Local Area Catchment Study

Brisbane Water Catchment

For Stages 4/5 Science

Contents

Comment [RQ1]:

Contents

Comment [RQ2]:

In 1997 a sub-committee of the Koolewong Point Clare-Tascott Progress Association, the Clean and Safe Team, initiated a community-based project addressing water quality issues on the Central Coast.

The key focus of the project was to develop a network of community groups regularly monitoring water quality in the waterways of Gosford thereby building a database of community water quality data that would contribute to more effective natural resource management in the region. The project would develop links between a range of stakeholders and increase community understanding and ownership of resource management.

An important aspect of any project aiming to bring about change is education. As such, activities commenced to develop education resources for schools focusing on the local catchment. This gained support from Brisbane Water and Gosford Lagoons Catchment Management Committee (BWGLCMC), the Environmental Education Curriculum Directorate (Dept of Education and Training), Rumbalara Environmental Education Centre and the Central Coast Community Environment Network (CCCEN).

During 1997/1998 a process was implemented involving consultation with schools in identifying curriculum needs, the formation of a writing team to develop content of the unit, the trial of the "Catchment Studies Module" at two local high schools, evaluation of those trials and further refinement of the module.

During that timeframe new Science and Geography syllabi were also introduced into NSW schools resulting in a need to review progress to date and further refine the curriculum areas addressed by the unit – thus delaying the anticipated completion of the project.

The final product was published in December 2000. It consists of this core unit with additional resources to support the module provided through Natural Heritage Trust funding. The unit as it currently stands is most ideally suited to Stage 4/5 Science however is also highly relevant to the Stage 4/5 Geography syllabus.

Through partnerships with Rumbalara Environmental Education Centre, Brisbane Water and Gosford Lagoons Catchment Management Committee, the Central Coast Community Environment Network and local Councils it is anticipated that case studies will be further developed to ensure relevance.

Feedback on the use of this resource is most welcome.

Contact Mark Attwooll at Rumbalara Environmental Education Centre, Donnison St Gosford.
Ph 43 247 200, Fax 43 237451, e-mail: Mark.Attwooll@det.nsw.edu.au

Acknowledgement and thanks:

Editors

Mark Attwooll	Rumbalara Environmental Education Centre
Jane Smith	Henry Kendall High School

Contributions and Advice

Kevin Butler	Wyong Shire Council
Michael Dean	BWGLCMC
Graeme Eggleton	Narara Valley High School
Jenny Ferguson	Gosford High School
Christine Freeman	Rumbalara Environmental Education Centre
Kate Marco	Erina High School
Andrew McPherson	Green Point Christian College
John Reynolds	Kincumber High School
Steve Row	CCCEN
Beverley Sampford	Henry Kendall High School
Brad Sneddon	Gosford City Council
Anne Vine	Henry Kendall High School
Ross Wellington	Rumbalara Environmental Education Centre

Financial sponsorship:

- Koolewong, Point Clare-Tascott Progress Association (through Natural Heritage Trust funding)
- Brisbane Water and Gosford Lagoon Catchment Management Committee
- Environmental Education Curriculum Directorate, Dept of Education and Training
- Central Coast Community Environment Network

With assistance from:

- Rumbalara Environmental Education Centre
- Gosford City Council
- Science staff of Henry Kendall High School
- Science staff at Kincumber High School

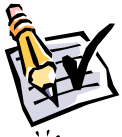
This unit of work provides activities and resources for use in Stage 4/5 Science.

As a general rule, the right hand page throughout the document provides material for use in class. The left hand page provides additional notes for teachers or is left blank for teacher comments.

The following symbols are used in this document:

Science Outcome(s) most relevant to this activity / section.

Teacher's Notes



Student activity.

Suggested assessment task

Suggested answers to an Exercise

Additional resources supplied to support the introduction of this module include:

- 15x 1:25000 local area topographic maps
- water quality testing equipment
  - 1x turbidity tube
  - 3x (ammonia, phosphate and dissolved oxygen) water test kits
  - 2x TDS (conductivity) meters. PPT and PPM -
- 1x $1m^2$ laminated aerial photo of the local area
- 5x colour A3 copies of the catchment illustration
- 1x weed identification guide "Attack of the Killer Weeds"
- 8x sets colour worksheets
- 10 x streamwatch water bug identification guides

Case studies and support material will also be available through the Rumbalara Environmental Education Centre website at **www.rumbalara-e.schools.nsw.edu.au**

Total Catchment Management

Australia is a land of excesses: excessive dry periods, excessive wet periods, excessive land clearing, excessive livestock for the capacity of the land, excess nutrients entering watercourses from urban development, industry and agricultural activities, excessive land degradation caused by soil erosion and dry land salinity and so the list goes on.

Currently there is a population of about 18 million people in Australia. This vast number of people consume, generate wastes and pollute the environment. There are unmistakable signs that the land, water, wildlife and natural resources that make up our environment, are under stress from the activities associated with providing food, housing, places to work and recreational facilities. The provision and maintenance of an adequate water supply that meets quality standards, the treatment and disposal of wastes (landfill and sewage) generated by the population are major concerns recognised in all sections of the community.

Managing our natural resources in an ecologically sustainable manner for current and future generations and dealing with the threats that they are presently facing is a huge undertaking.

Everyone lives and works in a catchment and therefore has an impact on its health. The logical place to start is tackling these issues is in our own river, lagoon, harbour, or beach catchment. Each catchment is separated by hills or ridges which direct the flow of water. They provide a convenient and manageable part of the environment to focus on, set priorities on the issues and work towards long-term solutions.

Total Catchment Management (TCM) is the co-ordinated and sustainable use and management of land, water, vegetation and other natural resources on a water catchment basis so as to balance resource utilisation and conservation. By implementing TCM principles we can have productive land, cleaner water and maintain diversity of vegetation and wildlife. TCM provides management direction for a catchment by having everybody within the catchment considering the impacts of their activities on others and on the catchment itself.

The NSW Government created the operational and policy framework for TCM in NSW by passing the Catchment Management Act in 1989. As a result there is a network of Catchment Management Committees, coordinated by the State Catchment Management Coordinating Committee, and Catchment Management Trusts linking the Government and community to achieve the objectives of total catchment management.

Committees and trusts do not work alone, but are joined in their work by many thousands of people throughout the community – householders, landholders, interest groups and a large range of specialists from all levels of government, university and other research institutions.

Without much fuss or widespread recognition they are successfully tackling major environmental problems.

Blue-green algae, erosion and runoff, overgrazing, salinity, weed invasion and loss of biodiversity are some examples. Degradation of urban bushland is a big issue in urban catchments.

All pose threats to the health and sustainability of life-giving soil, water, vegetation and wildlife, and all can be tackled by everyone in the catchment working together.

from The Role of the EPA in Protecting the Environment

Summary - Outcomes

The table below indicates where outcomes may be achieved.

Outcomes Stage 4	**Pages**	**Outcomes Stage 5**	**Pages**
A student: 4.10 identifies the factors affecting survival of organisms in an ecosystem	37, 39, 41, 69,	A student: 5.10 assesses human impacts on the interaction of biotic and abiotic features of the environment	16, 36, 49, 52, 58, 60, 68, 70,
4.11 identifies resources used by humans and where they are found and describes ways in which they are exploited	27, 41, 44, 55,	5.11 analyses the impact of human resource use on the biosphere to evaluate methods of conserving, protecting and maintaining earth's resources.	27, 35, 44, 51, 58, 61, 63, 108
4.13 clarifies the purpose of an investigation and with guidance, produces a plan to investigate a problem	27, 35, 51,	5.13 Identifies a problem and independently produces an appropriate investigation plan	27, 51, 65, 72, 75.
4.14 follows a sequence of instructions to undertake a first hand investigation	21, 29 33, 59	5.14 undertakes a first hand investigation independently with safety and confidence	16, 27 33, 35 51, 59
4.15 uses given criteria to gather first-hand data	33, 35	5.15 gathers first-hand data accurately	33, 51 53, 58
4.16 accesses information from identified secondary sources	27, 77 93, 108	5.16 accesses information from a wide variety of secondary sources	16, 27 61, 77, 108
4.17 evaluates the relevance of data and information	16, 29 31, 35 108	5.17 explains trends, patterns and relationships in data and / or information from a variety of sources	29, 31 33, 51 57, 95
4.18 with guidance, presents information to an audience to achieve a particular outcome	27	5.18 selects and uses appropriate forms of communication to present information to an audience	27 108- 117
4.19 draws conclusions based on information available	16, 31 41, 44	5.19 uses critical thinking skills in evaluating information and drawing conclusions	16, 27 31, 33 49, 55 57, 69
4.20 uses an identified strategy to solve problems	29, 43	5.20 selects and uses appropriate strategies to solve problems	29, 41 43,49 51, 63
Outcomes Stage 4	**Pages**	**Outcomes Stage 5**	**Pages**

A student: 4.21 uses creativity and imagination to suggest plausible solutions to familiar problems	14, 65	A student: 5.21 uses creativity and imagination in the analysis of problems and the development of possible solutions	16, 31 35, 44 51
4.22 undertakes a variety of individual and team tasks with guidance.	21, 27 49, 95	5.22 plans, implements and evaluates the effectiveness of a variety of tasks as an individual and as a team member.	27, 51 53, 75 83, 95
4/5.23 demonstrates confidence and willingness to make decisions and to take responsible actions	51, 79 103, 109.	4/5.24 respects different viewpoints and is fair and honest in dealing with others	14, 51 101, 103
4/5.25 recognises the relevance and importance of lifelong learning	44, 51, 108- 117	4/5.26 recognises the role of science in providing information about issues being considered and in increasing understanding of the world around them.	51, 61, 108- 117
4/5.27 acknowledges their responsibility to conserve, protect and maintain the environment for future generations.	44, 51, 61, 79, 101, 103, 108-117		

Summary – Suggested Assessment

Outcome	Task	Page
5.10 c Students will learn about ecosystems to describe some impacts of human activities on ecosystems.	Exercise 1: History of the Catchment	27
4.17: A student evaluates the relevance of data and information. **5.17**: A student explains trends, patterns and relationships in data and/or information from a variety of sources	Exercise 2: Interpreting maps of your Catchment	29
4.10 b Students will learn about ecosystems to describe how producers, consumers and decomposers in Australian ecosystems are related, using food chains and food webs	Exercise 7: Rainforest Food Web	45
5.19 and 5.22.2 A student: **5.19** uses critical thinking skills in evaluating information and drawing conclusions. **5.22** independently plans, implements and evaluates the effectiveness of a variety of tasks as an individual and as a team member.	Exercise25: Oyster Bay Mystery	82

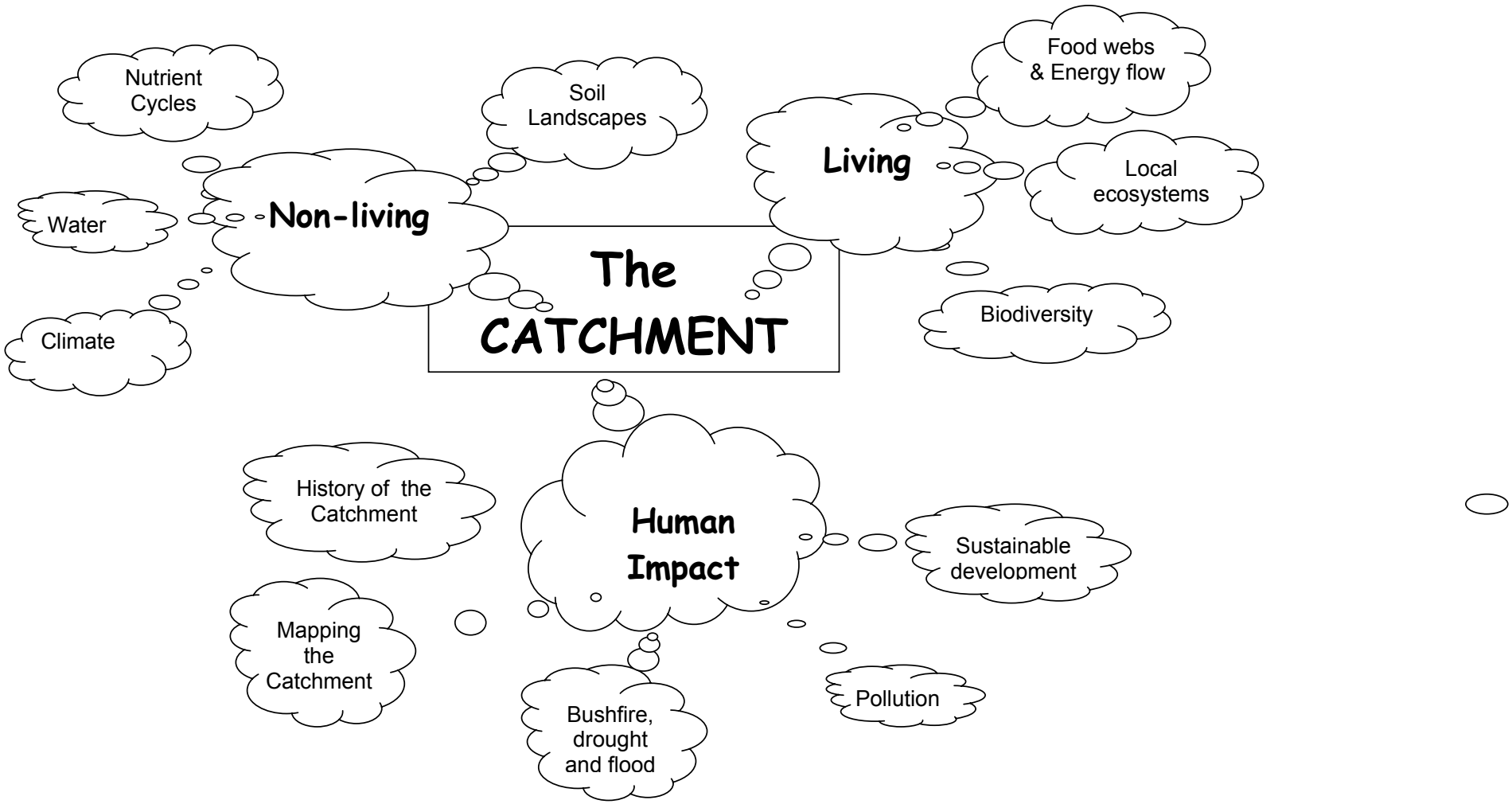
Timing of Activities

Section	Pages	Suggested Timing (mins)
Introduction & Catchment Title Page	13 - 15	½ hr
History of the catchment	17 - 27	1 hr
Mapping the catchment	29 - 35	2-3 hrs
Ecosystems	37 - 45	1½ hrs
Biodiversity – conservation	44 - 51	2 hrs
The Water Cycle	53 - 67	3 hrs
Nutrient Cycles	69 - 77	2 hrs
A Catchment Story	79 - 81	½ hr
Oyster Bay Mystery	82 - 93	2 hrs
Assessing Water Quality in the Local Area	94 - 99	Suggested excursion Activity
Values and Sustainability	101 -107	2 hrs
Group Case Studies	108 - 117	2 hrs

Teacher's Note – Title Page

A title page for the unit is provided in the form of a mind map showing students what they are going to cover in this unit and the relationships between the different content areas.

We suggest that students copy this title page from an overhead and then refer back to this page throughout the unit – maybe colouring in relevant clouds as that content is covered.


The CATCHMENT
Non-living
Nutrient Cycles
Soil Landscapes
Water
Climate
Living
Food webs & Energy flow
Local ecosystems
Biodiversity
Human Impact
History of the Catchment
Mapping the Catchment
Bushfire, drought and flood
Pollution
Sustainable development

Teacher's Note

Provide students with copies of both the coer illustration (appendix) and the map (p15) of the Brisbane Water and Gosford Lagoons Catchment to place in their workbooks. A3 colour copies of the illustration are provided as a wall poster.

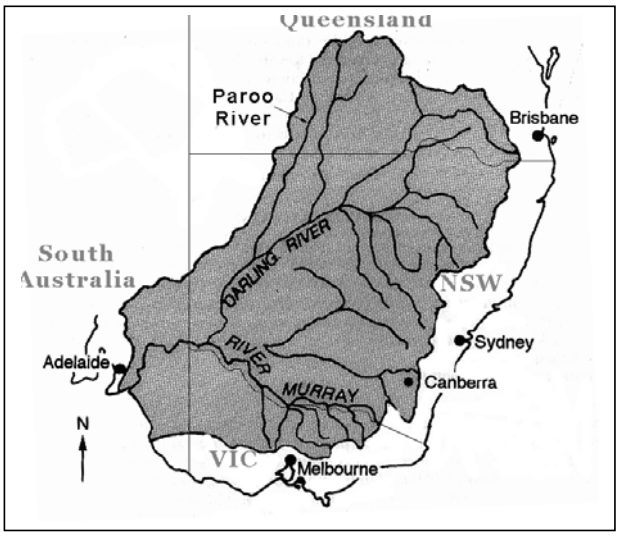
Students work in groups to arrive at a definition of a catchment. Discuss the various definitions and record the most acceptable. eg:- A catchment is the land area over or through which water drains to a common waterway such as a creek, river, dam or lake.

Teacher's Note: Why study Catchments?

(Students record the main points to arise out of the discussions)

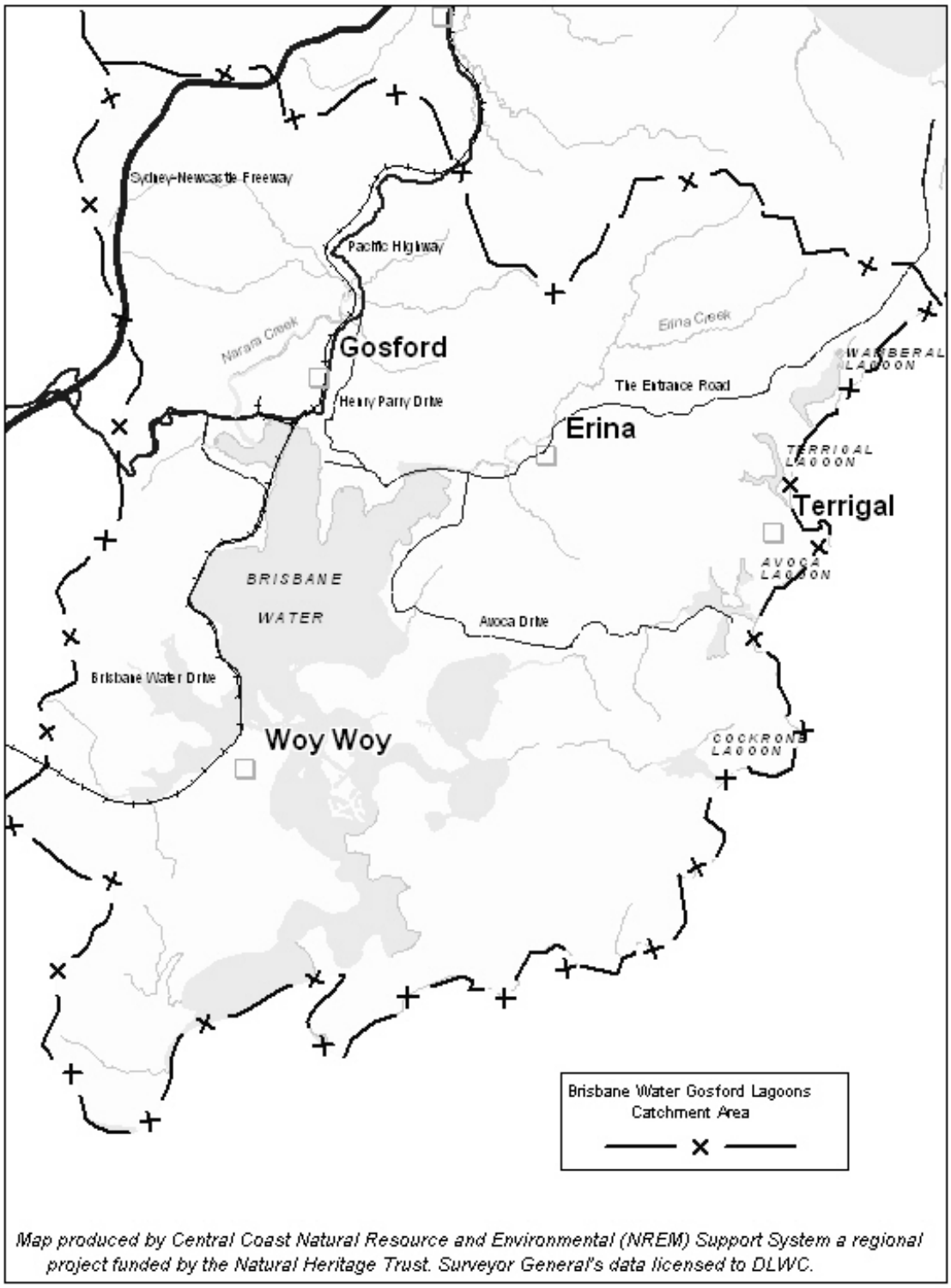
- **Discuss the advantages and disadvantages of looking after a whole catchment.**
  An important consideration is that what happens in one part of the catchment, particularly upstream, effects the quality of the whole.

- **Discuss problems in managing catchments that extend over two or more local government areas**.
  Consider the Murray–Darling Catchment, it not only encompasses many Local Government Areas but is also within four States. Regulations often have to be imposed on upstream users of water to protect the water supply of those living downstream.

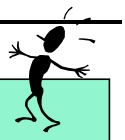


- **Conduct a role-play.**
  Base it on a hypothetical region* or a real one such as the proposal to dam the Paroo River in South Western Queensland. Have the conservationists, cattle farmers, rice and cotton farmers, tourism operators, politicians etc put their case to a city journalist. (These negotiations are often difficult as Governments strive to serve many different interest groups. In places where countries share a catchment, disputes over water supply can lead to war. Students will be relieved to know that the boundary between Gosford and Wyong Council areas approximates the catchment boundary. They could mark in the Local Government boundary on the Catchment map).
  *A hypothetical role-play is provided in the appendix as Imagi-Nation

- **Discuss ways of subdividing the catchment into smaller units.**
  Students should realise that each tributary forms a sub - catchment.



Map produced by Central Coast Natural Resource and Environmental (NREM) Support System a regional project funded by the Natural Heritage Trust. Surveyor General's data licensed to DLWC.



Science outcome 5.10 (c)

Students will learn about ecosystems to describe some impacts of human activities on ecosystems.

Teacher's Note: Discussion Questions
The Catchment before European Occupation

1. **Find out what people were doing in other parts of the world 11000 years ago**

2. **The archaeologist reported indications of a sudden increase in habitation sites at Mangrove Creek starting about 5000 years ago. Suggest reasons for such an increase.**

   Students may like to explore reasons associated with a stabilisation of sea levels about 6000 years ago. There is evidence that coastal areas supported greater population densities - Gov. Phillip estimated that the Cumberland Plain west of Sydney supported a population density about half that of the coast. There is also evidence to support the idea that there was a general increase in the Aboriginal population beginning about 5000 years ago and that this is associated with new technology in toolmaking (Kohen 1995).

3. **Describe changes to our catchment in the last 10,000 years.**

   A map of the coastal area marked with depth contours out to sea provides the basis for a reconstruction of the ancient catchment. Students will have to best guess the paths of watercourses such as the Hawkesbury, Wyong and Ourimbah creeks and also those that would have emanated from the coastal lagoons. Students may like to extend their modelling to a map that takes account of sea level rises predicted to occur as a result of global warming.

4. **Discuss ways of improving the pre-European population estimate for the Central Coast.**

   The discussion should be directed towards an appreciation of the difficulty in establishing a reliable population estimate. Many types of evidence may be used e.g. historical accounts, genetic studies of remains (ethical issues), number of camp sites, seasonal availability of food and water, comparison with other regions etc. The total population for Gosford Council Area (1996 census) is144,840.

5. **Compare cultural attitudes to the Environment.**

   In drawing comparisons students may extend their focus to consider how attitudes to land effect its ability to sustain populations in the long term. Encourage students to find out about civilisations that have succumbed to unsustainable practices eg New Zealand, Easter Island, Nauru, the Romans in North Africa etc. Flannery 1994 has argued that the Aboriginals may have contributed to the extinction of the megafauna. Other scientists (Benson, Kohen) disagree and have countered Flannery's arguments with evidence that suggests the changes occurred slowly and were induced by climate change.

…since the Dreamtime….

It is a great shame that within 30 years of the English invasion in 1788, Koori culture on the Central Coast had been decimated. Our meagre understanding of that traditional way of life is based on:

1. information handed down through Aboriginal communities.
2. archaeological evidence (middens, art, grinding grooves, artefacts)
3. collections of artefacts held in museums
4. observations recorded by the first Europeans to visit the area

The earliest evidence of Aboriginal occupation on the Central Coast dates back 11000 years and comes from a site now flooded by the Mangrove Creek dam. At this time the earth was coming out of an ice age and sea levels were rising. Brisbane Water was a river valley that joined the deep gorge of the Hawkesbury River whose mouth at the time was about 20 kms further east. The coastal lakes and lagoons were not formed until sea levels stabilised at the present level about 6000 years ago. The study at Mangrove Creek found a dramatic increase in the number of Aboriginal sites being used about 5,000 years ago.

Population….

Governor Phillip reported that there were 1500 Aborigines living on the coast between Botany Bay and Broken Bay. The estimate is unreliable as he didn't explain his methods or define the area, but recent workers (Kohen 1995) used this to calculate a population density of 1.2 per square kilometre. Broken Bay to Norah Head is a similar distance and assuming a similar density the Central Coast population could have been about the same.

Land….

The religious aspect of land ownership was more important to the Aboriginal than the economic aspect and it would be as correct to speak of land possessing men as of men possessing land. (Berndt 1977). A group or clan inherited land, not individuals. The territories described for each tribe (consisting of many clans) are based mainly on language differences. It is thought that the Kurringai lived along the coast, further inland was Darkinjung and to the north around Lake Macquarie and Newcastle was Awabagal. There is still some confusion about the boundaries because Aboriginals travelled outside their territory for trade and ceremony with other groups. Just five weeks after settling at Sydney Cove Governor Phillip met with Aborigines at Brisbane Water and recognised trade beads and a European straw hat that had been given to Aboriginals around Sydney.

Prior to the invasion they followed a hunter/gatherer existence that required a deep understanding of their environment. Survival required knowledge of seasonal changes in the availability of food, the use of fire and an ability to make tools. The following quotes provide a glimpse of this lifestyle.

Teacher's Note

Role play activity: Students take turns reading the following quotes taken from the journals of the British colonisers (in the appropriate accent of course)

Shelter…

"The native camp gave a cheerfulness to the scene at night in consequence of the number of fires kept up by the families in front of their respective sleeping places, which were erections of boughs of trees, or sheets of bark placed upright supported by stakes" (Rev. Threlkeld)

"..they made use of excavations in the rock; and as the situations of these were various, they could always choose them out of the reach of wind and rain" (Capt. Collins 1798)

"..in order to make their apartment as comfortable as possible, they commonly make a good fire in it before they lie down to rest; by which means, the rock all round them is so heated as to retain its warmth like an oven for a considerable time" (Hunter 1788)

Food…

"The waters of the bay teamed with fish of every description... the rocks were covered with oysters which formed a staple part of their diet. The bush abounded with game in the form of kangaroos, wallabies, possums, emus, flying foxes, wild duck, swans, parrots... There were edible roots in the gullies, wild fruits in the bushes. It really was a land of plenty". (Scott)

"Their mode of fishing is curious, sometimes angling with hook and line thrown by the hand as they are seated in their bark canoe, sometimes diving for shellfish, sometimes standing in their frail bark canoe darting their spear into fish as they pass, or at other times using hand nets forming a circle in shallow waters and enclosing the fish.(Rev. Threlkeld)

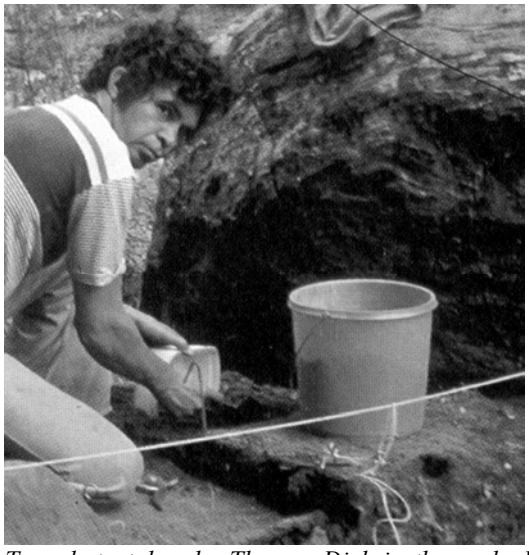
"The natives here (Hawkesbury River) *appear to live chiefly on the roots which they dig from the ground...We put on shore and examined the places which had been dug and found the wild yam...they appear to be in the greatest plenty on the banks of the river."* (Gov. Hunter 1793)

"...they scatter themselves so as to surround a valley, leaving the entrance guarded by several good marksmen armed with spears. The surrounding party, chiefly women, then begin to enclose shouting with all their might, but still in regular time. The kangaroos and other animals become alarmed and make towards the entrance of the valley, where a shower of spears transfixed them in their endeavour to escape. Seven or eight animals were obtained in less than two hours. (Rev. Threlkeld)

The numerous middens around the waterways are the product of countless meals and provide evidence that shellfish were an important part of the diet.

Technology…

The contents of a well constructed hut at Broken Bay was described by Surgeon White as containing "*two very well made nets, good quality fishing lines, some spears, a stone hatchet of superior quality and two wooden vessels for carrying water".*



Top photo taken by Thomas Dick in the early 1900's. Grey Mangrove (Avicennia marina) provided many resources. Here a shield has been cut using stone axes and stone wedges are being used to prise it from the tree. In the background is a bark canoe probably constructed from Swamp Mahogany (Eucalyptus robusta). Left above - an archaeological excavation of a midden site west of Wyong. Right above- hand stencils in a cave near Somersby.

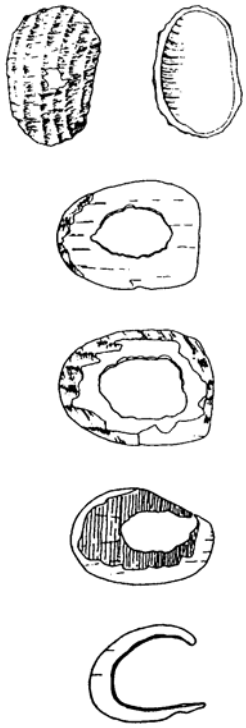
"The women are very ingenious; they form fish-hooks from the oyster shell and make string from bark with great facility, equally as good as can be purchased in England, they twist and roll the bark in a curious manner with the palm of the hand upon the leg; with this string they form nets of curious workmanship."(Ebsworth)

"The fish-hooks are chopped with a stone out of a particular shell, and afterwards rubbed until they become smooth. They are very much curved and not barbed. Considering the quickness with which they are finished, the excellence of the work, if it be inspected is admirable". (Tench 1793)

Activity: Making Fish-hooks.

Early written records indicate that fish hook making was a skill practiced mainly by the women. The archaeological record indicates that shell fish-hooks became part of the Aboriginal tool kit of coastal south-eastern Australia in the last 1000 years. The majority of shell fish-hooks and stone files have been found in the surface layers of middens. The stone files were used to sharpen the hooks. Although Turban shells are shown here it was recorded that oysters were commonly used. Put the finished hooks to the test and go fishing. You might like to try your hand at making the line out of plant fibres.

Stone file about 4cm long



Stages in the making of a fish-hook from sections of Turban Shell (Turbo torquata).

1) Edges of blanks are smoothed by filing
2) The outer convex surface of the blank is worn down by rubbing on a flat stone until the centre is worn through.
3) The hole is enlarged by chipping out the thinned central area.
4) Rough shape is formed by rubbing away a small section of the ring
5) The final hook was shaped by filing the interior smooth, finishing the point and notching the shank.

From 'Stone files and shell fish-hooks in Southeastern Australia' Val Attenbrow, Richard Fullager, Cheryl Szpak. Australian Museum 1998

fastened round the head by a very adhesive gum ... taken from a plant called the grass tree... With their stone hatchets they can cut notches in the bark of trees, which they climb for the wild honey or for possums and goannas." (Dawson)

Upper Mangrove Creek Catchment

Animal species represented in the remains retrieved from the archaeological deposits (1987).

A. MAMMALS	
LARGE MACROPODID	
Macropus robustus	Euro/Wallaroo
Macropus giganteus	Eastern Grey Kangaroo
MEDIUM MACROPODID	
M. rufogriseus	Red-necked Wallaby
Wallabia bicolor	Swamp Wallaby
SMALL MACROPODID	
Petrogale penicillata	Brush-tailed Rock Wallaby
Thylogale sp.	Pademelon
POTOROIDAE	
Bettongia gaimardi	Eastern Bettong
Potorous sp.	Potoroo
PHALANGERIDAE	
Trichosurus vulpecula	Brush-tailed Possum / Bobuck
PETAURIDAE	
Pseudocheirus peregrinus	Common Ringtail Possum
Schoinobates volans	Greater Glider
Petaurus breviceps	Sugar Glider
Petaurus australis	Yellow-bellied glider
Petaurus sp.	Lesser gliding possums
Pteropus scapulatus	Large possum
BURRYAMYIDAE	
Acrobates pygmaeus	Feather-tail glider
Cercartetus nanus	Pygmy possum
PERAMELIDAE	
Isoodon sp.	Short-nosed Bandicoot
Parameles nasuta	Long-nosed bandicoot
VOMBATIDAE	
Vombatus ursinus	Common wombat
PHASCOLARCTIDAE	
Cf Phascolarctus cinereus	Koala
DASYURIDAE	
Dasyurus maculatus	
Dasyurus sp.	Native or tiger cat
Antechinus swainsonii	Dusky Antechinus
Antechinus flavipes	Yellow-footed Antechinus
Antechinus stuartii	Brown marsupial mouse
Small dasyurid	Unidentified small dasyurid
ORNITHORHYNCHIDAE	
Ornithorhynchus anatinus	Platypus
CANIDAE	
Canis familiaris	Dingo
MURIDAE	
Attus fuscipes	Southern Bush-rat
Rattus lutreolus	Eastern Swamp-rat
Pseudomys oralis	Hastings River Mouse
Pseudomys novaehollandiae	New Holland Mouse

From A Summary of Archaeological Research Undertaken in the Upper MangroveCreek Catchment by Val Attenbrow (Anthropology Division, Australian Museum) June 1990

Fire…

"In the centre (of the canoe) *a hearth is made of earth upon which a fire is always kindled when they are upon the water. When fishing it not only serves to warm their feet and hands but is used principally to roast the bait, whether cockles, or the flesh of the star- or any other fish, besides which the fire is useful to cook the fish as soon as it is caught."* (Rev. Threlkeld)

"The weather now being very dry, the natives were ... burning the grass...in order to catch rats and other animals, whilst the women were employed in fishing" (Gov. Phillip's journal 1790)

"The omission of the annual periodical burning by the natives, of grass and young saplings, has already produced in the open forest lands nearest to Sydney, thick forests of young trees, where formerly a man might gallop without impediment and see miles before him."(Major Mitchell 1848)

European contact and occupation.

Within a year of the English invasion smallpox had decimated the Aboriginal population around Sydney including Broken Bay. As white settlers moved into the Hawkesbury there was an escalation of conflict and by the time the first census of the Aboriginal population of the Central Coast was taken in 1828 only 5 family groups, a total of 65 people remained.

The isolation of the Central Coast was reinforced in the 1820's by the construction using convict labour of the Great North Road. Bypassing the Central Coast it linked Sydney with the rapidly developing Hunter Valley via Wisemans Ferry.

Timber, Boats and Shells . . .

With the development of agriculture along the Hawkesbury there were many boats passing the entrance to Brisbane water but it wasn't settled until 1823 when James Webb established boat building at Booker Bay. The earliest cargoes shipped out of Brisbane Water were for Sydney's building trade. Roofing shingles “tens of thousands from ironbark”, timber and shells. The shells were obtained most easily from the Aboriginal middens and were burnt to make lime mortar. Thousands of tons of shells were carried out until the 1890's when limestone became available. Mangrove ash (potash) was also in demand for soap making and fertiliser. Fish, lobsters and vegetables were recorded in later cargoes.

The open forests provided timbers like Spotted Gum, Blackbutt and Ironbark while in the gullies of the closed forest Sydney Blue Gum, Turpentine and Rainforest softwoods were highly prized. Timber was shipped to Sydney from wharves on Narara and Erina Creek (Woodport). Not all timber, however, was sent to Sydney as great quantities were used locally for shipbuilding. Between 1829 and 1953, 500 vessels were built in the region.

By 1842 East Gosford flourished. There were two wharves and a regular boat connection to Sydney (the *William the Fourth* paddle steamer was plying between Sydney and East Gosford twice a week).

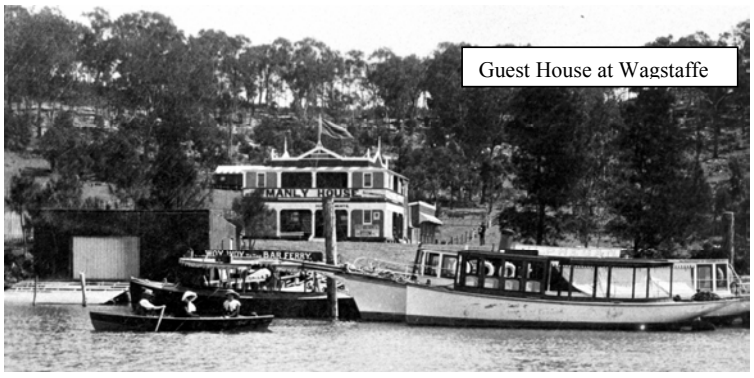
The Railway . . .

Prior to the construction of the railway, boats were the most practical method of transporting goods to Sydney. The opening of the rail connection in 1889 was the catalyst for the growth of the region established Gosford's dominance as the municipal centre of the district. At this time the combined population of Gosford and East Gosford was about 1000.The construction of this last rail link between Brisbane and Adelaide was a major engineering achievement. It required building a bridge across the Hawkesbury and the construction of Woy Woy tunnel - the longest railway tunnel in Australia.

Small Farms …

A government act of 1884 encouraged the 'little man' to buy small acreages to make a living from the soil. Subdivisions occurred along the railway between Gosford and Wyong, also at Green Point, Chertsey and the largest of all was 2000 acres between Erina and Terrigal. These were sold off the plan regardless of soil or topography and very few succeeded. Citrus growing became the main activity.

Tourism …



Guest House at Wagstaffe

Being more accessible, the region became the focus of a developing tourist industry, particularly in the Woy Woy area. In September 1897 it was reported that over 9000 pleasure seekers had visited the region during the previous holiday season. Boarding houses began to flourish attracting tourists from the city. Both the Woy Woy Hotel (1897) and the Bay View Hotel (1907) were built at this time. By 1916 over 30 holiday resorts had been built around Brisbane Water. Most were reached by boat from Woy Woy. By 1928 its population had grown considerably and Woy Woy Shire Council was formed.

The trend accelerated with the development of vehicular access and shorter working hours. The weekender, holiday house and retirement home was coming into its own.

Urbanisation and commuting . .

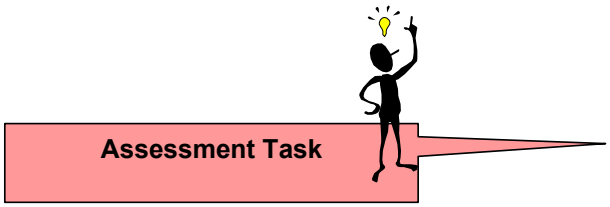
The Erina Shire Council was formed in 1907 and a radiating road network was begun. The major arterial roads constructed then remain today. The establishment of the Shires of Gosford and Wyong in 1947, (Shires of Erina and Woy Woy ceased to exist), the dedication of the Brisbane Water National Park in 1958 and Bouddi in 1967 all helped frame the pattern of development as it is today.

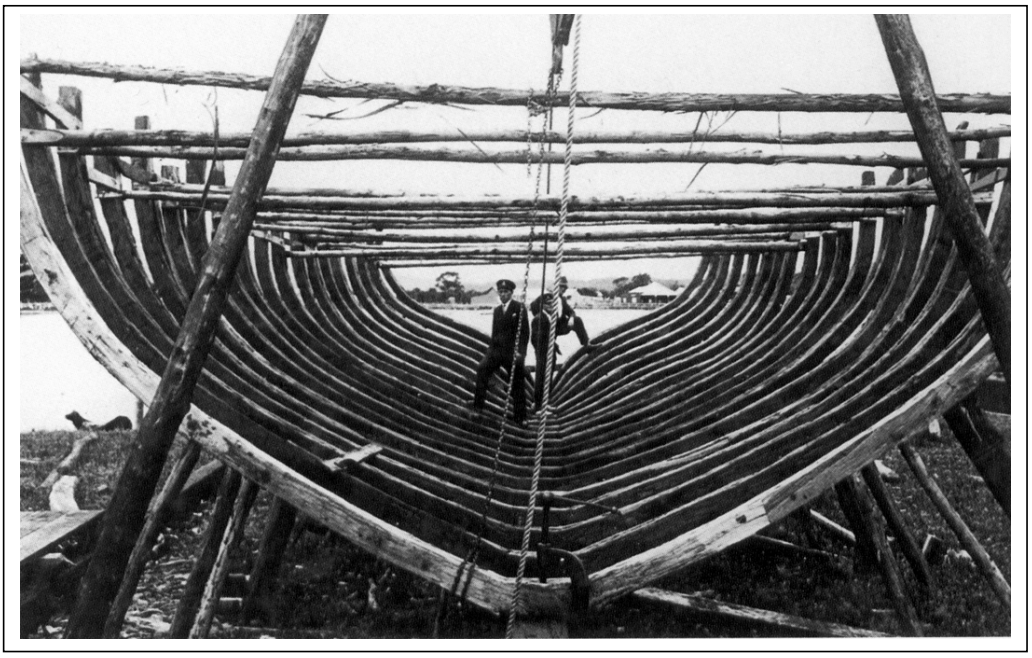
The electrification of the rail link in 1963 and the construction of the Sydney-Newcastle expressway in 1965 brought the Central Coast within commuting distance of Sydney. This fed the urban expansion that continues at a rapid pace as people leave the congestion of Sydney and settle in the relatively quiet, unspoilt environment of the Central Coast. The challenge is to meet the demand of increasing urbanisation without destroying the environmental qualities that people find so attractive.

Teachers Note – Exercise 1: History of the Catchment

- It is suggested that this activity be used as a homework task for the duration of the unit with the final work being a major part of the overall unit assessment.
- Gosford Library's Local History Section is an excellent resource. Appendix A also contains a list of useful references. For other useful contacts visit the Rumbalara Environmental Education Centre Website at www.rumbalarfsc.nsw.edu.au

Historic photos of both Gosford and Wyong are available on the Internet at: www.ccrdc.org.au/libphoto/





from The Shipbuilders of Brisbane Water NSW by Gwen Dundan

Exercise 1: History of the Catchment

After reading the **"History of the Catchment**" choose an aspect that you would like to investigate and report on. You may like to use some of the following ideas or develop your own.

1) Construct a timeline for the changes that have occurred in the Brisbane Water Catchment.

2) Write a narrative from the point of view of an Aboriginal person experiencing the impact of European settlement.

3) Write a narrative describing the daily life of an Aboriginal living in Brisbane Water before the British invaded.

4) Write a narrative describing the life of a British settler on the shores of Brisbane Water about 1850.

5) Draw or paint views of Brisbane Water as Governor Phillip may have observed them. Try to indicate details of the original vegetation.

6) Report on the history of boat building on the Central Coast.

7) Produce a radio play about a family holiday on the Central Coast in the newly built Woy Woy Hotel around 1897.

8) Record the oral history memories of someone who has lived in the area for 60 years. (How has the catchment changed?)

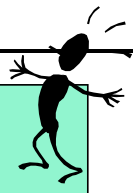
9) Search your local area and report on evidence of past activities. Your report could include photographs and maps showing the evidence and its location as well as your interpretations of the evidence ie do some detective work.

10) Imagine you have an opportunity to go back in time and influence the changes that have occurred in the Brisbane Water Catchment. What would you change and why? Present your vision of what Brisbane Water could have been.

11) Experiment with early manufacturing techniques eg. Making lime from shells.

12) Make a historical record of this place at this time in history. Explain why you have included the different items and how they might contribute to a historical account of the area.

All activities should show evidence that you have read the passage, that you have done some research and that you have considered the changes over time. All work should be accompanied by a bibliography listing sources of information including websites, interviewees etc.



Science Outcome

4.17: A student evaluates the relevance of data and information.
5.17: A student explains trends, patterns and relationships in data and/or information from a variety of sources

Teacher's Note

Ecology is largely concerned with the distribution and abundance of organisms. Maps provide this information in a way that enables patterns and relationships to be observed. The following exercise is designed to provide students with an overview of the patterns of land use in their catchment.

Suggested answers.

1. The question aims to provide students with an opportunity to become familiar with the catchment map. It is not necessary for the students to give grid reference answers

2. Yattalunga - Tascott ~ 4.5km, Graham Park - Woy Woy ~ 6km, Lisarow - Adcock Park ~ 7km

3. This question aims to develop two skills: a) using contour lines to map catchment boundaries and b) using a grid to calculate irregular areas. Approximate catchment areas (including deltas). Narara Ck ~ 44 sq km, Erina Ck 37 sq km, Kincumber Ck 6 sq km.

4. Residential areas determined using 1km sq. map grids on 1984 topographic map. More accurate estimates using smaller grids and more recent maps eg Photo topographic maps Narara Ck ~ 6 sq km (13%), Erina Ck ~ 2sq km (5%), Kincumber Ck ~ 1.5sq km (25%)

5. Height: Mt Elliot ~ 200m, Copacabana lookout ~ 100m, Lisarow station ~ 30m, Freeway 200m

6. Develops the skill of overlaying to extract relevant information. The planning map provides a simple description of land use within the catchment. Students should decide on the various categories, boundaries etc through group discussion.

7. Students should provide written descriptions of the corrections they would make to the topographic map based on their examination of the aerial photo.

8. Students should discuss how to categorise the variety of land uses.

9. Low lying, flood prone and steep landscapes have been designated for conservation probably because they were the least valued sites rather than from any scientific assessment of their conservation value. A best practice conservation strategy would ensure that all vegetation types were represented. Flat, well drained landscapes are poorly represented in this catchment.

Exercise 2: Interpreting Maps of your Catchment

Working in groups for this activity you will need access to at least one laminated topographic map, an aerial photo, the single page map of Brisbane Water Catchment (Map1) and a transparent grid overlay.

Using the topographic map(s):

1. Locate your School, your house, Winnie Bay sewerage outfall, the railway, the expressway, Coorumbine Creek, Gosford Golf Course, Adcock Park, Kincumber rubbish tip and Woy Woy Ck.

2. Calculate the distance:
   - across Brisbane Water from Yattalunga Wharf to the foreshore near Tascott Station?
   - from Graham Park to Woy Woy Channel.
   - From Lisarow Station to Adcock Park

3. Calculate the area of the Narara, Erina and Kincumber sub-catchments using the grid on the map. Here's how: - use a felt pen to draw the boundary of the sub-catchments on the laminated topographic map then count the grid squares inside each boundary. Each square in the grid represents an area of 1 sq. km. For those that fall on the boundary, only count them if they are more than half in the sub catchment.

4. Calculate the area given to residential land in each of the above catchments (note any changes since the maps were produced).

5. Find the height above sea level at: Mt Elliot (Katandra Reserve), Captain Cook lookout (Copacabana), Lisarow railway station, the Freeway at top of Narara Ck.

6. Use a transparent overlay to make a planning map of your local area (including your school) in your workbook. First trace the main features onto an A4 overlay. Include the catchment boundaries, waterways outlines of residential areas playing fields, major roads, beach, estuary, mountain, shopping centre etc. Photocopy the overlay and paste the copy into your workbook. Label neatly and clearly.

7. Locate the boundaries of the aerial photograph (taken in 1998 and which includes your school) on the topographic map. Examine the photo and then a) describe corrections to the topographic map and b) make corrections to your planning map (new housing developments, schools etc).

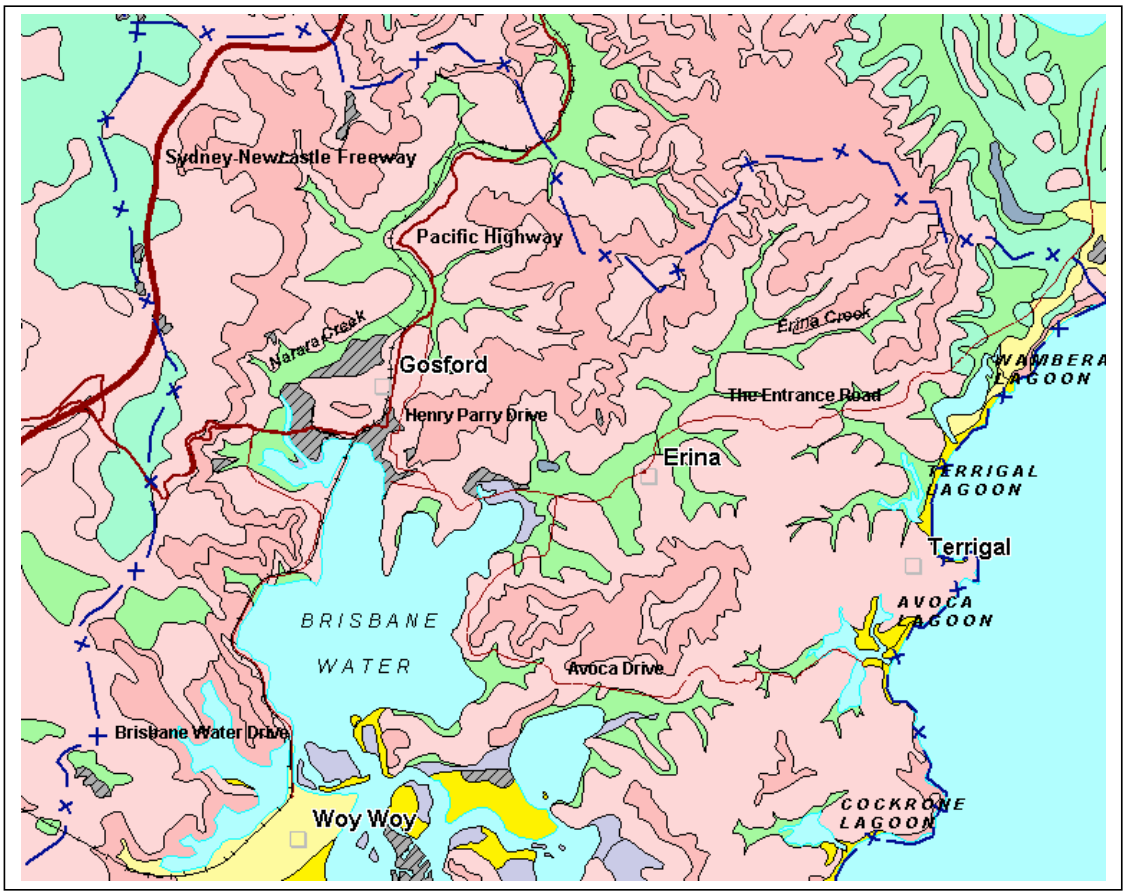
8. Make a list of the different types of land use in your local area.

9. Identify patterns associated with human settlement from the maps? What types of landscapes have been reserved for conservation? Why? What landscape feature do you associate with residential land? Why?

Suggested Answers – Exercise 3: Soil Landscapes and Vegetation

1. Check the profile against the topographic map to ascertain exact locations. Note that on the profile Narara Ck. is a mangrove wetland, rainforest tends to occupy south and east facing gullies east of Rumbalara, open forest on the drier slopes eg west of Rumbalara and the open woodland is found on the plateau.
2. Topography and aspect.
3. A) Experimental procedures such as growth rates of rainforest species under various conditions eg light, humidity, soil moisture. Stress the importance of limiting the number of variables and the use of controls.
   B) Correlation eg by identifying that rainforests grow in south to east facing gullies on a wide variety of soil types indicates that aspect and topography may be more influential than soil type. C) Transplant experiments eg Measure the growth of seedlings of an open forest species such as Blackbutt (*Eucalyptus pilularis)* in a rainforest or woodland. Emphasise the use of controls.
4. Application of fertilizer. Discuss the leaching of fertilizer into the groundwater in these permeable soils.
5. Organic matter is incorporated into soils from the death and decay of organisms. It increases the water holding capacity and fertility of sandy soils and creates a more open friable soil in clay.

Soils of the Brisbane Water Catchment (courtesy CCNREM)

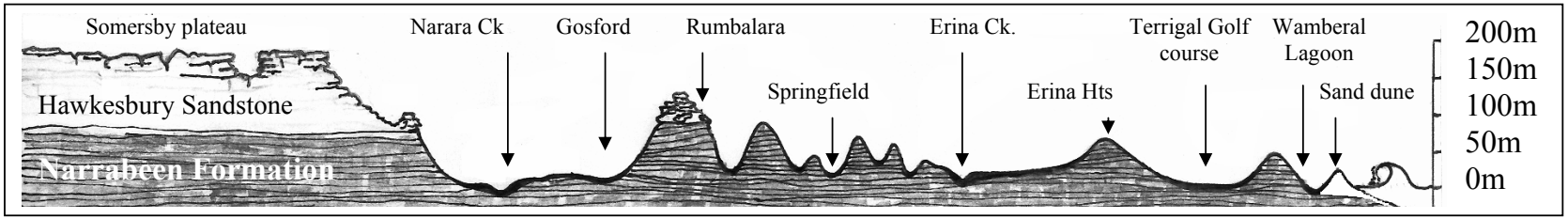


A key to this map is provided on the "*Gosford - Lake Macquarie* 1:100 000 Sheet"
This most useful resource is available from Dept. Land & Water Conservation, Mann St. Gosford

The Brisbane Water Catchment was carved out of the Sandstones and Shales of The Sydney Basin

The Narrabeen formation with its layers of shale erodes readily to form a landscape of rounded hills (The Erina Hills). Hawkesbury sandstone caps the Somersby Plateau and the higher ridges of Mt Elliot, Kincumber Mountain and Bouddi Peninsula. It weathers more slowly to an infertile sandy soil. The valleys contain sediments eroded from these formations together with organic matter.

Profile across Brisbane Water Catchment from Wamberal to Somersby along gridline 6300



Questions:

1. Where on the profile would you place each of the four vegetation types described below?
2. What factors other than soil could have influenced the location of each of these plant communities?
3. Suggest a way to find out why a plant community grows in one place but not another?
4. The plateau is a rural area. How may farmers have made up for the low availability of phosphorous?
5. Where does organic matter come from and how does it effect a soil?

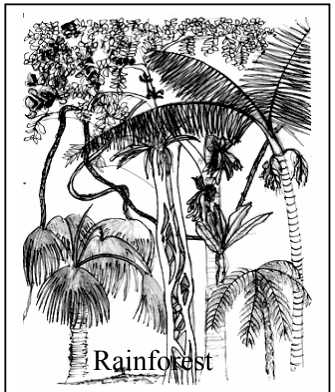
Results of some Soil Tests in the Brisbane Water Catchment.

SOIL CHARACTERISTICS	Plateau	Erina Ck.	Erina Hts.
pH	5.3	4.9	5.1
Organic matter(%)	1.2	3.5	7.3
Water Holding Capacity (%)	6.2	15	12.9
Available Phosphorous mg/kg	1	6	13

Low open woodland

Mangrove wetland

Open Forest



Rainforest

Teachers Notes - Field Activity (Soil Landscapes and Vegetation)

Use an area near the school as a class exercise. Students should consult the vegetation classification table (included in the appendix) and sketch a profile of the study area to describe the plant community while in the field. Test the soils and record slope aspect etc. The comparison with other vegetation types can be done as a homework exercise with students bringing vegetation profiles and soil samples to school for testing.

The final analysis of class results will attempt to identify a relationship between vegetation and landscape factors.

Consult 'Soil Landscapes of the Gosford Lake Macquarie 1:1000000 sheet'. Available from DLWC

Following are some suggested soil testing procedures

pH

1) Place a small sample of soil (half teaspoon) in a clean container.
2) Saturate sample with universal indicator
3) Sprinkle barium sulfate powder over surface of soil
4) Compare colour change with universal indicator colour chart.

Organic Matter

- Weigh a sample of oven dried soil in a vessel of known weight.
- Heat soil using a bunsen to cause combustion of all the organic matter. Stir soil while heating but be careful not to lose any as this will effect the final result.
- Weigh the **Burnt Soil** in the vessel and then subtract the weight of the vessel
- Calculate the **% Organic Matter** as = $\frac{\text{Dry soil weight – Burnt soil weight}}{\text{Dry soil Weight}} \times 100$

Soil Texture

1a. can't be rolled into a rod---------*go to 2*
1b. rolls into a rod----------*go to 3*
2a. gritty feel ---------- *sand*
2b. not gritty ---------- *loam*
3a. rod can't be made into a ring --- go to 4
3b. rod can be made into a ring ---- go to 5
4a. has a gritty feel ---------- *sandy clay*
4b. has a silky smooth feel ------ *clay loam*
5a. easy to mould ---------- *light clay*
5b stiff and plastic ---------- *heavy clay*

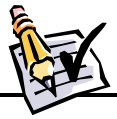
Soil Water

Design your own experiment!

Do soils all hold the same amount of water after rain?
Do some soils drain more quickly than others?
Do some soils dry out more quickly than others?
Think about it, discuss it, write down the method, try it out, make changes and repeat it if necessary (good science takes a lot of trial and error).
Record your results and write about the experiment.

Salinity: Shake 1 part soil with 5 parts distilled water and then test with the TDS meter (supplied)

Colours: **Reds** are a sign of well drained soils and **Yellows** poorly drained. **Mottled** have intermediate drainage. **Dark** colours are a sign of high fertility and **Pale** colours of low fertility.



Why is this Vegetation here?

Introduction: In this exercise you will attempt to explain differences in vegetation.
Method: -

1. **Describe the vegetation types** Choose two places in the local area that have different vegetation types. Classify each plant community using the classification table provided (appendix). In the boxes below draw a profile diagram of each vegetation type.

Veg. type_____ Veg. type_____

2. **Measure Landscape factors and Compare with other sites**. Describe topography and conduct soil tests to determine colour, structure, pH, salinity, water holding capacity and % organic content.

Slope =	Slope =
Aspect =	Aspect =
pH =	pH =
Colour =	Colour =
Structure =	Structure =
Organic content =	Organic content =
Water retention =	Water retention =
Salinity =	Salinity =

Discuss your results.

- Do you have enough information?
- Explain how results from other sites could:
  a) support your findings and **b)** refute your findings.

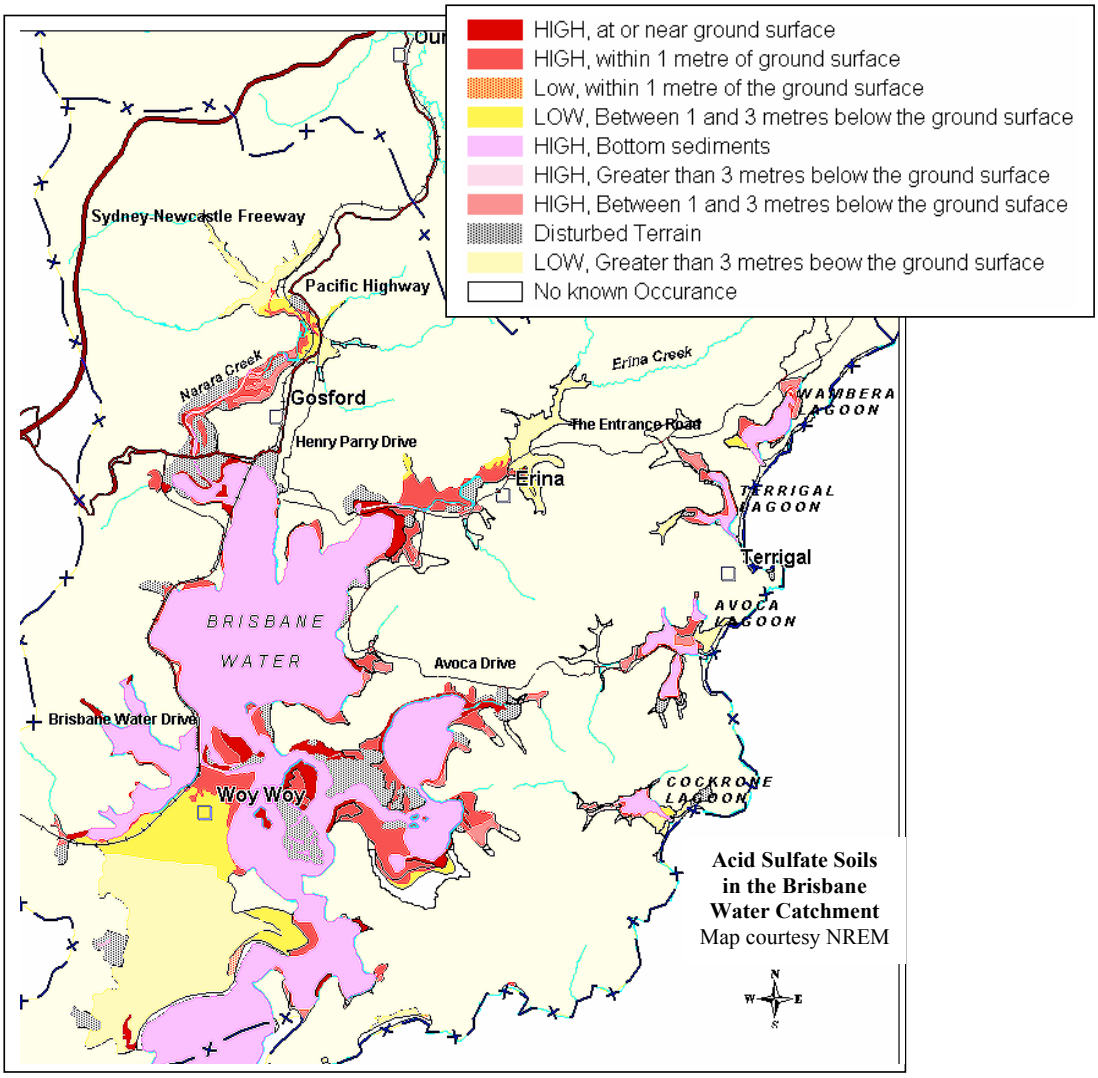
Teachers Notes - Acid Sulfate Soils in the Brisbane Water Catchment

Identifying Potential Acid Sulfate Soils:- Acid Sulfate Soils react with Hydrogen Peroxide due to the presence of iron sulfide (note that organic matter in soil reacts more slowly).
Procedure: To 5 parts hydrogen peroxide (30%) add about 1 part sodium hydroxide (0.1M) to get the pH below 5.5. Mix this with the soil sample to make a slurry. The following signs indicate acid sulfate soils:

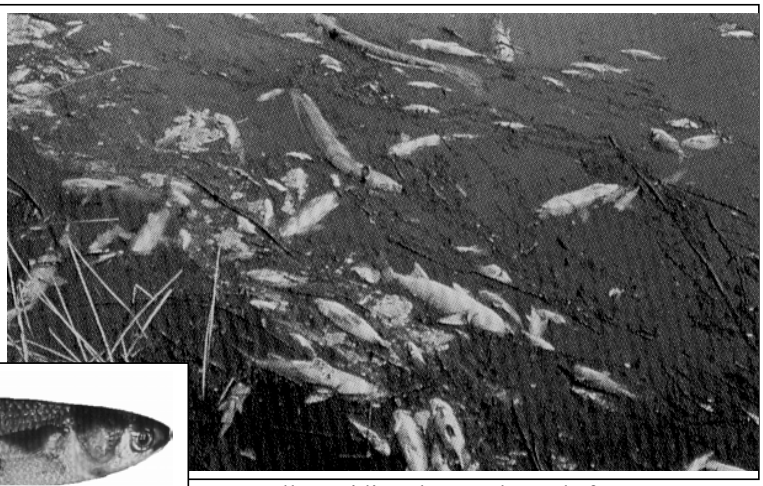
- A dramatic drop in pH (eg less than 3)
- Effervescence
- Colour change (eg grey to brown)
- A sulfurous odour

Suggested Answers

a) Mangroves, Saltmarsh,, Paperbarks (Melaleuca), Casuarina
b) Excavating roads,dredging,lagoons, draining swamps
c) Experiment with samples and then extrapolate the result to the effected area of soil. Consider treatment versus prevention as management strategies.



DANGER!!!
Don't Disturb
ACID
SOILS



Acid effects the skin and gills causing ulcerated sores or red spot disease.

Naturally acidic clay and mud from swamps and estuaries releases strong sulfuric acid when exposed to the air. This may happen as a result of draining, dredging or excavation.

iron sulfide + oxygen = sulfuric acid + iron oxide

Seawater normally has a pH about 8, which is slightly alkaline. Disturbance of Acid Sulfate soils can cause the pH of effected waterways to drop below 4, which is very acidic. This can cause massive kills of the plants, fish and invertebrates in the surrounding waters. It can also corrode steel and concrete. The acidity causes other nasty side effects including the release of toxic loads of aluminium and heavy metals.

In NSW planning and development controls now protect waterways from this type of pollution.
St Huberts Island (below) was developed before these laws came into place

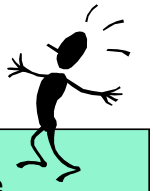
Questions

1) What types of plants are associated with potential acid sulfate soils?

2) Make a list of activities that could expose potential acid sulfate soils.

3) Conduct experiments into the use of lime as a treatment for acid sulfate pollution. How would you determine the correct amount needed to neutralise the acid? (Too much lime can be just as bad as the acid).

Ecosystems in the Catchment



Science Outcomes
5.10 Assesses human Impact on the interaction of biotic and abiotic features of the environment
Content a) Students will learn about ecosystems to distinguish between biotic and abiotic features of the local environment

Answers – Exercise 4: Biotic and Abiotic Features

Biotic	Abiotic
trees	nitrates
seeds	carbon dioxide
fungus	wind
worms	phosphates
bacteria	acidity
microscopic organisms	rocks
algae	rainfall
pelicans	oxygen

1. Increased nutrients would provide conditions suitable for other plants to displace the heathplants which are adapted to low nutrient soils.

Teachers Notes:
Students should discuss some abiotic conditions that influence the distribution of local ecosystems such as:- Rainforest, Open forest, Heath, Mangrove Wetland and Freshwater Wetland.

Abiotic conditions for plant communities

- Rainforest – high humidity, low wind exposure, south / east aspect, soil moisture, lack of fire
- Open Forest – exposed to wind, sun, high fire frequency
- Heath - shallow soils, exposure to wind, sun, high fire frequency
- Estuarine wetland – tidal inundation by salt water, stabilised soils (not beach sand)
- Freshwater wetland – free standing freshwater for long periods, high water table during drought.

Ecosystems

An ecosystem is made up of groups of organisms (bacteria, animals, fungi and plants) interacting with each other and the non-living environment (water, soil, salts, oxygen, temperature, acidity etc).

Ecosystems are extremely complex but as people are such an influential part of them it's important for scientists to study and learn how they work. We need this knowledge to avoid making mistakes that damage the environment and make it worse for future generations.

Exercise 4: Biotic (Living) and Abiotic (Non-living) Features

Classify the following parts of an ecosystem into biotic (living) and abiotic (non-living) features. Present your information in the table and then add 5 more biotic and 5 more abiotic examples.

fungus, acidity, oxygen, carbon dioxide, worms, rocks, microscopic plankton, trees, wind, rain, algae, seeds, phosphates, bacteria, pelicans, leaf mulch, nitrates.

Biotic	Abiotic

Ecosystems

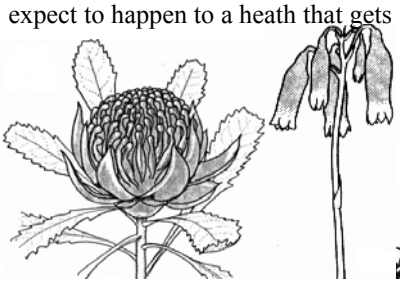
Many factors determine what types of plants and animals can survive in any given place.

- The structure of the soil and the amount of water and type of nutrients it contains.
- The slope of the land effects exposure to sun, frost and wind.
- Other organisms may provide shelters like tree hollows for nesting or they may be predators, pollinators or food.
- The frequency of fires, floods or drought might be important.

When scientists measure all these things in a given place they are describing an ecosystem.

Communities

A community is all the living things that characterise an environment. The sandstone heath communities in places like Brisbane Water National Park are famous for their wildflowers. The poor Hawkesbury Sandstone soils support a fantastic variety of plants. Perhaps it's because no single species is able to dominate a place with so few nutrients. If this is correct, what would you expect to happen to a heath that gets 'fertilised' by polluted urban runoff?



Science outcome 4.10 (b)

Students will learn about ecosystems to describe how producers, consumers and decomposers in Australian ecosystems are related, using food chains and food webs

Answers – Exercise 5:

Producers and Consumers

1. Producers **Algae**, Ist order consumer **prawn**, 2nd order consumer **fish**, 3rd order consumer **shark**
2. Herbivore is the prawn
3. Human

Energy in the Community

1. A common method is to measure the dry weight or biomass of each trophic level. (The most accurate method is calorimetric (burn a representative sample of organisms at each level of the food pyramid and calculate the energy released as heat).

2. As energy is lost from the system (as respiratory heat loss) there is less energy available for the top consumers. A rule of thumb is that only about 10% of the energy contained in one trophic level gets transferred to the next level. The biomass of the carnivore population should be about 10% of the biomass of the herbivore population.

3. Humans can choose which trophic level they belong to. More people can be supported on the wheat than on the chooks that eat it. The demand for agricultural land would decline if humans stepped down a level in the food chain.

4. With less energy available top carnivores need larger areas to extract sufficient food.

5. A nature reserve needs to be large enough to contain a viable population of animals that have large territories. Viable means that there need to be enough territories or links to neighbouring territories to avoid the effects of inbreeding

6. Bio-accumulation occurs when pollutants such as heavy metals and pesticides get stored (often in the fat) of organisms. As these pollutants are not metabolised they get passed on in the food chain and become concentrated in the top order consumers.

7. During a bushfire a lot of the energy contained within the community is lost as heat. The ability of the community to tolerate bushfires depends on adaptations like those in eucalypts that enable energy reserves in the roots and bark to be utilised to produce new leaves for photosynthesis. It also depends on the frequency and intensity of the fires.

Energy Flow

The living things in an ecosystem are its **community**. This whole community runs on energy from plants. They make the sugars - the fuel needed by all the other organisms including ourselves. And like the fuel in a car it eventually gets used up, lost as heat and so we need to be constantly refuelling.
A **food chain** is a simple way of showing a pathway along which energy flows. Food chains always start with the **producers** of energy (plants). Plant eaters (**Herbivores)** are the first consumers (1st in order) then the **carnivores** (2nd in order).

For example we can describe energy flowing from **Nectar → Bee → Spider**

or more generally **Producer → Consumer (1st order) → Consumer (2nd order)**

If the 2nd Order Consumer is eaten by a wasp then it is easy to add in a 3rd order consumer. If the wasp is eaten by a bird it will be the 4th Order consumer and so on.

Exercise 5: Producers and Consumers

1. Identify the Producer and the 1st, 2nd and 3rd order consumers in the following food chain

   Algae→ prawn → fish→ shark

   Producer _____, 1st order consumer _____

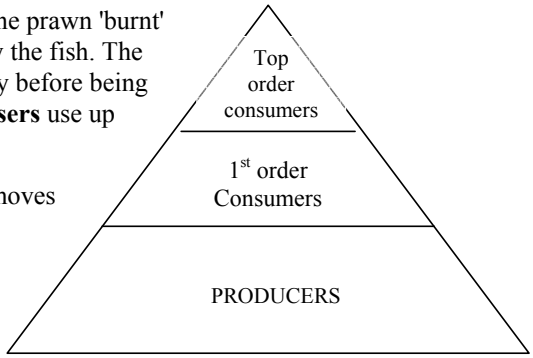
   2nd order consumer _____, 3rd order consumer _____

2. Circle the herbivore in the above example.
3. Add a 4th order consumer to the food chain.

Energy in the Community

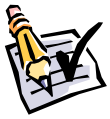
Energy is lost as it moves along a food chain. Think about all the energy from all the foods that you've consumed in your lifetime. You burnt most of it up in your daily activities and even when you slept.

In the food chain: **Algae → Prawn → Fish → Shark,** the prawn 'burnt' up (respired) a lot of the algal energy before it was eaten by the fish. The fish eats a lot of prawns and 'burns' up a lot of prawn energy before being eaten by the shark. Eventually the shark dies and **decomposers** use up all the energy remaining in its body.



A **food (energy) pyramid** shows how energy is lost as it moves along a food chain. It shows that in any ecosystem there is always more energy available at the start and only a small amount (less than 10%) gets passed on to the next level.

Questions



1. Find out how scientists measure the energy at each level in a food chain.
2. Explain why ecosystems support fewer carnivores than herbivores.
3. Explain how a change in diet can reduce land clearing for agriculture.
4. Why do top carnivores like sharks and eagles need larger territories?
5. How big does a nature reserve need to be in order to conserve an ecosystem?
6. Find out why toxic pollutants like pesticides and heavy metals accumulate at the top of food chains

Answers – Exercise 6: Food Webs

1. Decaying leaves are the energy source for the insects and worms.
2. Frog, Skink, Centipede, Spider
3. Reduce the detritus / leaflitter which supports the food of the Lyrebird. Fewer Lyrebirds.
4. No, it is a generalist.
5. Scrub Turkey is a competitor. Predict fewer Lyrebirds.
6. Fox is a predator on both Lyrebirds and Turkeys, especially the chicks and the eggs. Predict a decrease in both birds.

Teacher's Notes –
Foodweb information for other Local Ecosystems are included in the appendix.

Exercise 6a: Food Web Game
Students form groups.
Need to assign roles of timekeepers and team leaders.

1. Teacher puts up an overhead of the Forest Ecosystem see Appendix B with names blanked out and a list of missing plants and animals. Each group also receives a blank figure. (provided in Appendix B)

2. Students need to determine where the plants and animals belong. The group that achieves this in the fastest time is the winner. If stuck - groups may buy hints from the teacher at a cost of 30 seconds (provided in Appendix B) – hints are arbitrarily given.

3. Solutions provided in Appendix B.

List of missing animals / plants:

• Kookaburra	Moth
• Mistletoe & Borer	Cat (introduced animal)
• Flower & Fruit	Bee
• Possum & Bat	Koala
• Parrots	Mantis
• Leaf	Wagtail
• Sap	Aphid, Caterpillars, Beetles

N.B. The Gould League has produced a great set of animal and plant cut outs that can be used to develop students understanding of food webs. They come with the book titled 'Food Webs, Classification and Biodiversity'.

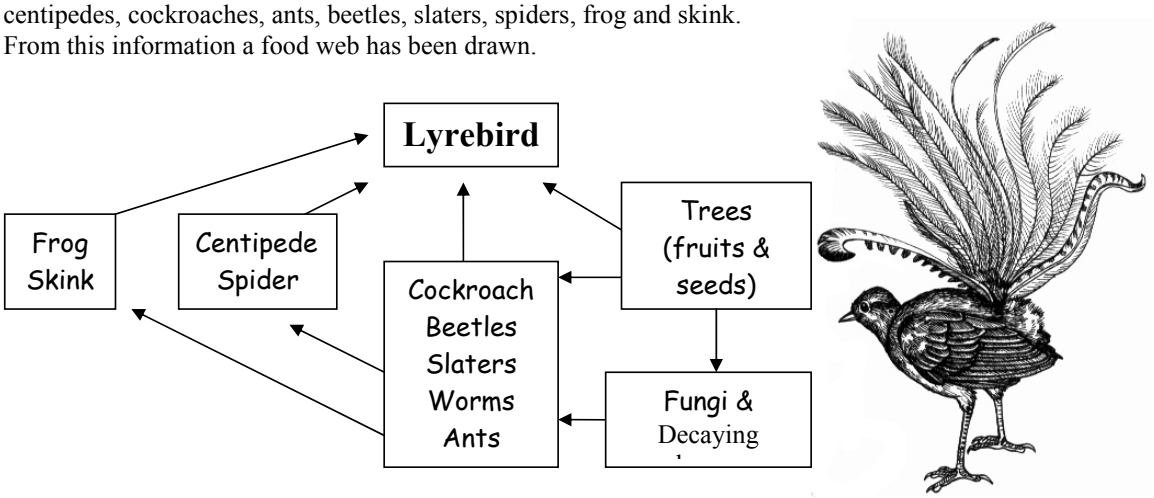
Food Webs

Within a community there can be thousands of food chains that branch and link up with each other to form a **food web**. A food web shows the feeding relationships – what eats what and which animals compete for food. With so many organisms it is common practice to group some species together eg the **decomposers. (**They are the animals often found living in the top layers of the soil. They extract energy from dead leaves, wood, faeces and other waste. They include many species of bacteria , fungi, worms and insects some of which we know very little about).

The information needed to make a food web can come from observations in the field but for many animals an examination of their scats or their stomach contents is a far easier way to find out about their diet.

Exercise 6: Food Webs

The Lyrebird finds its food by raking the forest floor. It's difficult to observe exactly what this shy bird is eating and so a scientist identified the food items found in the stomachs of 16 road killed Lyrebirds. The findings were published in 'The Australian Birdwatcher' March 1999. They include seeds, worms, centipedes, cockroaches, ants, beetles, slaters, spiders, frog and skink.
From this information a food web has been drawn.



1. Why was it necessary to include Fungi and decaying leaves in the food web when these were not found to be part of the Lyrebird's diet?

2. Which animals are both prey and competition for the Lyrebird?

3. How would a bushfire or even a slow, controlled burn off to reduce the fire hazard effect Lyrebirds?

4. Would you say that the Lyrebird is particular about what it eats?

5. The Scrub Turkey also finds its food on the forest floor. Add the Scub Turkey to the food web. What effect might the Scrub Turkey have on the Lyrebird population? Explain.

6. Introduce a feral animal (eg a fox) into the food web and predict what changes would occur.

7. Make a food web for the school or your home garden.

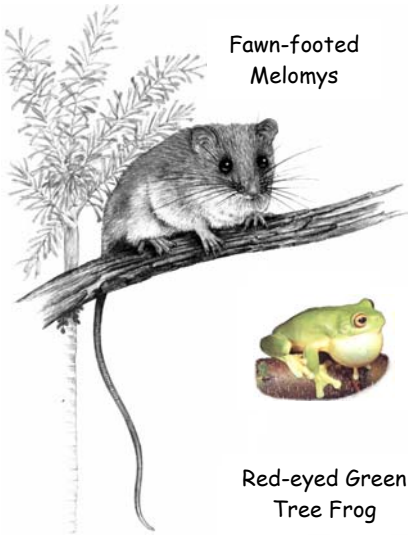
Exercise 7: Teachers Notes

- The Rainforest sheet is designed to stimulate interest and provide information to help students construct a rainforest foodweb. It could be used as a homework exercise.
- **There is no correct answer but in attempting to construct a foodweb for just a few rainforest organisms students will begin to appreciate the enormous complexity of ecosystems.**
- Incorporate the Lyrebird foodweb into the rainforest foodweb.
- Stimulus sheets for other habitats on the Central Coast are included in the appendix.
- Encourage students to make observations and research the animals in their local area in order to construct a **local area foodweb.**
  Flora and fauna lists can be found on the NSW National Parks and Wildlife Service website.
  http://www.npws.nsw.gov.au/

Some Animals Found in Central Coast Rainforests

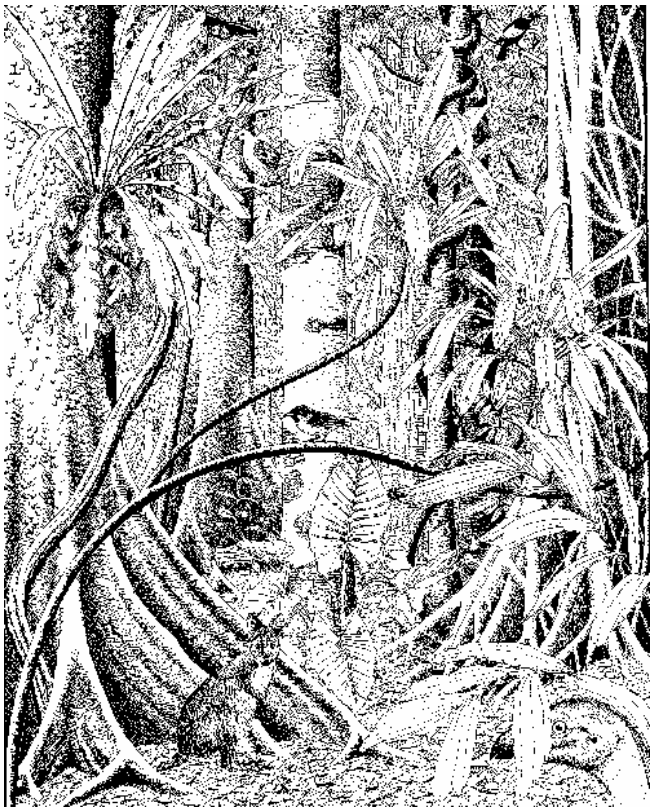
Sooty Owl

Animal	Food
Pademelon	Fungi, grass and herbs
Fawn-footed Melomys	Leaves, shoots and fruits of trees
Sooty Owl	Rats and mice
Grey Goshawk	Pigeons, parrots
White Headed Pigeon	Seeds and fruit
King Parrot	Seeds and fruit
Wonga pigeon	Seeds and fruit on the ground
Brush Turkey	Seeds, fruit, worms, grubs.
Yellow-tail Black Cockatoo	Grubs and beetles in trees
Black-faced Monarch	Arboreal Insects
Red-browed Finch	Seeds
Pacific Baza (Crested Hawk)	lizards, nestlings, large insect
Yellow-throated scrubwren	Worms and Insects on the ground
Angle-headed Dragon	Insects
Land Mullet	Invertebrates and fruits
Diamond python	Small mammals and large lizards
Red-eyed tree frog	Arboreal Insects
Stuttering frog	Insects, worms on ground



Fawn-footed Melomys

Red-eyed Green Tree Frog



Brush Turkey

Land Mullet

Teachers Notes

Exercise 8 – Habitat Loss

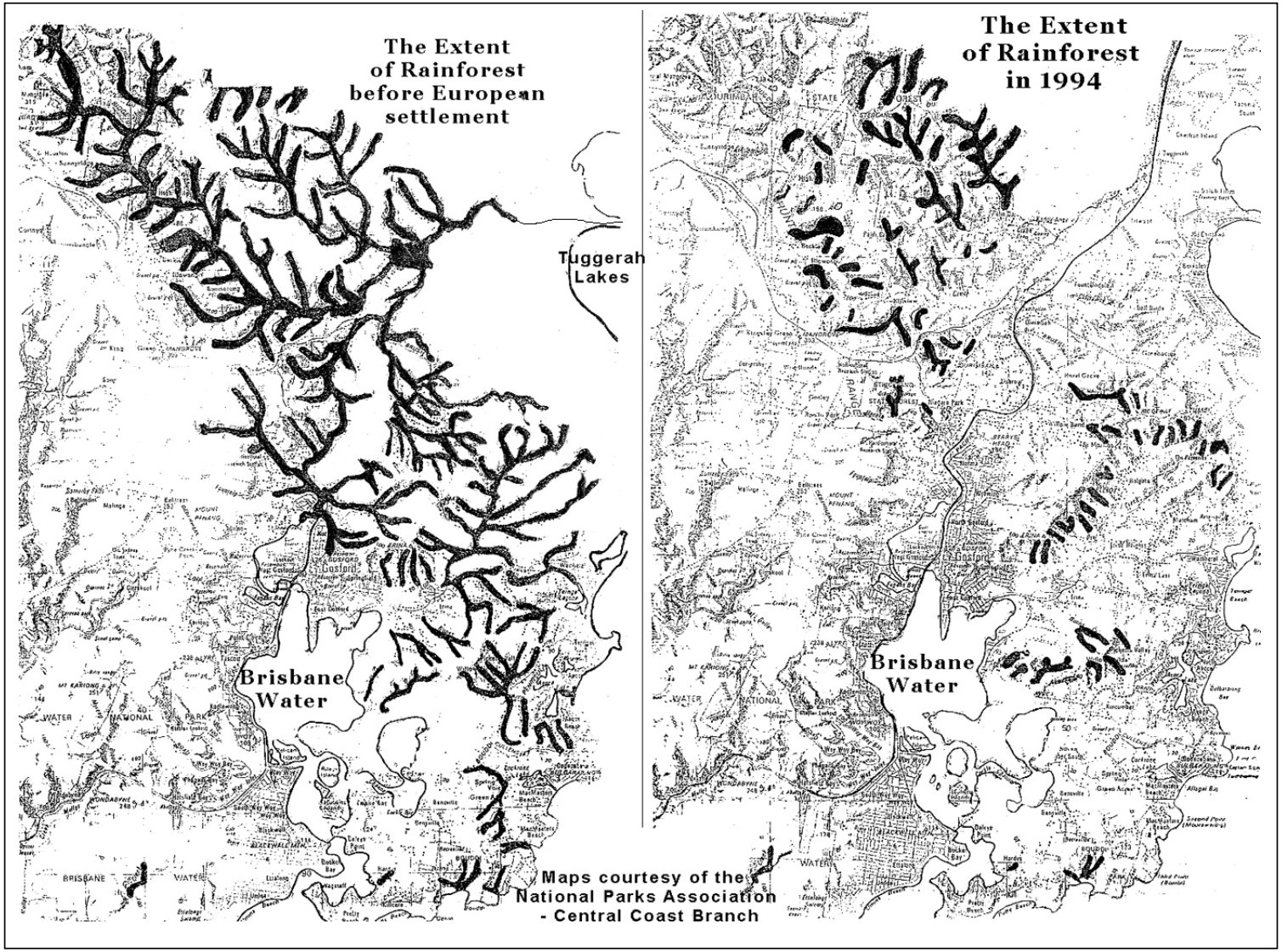
Use the Rainforest maps to focus on the impact of habitat loss and fragmentation.

1. **Examine the Rainforest maps and then describe the distribution of rainforests.**
   (the Rainforests tend to be situated in gullies).
2. **Consider reasons for loss of so much rainforest habitat**.
   (Timber getting. Agriculture. Housing. Increased fire frequency. Weeds.
3. **Suggest why some areas survived.** (within forestry reserves, rugged terrain)
4. **How does fragmentation of the rainforest makes it more vulnerable?**
   - fragments are subject to more boundary effects eg clearing of surrounding areas allows more wind and light to penetrate. Weeds and ferals also have greater access.
   - fragments may not support viable populations of animals that require larger territories.
   - fragments are islands that can't be recolonised by frogs, reptiles, mammals.
   - dams, clearing and agriculture above a fragment changes the water quality and hydrology.

5. **Why are the Rainforests of the Central Coast worth conserving?**
   - Rainforests are relatively rich source of biodiversity. Some rainforest species are already listed as vulnerable (see next page). The Central Coast Rainforests are the southern limits of distribution for many species (eg Southern Angle-headed Dragon) ie any loss will result in a reduced range. Species at the limit of distribution are more likely to be genetically different and so the loss of these populations would result in reduced genetic diversity.
   - Ethically – other species have a right to exist.
   - Rainforests are useful – they rapidly consume nutrients and reduce erosion thereby playing a valuable role in maintaining water quality in the catchment. They have been found to be a source of useful products - timber, drugs, foods etc. Inter–generational equity. Does this generation have the right to deprive the next generation of future utility?
   - Rainforests are aesthetically pleasing and have a recreational value and as a community we would be worse off without these beautiful places to visit.
   - They have scientific and educational value. The uncertainty principle applies - we don't know enough about rainforests to be sure that future generations can live as well without them.

6. **What can we do to Conserve Central Coast Rainforests?.**
   - Ensure that all remaining rainforests are adequately protected eg in National Parks, Council Reserves or by conservation zonings if they are on private land. Write letters of support for the protection of these areas
   - Maintain existing Rainforest areas. Erosion control, keep the weeds out and protect from fire.
   - Create rainforest corridors to link the fragments.
   - Educate people about the value of rainforest.

A digital vegetation map showing 55 different plant communities on the Central coast and Lower Hunter can be accessed at Gosford Library and at Rumbalara Environmental Education Centre. This GIS map includes data on climate, landscape and history and lists the plant species for each community.


The Extent of Rainforest before European settlement
Tuggerah Lakes
Brisbane Water
The Extent of Rainforest in 1994
Brisbane Water
Maps courtesy of the National Parks Association - Central Coast Branch

NPWS Conservation areas in the Brisbane Water Catchment

Written approval needs to be obtained before taking school groups into National Parks.

Bouddi National Park beautiful small beaches beneath coastal heaths, forests, steep hills and cliffs. There are interesting Aboriginal engravings and a ship wreck that gave its name to Maitland Bay. This park also includes a unique marine extension, where there is fabulous snorkelling. With its perched sand dunes and Hawkesbury and Narabeen sandstones influencing the vegetation there are many opportunities for field work. Toilet facilities at Putty, Little and Tallows Beaches. Home of the threatened Red-crowned Toadlet. The old Maitland Bay Store now operates as the Visitors Centre.

Brisbane Water National Park superb water views over the Hawkesbury on the Patonga side. Sandstone landscapes rich in Aboriginal art and engravings and excellent rainforest walks and picnic facilities. Some of the best wildflower displays in Australia occur on its perched wetlands and sandstone heaths. Girrakool has picnic facilities and excellent walks down into the gorge of Piles Ck.

Cockle Bay Nature Reserve located near Empire Bay is an important salt marsh community of which much has been degraded elsewhere. Good examples of successional stages. Access from the tennis courts at Empire Bay. (get approval from NPWS before visiting)

Wamberal Lagoon Nature Reserve this Reserve protects some of the last remnants of littoral rainforest. A closed heath surrounds the lagoon which provides good bird spotting. There are walking tracks to protect the fragile dunes, please use them. (get approval from NPWS before visiting)

Gosford City Council

Rumbalara Reserve. A prominent ridge that forms the eastern boundary of the Narara Valley Catchment. Provides easy access to a wide variety of communities. From Rumbalara EEC there are walking trails and great views of the Brisbane Water Catchment. Wet and Dry sclerophyll forest.

Katandra Reserve (off Wattle Tree Rd Holgate) –A delightful rainforest with many interesting features. There are easy walking trails and toilet facilities - probably the best place to study rainforest in the Catchment. From the rainforest a circuit leads up through changing vegetation types to St Johns lookout (with its excellent views over the coastal belt) and back down the ridge to the car park.

Kincumba Mountain Reserve contains a variety of habitats. Picnic facilities available at the top, good views and great opportunities for field work. (check bus access)

Carawah Reserve Off the highway at West Gosford a boardwalk provides access to mangrove and saltmarsh areas. Interpretive signs. Good for a short class visit or student research projects.

State Forests of NSW

Strickland State Forest is no longer used for logging and is maintained by State Forests for recreation and Education. At the headwaters of Narara Ck - a good place to include on a catchment study. Contains Aboriginal heritage sites. Open forest and heath on the ridges giving way to closed forest and rainforest in the gullies. Very old plantings of rainforest species in the arboretum.

Contact Rumbalara Environmental Education Centre for more information on field work.

Australia really is Mega

.... when it comes to Biodiversity

Australia is regarded as one of 12 "Mega" diverse regions in the world. Basically this means we are lucky in having a huge number of different animal and plant species. What makes this even more important is the fact most of our animals and plants are endemic. In fact 90% of our mammals; 70% of our birds; 85% of our flowering plants; 88% of the reptiles and 92% of our frogs are found nowhere else.

However Australia also has the not so envious reputation for having the greatest **losses** of biodiversity. Since European colonisation of Australia in 1788, 125 plant and animal species have become extinct (83 plants and 42 vertebrate animals). Since 7% of our mammals are gone this gives us the worst mammal extinction rate of all the continents (50% of all the known mammal extinctions to occur in the last 200 years).

What also needs to be considered is the fact that this does not include lower plants (mosses, algae etc) nor invertebrate animals such as insects and other groups which are even less well known. Estimates are that for every extinct plant there is likely to be 15 species of dependent invertebrates which have also gone extinct without us even noticing.

Today we have 111 species of vertebrates and over 800 species of higher plants which are considered endangered, vulnerable or threatened.

On the Central Coast species falling into these categories are as follows:

Mammals

* Southern Brown Bandicoot *Isoodon obesulus*
Tiger Quoll *Dasyurus maculatus*
Brush Tailed Phascogale *Phascogale tapoatafa*
Parma Wallaby *Macropus parma*
Brush Tailed Rock Wallaby *Petrogale penicillata*
Red Legged Pademelon *Thylogale stigmatica*
Yellow Bellied Glider *Petaurus australis*
Squirrel Glider *Petaurus norfolcensis*
Koala *Phascolarctos cinereus*
Long Nosed Potoroo *Potorous tridactylus*
Eastern Chestnut Mouse *Pseudomys gracilicaudatus*
Yellow Bellied Sheath Tailed Bat *Saccolaimus flaviventris*
Eastern Little Mastiff Bat *Mormopterus norfolkensis*
Large Pied Bat *Chalinolobus dwyeri*
Little Bent Wing Bat *Miniopterus australis*
Large Bent Wing Bat *Miniopterus schreibersii*
Large Footed Mouse Eared Bat *Myotis adversus*
Golden Tip Bat *Kervoula papuensis*
Greater Broad nosed bat *Scoteanax rueppellii*
Plus all Marine Mammals (dolphins, whales & seals etc)

Frogs

* Green and Golden Bell Frog *Litoria aurea*
Green Thighed Frog *Litoria brevipalmata*
Barred River Frog *Mixophyes iteratus*
Barred River Frog *Mixophyes balbus*
Red Crowned Toadlet *Pseudophryne australis*
Giant Burrowing Frog *Heleioporus australiacus*

Lizards

Sydney Sand Goanna *Varanus rosenbergi kuringai*

Snakes

* Broad Headed Snake *Hoplocephalus bungaroides*
Stephens Banded Snake *Hoplocephalus stephensii*
Pale Headed Snake *Hoplocephalus bitorquatus*

Turtles

Leather Back Turtle *Dermochelys coriacea*
Green Turtle *Chelonia mydas*
Loggerhead Turtle *Caretta caretta*

Birds

* Bush Thick Knee *Burhinus magnirostris*
* Little Tern *Sterna albifrons*
* Regent Honeyeater *Xanthomyza phrygia*
Superb Fruit Dove *Ptilinopus superbus*
Glossy Black Cockatoo *Calyptorhynchus lathami*
Swift Parrot *Lathamus discolor*
Turquoise Parrot *Neophema pulchella*
Eastern Grass Owl *Tyto longimembrus*
Sooty Owl *Tyto tenebricosa*
Painted Honey Eater *Grantiella picta*
Ninox strenua *Powerful Owl*
Masked Owl *Tyto novaehollandiae*
Wandering Albatross *Diomeda exulans*
Goulds Petrel *Pterodroma leucoptera*
Kermadec Petrel *Pterodroma neglecta*
Providence Petrel *Pterodroma solandri*
Little Shearwater *Puffinus assimilus*
Fleshy Footed Shearwater *Puffinus carneipes*
Australasian Bittern *Botaurus poiciloptilus*
Black Bittern *Dupetor flavicollis*
Black Necked Stork *Xenorhynchus asiaticus*
Osprey *Pandion haliaetus*
Comb Crested Jacana *Irediparra gallinacea*
Sanderling *Calidris alba*
Great Knot *Calidris tenuirostris*
Mongolian Plover *Chardrius mongolus*
Sooty Oyster Catcher *Haematopus fulginosus*
Pied Oyster Catcher *Haematopus longirostris*
Broad-billed Sandpiper *Limicola falcinellus*
Sooty Tern *Sterna fuscata*
Terek Sandpiper *Tringa terek*

Plants

• Gosford Wattle *Acacia prominens*
• Black Eyed Susan *Tetratheca juncea*
• Magenta Lilly Pilly *Syzigium paniculatum*
• A Paperbark-*Melaleuca biconvexa*

There are many more plants . A complete list can be obtained from NPWS or Rumbalara EEC

* means Threatened , without indicates Vulnerable and Rare

Suggested Answers: Exercise 9

Date	**# Caught** (sample)	# Recaptures (sample)	Total # marked in the population	**Population Estimates**
5 Nov. 98	**24**	**0**	**0**	
6 Nov. 98	**15**	**5**	**24**	**72**
17 Dec. 98	**49**	**7**	**34**	**238**
18 Dec. 98	**33**	**11**	**76**	**228**

2) Estimates vary because the method is based on probability. The bigger the sample the more reliable the estimate. A best estimate would be to average the estimates made from data collected on consecutive days. eg for the above study 233 is the best estimate at that time in December. Sampling on consecutive days minimises the effect of changes in the population due to deaths, emigration, births and immigration.

3) Error can result from: Non random mixing of released animals in the population prior to subsequent sampling, deaths of marked animals, behaviour modification of marked animals making them more or less likely to be recaptured.

4) 98 frogs marked after the 18/12/98

Teachers Note

The Plague Minnow or Mosquito Fish *Gambusia holbrooki* has recently been listed as a Key Threatening Process under the Threatened Species Conservation Act 1995. Key threatening processes are those that adversely affects two or more threatened species, populations or ecological communities. The listing of a key threatening process assists in conservation by:

- Influencing the planning process; and
- Requiring the preparation of a threat abatement plan.

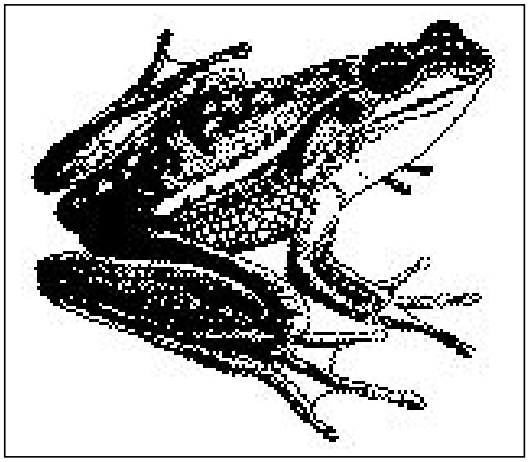
Threatening processes which are currently listed under the TSC Act include the removal of bushrock, high frequency fire, invasion of bitou bush; and predation by the European red fox, feral cats, mosquito fish, ship rats on Lord Howe Island and the impacts of climate change.

The listing of *Gambusia* presents students with some interesting **research projects**:

- What is the distribution and abundance of gambusia in the local area?;
- Population growth studies;
- Factors effecting population size. etc

Exercise 9. A Threatened Species Activity

How Many Green and Golden Bell Frogs are left?



The Green and Golden Bell Frog was once abundant on the Central Coast, however like many other frog species it is disappearing from some areas and existing populations are in rapid decline. The exact causes are unknown however the introduced plague minnow (G*ambusia holbrooki*) feeds on frog's eggs and tadpoles and consequently has recently been listed as a Key Threatening Process. An introduced fungal disease is also being investigated. Other threats include: - alteration of drainage patterns and stormwater runoff, changes to water quality, the infilling and destruction of wetlands, herbicides and other weed control measures and predation by feral cats and foxes.

Microchips (smaller than a grain of rice) placed under the skin of the frogs enable them to be recognised when scanned. Frogs caught on each of the monthly surveys are scanned and the weight, length and sex recorded. New frogs are given a microchip and then all frogs are released unharmed exactly where they were found.

Data from the mark - release - recapture survey of the endangered Green and Golden Bell Frog *(Litoria aurea)* population at North Avoca.

Date	**Number Caught** (sample)	Number of Recaptures (sample)	Total number marked in the population	**Population Estimates**
5 Nov. 98	24	0	0	
6 Nov. 98	15	5	24	
17 Dec. 98	49	7	34	
18 Dec. 98	33	11	76	

1Use the following formula to estimate the population on the 6/11/98, 17 and 18/12/98
2) Explain why the estimates are different and how you would arrive at a best estimate
3) Explain possible sources of error in these estimates.
4) How many marked frogs are there in the population after the 18/12/98?

$$\text{Total Population} = \frac{\text{Total marked in population} \times \text{Number caught in sample}}{\text{Number of recaptures in sample}}$$

Teachers Note

The development of a conservation plan provides opportunities for **student research projects** (see also page 118) and is best done as a group activity.
Biodiversity monitoring is another interesting activity and one in which students can contribute to the data base needed for the planning of conservation strategies. It also teaches the important skills of observation, recording, research and analysis.
Birds are a good subject for a student research project. There are regular bird surveys that encourage student input. (Check the Australian Museum Website and others listed below).
Begin by recording the species in the school grounds. Include date, time, number and any comments eg *feeding on Eucalypt blossoms.* All students should have an opportunity to use Field guides and binoculars.
Recording on a wall chart is a constant reminder to maintain the records. A computer data base is better.
Long term records enable analysis of trends and seasonal changes. They identify birds as regular, seasonal or unpredictable visitors.
Extension activities could include surveys of introduced species, research on threatened species, the association of birds with vegetation types, weather etc

References:
'The Slater Field Guide to birds of Australia'
The Australian Museum online http://www.austmus.gov.au/
The Australian Birdcount http://www.abc.net.au/birds/
Timelines http://www.gould.edu.au/timeline.htm

Conservation Areas

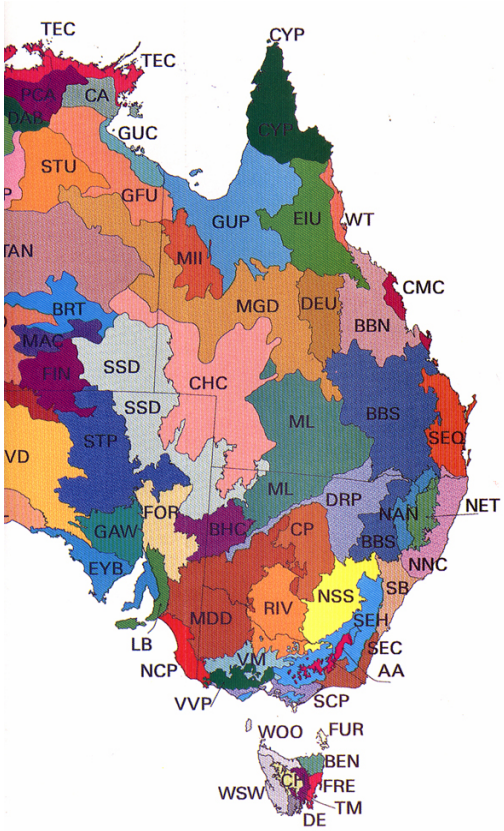
Brisbane Water Catchment is part of the Sydney Basin Bioregion (SB on the map) Each bioregion is defined by its characteristic climate, geology, landform, vegetation, flora and fauna, and land use.

Bioregion maps can be used to plan for biodiversity management. The first step is to ensure that there are adequate conservation areas in each bioregion. This recognises the importance of habitat protection as a conservation strategy.

At this coarse continental level the Sydney Basin is considered to be well represented (more than 10% of the land area is within reserves). Some bioregions such as the south western slopes of NSW (NSS on the map) which provide agricultural opportunities are inadequately represented in conservation areas.

Of course the heterogeneity of the bioregion is an important consideration. To be effective the conservation areas must include all the habit types within the bioregion. On the Central Coast more detailed maps are being developed to assist in biodiversity management within the bioregion.

Map courtesy of 'An interim Biogeographic Regionalisation for Australia' ANCA 1995



Exercise 10: Conserving Biodiversity in My Local Area

To conserve biodiversity you need to conserve, improve or create appropriate habitat. Start by mapping all the remnant vegetation in your locality, then assess its condition and then plan ways to maintain or improve things.

An aerial view is a good way to locate remnant vegetation. Aerial photographs provide an overall picture but you still need to see what is present on the ground. Comparing recent photographs with older ones provides valuable historical evidence about how native vegetation cover has changed over the years.

Mapping

1. Take a clear plastic sheet and lay it over the top of your aerial photo.
2. Trace features that help identify locations (roads, buildings, creeks, etc).
3. Trace areas of native vegetation. (include creek and roadside remnants, even vacant cemeteries. Your local knowledge will help to identify potential habitats that don't show up on the map because they lack tree cover.
4. Visit the sites to check the accuracy of the mapping.
5. Number (code) the marked areas.

Assessing

Visit and report on the condition of each of the sites. Consider the following:

- Small remnants and those with long boundaries are more exposed to impact (weeds, ferals, tracks, fire etc) and so are harder to maintain.
- Describe the community (eg wetland, woodland, heath). If possible name the dominant trees (eg Broad leaved Paperbark, Blackbutt etc)
- Describe the extent of weed invasion on a scale from 0 to 5
- Note impacts such as erosion, litter, frequent fires tracks etc
- Look for opportunities to connect remnants by creating wildlife corridors.

You could use a table with headings like these to record the information about each site.

Code no.	Size/shape	Dominant Native plants	Weeds	Human Impact (erosion, walking tracks fire, mowed, feral etc)	Connections (to other vegetation)

Planning

1. Rank the conservation value of each area (eg High if it's the last remnant of a particular plant community or contains a threatened species. Low if it's small, weed infested, isolated and has no threatened species)
2. Make a prioritised list of actions.
3. Present your plan for review (a bush regenerator or council bushcare officer)

Action

Try to achieve at least one of the actions proposed in your plan.

Where to get help

- The local community. Check the list of contacts on the Rumbalara EEC website.
- Some old photos provide a glimpse of the original vegetation. Search for these in the local history section of the Council library.
- Local Bushcare groups.
- Read about local biodiversity in Council's 'State of the Environment' report. The council may be interested in your project and assist with your vegetation map.
- A field guide to common weeds is provided as a companion to this manual.

Science outcome 5.10 (b)

Students will … describe the importance of cycles of materials in ecosystems.

Suggested Answers to exercise 11: cloze activity in order:
solar, land, ice, clouds, catchment, evaporate, transpiration, infiltrate, groundwater, seep, runoff.

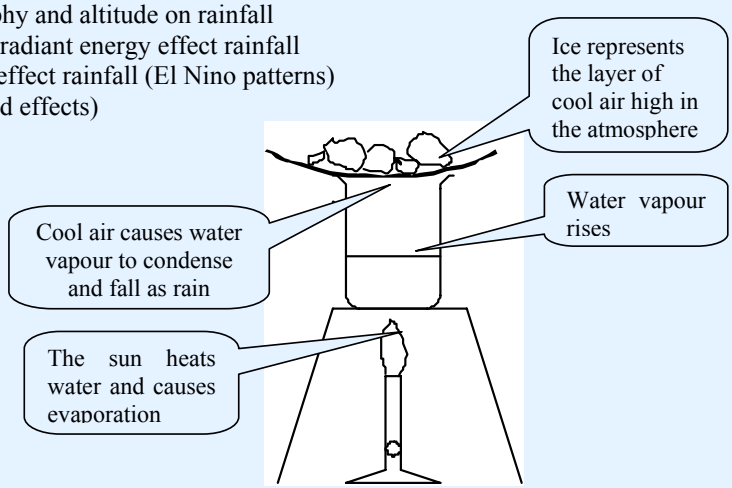
Teacher's Notes – the water cycle should be revised before starting this section

Water Cycle Diagrams to suit different abilities (complete, labels removed and jigsaw) included in the appendix.

Modelling The Water Cycle

Use as a hands on activity or demonstration when revising the water cycle. Consider modifications to the model to represent factors that influence weather patterns eg :

- ☼ The influence of topography and altitude on rainfall
- ☼ How seasonal changes in radiant energy effect rainfall
- ☼ How ocean temperatures effect rainfall (El Nino patterns)
- ☼ Global warming (predicted effects)



The Bureau of Meteorology provides climate averages for the region. They can be accessed via their website www.bom.gov.au/climate/averages Locations that apply to this region are: 061087 Narara, 061273 Norah Head, 061083 Wyong, 061351 Peats Ridge, 061375 Mangrove Mtn.

The **Gosford Council State of Environment Report** contains data on rainfall throughout the region as well as information on water use and quality. Copies of these annual reports are sent to all schools in the Gosford area and can also be accessed on the internet www.gosford.nsw.gov.au

Teacher's Note – Exercise 12: Monitoring the weather

Requires access to an installed minimum and maximum thermometer, rain gauge and hydrometer. A roster could be organised to allow each student to take responsibility for one days readings. Measurements should taken at the same time each day.

Exercise 11: CLOZE Activity – The Water Cycle

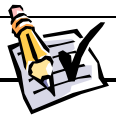
Complete the sentences below using the following words:
SOLAR, GROUNDWATER, ICE, EVAPORATE, SEEP, RUNOFF, CLOUDS, LAND, TRANSPIRATION, CATCHMENT, INFILTRATE

The water cycle is powered by _____energy and gravity. Without a system to cycle water there would be no life on _____. Within the cycle water has many forms, it is found as _____, vapour, _____ , rain, running rivers, lakes, groundwater and as a part of all living things.

After rain has fallen into a _____ there are three main pathways that it might follow:

1. some will _____ and return to the atmosphere either from land and water surfaces or from vegetation (called _____).
2. some will _____ the soil and will be temporarily stored in the soil and rock as _____ which may eventually _____ through into a lower part of the catchment
3. some will _____ into the watercourses of the catchment.

Exercise 12: Monitoring the Weather



Aim: To measure and monitor the weather in the catchment and compare with long term averages.

Procedure: Measure the maximum and minimum temperatures, humidity and rainfall each day (preferably at the same time).

Results: (*extend table as required*)

Date	Time	Temperature (°C)		Humidity (%)	Rainfall (mm)
		Min.	Max.		

Discussion: Plot the changes and compare with long-term averages.

Suggested Answers: Exercise 13 – Features of the Water Cycle in Australia

1. The value we place on water probably depends on where in Australia we live, how much we use, the cost, memories of water shortages and our understanding of the environmental cost of regulating rivers. The economic value of water is increasing rapidly as farmers profit from thirsty crops such as cotton and rice.
2. All areas except 1, 3, 9 and 8
3. The Timor Sea Division gets all its water during the summer monsoon and then suffers a prolonged dry season. The S.E. Division doesn't have a pronounced dry season.
4. In the table the runoff (cubic metres) is divided by the catchment area (square metres) Runoff could be measured as the volume of water flowing into the sea from the rivers. Students could suggest various ways of measuring the volume.
5. Like most of Australia, Brisbane Water suffers drought and flood. The rainfall is not reliable.
6. Seasonal averages, frequency of floods and droughts, availability of groundwater, water quality especially as it relates to salinity.

Teacher's Notes – Suggested Runoff and Infiltration Experiments

1. Design and then conduct an experiment to measure evaporation under different soil treatments.
   - investigate ways to measure evaporation rates and to compare various treatments
      a. eg mulched v's non mulched soils
      b. drip watering v's spray etc

2. Investigate evapo-transpiration eg compare water loss from pots of soil with and without plants. (Measure evaporation as weight loss from the pots). Relate to salinity problems. Research reasons for land degradation due to increasing salinity

3. Compare soil loss (erosion) from planted and unplanted trays of soil.

4. Compare infiltration rates in different soil types.

The availability of water depends on both **Rainfall** and **Evaporation**.
Together they provide a measure of availability - we call it **runoff .**

Runoff around the world

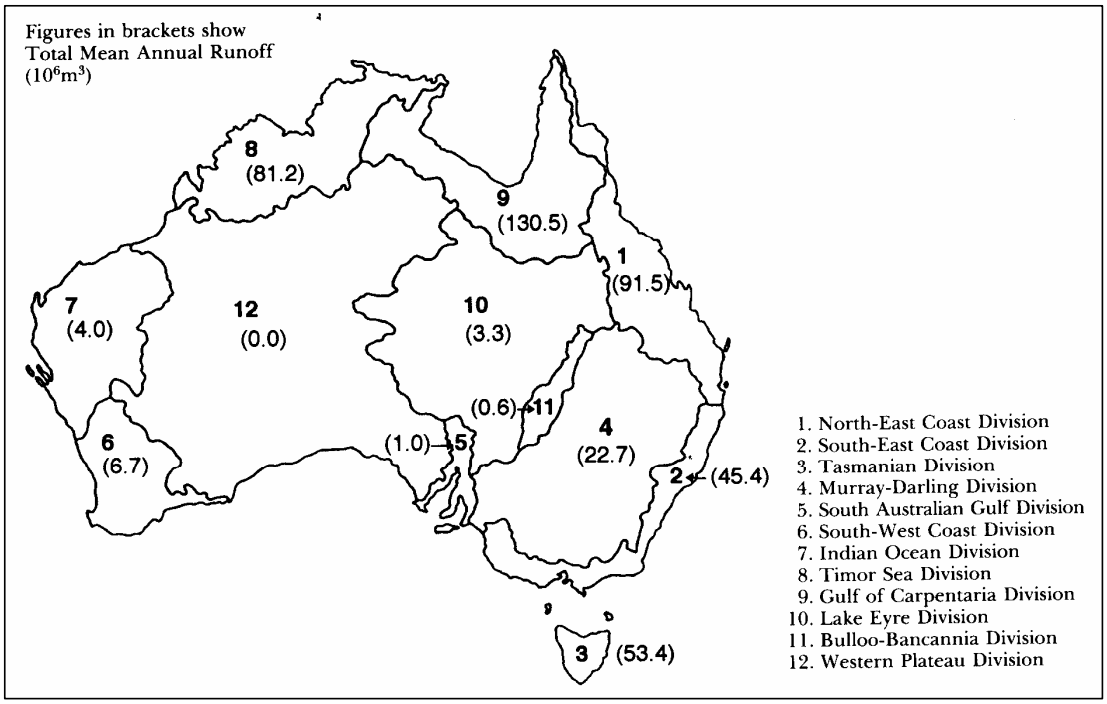
Region	Europe	Asia	Africa	North & Central America	South America	**Australia**	Oceania	Antarctica
***Runoff** (mm)	306	332	151	339	661	**45**	1610	160

*The total annual stream flow of all catchments divided by their area. This is the water that has not evaporated or transpired back into the atmosphere.

1. From the comparisons above you would expect Australians to value water very highly. Do they?

Runoff around Australia

2. In the figure below, colour the regions that have less runoff than yours**.**



3. Suggest why the Timor Sea Division is relatively arid and yet it has nearly double the **runoff** of the heavily timbered South East Division

4. Explain why the units of runoff are in mm in the top table and in millions of cubic metres in the map. How might the scientists have measured runoff?

5. In Dorothea Mackella's famous poem "A sunburnt country" Australia is described as a land of 'droughts and flooding rains'. Australia is also described as the 'driest continent on earth'. Are these descriptions relevant to the Brisbane Water Catchment? Discuss

6. What additional information could scientists provide so that we have a better understanding of water availability in Australia?

Suggested Answers – Exercise 14:

1. 1321.7

2. a) Students should discuss what wettest means. Is it the month with highest average rainfall (March) or the month with the most raindays (also March) or the month with the record for the most rain in a month (June)?
   b) The information could be useful to event organisers, farmers, tourism and hospitality industry

3. July or August both have low mean rainfall and low mean number of days without rain. The February record is unexpected based on the records for January and March.

4. 218.4 mm. April is not the wettest month.

5. Drought is based on historical records as follows:

   Well below average - rainfalls in the lowest 10% of historical totals
   Below average - rainfalls in the lowest 30% of historical totals, but not in the lowest 10%
   Serious deficiency - rainfalls in the lowest 10% of historical totals, but not in the lowest 5%
   Severe deficiency - rainfalls in the lowest 5% of historical totals

6. Ensure students place the months along thex axis (independent variable) and label correctly.

7. The hottest month is January. With higher temperatures evaporation increases and the availability of water is reduced.

8. There doesn't appear to be any significant seasonal variation in humidity.

9. No. The average minimum temperatures doesn't tell us about variation or the range.

10. Encourage students to visit the website as there is a wealth of relevant information on climate and its influence on the environment. The rainfall data from the three sites (see below) shows that: - Byron Bay has more rainfall and greater seasonal variation than Bega and Bourke. Bourke has the lowest rainfall. Temperature and humidity data are probably significant influences on vegetation. Keen students could obtain data for these factors from the Bureau of Meteorology website, plot them and see if they correlate to vegetation.

Monthly Rainfall (mm)

Region	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Bega	82	89.7	97.1	73.8	76.7	82.8	52.9	51.8	53.1	70.7	68.0	79.9
Byron	169	194	218	182	191	161	102	95	67	106	116	148
Bourke	41.9	42.2	34.8	27.5	30.4	27.3	23.4	20.0	19.9	26.3	29.1	32.2

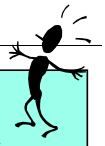
Table 1: Rainfall and Temperature Averages from the Narara Agricultural Research Station, (situated in Brisbane Water Catchment). This data is based on 110 years of records. Updates and additional data available from Bureau of Meteorology **www.bom.gov.au**

Month	Mean rainfall (mm)	Mean No. of Rain days	Highest monthly rainfall (mm)	Lowest monthly rainfall (mm)	Highest daily rainfall (mm)	Mean Max. Temp. (C)	Mean Min Temp. (C)	Mean 3pm Humidity (%)
Jan	139.3	11.0	517.5	4.3	210.8	27.1	16.5	62
Feb	148.2	10.8	597.7	0.0	191.8	26.9	17.1	61
Mar	153.0	11.2	500.3	6.0	205.5	26.0	15.3	63
Apr	137.4	10.6	661.9	4.6	218.4	23.8	11.7	60
May	115.1	9.1	634.0	6.1	177.3	20.2	8.0	66
Jun	128.7	9.6	664.0	1.9	170.7	17.5	6.3	71
Jul	78.5	7.8	455.6	0.0	194.8	17.3	4.0	60
Aug	73.0	8.0	426.2	0.0	119.2	18.7	5.1	55
Sep	68.5	8.2	232.1	2.0	106.9	20.6	7.2	61
Oct	84.0	8.9	344.1	1.0	129.3	23.4	10.6	59
Nov	93.0	9.5	361.5	4.1	155.2	25.1	12.6	58
Dec	103.0	10.0	417.0	6.0	155.0	26.9	15.0	61

Examine the data presented in Table 1 above and then answer the following questions:

1. What is the mean yearly rainfall in Narara based on 110 years of records?
2. a) Which month is wettest?

   b) For what purposes would this be useful information?
3. a) Records show that in the past only three months have ever experienced a total lack of rain. Which month would you choose to hold an outdoor concert? Explain.
4. What was the highest recorded rainfall for one day? Did it occur in the wettest month?
5. What is drought? Is there any evidence of drought in the data?
6. Plot the mean monthly rainfall for Narara using a line graph.
7. What is the hottest month? How does temperature influence the availability of water?
8. Does the humidity data show any seasonal variation?
9. From the data would you be able to say that frosts don't occur at Narara?
10. Vegetation can be used as an indicator of climate. From the Bureau of Meteorology Website www.bom.gov.au obtain mean monthly rainfall figures for Bega, Byron Bay and Bourke. Plot them on the same graph as Narara (Q6 above) and compare. These sites represent Temperate, Sub-tropical and Grassland respectively. What are the main differences in the rainfall data between these sites? What factors other than rainfall would help to explain differences in the vegetation?



Science Outcome 5.11

5.11 A student analyses the impact of human resource use on the biosphere to evaluate methods of conserving, protecting and maintaining earths resources

Suggested Answers - Exercise 15

1. A closed Catchment is one in which humans are excluded. This reduces the risk of contaminating the water supply.
2. Total Catchment Management Principles are the only way that water supplies with existing human activity can be protected. This means that all landholders need to be aware of their responsibility to the rest of the community. Catchment Management committees made up of representatives from the community meet to consider the best way to look after the whole of the catchment. Education is an important element in the TCM approach as is water quality monitoring. Regulation of pollution is the job of the EPA (Environment Protection Authority). New development proposals go to council who must take into account the impact on the catchment including the water supply. eg An abattoir would be unlikely to proceed without very stringent controls.

Exercise 16: Modelling the Somersby Water Treatment Plant Process

An outcome of this activity is for students to recognise that water treatment is an expensive and time consuming process. Far better to employ **Total Catchment Management** practices that reduce the need for treatment. (Prevention is better than cure).
There has been greater emphasis on TCM as a means of maintaining water quality since 1998 when residents of Sydney boiled their water because of contamination with the disease causing organisms Giardia and Cryptosporidium. The latter is not killed by conventional chlorine or ozone disinfection

Preparation: The water that arrives at the Somersby plant is not likely to be as dirty as that which students enjoy treating. Make up a bucketful of turbid water using clay and some tea for colour (tannin).
Use about 1mg Alum /litre and 0.5mg/litre sodium carbonate (more if the water is very cloudy)
Decanting is best done after overnight settling.
Filtering sand is available from Rumbalara EEC
The Somersby plant uses about 1.5mg/l of gaseous chlorine of which about 1l gets used up by the natural organic matter in the water leaving about 0.5mg/l. If pool chlorine is used calculate equivalent amounts.

Extension Activities

1. What factors need to be considered when planning for the water supply needs of the Central Coast in twenty or fifty years time. *(population size, water consumption per head of population, average rainfall and the chance of drought).*
2. Find out how much water your household consumes and how much you pay for it. The water rates notice provides this information. Conduct an audit to find out where it all goes - how much is being used in the kitchen, laundry, garden, bathroom etc The average water consumption per property in Gosford is about 270000 litres per year (740 litres/day. This figure includes residential, commercial and industrial properties). (guidelines next page)
3. Report on your attempt to reduce water use in the home. Describe your plan, how you implemented it and how successful it was. Make recommendations based on your experience.
4. Report on the feasibility of supplementing your water supply by collecting household rainwater. Calculate how much rainwater you can collect in a year. (Measure the area of your roof. One litre of water is collected for every millimetre of rain falling onto every one sq. metre of roof. Use the Narara rainfall data to estimate how much water can be collected in a month, year etc. List advantages and disadvantages costs etc
5. The provision of water impacts on other catchments. All of our impacts add up to our ecological footprint. List all the ways in which you impact on areas outside of this catchment. How big is your footprint? (Consider food, electricity, transport, building materials etc)

Exercise 15: Drinking Water and TCM

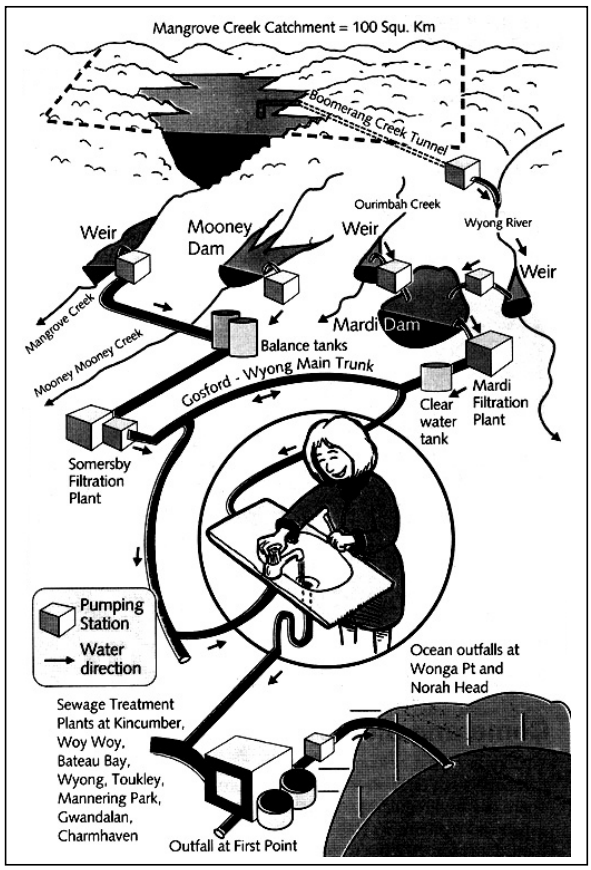
Clean water is fundamental to any civilisation. To ensure that we have a constant supply of drinking water, the flows of Mangrove and Mooney Mooney Creeks which drain into the Hawkesbury River, and Ourimbah and Wyong Creeks which drain into Tuggerah Lakes, have been regulated

Surface water can become contaminated with impurities that cause colour, odour and taste problems but by far the greatest threat are diseases such as cholera, typhoid and dysentry from sewage. Groundwaters are usually cleaner as they have been filtered by soil.

Total Catchment Management principles are employed in water supply catchments. This means that the community has a say in what happens.

1. Locate our water supply catchments on a map. Mangrove Ck. is a closed Catchment. What does this mean and why is it closed?

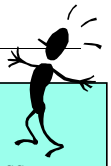
2. Wyong River Catchment has many existing land uses. Within the catchment there are towns, roads, poultry farms, turf farms, orchards, dairies, horses, cattle and timber mills. Many of the houses rely on septic systems. With all of these activities how can we ensure a clean and safe water supply?



Exercise 16: Modelling the Somersby Water Treatment Plant Process

You will be provided with a sample of water containing impurities. Your task is to bring the water quality up to drinking standard. i.e. remove objectionable odours, colours, toxins, suspended solids and sediments.

1. Measure the turbidity and pH and describe the colour of the sample.
2. Remove suspended solids using Alum. When dissolved in the water it will cause the suspended particles responsible for the cloudiness to come together (flocculate) and precipitate out. Be careful not to add too much alum as excess will remain in the water supply. Adjust the pH using sodium carbonate as the alum is ineffective in acid conditions. Stir to ensure mixing.
3. Allow the sediment to settle then decant.
4. Any colour and odours as well as toxins from Blue Green Algae can be removed used a small amount of activated charcoal stirred into the water. The charcoal adsorbs chemicals.
5. Remove the charcoal and any other particles using a sand filter. Place a filter paper in a filter funnel and fill with the filter sand (1mm grain size - not beach sand)
6. Disinfect the water using pool chlorine (sodium hypochlorite).
7. Check the turbidity, pH and colour of the treated water.



Science Outcomes 5.10

Students will learn about ecosystems to: - describe some impacts of human activities and to discuss strategies used to balance human activities and needs in ecosystems with conserving, protecting and maintaining the quality of the environment.

Suggested Answers – Exercise 17

1. Fish ladders are devices that allow fish to swim over the wall of a dam to complete their life cycles.
2. Environmental Flows are releases of water from reservoirs sufficient to sustain natural populations.
3. In order to reduce the risk of contamination, water supply catchments have restricted access and any development is highly regulated. They can be effective conservation areas.
4. A unique lake habitat was destroyed to provide cheap hydro-electricity in the to attract an aluminium industry that would provide jobs. The Aluminium industry didn't arrive.
5. An archaeological survey of the Aboriginal heritage sites was conducted prior to construction of Mangrove Ck Dam. In the Snowy Mountains whole towns were moved and in Egypt many but not all monuments were moved before the Aswan Dam flooded the area.
6. The Environment Australia Website has links to information on this issue.

Guidelines for conducting an Audit of water use

Record the water meter readings at the beginning of your survey period
Survey and monitor household water use
Toilet (Single flush = 11litres, dual flush = 6 or 9 litres)
Dishwashing by hand = 18 litres
Dishwasher = 35 litres
Clothes washer (toploading = 170litres, frontloading = 100litres)
Handwashing, teeth cleaning, drinking, cooking & house cleaning about 18 litres/person /day
Leaking taps : One drop / second = 20 litres / day
Calculate the shower and bath by timing how many seconds it takes to fill a 10 litre bucket. Divide 600 by the number of seconds to get the flow rate in litres / minute then multiply this number by the number of minutes the shower/bath was running to get the volume used.
Watering garden, washing car, topping up pool etc use method described above.
Calculate the amount of water used for different purposes and present results as a histogram.
Take meter reading at end of survey (Compare your surveyed consumption with the metered consumption to make sure there are no significant differences).

Exercise 17: Water Supply - Environmental Impacts

Australia stores more water per head of population than any other country. We know the benefits of having a reliable water supply for irrigation and domestic use but what are the costs?

- **Changing the flow of water from extremely variable to a constant trickle**.

Many animals have adapted to floods. For the Golden Perch a flood signals that it is time to breed. Frogs and aquatic insects take advantage of the pools and billabongs that remain long after floodwaters recede and water birds arrive to feast on this abundant food supply. Plants are nourished by the load of fertile sediment that a flood delivers to the floodplain. Without floods to flush the river pollutants become concentrated and toxic Blue Green Algae can develop. A reduced flow of water from Wyong and Ourimbah Creeks into Tuggerah lakes means less flushing and greater salinity.

- **Preventing the migrations of fish**.

Native fish like Australian Bass, Spotted Minnows and Long-finned Eels live in the freshwater streams but migrate to the sea or estuary to breed. Dam walls can break their lifecycles.

- **Habitat Destruction.**

A dam floods and destroys large areas of terrestrial and aquatic habitat. Many organisms that lived in the shallow, fast flowing streams are unable to survive in the deep, still waters of the dam.

4) **Stops the flow of food downstream**.

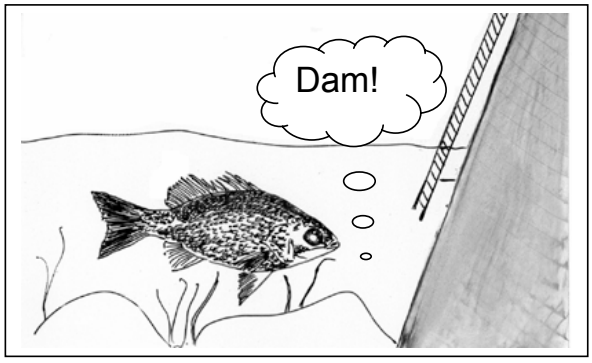
Water released from dams is lacking in logs, leaves, fruits, insects, etc that would naturally wash into a river from its catchment. These provide food and shelter for aquatic organisms.

- **Destruction of heritage sites.**

Aboriginal campsites, middens and engravings dating back to 11000 years are lost beneath the waters of Mangrove Ck Dam.

1. Increased Salinity.

The clearing of forest and the irrigation of crops has resulted in a raising of the salt water table that lies beneath much of Australia. Salt effected land is useless for agriculture and the salt water drains into the river systems where it impacts on aquatic life. Inland river systems are now many times saltier and they also carry a bigger load of sediment, fertilizers and pesticides from farm runoff



Questions

1. Find out about fish ladders then write a caption for this cartoon (a dam has stopped the migration of the Bass).
2. What is meant by the term 'Environmental Flow'?
3. Water supply reservoirs destroy habitat but they also provide conservation areas. Explain
4. The damming of Lake Pedder in Tasmania caused outrage and protest. Find out why?
5. Suggest actions to reduce the impact on heritage threatened by a dam proposal?
6. Research salinity. Report on the causes, problems and solutions

Sewerage and Stormwater

Teacher's Note

Suggestions for student research reports. The Gosford and Wyong State of Environment Reports are recommended references.

Suggested Answers: Exercise 18 – Sewerage and Stormwater

1.

SEWERAGE	STORMWATER
Soap	Chlorine in Swimming Pool
Shampoo	Detergent from washing car on road
Bleach	Oil from washing car on road
Toilet paper	Dog droppings
Toilet cleaner	Cigarette butts
Food scraps	Fertilizer
Cooking oil	Pesticide
Washing powder	Dirt from excavations
etc	etc

2. As per table.

3. Research and education. Find out where the litter comes from, drain stencilling can be conducted as a class activity in your local area. Contact Rumbalara EEC to get the equipment. Include a map of the stormwater system in the display.

4. The stormwater questions are designed to encourage students to act. A map could be used to trace the path of stormwater however a site inspection is preferable. Take Photo's of the outlets and gutters, dogs defaecating, people littering, animals effected by litter etc.

5. Use the survey and photographs as part of the display.

Teacher's Note

Excursions to the Water Supply and Sewerage Treatment Works can be organised through Gosford Council.

Sewerage contains disease causing bacteria from toilets, detergents from washing machines and food scraps and oils from the kitchen sink. Most of it goes to a sewerage treatment plant at Kincumber or Woy Woy. Here it gets handed over to bacteria that consume the nutrients until it can be pumped safely into the ocean at Winnie Bay (see map). **Sewerage treatment systems don't like oil, poisonous chemicals or plastics and other rubbish.**

Stormwater flows from the roof, roads, gardens and lawns. It flows to the nearest open waterway – usually without treatment.

1. Make a list of things that water carries with it to the sewerage treatment works and another list of things that water carries in stormwater.

2. Some stormwater drains are fitted with a mesh that traps larger bits of rubbish. (Most of the sediment, organic matter, cigarette butts and small papers etc escape) The amount and type of litter collected in a 6-month period is described in the table below. What was the main type of litter in your area? Assuming these traps are only stopping about 10% of the litter, calculate how much went through the trap. (Remember there are many more stormwater outlets without trap devices).

	Location of Litter Trap				
Quantity of Litter Removed	**Erina**	**Gosford**	**Woy Woy**	**Umina**	**Ettalong**
Total Weight (kg)	1090	695	2120	375	425
Type of Litter Removed (%)					
Domestic Plastics	35	35	20	20	5
Industrial Packaging	20	25	20	20	10
Metals	5	10	5	10	5
Plastic Bottles	20	15	20	5	5
Paper	5	5	10	5	5
Sediments	2	5	10	15	30
Organic Matter	13	5	15	25	40

3. Suggest ways to reduce the amount of litter in your area. Create an awareness raising display on the issue.

4. Trace the route of stormwater from your school to its outlet. Is it fitted with a litter-trapping device? What is the state of the waterway near the outlet? Take some photos.

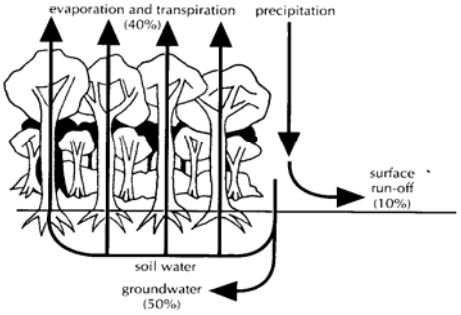
5. Conduct a survey. Do people know where the stormwater goes and what it contains? Do they pick up dog droppings? Do they hose their paths?

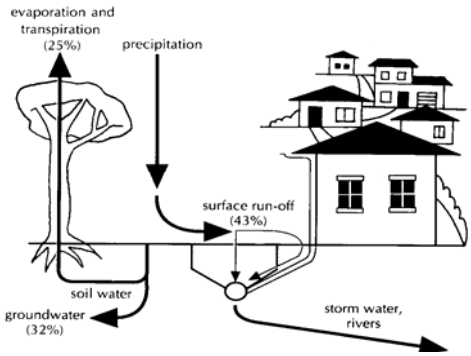
Suggested Answers

1. Increasing urbanisation is creating more impervious surfaces. This results in more runoff and less infiltration of the soil.
2. Vegetation acts as a filter removing sediment and absorbing nutrients.
3. Less infiltration
4. Baker St. runs above the old stream (see photo below)
5. Animal and Plant life of the streams is destroyed when replaced by concrete pipes and drains. Compensation for these losses can be made by ensuring that remaining streams are being properly cared for and by creating wetlands to manage stormwater. Greater recognition of Catchment Management procedures is resulting in more 'natural' constructed watercourses eg at Wyoming. (see photo below)
6. The outlet is high as the water at the top is cleaner. Detention Basins allow the sediments in stormwater to settle out. They also allow an aquatic ecosystem to develop that provides habitat for a variety of organisms and a means of consuming nutrients in the stormwater before it is released into the environment
7. Filter muddy water through the mesh, hay etc and compare. Measure sedimentation rates
8. Use the turbidity tube provided and conduct regular monitoring especially after rain

Baker St Gosford - where the stream shown in the old photo (opposite) now flows.

Better than concrete! A growing acceptance that Watercourses are habitats, and not just drains is shown in new work on Wingello Creek, Wyoming. Rock barriers mimic the pools that retain water during droughts. With some restoration of the original vegetation the wildlife of Wingello Ck may return.





1. Write an explanation to accompany the diagram above?

2. Design an experiment to test the idea that runoff through vegetation (grass etc) cleans the water.

3. Examine the photo of Gosford looking towards Rumbalara from where the Leagues Club is today.
   Where is the stream now?

4. There is more runoff into Brisbane Water now than when this photo was taken.
   Why?

5. What are the obvious human impacts on the stream when the photo was taken?

6. Explain why the outlet for this pond is above the water level and why holding stormwater in a dam helps the catchment?

New estates like this one at Bensville have included litter traps and sediment basins to hold

7. Design experiments to measure the effectiveness of different types of sediment control eg synthetic mesh, hay bales, dams.

8. Measure turbidity in the local stream at regular intervals.

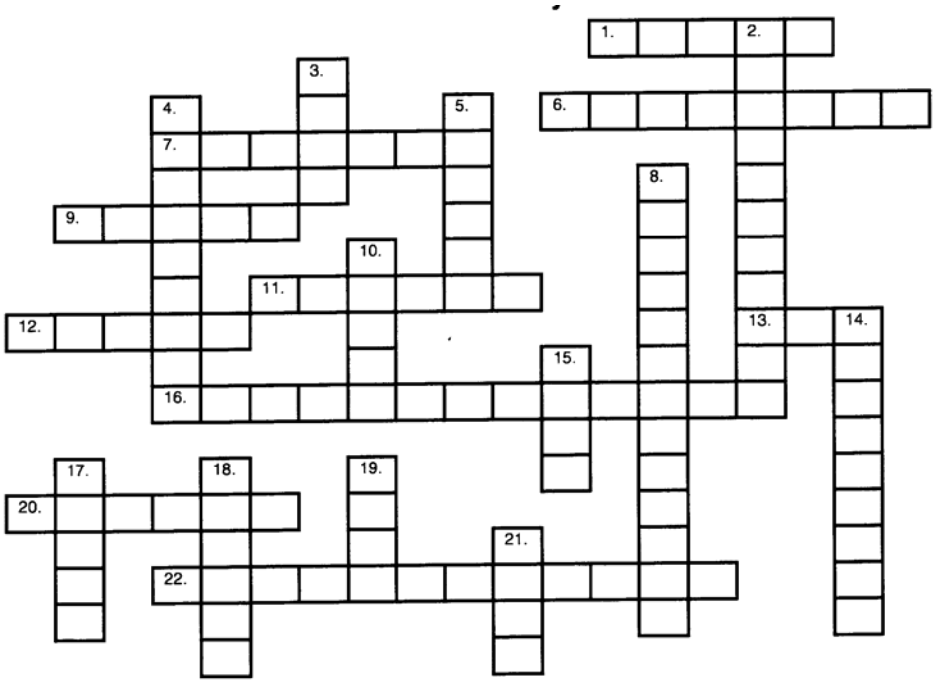
Answers – Exercise 20: Water Cycle Crossword

Across

1. water
6. wetlands
7. aquifer
9. cycle
11. clouds
12. river
13. ice
16. transpiration
20. vapour
22. condensation

Down

2. evaporation
3. hail
4. catchment
5. ground
8. precipitation
10. bores
14. evaporates
15. rain
17. salty
18. runoff
19. lake
21. dams



Across

1. A natural resource.

6. Land areas which are inundated with water.

7. What groundwater is held in.

9. The movement of water around the earth is known as the water _ _ _ _ _.

11. In the atmosphere water vapour forms _ _ _ _ _ _.

12. Water flowing in a definite course or channel.

13. 2% of the earths water is held as _ _ _.

16. _ _ _ _ _ _ _ _ _ _ _ _ _ is the process of water passing from the leaves of plants.

20. Steam is also known as water _ _ _ _ _ _.

22. Clouds are formed by _ _ _ _ _ _ _ _ _ _ _ _.

Down

2. The stage in the water cycle when water leaves the earths surface.

3. Frozen rain drops.

4. We all live in one of these.

5. Water which travels slowly under the earths surface is _ _ _ _ _ _water.

8. Rain, hail, snow and sleet.

10. How groundwater is accessed.

14. When temperatures are high water does this more readily.

15. Water can fall from the atmosphere as this.

17. 97% of the earths water is too _ _ _ _ _ to drink.

18. Rain which is not absorbed by the ground.

19. A body of water of considerable size.

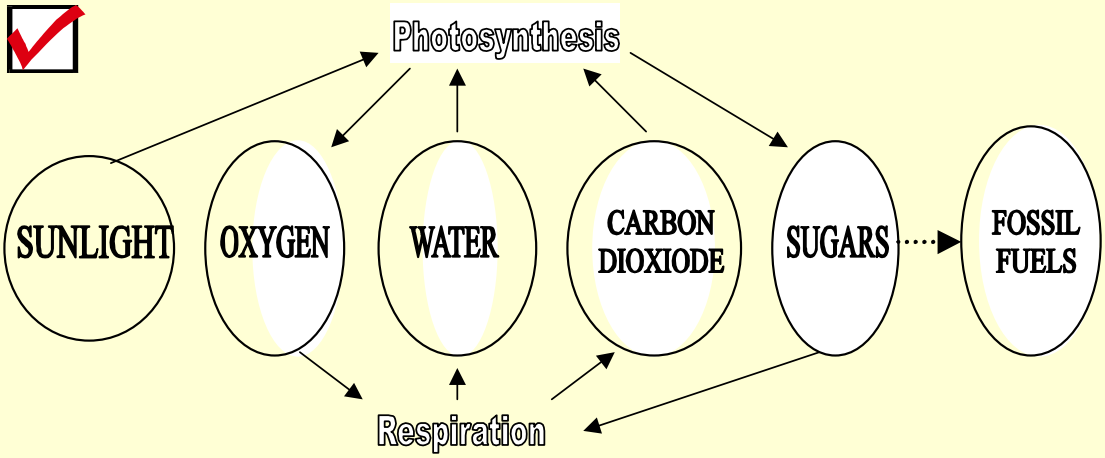
21. _ _ _ _ and river weirs influence the water cycle.

Science outcomes

4.10 (c) Students will learn about ecosystems to describe the roles of photosynthesis and respiration in ecosystems.
5.10 (b) Students will learn about ecosystems to describe the importance of cycles of materials

Teacher's Notes: The Carbon Cycle

Students may need to have a flow diagram explained before attempting this exercise.



1. see above
2. Burning fossil fuels releases Carbon dioxide (25% increase in since the beginning of the industrial revolution). Clearing forests reduces the uptake of carbon dioxide from the air. Burning and decomposition of cleared vegetation results in increased carbon dioxide emissions.

Extension Exercises.

1. What solutions are available to reduce the rate of global warming?
2. Scientists are using complex computer models to try and predict the effects of global warming but with so many variables this is a very difficult task. It is agreed however that a rise in sea levels would cause massive disruption. At a recent international climate conference many nations (but not Australia) agreed to reduce their greenhouse emissions. Should we ignore the evidence of global warming until we can make better predictions or should we take precautions now? Discuss.
3. Do you think that tree planting (carbon sinks) will be an effective way of reducing the Greenhouse effect? Find out what happens when the tree dies. How many trees are needed to consume the carbon dioxide produced to provide your annual electricity bill? What about tree clearing?

1. Read the following passage then use arrows to construct a flow diagram by connecting the elements of the diagram below.

Living things drive the Carbon Cycle. It all starts with a process called **photosynthesis** in which plants use sunlight energy to build energy rich carbon compounds like sugars out of carbon dioxide and water.

Oxygen is released as a by-product of this process.

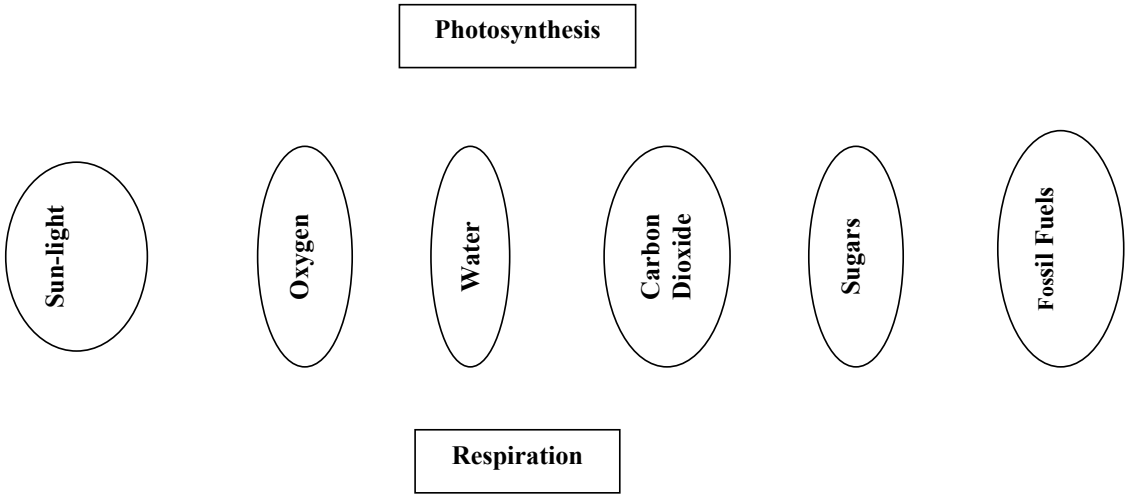
These energy rich compounds are the fuel of life and are always in demand. Plants make enough to fulfil not only their own needs but the needs of Animals as well. None is wasted; even in death there are plenty of decomposers waiting to get at the energy rich compounds that remain.

Like most fuels its energy is released and harnessed only when it is 'burnt' with oxygen. This happens in a controlled way inside the cells of living things and is called **respiration**.

By-products of respiration are carbon dioxide and water.

Without **decomposers,** dead organisms would slowly accumulate. At various times in the past conditions have arisen where this has occurred. At the bottom of swamps where there is not enough oxygen for decomposers, dead plants and animals have accumulated. Over millions of years they turned into the fossil fuels (coal, oil and gas) that has fuelled our domination of the planet.

In just over 100 years of burning fossil fuels the Carbon Dioxide of the atmosphere has increased by 25%. There is evidence that the increase in carbon dioxide is causing a **greenhouse effect** and that the earth is becoming warmer. The large scale clearing of forests has exacerbated the problem by removing the plants that absorb carbon dioxide.



2. Use the flow diagram to show the impact on this cycle of burning the storehouse of fossil fuels and of clearing forests.

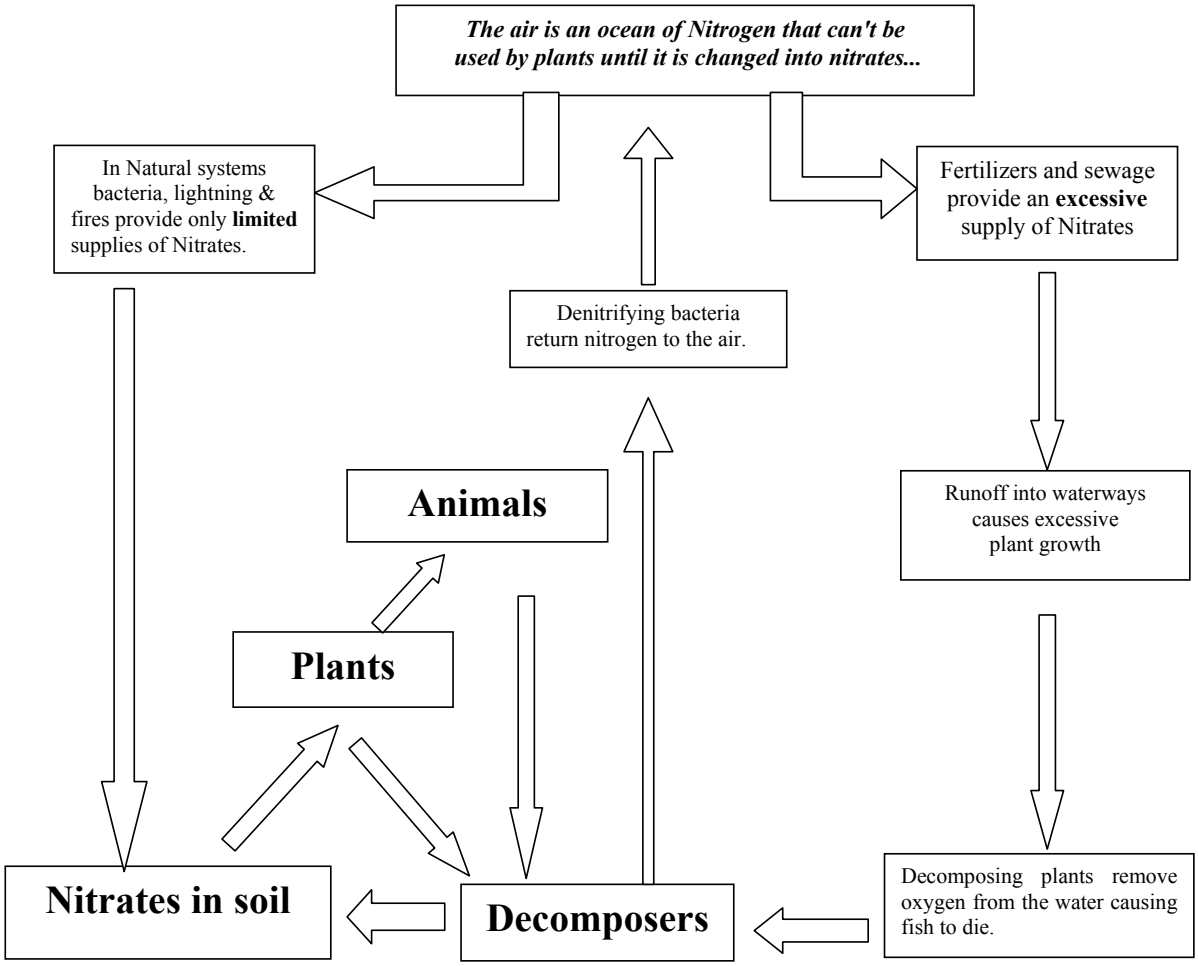
Science Outcome

5.10 (b) Students will learn about ecosystems to describe the importance of cycles of materials

Teacher's Note

Students should understand the Nitrogen Cycle before attempting to analyse the results of water testing on Brisbane Water. They should be able to relate the results to land use in the respective catchments. The information presented opposite is from the Gosford State of Environment Report 1999. This report also provides information on nutrient levels in the lagoons.

The Nitrogen Cycle



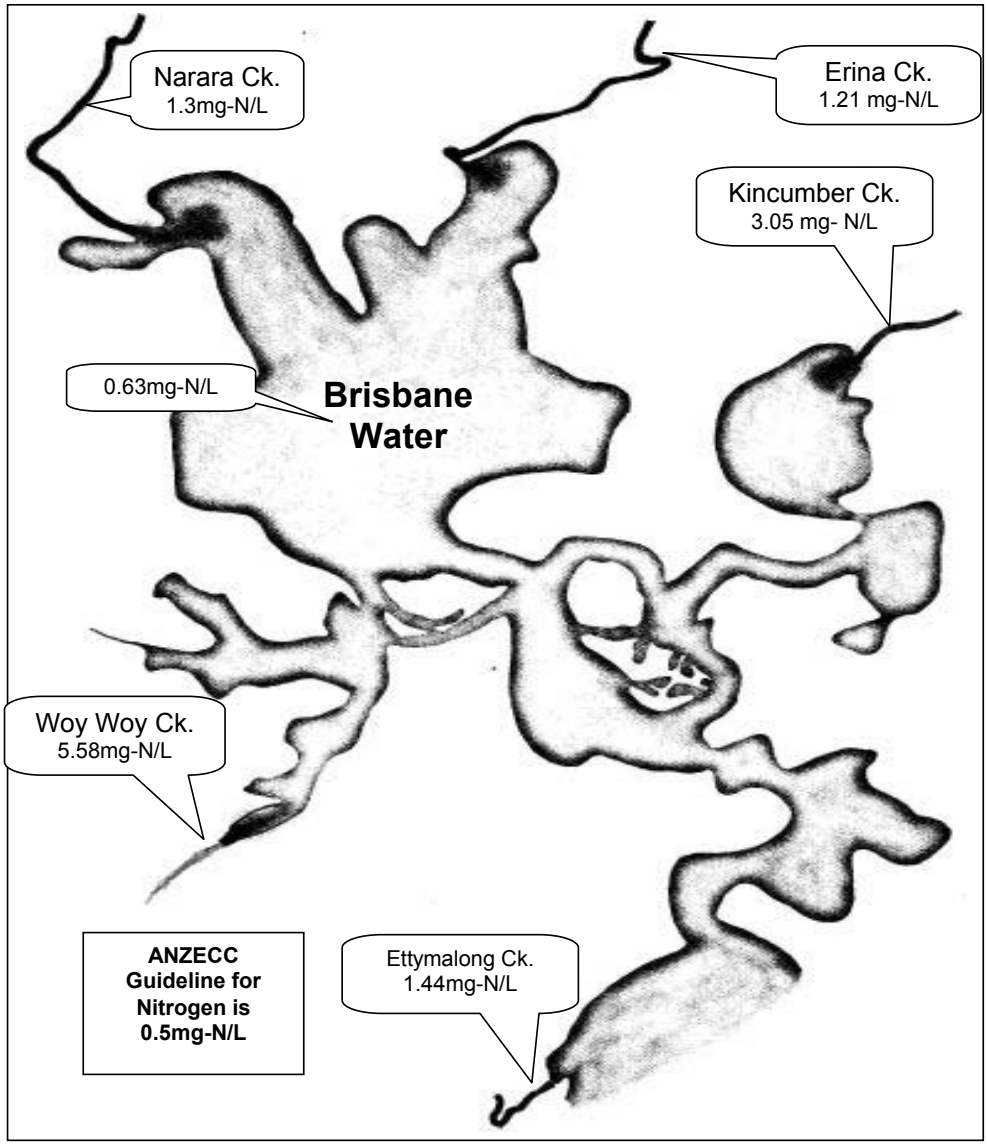
Exercise 22: **The Nitrogen Cycle**

Nitrogen is an essential element. It is required to make the proteins that all organisms need for growth, repair and reproduction. It is easily washed out of the soil and so there is usually only a limited supply. This is why plants respond well to nitrogenous fertilizers. They might be good for the farmer's crops but fertilizing the streams with farm runoff causes excessive plant growth called algal blooms.

These **'algal blooms'** not only choke streams and stop light penetrating but when the plants die they rot on the bottom, using up all the oxygen and fish can actually suffocate. Some blooms of blue-green algae are toxic and can even kill animals that drink the water. Sources of nitrates include fertilisers, animal manure (including pet droppings) and sewerage.

1. Suggest the sources of nitrogen flowing into Kincumber and Woy Woy Creeks

Highest Total Nitrogen in Brisbane Water 1996 to1999



Teacher's Notes: The Nitrogen Cycle in Practice

Suggested Activities:

1. Visit the sewerage treatment works at Kincumber to find out about denitrifying bacteria and how they clean up our sewerage.
2. Examine root nodules on nitrogen fixing plants
3. Make a herbarium of native nitrogen fixing plants. Press and dry specimens before presenting on A4 paper.
4. Identify an area in the school grounds in need of rehabilitation. Research and plan a suitable rehabilitation based on a natural succession. Obtain plants and get the project started.
5. Collect and germinate seeds from local nitrogen fixing plants. Provide seedlings for a rehabilitation project.

Teacher's Notes: 3 optional experiments

1. Experiment on Eutrophication - setting up a range of nutrient concentrations in beakers containing equal amounts of algae as a starter. The algae should be examined microscopically and described.

2. Experiment to show that nutrient cycling is a closed system. Place moist soil and some humus in the bottom of a large clear plastic bottle eg 4L fruit juice. Add some plants eg moss, ferns etc that don't grow taller than the bottle. Seal with lid and leave in light (not too hot) Similar to a space station

3. Conduct an experiment to test the effect of adding nitrogen fixing bacteria to seeds. Bio-care Technology at Somersby specialises in the culturing of rhizobium (nitrogen fixing) bacteria for farmers ph 43 40 2246

Root nodules formed by symbiotic nitrogen fixing bacteria

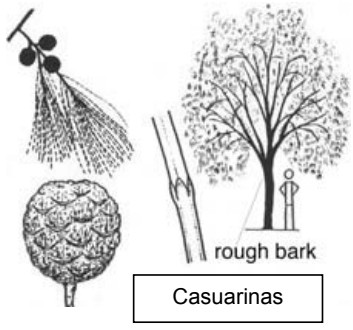
1. Symbiotic Relationships

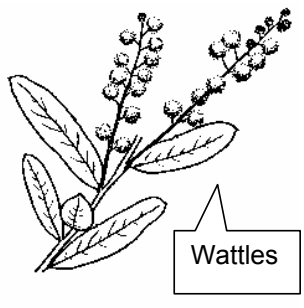
Most plants in the Pea family (legumes) have a cosy **symbiotic relationship** with **Nitrogen Fixing Bacteria.** These bacteria live in the roots and help the plant by providing it with nitrates. In return the plant supplies the bacteria with sugars. Farmers have known for a long time that legume crops such as lucerne or beans can replenish the soil after hungry crops like corn or wheat removed the Nitrogen. This crop rotation saves the cost of artificial fertilizer and reduces fertilizer runoff into watercourses. This is an example of **Ecologically Sustainable Agriculture** – and its not new!

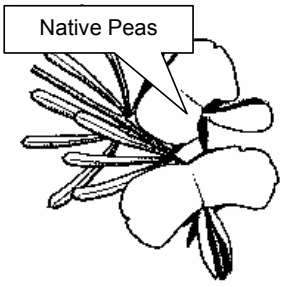
Activity
Observe the nodules on the roots of a nitrogen fixing plant (eg clover). In the space provided use a diagram to describe the root system.

2. Symbiotic Natives - Nitrogen fixing plants for Rehabilitation and Gardens

Of the many plants that grow on the infertile sandstone soils, there are some whose role is vital. These are the nitrogen fixing native Peas (often called 'Eggs and Bacon'), Wattles and Casuarinas that supply nitrates to the system. They are used in the first stage of **rehabilitation** works because they nourish the soil with their nitrogen rich compost making it suitable for a **succession** of other plants to become established.







Insectivorous plants like Sundews are an indicator of nitrogen-depleted soils. They are often found in wet places where any nitrates get washed out of the soil. These tiny plants trap animals on their sticky, hairy leaves and then digest them to get at their nitrogen rich proteins.

When nutrients from a leaking septic tank, manure, fertilizer runoff etc enters a natural ecosystem, the native plants that have adapted to low nitrogen lose their advantage and are replaced by those that need it more (many **weeds**).

Mulch (wood chips) on top of the garden stops it drying out but it shouldn't be dug into the garden as it takes all the available nitrogen to break it down.

Water Quality Objectives for Brisbane Water Catchment

These are the stated Water Quality Objectives for Brisbane Water Catchment

	Aquatic Ecosystems	Swimming	Drinking
Total Phosphorus	Rivers/Estuaries 10-100µg/L Lakes/Reservoirs 5-50µg/L		
Total Nitrogen	Rivers/Estuaries 100-750µg/L Lakes/Reservoirs 100-500µg/L		
Turbidity	<10% change in seasonal mean NTU. Coastal lakes, lagoons, estuaries should be <5NTU.	6 NTU	Site specific
Salinity	Fresh waters < 1500 µS/cm		< 1500 µS/cm
Dissolved Oxygen	> 6mg/L or 80-90% saturation		> 6.5mg/L or 80-90% saturation
pH	Fresh water 6.5-9.0. Investigate changes >0.5pH units outside normal seasonal limits. Marine waters < 0.2 pH unit change	5.0 – 9.0	6.5 – 8.5
Temperature	< 2°C increase in natural levels	15 - 35°C	
Faecal Coliform		< 150/100ml (median)	0/100ml

Teachers Note

Rumbalara Fax sheets on 'Phosphorus' and 'Toxic Algae' can be downloaded from the internet.

Teacher's Note

The Chem mets Water testing kits supplied with this manual are simple and easy to use. The main advantage is that they enable rapid testing of sites in the field. They are not meant to replace the Streamwatch Kits.
Students may wish to start water quality testing at this stage however it is adviseable to work through the hypothetical 'Oyster Bay Mystery' beforehand

3. Sewerage Treatment

The Sewerage Treatment plants at Kincumber and Woy Woy use **denitrifying bacteria** to remove nitrogen from raw sewerage. On an average day over 40 million litres of raw sewerage with about 60mg/litre nitrogen is treated then pumped into the ocean at Winnie Bay with less than 20mg/l Nitrogen.

Gosford, like all other Councils must have a licence to put this much pollution into the sea. The more nitrates and phosphates it discharges the more the licence costs – so there is an incentive to keep our pollution loads down.

Phosphorus is another key plant nutrient that is found in large amounts in sewerage. Australia is generally low in phosphorus so plants thrive on even small amounts that enter our waterways in runoff or from sewerage. It can cause the growth of weeds in waterways and also toxic algal blooms. These can kill fish and even land animals that drink the water. Phosphates are also found in fertilisers, and detergents.

What Can We Do?

Overall we should aim to reduce amounts of phosphate entering our waterways.
Ways to do this include:

***not** washing sand, dirt, lawn clippings etc into the gutter or down driveways and paths

***not** using excessive amounts of garden/lawn fertilisers and make sure it is accurately applied

***do** pick up your dog's do and collect and bury or dispose of in sewer or garbage

***do** wash cars on the lawn and not on the street

***do** use environmentally friendly detergents - phosphate free and used sparingly

***do** maintain you're septic system (if connected)

***do** compost green waste where possible and use as fertiliser on gardens

***do** ensure that your home is connected to the sewerage system if it is available

***do** re-use sewerage sludge as a resource for agro-forestry

Ideas for a student Research Project?

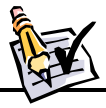
1. Conduct a survey of the phosphorus content of laundry and garden products
2. Make up some solutions of washing powder, fertilizer etc according to the manufacturers instructions and test for phosphorus, nitrogen (as ammonia), pH, and salinity. Record the results
3. Leave some of the samples to stand for a few days and then test again. Are the nutrients breaking down?
4. How much dilution is needed to make the water acceptable for disposal
5. Investigate methods of removing the nutrients from the samples

Teacher's Note – Exercise 23: Library Worksheet

Students research the meanings of the words listed and the effect on the catchment. Some suggested definitions and effects are given below.

Answers – Exercise 23: Library Worksheet

Term	Definition / Description	Effect on the catchment
Erosion	the movement of rock and soil materials by running water, wind, moving ice or gravity. This is a natural process, however increased erosion rates occur due to poor landuse practices.	• loss of topsoil, affects vegetation • increases sedimentation and turbidity → reduces water quality and decreases benthic habitat
Sedimentation	the movement and deposition of sediment usually by water.	• decreases benthic habitat
Salinity	the total quantity of dissolved salts in water, measured by weight in parts per million (35,000 parts of salt in seawater – sometimes referred to as 3.5%).	• in some catchments a serious problem – reduces vegetation growth • increased salt can kill trees and plants
Eutrophication	the enrichment of a water body by inorganic plant nutrients (e.g. nitrate and phosphate). This occurs naturally over time but can be accelerated by human activities (eg.sewage disposal, fertiliser runoff). Rapid increases in nutrients stimulates algal blooms.	• leads to algal blooms which result in oxygen depletion that effects aquatic animals. • Obstructs (chokes)waterways and modifies habitat (less open water and less light penetration) • Blue green algae can be toxic
Pesticide	any chemical or biological agent that kills a plant or animal pest (e.g. herbicide, insecticide or fungicide).	• .Kills sensitive organisms • Accumulates in top order consumers
Pollution	any harmful or undesirable change in the physical, chemical or biological quality of air, water or soil as a result of the release of chemicals, radioactivity, heat, large amounts of organic matter.	• Many and varied effects. Some are obvious eg oil coating sea birds, others are subtle eg bio-accumulation of pesticides, others are complex eg greenhouse effect
Biodegradable	compounds and materials that can be broken down by micro-organisms.	• Consumers choosing Biodegradeable detergents can reduce water pollution
Fertiliser	any substance, natural or manufactured, which is added to the soil to supply essential nutrients for plant growth.	• Runoff can cause eutrophication. • Promotes weeds
Herbicide	a chemical substance used for killing plants, usually weeds.	• Effect on neighbouring bushland if not confined to the crop area.
Runoff	water that flows across the land surface and does not soak into the ground.	• Increase runoff as a result of increase in impervious surfaces in urban areas • Pollution (see above)
Ecosystem	a community of organisms, interacting with one another, plus the environment in which they live	• current extinction rates are evidence that humans are a destabilising influence in almost all ecosystems.
Sewage	household and commercial waste water that contains human waste.	• Eutrophication, decreasing health of waterways (disease), and heavy metal s etc.



Term	Definition / Description	Effect on the catchment
Erosion		
Sedimentation		
Salinity		
Eutrophication		
Pesticide		
Pollution		
Biodegradable		
Fertiliser		
Herbicide		
Runoff		
Ecosystem		
Sewage		

Teacher's Notes - A CATCHMENT STORY

The exercise is designed to increase knowledge and awareness of catchment use and water quality issues. It has been used successfully with all age groups and in a variety of situations

Materials.
An aquarium (about 2 or 3 foot) or similar container. 24 to 30 small plastic sauce Tubs say 70 mm diam 60 mm depth or similar. Various materials to represent pollution as outlined in the list below. Two large glasses. Paper towels, scoops, strainers, milk cartons with soil to dispose of polluted water and clean up.

Preparation.
1. Label each of the plastic tubs with a character's name from the story. Duplicate containers can be prepared to cater for all of the members in the group if necessary.
2. Place or pour the appropriate materials in each tub in accordance with the list.
3. Distribute the labelled tubs to people in the demonstration. Request that they be careful and keep the container closed until they are told to open it.
4. Fill the aquarium with clear, clean water and place in a prominent, visible and accessible position.
5. Introduce the Catchment Story.
6. Fill one large glass with water out of the aquarium, demonstrate its cleanliness and properties by pouring from one glass to another. Leave the glass aside for comparison at the end of the story.

Adaptated from a presentation by Jane Tinnion and Colin Mondy, Streamwatch Coordinators.

The People in the Catchment.

Tub	Name	Position	Substance	Amount
1	Elly Trick	Power station	Vinegar (acid rain)	½ Tub
2	Luis Plonk	Vineyard	Pesticide spray	A few sprays
3	Percy Trotter	Piggery	Mud + dynamic lifter	½ Tub
4	Fossy Fate	Orchardist	Super phosphate	tablespoon
5	Lilly Latte	Dairy farmer	Soil	½ Tub
6	Lotta Grass	Turf farmer	Salt	tablespoon
7	Slim Dusty	Quarry	Talc/ Clay (dust)	Tablespoon
8	Linda Leghoorn	Poultry Farmer	Crushed Dynamic Lifter	½ Tub
9	Kerry Slacker	Hobby Farm	Yellow colour + toilet paper	Tub
10	Jimmy Pitt	Coal Miner	Carbon or charcoal	Tablespoon
11	Tangle Bags	Fisherperson	Fishing line and bait bag	Tangled line + bag
12	Lorraine Leak	Water Skier	Sump oil	Tsp in tub water
13	Barbie Que	Picnicker	Litter-papers, bottles etc	
14	Gary Guzzler	Tour Boat	Litter- bottle, ring pulls, lids.	
15	Bob Bilgewater	Yacht owner	Yellow color + toilet paper	tub
16	Quick Harry	Builder	Cement, lime or plaster	½ Tub
17	Happy Couple	Homeowners	Soil + paint	½ Tub + 1 drop paint
18	Joe Bindy	Builder	mock Herbicide spray	Few sprays
19	Victor	Home owner	Grass clippings	½ Tub
20	Leda Pooch	Dog Owner	Mock Dog Droppings	½ Tub
21	Cam Shaft	Motorist	Sump oil	Teaspoon / tub water
22	Max Profit	Factory owner	Copper sulfate solution	full Tub
23	Ruby wax	Car lover	Detergent	Made up in tub water
24	Dangerous Dan	Demolisher	Tea coloured liquid	full Tub
25	Dollar constructions	Developer	Vinegar	full Tub
26 -30	Towns people	Community	Yellow+toilet paper+bits…	full Tub

Exercise 24: A CATCHMENT STORY – Introduction

Today I am going to tell you a little story about a very important part of our environment – a river, our river. The story talks about how each of us and everyone else along the river affects the river's health.

I have given many of you a small container with a name on it. When I mention that name in the story I want you to come up and empty what is in the container into the river catchment (the aquarium).

Before I start the story about our river and its catchment, let us have a think about what a catchment is.
(Ask for suggestions and then demonstrate by getting everyone to cup hands and pretend that they are standing in the rain. What would happen? This is a small example of a catchment and the Earth's surface is divided into lots of bowls just like that, with a river in the bottom of each bowl.)

A catchment includes a river and all of the creeks, streams and other smaller rivers which run into it. But the catchment also includes the land around these waterways. This means that although you and I may live 20 minutes or even more from the river, we are still part of the catchment. Even from this distance we can have an effect on the quality of the water in the river.

Can anyone tell me some ways in which we are linked to the river from our houses and schools?

- **Stormwater Drains.** Do you agree that stormwater drains are linked directly to our waterways? There are usually no filters in the stormwater drains and they do not go through the sewerage plant. This means that whatever we drop into the stormwater drain, whether it is litter, paint or detergent, it goes straight to our local waterway.
- **Sewerage systems.** Everything we put down our toilet or sink goes to sewerage system, where most of it can be treated. Some, however, such as fat, detergents, chemicals, is difficult to remove from the water before it is sent into our waterways and ocean. This is bad news for our fish and water plants.
- **Streets.** If we leave litter or oil from the family car on the road or in gutters it can either be washed into the stormwater drain and then into the river, or it can be washed by rain down the street into the river.

So these are just three ways in which our houses and schools are linked to the river. Think about farms, parks and boats on the river.

The Catchment Story

Now let us begin our story. If you have a container with a name on it, remember that when you hear your name, come out the front here and empty your container into the river.

Our river begins way up in the mountains and flows down and around hills and through farms, small urban areas and the city. Everybody has an affect on the river all the way along. We will follow some clean droplets which just fell from the sky and entered our river at the very top in the mountains all the way along the river until it reaches the sea. As the water travels down the mountain it arrives at a valley where **1.Elly Trick** runs a power station. The power station produces the electricity for the region and burns large quantities of coal and can release pollutant gases into the air. These pollutants combine with moisture in the atmosphere to produce acids. Rainfall carries these acids back to the earth's surface and can pollute the very source of the river.

As the water goes down the slopes it gathers speed and enters into farming country. Within the farmer community live Luis Plonk, Percy Trotter, Fossy Fate, Lilly Latte, Lotta Grass, Linda Leghorn and Kerry Slacker. As the water passes **2. Luis Plonk's** vineyard insecticide spray washes into the water. Passing **3. Percy Trotter's** piggery some of the pigs' manure is washed into a drainage pipe and then into the river. By **4. Fossy Fate's** orchard some fertiliser washes in as she waters her orange trees after fertilising. As the water passes **5. Lilly Latte's** Dairy Farm, soil is pushed into the river by cows walking on the riverbank. Trees have been removed and they no longer hold the soil on the riverbank. From **6. Lotta Grass's** Turf farm comes salt. The constant irrigation has caused the water table to rise beneath the soil and as it has risen it has brought up salt. Salt harms the freshwater animals living in the river and creates a problem for people who want to use the water downstream. As the river passes **7. Slim Dusty's** Quarry it gets a load of fine mud that makes it go all cloudy. Water plants are unable to grow because the dirt has reduced the amount of light that gets through.
Just around the corner at **8. Linda Leghorn's** Poultry Farm a load of chicken manure arrives. This is a good fertilizer but in the river it can cause the growth of toxic blue green algae.

Slowly the river starts to wind its way through the outskirts of a major town. Out here there are a number of hobby farms. People like **9. Kerry Slacker** comes out to the country on the weekend to get away from the hustle and bustle of the city. Their small houses, on these farms, are not connected to the sewerage system like they are in the city, they have septic tanks. Sometimes when they stay for longer than expected, or bring friends along, the septic tank overflows and raw or untreated sewage enters the water.

Near the railway the river passes **10. Jim Pitt's** coal washing plant. Here the river takes on a black look and visibility is further reduced. Downstream all this coal dust will settle on the bottom, covering the rocks and logs that provide habitat for the animals of the river.

Look how our once clean water now looks and smells? But the journey isn't over yet. Coming up around the bend there are people using the river for recreation. **11. Tangle Bags** is fishing off the riverbank. Unfortunately he leaves his tangled line and plastic bait bags behind where it may get wrapped around a fish or platypus. Also on the river there are some people water-skiing. **12. Lorraine Leak** has not been maintaining her ski boat and, as a result, some oil is leaking from the boat directly into the river.

13. Barbie Que is having a picnic with her family in the park around the next bend. They are having a lovely time, playing cricket, relaxing and having a chat. Then suddenly, a big gust of wind comes along and blows their litter into the water. There are plastic bags which fish could swim into, plastic rings from the milk containers which birds can get stuck around their necks and bottles which fish and other small creatures like frogs may swim into and may not be able to get out of. Not only is it harmful to the animals, but also the water is starting to look quite disgusting.

Teacher's Notes: Conclusion of A Catchment Story

Can anyone tell me some ways by which we might be able to reduce our impact on our river?

Here are some suggestions .

- compost garden and kitchen waste.
- if you have to use chemicals, choose the less toxic ones and dispose of them in the right way.
- don't put rubbish, oils or poisons in the toilet or down the sink – they can clog up the sewage system.
- wash dishes in the sink rather than in the dishwasher, this will reduce the amount of water and detergent being sent to the sewer and then the river.
- clean up your dog's faeces when you take it for a walk.
- don't put waste down the stormwater drain - litter, grass clippings, paint, oil, cigarette butts etc
- plantgrasses, reeds and trees along the river bank to reduce the amount of soil being washed into the river.
- pick up litter when we see it so that it doesn't go down the stormwater drain and into the river.
- Try alternatives to pesticides. Most insects,are helpful to the plants.
- Let people know that cigarette butts are poisonous. Washed into stormwater drains they may harm life in the waterways.

There are so many things we can do to reduce the pollution in the river and most of them are so easy.

I'd like everybody to choose one thing they can do this week to reduce the pollution in the river.
This week my goal will be to use less toxic chemicals to clean the bathroom and to dispose of it in the garden, not down the sink. Would anyone else like to share their goal for the week?

The Finale.

Even if you don't mention it, someone is sure to ask "What are you going to do with the water now???" The answer is "behave like a sewerage treatment plant and do the best that I can to clean and dispose of the water safely." There will be no shortage of volunteers for this gruesome job. Strain and filter the solids. Remove the oils by decanting and then absorbing with paper towels or milk carton filled with sawdust. Dispose of the water to sewer or to a safe place in order to minimise harm to the environment.

Further down the river there is a boat taking tourists on a tour of the river. Beer is provided and people like **14. Gary Guzzler** aren't using the bins to dispose of their bottles, and are just throwing them overboard. They go for a swim unaware that **15. Bobo Bilgewater's** cruiser doesn't have a storage tank for toilet waste and so it gets pumped straight into the river.

The river now begins to wind through the suburban part of town where **16. Quick Harry** is building new homes. The concrete trucks wash out their alkaline loads into the stormwater and it runs down into the river. **17. Happy Couple** are paying off their homes in a new subdivision. Many of the trees have been removed and when it rains the top layer of soil is eroded and adds to silting up the river. This makes the water look dirty and cloudy and can harm plant and animal life in the river. They are also painting the inside of their new house and washing the brushes out in the outside tap. This also ends up in the stormwater.

Most houses like **18. Jo Bindy's** in the developed parts of the town have lawns that they spray to keep out weeds. When she has completed her spraying she turns on the sprinkler to water the plants and the pesticide washes off into the stormwater drains and then enters the river. Jo's neighbour, **19. Victor**, has just finished mowing his lawn for the third time this month and rather than putting the grass clippings on the garden for mulch, he puts them down the stormwater drain where they also washed into the river.

Also in the area lives **20. Leda Pooch** Leda, like a good dog owner should, takes her dog for a walk every day. The dog does his business during the walk. This untreated sewage is washed into the stormwater drain when it rains and into the river.

People like **21. Cam Shaft** are now driving home from work. The roads are choked with traffic. Oil drips out of Cam's poorly maintained car and into the stormwater drains. Sometimes he brakes suddenly and leaves pieces of rubber from the tyres on the road which are then washed by rain down the stormwater drain and into the river.

Our poor water is really staring to look very sick now!!
But it hasn't reached the mouth of the river yet; it is still in our catchment.

Further down the river there is some industry. **22. Max Profit** is one of the factory owners who uses many dangerous chemicals. Max has to pay to get the waste from the factory processes removed but to save money he sometimes releases it into the river. He knows this is illegal but he also knows that the risk of getting caught is low and the fines are fairly small. **23. Ruby Wax** washes Max's luxury cars out on the street. The water, dirt, oil and detergent wash into a gutter which flows to the river. In the detergent there are phosphates which can cause an algal bloom in the river. When the algae dies and begins to rot it uses up oxygen which animals in the water rely on and they may suffocate as a result.

Redevelopment is occurring on the opposite side of the river. **24. Dan the Demolisher** found a few drums of something that he wasn't sure of. He couldn't sell it and he would have to pay to take it to landfill or a hazardous waste dump so he emptied it into the river. The waste was chemicals from an old tannery. These chemicals are very poisonous to the animals and plants living in the river. **25. Dollar Constructions** are the developers of the site and they are building wharves. As they dig up the mud it reacts with the air and becomes very acidic. The acid washes into the river and kills the fish.

The mouth of the river is just ahead. There is just one more pollutant to enter our now very dirty and unhealthy water - sewage. The sewage from **25. Everyone's** homes enters the river just near the mouth. The sewage is treated but things like our detergents, paints, chemicals and cooking oils are not removed in the sewerage treatment process. This is all added to our water before it reaches the sea.

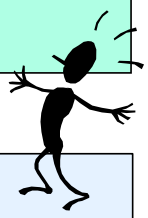
Entering the sea, our once clean water is full of oils, chemicals, litter and sewage - it looks extremely unhealthy.

What do think of the water now? (Take a glass full and pretend to drink. Compare it to the original water in the glass.) I think it is a disgrace. What do think? Look at what we have done to the water in our river. Look at how dirty it looks and it doesn't smell too good either. Could you imagine being a fish and living in that water or a plant trying to grow. (If possible give people a closer look.)

It is terrible but this is what happens to the water everyday in our river.

Science outcome 5.19 and 5.22.2

A student:
5.19 uses critical thinking skills in evaluating information and drawing conclusions.
5.22 independently plans, implements and evaluates the effectiveness of a variety of tasks as an individual and as a team member.



Teacher's Notes – Exercise 25: Oyster Bay Mystery

This introduction to water quality monitoring is a classroom exercise designed to prepare students for the excursion to study their catchment.
Students are divided into groups. They are told in the "Introduction to Oyster Bay" that Streamwatchers have been testing water at 4 sites in the local catchment but have lost the labels on the samples. The groups need to determine from which site each sample of water came. There are 3 lines of evidence:

25A **Buckets of Bugs –** simulating the use of bio - indicators

25B **Water samples** – a water testing simulation

25C **Newspaper reports –** research

When the groups have completed the three exercises they will relate their findings to the land use shown on the map of Oyster Bay.

Assessment Task

Oyster Bay Mystery – Resource Kits
This module is accompanied by 10 Oyster Bay Mystery Resource Kits. Each kit contains:

- 1 x laminated map of Oyster Bay
- 1 x laminated Bucket of Bugs - Samples
- 1 x laminated Water Sample A
- 1 x laminated Water Sample B
- 1 x laminated Water Sample C
- 1 x laminated Water Sample D

Students should also be given a copy of the "Bucket of Bugs – Recording Sheet" and "Water Samples – Results Sheet"

See appendix 1

See appendix 2

Exercise 25: Oyster Bay Mystery

An Introduction to Oyster Bay

by Kate Kennedy
Year 9

Oyster Bay is a beautiful place to live. It's on the edge of the lake surrounded by bush and a few farms and it's also close to the beach. I've got lots of friends and we go horse riding, sailing, fishing, surfing – there's always things to do. It seems that people have just discovered how much nicer it is to live here than in the city. There are lots of new houses being built, a new industrial estate and heaps of roadwork. We even have a new golf course and a picture theatre.

Dad has lived here all his life. He's an oyster farmer and although he likes the golf course he worries about the pollution that comes with having so many more houses in the catchment. If his oysters get polluted someone might get sick – and that could put an end to our oyster business! He hopes that everyone in the catchment is doing the right thing otherwise there will be a lot of oyster farmers and fishermen out of work. If that happened I don't think I'd like to live here anyway because if the water's too dirty for the fish, oysters and prawns then it wouldn't be very healthy.

Our school has a Streamwatch kit that we use to test the water around our district. Sometimes we find that the water is polluted and we can go and do something about it before people get sick or fish start to die. Some people don't even know they're polluting the water or else they think a little bit of pollution won't hurt. We explain that lots of little bits of pollution adds up to heaps and this ends up spoiling the environment for everything that lives here including us.

Oyster Bay Catchment

The local newspaper has reported a few problems that have occurred in the waterways around Oyster Bay. Some kids at Oyster Bay (not as smart as you) have been out to take some samples from these trouble spots and elsewhere in the catchment. It is your job to analyse these samples.

Unfortunately the labels have come off the samples so you will have to do a bit of detective work to match each of the samples to the places marked on the map where they were collected.

1. **Locate the 4 sites on the map of Oyster Bay. Describe the activities around each site.**
2. **Testing the Water**
3. **Buckets of Bugs Activity.**
4. **Questions based on Newspaper articles**
5. **Write a report identifying which samples came from each site. Give reasons for your decisions**.

Teacher's Notes – Exercise 25A: Testing the Water

Best done as a hands on activity. 'Mix up' four hypothetical water samples using coloured sequins to represent the composition. Students dip into the samples and count the sequens in their sub sample.

Composition of Water Samples – Note: it is important that proportions are maintained

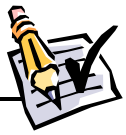
	Sample			
	A (Golf Course ponds)	B (Rocky Ponds)	C (Catfish Creek)	D (Smiths Spring Falls)
Blue (water)	62	63	63	83
Green (nitrates)	10	7	5	1
White (oxygen)	10	1	3	15
Brown (suspended solids)	2	6	10	1
Yellow (salt)	3	2	4	0
Orange (phosphorous)	7	8	4	0
Purple (faecal coliform)	4	10	10	0
Black	2	3	1	0

OR

Use the laminated diagrams in the Resource kit representing the 4 water samples – students then need to count up the different components represented (using the colour chart given) and fill out the table in their books.

Teacher's Notes – Optional Focus Questions

1. Is one sample from each site sufficient to get reliable results?
2. If sewage was entering a waterway how would you expect it to show up in a water test analysis?
3. What actions by humans could lead to high suspended solids readings?



If we could see pollutants in the water it might make us more aware of the problems we create. Unfortunately polluted water often looks the same as healthy water. Oil and dirt are obvious but water might be polluted because it doesn't contain enough oxygen or it might contain toxic chemicals, salt or harmful bacteria. We can't see these things and so special techniques are needed to detect and measure them – that's what Streamwatch kits are for.

In this activity you are going to imagine that you have microscopic eyes that can actually see the different pollutants in water. With this superhuman vision you will be analysing the water samples that Kate and her friends collected in the Oyster Bay area.**(SEE APPENDIX 3)**

Step 1 Count the different coloured things in your sample and record the numbers of each in a table in your book. (The key below tells you what each of the colours represents).

Step 2 Repeat this procedure with samples from the other 3 sites.

Step 3 Compare the sample results and decide where each of the samples came from. Write a short explanation to justify each of your decisions.

Step 4 A representative from each group describes their findings to the class and takes questions from the floor.

Water Samples - Results

	Samples			
	A	B	C	D
Water				
Dissolved oxygen				
Chlorides				
Pesticides				
Nitrogen compounds				
Suspended solids				
Phosphates				
Faecal bacteria				

Colour Key

Blue ---------- Water
White ---------- Dissolved Oxygen
Yellow ---------- Chlorides
Black ---------- Pesticides

Green ---------- Nitrogen Compounds
Brown ---------- Suspended Solids
Orange ---------- Phosphates
Purple ---------- Faecal Bacteria

Teachers Notes – Exercise 25B.
Buckets of Bugs

This table is to be used to score the 'buckets of bugs' diagrams on the following page.

Some bugs can tolerate pollution, others are more sensitive and will not be found in polluted water. The Freshwater Bug Guide table gives each type of bug a value depending on how sensitive it is to pollution. The highest numbers are given to the most sensitive bugs. For each type of bug found in bucket 1, enter its value in the bucket 1 column alongside its picture. (Points are given for types not numbers e.g. 10 tadpoles scores the same as one tadpole, if there are three types of water beetles give 9 points). Repeat for each of the buckets then add up the scores to get a stream quality index.

Note that the latest index method includes a weighting to allow for the numbers of each species. This method is detailed on the streamwatch website. www.streamwatch.org.au/bugs/index.html

Pollution Index	Stream Quality Rating
20 or less	Poor
21-35	Fair
36-50	Good
51 or more	Excellent

See appendix 4

Teacher's Notes: Exercise 25B - Buckets of Bugs

Suggested that an overhead transparency is made of the Buckets of Bugs sheet for students to work from.

See Appendix 5

Teacher's Notes – Exercise 25C

Suggested that this be used as a homework sheet.

Answers – Exercise 25C: Newspaper Articles

Green River of Death

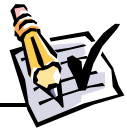
1. Fish suffocated because algae used up available oxygen.
2. Early morning
3. excess phosphates
4. Less use of fertilisers, ways to stop runoff into creeks; vegetation on banks.

Creek Disappears

1. Clearing of land to build houses
2. Left vegetation strip along banks of creek; left vegetation corridors in estate; sedimentation traps.
3. Looks better; slows down runoff and sedimentation; holds soil together.
4. Return it to the way it was.
5. cost; takes a long time for changes.
6. plant gardens, mulch, not litter.

Missing Frog Mystery

1. To eat mosquito larvae.
2. No
3. Frogs
4. Carp, rabbit, lantana, bitou bush, cane toads.
5. Don't empty into waterways; ensure no fish eggs in aquarium.



Green River of Death

A big haul of fish is something you'd expect fishermen to boast about. But Jack Wells was not happy. Returning from his fishing trip with over twenty good-sized fish he headed straight for the NSW Fisheries Department. Jack described a 'green river of death' where fish were floating on the surface barely able to move, others were belly up. "I think this shows that we have a slight problem" he said holding up a couple of good sized estuary perch for a photo that he wouldn't be hanging on his wall. He said that in all the years he had been coming to the river he had never seen it in such an unhealthy state. "The green water and the stench of dead fish made a depressing scene, especially if you knew how clear the water used to be."

The EPA's Dr. Chris Lean said that an overgrowth of algae was causing the fish to suffocate. She said that although the algae produce oxygen during the day, at night they use it up again and so by the next morning there isn't enough oxygen in the water for the fish. To make matters even worse, because of all the algae there is a lot more rotting vegetation at the bottom of the creek. The microbes living in this use up lots of oxygen. Another problem is that in the summer the water gets warmer and it can't hold as much oxygen.

Water samples taken at the site and further upstream showed that the cause of the 'algal bloom' is high phosphate levels. Dr Lean said that fertilizers are a common source of phosphates but if they end up in waterways fertilizing algae they become pollutants.

Focus Questions

1. How did algae cause the fish to die?
2. When would you expect the oxygen content of the water to be lowest?
3. What caused the overgrowth of algae?
4. Suggest a long-term solution to this problem.

Creek Disappears

Stan Goodman feels sorry for the young kids of today as he straddles the creek that seventy years ago was one of his favourite fishing and swimming holes. "In those days we could row a boat up here but today its so silted up even the ducks get stranded. The water was so clear we could see the catfish on the bottom and platypus were common. It was about 4 feet deep with steep banks and tall trees all around – never thought it would end up like this. It all seemed to happen when the housing estate was built. I don't know why they couldn't have looked after this creek so that the families who move here could enjoy it like I did when I was a boy".

Today Council environment officers met with local residents, some claim the creek is a health hazard and have requested that concrete drains be installed. Others believe that it should be fixed up so that it is more like it used to be when Stan was a boy.

Council's environment officer said that the clearing of land to build houses had allowed tonnes of soil to wash into the creek. Not only had this buried plants that once grew in the creek but it had also caused the water to become muddy so that not enough light reaches the bottom for new plants to grow. She said that as a result the creek was as barren as a desert.

Focus Questions.

1. Where did the sediment come from?
2. How could the developers of the housing estate have looked after the creek?
3. What are some of the advantages of retaining vegetation along the side of the creek?
4. What are the advantages of rehabilitating the creek?
5. What would be some of the problems of rehabilitating the creek?
6. What can the residents of the housing estate do to prevent sediment entering the creek?

Missing Frog Mystery

Frog populations have crashed in recent years and the reasons are not at all clear. Frogs that were once common are now rare or endangered and some species may already be extinct. The once widespread green and gold bell frog (that has been promoted as our Olympic Mascot) is once that has taken a real nosedive in recent times. Its numbers have dwindled to the point where they now need our help to prevent their extinction.

Viruses, an increase in U.V radiation, herbicides and pesticides have all been blamed and now an introduced predator is being put under the spotlight.

Gambusia (also known as the Plague Minnow or Mosquito Fish) is a small fish (2-4cm) that was brought from North America and put into our waterways to eat mosquito larvae. The mosquitoes are still here and the Gambusia have spread like rabbits. They are incredibly hardy and eat anything from plants to larger fish that they've ganged up on – and this includes tadpoles and frog's eggs. In some places only old adult frogs remain because the tadpoles are not making it to froglet stage.

In the district, local frog watchers are busy putting in frog ponds so that species like the Green and Gold Bell Frog can breed beyond the reach of the Plague Minnow.

Focus Questions.

1. Why were plague minnows introduced?
2. Did they do the job they were brought here for?
3. What animals do we know have been affected by the Plague Minnow?
4. What is another introduced species that has become a major problem in Australia?
5. What precautions should people take when emptying aquariums?

Teacher's Note: Water Testing

This section of the module involves students undertaking practical activities to test the water quality at a site near to the school. It is suggested that ideally this would be a half-day excursion whereby students would walk to the site, conduct a habitat survey, Bug survey and chemical testing of the water. A Practical Manual outlining these activities is provided in the resources.

The emphasis is on the process of scientific investigation not the validity of the data. Activities outlined above should be modified to suit the constraints of your locality, school structure and class –eg the teacher may need to collect water samples and later conduct chemical tests during timetabled periods. Note, some tests eg oxygen can only be tested on site

SAFETY should be a prime consideration in conducting these activities.

Should you require assistance in organising these activities contact Rumbalara Environmental Education Centre, Donnison Street, Gosford. Ph. 4324 7200

Streamwatch is also an established water quality monitoring program for schools and community groups. For more information contact the Streamwatch Coordinator or visit the Streamwatch website at www.streamwatch.org.au

Teacher's Notes - Resources for Water Testing

Resources accompanying this module include the following resources for water quality testing:-

- turbidity tube x 3
- pH test kits x 3
- thermometer x 3
- Total Dissolved Solids (TDS) meters x 3
- Chemmet kit for Ammonia x 3
- Chemmet kit for Dissolved oxygen x 3
- Chemmet kit for Phosphates x 3

We suggest that teachers check to ensure that all items are functioning and adequately stocked before use.

Exercise 26: Testing Water Quality

Group Members:	
Date:	Time:
Location of site:	
Weather:	
Recent rainfall:	

Test	Result	Test	Result
turbidity		pH	
temperature		ammonia	
Total dissolved solids		phosphates	
dissolved oxygen			

Discussion:

Teacher's Notes - Habitat survey

Use the survey form in conjunction with water testing.

Explain the items to be assessed:

Vegetation – has it been mowed, underscrubbed, planted or is it undisturbed?
Weeds – point out the different weeds
Rubbish - look for litter etc
Drains – are there any outlets nearby
Sewer – are there any pump stations nearby (that could fail and overflow)

Then ask students to reach agreement on where it fits on the sliding scale.

Exercise 27: Habitat Survey

Feature	Assessment	Description
VEGETATION	Original — Changed	
WEEDS	None — A Lot	
RUBBISH	None — A Lot	
SLICKS & FROTH	None — A Lot	
DRAINS	None — A lot	
SEWER POLLUTION RISK	Low — High	
EROSION	None — A Lot	
OTHER OBSERVATIONS		

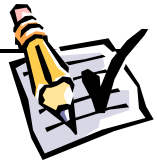
Teacher's Notes: Bio-Indicators

The Streamwatch Water Bug Detective Guide has been developed to provide a quick method of assessing the health of freshwater (not for use in marine/ estuarine conditions)

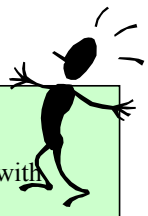
The bugs are ranked according to their sensitivity to declining water quality. Those that are most sensitive receive the highest score. Using the sampling method described on the sheets in the appendix, an index of water quality is determined. The higher the index, the better the water.

Streamwatch conducts a spring and autumn 'bugwatch' each year. Students can download information from the streamwatch website to find out how to enter. The results from all schools are put onto the web.

Exercise 28: Water bug Survey



See appendix 6



Science outcome 5.10 (c) and 5.27

Students will discuss strategies used to balance human activities and needs in ecosystems with conserving, protecting and maintaining the quality of the environment.

Acknowledge their responsibility to conserve, protect and maintain the environment for future generations.

Teacher's Note

(Individual or group) Students use magazines, newspapers etc to develop a collage using the template provided that illustrates their perception of human use of the catchment.

Teacher's Note: Discussion of collage

Sample questions for teachers to use

1. a) Identify 2 features in the collage which conflict with each other.

   b) What is the conflict?

   c) How could the conflict be resolved?

3. From the collage

   a) list 1 feature that you expect would have minimal impact on the environment of the catchment

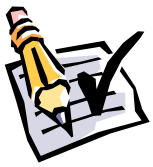
   b) list 1 feature that you would expect to have a major negative impact on the environment of the catchment.

<u>Personal Values</u>

Having discussed the features of the catchment from the collage students then identify 1-3 features that they personally value most in living in the Brisbane Water catchment.

Students also identify the cost to that catchment in realising these pursuits.

Exercise 29: Values



Develop a collage or mindmap using the template provided that illustrates your perception of human use of the catchment using the headings below.

Leisure
Tourism

Our Catchment

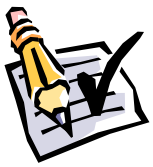
Personal

Work

Teacher's Note: Sustainability in the Catchment

Each student receives two handouts:
1. the figure showing a sustainable and unsustainable catchment (p105)
2. a page of labels (opposite)

Students are to cut out the labels then match them to sites 1 – 9 on the figure, colour the figure in appropriately then paste in books.



Exercise 30: Sustainable Catchments

Match these labels to sites (1) to (9) on the figure of sustainable/ unsustainable catchment. Colour appropriately then paste in book.

Sustainable catchment	Unsustainable catchment
A clear bay provides a pleasant environment for human activities and encourages the growth of seagrass to maintain a healthy environment for aquatic life.	Poorly sited public facilities and unplanned use of the beachfront can cause coastal erosion and destroy the attractiveness of the area.
A clear river mouth enables navigation of boats upstream and ensures the most efficient discharge of river water and nutrients into the bay.	Poorly maintained farmland contributes to: • erosion • decline in yields and farm income • deteriorating farm water supplied • silting of streams
Carefully sited public facilities and a well-managed beach ensure a pleasant and stable environment for future generations.	Poor quality dirty water results from soil being washed into the storage from the cleared hills. The storage gradually becomes filled with silt.
The high quality of the water in the storage is maintained because the water has been 'filtered' by the forested area. The water is clear and suitable for farm, domestic and industrial use.	Cultivation down the slope is more likely to cause soil erosion and create massive scars in the landscape.
Well managed farmland which maintains a good groundcover of trees, grasses or crops helps to: • minimise erosion • increase yields and farm income • maintain high quality farm water supplies • prevent silting of streams	A bay polluted by rubbish and the discharge of wastes and sediments from the river is unattractive to humans and unsuitable for aquatic life.
Forests on steep slopes protect the soil and maintain water quality. National Parks provide wildlife habitats and cater for recreational areas and tourism.	Over-clearing of forests on steep slopes exposes the land, leading to landslips and erosion of the soil. Eroded soil is eventually washed into streams.
Contour cultivation and a system of contour banks, waterways and conservation cropping enables the use of land while minimising soil erosion.	When trees are not maintained along stream banks or on farms, soil suffers from erosion by water and wind.
Trees along stream banks help prevent streambank erosion. Strips of trees provide windbreaks to prevent soil erosion, shade and shelter for livestock and wildlife, and improve the appearance of the farm.	Cultivation and over-grazing on steep slopes can lead to erosion.
Treatment of industrial and domestic wastes ensures that discharges do not harm the environment.	Uncontrolled discharge of industrial and domestic wastes can harm the environment by lowering water quality, making it unsuitable for human use, and possibly killing fish and other aquatic life.

See appendix 7

The discussion of the principles of Ecologically Sustainable Development leads into the following case studies. Each case study is a development proposal. Students work in groups to assess whether the proposal is in keeping with the principles of ESD and then produce a report with their recommendation – (either approval or non-approval).

Precautionary Principle - an example would be if you were trialing a new drug. It's not introduced until a full assessment has been completed in case there are any unknown side effects. This same principle should be applied in managing the environment.

Point ii) - keeping the drug analogy: a possible scenario would be a new drug being available to treat acne however it may cause a weight increase - would you take the drug?

Intergenerational Equity: Suppose a wealthy landowner had bought the land surrounding Avoca Beach in 1950 and has developed it as a private resort complex - thereby denying access to the public to the beach. Did this purchase consider the needs of future generations?

Improved valuation

Point 1 - environmental assessment of proposed development should include costings on the loss or damage to environmental features present. For example: a costing on the proposed fast ferry service might include a financial assessment of the impact on features we take for granted:

- mangroves - filtering mechanism, sediment control, erosion protection.
- sea grass beds – fish / prawn nursery

Point 2 – How do we assess the effects of pollution? Need to measure the features of the environment before approval in order to assess impact.

Point 3 - life cycle of goods
The full life cycle of a big Mac includes - farming and agriculture producing raw materials such as beef, bread roll, paper packaging - labour in cooking and serving - disposal of packaging

While many companies price structure take into account all of those steps in producing the merchandise there is very little, if any, account of the disposal of the product. eg – Styrofoam

Point 4 - Examples of incentives would be aluminium can recycling, deposits on bottles, cheaper prices for recycled goods.

Additional resource – McLibel Website

Principles of Ecologically Sustainable Development

From 1992 the government agreed to support ecologically sustainable development(ESD). The principles of ESD are:

- **Precautionary Principle ("If your not sure, don't do it")**

If what you are going to do might damage the environment then it's better not to do it.

When deciding whether to develop the catchment you should:

i) avoid, where possible, damage to the environment
ii) look at all the options and rate them in terms of risk to the catchment.

- **Intergenerational Equity (the welfare of future generations is considered)**

Consider the future - we need to make sure that what we do now keeps the environment healthy or in a better condition for future generations.

- **Conservation of biological diversity and ecological integrity-**

It is most important that we conserve biological diversity and keep ecosystems in a healthy state.

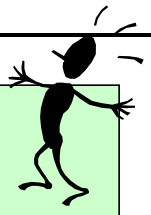
- **Improved valuation, pricing and incentive mechanisms:**

⇒ The financial value of the environment needs to be included when planning changes to the environment.

⇒ polluter pays, if people pollute then they should pay to fix up the environment

⇒ when working out the cost of a product or service, the cost of recycling or disposal should be included (full life-cycle costs)

⇒ Structures should be put in place to keep the cost of solving environmental problems as low as possible



Outcomes

After completing this section students should be able to:

- produce a report / presentation based on a problem solving exercise
- understand the roles of various agencies / stakeholders in managing the catchment

Teacher's note: Case Studies

Only three group case studies are presented here as it is hoped that teachers will use the Rumbalara Website to access current community issues posted there by local community groups. Alternatively, students may wish to explore local issues from their area. Newspaper clippings make good starting points.

In developing a report for or against the proposal or issue, students should be encouraged to consider all points of view and to measure these against the 4 principles of **ecologically sustainable development (ESD)**.

A scaffold for writing such a report is available opposite.

These case studies could also act as starting points for Stage 5 individual projects for some students.

Introduction
This paragraph should clearly state:

- what the proposal or issue is
- where the site is and its current use
- who the stakeholders are

Arguments for the proposal
This section should

- list the benefits of the proposal
- describe who would benefit and how
- examine any long term benefits of the proposal for the region
- state any evidence of community support for the proposal

Precautionary Principle
This section should examine:

- the environmental threats the proposal or issue presents
- whether these threats are serious or irreversible
- whether other options exist or have been considered
- conditions which might be imposed to prevent serious damage

Intergenerational equity
This section should consider whether the proposal or issue could have long term effects:

- on health
- on biological diversity
- on the productivity of the environment

Conservation of biological diversity and ecological integrity
This section examines:

- whether or not the proposal or issue will threaten individual species within the environment
- what studies or data would be needed to ensure no harm to individual species
- how to ensure that ecosystems are protected
- the need for guidelines to prevent ecosystem damage during development

Improved valuation, pricing and incentive mechanisms
This section discusses:

- the value of the environment under consideration (eg attracts tourists, better fishing, etc)
- what additional pollution or wastes the proposal might generate
- how that pollution or wastes could be limited (and who pays for this)
- how wastes will be disposed of (and who has the responsibility for this)
- what incentive structures exist to ensure that the developer will develop environmentally friendly solutions to any problems encountered

Conclusion
The final paragraph contains a firm recommendation for or against the proposal and states the main reasons behind your group's decision. This section could also state any conditions or guidelines that you feel should be imposed on the developer.

Scenario:

Your group represents a Sydney based Development Company that wishes to build a housing estate at Kincumber.

The area of land is shown on the map attached. The land borders on Kincumber Creek and also an area of wetland.

The following documentation is provided:

- Characteristics of site
- A report from NSW Fisheries
- Wetlands appraisal
- A report from National Parks and Wildlife Service (NPWS)
- Section 90 questions

The process:

Your group is to study the map and the DA. Each person in the group reads one of the reports provided - and needs to become an "expert" on that information.

What you need to do:

Your group must produce a report that addresses the questions in Section 90 for your development and makes a recommendation for or against the proposal.

Your report should follow the **Report Scaffold for the case study**.

CHARACTERISITCS OF THE SITE

LOCATION: The proposed site is located next to Kincumber Creek within the township of Kincumber.

Kincumber lies six kilometres to the southeast of Gosford, approximately 80 kilometres north of Sydney, on the Central Coast of New South Wales.

LAND USE: Land use is controlled under the Gosford Planning Scheme (as amended). Six principal land uses occur – urban investigations, residential, industrial, special uses, open space and conservation.

The dominant proportion of the population resides within the urban centres lining the coast and Brisbane Water. Selected industrial areas exist, for example, Erina. The wetlands, major ridgelands and coastal cliffs are zoned as Open Space or Conservation with their long-term value for environmental protection and the retention of their existing natural character.

NEW SOUTH WALES FISHERIES

REPORT ON THE PROPOSED HOUSING DEVELOPMENT SITE AT KINCUMBER

The proposed development may impact on Kincumber Creek.

Kincumber Creek is expected to support a variety of marine fauna, including fish and crustaceans. The distribution of fauna types in the creek varies according to the site being sampled.

The seagrass habitat is important to many species as a source of food, shelter and protection. The adjacent mangrove and saltmarsh communities enhance the value of this habitat.

Various studies on the NSW Central Coast have emphasised the "nursery" role of seagrass beds and mangroves in providing temporary habitat for many young fish. The seagrass beds are also important in providing a habitat for many invertebrates.

Fish likely to be found in the area around the mangroves include silver buddies and flat tail mullet. The seagrass beds tend to attract yellow-finned bream. Sand whiting can be found in sandy habitats along the creek and Trevally in the estuaries.

School prawns are likely to be found in significant numbers in Kincumber Creek and The Broadwater. The provision of cover seems to be an important factor in maintenance of a nursery habitat for many of these species.

Invertebrates such as worms, molluscs, small crustaceans and insect larvae are essential elements in the food chain.

The investigation shows a general lack of diversity outside the mangroves and seagrass beds.

An oyster farm is located 300m south of the entrance of Kincumber Creek. Oyster productivity can be influenced by poor water quality; high levels of turbidity and non-filterable residue are most damaging.

NATIONAL PARKS AND WILDLIFE SERVICE

A REPORT ON THE PROPOSED HOUSING DEVELOPMENT SITE AT KINCUMBER

The site and areas surrounding it have the capacity to support various forms of wildlife.

The vegetation along Kincumber Creek and the estuarine waters attract a large diversity of birds. Several bird species are migratory waders, which are protected under the terms of the Japan Australian Migratory Birds Agreement. These species are particularly dependent upon the creek with its shallow water and regularly exposed mud flats with several species using the saltmarshes and the mangrove communities landward.

The shallow waters and mangroves are also important components of bird habitats providing night roosts, nesting areas and feeding areas.

The area is found to have Bush Stone Curlews that are classified as threatened fauna and scarce bird species such as the Mangrove Heron and Buff-banded Rail.

The lack of much groundcover in the area creates an environment generally unsuitable for mammals. Bats are the most common species to be sighted. The occurrence of native mammals is further lessened by the presence of dogs and cats.

It is highly probable that neither amphibians nor reptiles would be permanent residents within the area due to much unsuitable habitat.

WETLANDS APPRAISAL

SOURCE: GOSFORD CITY COUNCIL

REPORT ON THE PROPOSED HOUSING DEVELOPMENT SITE AT KINCUMBER

The low sloping foreshores of Kincumber Creek and surrounding areas have produced extensive wetlands. The foreshores are diverse in ecological structure and detail. It is regarded as a significant ecosystem, which must meet the minimal disturbance requirement outlined in the relevant policy.

The wetland site is the area generally defined by the common edge between the Casuarina forest and Eucalyptus forest, often bordering residential blocks (refer to Figure 1). The area extends down to the mean high tide watermark covering approximately 20 hectares.

Wetland degradation has been common in the past. The area of mangroves has not substantially changed sine 1954, but the area of saltmarsh has been reduced from ten to four hectares as a result of the intrusion of other residential development.

At present, various threats to the condition of the wetland exist. Such threats include uncontrolled access and formation of indiscriminate tracks, compaction of soil and destruction of ground cover vegetation, siltation of the creek and increased turbidity, dumping of non-biodegradable rubbish and the growth of noxious weeds.

Specific land uses immediately adjacent to the creek such as Frost Reserve and the Kincumber Pumping Station also interacts with the wetland ecology. In addition, there is the potential for illegal cutting of mangroves and Casuarinas where they back onto recently developed subdivisions and residents may attempt to reclaim the public reserve along Kincumber Creek for their own purposes.

SECTION 90 CONSIDERATIONS

The following points are taken from the Environmental and Planning Act (section 90) that must be considered when presenting a developmental application to Gosford.

a) the impact of that development on the environment (whether or not the subject of an environmental impact statement) and, where harm to the environment is likely to be caused, any means that may be employed to protect the environment or to mitigate that harm;

b) the effect of that development on the landscape or scenic quality of the locality;

c) the effect of that development on any wilderness are in the locality;

d) the social effect and the economic effect of that development in the locality;

e) the character, location, siting, bulk, scale, shape, size, height, density, design or external appearance of the development;

f) the size and shape of the land to which that development application relates, the siting of any building or works on that land the area to be occupied by that development;

g) whether the land to which that development application relates is unsuitable for that development by reason of its being, or likely to be subject to flooding, tidal inundation, subsidence, slip or bushfire or any other risk;

h) the relationship of that development to other development on adjoining land or on other land in the locality;

i) whether the proposed means of entrance to and exit from that development and the land to which that development application relates are adequate and whether there is adequate provision for loading, unloading, manoeuvring and parking vehicles within that development or on that land;

j) the amount of traffic likely to be generated by the development, particularly in relation to the capacity of the local road system and the probably effect of that traffic on their movement of traffic on that road system;

k) whether public transport services are available and adequate of that development;

l) whether utility services are available and adequate for that development;

m) whether that development is likely to cause soil erosion;

n) the public interest.

Case Study 2 - Marina Development

Scenario:

Your group represents a boating club that uses Brisbane Water. They wish to develop a marina for their use. This involves less than 30 vessels (so no Environmental Impact Study is required).

The process:

You are provided with
- a map of Brisbane Water showing the location of sensitive areas such as wetlands and seagrass beds
- a UBD street directory for the Central Coast

You need to choose a site for your marina.

You need to consider such things as:
- access to the marina for both boats and road vehicles
- environmental considerations
  - pollution risk (sewerage, fuel, antifouling paints etc)
  - noise
  - wash, erosion
  - acid-sulfate soils
  - habitat loss (wetlands, mangroves, seagrasses)
- visual impact and heritage considerations
- the impact of your development on the surrounding area

Three agencies are linked to this development - Waterways, NSW Fisheries and Department of Land and Water Conservation.

What you need to do:

Your group must present a proposal for your marina. This will include:
- a drawing of the marina in its setting;
- an explanation of the benefits of the chosen location;
- a report to Council (using the **Report Scaffold for the case studies)** explaining the proposal and recommending that they approve the development because you have considered the environmental implications.

References
- Gosford City Councils Brisbane Water Plan of Management
  Section 11.2 (Marinas and Recreational Boating Facilities)

See appendix 8

Case Study 3 – Sydney / Gosford Ferry Proposal

The proposal to develop a regular 'Super-Ferry' service between Gosford and Sydney has aroused the community. Read the following newspaper articles and then answer the Questions that follow:

See appendix 9

Case Study 3 – Sydney / Gosford Ferry Proposal

1. List the concerns expressed by the Community
2. List the benefits of the proposal.
3. The ferry won't be built until approval is given to operate within Brisbane Water. Should approval be given on the basis of the modelling done by the operators?
4. How can the communities concerns be addressed scientifically?
5. Where can the community get reliable information on the impacts?
6. Hold a mock Council meeting to consider whether or not the ferry should be approved.

USING THE BRISBANE WATER CATCHMENT UNIT TO LEAD INTO A STUDENT RESEARCH PROJECT

The following section may assist teachers and students in developing a student research project that will meet the requirements of the Stage 4/5 Science syllabus.

Stage 4 projects may be all group efforts but at least one project in Stage 5 must be an individual effort.

It is hoped that this unit of work will stimulate students to want to study further aspects of their local area.

The project may be used to enter competitions. Information about these competitions and past projects in this area can be found at the following:

- BHP Science Awards (http://www.Bhp.com.au/scienceawards/student3.htm)
- The Earthworm Environmental Awards (see ASTA's internet site for more details http://www.asta.edu.au)
- CREST (http://www.csiro.au/communication/csiroedp/crest.htm)

Another good resource is the Science Stages 4/5 support document p115-147.

The following example is presented to show how a project may follow on from this unit of work.

NB Lessons may have gaps between them depending on the teaching plan and duration of the project. It is anticipated that a project will span about 4 weeks.

Lesson 1

(a) Discuss criteria for a successful project e.g. teacher may have a proforma.

(b) Discuss various ways in which the project can be presented.
e.g. video essay
photographic essay
survey
practical report
research assignment

(c) Decide on assessment.

(d) Homework – think about an issue/question that you would like to investigate.

Lesson 2 **Brainstorm research topics e.g.**

- A personal history showing how the local area has changed
- Water-holding capacity of different soils and the implications for plants growing in these soils
- A report on local endangered species
- A study of a local waterway (Streamwatch)
- An airwatch study
- The effect of fertiliser on plant growth
- Factors effecting seagrass growth
- Mangroves in the Brisbane water catchment
- Use the Internet link to Rumbalara to investigate an issue identified by local groups as being of concern.

Homework – students select a research topic/question and present a draft plan of what they intend to do before starting the project. This is an assessable part of the project and important in skills development.
This plan is checked by the teacher to determine if the project

- meets the criteria
- is achievable in the set time frame
- does not involve activities that are dangerous or cruel

Lesson 3 **Mid project progress report. This could be the presentation of a log book of activities, or a report to the class.**

It is up to the teachers to decide how much time is spent in class on the project.

Lesson 4 This lesson should occur after the data collection phase of the project. Students may need assistance with putting the results together in a meaningful way.

Lesson 5 Presentation of reports. Peer assessment may be a part of this process.

APPENDIX A: References relating to the History of the Central Coast

Author	Title	Published	Year
	A History of Central Coast Schools	Education Sub-committee of Gosford Bicentennial Community Committee & Gosford City Council	1988
	Bouddi Peninsula Study "Coastwatch"	Association for Environmental Education (NSW) Central Coast Region	1986
	Central Coast Heritage 1788-1988	Heritage Sub-committee of Gosford Bicentennial Community Committee	1988
	Convict Trail Video	Produced by Monterose Media	1996
	Pioneer families of the Brisbane Water District of NSW	Central Coast Family History Group and Gosford City Council	1992
	The Cockle Bay Wetland	Assocn for Environmental Education (NSW) Central Coast Region	1988
	These are my people this is my land [Bungaree] – Aboriginal people and their culture, North of Sydney Harbour	NSW Dept School Education Professional Services Met North Region	1991
Bennett, F. S	An Historical of The Entrance and district – Hist Mon 2		
Bennett, F. S	An historical tour of Wyong and district – Hist Mon 3		
Bennett, F. S	Story of the Aboriginal People of the Central Coast – Hist Mon 1		
Bottomley, W	Back Then – Talking about the past around Yarramalong	Wirrimbirra Workshop Brush Creek	1993
Bottomley, W.	Great North Road Oral History		1996
Branagan, Herbert & Langford Smith	The Sydney Basin	Science Press Univ, Sydney	1970
Brennan, F. E	History of Gosford	Wyong Shire Historical Society	1981
Brennan, F. E.	History of Gosford Historical Monograph No. 4	Wyong Shire Historical Society 28 pp	1970
Dundon	Old Gosford & District in Pictures (three books)	Gosford Printing Co	1980
Dundon, G.	More Old Gosford and District in Pictures	Dundon, G.	1978
Dundon, G.	Old Gosford and District Album	Dundon, G.	1985
Dundon, G.	Old Gosford and District in Pictures	Dundon, G	1977
Dundon, G.	The Third Old Gosford and District in Pictures	Dundon, G.	1980
Dundon, Gwen	The Shipbuilders of Brisbane Water NSW		1997
Fisher, Darrell G.	The Central Coast of New South Wales. Environment and People		1997
Gosford District Historical Research Assocn	The Gosford Model Farms … A Review	Gosford Printing Pty Ltd	1981
Nashar	Geology of the Sydney Basin	Jacaranda	1967
Pratt, E.	Place Names of the Central Coast Origins and Meanings. Historical Monograph No. 5	Brisbane Water Historical Society	1978
Pratt, Eileen	Place Names of the Central Coast – Origins and Meanings	Brisbane Water Historical Society	1978
Russell, B	From Pudgeway to Budgewoi – A Brief History of Budgewoi – one of the Central Coast's popular and picturesque areas	Russell, B	1984
Smith, B.	Pearl Beach – Early Days	Leisure Publications, Pearl Beach	1993
Stinson, Edward	A Pictorial History of the Wyong Shire – Volume 1	Wyong Shire Council	(4th Edn) 1994

Stinson, Edward	A Pictorial History of the Wyong Shire – Volume 2	Wyong Shire Council	(2nd Edn) 1986
Stinson, Edward	A Pictorial History of the Wyong Shire – Volume 3	Wyong Shire Council	(2nd Edn) 1994
Stinson, Edward	A Pictorial History of the Wyong Shire – Volume 4	Wyong Shire Council	(1st Edn) 1983
Stinson, Edward	A Pictorial History of the Wyong Shire – Volume 5	Wyong Shire Council	1st edn - 1984
Stinson, Edward	A Pictorial History of the Wyong Shire – Volume 6	Wyong Museum Group and Historical Society	1988
Stinson, Edward	Centenary of Wyong – A Pictorial Record.	Wyong Museum Group and Historical Society	1987
Strom, Allen A.	Wamberal Lagoon Nature Reserve	National Parks and Wildlife Service	
Strom, B.	Gosford / Wyong History and Heritage.	Gosford District Historical Research and Heritage Association	1985
Strom, B.	McMasters Beach – A History.	Gosford District Historical Research and Heritage Association	1985
Strom, B.	The Maitland Story Information Sheet	Available from Woy Woy Environment Centre	1992
Strom, Goldstein & Strom	Central Coast (Evaluating the Environment of a Region)	National Parks & Wildlife Service	1978
Swancott, C.	Gosford and the Henry Kendall Country (Koolewong to Lisarow)	Brisbane Water Historical Society	1966
Swancott, C.	Highlights of Central Coast History	Brisbane Water Historical Society	1984
Swancott, C.	The Brisbane Water Story – Part 1 – Gosford and Early Brisbane Water	Brisbane Water Historical Society	1953
Swancott, C.	The Brisbane Water Story – Part 3. Enchanted Waters: Terrigal, Wamberal, Kincumber, Erina, Avoca to Wagstaff Point, etc	Brisbane Water Historical Society	1961
Swancott, C.	Wisemans Ferry	Brisbane Water Historical Society	1965
Tabuteau, P. E	Collected Records of the District of Brisbane Water to 1891.	Gosford District Local History Study Group	1991
Tabuteau, P. E	Historical Records of the Central Coast of New South Wales; Rev. Alfred Glennie Journals 1855-60.	Gosford District Local History Study Group	1987
Tabuteau, P. E	Historical Records of the Central Coast of New South Wales; Rev. Alfred Glennie Journals 1860 on.	Gosford District Local History Study Group	1988
Tabuteau, P. E	Historical Records of the Central Coast of New South Wales; The Brisbane Water Case 1837-8	Gosford District Local History Study Group	1989
Toghill, J.	The Historic Hawkesbury River – A Waterway of Magnificant Contrast	Reed Pub.	1981
Vinnicombe, P.	Predilection and Prediction (unpublished) Report to NSW NPWS Gosford	Held Local Studies Section Gosford City Library	1981

Other sources of information…… visit the Rumbalara Website at *www.rumbalarafsc.nsw.edu.com*

Appendix B: Master Copies

1. Vegetation Classification

Height of Tallest Layer	Foliage Cover of Tallest Layer				
	100-70%	70-50%	50-30%	30-10%	<10%
Trees > 30m	Tall closed – forest	Tall forest	Tall open-forest	Tall woodland	
Trees 10 –30m	Closed-forest	Forest	Open forest	Woodland	Open-woodland
Trees< 10m	Low closed - forest	Low forest	Low open-forest	Low woodland	Low open-woodland
Shrubs > 2m	Closed-scrub	Scrub	Open-scrub	Tall Shrubland	Tall open-shrubland
Shrubs 0.25-2m					
Sclerophyllous	Closed-heathland	Heathland	Open-heathland	Scrubland	Open-shrubland
Non-sclerophyllous	-	-	Low shrubland	Low shrubland	Low open-shrubland
Shrubs < 0.25m					
Sclerophyllous	-	-	-	Dwarf open-heathland	Dwarf open-heathland
Non-sclerophyllous	-	-	-	Dwarf shrubland	Dwarf open-shrubland
Grasses (tussock)	Closed grassland	Grassland	Grassland	Open grassland	Very open grassland
Sedges	Closed -sedgeland	Sedgeland	Sedgeland	Open-sedgeland	Very open-sedgeland
Herbs	Closed-herbland	Herbland	Herbland	Open-herbland	Very open-herbland
Ferns	Closed-fernland	Fernland	Fernland	-	

* A tree is defined as a woody plant usually with a single stem; a shrub is a woody plant usually with many stems arising at or near the base.