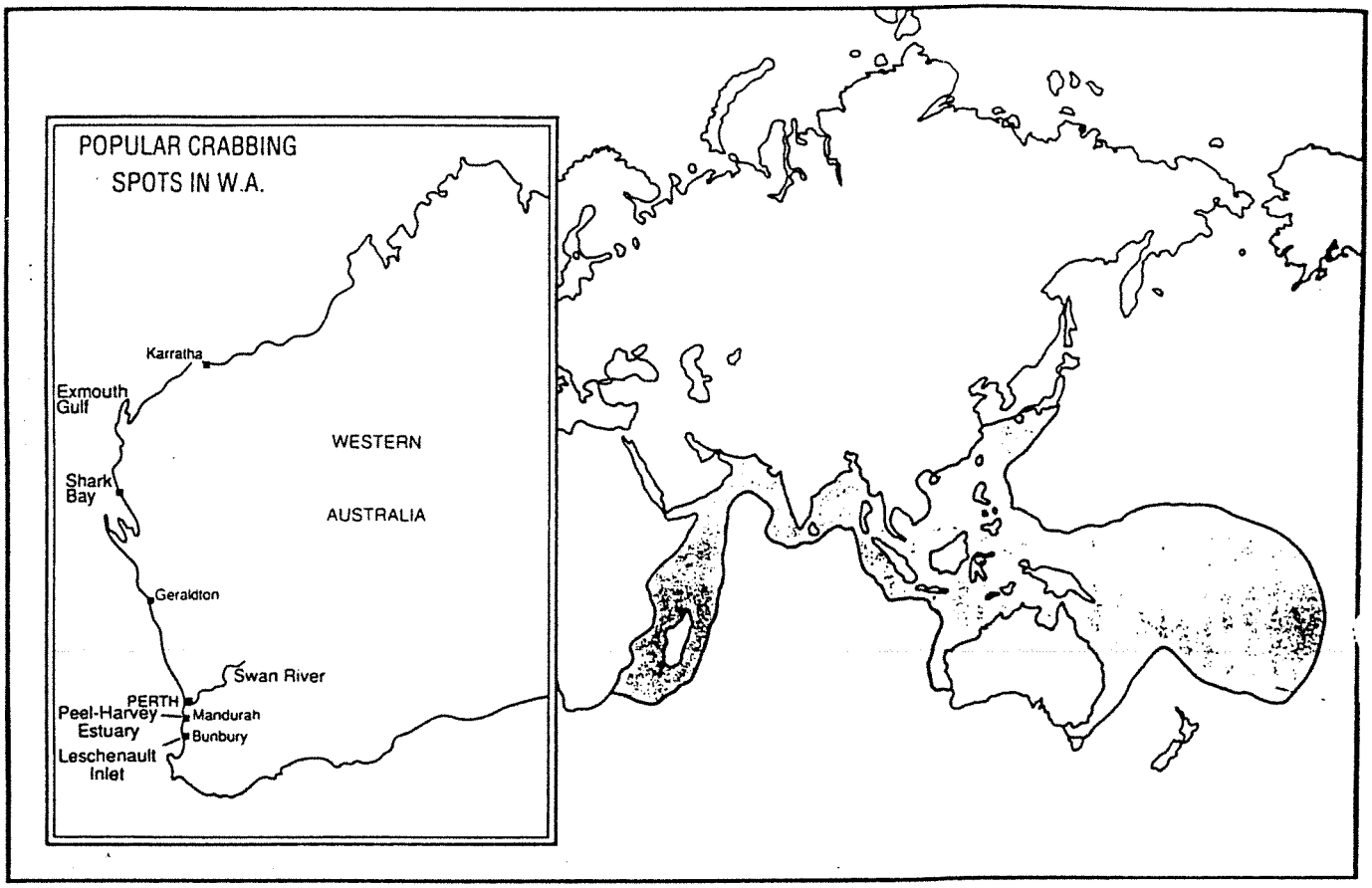
The male crab is larger than the female, with a mottled dark blue carapace, pale belly and rich blue on the legs. The female is sandy brown in colour and is also extensively mottled. The crabs measure about 100 millimetres (mm) across the carapace (shell) when they reach adulthood at about one year of age in their first summer and continue to grow to over 200 mm in carapace width.

Distribution

The blue manna crab is found throughout the Indo-West Pacific and has attracted a variety of common names, including the blue swimmer and the sand crab.

In Western Australia, they are found along most of the coastline, particularly in sheltered embayments such as Shark Bay, Exmouth Gulf, Cockburn Sound and Geographe Bay. They are also seasonally abundant in south-west coastal estuaries including Peel Inlet and Leschenault Inlet. The crabs, particularly the breeding stock, live close to shore in the ocean. However, large numbers also move into estuaries in spring and summer when the estuarine salinity rises.

Crabs can remain in the estuaries over winter if the rainfall is low, but usually they move out to entrance channels or the ocean when freshwater river-flow lowers the salinity. The abundance of crabs in the south-



The blue manna crab (Portunus pelagicus) is found throughout the Indo–West Pacific (from Smith, 1982)

west estuaries varies from year to year depending on conditions. For example, wet winters force the crabs out of the estuaries, whereas drier winters can allow many crabs to stay and provide bumper catches the following summer.

Blue manna crabs are found living on sand, mud and weed bottom throughout estuaries and embayments. During the day, most crabs remain buried beneath the sand with only the eyes protruding. They hide from predators such as stingrays and other large fish, while waiting to launch at small fish and invertebrate prey with their outstretched nippers.

Life cycle

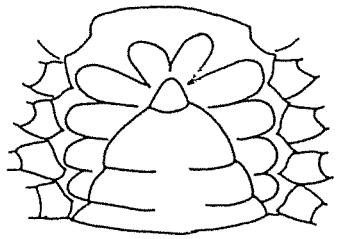
Adult crabs in the south-west mate in autumn. The males moult first, during the early summer, so that their shells have hardened before the females moult and mating takes place. A courting male catches a female then carries her beneath him for 4 to 10 days while aggressively fending off other males. The male assists her to moult and then turns her over to mate while she is still soft-shelled. After mating, the male continues to carry around and protect the female for another 3 to 4 days while her shell hardens. A male can mate with a number of females over the season.

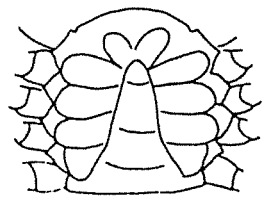
The female crab retains the sperm over winter until her ovaries begin to develop as water temperatures increase in spring. In the ocean large females spawn predominantly in late spring and early summer. Smaller, but mature, estuarine crabs tend to spawn later in summer, after making a 'run' to marine waters or the estuary mouth. The 180,000 to 2 million orange eggs are fertilised by the stored sperm and then pile up in a spongy mass under the crab's abdomen as she lays, after which she is described as a female 'in berry' . The eggs are then incubated for up to 18 days depending on the water temperature. A female can spawn more than once in a season, using sperm from the one mating.

After hatching from the eggs, the young crabs grow through a series of larval stages over a period of about 4 to 6 weeks. During this period the larval crabs drift up to 80 kilometres out to sea before returning to the coast. This movement offshore and along the coast at the whim of the winds and tidal currents causes the larvae from any location to be widely distributed along the coast before settling back onto the bottom.

The underside of male and female blue manna crabs

The female blue manna has a broad 'flap' on the underside





The male blue manna has a narrow 'flap' on the underside.

The later stage larvae begin to look more like the adults and attain a body size of about a 10 cent coin by the time they reach inshore waters and are able to enter the estuaries.

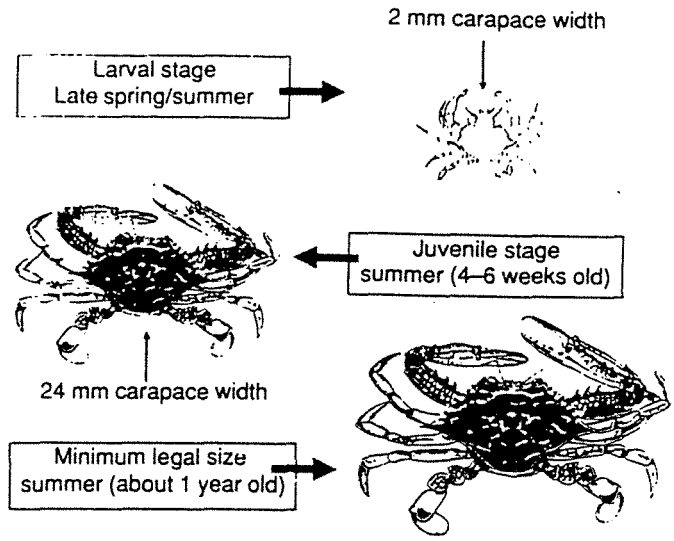
There is a high mortality rate amongst the millions of eggs produced by each female. Few larvae survive to reach the shallow coastal nursery areas. The survivors continue to moult frequently and rapidly increase in size and weight. They usually reach maturity at the end of their first year.

Moulting

All crustaceans must undergo the process of ecdysis or moulting, i.e. replacing their shells to grow. When crabs shed their old shell, the new fully-formed shell underneath is still soft. The crab swells to a larger size by absorbing water before the new shell hardens. Moulting occurs frequently (about every two weeks) when the crabs are young, but becomes less frequent as the animal grows older. Mature crabs usually moult only once each year.

Crabs remain buried in the sand during the soft-shelled period because they are vulnerable to predators. They are particularly hungry once the shell hardens and are easily caught in baited traps. However, there is little muscle (meat) inside the new, larger shell and the meat is usually soft and "mushy". For the larger male (legal size) crabs, the moulting period is usually around January. Drop-net fishermen, in particular, should check the underside of the shell for softness, which indicates a recent moult, and return any soft crabs to the water.

Growth of the blue manna crab

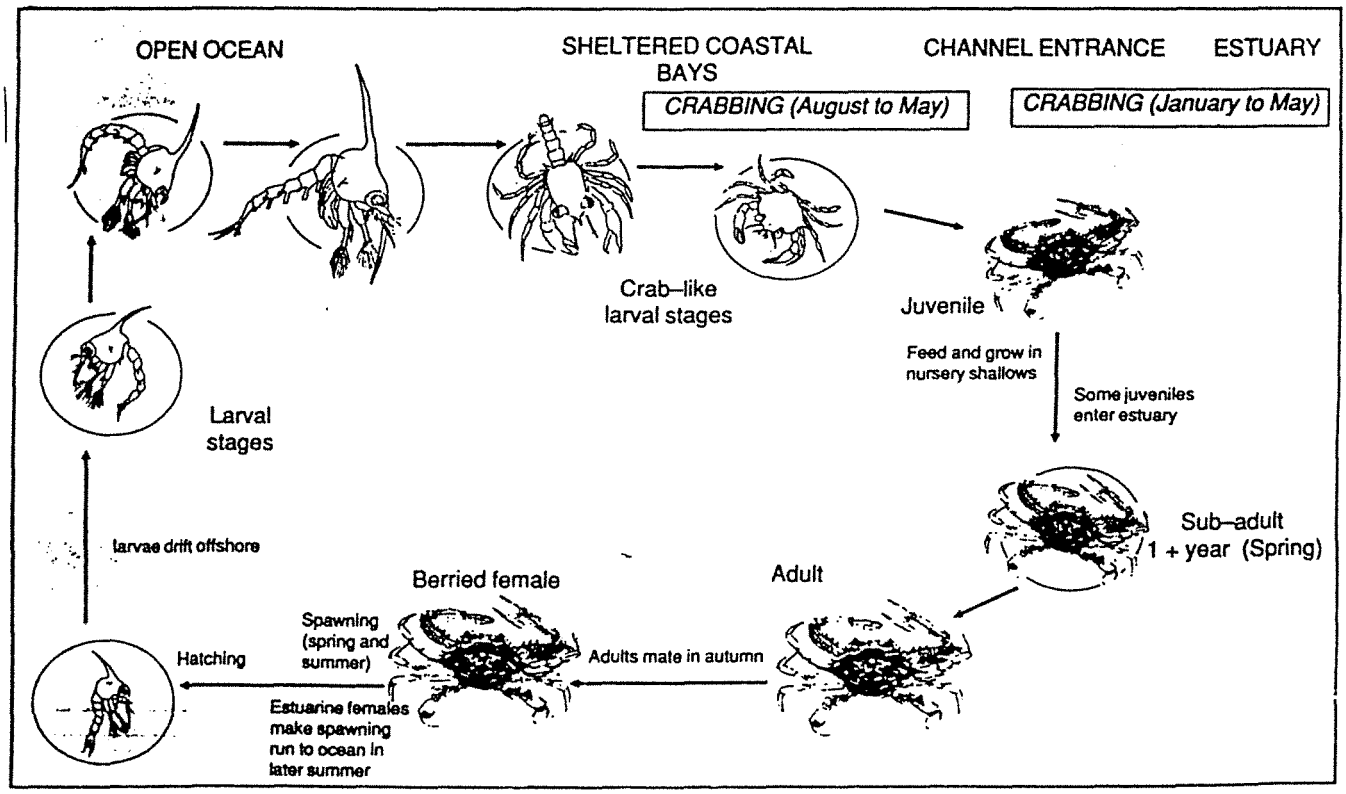


Minimum legal size: 127 mm across the carapace. Undersized crabs must be returned immediately to the water, alive.

Bag limit: 24 crabs per person per day.

Means of capture: Recreational crabbers may not use set nets to catch crabs. Crabs can be taken by baited drop nets, hand scoop nets and wire scoops. No more than 10 drop nets can be used from one boat.

Berried females: Female crabs with eggs attached must be returned to the water.



The life cycle of the blue manna crab

Sharing the catch

Fishing rules apply to maintain the blue manna crab stocks throughout Western Australia. A booklet, Recreational Fishing - A Guide to the Rules, which is available from the Fisheries Department, gives details of the regulations which protect the crab stocks and provide a reasonable sharing of the catch between recreational crabbers.

Blue manna crab populations are able to support heavy fishing because of their high reproductive rate and fast growth. Because estuarine populations are generally replenished from marine areas, heavy fishing pressure in estuaries will not necessarily reduce the flow of new crabs into the estuaries. It will, however, reduce the number of crabs caught by each person. Bag limits are one method of sharing the catch amongst a large number of recreational crabbers.

Catching blue manna crabs

Fishing areas

The Swan River, Cockburn Sound, Peel-Harvey Estuary, Leschenault Inlet and Geographe Bay all produce large numbers of crabs each year.

Catching times and seasons

Crabs are most easily caught in the late afternoon, evening and early morning. There is no closed season for catching blue manna crabs. However, they are most easily caught in the ocean during spring and summer. Peak catches occur In the estuaries from January to May. Females usually make up more of the catch in autumn because males are often caught early in the season following moulting.

Equipment

Baited drop nets are the most popular method for catching crabs in deeper waters, such as in embayments and channels in the estuaries. Commonly-used baits are 'mulies' in mesh containers, or meat and bone scraps. Scoop nets are used to catch crabs in clear, shallow water, where they lie buried in the sand in shallow depressions, or from estuary bridges during a 'run' when the crabs are swimming in the current. More adventurous recreational crabbers also catch crabs by hand while snorkel diving.

The commercial fishery

The blue manna crab is an important economic species. Commercial catches are taken throughout the year from south-west estuaries and embayments, especially Cockburn Sound and the Swan River. However, much of the catch is provided by trawlers operating in the north of the State where the crabs are caught incidentally in the prawn trawls.

This leaflet is one of a series produced by the Fisheries Department of W.A.
Information provided by the Fisheries Department's Research Branch, based at the W.A. Marine Research Laboratories at Waterman.
10/88/5m

Classification

Phylum:	*Arthropoda*
Class:	*Crustacea*
Order:	*Decapoda*
Family:	*Portunidae*
Genus:	*Portunus*
Species:	*pelagicus*

Records

Carapace width: *218 mm*
Claw Span: *500 mm*
(W.A. Museum record, female caught at Crawley in the Swan River on a fishing line.)

Preparing the catch

Crabs are best cooked immediately after capture. They can be kept alive for some time in a wet bag out of the sun. Drop the crabs into boiling salted water for 5-10 minutes (depending on size). Drain immediately and allow to cool. Remove the claws and crack them open to extract the meat. Remove the upper shell (carapace) and throw away the digestive system (a sac and green matter) and 'lungs' (spongy fingers), leaving the white flesh. Serve chilled with lemon wedges, crusty bread and salad.

Crabs do not freeze well. The tender flesh loses its texture and becomes mushy.

References and additional reading

Davis, G. (1988) The biology and exploitation of the blue manna crab, Portunus pelagicus, in the Peel-Harvey estuary. Waterways Information No 1. Waterways Commission and Fisheries Department of Western Australia.

Fisheries Department, Western Australia Recreational fishing - a guide to the rules.

Meagher, T. (1970) Crab Research Programme - Leschenault Inlet, Bunbury, FINS (Vol 3 No.1), 18-27

Penn, J.W. (1977) Trawl caught fish and crustaceans from Cockburn Sound. Department of Fisheries and Wildlife, Western Australia, Report 20.

Potter, I.C., Chrystal, P.J. and Loneragan, H.R. (1983) The biology of the blue manna crab *Portunus pelagicus* in an Australian estuary. Marine Biology 78: 75-85.

Smith, H. (1982) Blue crabs in South Australia, their status, potential and biology. Safic, 6 (5).

Western Australian Museum. Blue manna crab, Portunus pelagicus. Information pamphlet.

Further Information

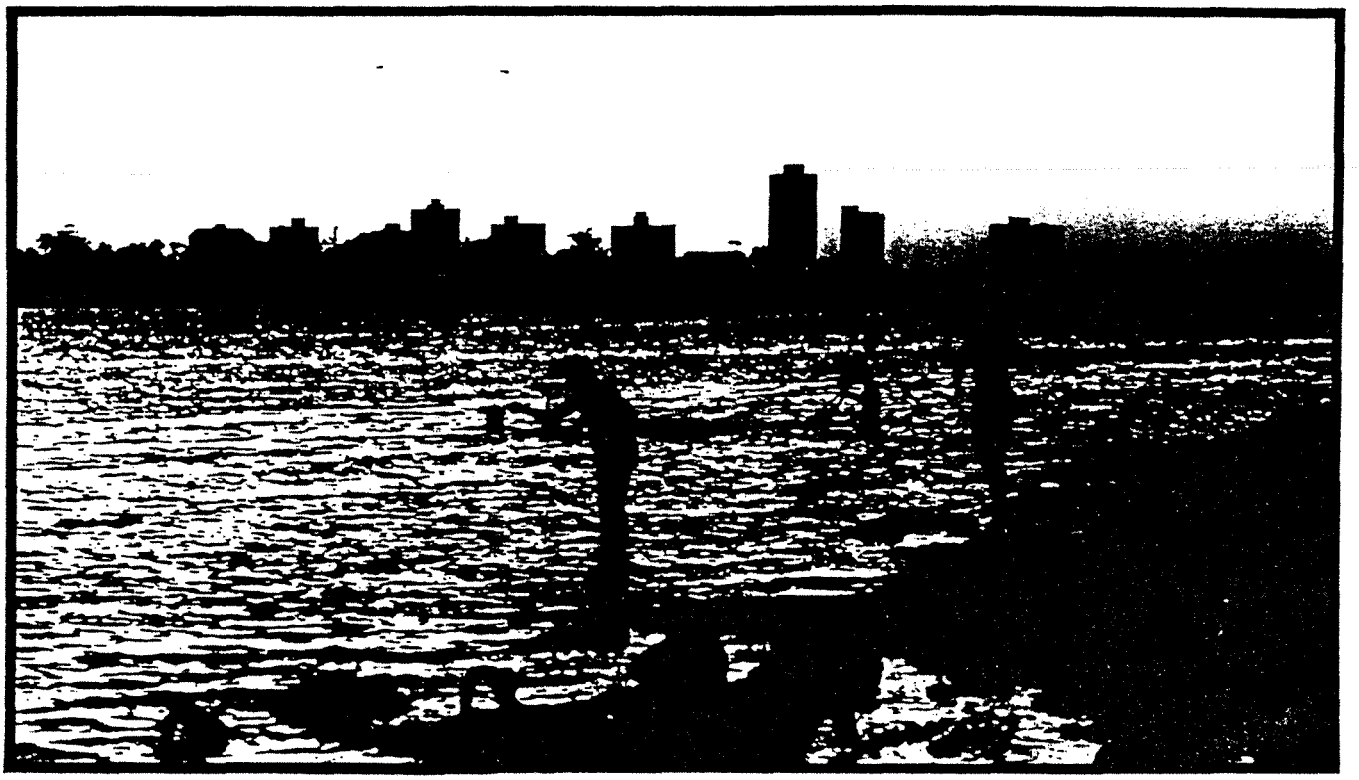
Fisheries officers are always glad to help. If you have any questions on the management of W.A.'s fisheries please contact your nearest district fisheries office (listed in the W.A. country telephone book).
For further leaflets and general enquiries contact:
The Fisheries Department of W.A.
108 Adelaide Terrace
PERTH 6000, Western Australia
Tel. (09) 325 5988

Fisheries Department
and
Fisheries Department Research Branch
W.A. Marine Research Laboratories

FISHING W.A.

LEAFLET No 1, 1987

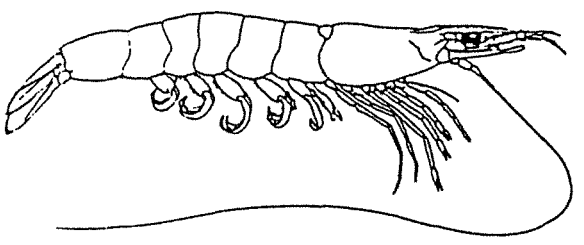
THE WESTERN SCHOOL PRAWN (RIVER PRAWN)



Hand trawling for river prawns in the Swan River

Prawns in South West Estuaries

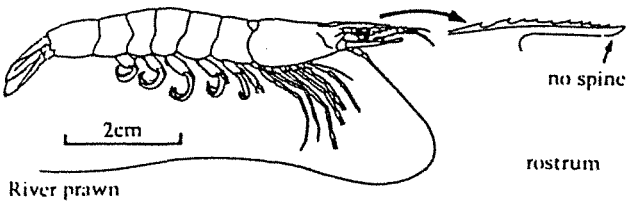
Prawning is a popular pastime for many West Australians. Perth is one of the few places in the world where prawns can be caught near the centre of the city. The lights of prawning parties on the shore are a familiar sight around the Swan and Canning River estuaries over the summer months. Peel Inlet and the Murray River are other favourite spots.



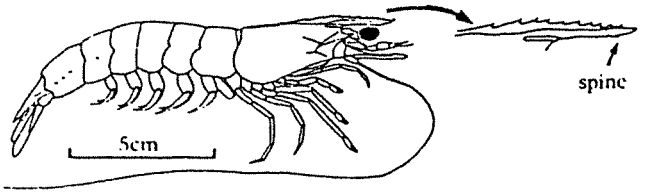
The western school prawn *Metapenaeus dalli*

Two species of prawns are commonly caught in south west estuaries:

- the small western school prawn (locally known as the river prawn) *Metapenaeus dalli*;
- the western king prawn *Penaeus latisulcatus* (see leaflet 2 of this series).



River prawn



Western king prawn

The River Prawn

Description

Live river prawns are almost translucent with blue tips. They are smaller than king prawns and feel greasy to the touch.

Distribution

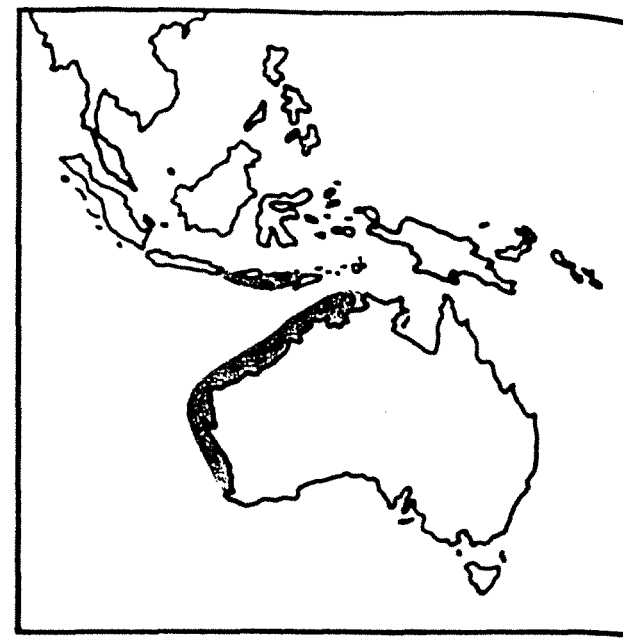
River prawns live in estuaries and rivers in south western Australia. They are also abundant in northern coastal waters, especially Shark Bay and Exmouth Gulf, and in the Kimberleys, the Northern Territory and Indonesia.

A similar prawn (the eastern school prawn) is found in estuaries along the eastern Australian coast.

Life cycle

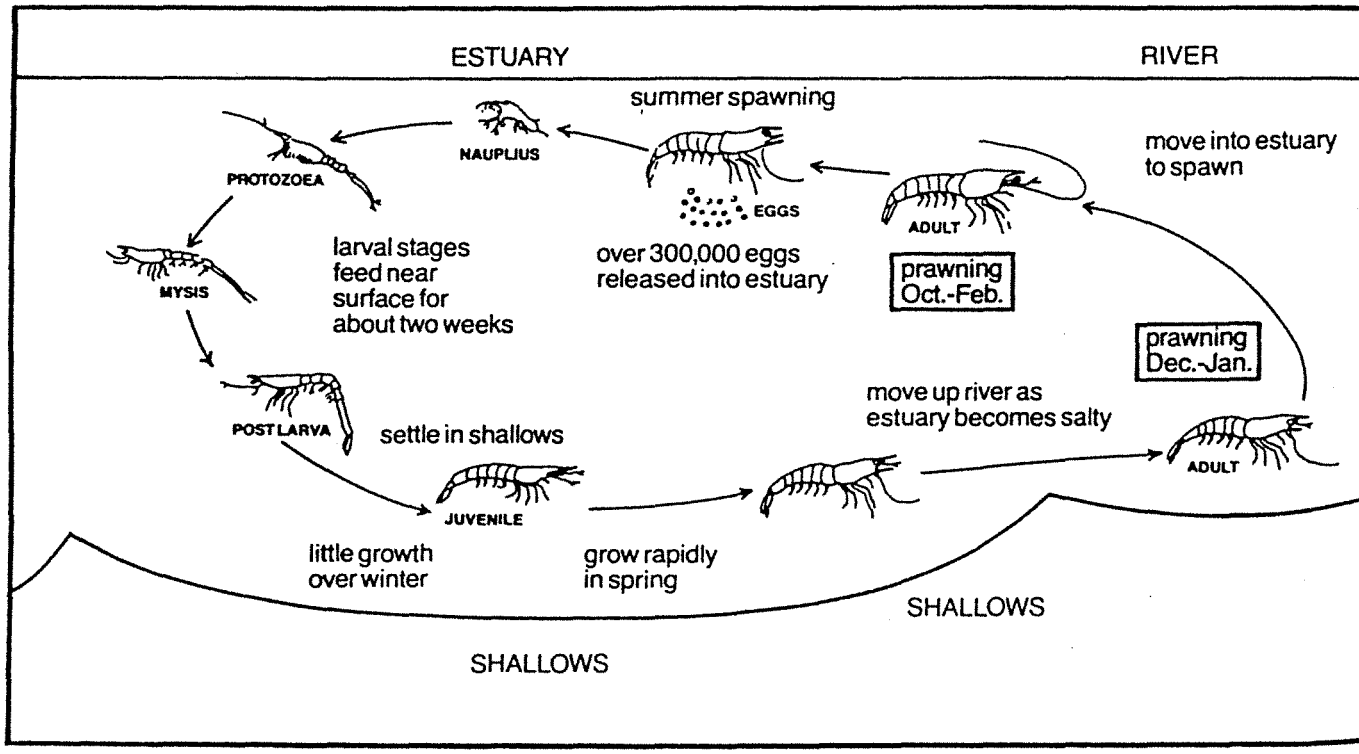
In the south west, river prawns spend their whole lives in estuaries. They reach catching size at nine to ten months and spawn when they are a year old. They can live for up to two years in deeper waters in the middle of the estuary.

The prawns' breeding success varies from year to year. Periods of two or more dry winters such as occurred in 1977 to 1980 and 1984-85 provide the best conditions because more young prawns survive through the winter to reach full size in spring.



Geographical distribution of the western school prawn (river prawn)

From Gray, D.L., Dall, W. and Baker A. (1983)



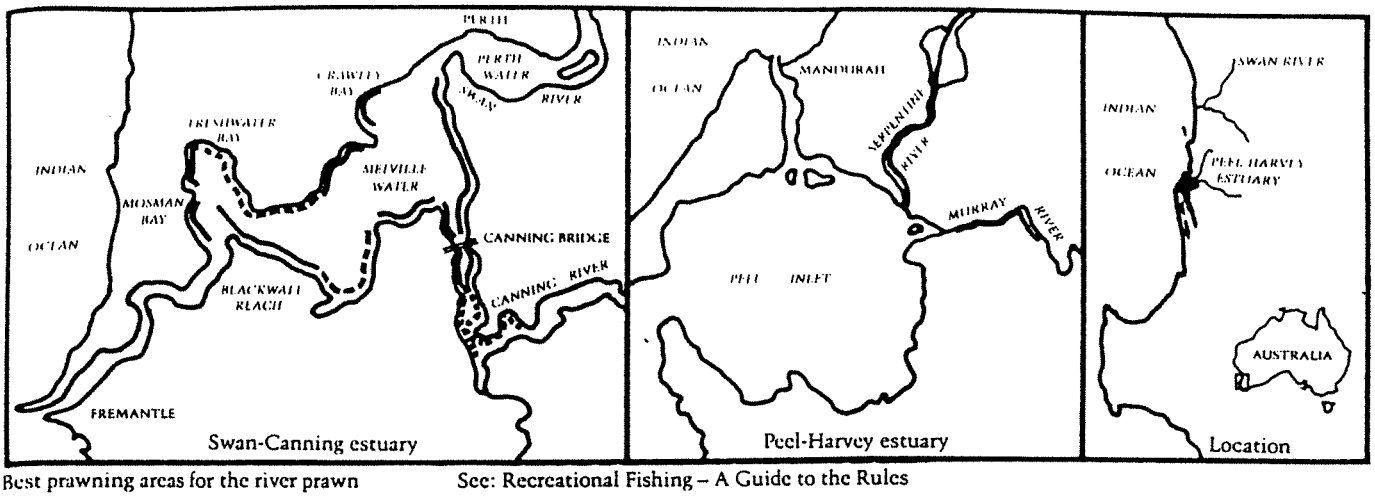
Life cycle of the river prawn

Catching River Prawns

Location

River prawns are most commonly found in the Swan River estuary between Fremantle and the Narrows Bridge but extending upstream to Maylands and in the Canning River.

At Mandurah, river prawns are caught mainly in the Murray River during summer. (The prawns caught in the inlet channel in Peel Inlet are western king prawns.)



Best prawning areas for the river prawn

See: Recreational Fishing – A Guide to the Rules

Catching times

Prawns are usually of catching size in the estuaries from October to February. However hand trawling in the upper reaches of the rivers is usually productive only during December and January.

Prawns can only be caught at night when they emerge from the sand to feed. They bury into the sand during the day and on bright moonlit nights.

Equipment

Recreational prawners catch river prawns with hand trawl nets which can be purchased from fishing tackle shops.

Sharing the Catch (Regulations)

Increasing numbers of people are prawning in our estuaries. Some rules are therefore necessary to make sure that everyone gets a fair share of the available catch and that the prawns are not fished out.

By observing the rules you can help to ensure that there are prawns to catch in years to come.

Please consider other users of the river bank – take your rubbish and prawn scraps away with you.

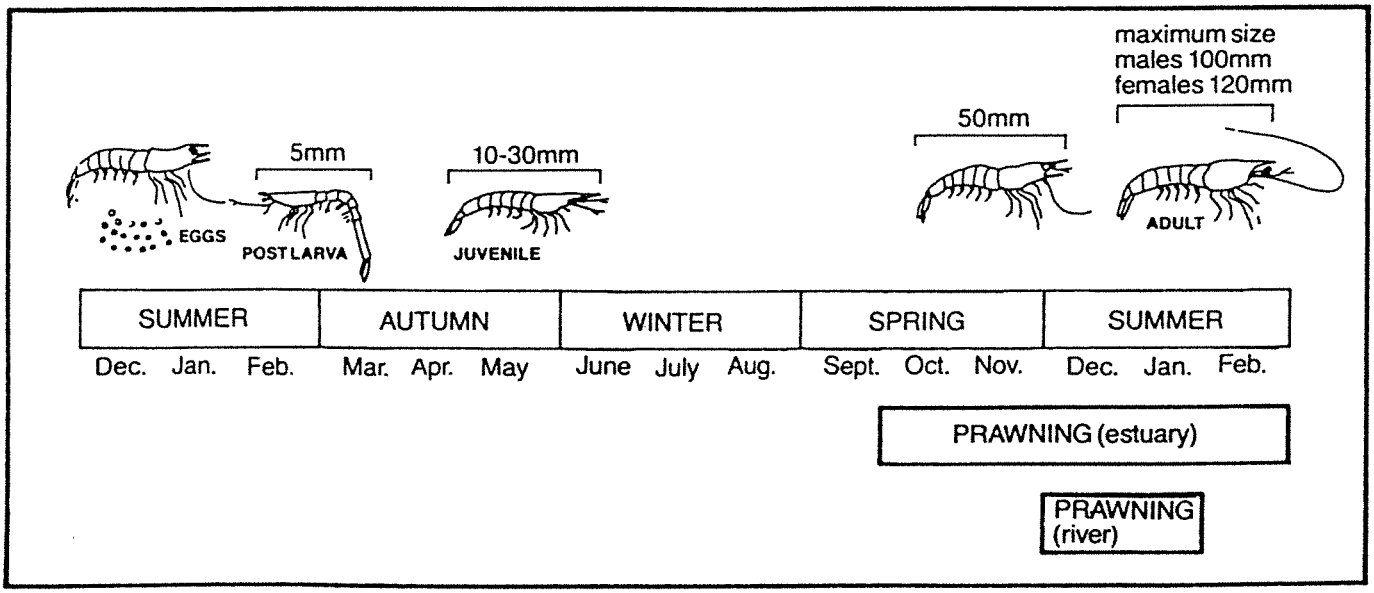
A booklet, Recreational Fishing – A Guide to the Rules, explains the regulations on fishing and gives details of closed seasons and prohibited and restricted areas. It is available from the Fisheries Department.

Bag limit: Nine litres of prawns per person per day.

Minimum legal size: 50 millimetres, measured from the eye to the tip of the tail.

Means of capture: Prawns may only be taken by a hand scoop net, hand trawl net or hand dip net. Hand trawl nets must not exceed four metres in width, nor may they contain any mesh measuring less than 16 millimetres. (See Recreational Fishing – A Guide to the Rules for regulations on hand trawls and hand dip nets in restricted areas.)

Sale of prawns: Prawns may not be sold, consigned or offered for sale by recreational prawners.



Growth of the river prawn

Preparing the Catch

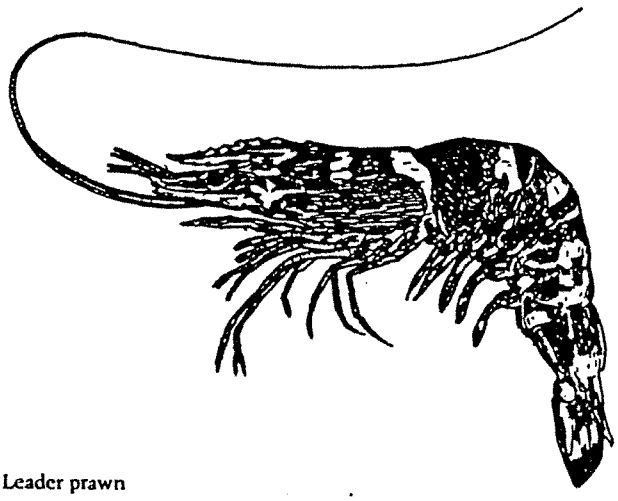
Prawns are best cooked as soon as possible after catching. Drop them into boiling sea water or salted water (one tablespoon of salt to each litre of water). Bring the prawns back to the boil then cook for not more than one to two minutes. The prawns turn a pinkish orange colour when cooked. Cool quickly in cold water.

Other Catches

Other animals may turn up in a prawning net.

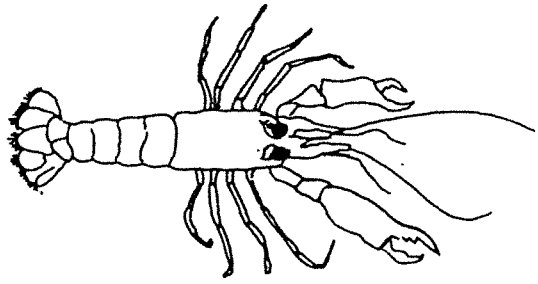
Soft-shelled prawns
These are prawns which have moulted recently by casting off their old shell. Moulting occurs at about monthly intervals. They are still edible.

Leader prawns (giant tiger prawns)
These are large (up to 250mm), pink prawns with brown stripes, and are good to eat. They probably arrive on our coast in ballast water of ships from south east Asia. The Fisheries Department is interested in catches of this species – please report finds to the W.A. Marine Research Laboratories, (09) 447 1366.



Leader prawn

Snapping shrimp
These small lobster-like animals are often caught while prawning. They have a small nipper for feeding and a large one which makes a snapping noise to communicate with other snapping shrimp. They are edible. Catches need not be reported as they are relatively common.



Snapping shrimp

Spaghetti marinara –

a useful recipe for using cooked prawns. Serves 4.

Sauce:
500g prawns
500g squid (optional)
45g can anchovy fillets
1 can tomatoes (450g)
½ cup dry white wine
½ cup water
2 tablespoons oil
1 clove garlic
2 tablespoons tomato paste
3 tablespoons chopped parsley
1 tablespoon chopped mint
Freshly ground black pepper

Shell and de-vein prawns. Drain anchovies on absorbent paper and cut into small pieces. Cut cleaned squid bodies into small pieces (2cm × 2cm) and cook in water and wine for 1 minute. Remove and drain. Heat oil in pan. Add chopped tomatoes, crushed garlic, and tomato paste. Stir until combined and cook for 2 minutes. Add seafood to pan and cook for a further 1 minute. Add parsley and mint and season to taste. Serve with spaghetti and a crisp salad.

References

Fisheries Department, Western Australia.
Recreational fishing – a guide to the rules.

Gray, D.L., Dall, W. and Baker, A. (1983),
A guide to the Australian Penaeid prawns.
Northern Territory Printing Office, Darwin.

Potter, I.C., Penn, J.W. and Brooker, K.S. (1986),
Life cycle of the western school prawn, *Metapenaeus dalli* Racek, in a Western Australian estuary. Australian Journal of Marine and Freshwater Research, 37, 95-103.

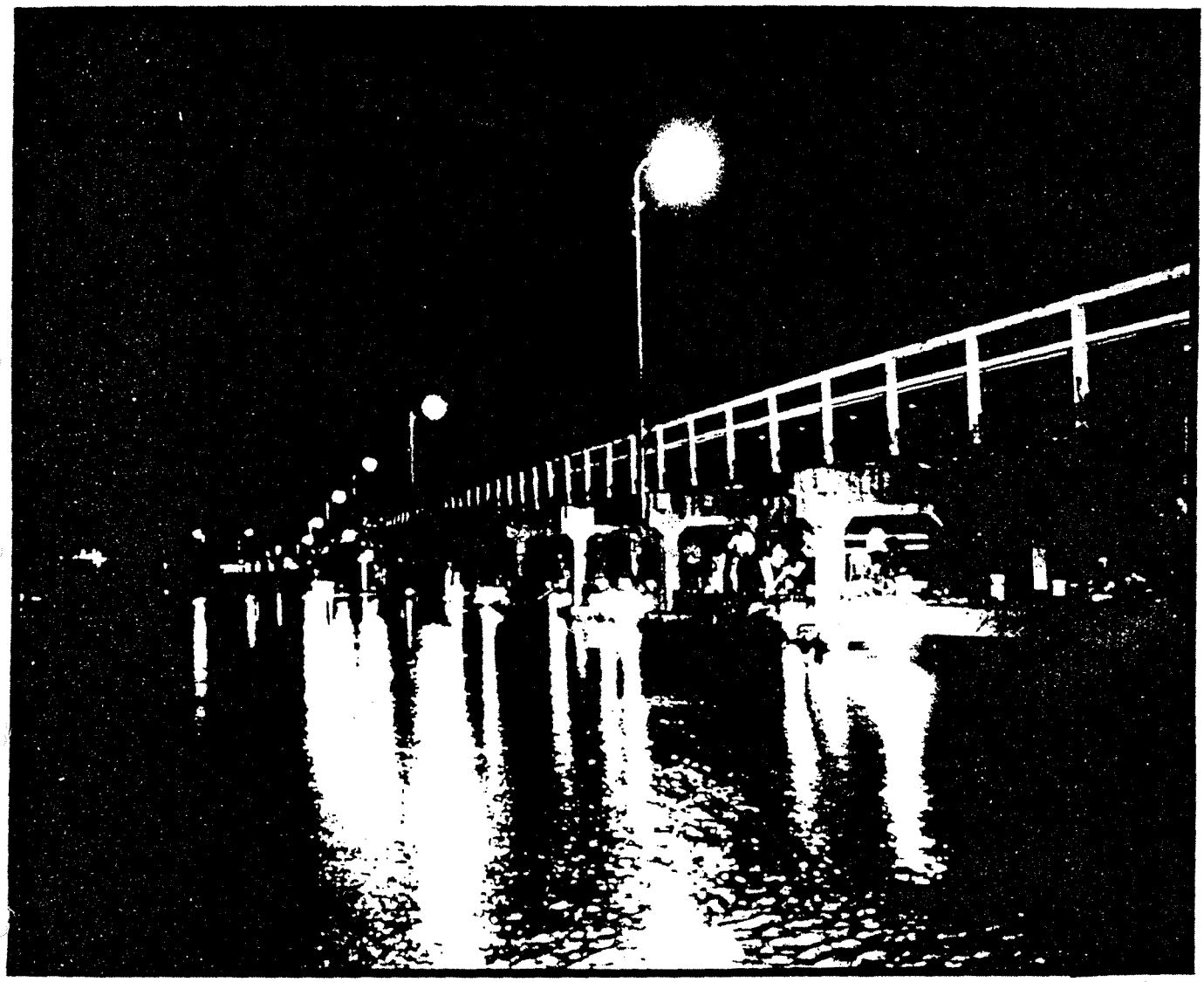
This leaflet is one of a series on Western Australian fisheries produced by the Fisheries Department and the W.A. Marine Research Laboratories. Further leaflets can be obtained from:
The Publications and Extension Services section
Fisheries Department
108 Adelaide Terrace
PERTH 6000
WESTERN AUSTRALIA
(09) 325 5988

Fisheries Department
and
Fisheries Department Research Branch
W.A. Marine Research Laboratories

FISHING W.A.

LEAFLET No 2, 1987

THE WESTERN KING PRAWN

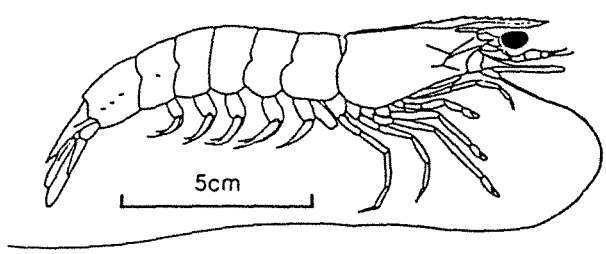


Prawning from the bridge, Mandurah. Photograph courtesy of Halls Head Estate.

Fishing for western king prawns is a popular recreational pastime in south west estuaries. Commercial catches also supply this highly prized seafood to local restaurants and shops.

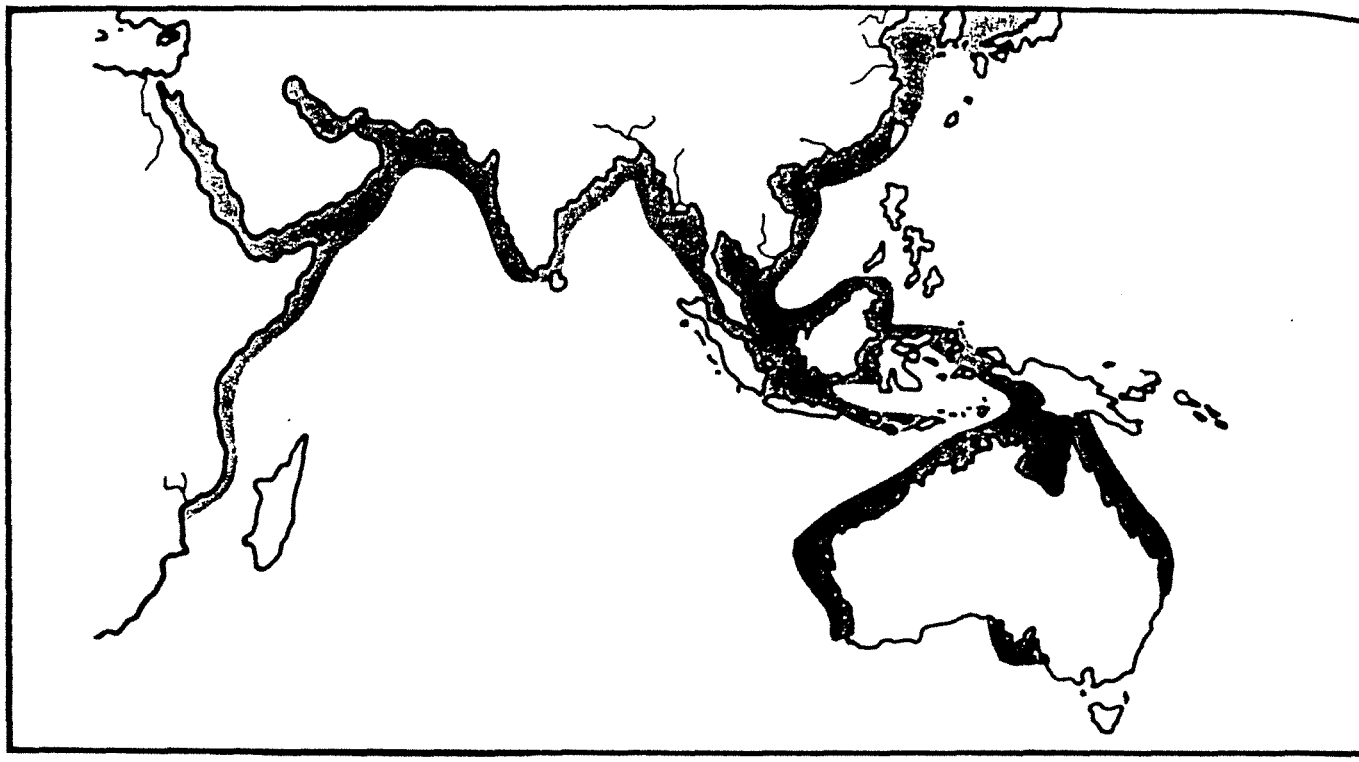
Description

Live king prawns are generally a translucent to cream colour with brown body markings and blue legs and tail fins. They are larger than the western school (or river) prawns which are also caught by recreational prawners in the south west estuaries (see leaflet 1 of this series).



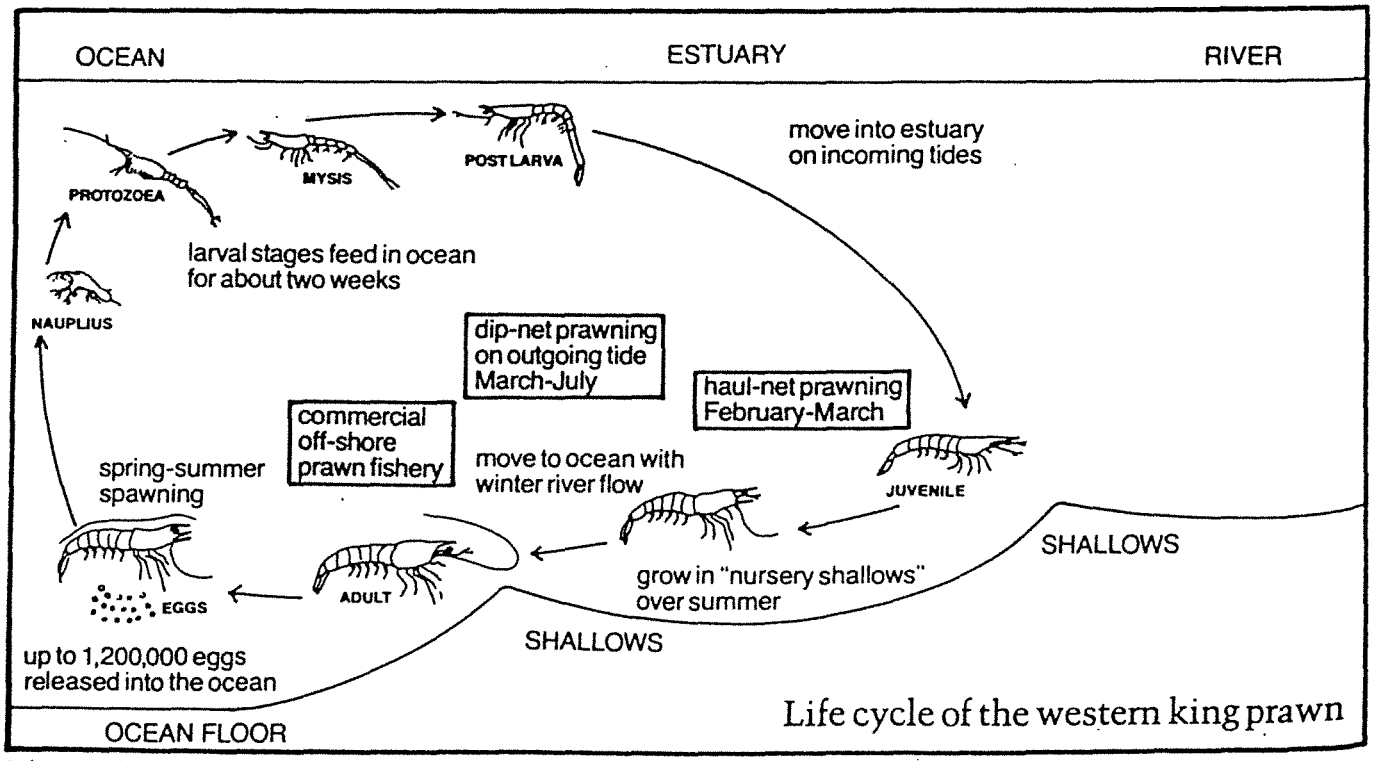
The western king prawn, *Penaeus latisulcatus*

Distribution
King prawns occur in many parts of the world from the Red Sea throughout south-east Africa to Korea, Japan, Malaysia, Indonesia, New Guinea and Australia. They occur in estuaries and marine embayments along most of the Western Australian coastline.



Geographical distribution of the western king prawn
From Gray, D.L., Dall, W. and Baker, A. 1983.

Life cycle
In the south of the state, king prawns generally spawn in the ocean during the summer. Spawning occurs all year round in warmer northern waters. The young post-larval prawns settle in the shallows around marine embayments or move into the salty lower reaches of estuaries where they feed and grow in the shallows over summer. They usually migrate back to the ocean when they reach maturity in the autumn but sometimes stay in the lower reaches of the Swan River until their second year, particularly in dry winters when the estuary is not flushed by fresh water.



Life cycle of the western king prawn

Catching Western King Prawns

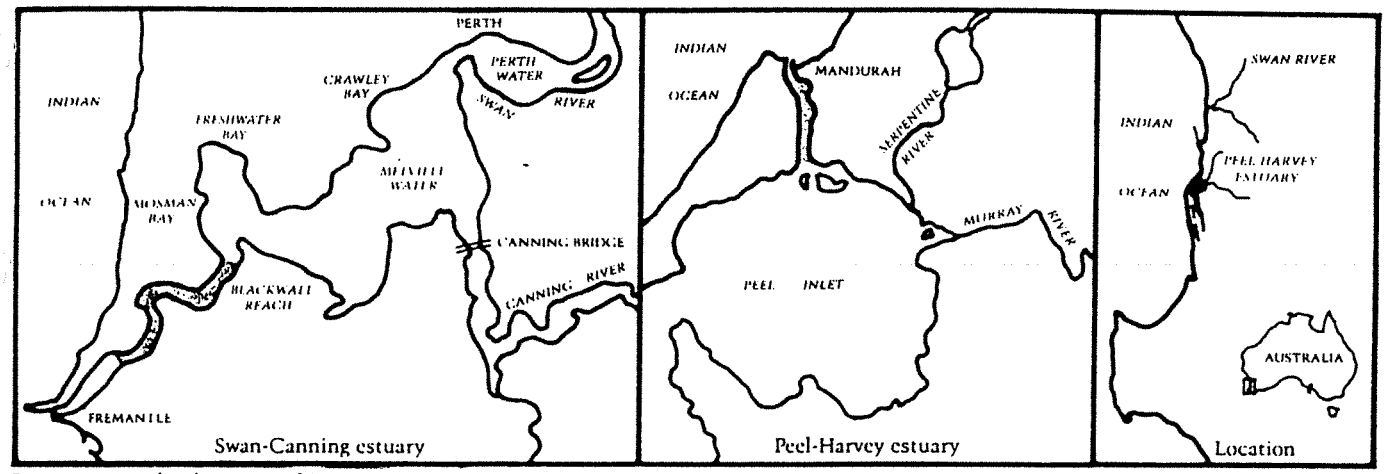
Location
In the south west of the state, king prawns are abundant in the lower reaches of the Swan River and in Peel Inlet.

Catching times
Prawns can only be caught at night since they bury into the sand during the day. They are difficult to catch on moonlit nights when fewer prawns emerge from the sand to feed.

Equipment
King prawns are caught in late summer (February-March) using hand trawl nets in the shallows. From March to July, they are caught in dip nets (hand scoop nets) in the river mouth and inlet channels as they leave the estuaries. Netting in the channels is most productive during the annual "prawn run" on outgoing (ebb) tides after the first rains in autumn.

The prawns swim off the bottom to the surface and allow the ebb tide to carry them out of the estuary. At this time they are attracted to bright lights, so a lantern is used to attract them and enable them to be seen for dip netting from jetties, bridge pylons and dinghies anchored in the estuary mouths.

Dip and hand trawl nets are available from fishing tackle shops.



Prawning areas for the western king prawn

Sharing the Catch (Regulations)

Increasing numbers of people are prawning in our estuaries. Some rules are therefore necessary to make sure that everyone gets a fair share of the available catch and that the prawns are not fished out.

By observing the rules, you can help to ensure that there are prawns to catch in years to come.

A booklet, Recreational Fishing – A Guide to the Rules, explains the regulations on fishing and gives details of closed seasons and prohibited and restricted areas. It is available from the Fisheries Department.

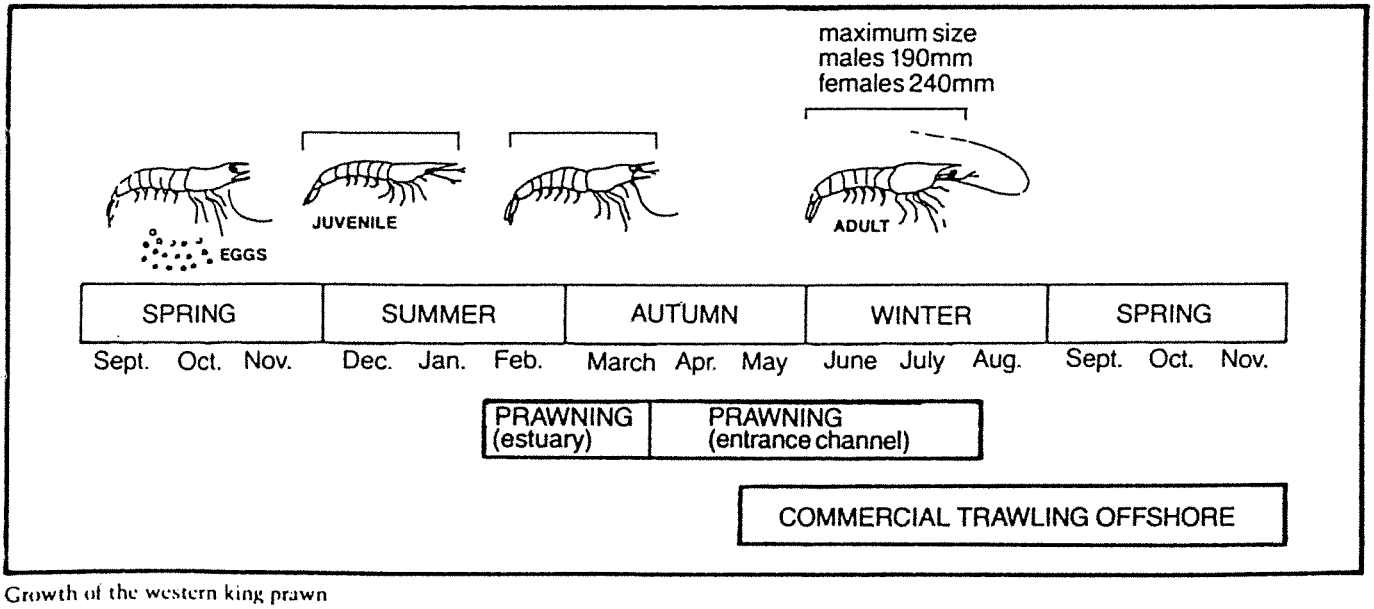
Please consider other users of the river bank – take your rubbish and prawn scraps away with you.

Bag limit: Nine litres of prawns per person per day.

Minimum legal size: 76 millimetres, measured from the eye to the tip of the tail.

Means of capture: Prawns may only be taken by a hand scoop net, hand trawl net or hand dip net. Hand trawl nets must not exceed four metres in width, nor may they contain any mesh measuring less than 16 millimetres. (See Recreational Fishing – A Guide to the Rules for regulations on hand trawls and hand dip nets in restricted areas.)

Sale of prawns: Prawns may not be sold, consigned or offered for sale by recreational prawners.



Growth of the western king prawn

Preparing the Catch

Prawns are best cooked as soon as possible after catching. Drop them into boiling sea water or salted water (1 tablespoon of salt to each litre of water). Bring back to the boil then cook for one to two minutes. The prawns turn a pinkish orange colour when cooked. Cool quickly in cold water otherwise the prawns will continue to cook and become tough.

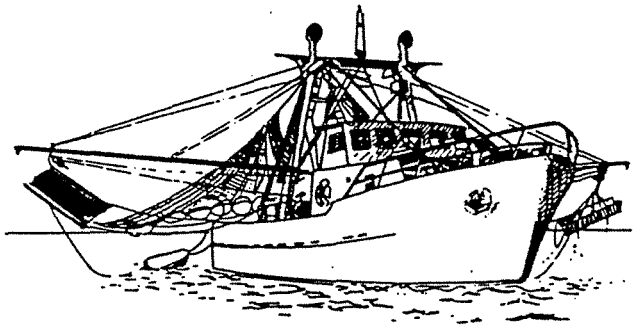
King prawns may also be frozen raw for use in recipes which call for "green" or uncooked prawn flesh. Uncooked prawns should not be kept unfrozen in the refrigerator for extended periods as the shells will darken and go black.

Other Catches

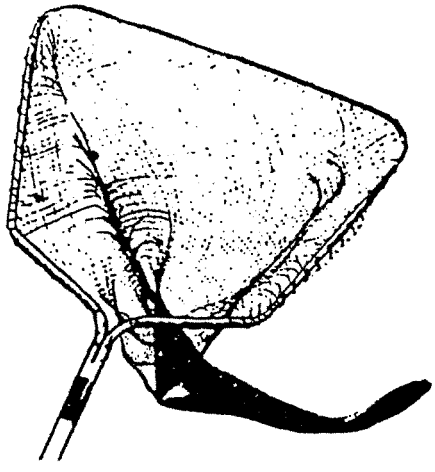
Other unusual animals which may turn up in prawning nets are soft-shelled prawns (which have recently moulted), leader prawns (giant tiger prawns), and "snapping shrimp". See leaflet 1 in this series for more information on these animals.

Commercial Prawning

Professional fishermen catch king prawns in the Mandurah Channel (using beam tide nets) and in the sea off Mandurah and Fremantle (using motorised otter trawling) during winter and spring to supply local markets. Other important king prawn fishing grounds are in Shark Bay, Exmouth Gulf and Nickol Bay. The total catch from these areas is valued at $25 million each year. In these areas the Fisheries Department manages commercial prawning operations to ensure that the prawn stocks are not over fished. A strict control is kept on the number of commercial trawlers in each area and on the areas that they may fish.



A Western Australian vessel rigged for prawn trawling.



Dip or hand scoop net

Prawns in beer batter

Beer batter:
2 eggs
1 tablespoon melted butter
1 ½ cups plain flour
1 cup beer
salt

Prepare the batter as follows:
Beat the eggs and add the melted butter. Stir in flour and a pinch of salt. Gradually beat in enough beer to make a smooth batter. Allow the batter to rest in a warm place for at least an hour.

Shell and de-vein the prawns. Spread the tails out into wings by scoring each tail along its inner curve, without cutting all the way through.

Roll the prawns in plain flour, shake off excess and coat with batter. Deep fry in very hot oil until golden. Drain on absorbent paper.

References

Fisheries Department, Western Australia.
Recreational fishing – a guide to the rules.

Gray, D.L., Dall, W. and Baker A. (1983),
A guide to the Australian Penaeid prawns. Northern Territory Printing Office, Darwin.

Bowen, B.K. and Hancock, D.A. (1982),
The limited entry prawn fisheries of Western Australia – research and management. Fisheries Research Bulletin 27.

Penn, J.W. and Stalker, R.W., (1979),
The Shark Bay prawn fishery (1970-1976). Department of Fisheries and Wildlife Report No. 38.

This leaflet is one in a series on Western Australian fisheries produced by the Fisheries Department and the W.A. Marine Research Laboratories. Further leaflets can be obtained from:
Publications and Extensions Services section.
Fisheries Department
108 Adelaide Terrace
PERTH 6000
WESTERN AUSTRALIA
(09) 325 5988

COMMERCIAL FISHING IN THE ESTUARY

MR D BROWN

SECRETARY, BUNBURY PROFESSIONAL FISHERMENS ASSOCIATION

The estuary was first fished in 1841 by the first Australind settlers as they began to arrive only 12 years after settlement at the Swan River Colony.

However, it was 1890 before any regular marketing was organised and proper records were kept.

At that time the Leschenault Inlet supplied only the Bunbury and hinterland markets.

In 1892 the development of rail transport, and later road transport, opened up the Metropolitan markets in Perth for fresh fish from the Inlet.

For years, the fish was packed in wooden crates between layers of newspaper and covered with ice.

Travelling that way, which would now be considered unhygenic, consignments would go by overnight goods train to reach Perth next day for the early morning sale at the Metropolitan fish markets.

Prices there were much better than those available in Bunbury.

Between 1929 and 1938 licensed fishermen operated at a peak of 35 boats on the Inlet. This gradually declined to 20 in 1937 and 15 a year later, and during World War 2 the number declined further. When servicemen returned from war service, in 1946, an oversupply of fish occurred, which made the product harder to sell.

However, a market for estuarine bait then began to grow with the development of the rock lobster industry - sea mullet, yellow-eyed mullet and herring comprising most of the bait.

The estuarine fishery has been the traditional source of bait for the lobster industry for 35 years, and probably will continue to be so in the foreseeable future.

A good local market has developed for processed edible fish and most estuary fishermen have fishshops at the rear of their homes, selling fillets of whiting, herring and cobbler, as well as whole fish and bait. The Shire Health Department strictly supervises these outlets.

This is where the industry stands today, mainly as a supplier of bait to the rock lobster industry and amateur angler, and also supplying locals and tourists with crabs, prawns and filleted and fresh fish.

The fresh and filleted fish market has grown in the last few years since the community has become more diet conscious and most families include fish in their meals once or twice a week.

Crabs are a prominent product of the estuary, and the crab season begins at about the second week in December, sometimes sooner, if it happens to be an early summer.

Many creatures are actively feeding at sunup and sundown, and crabs are no exception; they tend to bury themselves in the bottom of the inlet during the day. So the licenced fishermen usually has to start at 3.30am in mid summer, pulling drop nets and heading for home at 8.00am.

In the past few years it has become increasingly evident that earning a viable living on the inlet has become impossible. It is now mainly a part time activity for many, with only one fisherman exclusively in the inlet.

Experience has shown that changing the physical features of the inlet has changed the fish habitat. Since the Cut has been put in, far fewer cobbler have been found in the inlet waters.

Fishermen are now diversifying into other activities.

The beach fishery, which includes salmon and white bait, keeps 10 fishermen on the beach for about seven months of the year.

The Fisheries Department are no longer transferring licences, or renewing them when a licenced fisherman retires.

The amateur and professional fisheries are strictly managed and any further restrictions would not serve any useful purpose.

The verbal conflict of competition for the Inlet's fishery resource between the professional and recreational fishermen is continuing, but the professional fishermen in the Inlet are now virtually wholly engaged as suppliers of bait to the rock lobster industry.

IMPACTS OF HUMAN ACTIVITIES ON

ESTUARY SYSTEMS

Speaker: Dr R Humphries
Manager, Estuarine Impacts Branch
Environmental Protection Authority

The estuaries of the west coast of Western Australia are particularly susceptible to damage from a range of human activities in their catchment and within or next to the waterbody itself.

The reasons for this high susceptibility to damage, and hence risk to estuary water quality and fisheries include:

1. Horizontally distinct water masses with limited ocean exchange, and hence limited flushing of algae, nutrients and other pollutants to the sea;

2. A vertically stratified water mass, which encourages sediment-water nutrient exchange and favours growth of blue-green algae (Cyanobacteria);

3. Warm water temperatures which encourages rapid algal growth;

4. High incident light intensities or photosynthetically active radiation levels (PAR), which favour high algal growth rates;

5. High internal and external loadings of organic matter, which contribute to water column deoxygenation and hence to nutrient release;

6. High external loadings of nutrients and other pollutants (particularly nitrogen and/or phosphorus) from catchments with sandy, leaching soils;

7. Adequate availability of the trace elements required for algal growth (eg Mo, Co, Cu, Fe) which are washed in to the estuaries from applied fertilisers.

8. Sediments physically and nutritionally suitable as "seed beds" for storing and supplying the needs of resting algal growth stages.

9. Extensive clearing and development of estuary catchments for urban, industrial and rural use.

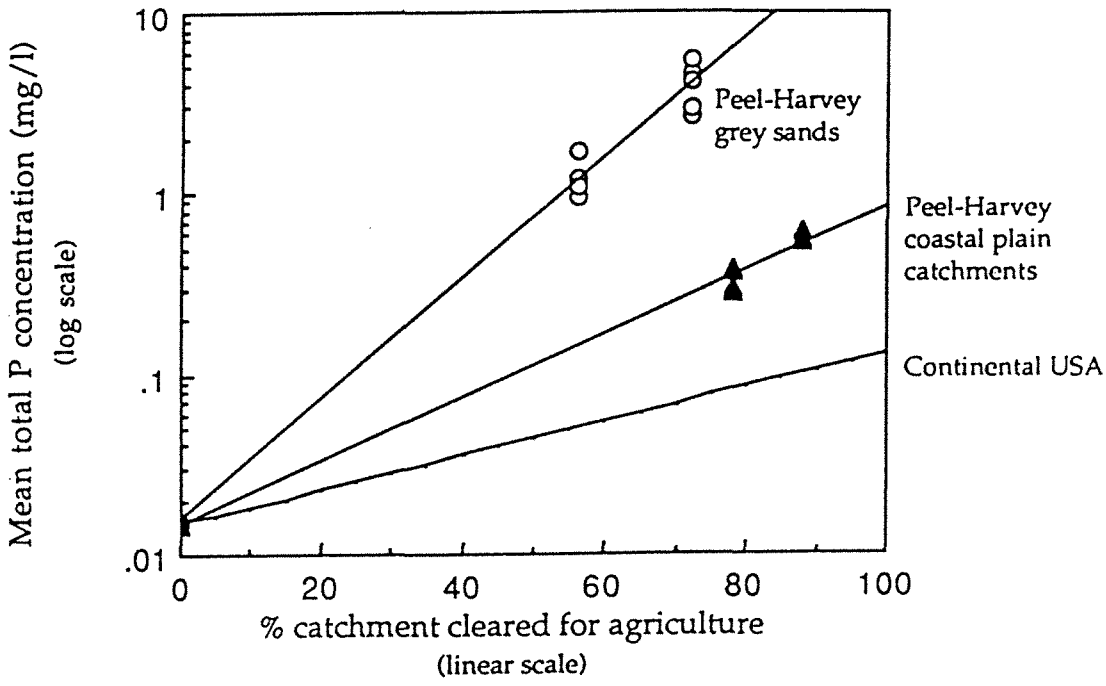


Figure 1. Average phosphorus concentration in surface runoff plotted against the percent of the catchment cleared for agriculture. Continental USA data from Omernik (1976).

Figure 1 shows the hard facts of what is happening in our coastal plain catchments with sandy, leaching soils.

The middle line shows the relationship between the proportion of a river catchment cleared for agriculture and the concentration of phosphorus that runs off in drainage water flowing into lakes and estuaries.

Phosphorus is the most critical element, and is the cause of most of the problems.

The upper line labelled US shows that for a catchment in the United States which has been completely cleared, the concentration of phosphorus in stream water gets to about 1/10 of a milligram per litre.

The top line in Figure 1 shows the concentration of phosphorus that we are getting off the grey sands that occur on the Swan Coastal Plain.

In the two experimental catchments established for monitoring in the Peel-Harvey catchment area, we are getting from 1 milligram per litre up to about 5 milligrams per litre of phosphorus. The first is 55% cleared, and the second is 75% cleared.

The curve labelled HS in Figure 1 shows the phosphorus concentrations for the Harvey and Serpentine river catchments and represents the average for the whole of the Peel-Harvey catchment area.

It can be seen from the graph that the levels of phosphorus from the estuarine catchments are directly related to the amount of area cleared for agriculture, and the intensity of the agriculture.

The estuary environment reacts badly to these levels of nutrient input, usually with high levels of algal growth, and the plant ecology of the estuarine system is thrown out of balance.

The social and economic consequences of nutrient enrichment are several and include:

- Perceptible deterioration of water quality, including loss of water clarity (transparency), algal fouling of water and beaches, and production of bad tastes and odours;

- Changes to the food web of the waterbody, including changes in dominant fish species; loss of fishery production; loss of organisms eaten by fish, and replacement of previously desirable plant species with obnoxious ones.

- Chronic or intermittent health hazards, including promotion of the growth of pathogenic microbes; phytoplankton poisoning of aquatic animals as well as domestic animals and man; induction of fish diseases by stressful changes to water quality; and

- A wide variety of aesthetic impacts, including foul odours and tastes associated with blooms; water discolouration (eg Red Tides) and cyanobacterial scums); poor conditions for recreation; poor fishing and poor conditions for boating because of engine water intake and propellor fouling.

There is a large gap between people's expectations of what they want from their local estuary and the estuary's ability to handle the stresses placed upon it by their activity. The most important stresses placed directly on estuaries by human activity include;

- direct discharge of industrial wastes and urban stormwater;

- deliberate or inadvertent introduction of pesticides from surrounding rural or urban areas, or from saltmarsh mosquito control;

- removal of fringing vegetation for nearshore developments;

- dredging and spoil disposal which can remove shallow habitat, and reduce flushing of the estuary.

Tidal Flushing and Estuary Shape

The shape of an estuary, its depth and its climatic regime are critically important determinants of the effects that nutrient enrichment can have on the estuary.

The point at which the inflowing streams meet the estuary has turned out to be extremely important, and can be demonstrated with a comparison of the Peel-Harvey Estuary and the Leschenault Inlet.

Both water bodies have catchments with similar soil types, but the distance from the point of entry of the rivers through the estuary to the ocean is vastly different. Map 1 shows the relationship. The water from the Harvey River enters the Harvey Estuary, has 22 kilometres to get to the Peel Inlet, and 16 kilometres across Peel Inlet and out through the Mandurah Channel to the sea. The estuary on average takes 40 days to achieve a significant water exchange, so there is plenty of time for the biology of the estuary to latch onto those nutrients and be affected by them. The Murray and Serpentine systems flow into the Peel Inlet and are somewhat intermediate with 10 to 15 kilometres distance to the ocean entrance.

The Peel Inlet is better flushed with ocean water than Harvey Estuary.

In contrast, the Leschenault Inlet system has much more efficient flushing, since the Collie and Preston Rivers discharge directly opposite the ocean entrance at the Cut.

Leschenault Inlet receives about the same levels of phosphorus and nitrogen as does the Peel-Harvey system, but is not as badly polluted with nutrients as it could be, due to the better tidal flushing at the river input end of the estuary.

There are drains entering Leschenault Inlet from the north end, but these are not as significant as the larger river systems which enter from the south.

It is most important to understand that while the flushing of the Leschenault Inlet appears to be effective at the moment, we cannot be complacent about the problem of nutrient pollution.

The total amount of plant life that an estuary or even the ocean can support is a direct function of the amount of the nutrients that flow into it, provided that some other factor, such as lack of light, prevents plant growth.

The coastal plains sands are extremely poor, and agriculture and urban areas on them require careful management if all estuaries with developed catchments are not to go the way of the Peel-Harvey system.

We must increase our efforts to reduce nutrient inflow into the coastal estuaries and prevent excessive algal growth, and to revegetate the coastal plain and inland catchment areas; so that estuarine quality, and our water-based lifestyles can be maintained.

MANAGEMENT OF HUMAN ACTIVITY ON ESTUARINE HABITAT

Speaker: Mr R.P. Atkins

Waterways Commission Scientific Officer

An estuary is an area where land drainage meets the ocean, a usually sheltered area of mixing salt and fresh water.

Estuaries are attractive places for juvenile marine fish and crabs to develop during the early part of their life cycles.

Land drainage carries nutrients for plants and animals into the estuary, and this makes it a place of very high productivity - much higher than coastal waters.

The first thing we have to look at when managing an estuary is the habitat and the water quality. The basic rule is to look after the carrying capacity of the estuary, there needs to be a sufficient area of habitat for the fish and crabs, and enough food to feed them.

The important estuary habitats include the shallow mudflats, the fringing wetlands and the seagrass meadows.

The shallow mudflats are the home of worms and molluscs that the fish feed on, the seagrass meadows provide both food and shelter and the fringing wetlands provide another source of food for fish in insects, insects larvae and plant material.

The high tide waters as they drain off the fringing wetlands bring dead plant material and all sorts of other different food sources into the estuary system. Algae, seagrass and mudflats certainly provide more food than the wetlands but, nevertheless, the wetlands are a key part of the system.

The productivity of any fishery can be sustained by ensuring there is the right balance of plant nutrients and plant growth to support the fishery. If the plant growth gets out of control then the water quality deteriorates and the fish numbers reduce. The deteriorating water quality is brought about by large quantities of decomposing plant material, which causes a fouling of the water, poor clarity, and low oxygen levels.

To look after the fishery, we have got to do much more than just regulate fishermen. Maintenance of water quality to retain the right balance of plant growth, water conditions favourable to the fishery and maintenance of the correct ecological balance are key management objectives.

The maintenance of the fishery is linked directly to the health of the whole estuarine system, and so becomes a whole-of-catchment management task.

The community's use of the estuary and occupation of the adjacent environs means that the estuary is subject to a whole rnage of uses, some of which are not compatible with maintaining the fishery, for example the construction of marinas on shallow mudflats, the filling of shallow foreshore wetlands, dredging and the harvesting of algae.

The structure that Government has set in place for managing estuaries and waterways in general, centres around the Waterways Commission.

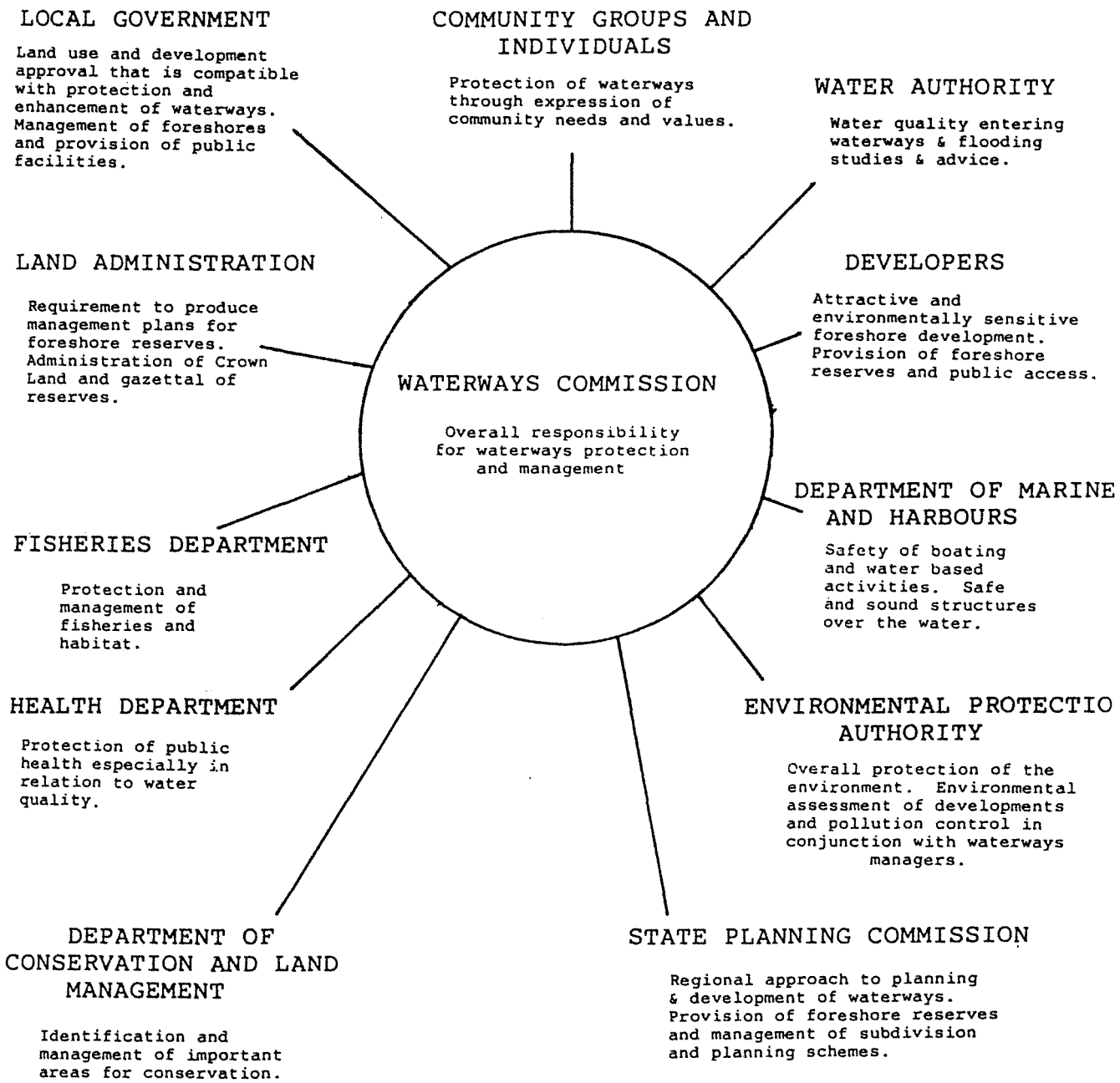


Figure 1. The role of the Waterways Commission in relation to the role of the other organisations and groups in planning and managing waterways.

Figure 1 shows a diagramatic representation of the Waterways Commission role in relation to other organisations in planning and managing the waterways.

At the top of the diagram is the general community. The role of the community is vital because without their support for policy and management strategies, it will be very difficult to ensure the future sustainable use of the estuary for the widest possible benefit.

The other involved parties and organisations are:

West Australian Water Authority - Prime responsibility for managing land drainage, land rating for drainage, carrying out flood studies and providing advice on drainage and flood levels.

Developers - The developers are a part of the community, and they have a responsibility to design and build developments that have a minimal impact on the environment. Developers can assist by making adequate provision for foreshore reserves and providing for public access.

Department of Marine and Harbours - Manage the safety of boating, navigation and other water based activities. Manage and provide advice on coastal engineering, as well as over-the-water structures and buildings.

Environmental Protection Authority - Responsible for the overall protection of the environment. Carry out environmental assessment of developments and pollution control in conjunction with waterways managers.

State Planning Commission - Has the broad role of regional planning for land use and development of the waterways, as well as the land adjacent to waterways.

SPC makes provision for foreshore reserves and manages the development of subdivision and planning schemes.

Department of Conservation and Land Management - Responsible for identification and management of important areas for conservation, and for the protection of flora and fauna.

Health Department - Responsible for the protection of public health, especially in relation to water quality.

Fisheries Department - Responsible for the protection and management of the fisheries and habitat. Controls the commercial fishery, the recreational fishery and carries out research to facilitate management.

Department of Land Administration - Plays an important role in the acquisition and management of public land, and gazettal of reserves. They have introduced a requirement for management plans to be produced for all new foreshore reserves in order to improve the management of land adjacent the waterways.

Local Government - Local government has an important role to play because they manage the community we live in.

Most of the foreshore reserves that provide access to the waterways are managed by local government.

The local government authorities and the waterways managers work closely together to ensure land use and development approvals are compatible with the protection and enhancement of the waterways.

The Waterways Commission has the overall responsibility for managing the waterway, and each of the other organisations approach the task from a different viewpoint.

The role of the Waterways Commission is achieved by several mechanisms :

- The cooperation of the other decision-making authorities.
- Providing advice to decision-making authorities.
- Controlling changes to the beds and banks of rivers and estuaries.
- Preparation of management programmes which bring together all aspects of management, development, improvement and use of waterways.

Waterways management is carried out on two main levels.

- Large scale management at a regional level.
- Small scale management at a local level.

Regional management takes place in the planning stages, and involves the preparation of a regional plan, usually by the State Planning Commission, with input from all of the other organisations and groups. The Bunbury Region Plan and the Peel Region Plan are examples.

A regional plan is not specific to environmental management, but rather details the whole scale of community use and activity throughout the region.

At the local level, a management programme is prepared for a declared waterways management area. The Leschenault Inlet Management Authority has the Leschenault Inlet Management Programme, and the Peel Inlet Authority has the Peel Inlet Management Programme.

These local area management programmes detail the role, function and responsibilities of the Management Authorities, and provide a guide to other agencies and groups as to how they can best manage their operations and activities to help to maintain and conserve the waterway environment.

The Waterways Commission carries out studies at a local level to establish a knowledge base for determining management strategies. The Waterbird Study, Nutrient Monitoring Programmes, Pesticide Study and Wetlands Surveys are examples of these.

The Waterbird Study is specifically aimed at determining the activity of waterbirds, the sort of food they need and how the waterbirds use the wetlands on a seasonal basis.

This information is needed to produce management strategies for mosquito control that will protect the interests of the waterbirds, which are a very important part of natural environment.

Conclusion - The management of the waterway environment involves the control of activities that would impact upon or change that environment. A whole of catchment management approach is essential if the job is to be done properly. The catchment management strategy for the Harvey-Peel Estuary is an example of this. The causes of the problems of algal growth in that estuary are being tackled at their source, with fertiliser management strategies, encouragement of reforestation on the coastal plain, the identification and control of point sources of nutrients and industrial discharges.

It is also important that individual and local development proposals be managed and planned so that they fit into the regional approach to waterways management.

Activities or developments that are likely to cause deleterious impact must be studied and assessed. Although safeguards can often be applied to minimise impacts, most proposals have some impact, and we must be aware of the cumulative effects of many proposals.

It is essential to know how many proposals the system can accommodate without causing unacceptable effects.

The formulation of management strategies enable development to occur in a way that maximises the benefits to the community while sustaining the waterway environment.

MANAGEMENT OF HUMAN ACTIVITY ON ESTUARINE HABITAT

RECREATIONAL AND COMMERCIAL FISHING

BY

PETER MILLINGTON

FISHERIES DEPARTMENT

1988

The major estuaries on the west coast of Western Australia where there are significant commercial activities are the Swan/Canning, Peel/Harvey and Leschenault. On the south coast there is commercial fishing in the Hardy Inlet and in a large percentage of the south coast estuaries.

All five of these estuary complexes have been under some degree of fisheries management since the late 1960's to early 1970's. The particular rules for Leschenault Inlet have been in place since January 1979.

The rules for all the State's estuary fisheries restrict the number of professional fishermen permitted to operate and the number of boats they can use, as well as requiring the licence to actually operate the boat. There are also rules to control the transfer of licences, primarily limiting such transfers within families.

Rules for recreational fishermen do not place any limit on the number of licences. They tend to be concentrated on measures such as areas closed to set netting or all netting, seasonal closures and bag limits.

The trends evident in Western Australian estuary fisheries parallel experience on the eastern Australian coast and overseas. These include gradual tightening of rules for both professional and recreational fishermen through seasonal or total closures, gear limitations (e.g. net length) and gear regulations (e.g. net setting times). Most of these rules are being introduced more in response to competition between users and user groups rather than direct concern about the status of the fish resource in the estuary.

As a result of this interaction and other cost pressures there has been a reduction in the number of active estuary fishermen. Actual numbers have also declined through death, non-renewal of licences and licence buy-back scheme financed in part by a levy on professional fishermen.

The Fisheries Deparment's attitude is that there remains a future for professional fishing in the State's estuaries at a level somewhat lower than at present. Some such activity should continue as it enables the supply of fresh fish in a legitimate manner to those who cannot or do not wish to catch it themselves.

The ongoing problem for the Department is to determine and then enforce equitable sharing of the available resource amongst user groups such as professional/recreational, netting/etc. This will require consultation at both the local and State level, promulgation of pragmatic and acceptable regulations and adequate resources to enforce them.

PANEL SESSION - QUESTIONS TO SPEAKERS

(SAMPLE)

1.) TO: Bob Humphries
SUBJECT: Construction of Dawesville Cut.

Do you agree with the construction of the Dawesville Cut? If so, what do you see as the immediate, medium and long term effects?

A. Yes, the Dawesville Cut should go ahead.
To give the estuary more resilience to disturbance, as we have with the Swan and Leschenault estuaries, and to minimise severe disruption to agriculture in the catchment.

The major effects will be:

- The immediate cessation of nodularia blooms.
- An increased daily tide of 50% of the ocean tide. Currently the daily tide is 20% to 30% of the ocean tide.
- Some erosion and localised flooding of low areas.
- In the long term, the clarity of the Peel/Harvey Estuary should improve, and,
- become more marine.

2.) TO: Bob Humphries
SUBJECT: Kemerton

What long term effect will Kemerton have on our Estuary environment. (Leschenault)

A. The development of industry at Kemerton will have no adverse effect that we can anticipate.
With proper management and operation there should be no detectable effect.

3.) TO: Bob Humphries
SUBJECT: Pollution from Piggeries

Why aren't piggeries and other sources of heavy pollution made to reduce the pollution?
There have been three new "sources" established in the last couple of years in the Peel/Harvey catchment area.

A. There were no organised pollution abatement powers until 1987 when the Environmental Protection Act (1986) was established.
Since then, the EPA has been insufficiently resourced to cope with the backlog situation, so what we do is deal with the known severe polluters.
Also, the resources available cater for new applications for piggeries, while the smaller existing ones will be caught up with over time.

4.) TO: Jim Penn
SUBJECT: Crab Fishery

What are the factors which determine a good or bad year for crabs?
Jim said dry years can increase likelihood of crabs staying in the estuary.

A. Salinity and temperature are among the factors which determine the numbers of crabs in an estuary. Crabs can remain in the estuaries over winter if the rainfall is low, but usually they move out to entrance channels or the ocean when freshwater river flow lowers the salinity.

5.) TO: Jim Penn
SUBJECT: Crab Breeding

What percentage of crab spawn survive?

A. A very low percentage of eggs will eventually mature to an adult crab, however, the very large numbers of eggs generall compensate for the losses due to early predation by fish, getting lost on currents or finding estuary conditions unsuitable.

6.) TO: General Panel
SUBJECT: Slow Release Fertiliser

Why isn't more slow release fertiliser being used by farmers Is it due to the small market, or is it too expensive for farmers to buy?

A. Slow release fertiliser has been more expensive than regular super, however, less of the slow release fertiliser has been required so the costs should balance out. CSBP have stopped producing the slow release fertiliser and Government has approached the company to try to get it produced again.

7.) TO: Derrick Brown
SUBJECT: Fish Caught for Lobster Bait

How much fish caught in Leschenault Estuary is used for lobster bait?
What is the proportion when compared with lobster bait caught from Geographe Bay?
Is whiting sold for bait?

A. 70% to 80% of the Mullet and Pilchards caught in Leschenault estuary are used for crayfish bait.
Whiting is not sold for crayfish bait.

8.) TO: Derrick Brown
SUBJECT: Effect of Cut on Fishery.

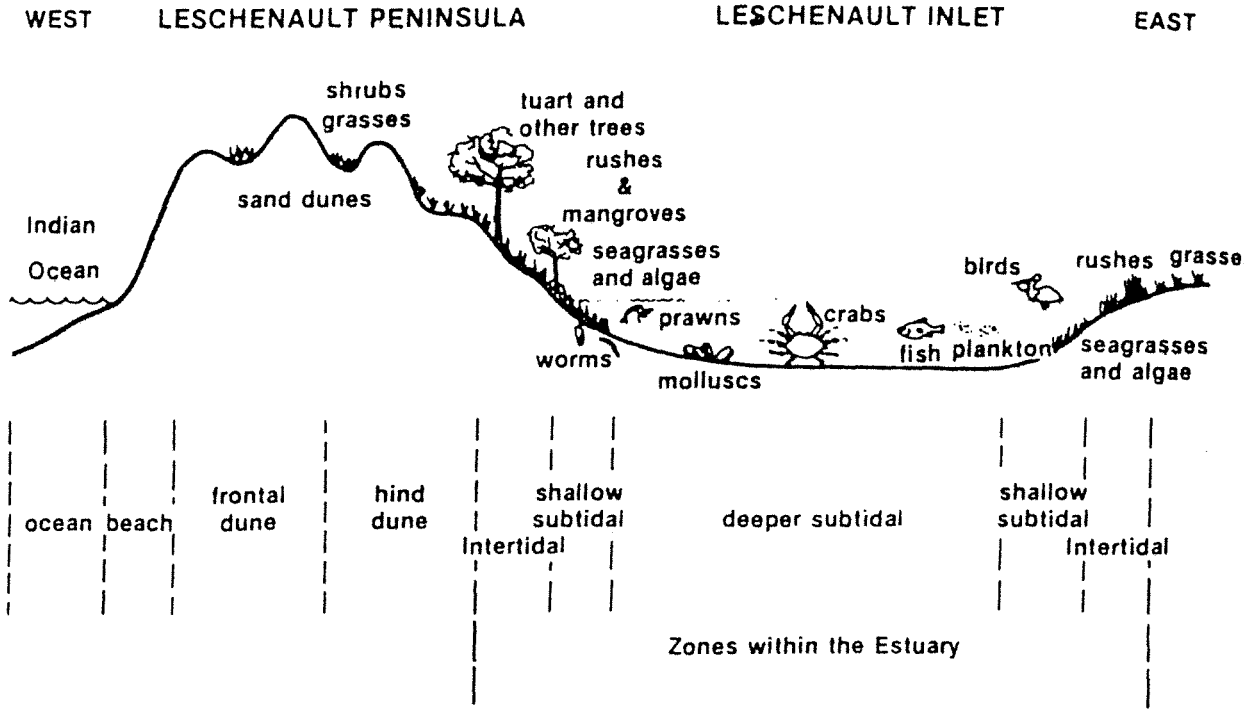
Has the Cut effected the fishery in the estuary?

A. The fishery has only been effected as far as the cobbler are concerned, with their numbers being significantly reduced.

9.) TO: Fisheries Department Officers
SUBJECT: Leeuwin Current

What will be/has been the effect of the change in the Leeuwin Current on fish stocks?

A. Details of the coastal water movements and fish larvae are not well enough known to provide an accurate answer.



West-east transect of Leschenault Inlet with typical flora and fauna.
(not to scale)

Table 1: Alterations to Leschenault Inlet since 1895

ALTERATION	YEAR COMPLETED
Original outlet to estuary filled (known as "The Plug")	1951
"The Cut" opened	1951
Wellington Dam (Collie River) completed	1960
Laporte pipeline	Commissioned 1963
Inner Harbour development	Carried out from 1967-1976
Reclamation of old inlet channel near Inner Harbour	Carried out from 1967-1976
Preston River channel redirected	1969-1970
New boat channel from lower estuary to ocean	1974
Parkfield drain	1977