Yallingup Brook
Action Plan

1999

Soil and Land Conservation Council Western Australia

Water and Rivers Commission

GeoCatch

Natural Heritage Trust

Yallingup Brook
Action Plan

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Prepared for Geographe Catchment Council - GeoCatch
and the Yallingup LCDC

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Funded by the Natural Heritage Trust and GeoCatch

How to Use This Report

This report is a community document focusing upon management of Yallingup Brook. Further detail can be obtained from the Yallingup Brook Action Plan Reference Document. Additional Worksheets, related to particular sections of the Brook, have been provided to land managers.

This Action Plan uses the same table of contents as the Reference Document so that readers may easily transfer between the two when seeking more or less detail.

Understanding the background and methodology

Chapters 1 - 3 provide introductory and methodological information on the report and the catchment.

Characterising the catchment

Chapters 4 - 6 characterise the area and describe the natural resources within the catchment.

Interpreting the results

Chapters 7 - 9 detail the foreshore survey results and identify issues affecting the state of the Brook. Management advice is provided to help remedy these issues. A table of suggested management actions is included for each survey section. The management issues and suggested actions directly correspond with the information presented on the maps overleaf, which should be examined in conjunction with section information.

Seeing the survey results

Maps 1A-1C depict the whole catchment and present a summary of the report findings. A legend is provided opposite each map, to interpret symbols and information shown on the maps.

Acronyms

CALM	The Department of Conservation and Land Management
AgWA	Agriculture Western Australia
LCDC	Land Conservation District Committee
WRC	Water and Rivers Commission
DOLA	Department of Land Administration
Sh.Bsn.	Shire of Busselton
NHT	Natural Heritage Trust
YRA	Yallingup Residents Association

Acknowledgments

The authors wish to acknowledge the initiative and commitment demonstrated by the Yallingup Land Conservation District Committee (LCDC). The LCDC has been involved with addressing the degradation of the Yallingup Brook for a number of years. In the interest of efficient use of resources and sound ecological planning, the group supported a 1997 GeoCatch funding application to produce a detailed survey and action plan for the Yallingup Brook.

We extend our appreciation to members of the reference group who have provided useful comment throughout the project:

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Summary

Yallingup Brook is located on the Leeuwin Naturaliste Ridge in the south west of Western Australia. The Brook's 5.5 km length traverses a variety of land uses as it meanders towards the Indian Ocean where it meets the Yallingup Beach Lagoon.

The upper portion of the Brook is seasonal, whereas the lower portion is perennial with a permanent freshwater seep from the limestone formation within the Leeuwin Naturaliste National Park. The flow is again subsurface for some distance between the Caves House Hotel dam and where it reappears below the steep slope of the Ghost trail.

Most of the catchment remains under native vegetation and is contained within the National Park and Reserves. There has been considerable clearing in the upper catchment, which is currently used for agricultural purposes.

This Action Plan assesses the condition of the Brook and proposes practical management actions taking account of the likely cause, remediation, timing and priorities. The Action Plan was developed with community involvement.

Erosion and sediment deposition are significant management issues throughout the Brook with a large volume of active sediment apparent in the streambed of all sections surveyed. Rehabilitation of fringing vegetation, with its bio-filtering and erosion control functions, can be expected to significantly address this issue. Weed infestation was found to be significantly affecting the health of the Brook, with actions already under way to remove the weeds. Detailed water quality analysis was beyond the scope of this report, however initial sampling was undertaken and the community may decide to follow up with continued investigations.

The findings and recommendations of the survey are designed to provide advice and encouragement to land managers to implement actions which will protect and restore the condition of the Yallingup Brook. It is recommended that all opportunities are taken to rehabilitate and enhance native vegetation within the riparian zone of the Yallingup Brook. Land managers are advised to:

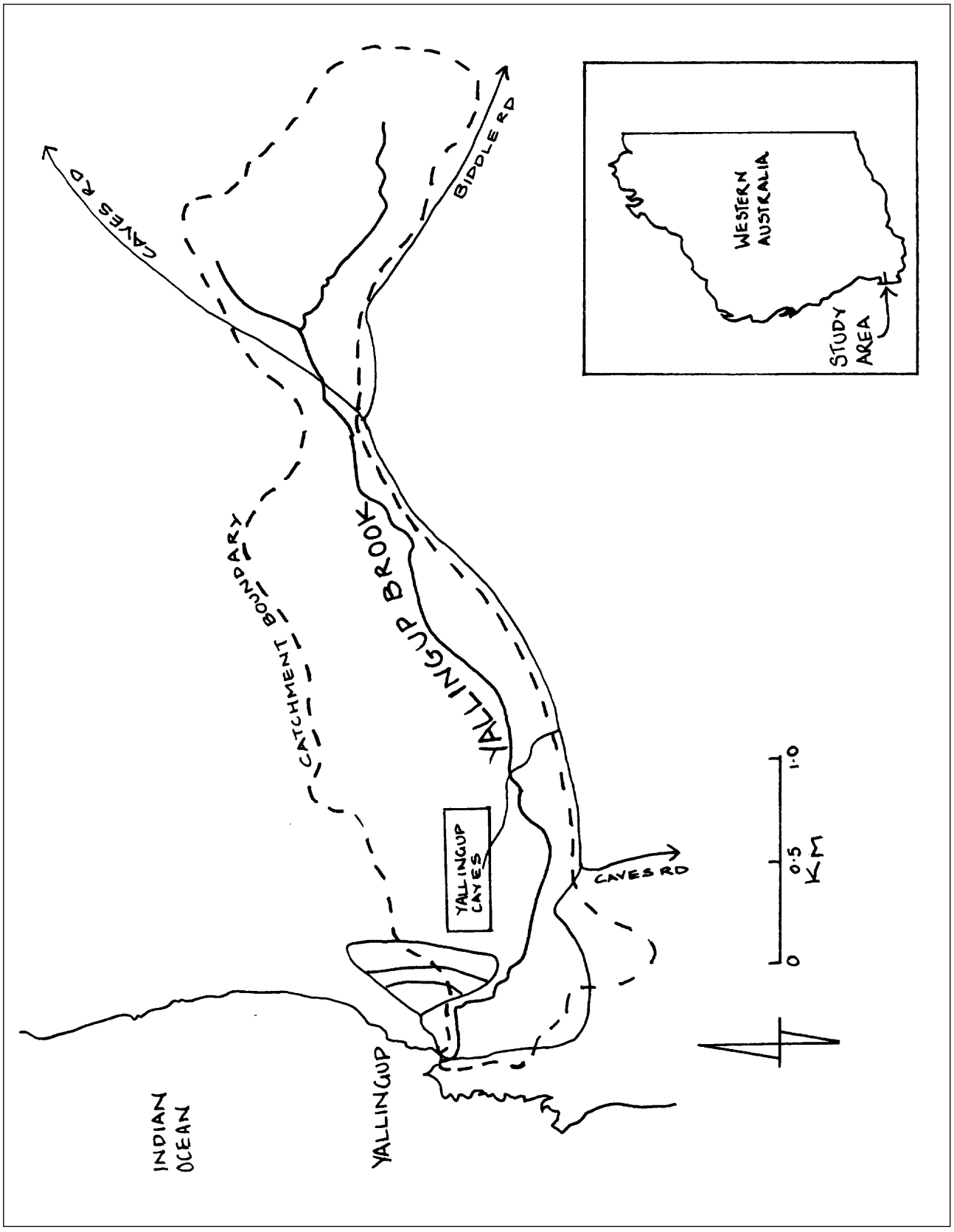
- increase the amount of existing native vegetation fringing the Brook;
- avoid further clearing of native vegetation and protect existing native vegetation;
- obtain environmental management advice and approvals prior to constructing dams or any other structures affecting water courses;
- investigate formalising traffic crossings and access to the foreshore where problems currently occur;
- assist with constructing pools and riffles, and stabilising head cuts where erosion is occurring in the streambed;
- act to contain or eradicate weeds wherever possible;
- apply appropriate levels of fertiliser, recognising the retention capacity of soils;
- maintain groundcover where possible by limiting traffic or by appropriate stock management.

The following table provides summary information from the foreshore survey of the Yallingup Brook.

Table 1: Summary of survey results

Section No.	Location	Classification
1	Mouth to stormwater pipe	Slightly disturbed-Some weeds
2	Stormwater pipe to crossover	Eroded-Weed dominated drain
3	Crossover to Hotel dam	Erosion prone-Weed dominated drain
4	Hotel dam to powerline track	Near pristine-Slightly disturbed
5	Powerline track to Hemsley Rd	Slightly disturbed-Some weeds
6	Hemsley Rd to Caves Rd	Degraded-Erosion prone
7	Upper catchment	Some weeds-Eroding ditch
8	Upper catchment	Some weeds-Eroded
9	Upper catchment	Erosion prone - Eroding ditch

Map 1: Location map for the Yallingup Brook catchment



Introduction

Aims and objectives of the study

Aims

The aim of the Yallingup Brook Action Plan was to produce a large map of Yallingup Brook detailing land tenure and condition of the Brook. The map was to be accompanied by an Action Plan which provides an ongoing prioritised plan of action through which riverine degradation can be addressed.

Objectives

- provide a benchmark against which the local community's future work to protect and rehabilitate the Brook can be gauged
- provide a tool to better guide the expenditure of limited resources to achieve optimum usage, weed control, erosion control, tree planting and rehabilitation
- provide a sound technical basis for future funding or project submissions.

Study area

The study area includes the entire length of the Yallingup Brook. Map 1 shows the head of the Brook located north of Biddle Road and east of Caves Road, in the Quedjinup locality. The Brook crosses Caves Road and Hemsley Road before running through the Leeuwin Naturaliste National Park on the western side of Caves Road. The Brook passes below Caves House Hotel complex, alongside the Ghost trail and through an area of public reserve before entering the ocean at Yallingup Lagoon.

The catchment boundaries (Map 1) for Yallingup Brook were determined during the project, specifically during meetings with landholders and stakeholders. The catchment boundaries have been used to interpret the drainage pattern which influences the Brook, however the primary focus of the project was on the immediate foreshore of the Brook. The area considered in the foreshore survey includes the channel embankments, the floodway, the valley embankments which rise immediately above these and the land use adjacent to the Brook.

Background to the study

For some time the community of Yallingup has recognised the need to improve the health and condition of the Yallingup Brook. People have voiced concern about a range of issues including the potential impact on the Yallingup lagoon, water quality, the spread of exotic weeds and a reduced amenity value along the Ghost trail. Community action to clean up rubbish, control weeds and apply for funding has been overseen by the Yallingup LCDC and the Yallingup Residents Association (YRA).

In light of the issues involved, the needs of various stakeholders and the potential cost of rehabilitation, the Yallingup LCDC recognised that for effective management, a thorough examination of the Brook was needed. This examination would provide the necessary information on which a prioritised plan of action could be based.

An opportunity to assess the Brook was provided by the Geographe Catchment Council (GeoCatch) in 1997. Recognising the need to address the poor state of health of waterways in the region, GeoCatch applied for a National Heritage Trust (NHT) grant to develop River Action Plans, following consultation with the relevant LCDC's. The successful application was funded through the National Rivercare component of NHT which operates under the goal: *To ensure progress towards the sustainable management, rehabilitation and conservation of rivers and to improve the health of these river systems.*

Description of the area

The Yallingup Brook drainage basin lies approximately 12 km south of Cape Naturaliste, within the Shire of Busselton (Sh. Bsn.). The Brook primarily drains through the Leeuwin Block, a north - south ridge of discontinuous Tamala limestone interspersed with granite-gneiss rock.

The Yallingup Brook extends some 5 km inland from the mouth at Yallingup Lagoon. The Brook begins on rural land north of Biddle Rd and the mouth of the Brook is located at the Yallingup Lagoon, where Yallingup Beach Rd crosses the bridge before entering the townsite (refer to Map 1).

The values of fringing vegetation

Values of fringing vegetation have been identified by Pen (1994) have been included here in response to a number of questions commonly asked by community members when considering the need for assessing waterways and ultimately repairing them.

Streambank stabilisation and soil conservation

The soils of the natural stream valley support a varied flora of trees, shrubs, sedges and herbs. In turn, the vegetation supports the stream bank and protects it from erosion and subsidence. The vegetation does this in a number of ways. Firstly, fringing vegetation increases stream bank roughness which acts to dissipate the energy of running water, and so reduce the erosive capacity of the stream flow (Troeh *et al*. 1980). Secondly, roots and rhizomes bind and reinforce the soil of the embankments. The large roots of trees anchor the embankment in place and the smaller roots and rhizomes of shrubs, sedges and grasses hold the soil firmly at the surface of the ground between the large tree roots. In fact, the soil root matrix can add extra cohesion of the order of ten times that of an unvegetated embankment (Thorne, 1990).

The roots and rhizomes also act to loosen and break up the soil, with the result that a well vegetated bank enables rapid infiltration of rain water (Riding and Carter, 1992). Together with the extraction of water by the plants themselves, greater hydrological conductivity causes the bank to be drier than a similar unvegetated bank. In wet weather, this means that the embankment is less likely to become saturated with water, and thus is less prone to mass failure, such as subsidence and toppling caused by the added bulk weight of the water (Thorne, 1990).

Lastly, riparian vegetation is highly resilient, exhibiting quick regeneration and recolonisation following severe floods. In this way the vegetation helps stabilise the river system against the effects of severe erosion and sedimentation (DeBano and Schmidt, 1990).

Sediment and nutrient retention

Ongoing international research increasingly highlights the important function that riparian zone vegetation has in filtering out sediment and nutrients carried in flowing waters. Work on vegetated buffer strips along waterways or between waterways and agricultural land has shown that vegetation of many forms, including grasslands, sedgelands, woodlands and forests, can filter out and retain substantial amounts of sediment and nutrients (Knauer and Mander, 1989). Dissolved nutrients, especially nitrate, are readily taken up and assimilated by plants (Pinay *et al*. 1990).

By reducing stream flow, riparian vegetation promotes sediment deposition (Thorne, 1990). Sand can be deposited even where water is fast moving and silt will settle out where vegetation causes a marked reduction in flow. However, near-still water , such as that caught in densely vegetated floodplains, is required for the deposition of the very fine clay fractions (Troeh *et al*.1980). Over time, substantial stream bank and floodplain accretion can occur in certain areas as a result of sediment deposition, and this can alter hydrological processes (Thorne, 1990). The removal of suspended sediment by vegetation is especially important, as water carrying sediment has a greater momentum and is more abrasive than clean water, and thus has an enhanced capacity to cause erosion (Troeh *et al*. 1980).

Much if the nutrient trapped in the vegetation of waterways or in buffer strips is assimilated by the vegetation. Generally, the longer the water is held by the vegetation, the greater the uptake of nutrients (Howard-Williams and Downes, 1986) Of course, the nutrients may be eventually released back into the water column when plant material decays, but much of this will once again be assimilated. In this way the riparian system retards the rate of transfer of nutrient particles downstream , in a process known as nutrient spiralling (Pinay *et al*. 1990).

Nitrogen can be removed from riparian systems completely. This occurs via the biochemical process of denitrification, which causes nitrate to be converted to gaseous nitrogen. This process can be the major form of removal in certain riparian zones and during particular environmental conditions such as those which occur during and after flooding (Pinay *et al*., 1990).

Ecological values

Streamline vegetation not only has natural resource value in its own right, it also provides a range of habitats for a large variety of plants and animals, particularly species which are restricted to moist or aquatic environments, or species which are restricted to particular rivers or streams. For example, the freshwater streams along the south coast provide one of the few breeding environments for the Pouched lamprey (*Geotria australis*) and some of the freshwater streams along the Leeuwin Naturaliste Ridge are the only known habitat for the rare snail, *Austroassiminea letha*.

Furthermore as stream systems are linear in form and cover large distances, their vegetation helps to create ecological corridors. These natural corridors, along with unnatural ones such as vegetated strips planted along road and rail reserves, enable plant and animal species to move between larger patches of remnant habitat (Hussey *et al*. 1989).

Recreational and landscape value

Foreshore areas alongside the Yallingup Brook have important recreational and landscape protection values. This is especially the case where the Brook is close to a population centre, or a site frequently visited by residents and tourists. For instance, the Ghost trail which links the Yallingup townsite to the Caves House Hotel complex and the Post Office is likely to be one of the most visited paths in the Sh. Bsn.. This trail crosses the course of the Brook over a bridge and runs along the upper north side of the Brook, overlooking its course. Another walk popular with tourists and locals crosses the Brook east of the Ghost trail by a small foot bridge, connecting Caves House Hotel complex with the Leeuwin Naturaliste National Park where it connects onto a series of public walks maintained by CALM and the Yallingup LCDC.

The recreational and landscape value of the Yallingup Brook is recognised and efforts to improve its amenity have already commenced. Residents of the Yallingup area have reported that informal access and recreational use of the Yallingup Brook has been increasing over the past years. They have commented that the recreational and landscape value of the Brook would be improved by re-establishing native vegetation in place of the existing weeds, enhancing water quality.

Catchment, Context and Community

The broad community

Catchments ask us to think beyond our back fence and pass solutions not problems on to our neighbours (Youl, R.,undated).

A catchment is recognised as the most appropriate level upon which to base management of the environment, because it is a natural landscape feature which influences much of the activity within its boundaries. A catchment is a drainage area bounded by the highest points in a landscape from which all runoff water flows to a common low point, such as the Yallingup Brook.

The activities at one end of the catchment are likely to have effects further down stream. Natural features such as waterways do not recognise the superficial boundaries which are imposed through land ownership, rather they reflect the truly interconnected relationships of our ecological systems which support life.

As land managers and members of the community we have a responsibility to each other, to the ecosystem and to future generations, to leave the land and water in a better condition than when we found it. Understanding our environment means understanding the fleeting nature of our tenancy and our fences. (Reference Group Member, *pers. comm.*).

The Yallingup Brook catchment supports a number of different land uses and interests within the community. These include: horse riding , horse agistment, sheep grazing, tourism, nature conservation, recreation and residential purposes.

CALM is the largest single land manager in the catchment, administering land in the mid catchment from Hemsley Rd in the north east to behind the Yallingup townsite, and at the mouth of the Brook. This area of CALM managed land is within the Leeuwin Naturaliste National Park and is administered under a management plan with the objective:

to fulfil as much of the demand for recreation by members of the public as is consistent with the proper maintenance and restoration of the natural environment, the protection of indigenous flora and fauna and the preservation of any feature of archaeological, historic or scientific interest (CALM, 1989).

A significant area of the catchment is in Public reserve, such as the reserve in the lower catchment managed by the Sh. Bsn. and a reserve in the upper catchment.

The townsite of Yallingup is located beside the lower reaches of the Brook. Landowners in the townsite recognise the important value of the Yallingup Brook and the Yallingup Residents Association has begun negotiating with the Yallingup LCDC to address some issues of degradation such as weed management. Landowners in the town site who responded to a questionnaire indicated unanimously that the Yallingup Brook was an important asset to the Yallingup area. The results of the questionnaire can be seen in greater detail in Appendix 1.

The Yallingup Brook is an invaluable asset to the community of Yallingup and all those who come to share our good fortune - the Yallingup area. We are a small community and we should be able to put aside our differences and our self-interest to work together to improve the health of the Brook. (Reference Group Member, *pers. comm.*).

Yallingup LCDC

LCDC's are set up under an Act of Parliament and are responsible to the Soil and Land Conservation Commissioner for preventing, remedying or mitigating land degradation. Their aim is the prevention of land degradation, and the promotion of sound conservation and reclamation.

The Yallingup LCDC has been actively managing land within the catchment and along the coastline for the past six years. In the past several years it has joined with the Yallingup Residents Association in acknowledging that management of the Yallingup Brook will need to be more actively addressed. Whilst the organisation and motivation has come largely from these two groups, both recognise the invaluable contribution which others can bring to community management, and strongly encourage wider input.

The aims of the Yallingup LCDC are:

- to repair damage to the environment
- to protect and enhance the native vegetation
- to cater for peoples' use of the environment in a responsible and sustainable manner (Schlueter, *pers. comm.*).

Approach

The Yallingup Brook Action Plan was prepared in two main stages: the assessment of the Brook in a catchment context, and the determination of remedial advice to guide future rehabilitation work. Assessment of the catchment was conducted through a desktop review and a field survey using the Stream Foreshore Assessment survey technique (Pen and Scott 1995).

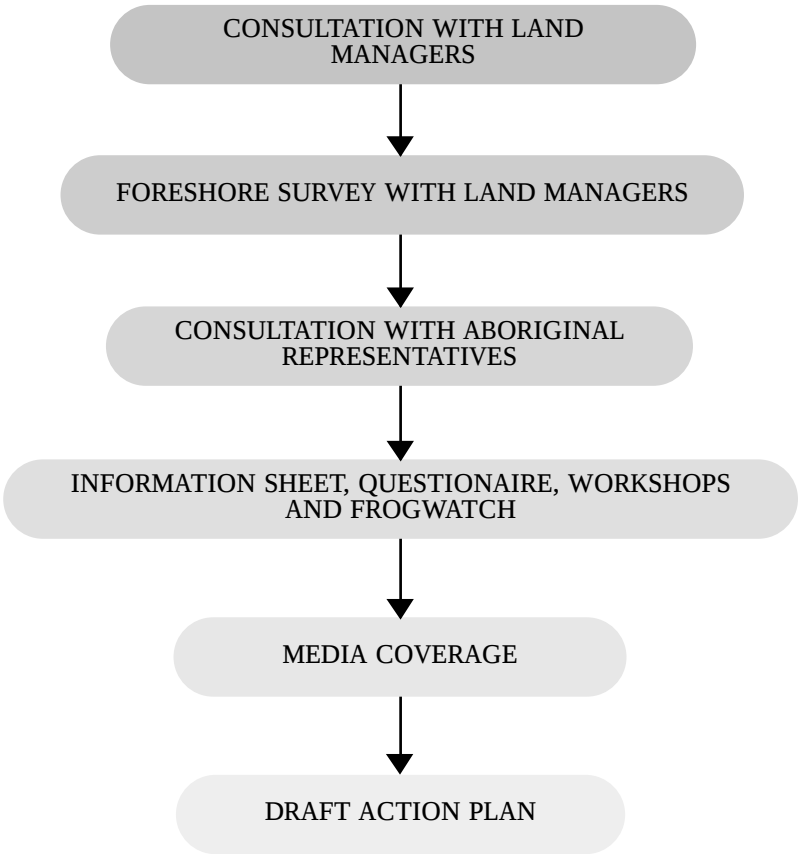
Additional components included in the report as a result of community interests are:

- heritage sites within the catchment
- Aboriginal values
- water quality
- detailed catchment information

Consultation

Consultation with members of the catchment formed an integral component of the project. The community was recognised for their knowledge and management responsibilities. Figure 1 shows the milestones of community involvement in the Action Plan.

Figure 1: Community consultation flow diagram



Stream Foreshore Assessment survey technique

The condition of the Yallingup Brook foreshore was assessed using the Stream Foreshore Assessment survey technique (Pen and Scott 1995). This technique was developed for rapid, inexpensive assessment of waterways which could be undertaken by the community, agencies and professionals alike. The basis for this technique comes from expert observations by Pen, of waterway degradation in the south west.

The assessment technique applies a range of grades A, B, C and D which represent the condition of the foreshore from *pristine* to *completely degraded*. Each grade can be further separated into three sub grades which allow for more detailed assessment.

The grading system is described below and represented in Figure 2:

A Grade Foreshore

A1 Pristine

The river embankments and floodway are entirely vegetated with native species and there are no weeds or soil disturbances.

A2 Near pristine

Native vegetation dominates but weeds are occasionally present in the understorey, though not to the extent that they displace the native species. Otherwise there is no human impact.

A3 Slightly disturbed

Here there are areas of localised human disturbance where soil may be exposed and weeds are present, such as along walking or vehicle tracks. Otherwise, native plants dominate and would quickly recolonise disturbed areas should human activity decline.

B Grade Foreshore

B1 Degraded /weed infested

Native species remain dominant, a few have probably been replaced or are being replaced by weeds. Some erosion.

B2 Degraded/ heavily weed infested

In the understorey weeds are about as abundant as native species. The regeneration of some tree and large shrub species may have declined. Soil disturbance may be common, but not extensive. Some erosion.

B3 Degraded/ weed dominated

Weeds dominate the understorey, but many native species remain. Some tree and large shrub species may have declined or disappeared altogether. Soil disturbance is present and there is some erosion.

C Grade Foreshore

C1 Erosion prone

While trees remain, possibly with some large shrubs or grass trees, the understorey consists entirely of weeds, mainly annual grasses. Most of the trees will be of only a few resilient or long lived species and their regeneration will be at most below replacement level or at worst negligible. Foreshore may be just plain pasture. In this state, where the soil is supported by short lived weeds, a small increase in physical disturbance will expose the soil and render the river embankments and floodway vulnerable to erosion.

C2 Soil exposed

Here the foreshore is exposed in significant areas and has begun to erode.

C3 Eroded

Soil is washed away from between any tree roots and trees are being undermined. Unsupported embankments are subsiding into the waterway. Localised erosion is present.

D Grade Foreshore

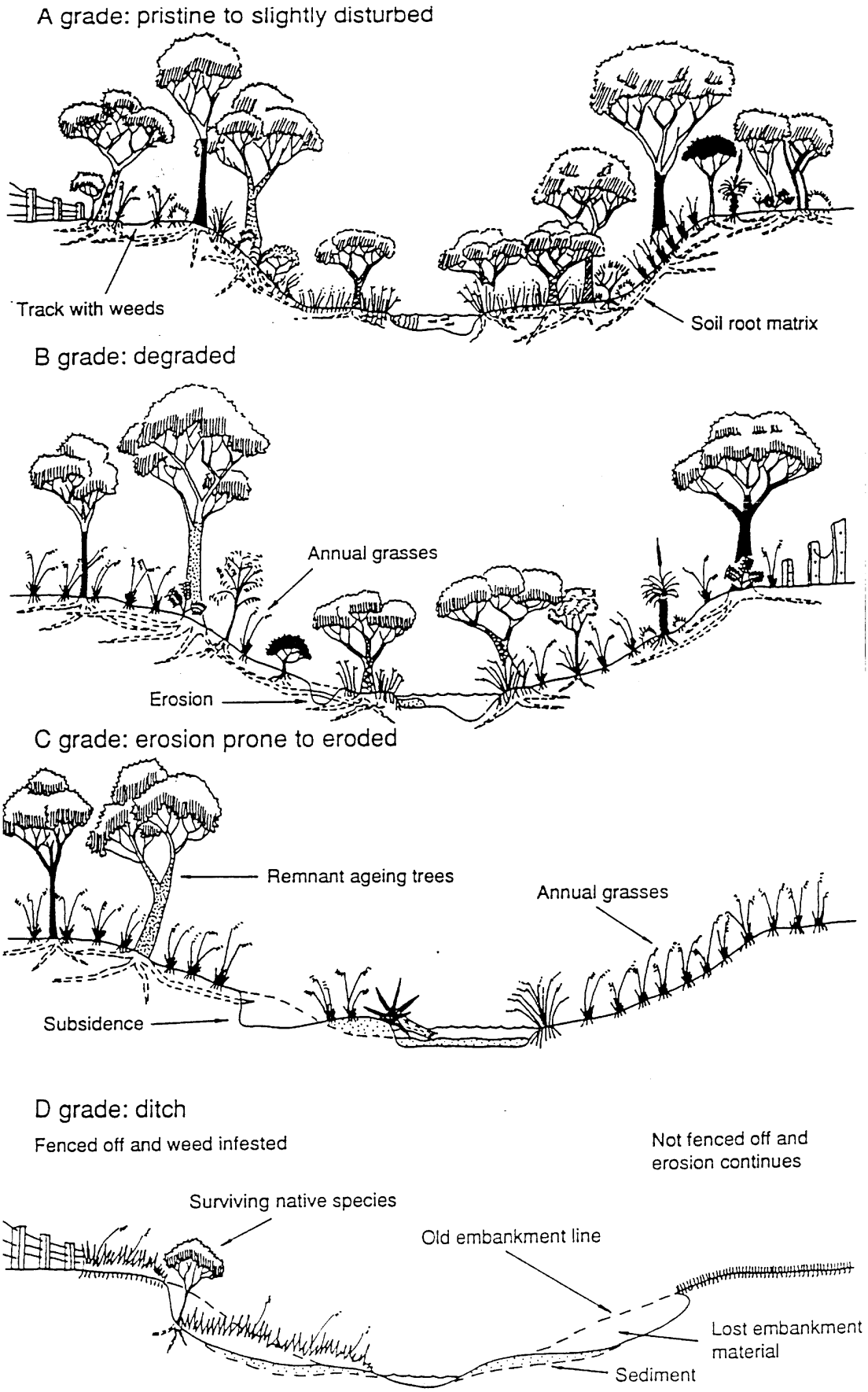
D1 Ditch eroding

Fringing vegetation no longer acts to control erosion. The waterway resembles a drain with few or no remaining trees. Erosion and siltation is commonly occurring. Sediment deposits are common along the river channel.

D2 Drain/weed dominated

The waterway is highly eroded. Weeds dominate the streamline, such as kikuyu, buffalo grass and weedy rushes. The waterway has become a simple drain.

Figure 2: River foreshore stages of degradation - A (pristine) to D (drain)



Description of the Catchment

Physiography

The Yallingup Brook is located within the Leeuwin Naturaliste area and crosses two physiographic regions, the Margaret River Plateau and the Leeuwin Naturaliste Coast. The Margaret River Plateau is described as a gently undulating plateau between 5 - 15 km wide, which is dissected by a series of valley systems. It has formed on the laterised granitic and gniessic basement rock of the Leeuwin Block and stretches from Eagle Bay to Augusta. The Leeuwin Naturaliste Coast is a narrow strip, 0.2 - 6 km wide, which stretches between Cape Naturaliste and Cape Leeuwin. This coastal region is a discontinuous ridge of Tamala Limestone, with the granite of the underlying Leeuwin Block exposed in places.

Fifteen land systems have been identified by Tille and Lantzke (1990) as occurring within the Leeuwin Naturaliste area, four of which are present within the catchment:

1. Kilcarnup Dunes land system

2. Gracetown Ridge land system

3. Cowaramup Upland land system

4. Wilyabrup Valley land system

Climate and moisture balance

The catchment experiences a warm temperate Mediterranean-type climate with winter rains and summer dry season. The long term average climatic pattern as recorded over 93 years at Cape Naturaliste lighthouse is characterised by the following features:

- a total mean annual rainfall of 826 mm,
- mild to cool rainy season with four months, May to August inclusive, when rainfall exceeds 100 mm,
- a warm to sometimes hot summer and autumn dry season from November to April,
- the total mean annual evaporation exceeds the mean annual precipitation by about one and a half times.*

The last 23 years have been predominantly times of very low recharge compared to the preceding 12 years (1963 to 1974) which had consecutive years of high rainfall (except for one low in 1969) with positive departures from the mean of between 100 and 300 mm.

Vegetation

The vegetation and flora of the catchment forms part of the moister southern Jarrah Forest formation in the Menzies Subdistrict of the South West Botanical Province (Beard 1990). A regional vegetation survey of the SW Peninsula area by Smith (1973) recorded the plant associations and their structural form and cover density at a map scale of 1:250 000. At this scale three main plant associations are outlined for the area of the Yallingup Brook Catchment:

(i) wattle and teatree heath and scrub on frontal dunes and on limestone, (ii) peppermint or teatree woodland on back dunes and (iii) jarrah and marri forest on the laterised granite-gneiss of the oldland surface behind the dune belt.

Vegetation structure

In its natural state, the vegetation of the area would consist of an unbroken woody plant canopy from the primary frontal dune, limestone or granite outcrops above the beach, all the way inland. Vegetation structure would have appeared as a single canopy forming an increasing height and structural complexity gradient from the coast inland.

Canopy cover density is greatest nearer the coast where thickets and woodland groves form single layers of closely packed canopy that shade out the understorey. Today 64% of the basin remains under native forest and heath cover in the National Park and Reserves, and 36% is pasture grassland mainly in the upper catchment.

* At Jarrahwood, the nearest evaporation recording station in the region, the total mean annual evaporation from a free water surface is 1204 mm. Further, there is a midsummer (January) mean monthly total of 189 mm under mostly clear sky conditions, and 43 mm in midwinter (July) under generally cloudy conditions.

Jarrahwood is 33˚ 47' 55"S, 115˚ 39' 47"E, 130m alt., 30km inland from the sea.

Vegetation type

The plant communities identified by Smith (1973) have been recognised whilst examining the vegetation type in the catchment in greater detail. Vegetation type has been described in six separate components as shown below (refer to Figure 3). A species list for vegetation types 1 to 5 can be found in Appendix 3.

Vegetation Type 1: Dwarf scrub heath (1 - 3 m)
Vegetation Type 2: Dense scrub-thicket (0.5 - 5 m)
Vegetation Type 3: Woodland groves (3 - 10 m)
Vegetation Type 4: Tall peppermint thicket and woodland (1.5 - 12 m)
Vegetation Type 5: Jarrah, marri and sheoak forest (8 - 15 m)
Vegetation Type 6: Pasture grassland

In addition to these broad vegetation types there is a limited occurrence of true riparian vegetation in the few areas with permanent water flow.

Geographically significant flora

The distinguishing members of the perennial streambank plant community in the lower Yallingup Brook, albizia and karri hazel, are more typical as small understorey trees of the higher rainfall karri forest.

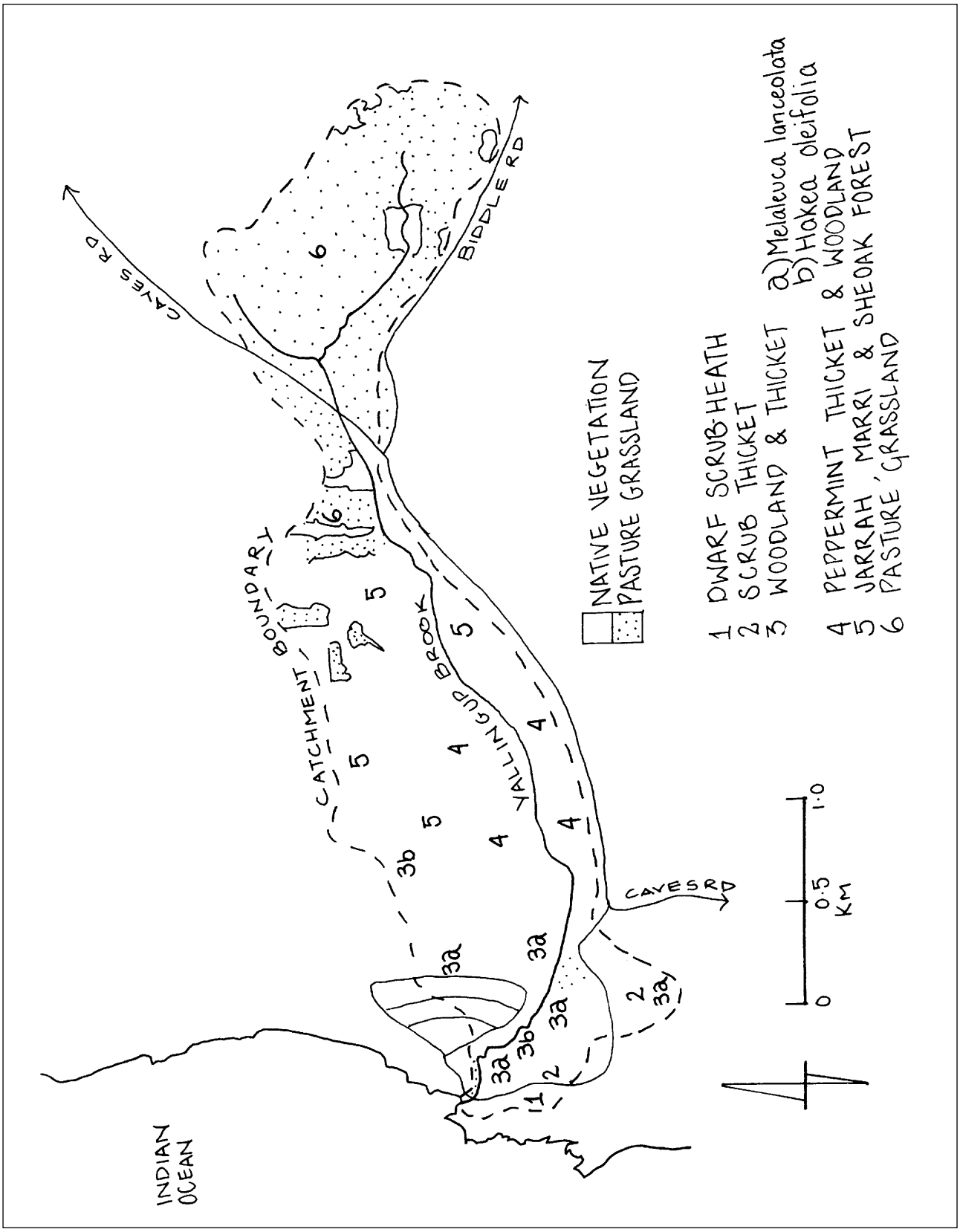
Plants with a more restricted distribution, or at their distributional limits in the northern Cape Naturaliste end of the south west Peninsula, include two wattles *Acacia inops* and *A. mooreana*, and *Anthotium junciforme* of the family Goodeniacea (Webb, *pers. comm.*). Two species of declared rare flora are known to exist within the Yallingup Brook catchment. Both of these are orchid species, *Caladenia hueglii* and *Caladenia excelsa*.

Drainage

Perennial surface flow in the Yallingup Brook is confined to two sections: section 4, the 400m long ravine tract in the National Park; and section 1 and 2 for some 550 m upstream from the mouth. Between these two sections is a 400 m length of disturbed ground where the flow is predominantly subsurface during the dry season. From the powerline track upstream to the source of the Brook, the drainage is markedly seasonal and quite dry in summer to autumn (sections 5-9) There are two small permanent seeps in the upper catchment .

Groundwater and aquifer recharge probably occurs over most of the basin area as topsoils are predominantly sandy. Sands typically are highly permeable with a high infiltration capacity. However certain surface sand patches at the coast and in the upland are water repellent, and silty clay loam areas of topsoil in the upper catchment are notably water shedding and reduce infiltration through sheet runoff.

Figure 3: Vegetation types 1 - 6 in the Yallingup Brook catchment



Water quality

Water quality was sampled through physical, chemical and biological tests, undertaken by Dunsborough Primary School Year 6 and 7 students. All of these tests were done as a snapshot only; continued monitoring is necessary to develop a reliable picture of water quality in the Yallingup Brook catchment. Most of the samples (except for the bacterial tests) were taken before the upper catchment had begun to flow for the season.

Yallingup Brook snapshot May - June 1998

In addition to macroinvertebrate sampling, water quality was measured for seven parameters, four of which were sampled in the field: pH, conductivity, temperature difference, turbidity; and three of which were collected for laboratory analysis: total phosphorous, total nitrogen and faecal coliforms. The following data shows that acceptable readings were obtained for the field samples.

The results from the laboratory show that all sites confirmed presence of thermotolerant (faecal) coliforms. Four sites were within the national guidelines for secondary contact recreation and two sites were within the national standards for primary contact recreation.

Aquatic invertebrates are sensitive to small changes in temperature, pH, turbidity and nutrient levels. The frequency and diversity of aquatic invertebrates found in the waterway can therefore give some indication of the current condition of the water. During the snapshot, seven different macroinvertebrates were found, the most sensitive being the dragonfly larvae. The overall water quality rating was 'fair'[1].

Yallingup Brook Snapshot Field Samples May 1998

Site No.	Temperature	Turbidity	pH	Salinity
Y2	15.5 ˚C	< 5 mg/L	7.4	146.6 µ/cm

Yallingup Brook Snapshot Nutrient Samples 1998

Site No.	Sample No.	Total Nitrogen (µg/L)	Total Phosphorous (µg/L)
Y1	1	26	25
	2	77	21
Y2	1	479	32
	2	trace	18
Y3	1	171	31
	2	1335	15
Y4	1	891	69
	2	1128	16

Australian Standards: Total Nitrogen (750 µg/L);Total Phosphorous (100 µg/L)

[1] A total score is determined from the sum of individual scores which the different macroinvertebrates represent. The snapshot found a total score of 23.

Fauna

Some of the major fauna species which are likely to be found in the Yallingup Brook area are listed below. Not all of these species have been positively sighted, however they are considered likely to be found in the area, based on the existing habitat and the requirements of the species. A fauna survey has not been completed for the Yallingup Brook catchment but it would provide valuable information for the management of the area. In particular, the existing fauna would influence the decisions on any fuel reduction and/or regenerative burning.

Likely to be found - native fauna

Western Ringtail Possum	*Pseudocheirus occidentalis*
Brushtail Possum	*Trichosurus vulpecula*
Quenda	*Isoodon obesulus*
Brush-tailed Phascogale	*Phascogale tapoatafa*
Chuditch	*Dasyrus geoffroii*
Echidna	*Tachyglossus aculeatus*
Mardo	*Antechinus flavipes*
Dunnart	*Sminthopsis spp*
Western Pygmy-possum	*Cercartetus concinnus*
Western Grey Kangaroo	*macropus fuliginosus*
Bush Rat	*Rattus fuscipes*

Possibly found - native fauna

Honey Possum	*Tarsipes rostratus*
Western Brush Wallaby	*Macropus irma*
Quokka	*Setonix brachyurus*
Water Rat	*Hydromys chrysogaster*

Likely to be found - introduced

Rabbit	*Oryctolagus cuniculus*
European Rat	*Rattus rattus*
House Mouse	*Mus musculus*

It is noted that the rare snail, *Austroassiminea letha*, has been previously recorded in freshwater habitats similar to the middle to lower reaches of the Yallingup Brook. This amphibious snail, which has a very limited distribution, has been positively identified in a number of locations on the Leeuwin Naturaliste Ridge.

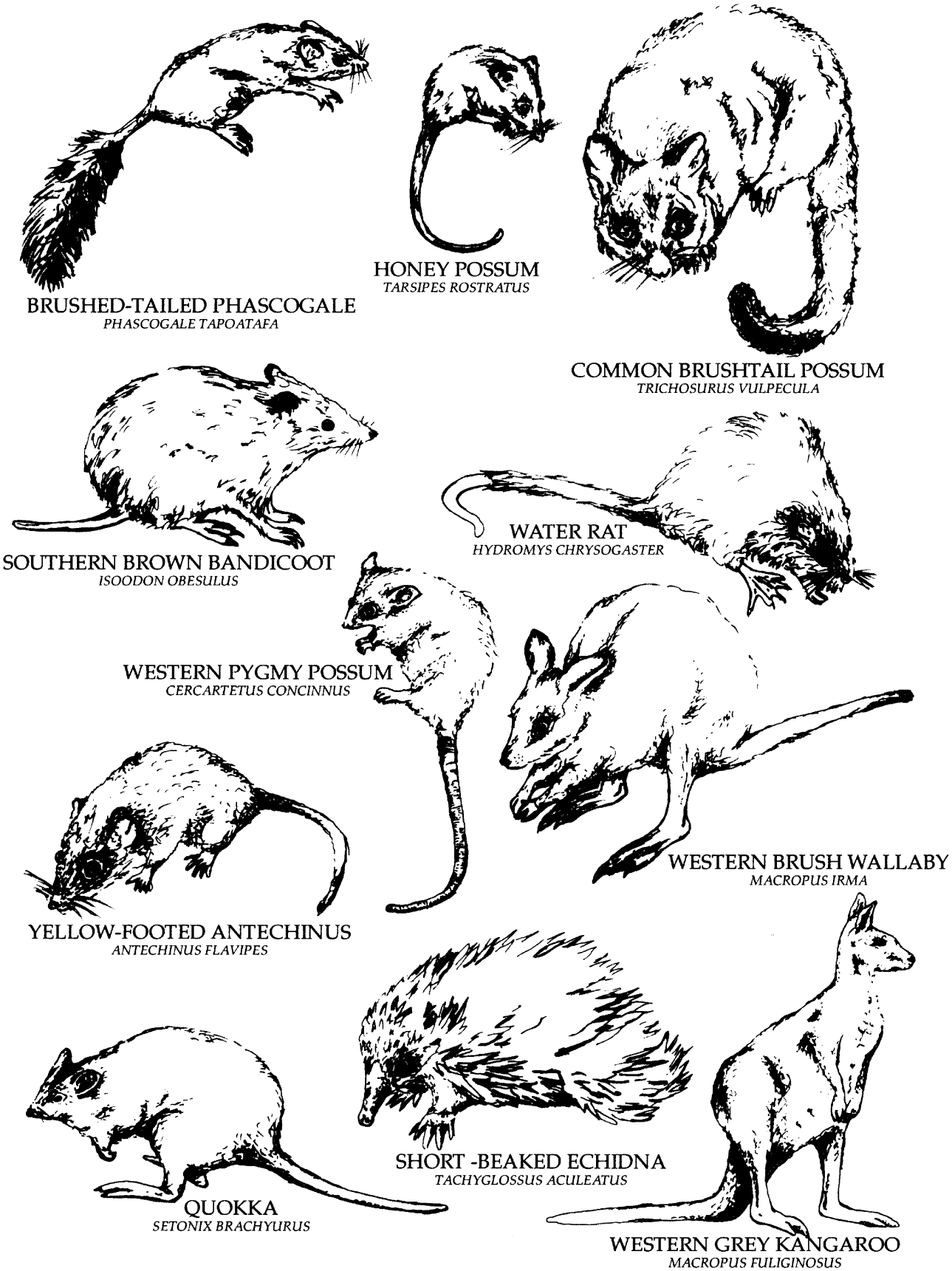
The habitat of the snail is critical; it favours a freshwater habitat where water occurs as a seep from limestone or lime sands. The snail is usually found on the slopes or flats beside the channel and it appears to be associated with soils with substantial humus content. Liaison with CALM (Busselton) and the WA Museum may allow for a more thorough survey for these snails in the lower reaches of the Yallingup Brook[2].

A 'frogwatch' held on the 7th of September 1998[3] in the lower reaches of the Yallingup Brook, identified three frog species: *Limnodynastes dorsalis* (banjo frog); *Littoria adelaidensis* (slender tree frog); and *Crinea glauerti* (Glauert's froglet). It was not positively determined if *Crinea insignifera* (brown or squelching froglet) was present. Continued frogwatches may contribute to an understanding of the changes in the population levels of frogs as a result of riparian rehabilitation.

[2] The WA Museum has indicated that they will investigate the possibility of the snail occurring along Yallingup Brook.

[3] The frogwatch, coordinated by Elizabeth Andrew, Ribbons of Blue, was attended by local residents and students of the Dunsborough Primary School.

Figure 4: Major fauna species likely to be found in the catchment.



Heritage and Land Tenure

Aboriginal heritage

Freshwater sources such as rivers, swamplands and minor waterways represented and continue to represent significant features of the landscape for Nyungar people. Not only were riverine systems significant as a sustainable resource base, they also hold spiritual value in Nyungar culture. Beliefs associated with the Dreaming figure, the Waugal, are an example of the relationship between spirituality and water. The Dreaming refers to that group /collection of beliefs which form part of the past, present and future in traditional Nyungar culture:

> *The great mythic beings of the dreaming established the foundations of human socio-cultural existence. They also attended to that environment, and in many cases were responsible for forming it.*
>
> (Berndt and Berndt 1964:137)

Aboriginal representatives identified the Yallingup Brook as a significant feature of their Dreaming heritage. One elderly Aboriginal representative reported the existence of an Aboriginal Sacred Site in the vicinity of Yallingup Brook. He described the site in relation to the legend of Ngiligi, the good spirit, and the bad spirit Wolgoine.

Wolgoine lived in a dark hole (*geedarluk*), to which he would entice Nyungar people in search of drinking water, never to be seen again. Ngiligi heard of this and joined forces with the elements: sea (*oderna*), thunder (*koondarnangoor*), lightning (*bal-bairn-chi*) and wind (*marr*) to drive Wolgoine away.

Together they drove Wolgoine back from the reef where he was watching the approaching storm. They forced Wolgoine up the mouth (*dar*) of the Brook and into his dark hole, all the while the storm increasing in strength. They fought for many hours along the valley floor, which eventually fell in, closing the mouth of the Brook from the reef. Ngiligi beat Wolgoine at this location and the latter made his escape from the dark hole that had opened up during the fighting. Ngiligi told Wolgoine he must never return to the hole, and Wolgoine acknowledged that he was finally beaten. The Nyungar people were free from Wolgoine, the bad spirit. Sometimes you can hear the rumbling of the waves as they roll over the reef and up the valley floor, seeming to say to all Nyungar people "walk softly and listen to the call of 'Ngitch-me', the good spirit Ngiligi".

Other Aboriginal representatives referred to the Brook's association with the Dreaming figure, the Waugal. According to O'Connor *et al.* (1989), the Waugal is '... a water-creative spirit force with a serpentine physical manifestation'. Bates (1992) defines the Waugal as 'a controller of the elements with the power to influence sickness and death'. A number of representatives reported the Waugal as residing within the Brook.

The catchment was also said to be a valuable source for the acquisition of food and water. Food was obtained from red gum (*marri*), jarrah (*djarryl*), hakea (toolgan), peppermint (wannang) and black boy (*nallang*) trees. In addition, bardi grubs were gathered from the coastal wattle (*quonnut*), specimens of which were identified in the vicinity of the Brook.

The Register of Aboriginal Sites held at the Aboriginal Affairs Department does not list any previously recorded sites within the study area. It should be noted that this does not preclude the existence of sites, rather, no sites have been registered to date.

The National Native Title Tribunal reports the listing of five native title claims within the vicinity of the Yallingup Brook.*

European heritage

Places of cultural heritage significance are required to be recognised by each Shire under the *Heritage of Western Australia Act 1990*. Heritage significance is defined by this Act as the relative value which that place has in terms of its aesthetic, historic or social significance, for the present community and future generations. The Heritage Act s45, requires that local municipalities prepare a Municipal Heritage Inventory to recognise such heritage places. The inventory for the Sh. Bsn. lists three heritage sites as within the Yallingup Brook catchment:

- Yallingup Caves Precinct
- Caves House
- Cape Naturaliste Area

Land tenure

Land tenure is depicted through location numbers in Maps 1A to 1C. Most of the land within the catchment is held in public ownership in the form of National Park and other Reserves. CALM is the largest single land manager in the catchment, administering the land vested in the National Parks and Nature Conservation Authority (NPNCA). The Sh. Bsn. has the vesting of a number of Reserves within the catchment as well as the control of the Valley Rd Reserve. Table 2 below identifies the details of tenure for the Reserves within the catchment.

Location No.	Reserve No.	Vesting	Zoning
4308	R8427	NPNCA	Recreation
4309	R8427	NPNCA	Recreation
4379	R27062	NPNCA	Recreation
4338	R24622	Sh.Bsn.	Recreation C Class
4120	R24622	Sh.Bsn.	Recreation C Class
4637	R34230	*unvested*	Public Purposes C Class
4720	R37300	Sh.Bsn	Bushfire Brigade Depot
360	R8427	NPNCA	Recreation
360	R27062	NPNCA	Recreation
4453	R27062	NPNCA	Recreation

Table 2: Land tenure and zoning of Reserves within the Yallingup Brook catchment

* These present claims may be subject to change in the future.

Reserves (as described in the Busselton Town Planning Scheme)

Clause 18.1. No person shall on a Scheme Reserve, without the approval of the Council:

a. Demolish or damage any building or works;

b. Remove or damage any tree;

c. Change the use of the land or building

d. Excavate, spoil or use the land so as to destroy, affect or impair its usefulness for the purpose for which it is reserved; or

e. Construct, extend, or alter any building or structure, other than a boundary fence.

Privately managed land within the catchment is detailed below in Table 3. The upper catchment contains land managed generally for rural, rural residential and tourism purposes. A public reserve also exists in this part of the catchment. The land in the upper catchment, east of Caves Rd, has been identified as rural residential in the Busselton Shire Town Planning Scheme.

In the lower part of the catchment, land is managed for residential, recreational and tourism purposes. Two major commercial tourism sites exist, Caves House Hotel complex and the Yallingup Beach Caravan Park. A portion of the Yallingup townsite is contained within the catchment boundaries (see Map 1).

Location/Lot No.	Zoning
885	Conservation
Lot 1, Hemsley Rd	Conservation
Lot 5, Hemsley Rd	Conservation
Lot 1	Agriculture
Lot 3	Agriculture/ Additional Use
Lot 4	Agriculture
Lot 6	Agriculture
Lot 1	Agriculture
Lot 7, Caves Rd	Rural Residential
Lot 5, Caves Rd	Rural Residential
Lot 58, Caves Rd	Rural Residential
4567	Special Purpose (Camping/Caravan Park)
4421	Special Purpose (Hotel)
4422	Special Purpose (Hotel/Camping/ Caravan Park)

Table 3: Land tenure and zoning for private land in the Yallingup Brook catchment.

Management Issues throughout the Catchment

Weeds

Western Australia has about 10 000 scientifically described plants, of which about 10 per cent have been introduced (Hussey *et al*. 1989). A plant is considered a weed when it causes problems or is not wanted in an area. In areas of native vegetation, introduced plants are considered environmental weeds; in agricultural areas plants may be considered weeds because they are troublesome in economic terms.

Weeds are commonly found in areas that have been disturbed and thus the native vegetation has incurred some setback. Weeds are strong competitors in these situations, often displaying faster, more vigorous growth rates. Each space occupied by a weed, is at the expense of the native vegetation which has evolved over a long period to become part of a balanced ecosystem supporting local fauna. Weeds disturb the existing balance to compete strongly with the native vegetation, displacing habitat among other things.

The relationships between native plant species and existing fauna can be destroyed by competing weeds. Weeds are typically not subject to the same control by pests and diseases, which play an important and natural role in balancing ecosystems. As weeds flourish and the natives are forced out, the richness and diversity of the native bushland is replaced by a relatively homogeneous vegetation.

The Yallingup Brook demonstrates this with areas of surrounding vegetation dominated by homogenous patches of weeds. For instance, section two of the Brook supports an extensive area of weeds which occupy the site to the almost total exclusion of native vegetation. This area is unsightly, impenetrable and lacking small birds.

Effects of weeds on bush

Weeds:

- compete directly with established native vegetation, inhibiting growth and displacing species
- replace diverse native plant communities with more uniform weed communities
- inhibit native plant regeneration though competition
- alter the nutrient cycling of natural communities
- may change the soil acidity
- may increase fire hazard
- alter the resources available for fauna by changing the habitat and reducing the food availability, for instance through the loss of nectar-producing native shrubs and groundlayer plants.

Allowing small patches of weeds to go unchecked may quickly result in a situation that seems almost too big to tackle. The adage that *prevention is better than cure* certainly applies to weed control. A relatively small amount of effort and funding applied early may save much larger amounts later. Weeds may typically appear to stay in relatively small numbers for quite some time, until some change in the ecological balance (e.g. fire, removal of vegetation etc.) can cause a population explosion.

Access

Access to the Yallingup Brook is a management issue where this access has a negative impact upon the ecological function of the Brook. Uncontrolled access contributes to the degradation of the Brook through loss of vegetation, increased erosion, bank collapse and sediment deposition. It also increases the spread and establishment of weeds throughout the Brook as well as reducing the natural nutrient filtering capacity of native riparian vegetation.

Uncontrolled access by livestock is occurring in the upper catchment and by people in the lower

[4] *Western Weeds* is a recent publication that documents and illustrates weeds present in Western Australia. The authors who have contributed to the book collectively represent a vast knowledge in vegetation management, making the book an excellent field guide. The reader is directed to this publication for photographic records.

catchment. Where uncontrolled access occurs, the management advice is not for blanket restrictions; rather, site specific characteristics and the cause of degradation and management goals have been taken into consideration. In a number of instances, formalisation rather than prevention may more appropriately control access. Similarly, whilst fencing is widely accepted as a standard method of formalising access to streams, the management advice in this report may consider alternative barriers and rehabilitation measures.

Loss of native riparian vegetation

Extensive loss of native riparian vegetation has occurred within the upper catchment as a result of agricultural pursuits[5]. Much of this area is cleared with paddocks managed for pasture grasses for livestock. There has been some re-establishment of vegetation and land managers have indicated interest in continuing with rehabilitation.

Where livestock is present it is often necessary to protect areas that are being re-established with native vegetation. Young seedlings are particularly vulnerable to trampling and browsing. Vegetative buffers can serve a range of land management goals including intermittent grazing, fodder crops, windbreaks, conservation, nutrient filtering and erosion control.

The use of local plant species for revegetation provides a hardy, low maintenance area with plants evolved to flourish in the local environment. There is little opportunity for local species to become a weed management problem for the immediate or adjacent land. It is appropriate to select local species for revegetation in Reserves. Appendix 3 provides a list of local plant species which may be selected for revegetation.

Erosion and siltation

Erosion is a significant issue throughout the length of the Yallingup Brook due to modification of the land within or adjacent to the riparian zone. A considerable amount of sediment enters the Brook at numerous points and moves down the channel. A degree of erosion and sediment deposition within riparian zones is a natural process as the stream creates a meandering path to absorb the power of water flow. It is the level of this erosion and the result of this erosion that creates a management issue. Where natural erosion occurs, there is rapid recolonisation of the banks by native seedlings which helps to re-establish a balance, whereas induced erosion is often an ongoing process which is out of balance and continually contributing sediment to the stream.

Erosion not only causes loss of valuable soil, it also has effects downstream where it contributes to a significant level of sediment deposition and silting-up of the channel. Most land managers along the Brook have noted the management imposition that increased erosion and sediment deposition creates. Silting of dams, increased erosive power of stream flow and increased flood potential due to a raised channel are some of the management problems created by increased erosion and siltation.

Where uncontrolled access is occurring and loss of vegetation is evident, erosion of the foreshore can be identified. Erosion is often best controlled by establishment of native vegetation which anchors the bank and increases the soil root matrix to bind the soil. Alternatives such as concrete embankments are often very costly and may require ongoing maintenance.

Water quality

Water quality in the Yallingup Brook was examined through a number of snapshot exercises that sampled for nutrient level, macroinvertebrates and faecal coliforms. These sampling exercises have begun to establish what is normal for the Yallingup Brook; ongoing monitoring will provide a more comprehensive understanding. The results of the water sampling show that there is scope for improving the quality of the water. The management advice in this Action Plan could, if implemented, significantly improve the quality of the water flowing through the Yallingup Brook.

[5] One resident notes the effects which cyclone Alby may have had on removing vegetation.

General Rehabilitation Techniques

Fencing

Fencing is a standard riparian management technique directed at controlling movement and access of livestock and people. Fencing type is determined by the existing site characteristics and that which is being controlled - cattle, sheep, people etc.

Where Yallingup Brook has stock grazing as an adjacent land use or within the foreshore itself, the overall condition rating for the Brook is generally low. It may be considered best practice to exclude livestock from riparian environments as far as practical. Uncontrolled access by stock, especially cattle and horses, is almost always destructive to the sustainable function of riparian environments. It contributes to loss of vegetation, bank collapse, soil erosion, downstream sediment deposition, and an increase in nutrient loads entering the waterway.

Fences are ideally placed set back at least 5-10 m from the top of the stream bank or valley slope. A setback will allow the establishment of perennial vegetation that will gradually take over the job of managing the waterway - soil stabilisation, nutrient filtering etc. Placing fences too close to the channel may allow them to be undermined by subsequent bank collapse, erosion or unusual heavy flows.

In some regions, land managers have chosen to use fences as a means to control, rather than excluding grazing altogether. Minimal grazing is periodically permitted without interfering with regeneration.

GeoCatch is currently administering a funding program called *Streamlining* which contributes to the cost of waterway/foreshore protection.

Vegetation rehabilitation

Vegetation rehabilitation is the central means of maintaining waterway health (see Chapter 1). Vegetation rehabilitation is discussed in Chapter 9 and advice given where appropriate. General advice on catchment vegetation rehabilitation can be sought from the Regional Bushcare Facilitator[6], or Bushcare support staff. Detailed advice can also be obtained from a number of publications including those listed in Appendix 4.

Weed management is a central aspect of vegetation rehabilitation and was noted as a primary motivation for the Action Plan. In particular, sections 1 and 2 of the Yallingup Brook contain significant infestations of weeds that are being treated by the Yallingup LCDC in cooperation with the YRA. A detailed discussion of weed management is provided below.

Weed management

Legalities

The *Agriculture and Related Resources Protection Act* administered by Agriculture Western Australia (AgWA)[7] may declare native or introduced plants which become a problem to agriculture and other forms of natural resource management. A declared plant is assigned a category which is determined according to the appropriate management strategy. Declared plants and their category may vary between areas. Landowners are obliged by the Act to control declared species on their property.

A local government authority may prescribe a plant a 'pest plant' which then permits a by - law to be made to effect control of the plant. The by - law should identify plants which are not declared, and which may adversely affect the value of property or the health, comfort or convenience of the residents.

Identifying the problem

The Yallingup LCDC, the Action Plan Reference Group and members of the wider community have identified a weed problem in the Yallingup Brook because weeds:

- create a fire hazard
- smother the native vegetation and create a degraded environment
- create an unpleasant odour when they rot
- reduce the amenity value of the Brook

[6] SW Regional Bushcare Facilitator, CALM Bunbury

[7] Formerly administered by the Agricultural Protection Board (APB), weed control is now administered by the Protection Services program.

- reduce the habitat value of the Brook for local fauna
- reduce the biological diversity
- encourage littering as the Brook appears degraded and uncared for
- create a poor impression to the visitors to Yallingup who walk past (even those weeds which may appear attractive to some for a short period when they are flowering, are unsightly when they begin to die off)
- significantly reduce the regeneration of native plants
- may be declared by the *Agriculture and Related Resources Protection Act (1976)*[8]

Identifying and controlling the weeds

The weeds which have been identified as causing the major problems for Yallingup Brook are listed below; management advice for treatment of the weeds is provided in related worksheets. The reader is referred to *Western Weeds* (1998) for a complete photographic display.

- *Zantedeschia aethiopica* (arum lily)

Arum lily is a declared plant in the Sh. Bsn.. It is a member of the Araceae family which was introduced from South Africa as a garden plant. It is a bulbous plant[9] typically found in moist, shaded areas although people report that it is increasingly found on drier soils and in more open positions.

Arum lily is a robust, dark green succulent herb. It has petioles (leaf stalks) up to 0.4 m long with smooth leaves in an elongated heart shape. The flower that appears in spring is white and tubular at the base. The roots of the plant form extensive tubers that allow it to regenerate in the following season.

The Agricultural Protection Board has reported that the arum lily competes with pasture growth, has been known to cause excema in humans, is poisonous when eaten raw and has resulted in stock deaths when grazed. It is a declared plant species (p4)[10]. Arum lilies spread vegetatively by regeneration from root fragments and by seeds. The seeds are frequently carried by birds or may be spread in hay. They have no dormancy.

- *Ricinus communis* (castor oil plant)

Castor oil plant is a perennial weed that is commonly found in disturbed sites. It is a soft wooded plant that can grow to about 4-5 metres. This native to tropical Asia and Africa has very poisonous seeds.

- *Ipomoea indica* (morning glory or dunny creeper)

Morning glory is a perennial weed that spreads as a climber. It rambles over existing vegetation and eventually smothers it, killing it. It is often found to be extensively out - competing most other surrounding vegetation, creating a 'wall' of morning glory. The flowers are purple/blue and trumpet shaped.

- *Asparagus aspargoides* (bridal creeper)

Bridal creeper is a bulbous weed that enjoys limestone heath and woodland. Western Weeds describes it as one of WA's most prevalent environmental weeds, particularly in coastal environments. It is known to invade healthy bush with apparent ease. The growth habit is for climbing and trailing over the ground and surrounding vegetation that it eventually smothers and kills. Its seed is commonly spread by birds.

- *Pennisetum clandestinum* (kikuyu)

Kikuyu is a perennial weed that has been introduced from Africa. It exhibits an extremely vigorous growth pattern and is not adversely affected by fire. Kikuyu is stimulated by cultivation which means that physical disturbance will often promote growth. It is a very successful weed that will invade healthy bush. It is less vigorous under shade. The roots of kikuyu commonly extend more than one

[8] one of the weeds is a declared species (arum lily)

[9] Definitions
Bulbous: plants with bulbs, corms or similar structures.
Perennial: plants with a life span that lasts more than two growing seasons.
Biennial: plants which complete their life cycle in more than one year but not more than two.
Annual: plants that complete their life cycle and die within one year.

[10] Under the Agriculture and Related Resources Protection Act (1976), arum lily is categorised as P4, a plant which should be prevented from spreading beyond its present distribution.

metre below the soil. It is a favoured lawn and pasture species which makes it a common invader of waterways in the south west. Kikuyu can act to successfully bind soil only where there is horizontal surface flow (i.e. across the top); it is not effective when there is vertical flow and will not prevent incision and erosion.

- *Pelargonium alchemilloides and Pelargonium capitatum* (rose geranium)

Both of these species are geraniums, typically garden escapees with furry leaves.
P. alchemilloides has been found at Hamelin Bay and may be present in the Yallingup Brook (it can be identified when flowering). It has a white flower with a prostrate growth habit.
P. capitatum has a head of grouped pink flowers, and has been positively identified.

- *Rorippa nasturtium aquaticum* (watercress)

This weed is a perennial aquatic that has been introduced from Europe, probably for consumption. It is has small deep green pinnate leaves and a white flower.

- *Arundo donax* (giant reed)

This weed is commonly referred to as bamboo, although it is not a member of the Bambusoideae sub-family. Giant reed is a vigorous perennial that grows with thick underground rhizomes, producing a hollow woody stem up to 8 metres. Tall canes grow from a large clump. The seed head is large and feathery, about 30-60 cm long with numerous stalklets showing spikelets about 1 cm long. Giant reed is native to the Mediterranean region and India and is another garden escapee. It thrives in damp soil yet can withstand summer dry periods. Giant reed will successfully displace almost all natives growing nearby. It greatly increases shade levels, preventing sunlight from entering naturally light areas. It often prevents the free drainage of streams and creates a substantial fire hazard. This weed can be spread by broken off pieces travelling in water and lodging down stream.

Planting in the riparian zone

A general recommendation for planting in the riparian zone is for the seedlings to be set back from the channel so as to avoid disturbance by flooding and erosion. It is recommended to begin planting away from the channel and continue closer to the channel as the banks become more stable. Where good foreshore vegetation exists generally, planting close to the channel with sedges or rushes which can tolerate seasonal inundation and flooding can be successful. It is also possible to establish plants on newly deposited sediment if it has been stabilised. Planting seedlings behind barriers such as logs can protect them from water flow, however it is important to ensure that the flow does not go over the top of the barrier which will then create a scour on the down-side.

Pest management may be necessary in both the lower and upper catchment to control rabbit and grasshopper damage to seedlings. Tree guards are available to prevent both pests[11] or alternatively, local land managers report success with planting additional seedlings in the expectation that some will be sacrificial.

Plant species for rehabilitation

Lists of plant species identified within the catchment are provided in Appendix 3 to help with the selection of appropriate seed or seedlings for revegetation. The lists indicate whether the species is a tree, shrub or groundlayer plant. Local nurseries and native vegetation enthusiasts in the area will be able to provide further advice on the growth habit of these species.

[11] Some tree guards cannot exclude young wingless grasshoppers, however larger adults are excluded. AgWA Busselton can provide more detailed advice on pest management if required.

Detailed description of the condition and rehabilitation needs of Yallingup Brook

The Yallingup Brook has been divided into nine sections in order to rationalise the survey and describe appropriate management advice. The sections have been chosen to reflect changes in land use and in land managers. The nine sections (S) are listed below and have been shown with the results of the survey in Maps 1a, 1b and 1c.

1	Mouth of Brook to stormwater pipe near Hammond Rd Sth
2	Stormwater pipe to crossover at Ghost trail
3	Crossover to Hotel dam
4	Hotel dam to powerline track (ravine section)
5	Powerline track to Hemsley Rd
6	Hemsley Rd to Caves Rd
7	Upper catchment
8	Upper catchment
9	Upper catchment

The information provided in this chapter includes:

- a condition rating (survey class) for each section
- a brief description of each section of Brook
- identification of the management issues for each section
- a summary of recommended management advice and timing
- parties involved in implementation.

This information is correlated with Maps 1a, 1b and 1c in the following manner:

- Map 1a: S 1, 2 and 3
- Map 1b: S 4, 5 and 6
- Map 1c: S 7, 8 and 9

Detailed information regarding weed control, fencing and vegetation rehabilitation can be found in the previous chapter. Descriptive management advice is provided in a series of loose-leaf worksheets that are for the guidance of individual land managers. Advice in the worksheets has been provided in response to the reference group's interest in practical management advice; it is relevant at the time of printing. Further practical advice may be sought from a landcare technician or coordinator and it is recommended that these worksheets be updated and additional information collected as management of the Brook continues.

Implementation of this Action Plan will be a co-operative effort and be subject to the availability of resources and funds from the local community, local government, State government and Commonwealth government.

Section 1 - Description

Section 1 of the Yallingup Brook extends approximately 0.62 km eastwards from the mouth of the Brook at the Yallingup Lagoon. The survey grade in this section is A3 (slightly disturbed) to B2 (degraded, localised weeds and some erosion).

Vegetation and weeds

The vegetation in this section is dominated by natives with patches of *Melaleuca lanceolata* thicket and *Hakea oleifoli*a thicket. There are localised occurrences of weeds including bridal creeper, coral tree, poplar, edible fig and arum lily - particularly in the streambed. Isolated occurrences of giant reed can be seen. The LCDC has commenced weed eradication in this section with the assistance of a spraying contractor who has targeted giant reed, castor oil and arum lily.

The bridal creeper is a major weed causing disturbance throughout WA, but it appears to have limited distribution in this section at present. The coral tree, poplars and fig tree also occur in a localised area; about midway through this section, all are recognised for their vigorous reproduction. Town protection burns are planned for this general area and it would be advantageous to investigate incorporating regeneration goals into this planning.

A dense tree canopy is relatively continuous on the southern bank, whereas this layer of vegetation has been removed from areas on the northern bank. Whilst the dense structure of the thickets contributes to the sparse understorey in general, the foreshore banks receive a greater amount of sunlight and it is likely they would have dense sedge cover in a natural state.

Transplantation of small (10 cm) clumps of the existing *Baumea* sedge should allow colonisation and a resulting increase in bank stability if pedestrian traffic is managed.

Erosion and access

Significant sheet erosion is evident in parts of this section as a result of bank trampling, particularly along the southern foreshore at the western end. Some localised undercutting and bank collapse is evident where unsupported banks have become saturated. Sediment deposition is evident in this section as a result of erosion upstream. In addition, erosion and sediment deposition is present in isolated occurrences along the foot of the northern bank where tracks lead between the Brook and the top of the northern embankment.

This area is currently accessed for informal recreation with established paths. The impact of access is evident in the form of litter, loss of vegetation, foreshore erosion, and localised undercutting. Access and pedestrian traffic is a management issue that needs remedial action.[12]

The vegetation on the banks in this section is of critical importance as it acts to absorb a large amount of erosive flow (high sediment load and peak volumes) from upstream. The previous vegetation cover has been significantly reduced, with a reduction in the present level of soil -root matrix which acts to stabilise these banks.[13] Protection and enhancement of existing native vegetation is necessary to prevent further erosion and bank collapse as the flow may edge its way up the sides of the slopes. Vegetation achieves bank stabilisation best when cover is maintained as an anchor on the flat top above a slope for at least 5-10 m.

[12] Throughout the development of this Action Plan, the issue of managing access in this section has attracted a range of views. It is beyond the scope of this project to resolve the issue of access beyond noting its present environmental impact. It is recommended that this issue be further investigated, and access managed by the present land manager, the Shire of Busselton.

[13] For instance the percentage cover which could be expected by the *Baumea spp*. may be about 80% along the channel. This cover is typical of this sedge in similar riparian systems; complete cover has also been recorded — (pers. comm. Dr Luke Pen, WRC).

Section 1: Condition Rating

North Bank	South Bank
A3 (slightly disturbed) - B2 (degraded, weeds, some erosion)	A3 (slightly disturbed) - B2 (degraded, weeds, some erosion)

Issues Identified	Management Advice	Timing	Implementation
weeds	•treatment of weeds (esp. bridal creeper and arum lily) •removal of weeds (coral tree, poplars, edible fig)	•when actively growing - ongoing prior to wet •prior to wet season	•Sh. Bsn., in consultation with LCDC, YRA and Caravan Park •Sh. Bsn., in consultation with LCDC, YRA and Caravan Park
access	•investigate management of pedestrian traffic, north bank •investigate management of pedestrian traffic, south bank	•prior to rehabilitation •prior to transplanting sedges	•Sh. Bsn., in consultation with DOLA and Caravan Park •Sh. Bsn., in consultation with interested groups
erosion	•rehabilitation of banks, e.g: brushing	•prior to wet season	•Sh. Bsn., in consultation with Caravan Park
loss of vegetation	•transplant sedges •establish natives in place of weeds	•during wet season •during wet season	•Sh. Bsn., in consultation with LCDC and Caravan Park
litter	•remove litter	•during holiday periods	•Sh. Bsn., in consultation with YRA and Caravan Park
*fire**	•investigate incorporating goals of regeneration into any planned burn	•prior to burning	•Sh. Bsn., in consultation with CALM, LCDC, Yallingup Fire Brigade, YRA and Caravan Park

**Fire itself does not currently pose an environmental threat to the foreshore, however burning is planned for the area (1988/1989). Burning can affect the health of existing vegetation and planning for potential impacts is advised.*

Section 2 - Description

Section 2 of the Yallingup Brook is located alongside the Ghost trail, from the stormwater pipe at the townsite through to the crossover into Caves House Hotel complex. The section begins approximately 0.62 km from the mouth and finishes at 0.78 km. The survey grade for this section is C3/D1 (eroding and subsiding) to D2 (drain, weed dominated) on the northern bank and D1-D2 (drain, weed dominated) on the southern bank. This section is recognised as a focus of concern and it has received management attention from the Yallingup LCDC in the past[14].

Vegetation and weeds

The native vegetation in this section of the foreshore has been largely displaced by weeds. These weeds in turn have been partially removed through chemical application and earth moving machinery. The foreshore in this section is severely degraded and the streambed of the Brook has been significantly disturbed. Much of the valley of the Brook is in need of revegetation to prevent further soil erosion and weed regrowth.

This section supports a large number of weeds including giant reed, castor oil, arum lily, kikuyu, watercress and blue periwinkle. Significant patches of giant reed which have been dug up and sprayed remain upright in the valley of the Brook, some of which have begun to re-sprout. The dense growth of weeds has obstructed the flow, diminished the habitat value, increased fire risk, prevented the establishment of native vegetation and obstructed the view from the adjacent Ghost trail.

Town protection burns are planned for this general area and, it would be advantageous to investigate incorporating regeneration goals into this planning. In addition, the Leschenault Community Nursery has agreed to conduct a seed collection workshop (for regeneration purposes) in this area with the LCDC, and Greening the South West has agreed to propagate the seedlings.

Erosion and access

Major bank collapse can be seen below the stormwater pipe; this appears to be a recurring event that coincides with rainfall episodes. As in the previous section, establishment of deep rooted perennial vegetation on the banks is necessary to prevent further erosion. A series of rock steps, layered with increasing size, would also reduce erosion and bank collapse. Again, effective stabilisation is best achieved when vegetation is allowed to form an anchor on the flat top above the slope.

The construction of the crossover at present allows flooding and erosion of this area during significant rainfall events. The angle and size of the pipes below the crossover restricts flow causing a build up during rain events, which then creates a surge on the release side that is exacerbated by a lower gradient. A head cut is evident as a result.

This area may be used for informal recreation, however access is greatly limited during flow periods by the waterlogged soil which creates a bog that is difficult to walk through. In addition, the thick growth of giant reed continues to make access difficult. Litter is evident in this section, particularly in the eastern end along the northern bank.

[14] A detailed description of past management actions has been compiled from official records and can be seen in Appendix 6. The management advice in this report takes account of these actions.

Section 2: Condition Rating

North Bank	South Bank
C3/ D1 (eroding and subsiding) -	D1 (ditch eroding) -
D2 (drain, weed dominated)	D2 (drain, weed dominated)

Issues Identified	Management Advice	Timing	Implementation
weeds	•treatment of weeds (esp. giant reed castor oil and arum lily)	•when actively growing - ongoing	•Sh. Bsn., in consultation with LCDC and YRA
erosion	•rehabilitation of banks, with vegetation •resolution of stormwater pipe construction •stabilisation of head-cut •resolution of crossover construction	•prior to wet season •prior to wet season •prior to wet season •prior to wet season	•Sh. Bsn., in consultation with LCDC and YRA •Sh. Bsn. •Sh. Bsn., and Caves House •Caves House and Sh.Bsn.,
loss of vegetation	•seed collection •establish vegetation and sedges	•workshop •during wet season	•LCDC in consultation with Leschenault Community Nursery •Sh. Bsn., in consultation with LCDC and Caves House
litter	•remove litter	•during holiday periods	•Sh. Bsn., in consultation with YRA and Caves House
*fire**	•investigate incorporating goals of regeneration into any planned burn	•prior to burning	•Sh. Bsn., in consultation with CALM, LCDC, Yallingup Fire Brigade, and ajoining land managers

**Fire itself does not currently pose an environmental threat to the foreshore, however burning is planned for the area (1988/1989). Burning can affect the health of existing vegetation and planning for potential impacts is advised.*

Section 3 - Description

Section 3 refers to the lower reaches of the catchment where the Brook meanders through the National Park and Caves House Hotel complex. This section extends approximately 0.3 km eastwards from the crossover to the dam. The survey grade for this section is C1(erosion prone, understorey of weeds) to D2 (drain, weed dominated) on the northern bank and D2 (drain, weed dominated) on the southern bank.

The riparian zone in this section has been significantly altered with a narrowing of the channel into a small portion of the wide valley. A striking limestone overhang is located above the dam on the northern bank.

Vegetation and weeds

On the southern foreshore there is very little remaining native vegetation. Some native vegetation exists on the northern foreshore, however much of the immediate bank has been cleared and soil is exposed. The limestone valley sides above the northern bank retain variable levels of native vegetation with peppermints, *melaleuca* and grass trees present.

Large infestations of giant reed and castor oil have been recently removed from both sides of the Brook by earth moving machinery and a grassed area is being established in some areas where this clearing has occurred. Alterations to the streambank occurred at this time where vegetation was removed.

Weeds such as arum lily, soursob, castor oil, morning glory and blue periwinkle are significantly established throughout this area. The morning glory and blue periwinkle form dense covers in areas of the northern bank. Limited regrowth of giant reed is also evident in parts.

Erosion and access

The streambed of the Brook in this section is still being actively incised, with considerable amounts of sediment being shifted throughout. There are at least four apparent head cuts which are working back upstream in an effort to establish a new balance. Bank collapse and sills of deposition are also frequent throughout this section.

A walk trail behind the real estate office is eroding and contributing sediment to the Brook, particularly to a dam which requires regular dredging due to build up of sediment. Gully and sheet erosion are also evident on the grassed banks above the dam.

Access throughout this section is freely achieved as the area has been cleared of native vegetation and maintained as a lawn area. A small foot bridge exists in the middle of this section which joins walk trails through the National Park, including the Yallingup Caves and the rear of the Yallingup townsite.

A stormwater drain that travels through the property in the west, exhibits some gully erosion which contributes sediment to the Brook. Here kikuyu limits lateral erosion from superficial flow, however it does not appear to prevent vertical erosion.

Section 3: Condition Rating

North Bank	South Bank
C1 (erosion prone, understorey of weeds) -	D2 (drain, weed dominated)
D2 (drain, weed dominated)	

Issues Identified	Management Advice	Timing	Implementation
weeds	•treatment of weeds (esp. giant reed, morning glory and arum lily)	•when actively growing - ongoing	•the adjoining land managers, Caves House Hotel complex and CALM[15]
erosion	•rehabilitation of banks, with vegetation •stabilisation of headcuts •stabilisation of path	•during wet season •prior to wet season •prior to wet season	•Caves House Hotel complex and CALM •Caves House Hotel complex and CALM[16] •Caves House Hotel complex
loss of vegetation	•establish vegetation and sedges	•during wet season	•Caves House Hotel complex and CALM

[15] If the boundary demarcation on the ground is unclear, the land managers may choose to further investigate this so as to clarify management responsibilities.

[16] A River Restoration Workshop is to be held in Busselton 1999 by WRC. This may provide an opportunity to further examine this section and sections 1 and 2, to assist with more detailed advice on the flow and flood potential, placement and construction of works for headcut stabilisation etc. (Pers.comm. Dr Luke Pen, WRC).

Excellent bank cover by sedge on north bank.
Loss of vegetation cover, erosion south bank.

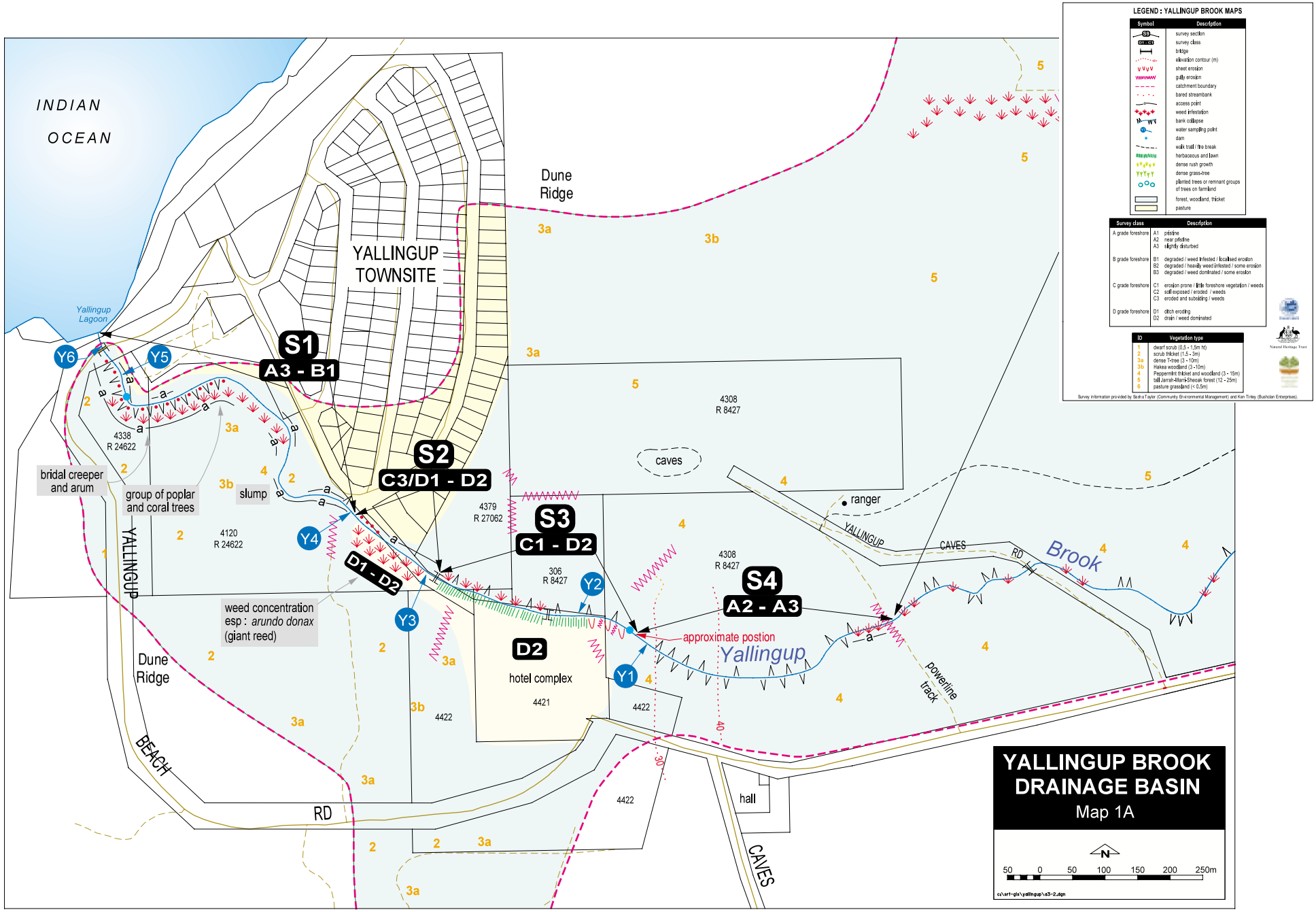
Loss of vegetation, gully and sheet erosion.

Vegetation replaced by morning glory and kikuyu.
Undercutting, bank collapse and sediment deposition.

Wide stream valley. Sheet erosion and infestation of arum lily and morning glory.

Remains of giant reed infestation after successful treatment.

Crossover at end of ghost trail. Exposed stream bank after weed removal.



LEGEND : YALLINGUP BROOK MAPS

Symbol	Description
S1	survey section
D1 - D2	survey class
	bridge
	elevation contour (m)
	sheet erosion
	gully erosion
	catchment boundary
	bared streambank
	access point
	weed infestation
	bank collapse
	water sampling point
	dam
	walk trail / fire break
	herbaceous and lawn
	dense rush growth
	dense grass-tree
	planted trees or remnant groups of trees on farmland
	forest, woodland, thicket
	pasture

Survey class		Description
A grade foreshore	A1	pristine
	A2	near pristine
	A3	slightly disturbed
B grade foreshore	B1	degraded / weed infested / localised erosion
	B2	degraded / heavily weed infested / some erosion
	B3	degraded / weed dominated / some erosion
C grade foreshore	C1	erosion prone / little foreshore vegetation / weeds
	C2	soil exposed / eroded / weeds
	C3	eroded and subsiding / weeds
D grade foreshore	D1	ditch eroding
	D2	drain / weed dominated

ID	Vegetation type
1	dwarf scrub (0.5 - 1.5m ht)
2	scrub thicket (1.5 - 3m)
3a	dense T-tree (3 - 10m)
3b	Hakea woodland (3 -10m)
4	Peppermint thicket and woodland (3 - 15m)
5	tall Jarrah-Marri-Sheoak forest (12 - 25m)
6	pasture grassland (< 0.5m)

Survey information provided by Sasha Taylor (Community Environmental Management) and Ken Tinley (Bushclan Enterprises).

Section 4 - Description

Section 4 of the Brook extends from the dam at Caves House Hotel complex to the powerline track which travels from Caves Rd in a north westerly direction to bisect Yallingup Caves Rd. This section extends from 1.1 km to 1.56 km from the mouth. The survey grade for this section is A2 (near pristine) to A3 (slightly disturbed). All of this section of the Brook is within the Leeuwin Naturaliste National Park.

The flow in this section is perennial and a freshwater seep appears from the limestone formation of the northern bank, about one third to mid-way through this section. It is likely that this flow is associated with the karst system of the NgILGI cave. Whilst there is no confirmed sighting, this habitat is similar to that preferred by the rare amphibious snail, *Austroassiminea letha,* which has been recorded elsewhere in the National Park.

Vegetation and weeds

This section of the Brook contains largely undisturbed, well vegetated foreshore which is in near pristine to slightly disturbed condition. It exhibits typical riparian vegetation of sedges and rushes which can be found in massive colonies along the banks of the foreshore. There is evidence of regeneration of vegetation.

There are localised occurrences of weeds, particularly arum lilies. At least one bulb species which may not be native is present and may be identified when in flower. The Leeuwin Naturaliste National Park Management Plan identifies the control of exotic species within the Park as a priority. Ten separate actions have been identified in the Leeuwin Naturaliste National Park Management Plan for the control of exotic species,

Methods should be used which do not compromise the conservation value of the area. Prevention is the preferred option as it has no environmental risk, low cost and high effectiveness (1989 p.21).

Erosion and access

There is little evidence of disturbance within this section; much of the terrain exhibits steep slopes, which makes movement beside the Brook difficult. The steep sides of the ravine are occasionally undercut and have slumped on the outer curves of the Brook's course. These naturally occurring slumps have been readily recolonised by natives.

Within the eastern portion of this section are large deposits of orange sand that have eroded from the powerline access track. This track exhibits gully and sheet erosion which is contributing significant sediment to the Brook. The removal of vegetation from the banks of the Brook at this location has allowed bank collapse to occur.

Section 4: Condition Rating

North Bank	South Bank
A2 (near pristine) -	A2 (near pristine) -
A3 (slightly disturbed)	A3 (slightly disturbed)

Issues Identified	Management Advice	Timing	Implementation
weeds	•identify bulb species •continue with treatment of arum lilies	•when actively growing •when actively growing	•CALM •CALM
erosion	•reduce erosion from powerline track	•prior to wet season	•Western Power in consultation with CALM

Section 5 - Description

Section 5 of Yallingup Brook extends in a north easterly direction from the powerline track at 1.56 km from the mouth to Hemsley Rd at approximately 3.9 km from the mouth. The survey grade for this section is A3 (slightly disturbed) to B1 (degraded, weed infested). Section 5 and upstream experience seasonal flow for up to five months per year.

The foreshore embankments of this section exhibit more gradual rising slopes than the previous section, with gentle rises from the Brook on both sides. The vegetation understorey becomes more open here, making access more achievable.

Vegetation and weeds

The native vegetation is jarrah, marri, sheoak forest in very good general condition despite occurrence of dieback. Regeneration of species is evident in this section, particularly where recent disturbance has occurred.

The occurrence of weeds is greater than in section 4, particularly around the powerline track and Hemsley Rd where there is significant growth of pasture grass. An old fence line and local history, confirms that this area was grazed in the past. The main weed through this section is arum lily in localised infestations. As previously discussed, the Leeuwin Naturaliste Park Management Plan outlines actions for the control of exotic species.

Erosion

There is a notable sequence of riffles and pools in this section that is characterised by outcrops of coffee rock, fallen trees and tree root mats. The meandering sections have sloping undercut outer banks and small deposits on the opposite bank of gravel and sand. Minimal bank scour is also evident.

Section 6 - Description

Section 6 extends from the bridge at Hemsley Rd to the bridge on Caves Rd at 4.1 km from the mouth. The survey grade for this section is B1/B2, (degraded and weed infested) to C1 (erosion prone). This section incorporates private land, part of a public reserve along the foreshore of the Brook and road reserve. The terrain in this section and upstream, exhibits low relief with a shallow channel.

Vegetation and weeds

Most of the original native vegetation throughout this section has been cleared. Much of it has been replaced by pasture grasses and weeds. The original cover would have been a mosaic of high forest on the orange to red-brown sands with shorter, more open forest and woodland groves (10 to 15 m) on the areas of white duplex sands where the typical trees include sheoak, peppermint, sand kunzea, parrot bush and woody pear.

Erosion

Significant silting of the Brook's channel occurs in this section, both from on site and upstream. There is a wide flat in the corner of Caves Rd and Hemsley Rd which would be likely to receive flood waters in a year of high rainfall. This flood potential should be considered when revegetating the foreshore. The road reserve contains more native foreshore vegetation (jarrah, marri). There has been recent clearing and disturbance to a portion of the foreshore on the western side of the bridge.

Section 5: Condition Rating

North Bank	South Bank
A3 (slightly disturbed) -	A3 (slightly disturbed) -
B1 (degraded, weed infested)	B1 (degraded, weed infested)

Issues Identified	Management Advice	Timing	Implementation
weeds	•continue with treatment of arum lilies	•when actively growing	•CALM •CALM

Section 6: Condition Rating

North Bank	South Bank
B1/B2 (degraded, weed infested) -	B1/B2 (degraded, weed infested) -
C1 (erosion prone)	C1 (erosion prone)

Issues Identified	Management Advice	Timing	Implementation
erosion	•erosion control on firebreaks •revegetate foreshore	•prior to wet season •during wet season	•land managers •land managers
loss of vegetation	•establish native vegetation	•during wet season	•land managers
flood potential	•plan for average -high rainfall events	•prior to establishing vegetation	•land managers

Excellent foreshore vegetation cover in National Park.

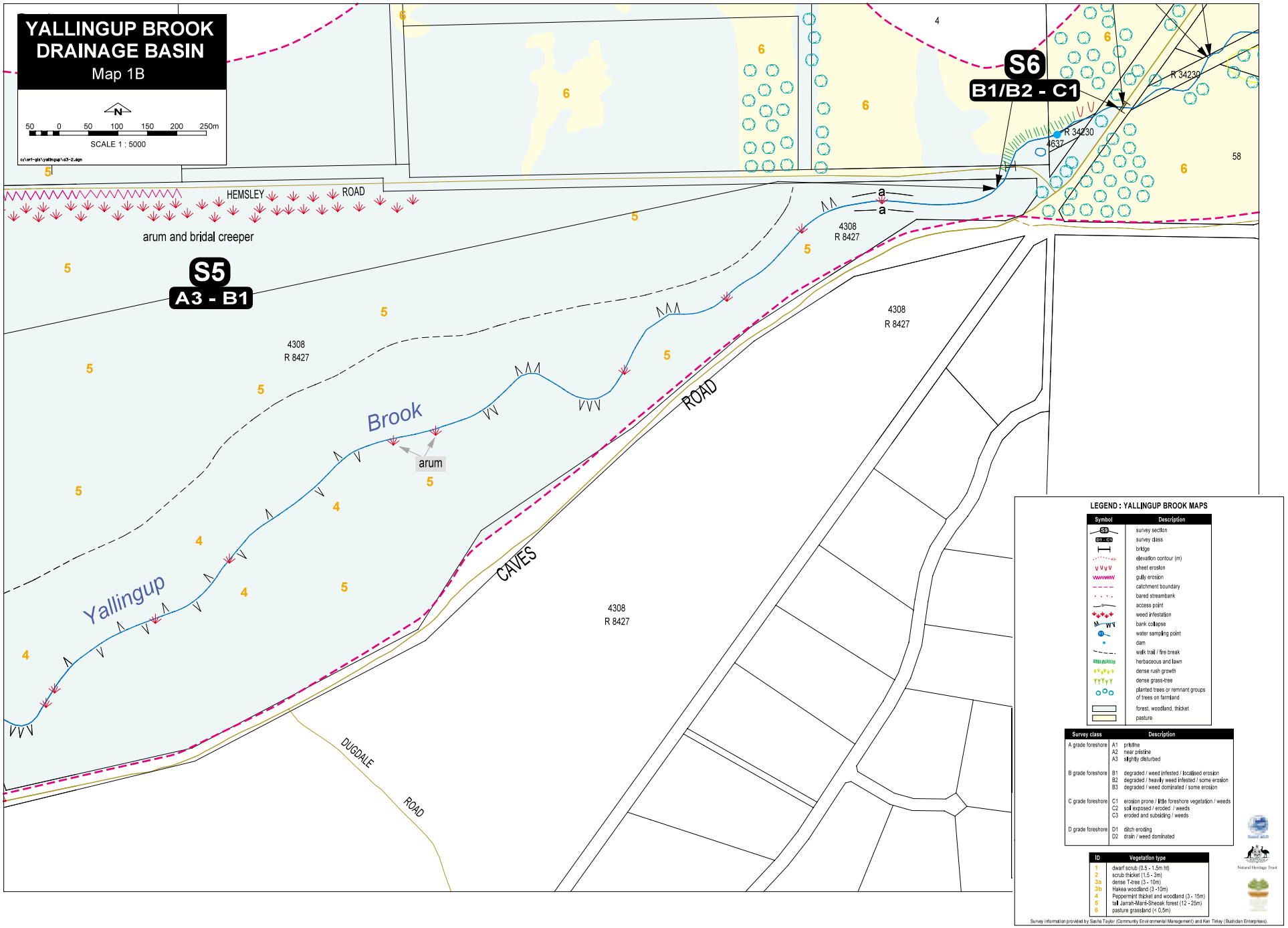
Good vegetation cover, localised weed infestations. Exposed basement rock creating riffles and pools.

Loss of vegetation cover, gully and sheet erosion along powerline track.

Good vegetation cover with banks stabilised by Lepidosperma *spp.*

Vegetation type 5, jarrah marri forest.

vegetation type 5, jarrah, marri, sheoak forest.


YALLINGUP BROOK
DRAINAGE BASIN
Map 1B
N
50 0 50 100 150 200 250m
SCALE 1 : 5000
S6
B1/B2 - C1
S5
A3 - B1
HEMSLEY
ROAD
arum and bridal creeper
Brook
Yallingup
arum
CAVES
ROAD
DUGDALE
ROAD
4308
R 8427
R 34230
4637
58
LEGEND : YALLINGUP BROOK MAPS
Symbol
Description
survey section
survey class
bridge
elevation contour (m)
sheet erosion
gully erosion
catchment boundary
bared streambank
access point
weed infestation
bank collapse
water sampling point
dam
walk trail / fire break
herbaceous and lawn
dense rush growth
dense grass-tree
planted trees or remnant groups of trees on farmland
forest, woodland, thicket
pasture
Survey class
Description
A grade foreshore
A1 pristine
A2 near pristine
A3 slightly disturbed
B grade foreshore
B1 degraded / weed infested / localised erosion
B2 degraded / heavily weed infested / some erosion
B3 degraded / weed dominated / some erosion
C grade foreshore
C1 erosion prone / little foreshore vegetation / weeds
C2 soil exposed / eroded / weeds
C3 eroded and subsiding / weeds
D grade foreshore
D1 ditch eroding
D2 drain / weed dominated
ID
Vegetation type
1 dwarf scrub (0.5 - 1.5m ht)
2 scrub thicket (1.5 - 3m)
3a dense T-tree (3 - 10m)
3b Hakea woodland (3 -10m)
4 Peppermint thicket and woodland (3 - 15m)
5 tall Jarrah-Marri-Sheoak forest (12 - 25m)
6 pasture grassland (< 0.5m)
Survey information provided by Sasha Taylor (Community Environmental Management) and Keri Tinley (Bushcare Enterprises).
Natural Heritage Trust

Section 7 - Description

This section refers to land in the upper catchment in two areas. The initial part of section 7 begins on the eastern side of the road bridge on Caves Rd and extends for approximately 0.16 km. The second part of this section recommences upstream at 5.04 km from the mouth and finishes at the source of the Brook some 5.6 km from the mouth at Yallingup Lagoon. This section of the Brook was not directly surveyed by walking its length. Survey was possible however from adjacent land and from aerial photography. The survey class for this section is B1 (degraded, weed infested) to D1 (ditch eroding).

Vegetation and weeds

The lower portion of the Brook in this section is dominated by pasture grasses and weeds with some remnant trees and a number of more recently established species. The upper portion contains two significantly different landscapes: cleared pasture below a dam on the source of the Brook and remnant vegetation.

An area of remnant vegetation exists further downstream of the dam; it is dominated by grass trees (*Xanthorrhoea preissii*) with limited occurrence of jarrah, marri and *Banksia* spp. This area has been fenced and is an example of the original vegetation type for the upland area. It was not possible to determine the occurrence of weeds in this area. The weeds present in the cleared pasture areas (such as cape weed and flat weed) are considered a possible agricultural problem rather than an environmental problem.

Above section 7, remnant patches of forest canopy trees, mainly marri and jarrah, have been left where laterite ironstone outcrops occur along the watershed divide shared with the Metricup Scarp drainage. These remnants appear to form a practical route for the consolidation of a corridor to link the Brook with the Metricup Scarp, Big Rock Nature Reserve and the coastal plain

Erosion

Exposure of coffee rock can be seen in the streambed of this section where the soil has been eroded over time. Further vertical erosion is limited where such rock exposure occurs.

The Brook originates as a soak which has been dammed. Limited inspection, indicates that gully and sheet erosion are present in this portion where it passes through pasture grass. There is no native vegetation on the foreshore or surrounding riparian zone.

A firebreak around the perimeter of the remnant vegetation contributes sediment to the Brook from erosion in parts, during rain events. Minor gullying has occurred in this area. There is also contribution of sediment from sheet erosion in a paddock above section 8.

Section 7: Condition Rating

North Bank	South Bank
B1 (degraded, weed infested) - D1 (ditch eroding)	B1 (degraded, weed infested) - D1 (ditch eroding)

Issues Identified	Management Advice	Timing	Implementation
erosion and siltation	•revegetation of foreshore •control stock access*	•during wet season •prior to establishing vegetation	•land manager
loss of vegetation	•establish native vegetation •control stock access	•during wet season •prior to establishing vegetation	•land manager

** Fencing and revegetation assistance is specifically available from GeoCatch through Rivercare Support.*

Section 8 - Description

Section 8 is located in the upper catchment where it extends from 4.24 km from the mouth to 5.04 km from the mouth. Portions of section 7 exists on either side of section 8. This section also contains a portion (approx. 0.16 km) of a tributary to the Brook which enters from section 9 upstream. The survey grade for section 8 is B3 (degraded, weed dominated) to C3 (eroded).

Vegetation and weeds

There are very few remnant trees present in this section with much of the property currently being grazed by sheep at a low stocking rate. Much of this section is dominated by pasture grasses, with some weeds such as arum lily and cape weed. Most of the foreshore exhibits pasture grasses with little or no deep rooted perennials. Revegetation has been instigated along the Brook for a number of years, with limited success.

A significant area has been colonised by a native sedge, *Juncus krausii*. This sedge provides an excellent cover on the foreshore and serves to stabilise the banks, limiting erosion and weed infestation. This area demonstrates the value of native riparian species for maintaining the ecological integrity of waterways. The sedge may be transplanted in small (10 cm) clumps when soil moisture content is high to moderate (during the wet season).

Erosion and access

The channel of the Brook through this section is characterised by a very low gradient, with much of the area being broad and flat. The shallow channel is exacerbated by erosion that is occurring both on site and from adjacent land. The resulting silting of the Brook increases the occurrence of flooding which in turn has negatively impacted upon the success of revegetation efforts.

In various portions, particularly the lower section, coffee rock is exposed which acts to prevent further significant vertical erosion. Lateral erosion and some gully erosion are evident however, especially during high rainfall events.

Stock access to the Brook contributes to erosion. There are areas of the streambed where the hard laterite base is exposed which would serve as practical stock crossings, should the balance of the foreshore be rehabilitated.

Section 9 - Description

Section 9 refers to the upper catchment that contains the tributary which enters the Yallingup Brook. This tributary is approximately 0.6 km in length, with about half of a kilometre occurring in section 9. The survey grade for this section is C1 (erosion prone) to D1 (ditch eroding).

Vegetation and weeds

Section 9 is dominated by pasture grasses. Horse agistment is the primary activity at a low stocking rate. There is no riparian vegetation along the channel of the tributary. The original vegetation cover is demonstrated by a small pocket of remnant in the south west corner of this Lot, dominated by jarrah, marri and peppermint.

Revegetation has been occurring on this location for some time with a number of established belts directing superficial flow and limiting erosion. An area above the dam has been fenced off, with plans to revegetate.

Erosion and access

The upper portion of the channel of the tributary exhibits a very shallow gradient with good soil cohesion. There is very little evidence of erosion in the upper portion of the tributary with pasture grass preventing lateral flow from causing erosion. In addition, some of the soils with a high clay content have been redistributed along the channel, so as to limit erosion.

Significant gully erosion is evident in the tributary where it approaches the dam. Here the gully is actively cutting back upslope (head cut). Further vertical incision of the streambed is limited by the exposure of subsoil laterite.

Drainage has been identified as an issue for the land managers for some time, however recent works upslope of this section appear to have increased the surface flow through the property and may in turn be contributing sediment to the Brook. Not all of the surface flow from this location is directed into the Yallingup Brook; some is diverted across Caves Rd into a holding dam.

Section 8: Condition Rating

North Bank	South Bank
B3 (degraded, weed dominated) -	B3 (degraded, weed dominated) -
C3 (eroded)	C3 (eroded)

Issues Identified	Management Advice	Timing	Implementation
erosion and siltation	•revegetation of foreshore •control stock access*	•during wet season •prior to establishing vegetation	•land manager
loss of vegetation	•transplant sedges •control stock access (e.g. fencing or brushing)	•during wet season •prior to establishing vegetation	•land manager

** Fencing and revegetation assistance is specifically available from GeoCatch through Rivercare Support.*

Section 9: Condition Rating

North Bank	South Bank
C1 (erosion prone) -	C1 (erosion prone) -
D1 (ditch eroding)	D1 (ditch eroding)

Issues Identified	Management Advice	Timing	Implementation
erosion and siltation	•continue with control of stock access* •revegetate foreshore	•prior to establishing vegetation •during wet season	•land manager •land manager
	above dam •negotiate drainage management with adjacent land manager	•prior to wet season	•land manager
loss of vegetation	•establish native vegetation (as above)	•during wet season	•land manager

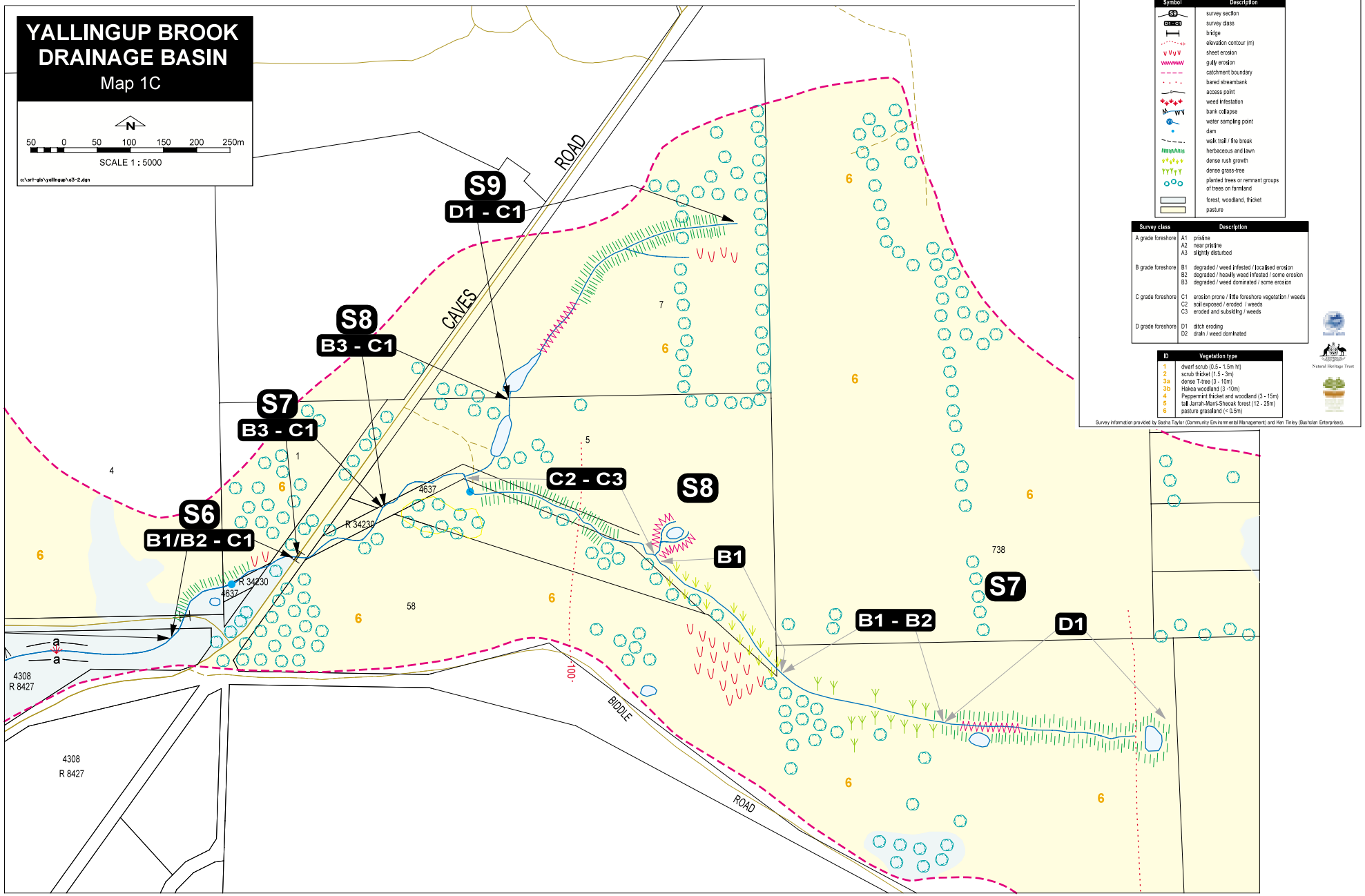
** Fencing and revegetation assistance is specifically available from GeoCatch through Rivercare Support.*

Cowaramup Uplands near the source of the Brook.

Excellent vegetation cover of the foreshore by Juncus kraussi. *Remnant vegetation in background.*

Yallingup Brook snapshot 1998. Sue Schlueter and the Dunsborough Primary 6 and 7's.

Gully and sheet erosion through pasture. Areas of exposed rocky streambed can be useful for stock crossings.


YALLINGUP BROOK
DRAINAGE BASIN
Map 1C
N
50 0 50 100 150 200 250m
SCALE 1 : 5000
c:\srt-gis\yallingup\a3-2.dgn
S9
D1 - C1
S8
B3 - C1
S7
B3 - C1
S6
B1/B2 - C1
C2 - C3
S8
B1
S7
B1 - B2
D1
ROAD
CAVES
BIDDLE
ROAD
4637
R 34230
4308
R 8427
738
58
LEGEND : YALLINGUP BROOK MAPS
Symbol
Description
survey section
survey class
bridge
elevation contour (m)
sheet erosion
gully erosion
catchment boundary
bared streambank
access point
weed infestation
bank collapse
water sampling point
dam
walk trail / fire break
herbaceous and lawn
dense rush growth
dense grass-tree
planted trees or remnant groups of trees on farmland
forest, woodland, thicket
pasture
Survey class
Description
A grade foreshore
A1 pristine
A2 near pristine
A3 slightly disturbed
B grade foreshore
B1 degraded / weed infested / localised erosion
B2 degraded / heavily weed infested / some erosion
B3 degraded / weed dominated / some erosion
C grade foreshore
C1 erosion prone / little foreshore vegetation / weeds
C2 soil exposed / eroded / weeds
C3 eroded and subsiding / weeds
D grade foreshore
D1 ditch eroding
D2 drain / weed dominated
ID
Vegetation type
1 dwarf scrub (0.5 - 1.5m ht)
2 scrub thicket (1.5 - 3m)
3a dense T-tree (3 - 10m)
3b Hakea woodland (3 -10m)
4 Peppermint thicket and woodland (3 - 15m)
5 tall Jarrah-Marri-Sheoak forest (12 - 25m)
6 pasture grassland (< 0.5m)
Survey information provided by Sasha Taylor (Community Environmental Management) and Keri Tinley (Bushcan Enterprises).
Natural Heritage Trust
Prepared by : Banksia Environmental Mapping Pty Ltd (September 1998)

Summary and Priorities

Summary

The following table provides summary information on the foreshore survey of the Yallingup Brook

Table 4: Summary information of survey findings

Section No.	Km from Mouth	Total Km	Survey *north bank*	Class *south bank*
1	0.00 - 0.62	0.62	A3-B2	A3-B2
2	0.62 - 0.77	0.15	C3/D1-D2	D1-D2
3	0.77 - 1.09	0.32	C1-D2	D2
4	1.09 - 1.56	0.47	A2-A3	A2-A3
5	1.56 - 3.86	2.3	A3-B1	A3-B1
6	3.86 - 4.08	0.22	B1/B2-C1	B1/B2-C1
7	4.08 - 4.24 and 5.04 - 5.60	0.72	B1-D1	B1-D1
8	4.24 - 5.04 and (4.34 - 4.50*)	1.01	B3-C3	B3-C3
9	4.50 - 5.00*	0.6	C1-D1	C1-D1

** denotes tributary to the Brook on Lot 5 and Lot 7.*

Priorities

Remedial work on the Brook may be undertaken with reference to the four levels of priority which have been assigned to the various sections of the Brook. These levels of priority are consistent with the standard established in previous foreshore surveys that have applied the Stream Foreshore Assessment survey technique. These levels are explained below.

Priority 1- Urgent

Areas exhibiting severe erosion and/or bank damage which threatens to get worse in the short term. Area exhibiting major weed infestation.

Priority 1

Areas showing either limited erosion or the first signs of erosion, or which are prone to erosion due to the absence of fringing vegetation, or areas having infestations of declared weeds (e.g. arum lilies).

Priority 2

Areas which retain substantial fringing vegetation that is becoming progressively degraded by livestock or significant weed infestations (e.g. giant reed).

Priority 3

Areas which have healthy fringing vegetation or moderately degraded vegetation which are being degraded at a relatively slow rate and are therefore unlikely to become significantly further degraded in the short term.

The following Table summarises the priority classifications for the nine sections of the Yallingup Brook.

Table 5: Priority classifications for nine survey sections of Yallingup Brook

Section No.	Erosion	Weed Control	Access	Revegetation
1	1	1	1 (pedestrian)	1
2	1-urgent	1-urgent	1 (pedestrian)	1-urgent
3	1-urgent	1-urgent		1-urgent
4		1		
5	1-urgent	1	1(pedestrian and vehicle)	
6	2			1
7	1-urgent		1 (stock)	1
8	1-urgent	1	1 (stock)	1
9	1-urgent/1		1 (stock)	1

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Appendices

Appendix 1 Results of Community Questionnaire

A questionnaire on the Yallingup Brook was sent to landowners in the Yallingup townsite. Over 30 responses to the questionnaire were received; 100 % of respondents indicated that they believed Yallingup Brook to be an important asset to the Yallingup area. Other results are shown below.

2) What are the values of the Yallingup Brook ?

ecological integrity/ natural feature	17
pleasant walk/recreation	7
fresh and green environment	1
heritage value /unique	7
picturesque/ scenic/ aesthetic	13
flora/ fauna	2
impression for visitors/tourism	2
relationship with the Ghost trail	3
importance for lagoon	1

3) What are issues regarding the health and management of the Brook ?

sewage effluent pollution	12
pollution (fertilisers, nutrients, pest/ herbicides, stormwater)	11
clean water for the lagoon	4
Erosion	2
weed control	15
revegetation with natives	2
open up viewing	3
and access	2
future commercial development	2
Litter	1
dams/blockages	2

4 and 5) How could the Brook be enhanced /What changes would you like to see?

board walk, bridge/s	4
creating/ formalising pathways beside Brook	8
rehabilitating with native vegetation	12
small weir with permanent water	3
improving access for quiet seats and viewing	8
elimination of pollution/nutrients	4
removal of weeds	11
minimal lighting	2
removal of blockages/dams	2
greater support for management	7
no further clearing near Brook	1
low key signs about environment	1
reduce extraction/ increase flow	1
preserve natural state	9

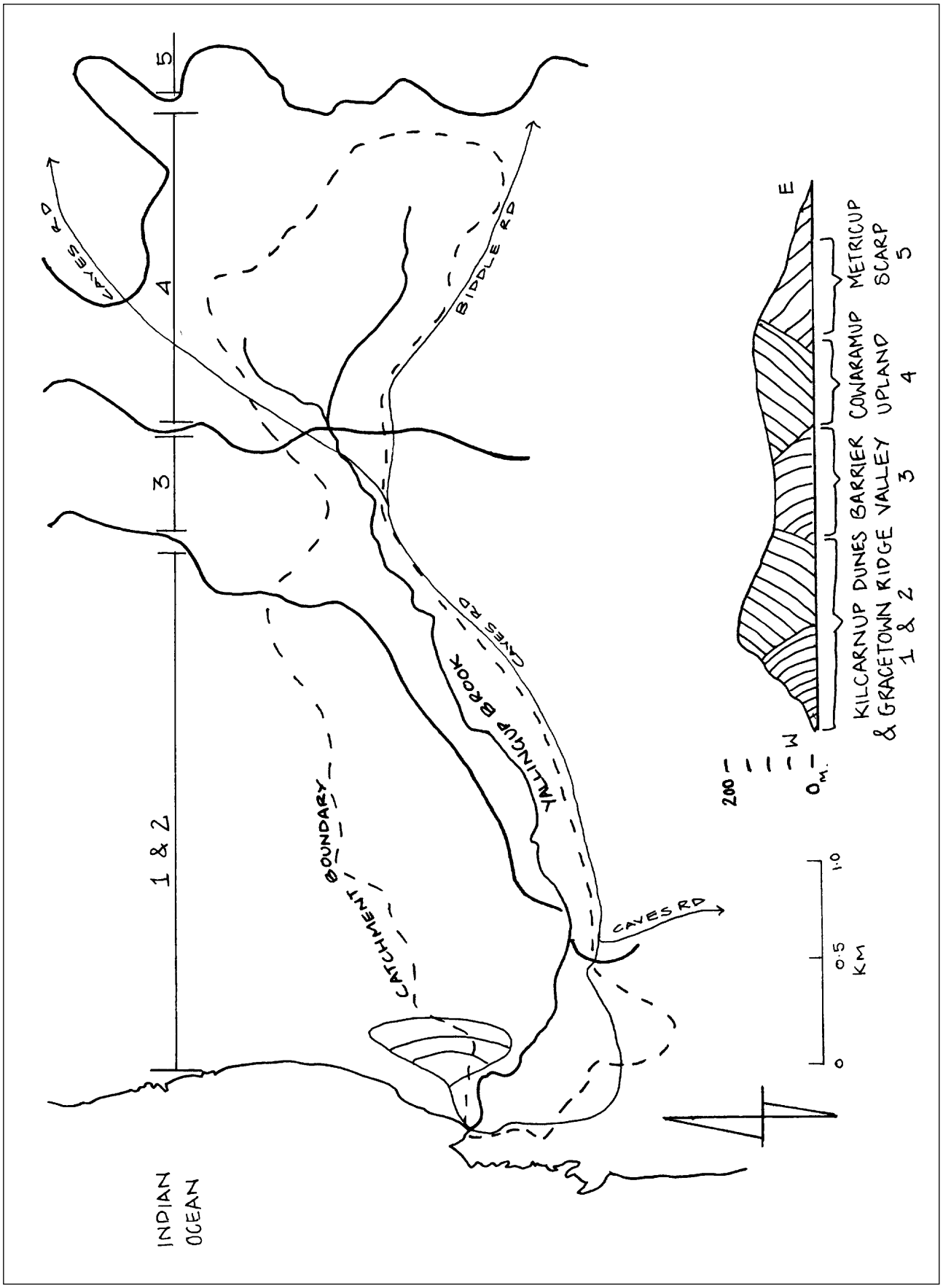
6) Other comments?

Several respondents expressed gratitude for the opportunity to be involved.

Other comments included:

- suggested weed pull by residents
- continue with water monitoring
- sensitive use of chemicals
- improve culvert and bridge at end of Ghost trail
- sensitive future development which preserves natural state of Brook

Appendix 2: Land Systems in the Catchment.



Appendix 3 Species Lists for Vegetation Types 1-5

Species name	Vegetation type									
	Tree	Shrub	Ground layer	Climber	Sedge	1	2	3* a & b	4	5
Acacia cyclops		s				x				
A. littorea		s				x			x	
A. cochlearis		s				x			x	x
A. pulchella		s	g						x	x
A. obovata		s	g							x
A. saligna		s							x	
A. myrtifolia		s								x
A. rostellifera		s				x			x	x
A. divergens		s								x
Adenanthos barbigeras			g							x
A. meissneri			g							x
Acanthocarpus preissii		s				x				
Astroloma ciliatum			g							x
Agonis flexuosa	t					x	x		x	x
Adriana quadripartita		s								x
Allocasuarina fraseriana	t								x	x
Bossiaea ornata		s								x
B. disticha										x
B. linophylla		s								x
Beyeria viscosa		s								x
Banksia attenuata	t						x			x
B. grandis	t									x
B. littoralis	t									
Boronia alata		s				x	x			
Baumea junca					Se	x			x	
B. articulata					se				x	
Corymbia calophylla	t					x	x			x
Cassytha racemosa		s		c						x
Chorizema ilicifolium			g						x	
Calothamnus sanguineus		s							x	
Chorilaena quercifolia		s							x	
Conostylis aculeata			g				x			
C. setigera			g							x
C. candicans			g							x
Clematis pubescens				c						x
Dryandra sessilis	t	s					x			x
Diplolaene dampieri	t	s				x			x	
Dodonaea aptera		s				x				
Dryandra nivea		s					x			

Daviesia divaricata			g				x			x
Eucalyptus marginata	t						x		x	x
E. megacarpa	t								x	
Exocarpos sparteus		s				x	x		x	
Eriochilus dilatatus			g				x			x
Eriostemon spicatus			g				x			x
Grevillea quercifolia		s	g				x			x
Guichenotia ledifolia		s							x	
Hibbertia cuneformis		s					x		x	x
H. hypericoides			g				x		x	x
H. racemosa			g			x				x
H. furfuracea			g				x			x
Hakea prostrata		s	g				x			
H. ruscifolia		s					x			x
H. trifurcata		s				x				
H. oleifolia	t							x	x	x
H. amplexicaulis		s							x	x
Hovea elliptica			g							x
H. chorizemifolia			g							x
Hypocalymma robustums			g						x	x
Hardenbergia comptoniana				c					x	x
Jacksonia horrida		s					x			x
Kennedia coccinea			g						x	x
Kunzea ericifoliat		s					x		x	x
Lepidosperma gladiatum		s			Se	x	x		x	x
L. tetraquetrum					se	x			x	
Leucopogon parviflorus		s				x			x	
L. verticillatus		s								x
L. propinquis			g							x
Loxocarya flexuosa			g							x
Melaleuca acerosa	t						x			
M. lanceolata	t					x		x	x	
M. huegelii	t					x				
M. thymoides	t									x
Mirbelia dilatata		s								x
Macrozamia riedlei		s							x	x
Olearia axillaris		s				x			x	
Pteridium aquilinum			g						x	
P. esculentum			g							x
Patersonia occidentalis			g						x	x
P. umbrosa			g							x
Persoonia longifolia	t						x		x	x
P. elliptica	t									x

Phyllanthus calycinus			g							x
Petrophile linearis			g							x
Pimelia ferruginea rosea		s	g						x	x
Rhagodia baccata		s								x
Synaphea floribunda		s					x			
S. petiolaris			g							x
Spyridium globulosum		s					x		x	x
Santalum acuminatum	t									
Scaevola crassifolia		s	g			x	x		x	
Stylidium adnatum		s							x	
Solanum symonii		s								x
Styphelia tenuiflora			g							x
Stackhousia monogyna		s							x	
Templetonia retusa		s				x				
Trymalium ledifolium		s								x
Tetratheca setigera			g							x
Viminaria juncea		s								x
Xanthorrhoea preissii		s								x
Xylomelum occidentale	t									x

** Vegetation Type 3 refers to dense thickets of single species*

Appendix 4 Useful References and Contacts for Catchment Management

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Bushcare Facilitator - South West
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