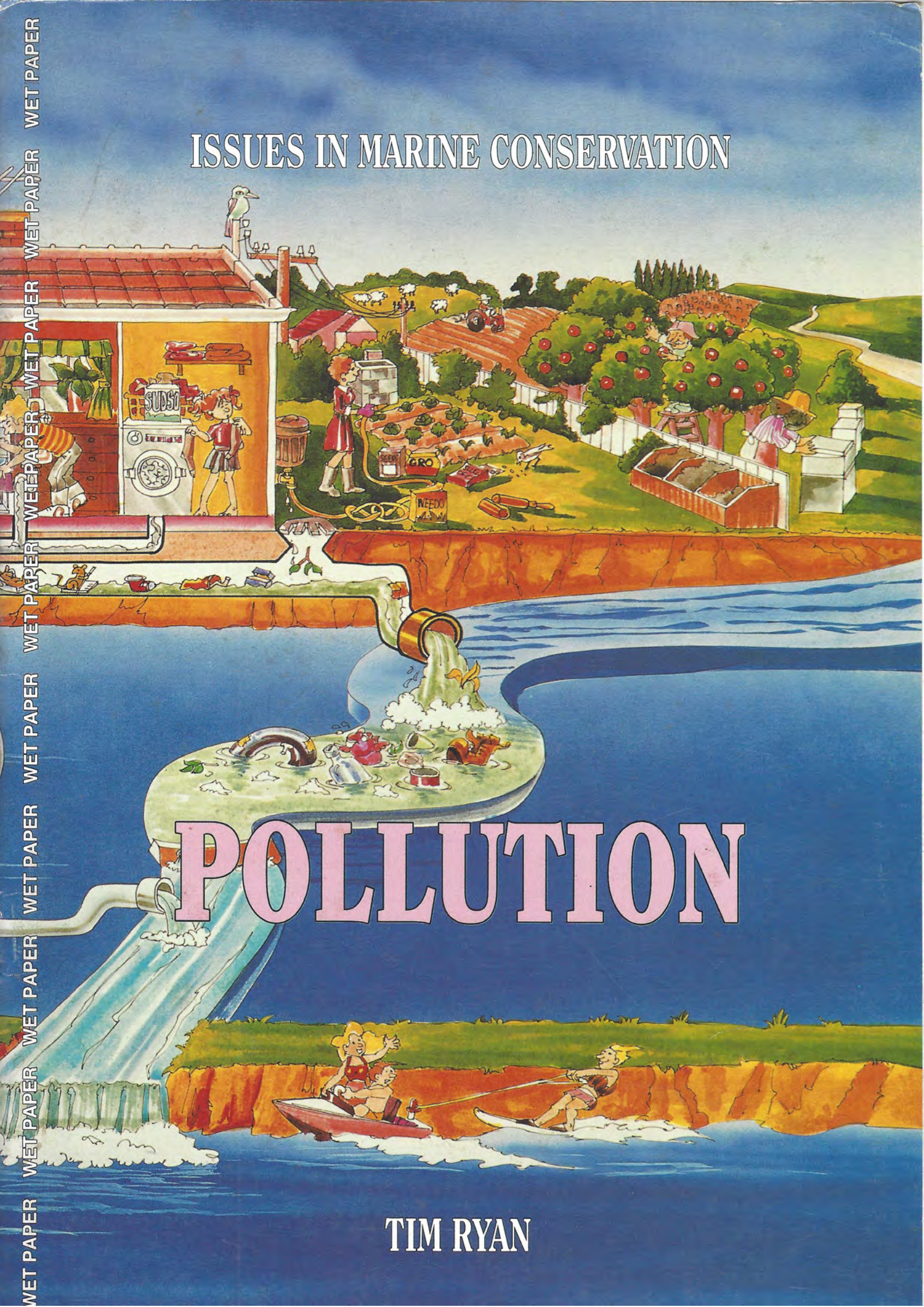


ISSUES IN MARINE CONSERVATION

POLLUTION

TIM RYAN



Copyright

© Tim Ryan 1990

All rights reserved

No part of this publication may be reproduced in any form without written permission of the publisher or publishers

Published by

Wet Paper®
14 Milbong Terrace
ASHMORE 4214 AUSTRALIA



Line illustrations and original cartoons

R. Michel

Computer illustrating and typesetting

R. Moffatt

Printing

Heaneys Printing Factory, 28 Industrial Ave, MOLENDINAR, 4214
First Printed July 1991
Reprinted November 1996

ISBN 1 86283 033 9

Cover

Courtesy New South Wales State Pollution Commission

ISSUES IN MARINE CONSERVATION

POLLUTION

TIM RYAN

B.Sc. App.Biol., Dip. Ed.

Marine Studies Subject Area Coordinator

Gympie State High School

Acknowledgements

The publishers wish to thank the following for their assistance in this publication. Greenpeace Australia, Queensland Beach Protection Authority, Department of Environment and Heritage, Australian Newspaper, Office of the Minister of Primary Industries, Department of Education, Waste Management Queensland, Swamp Productions, Gaffney International Licencing, Auspac Media, News Limited, The Sunday Mail, The Courier Mail, NSW State Pollution Control Commission, The Gympie Times, Toowoomba Chronicle, Merv Smith Graphics, New South Wales State Pollution Commission.

*The author wishes to thank his family for their tolerance, assistance and encouragement. Thanks also to Bob Moffatt for his assistance in the design and editing of the manuscript. In particular he would like to thank **Anne Ryan** for her assistance in the compilation of data, proofreading and editing.*

Photographic and Illustration credits

K. Loftus, Figures 1.12, 1.30, 1.32, 2.1. J. Ryan, Figures 1.30, 3.39. R. Michel, Figures 1.47, 2.3, 2.4, 2.6, 2.10, 2.16, 3.7, 3.12, 3.13, 3.14, 3.15, 3.19, 3.26, 3.29, 3.40, 3.41, 3.42, 3.44. R. Moffatt, Figures 1.35, 1.38, 2.5, 2.8, 2.9, 3.1, 3.2. Greenpeace, Figures 1.14, 1.15, 1.18, 1.19, 1.46, 2.7, 3.9., Toowoomba Chronicle P 62, , The Sunday Mail 1.22, J. Jack 1.36. New South Wales State Fisheries Board 1.13, Australian Water Resources Commission 1.23, Queensland Fish Management Authority 1.16, NSW State Pollution Control Commission 1.42, 1.43, Department of Environment and Heritage 1.9, Solarhart 3.38.

Unless otherwise acknowledged, all other photographs by the author.

While all care has been taken to trace the sources of additional material used in this book, the publishers tender their apologies for any accidental infringement where copyright has proven untraceable. They would be pleased to come to a suitable arrangement with the rightful owner in each case.

Contents

CHAPTER 1	BALANCE IN NATURE	...	...	...	5
	Food and Energy in the Ecosystem	...	...	6	
	Nutrient Cycles	...	...	8	
	Exploitation	...	...	13	
	New Competitors	...	...	22	
	Protected Species	...	...	27	
	Conservation of the Sea	...	...	27	
	Specific Conservation Issues	...	...	30	
	Reef Conservation	...	...	32	
	Tourism	...	...	33	
	Wetland Destruction	...	...	36	
	Urban and Agricultural Ecosystems	...	...	39	
	Student Activities	...	...	43	
CHAPTER 2	A WASTEFUL SOCIETY	...	...	...	47
	Pollution - Who causes it?	...	...	48	
	- Human and other Domestic Wastes	...	...	50	
	- Industry	...	...	52	
	- Agriculture	...	...	54	
	- Radioactive Waste	...	...	57	
	- Oil	...	...	58	
	- Mining Industry	...	...	59	
	- Construction Sites, Quarries and Roads	...	...	61	
	- Accidents	...	...	62	
	- Wars	...	...	63	
	- Natural	...	...	64	
	Student Activities	...	...	68	
CHAPTER 3	TURNING THE TIDE OF POLLUTION	...	...	...	73
	Assessing Water Quality	...	...	74	
	Biological Tests	...	...	74	
	Chemical and Physical Tests	...	...	75	
	Locating the Source and Cause of the Problem	...	...	78	
	Curing the Problem - Waste Disposal	...	...	78	
	Treatment	...	...	79	
	Dispersal	...	...	86	
	Reducing Wastes	...	...	91	
	Renewable and Non-renewable Resources	...	...	99	
	How can you help?	...	...	105	
	Student Activities	...	...	110	
INDEX	...	...	...	...	117

Introduction

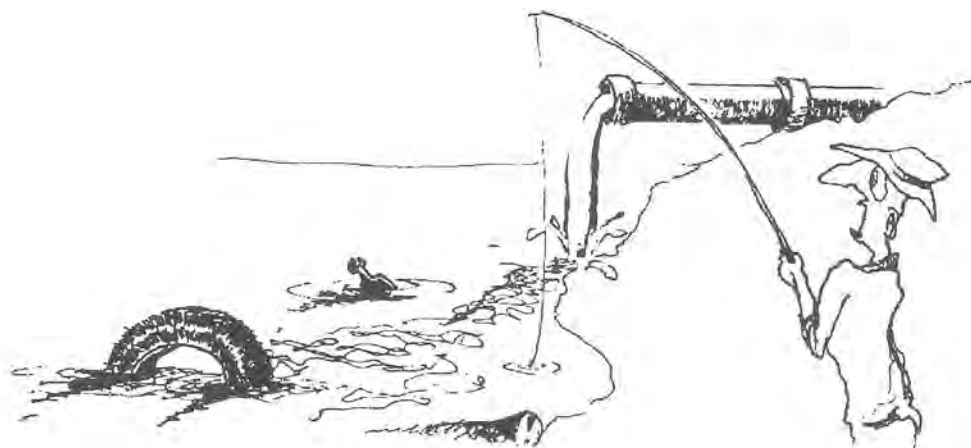
This book has been developed to heighten the awareness of the human impact on our environment. It is hoped that the need to conserve and preserve our resources is highlighted. The lay person, secondary school students and university students need to be conscious of basic information to become informed, conservationally minded citizens.

Australians rely on the sea for travel, for food, for minerals and energy, as well as being a source of pleasure. Many of us enjoy surfing, sailing, fishing, swimming and other recreational activities directly related to the sea. Structures such as the Great Barrier Reef and huge sand islands attract thousands of people each year and generate millions of dollars worth of business. If the sea is to continue to provide these needs we will have to maintain it in its present usable and wondrous form.

To embark on a conservation program we first of all need to know what we are going to conserve. We should know about the different types of plants and animals in the waters, how they are distributed and how they affect each other. No organism lives alone - each has its own place in a food chain, in the cycling of nutrients, and in relationships with other animals and plants. A major prerequisite for conservationists and environmental managers is to fully understand nature's complexities through painstaking research.

This book endeavours to illustrate the fragile nature of our seas and oceans and how humans can alter the delicate balance. It notes the effect and sources of the many forms of pollution from our wasteful society. Environmental issues continually make the headlines in news bulletins, in many cases giving evidence of new areas being polluted and reminding us of our responsibilities.

The book, as well as presenting a balanced view of the repercussions associated with the technology of modern society, suggests solutions to these dilemmas. Some of these solutions are already being implemented in some form, while others are in the developmental stage.



Chapter 1

Balance in Nature

Natural ecosystems are very complex and exist as a balanced system. The organisms that form part of the ecosystems have certain roles and functions in the system. There is a close relationship between these organisms and their habitat. Therefore, the animals and plants living in an area are usually studied in conjunction with their habitat. An **ecosystem** is defined as all the living and non-living things that interact together and how they recycle and exchange materials.

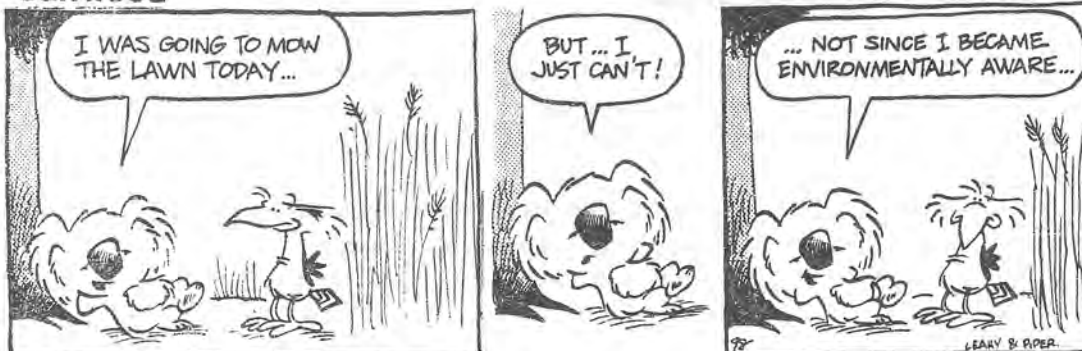
Most natural ecosystems have:

- (a) Many different producers.
- (b) Complex food webs.
- (c) Recycling of nutrients.
- (d) Physical, chemical and biological components.

The study of these ecosystems is termed **ecology**. This study is important because we obtain all our needs from the environment and need to understand the complexities of it in order to live with it harmoniously. Through the study of ecology we can better understand the relationships between living organisms and their non-living surroundings and gain an understanding that we cannot obtain all our needs without disturbing nature greatly.

No individual lives alone. Organisms live and interact with members of their own species and compete with, feed on, depend on, are eaten by and fight against themselves and other species. A **community** is defined as a group of independent organisms living in a common habitat or area. All communities are dynamic and constantly changing. The different communities found in nature are all inter-related and overlap with each other. For this reason, most of the natural communities have no defined boundaries as the animals co-exist together.

Saltwood





Some creeks are far from the safe fun places many of us played in as children.

Creeks are ecosystems, not tips

DEAD fish are found floating in a Kenmore waterhole, while at Jindalee, a creek is turned white by house paint for 100m.

These are just two recent examples from the water quality complaints file of the Department of Environment and Heritage.

Creeks are not sewers or stormwater drains, though they're often treated as such.

They are the beginning of our rivers and oceans, and the Australian Littoral Society recently released a book on the Brisbane River reminding us that a river is only as good as its catchment.

Healthy creeks are

This article was prepared by the Department of Environment.

wildlife corridors and living ecosystems.

Anyone who doubts that should see the busy underwater world created at Brisbane Forest Park's "Walk-about Creek" freshwater life display.

Urban living does require change to some creeks, for flood mitigation, roadworks and other reasons. Yet our many unmodified creeks are also under pressure.

Choked by weeds and litter and poisoned by careless use of garden pesticides, some creeks are far from the safe fun

places many of us played in as children.

Communities across Australia are working to reclaim their creeks. They are clearing weeds and replanting to stabilise banks, with the help of local councils and organisations such as Greening Australia.

You can help make your local creek healthy, by keeping in mind that gutters and stormwater drains wash into creeks and rivers. Wash your car on grass, not in the gutter or driveway, so detergent doesn't reach waterways.

Take care with pesti-

cides and fertilisers. Tiny amounts of pesticides can kill fish when leached into watercourses, and fertilisers make water plants grow to excess. Follow manufacturers' directions to avoid runoff, or choose natural alternatives.

Litter is a menace to watercourses. From street gutters it washes into creeks, causing unsightly pollution. From creeks litter may reach the ocean and choke sea creatures.

The department's environment division will investigate complaints about water quality in creeks. Ring (07) 227 6886 for Brisbane; elsewhere, see the local phone book's "government easy guide".

Fig 1.1: This article reproduced with permission of the Courier Mail 9/11/90 and the Department of Environment and Heritage.

FOOD AND ENERGY IN THE ECOSYSTEM

Food links all organisms together in an ecosystem. All living organisms need energy to survive. Food provides this energy for all animals. Although animals can exist for some periods of time without food, they cannot function indefinitely without a food source.

The **producers** of the ecosystem are the plants. These organisms take in simple chemical substances found in the environment and convert them into complex compounds. The process by which this is completed is called **photosynthesis**. Most plants have a special pigment called chlorophyll which absorbs solar energy from the sun. It is this energy that is used to convert the simple chemicals into complex organic substances. The energy is then stored in the chemical bonds of these complex organic substances. The sun is, therefore, the original source of energy for all living organisms. The producers are the original source of food material.

Only 1% - 2% of the energy that reaches earth from the sun is converted by producers into chemical energy.

The organisms which eat these producers are called **consumers**. These organisms take in the complex organic substances and convert them into simple chemical substances. This process is termed **respiration** and it supplies the energy needs of the consumer. As can be seen, the respiration process is the reverse of the photosynthesis process. Plants also carry out respiration as they cannot use the energy from the sun in its radiant form to provide the energy for normal life processes. A definition of life is that all living things carry out respiration.

Types of consumer organisms include:

- (a) *First order consumers* - The animals feed directly on the plants and are called **herbivores**.
- (b) *Second order consumers* - These animals feed on the first order consumers and are called **carnivores**.
- (c) *3rd, 4th and 5th order consumers* - These feed directly on the order below them. They get their energy indirectly from the producers.
- (d) *Decomposers* - These organisms break down the dead bodies of other organisms into simple compounds. Decomposers are important in the cycling of nutrients.

The sequence of organisms through which food passes in a community is called a **food chain**. Simple food chains or feeding relationships are very rare in nature as most animals have more than one type of plant or animal food in their diet. The feeding relationships become quite complex and involve a number of food chains all woven together. A **food web** shows the network of feeding relationships and gives an idea of the complex inter-relationships that exist in a community.

Animals depend on each other for survival and if anything was to happen to one species shown in the food web, all other animals in this network would be affected. It can be seen that all animals in nature have a role to play. If man starts to manipulate the numbers of certain species e.g. killing off certain pests such as mosquitoes, major changes of animal numbers in the community may occur. Fish numbers may decrease, while plant numbers may increase.

Animals only use approximately one tenth of their food intake for body building. The rest of the food is used by the animals either to keep warm, to keep moving, to stay alive, or is undigested.

Scientists use an **energy pyramid** to demonstrate this energy flow through a system. Energy cannot be recycled and flows in only one direction. Food pyramids differ from food chains in that they show the relative numbers of the organisms in the food chain.

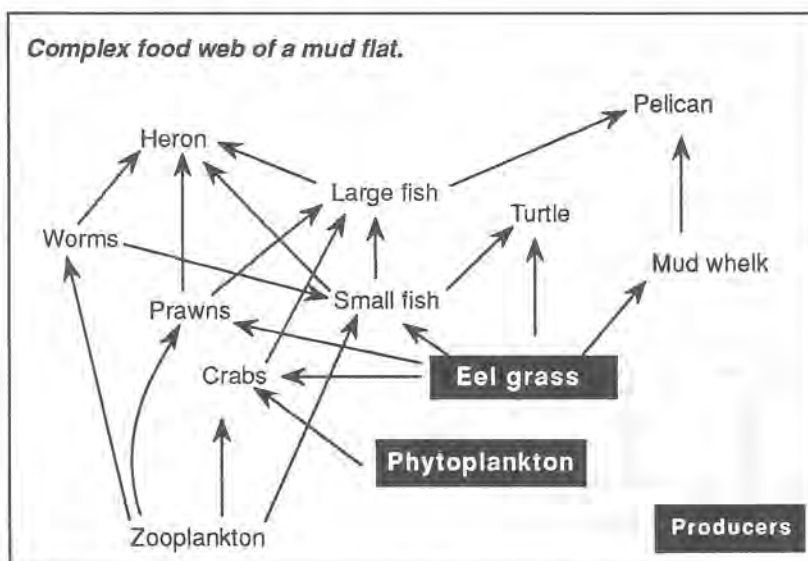


Fig 1.2: A food web shows the network of feeding relationships and gives an idea of the complex inter-relationships that exist in a community.

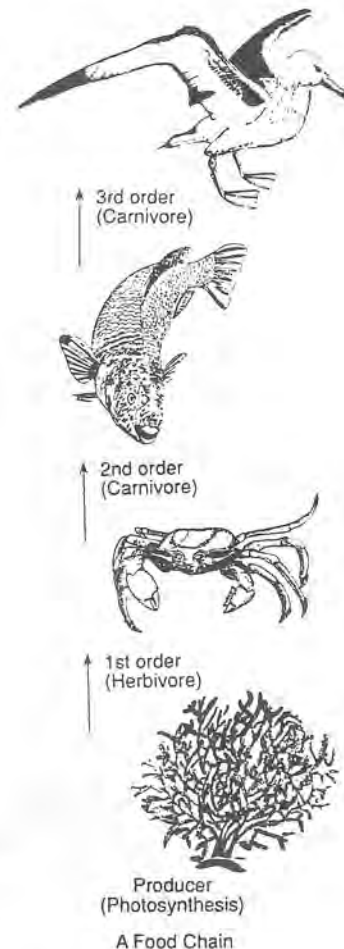


Fig 1.3: The sequence of organisms through which food passes in a community is called a **food chain**.

Many chemicals in the environment are said to be cumulative. **Cumulative chemicals** build up within the body and in most cases the body cannot rid itself of these chemicals. When a consumer organism eats an organism that contains one of these cumulative chemicals, the amount of chemical found in the prey can be absorbed.

If it then eats another organism containing the same chemical, the chemical is again absorbed and the amount found in the predator doubles. The process can repeat itself a number of times resulting in high levels of sometimes dangerous chemicals in higher order consumers. This process is known as **bioaccumulation**.

DIELDRIN FOUND IN WHALE

SYDNEY: The autopsy completed on a young sperm whale found beached north of Sydney has shown the body tissues contained high concentrations of heavy metals and the pesticide dieldrin.

Dieldrin is a highly toxic chemical that accumulates in the body fat and it is believed that the baby whale would have acquired the chemical

through its mother's milk.

Heavy metals that were also found in the baby included mercury, lead and arsenic.

The large sperm whales feed on the giant squids of the deep oceans indicating that dieldrin has found its way from our fields and paddocks to the depths of the Pacific Ocean.

Questions:

1. How would it be possible for the chemical Dieldrin to find its way from its target area on land to the depths of the oceans?
2. What is meant by bioaccumulation?
3. Describe procedures which need to be introduced to overcome the environmental problems caused by such chemicals.
4. What alternative measures could farmers take to overcome crop pests?

NUTRIENT CYCLES

All feeding relationships discussed so far show a one way flow of energy through the system called nature. This energy is not recycled. The plants may start the system using radiant energy from the sun, but would not survive without the nutrients that are made available from the nutrient cycles. Unlike energy the elements such as carbon, nitrogen, oxygen and sulphur are used and reused by plants and animals.

Most of the elements have their origin in the rocks which are broken down by nature to release their elements. Violent volcanic eruptions also release elements. Large amounts of these elements such as nitrogen and oxygen are found in the atmosphere.

Water cycle

The **water cycle** is also known as the hydrologic cycle. In this cycle water passes from the atmosphere to the earth and back again to the atmosphere. The oceans lose water by the process of **evaporation**. The sun provides the energy to convert the water molecules from a liquid state to a vapour. These water molecules then form clouds where they are carried around the earth by air currents. Eventually the air is cooled and the vapour turns back into water droplets and falls as rain. This process is known as **precipitation**. Only a minimal proportion of the earth's water is contained in living matter although it is essential for life. All the water that falls on the land eventually returns to the ocean via a system of streams, rivers and underground waterways. The water cycle is a giant distillation process.

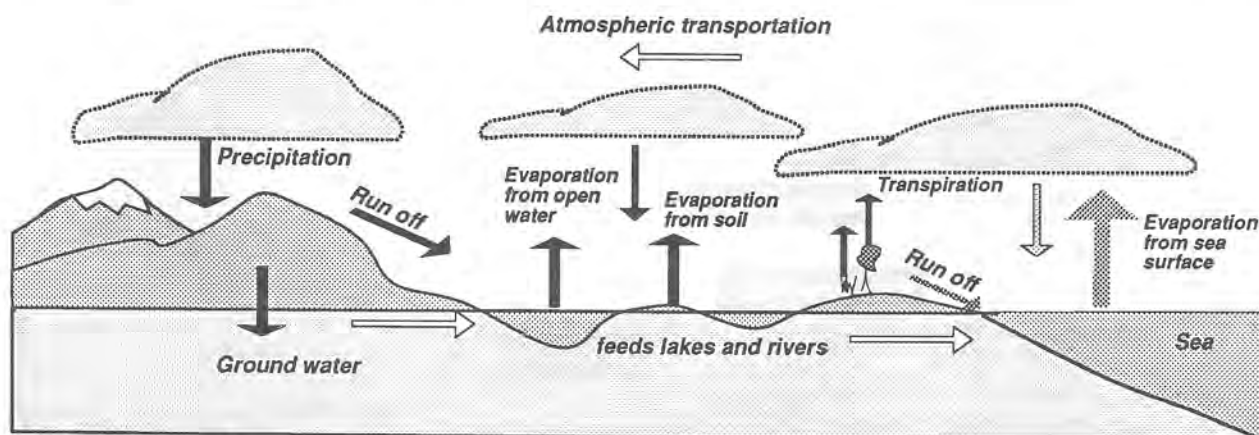


Fig 1.4: The water cycle.

Nitrogen cycle

Living organisms require nitrogen to build proteins. Life cannot exist without nitrogen or its products. There is ample nitrogen for all organisms in the atmosphere (79% of the air is nitrogen gas), but most organisms cannot absorb nitrogen in this form. The nitrogen is taken up by plants in the form of nitrates (nitrogen compounds). The nitrogen is then passed along the food chain.

Nitrogen is converted into nitrates in one of three ways.

- Biological fixation.** Some bacteria are able to convert atmospheric nitrogen gas into nitrates. These are called nitrogen-fixing bacteria. These bacteria can be found living in soil, or floating in water, while others live in the nodules on the roots of plants such as beans and clover. Blue green algae found in the oceans carry out this process.
- Atmospheric fixation.** The high temperatures generated in lightning flashes combine atmospheric nitrogen gas with oxygen gas. The compounds produced are dissolved in the rain and washed into the soil and waterways.
- Industrial fixation.** Artificial nitrogen fertilizers are manufactured by factories. These factories combine nitrogen and hydrogen gases at high temperatures and pressures.

These nitrates are absorbed by the plants and phytoplankton of the oceans and converted into protein compounds. These proteins are then consumed by fish and other marine animals. The nitrates are eventually recycled by the decomposing bacteria. The bacteria that convert the dead bodies and the wastes of the animals into nitrates are called **nitrifying bacteria**.

Denitrifying bacteria convert these nitrates into nitrogen and oxygen gases, thus completing the cycle.

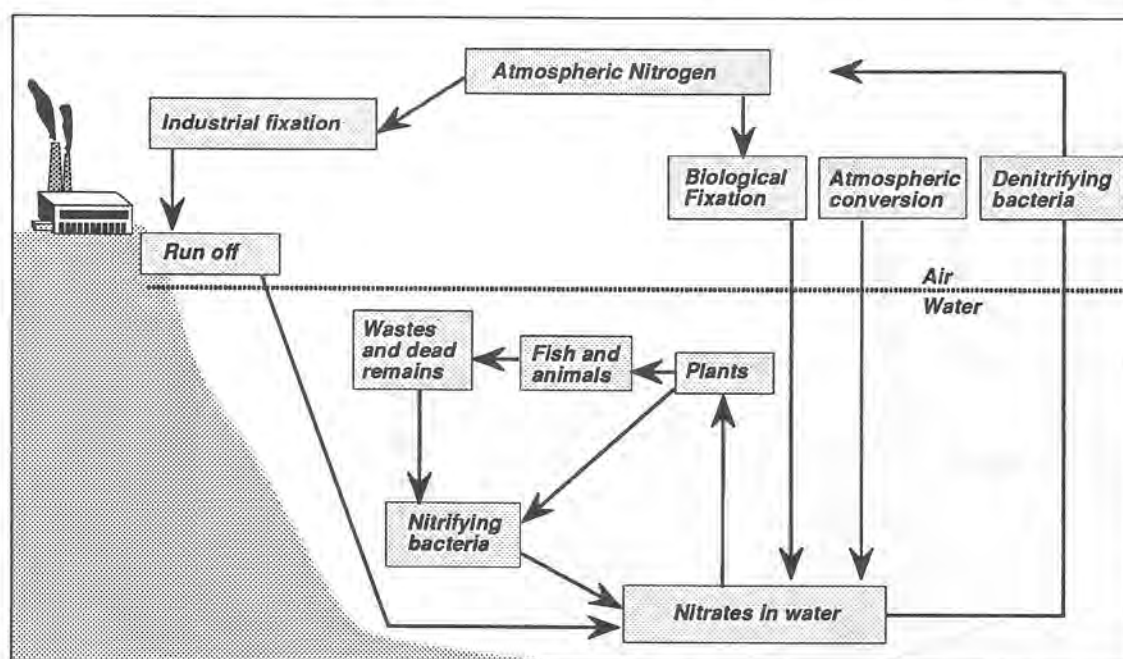


Fig 1.5: The nitrogen cycle.

Carbon cycle

Carbon is another element that is recycled. Carbon is one of the major components of all living bodies and is essential for life. The original source of carbon is the carbon dioxide gas found in the atmosphere. This carbon is removed from the air by green plants and phytoplankton while carrying out photosynthesis. Once the carbon is in the form of carbohydrates in the plants it can then be passed along the food chain.

Oceanographers estimate that phytoplankton produce 20 - 30 million tonnes of carbon each year forming 85% of the carbon found in the ocean. Marine organisms complete over one and a half times the photosynthesis of land plants.

Photosynthesis equation

Sunlight + water + carbon dioxide → carbohydrates + oxygen

The carbon dioxide may dissolve in rain, entering the water in this method. This dissolved carbon dioxide forms bicarbonate ions which can combine with calcium to form calcium carbonate. Many marine animals especially the ones with shells absorb carbon in this form. Large amounts of carbon containing compounds are also brought into the oceans as organic wastes which are washed down by the rivers.

Carbon is returned to the air by the process of respiration. All living organisms - plants, animals and decomposers - carry out respiration.

Respiration equation

Carbohydrate + oxygen → energy + water + carbon dioxide

Much of the dead and decaying organic matter of the sea is not decomposed and is buried in the sediments. Eventually these remains may form fossil fuels which man can recover and burn. This again releases carbon dioxide into the atmosphere.

The burning of fossil fuels by industry and in transport vehicles converts the carbon in the fossil fuel into carbon dioxide.

Combustion

C + O₂ → CO₂ (Combustion)

Water contains more than 60 times the amount of carbon dioxide than is found in air.

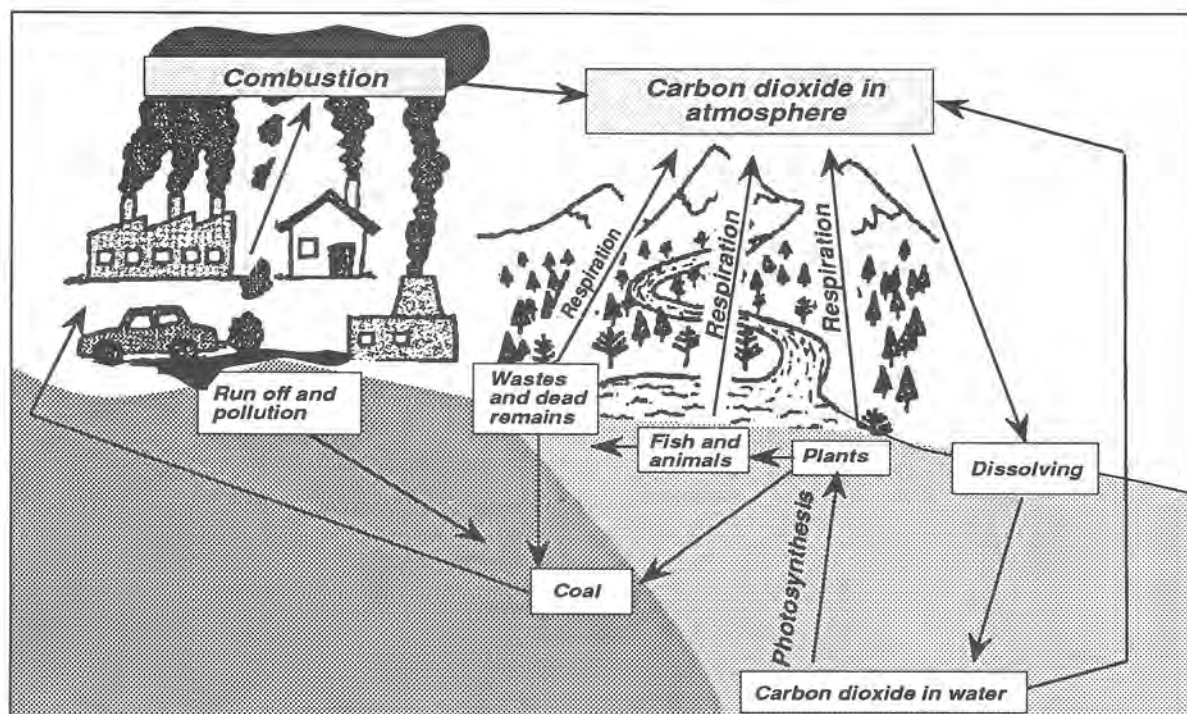


Fig 1.6: The carbon cycle (part illustration courtesy Department of Environment and Heritage).

The solid or liquid fuel that is burnt is all converted into gaseous wastes. If 1.2 tonnes of carbon is burnt, it will produce 4.4 tonnes of carbon dioxide gas. The volume of this gas would be hard to imagine. It can be calculated knowing the fact that 44 gms of carbon dioxide occupy a volume of approximately 25 litres at room conditions. We then have to consider the present consumption of fossil fuels. We find there are over 500 million tonnes of carbon dioxide being added to the atmosphere each year. The trees that convert this carbon dioxide back into oxygen are also being removed at a disturbing rate. The end result is a build up of carbon dioxide in the atmosphere.

This build up has a blanketing effect on the earth. The carbon dioxide and other exhaust gases allow the heat from the sun in, but reduce the release of this heat. The heat is absorbed and/or reflected back to the earth, allowing less of the heat to escape. The gas envelope acts like a glass greenhouse and will increase the earth's temperature and cause many changes. This is known as the **greenhouse effect**.

Weather patterns may change forever with changing rainfall patterns and more cyclones in the tropical areas. The weather patterns will tend to move south with Sydney experiencing Brisbane's weather. The summers will be wetter and the winters drier. The sea level is also expected to rise by at least 1.4 metres in the next 30 to 50 years. This will cause the inundation of many natural ecosystems with some Pacific islands being almost entirely destroyed.

Oxygen cycle

Oxygen is one of the most abundant elements on earth. It can be found in the form of oxygen gas which makes up one-fifth of the atmosphere, in H_2O and CO_2 . Oxygen is very reactive and can be found chemically combined with a number of other elements. Very little free oxygen is found in water as compared with air. The oxygen cycle is quite simple.

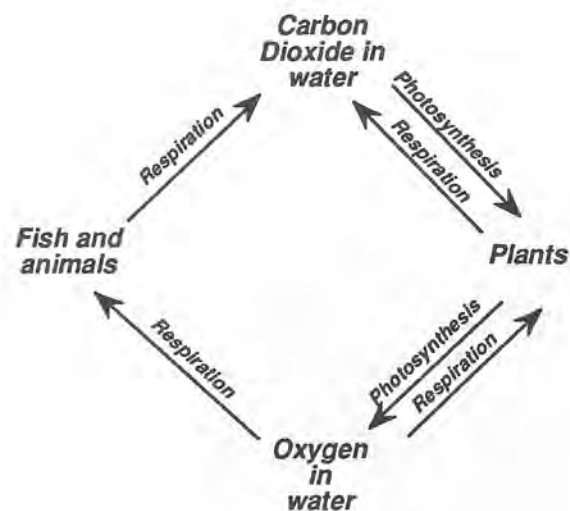


Fig 1.7: The oxygen cycle.

Sulphur cycle

Oceans are a rich source of sulphur with large amounts being found in the sediments at the bottom of the oceans. Sulphur is needed by most organisms to build proteins.

The plants and phytoplankton take in the sulphur in the form of sulphate ions (SO_4^{2-}). This sulphur is then passed along the food chain. The dead organisms and wastes are finally converted by bacteria back to the sulphate ions. Some anaerobic bacteria convert the proteins in hydrogen sulphide, a poisonous smelly pollutant.

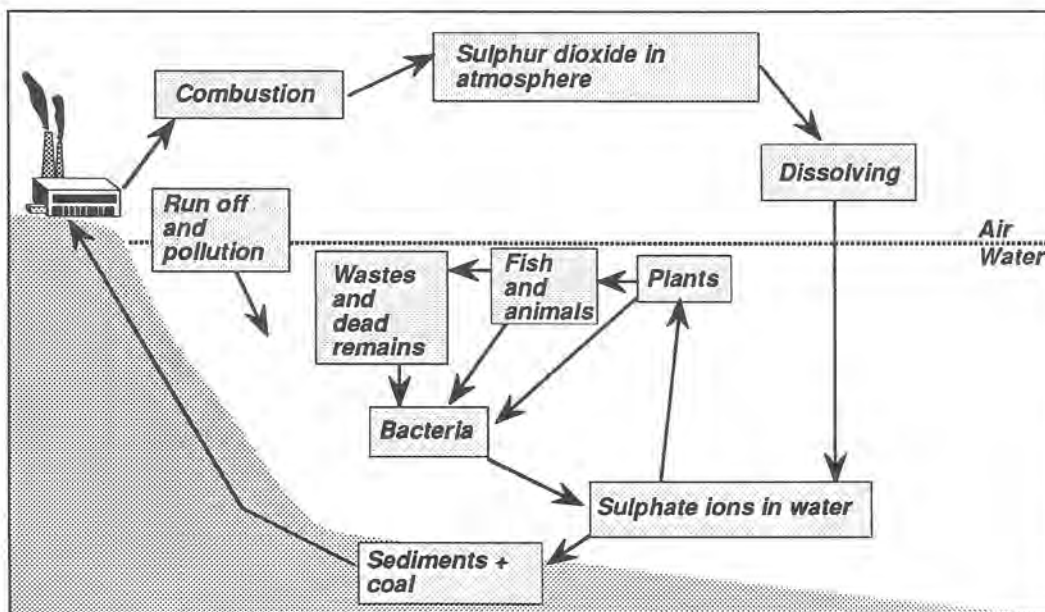


Fig 1.8: The sulphur cycle.

CHAPTER 1

Sulphur is building up in the atmosphere because of the burning of fossil fuels containing sulphur. The burning of sulphur converts it into sulphur dioxide (SO_2) which is a particular problem. This gas combines with rain to form sulphuric acid with the new mixture now called “acid rain”.

This acid rain can severely damage buildings, unprotected metals and cause the acidity of lakes and waterways to increase. This acidic water can dissolve many metal elements and these will be consumed in the drinking of this water. The sulphur cycle is not a balanced cycle.

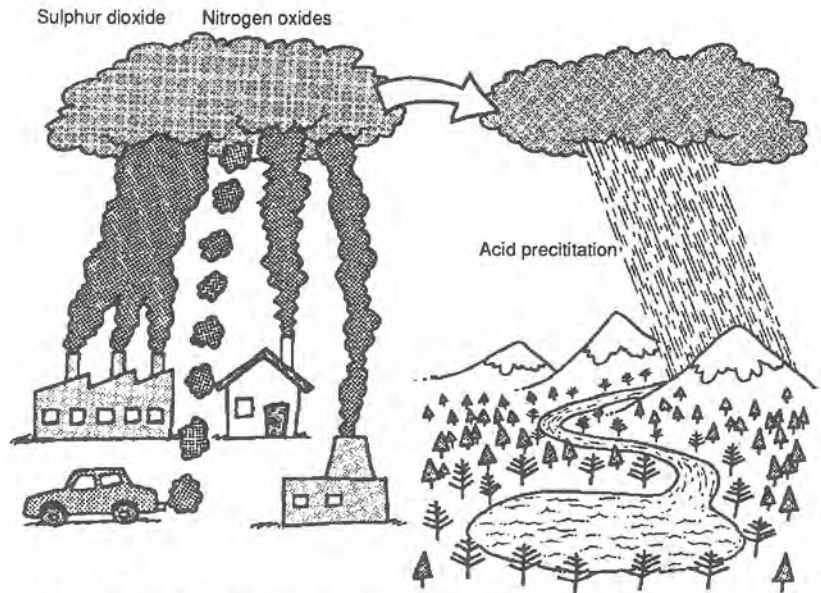


Fig 1.9: Illustration courtesy Department of Environment and Heritage.



Questions:

1. What effect do you think the increased acidity of the water may have on plants and animals living in the water?
2. Why is it important to continually monitor sediments on the ocean floor?

Fig 1.10: Collection of bottom samples for chemical analysis.

POPULATION SIZE

There is a natural balance of numbers of consumers and producers in a natural ecosystem. These numbers may fluctuate during a year, but these fluctuations are mostly due to seasonal variations such as the availability of water, light and heat. The term used to describe this natural balance is **dynamic equilibrium**. The word dynamic means that changes are taking place while the word equilibrium suggests that there is a balance. This suggests that within a natural community the numbers of different species are similar from year to year.

When talking about the numbers of organisms it is convenient to use the term **population**. A population refers to the number of a particular species living in a particular place at a particular time. Scientists studying populations of different species in an ecosystem often make graphs of their results. These graphs show the fluctuations in the population sizes.

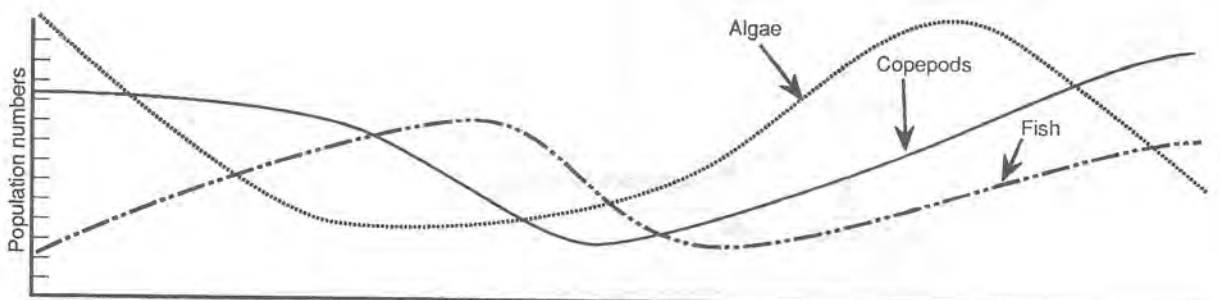


Fig 1.11: Graph of population number of different species versus time.

The human population is not consistent with the population trends found in nature. The human population is increasing at an alarming rate. The increase in technology has led to a decrease in the death rate. Agricultural and medical advances have allowed for more people to live longer. A population only remains constant if the birth rate equals the death rate. The birth rate has remained fairly constant, but the death rate has decreased resulting in a world population increase of approximately 2% each year. This value seems fairly low, but with the world population at approximately 5 billion people in 1990, it represents an increase of 100 million people each year. That's over 6 times Australia's population!



Fig 1.12: Townsville in 1989, large city developed close to the sea.

For most of us living in Australia it is hard to believe that the earth will ever become overcrowded. A visit to the major cities gives an idea of what life might be like in the future. The huge future population will place enormous pressures on our food producing capacities and our water resources. Family planning and population policies are critical issues the future generations have to face.

Some countries such as China and India have already implemented policies to combat this problem. Suggestions of placing contraceptives in water supplies and enforced infertility such as castration after the birth of the first child seem drastic! How would you react if these measures were implemented on our society?

EXPLOITATION

Overfishing

The oceans were once thought to have a limitless supply of fish, whales and other marine creatures. It has been shown that the blind aggressive slaughter of marine creatures by some commercial operations has greatly reduced the numbers of some species. Some countries which highly prize seafood have fished out their local fisheries and many are now exploiting international fishing grounds. Some are even fishing illegally in other countries' territorial waters. They are out to harvest as much of the product as possible and show little concern for the future of the fisheries.

Commercial net fishing has been carried out for centuries, but only recently has the improved technology allowed commercial fishermen to harvest the seas more effectively. This new technology includes the use of new materials from which the nets are made and new methods of netting. The trawlers are also becoming larger and more sophisticated and use recent technological developments to locate their catch. A good example of new fishing methods is drift net fishing.

New technology includes:-

- Underwater sonar to locate fish.
- Satellite navigation.
- Use of satellite photos to locate fish.
- Use of spotter aircraft.
- Use of larger processing vessels (allows vessels to stay at sea longer).
- Use of underwater cameras for surveying and monitoring.
- Use of 'flume tanks' or water filled tanks to improve performance of ships hulls and fishing gear.

CHAPTER 1

Drift nets or **drift gill nets** are made of fine plastic and float from the surface to a depth of 15 metres. These nets trap or entangle any fish or marine creatures that swim into them. Fish, dolphins, sea birds, seals, or any other creatures become entangled and die a slow death by drowning.

These nets are being used by Asian countries such as Japan, Taiwan and Korea. People from most western countries are trying to get a world-wide ban on the use of this fishing method. The Asian fleets are thought to number approximately 1,500 vessels, with each vessel operating 50 kms of net. This gives a massive coverage of the ocean and, according to Greenpeace sources, "during the first commercial season the Asian drift netters working in international waters in the Pacific caught between 40,000 and 60,000 tonnes of albacore tuna. That figure represents 4 - 6 times the annual tonnage ever taken before and fishery scientists are very worried for the future of the tuna stock." It is believed that the tuna fishery could collapse within 2 - 5 years.

Another problem associated with this form of fishing is the large loss of nets or sections of nets. These nets which could stretch from Brisbane outskirts to the Gold Coast, are often damaged by passing ships. The lost sections of net are non-biodegradable and will carry on their indiscriminate killing as they float across the oceans. Greenpeace estimates that 1,000 kms of these floating "ghost nets" are lost each year.

These nets are also indiscriminately killing thousands of dolphins, sea turtles, seals and sea birds. Even small whales do not escape this tangled web. These nets may also affect the migratory habits of whales and turtles. Greenpeace sources estimate that 800,000 sea birds are killed annually by these nets.

Commercial trawling is considered by many to be another destructive form of netting. **Trawling** involves the dragging of nets along the sea bed which can destroy the eel grass and other plant life found on the sea floor. These are the areas of food production of the sea and the destruction of the sea floor will decrease the animal life found there. The trawler fishermen argue that the trawlers are like the farmers of the sea and plough up the sea bed which in the long run improves the fishery. They argue that areas once heavily exploited have become rejuvenated and in some cases are producing better catches than in the past. The use of **purse-seine nets** are also having an effect on the populations of marine animals. These nets are a very effective way of catching surface fish such as tuna, and the world catches are decreasing because of overfishing by this method.

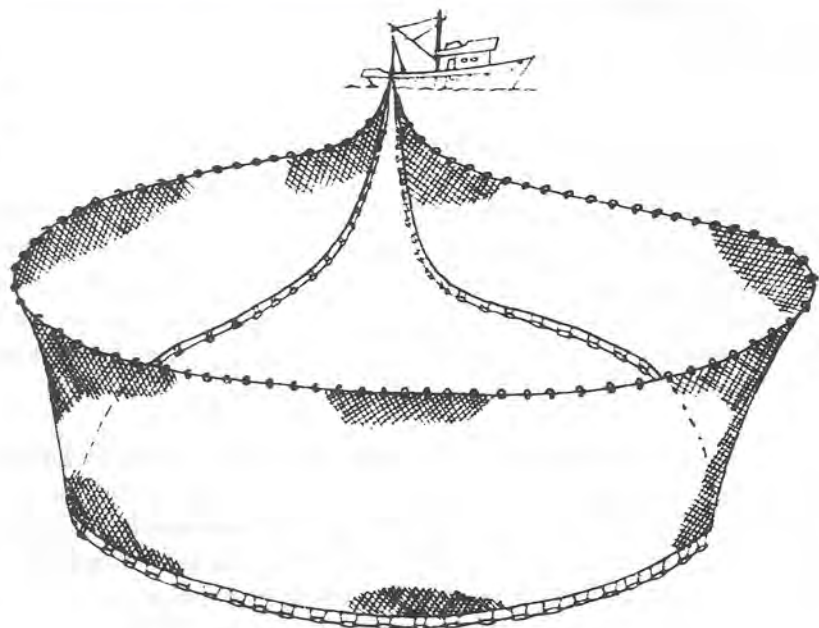


Fig 1.13: Some fishing methods. Courtesy N.S.W. State Fisheries Branch.

PURSE SEINING

They are also killing large numbers of dolphins because of their association with schools of tuna. The tuna are often found swimming under herds of dolphins and some Asian net fishermen encircle the herds of dolphin with speed boats laying purse-seine nets. The nets are then drawn closed at the bottom and the tuna and dolphin are hauled onto the trawler. Greenpeace sources estimate that in 1986/87, 250 000 dolphins were killed by this fishing method in the Pacific Ocean alone.



Fig 1.14: Dolphins caught in purse-seine nets. Photo courtesy of Greenpeace.

The management of our resource is a difficult task. In 1979 the Australian Government proclaimed a 200 nautical mile **Australian fishing zone**. This is an enormous area when you consider Australia has a coastline of over 39 000 klms. The area of this fishing zone has been estimated at 12 million square kilometres. Thus each adult in Australia would be responsible for an area of one kilometre by one kilometre off the coast.

The fishing area of the estuaries, rivers and other waterways would also be added to their responsibility. Our fishing area has a huge bounty and the temptation for foreign fishermen to fish this area may be greater than the risk of being caught. The penalties imposed by the Australian Government do not seem to deter would-be poachers. The foreign fishermen have often fished out their own areas and need to seek new fishing grounds to remain in their chosen occupation.

The Queensland fisheries are under the management of the Queensland Fish Management Authority (QFMA) in conjunction with the Department of Primary Industries (DPI). Other Australian states have similar fishing management authorities. Do you know who manages fishing in your state?

The aims of the Queensland Fish Management Authority are to:

- (a) *Maintain or increase present numbers of fish and other marine creatures.*
- (b) *Protect and conserve marine habitats.*
- (c) *Complete research so that we have a better understanding of the fisheries.*
- (d) *Develop aquaculture ventures.*
- (e) *Regulate the sale and marketing of fish.*

40% of fish killed by amateur fishermen are undersized.

Research the fishing laws to find out which areas have been closed to fishing in your region and which species have closed seasons.

Driftnets, a relatively new fishing technology described as "the wall of death", now threaten the high seas with ecological disaster. Each year, driftnet fleets operating throughout the Pacific entangle and drown tens of thousands of marine animals and birds.

1. DRIFTNETS

High seas driftnets are large-scale monofilament plastic gillnets deployed in the open ocean. A standard drift gillnet is a panel of strong plastic webbing suspended vertically in the water by floats attached at the top of the panel and weights attached at the bottom. A single driftnet vessel deploys up to 38 nautical miles (60 kms) of driftnet to a depth of 15 metres below the surface in a single setting. The high seas driftnet has been appropriately nicknamed the "wall of death" because it indiscriminately catches and kills virtually every living creature, from entire schools of tuna to dolphins and small whales, which swim into it. The nets are so sheer that they cannot be seen by diving birds or detected by dolphin sonar. Marine creatures in search of food and lured by fish already caught in the nets, swim or drive into the plastic web where they become entangled and drown.

High seas driftnet fisheries are taking a dangerous toll on marine resources throughout the Pacific. The large driftnet fleets of Japan, Taiwan and the Republic of Korea are slaughtering tens of thousands of marine animals (such as seals and dolphins) and hundreds of thousands of seabirds during fishing operations annually. Driftnets are also dangerously depleting fisheries resources — including salmon species of North American origin, and tuna species which the fragile economies of South Pacific island nations depend on for survival. If ocean wildlife are to be preserved and fish stocks kept at sustainable levels, this practice of "stripmining" the seas must be banned worldwide.

UN SOUND FISHING TECHNOLOGY

Using driftnets makes sound, ecological management of fisheries resources impossible. Dur-

ing the fishing season in the North Pacific, the 1,000 vessel Asian fleet sets more than 20,000 nautical miles (32,000 kms) of net each day — more than one million miles (1.6 million kms) each year. In the South Pacific, as many as 160 vessels set over 5,600 nautical miles (9,000 kms) of driftnet each night.

In the North Pacific, there are three driftnet fisheries operating. In the north, Japan operates over 200 salmon fishing ships. In the central North Pacific, Japan and Taiwan operate at least 600 driftnet vessels targeting billfish, primarily marlin and sailfish. Also in the North Pacific, the 700 squid driftnet ships of Japan, Taiwan and the Republic of Korea use nets up to 30 nautical miles (48kms) long.

In the South Pacific, Taiwan used 130 driftnet vessels during the 1988/89 season, while Japan had 30 ships and South Korea two. They target albacore tuna, but significant by-catches include skipjack tuna, southern bluefin tuna, swordfish and marlin. The South Pacific driftnetters have been fishing in international waters in the Tasman Sea and off the east side of New Zealand between latitudes 38 and 41 degrees south.

In July 1990, Japan suspended its driftnetting operations in the South Pacific in response to Greenpeace and international pressure, including a UN Resolution calling for a ban on driftnets.

Driftnetting is a highly wasteful fishing technology. For example, as much as 40% of the catch in the South Pacific tuna fishery falls out of the net while it is being hauled back into the boat. Many of these lost fish eventually die, or are caught later by longline or troll fisheries; however, since they are often badly net scarred, these fish are unmarketable.

Unfortunately, we may never know the real impact that the driftnet fleets are having on the Pacific marine ecosystem until it is too late. The North Pacific salmon driftnet fishery is the only one regulated by an international fisheries convention. The remaining fisheries for squid and billfish in the North Pacific, and the South Pacific tuna driftnet fishery have been totally unregulated. Japan, Taiwan and Korea refuse to allow independent observers onto most of their ships which operate outside territorial waters and continue to reject requests to begin such monitoring programs.

DEATH TRAP FOR SEABIRDS

When seabirds dive into driftnets for fish, their feet or wings become entangled and they often drown. The North Pacific driftnet fisheries kill more than 800,000 seabirds each year. This figure does not include dead birds which drop out of the

Ocean Ecology

nets before retrieval by the fishing vessel. Because many of the nets of the Japanese mothership salmon fishery have been set near the Aleutian Islands puffin, murre and auklet, nesting colonies, the bird populations may well be declining. This driftnet fishery also kills a large number of short-tailed shearwaters which originate in the Southern Hemisphere. Information on the extent of seabird deaths in the South Pacific driftnet fishery is currently unavailable.



Greenpeace prevents setting of a driftnet.

Driftnets



Greenpeace crew members find some of the hundreds of thousands of seabirds which die in driftnets each year.

GREENPEACE

Questions on the Greenpeace article opposite:

1. What is the very apt nickname given to the driftnet method of fishing?
2. Describe the driftnet method of fishing.
3. Which countries are using this method of fishing?
4. Why are birds and mammals such as dolphins not able to detect the nets?
5. How many Asian vessels are thought to be fishing the North Pacific and how many kilometres of nets are they thought to be setting each day?
6. Give reasons why Japan suspended driftnet fishing in the South Pacific in 1990. Are there any other countries presently driftnet fishing in this region?
7. Explain why driftnet fishing is a wasteful technology.
8. How do you believe conservationists may be able to stop this type of fishing? Why would the banning of this type of fishing be hard to enforce?
9. Comment on the saying "Commercial fishing is a necessary evil".

Commercial fishing

The local commercial fisherman is seen in some quarters as essentially a farmer of the sea. Most of these fishermen understand how overfishing or pollution of the environment can seriously affect their catches and future income. Many have become environmentally conscious. Some commercial operators, however, are still exploiting fragile environments and are running the risk of destroying certain fisheries. To overcome this, **Fish Management Authorities** set management guidelines to control the industry.

Examples of this can be found in the Queensland Fish Management Authority guidelines. These steps include:

- * *Freezing the number of commercial fishing licences to that number which existed in 1984 and not issuing any new licences. This will restrict the number and type of commercial fishermen.*
- * *Introducing new training schemes to better educate the commercial fisherman.*
- * *Closing some areas to commercial fishing and enforcing closed seasons on certain types of fisheries.*
- * *Restricting the mesh size, size of nets and other fishing gear used in some areas.*

The commercial fishing industry employs over 8,000 people and is one of the major primary industries established in Queensland. It is very important to the Queensland economy. Large volumes of seafood are processed and marketed. There are over 95 licensed processing plants in Queensland which produce seafood for the local and export markets. Commercial fishery catches include prawns, scallops, fish and bay lobsters. The export market takes most of the prawn and scallop catch. Commercial fishermen are required to sell their catch through licensed processors and wholesalers and the Queensland Fish Marketing Board.

Recreational fishing

Recreational fishing is one of the major activities conducted by Queenslanders in their spare time. It has been estimated that some 40% of Queensland families fish our waters some time during the year. It has become an important industry, estimated to be worth \$500 million each year. Most of these anglers are finding their catches are decreasing even though fishing methods and equipment have improved. Most believe this is a result of overfishing and destruction of some areas of the marine environment.

The QFMA has undertaken to protect this precious resource. One method has been the implementation of bag limits on certain species of fish, crabs and molluscs.

Species of Fish or Marine Product	Maximum number or quantity which may be taken, or had in possession	Areas applicable in Queensland	Period of time applicable
Barramundi	5 fish taken or had in possession at any time	All Queensland	All year round, except during any closed season of total protection
Spanner or Frog Crab	20 taken or had in possession at any time	All Queensland	All year round, except during any closed season of total protection
Australian Bass	2 fish taken or had in possession at any time	All Queensland	All year round
Any Molluscs (excluding oysters)	50 of any species to be taken or had in possession at any time	All Queensland	All year round
Mud Crabs	10 to be taken or had in possession at any time	All Queensland	All year round

Fig 1.16: An example of a bag limit. Table courtesy Queensland Fish Management Authority.

CHAPTER 1

It has also imposed closed seasons on certain fisheries. The QFMA has also closed some areas to all forms of fishing in an effort to better manage our fisheries.

These areas include:

- * *Certain areas within Marine Parks (more information on these restricted areas can be obtained from maps supplied by the Great Barrier Reef Marine Park Authority).*
- * *Areas designated fish sanctuaries by the DPI.*
- * *Waters within 400 metres of many weirs on Queensland rivers. This closed area lies 400 metres upstream and 400 metres downstream from these weirs. In the cases of dams, the distances are 400 metres downstream and 200 metres upstream from the dam wall.*
- * *Certain waters around Hammond Island in the Torres Strait.*
- * *Certain waters of various rivers which are important to some fish species.*

CLOSED SEASONS

SPECIES	AREAS APPLICABLE	PERIODS OF TIME APPLICABLE
Barramundi	All Queensland	Midday 1 Nov - Midday 1 Feb each year
Spanner or Frog crab	All Queensland	Midday 20 Nov - Midday 20 Dec each year
All species	On Fraser Island from a point 400m north of Waddy Point to 400 m south of Indian Head and 400 m seaward from this area	Midday 1 Sept - Midday 30 Sept each year

Question:

Are there any areas in your region that are fish sanctuaries? Are there any dams or weirs in your region where fishing is prohibited?

A class survey:

Request members of your class to answer the following questions:-

1. Have you gone fishing during the past 12 months?
2. Did you know the regulations before studying this section?
3. Do you agree with the introduction of :-
(a) Bag limits?
(b) Size limits?
(c) Closed seasons?
4. Can fish be sold to the public by recreational fishermen?
5. Do you eat fish bought from the fish shop?
6. Do you eat tinned seafood?
7. How many times a week do you eat fish?
8. Is imported fish sold fresh at your local fish shop or supermarket?

Information regarding the rivers and areas concerned can be obtained by consulting the QFMA's pamphlets which summarize the acts and regulations relating to recreational fishing. This pamphlet also outlines the areas which are prohibited to spearfishing and other illegal activities such as netting, jugging fish and the use of explosives. The regulations are designed to preserve other marine organisms such as oysters and coral. Coral cannot be collected without a permit. Minimum sizes have been introduced so that species whose numbers are threatened will be able to reach breeding age before they can be captured and killed for food.

The Department of Primary Industries has also set aside Wetland Reserves and Fish Habitat Reserves. These areas allow normal fishing practices, but protect the area or habitat of the fish from developers or other groups which may destroy the areas. Commercial fishermen require special licences to fish these areas. These regulations are enforced by the Boating and Fisheries Patrol officers from the Department of Harbours and Marine.



Fig 1.17: Examples of management signage (courtesy Queensland Primary Industries Department).

Whaling

Although many species of whales have been hunted to near extinction with some species having a population of just 1% of their original number, it is a sad reflection on the human race that the slaughter is continuing. We now have alternatives to most whale products. If action is not taken soon to stop the killings, the number of whales may become too low to maintain a viable population. The loss of these animals from our ecosystem would be sad as well as having a major effect.

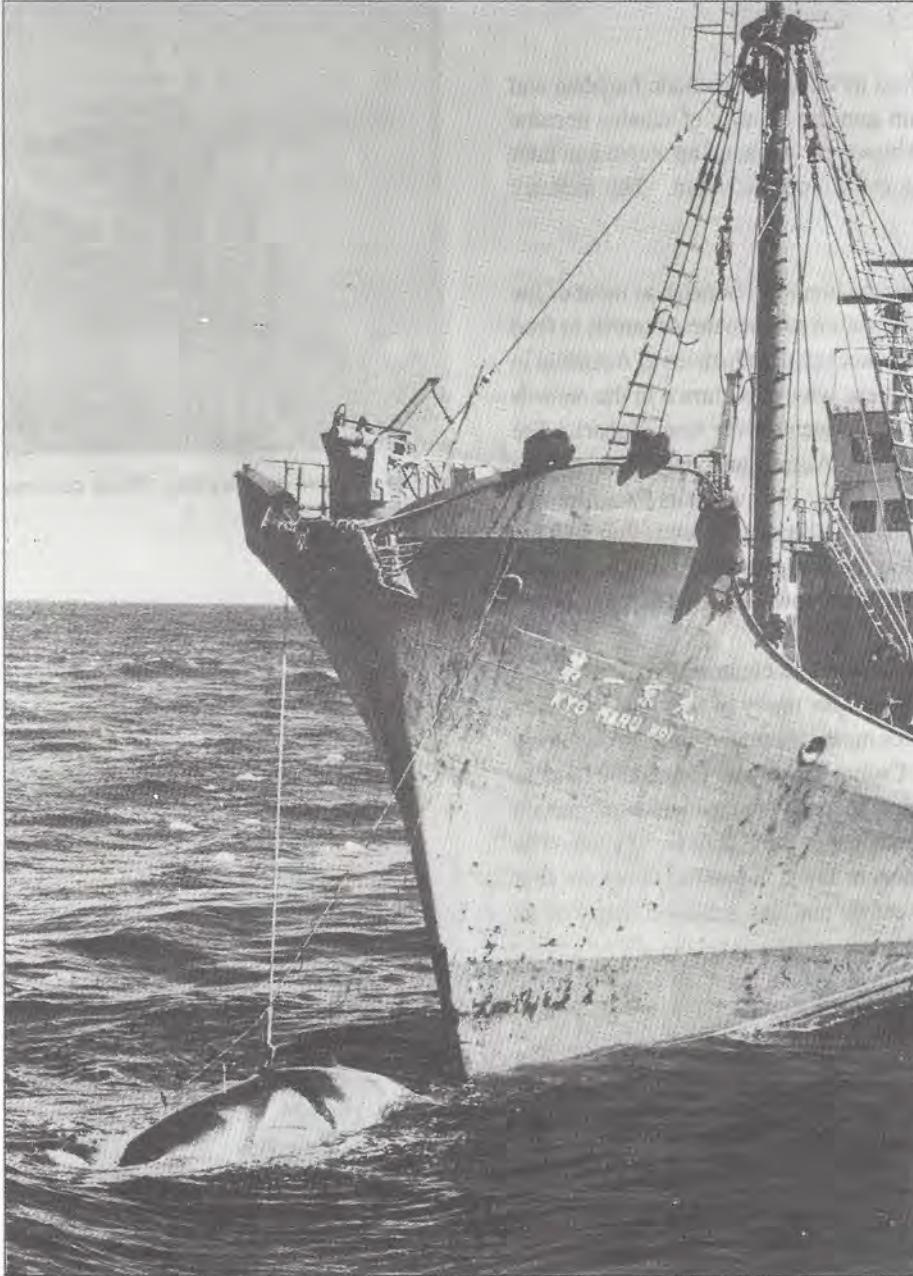


Fig 1.18: A Japanese whaling ship with harpooned minke whale alongside. Photo courtesy of Greenpeace.

The whales have a very low birth rate and if the killing continues the population will continue to decrease. It has been estimated that originally there was a population of 250 000 blue whales but now scientists believe there could be as few as 200 to 1,000 remaining in the southern hemisphere. The bowhead whale population has decreased from an estimated 300,000 to 4,000.

The huge blue whales can weigh up to 136 tonnes and reach lengths of 30 metres and circumferences of 20 metres. They have been mistaken for islands and have a size equivalent to 25 elephants or 60 cattle. The blue whales are gentle giants with little natural aggression and a playful disposition. These wonderful animals are being killed for chicken food, pet food, candle wax and animal fodder. The whales are also being killed for human consumption. Most people who come in contact with them in their natural environment are filled with admiration and fascination.

CHAPTER 1

For centuries whales have been hunted for their meat, oil and bristles. Commercial whaling began in the 12th century in the Bay of Biscay. These original whaling activities had only a minimal effect on the whale population. The whalers used hand-held harpoons in long row boats to capture their prey. The industry was still very successful with the highly prized whale oil being used to fuel lights. Whale bone bristles from the whale's mouth were used to make corsets which maintained the figure of the ladies of that century.

In the 19th century the Norwegians developed a grenade harpoon and with the development of the harpoon gun the hunting of whales became more effective. The slower sailing ships were replaced by steam and later diesel driven ships making whaling even more lucrative. The industry boomed.

The whaling industry in Australia was bound to flourish as most of the whales passed our shoreline in their migration south to the Antarctic to feed on krill. Whaling was one of our most successful industries in Australia in the 19th century. The abundance of these whales is shown in the records where whales were even killed in the Derwent River near Hobart. The humpback whale numbers found off the Australian coast were greatly reduced (from an estimated 10,000 to 200) by 1963 when its slaughter was banned in the southern hemisphere. The Queensland connection was the whaling station at Tangalooma on Moreton Island that operated from 1952 to 1962. Humpback whale populations have now increased to 500 - 1,000.

The industry started to decline when gas and electricity took the place of whale oil. Substitutes were also found for many of the other products taken from whales. The lack of whales meant increased costs in capturing them. An **International Whaling Commission** was formed in 1946 to safeguard the numbers of whales and to stop the extinction of certain species. Blue whales were finally protected in the Antarctic in 1965. The IWC has no means of enforcing quotas or laws. It was however the first global management authority to be set up and has achieved many of its goals.



Fig 1.19: Modern day harpoon. Photo courtesy of Greenpeace.

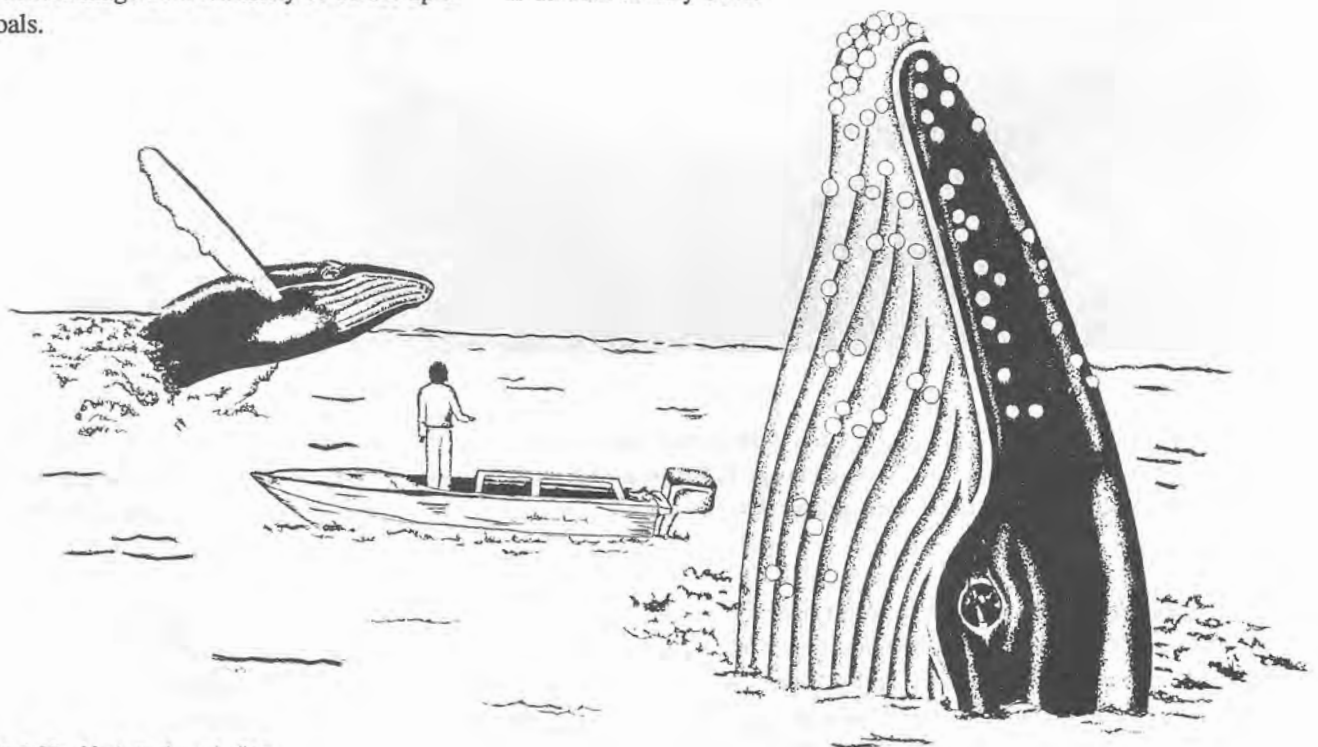


Fig 1.20: Modern day whaling.

Some countries such as Japan, Norway, and Iceland are still hunting and killing whales. They have been able to do this by finding a loophole in the IWC laws. The IWC allows for the taking of whales in an effort to obtain scientific data. These nations take the whales under the pretence of scientific research, take a couple of measurements and samples, and then process the whale for commercial gain. The Japanese and Norwegian whalers face continued world pressure to stop the slaughter, but are fighting to keep their industry. In 1960 the Japanese had 10 huge whaling fleets. Most of these fleets consisted of a mother ship and a dozen killer ships. 15,000 jobs were directly involved in the whaling industry and 20,000 whales were taken annually. To-day less than 1,200 jobs are involved with only one fleet taking whales.

The Japanese process most of the whale for domestic use. The whale meat tastes more like beef than it does fish. This is obvious when we realise that the whale is a mammal, not a fish. Like beef the whale has a number of different cuts which can be cooked by a variety of methods giving different tastes. Some Japanese refuse to eat four legged animals for religious reasons and therefore, whale meat provides an important source of protein in their diet. In 1960 Japan consumed over 200 000 tonnes of whale meat. To-day less than 20,000 tonnes are being consumed.

Whale oil has been replaced by many different plant oils. The oil of the Jojoba bean is being used as a substitute for whale oil in high temperature friction machinery. Linseed oil, coconut oil and palm oil are now being used as substitutes in the cosmetic and other industries.

The tourist industry in areas such as Hervey Bay in Queensland has been developed around the annual migration of the whales. The threat of extinction of whales has probably attracted more attention than any other campaign. Greenpeace activists have even put their lives on the line to protect whales from the Japanese harpoons.

Whale products were used in the manufacture of:-			
* corsets	* candles	* piano keys	* antifreeze
* perfumes	* crayons	* fishing rods	* food (meat)
* shampoos	* paint	* tennis racquets	* margarine
* soaps	* printer's ink	* umbrellas	
* lipstick	* fertilizers	* lamp oil	
* waxes	* stock fodder	* machinery oil	
* polishes	* pet food		

In recent times whales are regarded as being worth more alive than dead.

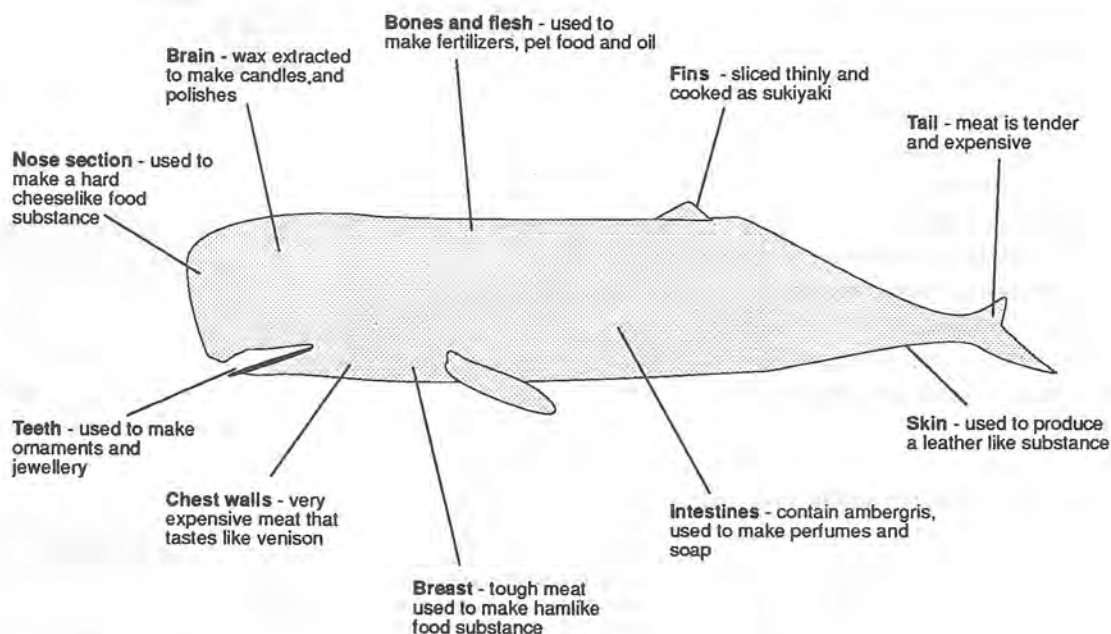


Fig 1.21: Whale products - !!!!

NEW COMPETITORS

Introduced species

Nature in its pristine state is in a perfect state of balance. This fragile environment can be upset forever by the introduction of a foreign species. The inter-relationships that exist in the environment between the species would be altered.

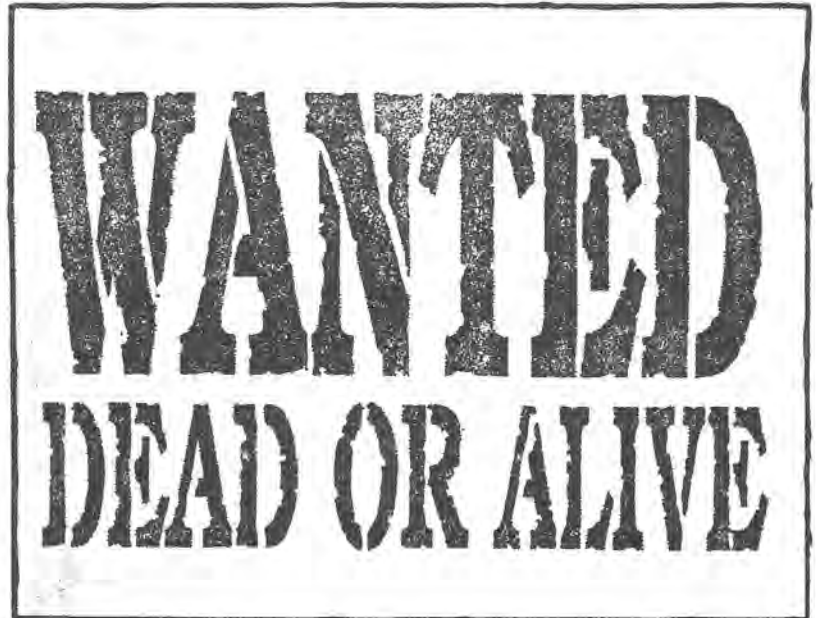
Over the past 200 years many new species of plants and animals have been introduced into Australia. The first fleet brought with it more than soldiers, sailors and convicts. Many of the creatures that have been introduced are nearly naturalized Australians. Most people are well aware that animals such as rabbits, hares and cane toads which have reached plague proportions in some areas are introduced. Other animals such as flies, fleas, animal lice, mosquitoes, silverfish, some species of cockroaches, many species of ants, snails and slugs, rats and mice, foxes, buffalo, camels and several species of freshwater fish have all been introduced. Some of these have been introduced accidentally, some deliberately and some for no reason at all causing many of the endemic species to be reduced in numbers.

The introduction of plants and animals to our waterways can cause many problems. This is because the introduced species:-

- (a) are better competitors,
- (b) are predatory, and/or,
- (c) may change the conditions.

To-day there are nine species of introduced fish living happily (for them, that is) in our waterways. These include the very common mosquito fish, guppy and swordtail found in most gullies, pools and creeks of Queensland. The *mosquito fish* was introduced in the 1920s in an effort to control the mosquito problem and was widely distributed. In some urban creeks the mosquito fish which has an average size of approximately two centimetres, comprises over 90% of the total fish population. Its dominance is caused by the fact that it is an aggressive feeder and eats the eggs of other fish.

The mosquito fish, the guppy and the swordtail all bear their young as live juveniles, not eggs. Many of the other introduced plants and animals are better competitors than the endemic species and take over the area. Another good example of this is the *tilapia*, a species of African fish which now inhabits some Australian states.



THE Queensland Government is posting wanted signs for a foreign killer.

Fisheries experts want to know the whereabouts of populations of tilapia, a South African fish that has already invaded several Queensland waterways from the Gold Coast to north Queensland and threatens to wipe out populations of native species.

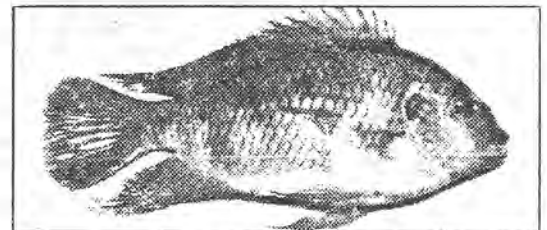
They recently poisoned 18 tonnes of the fish in a pond at Port Douglas. The population had grown from five fish released 3½ years earlier.

"That gives some idea of how fast they breed," the principal fisheries biologist of the Department of Primary Industries, Dr John Beumer, said.

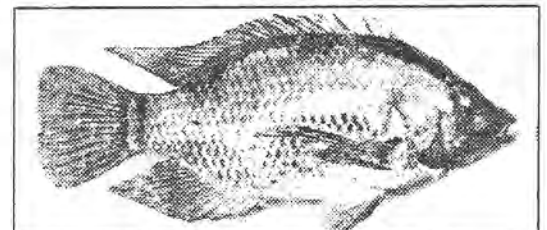
"They wipe out native populations by eating their eggs and larvae, and competing for food and space."

The tilapia can grow to 45cm and attain a weight of 1kg to 1.5kg, but often explodes into huge populations of small fish in restricted conditions.

It is adaptable, and can live in brackish water and even migrate along the coast when fresh water extends out to sea after heavy rains.



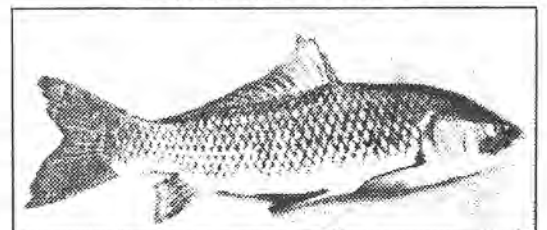
TILAPIA MARIAE male



OREOCHROMIS MOSSAMBICUS female



OREOCHROMIS MOSSAMBICUS male



EUROPEAN CARP (noxious)

Fig 1.22: Article courtesy of The Sunday Mail.

The tilapia has a rapid growth rate, reproduces at a young age, has three breeding seasons a year and is an aggressive fish. It consumes and destroys the native plant material and is predatory on native species of fish. It was an aquarium fish and was, most likely, accidentally introduced into the waterways. The Queensland Government in 1991 has now placed a \$60,000 fine for the introduction of this noxious fish into our waterways.

The quality of the water may also be changed. Many water weeds such as water hyacinth, Salvinia, water lettuce, duck weed, and Elodea reduce the flow of water which can eventually cause silting of the rivers. They alter the level of nutrients and oxygen in the water and change the ecological balance in the water. The article below is from the Australian Water Resources Council and describes water hyacinth.

Endemic means found in only one particular area and is native to that area.

Exotic species means introduced species from another area (it does not have to be from overseas).

Water Hyacinth (*Eichhornia crassipes*)

A free-floating plant joined by short stolons, each plant consisting of a clump of leaves on a short stem bearing roots trailing in the water. Leaf blades are circular to oblong, flat, hairless and 2-12cm in diameter. Leaf stalks are large, swollen and spongy. The inflorescence is erect with 4-20 pale, lilac-blue flowers. Each flower has 6 petals, 3.5-5cm long, the top one with a yellow blotch. After flowering, inflorescences bend over carrying capsules of seeds into the water.

Water hyacinth reproduces by seed, which is produced in large quantities and germinates in shallow water or on moist mud. Seeds can remain viable under water for 20 years or more. Vegetative reproduction is also highly effective and occurs when new plants form at the ends of stolons, thus enabling the weed to spread over a body of water. Under favourable conditions, water hyacinth can double its mass, and the area it covers, every 5 days.

Dispersal occurs both by seed and by the breaking away of daughter plants from stolons. Both types of propagule are then carried downstream, especially in flood waters.

Water hyacinth infests most coastal river systems in Queensland and in New South Wales north of Sydney. It also occurs in the Northern Territory (near Darwin and Jabiru) and Western Australia (vicinity of Perth). It has also occurred in South Australia and Victoria, where infestations have been eradicated, though new outbreaks can still occur, usually when the plant is mistakenly re-introduced. A major infestation of 7,000ha near Moree threatened the Murray-Darling system, before it was controlled.

Water hyacinth is the world's worst water weed, and is a declared noxious weed in Australia. It is a native of South America and was brought into Australia late last century as an ornamental plant for ponds and aquaria. It has rendered coastal river systems useless for navigation, blocked up or damaged irrigation and flood mitigation systems and made stock and domestic supplies undrinkable. A dense water hyacinth mat reduces dissolved oxygen concentrations, pH and temperature, thereby severely affecting native plants and animals. Water hyacinth is a prolific user of water and infested dams will evaporate water at a faster rate than if free of the weed.

Physically removing plants from small areas of water is a good way of controlling small infestations of water hyacinth. Large infestations can be controlled by aerial, high volume applications of various formulations of 2,4-D.

Two species of insects, a weevil and a moth, have been released for biological control. The larvae burrow in the leaf stalks, allowing water and bacteria to enter. Eventually the plants rot, die and sink. Both insects have been effective in killing water hyacinth in coastal areas of Queensland and northern New South Wales.

High nutrient levels encourage rapid growth of water hyacinth. Thus, as part of a control program, it is important to minimise nutrient runoff e.g. from cattle yards, domestic and municipal sewerage outfalls, and other waste discharges into infested areas.

Control of water hyacinth now centres on the integration of chemical, biological and physical control techniques.



Australian Water Resources Council
GPO Box 858, Canberra City ACT 2601.



Fig 1.23: Water hyacinth - *Eichhornia crassipes*. This article from the Australian Water Resources Council.

Questions on Water Hyacinth article last page.

1. What is the scientific name for water hyacinth?
2. Outline the problems water hyacinth causes in many Queensland waterways.
3. How long can the seed of the water hyacinth remain viable? Why may this cause a problem in the eradication of the water hyacinth?
4. The reproduction of water hyacinth can be sexual or asexual. Explain.
5. The water hyacinth is endemic to which country?
6. What are some of the methods used to control this waterweed?
7. Why do introduced species cause such a problem in their new habitat when they weren't in their native habitat?

Word puzzle

Make a list from the word puzzle of animals and plants that have been introduced to Australia and are now established in the wild.

There are over twenty organisms listed.

C	A	M	E	L	I	C	E	F	F	A	H	I	D
X	A	O	U	S	B	I	T	O	U	N	Y	Y	I
B	N	U	T	C	A	T	I	X	N	O	A	R	N
U	F	S	N	A	I	L	L	E	H	O	C	M	G
F	G	E	H	D	V	O	A	W	A	N	I	M	O
F	J	I	G	O	A	T	P	Y	R	X	N	I	M
A	N	T	S	G	Z	P	I	R	E	N	T	C	F
L	P	K	L	Q	T	U	A	A	N	O	H	E	Z
O	I	M	O	S	Q	U	I	T	O	F	I	S	H
Q	G	F	T	L	N	A	I	P	N	F	L	E	A
D	E	E	R	U	C	A	N	E	T	O	A	D	S
R	S	P	I	G	T	S	P	A	R	R	O	W	Z

The environmental effects of introduced species are being studied by the CSIRO. One of the major environmental problems being studied is that of the **cane toad**. Cane toads were deliberately introduced in the 1930s to control a beetle that was a pest to the sugar cane plants. It quickly became more of a problem itself than the problem it was meant to solve. The natural habitats of many Queensland wetlands have been destroyed by this pest. It has now reached plague proportions over much of Queensland and is spreading rapidly into other Australian states and territories.

Piranha caught by quarantine net

QUARANTINE officers found a piranha in a consignment of tropical fish from Hong Kong bound for Brisbane pet shops yesterday.

The flesh-eating South American fish had come from a fish farm where it had been accidentally mixed with tropical aquarium fish.

It is legal to keep piranhas in Hong Kong as pets.

Queensland Department of Primary Industries quarantine inspector Mr Dean Purser said the 6cm piranha would be capable of inflicting a nasty bite.

It was suffering jet-lag but when it recovered its appetite it would have to be segregated from the other fish that had been confiscated and put in the quarantine aquarium.

"It will get used to fish food but it would prefer live fish," Mr Purser said.



The piranha, above, was intercepted by a Queensland Department of Primary Industries quarantine inspector.

"It will stay here as long as it lives.

"If it is released it could breed. Can you imagine piranhas in Wivenhoe Dam?"

He said the fish was about six months old and could grow to about 30cm.

Quarantine officers would keep it as a pet but said they would watch their fingers when feeding it.

The Hong Kong exporter was likely to lose his licence over the incident.

— DANIELLE KOOPMAN

Fig 1.24: Article courtesy of The Courier Mail.

Imported exotica

Another problem that is of real concern to conservationists is the discharge of ballast from cargo ships. Many ships carry water as ballast as they come to Australia. This water that has come from overseas ports can contain disease-causing organisms and parasites. Discharging this water could have a drastic effect on oyster industries, fisheries, aquaculture, prawns and other marine life.



Fig 1.25: Many ships carry water as ballast as they come to Australia.

Quarantine

Quarantine stations and regulations are important in the prevention of exotic diseases and pests being introduced into Australia. If you are importing any plants or animals into Australia these must spend time in isolation to see if they are diseased or carrying disease. Government laws are enforced to stop or prevent the introduction of plants and animals that may cause problems if introduced into Australian ecosystems.

We often read of examples where customs officials have seized fish, birds, snakes, food stuffs and seeds from the luggage of incoming travellers. **The Australian Customs Service** is also on the look-out for unauthorized landings by overseas vessels and aircraft that could introduce diseases such as Foot and Mouth, Swine Fever and Rabies which would devastate our agricultural industries, our wildlife and human health.

Even the introduction or non-declaration of salami at an airport could have a severe and overwhelming effect on Australia! It is extremely important not to break any customs regulations and to report any incidences of such events to the customs authorities even if the incident seems trivial.

As responsible Australians it is the duty of each and every one of us to protect our country.

Extinctions

The dying out of a species is known as **extinction**. The four major causes of extinctions are:

- (a) Loss of habitat.
- (b) Exploitation.
- (c) Introduction of a new species.
- (d) Pollution.

CHAPTER 1

Many of the animals that live in the oceans have been seriously affected by marine pollution by developments which have destroyed habitats. Many lesser known species including different species of phytoplankton are disappearing before they have even been named or classified. Animals close to extinction include some species of whales, dugong and turtles.

Turtles, for example, have been severely affected by netting and the destruction of the sandy beaches where they come to lay their eggs. Civilization has invaded the sandy beaches bringing with it street lighting and noise which may inhibit the turtles coming to breed in their traditional sites. Much research is going into the turtles' migration and breeding habits in an effort to better understand and safeguard the life of the turtles.

Turtles are also being commercially exploited by many countries. They are hunted in great numbers for their meat, skin, shell and eggs. A large trade in turtles exists in Japan which still imports products of these endangered species. Indonesia which lies just north of Australia has a major commercial turtle industry. Greenpeace estimate that between 7 - 10 thousand turtle eggs are collected and sold each year in this region. Considering turtles are migratory animals a large scale annihilation in this region will seriously affect turtle numbers worldwide.

In Australia all turtles are protected by law with the exception of local Aboriginals and Torres Strait Islanders who may take them for traditional uses. It has been estimated that the Aboriginals and Torres Strait Islanders are killing over 10 000 adult turtles each year. With the decline in turtle populations the law which allows their taking of the turtles may need to be re-evaluated. All commercial imports and exports of turtle products are prohibited.

A well known turtle nesting area in Queensland is at Mon Repos near Bundaberg. This photograph shows researchers taking measurements of an egg laying Loggerhead turtle. The area has become a tourist attraction with many people flocking along the beach at night during nesting season. This tourist attraction may be short lived as the number of nesting turtles has declined by 40% between 1985 and 1990.

We have many unique animals in Australia and we must allow future generations a chance to marvel at these plants and animals as they live free in nature. The uniqueness of these animals is best exemplified by the platypus. The first specimen that was preserved and sent to Europe was viewed with some scepticism. The scientific community refused to believe such an animal existed and thought it was a clever fraud made from a number of different animals.

This animal was once found in large numbers but was hunted to near extinction for its fur. The implementation of laws making it a protected species seemed to have saved it from extinction but with the continual destruction of its environment future generations may, once again, not believe that such an animal existed.



Fig 1.26: This photograph shows researchers taking measurements of an egg laying Loggerhead turtle.

It has also been recognised that there has been an increase in predation of the eggs which are laid in the sand. A female turtle can lay up to 200 eggs which can take two months to incubate in the sand. These eggs are easy prey for native species such as goannas and introduced species such as foxes, pigs and feral cats and dogs.

The major point one should remember about extinctions is inscribed on the World Wildlife Fund banner. It reads "EXTINCTION IS FOREVER".

PROTECTED SPECIES

Many marine species are now fully protected by law making it illegal to capture them. This has been instigated to preserve the numbers and the viability of the species. The genetic diversity of the species will only remain while there are numerous individuals in diverse habitats.



Protected species

The following species are protected.

- (a) Ceratodus or Lungfish
- (b) Helmet, Trumpet and Clam Shells
- (c) Female Mud and Sand Crabs
- (d) Whales, Porpoises, Dugong and Dolphins.
- (e) Turtles.
- (f) Egg-bearing:
 - * Female spanner crabs
 - * Moreton Bay Bugs or other Sea Bugs
 - * Female Slipper Lobsters

Data supplied courtesy Queensland Fisheries Patrol

CONSERVATION OF THE SEA

Homo sapiens or humans are land animals and they have through the centuries developed the land on which they live. The oceans, seas and inland waterways have only been regarded as a medium which had to be crossed to get from point A to point B.

We are now, in the late 20th century, having to turn to the sea for food and other resources. We have overdeveloped the land and are becoming aware of the fact that we may soon exhaust the land's ability to supply all our food and resources as the population increases. We need to conserve land and sea.

The shoreline of Australia has always held a special attraction for Australians and tourists from other countries. These shorelines are under great people pressure as they try to take advantage of this wondrous environment. It has been calculated that 83% of Australians live in cities or towns less than one hour's drive from the sea. This compares with a value of 49% for the USA.

Conservation according to the Webster Dictionary is "the deliberate, planned or thoughtful preserving, guarding or protecting, or keeping in a safe or entire state." It involves the care of the world's environments and the maintenance and preservation of life. Conservation can be defined as *keeping the environment from destruction or change*.

To embark on a conservation program we first of all need to know what we are going to conserve. We should know about the different types of plants and animals in the waters, how they are distributed and how they affect each other. No organism lives alone - each has its own place in a food chain, in the cycling of nutrients, and in relationships with other animals and plants. A major prerequisite for conservationists and environmental managers is to fully understand nature's complexities through painstaking research.



Questions:

1. Determine which groups are associated with these logos and their role in conservation.
2. Try to design your own logo for conservation of the sea.

CSIRO researchers have and are continuing to study the vast marine habitats of Australia. They have developed new survey methods such as Landsat satellite imagery to map the Great Barrier Reef so as to get a better overall picture of the reef. There is still a need for field studies and these are many and varied. One such study the CSIRO is working on is that of the crown-of-thorns starfish. It studies the population numbers and their variation with time. This type of study is termed **demography**. CSIRO studies also are directed towards the life cycles of many of the commercial species.

NATURE CONSERVATION

- "1. Conserve natural areas - don't destroy or remove flora; don't deface geological formations; disturb wildlife as little as possible.
2. When camping or picnicking, leave as little imprint as possible on the natural environment - take your refuse with you.
3. Learn to appreciate native flora and fauna. Walk in the bush with binoculars, camera and field identification manuals. Encourage your children to do the same.
4. Don't dump unwanted pets in the bushland as these animals when wild, kill native wildlife.
5. Be proud of National Parks. Use and enjoy them whilst observing the regulations. Support proposals for new Parks.
6. Don't buy products made from endangered species.
7. Preserve fauna habitat. Discourage excessive land clearing and development and don't pollute watercourses in natural areas.
8. Be very careful with matches in natural bushland settings. Bushfires destroy flora and fauna, cause water and air pollution and soil erosion, as well as endangering human life.
9. Protect native fauna. Be an example to others and a leader in the community. Join a wildlife society.
10. Don't exploit fauna and rare flora (e.g. native orchids) commercially.
11. Protect our beaches. Always use access paths and steps to the beach to avoid damaging the dunes. Never light fires, drive vehicles or graze cattle on the dunes and don't remove vegetation or sand from the dunes. Be careful not to leave glass, fish hooks or other dangerous objects on the beach."

Information supplied courtesy Queensland Environmental Control Council.

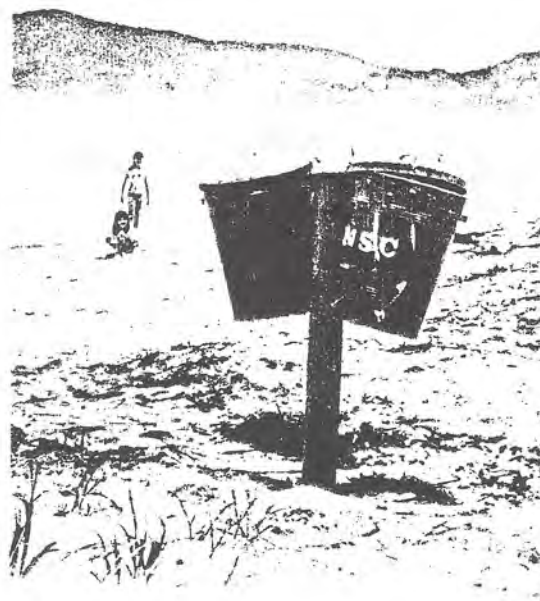


Fig 1.27: Many councils have endeavoured to reduce beach pollution by placing rubbish bins on the beaches. This photograph shows bins located on Noosa beach.



Feral - animals which were once domesticated but have now reverted to the wild.

Fig 1.28: When picnicking, leave as little imprint as possible on the natural environment. Here picnickers are using and enjoying a National Park whilst observing the regulations.

In Queensland the *Department of Environment and Heritage* is the main organisation concerned with the management and protection of Queensland's natural and man-made environments. Its aim is to make the resource "beneficial to present generations while maintaining their potential to meet the needs and aspirations of future generations."

The five goals of the department are:

- * "To conserve, protect and improve Queensland's environment;
- * to ensure the survival of flora and fauna throughout their range through sound conservation strategies;
- * to ensure representative, significant parts of the Queensland landscapes and cultural heritage are protected by sound strategies and actions;
- * to protect the physical integrity of the coastal zone, adjacent wetlands and offshore islands, consistent with orderly and balanced development;
- * to achieve in the community an understanding of and sense of responsibility for our environment and heritage."

The Department of Environment and Heritage is responsible for the enforcing of many of the Acts concerning the management of state environments. The Department has a staff of only 750 and a budget of \$70 million in 1991 to complete this huge task.

In one Australian state these Acts include the:-

- * Beach Protection Act
- * Clean Air Act
- * Clean Water Act
- * Fauna Conservation Act
- * Emissions Act
- * Litter Act
- * Marine Parks Act
- * National Parks and Wildlife Act
- * Pollution of Water by Oil Act
- * Recreation Areas Management Act
- * State Environment Act
- * State Marine (Sea Dumping) Act.

With the development of Coastal Protection Units, states have the opportunity to establish a workable and co-ordinated approach towards coastal management.

Research questions

1. What do these groups have to do with conservation?
 - * Australian Conservation Foundation.
 - * State Department of Environment and Heritage.
 - * Queensland Parks and Wildlife Service.
 - * Water Quality Control Board.
 - * DPI.
 - * Rural Land Protection Board.
 - * The Great Barrier Reef Marine Park Authority.
 - * CSIRO.
 - * Greenpeace.
 - * Operation Noah.
 - * Animal Liberation Society.
2. What other agencies are concerned with conservation?
3. Identify which areas in your state are zoned and who controls each zone?
4. What are the reasons for the zones selected and what effect might the zonings have on the marine parks or reserves?



SPECIFIC CONSERVATION ISSUES

Major Constructions

Technology has allowed for the development of massive mining operations, huge dams and quick and effective methods of clearing the land. These developments quickly alter the natural environment. Dams, for instance, completely wipe out the natural environments upstream from the dam by inundating them with water. The natural environments below the dam are also drastically affected by the lack of water flow and change in conditions.

The outflow of water from the bottom of the dam is up to 15 degrees Centigrade lower than the surface layers. Some organisms are capable of withstanding a wide range of temperature. These animals are called **eurythermal**. The water also contains large quantities of dead plant material that has accumulated in the depths. The water thus contains more nutrients but little oxygen.

Dams do, however, have some redeeming features. They do provide large volumes of water for domestic and agricultural usage. We are in a very dry continent and we need to have large storage areas for water which are essential in times of drought.

These large expanses of water also provide a sanctuary for thousands of birds, fish and other animals. Many species whose numbers were endangered by the destruction of marshlands have relocated to these man-made lakes. The increase in the availability of water leads to an increase in plant numbers which in turn leads to increases in animal populations.

Questions:

1. Where does your town water come from?
2. If a dam was to be built on your local waterway, what effect do you think this would have on the natural ecosystems of the area?



Fig 1.29: Man-made lakes have a dramatic effect on the populations and types of animals found in an area. There are arguments for and against this type of resource.

Mines, especially open cut mines, completely destroy the top layer of the earth. They expose the Earth to the problems of extra silt in the waterways and the unearthing of pollutants such as heavy metals that were locked up inside the earth.



Fig 1.30: Queenstown in Tasmania where the natural forest has been destroyed by pollution associated with the local copper mine.

Logging

The major forests of the world are disappearing at a rate of a football field every second. It has been estimated that the jungles of the Amazon will be gone within 40 years if clearing at the present rate continues. In Australia over 50% of the natural forests have been destroyed in the last 200 years. Very little of Australia is able to support a forest ecosystem and it is believed that there is less than 10% of Australia's natural forests still standing. Less than 10% of this forest area is protected by national parks. Low land tropical rainforests are almost extinct. This clearing of the natural forest is termed **deforestation**.

Saltwood



The logging of such areas as Fraser Island off the south-eastern coast of Queensland, the largest sand island in the world, has sparked much debate and protest. The government forestry services have argued that the natural forests are a renewable source and with sensible management practices can replenish themselves after a period of time. The protesters argue that the loggers are taking trees that are over 200 years old and it will take many years before the forest and its wildlife can be restored to its former glory. They believe that the removal of the upper canopy may destroy the delicate environment of the rainforest below.

Alternative employment for the loggers may be found in the establishment of new pine plantations in areas already cleared. The timber produced would be able to replace the timbers now cut from the natural forest. The natural forests may even have value as a tourist attraction and provide employment in this industry.

Has the Department of Forestry established any pine forests in your area? If so, what area has undergone reafforestation and what effect may this have on the area? Do you agree with the establishment of pine forests which have higher growth rates than native flora?

Reef conservation

Another area of concern is the Great Barrier Reef. It is the largest complex of coral reefs and islands in the world. It stretches from above the tip of Cape York to Lady Elliott Island off Bundaberg (latitude 24° 35'), a distance of some 2 000 klms. It is larger in size than the state of Victoria. Second only to its size is the richness in biological diversity found on the reef.

The Barrier Reef is the home for more than 1,500 species of fish, 330 species of corals and thousands of other invertebrates. This multitude of plants and animals live together harmoniously in a fragile environment. They have a complex ecosystem that could be very easily destroyed if it was not protected.

The reef has been declared a world heritage site and has been designated a Marine Park under the control of the Commonwealth Government. The Great Barrier Reef Marine Park Authority which controls activities on the reef has a goal "to provide for the protection, wise use, understanding and enjoyment of the Great Barrier Reef in perpetuity". The Queensland National Parks and Wildlife Service is the principal agent responsible for the everyday management of the Great Barrier Reef on behalf of the Great Barrier Reef Marine Park Authority.

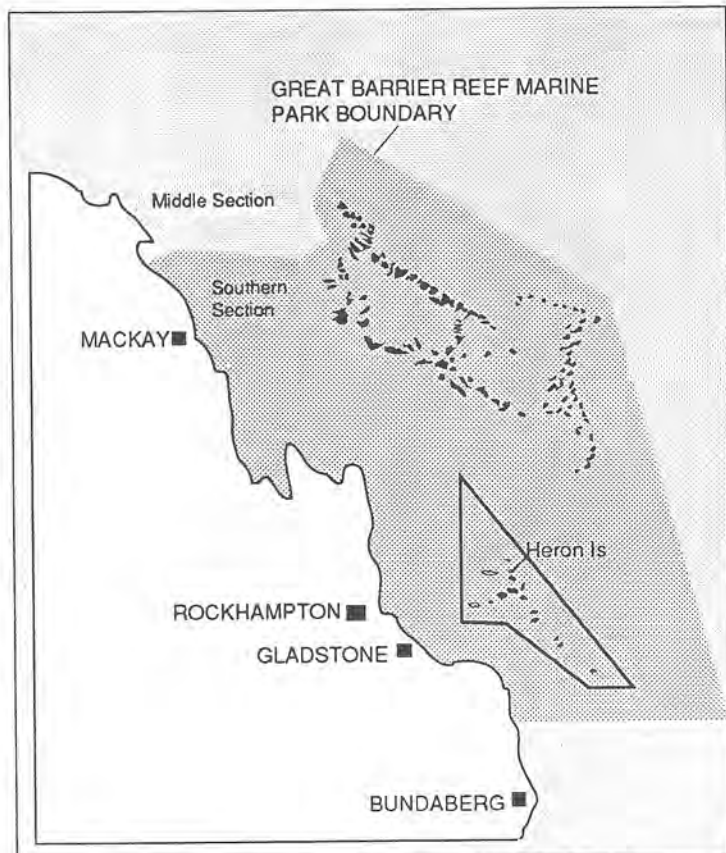


Fig 1.31: Southern section of the Great Barrier Reef Marine Park.

To allow the public access to the Great Barrier Reef zones were drawn up to allow for varying types of activities. Groups interested in activities such as commercial fishing, boating, recreational fishing, bait netting, spear fishing, scuba diving, snorkelling, reef walking, collection of shells and fish, camping, tourist operations and scientific research all wanted access to the reef. It was apparent that all groups could not have unlimited access if the reef was to survive.

Special zones were drawn up to accommodate each group. Permits are required for collecting of marine aquarium fish, corals and shells, camping on islands within National Parks, the operation of tourist activities and any development on the reefs.

ZONING OF THE GREAT BARRIER REEF

(After Great Barrier Reef Marine Park Authority)

Marine National Park 'A' Zone: Activities that are allowed include general recreational activities, trolling for pelagic fish species (e.g. mackerel), line fishing with one hand-held rod or line, and approved research.

Marine National Park 'B' Zone: This may be thought of as a "look but don't take" zone. Similar in concept to the MNP'A' zone, except that all fishing is prohibited so that people may appreciate and enjoy an area in its relatively undisturbed state.

Marine National Park Buffer Zone: This is similar in concept to MNP'B' zone, however this zone makes special provision for trolling for pelagic fish species between areas where all fishing is prohibited.

Scientific Research Zone: The objective of the Scientific Research Zone is to provide areas where permitted research may be carried out free from the influences of other activities.

Preservation Zone: The objective of the Preservation Zone is to preserve areas of the Great Barrier Reef in their natural state undisturbed by man, except for the purpose of scientific research that cannot be conducted elsewhere. It is important to protect turtle and bird nesting sites.

Replenishment Areas: These areas may be closed to collecting and fishing during specified periods to enable recovery of fish and other resource stocks.

Write to the Great Barrier Reef Marine Park Authority for maps showing the zoning of different sections of the reef. Use these pamphlets to determine which activities can be completed in the different areas of the Great Barrier Reef. For example, is general shipping allowed in all sections of the reef network? Address: GBRMPA, PO Box 1379, Townsville, 4810.

The Great Barrier Reef is almost completely in its natural state, giving conservationist a great chance to conserve and preserve a very unique environment. The major factors affecting the reef are:

- (a) Tourism.
- (b) Crown-of-thorns starfish.
- (c) Pollution.
- (d) Overfishing.

Tourism

Tourism is one of our fastest growing industries. Most overseas tourists come to Australia from the northern hemisphere to escape the wintry conditions there. (If it is winter in the northern hemisphere it will be summer in Australia.) Many people arrive here to find very hot conditions and head straight for the beaches. Our beaches do have a natural attraction and most are a lot less crowded and less polluted than the ones with which the tourists are familiar.

Big developments are necessary to cater for the tourists' needs. Nearly all developments that have recently angered environmentalists have been for resort developments that take advantage of some natural beauty.



Fig 1.32: Compare this photo with Fig 2.1 in the next chapter.

The tourist dollar is important to Australia and there is a need to find some middle ground in this debate. It does not entirely go to the big companies that have set up the resorts, but to many other sources as can be seen in Figure 1.33 below.

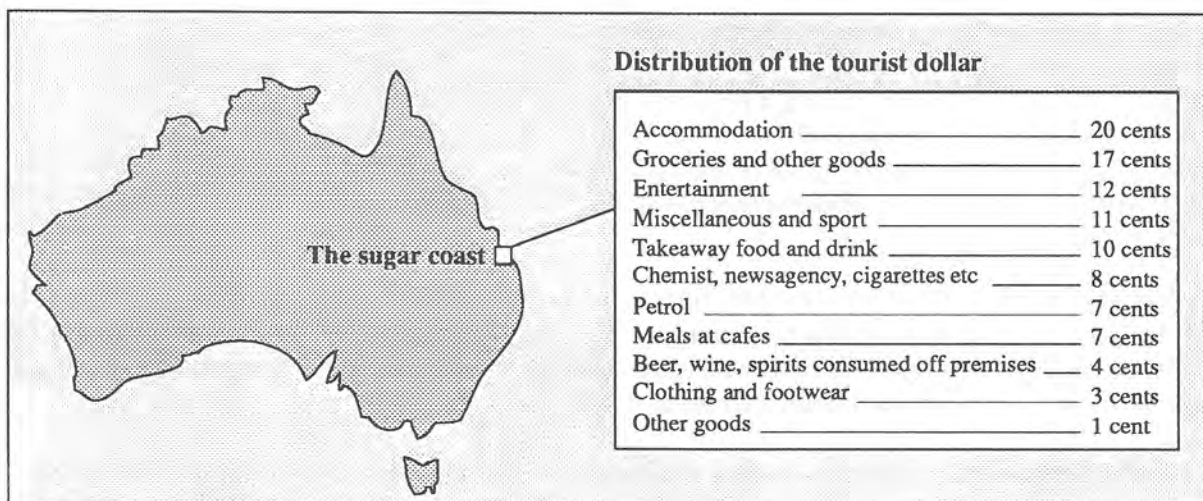


Fig 1.33: Data supplied courtesy of Burnett Regional Tourist Board (Qld 1990)

The Great Barrier Reef attracts many thousands of tourists each year. They flock to this majestic and splendid structure which is one of the seven wonders of the world. Tourists generate millions of dollars of business in many industries. It is important that the tourist operators which take these people to the reef are well informed and are mindful of its conservation. The Great Barrier Reef Marine Park Authority runs a number of courses designed to assist operators in providing a more professional and responsible attitude to the reef. The operators are becoming well educated and conservationally minded, thereby educating the tourists. Hopefully, the tourists will leave the reef with good attitudes and a better understanding of the environment.

Coastal development worth at least \$8000m

DEVELOPERS have claimed at least 100 Queensland coastal sites for about 150 proposed tourism projects valued at more than \$8 billion.

Developments are proposed for at least 100 sites, some undeveloped and some already with an established tourist industry.

Some proposals are still on the drawing board, some are tied up in Local Government

Court action and others are almost finished.

The Queensland Conservation Council has estimated 150 proposals valued at least \$12 billion exist.

The official figure from the Queensland Tourism and Travel Corporation is \$8.15 billion.

Cabinet yesterday approved two new developments and the Opposition environment spokesman, Mr Comben,

warned that the Gold Coast's billion-dollar tourist industry could be destroyed if beach erosion was not checked.

A tourism industry pioneer and owner of Hamilton Island, Mr Keith Williams, has said many of the established coastal and island resorts were "floundering in a bath of red ink".

Mr Williams this week damned some tourist develop-

ments as "lemons" which would never be successful.

"Some are being built only to flog them off, some will go down the tube," he said.

The only ones who would benefit from tourism would be those who personally understood the industry.

Fig 1.34: This article, courtesy of the Courier Mail, gives an idea of the magnitude of the developments taking place along the coast in one Australian State. What effects might these have over the whole of Australia?

Crown-of-thorns starfish

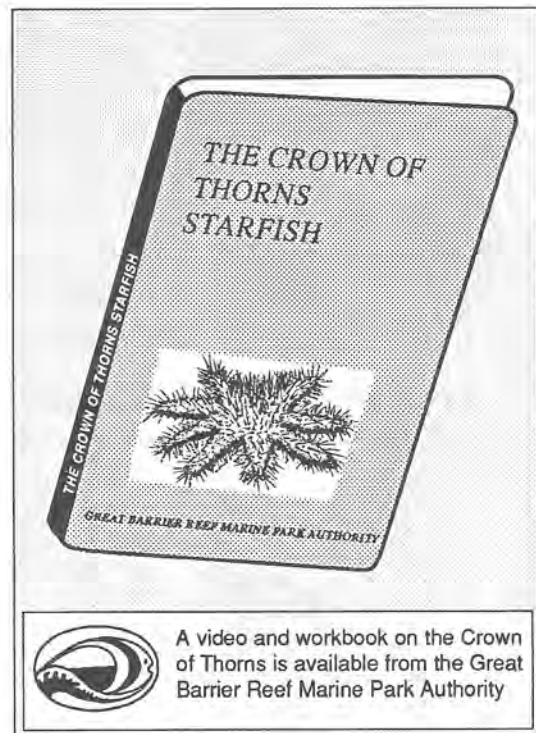
The crown-of-thorns starfish problem is one of the most serious scientific issues facing the managers of the Barrier Reef. The crown-of-thorns is a starfish which feeds on living coral and is found naturally in many reef areas. The starfish can regurgitate its stomach through its mouth, a process known as **stomach eversion**. The stomach enzymes then digest the coral polyps and form a type of "reef soup" which is then absorbed by the starfish.

It is believed that this "reef soup" attracts other crown-of-thorns starfish, causing a build up of numbers in that area. This process is known as **aggregation**. Outbreaks of infestation by this animal have occurred on many of the coral reefs.

The crown-of-thorns starfish has a great reproductive potential as one female can produce 20 million eggs. If conditions are favourable many of these eggs survive causing a population explosion and possible destruction of some reefs. The Australian government has spent \$5 million researching this problem to find answers as to why these population explosions have occurred and how to control them.

The first infestation was noted on Green Island Reef off Cairns in 1962. Since that time many areas have been infested by vast numbers of these reef destroying starfish. The triton shell is the natural predator of the crown-of-thorns starfish and many believe that reduction in triton shell numbers have sparked these explosions. Research is being undertaken to find an effective control of the pest. Biological control is one method being investigated.

Some scientists believe that it is human activities and man's manipulation of the environment that have produced environmental conditions suitable for the mass growth of these starfish.



Pollution

The Great Barrier Reef is one of the few areas of the world in a pristine condition. Monitoring by government agencies has detected little evidence of pollution on the reef. The major concern to the authorities managing the area is the possibility of a shipping disaster resulting in an oil spill.

To reduce the risk of this occurring, ships that navigate the waters of the Barrier Reef are required to have on board a pilot. An oil spill contingency plan called "Reef Plan" is in place. Even with this an oil spill could devastate the reef even with the latest methods available to clean up the spills. The catastrophic problems caused by the oil released during the Gulf War of 1991 showed the technology we have available to us cannot satisfactorily deal with large oil spills.

Over 2,000 ships use the Barrier Reef shipping channels each year. Some are oil tankers of up to 100,000 tonnes.

Other pollution problems are caused by human activities on the shore line. The increase in nutrients, chemicals, silt, heavy metals, etc. that are being released into the rivers will eventually find their way onto the reef. Destruction of the mainland vegetation for road and developments increases erosion and the possibility of silt covering the reef.



Fig 1.35: National Parks have been established on the reef for management purposes.

A sustainable fishery

The Great Barrier Reef fishing industry is believed to be worth \$100 million a year. It has been estimated that over half of the Queensland fish catch is taken from the reef area, representing approximately 15% of Australia's catch. The Great Barrier Reef Authority has endeavoured to protect and maintain this fishery by closing some areas to all trawling. Approximately 30% of the total area of the reef has been zoned as areas closed to fishing.

Other factors

Other factors affecting the reef include:

- (a) Cyclones.
- (b) Temperature change due to Greenhouse effect.
- (c) Reduced salinity due to flooding.
- (d) Increased turbidity due to mainland erosion.
- (e) Collection of shells, exotic fish and other marine creatures by poachers.
- (f) Possible oil exploration in adjacent areas.



Fig 1.36: Recreational fishermen can have a major effect on the reef.

CHAPTER 1

Wetland destruction

Wetlands are defined as vegetated areas that are permanently or temporarily water logged or under shallow water. The term therefore covers marshes, swamps and mangrove areas. Australia, being the driest land mass, has very little of this type of habitat. The areas we do have are mostly found along our coastline and contain rare flora and fauna which have evolved to survive successfully in this unusual environment.



As much as 75% of low-lying tropical shorelines are dominated by mangroves. Mangroves are the forests of the sea. These extraordinary plants are capable of withstanding great ranges in environmental conditions such as salinity, temperatures, nutrients and oxygen. They are called **halophytes** - plants that tolerate saline conditions. These trees or shrubs usually develop in areas where there is abundant silt such as at the mouth of a river.

In Australia most of the thirty species of mangroves native to Australia are found in the tropics. The number of mangrove species decreases as one moves south. These plants have many special adaptations to survive in this changing environment. These adaptations make the mangrove an interesting and unique plant.

The root system of the mangrove is well adapted to survive in water-logged soils. Mangroves have developed special breathing roots called **pneumatophores**. Most plants cannot live in water-logged soil as the roots that hold the plant in the soil are made up of living cells, and as living cells they must carry out respiration. The pneumatophores absorb oxygen into the spongy gas-filled tissue of the lateral roots at low tide to be used by the plant when it is under water. The roots are also important in the support and anchorage of these plants in this muddy environment.

Many mangroves have the ability to exclude salts from the water taken in through the roots. These mangroves are called **salt excluders**. The small amounts of salt that are taken up accumulate in the leaves which eventually fall from the tree. Other mangroves have the ability to secrete salt from special glands at the base of their leaves.

Some mangroves are **viviparous**. **Viviparous** means they have seeds that germinate within the fruit while it is still attached to the parent plant. The seedlings are dropped at an advanced stage to be dispersed by the tidal currents. This allows for rapid growth of the seedling once it becomes attached to the substrate.

The importance of mangroves lies in their ability to support a rich and diverse ecosystem. The real value of mangroves has only been realised in recent years.



Fig 1.37: The importance of mangroves lies in their ability to support a rich and diverse ecosystem.

Mangroves can:

- Stabilize coastline by reducing the destructive forces of tides, river currents and storm surges.
- Stop erosion of the coast and help in flood control.
- Cycle nutrients.
- Provide breeding grounds and shelter for the juvenile stages of many important commercial marine species.

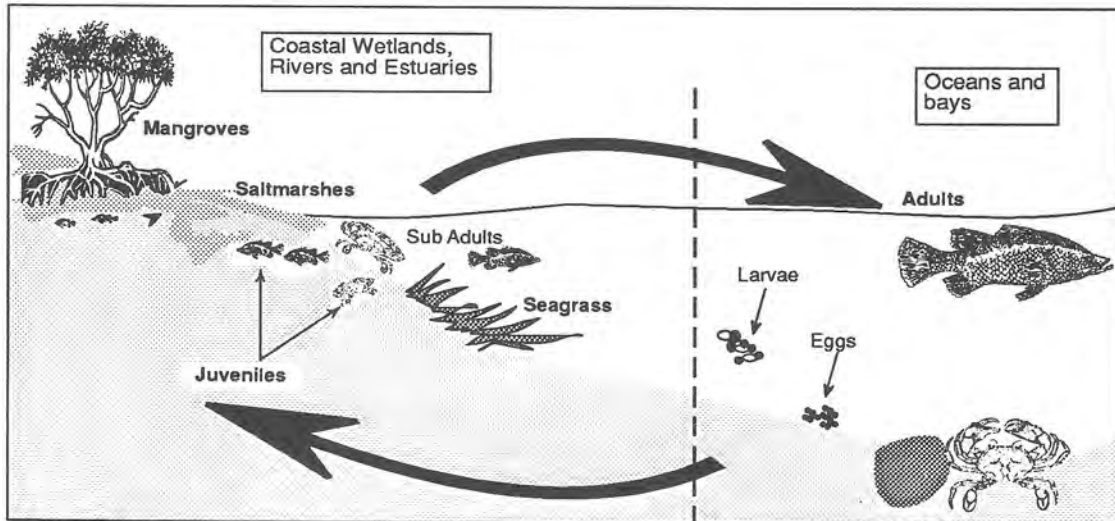


Fig 1.38: Mangroves provide a crucial link in the life histories of many marine individuals.

For thousands of years people who lived in mangrove infested areas made use of these plants. Different species were used as food, as building materials, as medicines and as fuels. Extracts from certain species were believed to cure anything from ulcers to diarrhoea. Native people used the mangrove to make tools; some even used the young fronds as cigarette papers; and alcohol was made from the sap of some species. Recent research has shown that over 70% of the fish that are commercially taken off Australia's coast can be directly linked to the ecosystems of the mangroves. Most begin life or rely on other organisms that begin life among the mangroves. The mangroves are the major producers in the complex food webs of this low coastal area. They also give protection to many of the small juvenile stages.

Mangroves are now being destroyed all over the world. Many people consider mangroves and other wetlands as wastelands and developers have been allowed to reclaim the land to develop canal estates. Many townships have been developed on low coastal areas and over the years the mangroves have made way for housing, industrial sites, commercial industries, sporting facilities and golf courses. Some areas have simply been destroyed because the locals thought that they were breeding grounds for sandflies. The areas that were left were thought by some to be unsightly and were used as the local dump.



Fig 1.39: Sights such as this showing destruction of natural vegetation are becoming evident more often. What may have happened to destroy this vegetation?

CHAPTER 1

In other parts of the world mangroves have also been exploited. In Malaysia, for instance, mangroves are used in wood chip plants to supply the country with building materials. In the Philippines and South America they have been cleared to make way for huge prawn farms and other aquaculture ventures. It has been estimated that some countries will have no mangrove areas left by the 21st century.

The damming of river systems to provide coastal towns with fresh water has also inhibited the flow of nutrients to the mangroves. By reducing the flow of water the silting patterns have been changed at the mouths of the rivers, again affecting the mangroves.

All mangroves and other marine plants are fully protected under the existing legislation in Queensland (Section 71 of the Fisheries Act). People are becoming more environmentally conscious worldwide. A number of government agencies are responsible for the conservation of these wetlands. Effective management will require a co-ordinated approach by the different government agencies to allow this valuable but diminishing resource to be conserved.

Beyond the mangroves can often be found beds of **seagrass** which are flowering plants. These primary producers are found growing on the bottom at depths of up to 10 metres in clear water. They are particularly sensitive to turbidity which can be increased by dredging or pollution from sewage discharge. Increased erosion caused by some agricultural practices also contributes to turbidity. The seagrass is extremely important to many of our fisheries such as prawns, crabs, barramundi, mullet and other estuarine fish as it provides food and protection for them. It is also very important to larger herbivores such as dugong and turtles.

The seagrass ecosystem is extremely fragile and its destruction by human activities such as dredging, trawler fishing, or reclaiming for commercial industries and residential developments including canal estates could see some fisheries being destroyed.

Question

What Government agencies are responsible for the management of mangroves and wetlands in your local area?

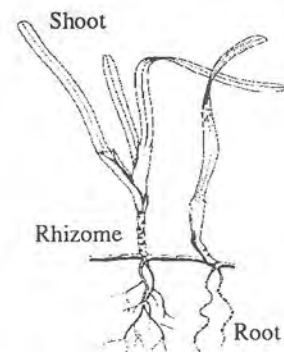


Fig 1.40: Seagrass.



Fig 1.41: Canal estate developments have major impacts on mangroves and marine life.

URBAN AND AGRICULTURAL ECOSYSTEMS

Urban Biomes

When people began to crowd together in towns and cities new environments were created or established. The natural environments in most cases were wiped out to make way for the building of houses, factories, roads, schools, etc.

The climate was also modified by industries and human activities causing air pollution. Certain species such as pigeons, sparrows, rats, mice, cockroaches and fleas have flourished in these new urban ecosystems.

Biomes are large ecological regions of the earth that have similar ecosystems. The entire living component of the earth where all biomes are joined together is called the "**biosphere**".

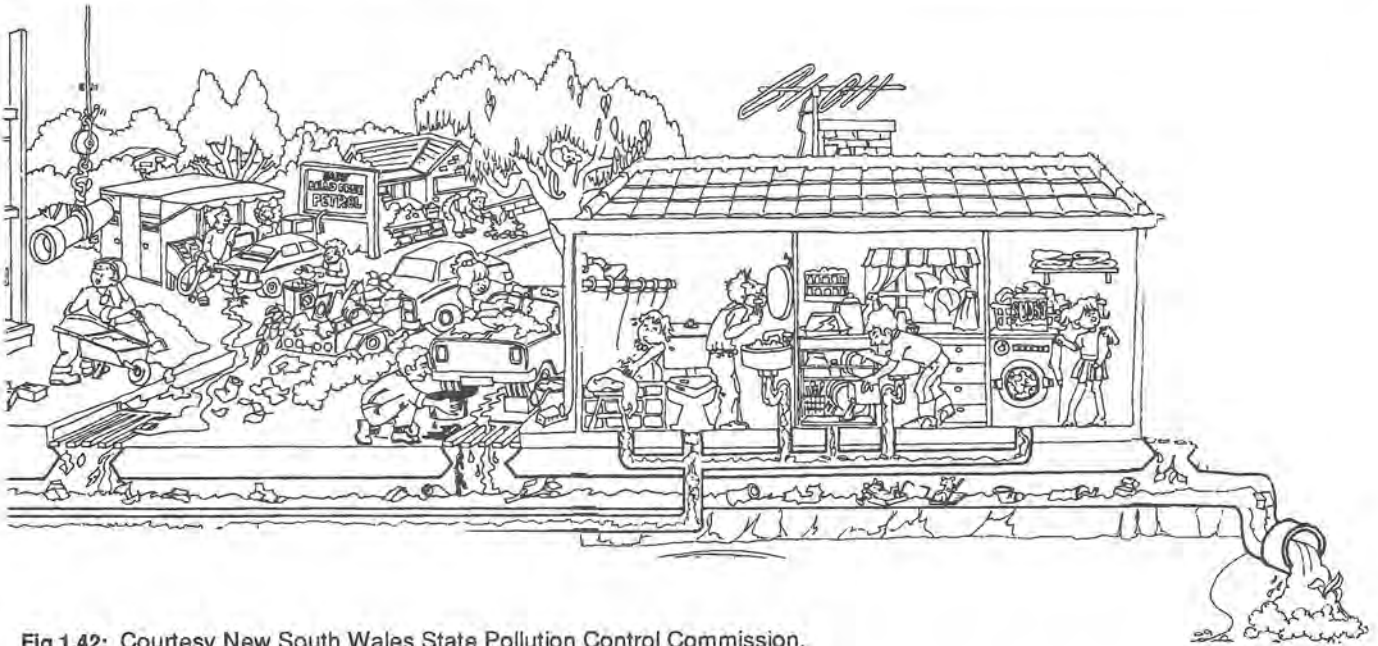


Fig 1.42: Courtesy New South Wales State Pollution Control Commission.

Water conditions were also changed with the increase in nutrient concentrations and many waterways became more acidic. The increase in acidity was due to a phenomenon known as "**acid rain**". The burning of fossil fuels which contain sulphur caused the production of sulphur dioxide which, when mixed with water or rain, forms sulphuric acid.

The population of aquatic organisms also changed as some organisms were less susceptible to pollution, while others were affected almost immediately. Biologists often use organisms which are very susceptible to pollution as **ecological indicators**. These organisms are called **indicator species** as they indicate the level of pollution in the waterway. A determination of the biological effect of a chemical using living organisms as indicators is termed a **bioassay**.

Trout have been found to be very sensitive to pollutants. They have been used as early warning systems to indicate the presence of pollutants in urban water supplies. Scientists, by monitoring the swimming behaviour, gill movements and heart rates of trout, can detect subtle changes in water quality without completing exhaustive chemical tests.

One of the best examples of indicator species was the use of canaries in underground mining operations at the turn of the century. The canaries were very sensitive to changes in air quality and if they started to literally fall off their perches, it was time for the miners to leave the area as dangerous gases were present. One of the major gases that the miners of the time were concerned with was methane, a poisonous and explosive gas.

Urban waters mostly contain less flora and fauna and are sometimes a near "**biological desert**" with no detectable life. Introduced species such as the mosquito fish and waterweeds have become the dominating species within the food web as they are better competitors and are more tolerant of pollutants. The animals and plants of these waters are often severely affected by pollutants and eating of fish, mussels, oysters and other marine creatures from these urban waterways is not advised. The oysters and mussels which feed by filtering the water through their body are particularly susceptible to pollutants.

Agricultural biomes

The human population increase has seen the need to develop efficient food producing methods. It is estimated that most of Australia's food comes from less than 5% of Australia's land area. This area is being efficiently farmed which means that the natural communities of these areas have been destroyed or replaced by, in most cases, a monoculture.

A **monoculture** means only one type of organism or plant is selected for cultivation and measures are taken to increase the yield of this species e.g. wheat, rice, cattle or sheep.

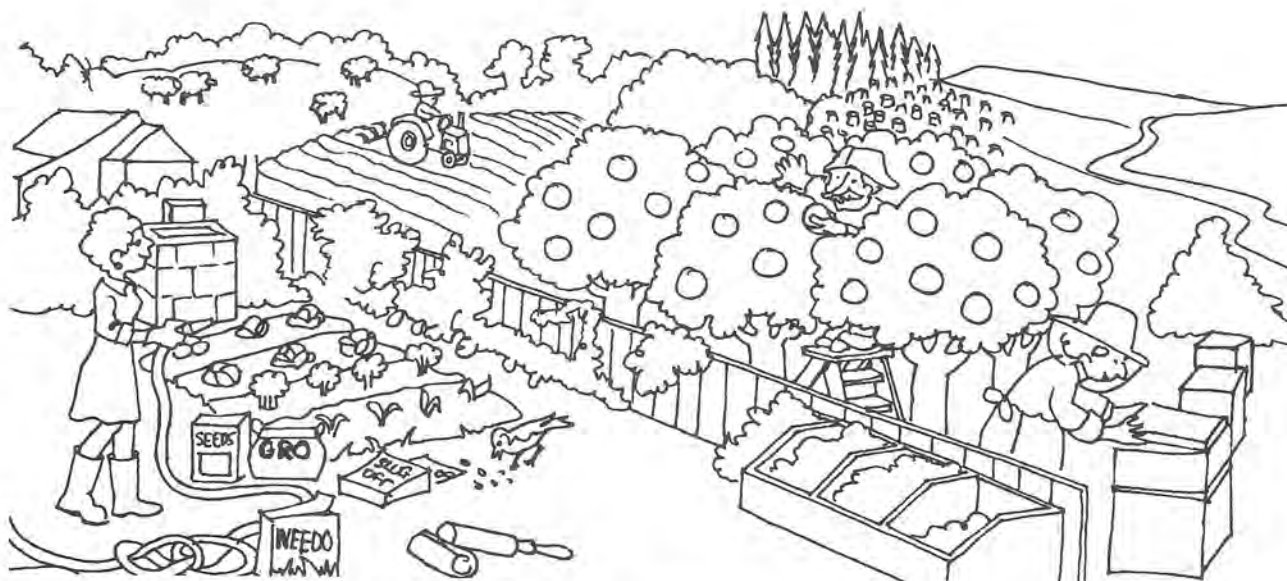


Fig 1.43: Courtesy New South Wales State Pollution Control Commission.

Some problems arising from this development of monocultures are:

- (a) Land degradation.
- (b) Reduction of nutrients.
- (c) Use of pesticides.

Land degradation in Australia is one of the least understood environmental problems. This problem may have very serious effects on the future use of agricultural lands. It is believed that many of the deserts of the world were once fertile agricultural land which were heavily farmed and eventually destroyed. In Australia the deserts or non-arable are slowly expanding and creeping onto the surrounding farmlands.

Common forms of land degradation include:

- (a) Soil erosion.
- (b) Increase in soil salinity.
- (c) Increase in soil acidity.
- (d) Loss of soil structure.
- (e) Reduced fertility.

Natural erosion is commonly kept in check by the root systems of the native plants holding the soil particles together. Farms have paved the way for water and wind to remove the precious top few centimetres of soil by removing the natural vegetation. Many of the introduced crops have a shallow root system and the land between the rows of plants are kept free of weeds by the farmer.

A pesticide leak in Bhopal in India killed over 1,000 people and injured 100,000 more.

Up to 50% of insecticides that are sprayed onto an area do not land on the cropped area.

Of this 50% only 1% of the chemical actually comes in contact with the pest.

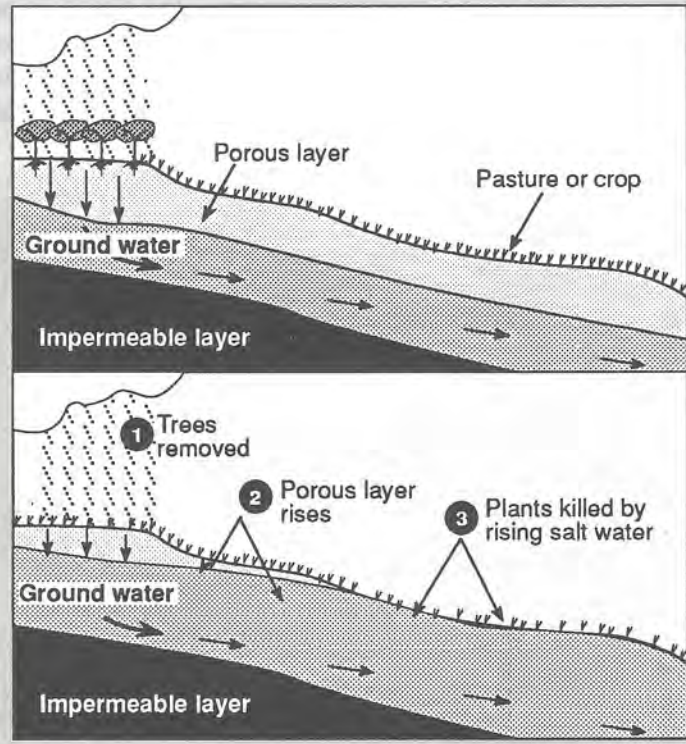
An increase in **soil salinity** occurs when the salt content of the soil builds up.

This can be caused by continual watering (irrigation) or the clearing from the land of the natural trees. In irrigation the water used penetrates the soil and dissolves the salts found deep underground. These waters may be reused and the salts they contain deposited in the topsoil.

The underground water table is rising in certain areas where land has been cleared. Natural environments mostly contain many large trees whose deep root systems draw large volumes of water from the table. These trees keep the water table at a level low enough not to affect most soils.

The replacement of natural vegetation with plants such as wheat and sugar cane which have shallow roots systems allows the water table to rise causing low lying areas to become water logged.

The evaporation of this water will leave the salts behind making the land unfit for plant life.



An increase in **soil acidity** is due to the build up of nitrogen compounds in the soil. This can be caused by the excessive use of fertilizers in some areas. Many farmers believe in the adage more fertilizer - more growth. Poor farm management methods and lack of knowledge have lead to the excessive use of nitrogen fertilizers in some areas. Agencies such as the DPI and CSIRO are continually educating and advising farmers to alleviate this problem.

The **soil structure** is affected by the over-cultivation or ploughing of the soil. To-day most farmers rely on artificial fertilizers and many of the soils lack organic matter or mulch. The continual loosening of the surface layer may cause the top couple of centimetres to be removed and the heavier clays to work to the surface.

Agriculture has also affected the environment with the use of chemicals to control pest numbers. We need to ask ourselves to what extent do farmers need to worry about controlling pests. It has been estimated that if farmers were not to control insect and plant pests their production would be reduced by 40-60%. This would mean the profits of the farmers would decrease, food production would drop and one of Australia's major exports would cease. The cost to Australia would be immeasurable.



Fig 1.44: Chemicals available at local shops have the potential to greatly affect our environment.

Many people see the need for the use of pesticides but better management practices and control over the use of these pesticides need to be implemented. An alternative may be the use of biological control. **Biological control** is the use of a pest's natural enemies to control the pest population. This method of pest control is non-polluting and everlasting. In addition it would only require one application. Successful biological control programs have been implemented to control prickly pear and salvinia.

CHAPTER 1

Salvinia is a water weed that lives on the surface of the water and can eventually form thick impenetrable mats over the waterway. The *Salvinia* chocks the waterway preventing light penetrating to the water, removing nutrients, increasing evaporation and reducing oxygen content. It also affects the movement of boats, fishing and other recreational activities. It has been declared a noxious weed in Australia. The CSIRO were able to introduce a weevil from South America to effectively control this weed. Many waterways which were completely covered with this weed have been cleared since the introduction of the weevil.



Fig 1.45: An urban creek where the natural community has drastically changed.

The biosphere

No ecosystem exists by itself. The ecosystems of the world interact together and form a total area called a **biosphere**. The carbon, water, nitrogen and sulphur all cycle through the different ecosystems linking them together. The food webs mostly contain some animals which move through many communities whilst migrating or simply looking for food. Thus, the way we treat our environment will affect environments in other regions of the world.

The pollution control measures and efforts to stop exploitation of certain species in one country will be ineffective unless there is an international effort.

MARINE MANAGEMENT IS A GLOBAL PROBLEM

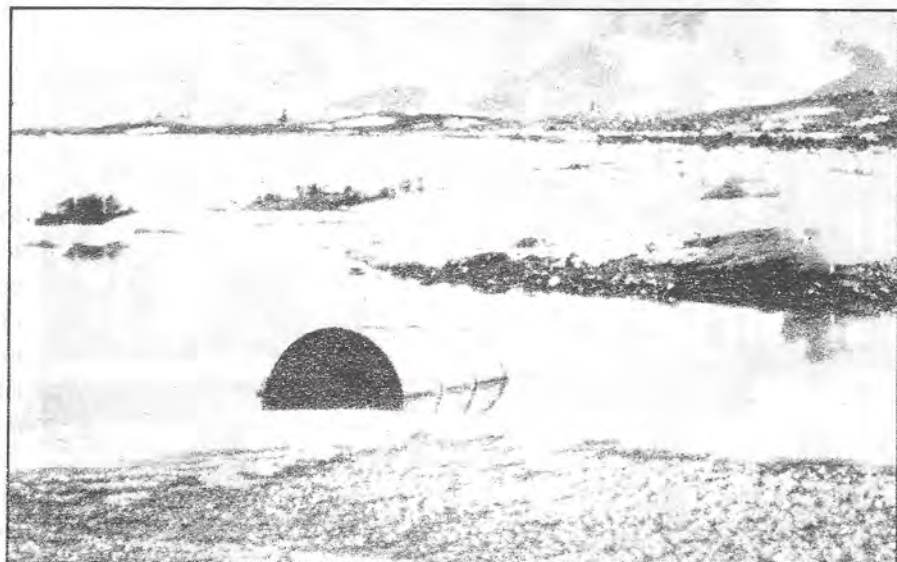


Fig 1.46: Discuss the implications of the photograph opposite. Photo courtesy Greenpeace.

An example of human degradation of the near-pristine Antarctic environment.

© GREENPEACE

QUESTIONS

- Define the following terms:
 - ecology
 - community
 - energy pyramid
 - ecosystems
 - nitrifying bacteria
 - extinction
 - population
 - endemic.
- What is the relationship between the community and the ecosystem?
- Could the non-living substances such as nutrients and water be regarded as part of the ecosystem? Explain.
- What is the difference between a food web and a food pyramid? Construct a food web and a food pyramid for a local waterway.
- Why does the removal of one species from the community have such a drastic effect on the other species in that community?
- Suggest how polar bears might have accumulated traces of chemicals such as DDT in their body tissue although these chemicals have not been used in their environment.
- Human milk has high levels of DDT and other cumulative chemicals such as lead and PCBs. These chemicals, therefore, start to build up in infants from the time they take their first drink of milk. Suggest a food chain to explain the occurrences of this fact.
- How can plants obtain nitrogen from their environment?
- How are bacteria important in the nitrogen cycle? Distinguish between the different types of bacteria in this cycle.
- How does the sulphur contained in the bodies of living organisms cycle back to the soil?
- Why is the human population increasing and what is rate of increase? Evaluate the effect of this increase in population on the environment.
- List some of the new methods used to harvest the sea and assess their effects on the ecosystem.
- List some of the species of plants and animals that we consider to be native to Australia, but in fact have been introduced into Australia only in the last 200 years.
- Name some of the species of animals that are in danger of becoming extinct. What can be done to prevent this occurring?
- What effect has the introduction of certain species of fish had on our waterways? Give examples of introduced fish. Why does the population of introduced plants increase to the point where they cause problems when they have not been a problem in their native country?
- What use do the Japanese make of whale products?

ESSAY TOPICS

- Discuss these statements:
 - No organism lives alone.
 - The population time bomb.
 - As safe as mother's milk.
 - The sea is an endless source of food.
- Some amateur fishermen have reacted strongly against the introduction of the new Queensland State Laws which prohibit the taking of any undersized fish of certain species and bag limits on other species. What is your reaction to the introduction to such laws? What other measures could be used to preserve the fish numbers?

ACTIVITIES

1. Construct a food web for a community near your home or in a local waterway. Identify the animals and plants that live there and their food sources to complete this food web. What decomposers might be in the community? Should they be a part of the food web?
2. The present world human population is approximately 5 billion. This huge number is fairly hard to comprehend. To comprehend the size of this number, calculate how long it would take you to count to this number. Starting at the number 1,234,756, count as quickly as possible for 60 seconds. Using this answer, calculate how long it will take you to count to 5 billion. The present population is increasing by 2% each year. What will be the population of the world when you finish counting?
3. Visit a local trawler fishing vessel to get a better understanding of the technological advances that have been made in commercial fishing. Question the fishermen on their views of the problem of declining fish numbers and their suggestions to overcome these problems.

RESEARCH

1. Use the library to research the following topics:
 - a. History of the whaling industry.
 - b. Products from the sea.
 - c. The decline of fisheries around the world.
 - d. The migration and habits of particular fish, whales or turtles.
 - e. Nutrient cycles other than those mentioned in the text.
 - f. Species on the brink of extinction.
2. Research the conditions in the cities of Europe between the 10th and 14th centuries. What diseases were prevalent? What were the symptoms of these diseases and how were they spread? Why aren't these diseases so common to-day?
3. The population increases at different rates in various countries or regions. What are the rates in the different countries and what factors affect the population increases? Suggest some methods to reduce the population growth.
4. Make a folio of newspaper clippings on people breaking quarantine laws trying to smuggle food, seeds and living creatures into Australia. Also collect clippings on the illegal fishing of Australian waters.
5. Find out which Queensland Government Departments are in charge of the management of Marine Parks and Reserves. Reference *The Barrier Reef World*, Wet Paper Publications, Page 72.

EXPERIMENTS

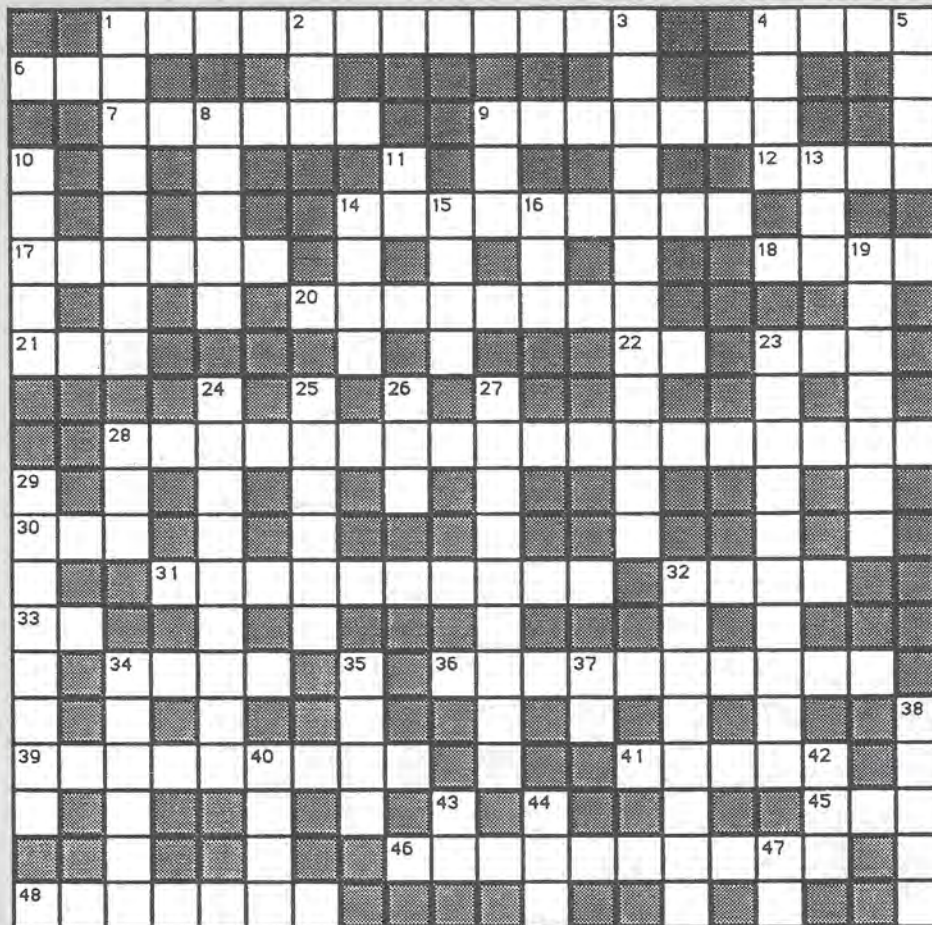
1. Pollution affects the growth of pond organisms. Create a number of miniaquariums in 500ml beakers. Place a small amount of pollutants such as oil, insecticides and detergents into the separate miniaquariums. Record the results over a period of time (A short spray of insecticide may be sufficient).

CAUTION

Use only small amounts.
Read instructions on the insecticides and
herbicides carefully and follow the instructions for the use of each.

2. Design and complete an experiment which will allow you to plot the growth of a natural population. The use of a plant such as duck weed which is easily grown in nutrient water solutions could be used. Record the population growth over a period of time.

CROSSWORD



CLUES

Across

1. Made during photosynthesis.
4. Fossil fuel.
6. World health organisation.
7. Environment.
9. Builds up in atmosphere due to burning fossil fuels.
12. Compass point.
14. Feeds on producers.
17. An element that is cycled in nature.
18. Barrier _____.
20. Wall of death.
21. Visual organ.
22. Symbol for gold.
23. Self.
28. 10, 8 bacteria convert nitrogen gas into nitrates.
30. Clear.
31. A type of net.
32. Chop.
33. Perform.

34. Placed on a fish hook.

36. A number of organisms.
39. All living and non living things together.
41. The keys of this are made from whale products.
45. Curved bone joined to the spine.
46. Isolation.
48. Methods of organising.

Down

1. To save.
2. Paddle.
3. Over fishing.
4. The centre of the earth.
5. Not first.
8. Single voice.
9. To cry.
10. Hydrologic _____.
11. To exist.
13. Beer.
14. Injure.
15. A fault.

16. Hotel.

19. A study of ecosystems.
23. The dying out of a species.
24. A group of organisms.
25. A product obtained from a whale.
26. Loss of life.
27. Feeds on herbivores.
28. Biological oxygen demand.
29. A plant.
32. A water weed.
34. All ecosystems together.
35. Extent of surface.
37. Not down.
38. Relating to town or city.
40. Part of a plant.
42. Naturally occurring mineral.
43. Symbol for copper.
44. Creative skill.
47. Symbol for nickel.



Building blocks of modern society!

Chapter 2

A Wasteful Society

Human civilizations once believed that the oceans were of such a huge volume that they could absorb or dilute most of their wastes. We are now realizing that this is not possible as the oceans have a finite quantity.

The oceans are in a state of delicate balance and there are fragile interrelationships between all the life forms that exist there. To maintain this natural equilibrium we must make sure that our presence has little impact on the oceans. There is, however, ample evidence that there are serious effects due to human presence. Every day we read articles in the newspapers telling of new evidence of some polluted area.



Fig 2.1: Our idyllic view of the ocean.

We have a wonderful resource at our disposal, but we tend to turn the inland waters into inland sewage or drainage systems and the estuaries into convenient dump sites for a wide variety of harmful concoctions. Most of our waterways near Australian cities and ports are showing evidence of contamination.

The introduction of harmful waste substances into an area is termed **pollution**. Pollution of the marine environment has been defined by the United Nations as: "The introduction by man, directly or indirectly of substances or energy into the marine environment resulting in

If the volume of the oceans of the world is 1,300,000,000 cubic kilometres, calculate the dilution factor if 100,000,000 litres of oil from an oil tanker disaster is spilt into this volume.

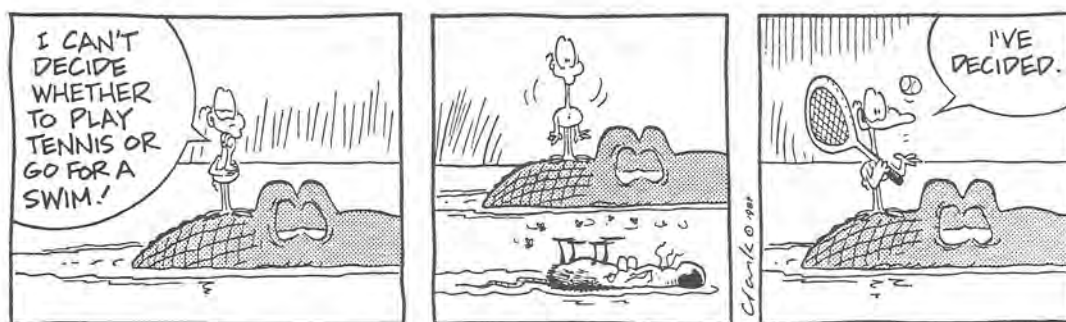
CHAPTER 2

such deleterious effects as harm to living resources, hazards to human health, hindrance to marine activities including fishing, impairment of quality of seawater, and reduction of amenities." This pollution is now being shown to be a serious problem as the harmful wastes do not mix evenly with all the waters.

In landlocked seas such as the Mediterranean Sea the waters have relatively small volumes and are more easily contaminated. The Mediterranean also has very small tidal ranges and it has been calculated it will take up to 70 years for the waters to be renewed. Over one hundred million people from sixteen different countries live on the Mediterranean coastline. It has been estimated that they produce and release into the Mediterranean a staggering 500 billion tonnes of wastes each year! 70% of the sewage which is pumped into the Mediterranean is untreated. In Australia most of the pollution occurs in coastal and estuarine waters as these are the sites of most major cities and the home of over 70% of the Australian population. Consequently, most of the waste materials and substances are released here and this area is more polluted than the open ocean.

Polluted Beaches Worry English Councils

LONDON:- It has been reported that nine out of ten bathing beaches in England are dangerously polluted, the Green Party says. Two hundred and twenty of England's bathing beaches weren't up to health standards and concern for public safety has been registered. Local councils are considering erecting warning signs.



POLLUTION - WHO CAUSES IT?

Most people believe that they are somewhat environmentally concerned and that they have little effect on their environment. They believe that it is the major factories and industries that are causing the problem. Most of these industries have been developed to create products that make life easier for us. If we examine the ways in which we use these products and how these products affect the environment we may have a better chance of overcoming some of the pollution problems.

Attempt to answer the following questions to determine how you are affecting the environment.

At school

- (1) How heavy is your port and what weight of paper do you estimate is in it? How much paper would you estimate you would use in one year?
- (2) What materials were used to make your school pens? How many synthetic items e.g. plastics, are found in your port?
- (3) Work out the volume of wood found in the classroom furniture and fittings. What other types of products have been used in the construction of this building? How could the design of this building be improved to make it more energy efficient?
- (4) What processed foods do you sometimes find in your lunch?
- (5) Who produced the foods in your lunch to-day and could chemical sprays have been used to kill insect pests?
- (6) Do you believe that the farmer would have used fertilizer to produce his product?
- (7) What region might the food have come from? One sandwich may contain foods grown in many different regions of Australia and overseas.
- (8) Of what type of material are your clothes made? If your clothing contains nylon or other synthetic fibres, what types of environmental problems may be associated with them?



At home

1. Who took the rubbish bin out this week and on which day was the rubbish collected? What volume of rubbish is normally placed in your bin each week? Calculate the volume of rubbish your family produces during one year. Estimate the volume of rubbish produced by your street during the year.
2. What type of compounds/materials are to be found in this rubbish? How long do you estimate it might take for each of these compounds to decay?
3. What type of packaging is found on items bought from the local supermarket? How could the amount of packaging be reduced?
4. Gauge the amount of garden wastes that are produced at your home during the year, e.g. lawn clippings, leaves, branches and other plant material.
5. What type of chemical preparations do you use during an average day? e.g. shampoo, deodorant, soap, toothpaste and detergents. How many of these products are biodegradable?
6. Estimate the volume of water used to flush the toilet. How much water might be used during an average week? Ask your parents if the total volume of water used by your household is shown on your rates notice. If it is, calculate the average daily usage. How might it be possible to reduce this volume?
7. What substances/chemicals might be disposed of down the sink in the laundry, the bathroom, the kitchen and other drains? Have you ever disposed of turps, water-soluble paints, insecticides, bleach, motor oils and car-care products by washing them down drains?
8. Look up a recent electricity account and assess the amount of electricity used by the family during that fixed period. What suggestions do you have to reduce the amount of electricity used?



It requires 1.0kg of coal to produce 2 kilowatt-hours of power.

How much coal is needed to produce your power needs for 1 year?



Travel

1. Have you travelled by car this week? Estimate how many kilometres you might travel in one week. Using this estimate of distance calculate the amount of fuel your car may have burnt. What weight of fuel does this equal?
2. Was the fuel lead-free?
3. How much damage to the environment may have been done in collecting the ore from which your car was made? Estimate the weight of your car and suggest the amount of raw materials which may have been needed to build the car.
4. Have you ever considered how much coal was burnt to produce the energy to convert the raw materials into your family car?
5. How many sets of car tyres has your car used? From what materials are these tyres made and what toxic by-products may be produced during their manufacture? How are these worn-out tyres disposed of? Could they be recycled?
6. Is the car driven in an energy efficient manner, is it serviced regularly, and does it have pollution control components? What might be some methods of increasing the energy efficiency of your vehicle?
7. How many trees and natural ecosystems were destroyed to make way for the roads on which you drive? What are the roads made of and estimate the volume of road building materials needed to produce a surface 4cm thick, 6m wide and 2km long? Can you visualize the amount of material that has been used by your city council to manufacture the network of roads in and around your city?
8. Would it have been possible for your family to have used your family car less? Would it have been better to have used public transport, a bicycle, or to have even walked on some occasions?

Car facts

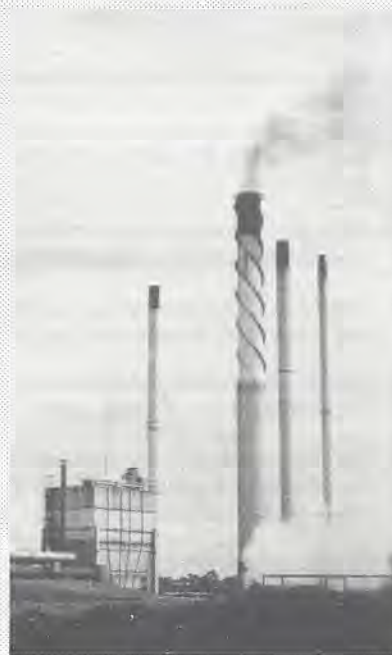
Car exhausts contain five major air pollutants

- * Hydrocarbons
- * Lead
- * Carbon Dioxide
- * Nitrogen Oxide
- * Sulphur Dioxide

CAUSES OF POLLUTION

The causes of pollution are many and growing at an alarming rate each year. The discussion which follows identifies the following as causes:

- * *Pollution by human wastes and other domestic wastes.*
- * *Technological and household wastes.*
- * *Pollution by industry (thermal, toxic, organic, nutrient and acidic substances).*
- * *Pollution by agriculture (deforestation, fertilizers and pesticides).*
- * *Radioactive wastes.*
- * *Oil pollution.*
- * *Mining.*
- * *Construction sites, quarries and roads.*
- * *Accidents.*
- * *War.*
- * *Natural causes.*
- * *New sources.*



Industry producing air pollution. How could this affect our waters?

POLLUTION BY HUMAN WASTES AND OTHER DOMESTIC WASTES

Organic wastes such as animal and human excreta can become a major pollution problem. These organic materials do not constitute a problem in small quantities as they decay reasonably quickly, but the concentrations of organic wastes in waters draining large cities often reach levels which may be a threat to public health or the fish of the area. The organic wastes take longer to break down and become an unhealthy and unsightly problem. Heavy pollution in Sydney created by an inadequate municipal system is causing many pollution problems to beaches such as Bondi and North Head as well as choking the harbour.

In nature the organic material is decomposed by micro-organisms such as bacteria. These materials are said to be **biodegradable**. The bacteria convert the complex organic substances into simpler compounds, but in the process use up oxygen. The large numbers of bacteria use up large amounts of oxygen that other animals such as fish may require. The amount of dissolved oxygen in the water is unable to meet the **biological oxygen demand (BOD)** of the other animals living in the water.

These wastes may also contain harmful micro-organisms such as bacteria and viruses which cause diseases such as typhoid, amoebic dysentery, hepatitis and cholera.

The micro-organisms that cause these diseases are called **pathogenic microorganisms** or simply **pathogens**.

Epidemics of typhoid and hepatitis have been caused by people eating shellfish containing pathogens. These shellfish have come from areas which have high faecal contamination.

Sewerage may solve some of the fuel problems of the 20th Century.

The bacteria which break down the sewerage produce methane gas. This gas could be used to power cars, generators, and hot water systems.

These biodegradable detergents are a bit harsh on the clothes!



Research also indicates that the Great Barrier Reef is at risk of being destroyed by waste produced by the coastal cities and towns. It is believed that the corals will be smothered by debris and plants, such as algae, which will increase in number as they break down the wastes.



Fig 2.2: Some of the different life forms of life found on a reef.

TECHNOLOGICAL AND HOUSEHOLD WASTES

With the increase in technology has come an increase in waste production. We are now living in a “throw-away” society with most goods we buy having specialized packaging which cannot be reused. It has been estimated that on a national basis each person in Australia is responsible for one tonne of rubbish each year.

The amount of garbage that Australians throw out each year has been estimated to contain:

- * 400,000 tonnes of metal.
- * 600,000 tonnes of plastics.
- * 1,000,000 tonnes of paper, which represents 10 million trees or a large forest.
- * 700,000 tonnes of glass, mostly in the form of soft drink and beer bottles.

Over 2 billion tonnes of solid waste are produced each year in the USA.

Most of these wastes are used as land fill around our major cities, although some finds its way into our waterways. The cheapest method of disposal is to bury the lot (most are left open and are therefore health hazards). Most city councils are running out of space for dump sites. In Sydney by the year 2000 it has been estimated that the council will need an area the size of a major suburb to dispose of the 10 million tonnes or 200 million cubic metres of wastes.

The average local council in Australia spends over 20% of its annual budget on waste disposal. It is, therefore, estimated that over 800 million dollars each year is spent on this problem. Many of the landfill sites were originally unique estuarine mangrove communities.

These communities have been destroyed forever to make way for the disposal of household wastes. Many plants and animals that were once found in these areas are now becoming endangered species.



Fig 2.3: A typical dump site.

COUNTRY	INDUSTRIAL WASTE PER PERSON PER DAY
---------	--

India	0.20kg
Asia	0.25kg
Switzerland	0.60kg
England	1.20kg
Australia	1.40kg
USA	2.50kg

COMPOSITION OF A TOWN DUMP

- 50% Paper and timber products.
- 14% Garden wastes.
- 12% Food wastes.
- 10% Plastic and rubber.
- 8% Metal.
- 6% Glass.

Graph this information as a pie chart and suggest how recycling could change these proportions.



Another major problem has been that the technological wastes have affected the local fauna. Plastic bags have been inadvertently mistaken for jellyfish and eaten by seals, turtles and whales. These animals choke on the plastic bags and eventually die. On one occasion an autopsy on a sperm whale revealed over forty plastic bags stuck in its throat.

POLLUTION BY INDUSTRY

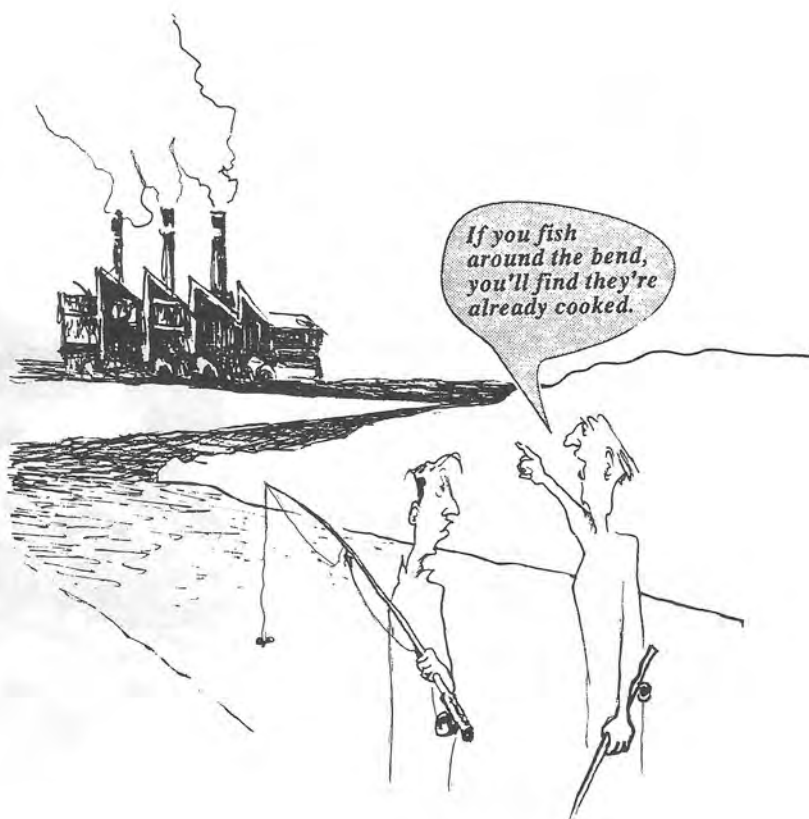
Thermal Pollution

Many industries have heavy machinery which generate large amounts of heat. Industries such as steel manufacture and electricity generating plants use large volumes of water as coolants.

This causes **thermal pollution** of many streams and rivers by raising their temperatures by up to 10°C. This, of course, will have a major effect on the natural communities and the individuals living in these areas.

The behaviour patterns of many aquatic animals are influenced by water temperature. This temperature is the stimulus for many fish to spawn and migrate.

Fish, being "cold blooded" animals, become more active in warm water, thereby affecting their growth rates.

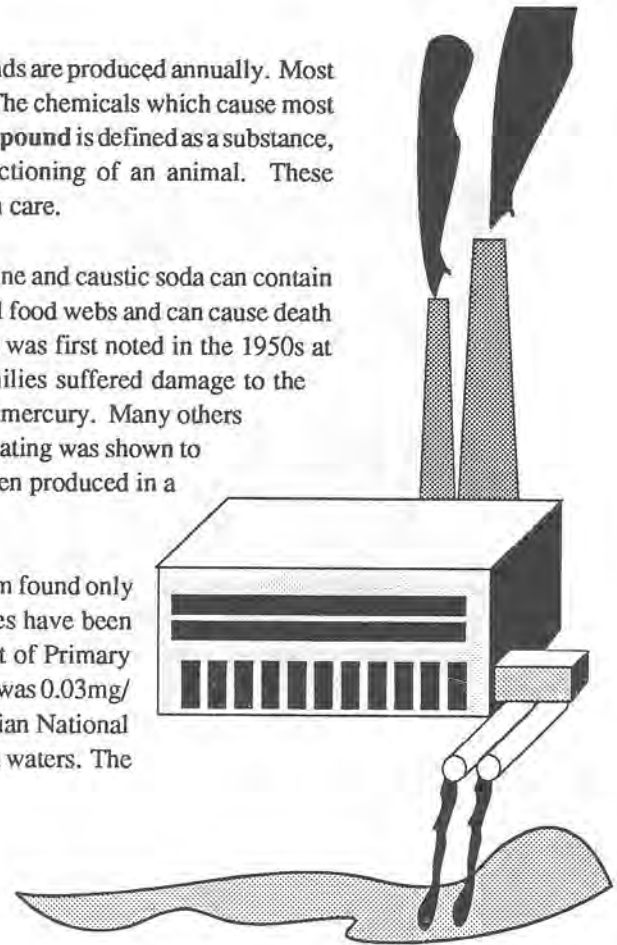


Toxic compounds

World wide, over 25 million tonnes of manufactured compounds are produced annually. Most of these eventually find their way into the marine environment. The chemicals which cause most concern are the non-biodegradable toxic compounds. A **toxic compound** is defined as a substance, that by its chemical action, can kill, injure or impair the functioning of an animal. These compounds are also dangerous to man and must be handled with care.

Effluents from paper mills and factories manufacturing chlorine and caustic soda can contain large amounts of mercury. Mercury can accumulate in the natural food webs and can cause death to many animals including man. Mercury poisoning of humans was first noted in the 1950s at Minamata Bay, Japan. The fishermen of the bay and their families suffered damage to the nervous system and over 110 people died as a direct result of the mercury. Many others were left crippled, blind and/or infertile. The fish that they were eating was shown to contain extremely high concentrations of mercury which had been produced in a factory making acetaldehyde.

This problem of mercury contamination of fish is not a problem found only in overseas countries. The levels of mercury in local fish species have been shown to be very high in surveys carried out by the Department of Primary Industries. In 1971 the maximum recommended level of mercury was 0.03mg/kg (ppm) in all foods. This was changed in 1972 by the Australian National Health because of the high levels found in fish caught in Australian waters. The new level was set at 0.5mg/kg, a large increase.



Toxic chemical in the top three Aust imports

AUSTRALIA spent \$1.84 billion importing toxic chemicals last financial year.

Australian importers spent \$120m on cyanides often used in gold mining and \$361m on sodium hydroxide used in soap manufacture.

It was the country's third highest import cost.

Only the importation of motor vehicles (\$2.23b) and computers (\$1.96b) out-ranked chemicals in the 1989-90 financial year, Statistics Bureau figures show.

The danger in storing, handling and using hazardous substances prompted a State Government crackdown on safety in chemical industry workplaces.

The accident prevention division director, Mr John Hodges, said many Queensland employees in the chemicals industry worked in unsafe workplaces.

He said employers and employees were often unaware of the dangers.

The State Government, under the Workplace Health and Safety Act, has moved to improve safety at workplaces which used hazardous substances.

By JOHN LEHMANN

The Employment, Training and Industrial Relations Minister, Mr Warburton, said: "The risks of a hazardous substance are usually invisible and undetectable to workers and other persons associated with the workplace.

"There is usually no immediate or blatant warning of any imminent risk, whereas it is obvious that a machine without guarding may be dangerous.

"The damage caused by exposure to hazardous substances may not be immediate as symptoms of ill-health may not become apparent for months or years."

Mr Warburton said the provision and implementation of safety controls would be costly.

About 500 people last week attended two seminars the Chemicals and Chemical Products Industry Health and Safety Advisory Committee organised after manufacturers and employees requested an outline of their obligations under the Act.

Species	Mercury Level
Whiting - sand	0.30 mg/kg
Tailor	0.23 mg/kg
Mullet	0.02 mg/kg
Flathead	0.29 mg/kg
Barramundi	0.11 mg/kg
Marlin - black	7.27 mg/kg
Hammer head shark	0.92 mg/kg

Source DPI Report on Mercury in Fish AGPS 1985

From these values it can be seen that high levels of mercury are found in the fish we eat and will, therefore, be in our body. Some of these fish samples were also shown to contain selenium, arsenic, copper and zinc.

Many other toxic compounds are produced in the manufacturing industries and most have no effective method of disposal. Thousands of tonnes of lead and other heavy metals are produced by industries simply by burning fossil fuel which contain these elements.

Highly toxic industrial wastes in Buenos Aires have contaminated their water supply and even closed some beaches.

This article courtesy Courier Mail.

CHAPTER 2

Organic compounds

Many of the food processing industries release large amounts of organic material into the oceans. Abattoirs, for instance, release large volumes of non-usable materials such as blood and offal into their nearest river system. Large volumes of water are also used to wash the carcasses and floors.

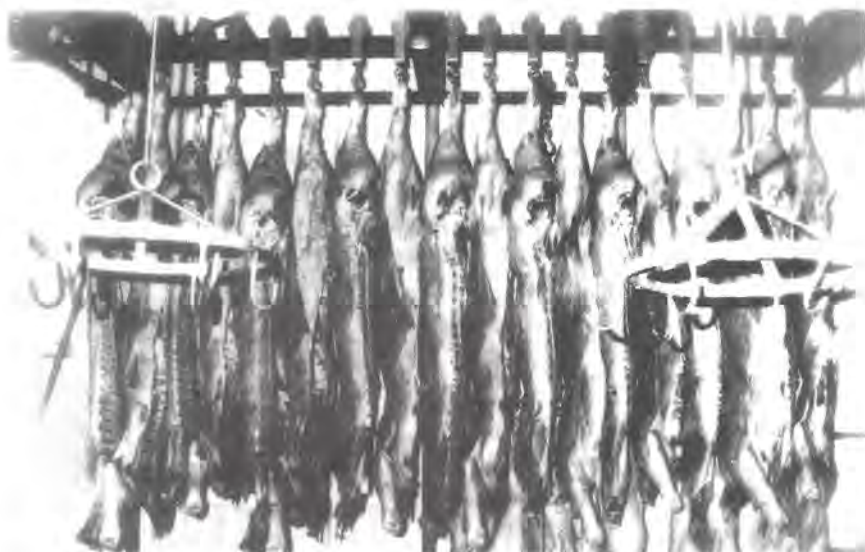


Fig 2.4: Abattoirs and food processing factories release large volumes of non-usable materials.

Other food industries including dairies, breweries, fish markets and canneries contribute to this organic pollution by releasing food materials into the water. This causes a build-up of micro-organisms and a decrease of oxygen in the water. Other industries which contribute to the problem include paper mills, textile manufacturers and petroleum industries.

Nutrient compounds

Industries also produce as wastes many substances which are high in nutrients. Nutrients such as nitrates and phosphates, when present in very high concentrations, cause population explosions of algae and other phytoplankton. This excessive growth of algae in the water causes the water to taste unpleasant and poisons fish with their wastes. When these algae die, the bacteria that break them down, use up the dissolved oxygen that is so necessary for other animal life. The process by which the waterway becomes enriched with nutrients so that it can no longer support life because of the oxygen depletion is termed **eutrophication**. The growth of red algae off Japan has choked much of the marine life found on its shores and causes a phenomenon known as red tides.

Acids

Steel rusts or corrodes in air and must be treated if it is to last for any period of time. The main method of stopping this corrosion is by coating the metal with paint. Before the metal can be painted it must be cleaned, usually with **acids**. The metal needs to be washed free of acid before painting. This acid along with the acid baths themselves which may need replacing are flushed into the streams.

POLLUTION BY AGRICULTURE

Deforestation

The clearing of large areas of land of their natural vegetation has increased the erosion due to water run-off. The natural vegetation in the area would have held the soil in place. The increase in ploughing and the planting of crops such as wheat, corn and sugar cane (which do not have extensive root systems) has also caused more erosion. Poor farm management in the form of over-grazing by cattle and sheep has also contributed to this problem.



This eroded material settles to the bottom and clogs up the rivers and estuaries. The waters also become very muddy, decreasing the clarity of the water. This reduces the amount of light that can penetrate the water and thus, decreases the amount of plant life that can exist in the water. The silt also has an effect on structures of certain animals, such as the gills of fish. The build-up of sediments on the river bed also limits the breeding of certain species of fish such as the catfish which builds its nest on the gravelly bottom.



Fig 2.5: Sugar cane farms use large areas of land near rivers and are heavily fertilized.

Fertilizers

Most farmers, in their effort to increase production, add extra nutrients to the soil. These fertilizers such as phosphates and nitrates are washed by the rain into rivers where they can produce major increases in plant growth. This huge increase in the amounts of aquatic plants can clog up streams and rivers. At night these plants use up oxygen that is required by aquatic animals.

Pesticides

The farmers are constantly having problems with insect pests eating their crops and threatening the health of their animals. The cheapest and most effective way of reducing the pest numbers is by the use of insecticides and pesticides. These chemicals are produced synthetically and can be classified into two groups:

- (a) The chlorinated hydrocarbons or organo-chlorides such as DDT and Dieldrin.
- (b) The organic phosphates.

It has been estimated that over 2.5 million tonnes of organo-chlorides have been used by farmers around the world. These chemicals are sometimes called **biocides** because they affect animals other than the target pest for which they were designed. They accumulate in the food chains until they reach toxic concentrations. Their full effects are not known as yet as their effects may only show up in the third or fourth generations in 30 - 40 years time.



DDT is an important pesticide used to control insects and other destructive organisms. It can last up to 20 years and is not broken down in the body. It has been estimated that over 2 million tonnes of DDT have been scattered across the earth. DDT residues have now been found in human tissue. The organo-chlorides dissolve in the fat tissue and remain in the human body until death.

A large amount of the chemicals that are sprayed by the farmers, in fact, never reach the insect or pest for which it was intended. Of the thousands of litres that are sprayed over crops, less than 500mls come in contact with the target insects. The rest of the chemical is eventually washed into the waterways after rain or irrigation.



Fig 2.6: Pesticides freely available for purchase.

Source	Parts per million (ppm)
Water	0.0002
Plankton	0.12
Small fish	1.2
Predatory fish	15.0
Sea bird	80.0

These organisms represent steps within a food chain and show the build-up of DDT along the chain.

The dispersal of these chemicals into the air is also a problem for people living in the vicinity. Many of these chemicals can be absorbed readily into the human body where they can cause cancer and deformities in unborn babies.

Organo-chlorides are now being sprayed in higher concentrations as each new generation of insects becomes more resistant to their effects.

These chemicals are killing many useful or beneficial animals such as bees and prawns as well as the pests.

These chemicals have also caused deformities in embryos, genetic disorders and even threatened the survival of many bird species by reducing the thickness of their eggshells.

RESIDENTS PUSH FOR AERIAL SPRAYING REVIEW PAYS OFF

From LEISA SCOTT
at Tully

PRESSURE from a north Queensland lobby group has prompted the State Government to review legislation governing aerial spraying of crops.

A spokesman for the Primary Industries Minister, Mr Casey, yesterday said the Government was aware people in the Tully district and other parts of Queensland were concerned about chemical spray drift on to their properties.

He said the legislation covering spraying would be reviewed because of concern that chemicals were reaching homes and causing health problems.

Members of the Tully-based Citizens Against Aerial Spraying, said they suffered sore eyes, nausea and giddiness after bananas and sugar cane near their homes were sprayed. They said they feared long-term health damage as the chemicals had drifted to their properties.

A Primary Industries Department senior technologist, Mr Garth Granger, yesterday said prosecution was possible if crop or stock were damaged by aerial spray drift, "but there is no legislation to look at drift on to people".

Mr Granger said Queensland was the only mainland State that did not have legislation to enable residents to prosecute if spray drifted on to their properties.



THE Tully-based Citizens Against Aerial Spraying ... will pressure the Government to have legislation changed. Pictures: DAVID CROSLING

A department discussion paper presented to the former National Party Government in January last year proposed that "the drift of chemical spray on to a built-up area or place of human habitation be made an offence with a maximum fine of \$12,000".

Mr Granger said the paper's recommendations had not been acted on.

A spokesman for the lobby group, Ms Rosie Miller, said yesterday she was encouraged by information that the Government was reviewing legislation but would continue to pressure until the legislation was changed.

"There are no laws to pro-

tect us — our argument is that sure, farmers have their rights as long as they keep it on their crops and not on us," Ms Miller said.

"I get sore eyes from some of the chemicals they use around my place. Does someone have to go blind before anything is done about it?"

Group members claim spraying has been conducted in strong winds and that children have been caught in thick spray when playing in crooks and on properties.

The group is planning a health survey of the district to determine if there is an abnormal percentage of people suffering certain illnesses.

The Tully and District Chemical Monitoring Committee, which was set up last year by the banana and cane growers in response to the residents' group, aims to educate growers and operators on the correct usage and storage of chemicals.

A committee member, Mr Peter Lucy, said he believed education, not legislation would help solve disputes.

In 1987, people in Emerald feared that aerial and ground spraying had contributed to an increase in rates of leukaemia among children. Sunshine Coast residents have lobbied against aerial spraying in the past.

This article courtesy of The Courier Mail.

RADIO-ACTIVE WASTES

The dumping of radio-active wastes occurs in many parts of the Pacific Ocean. Many of the most dangerous substances ever to be created are being packed into drums and being dumped into the sea. These drums which can contain the highly radio-active plutonium will eventually corrode in the seawater allowing these substances to escape. These dangerous substances will then enter the food chains and eventually humans.

European countries have been dumping radio-active materials in the Atlantic since 1950. The quantities rose from 3.5curies in 1950 to over 100,000curies in the 1980s. We all know that the oceans are a finite quantity and these large doses of radiation may cause problems for future generations.

Low energy radio-active wastes are also being produced by hospitals, universities, atomic research facilities and certain industries. The mining of uranium in British Columbia has caused radio-active pollution to that area. Mines in the Northern Territory are also thought to be causing problems.

Radiation from nuclear tests in the Pacific by the French and American governments has also led to high levels of radiation. The fall-out from atmospheric tests all ended up in the ocean. Underground tests are now thought to have caused cracks within the structure of the islands allowing for the escape of some radiation.

Radiation effects the reproductive organs of most animals causing the malformation of the developing young. This is known as **mutations**. Radiation can also cause the uncontrolled growth of some cells which are known as cancers and tumours. Very high concentrations can kill the living cells causing severe burns and death. Organisms vary in their ability to withstand radiation. Humans become sterile at 0.1Krads and die at 0.5Krads, whereas the common cockroach can survive 400 times this radiation level.

NUCLEAR DISASTER

Moscow: At Chernobyl in the U.S.S.R. on the 26 April 1986, a nuclear reactor exploded. Several tons of radioactive material escaped into the air, killing 30 people and effects millions of other Europeans.

Curie - a unit of measuring radio-activity. The amount of substance in which 37 million atoms per second undergo radioactive change

Radioactivity can accumulate in human bodies just as pesticides and other toxic compounds.

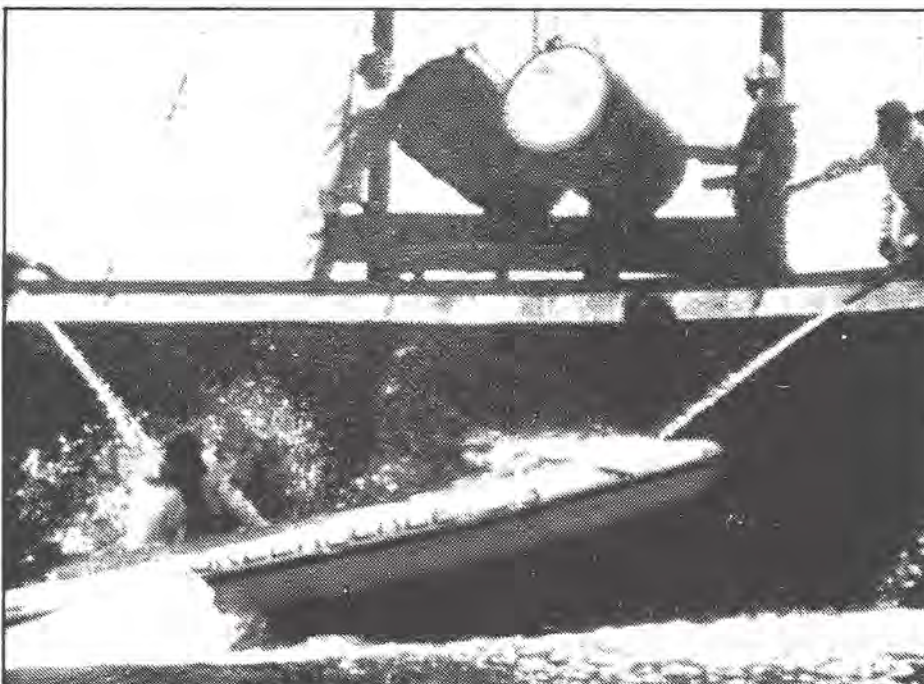


Fig 2.7: Protestors trying to stop dumping of radioactive waste. Photograph courtesy of Greenpeace.

OIL POLLUTION

Oil pollution poses a major threat to the marine environment. The sources of this pollution are:

- * Industry.
- * Spillages from oil-rigs and oil-refineries.
- * Discharges from ships.
- * Tanker accidents.

The major source of the oil is not via accidents or spillages, but from industry. Oil spillages from tankers only represent 4% of the total oil pollution of the oceans. Newspaper headlines are grabbed by the major oil spills causing oil slicks. When oil is spilt, it spreads over the ocean forming a thin layer called a slick. One litre of oil can form an oil slick covering 8,000sq.m.

When a major oil spill occurs, a massive area of the sea becomes covered with oil and has a catastrophic effect on the coastline if it comes in contact with it. Coral reefs and mangrove areas would become smothered with oil. Shellfish such as oysters and mussels would become inedible and whole fisheries may be wiped out. Animals which live on the surface such as birds and seals could become coated with oil and die.



Fig 2.8: California 1970, showing oil pumps beside beach.



Fig 2.9: Offshore oil rigs near Malibu, California, USA.

OIL SLICK THREATENS MOROCCO

MOROCCO: Morocco is set to become an ecological disaster area. The Iranian supertanker Kharg-5 spilt an estimated 27,000 tonnes of crude oil 100 nautical miles off the coast of North Africa near Morocco. An explosion on board the Kharg-5 started a massive fire

causing the ship to be abandoned.

Escaping oil caused a slick which covered an area of 4,000 sq km. The coastal communities of Safi and Casablanca are expecting their beaches to be covered by oil within the next 3 days.

This area supports a large fishing industry with

over 40,000 fishermen. A government spokesman said that this may be the worst catastrophe to ever hit the area.

Thousands of local fishermen may lose their jobs and the tourist industry may be severely affected.

Questions:

- (1) What factors affect the movement of oil slicks?
- (2) Who should pay for the clean-up operation?
- (3) What measures may be taken to reduce the occurrence of major shipping disasters producing oil slicks?
- (4) How does the oil affect the ecosystems which it covers?

The birds become covered in oil upon landing on the surface and the feathers lose their waterproofing capacities. When the birds attempt to preen their feathers, they ingest the oil and die. The birds also die as a result of hypothermia (loss of body heat) as the insulating air layer around the body is lost as the feathers become slicked down.

The oil has little effect on the plankton and fish that are found below the oil slick. These animals, however, have been severely affected by some of the chemicals that have been used in the past to break up the oil slicks.



Major oil slicks of the oceans can now be monitored by satellites circling the Earth. One of the major sources of oil pollution in the past came from oil tankers washing out their tanks. Oil tankers take oil from the oil fields to the port that requires the oil and off-load the cargo. On the return trip they carry water as ballast so as to remain stable in the water. These tankers have to be cleaned out before the tank can be refilled with oil. This cleaning produces a mixture of oil and water that has to be separated. Some of the water is separated from the oil and the mixture left is required by law to be stored on board for discharge at the next port or reused for cleaning. However, some is believed to be dumped at sea. This practice is now strictly controlled under international law and ships are required to meet construction and operational standards which are enforced by regular port inspections, survey and certifications.

Australia has a national program to deal with the possible oil spillage occurring in Australian waters. Most states have equipment and a supply store ready to be used in case of an oil spill. If such a spill occurred it would be nationally controlled from Canberra with experts ready to step in and clean up the area immediately.

PETROL FACTS

Petrol is processed from crude oil in oil refineries. Petrol consists of the elements hydrogen and carbon and is called a **hydrocarbon**. Many hydrocarbons contain lead additives to increase the octane rating of the fuel. This high octane fuel (super) is needed by many of our high performance engines and most car engines produced before 1985.

Because of the volumes of petrol consumed it is estimated that the burning of lead-based fuel leads to thousands of tonnes of lead being deposited in the seas. We have now 400 million cars in the world producing 10,000 billion cubic metres of exhaust gas per year. This is enough gas to envelope the entire Earth's surface to a depth of just less than one metre. These poisonous fumes are simply dispersed into the atmosphere where they change our environments forever.

Approximately 40% of all shipping are vessels designed to carry oil. Approximately a half of all cargo carried around the sea-routes of the world is oil.

The fuel and oil that we take for granted at the local service station has been transported many thousands of kilometres to be available at the petrol pump. The chance of accidental spillage is great.



Fig 2.10: Fuel pump.

POLLUTION BY MINING INDUSTRIES

Heavy metals such as mercury, zinc, copper, arsenic, cadmium and lead are disturbed from their underground resting places by mining operations. Most of these operations use large quantities of water in the mining and separation of these minerals. Some of the minerals escape the mining procedures and are carried away into the river system.

These minerals are **persistent** i.e. not broken down by natural means. The metals are absorbed by the marine organisms, particularly the producers and build up in the food chain. When in large doses, these heavy metals have severe effects on humans, the major effect being on the nervous system as already discussed in the section on Toxic Compounds.

The **dredging** of the continental shelf and the coastal areas also causes many problems. The deep water dredging method is sometimes used to mine the seafloor. In these operations the dredges are used to bring to the surface nodules containing nickel, copper, manganese and cobalt.

These operations produce a lot of wastes since only 2-5% of the load is kept while

Questions:

1. One litre of fuel when burnt releases 2.4 kg of carbon dioxide gas. If your family car travelled 20,000 kms last year and it were to consume 1 litre of fuel for every 10 kms it travelled, calculate the number of kilograms of carbon dioxide produced. If we are going to plant trees to use up this amount of carbon dioxide, calculate the number of trees that need to be planted, given that an average tree uses 200 kgs of carbon dioxide each year.
2. Super petrol contains 8.4 grams of lead per 10 litres of fuel. Calculate the grams of lead produced by an average car that may burn up 1,000 litres of fuel per year.

the rest is returned to the ocean. This enormous amount of material clouds the water to the extent that it cuts out the sunlight. This kills the producers of the sea and, therefore, all life in the area.

The clouds of silt also cover most benthic organisms and destroys many fish breeding areas. The dredging also destroys the bottom on which it is operating.

Fig 2.11 A dredge used to nourish beaches. Photo courtesy Beach Protection Authority.

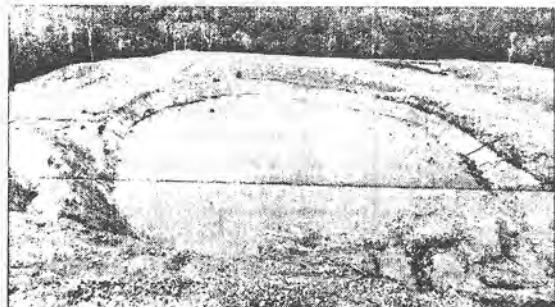


Dredges are used along our coast to remove sand banks, build up beaches and to clear silt from shipping channels. These sand banks can protect the shoreline from the erosive forces of the sea. Thus, the removal of the sandbars can lead to the destruction of mangroves and tidal estuaries.

Poison brew threat over coastal creeks



ABOVE: Drums piled up beside an abandoned gold mining tailings dam in the Conondale Ranges. BELOW: One of the two tailings dams containing a deadly sludge of cyanide and heavy metals



By STEPHEN LAMBLE

HOME and farm water supplies from the Sunshine Coast to Maryborough are threatened by a murky green witches' brew of cyanide and heavy metals.

The threat comes from two abandoned gold mine tailings dams high in the Conondale Ranges.

Both dams are fenced off and have warning signs but little has been done since the Astrik gold mine near Mount Cabnet, about 80km west of Caloundra, closed more than a year ago.

The dams are on a steep scarred ridge between the headwaters of Bundaroo and Booloumba creeks in the midst of magnificent rainforest. They are about 100m above Booloumba Creek which runs along the edge of the open cut mine.

Both creeks are tributaries of the Mary River.

The Astrik workings, formerly known as the Agricola mine, were reopened late in 1987 despite local protests about the threat to the environment. Astrik Resources NL managing director Mr Rob Slaughter said the miner was bending over backwards to protect the environment.

The company hoped to win \$20 million a year for at least four or five years from the mine but Astrik reported a loss of \$5.9 million in 1987-88, blaming smaller than expected gold reserves, bad weather and a world shortage of sodium cyanide for ore treatment.



Bill MacDonald ... "once you never had to speak about these things, now it's all different"

In February this year, the Queensland Supreme Court ordered the company wound up.

A spokeswoman for the Resource Industries Minister, Mr Vaughan, admitted there were potential problems at the mine.

"There is clear liquid on the top and sludge and solids at the bottom of the dams," she said. "The stuff at the top is not so bad, but there are very heavy concentrations of cyanide underneath."

"The problem is the company went broke and is in liquidation and the Government holds only a \$20,000 security deposit."

This article courtesy Courier Mail

Many canal estates have been set up along the coastline. These canal systems slow down the water flow and thereby cause silting. The mining of sand for minerals such as zircon and rutile has also had an effect on the beaches and the natural ecosystems.



Fig 2.12: Sand mining operations, Moreton Island.

CONSTRUCTION SITES, QUARRIES, AND ROADS

These also produce many substances that are not normally found in the water. Construction sites and quarries contribute to the increase in particles found in water. This silting has the same effect on the marine creatures as explained in the previous section.

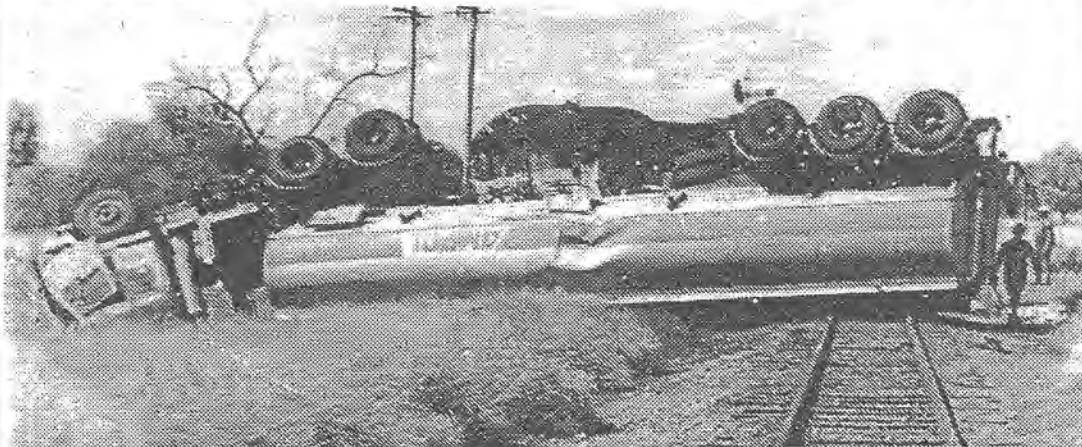


Fig 2.13: In an effort to give large ships access to land many piers are being built. This new pier is being build on Fisherman Island, Brisbane.

ACCIDENTS

Pollution problems may also be caused by accidental spillage or fire causing the escape of toxic or hazardous compounds into the environment. Some wastes are deemed to be too hazardous or so toxic that they cannot be stored in impervious pits. These are called **intractable wastes** and are currently stockpiled in safe areas.

Residents flee potential blast



• The 200 residents of Thallon were moved to shelter after this train and truck collided early yesterday.

BRISBANE — Residents fled in terror early yesterday after a road fuel tanker and a freight train carrying liquid gas collided at a level crossing, triggering fears of a major explosion in the tiny south-west Queensland town of Thallon.

Mrs Elva Beach, 55, of the Thallon Store, said: "We were very lucky there wasn't a massive fire. It could have been a terrible tragedy."

The tanker ruptured, spilling part of its 35,000 litres of fuel, and

the train, carrying 20 gas cylinders, was derailed in the Queensland-New South Wales border town, 400km south-west of Brisbane.

Police said the danger of a huge fireball erupting was heightened by the Thallon fuel depot, just 200m from the crash scene.

Mrs Beach said her husband, Harold, came running into their home just after the accident at 6.44am yelling "Get dressed, and get out".

A railway spokesman said the diesel locomotive was knocked 5m off the track by the impact and the assistant driver was taken to St George Hospital for treatment.

The road tanker driver had minor injuries.

Police declared a state of emergency and ordered the farming township's 200 residents to safety in the local schoolground.

Townfolk waited more than four hours while emergency crews battled to contain the leaking fuel.

Article courtesy The Toowoomba Chronicle.

These areas are mostly well away from the technology or industry that have produced them. These chemicals have to be carried to the area of storage and accidents may occur in the transport of this material. Many of the trucks carrying these highly dangerous wastes travel through local suburbs which is a dangerous policy. If accidental spills occurred some of these chemicals may be washed into the local waterways.

There is also a possibility of fire occurring in the storage area causing a dangerous mixture of chemicals to be released into the air. Some of the gases produced make it too hazardous for firefighters to tend the blaze and the fires are left to burn themselves out. If the fires are fought they are mostly doused with water.

This water will carry the hazardous compounds into the waterways as run-off. Poor storage (some in 44 gallon drums) or storage for long periods of time have caused many leakage problems. Many of these problems go unnoticed and only small fines or compensation payments are sought or imposed for the accidental release or leakage.

In Queensland the division of the Bureau of Emergency Services has a **Chemical Hazards and Emergency Management Unit (CHEM unit)**. The CHEM unit's main role is to:

- * Develop and oversee the safe transport of hazardous chemicals.
- * Prevent accidental contamination of the environment.
- * Identify the type and determine the amount of contamination in certain areas.
- * Supervise the clean-up of contaminated areas.
- * Help dispose of hazardous chemicals.
- * Educate the public.



Fig 2.14: Many chemicals are stored in drums in poorly secured areas. These areas can be subject to fire, flood, vandals and slow leakage due to corrosion.

Recent reports estimate about 20% of our hazardous wastes are being disposed of safely.

Many of the chemicals now banned in Australia can still be found stored in garden and farm sheds around the country. Many of these chemicals are not being used according to the directions, are being stored too long and/or are disposed of in an unsafe manner.

WARS

The major threat to the Earth's stable condition is the threat of war. It was seen in the Gulf war of 1991 and in the Vietnam war of the 1970s that wars have a potential to severely affect the environment. In the Vietnam war chemical defoliants such as Agent Orange were used to destroy the canopy of the forests to allow the American forces to detect the movement of enemy troops. In the Gulf war, the Iraqi troops released a major oil spill to inconvenience the US forces and affect the coasts of Saudi Arabia and their desalination plants. It not only inconvenienced the troops but had a catastrophic effect on the marine life of the area. The Iraqi troops set fire to over 600 oil wells in the area which were burning 1.5 billion barrels of oil a day. The environmental consequences of these fires will not be fully known for many years to come. The threat of widespread use of chemical, biological and nuclear weapons poses severe repercussions not only on the region but on the entire biosphere of the Earth.

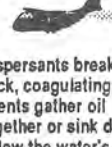
THE GULF WAR

Environmental disaster in the Gulf

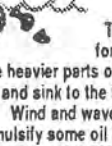
Environmental experts said there was no way to stop a mammoth oil slick pouring from Iraq-held Kuwait. The slick has already crept more than 113km south along the coast.

Techniques used to battle oil spills:

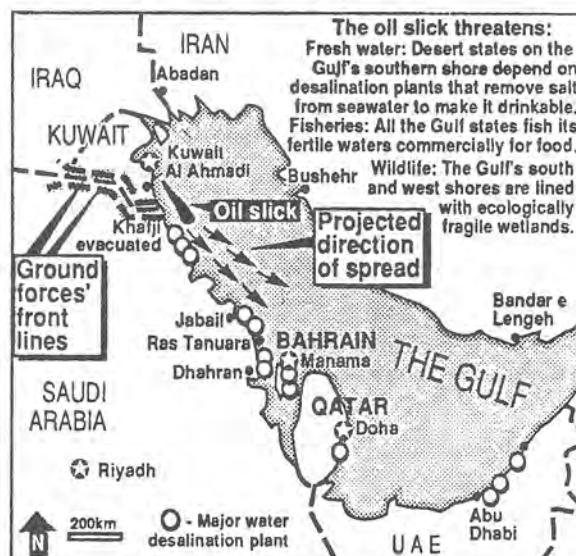
Technology

Containment Booms	Skimmer Boats	Chemicals
 Floating booms form a ring around spill to contain the oil.	 "Herd" the oil and vacuum it up from the water's surface onto collection barges.	 Dispersants break up oil slick, coagulating agents gather oil together or sink droplets below the water's surface.

Nature

Evaporation	Bacteria	Weather
 Volatile components of the oil evaporate into the atmosphere.	 Bacteria consume some crude over time.	 Tar balls form from the heavier parts of the oil and sink to the bottom. Wind and wave action emulsify some oil into the water forming "Mousse".

One barrel of oil: = 0.132 tonnes of oil
= 35.6 gallons
= 160 litres



NATURAL

Major eruptions of **volcanoes** can release massive amounts of ash, rock fragments, solidified lava, pumice and many gases and vapours. These gases include steam or water vapour, carbon monoxide and carbon dioxide, hydrogen chloride, sulphur dioxide and hydrogen sulphide. All these substances are shot up into the atmosphere and what goes up must come down! The substances fall to Earth usually dissolved in rain drops. The hydrogen chloride and sulphur dioxide form **acid rain** which can severely affect the environment in the vicinity of the volcano.

In 1883 the most violent explosion ever heard by man occurred on the island of Krakatoa. The whole island exploded, spraying millions of tonnes of earth fragments into the atmosphere. It was recorded that these clouds of dust remained in the atmosphere for years.

The shape of the earth is forever changing. Mountain ranges and valleys are being continually formed by volcanoes and other geological movements which are, in turn, continually worn away by wind, water and ice. These erosion agents cause a build up of chemicals and sediments in the water. If an area has a high concentration of a certain mineral in the soil, this mineral will be dissolved by the water and transported to the nearest large water mass. Some seas are found to vary in salinity e.g. the Red Sea has a high salt content whereas the Baltic has a low salt content.

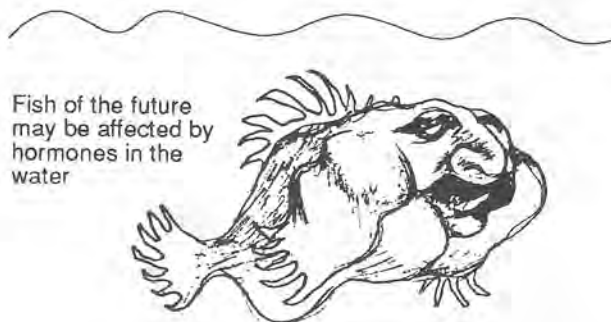


Fig 2.15: The island of Krakatoa lies between Java and Sumatra.

NEW SOURCES OF POLLUTION

The latest toxic chemical that has been introduced into the marine environment in an **anti-fouling paint** called Tributyl tin. This paint stops the growth of algae, barnacles and other marine creatures on the keels of ships. This chemical is, of course, very toxic to all forms of marine life. Only 0.003 micrograms/litre will kill most planktonic organisms. What weight of this substance would be needed to kill most of the algae build-up in an aquarium? What volume of substance do you think this would represent?

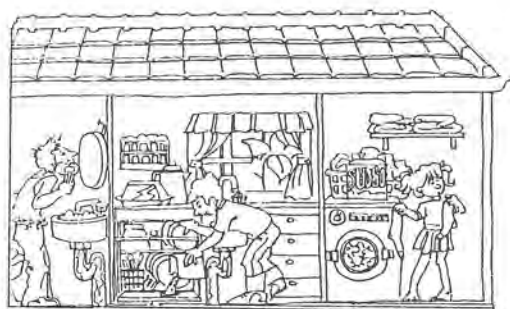
It has been recently reported that the concentrations of human female **contraceptives** are building up to such an extent that they are now detectable in some rivers. The female hormones that are present in contraceptives are being passed out in the urine. These hormones are not broken down in sewage treatment and are entering the waterways to be reused by humans downstream. It is thought that the build up of these hormones in the water supply may reduce human fertility. Each year modern technology is producing thousands of new chemicals in an effort to make life easier. Sometimes it seems new brands are simply introduced to supersede older brands and stay competitive in the market place.



Fish of the future may be affected by hormones in the water



Using this puzzle detect chemicals that you may find in most homes.



S	H	A	M	P	O	O	A	M	E	D	I	C	I	N	E
O	C	C	F	I	N	S	E	C	T	I	C	I	D	E	S
L	G	I	X	Y	I	R	I	D	F	K	L	H	I	J	U
V	A	D	I	N	P	E	R	F	U	M	E	S	K	H	N
E	V	S	K	T	E	T	Y	X	A	Y	A	B	C	G	C
N	X	P	P	N	S	O	A	P	S	R	N	O	I	L	R
T	I	O	L	E	T	C	L	E	A	N	E	R	O	L	E
S	V	L	A	S	I	N	K	R	N	M	R	O	I	K	E
L	A	I	S	V	C	F	C	S	T	S	S	P	S	N	N
O	R	S	T	U	I	O	T	O	I	L	S	M	I	F	N
M	N	H	I	T	P	F	V	X	S	Z	N	Q	N	R	T
P	I	S	C	S	E	U	U	Z	E	N	D	P	F	U	K
S	S	R	S	P	S	E	N	O	P	O	R	I	E	H	F
Q	H	U	L	F	I	L	N	F	T	O	U	A	C	A	P
N	B	L	E	A	C	H	E	S	I	T	G	H	T	C	A
I	B	A	T	T	E	R	Y	U	C	U	S	G	A	I	I
A	P	I	K	N	A	E	R	O	S	O	L	S	N	T	N
T	R	A	N	Q	U	I	L	L	I	Z	E	R	T	F	T

POLLUTION ISN'T NEW

The problem of pollution is not new. It has even been recorded in the Sumerian civilization 6,000 years ago. This civilization developed on the fertile flood plains between the Euphrates and the Tigris Rivers, an area controlled to-day by Iraq. The history of this civilization was reconstructed from recordings on clay tablets.

The Sumerian civilization prospered for many years and a large number of cities developed in the area. Overgrazing and deforestation led to major soil erosion and soil degradation. The silt produced choked rivers and waterways. It is believed that ancient civilizations created most of the desert areas of the Middle East. Many other civilizations have recorded evidence of the pollution in their times as well.

In more modern times technology has allowed scientists to develop many new chemicals. Many naturally occurring compounds were synthesised or manipulated to produce new "wonder" chemicals. The full effect of these chemicals wasn't immediately apparent nor were they fully tested before being released onto the market.

During World War 1 scientists developed self illuminating paint which contained the radio-active element Radium. This paint was used on the dials of machinery and clock faces. The paint was applied by workers using very fine

brushes. The workers often "tipped" the brushes in their mouths so that the brush hairs were drawn together to ensure fine lines on delicate work. Traces of Radium from the brushes entered the bodies of the workers causing bone cancers. An extremely high percentage of these workers died of diseases caused by the ingestion of this element.

In the 1930s industries started to produce polychlorinated biphenyls (PCBs). By the 1970s over 50,000 tonnes of PCBs were being produced annually. PCBs are chemically related to organochlorine insecticides as both have a structure where chlorine is attached to an organic compound. These synthetic oily compounds had a number of commercial applications. They were found in car tyres, PVCs, plastics, resins, paints and varnishes, sealants and electrical products. These products release PCBs back into the environment when they evaporate from paints and varnishes, are burnt or otherwise decomposed.

Cooking with microwave ovens is thought to release PCBs from compounds such as plastics into the cooking foods. It has been estimated that over 70% of the PCBs that have been added to products have not been released into the environment. Most are still in use or lying in dumps not yet decomposed. Once these PCBs have been released back into the environment they may wipe out much of the marine life.

CHAPTER 2

The people of the 1950s and 1960s thought science had all the answers and used new "wonder" chemicals with gay abandon. The DDT story was a good example of the acceptance and wide-spread use of what is now considered to be a dangerous chemical. DDT was developed by a Swiss scientist, Paul Muller which earned himself a Nobel Prize in 1948. DDT was thought to have no effects on the environment while being very effective in the control of insect pests.

It was used in large quantities and literally splashed around the countryside with millions of tonnes being washed into river systems. It was not until 1960s that the problems with the pesticide began to show themselves. PCBs accumulate in the fatty tissues and fat cells of the body. They are believed to cause birth defects, cancer, high blood pressure and also affect the immune system.

Many people believe we have produced a "high-tech holocaust" and will in the future pay dearly for our indiscriminate use of synthesised chemicals. Many industries have been more concerned with making the "fast buck" than considering the effects of their products on future generations.

DETERGENT FACTS

Detergents are cleaning agents which remove dirt, grease and grime from clothing and other surfaces.

Detergents break up the dirt and grease and combine the smaller particles with water molecules.

This causes the particles to become evenly distributed in the water.

This is called an **emulsion**.



FISH KILLS AND MORALITIES

(The following is an extract from the Queensland Department of Primary Industries and is reproduced with permission).

"The death of significant numbers of fish constitutes a "fish kill" and is an obvious sign of adverse change in a water body.

It may be the result of man made pollution, natural environmental disturbance or even the combination of both.

Throughout our waterways, environmental conditions normally fluctuate on a seasonal basis. However, in times of abnormal weather, these changes can occur daily.

Such rapid changes impose considerable stress on fish populations and can lead to disease outbreaks and mortalities.

Pollution of our waterways can also upset the balance of nature, resulting in extensive fish kills.

All such occurrences require investigation in order to ensure the mistakes of other advanced societies are not repeated here.

When to report a fish kill

To avoid tying up scarce resources in the investigation of all fish kills, only major significant fish kills should be reported.

A commonly accepted definition of a fish kill is where 3 to 5 kg or about 50 dead fish are observed.

Fewer fish result in inadequate amount of material for analysis.

What to look for

Some symptoms observed at fish kills include:

Death by disease

- * Fish die over an extended period of time.
- * Mortalities build up from low numbers to a peak.
- * Ill or dying fish usually of one species and also of same age float at surface.

Due to physical conditions

- * Low dissolved oxygen - fish mostly dies in early hours on the morning; larger species first. Moderately abrupt, often with changes in colour and smell of water; some fish may be seen gulping air at the surface. Specimens usually die with convulsively opened mouth and gill openings.

- * Underwater explosions - fish of all species perish at once; some fish have wounds, protruding eyes and ruptured swim bladders.

Due to pollutants

- * Usually an abrupt kill at any hour; fish of all species usually affected; small fish die first, usually with convulsions and loss of equilibrium.

What to do

Speed is the essence when reporting a significant fish kill.

Dead fish decompose rapidly in tropical temperatures and the action of wind, current and tide may carry away dead or dying fish and remove the cause of the "kill".

When a kill is observed, it is important that the following details be reported to the appropriate authorities.

1. The reporter's full name, address and telephone number.
2. The time when the kill occurred or was observed.
3. Some indication of the type of fishes affected and the numbers involved.
4. The exact location of the kill and details of accessibility by boat or car.
5. The symptoms observed and any unusual circumstances noticed at the time of the kill, e.g., Presence of algal scum, unusual water colour or turbidity; gill colour of dying fish.

If possible

6. Collect ten dying fish (not dead). Place in a plastic bag and store in ice. Dead fish cannot be analysed because they start to decompose internally immediately on death.
7. Collect at least one litre of water from the site in a clean glass bottle and refrigerate. Rinse the bottle three times with the water being sampled. **Do not freeze.**

Contact your local fisheries branch which can be found in the telephone book.



Fig 2.16: A fish kill can result from pollution.

QUESTIONS

1. Define the causes of water pollution.
2. Explain why land-locked seas and lakes are so prone to pollution.
3. Bio-degradable materials are of no threat to our waterways. Discuss this statement.
4. Define the terms:
 - (a) thermal pollution
 - (b) toxic compounds
 - (c) eutrophication
 - (d) biological control
 - (e) biocides.
5. Where does most of the pollution in Australia occur?
6. What does the term "BOD" stand for and what factors affect the BOD of the water?
7. To what extent do your own activities affect the environment and how might you reduce these effects?
8. We are now living in a "throw-away" society. What does this mean and do you agree with this statement?
9. Evaluate the contributions of industry to the pollution problem. Discuss measures that could be undertaken to alleviate these problems.
10. Explain how many of the pollution problems of the marine environment are a result of modern agricultural efforts to increase food production. What measures could be undertaken to overcome this problem?
11. Outline the two groups of pesticides and explain why it is that these pesticides are affecting many non-targeted animals.
12. Do you agree with the testing of nuclear weapons by France in the Pacific Ocean?
13. Did you know that a number of countries, including USA, store many toxic chemicals on Pacific islands. Do you agree with this policy? What problems may the storage of these chemicals cause?
14. Describe how the position and extent of an oil spill can now be detected.
15. Name a new source of marine pollution.
16. Identify the means by which oil can enter the marine environment.

ESSAY TOPICS

1. Discuss one of the following statements:
 - (a) An affluent society is an effluent one.
 - (b) Nature should be preserved not conserved.
 - (c) Are we trying to get more from the earth than it can give?
2. What effective guidelines do you think the international community, especially the governments could do to reduce the pollution problem?
3. A sand mining company wants to mine an area of beach near your favourite holiday destination. Discuss the arguments the (a) company director, (b) local councillor, (c) local business man and (d) an environmentalist might have for/against the project.
4. Debate the issue of dredging the entrance to harbours for commercial shipping.

RESEARCH TOPICS

1. What factories or industries are located in your area? Are special areas designated for these industries? What types of ways might water be used in these industries and what happens to the water after use? Perhaps you could do a survey.
2. Research the precautions/laws that the government has to reduce or minimize the pollution that may be caused by the mining for uranium at Roxby Downs in Australia.
3. Use the library to gather information on the major oil spills that have occurred in the Pacific in the last ten years. Record details of these spills and the methods used to contain/break-down the oil spill. Was compensation paid by the shipping line for causing the problem?
4. What is biological control and give examples where biological control has been successful. What other alternatives are there to the use of toxic pesticides?

ACTIVITIES

- You have just received a contract from a Japanese company to design a multi-functional polis in Queensland. The city is to have a population of 100,000 people and the Japanese wish to have large numbers of technological industries together in the city.
Consider:
 - the type of terrain you would choose
 - position of the city - near coast/near river/near fertile countryside
 - water supply problems
 - industries you would not allow
 - type of transport system
 - town plan - position of schools, shops, parks and other amenities
 - should it be centralized or decentralized
 - type of sewage treatment plant
 - type of government.
- Organise a trip to a local beach to survey the amount and types of pollutants found on the beach.
- Calculate the volume of rubbish collected by the school cleaners during the normal school day. By what means is this rubbish disposed? Evaluate the proportion of different substances in the rubbish.
- Organise a trip to the local sewage treatment plant. Find out the volume of sewage that enters the plant each day and find out the methods used to treat this sewage.

EXERCISES

HOW MUCH WATER DO YOU USE?

Water use is taken for granted by most people who live in towns or cities in coastal areas. It is only when we have water restrictions imposed by local councils that we show some concern as to how much water we use. In areas where people have to rely on rainwater as their only water supply, they tend to be very conservative. We use water for a number of purposes during the average day/week.

We use water for:

- drinking
- washing hands
- showering and bathing
- washing clothes
- flushing toilets
- watering lawns and gardens
- cooking and making drinks.

Cities such as Brisbane with a population over 1,000,000 use over 200,000,000 cubic meters of water per year.
(1 cubic metre = 1,000 litres)

Consider and answer the following questions that will highlight your water usage. (Are you a water wowser?).

- When you clean your teeth do you let the water run while you are brushing?
- If you shower, how long do you stay in the shower?
- Does your washing machine have a suds saver cycle and is it used?

- Do you use a dishwasher or do you do the dishes by hand?
- Do you use a sprinkler to water your garden and lawn or do you use a hand-held hose which targets the areas which need the water?
- Do you own a swimming pool?
- Do you have any dripping taps?
- Do you wash the car?
- Does your toilet have a half-flush device?
- Does your family pay excess water rates? Estimate your personal water use if
 - an average bath contains 100l
 - a wash basin contains 5l
 - a 5 minute shower uses 75l
 - an average dishwasher uses 50l per load
 - a washing machine uses 200l per load
 - a bucket contains 10l of water
 - a toilet cistern uses 12l per flush.

Hidden water uses. Remember that water is also used in the manufacture of a number of products. These products include most processed foods, paper, plastics, steel, clothing, etc. etc.

EXPERIMENTS

1. Investigate the effect of organic pollutants on the oxygen concentration in water. Methylene blue is a good oxygen indicator.

Methylene blue in the presence of oxygenated water gives a blue colour and in the absence of oxygen the solution is colourless.

Organic materials such as food or grass clippings may be tied up in a cloth bag and placed into a solution of water plus the indicator, methylene blue.

The colour of the solution can be recorded over a number of days. Make sure a control is used i.e. a similar solution without organic material is left for the same period of time in the same conditions.

NOTE: Do not use tap water unless it has been allowed to stand for 36 hours. Tap water can contain chlorine which kills the bacteria that cause the decay.

2. To observe the growth of microscopic decomposers.

Firstly, obtain a sample of microbes in water. This may be completed by adding soil or grass clippings to water. The water can then be added to nutrient agar on an enclosed petri dish.

Observe the nutrient agar plate after it and a control nutrient agar plate have been placed in an incubator for 3 - 4 days.

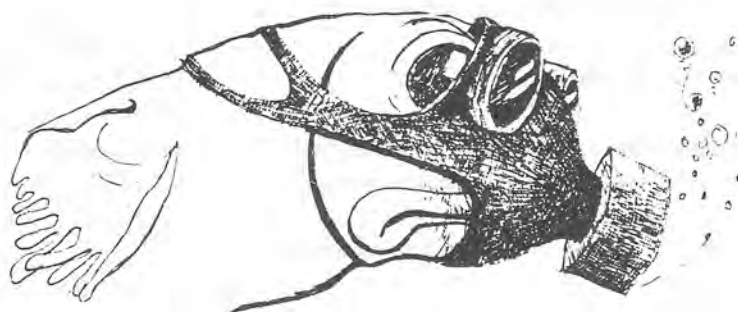
CAUTION:

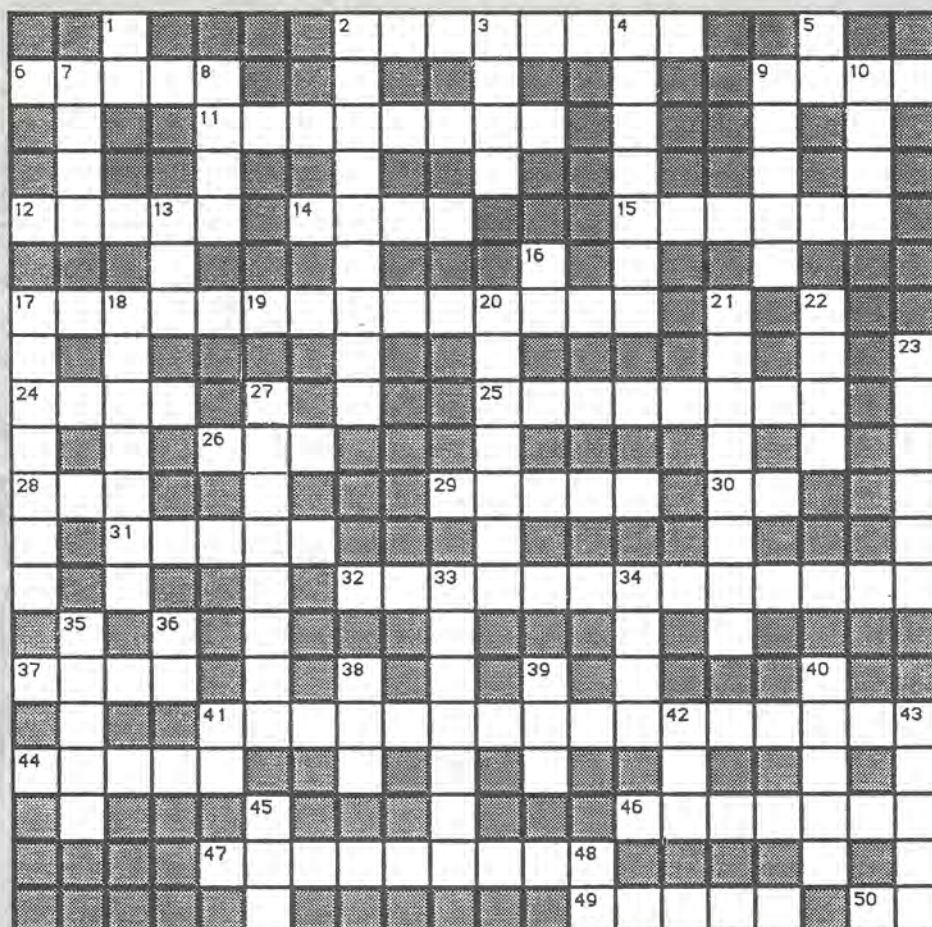
Do not open the plates after they have been incubated.
They could contain large numbers of disease causing micro-organisms.

3. Design a system to effectively contain or disperse an oil spill. Some of the different methods you may wish to try could include:

- (a) Soaking up the oil from the surface by using some absorbent material such as paper or sawdust.
- (b) Breaking up the oil by the use of different chemicals. Test the effectiveness of bio-degradable detergents.
- (c) Sink the oil by adding substances such as sand, iron filings, aluminium salts, clay or silica.
- (d) Scoop up the oil from the surface using some suction device such as a siphon hose.
- (e) Oil is an organic compound and bacteria may use it as a food source.
- (f) Try freezing the mixture.
- (g) Try to grow bacteria on the oil.

Evaluate the success of each method.





CROSSWORD

CLUES

Across

2. Disease causing microbe.
 6. A type of net.
 9. To clean with water.
 11. Liquid wastes.
 12. Hard transparent substance.
 14. Petrol.
 15. To take in food.
 17. Excess nutrients cause this problem.
 24. Abound.
 25. Minute organisms floating in the sea.
 26. _____ slick.
 28. Objective.
 29. A pollutant that can kill.
 30. Symbol for Aluminium.
 31. Mature.
 32. Can be naturally broken down.
 37. Vessel.
 41. 9,7 A species which first suffers from pollution.

44. Bring into line.
 46. A heavy metal.
 47. A chemical designed to kill a pest.
 49. Group.
 50. Symbol for Iron.

Down

1. Symbol for chlorine.
 2. Introduction of harmful substance.
 3. Pursue.
 4. Wearing away of rocks.
 5. Symbol for Calcium.
 7. To scream.
 8. Used to catch fish.
 9. A precious resource.
 10. Narrow opening.
 13. Polite term of address for a male.
 16. Symbol for titanium.
 17. Tidal river mouth.
 18. Related to heat.

19. Misprint.
 20. Pollution related disease.
 21. Salt marshes.
 22. Dig for a metal.
 23. Waste.
 27. A type of pesticide.
 33. Derived from living organism.
 34. Large flat fish (pl).
 35. A large mammal of the oceans.
 36. Opposite of down.
 38. A large hole.
 39. Amount of oxygen.
 40. A micro-organism that can cause disease.
 41. Among.
 42. Traditional Australian meal.
 43. Fashion.
 45. Large body of salt water.
 48. For example.



I wonder what the water is like?

Chapter 3

Turning the tide of Pollution

HOW ARE WE GOING TO OVERCOME OUR POLLUTION PROBLEM?

In the Middle Ages the cities of Europe were very insanitary. Human excreta and domestic wastes were simply thrown onto the street from the balconies above. Disease was rampant and the stench was unbearable. This pollution problem was thought to be overcome by introducing sewerage and waste collection to the cities. The problem, however, was really only pushed to the side as the pollutants were distributed away from immediate sight. Out of sight, out of mind!

Pollution is not a new problem. What is new, however, is the scale of the problem. With the increase in technology has come an increase in the volume and potency of the wastes. Since the industrial revolution the pollution predicament has escalated, especially pollution of the water. 97% of the Earth's water is saltwater, the remaining 3% is freshwater. Most of this freshwater is contained in the form of ice at the poles or is found underground. Only 0.003% of the world's water is available to and fit for human consumption. We, therefore, have to be very careful not to pollute this precious resource.

A number of steps must be taken if we are to control the pollution dilemma. These steps are:

- (a) Assessment of the problem - test the water quality to identify the pollutants.
- (b) Locate the cause and source of the problem.
- (c) Cure the problem - this may be difficult as the pollutants may already be in the food chain.

The most effective method to reduce pollution is avoidance. This, however, cannot happen in our industrialized society. As this is not possible, we must then reduce the amount or control the emission of pollutants.

Water makes up 70% of the human body. Humans can survive only for a few days without freshwater.



Fig 3.1: We use water in many ways and we need it to be clean.

ASSESSING WATER QUALITY

Many people believe that pollution in water is a very obvious fact. The water should look very dirty and have refuse floating on the surface. This, in fact, is not entirely true as many of the more toxic pollutants are invisible to the naked eye. Water may be heavily polluted but appear to be crystal clear. There are three different characteristics of water that can be measured to show pollution.

These characteristics are:

- (a) Biological.
- (b) Chemical.
- (c) Physical characteristics.

The physical characteristics of water that are measured include water temperature, total suspended solids, turbidity and odour. The chemical characteristics include the salinity, pH and dissolved nutrient substances. Its biological characteristics cover the number of bacteria and other organisms found in the water.



BIOLOGICAL TESTS

Biological tests are the most important as they give a good indication of the chances of any diseases being caught when one comes in contact with the water. The scientists test water for a harmless intestinal bacteria called *Escherichia coli*. Most, if not all, humans have this bacteria in their intestines where it does no harm. Although *Escherichia coli* causes no harm in the water, its presence indicates that there could be faecal contamination and other harmful bacteria present.

Table 3.1: Water categories

E. coli / 100ml	Quality
<2	safe to drink
<50	safe for bathing
50 - 1,000	poor quality - unsafe to eat seafood from these waters
>1,000	unsafe for swimming



Fig 3.2: Students working in a water quality control laboratory.

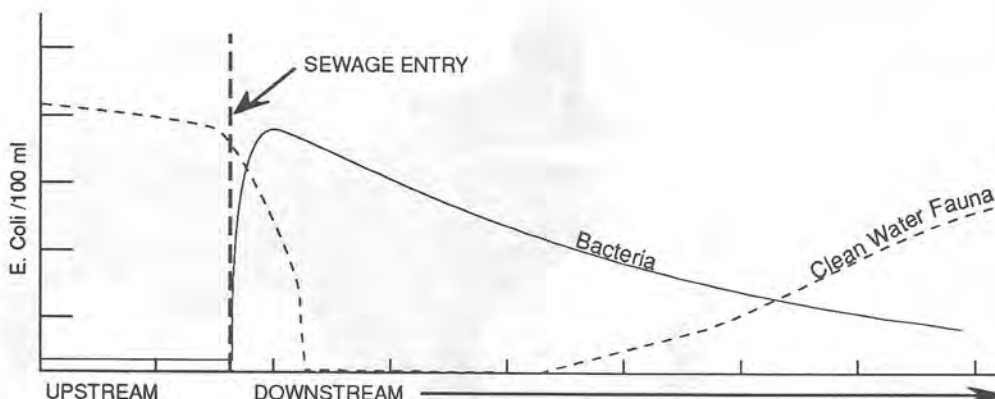


Fig 3.3: Effect of sewage on bacterial levels in a stream.

CHEMICAL AND PHYSICAL TESTS

(a) **B.O.D. - Biological Oxygen Demand.** This indicates the amount of organic material in the water. The B.O.D. measures the quantity of dissolved oxygen required by aerobic organisms to decompose (oxidize) the organic matter of the sewage.

(b) **Dissolved oxygen.** This test measures the amount of oxygen dissolved in the water which is so important to all the organisms living there and indicates the health of the water.

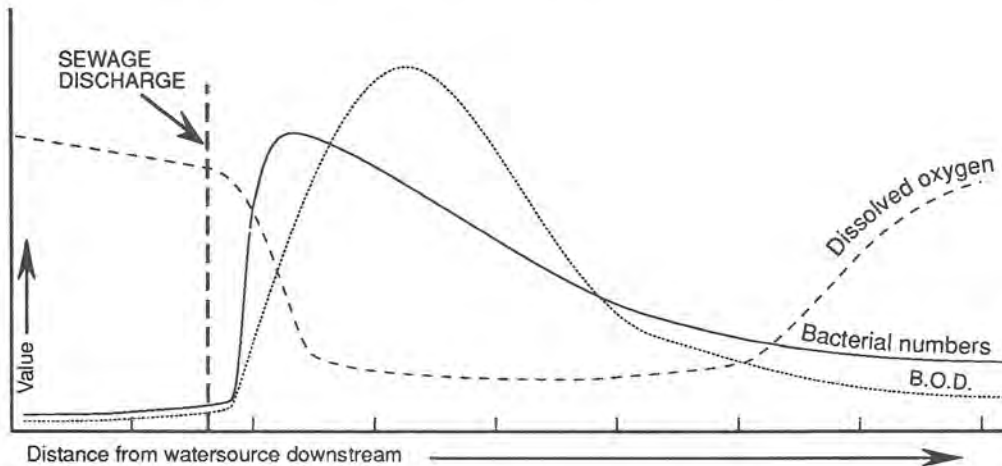


Fig 3.4: Bacterial numbers associated with sewage discharges and their effect on the amount of oxygen in the water.

(c) **pH.** The pH is a measure of the acidity of the water.

$\text{pH} = -\log_{10}[\text{H}^+]$ where $[\text{H}^+]$ is the concentration of hydrogen ions in the solution.
 If the pH value is between 1 - 7 the water is said to be acidic.
 If the pH value is between 7 - 14 the solution is alkaline.
 The normal pH range for natural water is between the values of 6.5 - 8.5.

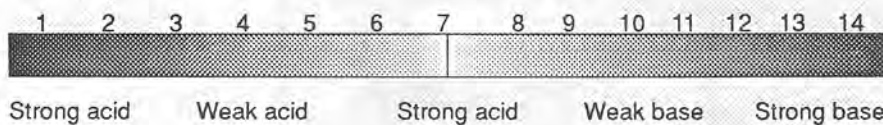


Fig 3.5: pH is a measure of the acidity of the water.

The pH of the water influences the nutrient release in the water and can also effect animal tissue.

(d) **Temperature.** The change of temperature in the water affects many of its properties such as the amount of dissolved oxygen and the pH. Many areas near industrial estates are effected by thermal pollution.

(e) **Turbidity.** Turbidity is the opposite to clarity. It is a measure of how cloudy or muddy the water is. It results from erosion, waste discharges, dredging, etc. The mud or fine suspended particles prevent light from penetrating the water. This physical factor is measured by using a **secchi disk**.

(f) **Total dissolved solids.** These tests measure the amount of both the dissolved solids and the suspended solids. A measured sample is simply heated and the amount of residue remaining after total evaporation is measured. This test gives an indication of the extent of the pollution problem that may exist, but gives no indication of the source or type of pollutant.



Fig 3.4: Secchi disc.

CHAPTER 3

(g) **Nutrient tests.** The presence of nutrients such as nitrates, ammonia, other nitrogen compounds and phosphates can be determined in the sample. These nutrients effect the amount of algae and other plant material in the water. The major sources of these pollutants are industry and agriculture.

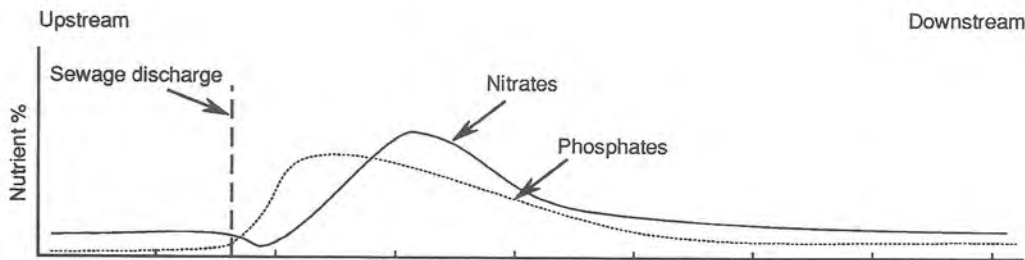


Fig 3.6: This graph shows how nitrate and phosphate concentrations increase after sewage enters a water system.

(h) **Salinity.** The salinity of the water is defined as the amount of salt or mineral ions dissolved in the water. Many physical properties of seawater vary with salinity including electrical conductivity, freezing point and density.

(i) **Colour.** Industries such as tanneries and food processing plants are often responsible for a change in water colour.



Fig 3.7: In the preparation of hides in a tannery, chemicals are released into the water which affect water colour.

Other more complex tests which can be conducted by research centres such as the CSIRO, DPI and other government departments include:

- * Chromatography which is used to detect the presence of substances such as grease, oil and detergents.
- * Infra-red spectrophotometer which detects the presence of detergents, fertilizers, insecticides, acids and alkalis.
- * Specific ion meters to detect metals, metallic compounds and fertilizers.
- * X-ray diffraction to identify many solids found in the water.
- * Chemiluminescence used to detect ozone.
- * Specific chemical tests which indicate the presence of various metals, ions and solids.

WATER.CONF.BB...

is the code name for a bulletin board that has been established for schools involved in the monitoring of waterways. A Global Rivers Environmental Education Network or GREEN, has been established so that water tests can be completed on a number of river systems and the results from these are logged by students world wide on computer bases. The table below describes the sorts of activities schools may become involved in. Chemical tests are done to establish the quality of water in an estuary based on a Q value.

Class Activity

For each test, the important value is the "Q" value. This gives an indication of the acceptability of the water in terms of its pollution level from a variety of sources. The closer a "Q" value is to 100, the better the water is in terms of the particular feature being monitored.

The "multiplying factors" then assign a relative importance to each of the factors in terms of their overall effect on the quality of the water. The Water Quality Index is an overall measure of the quality of the water, taking into account the contributions of each of the individual tests. Again, the closer the value is to 100, the "better" the water is.

Schools involved in the project carry out a bank of nine tests which give some indication as to the quality of the water. These tests are:

- * Dissolved oxygen - an indicator of the water's ability to support life.
- * Faecal coliform - indicates the possibility for potentially harmful bacteria being present in the water.
- * pH - indicates the possibility of atmospheric pollution within the catchment area or an indicator of the geological nature of the catchment.
- * B.O.D - is the Biological Oxygen Demand which indicates the abundance of the micro-organism population, which will compete for oxygen with the larger organisms.
- * Temperature change indicates the possibility of thermal pollution.
- * Total Phosphorous and
- * Nitrates - nutrients in the water and indicators of runoff from industry, particularly primary industries.
- * Turbidity - will affect the depth to which sunlight will penetrate, and
- * Total Solids - indicators of catchment erosion in fresh water streams.

For further information contact:

W. B. Stapp, 2050 Delaware, Ann Arbor, Michigan 48103 or Your local Environmental Education Centre.

Question

See if you can find the different sources of pollution in this maze of letters that may have caused this fish kill.



Fig 3.8: Can your efforts save fish lives?

I	N	D	U	S	T	R	Y	A	H	F	G	B	F	P
C	K	L	V	E	D	T	U	B	O	N	I	F	E	E
P	A	N	Y	W	E	W	A	R	S	R	C	A	R	S
A	N	Q	U	A	R	R	I	E	E	F	J	T	T	I
I	M	Z	V	G	O	O	P	W	Q	S	R	G	I	I
N	X	U	H	E	S	D	R	E	D	G	E	S	L	C
T	W	H	U	M	A	N	S	R	X	F	Y	S	I	I
F	A	C	T	O	R	Y	N	I	R	O	T	S	Z	D
A	W	A	G	G	L	L	F	E	E	D	C	B	E	E
R	B	D	A	I	R	I	E	S	F	D	F	A	R	A
M	X	N	U	C	L	E	A	R	T	E	S	T	S	B
S	O	L	V	E	N	T	S	Q	J	D	M	K	X	O
M	I	L	C	D	D	O	E	P	C	D	I	O	O	T
N	L	N	R	U	O	T	H	S	U	T	N	I	Z	T
I	R	M	M	M	Y	Z	O	P	I	E	E	F	N	O
P	I	P	A	P	E	R	M	I	L	L	S	G	W	I
Q	G	A	N	S	N	R	E	Q	H	C	H	V	X	R

CHAPTER 3

The detection of the pollution problem can also be completed by examining the animals and other organisms found in the area. Greenpeace has revealed that studies of fish taken off Sydney contained an array of toxic chemicals in high concentrations.

According to Greenpeace the "average concentration of an organochlorine, BHC, were 122 times the National Health and Medical Research Council (NHMRC) health limit. A follow-up study found the pesticide, Chlordane, in fish averaged 12 times the health limit, and the fungicide, HCB, three times the limit. The insecticides, Heptachlor epoxide, DDT and its derivatives, DDE and DDD, Dieldrin and PCB were also found."



Fig 3.9: Greenpeace divers taking night samples from a chemical company's wastepipe outlet in Cork Harbour.

LOCATING THE CAUSE AND SOURCE OF THE PROBLEM

The location of the source of the pollutant is fairly easy in a river or stream. Once the problem has been discovered, you then need to backtrack up the waterway, taking a series of samples to locate the source or entry point of the pollutant. If the problem is coming from a sewage outlet where many thousands of people and industries supply wastes to the plant complex, sampling from the different pumping stations can lead to the isolation of the person or industry concerned.

Pollution from agriculture and urban areas does not enter the rivers or streams at one point only. These forms of pollution are known as **diffused or non-point source pollution**. Discharges from sewers and drains that can be traced to their source, e.g. a factory, are known as **point source pollution**. The source of pollution problems found in ports or estuaries which have a huge number of entry points and many sources are almost impossible to locate.

CURING THE PROBLEM - WASTE DISPOSAL

The problem of accumulation of waste can be overcome by one of three methods, listed below:

- (a) Treatment.
- (b) Dispersal.
- (c) Containment.

Treatment is probably the most environmentally sound method of waste disposal.

Dispersal simply attempts to spread the waste over a large area and, in doing so, will have less effect on the environment. **Containment** is a no-win situation where it remains in the environment, having no effect on the environment, but with the potential to have drastic effects.



Fig 3.10: A common scene at beaches. This is where your rubbish ends.

TREATMENT

Although sewage is such an awful smelling mixture as it enters the treatment plant, it contains surprisingly an average of 99.4% water and less than 1% foreign material. This very small percentage of foreign material can, however, have an extremely serious effect on the water quality.

Some of these foreign materials include toxic oils, hydrocarbons, detergents, nitrates and phosphates, heavy metals, pesticides and disease-causing microbes. This horrible concoction has the potential to destroy ecosystems found in streams, rivers and even estuaries! It is possible sometimes that the joint action of two or more chemical substances is more lethal than the sum action of each of the individual pollutants. The term given to this occurrence is **synergism**.

Sewage is defined as the contents of pipes and drains which transport water-carried wastes. The sewage is made up of liquid called **effluent** and the solids are called **sludge**. Sewage and water treatment plants around Australia vary in size and complexity. Water treatment refers to the physical and chemical processes by which water will be made suitable for some usable purpose. The more important treatment processes are sedimentation, flotation, coagulation, filtration, bacterial break-down, disinfection and aeration. These are summarised over in Table 3.2.

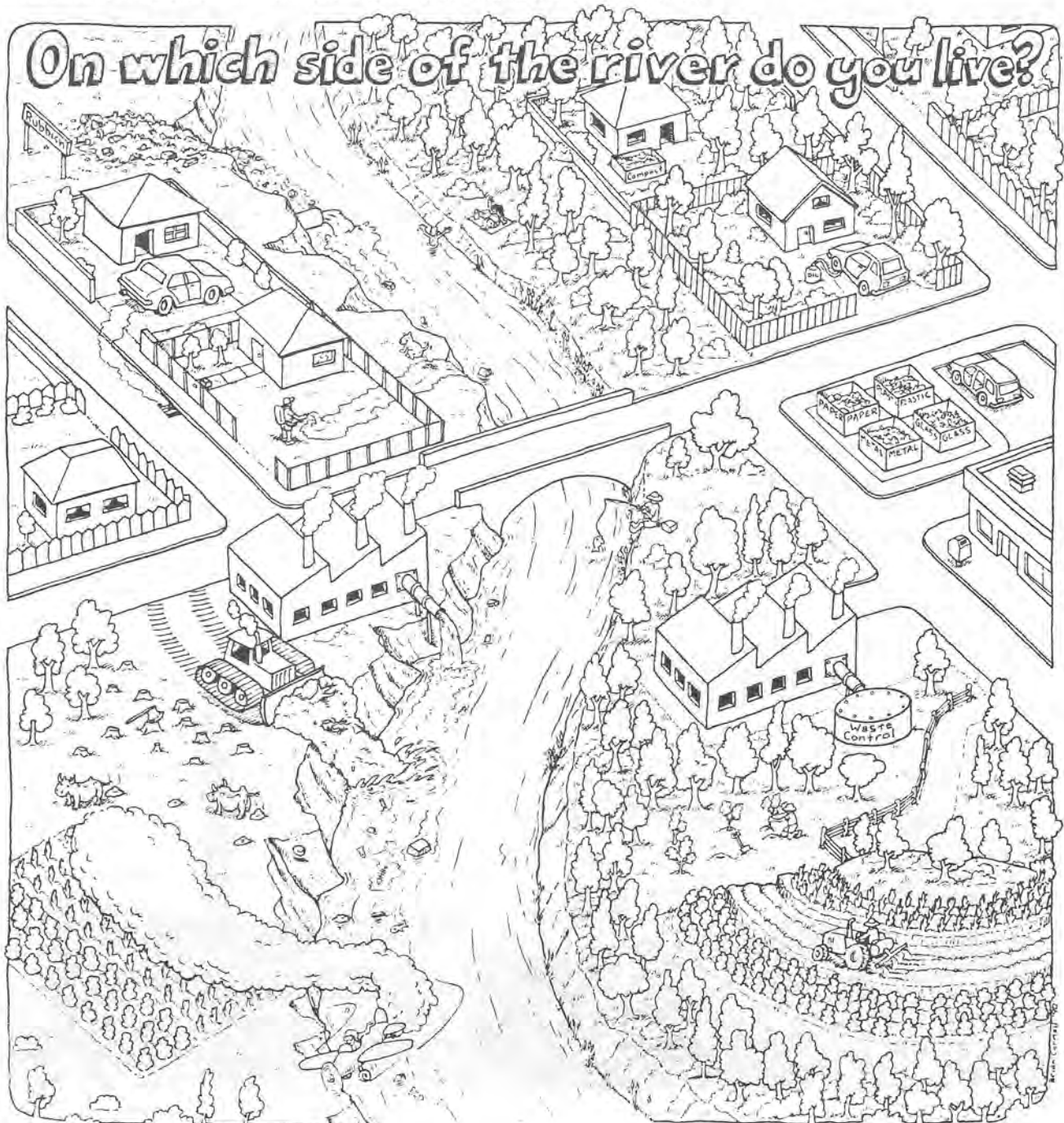


Fig 3.11: Courtesy Qld Department of Environment and Heritage.

CHAPTER 3

Table 3.2: Treatment plants may use one or more of these processes

Disinfection The removal of the disease causing microbes and other living organisms is imperative before the treated sewage can be released. This can be completed by using a number of different methods including the use of chlorine, ultra-violet light or even ozone. It can be done simply in the bush or at home by boiling the water.	Sedimentation Many of the pollutants are in the form of suspended solids. This material will tend to sink if the water flow is reduced. Most treatment plants have large tanks in which sewage is stored for a period of time to allow for sedimentation. The material that settles to the bottom is called sludge and is removed from the bottom of the tanks. Sedimentation, however, does not remove extremely fine or colloidal material over a short time, so this must be removed by other methods.	Coagulation Many fine particles can be combined with colloidal materials such as aluminium salts, powdered limestone, clay, iron or silica to form a combined mass heavy enough to settle out.
Bacterial break-down This process is used to remove some of the organic compounds from the water. The most common methods are trickling filters and oxidation ponds. These allow for the build-up of microbes which feed on the organic material. The trickling filters allow the sewage to flow gently over rocks, increasing the oxygen content of the water which is needed by the decomposers. Some of the decomposers include micro-organisms such as bacteria, fungi (yeast), and protozoans.	Aeration Once the bacteria and other decay organisms have broken down the organic compounds, the water becomes devoid of oxygen. The oxygen can be replenished by either forcing air through the water or by using fountains or waterfalls to aerate the water.	Filtration Suspended materials may also be moved from the water by passing the water through a filtration system. The sewage is passed through a screen or bed of sand to remove any remaining solid material.
		Flootation Some of the pollutants such as the hydrocarbons, in particular oils and grease, will tend to float to the surface in the settling tanks. This scum is simply scooped off the surface and added to the sludge.

SEWAGE TREATMENT PLANTS

Treatment plants vary in the amount of treatment that is given to the incoming sewage. Some plants give the sewage limited treatment by only removing small amounts of the contaminants, while other more sophisticated processing plants produce water that is fit for human consumption. There are three levels of treatment.

The first is **primary treatment** which is designed to remove those pollutants which sink or float. In these plants the sewage is normally screened by a metal mesh, and sometimes filtered through sand. The sewage is then passed into a sedimentation tank where the heavier sediments settle to the bottom and are removed. This treatment is mostly mechanical and removes up to 35% of the organic pollutants.



Fig 3.12: Trickle filter aeration (secondary treatment).

The next level of treatment which is designed to remove some of the soluble organic compounds is called **secondary treatment**. Here the number of bacteria and other decay organisms are increased and these organisms break down the sewage. Most common methods are trickling filters, activated sludge plants and oxidation ponds. The bacteria can break down up to 85% of the organic compounds found in the water if the plant is working effectively. These bacteria are killed by the addition of chlorine in the contact tank.

The final level of treatment is mainly chemical and is called **tertiary treatment**. This level of treatment can be very expensive as it removes the elements that prove difficult to extract. Here ultra-violet light, ozone and chlorine may be used to disinfect; chemicals may be added to coagulate some of the hard-to-remove sediments; and carbon absorption and ion exchange may take place. Other new methods such as the use of microwaves and even magnets are being developed in some plants.

Effective tertiary treatment plants can remove most of the disease causing micro-organisms and remove up to 98% of all other substances.

Oxidation ponds

Oxidation ponds are used in many small towns to dispose of the sewage. These ponds or dams are simply filled with sewage and nature is allowed time to break down the sewage. A problem can arise with these ponds during floods or periods of heavy rain if the sewage escapes from the pond into the creeks and rivers.

Sludge Treatment

The materials that are filtered or removed from the sewage are called **sludge**. This sludge may be treated or simply disposed of. Some plants use anaerobic digesters. Here anaerobic microbes, in the absence of oxygen, break down the organic compounds.

This process can take long periods of time, but the end product is friendlier to the environment. The decomposed sludge can then be disposed of in one of the following ways:

- * Landfill.
- * Ocean dispersal.
- * Incineration.
- * Placed in drying beds and used as fertilizer.

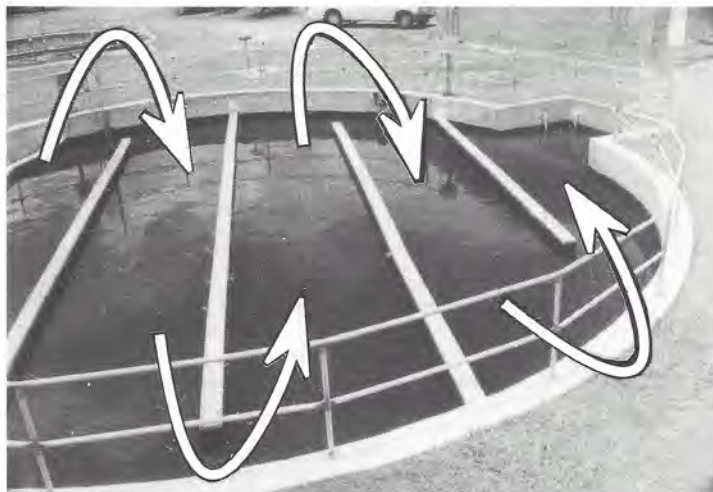


Fig 3.13: A contact tank (secondary treatment). The maze slows down the water flow to allow time for the chlorine to work.



Fig 3.14: Sewage digester (sludge treatment).

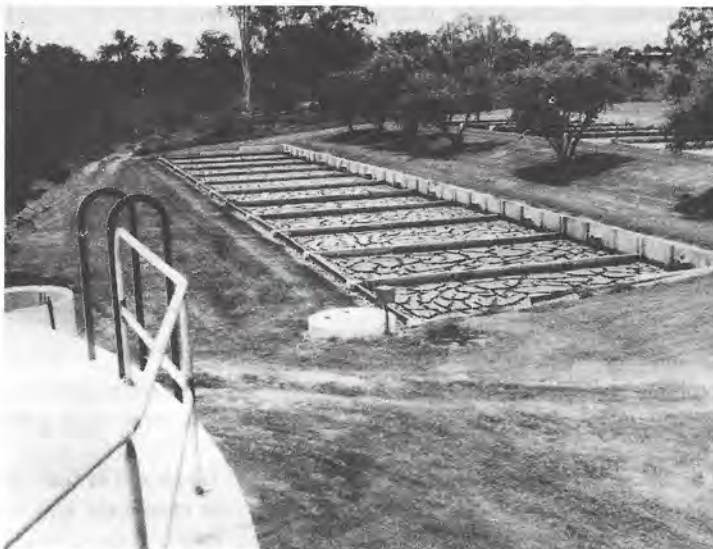


Fig 3.15: Drying beds (used to dry sludge after treatment).

WHAT HAPPENS AT THE SEWAGE PLANT

The illustration below shows the steps involved in processing raw sewage in three stages.

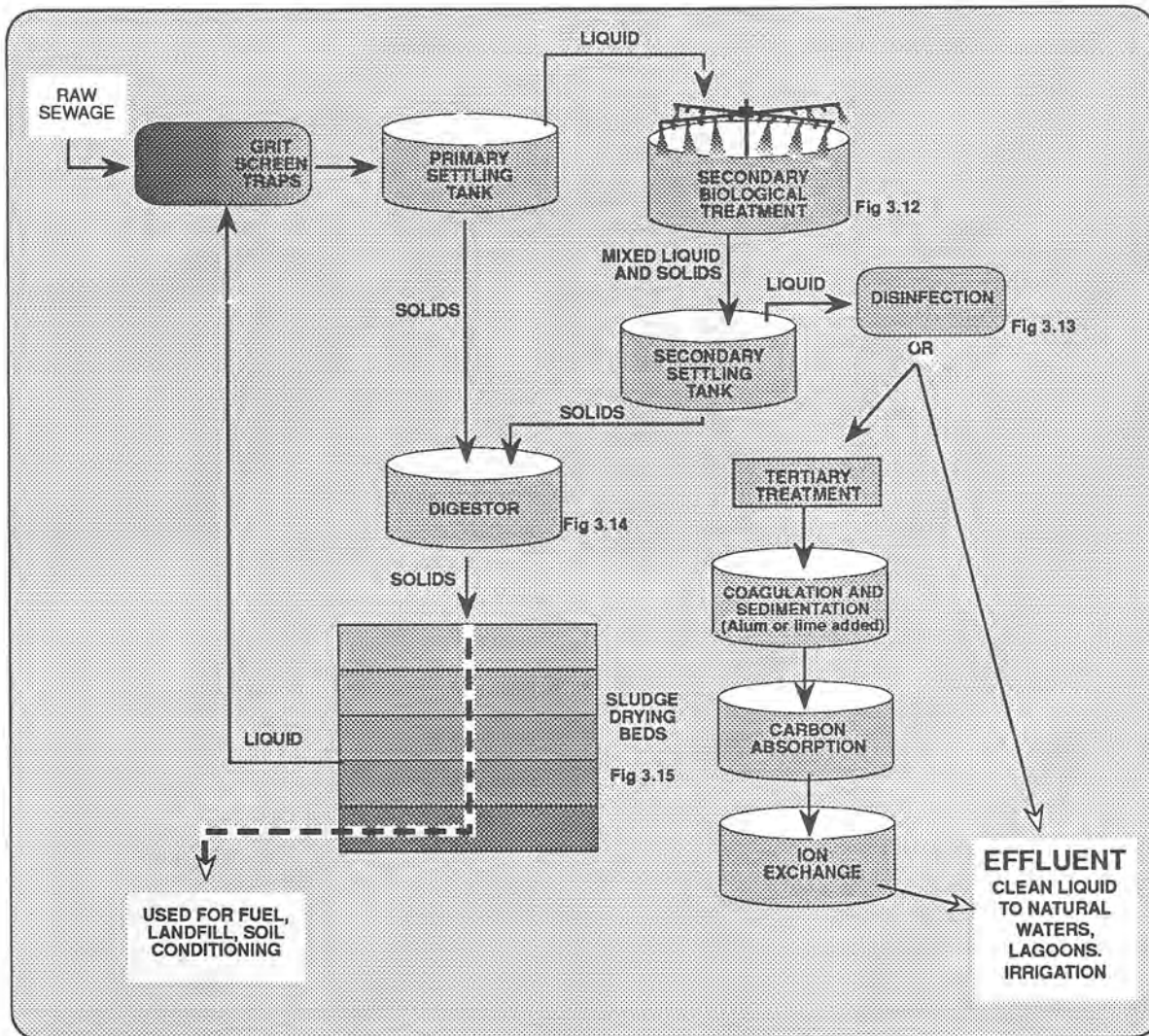


Fig 3.16: Secondary sewage treatment

How big is the problem of treating the sewage? Each day approximately 2,000 million litres of water flows out of our sewers overloading many treatment plants. The overloading of a plant can have serious and unpleasant consequences.

A good example is the Sydney sewage treatment plant which was designed for the population of Sydney in the 1960s.

Sydney has three primary treatment plants and can only filter out 19% of the solid wastes in the sewage - the rest is pumped out to sea.

Have you thought about?

- * What may be some of the problems caused to the environment if the sewage treatment plant breaks down?
- * What will happen if the volume of sewage is so large that the plant cannot handle this volume?

This could occur with an increase of population over a period of time, an influx of people for a concert or activity in the town, holiday time or after severe storms when storm water enters the sewage treatment works.

Questions:

- * What will happen if a severe flood occurs and the sewage treatment plant goes underwater?
- * Treatment of sewage involves the addition of large amounts of chemicals and huge filtration plants. Discuss this statement.

ACTIVATED SLUDGE PLANTS

Sometimes the microbes which cause sewage to break down are added with the oxygen they require to speed up the breakdown process. The addition of air and microbes to the sewage at the same time is known as **activated sludge**. When the sewage enters these treatment plants it is aerated using paddle wheels by pumping the water into the air using fountains or by bubbling air through the sewage. Microbes from development ponds where sewage is being decomposed are added to the sewage.

The advantage over the trickle filter method is that it is easier to manage and takes less time to treat the sewage. The biological break down may only take six hours. If the flow of sewage increases, it is a simple procedure to add more oxygen and microbes.

LAND TREATMENT

Some areas of Australia are using sewage to irrigate and fertilize farms and pastures. This mostly occurs after secondary treatment. The nutrients in the water are used to increase plant growth and there is less loss of water from the environment. In this way, water is simply recycled. Some of the problems associated with this method include the build-up of heavy metals and toxic compounds in the soil and the spread of pathogenic organisms.

BIOLOGICAL TOILET

Biological toilets are now being used in many National Parks to reduce the impact of people on these parks. A Clivus Multrum toilet located at Double Island Point is an environmentally friendly toilet that produces no pollution and does not require the addition of chemicals or water. The wastes are decomposed in large pits and the compost produced can be used as garden fertilizer after approximately three years.



Fig 3.17: Toilet at Double Island Point, Queensland.

WATER TREATMENT PLANTS

Most of the water that is used in the home has been through a number of treatment processes to make the river or dam water fit for human consumption. This water that is found naturally often contains many sediments which might be harmless, but in most cases makes the water look and taste unsavoury.

Most water treatment plants have two main objectives:

- * To reduce sediments.
- * To remove disease causing micro-organisms.

The simplest and most effective method of removing sediments is by **coagulation**. The water is mixed with colloidal material such as aluminium sulphate (alum) to form **flocculence or floc** - a mass of material formed when the chemical combines with impurities in the water. This material then precipitates out. Once the alum is dissolved in the water it must be given time to react to form a floc. This mixing can be done by passing the chemical and water through a series of tanks containing rotating paddle arms. The sediment that forms sinks to the bottom and is removed.

After settling, the water is then passed through a **filtration plant** where beds of sand and gravel and/or anthracite coal remove more of the sediments. The water finally goes through a **chlorination plant** where chlorine gas is added to the water to kill the microbes. Ammonia and Ozone can also be used to sterilize the water, but Ozone has the added advantage of bleaching out any discolouration of the water. Ozone is, however, very costly and is rarely used in large water treatment plants. It is used by many large commercial aquariums.

Large aquariums like Underwater World in Queensland or Aquariums in Western Australia use this method to sterilize the water as it is more effective and has fewer residual effects. Before the water is released into the public water mains many checks are made on its suitability for human consumption. These include chemical tests for certain ions and minerals, pH and biological tests.

The average person uses between 150 and 500 litres per day in the home. Most of this water that has to be processed is simply flushed down the toilet. It has been estimated that 45% of the water passing through each household water meter is lost in this way. A further 30% of the water is used in the bathroom having baths and showers. In addition 20% of the water is used in the washing clothes and cleaning the house. Less than 5% of household water is used for drinking. Industries in the production of many household items and processed food, consume huge volumes of water, increasing the average person's daily consumption.

Pure distilled water is tasteless and is formed by evaporation followed by condensation. The water we obtain from our taps is not pure, but it should contain only a few micro-organisms and little pollution. It will contain some chemicals that have been added to convert the river water into the product that is leaving the tap.



Fig 3.18: Water towers are used to distribute water by gravity to the consumer.

It has been estimated that over 30 million people have died in the last ten years because they drank unsafe water. Most of these people died of diseases such as cholera, hepatitis and diarrhoea.

Questions:

1. If an olympic swimming pool holds 2 million litres of water, how long would this volume support the population of your school? Assume the average volume of water used per person per day is 200 litres.
2. How long would it take the school population to drink this volume if average daily consumption is two litres?

Other methods of water treatment

Questions:

1. Other methods of water treatment include electro dialysis, distillation, reverse osmosis and freezing. Research these methods to find out how they work and where plants using these processes are in operation. The addition of fluorides to water supplies is a controversial issue.

Discuss some of the points for and against the fluoridation of water supplies.

2. The addition of alum is also being questioned in many areas as it has been shown that large concentrations of alum can lead to Alzheimer's Disease.

Discuss the implications of councils adding chemicals to the water that may, in the future, cause problems to humans.

Our drinking water dangerously unsafe

Just how safe is our drinking water?

Newspaper articles from time to time illustrate that all may not be as it should with our water. These articles that were written in 1991, challenge the purity of the drinking water in Australian cities.

Do you know how safe your drinking water is right now?

Disease bacteria in 25pc of city samples

By science and technology writer JULIAN CRIBB

DRINKING water in some capital cities and rural areas is dangerously contaminated with faecal and other disease-causing bacteria, a national investigation by *The Australian* has found.

Water samples taken in seven urban centres around the nation revealed in 25 per cent of cases levels of faecal microbes and other bacteria that violate national and world health standards.

The worst affected areas were the city of Adelaide, the Queensland Gold Coast and Perth. Water samples taken in Melbourne, Sydney, Brisbane and Hobart were fairly free of microbiological organisms.

Adelaide water showed the greatest cause for concern, with samples from three different areas of the city breaching National Health and Medical Research Council guidelines for drinking water.

Two were heavily contaminated with faecal bacteria, one with disease-causing pseudomonas, and the third had a total plate count (microbiological analysis) 140 per cent above the national limit.

A sample from Goodwood, South Australia, was contaminated with pseudomonas bacteria at levels too heavy to count — many hundreds of times the zero limit set by health authorities. Pseudomonas is known to cause gastrointestinal problems and skin conditions.

The Gold Coast sample taken at Southport also showed levels of coliforms, faecal coliforms, pseudomonas and other bacteria in excess of research council and

ON MONDAY
Part two: The deadly algae in our water supplies that threaten human health

World Health Organisation standards.

One of the West Australian samples, taken in North Perth, showed the highest level of micro-organisms in the entire test — 160 per cent above the national standard — but they were not the most dangerous sort.

The sample had a total plate count of 1308 microbes per millilitre of water, compared with a limit of 500.

A sample taken from Hornsby, in Sydney's northern suburbs, was only slightly below the national limit for total plate count of all microbial organisms. It scored 447 per millilitre of water, compared with a limit of 500.

The samples were tested by the University of NSW's Food for microbiological, pesticide and mineral contamination.

In two other respects city drinking water showed satisfactory quality. Residues of phosphate pesticides were all below the national limits of 0.1 and 0.05 parts per million.

The minerals test, while confirming that residents of Adelaide and Perth have the

Continued — Page 4



Country's lifeblood is threatened by neglect

By JULIAN CRIBB

AUSTRALIA'S lifeblood, its priceless water, is in an advanced state of degradation. It grows worse each day under a multiple assault from soil erosion, pollution, mismanagement and environmental destruction.

At stake are the health and quality of life of the nation, its \$10 billion livestock industries, its rivers, lakes and wetlands and all of their dwindling wildlife and plants.

Australian water supplies are extensively contaminated with faecal bacteria — in many cases far above World Health Organisation standards — and require increasingly heavy chemical treatment.

Toxic blooms of algae thrive in the nutrient-rich conditions produced by mismanagement of rivers and catchments. Dams and streambeds are clogged with silt and city water is increasingly turbid.

Saline groundwaters are welling up into

surface flows, poisoning low-lying lands and river systems and destroying an estimated \$200 million in export income each year.

Even the chemicals we use to cleanse our drinking water and destroy bacteria are themselves suspected of reacting with natural substances to cause long-term genetic damage, possibly cancer.

While debate rages periodically about Australia's population and immigration policies, it is likely that already a finite boundary to human occupation has been set — by our decaying water systems.

The sparkling streams which begin in Australia's hill country mutate rapidly to thick, brown flows, heavy with silt, salt and pollutants, winding down putrid, muddy channels lined with eroded banks and dead or dying vegetation — the work not of nature, but of man.

Continued — Page 4

LEVELS OF BACTERIA

	Total coliforms	Faecal coliforms	TPC	Pseudomonas Spp.
Gurr St, Goodwood, SA	10	0	1200*	0
Margaret St, Nth Adelaide, SA	57	50	198	0
Peterhead, Port Adelaide, SA	385*	154*	324	TNTC*
Pretoria Pde, Hornsby, NSW	0	0	447	0
Stacey South St, Bankstown, NSW	0	0	251	0
Nelligan St, Dianella, Perth, WA	0	0	92	0
Stirling St, Perth, WA	0	0	1308*	0
Olsen Ave, Southport, Qld	30*	27*	504*	2*
Brisbane Airport, Brisbane Nth, Qld	1	0	43	0
Williamstown, Vic	0	0	1	0
Bell St, Yarra Glen, Vic	0	0	0	0

* Count above recommended drinking water quality levels 1990-91
TNTC — Too numerous to count. TPC — Standard plate count

CHAPTER 3

Bacterial breakdown of hazardous compounds

Many of our most hazardous and potentially lethal chemicals are organic in nature. Scientists have now developed by genetic engineering a strain of bacteria that can break down some of these compounds.

Substances such as PCBs which were once thought to be very persistent and not bio-degradable can now be decomposed by bacteria in laboratory conditions. The Monash University genetics department has signed a two year contract with ICI Australia aimed at the biological breakdown of some of the 7,000 tonnes of toxic compounds at its Sydney depot.

DISPERSAL

The most common method used by local councils to dispose of rubbish is burying the waste underground in large dumps. This is termed the **landfill method**.

Table 3.3: Comparisons of some waste disposals methods

Advantages:	Disadvantages:
• Many smaller city councils favour landfill systems as they can be used to fill in so-called "non-usable spaces" such as gullies and wetlands. Once filled in, they can provide usable recreational areas. • Where land is available it is a very economical method. The establishment cost is very low. • All household rubbish collected by the sanitary services can be disposed of without sorting, thus reducing costs.	• The major problem with this method of waste disposal is that it has no control over the disposal of harmful and hazardous wastes which may be disposed of with the other rubbish. These compounds can leach out of the buried wastes into the underground water systems where it eventually joins rivers and oceans. • The natural ecosystems of these areas are destroyed. • Some major cities are finding a problem with this method of disposal as it costs a lot to haul the rubbish to the waste lands. All land inside the city boundaries is being used. These cities are producing, literally, mountains of rubbish each year and the logistics of removing this rubbish large distances is prohibitive. • Most have large areas of rubbish exposed to the air. The decaying rubbish produces methane and other smelly gases which may affect people living in the vicinity. Fires are also lit at times, producing a concoction of gases made from the burning of plastics, PVC, rubber and other chemicals. • Hazardous wastes such as toxic compounds, pathological wastes from hospitals and veterinary surgeries, paints and residues, chemicals used by pest control agencies and other dangerous substances could be illegally dumped.



Question:

Contact your local council or ask some of the older pioneers of your town to find out where the original dumps were.

What use is being made of that land now?

Fig 3.19: Dumps can be levelled and turned into recreational areas.

Most councils have health inspectors who supervise the dumps to stop:

- * The spread of disease.
- * The dumping of toxic compounds.
- * Dust and litter problems in the locality of the dump.

A national report, "Water 2000 Report", revealed a number of problems with landfill treatment plants operating within Australia.

The report outlined problems such as:

- * Leakage.
- * Poor design.
- * Poor testing procedures.
- * Low maintenance.
- * Lack of recycling procedures.

Question:

Do you believe that landfill dumps are the best method of disposal of household wastes?

Leaching is the process by which substances found in the dump material dissolve or are washed away by the water from the dump site into the underground water system.

This fluid which contains organic material, chemicals such as PCBs and other toxic compounds, heavy metals and other pollutants mixed with water is called **leachate**.

To control leachate the dump site needs to have a non-permeable base such as clay and a method of collecting this leachate before it reaches the underground water system.

To do this, a drainage system needs to be organised before the dump becomes operational. The leachate that is or should be collected needs to be tested for pollutants and if necessary treated. Underground water from the area of the dump also needs to be regularly checked.

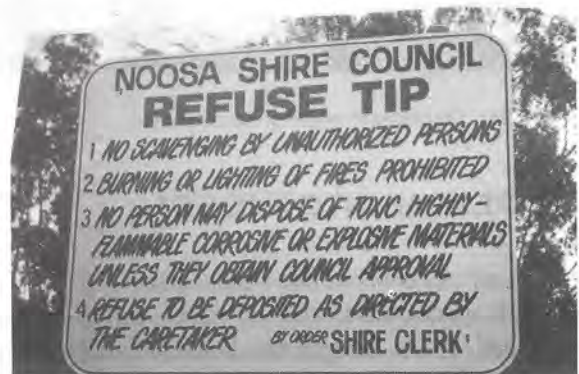


Fig 3.20: Measures taken by local councils to limit rubbish

SWAMP



OCEAN OUTFALLS

The sea naturally processes its organic wastes and the system thrives on wastes. It is the world's first and most effective treatment plant. Sewage and wastes dumped into the sea are diluted by the water and spread over large areas by wind and currents. Many people argue that this will increase the nutrient level of the oceans and increase the productivity of the sea. It is a very cheap method and can deal with very large volumes of wastes.

Others argue we are overloading this system causing a major alteration to the natural balance found in the ocean. They believe that it is a major health risk and could be disruptive to the tourist trade. No controls exist over wastes being dispelled out to sea and many non-biodegradable and toxic compounds are being released. The oceans do have a finite quantity and cannot cope with the huge volumes some areas such as Sydney are releasing.



Fig 3.21: Greenpeace photo of Bondi Beach.

DISPERSAL INTO THE SEA

Many city councils that were situated near major ports found the cheapest method of disposal of its solid wastes was to load the wastes onto a barge, take it out to sea and dump it. Out of sight, out of mind! It was thought that it would simply decompose in the sea but in many areas it formed **ecological deserts** in the water.

Some of these dump areas have been described as being "biologically dead". This method of waste disposal is now controlled by the **Commonwealth Environmental Protection (Sea Dumping) Act** which came into operation in 1984. This Act also prohibits the dumping of radioactive wastes at sea.

Before the introduction of this Act, many toxic wastes such as pesticides, petroleum products and hazardous chemicals were stored in drums and thrown into the sea. The result of this thoughtless practice may not be known until well into the next century when the drums corrode and release their contents.

The Act still allows some dumping of wastes into the sea. Wastes such as dredge spoil and effluent from certain industries such as paper mills and oil refineries are allowed. Many people believe that this is simply a licence to pollute, but the Department of Environment and Heritage which polices the Act in Queensland, believe that licencing allows for the managing and controlling of pollution. In addition, the licencing provides funds for water testing and the licences must be renewed each year.

Garbage from ships has been traditionally dumped into the sea. This dumping has now been prohibited and is policed by the Commonwealth Department of Transport and Communication. It hopes to educate the public through a campaign which carries a catch cry "Stow it, don't throw it".

Disposal of wastes into the sea may, in some cases, be beneficial. Artificial reef structures have been made out of old car bodies, barges, old ships, and other structural materials. These artificial reefs provide protection for marine life and the marine life flourishes with this protection. It has been found that once an artificial reef structure has been formed reef building organisms become established in the area and start to build a natural reef. In Queensland, a successful artificial reef has been set up in Hervey Bay.

DISPERSAL INTO AIR

One method of disposing of toxic compounds is by **high temperature incinerators**. They operate at temperatures of up to 1,200 degrees centigrade and break the toxic chemicals into their simplest constituents. These incinerators can destroy up to 99.9% of the toxic chemicals.

Some incinerators heat the toxic substances in the absence of air to temperatures above 1,500 degrees centigrade. The process is known as **pyrolysis**. It causes the breakdown of the chemical bonds destroying the potentially dangerous compounds.

The major advantage of this method is that it also reduces the volume of wastes by up to 80% leaving only ash behind and in doing so provides energy. The heat produced in the burning of these compounds can be used for heating and generating power. Some of these incinerators have been located on ocean going ships.

B.C.



The problem lies with the remaining 0.1% that cannot be destroyed. Such a small amount does not appear to be much of a problem, but when we consider that a total of 150,000 tonnes of toxic wastes are produced by Europe each year, 0.1% represents a total of 150 tonnes. These toxic residues can still find their way into food chains. Greenpeace believes that there is a need for special filters to control the gaseous emissions. It is also believed there is a risk of forming new, even more toxic compounds.

Many governments are not willing to go to the expense of building these incinerators. Australia has only recently decided to build a toxic waste incinerator in southern NSW near Corowa.

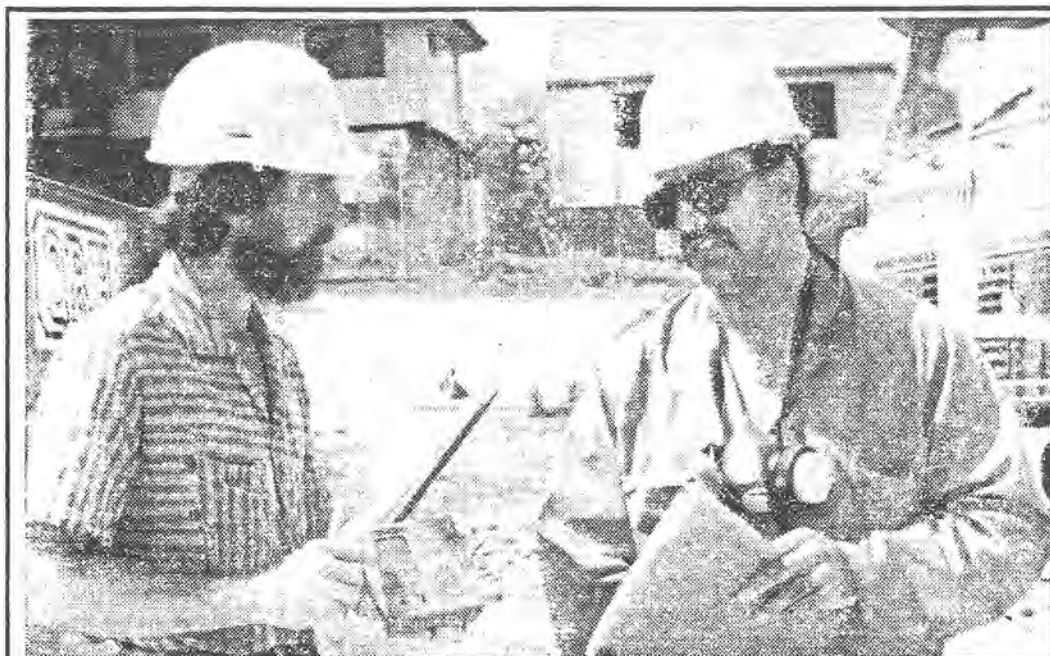
CONTAINMENT

Impermeable pits

Some of the low level hazardous compounds are being stored in clay pan pits. The wastes are placed in sealed tanks and buried. The clay is impervious to most, if not all, solutions. In the past, hazardous and toxic wastes were dumped down old mine shafts and other pits. At the time this was thought to be a good idea, but many of the chemicals have escaped from these storage areas and are now posing many problems.

One of the most recent examples was at Kingston, a suburb of Brisbane. Here, many toxic chemicals were stored in an old and disused mine shaft. The shaft was filled in and a housing estate was developed on the site. After many years signs of a toxic sludge appeared in many owners' yards. Following years of complaints and much debate, the Queensland State Government ordered an 8 million dollar rehabilitation of the site. 46 properties were resumed and an impervious cap was placed over the area.

A new suggestion is to place the highly toxic compounds in holes bored deep into the earth's crust. These holes would then be capped with concrete.



Environmental consultant Bruce Lloyd, left, and health and safety supervisor James Masselos check the last of the houses to be moved from Diamond Street, Kingston.

Kingston residents still feel trapped

THE concrete cap is soon to go over Kingston's toxic sludge. But some residents near what will become a "suburban bush-scape" remain fearful of contamination.

Some said yesterday they continued to live in uncertainty, unconvinced that no health dangers remained.

"We feel there could be some lingering problems which still need to be addressed," Residents Against Toxic Substances member Mrs Anita Long said.

Mrs Long, who lives near the Logan City site, said many people had recorded high arsenic levels which had so far been blamed on diet. "But we have been given no

By MARK VOISEY

details of the soil tests on our land," she said.

Mr Colin Caisley, whose wife Jill is ill in hospital, said he was trapped in nearby King Street because the value of his property was now so low he could not afford to sell and relocate.

Both Mrs Long and Mr Caisley said neighbors felt the same.

After a tour of the area yesterday, the Police and Emergency Services Minister, Mr Mackenroth, assured residents all reports into Kingston would be made public next year.

The Epidemiological Research Unit, headed by Dr Barry Smith-hurst, is due to report early in the New Year.

Mr Mackenroth said he believed the image of the area would eventually improve and the park would increase property values.

The State Government ordered the \$8 million rehabilitation of the site last May, including the resuming of 46 properties and sealing of the entire area with an impervious cap.

Mr Mackenroth said more than half the rehabilitation work was complete.

Radioactive wastes

We have no way of destroying or neutralizing radioactive or atomic wastes. They have to be stored until they become harmless. This, however, causes a problem as it takes 24,000 years for plutonium, one of the nuclear wastes, to lose half its radioactivity. The question arises what substance could store it for this period of time?

A new method being developed is to solidify the radioactive waste material into substances such as glass. This process is called **vitrification**. The glass compounds produced should last forever and the radioactive material would remain trapped within the glass. It has also been suggested that these wastes could be deposited in holes deep within the earth's crust.

REDUCING WASTES

A number of methods are available to reduce the volume of wastes. It is believed that the volume of wastes will double within the next ten years and if some of the following methods are not implemented these predictions will come to fruition. Methods which could be used include:

- * *Minimising wastes.*
- * *Recovering waste material.*
- * *Reusing materials.*
- * *Recycling.*

Minimising wastes

The wastes produced by society can easily be reduced if individuals, industry and other polluters are made aware of the problem and are educated or rewarded for reducing wastes. Many products to-day have excessive packaging which in most cases is not necessary. If consumers were to simply not buy these products market pressure would stop this practice.

Items with better durability also need to be produced and again market pressure may bring this about. The products need to be able to be repaired rather than replaced. The motor industry leads the way in producing throw-away items. If a small component such as a park light is damaged or broken the whole bumper bar or light assembly must be replaced.

Recovery

Our minimal resources are being mined, used for a short time and finally buried. What a waste! We need to endeavour to recover many of these precious materials. This may require society to change its disposal patterns.

Reuse

The dumps are full of items which have had only one owner, before being discarded. To cut production costs and to ensure a continuous market manufacturers are tending to make non-durable or disposable items. Some believe if the item produced never needs to be replaced they will make only one sale and therefore turn-over will be poor.

Enormous volumes of water are used in the manufacturing and production of many items.

Some estimates are

- (a) 1000 litres of water to produce one kilogram of wool.
- (b) 2000 litres of water to produce one kilogram of sugar.
- (c) 1500 litres of water to produce one kilogram of rubber.
- (d) 100,000 litres of water to produce one car.
- (e) The average family uses 2,000 plastic bags a year.

We need to find ways of minimizing or recycling this water usage.

Question:

Many of today's parents use disposable nappies.

Calculate

- (a) the number of disposable nappies a baby would use in its first two years of life if it soiled an average of 10 nappies per day.
- (b) the volume of this number and compare their cost with that of 2 dozen cloth nappies.



Fig 3.22: Some councils are collecting recyclable materials along with regular rubbish collections.

Recycling

The reprocessing of waste products for reuse is called **recycling**. Recycling programs are designed to collect and sort the waste materials into valuable sources of raw material. The earth's resources are running out and recycling will allow the resources to last longer. The reduction of the amount of raw materials needed is important as is the reduction of the mining for those resources. The mining of raw materials such as bauxite, iron ore and sand (the raw materials for making aluminium, steel and glass, respectively) uses up energy, causes pollution and destroys the natural environment.

Recycling of substances also saves energy in that it requires less energy to reprocess the substance. With aluminium, for example, the energy that is required to make a recycled can is only 5% of the energy needed to make a can from raw materials. The recycling of wastes will also reduce the amount of wastes filling the dumps around Australia. Less than 20% of to-day's wastes are recycled and most of this amount is the recycling of industrial wastes. The bulk collection of household wastes makes the separation of wastes almost impossible and, therefore, recycling is not practical.

Governments need to promote the recycling of compounds. One method of increasing recycling is to give subsidy to certain industries or other monetary incentives such as tax cuts. If money is to be made out of this system more people may become involved in the project (if not for the right reasons).

Plastics

Plastics are made from petroleum products. Petroleum is a limited resource and it is therefore important that the use of plastics be reduced. In addition a number of toxic compounds are produced in the manufacture of plastics. Unfortunately, the recycling of plastics has a very low potential and only 8% - 10% could hope to be recycled. In Queensland less than 2% is now being recycled.

Plastics are very useful and the reasons for their takeover are easily seen. Plastics use less energy to produce than glass or aluminium, are easier to mould, are more flexible and are a lot lighter and stronger. Many parts of to-day's cars are even made of plastic. This helps reduce the cost and overall weight of the car. In addition plastic compounds are very durable.

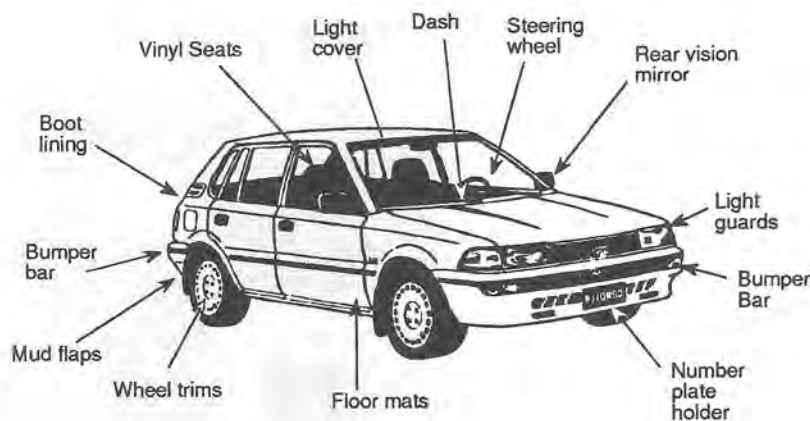


Fig 3.23: Some parts of a car made from plastics.

**HOMOGENISED
PASTEURISED
MILK**



**DON'T RUBBISH ME
RECYCLE ME**

Recycling facts

Japan recycles 50% of its wastes.

Do you believe Australia will ever recycle this proportion of its wastes?

The average Australian household produces enough wastes each year to fill the average three bedroom house with rubbish.

It has been estimated that in one Australian State, residents throw out over 100,000 tonnes of plastics annually.

Thermoplastics and thermosets make up the two main types of plastic.

The **thermoplastics** are soft plastics which, when heated, can be reshaped and moulded. These plastics can be recycled.

The **thermosets** keep their shape at high temperatures and are almost impossible to recycle. It has been suggested, however, that these thermosets may be recycled by moulding them with other wastes to make building materials.

Scientists have developed a photodegradable plastic. This plastic has been introduced by some retail chains in an effort to cut down the volume of wastes created. These plastics are claimed to break down when exposed to ultraviolet rays from the sun. Other plastics are now being created from plant starches and cellulose. It is hoped that this will allow these plastics to be biodegradable.

Paper

The recycling of paper has excellent potential. The making of recycled paper requires only half the water and energy that is required to make new paper. The recycling of one tonne of paper also saves one hectare of forest. Since approximately 50% of the rubbish dumped is comprised of paper and wood products the recycling potential is high. In some Australian states a mere 15% of waste paper is recycled.

In recycling the waste paper is broken up and mixed with water to produce a pulp which is then de-inked and placed in a chemical bath to separate the fibres. Recycled paper is made from this pulp.

Most of the paper we use has a very short useful life. In the case of newspapers and magazines, less than a week. Queensland residents screw up and throw out over 300,000 tonnes of paper. This represents enough timber to build over 50,000 new homes.

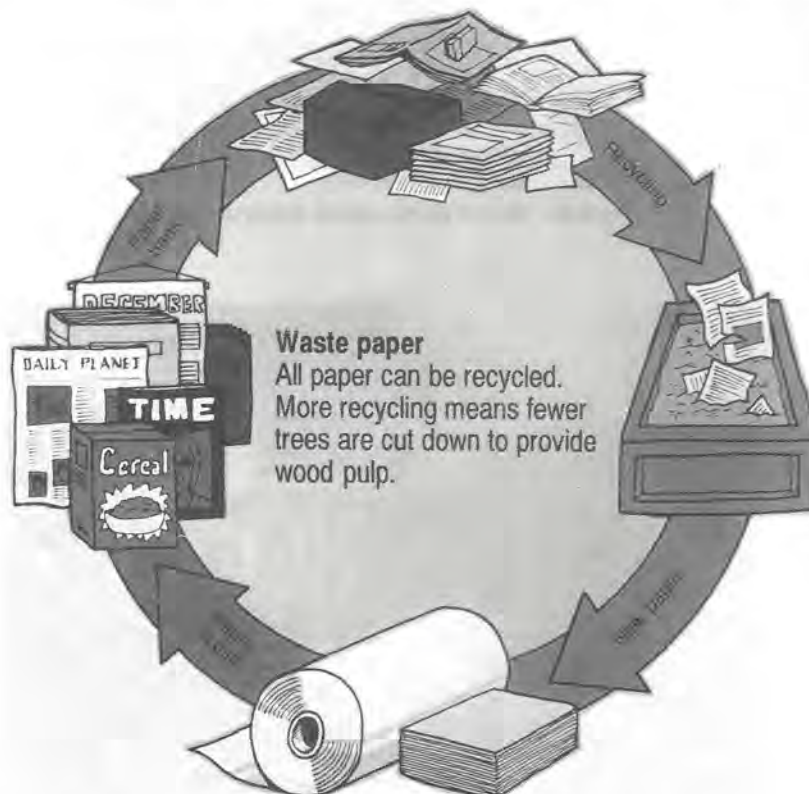


Fig 3.24: Illustration courtesy Department of Environment and Heritage



Job card is everyone's business

TOKYO: When Japanese scientist Senji Kaneko hands people his business card, they usually sniff it. It's made out of sewage.

Mr Kaneko, head of sewage technology at the Yokohama City Sewage Bureau, has developed a way to turn sewage sludge into paper.

He hopes his discovery will help solve the world's paper production problems by reducing the need to use trees.

"People usually sniff my card after I tell them it is made of sewage but there is no odor at all. It's just paper," Mr Kaneko said.

Mr Kaneko and two colleagues developed the sewage-into-paper process by heating sludge from sewage tanks at 1450 deg.

The ashes were then spun into a wool-like substance mixed with wood pulp at a ratio of seven to three.

— MATTHEW FRANKLIN

Article courtesy The Courier Mail 15/1/91

It has been estimated that Australians use over 1,000,000 tonnes of paper annually. This includes 400,000 tonnes of wrapping paper and 150,000 tonnes of tissue and toilet paper.

Class project

Investigate the amount of paper used annually at your school.

You may have to get your teacher to obtain the information from the school administration officer or other departments.

How much of it is used in photocopying and duplicating. How much is recycled?

CHAPTER 3

Glass

Glass containers may be refilled or reprocessed. The reprocessing of recycled glass, first of all, requires it to be broken up into a fine powder.

This powder is then added to a furnace in which glass is being made. Up to 30% of the new glass bottles can be made up of recycled glass. Australia wide 160 000 tonnes of glass are recycled each year.

This is a large amount when you consider it would take a train over 10 klms long to transport this volume.

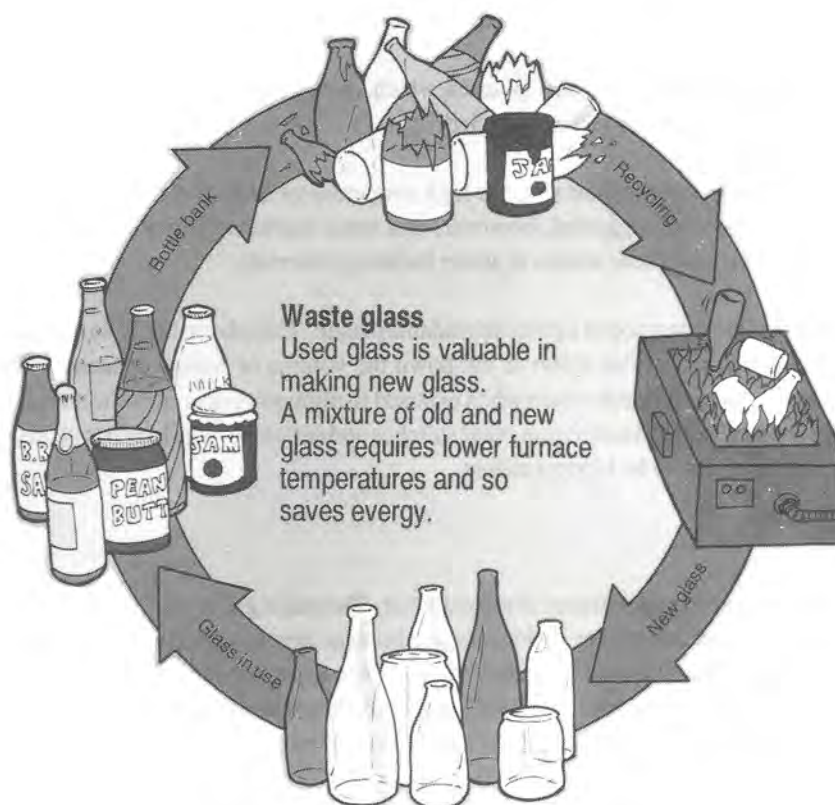


Fig 3.25: Illustration courtesy Department of Environment and Heritage.

Rubber

It takes one-third of a barrel of oil to produce a car tyre. Australians are thought to wear out two million tyres each year. Most of these tyres are simply dumped. Some 600,000 tyres are recycled each year as retread tyres. These retreaded tyres in the past were poorly manufactured and had a number of problems associated with them. These problems included the peeling off of the new layer and weakening of the tyre in certain parts.

The modern retread tyres have few problems but the stigma of the past remains and many consumers are unwilling to risk the new retreads.

Tyres are also recycled to make door mats, jetty fenders, sand stabilizers, garden ornaments and even fences! Rubber has a high energy value and has a potential as a fuel source. However the cost of collection of the large amounts of tyres needed to run a large generation plant makes the project not feasible.

The burning of these tyres causes many pollutants and the air pollution control devices that would have to be installed would make it even more expensive.



Fig 3.26: Most of these tyres are simply dumped.



Fig 3.27: A fence from old tyres with plants growing in them.

Chemicals

Many of the chemicals used to-day in industry are used once and simply discarded. A good example of this is the use of solvents which are used to clean spray painting equipment when the panel beater is changing paint colours. The solvent dissolves unused paint as it flushes out the equipment. This solvent is now being recycled by some spray painters and panel beaters. It is collected and taken to chemical plants where the solvent is distilled off to be reused. The paint and other residues left behind are then dumped at chemical dumps.



Fig 3.28: A chemical recycling plant.

Metals

The production of metals requires large amounts of energy and resources. The recycling of metals is extremely easy if they have been sorted thoroughly.

The metals are simply melted down and remoulded into the new shape that is required. There is a large tonnage of metals discarded at dumps and all of this could be reprocessed.

Building materials

A large proportion of the materials recovered in the demolition of buildings could be recycled. Most of the materials such as timbers, windows and doors could be structurally sound.

Many buildings are demolished simply to make way for new buildings. These buildings could be structurally sound and last another 100 years, but have been bulldozed and the potentially recyclable building materials simply used for landfill.



Fig 3.29: Suggest what these old cars might be reincarnated as if they were recycled. What are the environmental advantages of recycling metals?

CHAPTER 3

Aluminium

Aluminium is one of the metals which is successfully being recovered and recycled. 50% of aluminium cans used are now being recycled. Over 1,300 million cans or 24,000 tonnes of aluminium cans were recycled in 1988.

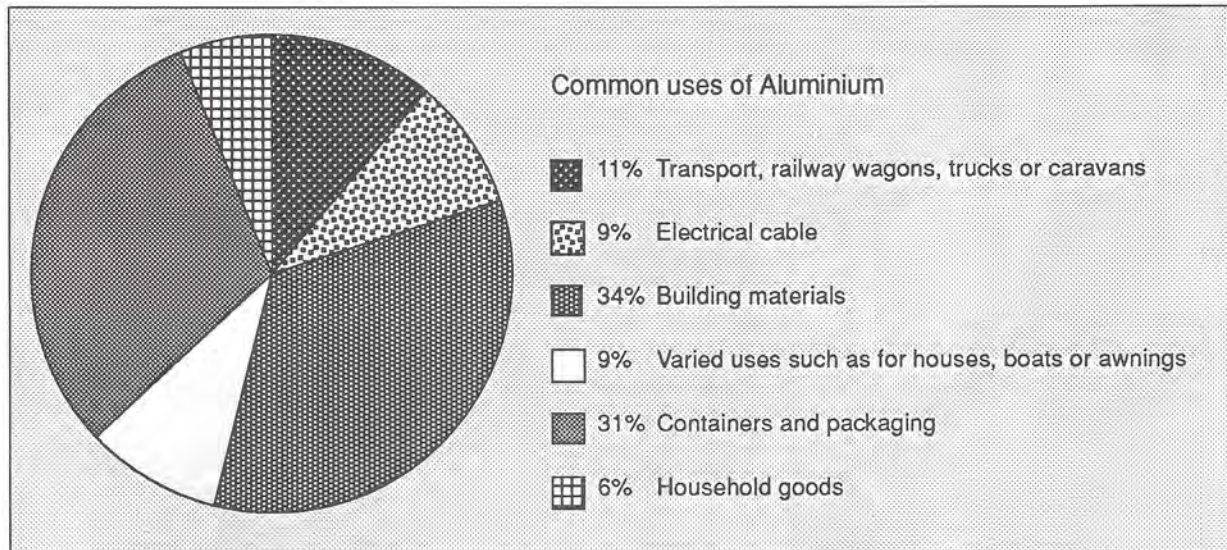


Fig 3.30: Common uses of Aluminium.

Aluminium is a strong lightweight metal that is resistant to corrosion. The fact that it resists corrosion makes it a persistent pollutant. Australia produces 35% of the world's alumina (the white powder, Al_2O_3) from which alumina is made.

Aluminium is extracted from the ore, bauxite, which is mined at Weipa in Queensland. It takes 6,000,000 tonnes of bauxite, 1,400,000 tonnes of coal, 500,000 tonnes of caustic soda, 300,000 tonnes of oil, 120,000 tonnes of limestone, 40 megalitres of water per day and 73 megawatts of electricity to produce 2.5 million tonnes of alumina. This alumina is then smelted to produce aluminium which requires huge amounts of electricity.

If aluminium is recycled, all these resources and 95% of the energy is saved.



Fig 3.31: Aluminium cans being collected for recycling. Photo courtesy Comalco Australia.

Wizard of Id



Aluminium can be re-melted again and again without losing any of its properties. Community groups, by collecting aluminium cans, not only reduce the litter problem, but save energy and resources and make money for community groups.



Fig 3.32: Alumina processing plant. (Photo courtesy Queensland Alumina)

Lubricants

Many companies are now recycling oil which has been collected from service stations and garages, industries and councils. Some of this oil is refined and sold again to the public. This is presently being used as a promotion to help sell certain brands of oil. Other uses for this recycled oil include use as fuels, in road making and the treatment of timber.

Composting

Composting is a money saving, environmentally friendly and convenient way of recycling food and garden wastes. Composting not only returns nutrients to the soil that the plants removed, but reduces garbage by up to 50%. It relies on micro-organisms such as bacteria and fungi to break down the complex plant and animal materials.

The process has been used for centuries by the Chinese and other Asian countries, but it has only become common practice in Australia relatively recently. Almost any organic material can be used as compost (garden clippings, leaves, weeds, lawn clippings, wood shavings, vegetable and fruit peels, peanut shells, tea bags and even seaweed). Chopping up or shredding the material increases the speed of decomposition by increasing



Fig 3.33: Recycled oil is now being sold to the public.

the surface area. The microbes that cause the decomposition are found naturally on the material or in soil. The rate of decomposition depends on the type of material, the nitrogen level in the material, the temperature of the compost and the moisture level.

Mulching (adding compost to the soil) improves soil fertility and consumes moisture. Meat and bones should not to be added as they encourage rats.

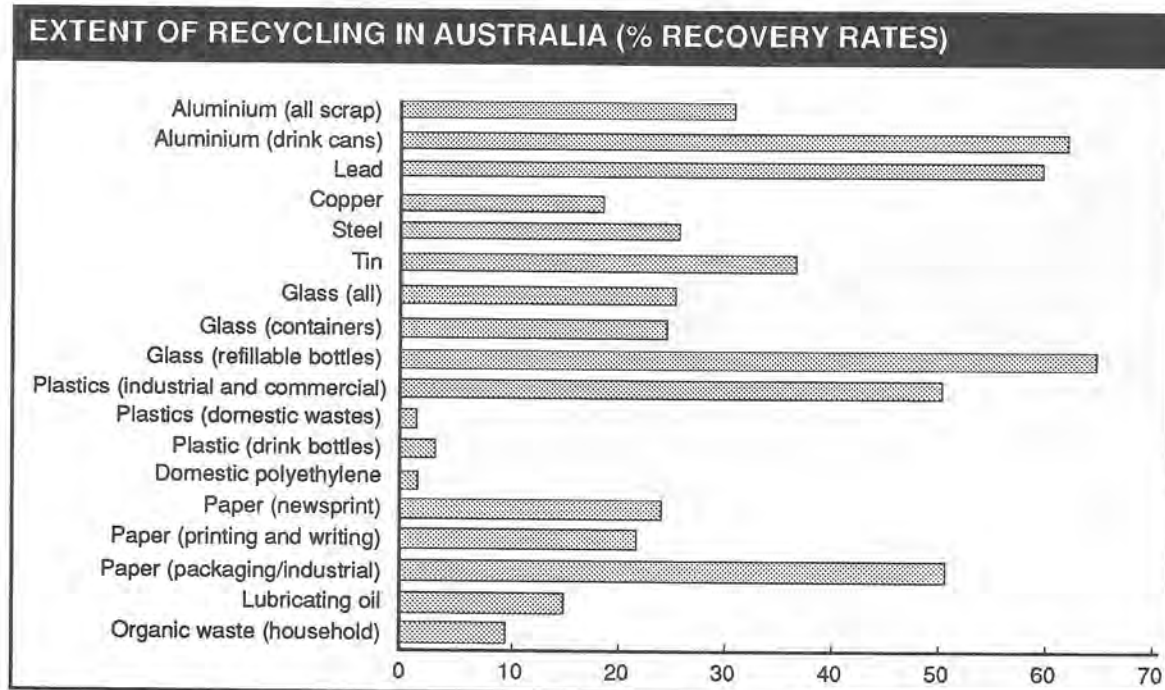


Fig 3.34: Information supplied by Australian Newspapers.

Planet earth — a junkyard

THE following facts and figures will hopefully stir more concern and thought on how each of us plays a detrimental or beneficial part in relation to how we effect our environment.

Have you ever considered how long it takes for the waste we create to decompose?

Just think — a plastic bottle may take 100 years although some environmental experts say

this is a very optimistic estimate.

Toothpaste tubes will be around for 50 to 100 years once thrown away.

A disposable razor takes 50 years to breakdown, while a cigarette butt will take 30 years if exposed to strong sunlight.

Glass bottles and aluminium cans virtually take forever to decompose (if they ever do). At least these items can be reused or recycled.

What about the volume of rubbish we produce? Statistics from a US study estimate that 1.6 billion disposable pens, 16 billion disposable nappies, two billion razors and blades and 220 million tyres were disposed of in landfill sites all within one year.

That would only account for a minute amount compared with what other rubbish we throw out each year.

It would seem before long we may well be buried under our own wastes if our disposable society keeps going the way it is.

Not all looks gloomy when you consider 95 per cent of the energy required to produce new aluminium can be saved (not to mention resources also) if cans are recycled.

When South Australia introduced the Beverage Containers Act (where a compulsory deposit on glass and aluminium drink containers was applied) the recovery rate rose to 90 per cent (twice the national average).

Benefits of a national deposit programme would be enormous both for recycling and saving our resources as well as a 30 per cent saving for the consumer when buying a drink.

Closer to home and not so promising were the alarming figures monitored from Sydney's Malabar outfall.

Here they found the following toxic wastes were being discharged into our oceans — 68 tonnes of lead, 29 tonnes of zinc, four tonnes mercury and 23 tonnes of cadmium.

Rainforests worldwide are being destroyed at the rate of one football field every 10



The Environment

By CATHY WALKER

seconds, that is three times the size of Switzerland in a year.

The rate of deforestation to reafforestation is 12 to 1. Since European settlement, 78 plants, one bird and 12 mammal species have become extinct in Australia. Most of this can be related to forest clearing.

Now 182 plants, 18 birds, two reptiles and 23 mammals are endangered.

Do you ever think about whether the products you buy are from animal testing? Perhaps this may stop you in your tracks.

The number of animals that die in laboratory experiments worldwide yearly is 200 million (20 animals per second).

The percentage of animals experiments performed for non-medical purposes is 70 per cent.

Have you any bright ideas or inventions that may help save our environment?

Look at the sugar cane industry, it may well diversify into ethanol production from sugar or paper production from the cane's fibrous matter. This will hopefully reduce our reliance on fossil fuels and the cutting down of more trees.

Benefits of recycling are:

- * Saves our energy supplies.
- * Saves our resources such as forests, coal, oil and minerals.
- * Saves our natural ecosystems being destroyed by the mining of resources.
- * Reduces volume of wastes to be disposed of, thus reducing our rates.
- * Reduces litter.
- * Reduces species loss.
- * Reduces Greenhouse effects.
- * Provides jobs.
- * Makes money for community groups.

Fig 3.35: Article courtesy Gympie Times.

RENEWABLE AND NON-RENEWABLE RESOURCES

It is becoming increasingly evident that the Earth's resources are not limitless. We are using up the resources at an astonishing rate. **Renewable resources** are those where the natural production rate for the resource is equal to or exceeds the demand for that resource. **Non-renewable resources** are the non-living resources which cannot be replaced at the rate at which they are being used. These include fossil fuels, minerals and chemicals. Most chemicals and minerals are not destroyed, but are transformed by industry into substances which cannot or will not be able to be used again. Most are simply used for a short time and dumped.

Renewable resources such as forests and fisheries are those where the natural production rate for them is approximately equal to the demand for them. These resources are in a state of balance and overuse or exploitation of them can result in the loss of this resource. It requires careful management to maintain renewable resources.



Fig 3.36: A farmer and an environmentalist discussing deforestation. What do you think they are saying? Continue the debate in class.

Queensland fisheries have a value of about \$1,000 million. Commercial fishermen harvest approximately 8,000 tonnes of fish and 12,000 tonnes of prawns annually. The amateur fisherman also removes thousands of tonnes of fish etc. from our waters. If these catches are going to remain at this level in the future we need to implement management practices now. The Department of Primary Industries is doing this now in Queensland with regulations which limit the size of catches, the size of fish that can be taken, closed seasons for certain species and the implementation of fish sanctuaries and fish habitat reserves. See Chapter 1 for more details of these regulations.

Queensland has immense mineral wealth. Its value to Queensland is approximately \$4 - \$5 billion annually and over 50% of our export income is derived from this source. The minerals being mined include coal, gold, copper, zinc, bauxite, oil and gas. We may be benefitting from the mining activities and the export of these minerals, but in the long term it may be wise to conserve these resources for future generations. Furthermore mining operations have an effect on the environment as discussed previously in Chapter 2.

CHAPTER 3

RENEWABLE FUELS

We live in a society that is very dependent on energy. The importance of this energy supply is soon realised when the energy supply fails for some reason and we have a blackout. We also appreciate the need for fuel when the family car runs out of petrol or we do not have the money to spend on petrol. Most of the time we take the supply of these fuels and energy for granted.

The demand for energy has grown dramatically in the last 200 years since the industrial revolution. The living standards of a country are directly proportional to the level of energy consumption. In Australia we use on the average 20 times more energy per person than people from poorer areas of Asia or South America.

Questions:

Most homes have a great variety of appliances that require energy for their operation.

1. Which of the items listed below are non-essential and in your opinion, a waste of energy?
2. Can you think of other electrical appliances that are found in some homes?

- * electric stove
- * refrigerator
- * freezer
- * washing machine
- * dryer
- * lights
- * hot water system
- * television
- * video
- * hi-fi
- * fans
- * air-conditioner
- * toaster
- * kettles
- * food processors
- * hair dryers
- * drills and saws
- * clock radios
- * computers
- * electric blankets
- * sewing machines
- * electric toothbrushes
- * blenders
- * electric shavers.

3. Redraw and complete the table opposite from reading the information supplied on the next four pages.

POWER SOURCE DATA	Solar power	Wind power	Nuclear power	Power from the sea	Geothermal power	Biological fuel	Hydroelectricity	Fossil fuel
Suitable for Australian conditions								
Suitable for remote areas								
Suitable for all areas								
Cost efficient								
Renewable								
Non polluting								
In development stage								
Inexhaustable supply								
Expensive to setup								

The traditional fuels that are used by most societies around the world are the fossil fuels - coal, oil and natural gas. We are quickly running out of these forms of fuel. Australian coal reserves will be exhausted by the 22nd century and gas reserves by the year 2050 at present consumption rates. These fuels can be manufactured by nature but the process takes millions of years and we are using the fuels at a faster rate than nature can produce them. In addition the fossil fuels are producing a number of pollution problems as discussed in Chapter 2.

Other sources of energy may be able to solve some of our energy problems, but most are still in the research stage. Some of these sources are very costly or do not give a continual supply of energy. Most scientists believe that no single source of energy will be able to supply the energy we will require in the future. They believe that we need to have a variety of sources at our disposal.

Other sources of energy include:

- * Solar power.
- * Power from the wind.
- * Hydro-electric power.
- * Power from the sea.
- * Atomic or nuclear power.
- * Geothermal power.
- * Biological fuels.

These forms of energy with the exception of nuclear energy, are considered to be clean sources of energy.

Solar Power

Solar power relies on the sun as a source of energy. The **radiant energy** is absorbed and converted into heat or electrical energy. Australia is an ideal region for the tapping of this energy with its weather patterns giving vast areas many cloud-free days during the year. This source of power is already being used in household hot water systems and power generation. It has even been used to power motor vehicles in races across Australia.

Remote area homesteads are using **photovoltaic cells** to convert radiant energy into electric energy.



Fig 3.37: A solar powered calculator

Photovoltaic cells or solar cells are made of pure silicon crystals.

Silicon is a very cheap raw material found in sand and on beaches. This silicon is then purified and crystallised. A very small voltage is produced when the sun shines on the solar cell.

Superior features put Solahart way out in front.

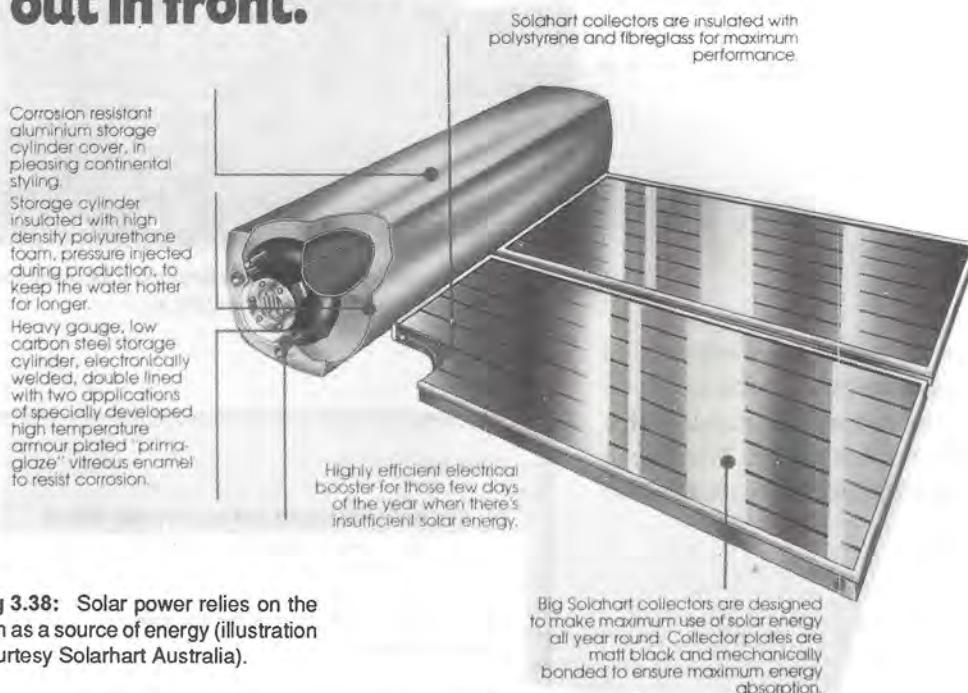


Fig 3.38: Solar power relies on the sun as a source of energy (illustration courtesy Solahart Australia).

CHAPTER 3

Much research has been completed in this field. The CSIRO has developed thin films for solar collectors that reduce reflection and increase efficiency by 25%. High temperature solar energy collectors which work at 250 degrees centigrade are being developed as well.

Complete this table	
Advantages of solar energy	Disadvantages of solar energy

Power from the Wind

This source of power has been used for many years in Australia with windmills pumping water from underground to the surface for cattle to drink. The windmills of the Neatherlands have been operating for centuries. Wind power allowed the ancient sailors to discover our continent and provided the power for moving most of the produce around Australia in the early days of white settlement.

Modern windmills are becoming more sophisticated and are sometimes called **wind turbines**. They are more efficient and are often designed by aircraft engineers. Some wind turbines look more like inverted egg beaters than the traditional blade design. This form of power generation is more suited to areas where prevailing weather patterns produce high velocity winds.

Countries such as Denmark, the Netherlands and regions of the USA such as California forecast that one-fifth of their energy will come from wind by the year 2000. Some areas of Australia such as Tasmania which have high wind velocities have excellent potential for developing wind power.

An Australian company, Energy Systems International Pty. Ltd, is marketing a wind powered system for outlying home-steads which uses wind power, fuel and batteries to produce a regular supply of energy.



Fig 3.39: Power from the wind has been used for many years to pump underground water to the surface.

Hydro-electric Power

Hydro-electricity involves the use of the water cycle to produce energy. Natural evaporation carries water molecules high into the atmosphere and some rain will fall in areas of high altitude. These waters then flow back to the sea. The force of this water coming down the mountain side can be used to drive **turbines**.

Question:

Manufacturing, transport and industry use 85% of most State's power supplies. Domestic use accounts for only 5%.

How might we be able to further conserve our energy supplies?

Power from the Sea

Energy from the sea comes from two main sources:

- * *Waves*
- * *Tides and currents.*

Anyone who has been surfing on Australian beaches would be well aware of the power (energy) of waves. Some waves have been measured as being able to carry 80 kilowatts of energy in each metre of their length. This means that a 200 metre wave in length will have enough energy to power 1,000 homes or a small suburb for a day. This energy is now being harnessed in Norway. They use wave action to compress air in a cylinder. The waves force a column of water up and down in a hollow oscillation chamber. This column moving up and down acts like a bicycle pump and forces air in and out of the top of the cylinder. The Norwegians use the compressed air to drive turbines and generate electricity.

Regions which have a very large tidal range could use the power of the flowing water to drive turbines and produce power. Areas such as the Bay of Fundy which have a 15 metre tidal range, and Derby and Broome in north-western Australia which have a tidal range of approximately 10 metres would be very suitable to harness this form of energy.

Atomic or nuclear power

There is a lot of controversy over the use of nuclear power as a future source of energy. It is a source of energy that has the potential to supply all our energy needs of the future and not have the harmful side effects the burning of fossil fuels has on our planet. The problem with this form of energy is the disposal of the waste products. Nuclear energy is derived from uranium of which Australia has vast resources.

A big advantage of nuclear power is that small amounts of fuel produce large amounts of energy. One gram of uranium produces about the same amount of energy as four tonnes of coal.

The **radiation** from the waste material produced is a form of energy just as the sun's energy can be in the form of radiation. This radiation (energy) can have severe effects on living cells. The very high radiation that might come from a nuclear weapon explosion will cause a living cell to fry. Lower levels of radiation can change or reassemble the complex molecular structure of cells. The level or dosage of radiation received depends both on the time of exposure and the type of waste that is emitting radiation. Radiation can cause skin burns, haemorrhaging, change in blood cell counts, loss of hair, nausea, abortion or birth abnormalities, tumors or cancers and especially genetic defects.

Other problems associated with the development of atomic energy are the possibility of terrorist groups obtaining nuclear substances, developing nuclear weapons or simply destroying nuclear power stations. The destruction of a nuclear power station by conventional weapons could lead to disasters similar to that of Chernobyl in USSR.



Fig 3.40: Unused power constantly pounds our shoreline.

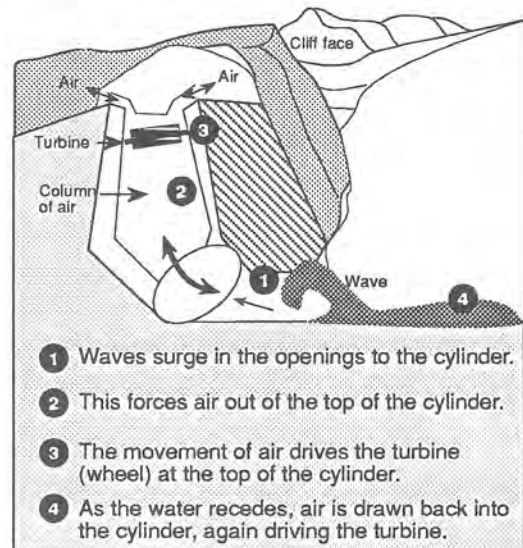


Fig 3.41: Schematic wave power station (not to scale).



Fig 3.42: Many areas are seeing the dangers of nuclear power.

CHAPTER 3

Geothermal Power

Geothermal energy is the energy gained from within the earth's crust. In volcanically active regions of the world large amounts of energy are available from the **hot springs and geysers**. The underground water in these areas is heated by the molten magma to form steam which escapes through vents at the earth's surface.

The gas or steam escaping from these vents can be used to drive turbines and therefore produce electricity. The heat of this gas can be harnessed to generate electricity. There is no possibility of this source of energy producing electricity in Australia, but New Zealand has developed geo-thermal power stations on the Waikato River in the North Island.

It has been suggested that it may be possible to drill holes deep into the earth's crust to tap the energy from the molten core. This however, seems impractical and it is hard to foresee this ever occurring.

Biological Fuel

Biological fuels such as alcohol and biogas are renewable fuels. **Alcohols** have been used since World War 11 to power motor engines.

Motor engines can be modified to run on a mixture of petrol and alcohol while some engines can run on pure alcohol, but the major reason for the non-conversion to alcohol has been the expense of alcohol compared to petrol. The difference in price is now becoming minimal and the future use of this fuel seems assured. Alcohols are produced by the fermentation of plant materials and sugars. One problem may be the ability to produce the massive volumes of alcohols that would be required by the transport and manufacturing industries.

When organic wastes decay the microbes responsible for this decay process produce methane and hydrogen gases. This combination of gases is called **biogas**. Biogas can be produced by sewage treatment plants, dumps and agricultural wastes for use in industry.



Fig 3.43: The Lady Knox geyser at Rotorua, New Zealand.



Fig 3.44: A digester which is used to produce biogas.

90% of cars in Brazil are powered by pure alcohol.

HOW CAN YOU HELP?

1. Walk or ride to school or work.
2. Recycle much of the material thrown out in your rubbish bin each week. Each year large volumes of organic material which could have better use as compost in your garden is dumped. Build a compost heap in your backyard.
3. Plan the use of food more carefully to reduce the wastage. Many refrigerators are full of food that is off or will go off before it is eaten. Go home to-night and look for food that will never be used as a result of poor meal planning.
4. Endeavour to buy food substances that do not have unnecessary packaging. The packaging makes the handling of some products more convenient but is it really necessary? Take a shopping bag with you to the shops. Especially avoid, where possible, plastic packaging.
5. Don't buy ice-cream and other foods in white plastic containers. The plastics in these contain PVC and cause many disposal problems. Many harmful substances are produced in the manufacture of these materials.
6. Avoid buying heavily processed foods. Endeavour to buy locally grown products where possible - this will save on transport costs.
7. Reduce garbage by buying fresh food rather than packaged food.
8. Recycle your bottles, cans and newspapers. Make full use of the product and reuse it if possible.
9. Conserve water and reduce water usage. See activity in Chapter 2.
10. Avoid pouring dangerous wastes down sinks or drains.
11. Endeavour to minimize the use of toxic compounds such as quick clean products e.g. oven cleaner, stain remover and bleaches. Seek natural alternatives.



The packaging industry is worth 4 billion dollars annually.

35% of this market is paper and cardboard, 25% plastics, 20% metal and 10% glass.

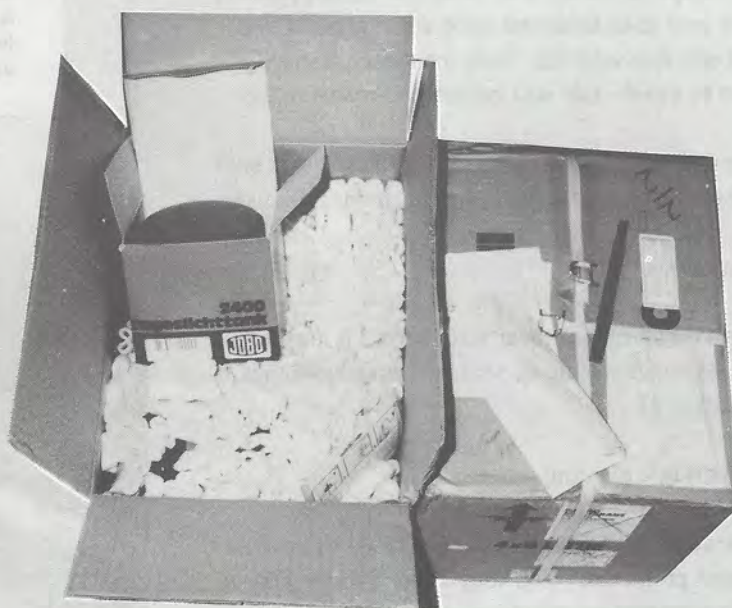


Fig 3.45: How much packing is necessary?

12. Don't use pesticides and herbicides unnecessarily. Get some exercise by pulling out the unwanted plants from your yard. If you do use pesticides take care you don't spray near food substances and plants that may be used as food; don't spray in windy conditions or in confined spaces, store chemicals in places that are not accessible to children; do not contaminate water which may be used for domestic or animal purposes; make sure no spray or chemical gets on yourself; obey safety instructions given with chemicals.
13. Use environmentally friendly products such as unbleached toilet paper, phosphate free biodegradable soaps and detergents.
14. Buy durables not disposables. Use china mugs instead of paper, plastic or styrofoam cups. Use handtowels instead of paper towelling. Use cloth nappies instead of disposables.
15. Endeavour to save energy by using less hot water, turning off unnecessary lighting, and reducing energy for cooking. Microwaves use less energy to cook food.
16. Energy may also be saved by insulating the home. Install a solar hot water system.
17. Care for your car - maintain and clean oil and air filters, keep the engine tuned, and operate tyres at recommended pressure.
18. Use less petrol. This may be accomplished by driving smoothly, avoiding peak hour traffic, not pushing each gear to its limit and using the car less. Choose fuel efficient vehicles. Walk the short distances you have to travel - this will improve your health, too.
19. Buy recycled paper and envelopes and write on both sides of the paper. Support paper recycling initiatives.
20. Don't litter.
21. Don't dump rubbish near waterways. It may affect animal and plant life as well as damaging outboard motors.
22. Support tree planting programs.
23. Endeavour to make other people aware of environmental problems. You may even wish to join an environmental organisation.
24. Can you think of any more ways?

HOW CAN YOU HELP?



Consider this

- * Approximately 10% of all energy is used for domestic purposes. What are the other major users and how might their consumption be reduced?
- * Burning a 100 watt light bulb for 10 hours causes the production of 1.2 kgs of carbon dioxide.
- * One litre of petrol can contaminate over 100,000 litres of water making it undrinkable.
- * 60% of average household rubbish bins is made up of organic materials such as food scraps and paper which could be used as compost.



Fig 3.46: Elevated walkways have been built to allow public access to beaches without destroying the natural vegetation.

Many books have been written outlining many extra ways the individual can help. These three books are particularly helpful:

1. *Simpson, Verna, Environment Friendly Home Hints; J.B. Fairfax, Sydney, 1990.*
2. *Gell, Rob and Beeby, Rosslyn, It's easy being green; McCulloch Publishing, Carlton, Vic, 1989.*
3. *Seymour, John, and Girardet, Herbert, Blue Print for a Green Planet; Angus and Robertson Publishers, North Ryde, NSW, 1987.*

THE ECONOMIC COST OF POLLUTION

We live in a cost conscious age. Many people are more concerned with monetary gains than stopping pollution. Pollution, however, is costly.

Costs involved include:

- * The cost to clean up the pollutants.
- * The cost of losing our natural ecosystems and fisheries.
- * The cost of using up resources.
- * Compensation costs.
- * Health bills.
- * The cost for future generations.



Fig 3.47: Pollution always costs.

Health Bills

Many pollutants have a severe effect on the human body. Some such as lead and cadmium move throughout the body tissues upon entry to the body. These elements are deposited in all organs including the bones. They have severe effects on the kidneys and the formation of blood cells. Cadmium can even cause high blood pressure and heart disease. It is also responsible for a painful disease of the bones and joints called "Itai-Itai-Byo" and death. Lead damages the brain and the central nervous system.

Toxic concoctions found in polluted waters can cause a multitude of human diseases. They can be:

- (a) **Carcinogenic** - causing cancer.
- (b) **Mutagenic** - causing mutations.
- (c) **Teratogenic** - causing abnormalities in the foetus (birth defects).
- (d) **Lethal** in high concentrations.

The long term effects of many of these toxic compounds are yet unknown.

Environmental Impact Studies

Scientists produce environmental impact statements which are reports compiled from all available information on the impact a development may make on the environment. They undertake detailed studies of the environment and the relationships between the organisms living there.

ROLE OF GOVERNMENTS

Even some of our business leaders and politicians are expressing the same concern for the environment as conservation groups. Public opinion has caused many governments to take note of the people's concern for the environment and recently some political parties have embraced a platform on environmental issues.

Governments are offering industry incentives to clean up their act and start recycling programs. Heavier penalties are now being introduced to fine industries doing the wrong thing.

They believe that "Human survival depends on the conservation of natural resources and the maintenance of essential ecological processes and life support systems." This statement comes from the Queensland Department of Environment and Heritage in a discussion paper, "Towards a Queensland Conservation Strategy".

Very little is understood of the complexities and inter-relationships found in nature. The question arises:- How can this balance be maintained and retained with the influx of humans and their technology into the ecosystem? Very little research has been undertaken into this area and few Environmental Impact Studies have been completed on major developments introduced in the 1970s and 1980s.

Governments have spent millions of dollars on research projects on outer space and space travel, but little on the marine environment. Does this mean we have a way of escaping the mess by leaving earth to move to another planet?

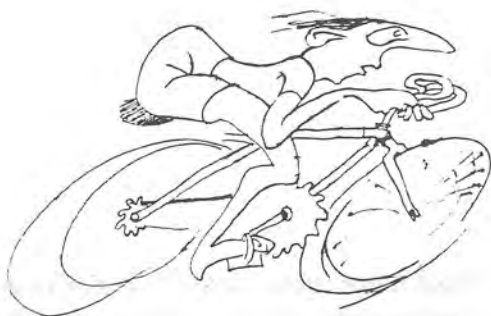


Fig 3.48: Bike don't drive.

Conservation strategies for Governments

- * **INTRODUCE** building regulations that will ensure more energy efficient buildings.
- * **INJECT** more money into departments involved in conservation of resources and wildlife.
- * **INCREASE** funding to departments to increase man power so that conservation laws are enforced more strictly.
- * **INSPIRE** the public to strive for better use of resources.
- * **INITIATE** more research into methods of reducing waste production and recycling of wastes.
- * **IMPLEMENT** better methods of waste treatment.
- * **INSTIGATE** programs to reduce litter.
- * **IMPROVE** public transport systems.
- * **INHIBIT** the introduction of exotic species.
- * **INSIST** that industry phases out the use of chemicals such as CFCs and halogens.
- * **IMPOSE** heavier fines on industries causing pollution.
- * **INVOKE** industries to produce less toxic compounds.
- * **INCREASE** the area of land that is designated flora and fauna reserves.
- * **INVESTIGATE** new forms of pest control.
- * **INTRODUCE** tax concessions for farmers implementing soil conservation methods.
- * **INSTITUTE** laws removing tax incentives for clearing land.
- * **IMPEDE** the development of mining operations that will affect the marine environment.
- * **INCORPORATE** environmental education programs into school curriculums and educate the general public.
- * **INVITE** community groups to provide input into conservation and management programs.
- * **INVOLVE** conservation societies such as Greenpeace in committees examining legislation on environmental issues.
- * **INFORM** the public of changes in legislation such as new fishing regulations.
- * **INTERFUSE** different government groups who are concerned with conservation problems.
- * **IMPROVE** co-ordination between federal and state government bodies.
- * **IMPLORE** society to conserve the planet so it will be in a fit state for the next generation.

Many governments in Australia appear to be treading lightly on the pollution problem. The major pollution-causing industries need to have expensive pollution control devices fitted but imposing such regulations may cause the industry to become unprofitable. An important income producing industry may be put out of business, jobs may be lost, and this might be political suicide for the governing party.

An example of the government's procrastination is the delay in introducing lead free petrol. The governments do realise that each year many thousands of tonnes of lead are being released into the environment. The cost to the public of stopping the sale of fuel with lead additives could have been enforced, but this would have meant costs to the public and the motor industries.

It is easy to condemn big industries and foreign governments for polluting the world and for making profound statements on the solution to pollution. We must remember, however, that it is you and I who can make a start in reducing the problem of society's self inflicted damage. Most of us need to adopt a more responsible attitude towards the environment. We need to stop discussing the problem and start to make positive commitments towards the goal of protecting and managing sensibly the marine environment.

The pollution problem can be turned around. There are many examples where a heavily polluted river had become an ecological desert but after a concerted effort to clean up the river life returned. One Australian example is the Parramatta River which was dying a few years ago. After a clean-up effort life returned.

Information for discussion

1. What type of information should be collected about the state of our waterways and who should collect it? Who should pay for this research?
2. How should this information be presented and dispersed to the public?
3. How can the co-ordination between different authorities be improved? How can the power of these authorities be increased? What should the penalties be ?



Fig 3.49: Many people treat the earth as if it belonged to someone else.

QUESTIONS

1. Define the following terms:
 - (a) turbidity
 - (b) coagulation
 - (c) anaerobic digesters
 - (d) photodegradable plastics
 - (e) Environmental Impact Study
 - (f) activated sludge
 - (g) leaching.
2. Outline the three different characteristics of water that can be measured to show pollution.
3. *Escherichia coli* is a harmless intestinal bacteria. Why is a harmless bacteria such as this tested in water to show evidence of pollution?
4. How does the Biological Oxygen Demand (BOD) differ from the dissolved oxygen content of the water? Why is it important to measure the amount of oxygen in the water?
5. What other tests could be used to test for the presence of water pollution?
6. What are the processes that could be completed in a primary sewage treatment plant? Why is town water chlorinated before it is supplied to the households?
7. What pollutants can be controlled by physical means and which by chemical means? What type of treatment plant is involved with the use of chemicals to treat the waste?
8. Define the term sludge. From where does it come and how is it treated?
9. List some of the problems associated with the disposal of wastes into large city dumps or landfill areas. How may these problems be overcome?
10. A national report, "Water 2000", revealed a number of problems associated with the treatment of wastes in landfills in Australia. Outline the reported problems.
11. Many people believe that ocean sewage outfall systems are the answer to the disposal of sewage. Discuss the advantages and the problems associated with this method of disposal.
12. Many scientists believe that high temperature toxic waste burning off may solve disposal difficulties. What problems might be associated with this method?
13. Discuss the Kingston sludge problem.
14. Nuclear wastes remain toxic for thousands of years. How might these wastes be stored so that they will have as little effect as possible on the environment?
15. State the advantages and disadvantages of the use of atomic or nuclear power.
16. What are the reasons to recycle?
17. Which substances are being presently recycled and which have the greatest potential to be recycled?
18. List the non-renewable resources that are being used by our society. Name some renewable resources that we need to take care of so that they remain renewable.
19. List sources of energy other than fossil fuel that may be able to solve some of our energy problems of the future. Which are still in the developmental stage? Which do you see as being the most suitable alternative to the use of traditional fuels?
20. Identify some of the ways you could reduce the amount of rubbish your family produces each week.
21. Summarize some of the ways in which the usage of energy by your family could be practically reduced.
22. Many pollutants have a severe effect on the human body. List some of the pollutants and their effects.
23. How is your life affected by environmental pollution?

ESSAY TOPICS

1. Discuss these statements:
 - (a) "Waste not, want not."
 - (b) Use and abuse of water.
 - (c) Reduce, recycle or recover.
 - (d) Biodegradables - are they as good as we are led to believe?
 - (e) Pollution is a "song and dance about nothing".
 - (f) "Cleanliness leads to dirty water."
2. Some manufacturers are using the environmental issue to sell their product. Some claim their products are environmentally friendly while others use slogans such as "The proceeds of the sale of these products will help or be used for environmental campaigns". Discuss this issue. Try to define the term "environmentally friendly".

RESEARCH

1. Find out what recycling procedures are in operation in your neighbourhood. What is the monetary incentive to return substances such as aluminium, glass and paper?
2. Research a local pollution problem..
3. Make up a folio of newspaper cuttings on the worldwide pollution problem.
4. Go to your pantry at home and make a list of all products that contain toxic substances. Check the rest of your house for other chemicals hazardous to the environment. Check especially the laundry and garden shed.
5. Obtain and examine an Environmental Impact Study.
6. Use the library to research one of the following topics. Prepare an oral report of your findings.
 - (a) Renewable fuels.
 - (b) Fuels from plants.
 - (c) Catalytic convertors and how they work.
 - (d) Alternative forms of energy.
 - (e) Natural products that could replace man-made ones.
 - (f) Alternative medicines.
 - (g) New pollution treatment methods.
 - (h) Pollution effects on health.
 - (i) Beneficial bacteria.
 - (j) Making of plastics and how they are recycled.
 - (k) Preservatives used in processed foods.

ACTIVITIES

1. Start a school campaign to emphasise the pollution problem. Design posters which may heighten student awareness of this problem.
2. Instigate a recycling campaign within the school. One method may be to collect all paper from classrooms and teacher staffrooms for recycling. You may be able to set up a collection point for aluminium cans and other recyclable compounds.
3. Join the "Clean up Australia" campaign.
4. Organise a trip to a local sewage treatment plant. Find the volume of sewage that enters the plant each day and the methods used to treat it.
5. Make a list of luxury items that are found in the home. Which of these items could you go without?

EXERCISES

This question refers to the information in the table below of mean total nitrogen levels (mg/l N) in some Queensland Estuaries (data supplied courtesy Dept of Primary Industries).

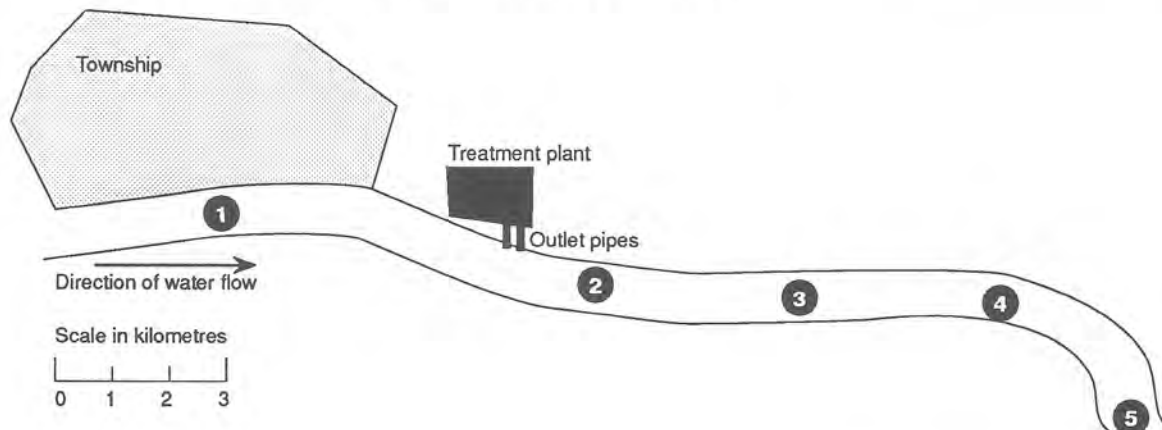
Estuary Description	Name of Estuary	Lower Estuary			Middle Estuary			Upper Estuary			
Unpolluted estuaries	Mooloolah Burrum	0.414	-	-	0.440	0.574	-	0.719	0.646	-	-
		0.567	-	-	0.546	0.645	-	0.756	0.763	0.770	-
Nutrient enriched estuaries	Burnett	0.549	-	-	0.684	0.888	-	1.178	1.118	1.051	-
	Hays Inlet	0.848	0.864	-	1.136	-	-	1.270	-	-	-
	North Pine	0.568	-	-	0.972	1.630	-	1.445	-	-	-
	Caboolture	-	-	-	0.766	0.882	1.154	1.344	1.745	2.347	1.840
Nutrient enriched estuaries with significantly light limited reaches	Logan 80/81	0.590	0.935	-	1.073	1.443	1.884	2.110	1.986	-	-
	Logan 83/84	0.590	0.985	-	1.280	1.714	1.796	1.600	-	0.800	-
	Albert	1.141	1.237	-	1.212	1.093	-	0.836	0.577	-	-
	Mary	0.408	0.567	-	0.998	1.197	1.132	0.907	0.698	0.684	-
	Brisbane	0.833	0.932	1.4.08	1.771	2.177	1.944	1.793	1.546	0.726	-
	Fitzroy	-	-	-	0.978	1.179	-	1.457	1.695	1.383	-
Small creek	Petrie Creek	0.805	-	-	1.903	-	-	3.295	5.418	6.920	-

- From the table of data above answer the following questions:
 - Which estuaries are regarded as unpolluted and which are nitrogen enriched?
 - Attempt to plot the nitrogen level for the Mary, Albert and Burrum Rivers in the lower, middle and upper estuaries. How might you explain the variation in the results?
 - Which river had the highest level of nitrogen (mg/l) and what was this value?
 - Is the amount of nitrogen in the water affected by latitude? Explain.
 - Graph the value for the Logan River for the period of 1980/81 and 1983/4. How have the values changed? Propose a suggestion to explain these values.
 - Attempt to explain the reason why the nitrogen levels are generally higher in the upper estuaries than the lower estuaries.
 - Where may the sewage be entering Petrie Creek? Explain.
 - Suggest other nutrients which may have shown similar trends to the nitrogen in the table above.
- Muswellbrook, Singleton, Maitland and Newcastle are towns situated on the Hunter River system of NSW. Each town is approximately 50 kilometres apart on the Hunter River and use the water for domestic, agricultural and industrial purposes.

What problems may be caused by having all four towns on the same river? Will it make the detection of the source of pollutants harder to track down?

EXERCISES (continued)

Question 3 refers to the illustration and the information in the table below:



Variable	Position 1	Position 2	Position 3	Position 4	Position 5
Water quality by Secchi disc (cm)	200cm	10cm	12cm	60cm	150cm
Temperature	22.3°C	26.2°C	25.1°C	25.0°C	24.2°C
Oxygen content	8.5 ml/l	1.0 ml/l	0.5 ml/l	3 ml/l	4 ml/l
Fish	Yellow Belly Catfish Mullet	Mullet	Nil	Catfish Mullet	Catfish Mullet
Mineral ions concentration	Low	High	High	High	High.

3. (a) Organisms which can only live in special environmental conditions are said to be indicator species. These organisms have a low tolerance range. Which of these species is an *indicator species*?
 - (i) Catfish.
 - (ii) Mullet.
 - (iii) Yellow belly.
- (b) Why will the oxygen concentration decrease as you progress from position 1 to position 5?
- (c) Discuss the water clarity, based on secchi disc readings, from position 1 to 5. What may have happened between position 1 and 2?
- (d) What effect might the increase in mineral ion concentration have on the aquatic life from positions 3 to 5?
4. How might the building of dams and water resource reservoirs affect the abiotic condition found in waterways?

EXPERIMENTS

1. A number of experiments can be conducted on the water samples from your local area. A very good set of experiments which are simple to use and give reliable information are found in the Water Quality Monitoring Program of Mitchell and Stapp.

The book is called "Field Manual for Water Quality Monitoring" and is distributed by William B Stapp, 2050 Delaware, Ann Arbor, Michigan 48103.

Chemical kits are available from scientific supply companies e.g Selbys (Brisbane Office) to complete all tests are available. Your school may wish to become involved in the Global Rivers Environmental Network mentioned in this chapter by joining the computer network system available in state run environmental education centres.

2. Experiments on water quality tests are also available in the book, "A Study of Seawater" by Wet Paper Publications. Suitable tests could be estimations of:

- (a) Dissolved oxygen.
- (b) Biological oxygen demand.
- (c) Nitrates (care needs to be taken when using salt water)
- (d) Faecal coliform
- (e) Turbidity.
- (f) Dissolved solids in water.
- (g) Temperature.

3. Attempt to make recycled paper. Procedures for its preparation can be found in most libraries.
4. Detergents can have a severe effect on plant growth in water. Select a few different brands and types of detergents. You may wish to investigate the effect of household washing up detergent, dishwasher compounds, household cleaners and soaps.

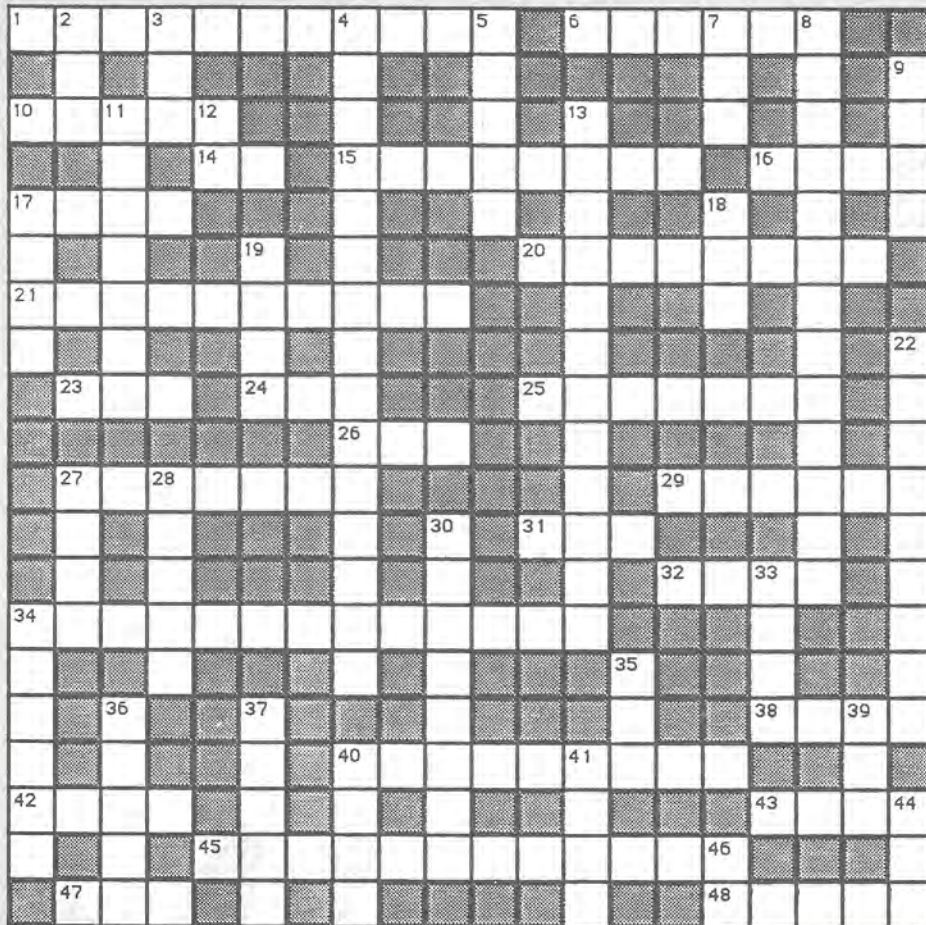
A suitable plant for this experiment could be duck weed or algae. Duck weed is most suitable as it is possible to count the number of leaves to indicate growth. You may wish to choose one detergent and use varying concentrations to ascertain its effect.

5. Attempt to purify samples of creek water. You will need to collect approximately two litres of creek water and if the sample is not muddy add clay and shake.

- * Place a sample into two gas jars or any other clear tall containers.
- * Add some aluminium sulphate to one sample and allow both to stand overnight.
- * Note the effect of the addition of aluminium sulphate.
- * With the remaining sample attempt to filter the muddy water using filter paper and sand filters.



What evils have left these pipes?



CROSSWORD

CLUES

Across

1. Particles combine with colloidal material
6. Refuse.
10. Can be recycled.
14. Symbol for nickel.
15. Addition of oxygen to water.
16. Holes used to bury rubbish.
17. Fine soil fragments.
20. Reduction in concentration.
21. Regulation of wastes.
23. A good serve in tennis.
24. An accumulative pesticide.
25. To use again.
26. Insecticide located in fish off Sydney.
27. Sewage emptied into the ocean.
29. Discarded rubbish.
31. Place where rubbish should be disposed.
32. Used to power cars.
34. The settling of suspended solids.

38. Soil.
40. Where anerobic breakdown of sludge occurs.
42. Objective.
43. Assist.
45. Cancer causing agent.
47. Ingested.
48. Endemic.

Down

2. A pollutant that floats on the water.
3. One of the three states of matter.
4. 9,6 a place where wastes are treated before being released.
5. A wanderer.
7. 80% nitrogen, 20% oxygen.
8. Of the surrounding conditions.
9. Entangle.
11. A poisonous substance found with gold.
12. Symbol for tin.
13. Removal of disease causing microbes.

17. A place where councils dispose of household wastes.
18. Pig pen.
19. A heavy metal.
22. Used for packaging/some disposal cups are made of this.
27. Exude/sluggish flow from underground.
28. Deadly (pollutant).
30. A nutrient tested for in water.
33. Bad/sinful.
34. A nutrient that is filtered or removed from sewage.
35. Derivative of DDT.
36. Producer.
37. A building material.
39. To be sick.
40. A bird that can swim.
41. A plant with a solid stem.
44. A brand of dog food.
46. Symbol for Chlorine.

PROJECT IDEAS

Recycling Project Ideas

Aluminium has many applications including roofing, aircraft, truck bodies, window frames, soft drink cans and kitchen equipment. Aluminium is easy to recycle and worth more than most other commonly recycled metals.

Activities to do:

- Use a magnet to test metals in the classroom and around the school. Note the difference between aluminium, which is not attracted by a magnet, and other metals. If possible pick up the articles to compare weights.
- Arrange a visit to a can-making plant or soft drink company for a tour of the operations.
- Comalco has a film about aluminium can recycling. Ask them to send it to your school.
- Make a list of ways in which your school could recycle aluminium. Organise an aluminium can collection scheme.
- Challenge another class or even another school to a can collecting contest.

Things to discuss:

- Why is recycling important to us today?
- Discuss some reasons why you think aluminium companies are involved in recycling?
- How does the community benefit from aluminium can recycling? Make a list and discuss ways of telling the community about the advantages of aluminium can recycling.
- Besides aluminium, what else can be recycled and how?
- Aluminium soft drink cans have become popular in Australia in recent years. How do you tell the difference between an aluminium can and a steel can? What are some of the advantages and disadvantages of using aluminium for drink containers as opposed to steel, plastic or glass?
- What are the advantages aluminium has over other metals? Look at aluminium products in the classroom or around the school, and explain the benefits for using aluminium in those situations?

Promotional items, brochures and films available from Comalco for schools:

■ Films or videotapes:

- "Conservation at Work" – explains the production of the metal, aluminium, the making of the can and the can recycling programme. For Upper Primary and Secondary schools (11 minutes)
- "Famous Four's Canny Plan" – this is a fun film about the can recycling programme for schools. Starring Jonathon Coleman (10 minutes).



This page courtesy Comalco Australia

Index

A

Acid rain 12, 39, 54
 Acids 54
 Activated sludge 83
 Aggregation 34
 Alcohols 104
 Aluminium 96
 Atmospheric fixation 9
 Atomic or nuclear power 103
 Australian fishing zone 15

B

Bacterial breakdown of hazardous compounds 86
 Bag limit 17
 Ballast 59
 Bioaccumulation 8
 Bioassay 39
 Biocides 55
 Biodegradable 50
 Biogas 104
 Biological control 41
 Biological desert 39
 Biological fixation 9
 Biological fuel 104
 Biological oxygen demand 50
 Biological tests 74
 Biomes 39
 Biosphere 39, 42

C

Cadmium 107
 Canal estates 61
 Cane toad 24
 Carbon cycle 9
 Carcinogenic 107
 Carnivores 7
 Chemical and physical tests 75
 Chemical Hazards and Emergency Management 62
 Chemicals 95
 Chlorinated hydrocarbons 55
 Chlorination plant 84
 Closed seasons 18
 Coagulation 83
 Commercial fishing 17
 Commonwealth Environmental Protection (Sea Dumping) 88

Community 5
 Conservation 27
 Consumers 6
 Contact tank 81
 Containment pits 90
 Contamination 47
 Contraceptives 64
 Crown-of-thorns starfish 34
 Cumulative chemicals 8
 Curie 57

D

DDT 55, 56, 66
 Decomposers 7
 Deforestation 31, 54
 Demography 28
 Denitrifying bacteria 9
 Department of Environment and Heritage 29
 Detergents 66
 Dieldrin 8, 55
 Diffused or non-point source pollution 78
 Dispersal into the air 89
 Dispersal into the sea 88
 Disposal 78
 Dolphins 15
 Dredges 60
 Drift nets 13
 Drinking water 85
 Dynamic equilibrium 12

E

Ecological deserts 88
 Ecological indicators 39
 Ecology 5
 Ecosystem 5
 Effluent 79
 Elodea 23
 Emulsion 66
 Endemic species 22
 Energy pyramid 7
 Environmental Impact Studies 107
 Escherichia coli 74
 Eurythermal 30
 Eutrophication 54
 Evaporation 8
 Exotic species 23
 Exploitation 13
 Extinction 25
 Extinctions 25

INDEX

F

Fertilizers 55
Filtration plant 84
First order consumers 7
Fish kills and mortalities 67
Flocculence or floc 83
Food and energy in the ecosystem 6
Food chain 7
Food web 7

G

Geothermal Power 104
Gill nets 14
Glass 94
Great Barrier Reef Marine Park Authority 32
Greenhouse effect 11
Greenpeace 14, 15

H

Halophytes 36
Heavy metals 59
Herbivores 7
High temperature incinerators 89
Hot springs and geysers 104
Humpback whale 20
Hydro-electric Power 102
Hydrocarbon 59

I

Imported exotica 25
Indicator species 39
Industrial fixation 9
Inland sewage 47
International Whaling Commission 20
Intractable wastes 62
Introduced species 22

L

Land treatment 83
Landfill method 86
Leachate 87
Leaching 87
Lethal 107
Logging 31

M

Major Constructions 30
Management 15
Mangroves 37, 38
Mediterranean Sea 48
Metals 95
Minimizing wastes 91
Modern windmills 102
Mosquito fish 22
Mutagenic 107
Mutations 57

N

National Health and Medical Research Council 78
Natural causes of pollution 64
Natural erosion 40
New competitors 22
Nitrifying bacteria 9
Nitrogen cycle 9
Nourish beaches 60
Nutrient compounds 54
Nutrient cycles 8
Nutrient tests 76

O

Ocean outfalls 88
Oil pollution 58
Oil slick 58
Organic compounds 54
Organic phosphates 55
Organo-chlorides 56
Overfishing 13
Oxidation ponds 81
Oxygen cycle 11

P

Paper 93
Pathogenic micro-organisms 50
Persistent 59
Pesticides 55
Petrol facts 59
pH 75
Photosynthesis 6, 10
Photosynthesis equation 10
Photovoltaic cells 101
Plastics 92
Platypus 26
Pneumatophores 36
Point source pollution 78

- Pollution 35, 47, 48
 - control of 73
 - point source 78
 - by agriculture 54
 - by industry 52
 - by mining industries 59
 - new sources 64
 - cost of 107
 - thermal 52
 - wars 63

Polychlorinated biphenyls PCBs 65

Population 12

Population sizes 12

Power from the Sea 103

Power from the Wind 102

Precipitation 8

Primary treatment 80

Producers 6

Protected species 27

Purse-seine nets 14

Pyrolysis 89

Q

Quarantine 25

R

Radiation 57, 103

Radiant energy 101

Radio-active wastes 57, 91

Radioactivity 57

Radium 65

Recovery of wastes method 91

Recreational fishing 17

Recycling 92

Reducing wastes 91

Reef conservation 32

Renewable and non renewable resources 99

Renewable fuels 100

Respiration 6, 10

Respiration equation: 10

Reuse 91

Role of government 108

Rubber 94

S

Salvinia 42

Sand mining 61

Seagrass 38

Secchi disk 75

Sewage 79

Sewage digester 81

Sewage treatment plants 80

Silicon 101

Slick 58

Sludge 79, 81

Sludge Treatment 81

Soil acidity 41

Soil structure 41

Solar Power 101

Sources of energy 101

Stapp 77

Sulphur cycle 11

Synergism 79

T

Technological and household wastes 51

Teratogenic 107

Tertiary treatment 81

Thermal pollution 52

Thermoplastics 93

Thermosets 93

Tilapia 22

Total dissolved solids 75

Tourism 33

Toxic compound 53

Trawling 14

triton shell 34

Turbidity 75

Turtles 26

U

Uranium 57

Urban Biomes 39

V

Vitrification 91

Viviparous 36

Volcanoes 64

W

Waste disposal 78

Water categories 74

Water cycle 8

Water Hyacinth 23

Water quality 74

Water treatment plants 83

Wetlands 36

Whales 19, 21

Whaling 19

Wind turbines 102

