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CENTRALIAN RANGE ASSESSMENT PROGRAM

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C.R.A.P.

CENTRALIAN RANGE ASSESSMENT PROGRAM

AN INSTRUCTION MANUAL FOR RANGE CONDITION ASSESSMENT

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SUSTAINABLE AGRICULTURE

THE DEPARTMENT OF PRIMARY INDUSTRY AND FISHERIES IS COMMITTED TO THE PRINCIPLES AND PRACTICES OF SUSTAINABLE AGRICULTURE

Definition:

Sustainable agriculture is the use of practices and systems which maintain or enhance:

- the economic viability of agricultural production;
- the natural resource base; and
- other ecosystems which are influenced by agricultural activities.

Principles:

1. Agricultural productivity is sustained or enhanced over the long term.
2. Adverse impacts on the natural resource base of agricultural and associated ecosystems are ameliorated, minimised or avoided.
3. Harmful residues resulting from the use of chemicals for agriculture are minimised.
4. The nett social benefit (in both dollar and non-dollar terms) derived from agriculture is maximised.
5. Agricultural systems are sufficiently flexible to manage risks associated with the vagaries of climate and markets.

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INTRODUCTION

This manual describes the field operation of the Centralian Range Assessment Program (CRAP). The manual was prepared as a reference document for current staff and as training material for new staff.

The objectives of the Centralian Range Assessment Program are to:-

(1) compile an inventory of the pasture types throughout the Alice Springs district in order to better understand the ecology and productivity of the pastoral resource;

(2) assess the current range condition of the more productive pasture types;

(3) monitor range trend at permanently marked sites;

(4) assess land capability of important pasture types and provide advice to pastoralists and government on the future grazing management of these areas.

(5) make technical information about range assessment available to other land monitoring agencies.

Pastoral leases form the survey unit area. Assessments are made at fixed sites. Implicit in this method of range assessment is the view that changes over the wider management area (paddock or water) will be reflected adequately in changes at the monitoring site.

THE SURVEY TEAM

Three people generally form a survey team. One person collects herbage yield, species composition and frequency data on a hand-held computer. The second person obtains quantitative tree and shrub information while the third person records the site location, describes the soil profile and records descriptive information such as feed condition, erosion, tree and shrub information, fire, productivity limitations and land capability.

Collection of herbage botanical data usually takes from 60 to 80 minutes; the other tasks somewhat less. Other tasks such as physical establishment of the site and landscape photography are shared between those people collecting descriptive and woody data.

PHOTO INTERPRETATION AND LAND SYSTEM MAPPING

Existing land systems, as described by Perry ***et al.*** (1962), are delineated on suitable (presently 1970/71 1:80000 black and white) aerial photography prior to a station survey. The more productive land systems are subdivided into major component land units where these units form manageable areas with significantly different pastoral values or management hazards. Mapping accuracy is checked during field survey and then transferred to 1:100 000 scale pastoral lease plans.

SELECTION OF RCA SITES

Sites of approximately 10 ha in area are selected in reasonably extensive areas of preferred grazing country at 3 to 4 kms from water (Foran, 1980). They are adjacent to tracks for ease of relocation.

All waters in the more productive grazing country on a station are inspected with one or two sites established off most waters giving a total of 15 to 25 sites on most stations.

The site is marked on the ground with a steel picket and identified by an attached aluminium tag bearing the appropriate punched RCA number. The site is also marked on the relevant aerial photo to assist relocation in the event of the picket disappearing or tracks changing.

SITE LANDSCAPE PHOTOGRAPHY

Eye level, oblique, hand-held colour 35 mm slide and print photos (50mm focal length lens) are taken of each site focussing on a site identification blackboard 15 m from the picket. Approximately one fifth of the scene should be sky. The blackboard shows the station name, survey date and site number.

DATA COLLECTION

Two forms of data are collected at each site; data that is specific to the site area and data that pertains to the surrounding management area. The broad data groupings collected at each site include:-

- site location details
- description of site (landform, soils and vegetation type)
- site herbage species composition and appropriate benchmark composition
- seasonal growth response and rainfall
- forage condition and species utilization
- erosion
- tree and shrub information (both quantitative and descriptive)
- fire history
- site productivity limitations
- present and recommended land use
- range condition and trend
- seasonal grazing capacities
- site pasture yield
- estimated recent grazing pressure
- herbage species frequency

Data is transferred from the field sheets to a data base on the NTPS computer via customized data entry screens. The data can then be:-

- assembled into various types of reports using a low-level query language running on the mainframe computer
- analyzed using mainframe statistical packages such as SPSS
- downloaded onto office PCs for the compilation of station management reports
- assembled into matrices for multivariate analyses using software such as PATN or TAXON.

The relevant sections of the field survey sheets are shown for each of the following parameters.

SITE LOCATION

SITE LOCATION DETAILS

RANGE CONDITION ASSESSMENT

STATION ATARTINGA.. SURVEYOR ..BASTIAN..... SITE No. RCA.795
DATE 10/11/89. ECOUNIT ..... LANDSYS./UNIT .....
LANDFORM see list below* ....VEG ASSOC.....
MAP SHEET ..... PHOTOREF ..... WATERPT YOUR BORE TYPE PB.....
DIST./DIRECTION .3.2Km.E. PEG LOCATION ..N.SIDE..TRACK.....
AREA ASSESSED .150m..WIDE,.200m DEEP,..AVOID.ROCKY..OUTCROPS

(1) Site Number, Survey Date, Station and Assessor's Name.

Each site assessment or reassessment is uniquely identified by the RCA site number and survey date. In addition, the station name and assessor's name are recorded.

(2) Physical Location and Water Type

The distance and direction travelled from the closest water to reach the site is used to locate the site on the station.

The water type gives an indication of the permanency of the water and the likely grazing pressure on the site. The different water type codes are:-

Code	Water type	
NA	Not applicable (site in an enclosure or located off some other feature)	
TW	Temporary waterhole	Approximately
TE	Temporary earth structure (dam)	9 months supply
TB	Temporary bore	
PW	Permanent waterhole	
PE	Permanent earth structure (dam)	
PB	Permanent bore with pump	
PF	Permanent flowing bore	

Details on which side of the track the site is located and any additional information required to find the site should be recorded in the "Peg Location" space. The dimensions of the site should be recorded ("Area Assessed"), particularly where the site is variable and atypical parts such as sand ridges intrude.

(3) Photo Reference

As a permanent reference, the site location and number is marked on the relevant aerial photograph in ink and recorded on the data sheet by:-

- the National Mapping reference for the 1:250 000 map sheet (minus the prefix "S").
- the year of photography (e.g.71)
- the photo run (e.g. 03)
- the last two digits of the photo number (e.g. 49)
- the distance in mm from the western border of the photo - i.e. where the photo image commences (e.g. 109)
- the distance in mm from the southern border of the photo (e.g. 079)

In this case, the PHOTOREF would be recorded as 71-03-49-109079

SITE DESCRIPTION

RANGE CONDITION ASSESSMENT

STATION ..... SURVEYOR ..... SITE No. .....
DATE ..... ECOUNIT OPEN WOODLAND (1). LANDSYS./UNIT Ac.-18/1.
LANDFORM ....8.... VEG ASSOC. WHITEWOOD OVER ANNUAL GRASSES.....
see list below *
MAP SHEET ..... PHOTOREF ..... WATERPT ..... TYPE .....
DIST./DIRECTION ..... PEG LOCATION .....
AREA ASSESSED .....

(i) Pasture Type (= Ecounit) and Land System

Geology and geomorphology are the broad criteria used in classifying landscapes into land systems ("an area or group of areas throughout which there is a recurring pattern of topography, soils and vegetation"; Christian and Stewart, 1968). Component land units which are described by a consistent and repeatable landform, soil and vegetation pattern, are often common to a number of land systems. Where these land units are pastorally important, they are called "pasture types" (Bastin *et al.*, 1983). Thus, pasture types are identifiable with the landform/soil/vegetation units described within land systems by Perry *et al.* (1962) but can extend across a number of similar land systems.

The most appropriate pasture type that the site is representative of should be recorded. Where landscapes have not previously been encountered, they are added to an open-ended inventory of range types which should be adequately described on the data sheet and the ensuing range condition report for that station. Some of the more common pasture types encountered in the Alice Springs district are listed in Appendix One.

The land system number on which the site is located should be recorded. The most appropriate Perry *et al.*(1962) land unit (number) description of the site area within the land system should also be recorded.

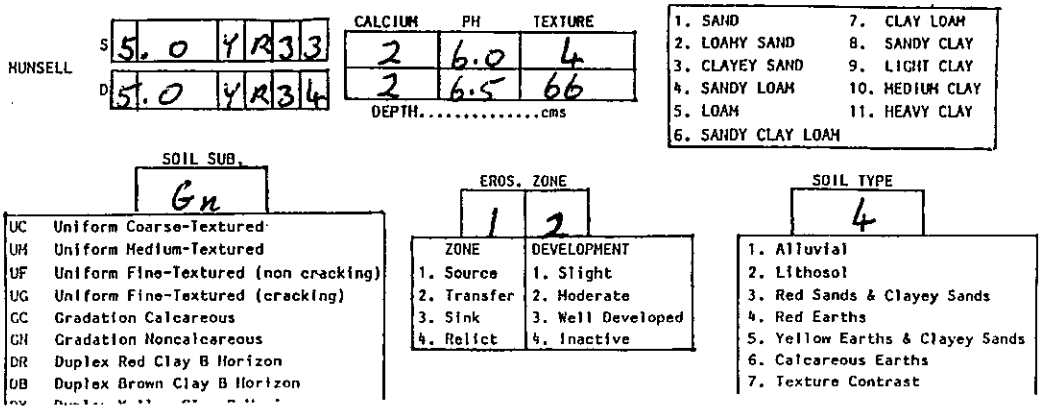
(ii) Landform and Vegetation Association

The most appropriate landform description from McDonald *et. al.*, (1984) is coded. The characteristics of each landform element are described in Appendix Two. These landforms have been given the following numbers:-.

Code	Landform
1	Hills
2	Low hills
3	Rise
4	Escarpment
5	Pediment
6	Pediplain
7	Peneplain
8	Plain
9	Sand plain
10	Dunefield
11	Playa plain
12	Terrace (alluvial)
13	Alluvial fan
14	Alluvial plain
15	Anastomotic plain
16	Bar plain
17	Covered plain
18	Flood plain

In addition, the floristic composition of major species' groups present in the woody and herbage layers should be recorded (Friedel and Squires, 1983) e.g. whitewood over mulga grass, open woodland over short grasses, mulga over perennial grasses etc.

(iii) Soils



Colour, Texture, Calcium, pH

A broad soil description is obtained to assist in pasture type classification and assessment of erosion hazard. The soil profile is described by digging a 50mm diameter auger hole to a depth of approximately 900mm (where soil depth will allow) and determining moist colour and texture - at the surface and at depth or where obvious horizon changes occur (F.A.O., 1977).

Moist soil colour is determined with a Munsell colour chart.

Moist soil is assigned to one of the following texture classes: (See Appendix 3 for greater detail)

Code	Texture
1	Sand
2	Loamy sand
3	Clayey sand
4	Sandy loam
5	Loam
6	Sandy clay loam
7	Clay loam
8	Sandy clay
9	Light clay
10	Medium clay
11	Heavy clay

0.1M HCL is used to test for the presence of calcium.

pH is measured at the surface and at depth with a CSIRO pH soil testing kit.

Soil Subdivision

Soils present are broadly described into a soil subdivision category (Northcote, 1979) according to texture change down the profile using the following codes.

UC	**Uniform Coarse Textured**	**DR**	**Duplex Red Clay B Horizon**
UM	**Uniform Medium Textured**	**DB**	**Duplex Brown Clay B Horizon**
UF	**Uniform Fine Textured** (non-cracking)	**DY**	**Duplex Yellow Clay B Horizon**
UG	**Uniform Fine Textured (cracking)**	**DD**	**Duplex Dark Clay B Horizon**
GC	**Gradational Calcareous**	**DG**	**Duplex Gley Clay B Horizon**
GN	**Gradational Noncalcareous**		

Characteristics of each subdivision or primary profile form (Northcote, 1979) are given in Appendix 4.

Soil type

The soil present on site is classified into a broad soil type. This description is broadly based on the soil groupings of Litchfield, 1962 pp 186 - 8. Additional soil types have been added from McDonald *et. al.,* (1984). Additional categories can be added where necessary provided such soil types are adequately described so as to be recognized by other people.

Soil types thus far encountered during survey are:-

Code	Soil Type
1	Alluvial
2	Lithosol
3	Red sands and clayey sands (= Earthy sands)
4	Red earths
5	Yellow earths and yellow clayey sands (of limited occurrence)
6	Calcareous earths
7	Texture contrast
8	Coarse-structured clays (cracking clay)
9	Calcareous sands
10	Siliceous sands
11	Grey-brown calcareous soil
12	Red calcareous soil
13	Desert loam
14	Brown clay
15	Red clay
16	Calcareous red earth
17	Stony red clay (eg clayey stony slope on Chandlers l.s.)

Erosion Zone

The erosion cell and it's level of development on which the site is located give an indication of site stability and allow a greater appreciation of likely seasonal pasture composition and biomass changes. The descriptive characteristics presented here are drawn from Pickup (1985) and are given in greater detail in Appendix 5.

Erosion Zones

Code	Zone	Characteristics
1	Source	Eroded area which sheds sediment following rainfall.
2	Transfer	Areas of alternating scour and fill as sediment passes slowly through zone.
3	Sink	Sediment accumulation
4	Relict	Stable, perched or inactive area

Development Levels

(a) Source Zone

Code	Development	Characteristics
1	Slight	Substantial islands of largely intact soil which support an original type vegetation. Areas with limited topsoil loss but not affected by scalding, rilling or gullying. Vegetation cover reduced and some tree death. Lag deposits of coarse particles often present.
2	Moderate	Areas of eroded topsoil dissected by scalds. Areas of exposed subsoil. Rills and gullies. Extensive sheetwash and wind erosion. Plants unlikely to survive except on eroding islands of top soil.
3	Well Developed	Bare exposed subsoil currently rapidly eroding - sheetwash, rills and gullies evident. Plants unlikely to survive as seeds easily removed and bare soil limits root penetration. Areas of bare ground where erosion has almost ceased. Exposed subsoil partly covered by coarse residual material which is difficult to transport. Colonization difficult because of poor nutrient status and hard surface.
4	Inactive	Generally applies to the Relict erozion zone

(b) Transfer Zone

Level of development is dependant on the rate of sediment transport and the amount of sediment available. It varies with the size of the erosion cell i.e. distance between source and sink zones. Sediment may rapidly move through small cells with a high transport capacity and the transfer zone will be poorly developed. Large cells, usually associated with major drainage lines and flat country have large amounts of sediment which may require many years (decades) to move through the zone.

Code	Development	Characteristics
1	Slight	Erosion cell is small in area. Adjacent source and sink zones are close together. e.g. transfer zone between upper fans and lower hillslopes.
2	Moderate	Moderate sized erosion cell allowing development of medium-sized transfer zones. Many of the surface types characteristic of transfer zones will have developed.
3	Well Developed	Source and sink zones widely separated giving rise to large transfer zone. Discrete waves of sediment visible moving through the zone giving rise to an alternating pattern of erosion and deposition.
4	Inactive	Generally applies to the Relict erozion zone

(c) Sink Zone

Sinks are relatively uniform features. Some minor variations occur depending on whether the particular area is currently experiencing deposition and the frequency at which deposition occurs.

Code	Development	Characteristics
1	Slight	Deposition occuring in virtually every flood. Rapid build-up of sediment. Usually located on channel systems within the sink and tend to be wetter than other locations.
2	Moderate	Deposition during major flood events. Older surfaces with slower accumulation as there is less chance of burial by new sediment.
3	Well Developed	Deposition virtually ceased. Usually oldest areas of sink. May be mounding of material around shrubs or fallen timber. May be slight erosion e.g. thin surface layer of coarser particles.
4	Inactive	Generally applies to the Relict erozion zone

HERBAGE SPECIES COMPOSITION

HERBAGE SPECIES COMPOSITION

(i) RELICT

The relict for that pasture type provides a benchmark against which the herbage species composition of the assessment site is compared to obtain a STARC score (Lendon and Lamacraft, 1976). Relict species compositions are of two forms:-

(i) Exclosures or lightly grazed areas which historically are little affected by grazing and on which the species composition forms a good basis for a benchmark.
(ii) Relicts constructed from a knowledge of species behaviour under grazing. These are used for highly preferred pasture types where it is not possible to locate areas in good or excellent condition.

Seasonal variation in species composition can be fairly confidently incorporated into the first type of relict as physical areas can be assessed and modified as required. The confidence associated with constructed relicts varies with seasonal conditions and the experience of the survey team.

(ii) ON SITE

Pasture yield, herbage species composition and species frequency present on site are estimated using a modified Comparative Yield and Dry Weight Rank procedure.

The site area should be defined before commencing the assessment with a collective decision made as to whether to exclude atypical areas intruding into the site (eg sand ridges, alluvial depressions). Where the site area is large and uniform, an area of approximately 150 m square is used for the herbage assessment.

Data is collected on a Sharp PC1500A pocket computer using the DWR program (Appendix 7).

The assessment involves the following procedure:-

1. Establish photo standards for comparative yield determination by placing and photographing quadrats which show a sequential increase in dry matter biomass. This should cover typical herbage species compositions and forms which are likely to be assessed.

2. Collect data on pasture yield, species composition and frequency in a $1m^2$ quadrat at 50 locations across the site. Divide the site area into 7 approximately equidistant transects and locate 7 approximately equally spaced quadrats along each transect. One additional randomly located quadrat is measured at the end.

3. Within each quadrat, use the DWR program in the SHARP PC1500A to record:-

   (i) the dry matter comparative yield estimate on a 25 point scale from 0 to 7.0 (i.e. 0, 0.25, 0.5, 0.75, 1.0 ..... 7.0) using photo standards where Standard 0 = bare ground; Standard 1 = 100 g/m^2; standard 2 = 200 g/m^2; ...Standard 7 = 700 g/m^2.

   (ii) first 3 species in biomass rank - ie species composition. Correct for species utilisation so that the grazed site is not penalized.

   (iii) other herbage species present - ie species frequency.

Additional Notes on Dry Weight Rank

At each quadrat location, estimate which species occupy first, second and third places in terms of dry weight. Grazed species should be adjusted upwards to their estimated pre-grazed size to correct for utilisation.

If one species occupies more than 85% of the quadrat yield, it is given first and second rank.

If two species are very close in their amount of dry matter, they are given equal rank.

If only one species is present in a quadrat, it receives all three ranks.

If only two species are present, ranks 1 and 2 are normally allocated to the dominant species. However, where the two species have an approximately equal dry biomass, each species is given half of the total rank score.

(iii) COMPARATIVE YIELD PHOTO STANDARDS

1. Requirement

An expanding inventory of photo guides for comparative yield estimation is required as new range types, herbage phenologies and plant forms are encountered. A field album should be carried on station surveys from which the most appropriate guides can be selected at each site.

2. Preparation

(i) Quadrat Placement

For the required photo standard, place paired quadrats to contain the estimated required dry weight biomass. Clip one quadrat, weigh the contents and after estimating for moisture content, determine the estimated dry weight. Relocate quadrats as necessary until the desired standard is obtained.

(ii) Photography

Take oblique and vertical colour print photographs of the unclipped quadrat. Use a camera with a 50 mm lens and a shutter speed of 125 (250 if the vegetation is being disturbed by wind). The oblique photo should be taken at eye level (170 - 180 cms height) standing 1.5 m from the front edge of the quadrat. Use a painted stick (50 mm gradations) placed near the tallest vegetation to indicate its height. The vertical photo should be taken from about 3 m above the quadrat (stand on canopy of Toyota) with a matchbox used to indicate scale.

(iii) Actual Quadrat Weight.

Harvest and weigh the major species within the photographed quadrat (bulk minor species). Oven dry and weigh this material to determine moisture content and actual dry weight.

3. Filing Photo Standards

(i) Colour Prints

Maintain both an office and a field copy of all photo standards (one standard per page with additional pages inserted as necessary).

For each photo:-

- record the comparative yield standard
- actual dry weight (gms per sq m)
- the dry weight of the major species
- the moisture content of the major species

eg 0.5 (56 g) SCDV (36 g; 50%) SAKA (14 g; 43%) OTSP (4 g; 5%)

(ii) Negatives

File the negatives by photo standard and date so that they can be relocated for additional reprints as required.

4. Using Photo Standards

The photo standards are used as a memory guide to assist in scoring comparative yield on assessment sites. Quadrats with a very low biomass, but which have identifiable species present, should be scored as an estimated proportion of the lowest comparative yield increment (eg 1 $g/m^2 = 0.01$, 15 $g/m^2 = 0.15$). The comparative yield score of zero should be reserved for completely bare-ground quadrats (ie scalds or areas which have no discernable plant species).

RECORDING SITE DATA

Relict composition information is recorded for each relevant species on the field data sheet.

Actual site species (and frequency) composition data can either be:-

- transferred from the PC1500A screen to the field data sheet
- printed out using the Sharp CE-150 printer interface with the printout stapled to the field data sheet
- saved on cassette tape for later transfer to an office PC. If doing this, be sure to also obtain a summary printout in case problems are later encountered in reading data off the cassette tape.

FEED CONDITION

FEED CONDITION

SEASON	1			1 SUMMER 3 MIXED 2 WINTER			
SEASONAL RNFL.	180			mm.			
				P structure	A of relict	V of relict	CODE
DESIREABLES	2	3	2	Gr.	Ab.	Go.	1.
UNDESIREABLES (All increasers of relict)	2	1	1	XO/GU	M.A.	Fo.	2.
EPHEMERALS (Non increasers)				Dry	Sp.	Po.	3.

(i) Season

The season of pasture growth response being assessed is recorded. Summer rains (Code 1) grow predominantly grasses, winter rains (Code 2) promote germination of winter-growing ephemeral forbs while late summer rains and follow-on winter rains (mixed response - Code 3) can promote the growth of both grasses and winter forbs.

(ii) Seasonal Rainfall

The approximate rainfall contributing to the pasture growth response being assessed is estimated or figures obtained from the Homestead are used as a guide. This may be either a single rainfall event or in a good growing season, the cumulative rainfall over several weeks. Known rainfall recordings from surrounding stations can also be a useful guide when estimating effective rainfall.

The survey team should make allowance for seasonal rainfall variation across extensive stations as judged by marked differences in pasture growth response, runoff into dams etc.

(iii) Forage Phenology, Abundance and Vigour.

This matrix provides an assessment of the maturity, relative abundance and vigour of the different components of the pasture.

The phenology/abundance/vigour codes are:-

Phenology	Abundance	Vigour
1 Green 2 Drying off or greening up 3 Dry	1 Abundant 2 Moderately abundant 3 Sparse	1 Good 2 Fair 3 Poor

DEFINITIONS

Definitions of Phenology, Abundance and Vigour

Phenology is the absolute level of greeness or maturity of the species group being assessed. That is, if the majority of the biomass of the species being assessed is drying off while a small proportion is dry, then the overall phenology is "drying off".

Abundance is scored on the amount of forage present on the site at the time of survey compared to the potential forage expected on the ungrazed relict under similar rainfall. That is, it is the amount of ungrazed forage remaining which is a function of both grazing pressure and range condition.

Vigour of species groups during their growth cycle is compared to that expected on the ungrazed relict receiving similar rainfall. Attributes of plant vigour which should be considered are:-

Good Vigour - robust
- well formed
- maximum height
- normal colour
- producing abundant leaf
- producing abundant seed stalks
- producing abundant shoots or tillers

Poor Vigour - short
- poorly formed
- unthrifty
- few seed stalks and seed heads
- dying or barely existing

Desirables are palatable species which tend to decrease on that pasture type with grazing. They are present on sites in good condition in similar proportions to that expected on the relict and form a lower proportion on sites in poorer condition.

Undesirables are less palatable species on that pasture type which tend to increase with grazing. They are present on sites in good condition in similar proportions to that expected on the relict and form a higher proportion on sites in poorer condition. Short-lived species which increase under heavy grazing (e.g. *Fimbristylis* spp., *Helipterum floribundum*) should be regarded as undesirable.

Ephemerals are those short lived species which are present in acceptable proportions due to seasonal conditions e.g. winter growing *Helipterum* and *Helichrysum* species; pioneer-type species present after a drought.

Ephemerals should not be assessed once they have become largely litter.

(iv) Forage Species Utilization

UTILIZATION of KEY FORAGE SPECIES

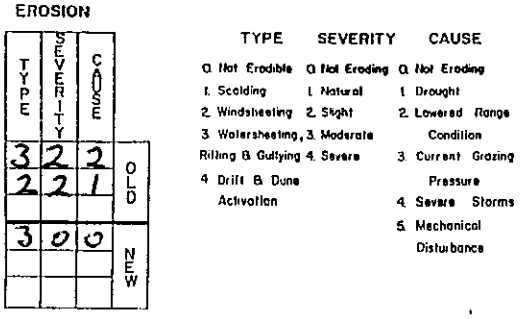
SPECIES	0	1.	2.	3.	4.	5.	6.	7.
DICO					✓			
EHPO			✓					
ARCO		✓						
	N.A	1. - 10 % GRAZED	11. - 25. % GRAZED	26. - 50. % GRAZED	51. - 75. % GRAZED	76. - 90. % GRAZED	91. - 99 % GRAZED	100 % GRAZED

The relative overall percentage biomass of key forage species removed by grazing is recorded. Key forage species are palatable species which tend to decrease under grazing. Grazing of less palatable species on low preference pasture types or sites in poor range condition should be recorded when more palatable species are absent. Up to 4 species are recorded. Where an area is destocked or the site area has not yet been grazed, then forage species utilization should be recorded as "not applicable". The standing biomass of key forage species at the time of assessment is compared with that expected to have been present prior to grazing.

The scoring system is designed so that a decision is first made as to whether more or less than 50% has been grazed: if less, then more or less than 25% has been grazed; if less, then more of less than 10% and so on for the other possible scores.

SOIL SURFACE STATUS

The age, type, severity and cause of on-site erosion is assessed. There is provision for recording up to three types of erosion.



(i) Age of Erosion

Old erosion is erosion caused by water or wind that has occurred prior to the onset of the last significant rainfall event. That is, it may be old, stabilized wind or water erosion (e.g. occurred during the 1958-65 drought) or it may be potentially active water-induced erosion which has temporarily stabilized over the last significant rainfall event.

New erosion is recent, and generally continuing, water erosion reactivated during the last significant rainfall event or is recent/current wind erosion occurring due to low cover levels on a susceptible soil surface.

(ii) Types and Severity of Erosion

The range of possible scores within each category are:-

Type	Severity	Cause
0 Not erodible 1 Scalding 2 Windsheeting 3 Watersheeting, rilling and gullying 4 Drift and dune activation	0 Not eroding 1 Natural 2 Slight 3 Moderate 4 Severe	0 Not eroding 1 Drought 2 Lowered range condition 3 Current grazing pressure 4 Severe storms 5 Mechanical disturbance

There is provision to record up to three types of "old" or "new" erosion at each site; eg water and wind induced erosion may be present. The single most appropriate cause of erosion being assessed (on or off site) should be recorded.

The "not eroding" code is used on non-erodible soil types - eg Mitchell grass plains.

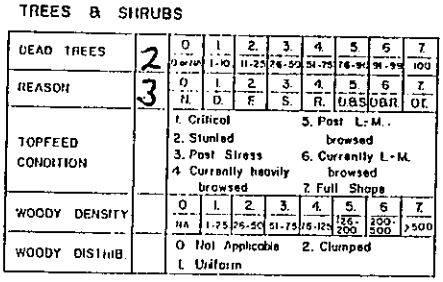
Where there is no "new" erosion, the type of erosion that the soil type is most susceptible to is assigned while Severity and Cause are recorded as "not eroding".

Detailed information on types and severities of erosion are presented in Appendix 6.

DESCRIPTIVE TREE AND SHRUB INFORMATION

This section qualitatively describes the tree and shrub layer as distinct from a later section in the manual which provides mainly quantitative woody information. *Maireana* (Bluebush) and *Atriplex* (Saltbush) species are regarded as subshrubs and not assessed in this section.

(i) Dead Trees and Reason



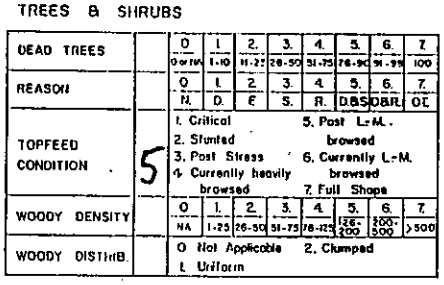
The proportion of dead erect and fallen trees and shrubs is estimated as a proportion of all woody plants present. The scoring method works in the same way as for estimating forage species utilization; i.e. are there more or less than 50% of the total woodies dead?; if less, are there more or less than 25%?; etc

Sites with no dead trees or shrubs should be recorded as "0" for "not applicable".

The predominant cause of tree or shrub death should be recorded according to the following code:-

Code	Reason
0	Natural mortality (e.g. old age or natural thinning through competition) OR no tree death OR no woodies present on site
1	Drought
2	Fire
3	Intense browsing by stock (cattle, horses, camels etc)
4	Rabbit damage e.g. ringbarking, browsing stress
5	Combined stress of cattle browsing and drought
6	Combined stress of rabbits and drought
7	Other causes e.g. mistletoe, insects

(ii) Topfeed Condition



The form and vigour of accessible topfeed species as a whole is compared to that of equivalent ungrazed plants present in an exclosure or on a relict site.

The allowable condition classes are:-

Code	Description
0	Not applicable - no topfeed species present
1	Topfeed plants are in a **critical** state with no sign of recovery shoot production; they are dead; dying; or barely existing as relics
2	All topfeed plants have a general stunted or malformed appearance; **show severe signs of stress** due to grazing and have an abnormal proportion of dead wood, broken branches etc.
3	Many topfeed plants have as a result of **past** browsing a much reduced canopy; **signs of stress** due to browsing e.g. suppressed new shoot production, an obvious browse line
4	Many topfeed plants are **currently being heavily browsed** with many broken branches and trees showing stress
5	Some topfeed plants have as a result of **past** browsing a less dense canopy; less even shape or signs of past browsing but **recovery growth made**
6	Some topfeed plants are **currently** being lightly or moderately browsed.
7	All topfeed plants have **a full even shape** and an optimum canopy.

N.B. Do not assess Bluebush or Saltbush as topfeed species.

(iii) Woody Density and Distribution

TREES & SHRUBS

DEAD TREES		0 0 NIL	1 1-10	2. 11-25	3. 26-50	4. 51-75	5 76-90	6. 91-95	7. 100
REASON		0 N.	1 D	2 F	3. S.	4. R.	5 D&S	6 D&R.	7. OT.
TOPFEED CONDITION		1. Critical 2. Stunted 3. Past Stress 4. Currently heavily browsed					5. Post L-M. browsed 6. Currently L-M. browsed 7. Full Shape		
WOODY DENSITY	6	0 NA	1. 1-25	2. 26-50	3. 51-75	4. 76-125	5. 126-200	6. 200-500	7. >500
WOODY DISTRIB	1	0 Not Applicable 1 Uniform					2. Clumped		

The density of **all** live trees and shrubs present on site is compared to that of the appropriate relict for that site using the following density groups:-

Code	Density
0	Not applicable - i.e. no live woodies present on site
1	Density of all live woodies is 1-25% of relict
2	Density of all live woodies is 26-50% of relict
3	Density of all live woodies is 51-75% of relict
4	Density of all live woodies is about equivalent to that of the relict (76-125%)
5	Density of all live woodies is 126-200% of the relict due to woody increase or invasion
6	Density of all live woodies is 2 to 5 times that of the relict
7	Density of all live woodies is greater than 5 times that of the relict

N.B. The density of Bluebush and Saltbush is not normally assessed when present - i.e. code "0" for "not applicable" if they are the only woody-type species present.

The distribution of trees and shrubs across the site is recorded as being either "**uniform**" or "**clumped**". A uniform distribution is characterised by a more or less random distribution across the whole site (e.g. an open woodland free of any shrub increase). A clumped distribution has the appearance of patchiness caused by small groupings or thickets of trees or shrubs interspersed by relatively open areas across the site e.g. thickets of *Acacia murrayana* on a sandy open woodland or *Cassia nemophila* increase on a calcareous grassland.

(iv) Woody Species that increase

INCREASER WOODY Spp. # woody density 4

Spp.	MATURE			JUVENILE		
	D	E	C	D	E	C
CAHE	6	2	2	7	1	2
ACES				7	2	4

DENSITY - same as WOODY DENSITY

EFFECT - same as PRODUCTIVITY LIMITATIONS

CONTROL - 0. Not Necessary
1. Cool Burn
2. Cool Burn, little fuel
3. Hot Burn
4. Hot Burn, little fuel
5. No Effect

Where the woody density on site is greater than that of the corresponding relict, information about the individual species (or species' groups) causing this increase should be recorded. Specifically, information is recorded for juvenile and mature forms of species' densities, the effect that this density is having on pasture growth and whether some form of control using fire is appropriate. Seedlings (<0.1m high) of all species are ignored as they are both very difficult to detect and their chances of survival are uncertain.

Maturity Level

	Trees and tall shrubs (eg. whitewood, mulga)	Medium shrubs (eg. Cassia)
MATURE	>2 m high	>0.5 m high
JUVENILE	0.1-2 m high	0.1-0.5 m high

Examples of trees and tall shrubs, and medium shrubs commonly encountered are:-

Trees and tall shrubs

ACAN *Acacia aneura*
ACES *A. estrophiolata*
ACKE *A. kempeana*
ACLI *A. ligulata*
ACTE *A. tetragonaphylla*
ACVI *A. victoriae*
ATHE *Atalaya hemiglauca*
CALI *Canthium lineare*
EUTE *Eucalyptus terminalis*
GRST *Grevillea striata*
HALE *Hakea leucoptera*
HASP { *H. eyreana*, *H. suberea*
VEVI *Ventilago viminalis*

Medium shrubs

CAAR *Cassia artemisioides*
CAHE *C. helmsii*
CANE *C. nemophila*
CANZ *C. nem var zygophylla*
CAOL *C. oligophylla*
CAST *C. sturtii*
ENTO *Enchylaena tomentosa*
ERGI *Eremophila gilesii*
ERLA *E. latrobei*
ERLO *E. longifolia*
ERST *E. sturtii*
JALI *Jasminum lineare*
MASP *Maireana sp*
RHSN *Rhagodia spinescens*

DENSITY, EFFECT and CONTROL CATEGORIES for Woody Species that increase

The range of possible scores within each category are:-

Density

5 126 - 200% of relict
6 2-5 times relict
7 Greater than 5 times relict

Effect

1 No Effect
2 Slight Effect
3 Moderate Effect
4 Severe Effect

Control

0 Burning not necessary
1 Cool burn
2 Cool burn but insufficient fuel
3 Hot burn
4 Hot burn but insufficient fuel
5 Burning will not aid control

A more detailed description of these codes follows.

Density of Woody species increase

The densities of up to 3 juvenile and/or mature tree and shrub species (or species' groups) that have increased on site are recorded in the same way as for total woody density. That is:-

Code	Density
5	Density of that juvenile and/or mature species is 126-200% of the relict
6	Density of that juvenile and/or mature species is 2 to 5 times that of the relict
7	Density of that juvenile and/or mature species is greater than 5 times that of the relict

Effect of Woody species increase

The current effect of each juvenile and/or mature increaser woody species (or species' group) on site productivity (pasture growth potential and grazing capacity) is recorded.

Code	Effect
1	Increase of that species is having no adverse effect
2	Increase of that species is having a slight effect. The density and vigour of pasture species is slightly reduced due to shading, competition for moisture, nutrients etc.
3	Increase is having a moderate effect on pasture growth. Pasture vigour and density is considerably reduced through competition with that woody species
4	Increase is severely restricting pasture growth. Pasture vigour and density is low; grasses are greatly suppressed; ephemerals predominate in a sparse pasture, considerable bare ground present.

Control of Woody species increase

Controlled burning is the only economically feasible method of reducing a broad scale woody weed problem. Record the most appropriate burning strategy required to control the increase of that juvenile and/or mature species or species group.

Code	Fire Control Method
0	Burning not necessary-that species has not, or is not likely to, reach a density where thinning will be necessary
1	Cool burn is recommended and fuel loads are adequate to carry such a fire e.g. juvenile mulga
2	Cool burn is recommended but fuel loads are presently insufficient to carry such a fire
3	Hot burn is recommended and adequate fuel is available e.g juvenile ironwood
4	Hot burn is recommended but fuel loads are presently insufficient to produce an intense fire
5	Burning will not aid control as that species is no longer sufficiently susceptible to fire

FIRE HISTORY

FIRE

TIME	5	0 None	1 <3mth	2 3-12mth	3 1-2 yrs	4 2-10 yrs	5 >10 yrs
SEVERITY	1	0 NONE, 1. LIGHT, 2. HOT					

Where a site has been burnt at some time in the past, both the relative age of the most recent fire and it's severity (as judged by it's effect on the vegetation) should be recorded into one of the following categories.

Time Since Fire

0 No fire
1 Less than 3 months
2 3 to 12 months
3 1 to 2 years
4 2 to 10 years
5 greater than 10 years

Severity

0 No fire
1 Cool fire
2 Hot fire

A more detailed description of these codes follows:

(i) Time Since Fire

Code Time

0 No signs that site has ever been burnt

1 Very recent fire - less than 3 months. Effect of fire very obvious; woodies still dying; ground blackened; some resprouting of perennials and germination of ephemerals if sufficient moisture available.

2 Recent fire - 3 to 12 months. Some resprouting of woodies that survived fire; woodies that didn't survive fairly obvious; dead or dying; charcoaled ground surface still visible; subsequent resprouting and germination of pasture species occurring dependant on intervening rainfall.

3 1 to 2 years. Pasture almost fully recovered; good cover of grasses and forbs if intervening rainfall satisfactory. Dead trees with blackened twigs obvious.

4 2 to 10 years. Pasture composition fully recovered; resprouting of fire tolerant woodies extensive; germination and growth of fire sensitive woodies to form juvenile storey below dead trees; blackened tips still apparent on dead trees.

5 Old fire - greater than 10 years. Only the bigger dead trees still standing; signs of charcoal on stumps and trunks of those dead trees.

(ii) Fire Severity

Code Severity

0 The site has not been burnt

1 Cool fire producing a light singe. Majority of woodies only slightly affected.

2 Hot fire - Majority of woodies (particularly mulga) killed; leaves scorched off trees; smaller twigs burnt.

SITE PRODUCTIVITY LIMITATIONS

PRODUCTION LIMITATIONS c.f. RELICT

EROSION	3
SALINITY	1
STONES	1
RABBITS	1
ROOS	2
INSECTS	1
POISON PLANTS	2

SEVERITY CODE
0. Not Applicable
1. No Limitation
2. Slight Limitation
3. Moderate Limitation
4. Severe Limitation

The extent to which various factors are affecting pasture growth on site and the ability of the site area to carry cattle are recorded. The limiting effects of intrinsic site factors such as salinity, stoniness, erosion and, to a lesser extent, poisonous plants should be scored with respect to the relict for that pasture type; e.g. a certain amount of stone occurs naturally on clayey stony slopes; saltbush plains will have some inherent salinity; and cottonbush flats, as transfer zones, tend to be naturally dynamic and show some evidence of erosion.

A severity code is given for each of the following factors which can potentially reduce site productivity.

Erosion - including scalding as a form of erosion

Salinity - a natural feature of some landscapes

Stoniness - as a component of normally low stone content pasture types or sites with stone mantling as a result of accelerated erosion.

Rabbits - both as they compete for available forage and their effect on range condition

Kangaroos - their competitive effect on available forage. Kangaroo numbers and effect will vary with pasture type (i.e. their preferred habitat) and season

Insects - including termites as forage consumers, seeds harvesters etc. Termites are a natural component of some pasture types

Poisonous - abundance determined by site factors, season and Plants range condition.

The severity of each factor, with respect to the relict where appropriate, should be scored as:-

Code	Severity
0	Not applicable
1	No limitation
2	Slight limitation
3	Moderate limitation
4	Severe limitation

Generally it is more appropriate to use the code '1 = No limitation', than '0 = N.A.' where a particular factor (e.g. rabbits) is having no effect on the site.

GRAZING USE AND LAND CAPABILITY

This section is intended to provide information on both present management and the future management that the survey team considers is most appropriate for both the site area and the surrounding paddock or water management area.

PRESENT USE	17	11 Breeders 12 Weaners 13 Steers / Bullocks 14 Store Country 15 Drought reserve country 16 Main holding &/or trucking area 17 Mixed Age & Sex cattle 18 Horse paddock 19 Area Destocked - dam dry or bore pulled 20 Site within an Exclosure & therefore not stocked
REC. USE (SITE)		
REC. USE (PADDOCK)		
LAND MAN. (SITE)		0 N.A. 0. N.A. 1 Cont H Stocking 1. Pitting 2 Inter H Stocking 2 Ponding 3 Cont M Stocking 3 Combination 4 Inter M " 4. Destock 5 Cont. L. " 6 Inter L. " 7 Unsuitable
LAND MAN. (PADDOCK)		
DRT. USE (SITE)		1. SOFT 2. INTERMEDIATE 3. HARD
DRT. USE (PADD)		

(i) Present Land Use

The predominant class of cattle present on the management area (and hence, on the site) should be recorded. Some areas may be temporarily destocked because of lack of water or be in special purpose areas such as an exclosure. Thus, not all codes specifically refer to grazing use by cattle.

Code	Type of Stock or Land Use
11	Breeders
12	Weaners
13	Steers or bullocks for fattening
14	Store country - inferior breeding country producing store steers or heifers for turnoff.
15	Country destocked and held for drought reserve
16	Main holding and/or trucking area
17	Mixed age and sex cattle
18	Horse paddock
19	Destocked area because dam dry or bore pulled or unserviceable
20	Site within an exclosure and therefore not stocked

(ii) Recommended Land Use

PRESENT USE		11 Breeders 12 Weaners 13 Steers / Bullocks 14 Store Country 15 Drought reserve country 16 Main holding &/or trucking area 17 Mixed Age & Sex cattle 18 Horse paddock 19 Area Destocked - dam dry or bore pulled 20 Site within an Exclosure & therefore not stocked
REC. USE (SITE)	13	
REC. USE (PADDOCK)	11	
LAND MAN. (SITE)		0 N.A. 0. N.A. 1 Cont H Stocking 1. Pitting 2. Inter.H Stocking 2. Ponding 3. Cont M Stocking 3 Combination 4 Inter M. " 4. Destock 5 Cont. L. " 6 Inter L. " 7 Unsuitable
LAND MAN. (PADDOCK)		
DRT. USE (SITE)		1. SOFT 2. INTERMEDIATE 3 HARD
DRT. USE (PADD.)		

Recommended land use is recorded in two parts:-

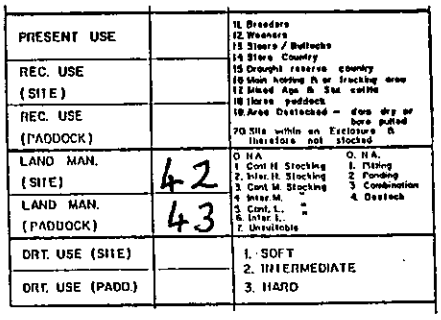
1. **Site Area** - i.e. as the most appropriate land use for the site as an example of that pasture type regardless of the area physically available.

2. **Management Area** in that paddock or around that water (where there are no paddocks) - i.e. the most appropriate grazing use for the general type of country present. This is determined by inspections made along station tracks and interpretation of patterns on the aerial photos.

   The same code as for 'Present Land Use' is used. A guide to the general type of country associated with different forms of recommended land use is:-

Code	Land Use	General Type of Country
11	Breeders	Harder country with mainly unpalatable pasture types e.g. mulga, spinifex with fire management.
12	Weaners	Open country with palatable pasture types where smaller paddocks are already available or can be easily erected and close to main yards.
13	Fattening	Palatable pasture types e.g. open woodlands, calcareous shrubby grasslands
14	Store country	Inferior breeding country which is only capable of turning off store cattle for fattening elsewhere - e.g. extensive areas of mulga perennial or spinifex sand plain.
15	Drought reserve	Hard resilient, low carrying country e.g. mulga perennial, spinifex
16	Main holding/trucking area	Small paddocks adjacent to major yards.
17	Mixed age and sex cattle	Small pockets of softer country suitable for fattening amongst harder breeding country i.e. breeding and fattening.
18	Horse paddock	Generally smaller paddocks free of *Indigofera, Swainsona* etc and close to Homestead

(iii) Recommended Land Management



The most appropriate grazing intensity and any reclamation measures required are recorded for both the site area (as an example of the broader pasture type) and management area (paddock or water). The pasture types present in the management area are determined by inspections along station tracks and photo interpretation.

Recommended Land Management Categories

The range of possible scores within the Grazing Intensity and Reclamation categories are:-

	Grazing Intensity		Reclamation
0	Not applicable	0	Not necessary
1	Continuous heavy stocking	1	Pitting and/or seeding
2	Intermittent heavy stocking	2	Structural measures
3	Continuous moderate stocking	3	Pitting and structural measures
4	Intermittent moderate stocking	4	Short term destocking
5	Continuous light stocking		
6	Intermittent light stocking		
7	Unsuitable for grazing		

A more detailed description of these codes follows:-

Grazing Intensity

A guide to the general type of country associated with each grazing intensity category is:-

Code	Grazing Intensity	General Type of Country
0	Not applicable	e.g. an exclosure
1	Continuous heavy stocking	Highly productive resilient country e.g. Mitchell grass plains.
2	Intermittent heavy stocking	Highly productive but erodible country e.g. Cottonbush flats.
3	Continuous moderate stocking	Productive and fairly stable country e.g. open woodlands in good condition.
4	Intermittent moderate stocking	Seasonally productive but erodible country e.g. calcareous shrubby grasslands in fair to good condition.
5	Continuous light stocking	Stable lower preference grazing country e.g. mulga annual in fair condition, mulga perennial with supplements.
6	Intermittent light stocking	Ephemeral country with erodible soils, e.g. open woodlands and calcareous shrubby grasslands in poor condition
7	Unsuitable for grazing	Country in lowered condition which if destocked would recover OR wastelands OR very low carrying country (not likely to be assessed anyway)

Reclamation

Rehabilitation that would allow the site or management area to recover in condition and productivity should be indicated. Reclamation costs may prohibit the treatment of large areas.

The different forms of rehabilitation that are considered appropriate include:

Code	Method of Reclamation
0	Not necessary or not economically feasible
1	Pitting and/or seeding with buffel grass
2	Structural measures (e.g. ponding banks) required to reduce runoff and erosion.
3	Both pitting and structural measures required
4	Short term destocking would allow a recovery in current reduced condition.

(iv) Drought Use

PRESENT USE		11 Breeders 12 Weaners 13 Steers / Bullocks 14 Store Country 15 Drought reserve country 16 Main trading B or breeding area 17 Mixed Age & Sex cattle 18 Horse paddock 19 Area Destocked - dams dry or bore pulled 20 Site within an Exclosure & therefore not stocked
REC. USE (SITE)		
REC. USE (PADDOCK)		
LAND MAN. (SITE)		0 N.A. 0. N.A. 1 Cont M. Stocking 1. Pitting 2. Inter M. Stocking 2 Ponding 3. Cont M. Stocking 3 Combination 4 Inter M. " 4. Destock 5 Cont L. " 6 Inter L. " 7 Unsuitable
LAND MAN. (PADDOCK)		
DRT. USE (SITE)	2	1. SOFT 2. INTERMEDIATE 3. HARD
DRT. USE (PADD)	2	

The most appropriate form of drought management is recorded for the site (as an example of the broader pasture type) and management area (paddock or water). The area involved is rated on both it's resilience and ability to supply edible forage in a major drought.

Code	Drought Rating	General Type of Country
0	Not applicable	e.g. an exclosure
1	Soft country	Fragile country with mainly annual herbage species and erodible soils e.g. calcareous shrubby grassland
2	Intermediate	Reasonably stable soils; mixture of annuals and perennials; topfeed within reach; run-on country that responds quickly to storms, e.g. open woodland in fair to good condition.
3	Hard country	Stable soils; moderate to good supply of **edible** dry feed; topfeed accessible e.g. stable timbered drainage lines with perennial grasses, hills and lower accessible ranges, mulga country with supplementation, spinifex country with fire management.

CONDITION AND TREND

STARC.	60	
GUTFEEL	55	
TREND	-5	
GRAZ. CAP (SITE)		
GRAZ. CAP (PADD)		
DRT. GRAZ. CAP (SITE)		
DRT. GRAZ. CAP (PADD.)		
YIELD		C. of V:=
SITE TYPICAL		
GRAZ. INTENSITY		

A subjective summary of the ecological data collected on site is recorded.

(i) STARC Condition Score

The STARC condition score of Lendon and Lamacraft (1976) is calculated for the site by comparing the herbage species composition present against that on the relict area. Each species contributes no more to the site condition score than its percentage presence in the relict composition.

(ii) Estimated Condition Score

This is the consensus intuitive condition score on a 0 - 100 scale determined by the survey team. It is based on pasture composition and amount, soil surface status and woody form and density compared to the relict (if physically accessible) or the assessor's perception of the relict. Often the STARC condition score, to the nearest 5 unit increment, will provide a good indicator of condition which may then be adjusted downwards in 5 unit increments for poor pasture growth; past or continuing erosion; heavy browsing and decrease of topfeed on calcareous land systems or woody increase on other land systems. Alternatively, the STARC score may be marginally increased where very good pasture growth has occurred or where a potential woody weed problem has been controlled.

(iii) Trend

A subjective assessment of the rate of any medium to longer term degradation or regeneration on the site is made at the time of survey. This assessment is in 5 unit increments on a scale of -50 to +50.

Factors important in the assessment of trend are pasture and litter cover levels for soil protection; active erosion (area affected, rate of erosion, susceptibility to erosion); pasture species vigour; woody density, cover and regeneration; fuel levels for possible fire management; feral animals and levels of grazing management. Short term seasonal responses should be downrated with emphasis placed on longer term ecological indicators.

A guide to the assessment of range trend is:-

Trend Score	Indicators of Rate of Change
-35 to -50	Very rapid degradation; severe overgrazing, rapid accelerated erosion, drastic shrub increase.
-15 to -30	Rapid degradation; overgrazing, loss of vigour and death of perennial grasses, small areas of active erosion, rapid shrub increase.
-5 and -10	The most likely category; slow deterioration; general lack of positive grazing management; heavy grazing of perennials and preferred annual grasses, seasonal use of topfeed, occasional reactivation of old erosion, small areas of shrub increase.
0	Apparent stability
+5 and +10	Visible recovery with lighter stocking or better seasons, slow recruitment and increase in vigour of desirable species, some stabilization of active erosion by plant colonization, minor recruitment of decreaser topfeeds, death of potential woody weeds.
+15 to +30	Rapid recovery with destocking and positive management to control erosion, feral animals etc; dense vigorous perennials and palatable annuals establishing, former active erosion virtually arrested, woody weeds eliminated by controlled burning.
+35 to +50	Not likely to be encountered, but if occurring, then directly attributable to good seasons in conjunction with positive land management. The above characteristics visible in an amplified form.

GRAZING CAPACITIES

STARC.		
GUTFEEL		
TREND		
GRAZ. CAP. (SITE)	8	
GRAZ. CAP. (PADD)	5	
ORT. GRAZ. CAP. (SITE)	2	
ORT. GRAZ. CAP. (PADD.)	3	
YIELD		C. of V:=
SITE TYPICAL		
GRAZ. INTENSITY		

The year long "safe" grazing capacities for the site (as an example of the broader pasture type) and management area (paddock or water) for a normal season and drought year are estimated. "Safe" grazing capacities are those that the survey team consider will maintain range condition at its present level. The country present in the management area is determined by inspections made along station tracks and interpretation of photo patterns.

A **normal** season is one in which the majority of the approximate average annual rainfall falls during the summer months while a **drought** year occurs after the failure of two consecutive summer rains.

Grazing capacities are estimated on a square mile basis in the field but converted to sq. kms. (divide by 2.59) for entry on the computer. Careful consideration should be given to how much edible forage the particular area will grow in its present condition under a given rainfall regime and what a safe utilization level is to prevent degradation in deciding how many cattle can be safely carried for the **whole** year.

As a broad guide, the following figures give approximate safe annual grazing capacities for different pasture types in good condition.

GRAZING CAPACITIES OF SOME PASTURE TYPES

Pasture Type	Typical Land Systems	Grazing Capacity (M.L.U./M²) Normal Year	Grazing Capacity (M.L.U./M²) Drought Year
Mitchell Grass Plain	Un, Ab	15-25	5 - 6
Clayey Wooded Floodout	Mg	15-25	5 - 6
Sandy Wooded Floodout	Al, Kn, Fi	12-15	4 - 5
River Frontage	Sa, Fi	14-16	3 - 4
Clayey Alluvial Plain	Td	15-20	4 - 5
Cottonbush Flat	Hm, Ac, Td, Pu	14-16	3 - 4
Open Woodland	Hm, Td, Ac, Ry	12-14	3 - 4
Open Woodland - Ironwood	Ri, Td	8-10	3 - 4
Open Woodland - Gidyea	Ri, De	8-10	3 - 4
Open Woodland - Granite	Ou, Cv	8-10	2
Sandy Open Woodland	Kn	6- 8	4
Calcareous Shrubby Grassland	Eb, Rn, Ac, Ta	8-10	2
Bluebush Slope	Eb, Ed	6-8	2
Bluebush Rise	Rn, Cn, Eb	4-6	2
Open Calcareous Rise	A l	6-8	2
Shrubby Grassland	Ar, De	6-8	2 - 3
Small Hills	Bs, Na	6-8	3 - 4
Clayey Stony Slopes	Cn	6	2
Saltbush Plain	Kl, Ku	6	2
Open Mulga Woodland	Ll	8	2
Mulga Annual	Bu, Bo	6	4
Mulga Perennial	Bu, Bo, Ka	<3	<3
Spinifex Sandplain/Sand Dunes	Sn, Sl	<2	<2

*M.L.U. = Mature Livestock (Cattle) Unit

PASTURE YIELD

STARC.			
GUTFEEL			
TREND			
GRAZ. CAP. (SITE)			
GRAZ. CAP. (PADD)			
DRT. GRAZ. CAP. (SITE)			
DRT. GRAZ. CAP. (PADD.)			
YIELD	750	C. of V.=	8.5
SITE TYPICAL	1		
GRAZ. INTENSITY	3		

The dry standing biomass of herbage present on the site is estimated using a modified Comparative Yield procedure in the DWR program (Appendix 7). th coefficient of variation in yield estimates across 50 quadrats provided by the program is also recorded.

CATTLE GRAZING INTENSITY

A subjective estimate of cattle grazing pressure across the site area over the recent past (last two years) is made. This estimate is based on dung and hoof print activity and grazing levels of palatable forage. A knowledge of the station and more particularly, stocking levels on the watering point, will assist this estimate.

The grazing intensity codes are:-

Code	Grazing Intensity
1	No grazing
2	Light grazing
3	Moderate grazing
4	Heavy grazing
5	Very heavy grazing

SITE CONFORMITY AND ADDITIONAL COMMENTS

The site's conformity with the relict, or otherwise, should be recorded. If the site is atypical, then relevant comments concerning differences should be made.

It may be necessary to make additional brief notes about features on or off the site that have not been adequately

described by the coded information.

HERBAGE SPECIES FREQUENCY

The use of species frequency for sampling vegetation is discussed in standard text books (e.g. Greig-Smith, 1983; Tothill, 1978). Herbage species frequency is used here to monitor range trend using the ordination techniques described by Foran *et al.*, 1985 and Austen, 1977.

Herbage species frequency present on site is recorded in one metre square quadrats using the DWR program (Appendix 7). Up to 30 species are recorded across the whole site. The data is transferred to a file summary sheet (shown below) as the percentage of quadrats in which each species was present.

Alternatively, the data may be printed out in summary form using the Sharp CE-150 printer interface and stapled to the main site data sheet or saved to cassette tape for later transfer to an office PC. If saving data on tape, it is highly desireable to also obtain a data summary printout in the field in case difficulties are later encountered in reading the cassette tape.

PERCENTAGE FREQUENCY – FILE SUMMARY SHEET

STATION : ATARTINGA SURVEYOR : BASTIN SITE No. : 795

DATE : 10/11/89 ECOUNIT : 1

SPECIES	%	%	SPECIES	%	%	SPECIES	%	%	SPECIES	%	%
TEMPO		36	SAKA		84	SCCT		62	TRLO		56
DICO		4	SOIL		4	FIDI		10	SCCO		2
ARCO		60	TRAC		2	DEBR		2			

MATURE WOODY COVER

BITTERLICH SUMMARY

SPACING : 30 m No. POINTS : 25

SPECIES	TOTAL COUNTS	% COVER
ACAN	22	4
ACKE	13	3
ERLA	5	1
OTSP	7	1
TOTAL	47	9

The percentage canopy cover of mature trees and shrubs is measured by one member of the survey team with the Bitterlich gauge. Measurements are particularly important on sites where it is felt that mature aerial cover will change substantially through time - eg a decrease on calcareous sites with sparse, heavily browsed topfeed and very little juvenile recruitment; or an increase on sites with a high density of juvenile woodies.

Total mature canopy cover and the cover of up to four of the main mature species (or spp. groups) present on site should be recorded. The canopy cover of *Maireana* and *Atriplex* subshrubs which are normally a fairly stable component of southern landscapes is not measured. Maturity levels for different tree and shrub forms are:-

Trees and tall shrubs (e.g. whitewood, mulga)	Medium shrubs (e.g. *Cassia*)
>2 m high	>0.5 m high

Examples of trees and tall shrubs, and medium shrubs commonly encountered are:-

Trees and tall shrubs

ACAN	*Acacia aneura*
ACES	*A. estrophiolata*
ACKE	*A. kempeana*
ACLI	*A. ligulata*
ACTE	*A. tetragonaphylla*
ACVI	*A. victoriae*
ATHE	*Atalaya hemiglauca*
CALI	*Canthium lineare*
EUTE	*Eucalyptus terminalis*
GRST	*Grevillea striata*
HALE	*Hakea leucoptera*
HASP	*H. eyreana*, *H. suberea*
VEVI	*Ventilago viminalis*

Medium shrubs

CAAR	*Cassia artemisioides*
CAHE	*C. helmsii*
CANE	*C. nemophila*
CANZ	*C. nem var zygophylla*
CAOL	*C. oligophylla*
CAST	*C. sturtii*
ENTO	*Ecnhylaena tomentosa*
ERGI	*Eremophila gilesii*
ERLA	*E. latrobei*
ERLO	*E. longifolia*
ERST	*E. sturtii*
JALI	*Jasminum lineare*
MASP	*Maireana* sp
RHSN	*Rhagodia spinescens*

Using the Bitterlich Gauge

A description of the Bitterlich gauge is given in Mueller-Dombois and Ellenberg, 1974.

The Bitterlich gauge is held to the eye and rotated through 360° at a sample point. The number of counts (by species) of tree or shrub canopies exceeding the width subtended by the selected pins is recorded before moving to the next sample point. Several tree or shrub canopies which fuse together and exceed the angle subtended is counted as a series of progressive pin spacings across the combined canopy. Where a closer canopy obscures a canopy further back, both should be recorded as a count. If this occurs frequently then a wider pin spacing should be used. Refer to the sketches (p. 30) for further explanation.

The pin spacing used on the Bitterlich gauge is determined by the distance that the operator can see with confidence; and the canopy diameter of the largest tree species encountered on site. This in turn determines the minimum distance between sample points. For areas with high total aerial cover (e.g. mulga woodland, areas with mature shrub increase), the wider pin spacings are used and the distance between sample points is reduced.

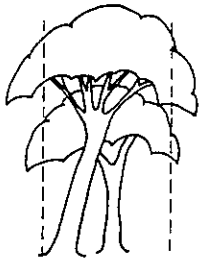
The minimum distance between sample points for various maximum-sized canopies present on site is given in the following table. The divisor of the total number of counts at that pin spacing, used to obtain percentage cover, is also given.

MINIMUM DISTANCE BETWEEN SAMPLE POINTS.

% Pin Spacing	Maximum canopy diameter on site (m) 1	2	3	4	5	Divisor of total counts to get % cover
	Distance between sample points (m)					
1	10	20	30	40	50	25
5	6	10	14	18	23	5

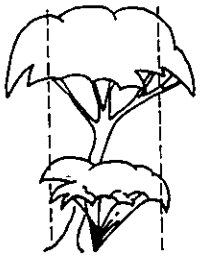
At least 25 points are required over typical sites and these should be located on a grid (5 equidistant points along 5 transects) so as to completely stratify the site. When using the 1% pin spacing with a largest tree canopy of 5 m, the minimum distance between sample points is 50 m and the total number of counts is divided by 25 to obtain percentage cover. With the same maximum tree canopy and a 5% pin spacing, the minimum distance between points is 23 m and the total number of counts is divided by 5 to obtain percentage cover.

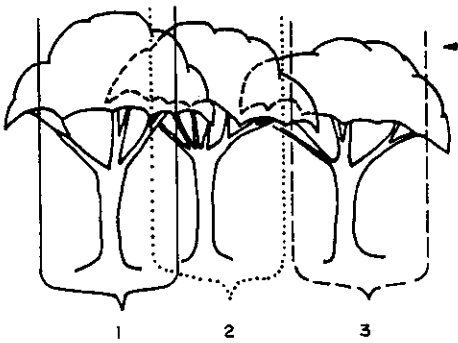
The data is transferred from the Bitterlich Field Sheet to the Bitterlich Summary Table (on the Woody Species Cover and Density Sheet) for filing and transfer to the computer data base.



TREES/SHRUBS IN THE FOREGROUND WHICH 'SCORE' DO NOT EXCLUDE THOSE BEHIND IT FROM ALSO BEING SCORED. IN THE DIAGRAM TO THE LEFT, BOTH TREES WOULD BE COUNTED.

SIMILARLY, IN THIS CASE (RIGHT), BOTH THE TREE AND THE SHRUB ARE COUNTED.





WHERE OVERLAPPING CANOPIES EXIST AND FULL CANOPY WIDTH IS HIDDEN, THE OBSERVER MAY NEED TO TEMPORARILY MOVE FROM THE SAMPLING POSITION IN ORDER TO VIEW OBSCURED CANOPIES. IN THE DIAGRAM SHOWN EACH TREE WOULD BE COUNTED, GIVING A TOTAL SCORE OF 3.

USING THE BITTERLICH GAUGE

INDIVIDUAL WOODY SPECIES DENSITY

SPECIES	DENSITY
ACAM	4
ACIC	3
ERLA	3
ATHE	2
VIVI	1
CAHI	2

N.A. Not Applicable (ie grasslands)
0 Not Present
1. Species just Present
2. Small no. Present
3. Moderate no. Present
4. Moderate to High Density
5. High Density
6. Forest of that species

The densities of live woody species present on site are coded to assist in the later numeric classification of pasture types. Combined seedling, juvenile and mature forms of ***all*** woody species are recorded. This includes the genera *Maireana, Atriplex, Enchylaena, Rhagodia, Chenopodium, Halosarcia* and the woody species of *Ptilotus, Indigofera* etc.

Species' densities are recorded using the following scoring system:-

Code	**Density of that species**
NA	Not applicable - i.e. a pure grassland or all woodies dead with no regeneration.
0	That species not present.
1	That species just present - less than 5 across the site (e.g. *Rhagodia* spp.)
2	Small number present - 5 to 20 across a 10 ha. site (e.g. corkwood on an open woodland).
3	Moderate density (e.g. whitewood on an open woodland).
4	Moderate to high density (e.g. bluebush on a bluebush slope).
5	High density (e.g. mulga on a mulga-annual grass unit)
6	Forest (e.g. very dense mulga watercourse)

JUVENILE WOODY DENSITY

SPECIES	DENSITY
CAHK	3
ACES	2

N. A. Not Applicable
0 No Juveniles
1 < 100 / ha.
2. 100 - 500 / ha.
3. 500 - 1000 / ha.
4. 1000 - 2000/ ha.
5. > 2000 / ha.

Juvenile woody density should be estimated into a density group as a measure of potential woody increase or decrease through time. The density size classes are structured so as to record very low recruitment levels associated with, for example, shrub decrease on southern rabbit-infested calcareous landscapes through to potential woody weed problems on northern woodlands and shrublands.

Training areas with a range of measured and remeasured juvenile woody densities should be periodically revisited. Estimation on site is assisted by walking a number of 1 or 2 m width belt transects in both directions across the site and counting the number of juveniles of each species (or species group) encountered. The distance walked (number of paces) along each transect should be recorded so that the area covered can be calculated and the number of juveniles encountered converted to a per hectare density. The required width belt transect is delineated by projecting past a marked stick held in front of the observer.

Height levels for the juvenile form of different trees and shrubs are:-

Trees and tall shrubs (e.g. whitewood, mulga)	Medium shrubs (e.g. *Cassia*)
0.1 - 2 m high	0.1- 0.5 m high

The different juvenile density codes used are:-

Code	Density	Characteristics
NA	Not applicable	No juveniles of any woody species or a grassland.
0	No juveniles of that species	
1	1 - 100 per ha	Small number of juveniles apparent across the site.
2	100-500 per ha	Moderate numbers present and visible when walking across the site.
3	500-1000 per ha	Moderate to high numbers present which are clearly visible across the site - probably about right level of recruitment for a groved mulga but potential woody weed problem on more open areas
4	1000-2000 per ha	High numbers present and an obvious future woody weed problem unless in mulga regenerating after a fire.
5	>2000 per ha	Very high numbers. Juvenile recruitment probably already associated with an obvious woody weed problem.

Examples of trees and tall shrubs, and medium shrubs commonly encountered are:-

Trees and tall shrubs

ACAN	*Acacia aneura*
ACES	*A. estrophiolata*
ACKE	*A. kempeana*
ACLI	*A. ligulata*
ACTE	*A. tetragonaphylla*
ACVI	*A. victoriae*
ATHE	*Atalaya hemiglauca*
CALI	*Canthium lineare*
EUTE	*Eucalyptus terminalis*
GRST	*Grevillea striata*
HALE	*Hakea leucoptera*
HASP	*H. eyreana* *H. suberea*
VEVI	*Ventilago viminalis*

Medium shrubs

CAAR	*Cassia artemisioides*
CAHE	*C. helmsii*
CANE	*C. nemophila*
CANZ	*C. nem var zygophylla*
CAOL	*C. oligophylla*
CAST	*C. sturtii*
ENTO	*Enchylaena tomentosa*
ERGI	*Eremophila gilesii*
ERLA	*E. latrobei*
ERLO	*E. longifolia*
ERST	*E. sturtii*
JALI	*Jasminum lineare*
MASP	*Maireana* sp
RHSN	*Rhagodia spinescens*

STORAGE OF FIELD DATA

Field data sheets are transferred to the relevant station "Pasture Regeneration Survey - Series 26/15/-" files immediately following each survey. Data is also entered onto the NTPS computer through the various Keymaster formats, checked for accuracy and then updated onto the master file. A separate data dictionary provides precise information on data entry and checking. Survey data can then be extracted with low level query language programs or analyzed statistically with packages such as SPSS.

STORAGE OF PHOTOGRAPHY

Colour slides are identified by station name, site number and date and stored in plastic drop files in a filing cabinet. Colour prints are identified in the same manner on the back of the print and stored in plastic print wallets in an appropriate folder. Colour negatives are stored in negative files with all negatives identified by site number and survey date in the index of that file. At least one source of photography should be stored in a fire-proof safe or cabinet.

ANCILLARY INFORMATION

Numeric information assembled in the compilation of station Range Condition Assessment reports is stored centrally on the NTPS computer. Rainfall information is also collected and stored as input data to assist in the determination of the climate vector in multivariate analyses of the survey data.

(i) Station Information

Information assembled during the compilation of RCA reports which should be extracted and entered onto the NTPS computer includes:-

1 Total station area and watered area at an 8 km radii from watering points as measured from the 1:100,000 station land system maps.

2 Total area and watered area grazing capacities for good, normal and drought years.

3 Estimated stock numbers present at the time of survey.

4 The Total Area - Normal Season grazing capacity calculated by Condon *et al.*, 1969.

5 Department of Lands stocking covenant for that lease.

6 The level of subdivision and watering intensity on the station using the following codes.

Level of Subdivision

Estimate the extent to which the station is subdivided, ***outside*** of the ***immediate homestead*** area.

Code	Number of Paddocks
0	Not applicable
1	Very little subdivision apart from boundary fence and some holding paddocks.
2	2 - 4 major paddocks on the station.
3	5 - 10 major paddocks on the station
4	>10 major paddocks on the station

Water Point Density

Estimate the intensity of waters in grazing land that can carry ***more than 1.2 A.U. per sq. km (3 per sq. mile) in normal seasons.***

Code	Number of Waters
0	Not applicable
1	Less than 1 water for every 100 sq.mile (260km^2) of fair to good carrying country.
2	About 1 water for every 80 sq.mile (200 km^2) etc.
3	About 1 water for every 60 - 80 sq.mile (150-200 km^2)
4	About 1 water for every 40 - 60 sq.mile (100-150 km^2)
5	About 1 water for every 20 - 40 sq.mile (50-100 km^2)
6	1 water for every 20 sq.mile (50 km^2) or less.

A separate data dictionary provides precise information on how to assemble, enter and check this information.

(ii) Land System Areas and Grazing Capacities

Measured total and watered areas (at an 8 km radius) of all land systems mapped on a station and their estimated safe seasonal grazing capacities are entered onto an office PC computer data base. This data can then be used to compile station or regional grazing capacities, land system areas etc.

(iii)Rainfall

Monthly rainfall summaries for approximately 30 reliable reporting stations throughout the Alice Springs district are available from the Darwin Bureau of Meteorology in April or May of each year. This information should be updated as annual records for each station on the relevant office PC data base when received.

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APPENDIX 1

SOME COMMON PASTURE TYPES OF THE ALICE SPRINGS DISTRICT

Code	Pasture type
1	Open woodland (eg Hamilton l.s.)
2	Cottonbush flat
3	Mulga-annual grass
4	Mulga-perennial grass
5	Mitchell grass plain
6	Calcareous shrubby grassland
7	Clayey wooded floodout (eg McGrath l.s.)
8	Small hills (eg Bond Springs l.s.)
9	Spinifex sandplain
10	Gilgaied neverfail plain (eg Undippa l.s.)
11	Limestone rise (eg Titra l.s.)
12	River frontage (eg Sandover l.s.)
13	Bluebush swamp
14	Saltbush flat (Amadeus l.s.)
15	Tea tree flat (eg Amadeus l.s.)
16	Clayey stony slope (Chandlers l.s.)
17	Southern bluebush rise
18	Sandy river frontage (Finke l.s.)
19	Mulga-annual grass sandplain (eg Angas l.s.)
20	Calcareous mulga grassland (eg Ebenezer l.s.)
21	Calcareous neverfail plain (eg Renners l.s.)
22	Southern open woodland (Chandlers l.s.)
23	Southern bluebush slope
24	Open calcareous rise (Allua l.s.)
25	Alluvial calcareous plain (eg Allua l.s.)
26	Open calcareous woodland
27	Stony rise (eg Chandlers l.s.)
28	Calcareous grassland (eg Ebenezer l.s.)
29	Calcareous floodplain (eg Allua l.s.)
30	Sandy wooded floodout
31	Stony calcareous shrubby grassland (eg Angas l.s.)
32	Open woodland - Todd l.s.
33	Sandy open woodland (eg Kanandra l.s.)
34	Open gidyea woodland (eg Ringwood l.s.)
35	Open ironwood woodland (eg Sandover l.s.)
36	Clayey alluvial plain (eg Todd l.s.)
37	Witchetty shrubland
38	Sandy open plain (eg Todd l.s.)
39	Mixed open woodland (corkwood, beefwood etc)
40	Gidyea-annual grass (eg Delny l.s.)
41	Clayey stony plain
42	Open calcareous woodland (eg Alcoota l.s.)
44	Clayey alluvial plain
45	Open stony slope
46	Neverfail plain
47	Mulga-perennial grass sandplain (eg Karee l.s.)
48	Limestone rise with bluebush (eg Lindavale l.s.)
49	Limestone rise with witchetty bush (eg Lindavale l.s.)
50	Depositional sandplain (Amadeus l.s.)
51	Small hills - granite (eg Chisholm l.s.)
52	Shrubby grassland (eg Anderinda l.s.)
53	Stony gidyea woodland (eg Delny l.s.)
54	Gidyea woodland with cottonbush (eg Alcoota l.s.)
55	Clayey gidyea woodland (Delny l.s.)
56	Stony open woodland (eg Bond Springs l.s.)
57	Alluvial mulga woodland
58	Saltbush plain (eg Kalamerta l.s.)
59	Southern open mulga woodland (eg Lilla l.s.)
60	Granitic open woodland (eg Outounya l.s.)

APPENDIX 2
DESCRIPTION OF LANDFORM CATEGORIES

Landform	Description
Hills	Landform pattern of high relief (90-300m) with gently inclined to precipitous slopes. Fixed, shallow erosional stream channels, closely to very widely spaced, form a non-directional or convergent integrated tributary network. There is continuously active erosion by wash, creep and, in some cases, rarely active erosion by landslides. **Typical elements:** hillcrest, hillslope (dominant), drainage depression, stream bed **Common elements:** footslope, alcove, valley flat, gully **Occasional elements:** tor, summit surface, scarp, landslide, talus, bench, terrace, doline Compare with **Mountains, Low hills, Rises,** and **Plain**
Low hills	Landform pattern of low relief (30-90m) and gentle to very steep slopes, typically with fixed erosional stream channels, closely to very widely spaced, which form a non-directional or convergent integrated tributary pattern. There is continuously active sheet flow, creep, and channelled stream flow. **Typical elements:** hillcrest, hillslope (dominant), drainage depression, stream bed **Common elements:** footslope, alcove, valley flat, gully **Occasional elements:** tor, summit surface, landslide, doline Compare with **Mountains, Hills, Rises,** and **Plain**
Rises	Landform pattern of very low relief (9-30m) and very gentle to steep slopes. The fixed erosional stream channels are closely to very widely spaced and form a non-directional to convergent, integrated or interrupted tributary pattern. The pattern is eroded by continuously active to barely active creep and sheet flow. **Typical elements:** hillcrest, hillslope (dominant), footslope, drainage depression **Common elements:** valley flat, gully **Occasional elements:** gully, fan, tor Compare with **Mountains, Hills, Low hills,** and **Plain**
Escarpment	Steep to precipitous landform pattern forming a linearly extensive, straight or sinuous inclined surface which separates terrains at different altitudes, that above the escarpment commonly being a plateau. Relief within the landform pattern may be high (hilly) or low (planar). The upper margin is often marked by an included cliff or scarp. **Typical elements:** hillcrest, hillslop, cliff-foot slope **Common elements:**cliff, scarp, scarp-foot slope, talus, footslope, alcove **Occasional elements:** stream bed
Pediment	Gently inclined to level landform pattern of extremely low relief, typically with numerous rapidly migrating, very shallow incipient stream channels which form a centrifugal to diverging integrated reticulated pattern. It is eroded, and locally aggraded, by frequently active channelled stream flow or sheet flow, with subordinate wind erosion. Pediments characteristically lie downslope from adjacent hills with markedly steeper slopes. **Typical elements:** pediment, plain, stream bed (?) Compare with **Sheet-flood fan** and **Alluvial fan**
Pediplain	Level to very gently inclined landform pattern with extremely low relief and no stream channels, eroded by barely active sheet flow and wind. Largely relict from more effective erosion by stream flow in incipient stream channels as on a pediment. **Typical element:** plain
Peneplain	Level to gently undulating landform pattern with extremely low relief and sparse slowly migrating alluvial stream channels which form a non-directional integrated tributary pattern. It is eroded by barely active sheet flow, creep, and channelled and over-bank stream flow. **Typical elements:** plain (dominant), stream channel
Plain	Level to undulating or, rarely, rolling landform pattern of extremely low relief (less tha 9m). Compare with **Mountains, Hills, Low hills** and **Rises**
Sand plain	Level to gently undulating landform pattern of extremely low relief and without channels; formed possibly by sheet flow or stream flow, but now relict and modified by wind action.

Typical elements: plain
Occasional elements: dune, playa, lunette

Dunefield — Level to rolling landform pattern of very low or extremely low relief without stream channels, built up or locally excavated, eroded or aggraded by wind.
Typical elements: dune, swale, blow-out

Playa plain — Level landform pattern with extremely low relief typically without stream channels, aggraded by rarely active sheet flow and modified by wind.
Typical elements: playa, lunette, plain

Terrace (alluvial) — Former flood-plain on which erosion and aggradation by channelled and over-bank stream flow is barely active or inactive because deepening or enlargement of the stream channel has lowered the level of flooding.
Typical elements: plain (dominant), scarp, channel, bench

Alluvial fan — Level (less than 1% slope) to very gently inclined complex landform pattern of extremely low relief. The rapidly migrating alluvial stream channels are shallow to moderately deep, locally numerous, but elsewhere widely spaced. The channels form a centrifugal to divergent, integrated, reticulated to distributary pattern. The landform pattern includes areas that are bar plains, being aggraded or eroded by frequently active channelled stream flow, and other areas comprising terraces or stagnant alluvial plains with slopes that are greater than usual, formed by channelled stream flow but now relict. Incision in the up-slope area may give rise to an erosional stream bed between scarps.
Typical elements: stream bed, bar, plain
Common elements: scarp
Compare with **Sheet-flood fan** and **Pediment**

Alluvial plain — Level landform pattern with extremely low relief. The shallow to deep alluvial stream channels are sparse to widely spaced, forming a unidirectional, integrated network. There may be frequently active erosion and aggradation by channelled and over-bank stream flow, or the landform may be relict from these processes.
Typical elements: stream channel (stream bed and bank), plain (dominant)
Common elements: bar, scroll, levee, backplain, swamp
Occasional elements: ox-bow, flood-out, lake
Included types of landform pattern are: **flood-plain, bar plain, meander plain, covered plain, anastomotic plain, delta, stagnant alluvial plain, terrace**

Anastomotic plain — **Flood plain** with slowly migrating deep alluvial channels, usually moderately spaced, forming a divergent to unidirectional integrated reticulated network. There is frequently active aggradation by over-bank and channelled stream flow.
Typical elements: stream channel (stream bed and bank), levee, backplain (dominant)
Common elements: swamp
Compare with other types under **Alluvial plain** and **Flood plain**

Bar plain — **Flood plain** with numerous rapidly migrating shallow alluvial channels forming a unidirectional integrated reticulated network. There is frequently active aggradation and erosion by channelled stream flow.
Typical elements: stream bed, bar (dominant)
Compare with other types under **Alluvial plain** and **Flood plain**

Covered plain — **Flood plain** with slowly migrating deep alluvial channels, usually widely spaced and forming an unidirectional integrated non-tributary network. There is frequently active aggradation by over-bank stream flow.
Typical elements: stream channel (stream bed and bank), levee, backplain (dominant)
Common elements: swamp
Compare with other types under **Alluvial plain** and **Flood plain**

Flood plain — **Alluvial plain** characterised by frequently active erosion and aggradation by channelled or over-bank stream flow.
Included types of landform pattern are: **bar plain, meander plain, covered plain, anastomotic plain**
Related relict landform patterns are: **stagnant alluvial plain, terrace**

APPENDIX 3
DETERMINATION OF SOIL TEXTURE

This guide to the determination of soil texture is taken from Northcote (1979).

Soil texture is a measure of the behaviour of a small handful of soil when moistened and kneaded into a ball and then pressed out between thumb and forefinger.

The method is to take a sample of soil sufficient to comfortably fit into the palm of the hand. The soil is moistened with water and kneaded until the ball of soil just fails to stick to the fingers. Kneading and moistening continues until there is no apparent change in the soil ball (or bolus). The bolus is then pressed between thumb and forefinger to form a ribbon.

Soil Texture Categories

Texture	Behaviour of Moist Bolus
Sand	Coherence nil to very slight; cannot be moulded; single sand grains adhere to fingers.
Loamy sand	Slight coherence; can be sheared between thumb and forefinger to give minimal ribbon of 6 - 7mm; discolours fingers with dark organic stain.
Clayey sand	Slight coherence; sticky when wet; many sand grains stick to fingers; will form minimal ribbon 6 - 13mm; discolours fingers with clay stain.
Sandy Loam	Bolus just coherent but very sandy to touch; will form ribbon of 13 - 25mm; dominant sand grains of medium size and readily visible.
Loam	Bolus coherent and rather spongy; smooth feel when manipulated but with no obvious sandiness or 'silkiness'; may be somewhat greasy to the touch if much organic matter present; will form ribbon of about 25mm.
Sandy clay loam	Strongly coherent bolus sandy to touch; medium size sand grains visible in finer matrix; will form ribbon of 25 - 38mm.
Clay Loam	Coherent plastic bolus; smooth to manipulate; will form ribbon of 38 - 50mm.
Sandy clay	Plastic bolus; fine to medium sands can be seen, felt or heard in clayey matrix; will form ribbon of 50 - 75mm.
Light Clay	Plastic bolus; smooth to touch; slight resistance to shearing between thumb and forefinger; will form ribbon of 50 - 75mm.
Medium Clay	Smooth plastic bolus, handles like plasticine and can be moulded into rods without fracture; has some resistance to ribboning shear; will form ribbon of 75mm or more.
Heavy Clay	Smooth plastic bolus; handles like stiff plasticine; can be moulded into rods without fracture; has firm resistance to ribboning shear; will form ribbon of 75mm or more.

APPENDIX 4
PROFILE DESCRIPTION FOR SOIL SUBDIVISION DETERMINATION

This description has been extracted from Northcote (1979).

Uniform

Soil profiles dominated by mineral fraction with small, if any, texture differences throughout such that no clearly defined texture boundaries are to be found (except possibly for surface crusts 25mm or less in thickness). The range of texture allowed throughout the profile would include, for example, part of the loam range passing to part of the clay loam range as well as profiles with textures within one texture group such as sand, loam or clay respectively.

Gradational

Soil profiles dominated by the mineral fraction and showing increasingly finer (more clayey) texture grades down the profile such that the texture of each successive horizon passes gradually from the one above into the one below. The texture difference between consecutive horizons is less than 1.5 texture groups, while the range of texture throughout the entire profile exceeds the equivalent of the span covered by one texture group.

Duplex

Soil profiles dominated by the mineral fraction with a texture contrast of 1.5 texture groups or greater between the A and B horizons. Horizon boundaries are clear to sharp. The distance between the bottom of the A horizons to the top of the main B horizons occurs over a vertical distance of 100mm or less except for those profiles where laterite occurs between the A and B horizons when the vertical interval between them may be as great as the thickness of the laterite.

Since the characteristic feature of these soils is the high clay content in the B horizon relative to the A horizon, the B horizon is called a clayey subsoil.

Examples of contrasting texture profiles include:-

(1) sand over clay
(2) sand over sandy clay loam
(3) loam over clay
(4) loam or clay loam over medium or heavy clay

APPENDIX 5
EROSION ZONE CHARACTERISTICS

This description of the different erosion zones (Pickup, 1985) is given to assist in recognising a site's location within an erosion cell.

The site area should be interpreted with respect to the broader surrounding landscape when determining into which erosion cell it best fits. Most of the descriptions reflect hydrologic processes with wind erosion covered only briefly.

A production cell or **Source Zone** consists of an eroded area which consistently sheds both water and sediment whenever rainfall of a sufficient magnitude occurs.

The **Transfer Zone** occurs downstream or below the source zone with sediment passing through this zone at generally slow rates. Thus, temporary and intermittent deposition may occur. The transfer zone is characterized by alternating scour and fill as material is added to, or removed from, storage.

While a wide range of surface types may be present in the transfer zone, most will cover the following classes:

(i) Eroded areas of varying severity but limited extent. These areas are frequently created by dissection of the downstream side of transit zone deposits by gullying. They are distinguished from eroded areas in the source zone because erosion is likely to be interspersed with deposition.

(ii) Regularly disturbed sandy deposits associated with channels and floodouts. These may be occupied by annual or perennial grasses but rarely by mature shrubs and trees which require longer to grow. The deposits are highly mobile and can be expected to change after most significant runoff events.

(iii) More stable deposits of sandy or finer material associated with small floodouts, minor levees or floodplain surfaces. These areas are currently accumulating material and are unlikely to be destroyed for some time. They therefore provide a relatively stable niche within the transfer zone unless the plants which colonise them are buried by rapid deposition.

These deposits may establish their own seed bank but they will also receive seeds washed in from surrounding areas. A diverse range of species may therefore become established but perennial grasses which prefer sites with a good moisture and nutrient status are likely to be preferred.

(iv) Composite surfaces involving deposition on an eroded surface. The deposits will be fairly thin and may be discontinuous in the early stages. Subsequently these areas will develop into conditions (ii) or (iii) of the transfer zone.

The **Sink** is an area of sediment accumulation downstream of the transfer zone. Rate of sediment accumulation is highly variable depending on the rate of delivery, shifts in the locus of deposition and position within the sink. There may also be small areas of erosion but these are insufficient to offset the overall tendency for sediment to accumulate.

In predominantly wind-formed landscapes, the sink may be a considerable distance from the source zone (e.g. sandplains) or the sediment may be widely dispersed and definite sink and transfer zones indistinguishable. Generally however, much of the blown material accumulates in existing sinks that are well vegetated, particularly by trees, and are resistant to further wind erosion. As winds strip a surface and the vegetation cover is lost, water erosion develops and becomes increasingly important. Wind erosion may continue, particularly in the source zone, but the transfer and sink zones gain material as a result of water erosion.

APPENDIX 6
EROSION TYPE & SEVERITY CHARACTERISTICS

This information is drawn from a more comprehensive description in "Soil erosion and pasture degeneration in Central Australia: Part 1 - Soil erosion and degeneration of pasture and topfeeds" by Condon **et al.** in **J. Soil Conservation Service N.S.W.** (1969) 25 : pp 62-81.

Type O - Non Erodible Soils

Heavy textured soils (surface textures ranging from sandy clays to heavy clays) are resistant to wind erosion. These soils occur on landforms that have little slope and have a minimal water erosion hazard.

Coarse sandy soils undergo some minor wind sorting at the surface during drought but are resistant to erosion. They have high infiltration rates and are not susceptible to water erosion.

Type 1 - Scalding

Scalding occurs where a sandy surface horizon is removed by wind and water erosion exposing a surface sealing clayey subsoil. Where the subsoil clay layer is at some depth (30cm or more) and the surface horizon has a large amount of fine sand, considerable drift may be associated with the scalding process.

Susceptible soils include shallow and deeper sandy texture contrast soils and silty brown alluvial loams.

Severity Rating

Severity 1:	Natural	- evidence of a regular scald pattern across the drainage flow on aerial photos - clay pans and small, naturally occurring, scalds - no evidence of attrition by rilling on scald margins - pasture in good condition
Severity 2:	Slight	- a thin veneer of surface seal on bare areas - wind and water sheeting causing litter loss - scalded areas widely separated, generally evenly vegetated and less than 10% of total area - pastures in fair condition but declining
Severity 3:	Moderate	- scalds frequent and becoming linked but generally less than 200 m^2 in individual area - bare areas 10 to 40% of total - pedestals present with mounding and hummocking on surface horizon between scalds - considerable rilling and gullying
Severity 4:	Severe	- scalds large and exceeding 40% of site area - absence of cover except for scald margins - considerable gullying downslope

Type 2 - Windsheeting

This form of wind erosion occurs on soils with a uniform or gradual change in texture and involves movement of sandy material from bare areas to where it is trapped against neighbouring vegetated areas or against obstructions to form drift mounds. Finer silt and clay fractions may become airborne and are completely lost. The resultant eroded surface has a similar texture and structure to the original surface and recolonization by the same plants can usually readily occur.

Sandy clay loams and sandy loams are most vulnerable to wind sheeting. Soil types include red earths and calcareous earths.

Deeper sandy soils (sandy loam and loamy sand textures) are very erodible and the fine sands may accumulate in shallow drift mounds as a result of windsheeting.

Severity Rating

Severity 1:	Natural	- Small drift mounds around logs and other obstacles but no significant bare areas
Severity 2:	Slight	- loss of fine fraction with exposed surface similar to non eroded surface - scattered areas with less vigorous vegetation or bare. Re-establishment probable with good seasons and reduced stocking - minor drift mounds against obstacles - in groved mulga, slight accelerated soil loss from bare areas in intergroves
Severity 3:	Moderate	- significant accumulation of coarser material against obstructions - occasional large areas bare or with less vigorous vegetation - coarse sand irregularly distributed over the surface - pebbles on surface due to loss of finer fraction - large areas with weak ground cover - pedestalled butts of perennial grasses - in groved mulga, moderate accelerated soil loss from bare area into groves - some accumulation of sands under gidyea
Severity 4:	Severe	- extensive hummocks of sand accumulation against obstacles and burying the trunks of standing timber - coarse gravels and small stones exposed - exposure of tree roots leading to tree death - sparse grass cover with a poor vigour - in mulga, extensive bare areas, lowered vigour and some tree death on grove margins - in gidyea, sand piling under trees and a lowered surface on adjacent treeless areas.

Type 3 - Watersheeting, Rilling and Gullying

Watersheeting is the loss of surface soil material through the overland flow of water.

Rilling and gullying occur through the channelling of surface flows along pads, vehicle tracks etc. A rill is a small channel up to 30 cm deep while a **gully** is a deeper channel.

Infiltration rate, slope, length of slope, amount of vegetation cover, surface roughness (e.g. stone) and extent of bare areas determine susceptibility to water erosion.

Medium textured soils (e.g. sandy clay loams) and texture contrast soils are highly susceptible. Sandy loams, loamy sands and sands usually have good infiltration and are fairly stable.

Severity Rating

Severity 1:	Natural	- watersheeting usually difficult to distinguish from "slight erosion" severity rating but a function of soil stability, cover levels etc - minor fretting of watercourse banks - rilling of low hills and around outcrops following severe storms
Severity 2:	Slight	- fairly even surface with some small stones exposed - bare areas small and irregularly distributed - small rills along pads, tracks or on bare areas - minor tree death associated with rilling

Severity 3:	Moderate	- formation of surface seal with poor infiltration - gritty fraction on soil surface - obvious flow marks on surface - gravel exposed - bare areas common (often larger than 100m²) - poor pasture cover and loss of grasses - rilling to a depth of 30cm; actively encroaching - obvious sediment movement down drainage lines - watercourses becoming choked with sediment
Severity 4:	Severe	- large bare areas; remaining areas have poor pasture cover and are in low range condition - gravel and pebbles exposed often resulting in a stony pavement - tree roots exposed leading to tree death - rilling around and across water sheeted areas - drainage lines downslope extensively gullied - drainage lines downslope may be choked with sediment

Type 4: Drift and Dune Activation

This form of erosion involves the formation of drifts or small dunes on level sands, or re-activation of dune movement. It is usually restricted to the deep sandy soils of dune fields, dunes associated with river flood plains or deep sandy plains flanking mountain ranges.

Severity

Severity 1:	Natural	- natural saltation along dune crest (the most frequent case)
Severity 2:	Slight	- weak vegetation cover and little litter - sandy surface smooth or slightly rippled
Severity 3:	Moderate	- little cover - rippled or scalloped surface - visible movement along dune - deposition on leeward face
Severity 4:	Severe	- dune crests blown out exposing concreted material in dune core - foot of dune encroaching on surrounding country

APPENDIX 7

DWR

A COMPUTER PROGRAM FOR RECORDING, CHECKING AND SUMMARISING ESTIMATES OF HERBAGE YIELD AND COMPOSITION USING A COMPARATIVE YIELD AND DRY-WEIGHT-RANK METHOD.

Version 1.2 for the SHARP PC1500A hand-held computer.

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March 1987.

APPENDIX 7 (DWR)
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DWR

INTRODUCTION

DWR is a computer program stored and executed in a Sharp PC1500A* portable computer. The data collected with DWR are related to site (location, date, recorder) particulars, comparative yield of the herbage, relative composition by species of the herbage yield and, frequency of occurrence of herbage species in randomly located sampling quadrats.

In addition to storing site details, this program:

(a) checks and stores the codes for every plant species recorded on a site,

(b) checks and stores the comparative yield estimated for each quadrat on the site,

(c) checks and stores the dry weight rank for every species estimated in each quadrat and,

(d) checks the code, and stores the occurrence of every species recorded as present in each quadrat, and

(e) enables data correction during and after collection.

(f) allows up to 50 quadrats with 30 species to be recorded (with 16k RAM expansion).

All of the stored data are made available, in the field, for statistical analyses and summarising from routines within the DWR program. Analyses and summaries can be presented as soon as data collection is completed, and:

(a) displayed on the screen of the Sharp PC1500A*, and-or,

(b) printed out in hard copy form, and-or,

(c) transmitted through a communications interface to another computer, and-or,

(d) permanently stored on cassette tape for subsequent analyses and transfer to another computer.

Detailed operating instructions for the program are provided in this manual. Operators will find however, that all information required for field operation will be displayed on the Sharp PC1500A* screen during running of the program, and that after initial familiarisation, the need to reference this manual will be minimal.

EQUIPMENT REQUIRED

The minimum equipment required to run DWR is a Sharp PC1500A* pocket computer with the 16K RAM memory module (Sharp CE-161*) installed and the program already loaded into the computer's memory (to load the program into memory from cassette tape see the Sharp PC1500A* owner's manual). If hard copy of the analysis and summary output is required then the computer must be connected to a printer-cassette interface (Sharp CE-150*). Pens must be installed in the printer (only one pen in position 0 is required). To store data onto cassette tape, a recorder with playback facilities must be provided (standard audio cassette devices are suitable). Transfer of data to another computer requires the connection of a communications interface (Sharp CE-158*) and appropriate communications software installed in the receiving computer.

PROGRAM STRUCTURE

The program is divided into four functional sections. Each section can be operated independently. The main section is the data entry and checking routine. Here the user is prompted for information about the site and for the detailed data about each plant species to be recorded from each quadrat on the site. The program automatically checks spelling of species codes and detects when the user moves from recording dry weight rank scores for plants to only recording presence of species in a quadrat. The program is initiated by typing RUN followed by pressing ENTER. This starts the data collection routine.

The second section allows the user to obtain a display of the summary of the plant information collected at the site. In addition, a hard copy printout of the site summary can be obtained if the user connects a printer-cassette interface (see Fig. 2 for an example). The site summary routine presents several statistics relating to the herbage yield and composition and frequency of occurrence of individual species recorded on the site. The routine can be selected by pressing the DEF key followed by the letter D.

Another routine allows the user to save the entire data set collected for the site on to cassette tape. The data is saved in its original format so that it may be subject to detailed analysis at some later time. The tape write and check read routine takes about 30 minutes per site to complete. In most cases, this routine could be executed while the user is driving between sites. The routine is selected by pressing the DEF key followed by the letter S.

The fourth routine allows the user to correct data recorded from the site. Any data collected from any quadrat may be displayed and changed. Alternatively, it may simply be displayed and not altered. Any number of corrections and recorrections are possible. The routine checks to see if any species that have been recorded have subsequently been removed from the list during correction. The routine is selected by pressing the DEF key followed by the letter Z.

The sequence of operation of each of the routines is given in Figs 1a, b, c and d. These figures represent a diagrammatic summary of the operating instructions, and demonstrate the various paths the program will take under the conditions of data entry and analysis.

Each routine is accessed separately and may be used in any order. Clearly though, it would be necessary to collect data with the first routine before using any of the other three routines. There is no limit to the number of times a routine may be used. For example, the site summary routine can be used to display its results for field copying, then used again to print the same results on the hard copy printer. If after analysis the operator realises that there is an error in the data the correction routine may be used to fix the data, then the site summary routine may be used again to get a correct summary.

DATA COLLECTION

The type of data collected with this program relates entirely to the herbage layer of a site. Data is gathered from up to 50 randomly placed one metre square quadrats. In each quadrat, the operator estimates the comparative yield score for the entire herbage. This is a ranked score between 0 and 7. This score is subsequently converted to a dry weight value through a regression formula. The slope and intercept of the regression formula are entered by the operator during the execution of the site summary routine.

In addition to total herbage yield in a quadrat, the operator also records the rank importance of individual species. This is done according to the procedures developed by Mannetje and Haydock (1963). When rank scoring is complete, the operator is then prompted to name all other species occurring in the quadrat. This information is stored for frequency analysis.

Data collected in each quadrat is entered directly into the SHARP while the DWR program is running. The operator selects a quadrat site, then begins entering data through the keys in response to the information displayed on the screen. At the completion of data collection at the site, the operator selects routines to work with the data. This may be done on the spot or back at the vehicle. It is important to remember that once the RUN instruction is issued, any data resident in memory is destroyed. For this reason all data processing and saving should be completed at a site before collecting data for another site.

Additional points on using the Sharp PC1500A.

1. The screen display may fade in hot or direct sunlight - a period in the shade should restore the display.

2. For quick entry of common-frequent species on each site, use the function keys. In particular, put the quadrat end code 'xxxx' on one of the function keys.

The procedure is

Type UNLOCK (Enter) - to get out of RUN mode

Shift Key and Mode Key to get into RESERVE mode

Press required Function Key and type 4 letter species code after it - an '@' at the end will automatically enter the species during data collection

After assigning required codes to Function Keys, return to RUN mode, type RUN and commence site data collection

*Items marked with an asterisk are product names and codes for products manufactured and sold by the Sharp Corporation.

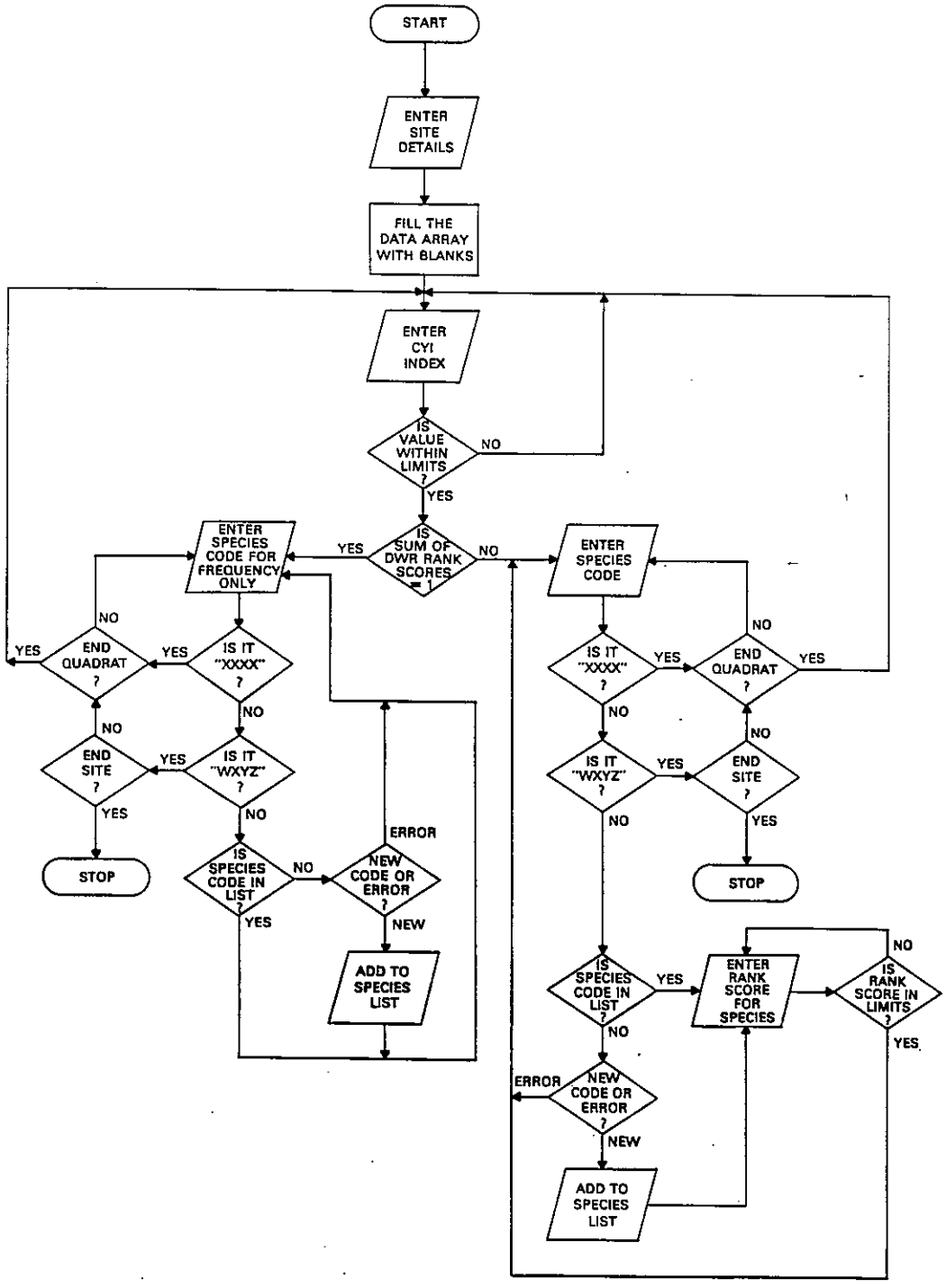

Figure 1a. Flowchart of DWR program for data entry

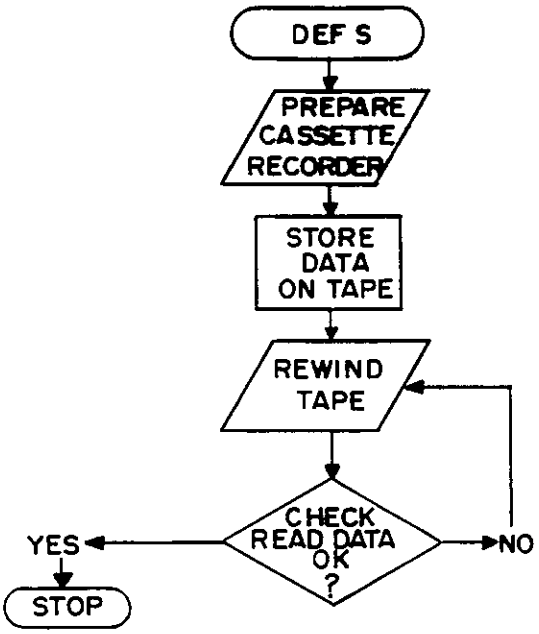

FIG. 1b. FLOWCHART OF THE DWR PROGRAM FOR SAVING DATA ON CASSETTE TAPE.

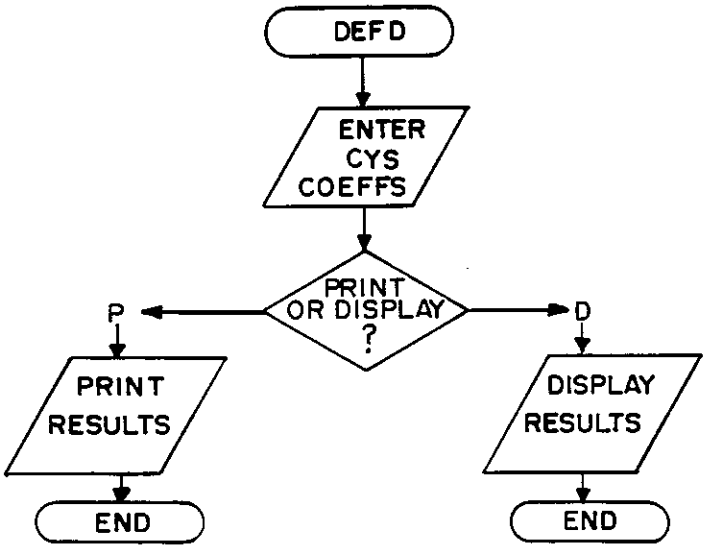

FIG. 1c. FLOWCHART OF THE DWR PROGRAM FOR OBTAINING SUMMARY OF SITE DATA.

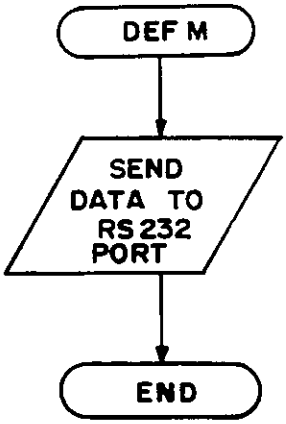

FIG. 1e. FLOWCHART OF DWR PROGRAM FOR SENDING DATA THROUGH THE R5232 PORT.

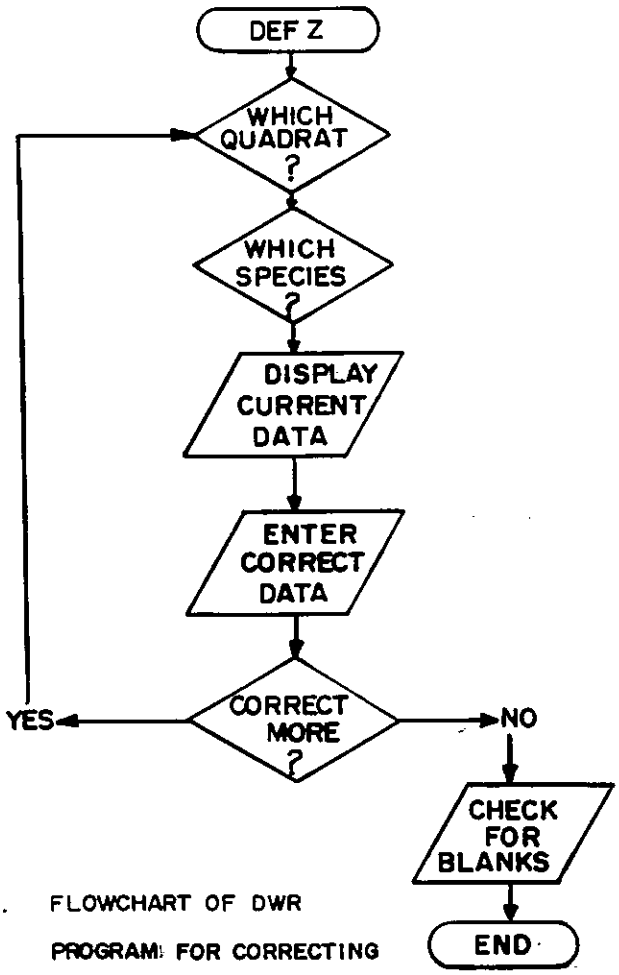

FIG. 1d. FLOWCHART OF DWR PROGRAM FOR CORRECTING DATA.

SITE- RCA 795
DATE- 18/1/90
RECORDERS
NAME- GB

SPECIES SUMMARY

MEAN YIELD IN 50 QUADRATS

YIELD= 1088.2 kg/ha
COEFF. VAR.= 7.6%

CODE	BIOMASS kg/ha	% COMP	FREQ	% FREQ
ENAC	140.51	12.88	13	26
FIDI	92.655	8.49	35	70
TRLO	0	0	6	12
SCDU	78.709	7.31	12	24
DARA	388.598	35.82	42	84
CHSC	135.843	12.46	22	44
ERLE	118.888	10.9	8	16
ALSP	2.589	0.23	7	14
MADR	9.289	0.85	4	8
BRCI	5.485	0.49	4	8
GOLU	0	0	1	2
POOL	2.599	0.23	7	14
ERDI	0	0	1	2
TRAU	5.939	0.54	7	14
BRMI	10.05	0.92	4	8
ARCO	12.105	1.11	9	18
TRTE	1.294	0.11	2	4
BODI	2.589	0.23	6	12
SPAC	10.709	0.98	1	2
SCLA	1.294	0.11	4	8
SOQU	0	0	1	2
PHRH	0	0	2	4
EUDR	0	0	7	14
SISP	31.365	2.87	8	16
ATHO	0	0	1	2
DIBR	14.059	1.28	2	4
ENPO	1.294	0.11	3	6
EUFU	21.417	1.96	1	2
TOT	1098.189	99.88	220	440

28 SPECIES
DIVERSITY= 0.89
EVENNESS= 0.62
DOMINANCE= 0.18

Figure 2. Sample output to the printer from the site summary routine

TEST
29/2/87
BASTIN

SITE YIELD IN 50 QUADRATS IS 848 Kg/h

COEFF. VAR= 6.9%

SPECIES	YIELD (Kg/h)	% COMP	FREQUENCY %	FREQUENCY
ENPO	56.476	6.66	14	28
ARCO	213.611	25.19	43	86
SCCT	113.292	13.36	26	52
CAHI	21.284	2.51	16	32
HEFL	0	0	9	18
INLN	22.302	2.63	21	42
TRLO	12.635	1.49	30	60
DICO	33.496	3.95	5	10
SAKA	55.798	6.58	17	34
FIDI	0	0	11	22
HECH	0.932	0.11	9	18
SCPT	5.088	0.6	6	12
HEAP	13.144	1.55	3	6
ENAC	48.844	5.76	4	8
SWBU	0	0	2	4
ARIN	16.281	1.92	1	2
ARBR	30.612	3.61	13	26
SCCO	73.776	8.7	10	20
SEMA	41.212	4.86	5	10
ENAV	10.091	1.19	5	10
TRZE	0	0	5	10
SWPH	0	0	2	4
BODI	0.932	0.11	5	10
PTOB	4.07	0.48	1	2
ARST	13.144	1.55	4	8
CALA	0	0	4	8
ERER	37.651	4.44	6	12
MASC	5.088	0.6	6	12
POOL	0	0	4	8
EVAV	0	0	3	6

30 SPECIES
DIVERSITY= 1.08
EVENNESS= 0.73
DOMINANCE= 0.11

Fig. 3. Sample output to external device through the communications port.

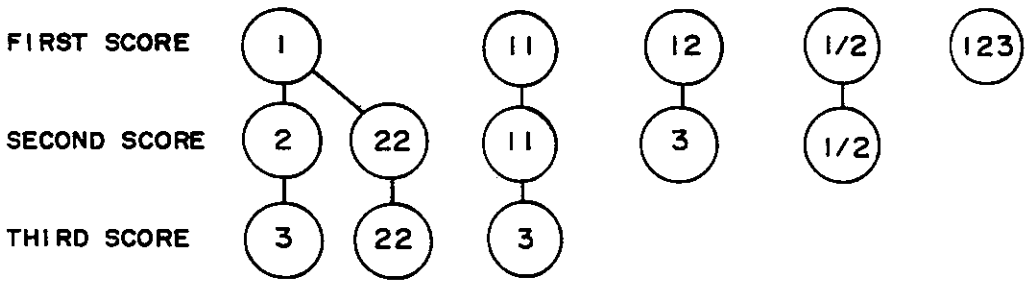

Fig. 4. Rank score sequences for a quadrat.

OPERATING INSTRUCTIONS

STEP	INPUT	DISPLAY	REMARKS
TO COLLECT DATA			
1	RUN	DWR	Pauses.
		SITENAME=	Enter a name for the site.
2	SN$	DATE=	Enter the date of recording. Date can be in any format, e.g. 5-2-86, 5 Feb 1986.
3	D$	RECORDER=	Enter the operator's name e.g. J. Bloggs.
4	RN$	PLEASE WAIT	Wait while the program puts blanks into all the data positions. You will hear beeps until the program is ready to go on.
5		QUAD X CYS=	For quadrat x (X=1 at the first quadrat) enter the comparative yield score (CYS). This value must be between 0 and 7. If you enter a value greater than 7 you will hear 3 beeps and the program will pause displaying INCORRECT DATA, after which, it will ask again for the CYS value.
6	CYS	CYS=X OK (Y OR N)?	If this value is OK, then enter a Y. If not, enter an N. If you enter a Y, go to step 7. If you enter an N, the program asks again for the CYS value (step 5). This asking is simply to give you the opportunity to check for data errors.
7	A$	QUAD A SPECIES B NAME=_	You are now entering data. You must enter the codes and dry weight ranks for those species being ranked first. Enter the four letter species code. You can do this through the function keys if desired. If the species has been previously recorded on this site, go to step 9. If the species has already been recorded on this quadrat you will be advised, then returned to step 7 for another try. If you have already ranked three species, or accumulated the maximum rank score, this step will be skipped. Goto step 10. You can terminate the data entry for this quadrat, or for the site, by entering XXXX (to end the quadrat) or WXYZ (to end the site). In both cases you will be asked a second time if you want toterminate. If you decide

not to, answer the questions in the negative and returnto data entry where you left off.

If you end the quadrat, you will be asked if you want to review it before proceeding to the next quadrat. If you answer a Y you will get a display for each species of the data recorded. You can choose to abandon the data and start the quadrat again or accept the data and go on to the next quadrat.

If the quadrat is bare, you should enter XXXX to skip to the next quadrat. Even so, you will be asked if you really want to end the quadrat.

8 T S$(0) CORRECT (Y OR N)_

This species code has not been previously recorded at thissite. If it is spelt correctly, and is a new code, then answer Y and go to step 9. If the code is in error (misidentification or misspelt), answer N and return to step 7.

T is the number of species, including this one, recorded for the site so far.

9 S$(0) RANK=_

Enter a rank score for this species. There are only seven possible rank scores in five possible combinations that can be entered (see Fig. 3). If you do not enter a correct score the program will tell you and return for another try. If you enter a rank score that is illegal (e.g. enter rank 12 for species 1 then try to enter rank 12 for species 2) the program will tell you there is an error and ask you to try again.

If you lose track of where you are with ranks, you can enter 999 for the rank score and this will take you back to the beginning of data entry for this quadrat. You should start data entry again for this quadrat.

If you enter a correct rank and the total rank score for the quadrat is still lessthan 1, you will return to step 7 for the next species.

If you have completed rank scoring for the quadrat (the total rank score=1 and there have been three or less species recorded) go to step 10.

10 ENTER FREQUENCY DATA

Pauses.

QUAD A SPECIES B=_

You are now entering frequency data. You need only enter a species code to record its presence in the quadrat.

If the species has been previously recorded on the site, the program will return to this step and prompt for the next code. To end dayY+ second time if you really want to terminate data entry. If you decide not to, answer the questions in the negative and return to data entry where you left off.

If you end data entry for the quadrat, go to step 5 for thenext quadrat.

If you end data entry for the site, the program stops.

Alternatively if you have recorded data for 50 quadrats and end the quadrat, the program stops after it has indicated that you should turn the computer off before connecting theprinter. This is IMPORTANT. You must turn the PC1500 off before connecting to the printer or you may lose both the data and the program.

Once you have terminated data entry for the site, you can now access any of the routines listed below. The order or frequency of access is not important except where you suspect errors in thedata. It would be most economical to perform the summary routine first to see if the results look OK. If all is well, then you could progress to saving data on tape. If there are errors in the data, you should use the correction routine to fix them before embarking on the time consuming tape save routine.

TO GET A SITE SUMMARY

1	DEF D	SITE SUMMARY	Pauses.
		CYS COEFFICIENTS	Pauses.
		SLOPE=	Enter the slope coefficient for the regression to calculate yield from the CYS values.
2	SL	INTERCEPT=	Enter the intercept coefficient for theregression to calculate yield from the CYS values.
3	IN	PRINT (P) OR DISPLAY (D)	If the printer is connected and you want a hard copy print of the site summary, enter a P. If you want the site summary to be displayed only on the PC1500 screen, enter a D.
4	if P		Site particulars are printed followed by the mean yield. The summary of biomass, composition and frequency data for each species recorded on the site is then printed (see the sample printout in Fig. 2). When printing ceases the program stops.
5	if D		The calculated yield in kg-ha for thesite along with the % coefficient of variation of the mean yield (CV) are displayed. If you wish to record this result copy it now then press ENTER to get to the summary of species.
6	ENTER	CALCULATING SPP.COMP.	Pauses.
		CALCULATING C$(B)	Displayed while calculations proceed.
		C$(B) BIOMASS=X	The calculated biomass (X) for the species C$(B) is displayed. Copy the result then press ENTER to get more data.
7	ENTER	C$(B) % COMP=X	The % composition (X) as calculated by the dry weight rank method is displayed. Copy the result then press ENTER to get more data.
8	ENTER	C$(B) FREQ=X	The total number of quadrats (X) in which this species C$(B)was present isdisplayed. Copy the result and press ENTER to get more data.
9	ENTER	C$(0) % FREQ=X	The % frequency of occurrence (X) of this species C$(B) as a proportion of all quadrats is displayed. Copy the result and press ENTER to go to the summary output for the next species (go to step 6). If this was the last species for the site go to step 10.
10	ENTER	TOT BIOMASS=X	The total mean biomass (X) for the site (a sum of the biomass of all species) is displayed. Copy the result and press ENTER to get more data.
11	ENTER	TOT % COMP=X	The total % biomass (X) for the site will be displayed. This will rarely come to exactly 10 0 since it is the sum of the values displayed for the species above and these results have been truncated to one significant place. Copy the result and press ENTER to get more data.
12	ENTER	TOT FREQ=X	The total count for all species occurrences in all quadrats is displayed. Copy the result and press ENTER to get more data.
13	ENTER	TOT % FREQ=X	The total % frequencies for all speciesin all quadrats is displayed. Copy the result and press ENTER to get more data.
14	ENTER	TOT SPECIES=X	The total number of species recorded on the site is displayed. Copy the result and press ENTER.

15	ENTER	DIVERSITY=D	The Shannon-weaver index of diversity is calculated on the yield values for eachspecies. Copy the result and press ENTERto get more details.
16	ENTER	EVENNESS=E	The index of equitability is calculated and displayed. Copy the result and press ENTER to get more data.
17	ENTER	DOMINANCE=DM	The dominance index is calculated and displayed. Copy the result and press
	ENTER.		The program stops.

TO SAVE DATA ON TAPE

1	DEF S	(R)AW OR (S)UMMARY DATA	If you want to save the raw quadrat data press R, otherwise press S to save only the summary data.
2	IF R	PREPARE TAPE	Prepare the cassette recorder to receive data. Write down the counter number ofthe tape position. You will need this when you check read the data (step 2).
			The connection of the cassette player to the computer is explained in the SHARP PC1500 owners manual. Ensure that the REMOTE switch on the SHARP printer-cassette interface is ON. Push down REC and PLAY on the recorder. Press ENTER on the SHARP.
		STORING SITE DATA	The site particulars are stored on the tape.
		STORING SPECIES LIST	The site name followed by a list of all the species codes recorded for the siteare stored on tape.
		STORING DATA	The site name followed by the matrix of data for all species on all quadrats are stored on tape. The matrix data includes the CYS for each quadrat, the rank score for each species in each quadrat and, thepresence-absence data for each species in each quadrat. It takes approximately 15 minutes to write the complete data set (for 50 quadrats) to tape.
3		REWIND TAPE-PLAY	Rewind the tape to the beginning of where data transfer commenced and press PLAY on the tape.
4	ENTER	CHECK READING	The stored data is read back to check if it is a good copy. If there is a read error the display will show READ ERROR-REWIND. Rewind the tape to the beginning (the counter value you previously wrote down) and press PLAY on the cassette. Press ENTER on the SHARP. You may tryadjusting the volume and tone controls on the cassette player if these are likely to be the cause of the read error. Check that batteries hold sufficient charge if all else seems to be well.
			If it is not possible to re+- read the tape you will need to make another copy. In this case go to step 1. If the check read proceeds normally, go to step 4.
5	SITE	DATA OK	The site data was read in without any errors.
		SPECIES LIST OK	The species list was read in without any errors.
		DATA OK	The data matrix was read in without any errors. This check read process takes about 15 minutes.
		CHECK READ OK	The program stops.

6	IF S	PREPARE TAPE	Prepare the cassette recorder to receive the summary data. Write down the counter number on the recorder; you will need it if you have a read error in step 7. The instructions for driving the cassette recorder are the same as in step 1 for saving the raw data.
7		STORING SITE DATA	The site particulars are stored.
8		STORING SPECIES	The list of species recorded on the site is stored.
9		STORING SUMMARY DATA	The summary data that appears in the printout is stored on tape.
10		REWIND TAPE+-PLAY	Rewind the tape to the beginning of the data write and press PLAY on the tape.
11	ENTER	CHECK READING	The stored data is read back to check if it is readable. If there is a read errorthe screen will display READ ERROR-REWIND.Rewind the tape to the beginning and play again. Try adjusting the volume and tone if read errors continue. If it is not possible to reread the tape then make another copy by pressing BREAK, then DEF S and go to step 1.
12		CHECK READ OK	If all the data is correctly read the program stops.

TO CORRECT DATA

1	DEF Z	DATA CORRECTION	Pauses.
		WHICH QUADRAT No_	Enter the quadrat number in which the correction is required. If you enter a number greater than 50, you will hear a series of beeps and you will be asked to repeat the entry.
2	QN	WHICH SPECIES CODE	Enter the code for the species, in the selected quadrat, that has the data record with it that you wish to correct. If you enter a code that was not recorded on the site you will be advised- SPECIES NOT FOUND, and asked to repeat the entry.
3	SC$(0)	SC$(0) DATA= X	The data (X) scored for the speciesSC$(0) is displayed. The data will be in the form A-B, where A is the rank score assigned to the species in the selected quadrat. The rank score can be 0 if the species was not ranked or any one of the legitimate rank scores. B is the presence-absence score and will be a 0 if the species was not recorded in the quadrat, or a 1 if it was recorded in the quadrat (it will always be a 1 if the species received a rank score).
4	ENTER	CORRECT DATA (X)=_	You must now enter the correct data for this species on this quadrat. If you do not wish to alter the data, simply enter it again as shown (X). If you do decide to alter it, you must enter the corrected data in the same format i.e. A/B.
5	X$ (SN,QN)	MORE CORRECTIONS (Y OR N)	Enter a Y if you wish to make other corrections (or even fix up the correction you just made) then go to step1. Enter an N if you do not want to make any more corrections. If you decide at some later time to make further corrections, you simply press DEF Z and start again in this routine.
6	N	PLEASE WAIT, CHECKING	The program now checks through the data array to see if there are any species that no longer have any data associated with them. In these cases, the species are removed from the array and the matrix adjusted to the reduced size. The program then stops.

SEND RESULTS THROUGH THE COMMUNICATIONS PORT

First set up the receiving device to accept input. For example set up an IBM computer to input a file through a communications package, or set up a printer to accept the SHARP output.

1	DEF M	COMMUNICATIONS	Pauses with this display then transmits the summary data as it appears in the printout in the SITE SUMMARY routine to the receiving device. The communications parameters are set in the program and can be inspected and-or altered by unlocking the mode and going into program mode (see the SHARP user's manual. The program stops after transmission.

ASSIGNMENT OF VARIABLE NAMES

A	A loop counter.
A$	Holds the answer to Y or N input questions.
B	A loop counter.
C	A loop counter.
C$(B)	Species code.
CH$(S)*4	Holds the list of all species codes recorded on the site.
CV	The coefficient of variation (%) of the mean yield value for the site.
C	The current value of the comparative yield score.
D	Diversity index.
D$	Date.
DM	Dominance index.
F	The frequency score for a species in a quadrat, i.e. a 1 or 0.
F(B)	Frequency score for species at B.
FP	The percent frequency of occurrences of a species in quadrats on the site as a proportion of all species frequencies.
FS	The total number of times a species was recorded as present in quadrats on the site.
FT	The total number of times all species were recorded as present in all quadrats.
KG	The calculated biomass of a species on the site. Calculated as a proportion of the total yield from the summed rank scores.
M	The mean yield value for the site.
NQ	The number of quadrats.
NS	The number of species in the current quadrat.
P(B)	Percent composition of the total yield for species at B.
PC	The percent composition of the biomass of species calculated from the comparative yield scores.
Q	Sets the number of quadrats for the site at 50.
QC	Set to 0 if entering rank data; set to 1 if entering frequency data.
QN	The quadrat number selected in the correction routine.
QS	The number of quadrats that have a CYI score greater than 0.
R	The current rank score for a species. Used in the species summary routine.
RN$	Recorder's name.
RS	The current rank score for the current species.
RT	The total rank value for the current quadrat.
RV	The rank proportional value assigned to the rank score RS.
S	Sets the number of species at 30 for the site.
S2	Sum of squares of the yield values SY.
SC$(0)*4	The species code selected for correcting in the correction routine.
SN$	Site name.SN+The array position of the species code selected for correcting in the correction routine.
SY	Sum of the yield values after conversion to kg-ha.
S$(0)*4	Current species code. This variable holds the species code just entered while it is checked against the list C$(S) to see if it has been previously recorded.
T	The number of species recorded on the site.
TT	A check value to determine if a species no longer has any data associated with it in the array.
TV	A temporary value holding the length of the current species code and several other values in the tape store routine.
V	The variance about the man yield score for the site.
X	Numerical value of the CY score. also the length of the data in each position in the data array.
X$(Q,S)*5	The data array of quadrats by species. All the rank and presence-absence data are stored in here. X$(Q,O) holds the comparative yield score for each quadrat.
Y	The calculated yield after regression on the comparative yield score.

LISTING OF DWR PROGRAM

```
5 REM  DWR (VERSION 1.2). WRITTEN BY G.F.GRIFFIN, MAR. 1987.
10 CLEAR :WAIT 0:PAUSE "DWR":SM=0:LOCK
12 QC=0
20 INPUT "SITENAME=";SN$:BEEP 1:INPUT "DATE=";D$:BEEP 1:INPUT "RECORDER=";RN$:BEEP 1
25 S=30:Q=50
60 LPRINT "TOT";TAB (5);KT;TAB (15);TP;TAB (22);TF;TAB (28);PP:LF 2
90 T=0
100 DIM X$(Q,S)*5,S$(0)*4,C$(S)*4,SC$(0)*4,P(S),F(S)
105 FOR A=1 TO Q:FOR B=1 TO S:X$(A,B)="0/0":NEXT B:BEEP 1:PRINT "PLEASE WAIT":NEXT A
110 BEEP 5:PAUSE "BEGIN DATA ENTRY"
120 FOR A=1 TO Q:CLS
122 CLS :PRINT "QUAD ";A;:INPUT " CYS=";CY:BEEP 1:GOTO 124
123 BEEP 3:GOTO 122
124 IF CY<0 OR CY>7 THEN BEEP 3:CLS :PAUSE "INCORRECT DATA":GOTO 122
126 CLS :PRINT "CYS=";CY;" OK (Y OR N)";
127 INPUT A$:BEEP 1:GOTO 130
128 BEEP 3:GOTO 126
130 IF A$="Y"GOTO 134
131 IF A$="N"GOTO 122
132 BEEP 3:GOTO 126
134 X$(A,0)=STR$ (CY)
138 RT=0:NS=0:FOR B=1 TO S:QC=0
139 IF INT (RT)=1 GOTO 185
140 CLS :PRINT "QUAD";A;" SPECIES";B;:INPUT " NAME=";S$(0):CLS :BEEP 1:GOTO 152
150 CLS :BEEP 5:PAUSE "NO CODE, TRY AGAIN":GOTO 140
152 IF S$(0)="XXXX"GOTO 200
154 IF S$(0)="WXYZ"GOTO 208
155 TV=LEN (S$(0)):IF TV<>4 BEEP 5:PAUSE "CODE ERROR":GOTO 140
158 GOSUB 280
159 IF X$(A,C)="0/0"GOTO 165
160 BEEP 3:PAUSE S$(0);" ALREADY RECORDED":GOTO 140
165 CLS :PRINT S$(0);:INPUT " RANK=";RS:BEEP 1:GOTO 167
166 BEEP 5:PAUSE "NO DATA  TRY AGAIN":GOTO 165
167 IF RS=0 LET RV=0:GOTO 138
168 IF RS=999 LET B=S:B=1:FOR TV=1 TO T:LET X$(A,TV)="0/0":NEXT TV:GOTO 138
170 IF RS=1 LET RV=.705:GOTO 180
171 IF RS=2 LET RV=.238:GOTO 180
172 IF RS=3 LET RV=.057:GOTO 180
173 IF RS=12 LET RV=.943:GOTO 180
174 IF RS=11 LET RV=.4715:GOTO 180
175 IF RS=22 LET RV=.1475:GOTO 180
176 IF RS=123 LET RV=1!:GOTO 180
177 BEEP 5:PAUSE "RANK ERROR  TRY AGAIN":GOTO 165
180 RT=RT+RV:IF RT>1 THEN BEEP 5:PAUSE "DATA ERROR START AGAIN":B=S:B=1:GOTO 350
181 IF INT (RT)=1 LET X$(A,C)=STR$ (RS)+"/1":GOTO 318
182 IF RT<1 AND NS<3 LET X$(A,C)=STR$ (RS)+"/1":GOTO 318
185 CLS :BEEP 2,50:PAUSE "ENTER FREQUENCY DATA"
186 QC=1
190 CLS :PRINT "QUAD ";A;" SPECIES ";B;"=";:INPUT S$(0):BEEP 1:CLS :GOTO 192
191 CLS :BEEP 5:PAUSE "NO CODE, TRY AGAIN":GOTO 190
192 IF S$(0)="XXXX"GOTO 200
193 IF S$(0)="WXYZ"GOTO 208
194 TV=LEN (S$(0)):IF TV<>4 BEEP 5:PAUSE "CODE ERROR":GOTO 1
195 GOSUB 280
196 IF X$(A,C)="0/0"GOTO 198
197 BEEP 3:PAUSE S$(0);" ALREADY RECORDED":GOTO 190
198 X$(A,C)="0/1":GOTO 318
199 .4*25
```

```
200 CLS :INPUT ''END QUADRAT (Y OR N)'';A$:BEEP 1:IF A$=''Y''GOTO 206
202 IF A$=''N''GOTO 140
204 BEEP 3:GOTO 200
206 NS=B-1:B=S:GOTO 320
208 CLS :INPUT ''END TRANSECT (Y OR N)'';A$:BEEP 1:IF A$=''Y''GOTO 214
210 IF A$=''N''GOTO 200
212 BEEP 3:GOTO 208
214 NQ=A-1:A=Q:GOTO 385
280 FOR C=1 TO T:IF S$(0=C$(C)THEN BEEP 1:RETURN
285 NEXT C
290 BEEP 2,50:PRINT T+1;'' '';S$(0);:INPUT '' CORRECT (Y OR N)'';A$
295 CLS :BEEP 1:IF A$=''Y''LET T=T+1:C=T:C$(T)=S$(0):RETURN
300 IF A$=''N''AND QC=0 GOTO 140
302 IF A$=''N''AND QC=1 GOTO 190
305 GOTO 290
310 NS=B:S$(0)=''''
312 GOTO 318
318 NEXT B
320 CLS :BEEP 2:INPUT ''REVIEW QUAD (Y OR N)'';A$:BEEP 1:GOTO 322
321 BEEP 3:GOTO 320
322 IF A$=''Y''GOTO 325
323 IF A$=''N''GOTO 380
324 GOTO 321
325 FOR C=1 TO T:IF X$(A,C)=''0/0"GOTO 328
327 CLS :PRINT C$(C);'' '';X$(A,C);:INPUT Z
328 NEXT C:BEEP 2
335 CLS :INPUT ''QUAD DATA OK (Y OR N)'';A$:BEEP 1:GOTO 337
336 BEEP 3:GOTO 335
337 IF A$=''Y''GOTO 380
338 IF A$=''N''GOTO 340
339 GOTO 336
340 CLS :INPUT ''REPEAT (Y OR N)'';A$:BEP 1:GOTO 342
341 BEEP 3:GOTO 340
342 IF A$=''Y''GOTO 350
343 IF A$=''N''GTO 335
344 GOTO 341
350 FOR C=1 TO T:X$(A,C)=''0/0":NEXT C:GOTO 138
380 NQ=A:NEXT A
385 CLS :PRINT ''END OF DATA ENTRY'':UNLOCK :BEEP 20
390 PRINT ''TURN OFF BEFORE PRINTING'':BEEP 20,50:END
400 ''S'':TEXT :WAIT 0:CLS :INPUT ''(R)AW OR (S)UMMARY DATA '';A$:IF A$=''R''GOTO 408
402 IF A$=''S''GOTO 570
405 BEEP 2:GOTO 400
408 CLS :INPUT ''PREPARE TAPE'';Z
410 PRINT ''STORING SITE DATA'':PRINT #SN$;D$,RN$,S,Q:BEP 2
420 PRINT ''STORING SPECIES LIST'':PRINT #SN$;C$(*):BEEP 2
430 PRINT ''STORING DATA'':PRINT #SN$;X$(*):BEEP 2
440 INPUT ''REWIND TAPE-PLAY'';Z
450 PAUSE ''CHECK READING''
460 ON ERROR GOTO 550
465 TV=1
470 INPUT #SN$;D$,RN$,T,NQ:BEEP 2:PRINT ''SITE DATA OK''
480 ON ERROR GOTO 550
485 TV=2
490 INPUT #SN$;C$(*):BEEP 2:PRINT ''SPECIES LIST OK''
495 ON ERROR GOTO 550
496 TV=3
497 INPUT #SN$;X$(*):BEEP 2:PRINT ''DATA OK''
500 BEEP 5:PAUSE ''CHECK READ OK'':END
550 RMT OFF :INPUT ''READ ERROR-REWIND'';Z
```

```
560 RMT ON :ON TVGOTO 470,490,497
570 CLS :INPUT ''PREPARE TAPE '';Z
572 PRINT ''STORING SITE DATA'':PRINT #SN$;D$,RN$,NQ,NS,T
574 PRINT ''STORING SPECIES LIST'':PRINT #SN$;C$(*)
576 PRINT ''STORING SPECIES DATA'':PRINT #SN$;M,P(*),F(*)
577 D=INT (D*100)/100:E=INT ((D/LOG (T))*100)/100:DM=INT (DM*100)/100
578 PRINT ''STORING INDICES DATA'':PRINT #SN$;D,E,DM
585 CLS :INPUT ''REWIND TAPE-PLAY'';Z
587 PAUSE ''CHECK READING''
588 ON ERROR GOTO 595
590 INPUT #SN$;D$,RN$,NQ,NS,T:INPUT #SN$;C$(*)
592 INPUT #SN$;M,P(*),F(*)
593 INPUT #SN$;D,E,DM:BEEP 5:PAUSE ''CHECK READ OK'':END
595 INPUT ''READ ERROR-REWIND'';Z
596 GOTO 587
600 ''Z'':PAUSE ''DATA CORRECTION'':WAIT 0
610 INPUT ''WHICH QUADRAT No '';QN:CLS :BEEP 1:GOTO 630
620 BEEP 5:GOTO 610
630 IF QN>QGOTO 620
640 INPUT ''WHICH SPECIES CODE '';SC$(0):CLS :BEEP 1
650 FOR B=1 TO T:IF SC$(0)=C$(B)LET SN=B:GOTO 670
660 NEXT B:BEEP 5:PAUSE ''SPECIES NOT FOUND'':GOTO 640
670 PRINT SC$(0);'' DATA='';X$(QN,SN);:INPUT Z
675 CLS :PRINT ''CORRECT DATA '';X$(QN,SN);:INPUT ''='';X$(QN,SN):CLS :BEEP 1
685 CLS :INPUT ''MORE CORRECTIONS (Y OR N)'';A$:CLS :BEEP 1
690 IF A$=''Y''GOTO 610
695 IF A$=''N''GOTO 2000
697 BEEP 5:GOTO 685
700 ''D'':WAIT 0:PAUSE ''SITE SUMMARY'':BEEP 2:PAUSE ''CYS COEFFICIENTS'':BEEP 2:INPUT
''SLOPE='';SL
701 BEEP 1:CLS :INPUT ''INTERCEPT='';IN:BEEP 1
702 INPUT ''PRINT (P) OR DISPLAY(D)'';A$:BEEP 1:IF A$=''P''GOTO 705
703 IF A$=''D''GOTO 712
704 BEEP 3:GOTO 702
705 COLOR 0:CSIZE 2
706 LPRINT ''SITE- '';SN$:LPRINT ''DATE- '';D$:LPRINT ''RECORDERS'':LPRINT ''NAME- '';RN$
707 D=0:DM=0
708 LF 3:LPRINT ''SPECIES SUMMARY'':LF 2:CSIZE 1:COLOR 2
710 LPRINT ''MEAN YIELD IN '';NQ;'' QUADRATS'':LF 1
712 PRINT ''COMPARATIVE YIELD CALC''
714 SY=0:S2=0:FT=0:QS=0:D=0:DM=0
716 FOR A=1 TO NQ:X=VAL (X$(A,0))
717 IF X=0 GOTO 719
718 Y=IN+SL*X:SY=SY+Y:S2=S2+Y^2:QS=QS+1
719 NEXT A
720 M=(((SY/NQ)*100)/100)*10:V=(S2-(SY^2)/NQ)/(NQ-1)
722 CV=((SQR V)/M)*100:CV=INT (CV*10)/10
724 IF A$=''D''GOTO 730
725 M=INT (M*1000)/1000
726 LPRINT ''YIELD= '';M;'' kg/ha''
728 LPRINT ''COEFF. VAR.= '';CV;''%'':LF 3:GOTO 732
730 PRINT ''YEILD='';M;'' '';CV='';CV;:INPUT Z
732 CLS :BEEP 2:PRINT ''CALCULATING SPP. COMP''
734 FOR A=1 TO NQ:FOR B=1 TO T:F=VAL (RIGHT$ (X$(A,B),1)):FT=FT+F:NEXT B:NEXT A
740 IF A$=''D''GOTO 748
742 LPRINT ''CODE BIOMASS %  FREQ %''
744 LPRINT ''  kg/ha  COMP  FREQ''
746 FOR A=1 TO 33:LPRINT ''-'';:NEXT A:LPRINT
748 KT=0:TP=0:TF0:PP=0
750 FOR B=1 TO T:FS=0:RT=0
```

```
751 CLS :PRINT ''CALCULATING '';C$(B)
755 FOR A=1 TO NQ:F=VAL (RIGHT$ (X$(A,B),1)):X=LEN (X$(A,B))
760 IF X=3 THEN LET R=VAL (EFT$ (X$(A,B),1))
762 IF X=4 THEN LET R=VAL (LEFT$ (X$(A,B),2))
764 IF X=5 THEN LET R=VAL (LEFT$ (X$(A,B),3))
769 IF R=0 LET RV=0:GOTO 780
770 IF R=1 LET RV=.705:GOTO 780
772 IF R=2 LET RV=.238:GOTO 780
774 IF R=3 LET RV=.057:GOTO 780
776 IF R=12 LET RV=.943:GOTO 780
777 IF R=11 LET RV=.4715:GOTO 780
778 IF R=22 LET RV=.1475:GOTO 780
779 IF R=123 LET RV=1
780 RT=RT+RV:FS=FS+F
785 NEXT A
790 PC=RT/QS:IF PC=0 LET KG=0:GOTO 795
791 KG=INT ((M*PC)*1000)/1000
795 FP=INT ((FS/NQ)*10000)/100
796 PC=INT ((PC*10000))/100
797 P(B)=PC:F(B)=FS
798 IF RT=0 GOTO 800
799 D=D+(-1*(RT/QS)*LOG (RT/QS)):DM=DM+(RT/QS)^2
800 IF A$=''D''GOTO 820
805 LPRINT C$(B);TAB (5);KG;TAB (15);PC;TAB (22);FS;TAB (28);FP
806 IF KG=0 GOTO 808
808 P(B)=PC:F(B)=FS
810 GOTO 830
820 BEEP 2:PRINT C$(B);'' YIELD='';KG;:INPUT '' '';Z
822 CLS :BEEP 2:PRINT C$(B);'' % COMP='';PC;:INPUT '' '';Z
823 CLS :BEEP 2:PRINT C$(B);'' FREQ='';FS;:INPUT '' '';Z
824 CLS :BEEP 2:PRINT C$(B);'' % FREQ='';FP;:INPUT '' '';Z
830 CLS :BEEP 2
832 KT=KT+KG:TP=TP+PC:TF=TF+FS:PP=PP+FP
840 NEXT B
842 IF A$=''P''GOTO 855
845 IF A$=''D''THEN PRINT ''TOT BIOMASS='';KT;:INPUT '' '';Z
846 CLS :PRINT ''TOT % COMP='';TP;:INPUT '' '';Z
847 CLS :PRINT ''TOT FREQ='';TF;:INPUT '' '';Z
848 CLS :PRINT ''TOT % FREQ='';PP;:INPUT '' '';Z
849 CLS :PRINT ''TOT SPECIES='';T;:INPUT '' '';Z
850 CLS :PRINT ''DIVERSITY='';INT (D*100)/100;:INPUT '' '';Z
851 CLS :PRINT ''EVENNESS=''INT ((D/LOG (T))*100)/100;:INPUT '' '';Z
852 CLS :PRINT ''DOMINANCE='';INT (DM*100)/100;:INPUT '' '';Z
853 END
855 FOR A=1 TO 33:LPRINT ''-'';:NEXT A:LPRINT :LF 1
865 LPRINT T;'' SPECIES''
870 LPRINT ''DIVERSITY='';INT (D*100)/100
875 LPRINT ''EVENNESS='';INT ((D/LOG (T))*100)/100
880 LPRINT ''DOMINANCE='';INT (DM*100)/100:LF 7:END
2000 PRINT ''PLEASE WAIT, CHECKING''
2010 FOR B=1 TO T:TT=0
2030 FOR A=1 TO NQ:TT=TT+VAL (X$(A,B)):NEXT A
2040 IF TT=0 GOTO 2060
2050 GOTO 2090
2060 FOR C=BTO T-1:LET C$(C)=C$(C+1)
2070 FOR A=1 TO NQ:LET X$(A,C)=X$(A,C+1):NEXT A
2080 NEXT C:T=T-1:C$(T+1)='''':FOR A=1 TO NQ:X$(A,T+1)='''':NEXT A
2090 NEXT B:TT=0
2095 END
2100 ''M'':CLS :AIT 0:PAUSE ''COMMUNICATIONS''
```

```
2110 SETCOM 1200,8,N,1:SETDEV PO:OUTSTAT 0:CONSOLE 80,0,1
2120 LPRINT ''SITE '';SN$:LPRINT ''DATE '';D$:LPRINT ''RECORDER '';RN$:LPRINT :LPRINT :LPRINT
2130 LPRINT ''SITE YIELD IN '';NQ;'' QUADRATS IS '';M;'' Kg/h'':LPRINT :LPRINT
2135 LPRINT ''COEFF. VAR='';CV;''%'':LPRINT :LPRINT
2140 LPRINT ''SPECIES  YIELD  (Kg/h)  % COMP  FREQUENCY  % FREQUENCY''
2142 FOR B=1 TO T
2145 KG=INT ((M*P(B)/100)*1000)/1000:FP=INT ((F(B)/NQ)*10000)/100
2150 LPRINT C$(B);TAB (10);KG;TAB(27);P(B);TAB (37);F(B);TAB (50);FP:NEXT B:LPRINT
2152 LPRINT :LPRINT
2160 LPRINT T;'' SPECIES''
2165 LPRINT ''DIVERSITY='';INT (D*100)/100
2170 LPRINT ''EVENNESS'';INT ((D/LOG (T))*100)/100
2172 LPRINT ''DOMINANCE='';INT (DM*100)/100:LPRINT :LPRINT
2200 SETCOM :SETDEV :OUTSTAT 1:PAUSE ''DONE'':END
```

APPENDIX 8
MATERIALS REQUIRED FOR FIELD SURVEY

Star pickets (approximately 20)

Picket driver

Aluminium site identification tags (stamped with RCA Site No)

Gutter bolts and nuts to affix tags

Blackboard and chalk

Cameras with adequate slide and print film

Prismatic compass (for location of sites away from tracks)

Sharp PC1500A computer, printer interface, cassette player

Cassette tape with DWR programme; spare cassettes

Spare AA size batteries

Relevant photo standards

1 m square quadrat

Bitterlich gauge

Marked 1 m stick (to assist in juvenile woody density estimation)

50 mm diameter soil auger

Munsell colour chart

pH kit, acid etc

Field data sheets (and stapler)

Instruction manual

Land system map and report (CSIRO Land Research Series No.6)

Plant press

Plant identification references (e.g. Lazarides; Plants of Western NSW)

Aerial photos

Pastoral map

Scale rulers, chinagraph pencil, rubber etc.