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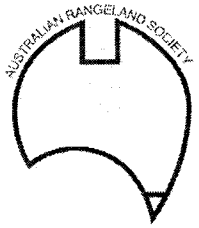

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HISTORY OF RANGELAND MONITORING IN WESTERN AUSTRALIA

P.J. Russell[1,3] *and I.W. Watson*[2]

[1]Centre for Management of Arid Environments, Locked Bag 22, Kalgoorlie, WA, 6433
[2]Department of Agriculture and Food Western Australia and Centre for Management of Arid Environments, PO Box 483, Northam, WA, 6401
[3] Corresponding author. Email: p.russell@cmae.curtin.edu.au

ABSTRACT
A relatively short history of systematic rangeland monitoring in Western Australia, spanning about one third of the pastoral industry's existence, has led to the current state wide program, known as the Western Australian Rangeland Monitoring System (WARMS). The pre-cursor to the current system began in the 1950s and was focused on assisting individual pastoralists set appropriate stocking rates. By the late 1960s and early 1970s, the additional objective of providing information on the state's natural resource base was added following growing realisation of widespread land degradation and the necessity for government land administrators to track change. Several techniques were trialled through the 1970s leading to a regional scale system in the early 1980s, which proved too ambitious. A revised system was developed in 1992 and fully installed by 1999. This is the Western Australian Rangeland Monitoring System (WARMS), a ground based system comprising 1,622 sites.

INTRODUCTION
This paper briefly chronicles the development of range monitoring in Western Australia, leading to the current state wide monitoring system. For reasons of brevity, it is limited to discussion of techniques in the southern shrublands and not the grasslands of the north. Rangeland monitoring (at the local scale) began in Western Australia in the early 1950s and since then, has been closely tied to the production of livestock grazing on native vegetation. The techniques developed in Western Australia, although partly influenced by Clementsian grassland succession theory, were instead tailored for shrublands, incorporating specific soil and perennial vegetation attributes that were thought to be appropriate indicators of range trend, based on the local experience of Australian rangeland scientists.

HISTORY OF DEVELOPMENT
Monitoring impetus
It is clear that monitoring objectives in Western Australia moved through several phases. In the first phase, the primary incentive in the early 1950s was to help individual pastoralists make better stocking rate decisions at the paddock scale. By the end of the 1960s there was also a desire to provide land administrators with broad scale range trend information. This second phase was helped by the need to establish systematic monitoring in the Gascoyne and Ashburton catchments following flooding of the Gascoyne River in 1961 resulting in severe damage to the town of Carnarvon and surrounding horticultural enterprises (Wilcox & McKinnon 1972). The programme of monitoring was requested by the Pastoral Appraisement (now Lands) Board in 1973, with enthusiasm for monitoring in general being generated by several rangeland conference workshops in the early 1970s (Anon. 1977; Noble 1979) and supported by an increasing national desire to better manage natural resources. These were important intellectual 'milestones' in range condition assessment. Importantly around this time, Cunningham (1976) and Noble (1979) urged the importance of including soil stability in assessments.

The overall effect of the 1970s conferences and workshops was to engender very strong enthusiasm for rangeland monitoring amongst Australian rangeland scientists. The dual objectives of providing both paddock scale and regional scale range trend assessments persisted through the 1970s and into the early 1980s and it was in this phase that several techniques were developed and trialled by Department of Agriculture (and now Food) Western Australia (DAFWA) officers. To meet the dual objectives, a suitable ground based monitoring technique would need to be installed at a minimum of about 10,000 sites across the state – a major challenge that eventually could not be met and which led to the third phase beginning in 1992 with the revised objective of providing only regional scale range trend information and which continues to the present.

Development chronology of techniques

Early work

Monitoring in the broadest sense of an experiment designed to compare changes in vegetation over time under different conditions began in Western Australia in 1951-1952. Plant data and photographs were collected from monitoring sites located inside and outside fenced exclosures. The University of Western Australia (UWA), the Pastoralists Association and the George Aitken Research Trust set up exclosures on saltbush country on Barnong, Belele and Boolardy stations. David Wilcox recorded these whilst a student at UWA and continued the work when he joined DAFWA. In 1955 he also began developing stocking rate decision strategies based on vegetation (rather than using precedent stock numbers) with Neil Mitchell of Barnong. An important part of the process was the establishment of a suite of exclosures against which grazed areas were compared. Additional exclosures were built elsewhere on different vegetation types from the late 1950s onwards. The exclosures were located on areas in poor condition, with the aim of tracking recovery (or otherwise) both inside and out.

Flight line technique

The first attempt at systematic monitoring in the Western Australian rangelands used a low level aerial photography technique (Carneggie *et al.* 1971). Sequences of colour and colour-infrared aerial photographs were taken of pre-determined ground marked sites. The photos were used to mark up the location, species identification and canopy cover of shrubs on the ground. Over 140 flight lines were installed on 50 properties between 1970 and 1980, initially in the Gascoyne and Ashburton and later in the Murchison and Kalgoorlie regions (Holm 1983). The flight lines had a relatively large sample size compared to later ground based techniques, however, the technique was discontinued by the early 1980s because of high aircraft operating and photo acquisition costs, the difficulty of seeing small shrubs, shrubs under larger canopies and shrubs obscured by shadows. Many of the flight lines were also installed in holding paddocks because these areas were most degraded. However, they were not necessarily representative of changes occurring elsewhere on the station.

"Meekatharra Waltz"

In 1973, a density sampling technique developed by John Morrissey, colloquially known as the "Meekatharra Waltz" involved assessment of both vegetation and, for the first time, soil condition. For vegetation, the density of selected indicator plants was measured. Selected plants consisted of two or three desirable (decreaser) species, one or two intermediate and one or two undesirable (increaser) species. Density was estimated by measuring the distance to the nearest individual of each of the indicator species at 10 randomly positioned sample points. Soil surface assessment comprised an "area-class" index based on seven erosional disturbance classes and sub-classes. A black and white polaroid photo was taken to aid site relocation.

HMW (Hacker-Morrissey-Wilcox) technique

Also in 1973 a combined technique was derived from the "Meekatharra Waltz" and a Modified Dyksterhuis Quantitative Climax method developed by Ron Hacker (Hacker 1973). In the HMW technique, the density of selected plant species was estimated by nearest neighbour method. As for the "Meekatharra Waltz", selected decreaser, intermediate and increaser species were sampled and a site photograph taken. Species density estimates were derived along with assessments of plant vigour for the decreaser species only and an overall site vigour index calculated. Soil surface condition assessment using a class based "type-intensity" index was done on the same twenty fixed points used for the plant density sampling plus an additional twenty points.

Ground photographic technique

A photographic technique was developed as a direct aid to pastoralists, to help them make tactical management decisions. The technique consisted of oblique photographs of fixed sites taken with a hand-held 35 mm camera (Morrissey 1976). Two photographs of the site were taken, one providing an overall site-landscape view and the second of just the ground (no sky). Individual shrubs were identified and marked up on clear overlays. A total of 469 sites on 38 pastoral leases were installed between 1975 and 1982 (Holm 1993). In 1982 the photograph protocol was modified so that only one photograph was taken, which covered a demarcated area and the landscape to the horizon. This photographic protocol including photo site layout is now standard for current WARMS sites.

Old and new WARMS

By 1980, accumulated field experience within DAFWA had developed to the stage where a more comprehensive technique for assessing range trend could be designed. The new technique combined the photo site with fixed belt transects for recording plant metrics and it was planned to undertake comparisons between monitoring sites and exclosures and water-remote reference sites located in the major vegetation communities so as to elucidate the relative effects of grazing and climate on observed plant changes (Holm *et al.* 1987).

Improvements to the technique were made following reviews in 1983, 1986 and 1992. However, even by 1992 the lack of a robust soil condition and erosion assessment method which could detect even moderate change was a major weakness. To overcome this, Landscape Function Analysis (LFA) and Soil Surface Condition (SSC) assessments were introduced (Tongway 1994). Other technical improvements included plant census using transect based cartesian coordinates. The principle strategic change in 1992 was the re-alignment of the system to provide only regional scale trend information for government purposes. Many existing sites were 'dropped' from the formal WARMS program and handed to pastoralists for their own use. These are now termed 'Old-WARMS' sites.

The first new WARMS sites were installed in 1994 in order to meet the regional scale stratification. WARMS now consists of a set of 1,622 sites across the pastoral rangelands of Western Australia. Separate techniques are used in the shrublands (as described above) and the grasslands to the north. WARMS is focused on providing information to government and to land administrators rather than to individual land managers. The system has remained largely unchanged since 1994 and over time it should provide consistent reliable information about range trend in representative areas of Western Australia's pastoral rangelands.

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