Site Vegetation Mapping in the Northern Jarrah Forest (Darling Range) III. Relationship of Site-Vegetation Types to Land Utilization

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RECREATION

FACTORS RESPONSIBLE FOR INCREASED DEMAND FOR OUTDOOR RECREATION.

One of the outstanding features of the second half of twentieth century has been the explosion of recreational activity. The underlying causes of this have been well documented (Pasmore 1970, Douglass 1969, Brockman and Merriam 1973, Greig 1974). In the main they reflect changes in social condition of majority of the people such as greater affluence, shorter working time and hence greater leisure, longer time spent at school, overall higher level of education, and greater mobility due to improved travel facilities. To a large degree these arise out of industralization and urbanization, which however, have also some unfavourable side-effects, such as crowding, monotony of work and sense of dislocation from natural surroundings. In Western Australia, the level of urbanization has always been high in terms of proportion of total population living in the metropolitan area, but the adverse effects are only being realized now. The net result of all these pressures is a greatly increased demand for outdoor recreation, and forests are eminently suited to meet that demand (Bacon 1967, Balfour 1974). Although the general demand is obvious and would be difficult to ignore, it is somewhat less clear what type of recreational experience is required, where and by whom. It is even more difficult to determine how the demand can be best met without causing disastrous dislocation of other activities and values.

ASSESSMENT OF DEMAND.

A whole new methodology has developed for the assessment of demand for recreation, for both land and waterbased recreation. The methods employed include traffic counts by pneumatic traffic counters on developed camping sites (James 1966, Curtis 1970) self-regislation stations and interviews in wilderness areas (James and Schr der 1971) and aerial photography on large waterbodies (James et al 1971). There are three such studies available for the area under study. Jones (1972)

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studied the recreational use of the John Forrest National Park, situated on the north western periphery. It is an area of jarrah-marri-wandoo forest near the escarpment, traversed by an ephimeral stream, and containing some rock outcrops. Jones utilized interviews, questionnaires and records of entrance fees. He concluded that the main form of recreation in the park was day-time picnicking. Family groups were in majority, and half of these consisted of one single family. There was above average participation by people with tertiary education. The length of stay was chiefly one to four hours, occasionally up to eight hours.

Car was the main means of access. The majority of visitors arrived during midday and left by 4 p.m. During the visit, bulk of the people settled in the picnic ground, and apart from a leisurely drive through the reserve, did not see much of it.

Spriggins (1975) used interviews and questionnaires to investigate recreational use of State Forest in the Northern Jarrah Region within 56 kilometre radius from Perth, that is again in the northwest portion of the region. The vegetation of the area is predominantly jarrah forest, in some areas strongly decimated by dieback. There are also some smaller areas of exotic pine plantations, mainly established on resumed agricultural land and dieback-affected portions of the native forest. The peak of the recreational activity was between 1 p.m. and 3 p.m. The density of use varied, being low ($0.5/km^3$) in normal jarrah forest and $6.15/km^3$ around granitic outcrops. Dieback affected areas had an above-average rate of visits, but it is not known to what degree this was due to proximity of surfaced roads, with which the dieback is strongly associated. Majority of visitors (54 percent) stayed within 200 metres of a surface road. The intensity of use in and around pine plots was sixteen times that for the area as a whole. The visitors came mostly as family groups, consisting of one or two families. As in preceding study, the proportion

of visitors with tertiary education was higher than would be expected from general census figures. The same was also true of the proportion of migrants from United Kingdom. The chief difference compared with the Jones (loc. cit.) study was relative absence of teenagers and young adults, and of migrants from continental Europe.

Edgecombe (1973) studied recreational patterns over the Easter period on the Murray River near Dwellingup, in the mid-west of the region, by combination of road traffic counters, interviews and questionnaires. He found that the main attraction of the area, the picnic area on Scarp Pool, was under continuous heavy use which exceeded the carrying capacity of the site, a fact that was criticized by many visitors. The visitors to the area were chiefly family picnic groups. High level of camping activity occurred during the same period along the Murray River. The visitors to the Dwellingup area tended to leave the surfaced roads to a much higher degree than those in Kelmscott. There was a much higher level of Australian-born participants.

On the basis of Spriggins and Edgecombe's studies, the annual recreational use of State forests in the State Forests of the Northern Jarrah Region has been estimated at between quarter and half a million visits per year. If National Parks on the periphery of the region are included, the figure will be much higher.

TYPES OF RECREATIONAL ACTIVITIES IN THE FOREST.

The range of possible recreational activities in a forested area is very large. Canada Land Inventory (1969) lists forty-six, of which all but few directly dependent on snow and ice, are also relevant locally. The activities covered by other studies form very active ones with major impact, such as hunting Morris (1973) and trail-bike riding (Marshall 1974) to such ephemeral one as re-living an earlier recreational experience (Edwards 1973). They may be carried out purely for enjoyment, or may have a definite educational component (Curtis 1974).

Attempts have been made to simplify this very wide range by classification and typology (Hendee et al, 1971), in order to facilitate planning. In U.S.A. by far the highest preference (57 percent) was found in the appreciative-symbolic category, which includes such activities as sightseeing on foot, hiking, maintain climbing and photography. This was followed by extractive symbolic (fishing, hunting) at 21 percent and passive free-play (relaxing, sight-seeing from car, sunbathing) at 16.8 percent.

The lowest preference was for sociable learning (nature study and lectures, singing, visiting) and active expressive (swimming, motorcycle-riding, boat racing, playing games) at 2.6 and 2.5 percent respectively. Yet provision of education through recreation is considered to be an important function of organizations administering outdoor recreation by Curtis (1974). Locally, the comparable preferences recorded by Spriggins (1975) are picnicking (55 percent) driving for pleasure (27.9 percent) wood collection (11.4 percent), motorcycle-riding and rock collection (1.4 percent each) exercising dogs, playing games, long-distance running and tree climbing (less than 1 percent each). This would indicate a much lower level of active participation, but it has to be born in mind that the survey was biased towards car-based recreation. Hewett (1975) described a much wider range of activities, including participation in motor rallies, trail-bike riding, rough country driving, fishing canoeing, horse-riding, orienteering bushwalking and camping in the forests of the south-western Australia. Of these motorcycling, bushwalking and fishing had by far the greatest number of participants, yet combined they amounted only to one tenth of the number of participants in passive recreation.

The activities described in Canada Land Inventory (1969) which are undertaken locally but have not been reported by either Spriggins or Hewett include exploration, nature and history interpretation, primitive camping and hunting. It is

probable that participation in these is at a very low level.

SEASONALITY OF FOREST-BASED RECREATION

Due to the dependence of outdoor recreation on weather, it is a strongly seasonal activity. This may be either reflected in strongly peaked recreational demand, or in substitution of one type of activity for another (Canada Land Inventory 1969). The former was observed in the Northern Jarrah Region by Jones (1972), who found that day-time picnicking, which was the dominant form of recreation in the John Forrest National Park, occurred chiefly in late winter and early spring. After September, the demand for recreation fell-off sharply, due to higher temperatures and increasing numbers of bush flies. The same peaking of recreation was observed also by Spriggins (1975), whose survey coincided with peak demand period. In the area studied by Spriggins more active forms of water based recreation, which may have extended into summer, are excluded by water supply restrictions. This is not the case in the Murray Valley and all areas southwards from it. This no doubt accounts for the high recreational demand observed in autumn by Edgecombe (1973) and by Shea (1973) in summer. Whereas the activities reported by Edgecombe were still predominantly passive (sightseeing by car, picnicking) the fishing for fresh-water crayfish (Marron) reported by Shea can be a very active, demanding sport. There is yet another peak of activity in the Murray River valley, associated with white-water canoeing in winter and early spring. Trout fishing south of the Murray River rapidly builds up to a peak after the legal opening of the trout season in early September. Nevertheless, the peak demand for forest recreation in the region is spring when abundance of wildflowers, mild but envigorating weather and relative freedom from flies combine to make it a memorable experience.

RESOURCE BASIS FOR FOREST RECREATION

The suitability of a particular piece for land for recreation is determined by combination of physical, biological and social factors. Of these, the physical factors determine the broad setting and form the basis for the biological factors, which enhance or detract from the purely physical assets. The social factors, such as economic and social constraints, determine to what degree the physical and biological assets are utilized.

LOCATION

The most detailed study of the natural recreational resources the Canada Land Inventory (1969), ignores the social factors on the grounds that these are not an essential part of the site, and are, in any case, subject to rapid modification. Location and present access development are ignored and uniform demand and accessibility are assumed; nor is the rating influenced by present use and management.

This contrast rather sharply with the views of McMichael (1971) who stresses the need to have a proportion of national park close to centres of population. Marshall (1974) reports that in British Columbia most forest recreationist do not operate beyond 320 km from home base. Myers and Kerr (1974) put the case for tying recreation to major centres of population even more strongly, using the current energy crises and likely reduction in mobility as one of the supporting arguments. Richards (1974) and Jorgenson (1974) take the idea even further and advocate urban forestry.

In the local context, location and legal constraints cannot be ignored. Earlier studies (Havel 1975 a and b) demonstrated that the chief environmental variation in the Northern Jarrah Region is in east-west direction, so that within each administrative division a similar sequence of climate topography and vegetation can be found. The recreational potential, from physical and biological viewpoint is roughly the same for each division. By contrast, the socially induced variation is

primarily north-south in direction. The Kelmscott and Mundaring Divisions overlap with the Metropolitan region, and some of the outer suburbs are situated hard-up against the north western perimeter of the State Forest. By contrast the nearest portion of the Collie Division is 160 km by road from Perth, beyond the range of a comfortable day trip. Whereas very rigid constraint on active recreation are applied by the water supply authority for most of the Mundaring and Kelmscot Divisions the constraints are minimal in Harvey and Collie Divisions. There is therefore an anomaly in that the areas most accessible from physical and economic viewpoint are largely legally inaccessible.

CAPACITY TO PROVIDE RECREATION.

The Canada Land Inventory (1969) for recreation classifies land according to its natural capability to provide recreation. The definition of this capability is rather general. Class I is defined as land having natural capability to engender and sustain very high total annual use based on intensive activities. The definition for class 2 merely substitues "high" for "very high", and the scale descends through moderately high, moderate, moderately low and low to very low for class 7. There is no clear definition or instruction on how capability levels are to be assessed. Within each class there are numerous sub-classes, denoted by letters, specifying the type of activity for which the land is best suited. It is only by examining a completed regional assessment, that a true appreciation of the method can be obtained (Canada Land Inventory 1968). The region surveyed (Prince George Region) bears some topographic resemblance to the Northern Jarrah Region, in that it consists of a plateau of moderate attitude dissected by several rivers and overlapped by a few monadnocks. It takes spectacular topographic features. Climatically it is of course a virtual opposite. The bulk of the plateau is classified as class 6 OE, that is low potential attributable to vegetation and

wildlife viewing. Most of the rivers are classified as Class 5 OWO that is moderate capability for canoe tripping and viewing dryland and wetland wildlife. Limited portion of the rivers is placed in class 4. Classification 3 ANY is reserved for some lakes with capacity for fishing, family recreation and boating. The higher classification is very restricted, and amounts to only 1 or 2 percent of the total. It takes the following forms:

2 SVO - a minor montain with potential skiing and view of upland, wildlife, enhanced by superior view.

2 VLCK - a river stretch with outstanding canoing and organized camping capability enhanced by superior views and interesting land forms.

2 ABNY - lake foreshore with outstanding capability for fishing, family bathing, boating and other activities.

The areas given class 1 for Canada as a whole include a pass in Yukon with rich historical associations, a particularly suitable ski-slope in Jasper National Park, a scenic shoreline with historic association on the eastern coast, a beautiful, accessible lake in British Columbia. Although both Litton (1968) in U.S.A. and Gentilli (1969) in Australia fully explore the description and evaluation of landscapes, they do not attempt classification or ranking on either aesthetic or utilitarian grounds. Quantification of value of wilderness areas has been also attempted by McKenny (1974), but his essay does not provide a sufficiently clear cut basis for localized application.

The study of Victorian Alps by Hogg (1973) is much more specific. It is based on both existing and potential recreational activities. Attention is given to integration of these activities, and to tying them in with other forms of land use. However present land tenure is not considered as irreconcilable restriction. The basic planning unit used is a block, defined as groups of continuous areas with similar

recreational potential. The capability classification is based on user suitability as determined by natural and man-made factors, and on carrying capacity. The natural factors considered include topography, geology, climate, vegetation, size, proximity to users, scenery, availability of water, wood, game and fish, presence of wildlife and freedom from undesirable factors such as mosquitos, flies and snakes. The cultural factors include access, roading, accommodation improvements such as boat ramps, safety features and freedom from conflicting land uses. Unsuitability is calculated by rating individual factors on a scale of 1 to 10, weighing them according to their importance and calculating the aggregate score.

Apart from the broad general studies just discussed, there are numerous studies on the methodology of delineating areas of significance to recreation. Linsay (1969) and OLSON et al (1969) are primarily concerned with the use of aerial photographs for this purpose. Lucas (1970) advocates the use of quantifiable criteria, such as lake size, shoreline materials, slope and tree species in classifying lakes with respect to their suitability for campground development.

The climatic aspects of site, such as coldness of lake water, recurs in Canadian literature on outdoor recreation (Canada Land Inventory 1969, Marshall 1974). Local limiting criteria would be of course quite different, e.g. predisposition to excessive insolation and high temperatures. The latter has been analysed for two types of vegetative cover by Schiller (1974); the study has been carried out in homoclimatic region, (Israel), it is relevant to local situation. Schiller found that a pine plantation provided better microclimatic conditions for outdoor recreation than open oak scrub in summer, but that in spring the situation was reversed.

So far, the chief accent in discussion has been on the capability of a site to provide enjoyment. There is, however, a reverse side of the coin, namely the capability to sustain

high intensity use without deterioration. This is given consideration by Canada Land Inventory (1969), Smith and Matthew (1972) and McMichael (1972). The latter pointed out that this problem cannot be confined to developed areas, but invariably spills over into surrounding natural areas, through overuse and misuse of walking tracks. Lime and Stankey (1971) consider the knowledge of the soil and vegetation aspects of this problem to be much better than that of fauna and water aspects. Virtually no study gives any clear-cut indication of relative vulnerability of sites. The factors limiting carrying capacity are considered to be soil erosion, exhaustion of resources such as firewood, fish or game animals, contamination of water supplies, physical and psychological overcrowding and interference with other forms of land use. Hogg (1973) distinguishes between temporary and cumulative factors, on basis of the time span required for recovery. He points out that some areas of high user suitability have very limited carrying capacity.

Wagar (1974) introduces a new dimension by pointing out that long before intensity of use reaches the level at which physical or biological deterioration of site takes place, a significant deterioration of recreational potential has already occurred through overcrowding and loss of solitude.

McMichael (1971) considers that this in fact can be considered as a control measure on unlimited growth of recreational demand. As the quality of recreational experience falls off with overcrowding, there is a tendency towards levelling off of demand.

LOCAL SITUATION

Despite the obvious limitations of both local and overseas knowledge, it will be necessary to attempt some classification or rating of the various landscape units and site-vegetation types with respect to recreational use. Consideration will be given both to the capability to provide recreational opportunity

and capacity to sustain intensive activity. As recreation, in particular sightseeing and hiking occur on macroscale, the discussion will be carried out at the level of geomorphic surfaces, amplified, where necessary, at thelevel of site-vegetation types.

1. LATERITIC UPLANDS (T,S,O,P,H.Z)

If judged by the stringent criteria of the Canada Land Inventory (1969), this unit has seemingly little to offer. It is topographically monotonous, with only mild underlations, no water bodies and no views. There is relatively little structural and floristic variation in the vegetation that would be noticed by a layment in course of even a moderately long walk. The grey and black colouring of the bark adds to the monotony. Wildlife is at low level, though what species are present (grey kangaroo, black-glove wallaby, emu) are large and can be seen fairly readily in day light. There is a continuous east-west variation in vegetation. The western extreme is attractive, in its virgin state, by virtue of tall, large trees and relatively unobstructed views, described by early explorers as cathedral-like. Very little of this type remains. The more extensive logged-over forest have lost part of the attractiveness by removal of some or all of the veterans. This is compensated to a degree by greater development of understorey trees (Banksia grandis), Persoonia longifolia and P. elliptica, Casuarina fraseriana) whose foliage provides diversity in texture and colour.

Unfortunately even this is at the expense of unobstructed views and access, which possibly accounts for the reluctance of many recreationist to leave the road margins. There are also extensive areas of dieback affected forest whose aesthetic value is seriously reduced by deaths. This is particularly so on lower slopes and upland depressions. The eastern extreme (types H, Z) generally remains open after logging, as the second storey is missing. Even prior to logging the forest is not impressive, due to shortness and poor shape of

boles. On the other hand, the shrub storey is floristically richer, and contains some species with spectacular flowers, e.g. Isopogon dubius, Melaleuca scabra and Beaufortis macrostemon.

The openess of the forest makes it suitable for horse riding, but supplementary feed for the horses would be necessary as the native vegetation is harsh and unpalatable. Riding tracks would need to descend into the valleys, as even at the height of winter there are no springs, streams or lakes.

2. GUNAPING SURFACE - TYPES J.F. ~~&~~

Gunaping surface - types J, F, to lesser extent A,B. topographically the Gunapin surface is monotonous in extreme, consisting of mildly sloping sand sheets. There is, however, considerable variation in vegetation, from the open woodland of Banksia species to the forest of jarrah. Floristically he unit is probably the richest in the region, and contains numerous attractive wildflowers, genera - Banksia, Nuytsia, Conospermum, Verticordia, Calythrix, Anigozanthus, Petrophile, Isopogon and Hibbertia. Due to openess of the vegetation, there are limited views despite flat topography. The unit would thus be suited for bush walking, horse riding and photography.

3. BERAKING SURFACE - TYPES A, Y.

Although topograhically monotonous, this unit has great variety in vegetation structure, ranging from treeless swampy flats to moderately tall, open wandoo forests. Floristically it is much poorer than the Goonaping surface, but the smooth light coloured bark of the dominant wandoo gives it attractive appearance. The openness of the forest in general and of the swampy flats in particular provide some limited views. The area is eminently suited for horse riding, as it carries some grasses and water is generally present in winter. In winter minor roads and tracks become bog y, and travel by vehicles is risky.

4. DISSECTED SLOPES - TYPES M, Y, Z, L, G.

This is an attractive unit with great variety in topography, ranging from remnants of the plateau surface, miniature escarpments (break-aways), ridges, moderately steep slopes and gullies, with occasional rock outcrops. This is matched by great variety of vegetation, from jarrah forest through tall wandoo and low Casuarina huegeliana to shrubberies, herbfields and base rock. There are occasional long distance views. As such it is free of the main drawback to hiking in the northern jarrah - the relative monotony, and long distances between change. The shrubberies are thorny and at times hard to penetrate. The rapid changes in topography make walking and horse riding difficult, but this is more than compensated for by the variety. The native fauna is moderately rich, and adds further variety, especially at dawn and dusk.

5. KNOCHINE SURFACE - TYPES M, Z

This is a subdued version of the dissected slopes from both topographical and ecological viewpoint. Although the terrain is easier, there is also less variety. This together with the more open nature of the vegetation favours horse riding rather than walking.

6. DARKIN SURFACE - TYPES M, L, R, C, Q.

Moderately steep nature of this unit provides occasional views across the valleys. The attractiveness is further enhanced by presence of medium-sized streams, which however, are often insufficiently large and permanent for trout and marron fishing. There is a moderately rapid change in structure of vegetation. This is particularly so where the alternate species to jarrah has a contrasting texture and colour of bark, such as wandoo in the north east and bullich in the south west. Moderately dense ot dense understorey makes walking somewhat somewhat difficult, and stream vegetation is particularly difficult to penetrate.

7. HELENA SURFACE - TYPE M, , R, G, C, Q.

From recreational viewpoint this surface is an extreme form of Darkin surface. The slopes are much steeper, and there is greater variety of vegetational types, with particularly high proportion of shrubberies and lichen-covered rock outcrops. There are generally excellent views, either across the major river valleys or over the coastal plain to the ocean. The attractiveness is locally and seasonally enhanced by waterfalls. The streams at the bottom of the valley, are generally of sufficient size for fishing and canoeing. The unit provides by far the widest range of recreational opportunities. Its main drawback for high intensity recreation is difficult vehicular access, lack of level surfaces for parking, and vulnerability to erosion. Hiking is arduous, and at times amounts to rock-climbing.

8. COOKE SURFACE - R, G, M

The unit resembles the Helena surface in recreational potential, but differs from it in two main aspects - the views are over the plateau instead of over valleys or coastal plain, and there are no major streams. In some cases, the potential for viewing is enhanced by fire-towers, from which it is possible to view all points of the compass. The absence of permanent streams reduces the range of recreational opportunities but wilderness illusion is stronger than in the case of Helena surface.

9. RANDALL SURFACE - TYPES B, E, J, H, P

The topographical and vegetational variety of this unit is only moderate. The almost universal occurrence of dieback further reduces its aesthetic appearance.

On this basis, it is possibly to group the geomorphological surfaces into the following main categories.

Class 1 provides wide range of recreational opportunities including outstanding views - Helena surface.

Class 2 somewhat narrower range of recreational opportunities but aesthetically still outstanding - Cooke surface,

Class 3 fair range of recreational opportunities, but lacking outstanding views - dissected slopes, Darkin surface.

Class 4 limited range of recreational opportunities, moderate variety in topography and vegetation - Mhockine, Beraking, Goonaping and Randall surfaces.

Class 5 very limited recreational opportunities, monotonous topography and vegetation - laterite uplands.

The superiority of the Helena and Cooke surfaces is somewhat reduced by poor accessibility and susceptibility to erosion. The poor rating of lateritic uplands is improved by ready accessibility and capacity to withstand heavy recreational use.

The localized classification given above is inflated in comparison with the more stringent classification of the Canada Land Inventory (1969). Only few isolated localities, such as Mt. Dale, Lesmurdie and Serpentine Falls and Long Island and Scarp Pools on Murray River, would reach Canadian class 2. The localized classification would need to be down-graded by two to three grades to obtain parity.

The heaviest recreational use tends to occur at the interface of two geomorphological surfaces, where one surface provides the recreational opportunities and the other provides motorized access and parking facilities. The Lesmurdie Falls at the interface of Helena surface and lateritic uplands, and Mt. Dale, at the interface of Cooke surface and lateritic uplands are ~~no~~ such examples.

Although outdoor recreation takes place chiefly in indigenous forests, exotic forests are also capable of providing recreational opportunity (Fernside 1972, Balfour 1974). Spriggins (1975) data would seem to indicate that in W.A. at least a proportion of recreationist actually prefers them. The blending of exotic plantations into the landscape has been

investigated by Orrom and Mitchell (1972) who consider it quite feasible.

MANAGEMENT OF RECREATIONAL AREAS

PLANNING

Planning for recreational use of forested lands is an essential first step in management if such problems as overuse and conflict with other forms of land use are to be avoided (Brockman and Merrom 1973).

Four prerequisites of planning have already been discussed, namely what demand for recreation there is, what form it takes, who participates in it, and what are the best sites on which it can be catered for. These make it possible to decide how demand can be best satisfied, without deterioration of the resource.

The most powerful planning and management tool appears to be zoning (Calder 1974, Marshall 1974). The delineation of zones in which varying types and intensities of recreational use are permitted or even encouraged. The zonation is generally based on evaluation of the likely conflicts with other forms of land use, as well as on the recreational capability of the land; and its capacity to withstand intensive use.

Zoning is essential to the next stage of planning, namely deciding what facilities are to be provided and where (Saunders 1972). As a basic principle, facilities for intensive use are only provided where the resulting increased usage is justified, where it can be sustained and where it will not create or accentuate conflicts (McMichael 1972), Marshall 1974).

Imposition of constraints on recreational use is the negative but necessary aspect of land use planning. Once it is decided that a particular type and intensity of recreation is undesirable in a given zone, provisions must be made for enforcing the decision. The options available include non-provision of new access, closure of existing roads and legal constraints, enforceable by prosecution and fines.

It is probable that despite all care taken in planning, some oversue and deterioration of site, will occur, and the final stage of planning will involve provisions for rehabilitation (Beardsley et al 1974).

In the Northern Jarrah Region, zoning of recreational activity is dominated by catchment protection. Virtually all forms of active recreation are excluded by the water supply authorities from catchments between Helena River in the north and South Dandalup River in the south.

Minor areas are excluded from recreational use in the vicinity of bauxite mining operations for safety reasons. At Jarrahdale, these overlap largely with catchment restrictions, but are additional to them at Dwellingup.

The third type of zone is to come into force shortly. All motorized activity is to be excluded from the central and near-eastern portion of the forest for three years as a quarantine measure designed to facilitate the mapping of existing Phytophthora cinnamomi infections. North of the Murray River, this overlaps almost entirely with the catchment zone, though it usually does not cover the westernmost portions of the catchments. South of the Murray River the quarantine zoning will affect areas as yet unaffected by other forms of zoning. The quarantine zoning does not preclude access to developed recreational facilities along designated all-weather roads, nor does it prohibit access into the quarantine area on foot.

The combined effect of this zoning is that the central portion of the State Forest, west of the dams and east of catchment boundary is largely out of bounds to public, except for travel along all weather roads. For this reason the main development of recreational facilities has taken place in the western zone, largely though not entirely outside the catchments. Fortuitously this zone has also many positive attributes, such as better views and proximity to centres of population. The chief negative attribute is higher degree of disturbance in form of mining, dieback, logging and road construction.

The easternmost zone outside the catchments and the dieback quarantine area, is as yet virtually unutilized, except for one or two roadside picnic spots on the main highways.

PROVISION OF RECREATIONAL FACILITIES

The usual facilities specifically provided for recreation by the Forests Department include barbecues, rustic tables and benches, gravelled parking areas and signposted walks with labelled trees and wild flowers, (Spriggins 1971). Other facilities are provided as spin-off benefit from normal forestry operations, e.g. roads, access tracks to river valleys and fire look-out towers. The localities in which the facilities are provided fall into the following categories.

a. Topographically prominent points, from which good views are obtainable, usually monadnock or upper slopes of dissected valleys - South and North Ledge, overlooking Helena Dam and valley, Mt. Dale, Mt. Cook, Mt. Gungin.
b. Outstanding rock outcrops - Boulder Rock, Sullivan Rock.
c. Former forestry settlement, with exotic trees and large playgrounds - Carinyah, Lesley, Gleneagle.
d. Smaller roadside picnic spots, usually without any outstanding features - Pimelea, Mycumbene, Grevillea, Mycumbene, Gungin Gully, The Dell, Christmas Tree Well.

Information on recreational opportunities is provided to the public.

All of these are within 65 km radius from Perth, within the Northern Jarrah Region, where recreational facilities are also provided within the region by other government instrumentalities. Metropolitan Water Board and Public Works Department provide picnic facilities below most of their dams, e.g. Mundaring Weir, Churchman Brook Dam, Canning Dam, Serpentine Dam and Serpentine Pipehead Dam. In addition to picnicking facilities, Mundaring Weir has also a historical museum, and Serpentine Dam has tea rooms. National Park Board provides facilities at several scenically outstanding spots, such as the Walyunga Lookout

overlooking the Avon Gorge, John Forrest National Park, Gooseberry Hill National Park, Geeseberry Hill National Park, Lesmurdie Falls, Araleun and Serpentine Falls. Some outstanding recreational facilities are provided by non-governmental bodies. Lake Leschenaultia, a disused water supply dam, is maintained by the Shire of Mundaring, which provides swimming as well as picnicking facilities. Lanford Park established by Alcoa company in a revegetated bauxite mine provides adventure playground in addition to gas barbecues and tables.

Outside the 65 km radius, picnicking facilities continue to be provided by both the Forests Department and water supply authorities and shires, but on a more dispersed pattern and smaller scale. The tendency in such a case is to concentrate on more outstanding features.

In areas not subject to catchment restriction, unofficial camping areas have developed in suitable localities, such as on Nanga Brook in the Murray Valley, and in Collie Valley. These are chiefly used by canoeists and fishermen. Proper camp facilities are provided on Waroona Dam. Caravan Parks within the region only occur at distance greater than 100 km from Perth, e.g. at Logie Brook Dam and Collie.

Along the western perimeter of the region, there are numerous holiday camps established by various voluntary bodies, such as Boy Scouts, church groups and youth organisations. Although many of these do not occur within the forest, forest provides the essential background and opportunity for outdoor recreation. The Wellington Mills forestry settlement has been converted into a recreational camp administered by the Recreation Council. Proximity to the metropolis has probably been the main obstacle to development of residential facilities for families. Restrictions imposed within catchment areas and State Forest has also largely presented development of holiday cottages, though many of the smaller farms on the western perimeter should be viewed as hobby farms, rather than productive units.

An outstanding recreational provision within the region

is the Bibbulmun Track (Gobby 1974). It traverses the entire region from Kalamunda in the north to Wellington Mills in the south. Considerable difficulties have been experienced in delineating the track in a way that would provide access to the best scenery without conflicting with catchment and quarantine regulations. For most of its length, the track follows seldom used minor forestry roads, and is provided with rustic wooden signposts. At several points shorter circuit routes are provided for short-term bushwalking of half to one day duration.

Earlier, voluntary bodies stocked some of the accessible streams in the western zone with brown and rainbow trout. As the latter does not breed, periodic restocking became necessary. This responsibility has been taken over by the Department of Fisheries and Wildlife, which controls and finances inland fishing by means of annually-renewable licences. This is virtually the only intentional provision for water based recreation in the region. However the release of water from the Wellington Dam to irrigation channels is a valuable addition to canoeing opportunities on the Collie River.

IMPACT OF RECREATION ON OTHER FORMS OF LAND USE

MINING

Recreation cannot have a direct impact on mining as such, however, recreationist are generally active in seeking constraint on mining activities. In Northern Jarrah Region, the potential conflict has been lessened by two facts:

a) the areas being mined are not aesthetically very attractive, nor do they provide a wide range of recreational opportunities

b) the oldest area mined for bauxite has been converted by reforestation and provision of picnicking, children's playground facilities into quite a popular intensive-recreation park.

COMMUNICATIONS

Some forms of recreation, such as shooting and horse-riding, are a minor source of risk for car travellers, particularly on high speed highways. Wilderness enthusiasts are one of the main sources of opposition to road and powerline construction, and at times succeed in enforcing costly detours.

AGRICULTURE

The direct effect of recreation on agriculture is chiefly dependent on how disciplined and responsible recreating public is. What conflict there is arises out of irresponsible or even illegal behaviour by some recreationist, such as indiscriminate shooting resulting in wounding or killing of stock, damage to fences and other farm structures, failure to close gates so that livestock is lost, careless use of fire and stealing of farm produce, especially fruit. Virtually all of these have occurred in the Northern Jarrah Region at some time.

On the positive side, recreation can improve financial viability of marginal farms in and for the forest. The means whereby this is achieved include provision of holiday accommodation, sale of hunting, fishing and camping rights, and hiring or agisting of horses. This aspect is as yet very poorly developed in Western Australia.

PRODUCTION FORESTRY

Although direct damage through vandalism and other undesirable forms of behaviour does occur (Clark 1971), the main danger posed by recreation to production forestry is through increase in risk. In the local context, the chief risk is accidental lighting of wildfires and dispersal of Phytophthora infected soil by vehicles used in recreational pursuits. Yet another source of risk is unauthorized use of narrow logging tracks, which may result in serious collisions (Marshall 1974).

Objections to intensive forestry by recreationists have caused withdrawal of forest land from production (Montgomery

and Walker 1973) especially in areas visible from roads and vantage points (Amidon and Elsner (1968), Elsner 1971) or alternatively modification of logging operations and of methods of regeneration. Financial loss is generally involved in these adjustments, and revenue that can be derived from recreation is relatively minor (Grayson et al 1973). The degree of conflict appears to reflect the maturity of people and degree of rapport between foresters and the people - careful utilization of timber is practised in Vienna woods, within walking distance of the city, without any public outcry.

WATER SUPPLIES

The chief objection to recreational use of catchments and reservoirs is the danger of biological pollution, and to a lesser degree chemical pollution. The published evidence varies considerably in its conclusions, but the variation in attitude of water supply authorities to recreation varies even more. Hillman (1969), dealing specifically with the Darling Range as source of water for the Perth Metropolitan area viewed recreation in catchments as danger to water quality, and a risk with respect to spread of water borne diseases and organic, physical and chemical pollution. For this reason he considered recreational use of terminal reservoirs and adjacent land as inimical to the basic function of supplying safe and portable water supply. He did not contemplate any relaxation of restrictions on the grounds that full treatment which would be required cannot be provided locally at rates adequate for peak consumption. This statement still essentially remains official policy on the matter. Downs (1972) views recreation in particular use of motorised recreation vehicles, as a growing threat to water quality in Victoria. The situation in Victoria closely parallels that in Western Australia. Recreation is provided for and controlled on country reservoirs primarily used for irrigation (Lewis and Bird 1972) but is excluded from reservoirs and catchments (State Rivers and Supply Commission 1971) used for metropolitan water supply (Fryer 1972).

Institute of Water Engineers (1972) restates its earlier view that the prime duty of water undertakers is to provide an adequate quantity of safe and suitable water, and that provision of recreational facilities on reservoirs can only be permitted where it is compatible with that priority. However it does not automatically exclude recreational use from catchments or even reservoirs, though it suggests that where water bodies are available which are not used for water supply, these should be developed for recreation in preference to those that are.

Though it recognises that provision of public access to reservoir must inevitably result in increased risk of pollution, the degree of that risk varies according to the particular set of conditions, and may or may not be of practical significance. The factors of greatest relevance are the nature of recreational activity, the use to which the reservoir is put, its size, the original quality of the water, the treatment given to it before delivery to the consumers. The maximum risk occurs on terminal (direct-supply) reservoirs, especially if they are of limited size and contain water of such quality as to interfere with its subsequent sterilization. The chief sources of risk are human faeces and sewage, and fuels and oils from motor boats and parking areas.

The Institution of Water Engineers (loc. cit.) views the various potential forms of recreation on direct supply reservoirs in England as follows:

a) Game fishing e.g. trout, permitted on more than ¼ of the reservoirs.
b) Coarse fishing, e.g. carp; generally resisted because of baits and techniques used.
c) Sailing - permitted on many reservoirs, but subject to legally enforceable covenants with sailing clubs,
d) Rowing - less common than sailing, subject to same conditions
e) Canoeing - rarely used as rivers and canals are more attractive, restrictions as for c) and d).

f) Water skiing - problematic, conflicts with other sports, source of bank erosion.

g) Power-boating and cruising - unacceptable due to high risk of chemical contamination.

h) Skindiving - possible if arranged legally with responsible clubs.

i) Swimming - reservoirs rarely suitable for this activity, should not be permitted.

j) Conducted public visits to waterworks - to be encouraged.

k) Picnicking - desirable to provide for controlled, and to avoid random activity.

l) Car parks - provision necessary.

m) Access to water edge - no significant danger of pollution, but should be controlled to minimise conflicts and dangers.

n) Nature study - dispersed, unlikely to cause any pollution or conflicts

Its views on activities within catchments of direct-supply reservoirs are as follows.

o) Camping and caravanning - to be discouraged because of high danger of pollution; if allowed, must be tightly controlled.

p) Rambling (bushwalking) and nature trails - need to direct to recognized paths, otherwise harmless.

q) Orienteering - unlikely to be harmful

r) Shooting - unlikely to cause pollution if carcasses removed.

s) Pony-trekking - not harmful away from edge of reservoir,

t) Rock-climbing - not harmful.

On reservoirs which are not terminal, the danger to water quality is much less, and restrictions can be relaxed.

Similarly on rivers and lakes, properly regulated recreational activity is considered unlikely to cause a significant pollution.

The Institution of Water Engineers (loc. cit) concluded that unless recreation clearly conflicts with provision of safe and suitable water, the water supply authorities have the duty to provide for recreational use.

König and Nusch (1973) also recognised the need for outdoor recreation around reservoirs, and attempted to define conditions under which recreation and water supply may be compatible. They used the reservoirs supplying the Ruhr district of West Germany, in particular Lake Brigge, as an example. They concluded that the substances contributing most to eutrophication of reservoirs, nitrogen and phosphorus - come from different sources. Nitrogen originates primarily from agriculture; phosphorus from domestic sources. The building of the reservoir significantly increased the recreational use of the district in which it is situated. Tourist lodging capacity in the district rose to 225 percent of its preconstruction level, compared with 125 percent over the same seven year period in surrounding districts.

The activities permitted on the reservoir include bathing in specially constructed steady-level basins, yachting based on several yacht harbours, sightseeing on motor specially designed and controlled to avoid pollution, and fishing.

This level of activity is considered to impose considerable stress on the self-purification capacity of the reservoir, particularly with respect to biological-oxygen-demand budget and eutrophication. It needs to be also stressed that all water in the Ruhr basin is drawn from the river, and therefore requires full treatment. Koenig and Nusch consider that where recreation in and around reservoirs is inevitable, it is preferable to provide for it and control it. In such a case it is desirable to stress to the public that this causes additional expenditure and results ultimately in higher price of water.

Effect of watershed use on water quality has been examined in detail by Lee et al (1970). Working in the forested areas of Washington State, they examined three catchments subject to varying level of human activity, ranging from high level of

protection to unrestricted recreational use. They concluded that bacterial indicator populations were not correlated with the level of catchment use by humans, and that the human effect was probably swamped by the effect of much larger wild animal populations. Enteric pathogens were recovered even from remote sampling station, where human use was at very low level. Turbidity and chemical quality of water was likewise similar for all three catchments.

The evidence available therefore does not give great support to the idea that recreation on catchments is a major threat. There are however two important specifications - firstly that the water from reservoirs used for recreation be given the full treatment, and that finance be available for the treatment. The full implication of this is described for the Ruhr by Imhoff (1974). It thus becomes a question of economic relativities, rather than scientific absolutes. The regions where recreation on reservoirs is tolerated or even provided for are those with heavy population densities; such as England and North western Germany. Their single purpose use cannot be justified, and no alternatives are available. In any case, recreation is only one of the many potential sources of pollution in such areas. It therefore becomes a question of whether or not some of the outer-suburban catchments and reservoirs in Western Australia fit into this category.

FAUNA CONSERVATION

The impact of recreation on fauna is both purposeful or accidental. To the former category belong hunting and fishing, where fauna is the object and the centre of the activity, categorized by Hendee et al (1971) as extractive symbolic behaviour. In its worst form of indiscriminate hunting it may lead to direct extermination of the species hunted. This is particularly characteristic of developing countries. In its best form, such as is characteristic of some present day central

European countries, it becomes a virtual insurance that the species will be perpetuated. This is achieved by strict limitation on the number and type of animal that can be taken, geared to ensure the population remains at or near the maximum carrying capacity of the site, and that only surplus individuals are removed. The feasibility of this in Eastern Australia has been considered by Morris (1973). It is fostered by supplementary feeding at times of stress, and even by artificial raising of young.

The accidental impact of recreation on fauna takes the form of destruction of habitat and disturbance of normal behaviour patterns, in particular breeding. It occurs chiefly in areas subject to heavy recreational use, but can also occur where a selective activity is centred on the animal itself. Classical examples of the latter is bird-watching.

Locally, hunting of indigenous mammals is prohibited in the whole of the study area Shooting of waterfowl is regulated by the Department of Fisheries and Wildlife, as is limited by lack of large natural waterbodies within the region. Except along the escarpment and adjacent valleys, the recreational use of the area is not sufficiently heavy to cause disruption of behavioural patterns. The overall impact on fauna thus appears to be relatively minor. However, the impact may have been much more serious in the past.

FLORA

The impact of recreation on flora is particularly well documented. McMichael (1972) considered that a basic step in management of national parks is the assessment of their capacity to absorb use by man. Bayfield (1970, 1973 described the trampling of vegetation in the highlands of Scotland and developed a set of guidelines to minimize the damage. Burden and Randerson (1972) attempted to relate the recreational pressure to its effect on vegetation and soils. Boden and Ovington (1973) observed localized damage to vegetation around picnic

tables provided in the Australian Capital Territory and stressed the need to identify peak use, which is most damaging. Beardsley and Wagar (1971) examined several alternatives in minimizing and repairing damage to vegetation by recreational use. Their recommendations include the correct initial planning of tracks and fostering of vegetation on key areas by fertilization and watering. Hendee (1970) stresses that natural areas are not primarily intended for recreation, which should only be tolerated if it does not interfere with preservation of natural resources and scientific and educational objectives.

In the study area, direct damage to vegetation by heavy recreational use is restricted to parks and picnic spots in the north western sector, and to river valleys. It is particularly marked around the periphery of the parking area at Araleum (type Q), in the Canning River valley. Vegetation of the thin soils on the periphery of granitic outcrops (type R) also appears very vulnerable. By contrast the damage to the more robust vegetation of the lateritic uplands (types S, T, O, P) is relatively minor. Although the vegetation of the stream-banks (type C) is frequently damaged along fishing trails, it has a strong capacity to recover.

By far the most serious potential impact is that from motorized cross country recreational travel by four-wheel drive vehicles and trail bikes (Hewett 1975). Although damage to vegetation by this type of recreation is best documented from the coastal dunes, the vegetation of the Northern Jarrah Region is also vulnerable. The capacity to distribute soil infected by Phytophthora cinnamomi and initiate dieback disorder is, however, far more serious aspect of this activity than direct damage, in terms of both extent and permanency.

CONFLICTS WITHIN RECREATION

Somomon and Hansen (1972) and Prausa (1971) emphasizes that in densely populated regions the new and growing forms of land use conflict - that between two incompatible forms of recreation and competition for space between people seeking solitude. By contrast Smith and Matthews (1972) conclude on the basis of research carried out into forest recreation in British Columbia that most people are less sensitive to surroundings, and less aware of site deterioration, than is normally assumed. They anticipate that the relatively large area per person in the region studied is a contributing factor.