



# FOREST FOCUS

NUMBER 26

JUNE 1982





The montage of press statements on page two highlights the nature of public domain land use conflicts in Western Australia. The article by Helen Bradbury describes a rational and objective approach to the resolution of such conflicts, and is worthy of close study.

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Published for Mr B J Beggs, Conservator of Forests, Forests Department of Western Australia, 50 Hayman Road, Como.

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Erratum to Forest Focus 24.

The photograph on page 7 attributed to P. Cheney, was in fact taken by M. Tanton.

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An aerial photograph of experimental plantations in the eastern part of the Murray Catchment near Popanyinning. Below the plantation is a salt seep that is being monitored to determine whether the plantation has any effect on it. Above the plantation is a dam used for supplying drinking water to farm animals with a roaded catchment to enhance runoff into it. (Photo courtesy of the Department of Administrative Services.)

# "ON RATIONAL GROUNDS..."

## a precis of a study on the Western Australian Murray River.

*On Rational Grounds* is a recently published book that describes a management tool designed to help decision makers plan land and water use in river catchments. The example used is the salt-affected Murray River catchment, south of Perth.

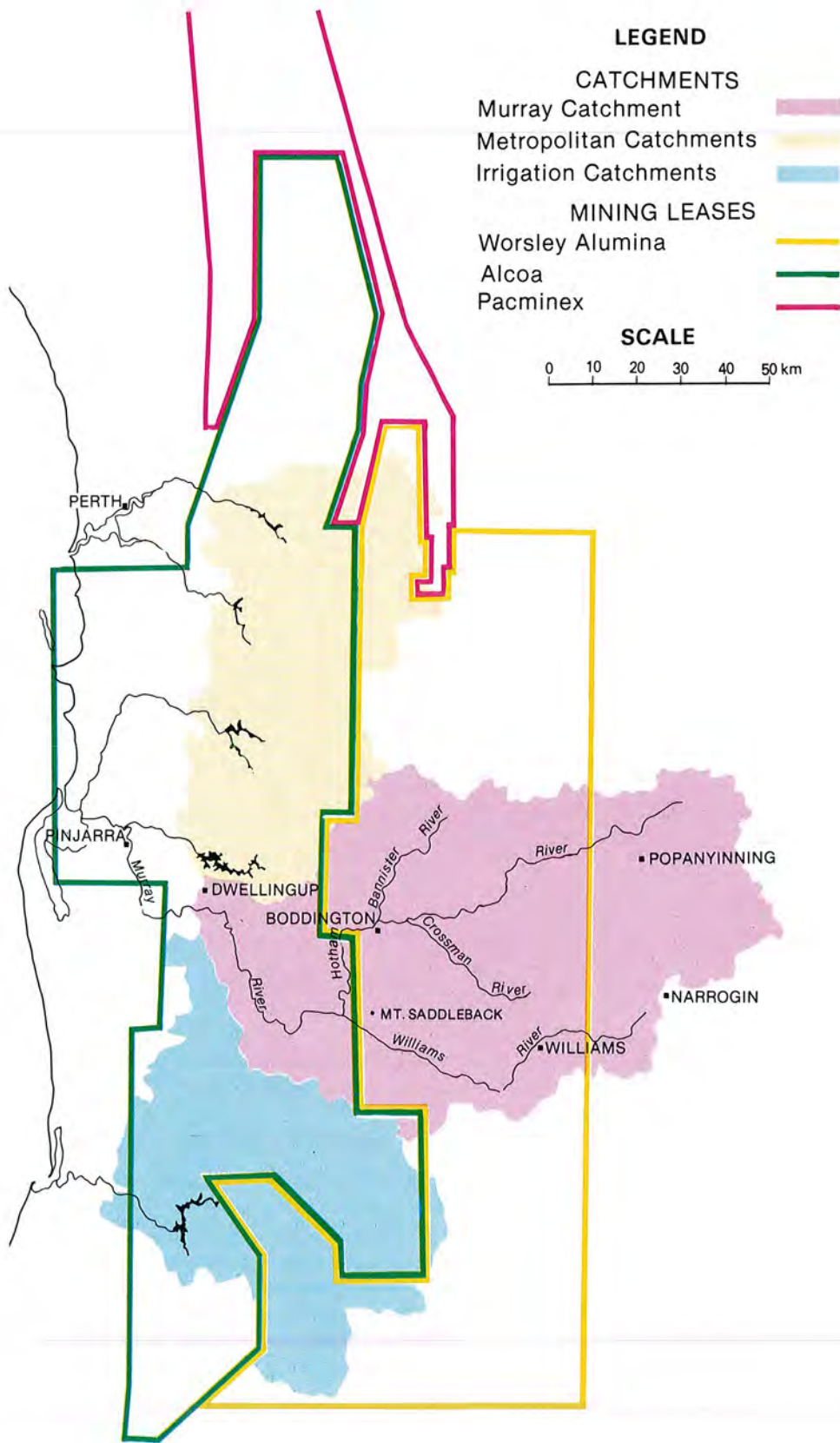
The book outlines a comprehensive approach, employing economics and systems analysis to the problem of increasing conflict between land uses in this water catchment area in the Darling Range. This approach requires highly specialized skills. Because of this, much of *On Rational Grounds* appears inaccessible to the general public and decision makers, many of whom have not been trained in economics and mathematics. But this report is valuable and pertinent, addressing a problem which affects many people in Western Australia.

A politically conservative document, *On Rational Grounds* points to the need for 'rational' planning (defined as involving objective assessment of all alternatives) within an area where rational planning has not been the case in the past. It reasserts some fundamental philosophies behind our political system — a system that is based on freedom of thought and expression, and decentralization of decision making. It points out the

need for greater communication between government bodies, analysts of resource management problems, and citizens, and an opening up of administrative procedures in Western Australia. We are presented with a case example of the place that objective planning could hold in our society — a society that has favoured experienced but unsystematic judgements, or has been swayed by the arguments of vested interests. The Murray catchment is changing. This document shows how that change might be approached in a way that makes optimum use of current information and modern decision aids, while retaining traditional democratic and scientific values. "Rational planning should ideally be viewed, not as an attempt to enforce reason on an unreasonable world, but as the improvement of decision makers' ability to decide rationally". The following is a brief resume of the method used, described in detail in *On Rational Grounds*. Further enquiries may be addressed to Dr David Bennett and Mr John Thomas from the CSIRO Land Resources Management Division, Perth or Mr Joe Havel and Mr Frank Batini, Forests Department, Como.

### The Problem

Timber, water, recreation, conservation or mining? Which of



these or several other uses should take priority? What forms of land use are best in the short and long term interests of this State?

In the northern jarrah forest in Western Australia, competing land uses are vying for preference. In view of the value of this resource to the community, and its proximity to the State's capital and main centre of population, a considerable number of people will eventually be affected by land use decisions made here.

The resources of the northern jarrah forest provide both wood and agriculture products, minerals (bauxite, gravel and blue metal) and various recreational and conservational values. Of paramount importance is its use as a catchment for domestic and industrial water supply and for irrigation. The bulk of the land still under forest is held as dedicated State forest and managed by the Forests Department of Western Australia. However, much of the region is privately owned and cleared for either pasture or crops, so that resource utilization involves other Government Departments, private companies and individual landowners.

The Murray is the largest undammed stream in the region. Its catchment is located some 100km to the south of Perth, has an area of 660,000 ha and extends eastwards well into the Agricultural belt. It lies between existing metropolitan and irrigation catchments (see fig. 1). Rainfall varies from less than 500mm to 1 300 mm per annum. Some 45 per cent of the catchment has already been cleared, causing severe salinity problems from salt seepages on farms and salination of the major waterways. It is possible that the Murray will be used for metropolitan water supplies by the end of the century and this would drastically affect the current recreational and conservational values of the main valley.

Within the catchment are some of the finest young regrowth stands of jarrah as well as some high quality bauxite deposits. Conflict in

Fig. 1.

resource management and development in the Darling Range is obvious. Now with damming proposals for the Murray River critical decisions must be made for the future of the catchment. How best to make decision for this and other catchments in the future?

## The Murray River Supply

The Murray could supply a large volume of water, probably 250 million cubic metres per year, given full utilization in its brackish state. Metropolitan consumption of water is currently 149 million cubic metres per year. The cost of delivering water from the Murray to the consumer in Perth would be lower than that for more southerly rivers, and similar to the cost of delivering underground water from an area near the Moore River, north of Perth.

The major problem with using the Murray is that its average salinity (approximately 1200 milligrams per litre total dissolved salts) is very much higher than existing metropolitan supply (approximately 350 milligrams per litre). Nevertheless, water from the Murray River could possibly be used in Perth's metropolitan supply system in a number of ways. The following have been suggested:

- direct use, using one dam, with reforestation in the catchment's agricultural areas to reduce current salinity levels;
- mixing with less saline supplies;
- construction of a secondary dam to divert saline headwaters;
- construction of small dams on the fresh tributaries in the forested area;

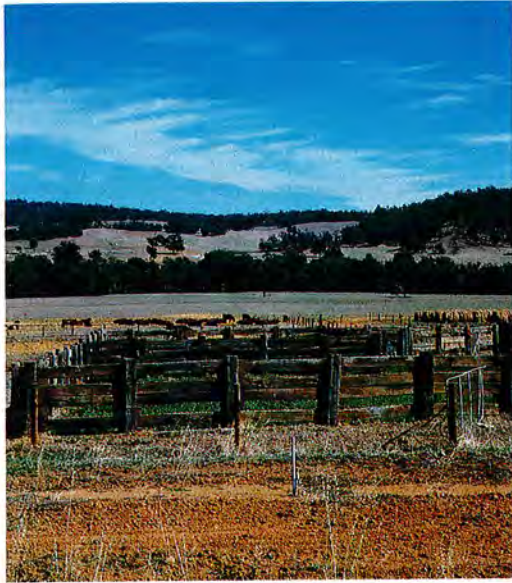
The visible expression of salinity in the Murray Catchment is the death of vegetation in the lower parts of the landscape in the east. G. Pead



In the eastern half of the catchment mixed farming predominates, sheep grazing alternating with cereal cropping. It is from here that most of the salt flow originates. G. Pead

The Hotham River Gauging Station is a v-notch weir where stream flow and salinity measures are taken. It is pictured during a period of winter flow. (Photo courtesy of the Public Works Department.)





▲ A prosperous looking farm in the eastern part of the catchment. Note that clearing of the area has not been total. G. Pead

Canoeing and rafting are popular forms of recreation on the free-flowing waters of the Murray River. J. Carey



- installation of desalination plants utilizing reverse osmosis technology.

Reforestation would involve a considerable amount of social disruption and effort to achieve the desired effect, and its capacity to do this is uncertain. It would increase transpiration and therefore reduce streamflow by perhaps 30 per cent, but it would still leave enough runoff to supply approximately 200 million cubic metres per year. Mixing with less saline supplies would involve fairly severe engineering problems to achieve an adequate mix of saline and fresh waters within the supply system. In the absence of special measures to increase runoff, the building of two dams would involve a lower yield of water for the metropolitan system (an approximate total of 100 million cubic metres per year), and would also more than double the cost of dams and pipes. But it would almost certainly involve less social disruption and less environmental effect than reforestation. The strategy of building small dams on fresh tributaries would yield less water (an approximate total of 30 million cubic metres per year) but it would possibly have lesser effects on other land uses. Physical desalination by reverse osmosis could produce a large volume of water (approximately 200 million cubic metres per year), with little social disruption, but at a high cost.

The complexities of the decisions required for future planning of this catchment become obvious when all of the variables are assessed.

## The Study Team

A number of experts from the CSIRO's Division of Land Resources Management, the Department of Agriculture and the Forests

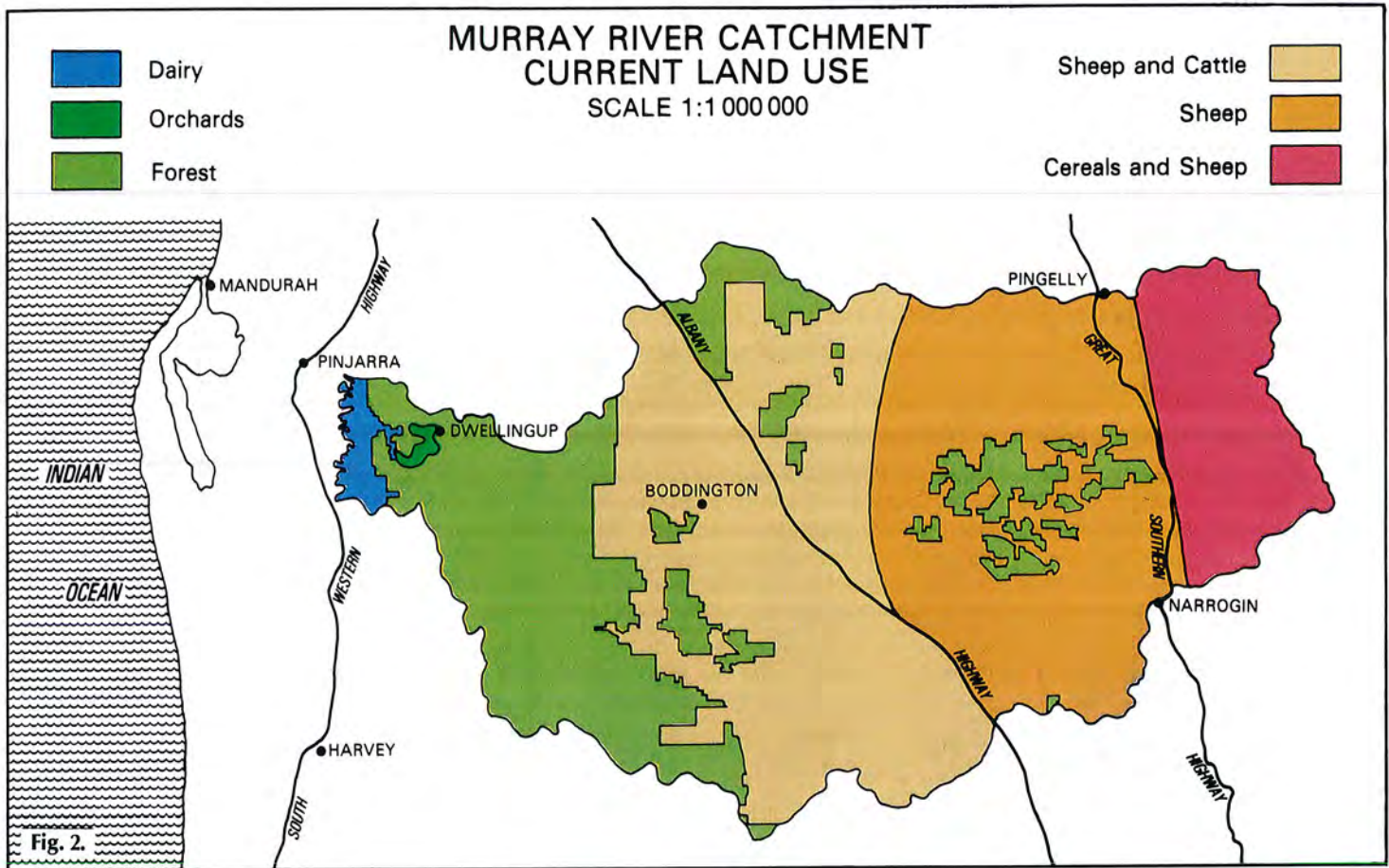
- ◀ The landscape of a roaded catchment. For efficient water collection the surface has to be free of plants, eradication of which causes high annual maintenance costs. (Photo courtesy of the W.A. Department of Agriculture.)

Department came together to propose a systematic and economic plan for the catchment. Members of other Government Departments and private companies assisted the group as advisers in more specialized fields. Public opinion on recreational use of the catchment was obtained through surveys and questionnaires administered by the Forests Department.

## The Model

A mathematical model was used to allocate land uses in the Murray catchment, under various scenarios of water planning, including the option of not to dam. The catchment was divided into 41 zones according to land form types, rainfall and vegetation coverage, and all probable land use activities were considered for each zone. A computer programme was written that would account for all combinations of the activities in the zones. Eleven land uses were considered, including flora and fauna reserves, national parks, eucalypt hardwood forestry, plantation forests, agriculture (as adapted to different zones), agroforestry, streamline plantations, water runoff enhancement by surface sealing land surfaces ("roading"), bauxite mining (followed by forestry, agriculture or roaded sub-catchments), and water storage. The task was to assess the economic value of each activity in each zone and work out which would be the most efficient land use, according to three basic water development options (no water using development, one dam with reforestation, two dams diverting saline headwaters).

Landform mapping, a technique developed by the CSIRO has now been applied to large areas of the south-west of Western Australia. The main reason for this is that land forms can be mapped from the air over very large areas, whereas quite significant differences in soils and vegetation can often be seen only from the ground, and can therefore



In the better vegetated parts of the catchment, beekeeping is carried out seasonally. *G. Pead*

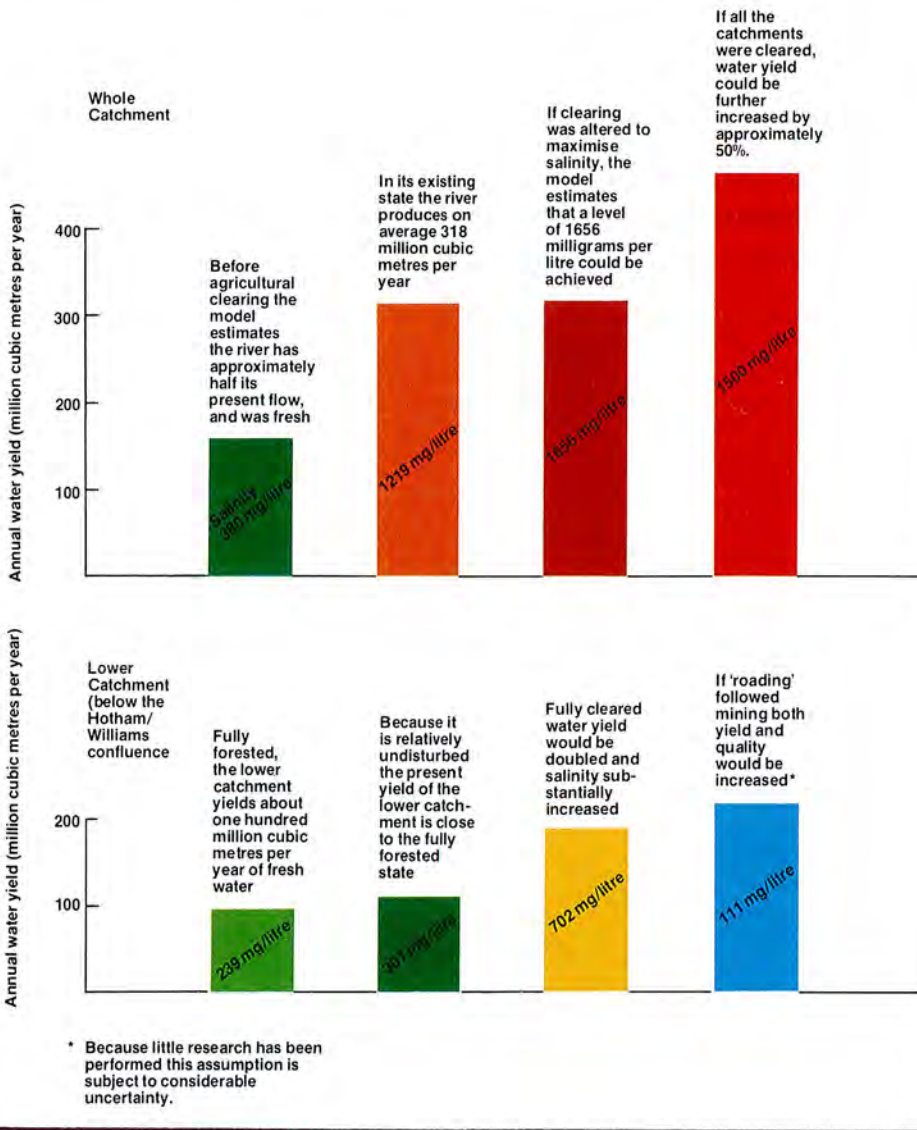
This picture shows a harmonious combination of land uses in the catchment - water supply, farming, private pine plantation forestry, with the hardwood jarrah forest in the background. *G. Pead*



Fig. 3.

WATER YIELDS IN THE MURRAY CATCHMENT UNDER DIFFERENT SCENARIOS

Water yields from the Murray depend on the amount of the catchment covered by forest which evaporates water all year, as opposed to annual crops and pastures which only evaporate water during the wet winter and spring seasons. The more forest there is, the less water yield.



zone was calculated on the basis of five 'budgets'.

- (1) An overall economic cost/benefit comparison of the activities themselves in each zone. For example, the cost of planting pines and the profit made in logging these pines, compared with direct cost/benefit of all other activities.
- (2) A water budget — how each activity in each zone would affect the amount of potable water released into the river, and how much this water would be worth.
- (3) A salinity budget — how each activity in each zone would affect the amount of salt released into the Murray River, and what economic costs would be incurred as a result.
- (4) A recreation budget — how much each activity, for example bauxite mining, would affect recreation in each zone. Numbers of visitors to the area were estimated and then valued.
- (5) A conservation budget. This was difficult to assess because the values of conservation cannot be directly incorporated into the model. Therefore, it was used as a constraint. By using conservation as a constraint an indirect value was gained in dollars as to how much it cost to allocate land to this purpose. This is called an opportunity cost, or the value foregone. Activities were assessed both with and without conservation constraints.

Overall then, the model accounted for 41 zones, 11 activities per zone, 5 budgets per activity per zone. The task then posed was to simulate the catchment under proposed water supply schemes and optimize land use activities. The overall economic return of each scheme could then be assessed.

only be mapped very laboriously. There are now several studies within State forests that successfully relate land forms to vegetation and soils. It is therefore possible to interpret landform maps in terms of vegetation and soils, and thus utilize them as a basis for land use planning. For example, the allocation of parts of the State forest to various land uses such as

catchment protection, recreation, flora and fauna conservation and timber production, is to a considerable degree based on land forms, though economic and social factors also have a strong influence.

**Budgets**

The economic value of each possible land use activity in each



York gums (*Eucalyptus loxophleba*) grow naturally in the low rainfall area of the eastern catchment, but have been largely cleared from the area to facilitate wheat and sheep farming. Note the experimental plantation in the background established by the CSIRO to monitor the effect on salinity levels of large-scale re-planting in agricultural areas. (Photo courtesy of CSIRO.)

## Results of the Study

A large number of different assumptions about data value, land use options and water exploitation strategies were examined in the book, only the most salient results are recorded here. In the absence of water resource development, present land use is close to the optimal allocation of agriculture and forestry.

Given the estimated values of water used in the study, the net benefits to the community from extensive reforestation in agricultural areas or large-scale diversion of saline tributaries (using two dams), or physical desalination would be either small or negative. Even at 45 per cent of estimated costs desalination plants would not be worthwhile. In these schemes, benefits from water resource development would be offset by the resource costs.

The model suggests that the two dam scenario will halve the yield and salinity, as compared with the one dam scenario of 250 million cubic metres yield and about 1200 milligrams per litre salinity. Within this major option, further variation will result from mining rehabilitation. If mining is followed by forestry rather than agriculture, the value of the catchment products will decrease by \$13 million, water yield by 28 million cubic metres, but salinity will further drop from 473 to 301 milligrams per litre. Under certain conditions, the two dam option might be justifiable, particularly if extensive recreational use were made of the upper diversionary dam.



Overall, however, it was concluded that unless a very efficient method of reducing stream salinity were to be found for this catchment, other methods of coping with Perth's water demand should be considered. The inclusion and optimal allocation of bauxite mining increases the overall net value, but does not alter the relative merits of the water development projects, compared with no development.

In addition to the conventional land uses discussed above, the impact of new forms of land use designed to improve water quality such as agroforestry, streamline plantations, and strategic enhancement of runoff by roading were investigated. In these analyses, considerable reductions in salinity were assumed to be achieved by relatively minor changes in land use. On these assumptions, water resource development appears much more economically viable. Again for a two dam scenario, introducing roading after mining instead of agriculture would virtually double water yield and reduce salinity to a quarter. This solution produces the best quality water but its implementation could well cause turbidity, bacteriological, and engineering problems.

The results of the case study also serve to emphasize two more general principles for management of this catchment. Firstly, the main land use conflict affecting water quality is that between clearing for agriculture and the alternative uses of agricultural land. The release of salt from agricultural land far exceeds that from any possible amount of bauxite mining, even if mining contributes substantially to the spread of jarrah dieback disease (though this would probably not be true in some other local catchments in which there is little agricultural clearing). Thus, measures to improve water quality by choice of land use must concentrate on agricultural land.

A second principle relates to the less extensive, though more intense, conflict between bauxite mining, conservation and recreation areas in the western forested part of the catchment. The area to be mined for bauxite is, on present projections, small compared with the total area where bauxite is found. Thus there is considerable freedom for allocating the areas to be mined so as to respect recreation and conservation areas. The resulting additional cost is not only small compared with the value of the

## THE COSTS OF CONSERVATION IN THE MURRAY VALLEY

The model estimates that the overall cost of implementing proposed conservation areas amounts to a discounted cost of \$24 million at 1976 prices, equivalent to an annual cost of \$1.68 million. The distribution of this cost between the affected land uses is shown in this diagram for the case of a single dam and 200 km<sup>2</sup> of mining.

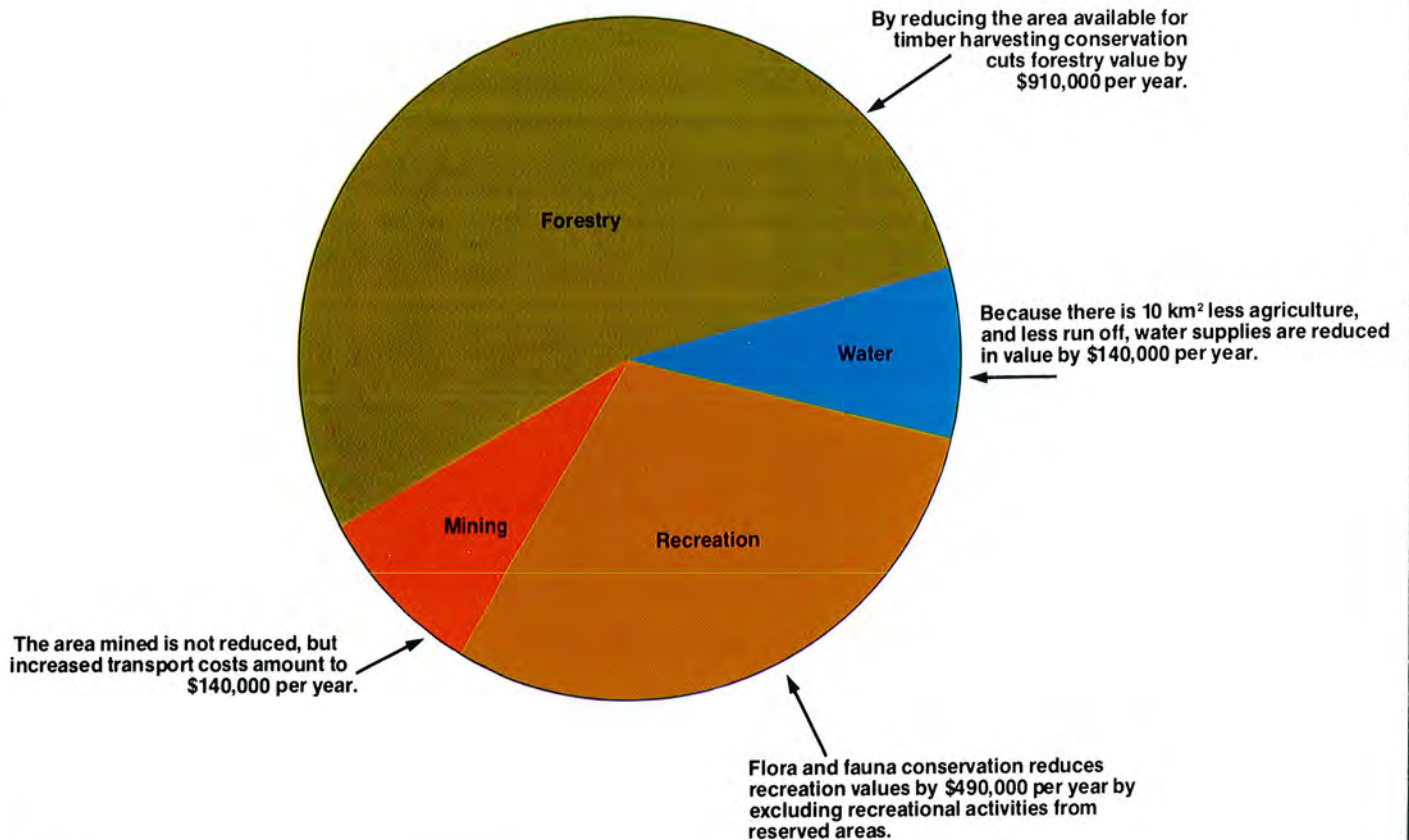


Fig. 4.

bauxite, but may well be exceeded by the value of recreation alone. Therefore, taking advantage of the potential mobility of mining is an important principle of efficient land use management in this and similar catchments.

### Discussion of the Study

On Rational Grounds includes an evaluation of the methods that were used in the case study. This evaluation illuminates some of the problems that affect the viability of

'rational' planning in our society. The available physical data is always far from perfect, so that some predictions will be in error. In addition, analysts and decision makers always have their own assumptions about what is good for society: about what environmental factors are important for instance, and about the evaluation of social welfare and benefit. Economic assumptions, though necessary, are always questionable. For instance, the task of ascribing values to recreation potential and conservation, both of which carry

much 'intangible' though real value, leads to a fundamental questioning of economic concepts, and makes great demand on logical reasoning. But if problems such as these are not tackled, much well-intentioned scientific data gathering may be fruitless.

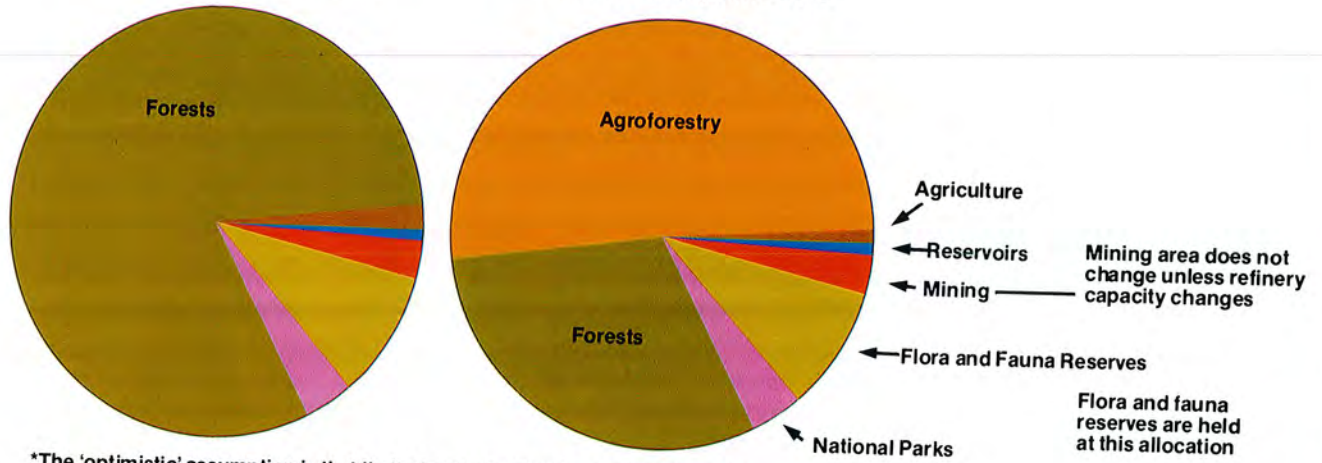
The study highlighted several areas where collection of more information would reduce, but not eliminate, the uncertainties of planning in the Murray study.

At the time of the study there was only a limited amount of data on

ONE DAM BELOW NANGA BRIDGE WITH LAND USES DESIGNED TO MEET  
WORLD HEALTH ORGANIZATION'S STANDARD OF 500 mg L<sup>-1</sup>  
TOTAL DISSOLVED SOLIDS

(a) Pessimistic assumption about land use/water quality interactions\*

(b) Optimistic assumption about land use/water quality interactions\*



\*The 'optimistic' assumption is that limited tree planting in agroforestry schemes would be effective in reducing salt flow from agricultural areas; the 'pessimistic' assumption is that it is not possible to find land management schemes which achieve this, other than full reforestation of agricultural areas.

To meet the salinity standard nearly all the agricultural land has to be planted to plantations which lose money. Annual value of the catchment products falls to \$25 million. Dam supplies, on average, 177 million cubic metres of water per year to Perth at 500 mg L<sup>-1</sup> Total Dissolved Solids.

Agroforestry replaces money losing plantations. Annual value of the catchments products rises to \$31 million. Dam supplies the same amount of water at the same quality standard.

Fig. 5.

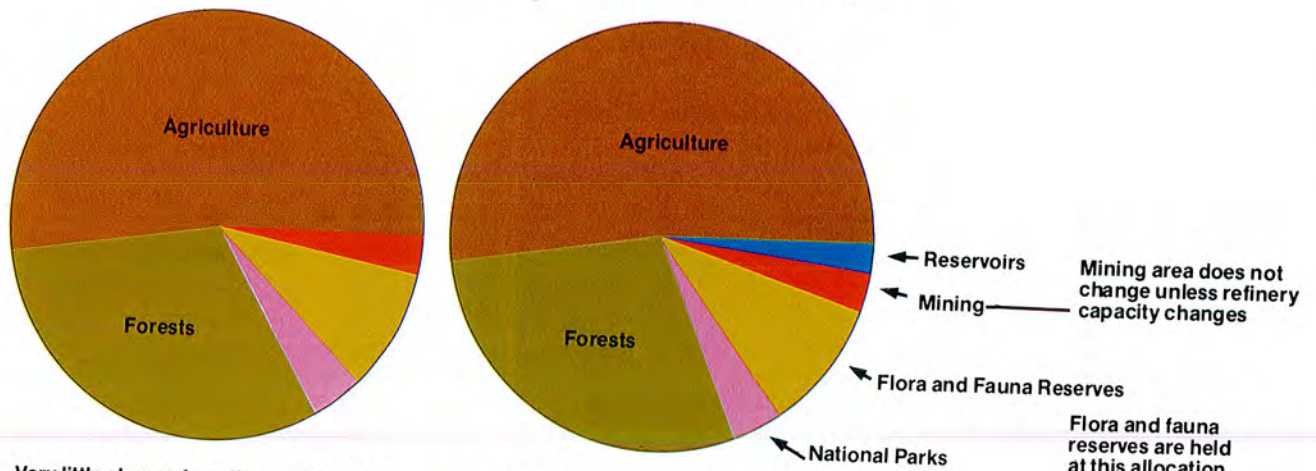
Fig. 6.

COMPARISON OF LAND USE ALLOCATION FOR  
NO DAM AND TWO DAMS OPTIONS

NO DAM

TWO DAMS

(One below Nanga Bridge and the upper dam to divert saline headwaters just below the junction of the Hotham and Williams Rivers)



Very little change from the existing land use is suggested. Annual value of the catchments products is \$28.7 million; the river flows at 294 million cubic metres per year at a salinity of approx. 1200 mg L<sup>-1</sup> Total Dissolved Solids.

Some land is flooded by the upper and lower dams. Annual value of the catchment products rises only \$0.3 million. Lower dam supplies on average, 126 million cubic metres of water per year to Perth at 450 mg L<sup>-1</sup> Total Dissolved Solids.



▲ Bauxite mining in the western part of the catchment. G. Pead

▼ Part of the jarrah forest devastated by dieback disease in the western part of the catchment. G. Pead



recreational activities. Subsequent Forests Department surveys have added considerably to the available information, however, data on the recreational use of streams, rivers and open bodies of water in the south-west is still relatively sparse and unco-ordinated. Surveys aimed specifically at the economic aspects of recreational activity have not been undertaken.

Another data deficiency noted in the study was the lack of reliable estimates of the way changes in price will change the demand for water. These are important for calculating growth in Perth's demand for water, the growth rate in the utilization of a particular water resource development, and thus, the estimation of benefits from building dams. Currently the Perth Metropolitan Water Supply Sewerage and Drainage Board is undertaking a major study of social and economic factors influencing water use that will yield data relevant to these purposes.

There is even less available information on the economic costs which result from salinity in water supplies. American data suggests that for a city the size of Perth, economic costs of about \$5 million annually could be incurred even at the acceptable standard for human consumption of 500 milligrams per litre total dissolved salts. This occurs from increased scaling and corrosion causing higher operating costs and a shorter working life for all manner of water-contacting appliances, for example, in industrial pipes and boilers, domestic water heaters, taps and valves, and the urban reticulation system. This does not include any health costs from raised concentrations of salts, or purchases of high quality bottled

▶ Pine plantations and jarrah forest flank the deeply incised Murray Valley near Dwellingup. In the distance is Nanga Bridge, below which the dam for the one dam option would be constructed. H. Bradbury

**Landscape No. 3.**

One of the many moods of a free-flowing river - the Murray in full flood.  
(*Photograph by Lachlan McCaw, Forests Department, Dwellingup.*)



water by consumers. Such cost estimates are of great relevance to resource management, where water quality is affected by land use practices.

In conclusion, it should be stressed that linear programming is just one tool for planning. In terms of theoretical economics it is very sound — practical details are not so well represented. The case example is still a very open area of interest, where decisions are yet to be made. On Rational Grounds does not make recommendations or decisions. This is not a drawback. A tool doesn't provide answers — it provides the potential for better answers.

“Whether or not water resource development takes place, there will still be conflicts between agricultural expansion and forestry, between conservation and recreation, between mining and forestry, and between mining and conservation. It follows that any

plan for resource use in the catchment needs to consider simultaneously the physical interactions between, and economic values from forestry, mining, agriculture, conservation, recreation, water yield and water quality”.

Helen Bradbury



Healthy regrowth jarrah forest. ▶  
Hardwood forestry is a valuable resource and employs the majority of the inhabitants of Dwellingup. G. Pead



Jarrah poles like these are used by Telecom and the State Energy Commission to support telephone and electricity cables in Western Australia. (Photo courtesy of the CSIRO.) ▼

## THE STUDY TEAM

### CSIRO Division of Land Resources Management

D. Bennett	: Originator, co-ordinator and editor
H.L. Davies	: Mathematical modelling
P.A. Downes	: Computer programme operator
D.K. Macpherson	: Discussant
W.M. McArthur	: Landform mapping
A.M. Murray	: Clearing analysis
A.J. Peck	: Salt yield estimates
P.L. Sewell	: Temporary co-ordinator 1975-76
J.F. Thomas	: Economic studies and editor

### W.A. Forests Department

F.E. Batini	: Originator, forestry budgets, recreation
J.J. Havel	: Originator, conservation, runoff estimates (western region)

### W.A. Department of Agriculture

K.J. Blich	: Runoff estimates (eastern region)
P.P. Eckersley	: Originator, agricultural budgets

### CSIRO Division of Building Research

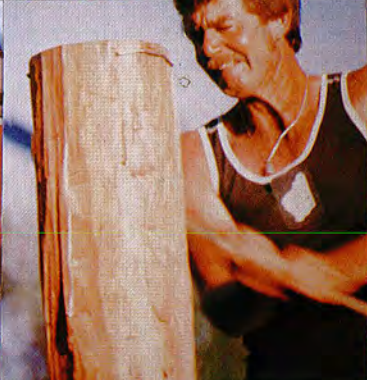
R. Sharpe	: Initial computer programme.
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On Rational Grounds was published in March 1982 by Elsevier Scientific Publishing Company, Amsterdam.

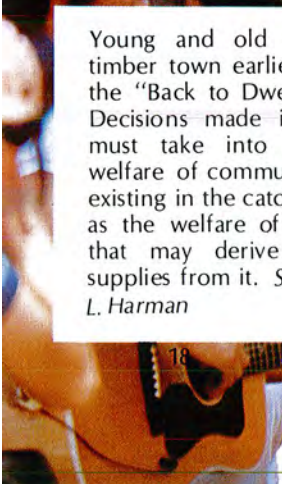




DWELLINGUP COMMUNITY HOTEL



Young and old meet in the timber town earlier this year at the "Back to Dwellingup" day. Decisions made in the future must take into account the welfare of communities already existing in the catchment as well as the welfare of communities that may derive their water supplies from it. S. Mairata and L. Harman





# General Working Plan No. 87 1982

## A Review

"The Forests Act (1918-1976) states that the Forests Department shall have exclusive control and management of all matters of forest policy, all State forests and all timber reserves. The Act also requires that working plans for the management of State forest and timber reserves be prepared to cover a period not exceeding ten years. These plans are to be approved by the Governor in Executive Council and shall not be altered except on the recommendation of the Conservator of Forests. The purpose of the general working plans is to set out how the Government's forest policy is to be achieved. Each State forest and timber reserve is to be managed in accordance with this general working plan".

These words introduce the Western Australian Forests Department's current working plan, General Working Plan No. 87, 1982, approved by the Governor in Executive Council on 9 March 1982.

The General Working Plan is a document covering management, by the Forests Department, of over two million hectares of State forests and timber reserves. It represents a commitment by Government for the Department to manage the resources under its control according to specifications in the plan.

This 1982 Plan outlines a history of previous working plans for specific forest areas and general working plans for the whole of State forest since the Forests Act was passed in 1918. It is placed within the context of these previous plans and also of recent events and developments that have affected and influenced management.

The previous plan, General Working Plan No. 86, was approved and published in 1977. The current Plan follows in the tradition of No. 86 which detailed the Government's forest policy based on the concept of multiple use management. No changes have been made to this policy and it provides the basis for the current Plan.

General Working Plan No. 87 sets out specifications for approaching the current issues and values confronting Western Australia's forest management. These specifications take the form of background information, statements of management objectives, policy and strategy and discussions concerning interaction of land uses, a necessary consideration in multiple use management.

The purpose of forest management is described as "conservation through planned use of forests and associated resources, for the greatest long term social and economic benefits". The definition of conservation adopted by the Department is that described by the International Union of Conservation of Nature and Natural Resources in the World Conservation Strategy ... *"the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations. Thus conservation is positive, embracing preservation, maintenance, sustainable utilization, restoration and enhancement of the natural environment."*

Because of the many demands placed on the forest for different purposes and values multiple use management is seen as the best way to achieve the benefits desired. The Plan defines multiple use as "the use of a tract of land for several different purposes", and this is achieved by defining priority use areas and within this framework presenting as many uses as possible.

Compared with General Working Plan No. 86 (the 1977 Plan) the 1982 Plan expands the application of multiple use management and provides a preliminary classification of all of State forest into Priority Use Areas. A Priority Use Area is defined according to its primary use. This does not preclude the areas from a secondary use, but where conflict in management arises, requirements for the primary use are given precedence. The main forest values for which the Plan specifies management guidelines are water, wood, flora, fauna, landscape, recreation, scientific study, education and minor products such as honey, sandalwood and wildflowers.

Historically, timber production has been the major objective of forest management in Western Australia. But in recognition of other values and the consequent application of multiple use management, timber production now takes its place alongside the other major forest values.

General Working Plan No. 87 specifies a reduction of harvesting eucalypts from the forest and an increased pine planting and logging programme for future timber supplies. The aim is "to ensure that the estimated local demand for sawn timber and other wood products is met as far as possible from local supplies."

Water production, recreation and flora and fauna protection are major values given emphasis in this Plan. Particular attention is paid to the protection of water catchments, as a large area of the northern jarrah forest covers catchment areas that are used to supply water for domestic, irrigation and industrial purposes. Recreation has received consideration, and specifications to co-ordinate recreation requirements and environmental protection are provided. Attention has also been given to the protection of wildlife, in the provision of flora, fauna and landscape priority use areas.

The Plan stresses the need for flexibility of management so that factors and events affecting forest resources, but beyond the control of the Department may be considered in future management decisions. An example of one such event in the previous planning period was Cyclone Alby in April 1978, which caused widespread damage in pine plantations.

Constructive comment on this 1982 Plan from organizations and interested members of the public is invited.

General Working Plan No. 87 is a comprehensive document covering all aspects of current forest management in Western Australian State forests and timber reserves. Copies are available to the public at a cost of \$12.00 each from the Forests Department, 50 Hayman Road, Como.

*Marianne Lewis*



## PLAYING POSSUM



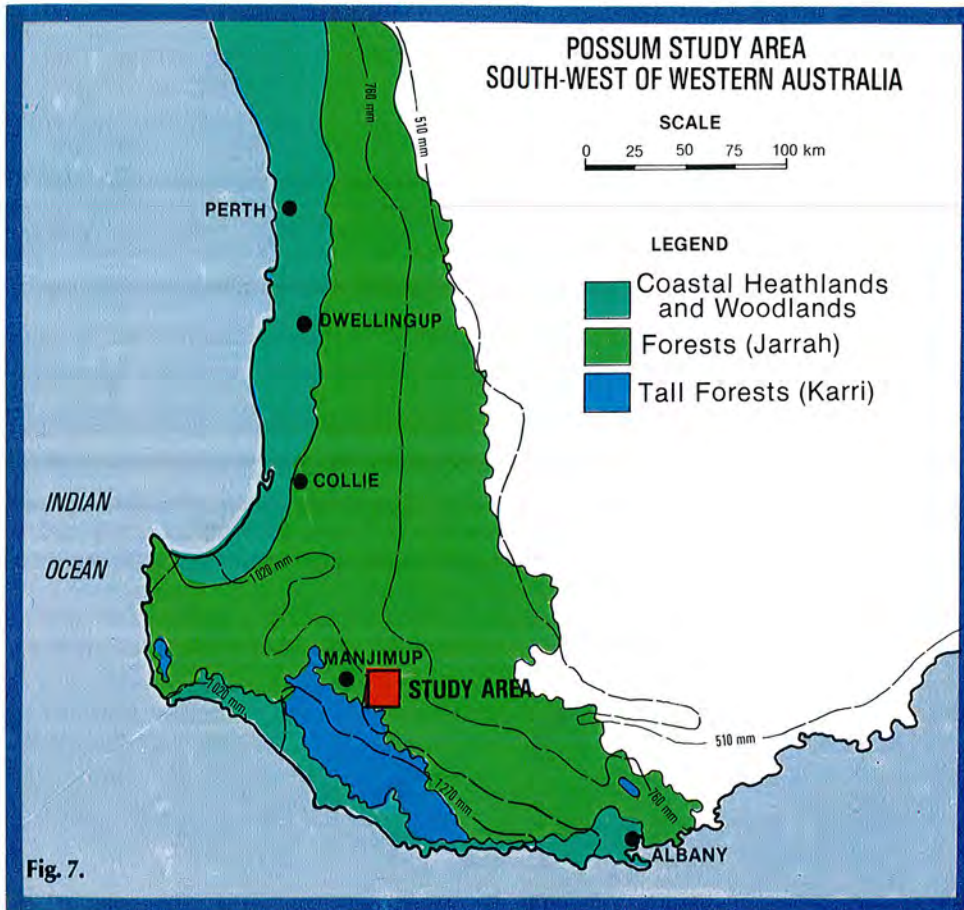
by  
*Gary Inions and Helen Bradbury*

Stumbling through jarrah forest late at night with the “beep” of a receiver as your only guide makes it easy to understand how the phrase “playing possum” has come to mean keeping quiet, watchful and deceptively docile. There was a surprise on this particular occasion when, after some time tracking a young female brush-tailed possum (affectionately named “Sheryl”) we had to admit being completely stumped. The frequency of the “beep” was at its loudest. That meant that she had to be right at this spot, yet there was no sign of her either feeding on the ground or in a

tree. Then we saw it — the transmitter tossed on the ground, the metal collar snapped open. She could be anywhere by now. This was a blow because we had not tracked such a young possum before and although we had followed her periodically for six weeks, this was not sufficient time to accumulate comprehensive information. Why did she travel so far, and why so randomly? What would be the extent of her home range? How would she find a mate? When? During the six weeks she had moved a lot through many jarrah and marri trees in the Perup

forest east of Manjimup. Because she was on the ground so much feeding on grasses and shoots, we had found her easy to locate when tracking. Like all possums, which are tree-dwelling mammals, her movements on the ground were cumbersome and slow. This meant that she would be easy prey for foxes. Would she be a survivor?

In comparison, “Cuthbert” was a survivor. We’d been tracking this male brush-tailed possum periodically for three months now and were accumulating a lot of data on his movements and habits.



▼ Radio tracking possums during burning operations. T. Leftwich



Cuthbert leads a reasonably comfortable life high up in the hollow of an old marri tree. Unlike Sheryl, he has established and appears to defend a limited home range featuring only one home tree. Perhaps Cuthbert is just getting old, or maybe he doesn't need to roam far for food. His home range is surprisingly small. The marri he inhabits is in an area in the Perup forest that has been recently burnt by wild fire. The trees have been regenerating after the burn, providing delicious epicormic leaves and shoots near the nesting holes of possums. Because he does not spend so much time on the ground Cuthbert is less vulnerable to predation. But what would have happened to him had his home tree been destroyed by the fire? Would he have been destroyed also?

## WHY STUDY POSSUMS?

The brush-tailed possum (*Trichosurus vulpecula*) has an amazing ability to adapt to, and colonize, new surroundings. In the eastern states of Australia damage to new shoots in pine plantations has caused alarm, and in New Zealand, the introduced possum has spread at an alarming rate causing damage to the local vegetation and affecting associated industry (for example, apiary). Most research into the possum has been stimulated from the fact that in these areas, it is a pest.

In Western Australia these marsupials are no nuisance, but we need to know how forest-dependent animals and birds are affected by forestry operations and related activities, such as logging, clearfelling, prescribed burning and mining. Gradually, the Forests Department Manjimup Research station is

Forests Department researchers use techniques such as spotlights at night to record the number of possums and observe their behaviour. N. Burrows

accumulating facts about species of forest fauna. Possum research aims at investigating the effects that logging and prescribed burning in particular have on our most common arboreal mammal. Research techniques include radio telemetry, spotlight surveys, analysis of faecal remains, trapping and observation, and field searching. Little is known about the ringtail possum (*Pseudocheirus peregrinus*), the other species of possum once common in Western Australia. Although researchers occasionally encounter them, studies are difficult to conduct on this species, as they rarely appear.



## IN THE ROOFTOPS

Historically, the brush-tailed possum has been one of the most familiar marsupials to Australians, many of whom would have experienced possums residing in their roofs, or stealing fruit from their orchards. During the last century possums provided a ready source of food for the early settlers, as well as a source of income. Brush-tailed possums were prized for their fur, pelts being worth 2s. 6d (25 cents) a dozen at the turn of the century. Possum skins were sold on the world market as "Australian opossum", and sales were exceeded only by the pelts of one other animal, the North American muskrat. The fur trade continued into the years of the



Caught by the spotlight, this possum shows how scratch tracks are made when climbing trees. N. Burrows



▲ This is a well used possum tree with a pronounced scratch track up its trunk. *G. Inions*

▼ A typical possum tree in the area has a broken top that has formed a hollow in which the possums can live. *G. Inions*



Great Depression when the price of a dozen possum pelts had risen to 15 shillings (\$1.50).

With European settlement and the opening up of forested areas for agriculture, the distribution of the possum in Western Australia gradually declined until the present day when numbers, not precisely known, are believed to be reduced to areas of dry sclerophyll forest with main populations south of Collie. The rapid reduction in possum numbers just after the Great Depression, combined with current data on predation of possums, leads us to believe that the introduction of the European red fox (*Vulpes vulpes*) to Western Australia in the 1930s has been a major threat to possum species.

## POSSUM TREES

Possums depend on trees for shelter and food. In the Perup Management Priority Area (M.P.A.), two areas of 36 hectares and 21 hectares respectively, each inhabited by possums, were chosen by researchers to observe the effects of logging on "possum trees", and to investigate the effects of high intensity autumn fire on the trees and on the possums themselves. The first step was to conduct a survey to record the number and type of possum tree in each area. This was done on a grid pattern followed by actually tracking individuals to their home trees. A tree was classified as a possum tree if it possessed a visible scratch track up the trunk showing habitual use by possums, leading to a hole which appeared inhabitable. We found that possums preferred trees with certain characteristics, but these were not associated with specific tree species. Possums showed no preference

for jarrah (*Eucalyptus marginata*) marri (*E. calophylla*) or flooded gum (*E. rudis*) when choosing nest trees. Rather the presence of a suitably sized hole seemed to be the critical factor. As trees form holes from broken branches or tops, we found most possum trees to be dead or decadent (that is, old and in declining condition), and no tree was smaller than 40cm in diameter.

## LOGGING

The effect of logging on the possum trees in the area was assessed by counting up the number of stumps left from logging operations of 12 years ago, and comparing this with the number of trees still standing that support a possum population. Some assumptions need further research. As possums inhabit decadent trees, which are of poor quality timber, then it would seem that logging would not have a great effect on possum populations in the short term. In the long-term view, logging perhaps affects the number of trees which can grow to maturity and develop the required habitat characteristics.

## BURNING

One area was burnt with a "hot" autumn prescribed burn, intended to improve the habitat for tammars and woylies (see *Forest Focus* 25), and the possum trees were relocated after the burn to assess the amount of damage (see figs. 8 & 9). We tracked individual possums before, during and after the burn. The fire had a marked effect on the possum population in the area both directly, and indirectly by destroying or damaging their nest trees. The trees which were most suitable for nesting were most severely affected by the burn.

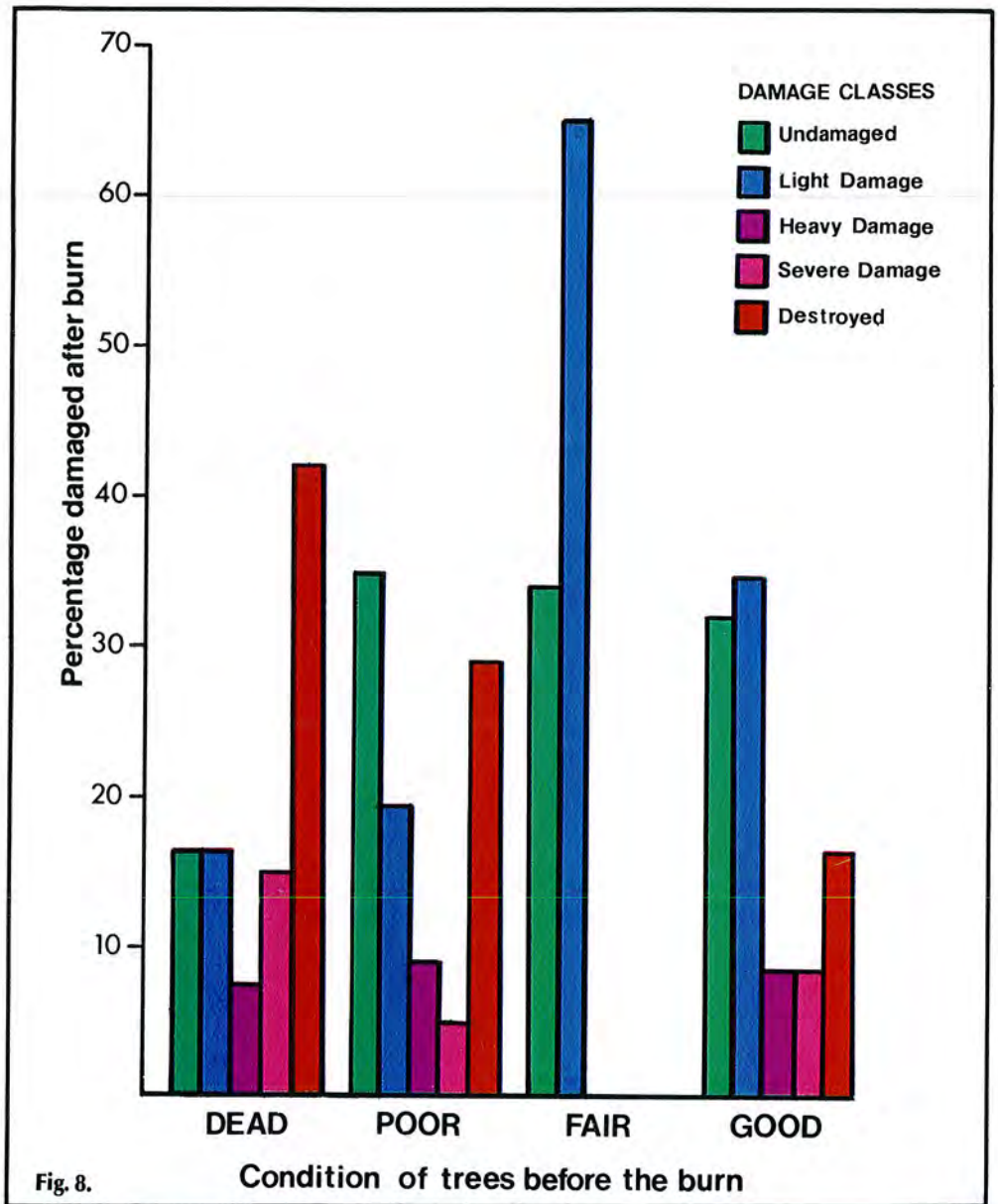
The behaviour of the tracked possums during the fire was observed closely. Their most common reaction to the burn was to remain inside the hole in the nest tree and sit the fire out. If the tree caught fire, then the possum would probably be destroyed. This was confirmed by one individual that was wearing a radio transmitter. Other possums that survived the flames died later from injuries during the burn, and some individuals survived.

Fire is a natural part of the environment in which possums live, and they have adapted to cope with such catastrophic events, so the area was soon re-colonizing with young possums from other areas. Epicormic growth on the trees stimulated from the fire was an attractive food source, attracting possums like Cuthbert to the burnt area. And although old trees were lost in the fire, burning created holes in trees that were not previously inhabitable. We can say that wild-fires do affect individual possums, but can't say that the species is adversely affected. Possums did survive in the burnt area and then together with others from neighbouring unburnt areas of forest re-colonized the area successfully in a short time. The rapidity with which such a burnt area is re-colonized depends to some extent on the size and proximity to each other of prescribed burn areas (see *Forest Focus* 25).

## RE-COLONIZATION

The brush-tailed possum has a remarkable ability to re-colonize areas that have been affected by burning, or to colonize new areas. This adaptability is largely related to its mating and territorial habits. After the young are born and

Immediately after the burn there is little green vegetation left. *T. Leftwich*





The same area only months after the burn provides food for re-colonizing possums. Note the abundance of epicormic growth from the trunks of the trees. *G. Inions*



A macabre silhouette - a brush-tailed ▲ possum hangs on to a branch as its habitat burns around it. *T. Leftwich*

MAP OF STUDY SITE (POST BURN) SHOWING RELATIONSHIP BETWEEN FIRE INTENSITY AND POSSUM TREE DAMAGE

LEGEND

- Possum tree, inhabitable after burn
- x Possum tree, uninhabitable
- Boundary road of burn area

- 1. COOL: 0 to 300 kwm-1
- 2. WARM: 300 to 500 kwm-1
- 3. HOT: 500 to 1000 kwm-1
- 4. VERY HOT: 100 to 1400 kwm-1

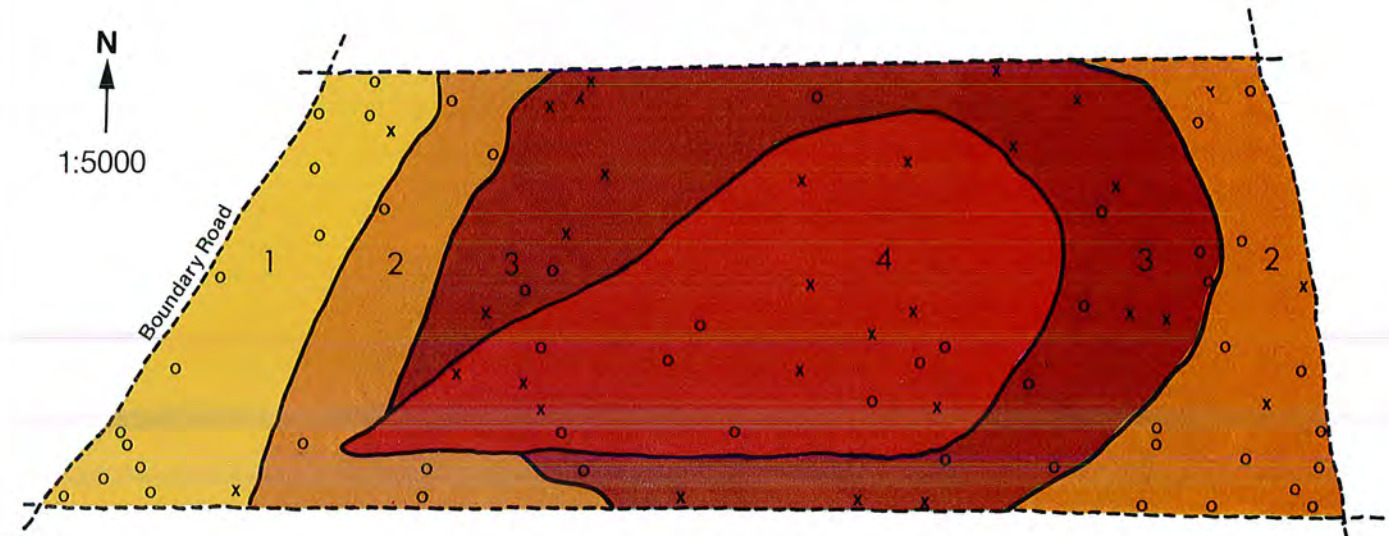
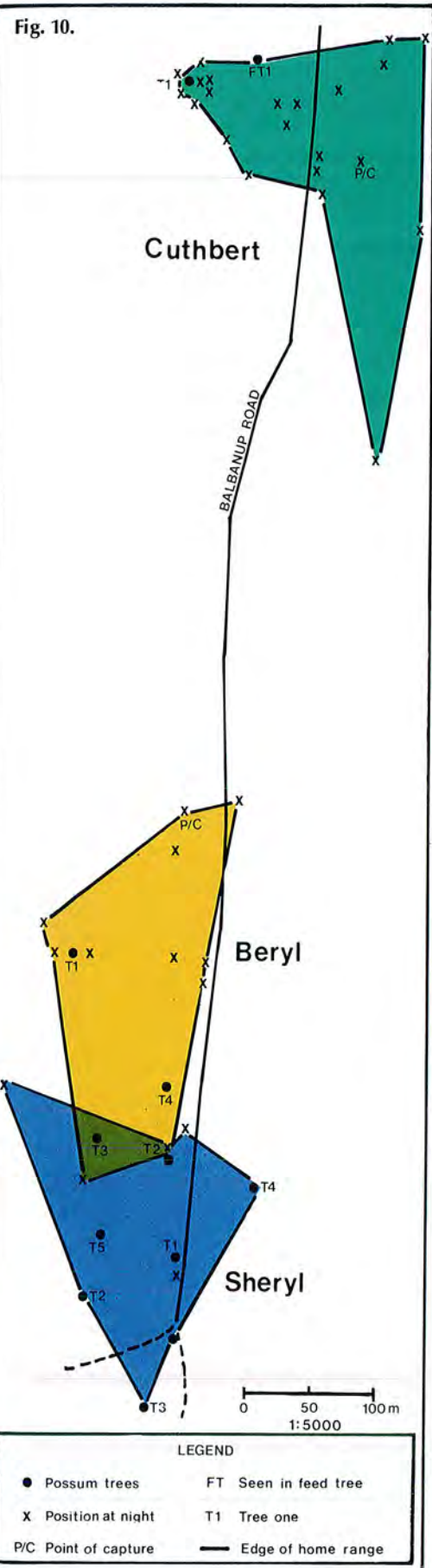


Fig. 9.



Fig. 10.

◀ Home ranges of Sheryl, Beryl and Cuthbert. Note the overlap between the females' territories and the broad distances between sightings. In comparison Cuthbert usually sticks to a more limited area.



weaned they move abroad, out of the home range of the parent possums. Young males in particular, are forced to find new territory, as they are likely to clash with older, established males. Females on the other hand, are not so territorial, as the study of Sheryl indicated. She shared part of her home range area with "Beryl", an older female who is more established than Sheryl (see fig. 10). Female possums appear to move freely through a male's range, but established males avoid each other as far as possible. Cuthbert's feeding behaviour has been observed to be strictly within the limits of his territory - for instance, he just never goes south of his home tree (T1) when searching for food. Also, we have observed male possums that appear to vie over the favours of a female, the female moving into the nest tree of the male that dominates.

Research has been continuing for over 12 months now and gradually we are piecing together information about these appealing creatures. There is much to find out and the work is slow, requiring many hours tracking and surveying, waiting and watching. Doubtless there are many more surprises in store. "Playing" possum may not involve too much play for us, but getting to know the brush-tailed possum makes rewarding work.



