Swan River Education Kit

Excursions in the Swan River Environment

Fieldwork and activities to support studies in Science, and Society and Environment

acknowledgements

This kit brings together many educational projects and resources which focus on the Swan River and its environment. Thanks go to the dedicated group of teachers who worked on the project 'Swan River Action Sites', which has been adapted for and incorporated in the kit. Many staff members of the Water and Rivers Commission and the Swan River Trust were involved in the development of this resource and their contributions are also acknowledged.

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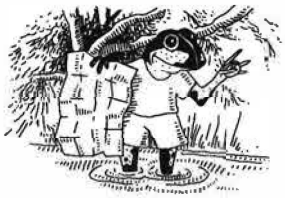
The Swan River Education Kit



The Swan River Education Kit, an initiative of the Water and Rivers Commission and the Swan River Trust, is a broad-based education program with curriculum support materials, developed for use by schools in the Swan River catchment.

The kit aims to encourage a knowledge of the river and provides a meaningful context in which students can develop skills of investigation and attitudes of environmental responsibility.

This resource has been developed for teachers of the Science, and Society and Environment learning areas. It aims to enrich teaching and study in these learning areas by providing a range of themes and ideas for studies of the Swan River that can be easily integrated into the school curriculum.

The kit was developed in the belief that direct experience of the river environment is essential for students to develop a close association with it and an environmentally responsible attitude. These materials have been written on the assumption that the teacher will provide students with the opportunity to visit a river site on at least one occasion to gain practical 'hands-on' experience.

An integrated, whole-school approach to a study of the Swan River environment could be developed within the context of the Curriculum Framework.

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experience of the river environment is essential for
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Contents of the Swan River Education Kit

The Swan River Education Kit consists of:

WORKING SCIENTIFICALLY IN THE SWAN RIVER ENVIRONMENT

Activities for studies of the physical and biological environment of the river in the Science learning area.

A SENSE OF PLACE IN THE SWAN RIVER ENVIRONMENT

Activities for studies of the Swan-Avon catchment in the Society and Environment learning area.

EXCURSIONS IN THE SWAN RIVER ENVIRONMENT

Fieldwork excursions and activities with worksheets and resource information. The excursions support some activities suggested in the Society and Environment, and Science booklets.

SUPPORT MATERIALS

- Brochures
- Water facts
- Video
- Posters
- Water Quality Data disc
- Swan-Canning River and Estuarine System Map

Contents

Teacher Notes

Excursions

Resources

Appendices

These teaching ideas and support materials are designed to assist teachers to develop understandings, values and skills as they relate to the Swan River and its catchment in particular, and to rivers and their catchments in general

Rationale and aims

This booklet is part of an educational program that comprises curriculum support materials developed for use by schools planning to conduct studies of the Swan River environment. The excursions and associated activities will provide for a variety of learning experiences at river sites. They are designed to enrich the teaching and learning of both Science, and Society and Environment. They will also assist teachers to develop some of the suggestions in the booklets *Working Scientifically in the Swan River Environment* and *A Sense of Place in the Swan River Environment.* Most of the student activities have a subcatchment emphasis and can be carried out at a single river site. The booklet consists of instructions and resource sheets for teachers, and worksheets and resource sheets for students.

The worksheets and resource sheets are open-ended and varied. Some are more comprehensive than others and suggest more extensive follow-up work. The emphasis is on students developing confidence in exploring the environment at a particular river site, and enjoying both the environment and their educational experiences in it. Each worksheet includes suggestions for tasks that facilitate student motivation, reflection, personal ownership of tasks and ongoing commitment to and interest in river systems and their care and management. The booklet commences with excursions and activities that encourage reflection, followed by observational investigative activities gradually increasing in complexity.

There is an old saying that students learn best about an environment through the soles of their feet. The full educational potential of the Swan River or one of its tributary streams is best realised when students are able to explore it for themselves.

A trip to a waterway provides a meaningful context in which to encourage students to develop a knowledge of the river, the catchment (or subcatchment) and rivercare issues. The activities encourage students to clarify values of concern for environmental protection and conservation, and help to develop problem-solving skills. Student outcomes of river site experiences include:

- a raised level of awareness of, and sensitivity towards, the river environment
- an improved understanding of environmental processes
- an improved understanding of the relationships between human activities and river health
- investigative skills to assist in solving environmental problems
- environmentally responsible attitudes and behaviours
- informed decisions about the future of the river environment
- an enjoyment of the river environment and the learning experiences in it

Choosing the excursions and using the worksheets

- Selected excursions and activities can be incorporated into a river study program created from the teaching approaches provided in the booklets *Working Scientifically in the Swan River Environment* and *A Sense of Place in the Swan River Environment.*
- Selected excursions could be incorporated into a one-day river fieldwork program.
- Selected worksheets and resource sheets can be incorporated into teaching programs as assessment tasks.
- The activities and the placement of the various steps involved in an excursion or activity can be modified to suit the ideas of the teacher, the students and the situation.
- The excursions and activities can be used in both the *Science* and *Society and Environment* booklets and even to develop themes in other learning areas.
- Most of the excursions are site-based experiences. They involve students observing in the field, considering their collected information and/or reflecting on perceptions and feelings gained from the experience.
- The excursions provide opportunities for collaborative learning and group work.
- Students should be encouraged to negotiate aspects of the task and afterwards to commit to some action that will ultimately benefit the river site.
- Some excursions and activities are based on ideas developed by other groups/organisations concerned with environmental education. Due acknowledgment is given in each case.

A trip to a waterway provides a meaningful context in which to encourage students to develop a knowledge of the river, the catchment (or subcatchment) and rivercare issues.

Excursions

How do I feel?

Students reflect on their personal feelings about the river site.

Outcomes

Students will be able to:

- show understanding that places can have values that are difficult to measure and evaluate
- discuss the feelings that people may have about places in the environment
- explain how the way people feel about a place influences the value they place on it
- recognise that the value people place on an environment affects how they behave towards it

Preparation

Photocopy a class set of the Student Worksheet *How do I feel about the river environment?*

At the site

- Allow quiet time for students to observe and reflect either before or after other exercises undertaken at the river site.
- Using the worksheet *How do I feel about the river environment?* students study the paired words and tick a position between them which best matches their feelings about the river environment at this site.
- Ask students to share and analyse their impressions.
- Encourage students to plan a creative task that reflects their feelings or helps to create positive feelings in others, e.g. creative writing (perhaps a poem), making a work of art, or performing a musical or dramatic item. Students might plan and draft their work at this stage if there is going to be some time to complete the activity later.

Follow-up activities

- Students complete their creative activity and display or perform it for the benefit of others.
- Teachers might use this activity as a stepping-stone for an exploration of students' feelings about the value and importance of natural landscapes in urban areas. For example, students could identify a personal special place (largely natural) in their local area and consider its intrinsic worth. They could survey or map the natural places in their local area and consider their value.
- Some affective activities such as those described in books from the Gould League or the Institute for Earth Education are also useful for focusing students' attention on the emotional tone of the environment.

REFERENCE CHECKLIST

Student Worksheet
How do I feel about the river environment?

OTHER RESOURCES

Gould League or Institute for Earth Education books

1 excursion

Student Worksheet

How do I feel about the river environment?

Sit in a quiet place (away from other people) and look around you. Listen. Concentrate on how your surroundings make you feel. Try to put all other thoughts out of your mind.

Try to work out your own feelings about this place. Do this by looking at the pairs of words listed below and decide, for each pair, which one of the words best describes your own feelings about the surrounding environment. Put a tick on the line in the position between the two words that indicate your feelings. For example, if you think the environment is fairly tranquil, but a little busy, you would put a tick towards the tranquil end. Tick in the middle if you cannot decide one way or the other.

tranquil	busy
interesting	boring
safe	dangerous
impressive	unimpressive
exciting	dull
valuable	worthless
mysterious	ordinary
cheerful	depressing
friendly	hostile
pleasant	unpleasant
natural	artificial
unspoiled	degraded
wild	tame
alive	dead
cared for	neglected
thriving	struggling

This activity is based on activity 125 *How do I Feel?* from *Project Reef-Ed* developed and published by the Great Barrier Reef Marine Park Authority, 1988.

Needs auction

Students assume the role of a character with a vested interest in the river site and bid for their needs at an auction.

Outcomes

Students will be able to:

- recognise the needs of both animals and people at river sites and the difficulties of accommodating environmental, social and economic values in any conflict situation
- explain the economic problem of limited resources but unlimited wants
- role play a situation in which they work with a simulated financial value that has been placed on environmental needs
- suggest ways of distributing financial resources so that competing needs are all accommodated
- recognise that individuals and organisations that have interests in river environments have different levels of power, influence and financial resources

Preparation

Photocopy the Student Worksheet *Auction bidding sheet* and prepare character cards for selected characters listed on the Teacher Resource Sheet *Bidders for needs auction.*

At the site

- Introduce the concept of the economic problem at the river site. River site users have unlimited and often different wants, but resources are limited. Discuss the value of sharing resources equitably.
- Students adopt the character of either an animal or a particular person who needs the resources of this site and select the matching character card.
- Students are given the student worksheet and are allocated an equal amount of 'money' (e.g. $1000) with which they can plan to buy their resource needs at an auction.
- Students consider and select the items they most need for survival from those listed on the worksheet, and decide which needs they will bid for and how much they can afford to spend on each.
- The auction then begins under the control of an auctioneer, who sells each item to the top bidder. (Students can bid by holding up their character cards for others to see.)
- At the conclusion of the auction, participants state what they have bought and what they missed out on. They can then discuss the outcome of the auction.

Follow-up activity

This activity can be tried again, by varying the amount of starting money received by different characters (so students can compare the artificial situation with the real-life situation of unequal distribution of purchasing power). They can then decide if equal resource distribution is the fairest way of solving access issues related to the river site.

REFERENCE CHECKLIST

- Teacher Resource Sheet *Bidders for needs auction*
- Student Worksheet *Auction bidding sheet*

Teacher Resource Sheet

Bidders for needs auction

Animals

a swan	a frog
a pelican	a tiger snake
a dolphin	an egret

People

a picnicker	a rower
a jetskier	a cyclist
a birdwatcher	a windsurfer
a waterskier	an angler
a **resident** who walks past this site daily	a **resident** who depends on drainage into the river to prevent winter flooding of their home
a local take-away **food shop owner** who discards hot fat into the drain leading through to the river	a **local hotel owner** who has carpets cleaned weekly and disposes of waste water into a stormwater drain leading to the river
a **town councillor** who needs the site as a rubbish tip	a **local motorist** who likes driving past this river view
a **local resident** who looks out on an attractive river view	a **tour operator** who takes tourists by boat up and down the river
a **local horse owner** who has horses grazing in riverside paddocks	a **local horticulturist** who extracts river water to irrigate orchids
a **local resident** who wants to restore the river to its natural healthy state	A **yoga teacher** who uses the spot for a daily early morning class

Student Worksheet

Auction bidding sheet

ITEMS (NEEDS)	AVAILABLE	MY TOP BID	ACTUAL TOP BID	PURCHASER
A rubbish-free environment				
Friendly, fun-loving tourists and visitors				
Good facilities (picnic tables, toilets, etc.)				
An attractive natural environment				
Wide grassy areas				
A big, efficient drain that flows into the river				
A major road with river views				
Pollution-free river water				
Healthy natural vegetation to protect river banks				
Plenty of eating-sized fish in the river				
Shallow water at the river's edge				
Lots of reeds and sedges at the river's edge				
Jetty and deep water				
Unrestricted rights to use water for irrigation or industry				
Plenty of parking				
Total				

3
excursion

Effects of human activities at the river

Students evaluate the problems caused by human activities along the river.

Students conduct a survey to note areas of pollution and other forms of degradation caused by people. They then consider possible solutions and prepare a creative presentation highlighting one or more of their suggestions.

REFERENCE CHECKLIST

- Student Worksheet *Possible impacts of human activities*

OTHER RESOURCES

- Resource sheets from the booklets *Working Scientifically in the Swan River Environment* and *A Sense of Place in the Swan River Environment*
- Water facts 3, *River and Estuary Pollution*

Outcomes

Students will be able to:

- identify human uses of a river site and accurately appraise conditions
- explain how human activity can both directly and indirectly impact on river environments in both positive and negative ways
- detail the ways in which direct human activity contributes to degradation of river sites
- discuss possible solutions for minimising the impact of human activity on specific river sites and river systems in general
- design a presentation that highlights a way of tackling problems caused by human activity

Preparation

Introduce or revise the terms 'degradation' and 'pollution', and discuss how pollutants enter waterways.

NOTE: Pollution includes discarded litter and dumped material, slicks on the water, sediments and chemicals entering through drains, and chemicals from gardens and road surfaces carried by surface water into the river. Other forms of degradation include eroding banks, aquatic weeds, foreshore weeds, compacted soil and the clearing of native vegetation.

At the site

- Using the Student Worksheet *Possible impacts of human activities* to record their observations, students explore the site for signs of past and present human activity. Brainstorm a list of less obvious human activities that might take place at the site.
- Students examine the site for observable signs of pollution and other forms of degradation. Suggest other less visible forms of degradation that may be occurring. Record on the worksheet the possible environmental consequences of each type of human activity listed.
- Students sketch a map or picture of the site to show the location of all forms of degradation, and annotate the map with brief suggestions as to why particular forms of degradation might be occurring.
- Discuss how each of the identified sources of degradation could be controlled.

Follow-up activities

- Students design creative solutions to the problems caused by human activity at the river site investigated. For example, they could develop a code of conduct for various users of the site, design a slogan to reinforce the code or produce a poster that lists the code's main points and uses for the slogan.

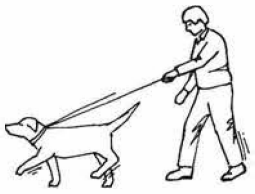
Student Worksheet

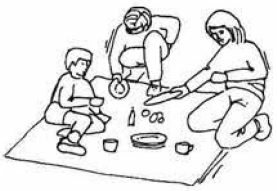
Possible impacts of human activities

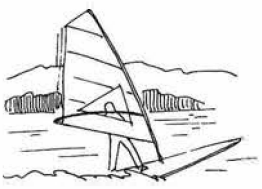
Instructions

A number of human activities may take place within a river environment. Tick the activities that you observed at your site or if there was any evidence of this activity occurring in the past. Make notes on the consequences of these activities.

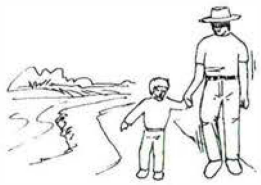
Walking dogs
Picnics and BBQs
Constructing dams, walls, jetties
Windsurfing
Boating/Jetskiing



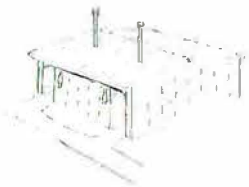




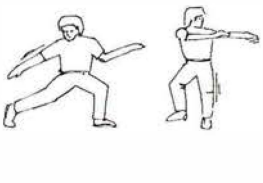
Digging for worms on banks



Fishing



Walking



Using toilets

Others (e.g. playing games, sightseeing, swimming)

Site design for recreational use

Students survey a riverside site to determine the opportunites that it presents for recreational development.

After considering the site's opportunities and constraints, students redesign the site for a specific recreational purpose and report on how their plan achieves the design objectives. As this is a design task relating to materials and systems, the activity is also relevant to the Technology and Enterprise area of the curriculum.

Outcomes

Students will be able to:

- use an appropriate design process to devise a plan for recreational use of a site that realistically reflects the objectives of their proposed development and the site's opportunities and constraints
- consider differing views on how river sites should be used
- explain the need for careful planning and controlled use of sites to allow user needs to be met without compromising a site's natural values
- discuss ways in which the community can have a say in the design of riparian open spaces

Preparation

- Review problem-solving and technology design processes in order to brief students on the way in which to manage the exercise. Organise students into design teams.
- Review appropriate background concepts, e.g. the idea that a river site could have multiple uses and that any site presents opportunities and constraints for development. (Here, development refers to engineered site changes, e.g. construction of car parks, cycle paths, jetties and replanted areas). Discuss the idea of optimal use of a site as long as there is minimal environmental damage.
- Use the Student Resource Sheet *Foreshore land uses – some options and constraints* to discuss the issues students need to consider when creating their design; put together the design brief and arrange for the collection of information.
- Generate student discussion about the full range of recreational uses of river sites.

At the site

- Students explore the site and use the Student Worksheet *Site design for recreational use* to carefully gather information about the site. They should be sure to list current users and consider possible future claimants to the area.
- Each group or design team then considers the information they have gathered and creates at least two possible scenarios for recreational use of the site.
- Consider the pros and cons of each of the proposals by discussing the various constraints on recreational site development outlined on the Student Resource Sheet *Foreshore land uses – some options and constraints.*

REFERENCE CHECKLIST

Student Resource Sheet *Foreshore land uses - some options and constraints*

Student Worksheet *Site design for recreational use*

- In working with the groups the teacher should encourage students to consider whether some constraints could actually be seen as opportunities.
- Students clarify what would need to be done to the site to enable implementation of the various options.
- Students make a decision on their preferred option and prepare the arguments they will use to justify their choice.
- Each group gives a preliminary oral report on their proposal.

Follow-up activities

- Students design and draw a site plan that will achieve their objectives. They then produce a report explaining how their design objectives are achieved, given the site's opportunities and constraints.

Foreshore land uses – some options and constraints

Foreshore land-use options

- Boat ramp with parking area
- Jetty
- Bird hide with walkway
- Cycle path
- Launch area for windsurfing, with parking
- Canoe or rowing shed with launch area and parking
- Picnic or barbecue area with tables and benches, play equipment, toilets and parking facilities

Constraints for recreational site development

- Any development that takes place should make use of areas that are already degraded and eroded, and should not cause further degradation.
- New use development should not contribute to degradation.
- Any built structures should be aesthetically sympathetic (look good and fit in with the river environment) and not interfere with river views, river flow or the floodplain.
- Remnant vegetation should be protected because trees, shrubs and sedges are important for habitat and riverbank stability. (Replanting may actually be needed to improve the site.)
- Areas of conservation value should be fenced off for protection.
- Runoff from car parks should not enter the river directly as it contains hydrocarbons and heavy metals. It is best if runoff can be diverted to areas of permeable vegetated soil which are not likely to be flooded.
- Paddle craft and sailboards need washdown and rig-up areas and erosion-proof river access.
- Compacted materials for cycle paths or other built structures should not interfere with groundwater flow, and should be placed away from the water's edge.
- Views from cycle paths and picnic areas are important.
- Paddlers, rowers, windsurfers, cyclists and powerboat users should not be brought into potential conflict.

Student Worksheet

Site design for recreational use

1. Observations of the suitability of site features

	OBSERVATIONS	
SITE FEATURES	OPPORTUNITIES	CONSTRAINTS
Depth of water near bank Steepness of bank Resistance of bank to erosion Width of bank Areas of permeable soil to allow water to run off Already eroded areas		
Types of vegetation (e.g. trees, sedges, weeds and grass) Width of vegetated strip along the bank Extent of undisturbed natural vegetation Range of habitats		

	OBSERVATIONS	
SITE FEATURES	OPPORTUNITIES	CONSTRAINTS
Birds on open water, in vegetation, on shallows Frogs and reptiles		
River views Evidence of degradation Presence of old drainage pipes, fences, etc.		
Built structures (e.g. ramp, jetty, toilet block, path and parking facilities) Drain entering river Grassed areas		

2. Recreational use possibilities

POSSIBILITY 1		
DESCRIPTION OF IDEA	ADVANTAGES	DISADVANTAGES
What would need doing?		

POSSIBILITY 1		
DESCRIPTION OF IDEA	ADVANTAGES	DISADVANTAGES
What would need doing?		

3. Decision on preferred option

OPTION CHOSEN	ARGUMENTS TO JUSTIFY CHOICE, RELATED TO OPTIONS AND CONSTRAINTS

5 excursion

River uses compatibility survey

Students identify all the uses of the river at the site and assess their compatibility.

Students should consider solutions that allow conflicting uses to co-exist and take into account likely objections of the various user groups.

REFERENCE CHECKLIST

- Student Worksheet *Compatibility of uses at the site*
- Student Worksheet *Discussion sheet*

Outcomes

Students will be able to:

- show understanding of the concept of co-existence of complementary activities at river sites
- discuss the views of all user groups
- explain why the potential environmental impact should be the primary consideration in determining the use of a site
- prepare reports

Preparation

In a preparatory lesson, brainstorm the uses of public access areas along our rivers. Then consider the potential for conflict when areas are used by groups of people with incompatible needs.

At the site

- After observing the site, list likely river-use activities (e.g. boating, fishing, rowing, picnicking, kayaking, jetskiing, educating, scientific research, birdwatching and walking dogs) on the Student Worksheet *Compatibility of uses at the site* in the numbered grids, both down and across.
- Students form user groups, each one representing a different use of the river.
- In their group, students discuss the following aspects:
  (i) what their needs are in terms of facilities, access and environment (e.g. clean water)
  (ii) possible rules and regulations that their activity requires
  (iii) how each of the other groups may affect them
- Students use the Student Worksheet *Discussion sheet* to organise and record their ideas.
- Students decide the degree to which activities interfere with each other and complete the worksheet grid, using the key down the left-hand side as a guide.
- As a whole-class activity, students brainstorm and discuss all the possible solutions to potential conflicts. They devise a set of guiding principles couched in general terms e.g. 'uses that degrade the banks should be discouraged', 'uses that contribute to health and fitness should be encouraged', 'families should be encouraged', 'frogs should be protected', etc.
- Students assess each of the 'interfering uses' marked on their worksheet to decide if there is a solution that would allow both activities to continue. If not, they then use the guiding principles to decide which of the activities should be discouraged. They should try to find win-win solutions – those that allow the best balance of uses while protecting the environment at the site. Students can then present a list of activities that should be encouraged at the site, along with any special conditions that need to be applied.

Follow-up activity

Students representing user groups produce written and oral presentations to demonstrate the solutions they have devised to allow compatible uses of the river environment to co-exist.

Student Worksheet

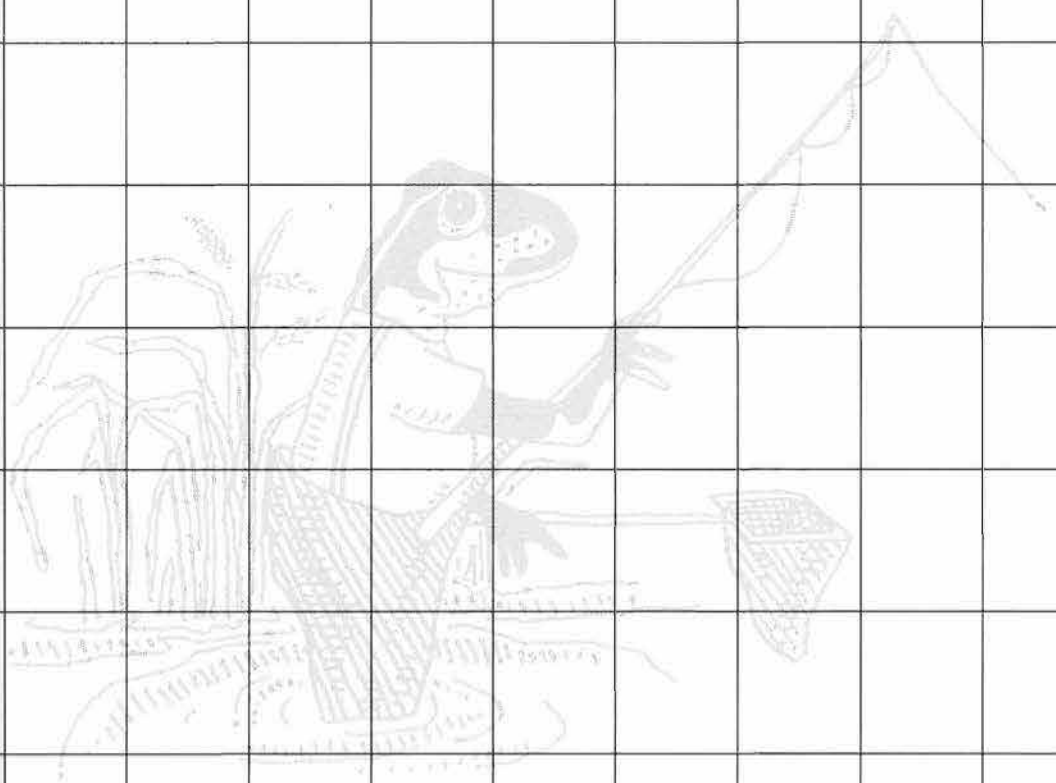
Compatibility of uses at the site

Instructions

When you have decided on your uses for the site, list these both across and down the chart. The example 'fishing' has been entered for you. Using the grid, consider how each use would affect the other uses and rate their compatibility using the key. Choose the appropriate symbols in the key and mark them in the empty boxes.

KEY	
o	slight or no interference
oo	complementary activities
x	some interference
xx	major interference

USES	fishing 1	2	3	4	5	6	7	8	9
1 fishing									
2									
3									
4									
5									
6									
7									
8									
9									



This activity is based on Activity 142, *Compatible Uses*, from *Project Reef-Ed*, developed and published by the Great Barrier Reef Marine Park Authority, 1988.

Student Worksheet

Discussion sheet

Use this worksheet to organise the ideas of your group

Name of group

Student representatives

River site activity

NEEDS OF YOUR GROUP	EFFECT ON OTHER GROUPS OF YOUR USE	COMPATIBILITY RATING FROM SURVEY SHEET

Conflicts that need solving:

conflicts

Possible solutions:

solutions

Rules for using the site harmoniously:

rules

6
excursion

Alien plant game

Students play a weed recognition game at a riverside site.

Students learn to identify the characteristics of common weeds, suggest how weeds might spread, and decide what actions they can take to reduce the 'alien invasion'.

REFERENCE CHECKLIST

- Teacher Resource Sheet *Weed cards*
- Teacher Resource Sheet *Weed invasion cross-sections*
- Student Resource Sheet *Alien appearances*

Outcomes

Students will be able to:

- distinguish weeds from native vegetation
- describe some common riverside weeds
- explain how weeds reproduce and rapidly degrade a river habitat
- suggest some actions to reduce the weed problem

Preparation

- Students read through and discuss Resource Sheet 15 *The problem with aquatic and foreshore weeds*, in the booklet *Working Scientifically in the Swan River Environment* or the pamphlet *Controlling weeds in waterways and wetlands.*
- Prepare group sets of weed cards using the Teacher Resource Sheet *Weed cards.* (Each card gives a description of a particular weed and one of its invasive features.) Prepare a class set of the Student Resource Sheet *Alien appearances.*
- Explain to students that their aim is to explore the site to find plants that might be weeds, and to attempt to identify them and determine how various weeds invade and destroy the river habitat.

At the site

- Divide students into groups. Give each group a set of weed cards, which provide clues for preliminary identification of a particular weed.
- At the completion of the search, distribute the Student Resource Sheet *Alien appearances* to assist them to make a positive identification of the weeds they have found.
- Students record a brief description of the weed and its habitat and prepare a labelled sketch indicating the main identifying features.
- In their groups, individual students describe the weeds they identified to the others. Descriptions are collated (and perhaps recorded on a chart).
- Assist students to compile a checklist of what they consider to be the common characteristics of the weeds they have discovered. Test the checklist against some other (native) plants. Revise the checklist if necessary.
- Through discussion determine ways in which weeds might have been introduced to the river environment.
- Encourage students to suggest what action they can take to reduce the spread of weeds, and to remove weeds from the environment.

Follow-up activities

- Students can design and draw the prototype for a new alien plant that has invasive and destructive properties.
- Then, taking the perspective of a native plant displaced by the weed, write a story about 'the battle of the alien invasion'.
- Use the Teacher Resource Sheet *Weed invasion cross-sections* to demonstrate and invite discussion about the 'before and after' weed invasion scenario. Students give possible reasons why the situation changed and what effect it would have on the environment and human uses.

OTHER RESOURCES

- Resource Sheet 15 *The problem with aquatic and foreshore weeds*, in the booklet *Working Scientifically in the Swan River Environment* or the pamphlet *Controlling weeds in waterways and wetlands*

Weed cards

I am the alien plant

pampas grass

You will recognise me by my fluffy white seed dispenser held high to catch the wind.

I am the alien plant

arum lily

I may look elegant and placid, but below the ground I'm working hard to divide and spread so I can come up when you're not looking.

I am the alien plant

bridal creeper

I mught look pretty and delicate but I spread by choking out the competition.

I am the alien plant

morning glory

I creep, cling and climb over plants in my path, block out the light and take all their food.

I am the alien plant

blackberry

My prickly branches take root and spread to become new blackberry bushes.

I am the alien plant

giant reed

I grow so tightly, send out new shoots so quickly, and my roots are so matted that nothing else has a chance.

I am the alien plant

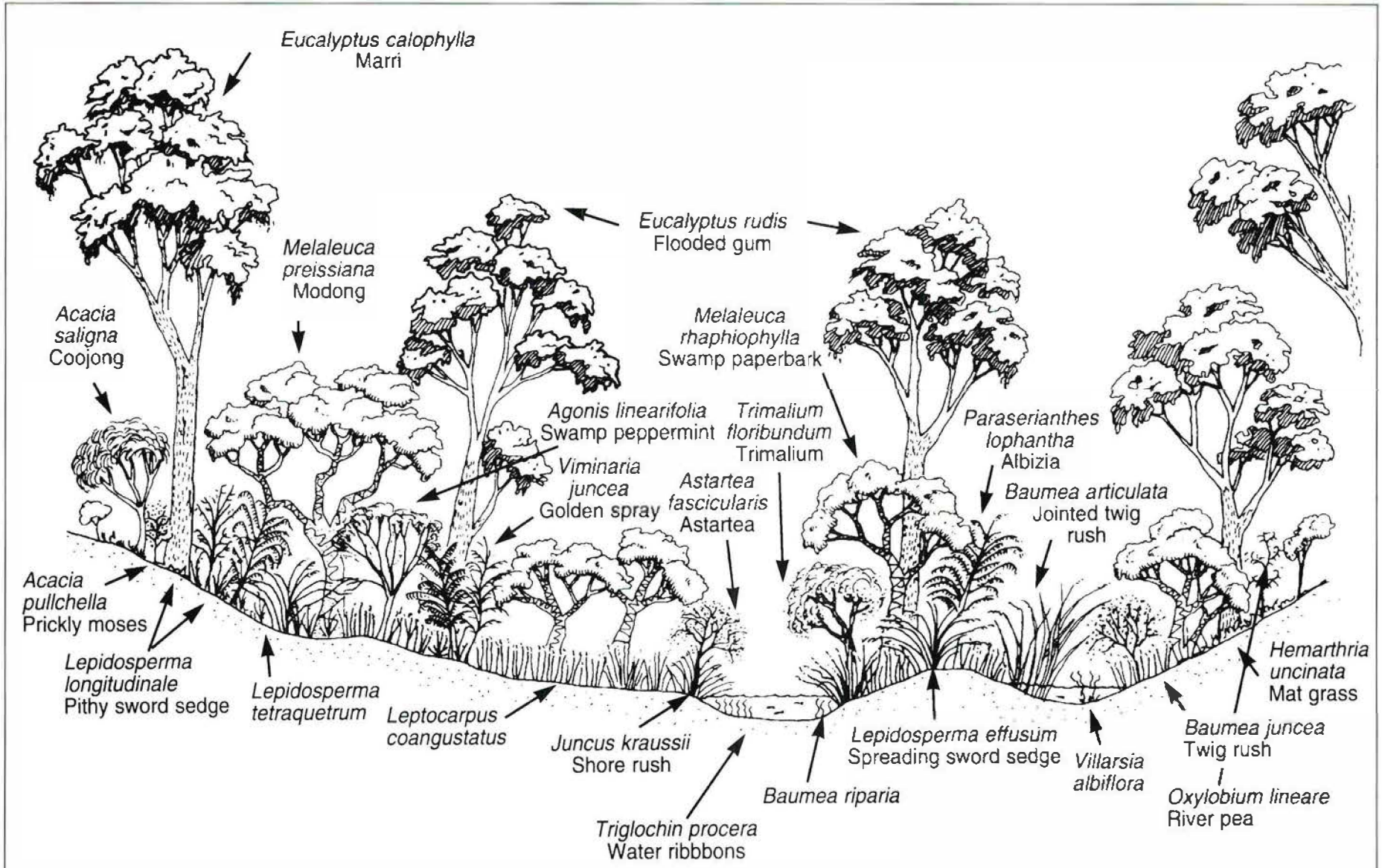
castor oil bush

I am an ugly shrub with hundreds of tiny seed pods that cling to carriers that pass by.

I am the alien plant

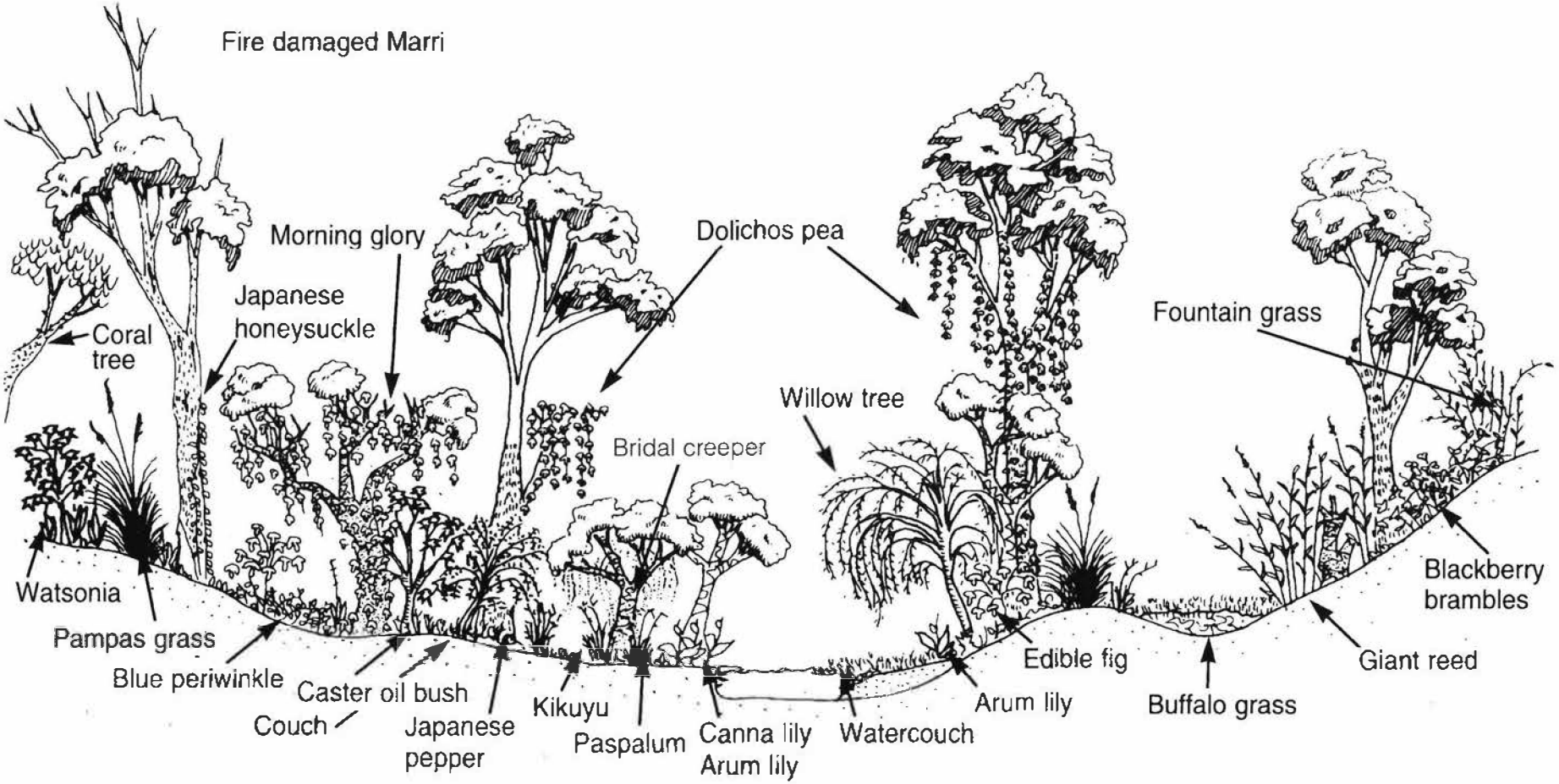
couch, kikuyu and buffalo grass

We escaped from your garden over a fence and down a drain. Now that we're no longer mowed and clipped we can spread wildly.



BEFORE Typical cross-section of native riparian plant species of the lower south-west of Western Australia

(Illustration by Luke Pen, Water and Rivers Commission)



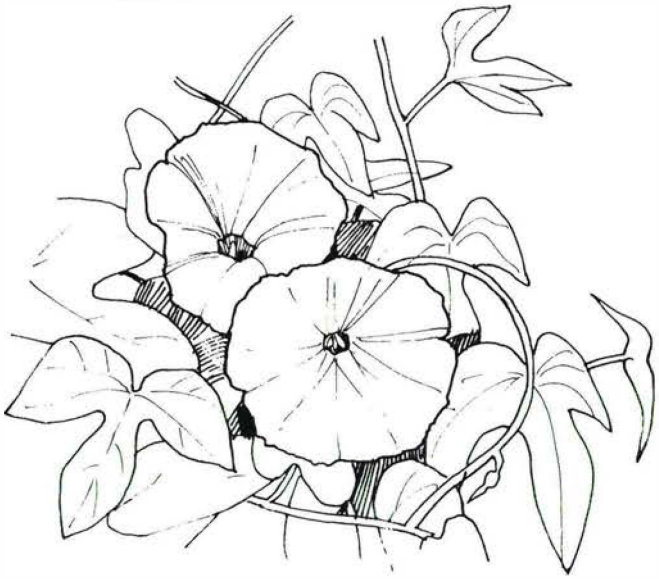
AFTER Weed invasion of the moist river valley

(Illustration by Luke Pen, Water and Rivers Commission)

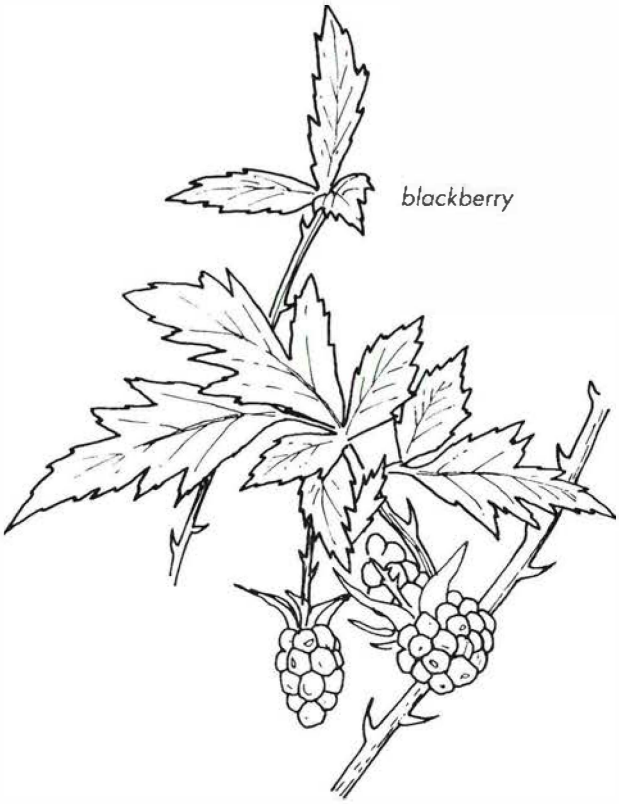
Student Resource Sheet

Alien appearances

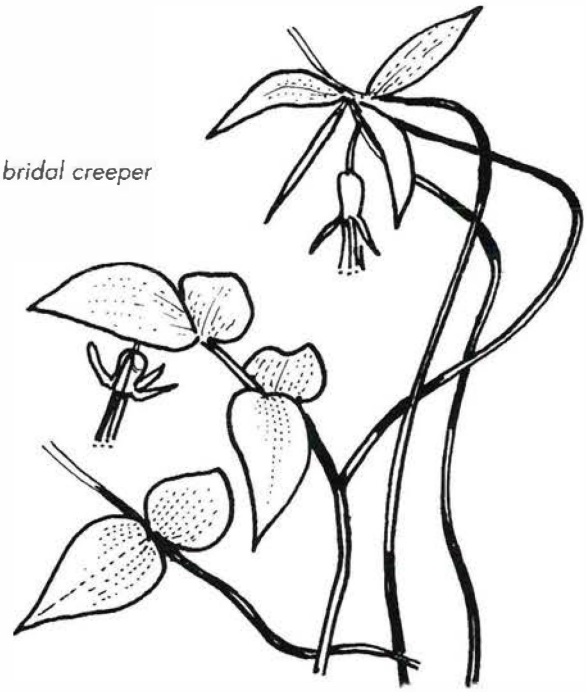
morning glory



blackberry

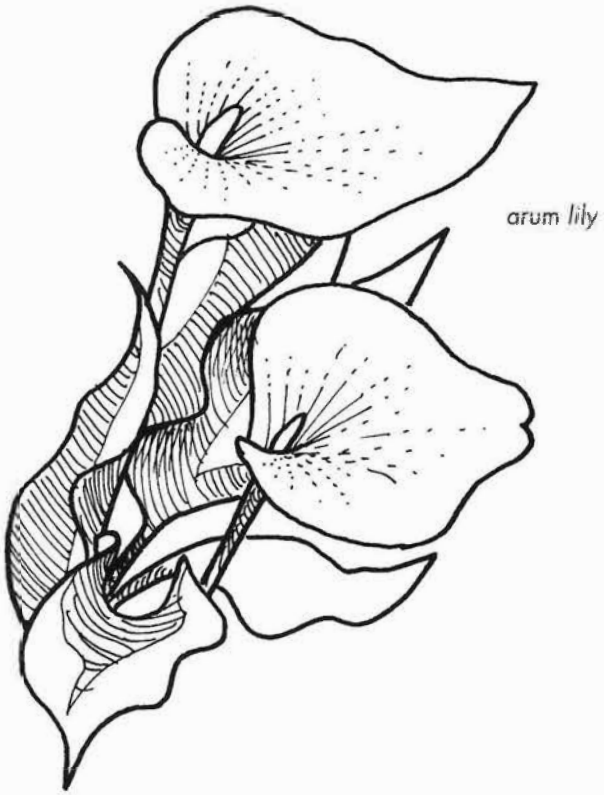


bridal creeper

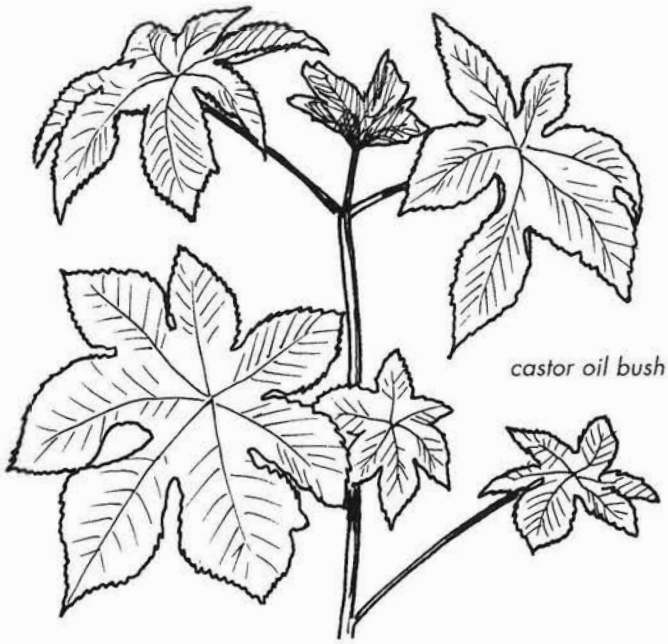


pampas grass

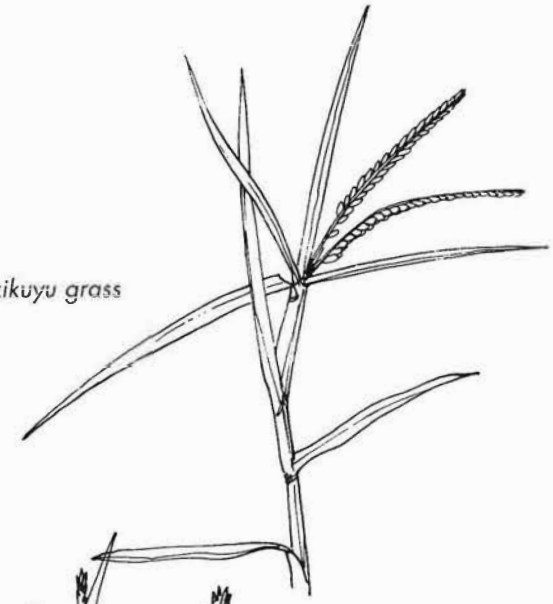
giant reed



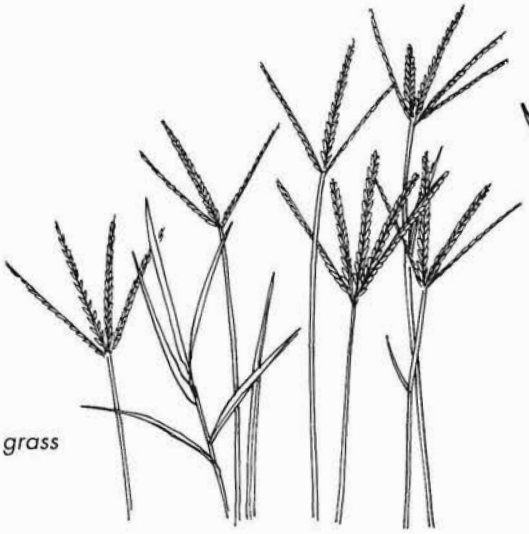
arum lily



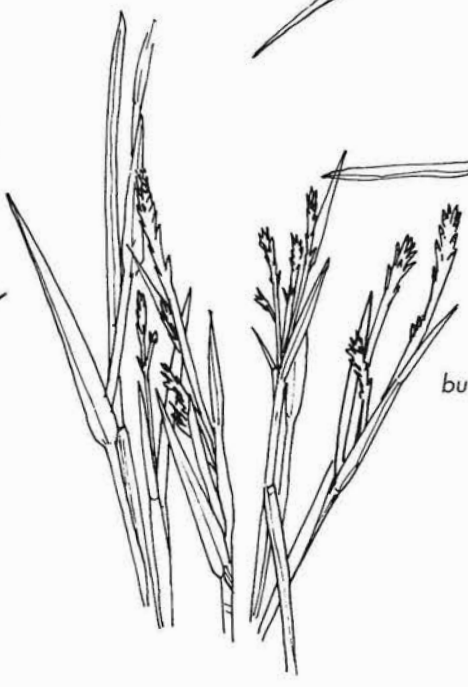
castor oil bush



kikuyu grass



couch grass



buffalo grass

7 excursion

Action plan for site revegetation

Students explore a river or stream environment to find a site showing evidence of weed invasion.

Students assess the extent of the problem, considering ways to restore the site to a weed-free condition, and then design an action plan for revegetation and ongoing site maintenance.

REFERENCE CHECKLIST

- Teacher Resource Sheet *Action plan for site revegetation*
- Student Worksheet *Action plan for site revegetation*
- Excursion 6 *Alien Plant game*

OTHER RESOURCES

- Resource Sheet 15, *The problem with foreshore and aquatic weeds*, in the booklet *Working Scientifically in the Swan River Environment* or the pamphlet *Controlling weeds in waterways and wetlands*
- Stepping Out Literacy and Learning Strategies (EDWA)
- Water facts 4, *Living Streams*

Outcomes

Students will be able to:

- recognise that many river sites are degraded by the presence and spread of weeds
- appreciate that weeds can be controlled and areas affected by weeds can be regenerated
- demonstrate a positive attitude towards protecting, managing and rehabilitating river foreshores that have been degraded
- appraise habitat conditions conducive to the spread of weeds
- suggest ways in which a weed-infested site can be regenerated and maintained

Preparation

- Ensure that students can identify common foreshore weeds and revise the ways in which weeds are introduced to the river and how they spread. See Excursion 6 *Alien plant game.* Refer also to Resource Sheet 15 *The problem with aquatic and foreshore weeds*, in the booklet *Working Scientifically in the Swan River Environment* or the pamphlet *Controlling weeds in waterways and wetlands*
- Use the Teacher Resource Sheet *Action plan for site revegetation* to familiarise yourself with the principles of planning a revegetation project.
- Prepare a Think Sheet (refer to Stepping Out Literacy and Learning Strategies, p. 95) using newspaper cuttings or TV news items relating to river health (such as the Swan River Trust or community group projects) to raise student awareness of the potential for waterway restoration and revegetation.
- Discuss with students the preparation and organisation that would be required for a river restoration project. Outline the concepts of problem-solving and action plans.
- Create an action plan with the students using the Student Worksheet *Action plan for site revegetation.* Refer also to Water facts 4, *Living Streams.*

At the site

- Students explore the site and map its features. They gather information, record details about the type of vegetation present and consider the degree of degradation of the site, especially in terms of vegetation loss and weed invasion.
- Students define the problem at the site in terms of loss of natural vegetation and invasion of weeds. Discuss possible solutions. Through consensus they arrive at the best possible solution.
- Students complete an action plan for revegetation of the site. See Student Worksheet *Action plan for site revegetation.*
- Discuss with students how they might follow up on the success of a revegetation project, i.e. how they might determine whether there has been improvement in habitat or water quality.

Follow-up activities

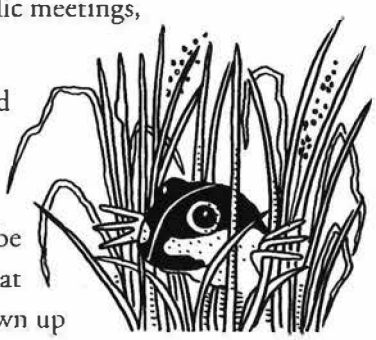
- Students could discuss in more detail the logistics of weed control and planting. They could compare their plan to one that has been devised by another group.
- Contact a landowner or community group undertaking a river or stream project. Inspect the site and ask them about their experiences.
- Plan to undertake revegetation work at a site. (Contact Ribbons of Blue for guidelines and a list of organisations that may be able to assist with various aspects of the work.)

Teacher Resource Sheet

Action plan for site revegetation

Revegetation projects in riparian environments enhance the waterways and protect and restore ecological functions. A revegetation project involves collecting information about aspects of the site's physical, biological (and cultural) environment, developing an action plan for weeding and revegetating, and then devising monitoring and maintenance strategies. Resources needed should be considered during the early planning stage (e.g. equipment, water monitoring kits, weed mats, plants, seed, netting, tree guards, fencing, technical advice from specialists, funds). For any revegetation project, seek advice and gain permission. The following points need to be considered for the planning stage:

- Gently sloped banks reduce **erosion** and allow for a greater range of plantings. (Mechanically modifying slopes is not always possible.) Planting, especially with rushes, will help to stabilise banks. Laying erosion-control matting may also assist. Baffle boards can also help to protect areas while vegetation establishes.
- **Weeds** may be hand-pulled (e.g. lupins), sprayed or painted with herbicide, smothered using a jute mat or cut (e.g. bulrushes). Grasses can be cut back with a brush cutter, then covered with weed suppression matting. Self-seeding of weeds can be prevented by removing flower heads (e.g. pampas grass). Weed out low-frequency weeds first and start on the bank that has fewer weeds. This will give a greater chance of success.
- **Restore vegetation** structure (shrubs, overstorey and understorey vegetation) by replanting trees, native grasses, shrubs, sedges and rushes along streamlines. When planning allow for about 1 tree per 5 square metres, 1 shrub/ground cover per square metre and up to 10 rushes per square metre. If slopes are gravelly, plant in high densities. Plant low, spreading shrubs on banks that need stabilising. Collect lots of local seed from the area (all year round) and either grow plants or pass the seeds on to other organisations that will grow them for you or provide advice. Drill cavities for some plants or seeds as appropriate. Some direct seeding could be done by scratching narrow furrows along contour lines, liberally sprinkling the seed, and backfilling with soil.
- **Feral animals** need to be controlled. Rabbits can cause damage to native vegetation, and foxes and feral cats prey on native fauna. Native waterbirds may nibble on the shoots of young native rushes and uproot the plants. New plantings can be protected using netting or tree guards.
- Signs may need to be erected to **inform people** of students' objectives and to suggest appropriate behaviour at the site. Alternative strategies include holding public meetings, creating displays, and designing and providing informative brochures.
- Students may decide that **firebreaks** are needed. The local fire brigade could help to design a plan for fire control in the area.
- Students could instigate a **water quality monitoring program** with the help of Ribbons of Blue. Where drains flow into rivers, water could be directed through filter beds planted with rushes. Individuals or businesses that may be polluting the area could be approached and a collaborative plan drawn up to help resolve the problem.



Note

The Swan Catchment Centre can put you in touch with Government and non-Government organisations, community groups and nurseries that will provide advice and assistance on revegetation projects. These include Ecoplan, Men of the Trees, APACE, Weeds Action Group, Native Environmental Systems, Ecosystem Management Services and some nurseries.

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www.wrc.wa.gov.au/swanavon

Student Worksheet

Action plan for site revegetation

1. Gather information to identify the nature and extent of the problem

Type of vegetation (native and weeds)
Animals
Water quality (e.g. muddy, salty)
State of the banks (e.g. steepness, erosion)
Human structures and activities
Other factors (e.g. fire)

2. Summarise the problem and identify possible solutions

Summary of problem

summary

Outline of possible solution 1

solution

Outline of possible solution 2

outline

Evaluation of both ideas and final decision on solution

evaluation

3. Action plan

Erosion • How will you stop erosion as you work?	
Weed Control • Where will you start? • When will you weed? • What methods of weeding will you use?	
Revegetation • What will you plant? • Where will you plant? • Will you use seeds or young plants? • When will you plant?	

3. Action plan (contd)

Protection • How will you protect your work from humans and feral and native animals?	
Other Considerations • What approvals/ permissions will you need? • What resources and equipment will you use? • Who might you seek help from? • How will you maintain the site? • How will you assess whether habitats and water quality have improved as a result of your work? • How will you explain your project to the local community?	

8
excursion

Decisions, decisions!

Students clarify some of their values-based ideas about the river site and compare their ideas with those of other people. (This activity is best done after other on-site activities.)

REFERENCE CHECKLIST

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Student Worksheet
Decisions, decisions!

Outcomes

Students will be able to:

- clarify and articulate their feelings about aspects of human activities at the river
- discuss the different ways in which people perceive the environment
- explain how human activities can have a negative impact on the river environment
- demonstrate interest in the river environment and environmentally responsible attitudes and behaviour
- describe ways in which the whole community can share the responsibility of looking after river environments

Preparation

- Photocopy two copies of the Student Worksheet *Decisions, decisions!* for each student and initially hand over one copy.
- Provide an explanation of any of the thoughts or statements on the worksheet if required. For example, ensure that students are able to differentiate in a general sense between weeds and native plants. (They may have already played Excursion 6, *Alien plant game.*)
- Students complete the first copy of the worksheet before the river visit. They should carefully read each of the fifteen statements in the left-hand column and tick the column that most closely matches their level of agreement or disagreement.
- Tally the responses of all students against each of the fifteen statements on the worksheet.
- Summarise and report on the findings.

At the site

- Using the second copy of the worksheet, students repeat the exercise after thinking about each statement in the context of their observations and feelings about the site's environment.
- Once again, tally the responses for each statement, and then compare them to those of the pre-visit responses.
- Ask students who changed their minds to explain their reasons.

Follow-up activity

Discuss with the class the idea that peoples' positive values and attitudes towards the river might be demonstrated by environmentally responsible behaviour. They could then list examples of environmentally responsible behaviour.

Student Worksheet

Decisions, decisions!

THOUGHTS AND DECISIONS	STRONGLY AGREE	MILDLY AGREE	NO OPINION	STRONGLY DISAGREE
1. People who fish for recreation should be allowed to catch as many fish as they wish.				
2. I can learn more about the river by reading a good book about it than by visiting it.				
3. Weeds look better than native plants so there is no need to get rid of them.				
4. It's okay for stormwater runoff from roads to drain into the river because there is nowhere else for it to go.				
5. Some parts of the estuary should be protected and used only by fish and birds, not humans.				
6. Jetskis and powerboats should be banned because they cause erosion of the banks.				
7. Rubbish is not a very serious pollution problem compared to chemicals because chemicals can get into the river through drains.				
8. More picnic areas and boat ramps should be established to give a greater number of people a chance to enjoy the river.				
9. People who own houses and businesses near the river have a responsibility to find out if what they do affects the river in some way.				
10. Only people who have an interest in studying some aspect of the river should be allowed near it because ordinary use creates too much damage.				
11. People should be able to use the river in whatever way suits them.				
12. We need environmental police to control people who pollute and degrade the river.				
13. If people knew more about the river, they would choose not to harm it and would do more to care for it.				
14. It's better to learn about this river than some other place we can't visit.				
15. Nothing I do could harm the river in any way.				

This activity is based on Activity 141 *Decisions! Decisions!* from *Project Reef-Ed*, developed and published by The Great Barrier Reef Marine Park Authority, 1988.

9 excursion

Creating a catchment model

Students create a model of either a hypothetical catchment or one of the Swan-Avon River subcatchments.

With the use of the model, students can demonstrate their understanding of various features of catchments and of the links between land-use activities and river problems.

REFERENCE CHECKLIST

- Student Resource Sheet *Hints for building a catchment model*
- Appendix 2, *Catchment model diagram*

OTHER RESOURCES

- Resource Sheet 16, *Catchments*, in the booklet *A Sense of Place in the Swan River Environment*

Outcomes

Students will be able to:

- define and explain the terms 'catchment' and 'subcatchment'
- describe the physical features (landforms and water features) and cultural features (land uses and structures) that comprise a catchment or subcatchment
- construct a model to demonstrate an understanding of the concept of a subcatchment and some of its features
- explain that land-use activities in different locations in a subcatchment can negatively affect the river further down the catchment

Preparation and model making

- Ensure that students are familiar with the concept of catchments and subcatchments, and with the range of land-use activities that may occur in a catchment. Site visits associated with previous activities should have provided sufficient information for this activity. However, a comprehensive tour to show various parts of a catchment could be arranged. Refer to Resource Sheet 16, *Catchments*, in the booklet *A Sense of Place in the Swan River Environment*, and Appendix 2, *Catchment model diagram*.
- Distribute the Student Resource Sheet *Hints for building a catchment model*. Discuss the aims of the activity and the steps involved in model-making.
- Students work in groups to construct and label their catchment model.

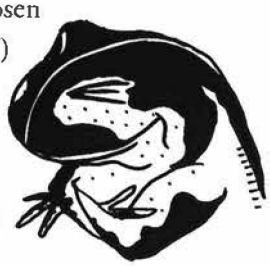
Follow-up activities

- Students display their models for other groups. They could:
  - (i) describe to others the physical aspects of their catchment and the types of land-use activities that occur in it
  - (ii) demonstrate an example of how a land-use activity in one part of a catchment can affect the river further down the catchment
  - (iii) evaluate the model-making experience
  - (iv) arrange to display models in the school resource centre or elsewhere
- Students compare models of different catchments and discuss how each catchment might have different impacts on downstream water quality.

Hints for building a catchment model

Step 1

Using Appendix 2, *Catchment model diagram,* or a map, try to visualise what your chosen catchment looks like in reality. Pick out the important topographical (landform or relief) features and waterways.



Step 2

Collect the items you will need to complete your model, according to the following advice:

Sealed chipboard or a piece of wood can be used to make the base of your model. (Choose something light if you're planning to move it around.) If your model is going to be really large, build it in sections so it can be easily dismantled.

Foam or chicken wire can be used to shape the topography of your model. A whole series of thin layers of polystyrene foam glued with Liquid Nails works well. If you want to make hills, build up the base with foam so the surface layer doesn't have to be too thick. (Contoured chicken wire with the edges tucked under the base is a good alternative to foam.)

Papier maché can be used to mould the final shapes of your model. Tear up magazines or newspaper into very fine strips and let them soak in a big tub overnight – the finer the pieces, the better the papier maché. It should have a nice thick feel. If it's too runny, add more paper. If it's too thick, add more water. Next, add cornflour to make the mixture set firmly. Note that washing-up sponges make good wetlands!

Poster paints, Estapol and brushes will be needed so that you can complete your model.

Step 3

Build up the foam or wire on the wooden base so that the topography of your model is clear. If you need wetlands, estuaries, dams, etc., roughly carve deep basins in the foam. Once the papier maché is thick, you can use it to start to mould your catchment. Place a really thick layer of papier maché on the foam base. Sculpt it to mimic the landscape of your catchment. If you're making water channels, remember to ensure the flow is always downslope.

The thicker the papier maché, the longer it will take to dry. It may even grow a coat of mould while it dries. Keep the model in a well-ventilated space, ideally in direct sun.

Step 4

When the papier maché is dry, you can paint it. Finally, seal your work of art with something like Estapol. Apply several coats, especially if it is going to be well used. If your model uses real water flows, then coat it in fibreglass and resin.

Step 5

Add the finishing touches to the model. You may choose to:

- use sponges for wetlands (these might get smelly if you don't let the model dry properly)
- paint roads black with white centre lines
- make bridges of painted matchsticks
- use pieces of gravel as rocks along waterways
- make buildings from foam or cardboard
- make forests and crops from plastic vegetation or natural materials from the garden

10 excursion

A story of an unhealthy river

Students observe the impact of pollution in a simulated catchment.

This game introduces students to the interconnections between human activities and water quality, and to some causes of water pollution.

Outcomes

Students will be able to:

- demonstrate that they can identify land uses that might degrade a river
- suggest the ways in which people who use catchments may contribute to degradation of rivers
- suggest some strategies to improve river health
- identify ways in which people can be encouraged to prevent waterway degradation and take responsibility for ensuring the health of the catchment

REFERENCE CHECKLIST

- Teacher Resource Sheet *A Story of an unhealthy river*
- Teacher Resource Sheet *Materials and labels for simulation game*

Preparation

Refer to the Teacher Resource Sheet *A story of an unhealthy river* for details of materials required and then:

- Fill the fish tank with around 4 or 5 litres of water to represent the river and put it in a central place in the classroom.
- Fill each of the small containers with the 'pollutant' substances for each land-use chosen from the Teacher Resource Sheet *Materials and labels for simulation game.* After labelling, distribute the containers among students.

MATERIALS

- A fish tank, large clear glass or plastic container to hold at least five litres of water
- 13 small (30 ml) plastic containers with firm lids (e.g. film containers, pill bottles)

School-based activity

- Read the story of an unhealthy river, stopping at the end of each section when a character and/or land-use activity is mentioned. At these points students come forward and empty the contents of the appropriate container into the river.
- Discuss students' observations and feelings by asking questions such as:
  - (i) What do you feel about the change in the colour and appearance of the water? How might river pollution affect you personally? How would you feel about drinking the water or swimming in it?
  - (ii) How did the water change in appearance and why? Is this how pollution might occur in the Swan River? How is it similar/different? Could this pollution affect other environments? Were any types of water pollution in the story illegal? Are there laws or penalties to protect waterways? How effective are they?
  - (iii) What can be done with a polluted river? (A heavy rainstorm might help flush out pollutants but this only relocates the problem to a coastal area.) What other measures could be used to prevent or reduce water pollution?

OTHER RESOURCES

- Water facts 2, *River and Estuary Pollution*

Follow-up activities

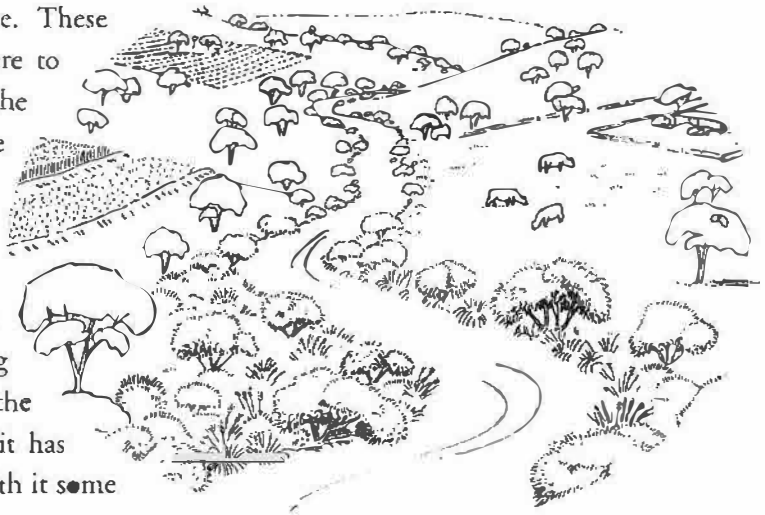
- Students could record observations on a class or teacher designed data sheet.
- Students could rewrite the story and name it 'The Story of a Healthy River'.
- Students read and discuss Water facts 2, *River and Estuary Pollution.*

Teacher Resource Sheet

A story of an unhealthy river

This is the story of the travels of the ..... River through its catchment. It starts in the higher parts of the catchment where the rain runs off the slopes and the river begins its journey to the sea.

In a valley below the outer reaches of the catchment there is a power station which generates electricity for the region. It burns large quantities of coal and releases polluting gases into the atmosphere. These pollutants combine with moisture in the atmosphere to produce acid rain. Rainfall carries these acids back to the earth's surface and this pollutes the very source of the river. The river water gathers momentum as it descends the slopes.



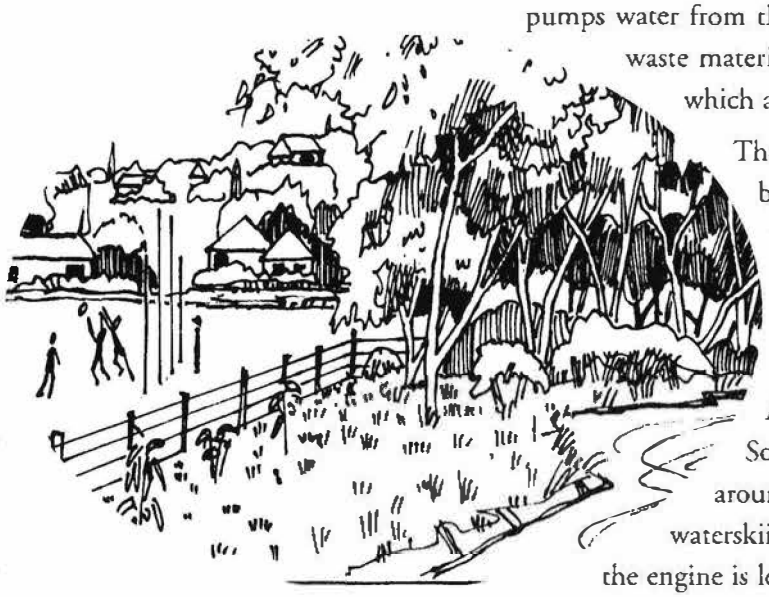
The river continues its journey towards the sea. It travels through farming country where some crops have been recently spread with fertilisers containing nitrogen and phosphorus. (The soils of this part of the catchment are deficient in these nutrients.) Lately it has rained a lot, and runoff into the river has brought with it some of the excess fertiliser from the croplands.

In the same part of the catchment there are some piggeries. Some of the manure from the pig pens washes into a drain and then empties into the river.

On the other side of the river there are grazing lands. There are very few native trees remaining and, in some of the lower parts of the pasture, the watertable has risen because the trees are not there to use the water any more. This water brings the salts in the soil up to the surface, making the land unusable. It also means that runoff from the land is salty and this threatens freshwater organisms and animals in the river.

A herd of grazing cattle denudes the vegetation and tramples the banks of the river. When heavy rains fall the banks are eroded and collapse into the river.

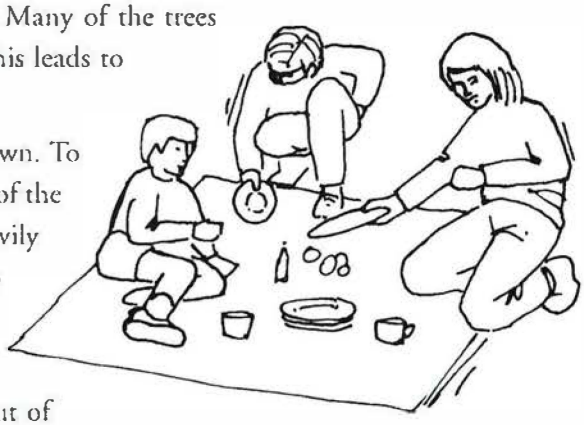
A little further down the river there is a coal mine, which supplies the coal for the power station. The coal mine pumps water from the river to clean its equipment and flushes out some waste materials from the mining site. This includes various acids which all drain back into the river.



The river slows down as it reaches the coastal plain and begins to wind its way through the outskirts of a major town. Here there are a number of hobby farms. The farmhouses are not connected to a sewerage system – they have their own septic tanks. Sewage seeps into the groundwater and then into the river.

Around the bend there are some people using the river. Someone is fishing on the banks. Their line gets caught around a rock and is left in the water. Other people are waterskiing. You can tell that their boat needs a service because the engine is leaking oil directly into the river.

Another group of people is enjoying a picnic at a park overlooking the river. Some of their rubbish is blown off the table and into the water. Further downstream a tourist boat is taking some tourists on a scenic tour of the river. Drinks are for sale on board, but not everyone uses the bins that are provided to dispose of their rubbish. The river now starts to meander through the suburbs. A new housing subdivision is being developed here. Many of the trees have been removed and when it rains the topsoil is eroded. This leads to further silting of the river.

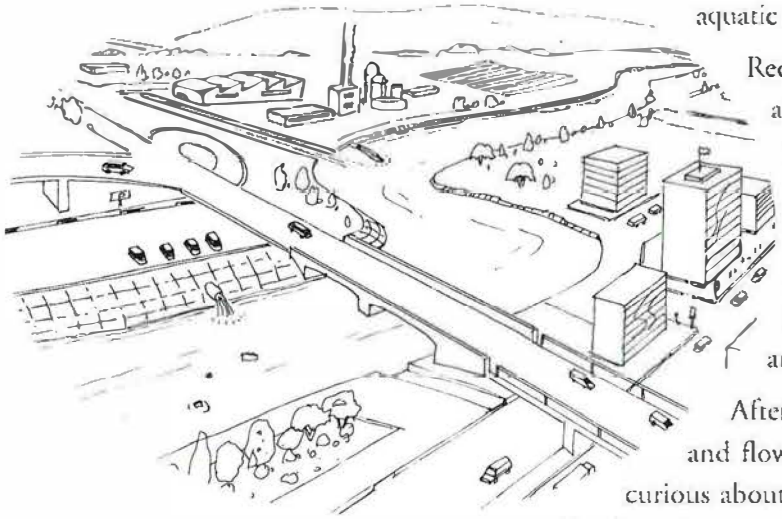


There are many gardens in the inner suburban areas of the town. To keep pests away gardeners use a range of pesticides. At the end of the day the sprinklers are turned on to water the plants and the heavily fertilised lawn. The pesticides and fertiliser wash off into stormwater drains and enter the river.

People who have spent the day at work are now starting to drive home. The roads are choked with traffic. Oil drips out of many of these cars and sometimes the drivers brake in a hurry, leaving traces of rubber on the road. Whenever it rains these pollutants are carried into the stormwater drains and straight into the river.

Some industries in the areas along the river use detergents to keep their production equipment clean. Often the dirty water is hosed out of the factory into the gutter, where it disappears into a stormwater drain. Once again, this water flows straight into the river.

Phosphates in the detergent also cause excess algal growth in the river. When the algae die and begin to rot, they use up oxygen, which aquatic animals rely on. They may suffocate as a result.



Redevelopment of an old tannery site is occurring in another area near the river. Demolishers have discovered a few drums of something mysterious. They won't be able to sell these drums as scrap, so somebody suggests emptying them into the river. All the waste from the old tannery is released into the river, to the detriment of all the organisms and animals living in it.

After one final bend the river finally arrives at its mouth and flows into the sea. People along the nearby beaches are curious about a large slick of strange-coloured water they can see heading into the ocean.

This activity is adapted from *Who Polluted the Potomac?*, Ann Ferguson Foundation, USA, and Queensland Waterwatch and printed in *Saltwatch: A Resource Book for Schools*, Department of Natural Resources and Environment, Victoria, 1997.

Materials and labels for simulation game

LAND-USE	SUBSTANCE	QUANTITY
power station	vinegar (acid rain)	1/2 container
herd of cattle	thick muddy water	1/2 container
farming country	baking powder (fertiliser)	1/2 teaspoon
piggery	thick muddy water	1/2 container
grazing land	salty water	1/2 teaspoon salt in a full container of water
coal mine	vinegar (acid runoff)	1/2 container
hobby farms	yellow water/toilet paper	small amount of paper in a full container of water
fishing	nylon line	tangle of nylon line
waterskiing	vegetable oil	1/2 teaspoon
park	(styrofoam, plastic etc.)	small amount
tourism	(paper, plastic etc.)	small amount
subdivision	soil	1/2 teaspoon
gardens	baking soda (pesticide)	1/2 teaspoon
roads	vinegar (polluted runoff)	1/2 container
industry	liquid soap (detergent)	1 drop in full container of water
tannery	water/food colour (red)	5 drops in full container of water

11
excursion

Catchment care dilemma

Students are introduced to some of the individuals and organisations that may be involved in a catchment conflict.

Students identify various interest groups involved and recognise the conflicting land-use options and priorities that may need to be resolved through cooperative efforts of all groups.

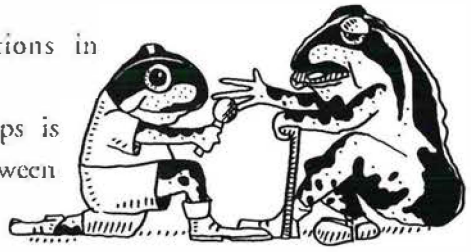
REFERENCE CHECKLIST

•

Teacher Resource Sheet *Role play – catchment care dilemma*

Outcomes

Students will be able to:



- recognise that there are conflicting land-use options in catchments
- explain why cooperation between people and groups is needed for resolution of conflicts that may arise between competing land uses
- identify various interest groups and their stances
- through consensus, find a resolution to a catchment care dilemma

Preparation

Prepare character cards and organise a suitable venue within the school for a meeting.

School-based activity

- Explain the catchment dilemma to the students as follows: Grazier Eric Woolridge has purchased a property in the hills of the Nessa River catchment basin. He is considering clearing the trees from about 300 hectares of his hilly lands to increase the number of sheep he can graze. He is not sure if this will affect other people in the catchment area. He discusses his concerns with neighbours and with people in the nearby small town. The local Landcare representative suggests that a community meeting be called. Eric agrees and hopes this meeting will resolve any potential problems. The Landcare representative organises the meeting.
- Provide role cards for each character. Students (or groups of students) choose a character and then pin on the corresponding character card as per the Teacher Resource Sheet *Role play – catchment care dilemma*. The cards give details about the characters, their personalities and their concerns. (In some cases students can decide what the personality of the character is like.)
- Students should spend some time discussing and developing the characters of their roles.

Conduct the Meeting

The chairperson calls the community meeting to order. He/she ensures that all characters have an opportunity to present their cases. At the conclusion of the meeting, several options will be available to grazier Eric Woolridge. The whole class should vote on which option to choose.

Follow-up activities

Reflect on the processes and outcomes of the meeting:

- Who were the characters and what different types of personalities did they display?
- Which characters were best able to put forward their point of view and why?
- What were the conflicts identified?
- What did you learn about the interrelated effects of changes in the catchment?

Role play – catchment care dilemma

Character cards

1. Chairperson

Personality: You are very fair and want everyone to have an opportunity to present a case. You must be strong to prevent some people from 'taking over' the discussion.

Case: You need to control the meeting so that a consensus decision can be reached. Ask people to explain their statements clearly and summarise the ideas presented. At the end of the meeting, you must re-state the options available to Eric (write a list on the blackboard or on butcher's paper) and arrange for the whole group to vote on the issue.

2. Grazier 1 – EricWoolridge

Personality: You are open to suggestions and willing to compromise. You are able to explain your case clearly.

Case: You are considering clearing 300 hectares of hills to provide more pastures. You feel you must increase sheep numbers to survive tough economic times.

3. Grazier 2 – Eric's neighbour

Personality: You are quite assertive and very opinionated.

Case: You've been in the district all your life. Many of the hills on your property have already been cleared. You have a few places on your property that are obviously eroded.

4. Crop Farmer

Personality: You do tend to be outspoken but you are prepared to listen to others.

Case: You moved to the area a year ago. In your previous farming region there were patches of salinity as a result of too many trees being cleared. You do not want to experience salinity problems on your new farm.

5. Conservationist

Personality: You are a bit domineering.

Case: You believe the entire area should be left alone and declared an Environmental Reserve. There are some precious native animals (e.g. the chuditch and the honey possum) and some unusual plants in some of the valleys. There has been very little study done on many of the plants and animals of the area, so nobody really knows exactly what damage may occur to habitats if the area is cleared.

6. Soil Conservation Officer

Personality: _____

Case: You've worked in the Agriculture Department for years, and know a great deal about the prevention and control of soil erosion. You believe that trees should be left on all the steeper areas and along stream banks and drainage lines, that extra pastures should be planted on the cleared, gentle slopes, and that sheep numbers should be controlled to prevent overgrazing.

This activity has been adapted from Activity 17, *Role Play: Clearing the Hills*, in the *Catchment Care Education Kit* Department of Primary Industries, Queensland, 1992.

7. Water Quality Officer

Personality: You see your concerns as being the most important.

Case: Treating water for domestic use requires extra staff and more money. Your Department is being criticised constantly for declining water quality, but you have no money to provide more staff and treatment facilities.

8. Landcare Representative

Personality: _____

_____

Case: You appreciate the need to increase productivity while maintaining unique flora and fauna and allowing for sustainable production. You believe that at least some pockets of trees should be left behind to allow a source of seed for revegetation if required. You are wary of salt problems and invasion by weeds, and point out that clearing steep land would provide only poor grazing. Productivity could be increased by increasing the turnover of stock or by improving pastures, rather than by trying to increase the numbers of stock.

9. Shire Councillor

Personality: _____

_____

Case: You believe that productivity of rural industries, especially grazing, is vital to the Shire and to maintaining businesses in the local town. If rural income decreases any further, unemployment will increase rapidly and local businesses will become bankrupt.

10. Town Resident

Personality: You are well educated and well spoken.

Case: You believe strongly in human rights and freedom. If the grazier wants to clear their land, that's fine as long as it doesn't harm other people. You perceive the main problem in the river to be pollution by farm chemicals.

11. Commercial Fisher

Personality: You are quietly spoken.

Case: You make a living by fishing near the mouth of the estuary. The fish population has started to decline. You think this is due to the estuary silting up and algal blooms caused by excess nutrients finding their way into the estuary. If the fish numbers decrease further, you will become bankrupt.

12. Landcare Representative

Personality: You are a bit of a 'know-all' and think you have all the answers.

Case: Engineers have been able to handle most problems in the past, or so you believe. Increased flooding in the town in the last few years can be handled by building bigger levee banks and river diversions. Siltation can be counter-balanced by dredging.

13. National Parks Officer

Personality: _____

Case: Your concern is the protection of the habitat of valuable and endangered native animals. You worry that clearing trees would isolate these animals in small pockets of remaining vegetation, and they would soon die out.

Rating river health

Students observe the health of a river at a chosen site.

Students devise and apply a rating scale to a number of observable indicators of river health and suggest ways in which it can be maintained and improved.

Outcomes

Students will be able to:

- complete a preliminary assessment of the health of a river by observing
- devise a useful, realistic health rating system which results in a reasonable judgment of the health of the river
- explain how the activities of people greatly affect river health
- discuss the ways people can care for and work towards improving river health
- demonstrate a level of concern for river health

Preparation

- Introduce students to the idea that they can rate the health of the river using their powers of observation and their senses (as distinct from assessing river health by conducting a scientific investigation of various parameters).
- Refer to the Student Resource Sheet *River health rating guidelines* and discuss the various factors that may affect river health.
- Refer to Student Worksheet *Health assessment factors and rating scale* and discuss the relevance of each question in the column 'health assessment factors'.
- Use the pamphet, *A wetlands/waterways health check* to develop with students the idea that the health of a river can be assessed by devising a scaled rating or scoring system. In the case of litter, the rating scale of 0-10 would allocate 0 points for large quantities of litter and 10 points for no litter. Students devise their rating system by considering all health categories on their worksheet. They should think carefully about what they would be looking for in each category to give a score of 10 points.

At the site

- Students check that their rating system is suitable and adjust it if necessary.
- Students explore the site, making careful observations and record their observations in the spaces provided on the worksheet. Complete the rating scale and tally the results to give an overall river rating according to their key.

Follow-up activities

- Students report on their results and consider how they could improve their rating system.
- They could then consider what would need to happen to make the site perfect or nearly perfect in terms of health, and plan to take further action.

- Students complete Resource Sheet 15, *The problem with aquatic weeds*, in the booklet *Working Scientifically in the Swan River Environment.*

REFERENCE CHECKLIST

- Student Resource Sheet *River health rating guidelines*
- Student Worksheet *Health assessment factors and rating scale*

OTHER RESOURCES

- Resource Sheet 15, *The problem with aquatic weeds*, in the booklet *Working Scientifically in the Swan River Environment*
- Ribbons of Blue primary school manual
- *A wetlands/ waterways health check, Rating your local wetland or waterway* (Waterwatch Australia pamphlet)

12 excursion

Student Resource Sheet

River health rating guidelines

Vegetation

- Vegetation (trees, rushes and shrubs) helps to keep river banks stable and prevent erosion. It also provides habitat for animals.
- Trees and shrubs that hang over the banks shade the water and help prevent aquatic fauna from becoming overheated.
- Plants that grow in the water provide a habitat for aquatic animals.
- Native hard-leafed trees drop leaves that decompose slowly in the water and provide food. Introduced deciduous trees are weeds that compete with native plants and produce leaf litter that decomposes rapidly, increasing nutrients in waterways.
- Healthy green lawn may indicate the excess use of fertiliser that can leach into the river.
- Bare ground may indicate that the banks have eroded, adding sediment to the river.

Water

- If the water is murky green or has a green scum floating on the surface there are algae present and the river may be stagnant. An oily slick or too much froth can indicate pollution. Light slicks and froths may be natural.
- If the water is clear but stained brown it may be due to tannin from paperbark trees growing on the banks further upstream. (This is quite natural and healthy.) If the water is cloudy (turbid) it could be because too much soil is washing into the stream. Trees, shrubs and reeds stop this happening. If the water is very turbid there will be few aquatic animals present.

The river

- Bends in the river or stream may show that it is still in its natural form and has not been changed into a drain or ditch. This is a good sign of river health.
- Rocks, logs and leaves in the river create different habitats, and allow for a stable stream bottom. This is better for some aquatic plants than moving sand.
- Where water flows quickly over rocks it gets mixed with oxygen. (This is called a riffle.) The more oxygen that mixes into the water, the healthier the water.

- Pools in a river are a good sign of river health because they provide an alternative habitat to the straight stretches of the river. The more types of habitat, the better. Pools also provide important refuges for animals if the rest of the stream dries up in summer.

Animals (native)

- Animal sounds indicate that the area has habitats for animals.
- The more types of animals you find under rocks, on the stems of plants or in the sediment of the stream, the healthier the water.

Litter

- The presence of litter or rubbish shows that people don't respect the site. The type of litter present may indicate how poorly the site is regarded.
- If people bring litter to dump at the river it shows they think of the river as a rubbish tip.

Land-use activities

- Buildings, roads and car parks encourage stormwater to run off hard surfaces directly into the river. This often results in vegetation and banks being altered from their natural form. Signs of industrial sites may indicate that effluents were present in the past or that soil is contaminated.
- The water of most freshwater streams would have been drinkable before being affected by human land uses.
- Drains from urban areas could carry hot water from roads and car parks, chemicals and oils from road runoff, and fertilisers and pesticides from garden water runoff.
- If people use the water for swimming, water sports and fishing it means that the water is generally healthy.

Health assessment factors and rating scale

HEALTH ASSESSMENT FACTORS	OBSERVATION	RATING
• Are there many trees and shrubs along the river bank? • Do trees and shrubs hang over the bank into the water? • Are there any plants growing in the water? • Do the trees or plants look like they are native plants or introduced plants? * • Are there large areas of lawn along the banks? • Are there any patches of bare ground along the banks?		
• Does the water look frothy or scummy? • Is the water clear or cloudy (turbid)? • Does the water smell clean and natural?		
• Can you hear or see any birds or frogs? • Are there animals under rocks, on plant stems or in stream sediments?		

* See Resource Sheet 15, *The problem with aquatic weeds,* in the booklet *Working Scientifically in the Swan River Environment.*

HEALTH ASSESSMENT FACTORS	OBSERVATION	RATING
• Are there any bends in the river? • Are there any rocks, sticks, logs or leaves in the river? • Is there any water flowing over rocks to form a riffle? • Are there any pools near the river?		
• Can you see any litter or rubbish? How damaging is it? • Suggest how the litter might have arrived at the site.		
• Are there any buildings beside the river? • Could you drink the water? • Are there any drains into the river at this site? • How do people use the river here? • Could you swim or fish in the water?		

This activity has been adapted from *Where Rivers Meet*, by Valerie Jones and Carmel Welch in *Global Issues*, a supplement to *Australian Geography* from Teacher Association Journal, Vol.1 No. 3, 1995.

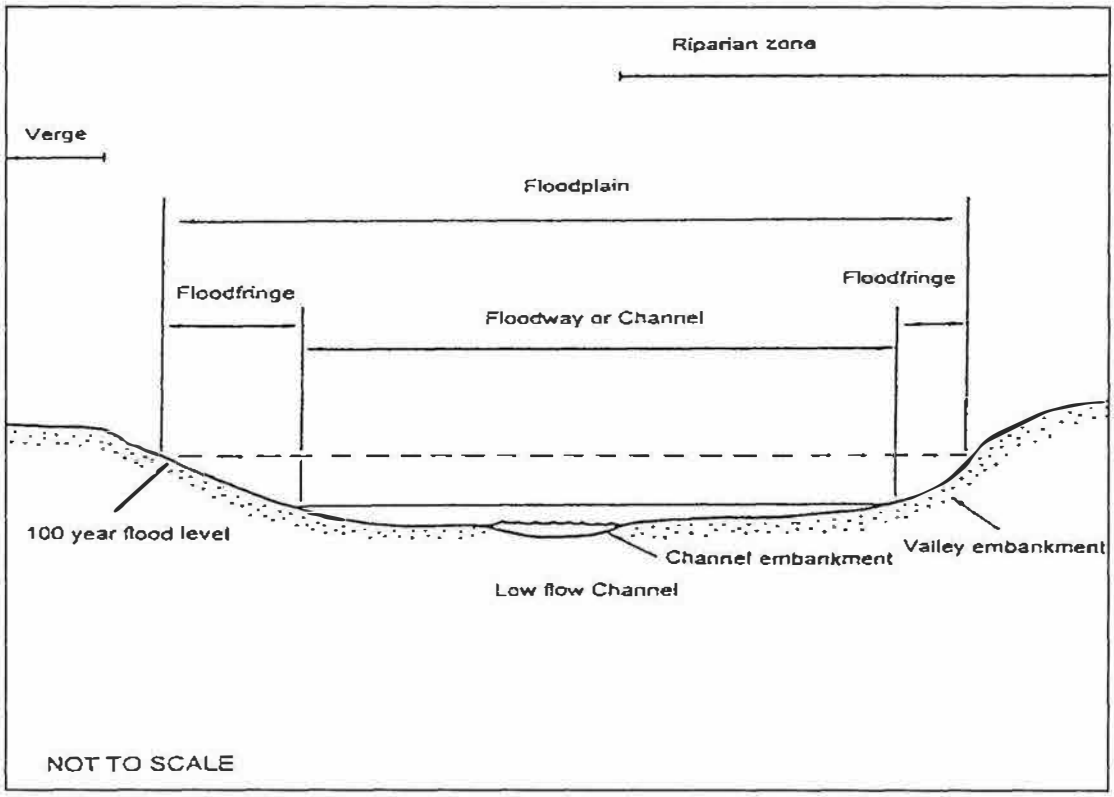
Streamline vegetation survey

This exercise involves rating the health of the riverine environment by assessing degradation through erosion and weed infestation.

This exercise should be conducted in conjunction with Excursion 14, *Living streams survey.* Both surveys enable students to draw conclusions about various important functions of riparian vegetation such as filtering nutrients, trapping sediments, stabilising banks and providing productivity and habitats. The surveys could be a starting-point for an examination of strategies for eradicating weeds and rehabilitating streamline vegetation.

Outcomes and resources listed here apply to both Excursions 13 and 14.

The cross-section of the river valley below shows the main riparian zones and features that students need to understand before commencing the vegetation surveys.



(From *Stream Foreshore Assessment in Farming Areas*, Luke Pen)

Outcomes

Students will be able to:

- recognise vegetation condition as a guide to stream health
- distinguish weeds from indigenous vegetation
- determine the health of a section of the stream by assessing the quality of the vegetation structure and the varieties of habitat present
- discuss the importance of vegetation in the riverine ecosystem

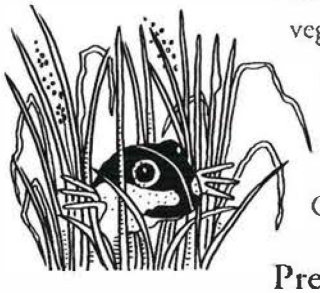
NOTE: For more information refer to Water facts 4, *Living Streams*, Resource Sheet 15, *The problem with aquatic weeds*, in the booklet *Working Scientifically in the Swan River Environment* and Excursion 7, Teacher Resource Sheet *Action plan for site revegetation*.

REFERENCE CHECKLIST

- Student Worksheet *Streamline vegetation survey*
- Student Resource Sheet *Grading descriptions*
- Excursion 7, Teacher Resource Sheet *Action plan for site revegetation*
- Excursion 14, *Living streams survey*

OTHER RESOURCES

- Resource Sheet 15, *The problem with aquatic weeds*, in the booklet *Working Scientifically in the Swan River Environment*
- Water facts 4, *Living Streams*
- *Controlling weeds in waterways and wetlands* (pamphlet)
- *Stream Foreshore Assessment in Farming Areas*



Background

The condition of a section of river foreshore can be determined by an assessment of the vegetation lining the river. Degradation occurs as remnant vegetation declines, weeds infest the area and banks become unstable and begin to erode.

The assessment system used for this survey consists of a number of grades developed from observations of riparian vegetation degradation throughout south west Australia. Grades vary from A (pristine) to D (compete degradation). Each grade has three sub-levels.

Preparation

- Familiarise students with the riparian vegetation zones, key terms and the concepts outlined on the worksheet. Refer to some of the resources listed on the previous page for more information.
- Assist students to identify the layers that make up the vegetation structure of a riparian environment (trees, shrubs, understorey and layers) and ensure that they can determine whether regrowth is occurring (i.e. recruitment of native species).
- Make sure that students can distinguish weeds from native vegetation. Refer to the pamphlet *Controlling weeds in waterways and wetlands* for more specific information about weeds.
- Select the study site for the streamline vegetation survey.
- Explain the procedure for conducting the survey:
  a) Rate the streamline site as A,B,C or D using the criteria on the Student Resource Sheet *Grading descriptions.*
  b) Examine the vegetation more closely and assess the vegetation condition as 1, 2 or 3, using the resource sheet noted above and the Student Worksheet *Streamline vegetation survey.*

At the site

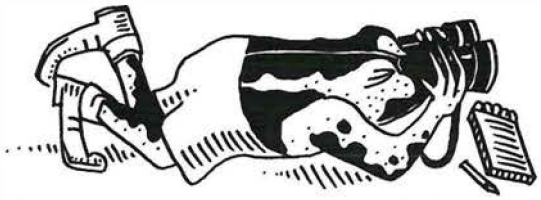
- Determine the area of the stream to be assessed.
- Conduct the survey.
- Discuss and justify assessments, and ensure that consensus has been reached.

A GRADE FORSHORE	*A.1 Pristine* The river embankments and floodway are entirely vegetated with native species, and there is no evidence of human presence or livestock damage.	*A.2 Near pristine* Native vegetation dominates. Some introduced weeds may be present in the understorey, but not to the extent that they displace native species. Otherwise, there is no human impact. (A river valley in this condition is as good as can be found today.)	*A.3 Slightly disturbed* Native plants dominate, but there are some areas of human disturbance where soil may be exposed and weeds are relatively dense (such as along tracks). The native vegetation would quickly recolonise the disturbed areas if human activity declined.
B GRADE FORESHORE	*B.1 Weed infested* Weeds have become a significant component of the understorey vegetation. Although native species are dominant, a few have been replaced or are being replaced by weeds.	*B.2 Heavily weed infested* In the understorey, weeds are about as abundant as native species. The regeneration of some types of trees and large shrubs may have declined.	*B.3 Degraded and weed-dominated* Weeds dominate the understorey, but many native species remain. Some trees and large shrub species may be less numerous or have disappeared altogether.
C GRADE FORESHORE	*C.1 Erosion prone* Trees remain, and possibly some large shrubs or grass trees, but the understorey consists entirely of weeds, mainly annual grasses. The trees are generally resilient or long-lived species, but there is little or no evidence of young trees or tree seedlings. The shallow-rooted weedy understorey provides no support to the soil, and only a small increase in physical disturbance will expose the soil and make the river embankments and floodway vulnerable to erosion.	*C.2 Soil exposed* Older trees remain, but the ground is virtually bare. Annual grasses and other weeds have been removed by livestock trampling or grazing the area, or through overuse by humans. Low- level soil erosion caused by wind or water has begun.	*C.3 Eroded* Soil is washed away from between tree roots, trees are being undermined, and unsupported embankments are subsiding into the river valley.
D GRADE FORESHORE	*D.1 Eroding ditch* There is not enough fringing vegetation to control erosion. Some trees and shrubs remain and retard erosion in certain spots, but are doomed to be undermined eventually.	*D.2 Freely eroding ditch* No significant fringing vegetation remains and erosion is completely out of control. Undermined and subsided embankments are common, and large sediment plumes are visible along the river channel.	*D.3 Weed-dominated drain* The highly eroded river valley has been fenced off, preventing control of weeds by stock. Perennial (long-lived) weeds have become established. The river has become a simple drain, similar or identical to a typical major urban drain.

13 excursion

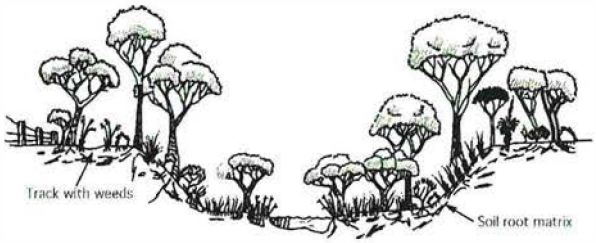
Student Worksheet

Streamline vegetation survey



SITE NAME: **WATERWAY:**

☐ **A** **Pristine – few weeds**

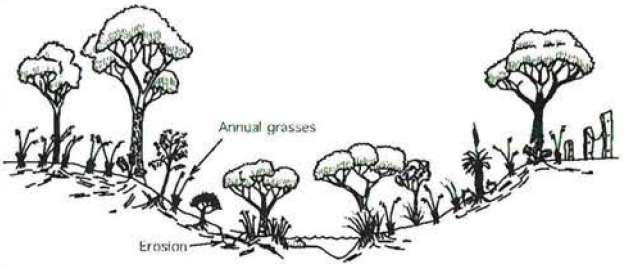


☐ A.1 Pristine: no weeds

☐ A.2 Near pristine: some weeds

☐ A.3 Slightly disturbed: local weed infestations

☐ **B** **Degraded – weed infestations**

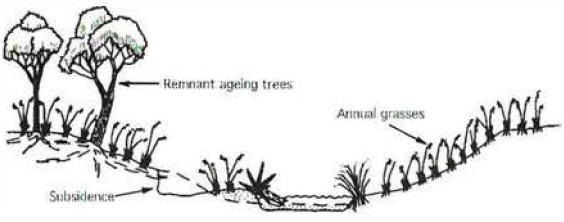


☐ B.1 Weed infested: understorey mainly natives

☐ B.2 Heavily weed infested: understorey natives and weeds

☐ B.3 Degraded: understorey dominated by weeds

☐ **C** **Eroding or erosion prone**

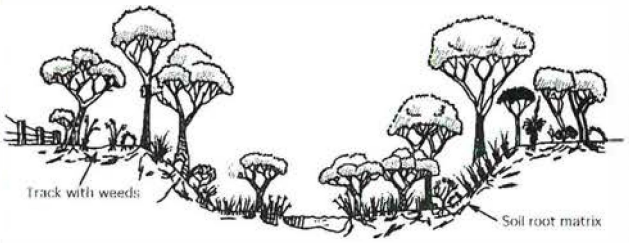


☐ C.1 Erosion prone: understorey weeds only

☐ C.2 Soil exposed: surface erosion

☐ C.3 Eroded: subsidence present

☐ **D** **Ditch or drain**



☐ D.1 Eroding: extensive erosion and siltation

☐ D.2 Freely eroding (ditch) erosion and siltation out of control

☐ D.3 Weed dominated (drain): highly eroded

Living streams survey

This excursion can be conducted in conjunction with Excursion 13.

The living streams survey provides an indication of stream health based on an assessment of the quality and diversity of habitats. Each parameter is scored and, from the total, an overall stream health assessment is made.

Outcomes (as for Excursion 13)

Students will be able to:

- recognise vegetation as a guide to stream health
- distinguish weeds from indigenous vegetation
- determine the health of a section of the stream by assessing the quality of the vegetation structure and the varieties of habitat present
- discuss the importance of vegetation in the riverine ecosystem

Preparation

- Select the study site for the living streams survey.
- Explain the purpose of the survey. Students assess and rate each of the different assessment parameters: bank and floodway vegetation, verge vegetation, stream cover, bank stability and erosion, and habitat diversity, in order to produce an overall stream health rating. They also examine and assess the surrounding land use as an additional factor affecting the quality and diversity of habitats.
- Familiarise students with the parameters to be assessed and with the explanations in the Student Worksheet *Living streams survey.*

At the site

- Determine the area to be surveyed. For each factor examined, survey a distance of about 100 m along both banks of the stream.
- Review information in the Student Worksheet *Living streams survey.*
- Using the resource sheet and worksheet, students identify and assess the different habitat types at the site, and select the rating they consider is most appropriate. Add the scores to obtain an overall environmental river health rating for the site. A separate rating survey sheet is needed for each site surveyed.
- Students then identify the major land use in the area and apply the appropriate rating. They add this to the score for other parameters. Note that, if one side of the stream differs greatly from the other in some way, students should evaluate each side separately, add the scores and divide the sum by two to determine the average condition.
- Students discuss each assessment within their groups and, when each is confirmed, add the scores to determine the overall health score. Then they apply the appropriate stream health assessment.

REFERENCE CHECKLIST

- Student Resource Sheet *Explanation of assessment parameters*
- Student Worksheet *Living streams survey*
- Excursion 7, *Action plan for site revegetation*

Follow-up activities

Focus on vegetation

- Write a general description of the vegetation at each site and illustrate it with a diagram based upon information from the 'Streamline Vegetation Assessment' sheet.
- Extend study of streamline vegetation – students could investigate different types of reeds, shrubs and trees associated with waterways and research their requirements in terms of abiotic and biotic environments, reproduction and their tolerance for habitat disturbances.

Focus on the links between vegetation and water quality

- Compare water quality and vegetation data for the sites that were visited. Respond to these questions: Does better vegetation correspond to better water quality? How does vegetation help in maintaining water quality? What is the link between vegetation and water temperature? How does vegetation reduce the turbidity of the water? How does vegetation prevent excess nutrients from entering the water? How does vegetation contribute to oxygen levels in the water?
- Consider each of the physical and chemical parameters measured in the Water Quality Testing activity and relate the results to the vegetation status of the stream.
- Consider why forest streams have clear, clean water and the sort of vegetation that would be found in/near a polluted stream. Consider whether vegetation is the controlling factor that determines water quality.
- Design a reed bed replacement strategy for the study site. Reed beds along waterways are now being recognised as important nutrient filters.
- Students could imagine they are horticulturists in their subcatchment. They would obviously prefer that the water they need to pump out of the river onto their orchards and gardens is clean. They could describe how they would like to see the vegetation that exists in the upstream part of the catchment managed.

Focus on the relationship between vegetation health and macroinvertebrates

- Relate the diversity and abundance of macroinvertebrates found in the macroinvertebrate study to the stream health rating. Investigate the habitat needs of each of the macroinvertebrates and see if they are adequately represented at the site. Decide if the site provides adequate habitat for stable, long-term macroinvertebrate communities.
- List all animals (including larger organisms) observed at the fieldwork site and determine if the vegetation is adequate for the habitat needs of large animals and smaller animals.
- Investigate the role of streamline vegetation in food chains. (Animals rely more on material falling into the water as a food source than on primary production in the water.)
- Write a report on the role of vegetation in riparian ecology.

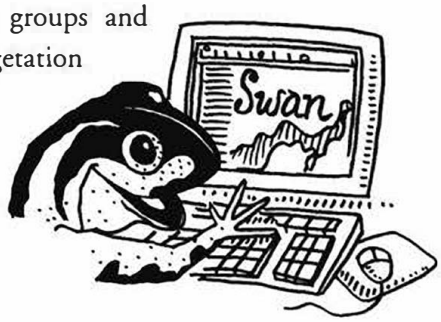
Follow-up activities (contd)

Focus on links between vegetation and land use

- Relate the condition of the vegetation to the surrounding land-use activities in the area. If the vegetation was found to be in poor condition, consider whether it is because of grazing by stock, overclearing of vegetation or other factors. If the vegetation is in good condition, is it because of fencing, or protection by a conservation zone, or other factors? Students should consider questions such as: Does the vegetation have a role in reducing the impact of land uses on the water? Does the vegetation seem to be acting as a sediment trap? Is it contributing to bank stability by reducing erosion?
- Compare the impacts of rural and urban land uses on streamline vegetation.

Focus on a revegetation plan

- Identify the main waterway weeds. Note that even plants that might not be considered invasive weeds in another situation (a non-riparian environment) can become noxious if they spread rapidly along streamlines. Discuss the means by which weeds are transported to the site and explain why they are a disadvantage to the health of streams. Research the soil-holding properties of the vegetation and its role in providing food and habitat. Consider the question: Are weeds able to fulfil the ecological role of native vegetation?
- Design a revegetation strategy for their site. See Excursion 7, *Action plan for site revegetation* for worksheets and teacher resource sheets.
- Investigate river conservation organisations and community action groups and discover what is involved in becoming a volunteer in a waterways revegetation project.



Assessment parameters →

Health rating key ↑

	BANK & FLOODWAY VEGETATION	VERGE VEGETATION	STREAM COVER	BANK STABILITY & EROSION	HABITAT DIVERSITY	SURROUNDING LAND-USE
EXCELLENT	• Healthy undisturbed native vegetation. • No weeds. 15	• Healthy undisturbed native vegetation. • Verges more than 20 m wide. 8	• Abundant cover: shade,overhanging vegetation. • Snags, leaf litter, rocks and/or aquatic vegetation in the stream. 8	• No erosion, subsidence or sediment deposits. • Dense vegetation cover on banks and verge. • No disturbance. 8	• Three or more habitat zones. • Some permanent water. 6	• Conservation reserve such as a National Park. 8
GOOD	• Mainly healthy undisturbed native vegetation. • Some weeds. • No recent disturbances. 12	• Mainly healthy undisturbed native vegetation. • Verges less than 20 m wide. 6	• Abundant shade and overhanging vegetation. • Some cover in the stream. 6	• No significant erosion, subsidence or sediment deposits in floodway or on lower banks. • May be some soil exposure and vegetation thinning on upper bank and verge. 6	• Two habitat zones. • Some permanent water. 4	• Remnant bush – healthy natural vegetation with little sign of disturbance. 6
MODERATE	• Good vegetation cover, but a mixture of native and exotic species. • Localised clearing. • Little recent disturbance. 6	• Good vegetation cover, but mixture of native and exotic species. • Verges 20 m wide or more. 4	• Some permanent shade and overhanging vegetation. • Some instream cover. 4	• Good vegetation cover. • Only localised erosion, bank collapse and sediment heaps. • Verges may have sparse vegetation cover. 4	• Mainly one habitat type with permanent water, or range of habitats with no permanent water. 2	• Rural. • Agricultural with stream buffer zone. • Urban with stream buffer zone. 4
POOR	• Mainly exotic ground cover. • Obvious site disturbance. 3	• Narrow verges only (<20 m wide). • Mainly exotic vegetation. 2	• Channel mainly clear. • Little permanent shade or instream cover. 2	• Extensive active erosion and sediment heaps. • Bare banks and verges common. • Banks may be collapsing. 2	• Mainly one habitat type with no permanent water. 1	• Agricultural with no stream buffer zone. • Urban with no stream buffer zone. 2
VERY POOR	• Mostly bare ground or exotic ground covers (i.e. pasture, gardens or weeds but no trees). 0	• Mostly bare ground or exotic ground covers (i.e. pastures, gardens or weeds but no trees). 0	• Virtually no shade or instream cover. 0	• Almost continuous erosion. • Over 50% of banks collapsing. • Sediment heaps line or fill much of the floodway. • Little or no vegetation cover. 0	• Stream channellised. • No pools, riffles, or meanders. • The stream forms a continuous channel. 0	• Commercial. • Industrial. 1

TOTAL SCORE	*40 - 53*	*30 - 39*	*20 - 29*	*10 - 19*	*0 - 9*
STREAM HEALTH ASSESSMENT	Excellent	Good	Moderate	Poor	Very poor

Student Resource Sheet

Explanation of assessment parameters

Bank and floodway vegetation

This vegetation grows in the floodway or on the banks and is the major source of energy, nutrients and carbon for the stream ecosystem. The canopy is the tree cover that overhangs the stream. Plant roots stabilise the floodway and banks against erosion and bank collapse. Stems and foliage dissipate the energy of floodwaters, reducing erosion and promoting sedimentation.

Verge vegetation

The stream verge, which extends from the top of the embankment to a paddock fence, backyard fence or road, is about 10-15 m wide. Sometimes the verge is part of streamside parkland. Verge vegetation provides habitat next to the water, increases the value of the riparian zone as an ecological corridor and stabilises the stream banks by anchoring them with tree roots to the adjacent land.

Stream cover

Fish and other aquatic organisms require logs, snags, leaf litter and rocks to provide shelter from predators. Aquatic plants are also very important for fish and other creatures. They have a direct effect on the oxygen available in the water, which in turn affects the type of fish and other animals found.

Protruding snags and rocks provide roosting and preening sites for birds and help to mix and oxygenate water in the faster flowing sections of the stream. Overhanging and emergent vegetation provides shade to which many aquatic animals retreat during the hot days of summer and autumn. Insects blown from flowers and leaves are an important source of food for fish and other animals.

Bank stability and erosion

Streams sometimes naturally erode on bends (meanders). However, when vegetation is cleared for agricultural activities and urban development, this can cause banks to become unstable, resulting in continuous erosion along the floodway and the build-up of sediment that is then slowly washed downstream. Erosion and bank collapse can also be caused by increased runoff from hard surfaces (e.g. car parks), from pipes and drains, and by straightening or channelling the stream.

Habitat diversity

Different habitat types in streams include cascades, rapids, riffles, waterfalls (which are quite rare), runs, meanders, pools and floodplains. Stream sections that have a range of habitat types can support a greater variety of species.

Rapids occur when rocks and snags protrude through rapidly flowing water. Areas where water flows quickly over stones and rocks or between tree stems are known as riffles, while areas where the water surface is essentially flat are known as a runs. Rapids and riffles aerate water and provide habitat for invertebrates. Usually the stream floodway, including rapids and riffles, is heavily vegetated.

The vegetated floodways are usually broken by deep pools that provide habitat for fish, turtles, marron and other animals. Pools are often the only part of the stream to retain water over summer, providing an essential drought refuge.

Long, broad sections of vegetated or clear floodway are typical of the lower reaches of our larger rivers. They provide different types of habitats because the cutting action of water at bends creates deeper areas and variable water speed. Seasonal floodwaters next to the stream may provide important breeding and feeding habitat for aquatic life.

Surrounding land-use

Land-use activities contribute greatly to the ecological value of the stream. A stream in an area of National Park or remnant bush contributes to, and benefits from, a wider biological diversity than could be found in either the stream or bushland. A stream in an agricultural setting will have higher sediment and nutrient levels, while a stream in an urban or industrial area will be more vulnerable to weed invasion and pollution. Native animals living in urban and semi-rural areas benefit from a stream environment or from the remnant bush along its flanks.

15
excursion

Land-use survey

Students conduct a land-use survey in which they identify, classify and map types of land-use activities occurring in a particular subcatchment.

This activity aims to help the student make the connection between land-use activities and river health and to suggest solutions to the problem.

Outcomes

Students are able to:

- explain how various forms of land-use activities occurring in river subcatchments can negatively affect the overall health of the river
- interpret research data relating to the quantifiable connections between land-use activities and the health of the waterways (note that surface runoff and groundwater movement are the links between land-use and water quality)

- identify and record (perhaps by mapping) types of land-use activities occurring at and near the river (explain the link between water quality and these activities)
- suggest solutions for problems associated with the management of catchment areas

Preparation

- Discuss with students, the physical and cultural aspects of the chosen subcatchment by using aerial photos, topographic map extracts and/or a metropolitan street directory. Refer also to Resource Sheet 17, *Subcatchments of the Swan-Canning river system*, in the booklet *A Sense of Place in the Swan River Environment.*
- Students discuss the concept of land uses and how they can be categorised, for example agriculture (grazing and/or cropping), urban (residential, commercial, business, recreational), industrial, transport. They devise their classification system and develop a colour code and key. Base maps could then be prepared.
- Discuss types of pollutants and their different sources (point source and diffuse source). Refer to Water facts 3, *River and Estuary Pollution.*
- Students will need to observe the landscape on their travels between their school and the site(s) to gain a more complete picture of subcatchment land uses.

At the site

- Students use the Student Worksheet *Catchment management land-use survey* to observe, identify and classify land uses at the site(s) visited. They then map them according to the categories and colour codes devised in the preparation stage.
- Students examine the area at the site for tributaries and open or closed drains that enter the river. They could map them and the land uses along their courses. Suggest what materials these drains might be carrying into the river. Consider other ways in which materials might find their way into the rivers (via surface runoff and groundwater flow).

REFERENCE CHECKLIST

- Student Worksheet *Catchment management land-use survey*

OTHER RESOURCES

- Resource Sheet 17, *Subcatchments of the Swan-Canning river system*, in the booklet *A Sense of Place in the Swan River Environment*
- Water facts 3, *River and Estuary Pollution*
- Aerial photographs and topographic maps of the chosen subcatchment and a metropolitan street directory
- Enlarged base map of the selected subcatchment area

At the site

- Students identify and note land-use activities that have a direct, observable effect on water quality (e.g. discharge of effluents from factories, sewage treatment plants, intensive animal husbandry sheds and intensive plant growing operations). Pipes and drains from such places provide evidence of point sources of pollution (which enter the stream at a single point).
- Consider whether less obvious pollution may be occuring and suggest land-use activities that might be the cause. (Note that water quality will be affected by activities that are occurring further upstream in the subcatchment, or even further away in other subcatchments). For example, broad-scale agricultural activities further upstream produce diffuse source pollution, since excess fertilisers and herbicides from these agricultural lands are carried into the waterway by ground and surface water movement.
- Observe and record evidence of environmentally good land-use practices – and poor practices. Good practices include vegetated buffer strips along stream banks, plenty of vegetation cover on paddocks, vegetated hilltops and fences that protect the river banks from stock. Poor practices are indicated by lack of vegetation (or fencing) along the waterway and eroded banks.

Follow-up activities

- Students complete their land-use maps with the help of aerial photos, topographic maps and metropolitan street directory maps. The maps can then be put on display.
- Students could construct a cross-section to explain the movement of water into the river by groundwater and surface flow. Consider factors that affect the amount and rate of flow (e.g. soil type).
- Students examine possible solutions to reduce pollution (e.g. revegetate areas) and discuss the need for catchment management. Reflect on whether it is possible to achieve long-term economic returns from the land while retaining much of the integrity of the ecosystem, and how this might be achieved. Consider who should assume the responsibility for managing the subcatchment and what the responsibilities of individual landholders, local government, the State Government, local businesses, industries and community groups might be.
- Consider how an integrated approach to catchment management could be achieved.

Student Worksheet

Catchment management land-use survey

LAND USES AT THE SITE	GOOD AND POOR PRACTICES NOTED INCLUDING POINT POINT-SOURCE AND DIFFUSE-SOURCE POLLUTION	RATING OF EFFECT ON RIVER SYSTEM
Urban • Residential • Commercial • Business • Recreational • Industrial		

Key for Rating	S slight or no effect on river health	N noticeable effect	M major effect

LAND USES AT THE SITE	GOOD AND POOR PRACTICES NOTED INCLUDING POINT POINT-SOURCE AND DIFFUSE-SOURCE POLLUTION	RATING OF EFFECT ON RIVER SYSTEM
Transport (highways, roads, tracks, etc.)		
Forestry		
Mining		
Agriculture		

16
excursion

Water quality testing

Students investigate sources of water pollution, its effects, and consider appropriate solutions.

Students develop technical skills while measuring the physical and chemical parameters of stream water quality. Values measured may include temperature, pH, turbidity, conductivity, dissolved oxygen and phosphate and nitrate concentrations.

REFERENCE CHECKLIST

- Student worksheet *Water quality testing*

OTHER RESOURCES

- Ribbons of Blue secondary school manual
- Water quality testing activities in the booklet *Working Scientifically in the Swan River Environment*
- *Swan-Canning River and Estuarine System Map* (poster)
- *Water Quality Data* (data disc)

Outcomes

Students are able to:

- explain how physical and chemical data provide a way of considering all abiotic changes that take place in a waterway – their source, the effects of change and their status in terms of river health
- discuss the factors (such as rainfall and seasonal events) that cause variations to water conditions
- relate the physical and chemical indicators of water quality to biological indicators (macroinvertebrate populations and vegetation) and to the catchment's land-use activities
- develop skills in the technical processes associated with measuring physical and chemical parameters used to test water quality
- show understanding of the fact that a water sample represents just a moment in the life of the river, and variables such as diffuse-source and point-source pollutants will cause changes in the values
- assess the health of the site through interpretation of measured physical and chemical parameters
- relate physical and chemical indicators of water quality to biological indicators and land-use activities of the catchment

Preparation

- Choose one or two waterways. Water quality comparisons could be made between a drain outlet or tributary and the main stream within the same study site. (Be aware that by late summer some of the sites may have no water.) Consider testing at an action site indicated on the *Swan-Canning River and Estuarine System Map* for which data are available.
- Familiarise students with the use of water-testing equipment. Refer to the Ribbons of Blue secondary school manual for instructions on the various types of equipment. For information on the loan and use of equipment, contact Ribbons of Blue, your local government environmental health officer or the Swan River Trust community catchment officers.
- Students should calibrate their equipment and familiarise themselves with its use and care, and with the format for recording their results.

At the site(s)

- Students select the most appropriate sampling point, ideally midstream, and halfway between the surface and the bottom. Otherwise, sample as far out from the bank as possible, and avoid eddies and backwaters. (To avoid contamination, thoroughly rinse sampling equipment downstream of the sampling point.)

At the site(s)

- Record results for the following activities on the Student Worksheet *Water quality testing.*
- Carefully observe the water, surrounding vegetation and land uses and make informal predictions about the results of all parameters to be tested. Students should briefly describe the site and water conditions and note the weather conditions so that their results can be analysed in context.
- Collect water samples and test them according to instructions given. Record results and relate them to predictions. If results seem unrealistic, students should reappraise their methods and if necessary resample and retest.
- Check results of water testing for all sites and display in table form for easy comparison.

Follow-up activities

Focus on data interpretation/analysis

- Compare each fieldwork site in terms of the parameters measured. Construct bar graphs to compare results from the different sites. Suggest reasons for any differences between data from the different sites and explain results in terms of the differences in vegetation and/or land uses of the sites and catchment.
- Check and analyse the results against the accepted standards provided in the Ribbons of Blue manual. Be aware that rainfall can cause sudden changes in values (especially phosphate and nitrate).
- From an assessment of all parameters tested, rate the water quality at each site.
- Using the data disc *Water Quality Data*, compare data collected with data previously collected from the same site(s) at roughly the same time of year. Students should decide whether data are consistent with those of previous years, and explain their results in terms of the time of year.
- Using the data disk *Water Quality Data*, graph data collected for each parameter from the site(s) over a year, and examine the seasonal changes. Identify those parameters that show the greatest seasonal range/fluctuation and try to explain why.
- Obtain rainfall data for Perth over the last few years to see if any of the changes on the graphs can be explained in terms of previous rainfall events.

Focus on a pollutant investigation

- Investigate how the parameters measured relate to water quality and the presence of pollutants. Consider why the values vary and what levels of change in the parameters are acceptable. Identify the source of the major pollutants of waterways (e.g. nutrients, organics, chemicals, sediment and metals). Differentiate between, and give examples of, point-source and diffuse-source pollution.
- Develop a hypothesis that attempts to explain the results at the site(s) visited. Plan an investigation to test the hypothesis.
- Contact a community catchment group and volunteer to help with further water sampling. Community catchment groups operate monthly sampling programs in many urban catchments. Ribbons of Blue can put you in touch with various groups.

16 excursion

Student Worksheet

Water quality testing

Site:_____ **Sampling Location:** _____

PREDICTIONS OF WATER QUALITY BASED ON PRELIMINARY OBSERVATION OF THE SITE	
OBSERVATIONS OF SITE FEATURES	PREDICTIONS
Water	Temperature
Vegetation	pH
Land-use	Phosphate levels
Site degradation	Dissolved oxygen
Pollutants	Salinity
Macroinvertebrates	
Weather conditions	

RESULTS OF WATER QUALITY TESTING		
PARAMETERS	SITE 1	SITE 2
Temperature pH Turbidity Dissolved oxygen Salinity (conductivity) Phosphate levels Nitrate levels		

INTERPRETATION OF RESULTS	
SITE 1	SITE 2

HEALTH ASSESSMENT OF RIVER SITES

17 excursion

Aquatic macroinvertebrates investigation

Students investigate aquatic macroinvertebrates in urban and semi-rural freshwater tributaries of the Swan River system.

REFERENCE CHECKLIST

- Student Worksheet *Macroinvertebrates water condition index*
- Excursion 13, *Streamline vegetation survey*
- Excursion 14, *Living streams survey*
- Excursion 16, *Water quality testing*

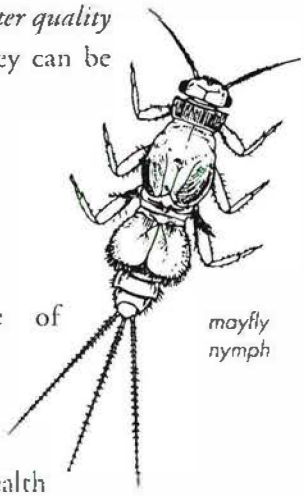
OTHER RESOURCES

- Water facts 2, *Macroinvertebrates and Water Quality*

Aquatic macroinvertebrates can be investigated in the context of the non-living conditions of the water, or they can be related to the number and quality of habitat types available. They can also be used to rate the health of a stream. The animals reflect the conditions in which they live: a full suite of macroinvertebrates indicates clean, healthy water.

This activity could be used as a preliminary investigation of the diversity, form, habits, adaptations and habitats of freshwater macroinvertebrates. It would be a worthwhile and interesting exercise to study the effects of seasonal changes on macroinvertebrates by comparing populations at two sites and/or at one site at various times of the year.

This investigation is best conducted in conjunction with Excursion 16, *Water quality testing*, and/or Excursion 13, *Streamline vegetation survey*, activities so they can be related to stream health and habitat types.



mayfly nymph

Outcomes

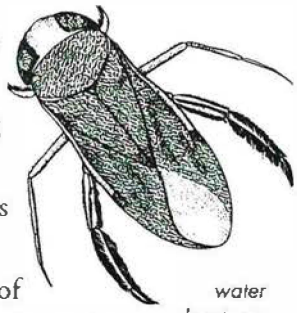
Students are able to:

- collect and identify macroinvertebrates
- clarify relationships between the diversity and abundance of macroinvertebrates and the condition of their non-living environment
- clarify relationships between aquatic macroinvertebrates, their aquatic habitats and the streamline vegetation
- relate the diversity and abundance of macroinvertebrates found to the health of the ecological system
- explain why a range of macroinvertebrates is necessary for the ecological balance of river systems

Preparation

- Choose appropriate sampling sites.
- Discuss the aims of the excursion activity with students.
- Discuss guidelines for collecting and preserving macroinvertebrates in the field.
- Select and photocopy extracts from Water facts 2, *Macroinvertebrates and Water Quality (How to sample for macroinvertebrates)*, to provide relevant information for students.
- Prepare macroinvertebrate collecting equipment and discuss how to use it.

At the site



water boatman

- Collect macroinvertebrates by using a long-handled dip net as described in Water facts 2. Students should demonstrate responsible behaviour by minimising environmental disturbance and returning aquatic life to the water as soon as possible.
- Identify collected macroinvertebrates according to their gross morphology and their behaviour.
- Record details of the presence (and absence) of macroinvertebrates of various types on the Student Worksheet *Macroinvertebrates water condition index*.

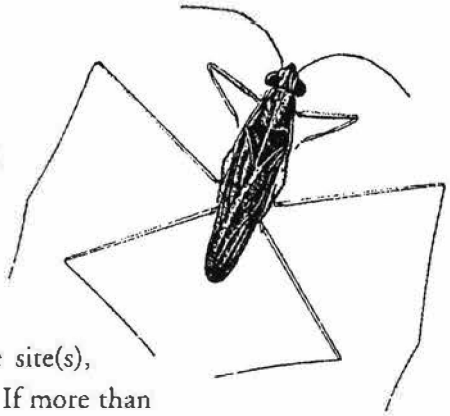
At the site

- Students calculate the stream water condition index using the sensitivity index column. (The method is described in Water facts 2.)
- Make sure that macroinvertebrates are returned to the water. If some macroinvertebrates are to be collected for further study, see Water facts 2 for guidelines on preservation.

Follow-up activities

Focus on biological studies of macroinvertebrates

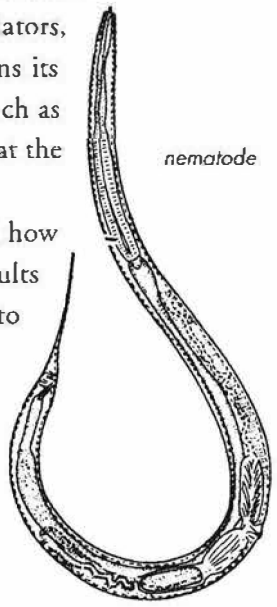
- Use the fieldwork as a basis for further studies of the natural history and ecology of macroinvertebrate life-cycles, adaptation, habitat, community and taxonomy.



water strider

Focus on links between macroinvertebrates and water quality

- Having calculated the macroinvertebrate water condition index for the site(s), decide whether it has a poor, fair, good or excellent stream quality rating. If more than one site was tested, site ratings can be compared and explanations for variations suggested.
- Think about another stream or river with which students are familiar and predict its stream quality rating. As a follow-up to this, students can plan an investigation to compare the ratings of different sites.
- Using the Student Worksheet *Macroinvertebrates water condition index* as a starting-point, research different macroinvertebrates and suggest reasons for their varying tolerances to water quality. Discuss the idea of particular species acting as indicators for specific forms of pollution. Try to explain why some macroinvertebrates were missing from the sampling site.
- Using reference books or information from Water facts 2 and the worksheet, students can classify the macroinvertebrates into the functional feeding groups of: predators, collectors, filter feeders, shredders and scrapers. Investigate how each group obtains its food. Predict how each group would be affected by changes in water conditions such as higher temperatures, increased sedimentation and excessive algal growth. Check that the sampling results verify predictions.
- Consider seasonal changes in the physical and chemical properties of the water and how these would affect aquatic organisms. Predict how the abundance and diversity results might differ in summer, winter and spring. (If possible, visit the sites again to evaluate predictions.)
- Graph the diversity and abundance of macroinvertebrate data from all sampling sites and compare the results. Graph diversity and/or abundance against certain physical or chemical conditions present. Interpret graphs by deciding which non-living factors have the most significant influence on macroinvertebrate diversity and/or abundance.



nematode

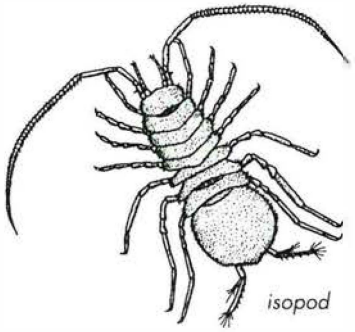
Note: Occasionally the macroinvertebrate results do not seem to reflect the site's non-living conditions. For example, Ellen Brook generally contains more macroinvertebrates than might be expected from its water quality. Students can suggest reasons why variations such as these might occur.

Focus on the links between macroinvertebrates and vegetation

- Relate the abundance and diversity of macroinvertebrates found at the site(s) to the quality of water that was determined by conducting Excursion 13, *Streamline vegetation survey*, at different sites. Display results graphically. Describe the ideal streamline vegetation structure for aquatic macroinvertebrates.
- Compare also the macroinvertebrate diversity and abundance to Excursion 14, *Living streams survey*. Using reference materials, find out more about the habitats that different types of macroinvertebrates prefer. Determine if this is reflected in the students' results.

Focus on ecosystems

- Present a report that compares the site(s) visited in terms of land-use, water quality, vegetation and macroinvertebrates.
- After discussion, create a simulation of the macroinvertebrate data you might expect to find in a pristine karri forest stream in spring, a wheatbelt stream in winter and an urban drain at the end of summer. For each, describe the effects of the seasons and land uses on water quality. Justify predictions.
- Write a short paper to explain why macroinvertebrates might give a better indication of the status of an ecological system than physical or chemical tests.
- Prepare a discussion paper that outlines the merits of restoring degraded waterways in urban and semi-rural areas.



isopod

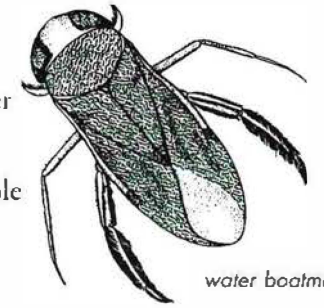
Student Worksheet

Macroinvertebrates water condition index

INVERTEBRATE	NUMBER FOUND	SENSITIVITY INDEX
Stonefly larvae		8
Mayfly larvae		7
Caddisfly larvae		6
Dragonfly larvae		6
Damselfly larvae		6
Water mites		5
Gilgies or marron		4
Freshwater mussels		4
Beetle larvae		4
Beetles (Coleoptera)		3
Bugs (Hemiptera)		3
Water fleas		3
Freshwater shrimp		3
Amphipods		3
Snails		3
Flatworms		3
Leeches		3
Fly larvae		2
Midge larvae		1
Aquatic earthworms		1
INDEX		

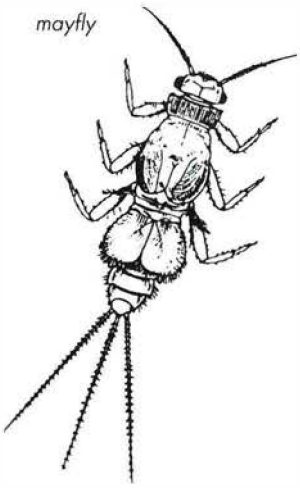
Instructions

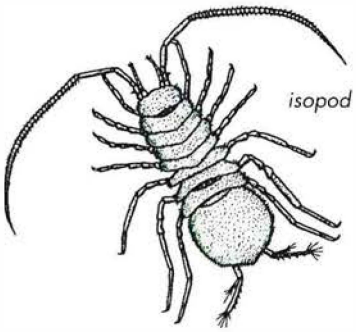
- Count the number of each different type of macroinvertebrate found.
- If a macroinvertebrate is present, circle its sensitivity score.
- At the end of your collecting session, add the circled numbers to find the water condition index.
- Use the water condition index to work out your stream quality rating from the table below.

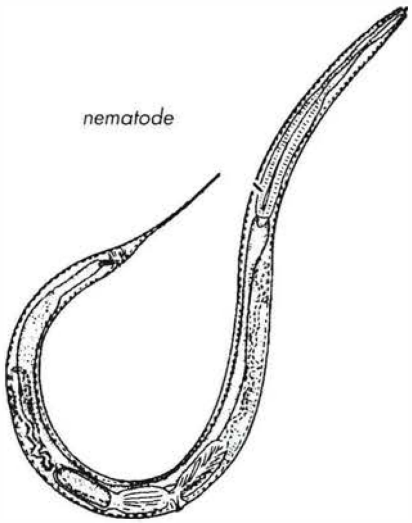

water boatman

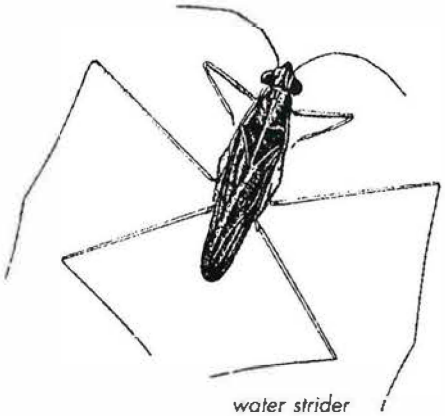
NOTE: To make results comparable, you must use the same collecting technique on all occasions.

MACROINVERTEBRATE WATER CONDITION INDEX	STREAM QUALITY RATING
19 or less	Poor
20-34	Fair
35-49	Good
50 or more	Excellent


mayfly


isopod


nematode


water strider

Resources

This kit contains the following resources:

Booklets

- *Excursions in the Swan River Environment, Fieldwork and activities to support studies in Science, and Society and Environment,* Water and Rivers Commission/Swan River Trust, 1999
- *Working Scientifically in the Swan River Environment, A teaching approach for Science,* Water and Rivers Commission/Swan River Trust, 1999
- *A Sense of Place in the Swan River Environment, A teaching approach for Society and Environment,* Water and Rivers Commission/Swan River Trust, 1999

Map/Poster

- *Swan-Canning River and Estuarine System Map,* Water and Rivers Commission, 1999

Data disc

- *Water Quality Data, Swan River Estuary and its Catchments,* Ribbons of Blue, 1999

Video

- *Living with Streams,* Water and Rivers Commission/Swan River Trust

Posters

- *H_2Only,* Swan River Trust
- *Don't Let your River go down the Drain,* Swan River Trust

Water facts

- Water facts 1, *Water Words,* Water and Rivers Commission, 1996
- Water facts 2, *Macroinvertebrates and Water Quality,* Water and Rivers Commission, 1996
- Water facts 3, *River and Estuary Pollution,* Water and Rivers Commission, 1997
- Water facts 6, *Algal Blooms,* Water and Rivers Commission, 1998
- Water facts 7, *The Water Cycle,* Water and Rivers Commission, 1998

Brochures

- *A Guide to Our Services,* Water and Rivers Commission, 1999
- *A Guide to Our Services,* Swan River Trust, 1998
- *A Guide to Our Services,* Ribbons of Blue, 1998
- *5 Entertaining and Educational Ways to Find Out More About Our Most Vital Resource: Groundwater, Wetlands, Rivers* (video order form), Water and Rivers Commission, 1996
- *An Educational Video on the Swan and Canning Rivers, New Release: Algal Blooms and Nutrients* (video order form), Water and Rivers Commission, 1998
- WaterTalk, *Wetlands,* Water and Rivers Commission, 1998
- *The Avon Ascent, A self-guided drive tour of the Avon Valley,* Avon River Management Authority, 1995

Other resources available from the Water and Rivers Commission/Ribbons of Blue/Swan River Trust:

Videos

- *Living with Wetlands,* Water and Rivers Commission/Swan River Trust
- *What is Groundwater?,* Water and Rivers Commission
- *Living on Groundwater: Part 1 - Country WA,* Water and Rivers Commission
- *Living on Groundwater: Part 2 - Urban WA,* Water and Rivers Commission
- *Algal Blooms and Nutrients,* Water and Rivers Commission/Swan River Trust

Posters

- *Living streams - I can do that!,* Water and Rivers Commission
- *Clean water - I can do that!,* Water and Rivers Commission
- *Healthy wetlands - I can do that!,* Water and Rivers Commission
- *Catchment friendly gardens - I can do that!,* Water and Rivers Commission

Manuals

- Ribbons of Blue manual: *Environmental Awareness to Action,* A water quality monitoring program for primary school students, Waterways Commission (now Water and Rivers Commission)
- Ribbons of Blue manual: *Environmental Awareness to Action,* A water quality monitoring program for secondary school students, Waterways Commission (now Water and Rivers Commission)

Brochures/Pamphlets

- *Native vegetation of estuaries and saline waterways in south Western Australia,* Water and Rivers Commission/Department of Conservation and Land Management, 1997
- *Native vegetation of freshwater rivers and creeks in south Western Australia,* Water and Rivers Commission/Department of Conservation and Land Management, 1997
- *A wetlands/waterways health check, Rating your local wetland or waterway,* Waterwatch Australia
- *Caring for our waterways: information and advice for people living near rivers, estuaries and harbours,* Water Advice no. 1, Water and Rivers Commission, 1996
- *Growing local plants to protect water resources,* Water Advice no. 6, Water and Rivers Commission, 1998
- Water facts 4, *Living Streams,* Water and Rivers Commission, 1998

Other

- *Riverview* (newsletter), Swan River Trust
- *Rivercare Directory,* Swan River Trust
- *Swan-Canning Cleanup Program Action Plan, An Action Plan to clean up the Swan-Canning Rivers and Estuary,* Swan River Trust, 1999
- *Controlling Weeds in Waterways and Wetlands,* Swan River Trust/Department of Environmental Protection, 1995

- *Drains to the River, Clean Water Only* (stencils), Swan River Trust
- *Western Australian Salinity Action Plan,* Agriculture Western Australia, Department of Conservation and Land Management, Department of Environmental Protection, Water and Rivers Commission, November 1996
- *Western Australian Salinity Action Plan,* Draft update, State Salinity Council, 1998
- *Draft Avon River Management Programme,* Water and Rivers Commission and Avon River Management Authority, 1999
- *Stream Foreshore Assessment in Farming Areas,* Luke Pen, 1995

Note: The *Water facts* and some other useful publications are available on the Water and River Commission website, www.wrc.wa.gov.au. You can also access a complete list of publications and order copies using the publication order form on the website.

Some other useful resources

- Landcare In Your Hands, *Land Conservation Activities for Secondary Science and Social Studies,* Department of Agriculture, 1991
- RGC wetlands teachers' manual *From Sand to Ducks,* RGC Wetlands
- *Web of Life Manual,* Year 11
- *Stepping out Literacy and Learning Strategies,* Education Department of Western Australia, Western Australia 1996
- Catchment Carers' Trail, *Years 5 - 7 Teacher and Student Notes: Notes for a trail as Part of an Upper Primary School Excursion,* Department of Conservation and Land Management and Water Corporation, 1996
- *Family Walks in the Perth Outdoors,* Department of Conservation and Land Management
- *Waterwatch and your Catchment: Involve Me and I'll Understand,* Department of Primary Industries, Queensland, 1995
- *Catchment Care Education Kit,* Department of Primary Industries, Queensland, 1992
- *Frog Symphony Unit,* Environmental Education Unit, Murray Darling Basin Commission, 1998
- Metropolitan Street Directory
- Topographical maps of the Perth region
- Aerial photographs of the Perth region (Department of Land Administration)
- Landscape photographs of the south-west of Western Australia and Swan-Avon catchment (Department of Land Administration)
- Atlas maps

Organisations/Departments/Associations

- APACE
- Avon Network Centre
- Avon River Management Authority (ARMA)
- Australian Association for Environmental Education (AAEE)
- Birds Australia
- Cockburn Wetlands Centre
- Department of Conservation and Land Management (CALM)
- Ecoplan
- Environmental Weeds Action Network
- Fisheries Western Australia
- Frogwatch CSIRO
- Gould League
- Herdsman Lake Wildlife Centre
- Institute for Earth Education
- Men of the Trees
- Peel-Harvey Catchment Support Group
- Perth Zoo Education Centre
- RGC Wetlands
- Ribbons of Blue
- Science Teachers' Association of Western Australia (STAWA)
- Swan Catchment Centre
- Tammin Alcoa Landcare Education Centre
- WA Museum
- WA Naturalists
- Water and Rivers Commission (WRC)
- Water Corporation
- Wildflower Society of WA
- York Tourist Bureau

Catchment groups within the Swan-Canning system

CATCHMENT GROUPS	DATE ESTABLISHED
Bayswater Integrated Catchment Management (BICM)	1991
Swan Working Group (Swan Catchment Council) (coordinating group for the Swan-Avon ICM Program in the Swan-Canning catchment)	1995
Canning Catchment Coordinating Group	1995
Litoria Catchment Care Group	1995
Bennett Brook Catchment Group	1995
Upper Canning/Southern-Wungong Catchment Team	1996
Ellen Brook Integrated Catchment Group	1996
Bannister Creek Catchment Group	1996
Blackadder Woodbridge Catchment Group	1997
Jane Brook Catchment Group	1997
Claisebrook Catchment Group	1997
Belmont Catchment Management Group	1998
Helena River Catchment Group	1998
Gingin Land Conservation District Committee	1984
Wooroloo Brook Land Conservation District Committee	1989
Chittering Land Conservation District Committee	1991
North Swan Land Conservation District Committee	1997

Integrated Catchment Management (ICM)

ICM is the process of coordinated planning, use and management of water, land, vegetation and other natural resources on a river or groundwater catchment basis. It involves the whole community of the catchment including landholders, businesses, residents, local government and state agencies.

Swan Catchment Centre

The Swan Catchment Centre was established in 1995, in response to community requests to provide support to ICM groups. The centre is open to everyone and is a place where you can find information and get advice on environmental issues in the Swan Catchment. It provides a place for the community to work together with Government and Local Government.

Getting in contact

Some catchment groups in the metropolitan region have employed coordinators who are involved in implementing catchment management activities. Catchment groups may be able to assist teachers in implementing some of the activities contained in the education kit. Teachers are encouraged to contact their local catchment group coordinator (or chairperson) if they are interested. Contact details for catchment groups are available from the Swan Catchment Centre on (08) 9221 3840.

Appendices

Appendix 1 – Twenty suggested fieldwork sites on the Swan, Canning and Avon Rivers

* Note: Please refer to the Swan-Canning River and Estuarine System Map for site locations

Site	Access	Description	Facilities and courses	Study opportunities	Notes
1. Marine Education Boatshed, South Fremantle 	Riverside and Pier Street, South Fremantle (accessible to disabled people)	• Education Centre run by Department of Transport, Marine Safety division	• Parking • Classroom • Toilets • Jetty • Canoes • Courses in snorkelling • Powerboating • Sailing • Seatrek and survival • Navigation • Canoeing	Courses run by Education Centre: • AYF TL3 (Certificate of Proficiency in Small Craft Safety) • Canoeing • Seatrek preparation *Other opportunities:* • Estuarine aquatic fauna (adaptations to estuarine/marine environment) • Water quality (port area) – pollution, salt wedge, pathogens, flotsam • Human uses – port, ferries, Aquarama, yacht club, transport, recreation • Catchment land uses – port, industry, commerce, residential • Foreshore treatments (concrete)	• Site nearest to estuary mouth – estuarine and marine influences • Possible bike ride from Boatshed to Point Walter (3 hours, European and Aboriginal heritage) Bookings: Ph (08) 9339 7851

* Please refer to the Swan-Canning River and Estuarine System Map for site locations

Site	Access	Description	Facilities and courses	Study opportunities	Notes
2. APACE Fremantle 	1 Johanna Street, North Fremantle	• Non-profit community organisation providing education and training in the environmental field; also undertake consultancies • Native plant nursery on site	• Parking • Plant nursery • Education centre • Library open to the public • Disabled toilet facilities	• Vegetation • Regeneration • Sustainability Courses: • Greening schools program • Introduction to bush regeneration • Seed collection of WA native plants	Bookings : Ph (08) 9336 1262 Fax (08) 9430 5729
3. Claisebrook Inlet, East Perth	Off Plain Street (into either Wittenoom or Brown Street), East Perth	• Claisbrook Inlet carries drainage/ irrigation water through the recreational area	• Bus parking • Jetties (sufficiently deep for boats) • Bridges • Picnic/lunch areas • Toilets	• Comparison of groundwater-fed water features and the river-fed inlet • Water quality • Aquatic fauna • Land-use (new residential, old gasworks)	

* Please refer to the Swan-Canning River and Estuarine System Map for site locations

Site	Access	Description	Facilities and courses	Study opportunities	Notes
4. Banks Reserve, East Perth	Joel Terrace from East Parade, East Perth	• Public recreation area close to Perth city; open drain	• Parking • Picnic sites • Toilets • Bairworm digging	• Vegetation transects • Birdlife • Habitat variety • Water quality • Human use/site design	
5a. South Belmont Main Drain, Belmont (south of Great Eastern Highway)	Off Abernethy Road just before Great Eastern Highway (down the steps from the café) 	• Open drain running parallel on the west side of Abernethy Road; buildings on other side	• Some parking outside café or on street • Lunch area with tables • Paved walkways for several hundred metres upstream • Bridges over drain • Toilets (behind café)	• Vegetation assessment • Aquatic fauna • Drain survey • Water quality • Comparison of pipe water with main drain • Catchment land-use – urban • Human use – litter surveys	
5b. South Belmont Main Drain, (north of Great Eastern Highway)	Off Great Eastern Highway, just before Abernethy Road, Belmont	• Confluence of the South Belmont Main Drain with the Swan River	• Bus parking • Boat ramp • Shaded area • Bridge crossing the drain	• Foreshore vegetation (clearing) • Aquatic fauna • Water quality • Land-use (e.g. Ascot Waters development) • Studies comparing the drain and river	• Although site is set back from the highway, be careful if taking small children there

* Please refer to the Swan-Canning River and Estuarine System Map for site locations

Site	Access	Description	Facilities and courses	Study opportunities	Notes
6. Bayswater Foreshore (Hines Reserve) 	Wright Crescent, Bayswater (pathway to Stone Street) Adjacent to Garratt Road Bridge	• Degraded Swan River foreshore with restoration under way (John Forrest SHS), bird sanctuary, Bayswater Main Drain, old tip site being restored as recreation area, Greenworks wetland rehabilitation site	• Bus parking • Toilets	• Vegetation – weeds, restoration, revegetation • Birds • Water quality (drain, river, pollution, algal blooms) • Hydrology (fresh springs, urban drainage) • Floodplain • Human use – recreation, boating, waterskiing, river ferries, train bridge • Mosquito control (site using physical and chemical techniques) • Catchment land-use – residential and industrial • Drain management – monitoring, revegetation, erosion control • Catchment Management – Bayswater ICM Group, Greenworks community volunteers	• Well-documented example of community-based catchment management improving water quality and drain environment

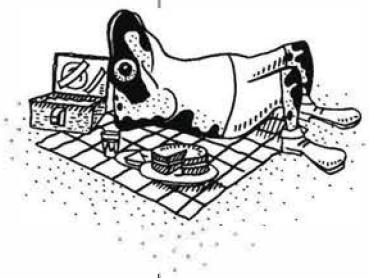
* Please refer to the Swan-Canning River and Estuarine System Map for site locations

Site	Access	Description	Facilities and courses	Study opportunities	Notes
7. Garvey Park, Belmont	End of Fauntleroy Avenue off Great Eastern Highway, Belmont	• Public recreation park on the south side of the Swan River	• Bus parking • Picnic sites • Toilets	• Estuarine fauna • Human use/site design	
8. Beverley Terrace, Belmont	End of Beverley Terrace off Great Eastern Highway, Belmont.	• Remnant vegetation and wetland on the south side of the Swan River	• Limited parking • Raised boardwalk	• Comparison of estuarine and freshwater ecology • Birds • Variety of habitat • Human use – site design and rehabilitation	• Limited access for water sampling
9. Kings Meadow, Guildford	Leave James Street, Guildford, and take Ethel Street or Stephen Street, then Hill Street.	• Open recreational park at the confluence of the Helena and Swan Rivers.	• Bus parking • Picnic sites • Jetties • Toilets	• Estuarine ecology • Birds • Water quality • Human use / site design	

* Please refer to the Swan-Canning River and Estuarine System Map for site locations

Site	Access	Description	Facilities and courses	Study opportunities	Notes
10. Guildford – foreshore reserve at Middle Swan Bridge, Guildford	Middle Swan Bridge 	• Cleared Swan River foreshore near traffic bridge	• Parking	• River fauna • Water quality – algae • Hydrology – tidal • Flood plain use • Human use – historic river transport, Guildford Port; recreation • Catchment land-use – agriculture, vineyards, semi-rural, urban	
11. All Saints Church, Guildford	All Saints Church	• Historic church	• Historic church • Parking • Path to river	• European heritage	• Access to river by path possibly not safe for young children • Take care to avoid entering private property
12. Challenger Reserve / Sandon Park, Manning	Off Challenger Avenue, Manning	• Extensive grassed area with some natural vegetation, a creek and wetland on north side of Canning River	• Bus parking	• Vegetation transect • Estuarine and freshwater ecology • Birds • Habitat investigations • Water quality • Land use • Human use/site design	

* Please refer to the Swan-Canning River and Estuarine System Map for site locations

Site	Access	Description	Facilities and courses	Study opportunities	Notes
13. Canoe Ramp. Riverton Bridge, Riverton	Barbican Street East (old Riverton Bridge)	• On south side of Canning River, paved area with view of regional park upstream	• Parking • Launching facility • Toilets • Disabled access	• Estuarine and freshwater ecology • Birds • Habitat – wildlife • Water quality	• Good access for water sampling
14. Kent Street Weir 	At the end of Kent Street Wilson	• Kent Street Weir on the Canning River, surrounded by park and sporting ovals: in the Canning River Regional Park	• Bus parking • Toilets • BBQ/lunch facilities • Playground • Walk trails through the Canning River Regional Park • Bridge (over weir) • Canoe ramps/access	• Vegetation • Algae • Aquatic weeds • Aquatic fauna • Water quality • Comparison of upstream (fresh) with downstream (estuarine) environment when weir boards are in place	• Algal Health Warning signs are erected if an algal bloom poses a health risk – contact City of Canning or Swan River Trust (08) 9278 0400 if signs are in place

* Please refer to the Swan-Canning River and Estuarine System Map for site locations

Site	Access	Description	Facilities and courses	Study opportunities	Notes
15. Mason's Landing, Cannington	End of River Road, Cannington 	• Park alongside the Canning River in the Canning River Regional Park	• Toilets • Bus parking • Undercover tables • Tap • BBQ area • Playground • Historical interpretive material	• Algae • Aquatic weeds • Vegetation assessment • Aquatic fauna • Water quality, contrasting when weir boards are up and down – contact City of Canning or Swan River Trust (08) 9278 0400 regarding Algal Health Warnings	• Contact City of Canning to check if the weir boards are in place • There are also several other good sites in the Canning River Regional Park
16. Rushton Park, Southern River, Gosnells	South-west of Southern River confluence with Canning River; near Rushton Community Centre 	• Drain entering degraded section of Southern River near confluence with Canning River	• Street parking • Shade • Mowed grass banks • Toilets • Bridge • Walk path along Southern River	• Vegetation • Weeds • Water quality (drain and river, stormwater, pollution, litter, algae) • Hydrology – drain to river • Urban drainage • Catchment land use – urban, rural, piggeries, chicken farm, nurseries • Stream and drain management – streamlines, stormwater management, weeds	• Gosnells SHS conducting student environmental projects nearby

* Please refer to the Swan-Canning River and Estuarine System Map for site locations

Site	Access	Description	Facilities and courses	Study opportunities	Notes
17. Northam Town Pool 	Northam	• River Pool on Avon River, Northam	• Parking • Gazebo with interpretive signage	• White swans • Water quality • Hydrology • Human use – historic, current • Catchment land use – agriculture, townsite • River management – one of last permanent pools on the Avon, dredging issues • Avon River Management Authority	• Education/ interpretation facilities being developed
18. Historical Balladong Farm, York 	On Great Southern Highway (York-Beverley), 5 minutes from York (1.5-hour drive from Perth)	• Historic farm where pioneering traditions are preserved in 1850s farm buildings; blacksmith's forge • On Avon River • Landcare Theatrette with free 14-minute audiovisual 'Spirit of the Land' introducing landcare in the Avon	• Bus parking • Toilets and picnic area (in farm) • Landcare audiovisual	• Cultural history – working historic farm • Avon Ascent site – introduction to river site at Gwambygine Park and farm site at Avondale Discovery Farm	• Landcare audiovisual is free; there is a charge for farm entry • Avon ascent is day trip from Perth

* Please refer to the Swan-Canning River and Estuarine System Map for site locations

Site	Access	Description	Facilities and courses	Study opportunities	Notes
19. Gwambygine Park, York 	On Great Southern Highway (York-Beverley), 10 kilometres from York	• Park on one of few remaining permanent Avon River pools	• Bus and car parking • Gas barbecues • Picnic areas • Toilets • Playground • Interpretive walk trail and river boardwalk	• Viewing tower with views of 'trained' and natural river • Vegetation – floodplain and upland (suit transects), revegetation site • Weeds • Birdlife • Water quality (limited access to river), salinity • River training • Floodplain function (interpreted flood levels) • Hydrology – seasonal river flow • European heritage – historic school site, York settler history • Aboriginal heritage – nearby sites, local mythology • Human use – recreation • Catchment land-use – agriculture	• Catchment and river management issues (Avon River Management Authority) • Avon Ascent site – education materials available; good site for lunch stop

* Please refer to the Swan-Canning River and Estuarine System Map for site locations

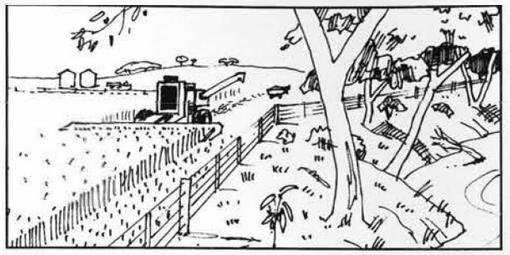
Site	Access	Description	Facilities and courses	Study opportunities	Notes
20. Avondale Discovery Farm, Beverley 	Waterhatch Road, Beverley (22 kilometres on from Gwambygine Park)	• Working experimental farm with landcare education facilities, in Avon River catchment • Interactive landcare education centre • Landcare drive trail with interpretive signage and gazebo	• Machinery museum • Settler's historic homestead • Working farm • Clydesdale horses • Animal nursery • Picnic area • Bus parking • Toilets • Landcare drivetrail • Landcare education centre	• Vegetation restoration (streamlines, corridors) • Fauna – terrestrial bird life (also kangaroos, emus in enclosure) • Soils, geology • Catchment concepts – views across catchment, can see junction of Avon and Dale rivers • Catchment land-use – agriculture • Landcare techniques, farm planning	• Avon Ascent site

* Please refer to the Swan-Canning River and Estuarine System Map for site locations

Appendix 2 – Catchment model diagram

Small town – e.g. Toodyay

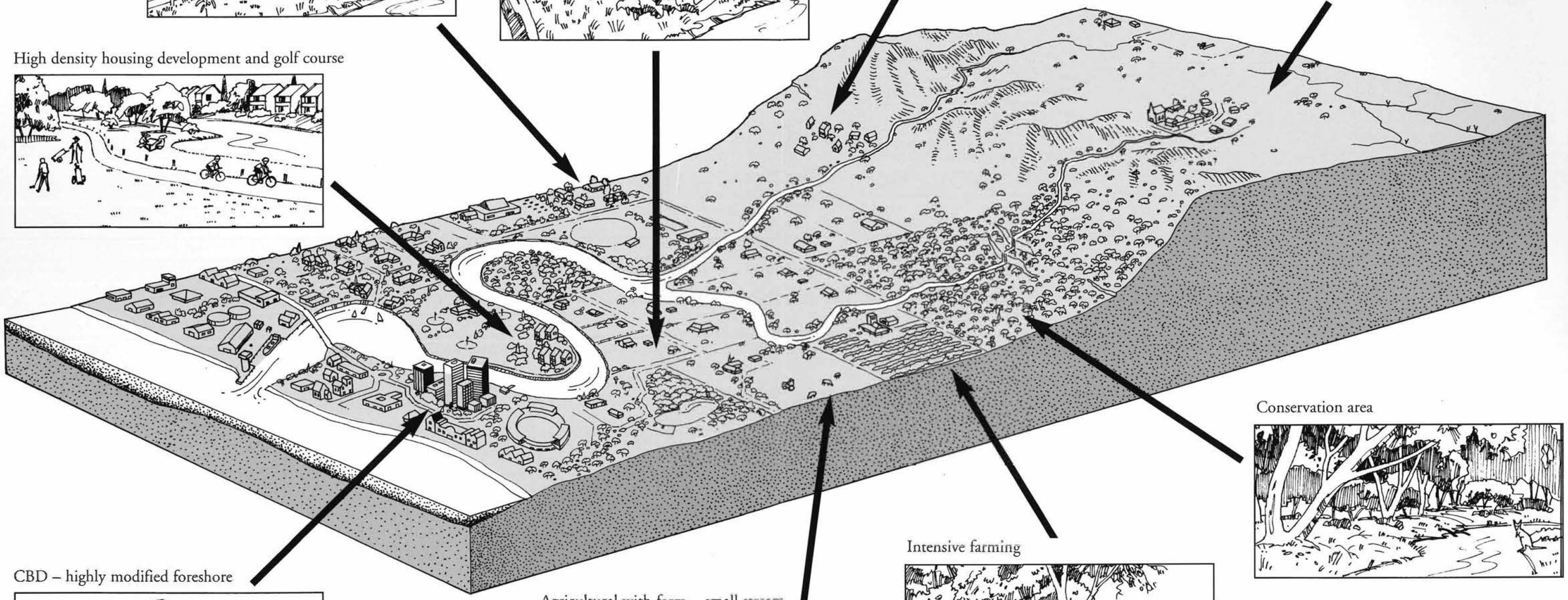
Wheatbelt – agriculture, intermittent stream



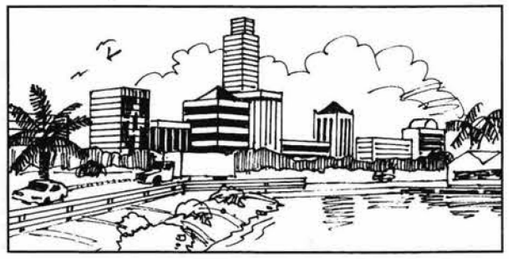
Urban settlement

Rural/residential

High density housing development and golf course



CBD – highly modified foreshore



Agricultural with farm – small stream

Intensive farming

Conservation area

Level 3, Hyatt Centre
87 Adelaide Terrace
East Perth WA 6004
Telephone: (08) 9278 0400
Facsimile: (08) 9278 0401
http://www.wrc.wa.gov.au/srt

Level 2, Hyatt Centre
3 Plain Street
East Perth WA 6004
Telephone: (08) 9278 0300
Facsimile: (08) 9278 0301
http://www.wrc.wa.gov.au

Level 2, Hyatt Centre
3 Plain Street
East Perth WA 6004
Telephone: (08) 9278 0300
Facsimile: (08) 9278 0301
http://www.wrc.wa.gov.au/ribbons

atural Heritage Trust