(6) The Australian Realm

Faunists and florists agree that the Australian continent as a whole is a distinct biogeographical entity, and it is ranked as a Region or Kingdom, respectively. Disagreement begins when we ask what else does belong to the Australian entity? The botanists consistently follow Engler in keeping the continent by itself. Zoologists, starting with Wallace, have annexed to Australia more or less of the surrounding island worlds. (See, for details, Udvardy 1969). It seems to be easiest to build up our position if we strip Australia step by step of the annexed areas.

Wallace built his system on Sclater's birds, and on the mammals, but these are absent from New Zealand. Modern zoogeographical study of ground-dwelling invertebrates provides evidence that parallels that of the botanist, viz. that New Zealand's basic fauna is not related to Australia's but it is rather of old Gondwanan stock (see at Realm 7). Thus New Zealand is by no strong evidence part of the Australian biogeographic unit. Most of the South Pacific Islands which Wallace attached as a subregion to Australia, show overwhelming Indomalayan historic ties both as regards the flora and the fauna (Gressitt, Usinger l.c.). Thus remains the transitional area of the Sunda Islands east of Wallace's line (cf. Mayr 1944) which deserves the name 'Wallacea', and further, New Guinea with the Bismarck and Solomon Islands. Whereas Wallacea is smoothly transitional regarding vertebrates, its insect fauna shows a basic Indomalaysian stock with a trinkling, if any, of Australian influence. Thus it seems easy to follow the florist in incorporating it into the Indomalaysian Realm (cf. Zimmermann 1948, Gressitt 1961).

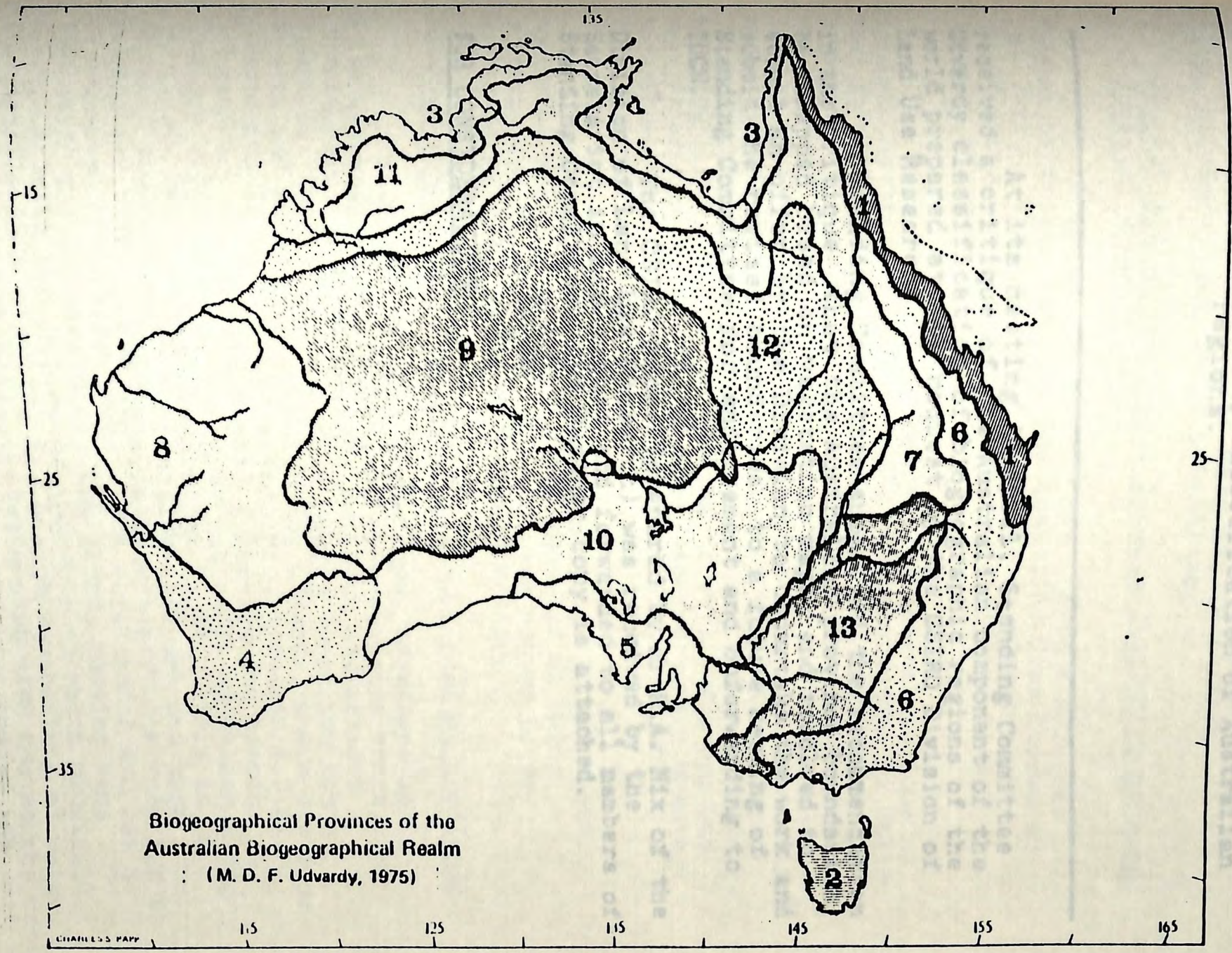
The consensus of contemporary zoogeographic studies is that though New Guinea and its shelf islands were joined to Australia during several phases of the Pleistocene, New Guinea has a basic, rich biota, much more ancient in origin as well as evolutionary history, and independent of Australian faunal or floral influence. Even though the two land masses - continent and almost continent-sized island, respectively - were joined by a land bridge, orography and climatic zonation seemed to aid in preserving their integrity with the exception of the climatic belt of the former land corridor. The present tropical savanna-dry forest zones of extreme southern New Guinea and Torresian Australia have caused and still cause a division among zoogeographers. Whereas Usinger (1963) attached the Cape York Peninsula of Queensland (Australia) to his Papuan subdivision of the Oriental Region, Gressitt (1961) treated it as a clearly transitional area together with southern New Guinea, and he (1975, in litt.) still opines that "the overlap of Australian and Oriental in southern New Guinea and Northern Australia needs to be shown as an overlap zone with dominance of Oriental elements ..."

For our uniform system of realms and provinces we retain the continent of Australia as a realm without showing its biogeographical involvement with New Guinea.

Faunistic research in Australia progresses with leaps and bounds, but, as expected in a state of flux, there is no agreement on faunistic provinces (cf. Keast 1959, 1972, McMichael and Iredale 1959, Horton 1973, and others). Therefore the basis of our biogeographical provinces is vegetational, and follows Dasmann (1974), also considering Leeper 1970.

(6) The Australian Realm

No.	Biogeographic Province
6.1.1	Queensland Coastal
6.2.2	Tasmanian
6.3.4	Northern Coastal
6.4.6	Western Sclerophyll
6.5.6	Southern Sclerophyll
6.6.6	Eastern Sclerophyll
6.7.6	Brigalow
6.8.7	Western Mulga
6.9.7	Central Desert
6.10.7	Southern Mulga/Saltbush
6.11.10	Northern Savanna
6.12.10	Northern Grasslands
6.13.11	Eastern Grasslands and Savannas



Biogeographical Provinces of the
Australian Biogeographical Realm
: (M. D. F. Udvardy, 1975)

APPENDIX C

COUNCIL OF NATURE CONSERVATION MINISTERS
STANDING COMMITTEE

24th Meeting, 6th October 1982, Alice Springs.

AGENDA ITEM 18: Udvardy classification of Australian regions.

At its meeting in April, Standing Committee received a critique of the Australian component of the Udvardy classification of biogeographic regions of the world prepared at its request by the CSIRO Division of Land Use Research.

Standing Committee supported the recommendation in the critique that the Australian province boundaries be remapped based on vegetation maps, and resolved to accept an offer by the Division to undertake the work and submit the revised boundaries to a future meeting of Standing Committee for endorsement and onforwarding to IUCN.

The CSIRO paper (prepared by Mr H.A. Nix of the Division of Land Use Research) was received by the Secretariat in mid-August and forwarded to all members of Standing Committee. A further copy is attached.

FOR CONSIDERATION

Secretariat,
Canberra,
September 1982.

Fortunately, its use as a descriptor for Tasmania is not critical, since Tasmania would be separated as a biogeographic province anyway. This (6.2.2) includes the larger Bass Strait islands (King, Flinders) and their satellites.

4. Tropical dry or deciduous forests (including monsoon forests) or woodlands

The original Udvardy map showed a Northern Coastal province, hugging the coastline from Broome to Cape York. This has no ecological or biogeographic significance, unless mangroves be considered as a singular diagnostic.

Only the higher rainfall (>1250mm) regions of northern Australia have significant occurrences of taller open forest dominated by Eucalyptus, but with understory elements of paleotropic, evergreen and deciduous plants, and disjunct occurrences of rainforest. The northern section of Cape York (6.3.4) is biogeographically distinct, with significant areas of rainforest and monsoon forest and numerous plant and animal taxa that indicate affinity with lowland Papua across Torres Strait. The Top End (6.4.4) of the Northern Territory shares some elements with Cape York, but has a number of endemics and distinctive isolates.

An even smaller outlier occurs in the North Kimberley region, but it is not regarded as being sufficiently distinctive or important enough to be separated at this level of classification.

6. Evergreen sclerophyllous forests, scrubs or woodlands

This ill-defined biome type, elsewhere seems to be assigned to Mediterranean type climatic zones, but in Australia includes all the southern and eastern Australian Eucalyptus and some Acacia dominated open-forests and woodlands. Following Udvardy, there are some adjustments to the south-western province (now 6.5.6), the boundary for the most part following the Acacia/Eucalypt line, with an eastward extension of mallee along the shores of the Great Australian Bight. This is an isolated province with distinctive isolates and high endemicity. The Southern sclerophyll province (now 6.6.6) is dominated by mallee (Eucalyptus shrublands) and has a moderately distinctive flora and fauna, showing some affinities with the mallee of the south-western province. Climatically this province has a high seasonality of water regime, sharing this characteristic also with the south-west. Small inclusions of Eucalyptus open forest and woodland (Mt Lofty and Flinders Ranges) show affinity with the Eastern sclerophyll.

Considerable adjustments have been made in eastern Australia. Firstly, the primary ecological and biogeographic division is between the humid coastal and subcoastal zone and the sub-humid to semi-arid zones of the interior slopes and plains.

The Eastern sclerophyll province (6.7.6) extends from the lower S.E. of South Australia around the south-eastern coast to Rockhampton and with outliers further north around Yeppoon, Mackay and the higher ranges of N.E. Queensland. Although Eucalyptus open forest dominates, there are inclusions of rainforest and woodlands.

This province has the highest species densities of many plant and animal taxa and can be further subdivided, but not simply. Increasing elevation tends to substitute for decreasing latitude, so that disjunct populations on mountain tops in the north and continuous populations on lowlands in the south tend to be a feature of this province. The inland boundary lies to the west of the coastal divide, and small disjunct outliers of 6.7.6 occur on higher mountains further west again within province 6.8.6 (Warrumbungle Mts, Nandewas Mts) and province 6.9.6 (Expedition Range, Carnarvon Range).

The sub-humid to semi-arid provinces, 6.9.6 (Brigalow) and 6.8.6 (Murray-Darling woodlands) share many plant and animal taxa, but have distinct assemblages. The Brigalow province (6.9.6) as now defined, includes a number of important sclerophyll open-forests dominated by Acacia (A. harpophylla, A. cambagei, A. shirleyi, A. argyrodendron, A. catenulata) together with associated Eucalyptus open-forests and woodlands. The Murray-Darling woodlands province (6.8.6) is dominated by Eucalyptus woodlands and open-woodlands, with some inclusions of Eucalyptus and Callitris open-forest and, in the north, extensive areas of Acacia open-forest and woodland (A. aneura). Although considerably modified, this province is essentially the Eastern grassland and savannas (6.13.11) of Udvardy. This designation is completely inappropriate, since grasslands are very limited in extent and the term savanna sensu strictu applies to tropical (mean air temperature >18°C) wet/dry climates with a grass dominant ground stratum with scattered emergent trees. The sclerophyll woodlands and open-forests are dominated by Eucalyptus with other genera such as Callitris, Casuarina and Acacia also prominent. The ground-stratum may be either grassy or shrub dominant.

7. Warm deserts, semi-deserts

The Australian arid zone is characterised by extensive distributions of plant and animal taxa and extremely broad transitions. However, there are significant north/south differences, with warmer-adapted

(megatherm) taxa in the north and cooler-adapted (mesotherm) taxa in the south. The latitudinal gradient in temperature is distorted by the Pilbara and Central Australian Ranges and the Central Lowlands (L. Eyre Basin). Udvardy (1975) recognized a Western Mulga province (6.8.7) Central Desert province (6.9.7) and a Southern Mulga/Saltbush province (6.10.7).

Within the Australian arid zone, the eastern sector centred on the Lake Eyre drainage has a number of distinctive isolates and endemic taxa. Chenopod shrublands are prominent in the south, intergrading with tussock grasslands northwards. Acacia woodlands and open woodlands are prominent. Extensive braided channels are flooded episodically and fill numerous playas. Seasonality of water regime is low with some chance of soil-water recharge in either summer or winter. This province has been mapped as 6.13.7 Eastern arid province or Lake Eyre basin province.

The western sector of the arid zone is distinguished by a high to very high seasonality of water regime with most soil-water recharge occurring from late summer through to early winter. Broadly coincident with Udvardy's Western Mulga province, I'd prefer Western arid province to conform with terminology for other sectors of the arid zone. Also, although mulga (A. aneura) is prominent eastwards, it is absent or subdominant to other Acacia spp. in the west. In fact, this province is particularly rich in endemic Acacia spp.

The Northern arid province (6.11.7 has mean air temperatures >18°C, summer dominant rainfall and is characterised by sparse open Acacia shrubland over hummock grass (Triodia) understorey. Northwards, it grades into Eucalyptus open woodland over hummock grass; and tussock grassland (6.15.10).

The southern arid province includes most of Udvardy's Southern Mulga/Saltbush province (6.10.7), but I have extended the boundary northwards to the Central Australian ranges, and have truncated the eastern segment. Extensive areas of Chenopod shrublands occur in the south and east, on finer-textured soils, while Eucalyptus and Casuarina open woodlands over hummock grass are extensive on coarser-textured soils in the west and north. Interspersed throughout are areas of Acacia shrublands. The lower temperatures associated with increased elevation of the Central Australian highlands and ranges displace the warmer adapted taxa northwards.

10. Tropical grasslands and savannas

A broad band of semi-arid, summer-rainfall dominant tussock grassland and Eucalyptus open woodland occurs across northern Australia, with the tussock grassland

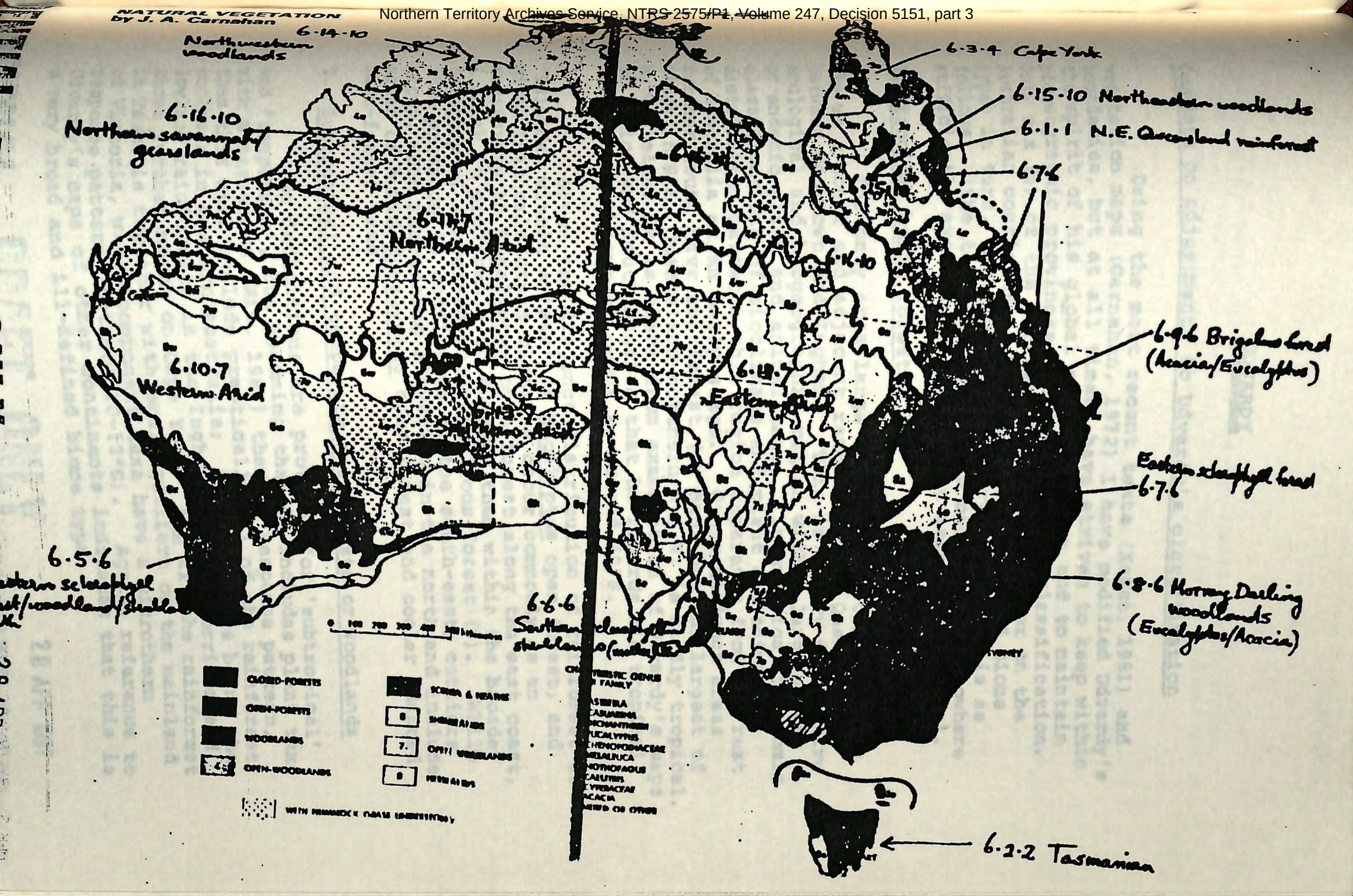
occurring on clay soils and the open woodland on sandy soils. Designated the Northern savannah/grassland province (6.16.10) it corresponds with Udvardy's Northern grasslands province (6.12.10).

The highly seasonal, wet/dry summer-rainfall dominant, Eucalyptus woodland zone is truncated at the head of the Gulf of Carpentaria, into an eastern and a western sector. Although many taxa are shared, there are important differences, between the two sectors. Extensive uplands in the eastern sector permit northwards extensions of eastern Australian plants and animals and very complex distribution patterns result. In the western sector, extensive sandstone formations (Arnhem Plateau and Kimberley Plateaux) possess endemic flora and fauna. Accordingly these are designated Northwestern woodland province (6.14.10) and North-eastern woodland province (6.15.10).

Because of the very broad groupings used and less than explicit definitions of biome types, this whole exercise is a compromise. Further subdivision is possible but unwarranted. Boundary adjustments are most certainly possible and warrant full and critical discussion. In the example provided I have attempted to use Carnaham's formation boundaries where possible. The problem is that important floristic and faunistic changes can occur within a single formation e.g. Eucalyptus woodlands of eastern Australia, so that these boundaries must be treated with caution.

The addition of three provinces, brings the total to sixteen (16) which seems to me not unreasonable or unbalanced compared with 22 provinces of the Nearctic, 44 of the Palaearctic, 29 of the Africotropical 27 of the Indomalayan and 47 of the Neotropical. Here again we lack objective criteria by which the global partitioning might be assessed.

The most recent biogeography of Australia (A. Keast, Ed. 1981) provides ample illustration of the fact that different taxa display different patterns of distribution. Thus, reptile, bird, butterfly and Eucalyptus patterns do not show good agreement except at the very broadest level i.e. a warm, humid to subhumid adapted assemblage labelled Torresian; a cool, humid to subhumid adapted assemblage labelled Bassian; an arid adapted assemblage labelled Eyrean. These broad patterns are subdivided by environmental barriers such as the Gulf of Carpentaria and arid environments at the head of the Great Australian Bight. The environmental controls of such patterning are analysed and discussed by Nix (1982, in press), who argues that New Guinea must be considered as an integral component of the Australian plate. Udvardy (1975) places New Guinea in the Oceanian Realm, which is preferable to its inclusion, by others, in the Oriental



UDVARDY

Comments on adjustments to Udvardy's classification

Using the most recent texts (Keast, 1981) and vegetation maps (Carnahan, 1972) I have modified Udvardy's boundaries, but at all times, have striven to keep within the spirit of his global classification and to maintain biogeographic provinces within his biome classification. Only six (6) of the fourteen biome types occur on the Australian continent. Taking each of these 6 biome types in turn, the logic of boundary adjustment is as follows: (the temperate grassland biome type is nowhere sufficiently extensive to warrant a separate province).

1. Tropical humid forests

The only area large enough to be considered is the we t coast and adjacent ranges of N.E. Queensland between Cooktown and Ingham. This is a very distinctive ecological and biogeographic region with a large number of endemic plant and animal taxa. In numerical taxonomic classifications of bioclimate and plant and animal distribution patterns this region separates from the rest of Australia at an early stage. Other disjunct areas further south have rainforest (or had) but the largest of these in S.E. Queensland-northern N.S.W. is hardly tropical. Nevertheless it is clear from examination of Udvardy's maps of Africa and South America that he regards his tropical humid forest biome to occur to around 30°S.

Given the disjunct distribution of rainforest as 'islands' within a 'sea' of *Eucalyptus* open forest, and given that rainforest elements occur commonly as an understory to *Eucalyptus* open forest along the east coast, I think it preferable to subsume them within the broader category of evergreen sclerophyllous forest (6). While this province is continuous in the south-east, outliers occur, with increasing elevation in the north and include areas of humid *Eucalyptus* open forest and cooler adapted rain-forest taxa.

2. Subtropical and temperate rainforests or woodlands

No definitions are provided for 'subtropical' and 'temperate', but assuming that it includes plant taxa with a mesotherm (Nix, 1981) thermal response pattern, then this will include practically all of the rainforest enclaves in eastern Australia, the exceptions being the lowland rainforests in the Ingham-Cooktown corridor and those further north on Cape York, and all the rainforest in Tasmania together with small outliers on the mainland of Victoria, where component taxa have a microtherm response pattern (optimum 10-12°C). Again, reference to Udvardy's maps of other continents indicates that this is a very broad and ill-defined biome type.

Landscape related research and survey programs completed or in progress and funded by the Australian National Parks and Wildlife Service and which are relevant or could have some relevance to Kakadu

1978-79 **Landuse Potential of the 'Gimbat' and 'Goodparla' Pastoral Leases,** Investigator: D. K. Story.

STORY, R. (1979), *National Park Value of Gimbat and Goodparla Pastoral Leases*, unpub. report to ANPWS, Canberra.

O'NEILL G.C. and MATTHEW, D.V. (1982), *An Investigation of Recent Geomorphological Change on Sections of the South Alligator River Floodplain Kakadu National Park*, unpub. report to ANPWS, Canberra.

1984-85 **Study of Geomorphology of the South Alligator Rivers Region.** Investigators: Dr J.M.A. Chappell, Australian National University, Dr B.G. Thom, University of New South Wales.

The project provided a chronological framework of the evolution of the present landscape by yielding a three dimensional account of the tidal and floodplain/wetland complex of the South Alligator River in Kakadu National Park.

1982-83 ANPWS Annual Report **An Integrated Land Classifications System for Nature Conservation Management in Kakadu National Park,** Chief Investigators: Dr. K. Myers and Dr. P. Laut, CSIRO, Canberra.

This project, using satellite imagery and aerial photo interpretation, is intended to develop an integrated classification of the Park in terms of vegetation, soils, geomorphology, fire history, water regimes and feral animals to provide a dynamic resource base for park management.

1983-84 ANPWS Annual Report **Feasibility Study into the Development of an Integrated Information System,** Investigators:, Dr. K. Myers, CSIRO Division of Water and Land Resources.

The system will provide a dynamic resources information base for decision-making on the wildlife resources and conservation values of the Park. It makes use of satellite imagery and aerial photographs and incorporates information on vegetation, soils, geography, fire history, water regimes and feral animal impacts.

1984-85
ANPWS
Annual Report

Feasibility Study into the Development of an Integrated Information System, Investigators: Dr. K. Myers, CSIRO Division of Water and Land Resources.

The system will provide a dynamic resources information base for decision-making on the wildlife resources and conservation values of the Park. It makes use of satellite and aerial photographs and incorporates information on vegetation, soils, geography, fire history, water regimes and feral animal impacts.

*
Sources

1. ANPWS (1986) Kakadu National Park Plan of Management, ANPWS, Canberra.

2. ANPWS Annual Reports 1975-76 to 1985-86.

Park Management related research and survey programs completed or in progress and funded by the Australian National Parks and Wildlife Service and which are relevant or could have some relevance to Kakadu*.

1982-83 ANPWS Annual Report

An Integrated Land Classifications System for Nature Conservation Management in Kakadu National Park, Chief Investigators: Dr. K. Myers and Dr. P. Laut, CSIRO, Canberra.

This project, using satellite imagery and aerial photo interpreation, is intended to develop an integrated classification of the Park in terms of vegetation, soils, geomorphology, fire history, water regimes and feral animals to provide a dynamic resource base for park management.

1983-84 ANPWS Annual Report

Feasibility Study into the Development of an Integrated Information System, Investigator, Dr. K. Myers, CSIRO Division of Water and Land Resources.

The system will provide a dynamic resources information base for decision-making on the wildlife resources and conservation values of the Park. It makes use of satellite imagery and aerial photographs and incorporates information on vegetation, soils, geography, fire history, water regimes and feral animal impacts.

1984-85 ANPWS Annual Report

Feasibility Study into the Development of an Integrated Information System, Investigator, Dr. K. Myers, CSIRO Division of Water and Land Resources.

The system will provide a dynamic resources information base for decision-making on the wildlife resources and conservation values of the Park. It makes use of satellite and aerial photographs and incorporates information on vegetation, soils, geography, fire history, water regimes and feral animal impacts.

1985-86 ANPWS Annual Report

Monitoring Environmental Change Using Landsat Imagery (Pilot Study), Investigators, Drs. D. Jupp and J. Walker, CSIRO, Division of Water and Land Resources.

Because of the extent and complexity of the Park, a means is required to obtain accurate and timely information. This pilot monitoring study is intended to build on earlier work to provide information on the possibility of remote assessments using satellite imagery to analyse vegetation structure and structural change as a means of monitoring habitats in the Park.

1984-85 ANPWS Annual Report

Expert System for Fire Management in Kakadu National Park Investigator, Dr. R. Davis, CSIRO Division of Water and Land Resources.

Involves development of an expert system to: assist in fire management by centralising and rationalising present knowledge of fire behaviour and fire effects; provide a tool for predicting fire behaviour and fire effects; and provide a computer-based information system to assist in the formulation of research and monitoring programs and for use by park management staff.

1985-86 ANPWS Annual Report

Expert System for Fire Management : Phases I and II, Investigator, Dr. R. Davis, CSIRO, Division of Water and Land Resources.

Involves further development, refinement and testing of an expert system to assist in fire management by centralising and rationalising present knowledge of fire behaviour and fire effects; provide a tool for predicting fire behaviour and fire effects; and provide a computer based information system to assist in the formulation of research and monitoring programs and for use by Park management staff.

1985-86 ANPWS Annual Report

A Feasibility Study for Assessment of the Impact of Fire on Flora and Fauna, Investigator, Dr. K. Myers, CSIRO, Division of Water and Land Resources.

This study is in its final phase. It aims to establish the framework for an integrated environmental database for Stage I of the Park for measuring the effects of fire and to provide information on other conservation problems, such as feral animals or Grass Finch conservation. The study has made extensive use of ground surveys, aerial photographs and satellite imagery for the two major transects in Stage I of the Park. A provisional landsat classification has also been produced for Stage I.

* Sources

1. ANPWS (1986) Kakadu National Park Plan of Management, ANPWS, Canberra.

2. ANPWS Annual Reports 1975-76 to 1985-86.

Flora related research and survey programs completed or in progress and funded by the Australian National Parks and Wildlife Service and which are relevant or could have some relevance to Kakadu*

1977-78 **An ecological survey of the monsoon forests of the north-western region of the Northern Territory.** Investigator: Dr L.J. Webb, CSIRO.

WEBB, L.J. and TRACEY, J.G. (1979), *An Ecological Survey on the Monsoon Forests of the North-Western Region of the Northern Territory*, unpub. report to ANPWS, Canberra.

1978-79 **Evaluation of Horticultural Material for Jabiru Township Kakadu National Park.** Investigator: Prof. L. D. Pryor.

The township of Jabiru is to be established by the Jabiru Town Development Authority within Kakadu National Park to service the uranium mining industry. The establishment of parks and gardens to create a pleasant environment within Jabiru will be important to the residents. Since Jabiru forms part of Kakadu National Park, careful thought must be given to ensure that any plants introduced into Jabiru do not become naturalised and spread into adjoining areas. As a result of this study lists of plants considered safe for use in Jabiru township have been compiled including species native to Kakadu which may prove to be desirable for amenity planting in the town.

PRYOR, L.D. (1979), *A Report on Exotic and Native Plant Species in the Kakadu Region in Relation to their Horticultural Value*, unpub. report to ANPWS. Canberra.

1979-80 **The effects of fire in tall open forest and woodland with particular reference to fire management in Kakadu National Park.** Investigator: Mr N.P. Cheney, CSIRO.

HOARE, J.R.L., HOOPER, R.J., CHENEY, N.P. and JACOBSON, K.L.S. (1980), *A Report on the Effects of Fire in Tall Open Forest and Woodland with Particular Reference to Fire Management in Kakadu National Park in the Northern Territory*, unpub. report to ANPWS, Canberra.

1979-80 **Floristic inventory, Kakadu National Park.** Investigator: Dr H. Eichlerand, Dr M. Lazarides, CSIRO.

LAZARIDES, M. (1981), *Floristic Inventory of Kakadu National Park*, unpub. report to ANPWS, Canberra.

1984-85

Population Dynamics and Productivity of Forest Trees in Kakadu National Park. A Comparison of 'Wet' and 'Dry' Years. Investigator: Dr P. Werner, Michigan State University, USA.

Investigation of the dynamics of open forests and woodlands through assessment, recruitment, productivity and biomass turnover rates.

1985-86

Vegetation Map.
Investigator: Dr R. Schodde, CSIRO, Division of Wildlife and Rangelands Research.

This study involves the revision and expansion of two earlier vegetation maps covering most of the Park. The work includes correcting distortions in existing airphoto mosaics and preparing a compilation map at 1:100,000 scale. The maps will be of immediate use in the planning and management of the Park.

1985-86

Population Dynamics and Productivity of Forest Trees: A Comparison of 'Wet' and 'Dry' Years.
Investigator: Dr P. Werner, CSIRO, Division of Wildlife and Rangelands Research.

The study is an investigation of the dynamics of open forests and woodlands through assessment of recruitment, productivity and biomass turnover rates. It is intended to establish a preliminary model for the dynamics of canopy tree species and allow comparison of the results from the Park with other areas.

1985-86

Updated List of Rate or Threatened Australian Plants.
Investigator: Dr J. Leigh, CSIRO, Division of Plant Industry.

The study involved revision and updating of information on Australian plant species listed in the ANPWS Special Publication *Rare or Threatened Australian Plants*. The work entailed compilation of current information on species which are probably extinct, or are endangered, vulnerable, rare or poorly known.

N/A

Survey of the ecology, fire history and enthnobotany of monsoon forests, Kakadu National Park.
Mr Jeremy Russell-Smith, ANU.

RUSSELL-SMITH, J. (1984), *The Status and Condition of Monsoon Vine-Forests in the Kakadu Region: a Management Report*, unpub. report to ANPWS, Canberra.

DAY, M.F. (1982), *Preliminary Report on Lichens Collected in the Kakadu National Park*, unpub. report to ANPWS, Canberra.

1978-79
ANPWS
Annual Report

Fauna Survey, Kakadu National Park. Chief Investigator: Dr. M.G. Ridpath, CSIRO.

The CSIRO Division of Wildlife Research completed a design study for a survey to provide quantitative data on the distribution and habitat preference of terrestrial fauna of Kakadu National Park. Detailed surveys which it is hoped will follow this preliminary study will provide baseline information for management of the living natural resources of the Park.

1981-82
ANPWS
Annual Report

Survey of Terrestrial Vertebrate Fauna of Kakadu National Park. Chief Investigator Dr. M.G. Ridpath of the CSIRO Division of Wildlife Research.

The project seeks to determine the relative abundance of mammals, birds, reptiles and amphibians at a replicated series of sites in varied habitats and during different seasons. This survey is providing essential scientific information for the development of appropriate management regimes.

1982-83
ANPWS
Annual Report

Survey of Terrestrial Fauna of Kakadu National Park. Chief Investigator Dr. M.G. Ridpath of the CSIRO Division of Wildlife and Rangelands Research.

This survey is providing essential scientific information for the development of appropriate management regimes. It seeks to determine the relative abundance of mammals, birds, reptiles and amphibians at a replicated series of sites in varied habitats and during different seasons. Field work has been completed and analysis of data is continuing.

1983-84
ANPWS
Annual Report

Survey of Vertebrate Fauna - Stages I and II. Investigator Dr. R. Braithwaite, CSIRO Division of Wildlife Research.

The survey is designed to provide essential information for fauna management in Kakadu National Park. The survey will assess a wide spectrum of vertebrate fauna in forested habitat and identify critical ecological relationships.

1984-85
ANPWS
Annual Report

Survey of Vertebrate Fauna - Stages I and II. Investigator Dr. R. Braithwaite, CSIRO Division of Wildlife and Rangelands Research.

The survey was designed to provide essential information for fauna management in Kakadu National Park and has assessed a wide spectrum of vertebrate fauna in forested habitat and identified critical ecological relationships.

BRAITHWAITE, R.W. (ed.) (1985), *The Kakadu Fauna Survey : An Ecological Survey of Kakadu National Park*, unpub. report to ANPWS, Canberra.

1978-79
ANPWS
Annual Report

Reconnaissance Survey of Tidal Wetlands, Kakadu National Park. Investigator: Mr. E. Hegerl.

A reconnaissance and feasibility study for a survey of the tidal wetlands of Kakadu National Park and its proposed Stage II extension was completed. The study collated and reviewed available information on the flora and fauna of the mangroves and tidal wetlands in the Alligator Rivers Region. It also assessed survey options to meet the needs of an integrated resource inventory and evaluation for long-term management of the tidal wetlands of Kakadu National Park.

HEGERL, E.J., DAVIE, P.J.F., CLARIDGE, G.F. and ELLIOTT, A.G. (1979), *The Kakadu National Park Mangrove Forests and Tidal Marshes*, unpub. report to ANPWS, Canberra.

1980-81
ANPWS
Annual Report

Survey of Tidal Wetlands and Mangrove Forests of Kakadu,. Investigator: Mr. E. Hegerl.

Following a reconnaissance survey and feasibility study in 1978-79, a second stage survey was established to provide an inventory of the flora and fauna of the tidal wetlands and mangrove forests of Kakadu National Park. This is supportive of the nomination of Kakadu for inclusion in the World Heritage List and the inclusion of the Park wetlands in the List of Wetlands of International Importance. The project is designed to assess the biogeographic significance of the tidal wetlands and mangrove forests by surveying the flora, including algae, fungi and lichens, and the fauna, including molluscs, crustaceans, insects, spiders, reptiles, amphibians, birds and mammals. From this information it is hoped to establish the effects on fauna and flora of changes in water level and to establish the relationships between vegetation and faunal communities and their component species.

1981-82
ANPWS
Annual Report

Survey of Tidal Wetlands and Mangrove Forests of Kakadu National Park. Chief Investigator Mr. E. Hegerl of the Queensland Conservation Council.

The project is designed to assess the biogeographic significance of the tidal wetlands and mangrove forests by surveying the flora, including algae, fungi and lichens, and the fauna, including molluscs, crustaceans, insects, spiders, reptiles, amphibians, birds and mammals. From this information it is hoped to establish the effects on fauna and flora of changes in water level and to establish the relationships between vegetation and faunal communities and their component species.

1982-83
ANPWS
Annual Report

Survey of Tidal Wetlands and Mangrove Forests of Kakadu National Park. Chief Investigator: Mr. E. Hegerl of the Queensland Conservation Council.

This survey is being undertaken to assess the biogeographic significance of the tidal wetlands and mangrove forests. It is comprehensive, covering the flora, including algae, fungi and lichens, and the fauna, including molluscs, crustaceans, insects, spiders, reptiles, amphibians, birds and mammals. From this information it is hoped to establish the effects on fauna and flora of changes in water level and to establish the relationships between plant and animal communities and their component species.

1982-83
ANPWS
Annual Report

An Integrated Land Classifications System for Nature Conservation Management in Kakadu National Park. Chief Investigator: Dr. K. Myers and Dr. P. Laut, CSIRO, Canberra.

This project, using satellite imagery and aerial photo interpretation, is intended to develop an integrated classification of the Park in terms of vegetation, soils, geomorphology, fire history, water regimes and feral animals to provide a dynamic resource base for park management.

1983-84
ANPWS
Annual Report

Feasibility Study into the Development of an Integrated Information System. Investigator: Dr. K. Myers, CSIRO Division of Water and Land Resources.

The system will provide a dynamic resources information base for decision-making on the wildlife resources and conservation values of the Park. It makes use of satellite imagery and aerial photographs and incorporates information on vegetation, soils, geography, fire history, water regimes and feral animal impacts.

1984-85
ANPWS
Annual Report

Feasibility Study into the Development of an Integrated Information System. Investigator: Dr. K. Myers, CSIRO Division of Water and Land Resources.

The system will provide a dynamic resources information base for decision-making on the wildlife resources and conservation values of the Park. It makes use of satellite and aerial photographs and incorporates information on vegetation, soils, geography, fire history, water regimes and feral animal impacts.

1985-86
ANPWS
Annual Report

Monitoring Environmental Change Using Landsat Imagery (Pilot Study). Investigators: Drs. D. Jupp and J. Walker, CSIRO, Division of Water and Land Resources.

Because of the extent and complexity of the Park, a means is required to obtain accurate and timely information. This pilot monitoring study is intended to build on earlier work to provide information on the possibility of remote assessments using satellite imagery to analyse vegetation structure and structural change as a means of monitoring habitats in the Park.

1985-86
ANPWS
Annual Report

A Feasibility Study for Assessment of the Impact of Fire on Flora and Fauna. Investigator: Dr. K. Myers, CSIRO, Division of Water and Land Resources.

This study is in its final phase. It aims to establish the framework for an integrated environmental database for Stage I of the Park for measuring the effects of fire and to provide information on other conservation problems, such as feral animals or Grass Finch conservation. The study has made extensive use of ground surveys, aerial photographs and satellite imagery for the two major transects in Stage I of the Park. A provisional landsat classification has also been produced for Stage I.

* Sources.

1. ANPWS (1986) Kakadu National Park Plan of Management, ANPWS, Canberra.

2. ANPWS Annual Reports 1975-76 to 1985-86.

Fauna related research and survey programs completed or in progress and funded by the Australian National Parks and Wildlife Service and which are relevant or could have some relevance to Kakadu*

1978-79 ANPWS Annual Report

Fauna Survey, Kakadu National Park Chief Investigator: Dr. M.G. Ridpath, CSIRO.

The CSIRO Division of Wildlife Research completed a design study for a survey to provide quantitative data on the distribution and habitat preference of terrestrial fauna of Kakadu National Park. Detailed surveys which it is hoped will follow this preliminary study will provide baseline information for management of the living natural resources of the Park.

1981-82 ANPWS Annual Report

Survey of Terrestrial Vertebrate Fauna of Kakadu National Park Chief Investigator: Dr. M.G. Ridpath of the CSIRO Division of Wildlife Research.

The project seeks to determine the relative abundance of mammals, birds, reptiles and amphibians at a replicated series of sites in varied habitats and during different seasons. This survey is providing essential scientific information for the development of appropriate management regimes.

1982-83 ANPWS Annual Report

Survey of Terrestrial Fauna of Kakadu National Park Chief Investigator: Dr. M.G. Ridpath of the CSIRO Division of Wildlife and Rangelands Research.

This survey is providing essential scientific information for the development of appropriate management regimes. It seeks to determine the relative abundance of mammals, birds, reptiles and amphibians at a replicated series of sites in varied habitats and during different seasons. Field work has been completed and analysis of data is continuing.

1983-84 ANPWS Annual Report

Survey of Vertebrate Fauna - Stages I and II Investigator: Dr. R. Braithwaite, CSIRO Division of Wildlife Research.

The survey is designed to provide essential information for fauna management in Kakadu National Park. The survey will assess a wide spectrum of vertebrate fauna in forested habitat and identify critical ecological relationships.

1984-85 ANPWS Annual Report

Survey of Vertebrate Fauna - Stages I and II Investigator: Dr. R. Braithwaite, CSIRO Division of Wildlife and Rangelands Research.

The survey was designed to provide essential information for fauna management in Kakadu National Park and has assessed a wide spectrum of vertebrate fauna in forested habitat and identified critical ecological relationships.

BRAITHWAITE, R.W. (ed.) (1985), *The Kakadu Fauna Survey : An Ecological Survey of Kakadu National Park*, unpub. report to ANPWS, Canberra.

1978-79
ANPWS
Annual Report

Reconnaissance Survey of Tidal Wetlands, Kakadu National Park Investigator: Mr. E. Hegerl.

A reconnaissance and feasibility study for a survey of the tidal wetlands of Kakadu National Park and its proposed Stage II extension was completed. The study collated and reviewed available information on the flora and fauna of the mangroves and tidal wetlands in the Alligator Rivers Region. It also assessed survey options to meet the needs of an integrated resource inventory and evaluation for long-term management of the tidal wetlands of Kakadu National Park.

HEGERL, E.J., DAVIE, P.J.F., CLARIDGE, G.F. and ELLIOTT, A.G. (1979), *The Kakadu National Park Mangrove Forests and Tidal Marshes*, unpub. report to ANPWS, Canberra.

1980-81
ANPWS
Annual Report

Survey of Tidal Wetlands and Mangrove Forests of Kakadu Investigator: Mr. E. Hegerl.

Following a reconnaissance survey and feasibility study in 1978-79, a second stage survey was established to provide an inventory of the flora and fauna of the tidal wetlands and mangrove forests of Kakadu National Park. This is supportive of the nomination of Kakadu for inclusion in the World Heritage List and the inclusion of the Park wetlands in the List of Wetlands of International Importance. The project is designed to assess the biogeographic significance of the tidal wetlands and mangrove forests by surveying the flora, including algae, fungi and lichens, and the fauna, including molluscs, crustaceans, insects, spiders, reptiles, amphibians, birds and mammals. From this information it is hoped to establish the effects on fauna and flora of changes in water level and to establish the relationships between vegetation and faunal communities and their component species.

1981-82
ANPWS
Annual Report

Survey of Tidal Wetlands and Mangrove Forests of Kakadu National Park Chief Investigator: Mr. E. Hegerl of the Queensland Conservation Council.

The project is designed to assess the biogeographic significance of the tidal wetlands and mangrove forests by surveying the flora, including algae, fungi and lichens, and the fauna, including molluscs, crustaceans, insects, spiders, reptiles, amphibians, birds and mammals. From this information it is hoped to establish the effects on fauna and flora of changes in water level and to establish the relationships between vegetation and faunal communities and their component species.

1982-83
ANPWS
Annual Report

Survey of Tidal Wetlands and Mangrove Forests of Kakadu National Park Chief Investigator: Mr. E. Hegerl of the Queensland Conservation Council.

This survey is being undertaken to assess the biogeographic significance of the tidal wetlands and mangrove forests. It is comprehensive, covering the flora, including algae, fungi and lichens, and the fauna, including molluscs, crustaceans, insects, spiders, reptiles, amphibians, birds and mammals. From this information it is hoped to establish the effects on fauna and flora of changes in water level and to establish the relationships between plant and animal communities and their component species.

1984-85
ANPWS
Annual Report

Species Surveys, Kakadu National Park Investigator: Mr. G. Thomas, Gagudju Association Inc.

A number of small species surveys are being conducted focusing particularly on the Flying Fox, Ghost Bat, macropods (including Antilopine Kangaroo, Black Wallaroo, Northern Nailtailed Wallaby and Spectacled Hare Wallaby, the Pig-nosed Turtle, various freshwater fish species, the Golden Backed Tree Rat, the Grass Owl and Leichhardt's Grasshopper.

1985-86
ANPWS
Annual Report

Species Surveys Investigator: Mr. G. Thomas, Gagudju Association Inc.

A number of surveys of small animals are being conducted, in co-operation with Aboriginal people in the Park focussing particularly on the Flying Fox *Pteropus scapulatus* and *Pteropus alecto*, Ghost Bat *Macroderma gigas*, macropods (including Antilopine Kangaroo *Macropus antilopinus*, Black Wallaroo *Macropus bernardus*, Northern Nailtail Wallaby *Onychogalea unguifera* and Spectacled Hare Wallaby *Lagorchestes conspicillatus)*, the Pig-nosed Turtle *Carettochelys insculpta*, various freshwater fish species, the Golden Backed Tree Rat *Mesembriomys macrurus*, the Grass Owl *Tyto longimembris* and Leichhardt's Grasshopper *Petasida ephippigera*.

1979-80
ANPWS
Annual Report

Aerial Survey of *Crocodylus porosus* Nesting Habitat in Kakadu National Park Investigator: Dr. G. Grigg.

During February 1980, the University of Sydney undertook an aerial survey of saltwater crocodile, *Crocodylus porosus*, nesting habitat in tidal and freshwater wetlands of Kakadu National Park and the adjacent proposed Conservation Zone. The survey area included Cooper Creek and the East Alligator, South Alligator, West Alligator and Wildman Rivers and their associated wetlands. Extensive areas of suitable nesting habitat for the saltwater crocodile are provided by the wetlands of the Alligator Rivers Region and several active nests were located. The survey concluded that the introduced water

buffalo has played a major role in denuding riverside areas of vegetation and removing the understorey from what would otherwise be suitable nesting habitat.

MAGNUSSUN, W.E., GRIGG, G.C. and TAYLOR, J.A. (1978), *An Aerial Survey of Potential Nesting Areas of the Saltwater Crocodile (Crocodylus porosus, Schneider) on the North Coast of Arnhem Land, Northern Australia*, unpub. report to ANPWS, Canberra.

1985-86
ANPWS
Annual Report

Crocodile Research - Kakadu National Park

Changes in populations of saltwater crocodiles in the East and South Alligator Rivers and their associated freshwater swamps continued to be monitored. Additional to these surveys, in November 1985, ANPWS biologists initiated a pilot survey using radio-telemetry to investigate the movement of relocated crocodiles. Techniques were developed to successfully trap, chemically immobilise, handle and transport saltwater crocodiles in the Park. When completed, the results of the study will enable ANPWS to formulate policies for the management of individual crocodiles which through their behaviour, present a threat to the safety of Park visitors.

1985-86
ANPWS
Annual Report

Study of Waders in Australia : Stage III Investigator: Dr. S. Davies, Royal Australasian Ornithologists Union

Information on nesting of Australian birds and the effects of habitat disturbance, especially on endangered species and those migrating across national boundaries, is required to develop conservation measures. A nest record scheme co-ordinated by the Royal Australasian Ornithologists Union has a total of 50 000 records of 524 species of Australian birds. Funds have been provided by ANPWS to develop a computer-based scheme for nest records that is compatible with existing distributional and bird-banding record systems. The study is also intended to develop guidelines for the development of monitoring techniques for bird populations and an assessment of requirements for permanent monitoring sites.

1979-80
ANPWS
Annual Report

Study of Animal Ecology in Monsoon Forests, Kakadu National Park Investigator: Professor J. Kikkawa.

The monsoon forests are relict areas of vegetation believed to be contracting as a result of European burning practices. The University of Queensland has completed a study on the use of birds, mammals, reptiles and insects of these refuge habitats in Kakadu National Park. The project has highlighted the significance of these habitats in assessing the biogeography of the Australian fauna.

KIKKAWA, J. and MONTEITH, G.B. (1980), *Animal Ecology of Monsoon Forests of the Kakadu Region, Northern Territory*, unpub. report to ANPWS, Canberra.

?

Survey of Fish and Crustaceans in the East Alligator River Estuary, Kakadu National Park, Dr. G. Murphy.

1982-83
ANPWS
Annual Report

An Integrated Land Classifications System for Nature Conservation Management in Kakadu National Park Chief Investigator: Dr. K. Myers and Dr. P. Laut, CSIRO, Canberra.

This project, using satellite imagery and aerial photo interpretation, is intended to develop an integrated classification of the Park in terms of vegetation, soils, geomorphology, fire history, water regimes and feral animals to provide a dynamic resource base for park management.

1983-84
ANPWS
Annual Report

Feasibility Study into the Development of an Integrated Information System Investigator: Dr. K. Myers, CSIRO Division of Water and Land Resources.

The system will provide a dynamic resources information base for decision-making on the wildlife resources and conservation values of the Park. It makes use of satellite imagery and aerial photographs and incorporates information on vegetation, soils, geography, fire history, water regimes and feral animal impacts.

1984-85
ANPWS
Annual Report

Feasibility Study into the Development of an Integrated Information System Investigator: Dr. K. Myers, CSIRO Division of Water and Land Resources.

The system will provide a dynamic resources information base for decision-making on the wildlife resources and conservation values of the Park. It makes use of satellite and aerial photographs and incorporates information on vegetation, soils, geography, fire history, water regimes and feral animal impacts.

1985-86
ANPWS
Annual Report

Monitoring Environmental Change Using Landsat Imagery (Pilot Study) Investigators: Drs. D. Jupp and J. Walker, CSIRO, Division of Water and Land Resources.

Because of the extent and complexity of the Park, a means is required to obtain accurate and timely information. This pilot monitoring study is intended to build on earlier work to provide information on the possibility of remote assessments using satellite imagery to analyse vegetation structure and structural change as a means of monitoring habitats in the Park.

1985-86
ANPWS
Annual Report

A Feasibility Study for Assessment of the Impact of Fire on Flora and Fauna Investigator: Dr. K. Myers, CSIRO, Division of Water and Land Resources.

This study is in its final phase. It aims to establish the framework for an integrated environmental database for Stage I of the Park for measuring the effects of fire and to provide information on other conservation problems, such as feral animals or Grass Finch conservation. The study has made extensive use of ground surveys, aerial photographs and satellite imagery for the two major transects in Stage I of the Park. A provisional landsat classification has also been produced for Stage I.

* Sources

1. ANPWS (1986) Kakadu National Park Plan of Management, ANPWS, Canberra.

2. ANPWS Annual Reports 1975-76 to 1985-86.