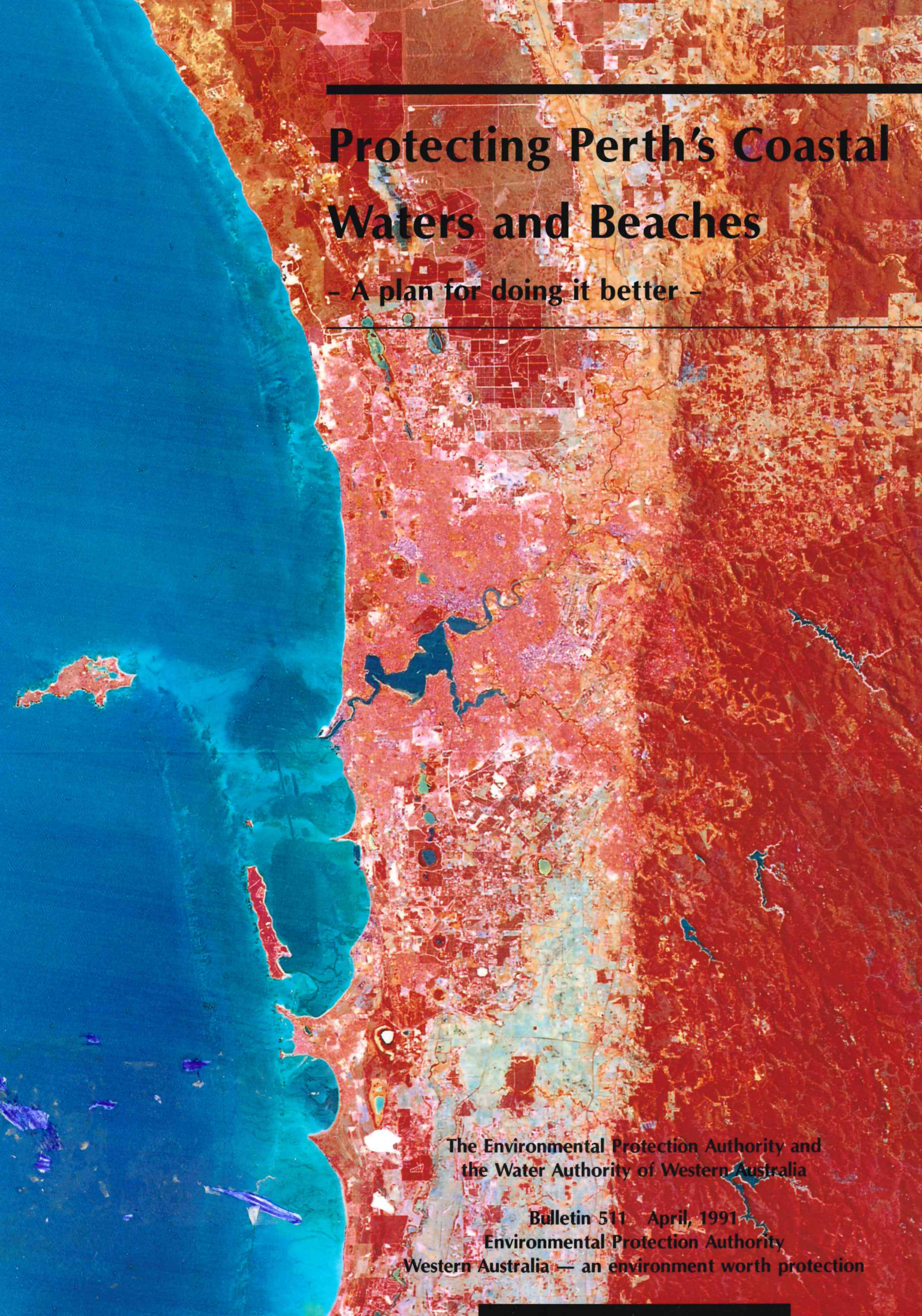


Protecting Perth's Coastal Waters and Beaches

– A plan for doing it better –

The Environmental Protection Authority and
the Water Authority of Western Australia

Bulletin 511 April, 1991
Environmental Protection Authority
Western Australia — an environment worth protection

Foreword

The marine waters off metropolitan Perth, including the waters of our offshore islands, have always held a special place in the hearts of the people of Perth. With their pristine waters and clean white beaches, Rottnest and Garden islands, the metropolitan beaches and the protected waters of the Marmion Lagoon to the north of Perth, have long been regarded as aquatic playgrounds. The recreational use of Perth's marine waters has increased dramatically over the past 10 years. This pressure led to the creation of the Marmion Marine Park in the northern metropolitan waters, and the Shoalwater Islands Marine Park in the southern metropolitan waters, to manage this increasing demand.

With Perth's population predicted to almost double from the current level of 1.1 million people to about 2 million people by the year 2021, the need to provide sound management of our marine environment has never been more urgent. With the accelerating urban and industrial development which accompanies population growth, the pressures on our nearshore marine waters over the coming decades from recreational usage and waste disposal will be greater than ever. If we are to manage these waters successfully, we must understand how they function so that the implications of any activities that potentially threaten the health of Perth's marine environment can be anticipated and prevented. Only when management is based on a sound understanding of these waters can we hope to prevent a repetition of the problems seen in the offshore waters of so many other coastal cities of the world.

The State Government believes that prevention is better than cure and, with this in mind, has initiated marine environmental studies in the southern and northern metropolitan marine waters of Perth. The **Southern Metropolitan Waters Study** is being co-ordinated by the Environmental Protection Authority and the **Northern Metropolitan Waters Study** will be co-ordinated by the Water Authority of Western Australia in collaboration with the Environmental Protection Authority, Fisheries Department and the Department of Conservation and Land Management.

Large schools of bullseyes are a common sight around the reefs off Perth.

These studies will provide the information necessary to formulate environmental management strategies to ensure that the generally high environmental quality of our metropolitan marine waters is maintained for future generations.

This booklet outlines the background, objectives and rationale for the Northern and Southern Metropolitan Waters studies.

Bob Pearce
MLA
Minister for the Environment
1991

Ernie Bridge
MLA
Minister for Water Resources
1991

Yanchep
Burns Beach
Mullaloo Beach
Hillarys
Marmion Marine Park
Trigg Island Beach
City Beach
Perth
Swanbourne Beach
Rottnest Island
Swan River
Canning River
Fremantle
Straggler Rocks
Owen Anchorage
Carnac Island
Woodman Point
Cockburn Sound
Garden Island
HMAS Stirling Naval Base
Kwinana
Cape Peron
Rockingham
Shoalwater Islands Marine Park
Warnbro Sound
Mandurah

Legend:

- Urban
- Industrial
- Restricted, RAN area
- Marine Parks

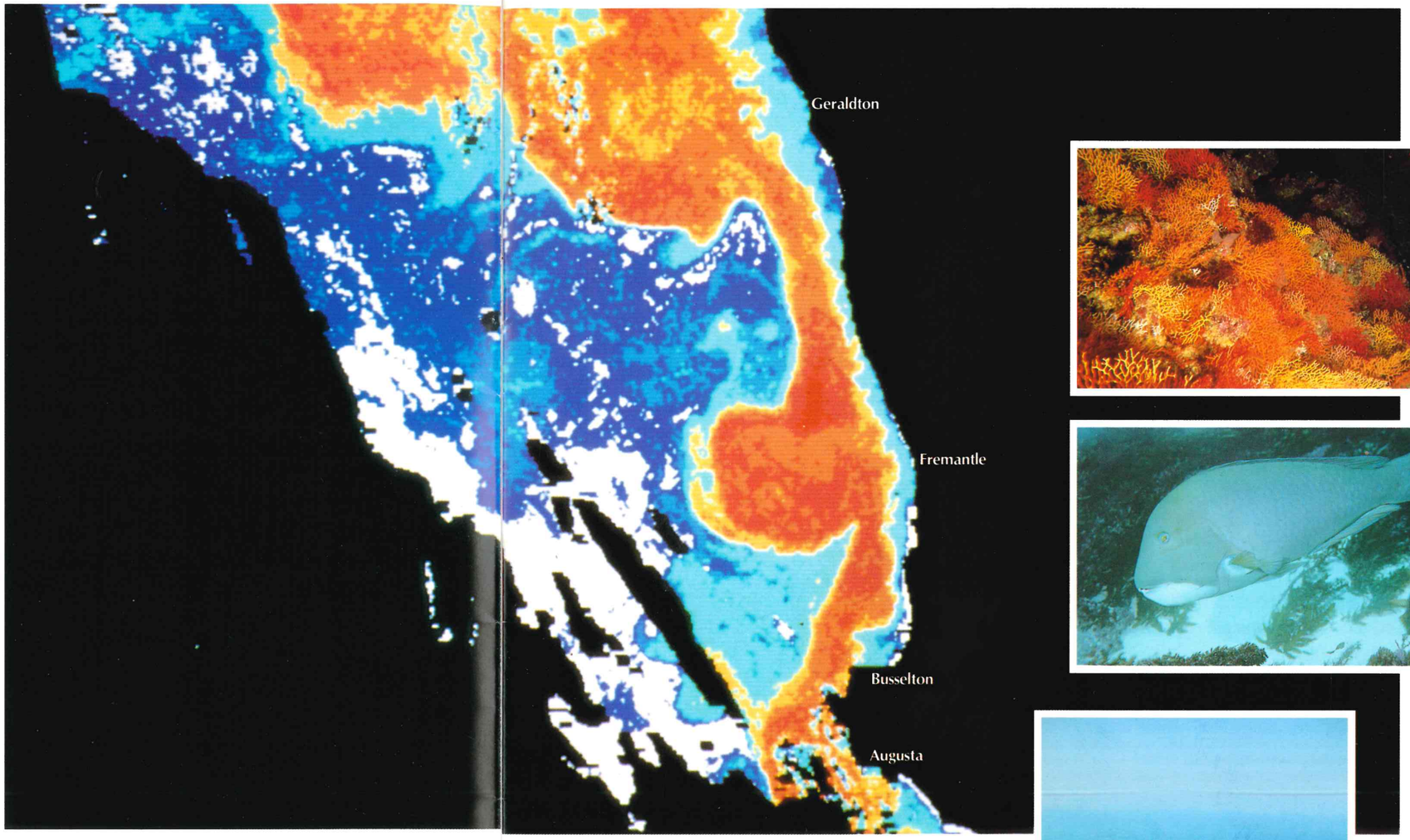
Garden Island's eastern shoreline has many protected bays which are becoming increasingly popular with recreational users. The seagrass meadows along this shoreline are some of the last remaining seagrasses in Cockburn Sound.

Perth's marine environment

The marine waters off metropolitan Perth support an unusually rich and interesting variety of temperate and tropical plants and animals. This is due in part to the Leeuwin Current, a warm ocean current that flows southward down the Western Australian coastline in autumn and winter bringing tropical animals to the cooler temperate waters off Perth. As a result, brightly coloured tropical fish are common at Rottnest Island, and tropical corals are found off Fremantle and even in Cockburn Sound. In addition, a diverse range of habitats also contributes to the richness of Perth's marine environment. These include offshore limestone reefs, protected shallow lagoons, nearshore intertidal reefs, the deep basins of Cockburn and Warnbro sounds and the reefs around Rottnest and Garden islands.

However, the marine environment off the metropolitan area has been dramatically altered since the first Europeans settled in Western Australia. An indication of the extent of some of these changes can be gained from Captain Stirling's diary account of his crew's fishing trips to Cockburn Sound in 1829. *"The Ship's Company caught an immense number of fish called Snappers, capital large fellows weighing ten and twelve pounds, I daresay two hundred on board."* Reports such as this are a far cry from today where, in the same area, the catching of snapper in such numbers is unheard of. Similarly, anecdotal information about fish catches in the northern metropolitan area and at Rottnest

Tropical animals, such as lionfish and coral, are commonly found in Perth's temperate waters.

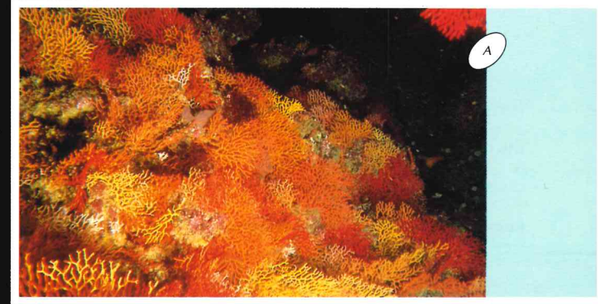


During autumn and winter the Leeuwin Current flows down the coastline of Western Australia carrying the larvae of tropical animals south. Warm water is red, cooler water is blue.

Island has shown that popular reef fish such as jewfish, baldchin groper and blue groper, which were common in the 1950s, are now rarely caught from the more accessible reefs.

As well as changes to local fish populations, less obvious changes have occurred to the marine plant communities. For example, most of the seagrass meadows in Cockburn Sound disappeared quite suddenly after about 20 years of continuous discharge of wastes.

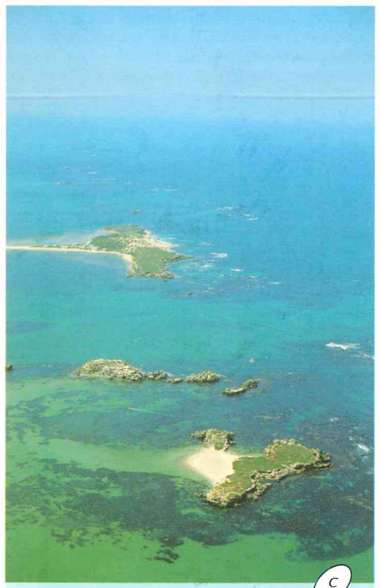
From an ecological perspective, the loss of marine plants, on which so many marine animals depend, is a much more serious problem than a decline in local fish populations.



A. The roofs of many caves in the Marmion Marine Park are covered by fragile, brightly coloured, gorgonian coral.

B. Popular reef fish such as the baldchin groper, common in the 1950s, are now rarely caught from the more accessible reefs around Perth and Rottnest Island.

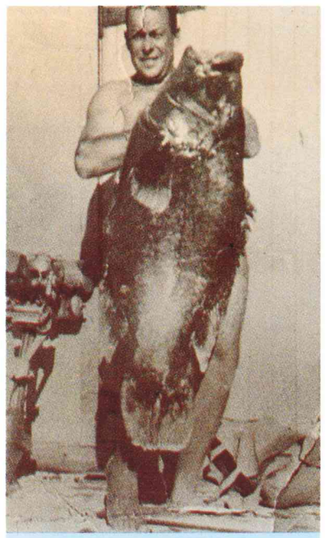
C. The islands and reefs of the Shoalwater Islands Marine Park provide a range of habitats for a variety of marine life. The close proximity of these islands to the mainland make them ideal for recreational activities such as boating, diving and windsurfing.



Demands on our marine environment

Changes to the plant and animal communities in the waters off Perth were largely the result of uncontrolled use of Perth's marine environment and a lack of understanding of the implications of this usage. These types of environmental changes, by no means unique to Western Australia, occurred largely in parallel with our population growth.

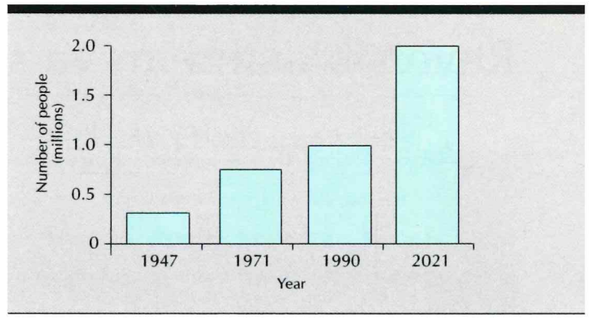
In 1947, Perth's population was 303,000. It rose to about 700,000 by 1971 and is now about 1,100,000. Current projections suggest that it will almost double to about 2,000,000 by the year 2021, with major metropolitan expansion along the coastal fringe. The rapid increase in population and the continuing expectation of a high standard of living will result in even greater demands on our marine environment to receive more waste. At the same time, the community expects a high environmental quality to be maintained in our coastal waters. These conflicting demands can only be resolved by careful planning and management based on a thorough understanding of the potential impacts of all activities on the marine environment.



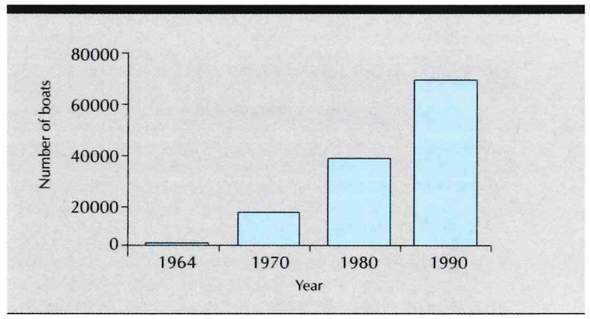
This 34-kilogram blue groper was speared in 1957, approximately two kilometres off Whitfords Beach and won the Marlin Trophy for the biggest fish caught in Australia that year. Nowadays, blue groper are rarely caught on these reefs.

Urban wastes will increase as Perth's population grows.

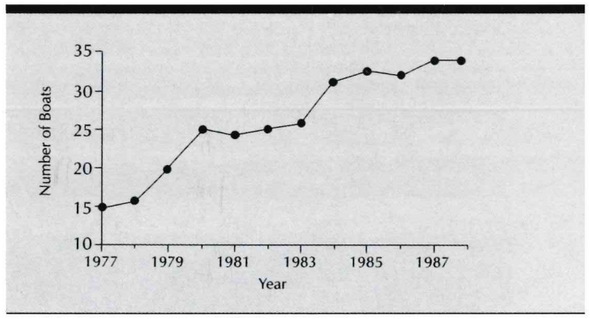
The common objective of the Northern and Southern Metropolitan Waters studies is to provide the information necessary to understand the implications of the uses and pressures we place on our marine waters so that any current or proposed activities that are likely to result in long-term or unacceptable damage can be prevented before it is too late.



Current predictions suggest that Perth's population will almost double by the year 2021. This means more wastewater (sewage), more urban run-off and more people wanting to use our coastal waters and beaches.



The number of recreational boats registered in Western Australia has risen dramatically, placing increasing demands on the marine animal stocks through fishing and collecting.



The number of professional fishing boats operating in Cockburn Sound doubled between 1977 and 1988 increasing pressure on local fish stocks.

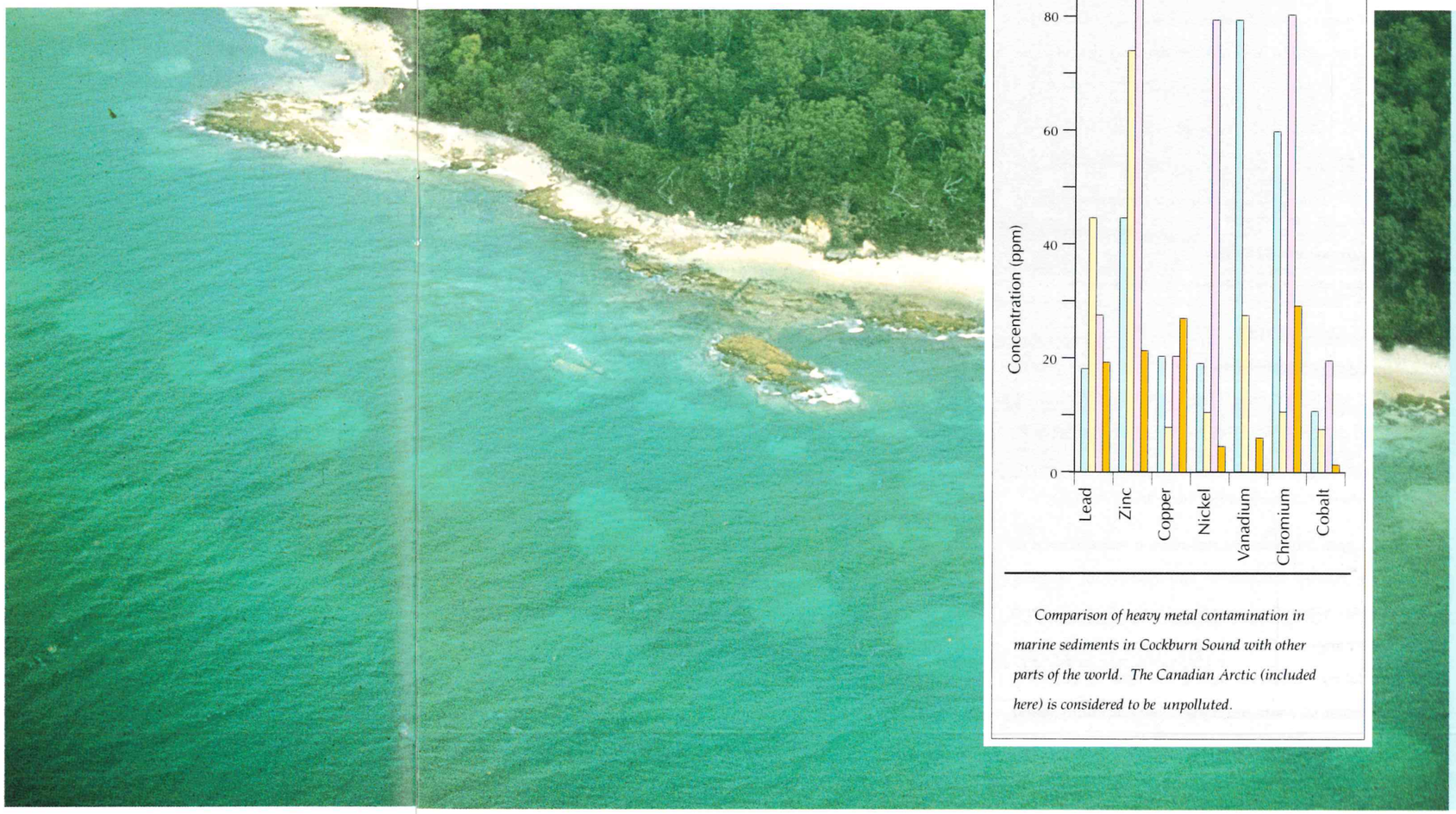
Parker Point, Rottnest Island is a popular anchorage for recreational boats. Most of the protected bays are already overcrowded and, in some, anchors and moorings have badly damaged seagrass meadows.

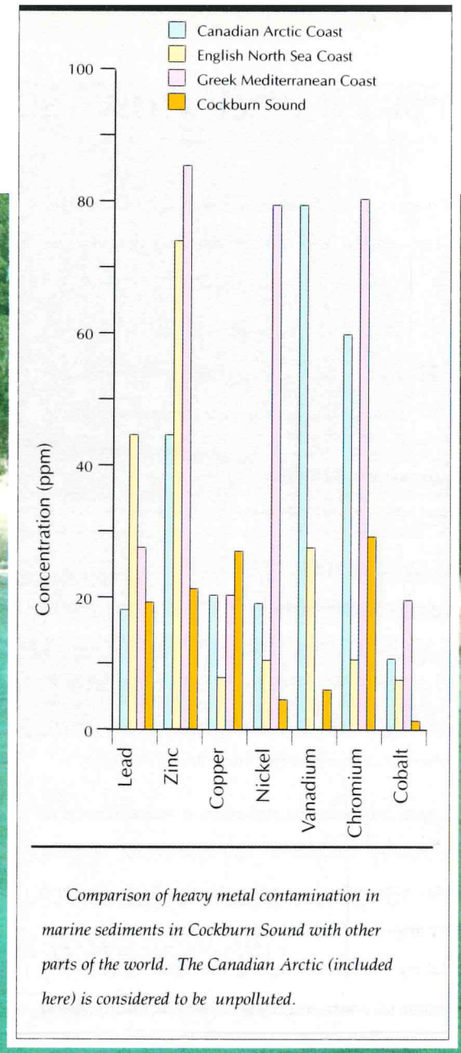
Reversible and irreversible change

Although many human induced changes have occurred in our coastal waters, most are largely reversible with appropriate management and sufficient time. For example, depleted fish numbers can be replenished by understanding their biology and then imposing appropriate size and catch limits. In cases where these measures do not work, more extreme measures such as the early closure of the fishing season can be used to prevent over-exploitation. The abalone fishery along the northern metropolitan coastline is a good example of this.

An effective way of managing large areas of our marine environment, rather than individual species, is by controlling activities in these areas through the creation of marine parks. The Marmion Marine Park and the Shoalwater Islands Marine Park, off the northern and southern metropolitan coastline respectively were established to regulate usage of the marine environment in these areas.

Some changes, however, are not reversible, even with the best remedial management measures. For example, the seagrass loss in Cockburn Sound is considered to be irreversible. Current scientific evidence suggests that once these seagrasses are lost they do not return.





Comparison of heavy metal contamination in marine sediments in Cockburn Sound with other parts of the world. The Canadian Arctic (included here) is considered to be unpolluted.

Seagrass meadows damaged by seismic blasting in 1962 show no signs of recovery nearly 30 years later. Current scientific evidence suggests that once these seagrasses are lost they do not return.

Although some changes have occurred to Perth's coastal waters we are fortunate that most of our marine environment is still healthy. However, as Perth's population increases, careful management will be required to protect these waters for future generations.

Even though some undesirable changes have occurred in parts of our marine environment, Western Australia is fortunate that most of its marine waters are healthy; mainly due to our small population and relatively short period of European settlement. In contrast, marine areas which have for centuries been surrounded by densely populated countries, for example the Mediterranean Sea, are generally severely polluted; a problem requiring extremely complex and costly management solutions.

The creation of marine parks such as the Marmion Marine Park in the northern metropolitan area, is one effective way of managing parts of our marine environment.

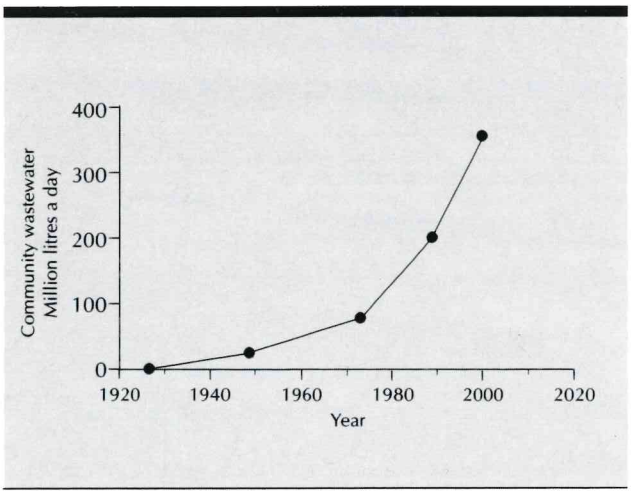
The collection of abalone from the inshore reefs north of Perth is a popular pastime. The increasing demand on abalone stocks has resulted in a progressive shortening of the fishing season to prevent over-exploitation.

Sources of pollution

The primary sources of pollution into the marine environment are wastes from the community, industry and agriculture.

Sources of pollution from the community include wastewater (sewage), stormwater run-off, and groundwater contaminated by septic tanks, rubbish tips and from pesticides and fertilisers used on household gardens. Most heavy industrial waste discharge is confined to the Cockburn Sound/Owen Anchorage area although a heavy industry site north of Perth, with the potential for ocean discharge, is being considered. Agricultural wastes currently entering Perth's coastal waters from market gardens are considered to be a relatively minor source of pollution compared to community and industrial sources. Pollutants also enter Perth's waters from atmospheric fall-out and the Swan River outflow.

In the past, industrial wastes were a major source of pollution to parts of the marine environment of Western Australia and were the primary cause of major and irreversible changes in Cockburn Sound and Princess Royal Harbour, Albany. However during the past 10 years the amount of industrial waste discharged into Cockburn Sound has been significantly reduced. In contrast, the amount of waste from the community has increased dramatically; in proportion to our rapidly growing population.



If current disposal practices continue, treated wastewater discharge to the metropolitan waters is predicted to rise sharply over the coming decades in proportion to Perth's rapidly growing population.

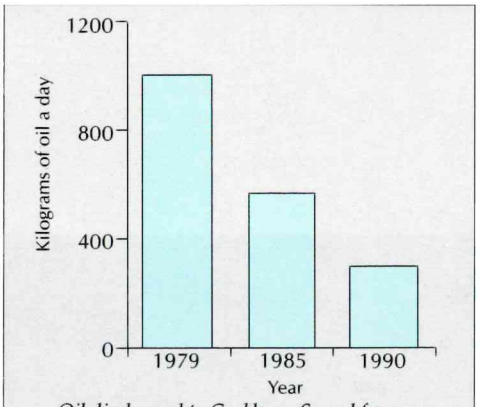
Pesticides and fertilisers used on market gardens in the Perth metropolitan area leach into the groundwater and some eventually reach the ocean.

If these trends continue, the major threat to the wider marine environment off Perth in the coming years is more likely to be from community wastes, particularly treated wastewater discharge, rather than industrial wastes.

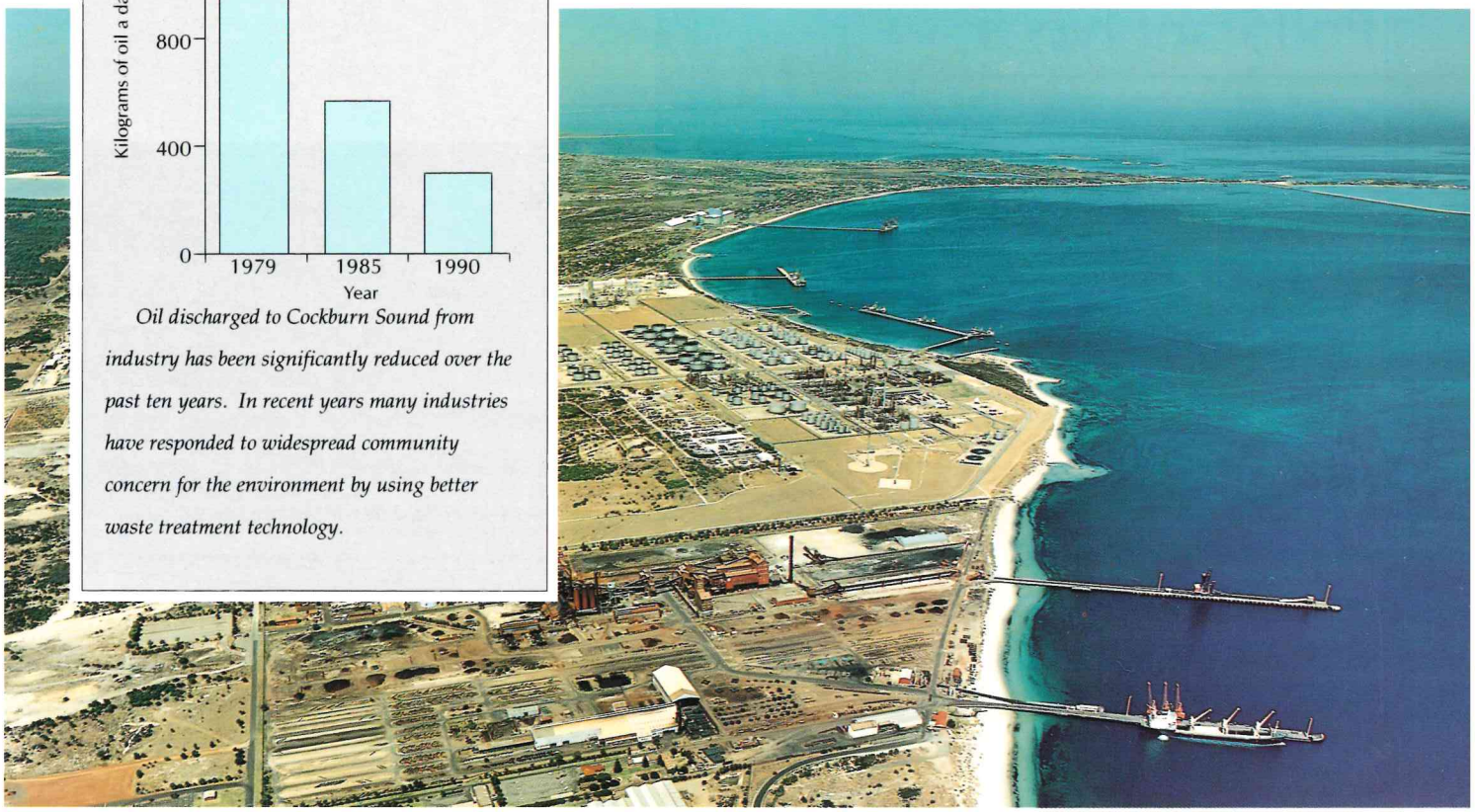
Many examples throughout the world highlight the dangers of discharging too much community waste, without the appropriate level of treatment, into the sea. Wastewater was associated with the deaths of marine mammals in the North Sea and the Mediterranean Sea. In Australia, the waters off Sydney have been heavily polluted, and hundreds of hectares of seagrass meadows have been destroyed in South Australia's Gulf St Vincent, both the result of excessive wastewater and sludge discharge.

The Environmental Protection Authority and the Water Authority are working together on the Northern and Southern Metropolitan Waters studies to ensure that similar problems do not occur in Western Australia.

Urban sources of pollution include treated wastewater, stormwater run-off, and groundwater contaminated by septic tanks, rubbish tips and pesticides and fertilisers used on household gardens.

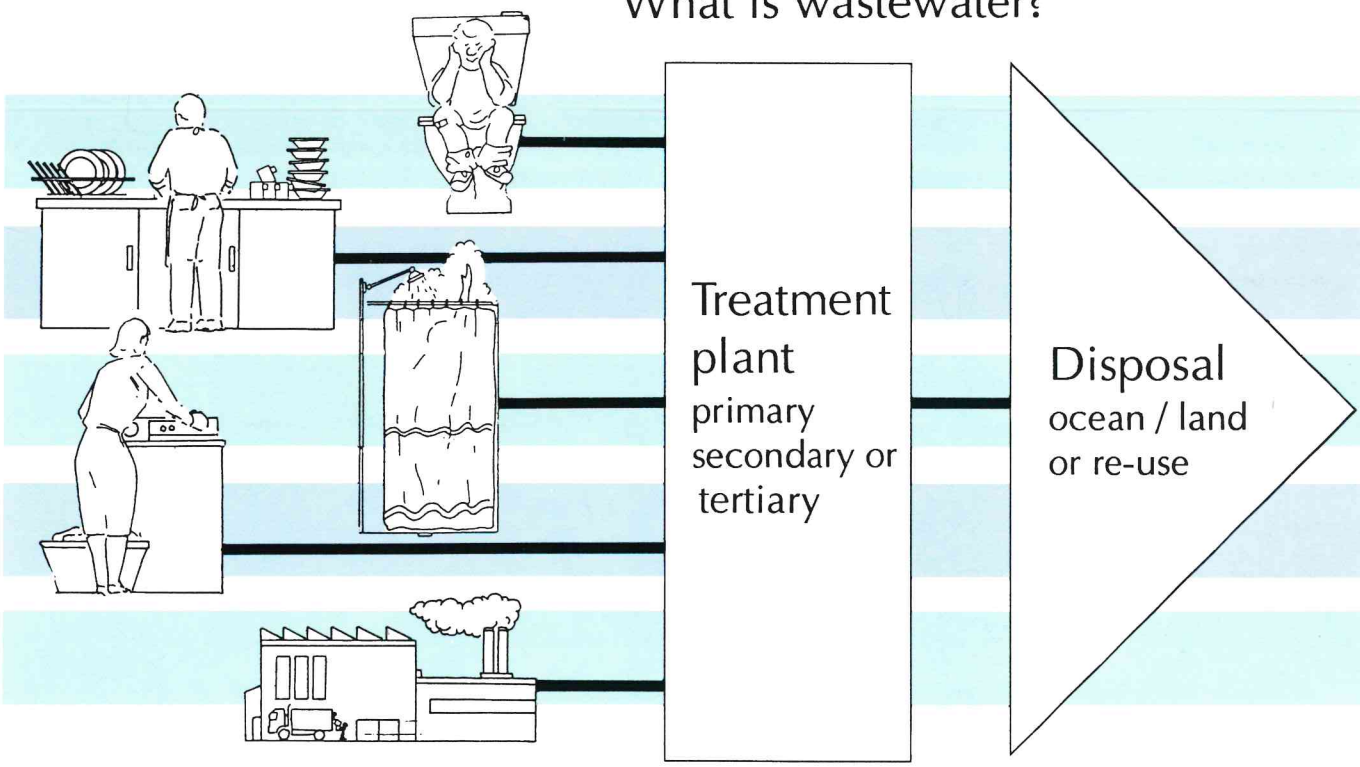


Oil discharged to Cockburn Sound from industry has been significantly reduced over the past ten years. In recent years many industries have responded to widespread community concern for the environment by using better waste treatment technology.



In the past, industrial wastes have been a major source of pollution to the marine environment of Cockburn Sound.

What is wastewater?



Community wastewater treated by the Water Authority is made up of wastes from your toilet, kitchen sink, shower, bath, laundry and approved industrial wastes. It is called wastewater rather than sewage because by far the greatest volume comes from baths, showers and washing machines. Every day each person uses 500 litres of water and about 200 litres of this enters the sewers as wastewater.

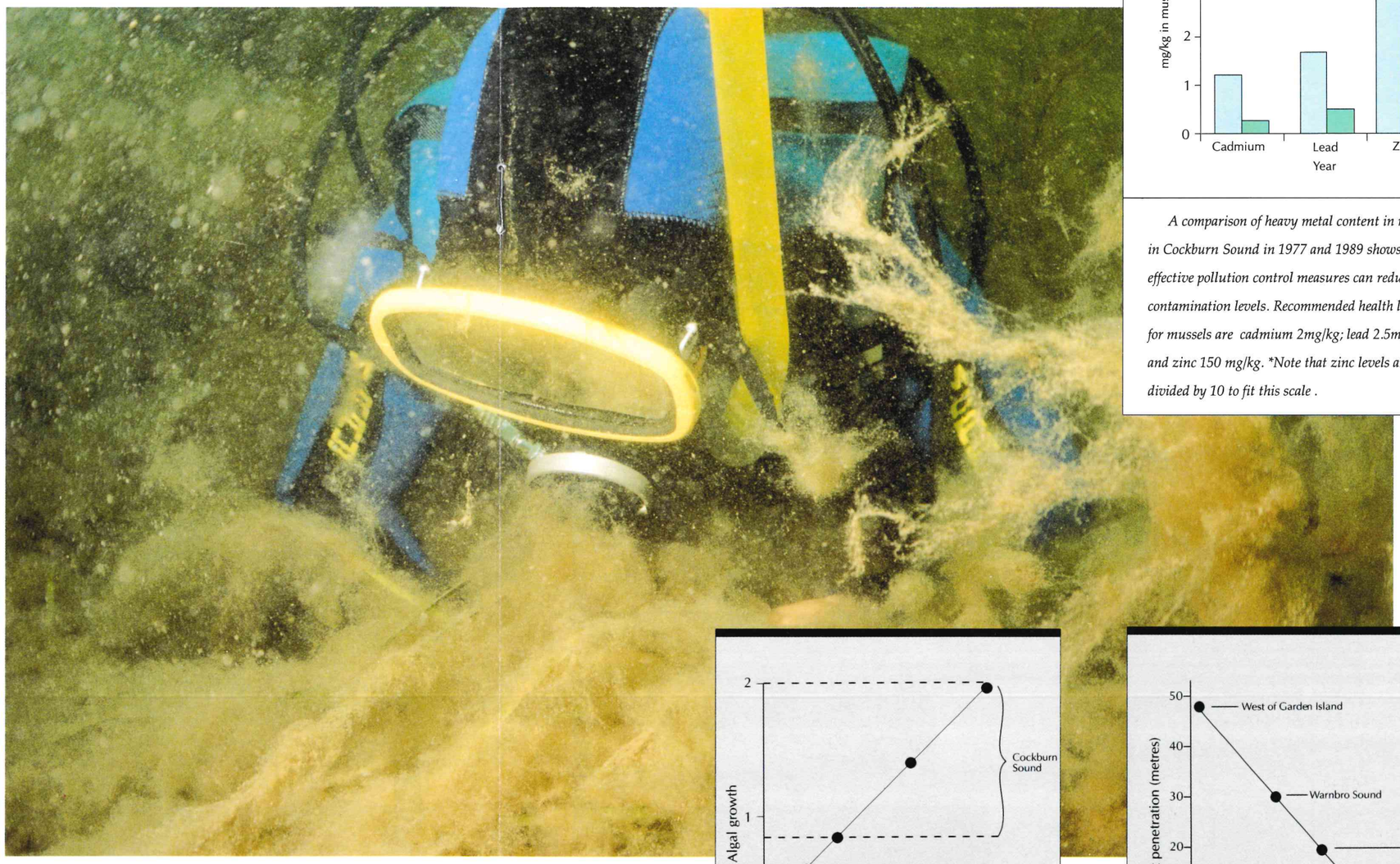
Pollutant types

The major types of pollutants are *toxic substances* (synthetic and natural) which damage and kill organisms directly, and *biostimulants* such as nutrients that promote the excessive growth of aquatic plants which indirectly damage or kill marine life and upset the ecological balance. Bacteria and viruses in human and animal wastes can also threaten marine life as well as posing a health hazard to humans.

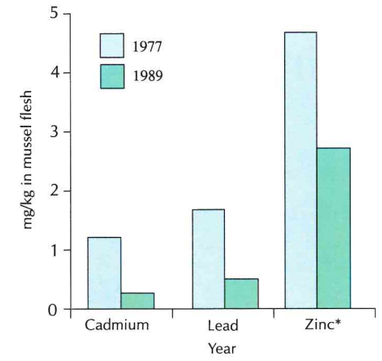
Contamination of Western Australia's marine environment by toxic substances such as heavy metals, pesticides and petroleum products is generally not widespread, although it has occurred close to industrial centres. When this type of pollution occurs through direct waste discharge, it can be controlled relatively easily through existing environmental laws and regulations.

Although naturally occurring toxic substances can threaten human health and cause local environmental impacts, they rarely threaten the 'health' of entire ecosystems. On the other hand, biostimulants, particularly nutrients, and some synthetic toxic substances such as dioxins, are entirely different. These substances can threaten entire ecosystems.

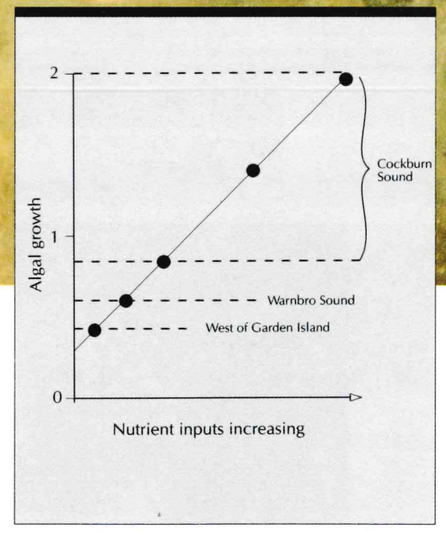
Currently, there is no threat to marine ecosystems in Western Australia from either naturally occurring or synthetic toxic substances. The major threat to our marine waters is more likely to be from excessive nutrient inputs. Nutrient enrichment of water bodies can threaten the ecological balance of whole marine ecosystems without being toxic to marine life or humans. For example, the irreversible losses of seagrass in Cockburn Sound and Princess Royal Harbour were caused primarily by nutrient enrichment which promoted the excessive growth of algae that shaded and smothered the seagrasses, causing their death.



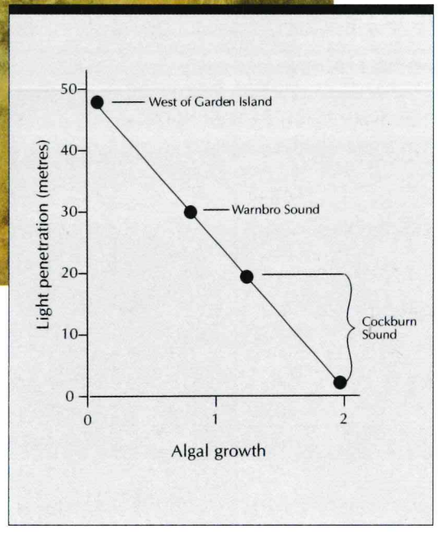
Biostimulants such as nutrients, promote the excessive growth of algae, that shade and smother seagrass, causing their death.



*A comparison of heavy metal content in mussels in Cockburn Sound in 1977 and 1989 shows that effective pollution control measures can reduce contamination levels. Recommended health limits for mussels are cadmium 2mg/kg; lead 2.5mg/kg; and zinc 150 mg/kg. *Note that zinc levels are divided by 10 to fit this scale .*



Increased nutrient loads entering Cockburn Sound cause algae to 'bloom'. The algae is the microscopic phytoplankton found in the water column and is used as an index of the 'health' of the water. Note that the algae concentrations in Warnbro Sound and to the west of Garden Island, which are considered to be unpolluted, are much lower.



Increased phytoplankton (algal) growth reduces light penetration. Without light plants die. Note that the light penetrates to greater depths (the water is clearer) in Warnbro Sound and to the west of Garden Island.

The importance of marine plants

The survival of all marine animals is linked to marine plants through a complex food web.

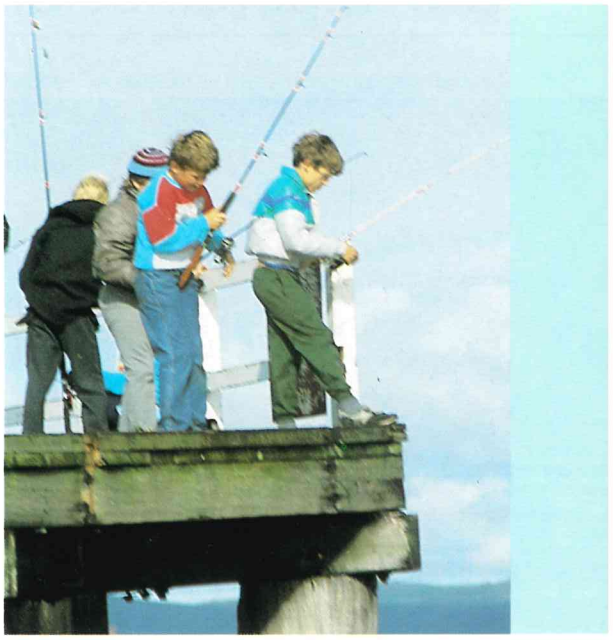
Plants form the base of this food web and use nutrients, carbon dioxide and the sun's energy to make food through the process of photosynthesis. The main plants in Perth's coastal waters are *seagrasses*, *algae* and floating, single-celled plants called *phytoplankton*. The living plants and their decomposing remains are eaten by animals such as crabs, worms and small fish and these, in turn, are eaten by larger fish, dolphins, seabirds and so on. Plants also provide habitat and protection for many marine animals.

Marine mammals including humpback whales and bottlenose dolphins are a common sight in Perth's coastal waters. The dolphins shown here depend on a plentiful supply of fish which are linked to the marine plants through the food web.

Because all animals ultimately depend on these marine plants, changes to the base of the food web — to the marine plants — will have more drastic and lasting effects than changes higher up the food web — to the marine animals such as fish.

Furthermore, losses of marine plant communities, particularly seagrasses, are often irreversible, whereas changes higher up the food web, such as to the fish, are generally reversible with appropriate management. This difference highlights the critical importance of plant communities to all marine life and is the reason why their protection is paramount.

The survival of all marine animals is linked to marine plants through a complex food web. Many molluscs found in Perth's marine waters live in seagrass meadows and feed on algae. This beautiful bubble shell was photographed feeding in the Marmion Marine Park.



Fish
Australian Herring, Whiting, Cobbler, Flathead, Australian Salmon.

Small fish
Pilchard, Whitebait, Anchovy

Filter Feeders
Oysters, Cockles

Invertebrates
Marine Snails, Worms, Shrimps, Crabs

Fish
Mullet, Leatherjackets

Zooplankton

Detritus
(Dead plant and animal matter)
Bacteria

Dead Animal Matter

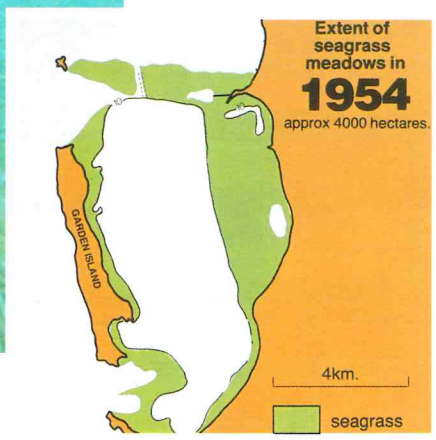
Phytoplankton

Algae

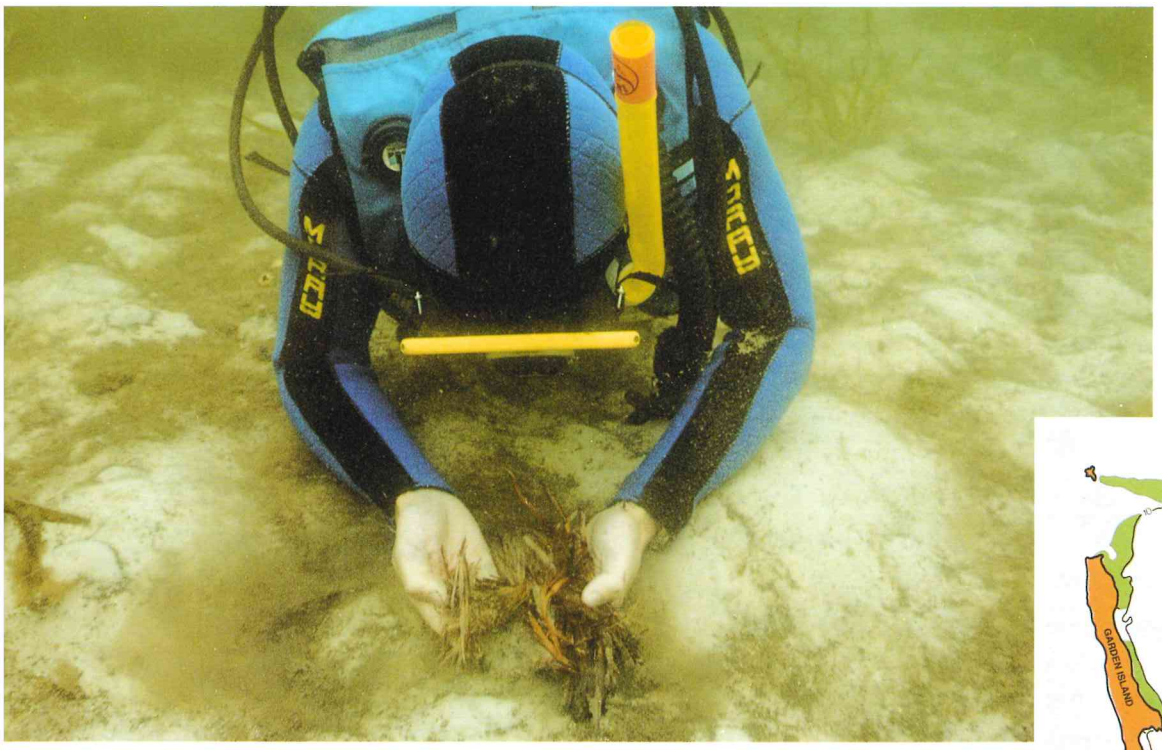
Seagrasses
(and the small plants living on them)

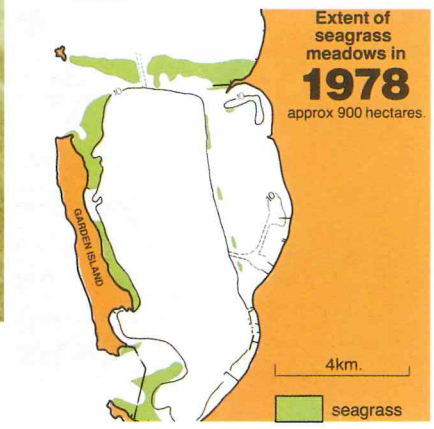
Simplified food web of Perth's coastal waters. The plants and animals shown here are examples of some of the many different types living in our waters.

The importance of seagrasses

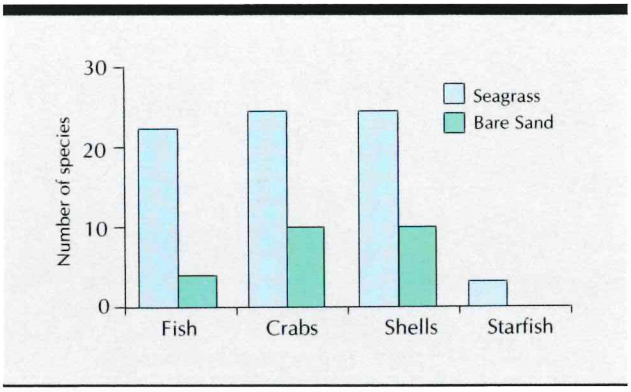


A dense seagrass meadow showing little algal growth. Such healthy meadows provide food and shelter for many animals.





Dead seagrass rhizomes (root-like structures) still remain in Cockburn Sound where luxuriant seagrass meadows once grew.



Seagrass meadows provide shelter for fish, crabs, shells and starfish. If seagrass meadows are lost, many of the animals associated with them also disappear.

More seagrass species are found off the southern Western Australian coastline than anywhere else in Australia. These seagrasses have adapted to the clear, nutrient-poor waters that occur along our southwest coast; the result of a dry climate and low sediment and nutrient input from our few rivers.

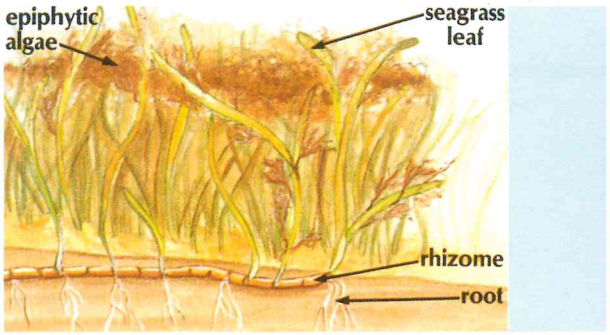
Healthy seagrasses are highly productive. Each year, they can produce as much organic matter, or potential food, as a similar area of tropical rainforest. Seagrass meadows are also important nurseries for many animals such as fish and crabs. Many of the fish species off Perth depend on the meadows at some stage of their life-cycle. If these meadows are destroyed, fish populations are likely to be dramatically altered.

In the past, algal blooms have been a common occurrence in the waters of Cockburn Sound as a result of nutrient pollution. Algal blooms reduce the amount of light reaching the seagrasses.

In addition to their biological role, the roots and rhizomes of seagrass plants protect sediments from erosion by waves and currents in much the same way as plants on land protect soil from erosion. But as seagrass meadows decline, sediments are more readily stirred up by waves and currents and changes in shorelines and beaches may occur. In addition, the water becomes murky, reducing the light available to the surviving seagrasses.

Seagrass death is usually caused by light starvation due to excessive amounts of algae shading the meadows. Provided algae do not grow excessively, they are natural and valuable parts of the marine environment. But if the water becomes enriched with nutrients, such as nitrogen and phosphorus, algae can grow rapidly and starve other plants of light. This happened in Cockburn Sound and Princess Royal Harbour.

In Western Australia, two types of algae have led to seagrass decline — *macroalgae* — some of which attach to seagrass leaves and others which remain unattached and smother the meadows, and — *phytoplankton* — microscopic, free-drifing algae which grow rapidly to form dense concentrations or 'blooms'. Both forms of algae reduce the amount of light reaching the seagrass leaves, and without light, seagrasses die.



Algae (seaweeds) which attach themselves to seagrass leaves are called epiphytic algae. These algae reduce the amount of light reaching the seagrass leaves. Extended periods of reduced light may eventually kill the seagrass.

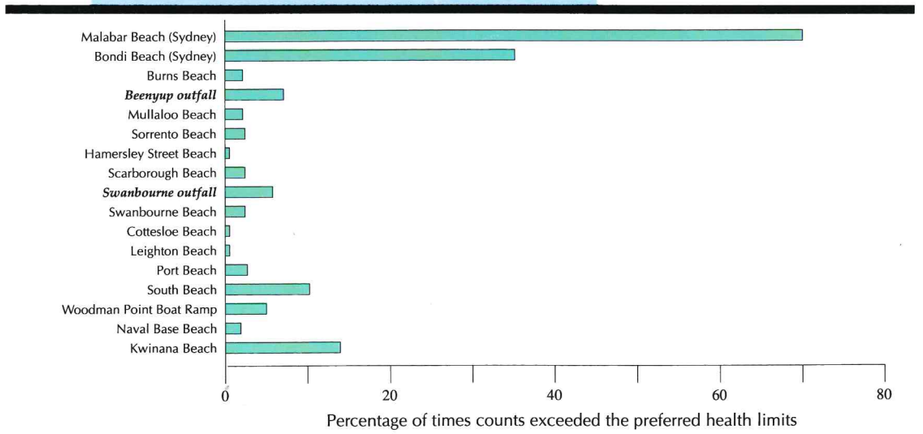
Changing community attitudes

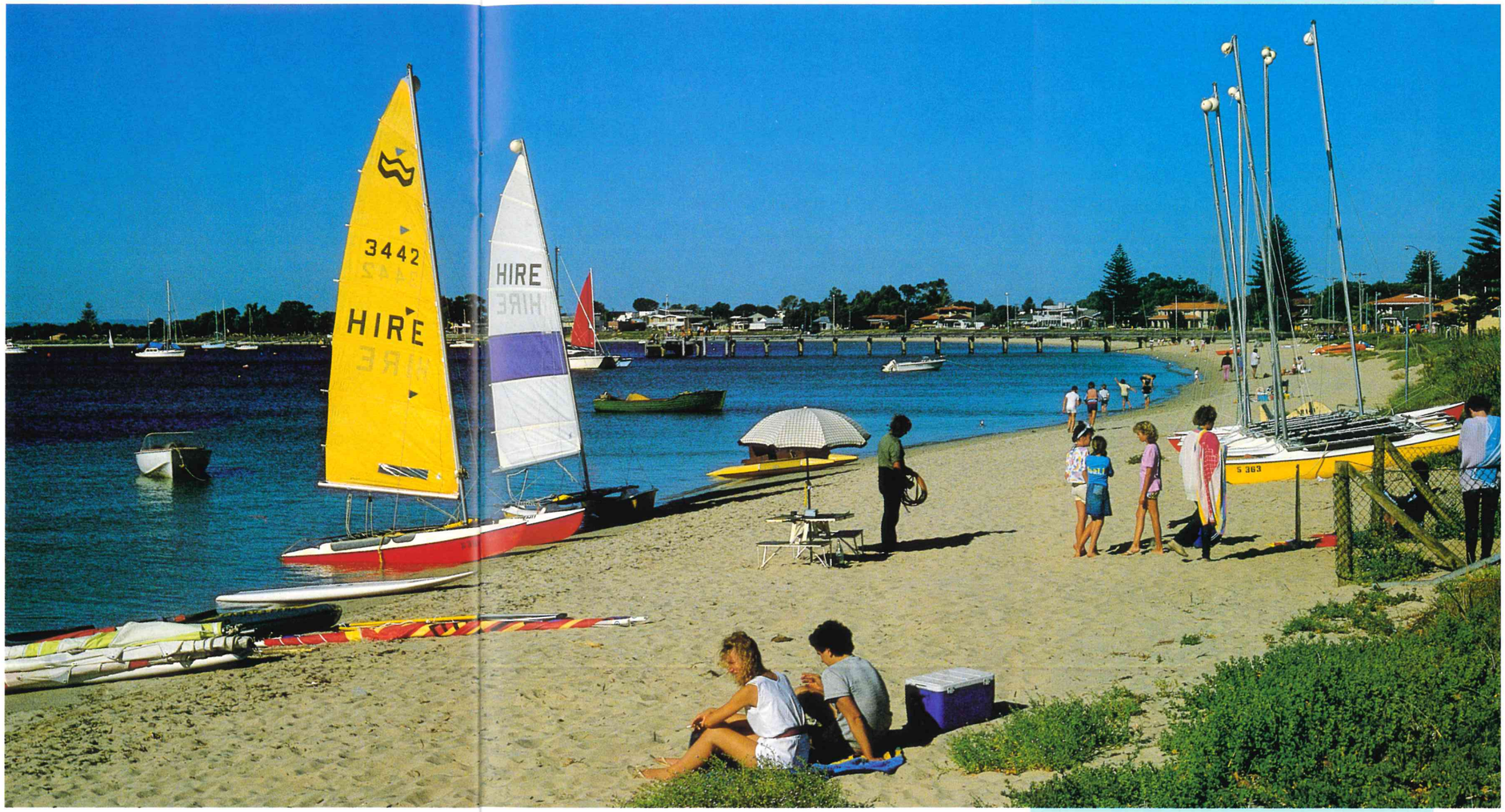
Community attitudes to the environment have changed dramatically over the past 40 years.

From the 1950s, when industry was first attracted to the eastern margin of Cockburn Sound and Owen Anchorage, until the early 1970s, when the area was booming as a major industrial centre, little attention was given to the environmental consequences of development, and nothing was known of the water's ability to assimilate or disperse wastes. It is not surprising then, that by the late 1970s, after 20 years of unrestricted waste discharge to the Sound, the area became extremely degraded.

Community concern for the environment is increasing. A 1988 survey, in the southern metropolitan area of Perth, indicated that the community wants effective management strategies put in place to ensure that a clean and healthy metropolitan marine environment is maintained and preserved for future generations. Similarly a recent survey of the residents of Rockingham voted overwhelmingly in favour of protecting Cockburn Sound from pollution.

Faecal bacteria contamination of waters off Perth (1983-87) and Sydney (1983-87) beaches showing the percentage of times counts exceeded the preferred health limits for Perth (150/100ml) and Sydney (300/100ml). As a result of widespread community concern, discharges of industrial and community wastewater into the waters off South Beach and Woodman Point have stopped. Since 1987 the water quality in these areas has greatly improved.





To achieve this goal, we must understand how these natural systems function. The Cockburn Sound Environmental Study (1976-79) was the first step in understanding how to effectively manage part of our metropolitan marine environment. Now, with ever-increasing pressures from urban and industrial expansion, a better understanding of the cumulative and long-term effects of pollution on these marine systems is urgently needed.

The Northern and Southern Metropolitan Waters studies will provide the information required to ensure that serious problems do not arise in the future.

Community concern for the environment has increased dramatically over the past 40 years. In the 1950s, when industry was first attracted to Cockburn Sound and Owen Anchorage, little thought was given to the environmental consequences. A 1990 survey of residents in Rockingham voted overwhelmingly in favour of protecting Cockburn Sound from pollution.

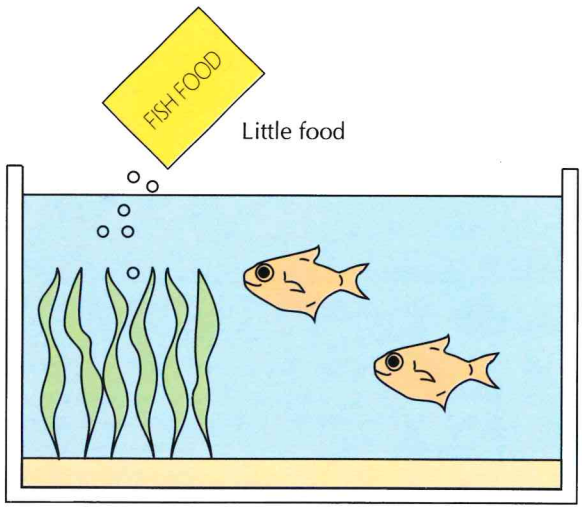
Assimilative Capacity

The challenge in protecting Perth's marine environment is to allow for a wide range of uses of our waters without putting their health in jeopardy. The Environmental Protection Authority believes that no marine ecosystem should become irreparably damaged. All marine ecosystems have a limited capacity to disperse, absorb or assimilate certain wastes with acceptable change. However, if this capacity is exceeded, the biological systems will ultimately become degraded. Therefore, the Environmental Protection Authority must first determine, in consultation with the community, the level of acceptable change and then set a limit on waste discharge.

This limit is known as the *assimilative capacity*. Ignorance of the capacity of Cockburn Sound to assimilate nutrient pollution in the 1950s and 1960s led to almost total loss of the seagrass meadows in the Sound during the 1970s. Thus, to avoid a repetition of past mistakes, the assimilative capacity of the marine environment should be determined well before urban and industrial development commences.

From past experience in Cockburn Sound and Princess Royal Harbour, and predictions of the types and quantities of pollutants likely to enter our nearshore waters, nutrient enrichment is considered to be the major threat to Perth's coastal waters over the coming decades.

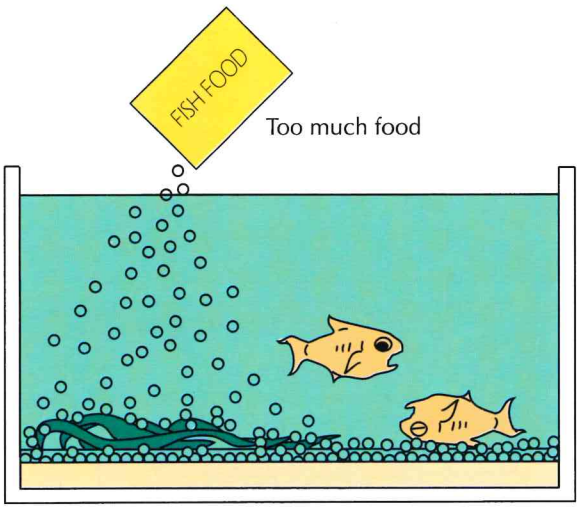
The Northern and Southern Metropolitan Waters studies will determine the nutrient assimilative capacity of Perth's coastal waters well before the possibility of further irreversible damage occurring, as happened in Cockburn Sound.



Healthy seagrass and fish

Assimilative capacity NOT exceeded

To some extent what happens in an aquarium can be used to explain the concept of assimilative capacity. Food, containing nutrients, is added to feed the fish. If we add more food than the fish can eat (or assimilate) then it will accumulate. The excess fish food decomposes, fertilising algae in the water and causing it to grow profusely. Everything becomes coated with this green slime-like algae, and the quality of the water deteriorates. What has happened? The 'ecosystem' has been thrown out of balance; it cannot assimilate the excess food without detrimental changes beginning to occur. At first, the plants and fish may survive but if nothing is done, such as changing the water, they will eventually die.



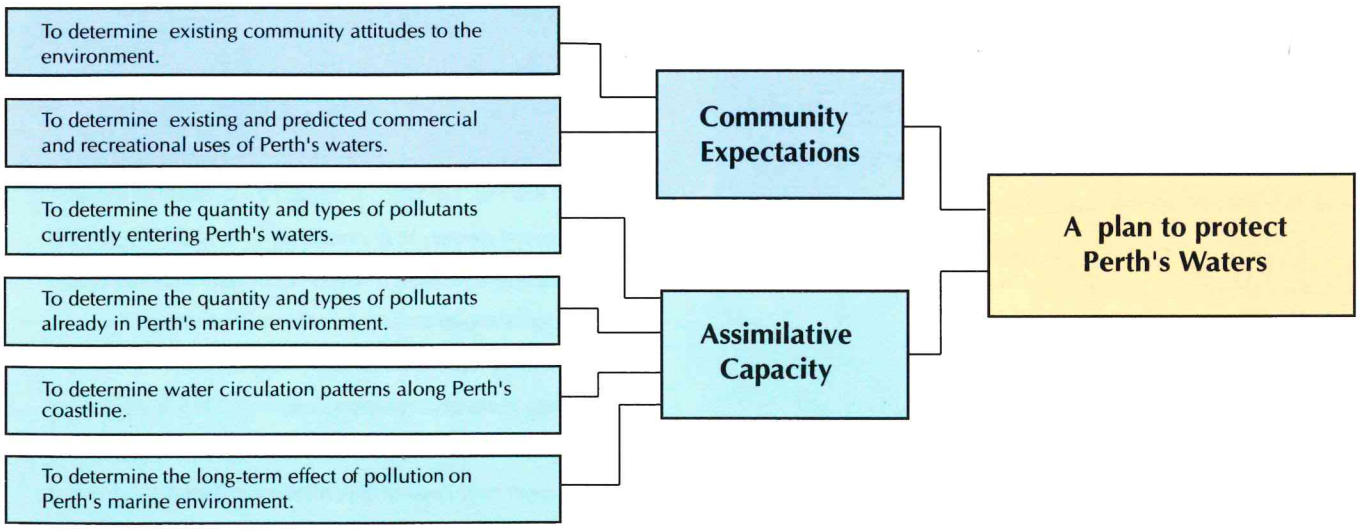
Sick seagrass and fish

Assimilative capacity exceeded

What happened in Cockburn Sound in the 1970s can be viewed in a similar way. Nutrients, like food in the aquarium, entered the Sound. Some of these were taken up or assimilated by the plants and animals, some accumulated in the sediments and some were flushed out into the open ocean by water currents. When the amount of nutrients entering the Sound increased to the extent that the water quality declined beyond an acceptable level then, like the plants and fish in the aquarium, the ecosystem began to 'die'. That is, the assimilative capacity had been exceeded.

To protect Perth's marine environment we must understand how today's decisions affect tomorrow's environment. To do this we must understand the consequences of all our actions.

A Strategy for the Study



What we can do

Once the assimilative capacity of Perth's waters has been determined, this level must not be exceeded if we are to protect our coastal waters and beaches. Without the community's support this will not be possible. If, for example, wastewater has to be treated to a much higher level before discharge into the marine environment, or diverted to land disposal, then the community must be prepared to pay the additional costs. Otherwise the community's expectation to continue to enjoy a healthy environment is not realistic. Similarly, further treatment of industrial wastes will inevitably result in price rises of the goods being produced which, in turn, will be passed on to consumers. Likewise, restrictions on the use of household fertilisers and pesticides may be necessary to prevent pollution of our marine environment.

The point here is that if the community is not prepared to support the measures required to protect our marine environment then ultimately the metropolitan waters of Perth could follow the same pattern of degradation that has occurred in many of the large coastal cities around the world. Only then, when it is too late, will the community accept the expensive remedial action necessary to restore the environment to tolerable, rather than desirable, levels.

The cost of remedial measures is usually much higher than the cost of preventative action, and the result less satisfactory. For example, the people of Sydney are now paying an extra $80 in rates a year for the next five years as part of a massive wastewater clean-up of their beaches and coastal waters. Preventative measures would have been a lot cheaper. The Northern and Southern Metropolitan Waters studies are the first steps in this preventative process.

Wastewater from the community

Currently 220 million litres of treated wastewater is discharged into the marine waters of Perth each day. The solids (sludge) are not discharged and most industrial waste is not allowed to enter Perth's wastewater system. About one third of our wastewater is primary treated and two thirds secondary treated. As a result, the effluent that is discharged is like a dilute liquid fertiliser. If nutrient and bacteria inputs from this effluent need to be reduced, several options can be considered:

- *further treatment to reduce nutrient and bacteria levels;*
- *extension of outfalls further out to sea;*
- *changing from ocean to land-based disposal; and*
- *re-use.*

Our homes

The waste we create and dispose of at the rubbish tip and in septic tanks, along with the fertiliser and pesticides we use on our gardens, eventually leach into the groundwater, which ultimately reaches the marine environment. With the rapid expansion of urban areas along the coastal strip, groundwater contamination is of increasing concern. If nutrients and toxic substances produced by households need to be reduced several options can be considered:

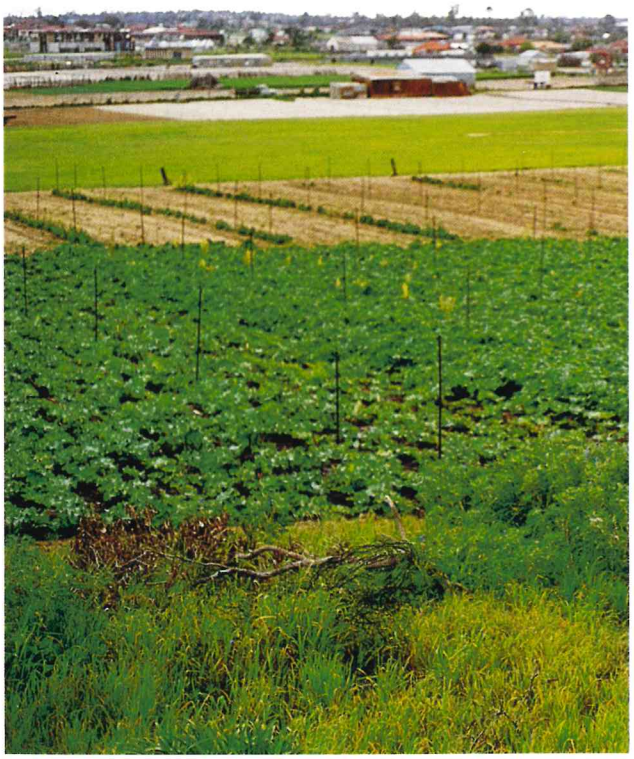
- *reducing the amount of fertiliser, pesticides and other toxic substances used on gardens and around our homes;*
- *not using septic tanks for wastewater disposal;*
- *using phosphorus-free detergents;*
- *using items which can be recycled, therefore reducing the amount of waste to be disposed of in rubbish tips; and*
- *regulating urban development in environmentally sensitive areas.*

Industry

An inventory of all industrial waste inputs directly (via drains and pipelines) and indirectly (via groundwater) into metropolitan marine waters will be undertaken during the studies.

If nutrient inputs and toxic substances being released by industry need to be reduced then, short of relocation, there is only one option:

- *using better waste treatment technology with stricter pollution controls.*



Market gardens

Nutrients and pesticides used on market gardens find their way into the groundwater which, in turn, discharges into the marine environment.

If these inputs need to be reduced several options can be considered:

- *more efficient use of fertiliser and pesticides;*
- *alternative management techniques; and*
- *preventing market gardening in environmentally sensitive areas.*

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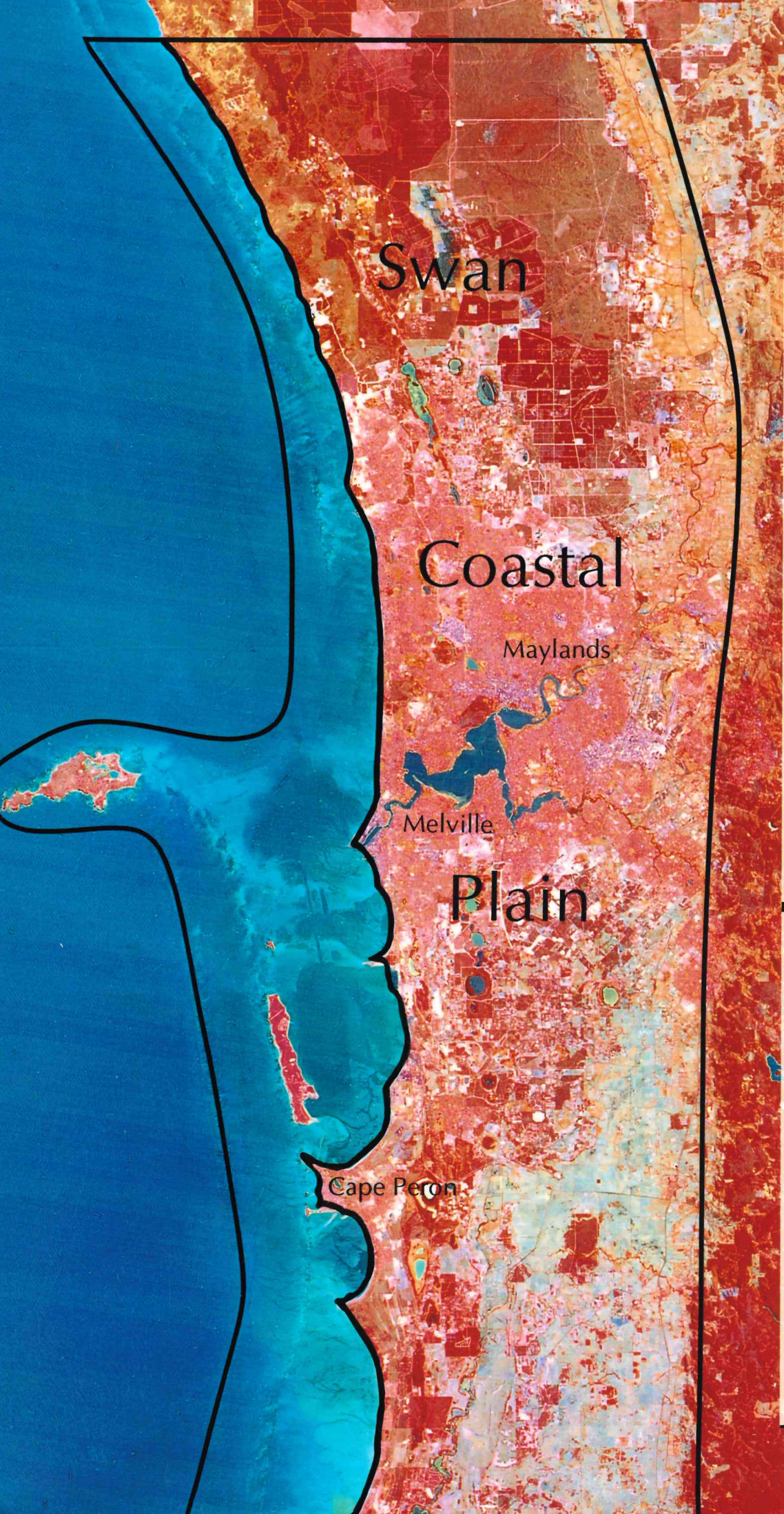
Western Australia — an environment worth protection



To some degree, all activities on the Swan Coastal Plain eventually affect the adjacent coastal waters. The waters adjacent to the area between Yanchep and Mandurah, where the concentration of activities is highest, is of greatest concern. For example, when industrial wastes from as far away as Maylands find their way into the Swan River, some will flow into our coastal waters 15 kilometres downstream. Wastewater produced in the suburb of Melville is treated and then discharged into the marine environment at Cape Peron, 30 kilometres away.

Similarly, rubbish tips, market gardens, septic tanks and household gardens leach nutrients and other contaminants, including heavy metals, micro-organisms and pesticides into the groundwater of which a small percentage currently reaches the sea. These inputs will inevitably increase over the coming decades.

The part of Perth's marine environment that is most valuable and most vulnerable to disturbance is the relatively shallow (less than 20 metres deep) area of reefs, lagoons and bays close to the offshore islands and mainland (see map). If this area is divided up among the 1.1 million people living in the Perth area, each person would 'own' the equivalent of one suburban building block or approximately 900 square metres of seabed. By the year 2021, when the population of Perth has doubled, our 'allotment' will have halved. How do the wastes from the day to day activities on your block of land affect 'your' block of seabed?