

## The Identification, Conservation and Management of Wild Rivers in the Kimberley Region of Western Australia

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**ABSTRACT:** A project identifying Australia's wild rivers is presently being undertaken. A specially developed G.I.S. has identified possible candidates and been proven to give a reasonably accurate indication. A pilot field study and verification exercise was undertaken in the Kimberley Region where excessive grazing pressure is the major cause of riverine degradation. All 65 of the Region's rivers were inspected, compared and assigned to one of five categories ranging from wild to degraded. Seventeen were found to still be in a wild condition and conclusions reached as to how their values might be conserved.

### 1. INTRODUCTION

The Australian Heritage Commission (AHC), on behalf of the Commonwealth Government, is undertaking what is known as the Wild Rivers Project. Its aims are to identify all wild rivers throughout Australia, to work with the States and Territories to develop guidelines for their management, and to make the whole community aware of their existence and special values.

Wild rivers are defined by the AHC as rivers which are relatively undisturbed by the impacts of modern technological society. Wild rivers remain undammed and exist within catchments where biological and hydrological processes continue without major interference. They occur within a variety of landscapes and may be permanent, seasonal, or dry water courses which flow only occasionally. The first phase of identification at the national level is being undertaken through a Geographic Information System (GIS) analysis being conducted for the Commission by the Centre for Resource and Environmental Studies (CRES) at the Australian National University (ANU).

At the same time, Western Australia has embarked upon a process of allocating all of the State's water resources, both divertible and in-situ, to all of the various consumptive and non-consumptive uses that society requires of them. The riparian zone is the most extensively degraded natural resource zone in Australia (CEPA 1992). As a part of the process of allocation, Western Australia is seeking to identify rivers that are 'outstanding' from various possible viewpoints. These include rivers with special

cultural significance to both Aboriginal peoples and more recent settlers; rivers with unique topographical, geological or biological features; and the finest, best preserved examples of rivers across the full range of hydrologic, physiographic, vegetation association and other variables.

These shared interests provided an opportunity to establish a collaborative project between the AHC and the Water Authority of Western Australia (WAWA) to assess the rivers of the Kimberley Region, testing the preliminary results of the CRES study and providing direction for similar verification studies which may be required in other parts of Australia. A joint field study was undertaken in June 1995. Its aim was to confirm the primary cause of riverine degradation in the Region, and to identify rivers in wild, and a range of less well preserved conditions. In doing so it has provided the basis of a future State Government riverine resource allocation, to be augmented by studies of Aboriginal significance, recreational, scientific and educational use, as well as diversion potential. It has also helped formulate ideas regarding future conservation and management of both the 'wild' and the somewhat degraded rivers of the Region.

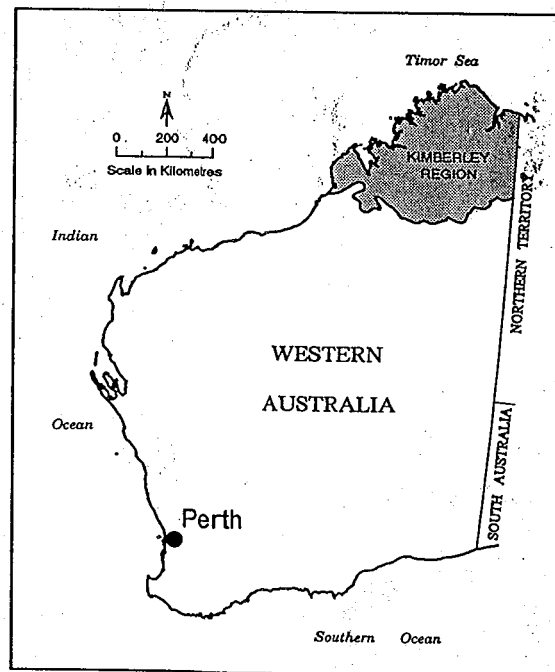


Fig. 1. Location Plan

## 2. THE KIMBERLEY REGION

The Kimberley Region is located in the extreme north of Western Australia, between latitudes 14° and 22° S (Fig. 1). It constitutes the portion of the AWRC's Timor Sea Drainage Division that comes within the State. It is 277 230 sq. km in area.

### 2.1 Climate

The Region experiences only two distinct seasons. The wet, tropical rainfall season extends over the summer months from April to October. Summer rainfall is monsoonal, resulting from cyclonic activity. Rainfall varies from over 1 400 mm per annum, received within a belt extending along the north-west coast from Admiralty Gulf down to the Prince Regent River, to less than 400 mm along the Region's southern boundary. Rainfall is relatively reliable in northern coastal areas, but not at all so in southern inland areas. Daily maximum temperatures vary little throughout the year. On the coast they range from about 30°C in July to about 33°C in January. Inland the corresponding figures are 27°C and 39°C respectively. Similarly, minima range from 12°C in July to 20°C in January at the coast, and from 9°C to 24°C inland.

### 2.2 Landform and Soils

While not mountainous, the highest point being the centrally located Mount Hann at 776 m AHD, the Kimberleys are rocky and rugged, with steep-sided ranges and gorges. The north-western portion, approximately half of the entire Region, consists of a broad and irregularly dissected plateau. This is flanked to the south and east by the rugged King Leopold and Durack Ranges. Beyond these lie the sand plains, dune fields and tidal flats of the Dampier Peninsula and the broad alluvial Fitzroy Valley to the south, while to the east lie the Ord Plains, the rugged Lamboo Hills and the Cambridge Gulf lowlands.

A wide range of soil types occur. However, over most of the Region there is mainly bare rock with small areas of shallow skeletal soils. Deep red or brown sandy soils occur on the sand plains and dune fields of the south and east. In addition, there are widely scattered areas of red and yellow earths, and the grey and brown cracking clays known as 'black soils', the latter being the backbone of the pastoral industry as well as holding the most potential for irrigated agriculture.

### 2.3 Vegetation

Most of the northern Kimberley is covered in an open forest or woodland formation, dominated by Eucalyptus or Acacia species (Beard, 1979). This becomes progressively more open as rainfall diminishes towards the south, where trees become

sparse and grasses become the most characteristic component. The Kimberley ground flora is dominated by grasses from a wide range of genera while shrubs are typically scarce. The World Conservation Strategy (IUCN, 1980) states that tropical grassland ecosystems, such as those of the Kimberley are under-represented in conservation reserve systems worldwide.

Two vegetation types of relatively limited extent deserve special mention. The first is the relatively numerous but small patches of rain forest, located mainly in heavy rainfall northern coastal areas, but with a few extending inland and as far south as Broome. The second is the mangrove communities forming extensive low closed forests on tidal flats at the mouths of most rivers. These are particularly diverse and rich in species composition.

### 2.4 Rivers

The Kimberley has a well defined and extensive network of surface water courses. Mean annual run-off to the ocean is an estimated 36 000 million cubic metres, 75% of that of the whole of State. Stream-flow is irregular; however, all major rivers do flow every year. Only a few rivers in the extreme north-west are perennial. Peak floods are very high by world standards and flooding can be severe. All rivers are fresh flowing. However, seawater penetrates up to 100 km inland in places as a result of low stream gradients, low dry season flows and very high tidal ranges. A total of 65 rivers and creeks (see Fig. 2) were identified for field inspection and assessment.

### 2.5 Population and Land Use

The Kimberley Region has a total population of 30 000 (DRDN/DPUD 1990) of which two-thirds live in 5 small urban centres: Broome; Derby; Fitzroy Crossing; Halls Creek; Wyndham and Kununurra. Approximately 45% of the population is of Aboriginal and Torres Strait Islander descent, compared with 3% for Western Australia as a whole. The main use of land in the Kimberley is for pastoral purposes. There are also a number of large national parks and nature reserves, a number of Aboriginal reserves and significant areas of Vacant Crown Land.

The very limited system of roads has ensured that most of the Region has remained remote and inaccessible. There are two main roads from west to east. The southerly paved Great Northern Highway passes through or close to the urban centres listed in the previous paragraph. The Gibb River Road to the north is unpaved, generally suitable for 4 wheel drive vehicles only, and is closed for a long period each wet season. A third road runs north from the Gibb

Road, providing access to a few pastoral stations and the Aboriginal settlement at Kalumburu.

### 3.0 METHOD OF ASSESSMENT

The Kimberley was first settled by pastoralists in the 1880s. With pastoralism the only form of land use over nearly all of the region, the most widespread cause of riverine degradation was thought likely to be vegetation damage and loss, and soil denudation resulting in sheet and gully erosion. A programme of inspection was planned based on this assumption.

A two-level aerial survey was undertaken. In the first instance, the rivers were inspected from a light aircraft flying at between 300 and 600 metres. Most rivers were flown from source to sea, covering all major tributaries. They were subsequently reflowed

and viewed from a helicopter, flying generally at between 30 and 60 metres. Landings were made at a number of locations in order to confirm the aerial impressions, and make a detailed on-the-ground inspection and analysis. The survey was made after the end of the wet season, when most of the rivers were still flowing, but at relatively low volumes. At or close to peak flows it would not have been possible to see much of the necessary detail.

There was not considered to be any point in taking water samples for analysis. None of the rivers would be conveying any quantity of any polluting substance. A detailed sediment load analysis would have been of benefit in many instances. However, such an analysis, to be of any value, needs an extremely lengthy, detailed and carefully planned programme for which neither sufficient time or money was available.

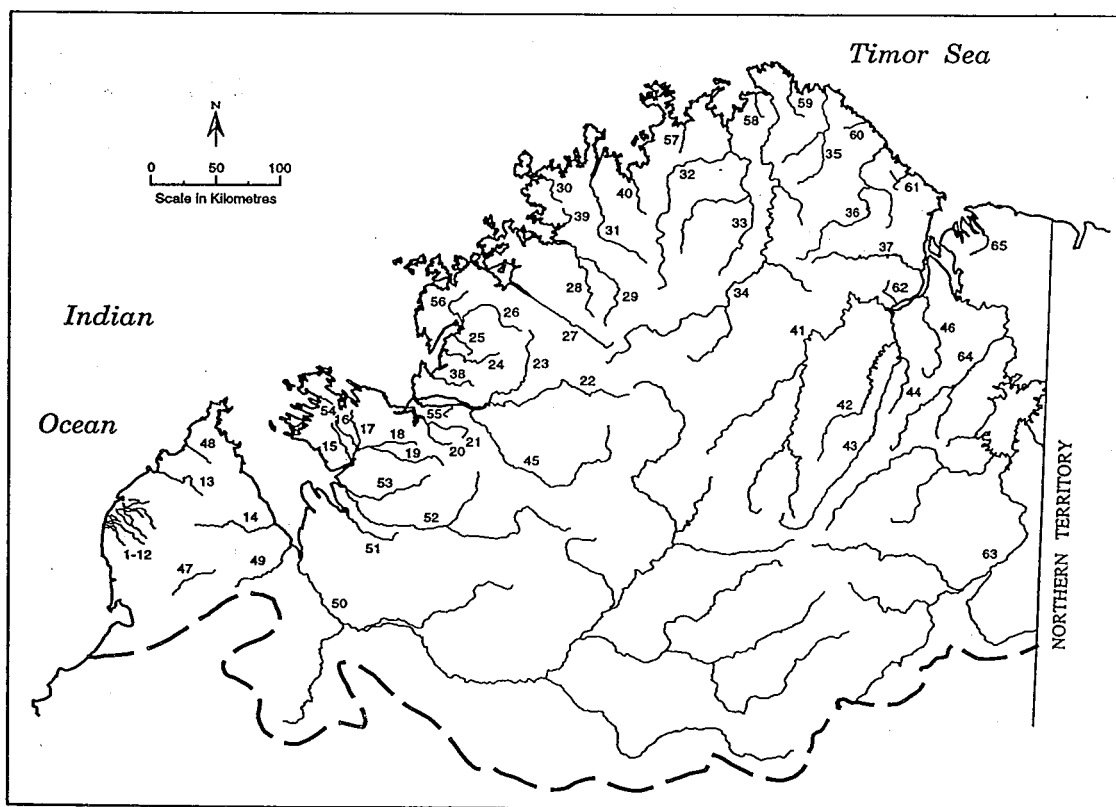


Fig. 2. Kimberley Region Rivers

### 4. CLASSIFICATION SYSTEM

The rivers inspected were assigned to one of the following categories:

- A1 Wild and undisturbed
- A2 Wild though modified
- B1 Relatively Natural
- B2 Altered
- C Degraded

Rivers assigned to category A1 (wild and undisturbed) have had no alterations to their water courses or to their catchments since European settlement. There has been no significant:

- clearing or other alteration to the landscape.
- road or track construction;
- increased fire frequency;
- introduction of foreign plants or animals;
- introduction of plant diseases;

Rivers assigned to Category A2 (wild though modified) have had no significant changes to their natural ecosystems, despite some past or present human activity within their catchments. However, there may be:

- some seldom-used minor foot and vehicle tracks;
- some increase in fire frequency;

- v. limited introduction of plant or animal species;
- minor evidence of grazing but no soil exposure.

Rivers in both Categories A1 and A2 fit the AHC project definition of 'wild'.

Rivers assigned to Category B1 (Relatively Natural) are still essentially dominated by native species throughout their catchments, and though they have been changed to some extent, it is considered that with the removal of grazing pressure, they would quickly return to a wild state. They may be experiencing:

- some, but not extensive problems of erosion and sediment deposition;
- relatively constant use of tracks;
- some loss of vegetation as a result of grazing;
- increased fire frequency;

Rivers assigned to Category B2 (Altered) have been significantly changed in one or a number of ways. They may have received:

- fairly heavy grazing;
- regular use of fire, degrading some plant communities;
- a moderate number and fairly heavily-used vehicular tracks;
- some unnatural bare patches, sheet erosion and gullyng;
- considerable sediment deposition in river floodways, but mainly on point bars.

Rivers in this category have been degraded to such an extent that it would not be possible or practical to return their catchments to a wild state. However, with appropriate rehabilitation measures and proper management, they could be made stable, healthy functioning ecosystems.

Rivers assigned to Category C (Degraded) have been very extensively and radically changed by post European settlement land use. They have been subject to all or most of the following:

- heavy grazing pressure, particularly on sedimentary plains and along water courses;
- frequent fires and related damage;
- many frequently-used stock and vehicle tracks;
- many bare patches, sheet and gully erosion;
- river channels and floodplains heavily silted and eroded;
- trampled river banks and fouled billabongs;
- widespread infestation of weed species;
- impoundments and regulation of river flows.

Though rivers in this category would be capable of being rehabilitated to a considerable extent, it is considered that they could never be returned to anything approaching their undisturbed state.

While there is a distinct theoretical difference between rivers in Category A1 and those in Category A2, there is not between A2 and B1. Also, there is a distinct theoretical difference between rivers in Category B1 and those in B2, but there is not between B2 and C. Rivers in Category A1 are unmodified and have not been changed in any way, as far as is known, since the time of European settlement. All the rivers in A2 and B1 have been changed, and from the best of those in A2 to the worst of those in B1 there is more or less a continuum. The dividing line between B1 and B2 is drawn on the basis that rivers in Category B1 would revert to a wild state, if the land uses causing change were to be removed. In contrast, in the case of rivers in Categories B2 and C, if the land uses causing alteration and degradation were to be removed, the river conditions would improve, but they would not be able to return to near their original undisturbed state. These rivers have been radically and permanently changed.

## 5. RESULTS

The pastoral potential, or rather the soil condition that gives rise to it, was found to be the determining factor in relation to the condition of rivers in the Kimberley Region. In general, the areas with high potential are the sedimentary river plains with deep productive soils. The bare rock and skeletal soils over most of the Plateau Region have little or no pastoral potential.

Continuous uncontrolled grazing by cattle and feral animals is the major cause of damage to, and decline of, the vegetation, and subsequently of the soil supporting it. Fire has also undoubtedly contributed to the decline, and continues to do so. High intensity rainfall, common throughout the Kimberley, the over use of land and susceptible soil, predispose large areas to soil erosion. Reports have shown that a large proportion (30%) of pastoral land has been subject to excessive grazing pressure and is in poor condition. It is generally the most productive valuable areas that are in the worst condition (Payne et al., 1972).

The rivers and creeks numbered 1 to 45 in Figure 2 were identified as possible or potential 'wild' rivers in the CRES study. All were given a detailed field inspection throughout their length. Most of the remainder (46 to 65) were flown over and inspected for a portion of their length, providing sufficient information, together with what was already known, to place them in their appropriate category. The rivers found in each of the 5 categories are listed below.

The creeks marked with an \* are representative of a number of other creeks in their vicinity. The two unallocated water courses, both located towards the

northern end of the Dampier Peninsula, remained so because no defined channel could be discerned from the air, except within tidal mud flats.

The rivers in Categories A2 and B1 in the table below are listed in their order of condition from best to worst. As stated in Section 4, there is more or less a continuum between the best of A2 (Jinunga River) and the worst of B1 (Chamberlain River). The line has been drawn where, for the moment, we believe the cut off should be made. However, at some time in the future, when the rivers over the remainder of the country have been examined in detail, and the line between wild though modified and relatively natural defined for other parameters or types of change, the rivers of the Kimberley will need to be looked at again, and the position of the dividing line perhaps redrawn.

<u>A1 Wild &amp; Undisturbed</u>	43 Chamberlain River
55 Mt Page Creek	<u>B2 Altered</u>
38 Doubtful River	47 Deep Creek
56 Mt King Creek	1-12 Complex N of Broome
27 Prince Regent River	14 Fraser River
39 Hunter River	49 Logue River
30 Scott Creek*	53 Alexander Creek
60 Cape Whiskey Ck*	16 Keightley River
<u>A2 Wild though Modified</u>	17 Townshend River
54 Jinunga River	18 Tarraji River
25 Gibson Creek	20 Swift Creek
26 Glenelg River	21 Humbert Creek
61 Thurburn Creek*	45 Isdell River
62 Bulla Nulla Ck*	31 Mitchell River
57 Wade Creek*	33 Carson River
59 Londonderry Ck*	34 Drysdale River
44 Pentecost River	41 Durack River
42 Salmond River	65 Emu Creek
<u>B1 Relatively Natural</u>	<u>C Degraded</u>
40 Lawley River	50 Fitzroy River
58 Placid Creek*	51 May River
36 Berkeley River	52 Meda/Lennard River
35 King George River	19 Robinson River
24 Sale River	46 King River
28 Roe River	63 Ord River
23 Calder River	64 Dunham River
37 Forest River	<u>Un allocated</u>
22 Charnley River	13 Beagle Creek
29 Moran River	48 Pender Creek
32 King Edward River	

## 6. COMPARISON WITH MODEL PREDICTIONS

Potential wild rivers in the Kimberley had been identified by CRES in their GIS analysis. A Wild River Index (WRI) was derived for each stream section. WRI is a dimensionless rating on a 0 - 1 scale, with 0 representing the undisturbed, or pristine end of the continuum. The index is made up of two

components, a Catchment Naturalness Index (CNI) and a Naturalness of Flow Regime Index (NFRI). These are computed by accumulating values calculated for individual stream sections from data relating to the location of settlements, infrastructure, extractive industries, cleared areas, dominant land use and alterations to the flow regime such as dams or diversions. This was obtained from the AHC's National Wilderness Inventory and supplemented from AUSLIG's GEODATA database.

The WRI for each streamline were mapped using 6 classes and plotted in different colours:

Class	Index Value	Colour
1	0	dark blue
2	0 - 0.025	light blue
3	0.025 - 0.05	green
4	0.05 - 0.15	brown
5	0.15 - 0.25	purple
6	> 0.25	red

It was necessary to interpret the plots and to allocate an anticipated potential or degree of wildness based on them. It was concluded that:

- rivers entirely dark blue were assumed to be A1;
- rivers mainly dark blue but with some reaches in light blue were assumed A2;
- rivers mainly dark and light blue but with significant areas in green and a few reaches extending into brown were assumed B1;
- rivers in the B2 and C categories were not differentiated in a definitive fashion, largely because there were not sufficient numbers of them covered. However, it follows that they will be indicated by reaches in browns and reds in increasing proportions of the whole.

When the comparison between the model predictions and the field assessments were made, it was seen that the CRES model gave a reasonably good indication of which rivers are in a 'wild' condition. In the 42 instances where comparison was possible, in 16 cases river condition was found to be the same as that predicted by the model, in 7 cases it was found to be better and in 19 cases worse. Of the seven instances in which the rivers were found to be in better condition than predicted, five were one grade and two were two grades better. Of those found to be worse, fourteen were found to be one grade, four two grades and one three grades worse.

## 7. IMPLICATIONS FOR RESOURCE ALLOCATION

Major potential development (dam) sites have been identified on all of the large rivers in the Kimberley, and in the case of the Fitzroy Rivers (50) on each of its major tributaries. Looking at the long-term future, the huge resources of the degraded Ord (63) and

Fitzroy Rivers are the most conveniently located to be in demand for export outside the Region, to the arid interior of the country, should such a scheme ever be economically feasible. Also, towards the downstream end of these two rivers, plus the degraded May (51) and Meda/Lennard Rivers (52), lies land with the greatest potential for irrigated agriculture. The Ord has already been, and the others could at some time be developed for such a purpose. It is difficult to envision any of the existing urban areas growing sufficiently in size to need a significant proportion of the Region's theoretically divertible water resource. However, it is worth noting that all of them are located within or adjacent to the Ord and Fitzroy River catchments.

All of the best preserved rivers, those in the A1, A2 and B1 categories, are located in the remote northern and north-western portions of the Region. It is difficult to imagine much demand for use in these areas, other than the development of small tributaries for any mining venture that might proceed. When it comes to allocating the in-situ resources of the Kimberley, it would appear that there are unlikely to be many conflicting demands. It should be possible to allocate the best preserved to the environment and ecosystem maintenance, and to Aboriginal significance and traditional use. Thus, in doing so, their wild nature will remain undisturbed and protected.

## 8. IMPLICATIONS FOR CONSERVATION AND MANAGEMENT

Pastoral activity, plus the grazing pressure from animals that have become feral over the last century, are by far the most significant causes of river degradation in the Kimberley. In the northern Kimberley the pastoral stations are large, all over 500 000 hectares. There are no boundary or internal fences. Consequently, the cattle are not prevented from straying into adjacent national parks, nature or, Aboriginal Reserves. Also, the cattle are not prevented from concentrating in the small portions of each station or other area that offer the greatest prospect for nourishment. Thus the small areas of river sediments supporting the palatable grasses and shrubs are the first and most heavily grazed, leading to denudation and erosion. Pastoralism in the area equates, more or less, to the periodic culling of what is in effect a feral cattle population.

The rivers found to be A1 all have catchments that are so isolated, rugged and rocky that they would not be at all attractive to cattle, and stock movement would be more or less impossible. The catchments are generally contained entirely within existing national parks, nature reserves and other areas of land afforded status and protection, but not in all cases. A number are within areas of Vacant Crown Land or have portions within parts of pastoral leases that are less susceptible to damage from over use by cattle.

The A2 catchments, generally, have increasing proportions within pastoral leases, though little or no areas with high pastoral potential and susceptibility to damage.

The management of wild river catchments in the Kimberley Region, and probably other regions across the country, will need to look specifically, at forms of degradation or damage associated with pastoral activity. There is no doubt that in catchments of rivers in Categories B1 (Relatively Natural) and B2 (Altered), degradation is progressing continuously, and perhaps accelerating. In particular, consideration should be given to implementing some form of control of grazing pressure on areas highly susceptible to damage, and also to determine the likely long-term effects of the deliberate and frequent (annual) use of fire.

The north-west Kimberley, comprising, say, the catchments of all rivers discharging to the coast from Walcott Inlet to the West Arm of Cambridge Gulf, constitutes one of the last great, remote isolated and virtually unscathed wilderness areas of the country, and perhaps of the earth as a whole. The area constitutes an eco-tourism resource of great potential value to the future of W.A.. Figures are not easy to arrive at, but the value of the area to tourism may well already exceed any income from pastoralism. The impact of grazing needs to be considered in relation to maintaining conservation values, in particular the wild river values.

The impact of tourism development also needs to be assessed in relation to the conservation of wild river values. The major natural tourist sights of the Kimberley happen to be located on less well (overall) preserved rivers. These include Mitchell River Falls, the King George River Falls, the Bungle Bungles Region of the Ord catchment and spectacular gorges along the Isdell, Charnley and Chamberlain Rivers. The values of these areas will best be maintained if access to view these sights and the beauty of the wild river catchments continues to be mainly from the air, by sea or on foot.

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