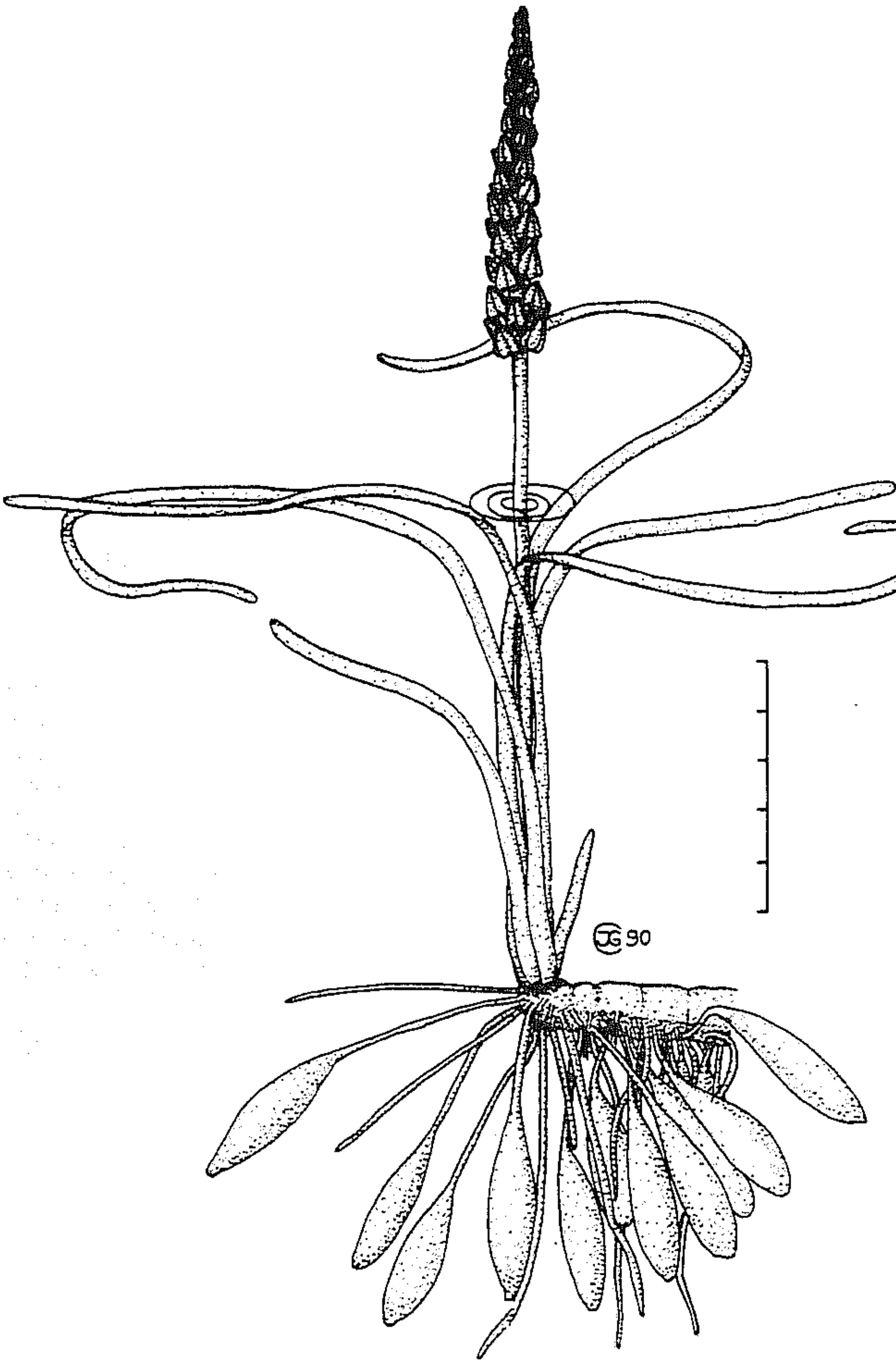
I.F.F.A
Indigenous Flora & Fauna Association



Indigenotes

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President's letter

Vegetation classification

It was a great pleasure to see so many come along to the talk by Beth Gott on Aboriginal plants and land management. The day was such a success that it is obvious that there is a strong interest amongst the IFFA membership and their friends in relevant topics. Keep your eyes peeled for more seminars. We will be organising others in the near future.

A seminar run by another organisation this past month has highlighted the need for clarity when it comes to vegetation classification. As most of you will be aware, Ecological Vegetation Classes (EVCs) have come into our lexicon in the past decade or so. The difficulties with the use of this vegetation classification system do not seem to have been resolved despite repeated attempts to do so. For many, the use of EVCs is problematic. How do we actually determine what an EVC is? How do we come up with a standardised way of classifying them? Do EVCs represent reality? Are they in fact a true taxonomy of vegetation classification? My personal criticism of the use of EVCs is based on the fact that they do not represent what we would normally know as a hierarchical classification system and there are no clear guidelines for determination of the units of classification.

Previous vegetation classification systems in Victoria were based on either structure or florisitics. These proved useful and were readily understood by the majority of people. Indeed, the use of structure and floristics in vegetation classification is recognised world-wide because they lend themselves to clear systematic classification. Recent work in NSW has seen a resurgence of the use of structure and floristics in vegetation classification. As a matter of fact, in a recently published book on the vegetation of NSW there is a dichotomous key to the vegetation of that state. What a pleasure to use! We struggle in Victoria with a vegetation classification that is essentially arbitrary and unable to be analysed.

Some fundamental questions have to be asked regarding vegetation classification in the state of Victoria. Do we want a vegetation classification that is accessible to only a chosen few in government circles that leave the rest of us confused and in the dark, or do we want a system that is open and transparent and able to be analysed properly? Have we taken a progressive step by forcing adoption of the EVC classification system or have we taken a retrograde step by abandoning classical structural and floristic classification systems as used by the rest of the world? It is time we started to openly debate this critical issue if we are to move ahead.

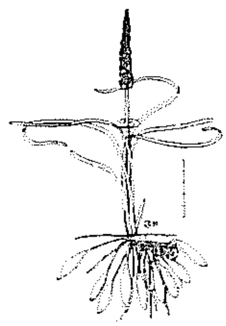
If you would like to contribute to this debate we would love to hear from you. We hope to organise a seminar on vegetation classification systems in the near future.

Beth Gott Workshop Review

On Saturday 18 March Dr Beth Gott, a highly respected ethnobotanist from Monash University gave a fascinating lecture to a packed lecture theatre of IFFA members and students from Victoria University. The lecture - on Aboriginal cultivation and use of plants, and fire management, covered some of the hundreds of plant species which Beth has researched which were used for food by Aborigines, and their response to fire. Beth made it quite clear that regular burning must have been carried out in south-easten Australia (at least in the regularly inhabited areas) to encourage the growth of these species.

Two of Beths publications were available at the workshop - *Aboriginal Plants in the grounds of Monash University - A Guide*, and *Victorian Koorie Plants*. These can be ordered from Beth by emailing her at beth.gott@sci.monash.edu.au.

Beth has also published a number of papers, the latest of which, *Aboriginal Fire Management in South-eastern Australia: aims and frequency*, was published in the Journal of Biogeography (2005) 32, pages 1203-1208.



Cover Artist

Dr John Conran

Pol-an-go (Wathaurung) or Water Ribbons, *Triglochin procera*.

Reproduced with permission from Victorian Koori Plants by Beth Gott and John Conran

Ecological Vegetation Classes - an over-simplification?

A number of methodologies have been developed for vegetation description and classification. Structural classifications along the lines of Specht (1970), which concentrate on the height and cover of the dominant life form, have been largely abandoned in Victoria because they don't help much in ecological management and species conservation. Modified structural classifications incorporating some species information are still used by the Commonwealth Government in analysis of the remaining extents of priority vegetation types[1].

The alternative floristic approach uses quadrat surveys of plant species to classify vegetation. The primary output of the computer based analysis of quadrat data are floristic sub-communities. Similar subcommunities are grouped for descriptive summaries and vegetation mapping purposes into communities.

Appendix G of the Comprehensive Regional Assessment, East Gippsland Environment and Heritage Report, July 1996, undertaken for the Regional Forest Agreement[2] defines subcommunities and communities as follows:

Floristic sub-community
A floristic sub-community comprises vegetation from a range of sites which share a high (subjectively-chosen) level of floristic similarity. These aggregations of quadrats may relate to different temporal phases of floristic communities (such as seral stages following fire), or the differences arising from a transient annual flora or, can be mediated by microclimatic variations below the landscape scale across localised landscapes which are related to position on the slope or proximity to another floristic community.

Floristic community
A floristic community is an aggregation of floristic sub-communities which share a common core of species, but with a lower (subjectively-chosen) level of floristic homogeneity than a floristic sub-community. A floristic community is typically considered to reflect the vegetation's response to perennial environmental and/or biogeographic factors at and above the landscape scale, with the term landscape taken to mean the combination of four or more adjacent topographic features (eg. ridge/ exposed slope/ drainage line/ protected slope). These influences include variations in geology, soils, minor altitudinal changes, landform and aspect.

Another classification system 'Ecological Vegetation Classes' (EVC's) was developed by the Department of Natural Resources and Environment in 1994 as part of the Regional Forest Agreement process, and is described in Appendix G of the East Gippsland report. According to Appendix G, the development of this system was driven by:

- the need to create an integrated statewide framework combining the results of regional and local studies;
- the need for a classification which would support the modelling of 'naturalness' at the landscape scale as part of the old growth assessment methodology;
- the need to summarize but not oversimplify the diversity of vegetation communities at the statewide level, and
- the desirability of making information on vegetation types more accessible to land managers and the broader community (e.g. the development of user-friendly common names).

Undoubtedly the cost of acquiring sufficient quadrat-level data across the state to use a floristic community approach also drove the decision.

Appendix G defines an EVC as follows:
Ecological vegetation class
An EVC consists of one or a number of floristic communities that appear to be associated with a recognisable environmental niche, and which can be characterised by a number of their adaptive responses to ecological processes that operate at the landscape scale level. Each ecological vegetation class is described through a combination of its floristic, life-form and reproductive strategy profiles, and through an inferred fidelity to particular environmental attributes.

The delineation of EVC's is a pragmatic process which depends on which data sets are available, and can be quite subjective. Nonetheless EVC's are being used more and more in description and analysis of vegetation. They form a key component of protocols developed by the State Government to assess habitat quality and measure net gain. Local Governments have been encouraged to use the approach as part of the Native Vegetation Management Framework.

There are some serious weaknesses in the use of EVC's. How do we actually determine what an EVC is? How do we come up with a standardised way of classifying them? Do EVCs represent reality? Are they in fact a true taxonomy of vegetation classification?

Given this major change in vegetation description and analysis careful critical review of the process and delineation of EVC's is needed to generate confidence in the approach and ensure it is as useful as possible.

Unfortunately only one peer review of EVC's is known to have been carried out. It forms part of Appendix G of the East Gippsland report[3] The brief but incisive review, which was undertaken by a group of experts, is included on the following pages.

For the many botanists, ecologists, planners and land managers currently grappling with the determination and use of Ecological Vegetation Classes (EVCs), a detailed knowledge of how EVCs were derived across Victoria may not be necessary, however there are certainly issues to consider.

Some questions to consider:

According to the peer review, EVCs were produced for regional use as a Statewide (Victoria) and Regional planning tool. Mapping of floristic communities is the ideal level of discrimination for detailed local conservation planning and land management.

—Are EVCs sufficient for Local Council planning needs i.e. should Local Councils be achieving a higher level of discrimination i.e. to floristic community level, for local conservation planning and land management?

According to the peer reveiw, some EVC's comprise only a single floristic community and may be appropriate for assessing floristic biodiversity conservation. Some EVCs are too broad and contain a significant amount of heterogeneity e.g. with several dominant tree species, with different fire sensitivities and regeneration mechanisms.

—Where broad EVCs occur, are land managers required to undertake comprehensive floristic community surveys to determine floristic biodiversity conservation needs?

The peer review proposed a validation project for EVC mapping and suggested validation components be included in standard vegetation and survey and mapping projects. The RFA vegetation mapping projects were undertaken over several years by a range of botanical teams.

—What validation projects have been completed by DSE (NRE) and what validation components are incorporated into standards of vegetation and survey and mapping projects?

The peer review proposed an investigation be conducted into whether an appropriate heterogeneity analysis could be used to compare the mapping outputs in different RFA regions across the States. RFA mapping across Victoria has been completed; there is now access to increased data and greater computing capability.

—Has DSE undertaken a statewide analysis of EVC mapping to identify heterogeneous EVCs?

Unfortunately it appears that despite requests, peer reviews were not undertaken for other RFA vegetation mapping as it progressed across Victoria. Additional peer reviews would have provided greater insight into the issues and improvements relating to EVC methodology and consistency.

EVCs are being increasingly used in planning and land management decisions. DSE is responsible for the consistency and reliability of EVCs and floristic communities as land management tools. Refinement of these tools requires continuous analysis, review and debate and a similar taxonomic validation process to that established for species taxonomy. A process which allows for publication, validation and peer review.

We hope to stimulate debate and urge government support for the essential survey and assessment of broad EVCs and a statewide floristic analysis to refine EVCs and determine floristic communities to level suitable for local land use decisions. Floristic biodiversity conservation across Victoria is dependent upon this.

If you are interested in discussing these issues visit IFFA's discussion forum at www.iffa.org.au

1. http://www.nrm.gov.au/monitoring/indicators/vegetation-extent/pre-european.html#how
2. http://www.affa.gov.au/content/output.cfm?ObjectID=D2C48F86-BA1A-11A1-A2200060B0A02732
3. http://www.affa.gov.au/content/output.cfm?ObjectID=D2C48F86-BA1A-11A1-A2200060B0A02735

Peer Review Report of Ecological Vegetation Classes

Reproduced from Comprehensive Regional Assessment, East Gippsland Environment and Heritage Report, July 1996 Appendix G

Background

Ecological Vegetation Classes (EVCs) are derived from underlying large scale forest type and floristic community mapping with floristic, structural, and environmental attributes being used to define individual EVCs.

The process of deriving EVCs had not previously been formally documented and critically appraised, although Woodgate et al. (1994) provided an overview of the methodology. The Department of Natural Resources and Environment (NRE), as part of the East Gippsland Comprehensive Regional Assessment, has prepared a full description of the methodology used to derive EVCs.

The Ecological Vegetation Classes Methodology Paper (Appendix G of the Environment and Hertiage Report) was peer reviewed on 5th June 1996, and modified in response to comments received.

The Peer Group

A group of experts was invited to peer review the EVC methodology report, as described in a draft report prepared by NRE. Members of the group were:

- Dr Mark Burgman, University of Melbourne, Victoria
- John Benson, National Herbarium, Sydney, New South Wales
- Sandy Kinnear, Department of Housing and Urban Development, South Australia.
- Prof Jamie Kirkpatrick, University of Tasmania, Tasmania
- Dr Bob Parsons, La Trobe University, Victoria

Adrian Moorrees, David Parkes and Bill Peel of the Department of Natural Resources and Environment (NRE), Victoria were present at the review to explain the EVC methodology and answer questions. Brendan Edgar and John Neldner of the Australian Nature Conservation Agency, and Harry Abrahams of the Australian Heritage Commission were present at the review as observers.

Objectives

To facilitate discussion by the peer group, a number of questions were presented for consideration These were:

- Do you understand the process to derive and define Ecological Vegetation Classes?
- Are these processes ecologically sound and valid?
- Is the relationship of EVCs to environmental attributes, floristic vegetation communities, floristic sub-communities and forest types understood and ecologically sound?
- Is the homogeneity within EVCs sufficient for biodiversity assessments of forest communities?
- Are Ecological Vegetation Classes suitable for a 1:100 000 scale vegetation map for the CRA forest biodiversity assessment of forest communities ?

Summary of Outcomes

The EVC concept was developed as a regional planning tool that can be applied consistently across the State to raise the awareness of land managers and the public regarding biodiversity conservation and ecological management, and ultimately to produce better land management practice. The identification and mapping of EVCs involves the combination of floristic, life form and reproductive strategy profiles, and relating these to particular environmental site attributes, including aspect, elevation, gradient, geology, soils, landform and rainfall. EVCs are derived from a generally consistent methodology and provide an important Statewide level of vegetation classification and the basis of an on-going mapping program;

The floristic analysis used to generate EVCs was generally understood. However the step of linking or amalgamating floristic groups into EVCs was less well understood and imprecise, as different environmental attributes were used in defining different EVCs. The attributes (rules) used to group floristic units into EVCs need to be clearly stated for each EVC;

Mapping of floristic communities (a more detailed level than EVCs) would provide a higher level of discrimination for local conservation planning and land management. This level of mapping will not be completed for many years, although this is not a major impediment to planning at the regional scale since the majority of EVCs comprise a single floristic community. In these cases the EVC is an appropriate basis for assessing floristic biodiversity conservation. However, some EVCs appear to be more heterogeneous, for example some EVCs combine several dominant tree species with different fire sensitivities and regeneration mechanisms. Within East Gippsland, four extensive ecological vegetation classes were considered to contain a significant amount of heterogeneity, particularly if dominant structural form and floristic composition only are used to define EVCs (Damp Forest, Wet Forest, Lowland Forest and Shrubby Dry Forest);

It was considered that the issue of heterogeneity within the four extensive EVCs in East Gippsland should be further examined. This issue was recognised in the development of the East Gippsland Forest Management Area Plan whereby a geographic sub-unit analysis, as a surrogate, was undertaken in an attempt to ensure that the heterogeneity and range of EVCs was represented in the reserve system;

The group of experts suggested additional analyses that could be undertaken to address the heterogeneity issue for the four large EVCs. These included the use of forest type mapping, and/or the construction of floristic communities, followed by an assessment of their occurrence in the reserve system. It was noted that if this work were to be conducted it could not be completed in time for inclusion in the Environment and Heritage assessment report for East Gippsland;

It was proposed that a validation project be designed for EVC mapping. (It was noted that a validation project for EVC old growth mapping was being considered). In future, validation components could be included as standard in vegetation survey and mapping projects; and

It was proposed that an investigation be conducted as to whether an appropriate heterogeneity analysis could be used to compare the mapping outputs in different Regional Forest Agreement regions across States.

Discussion

The EVC concept

1. The EVC concept was developed as a regional planning tool that can be applied consistently across the State, and should be judged mainly on its effectiveness in conservation planning - raising the awareness of land managers and the public regarding biodiversity conservation and ecological management, ultimately to produce better land management practice. The identification and mapping of EVCs involves the combination of floristic, life form and reproductive strategy profiles, and relating these to particular environmental site attributes, including aspect, elevation, gradient, geology, soils, landform and rainfall;

2. EVCs are derived from a generally consistent methodology and provide an important Statewide level of vegetation classification and the basis of an on-going mapping program. Mapping of floristic communities is the ideal level of discrimination for detailed local conservation planning and land management. However, because of the time and data required, it will not be completed for many years. At regional scales, most EVCs will exist as a single floristic community, and in these cases EVC mapping provides an adequate level of discrimination. For the EVCs where this is not the case, additional strategies for discrimination for planning purposes will be required.

Validity of the methods used

3. The best test of the validity of the EVC approach was seen as being a deliberate validation exercise, involving random selection and field validation of an independent sample of sites following vegetation survey, analysis and mapping.

4. It was recognised that subjective judgement is important in the EVC methodology, as well as for other vegetation classifications, although scientific analysis generally aims to reduce subjectivity. The step of linking or amalgamating floristic groups into EVCs, which relies on subjective assessments, made it difficult for participants to judge the consistency and validity of the overall approach. The group sought a description of the process used and the specific attributes applied to individual EVCs to clarify these issues.

Appropriateness of EVCs as units for biodiversity conservation

5. It was generally agreed that the participants would benefit from a better understanding of the relationships between EVCs and environmental parameters. However:

- most of the EVCs in East Gippsland seemed appropriate as the basis for assessing biodiversity conservation,
- some were considered to be more heterogeneous than others,
- if the heterogeneity issue could be addressed, EVCs were a good unit, given their floristic basis.

6. The classification which resulted from the EVC approach was seen as being too broad in some cases and needing additional discrimination - e.g. single units combining dominants with different fire sensitivities.

7. The main issue regarding heterogeneity in the East Gippsland Regional Forest Agreement region is with extensive ecological vegetation classes - Damp Forest, Wet Forest, Lowland Forest and Shrubby Dry Forest. This issue was recognised in the proposed East Gippsland Forest Management Plan, in which representative protection of this variation was considered by allocating reserved habitat across a framework of geographic sub-units for all EVCs.

8. Additional analyses that could be undertaken to address the heterogeneity issue for the four large EVCs included the use of forest type mapping, and/or the construction of floristic communities, followed by an assessment of their occurrence in the reserve system.

9. It was agreed that it would be valuable to consider undertaking a comparative assessment of the levels of heterogeneity within vegetation units used in various States for Comprehensive Regional Assessments.

Appropriateness of scale of mapping

10. Participants felt that vegetation mapping should aim to represent areas that act as the most effective surrogates for other elements of biodiversity, to maximise uniformity within vegetation types, and to map boundaries between types that can be identified in the field.

11. The scale of 1:100,000 used for EVCs was seen as an acceptable scale for this mapping given the average size of Regional Forest Agreement regions.

Appropriateness of mapping method

12. It was generally agreed that vegetation mapping should be based on a combination of survey, analysis, aerial photo interpretation (or other remote sensed information) and ground truthing.

13. It was proposed that formal validation procedures be used to verify the results.

Snippets

Rain & Rainbows or Bird's Showers

At my family home in Geelong one of the delightful sights on showery days was the Red Wattle-birds 'bathing'. There were bird baths about, but they shunned these, preferring their own technique.

After a rain shower, while the leaves were still wet they would fly to the top of a Variegated Pittosporum that grew there. They would then slide or drop down through the outer foliage of the small tree - repeating this over and over and so have a 'shower/bath'.

Along the front of my house in Coburg I have a number of gum trees - mostly indigenous. A Manna Gum, two Red Box and a Lemon Scented Gum. They are all reasonably tall, about 10 yo. The Rainbow Lorikeets love these tall trees - there aren't too many in my area. Most days you'll find some lorikeets resting, feeding and yelling in the upper branches. They tend to prefer the Manna Gum, except when it is too wet or windy when they'll move to the Brush Box in the naturestrip.

On Saturday after the initial showers had passed I was out having a look at the garden. There was a great din in the Lemon Scented Gum caused by 10 or so Rainbow Lorikeets in there 'bathing'. Their technique is highly acrobatic. They were in amongst clumps of foliage flopping about, right-way-up and upside-down (and everything in between) in the wet leaves having a wonderful time.

I wonder if their choice of bathing tree was due to a structural features of the tree, wetting properties of that foliage or do they like lemon bath oils?

- Wendy Moore

Koala habitat requirements

Australian Koala Foundation Senior Research Ecologist John Callaghan revealed the koala habitat 'must haves' identified by extensive survey work carried out in Noosa, Port Stephens and Ballarat Shires. The findings indicate that koalas need large patches of habitat - at least 100 hectares in size - within landscapes comprising 40-60 percent forest cover in New South Wales and Queensland koala habitats, and a fraction less in Victoria. The research is a three-way collaboration between the Australian Koala Foundation, University of Queensland and NSW Department of Environment and Conservation. The findings were presented at the Ecological Society of Australia's annual conference in Brisbane late last year.

Injured wildlife hotline

A phone call to RACV's Roadside Assist is useful for drivers having car trouble, but for injured wildlife it could prove the difference between life and death. RACV Wildlife Connect, launched by Healesville Sanctuary and the RACV, is a 24-hour-a-day phone service for drivers who hit an animal or find an injured animal. Last year, the RACV received 4421 vehicle claims related to animal collisions 43% more than in 2003. RACV president Clive Hall said many motorists were unsure of what to do when they hit or see an injured animal, and by calling one simple number, more animals could be rescued. Zoos Victoria chief executive Laura Mumwa said 1500 rescued animals were brought to the state's zoos each year, many injured in road accidents. State Environment Minister John Thwaites said the work of volunteers had been the driving force behind the hotline. If you see an injured animal, call: 13 1111

Article from Lilydale Yarra Valley Leader: 'Hotline to Save Wildlife' (March 6th 2006).

Rufous Fan Tail

I live in Coburg, north of Bell Street, more than a kilometre and over Sydney Road from the nearest creek or bushy remnant. Few of my neighbours have natives in their gardens. The areas' gardens are being increasingly over-run by white standard roses, instant turf, paving, box hedges and olive trees.

My front yard is a little different. For a start I have planted much of the naturestrip with (mostly) indigenous and native plants – grasses, rushes, Kangaroo Apples, daisies etc. My (small) front yard has several indigenous eucalypts, *Allocasuarina verticulata*, wattles and other native trees, plus 7 partially espaliered fruit trees. It's a bit crowded! Out back, there is less space. I only have a couple of citrus and a peach in the chook yard

Sadly, living where I do, I have only limited numbers and types of native bird. White plumed Honeyeaters and Little and Red Wattlebirds regularly breed in and around my front yard. Rainbow Lorikeets daily visit the tall eucalypts, and fruit trees in season! Little Ravens, Magpies, Mudlarks and occasionally Silver-eyes visit.

You can imagine my delight the other morning to find a Rufous Fantail feeding in my yard, gaily displaying its glorious plumage. It remained for at least an hour, mostly feeding in the base of plants and on the ground. When the sun came out, from deep clouds, it moved up into the mid-canopy of the trees.

Sadly my oasis is too small for it to stay. I wish my little rufous visitor all the best in its search for a home.

- Wendy Moore

Tree Frames at Organ Pipes National Park

By Robert Bender

In 1972 when an agricultural property on the Calder Highway was declared the Organ Pipes National Park, there were few trees standing, as nearly all had been removed during the early settlers' efforts to establish dairying, oat and hay-cropping. Revegetation commenced in 1973 with seedlings propagated in the back yards of members of the Friends of Organ Pipes. The first season, nearly all were quickly eaten by rabbits, of which there were many thousands in the park.

Jack Lyale, the first ranger, and the Friends, decided to try protecting the seedlings in chicken wire frames. This kept rabbits out, but the harsh dry summer winds desiccated many plants until hessian cloth was wrapped around the frames.

Over the first fifteen years or so, before mass-produced plastic tree guards became commercially available, these chicken wire frames, many made by school work experience students in the park works shed, were used as rabbit numbers remained high. Intensive rabbit poisoning, burrow-ripping and myxomatosis eventually reduced rabbit numbers by the mid-1980s, but about that time Eastern Grey Kangaroos and Black-tailed Swamp Wallabies moved into the park from nearby open space along the Maribyrnong and Jackson's Creek, and started browsing and grazing. So some form of protection was still urgently needed if survival of seedlings was to be acceptable.

One species of which a small number was established in the park was the White cypress Pine *Callitris glaucophylla*. This species is especially palatable to rabbit- and kangaroo-grazing in its early years, so chicken wire frames were seen as essential for their long-term survival.

Cypress Pine seedlings were planted in some parts of the park that are seldom visited, so some of them eventually outgrew their frames and poked foliage through the gaps. Rabbits and kangaroos sculpted some of these so they became cylindrical trees.

Over the past three years, the Friends group, with the support of a group of men on Community Service Orders have replaced most of these small wire frames (about 50cm diameter and 60cm height) with much larger ones (about 1.2m diameter and 1.3m height) to enable them to grow into a natural shape and become healthy adult trees. This has been spectacularly successful. The project has now extended to the major replanting with Black Wattles on the main flat near the Pipes, where nearly all the first generation of Black Wattles died without leaving progeny, due mainly to rabbit predation.

Hundreds of young Wattles were initially protected by tall opaque plastic triangles held in place by a single stake. These caused many plants to grow spindly and not put out branches until they had overtopped the 1.5-2m frames. The new large wire frames have allowed the young Wattles to put out branches within 25cm of the ground and to take on a much more natural shape, while still being protected from rabbits and kangaroos. (see photos 1,2 and 3 opposite)

The design was aimed at making the rim too high for a kangaroo to lean over and browse on the topmost foliage, the internal space too small for a kangaroo to leap in or out, and the two stakes much harder for even a big male kangaroo to just push over by leaning on the frame.

Some of the negative aspects of tree guards mentioned by Elizabeth Donoghue were certainly detected at Organ Pipes. Staff there are thinly spread over several properties all in urgent need of major restoration work and the Friends also have taken on many other tasks, so guard-removal working bees are too rarely organised. But if time is allocated to this important task, and larger frames are installed as young trees grow and spread, then in an area populated by sapling-browsers, tree guards can be of great benefit.

It is mainly an issue of management and building tree-guard removal or replacement with larger ones into the work program. The Friends of Werribee Gorge have dealt with the same problem in the same way – small frames for small seedlings, replaced by larger ones as the saplings grow, to keep the wallabies and kangaroos out long enough for the young trees to survive and grow into a natural shape.

Photo 4 (opposite) was taken at Picnic Point, Werribee Gorge. You can see that for the first metre or so above ground, the larger trees look like they are in tight corsets. Keeping up with tree growth is an ongoing problem, but if it were not for these protective frames, there would probably be no trees there now.

Photo 1: Organ Pipes NP Column Gully: framed Callitris

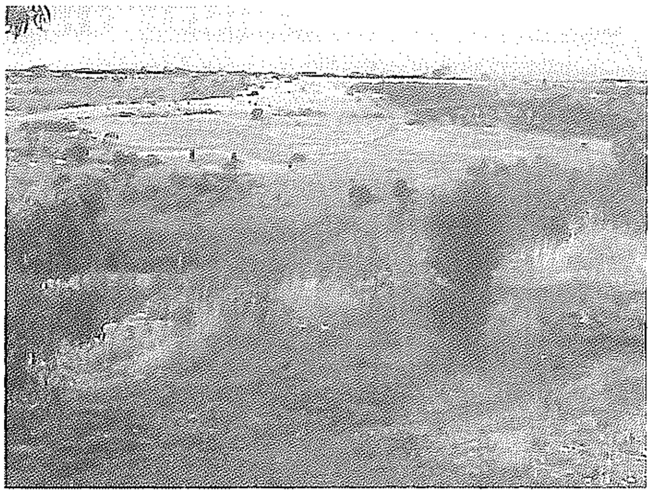


Photo 2: Organ Pipes NP Column Gully: framed Callitris

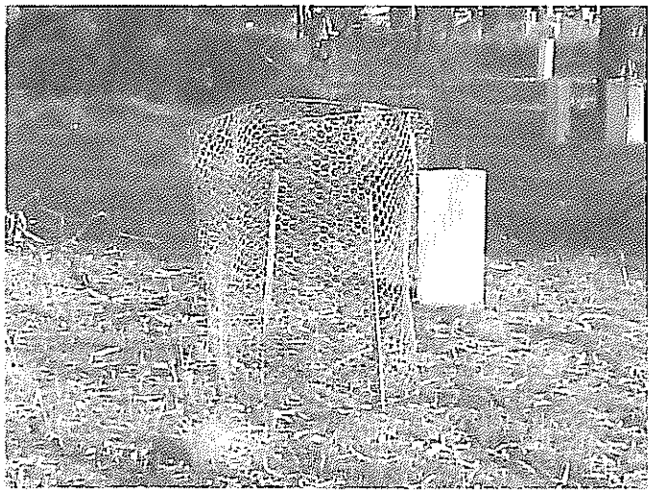


Photo 3: Black Wattle inside a new big frame

Photo 4: Picnic Point, Werribee Gorge

Literature Review:

The role of soil disturbance in promoting the recruitment of grassland forbs

By Deborah Reynolds

Part 2: Plant responses to soil disturbance:

Germination and recruitment

Germination depends on the ability of a seed to be able respond to water and other environmental cues (Chambers *et al.* 1994). It transforms a dehydrated embryo (seed) with a barely detectable metabolism into one that has a vigorous metabolism culminating in growth (Bewley & Black 1994). Germination requires successful pollination and viable seed followed by environmental triggers or cues specific for many species, which are, an optimum temperature regime, sufficient moisture and light (De Jong & Klinkhamer 1988; McIntyre 1990; Pons 1992; Probert 1992; Morgan & lunt 1994; Olff *et al.* 1994; Morgan 1998a; Eckstein 2005). Shallow soil disturbance (10-15cm) creates an irregular soil surface allowing seeds to be caught in slight depressions, i.e. microsites. Seeds that can successfully germinate have little chance of survival without a suitable soil microsite. Microsites aid the germination of a seed by providing suitable surface moisture, soil coverage and a favorable temperature regime. A smooth surface does not provide as many microsites as an irregular surface (Evans *et al.* 1972; Grubb 1977; Primack & Miao 1991; Chambers *et al.* 1994; Pyrke 1994; Morgan 1995b; Houle 1996; Foster 2001; Mouquet *et al.* 2004; Fenner & Thompson 2005). Disturbed soils provide many suitable microsites in which seeds can accumulate and germinate.

Recruitment as distinct from germination is the ability of a seedling to survive for at least one to two years achieving reproduction within the population. Successful recruitment by grassland forbs is limited by a large enough population to be reproductively viable or with sufficient pre-existing viable seed in the seed bank (Eriksson & Jakobsson 1998; Zobel *et al.* 2000). Additional factors include effective dispersal of the seeds or seed rain (Peart 1989; Primack *et al.* 1991; Zobel *et al.* 2000; Mouquet *et al.* 2004) and suitable microsite or gaps (free of ground litter) (Silvertown 1980; Erlandson *et al.* 1997; Coffin, Laycock & Lauenroth 1998; Gott 1999; Jutila 2003; Hofmann *et al.* 2004; Fenner *et al.* 2005; Verrier *et al.* 2005). Enough moisture needs to be present for continued survival of germinates (Grubb 1977; De Jong *et al.* 1988; McIntyre 1990; Pons 1992; Probert 1992; Morgan *et al.* 1994; Olff *et al.* 1994; Houle 1996; Morgan 1998a; Eckstein 2005). All of the above conditions need to be met for a seedling to successfully recruit and have the chance to become reproductively viable.

In Mediterranean grasslands worldwide small populations of forbs (< 200 plants) have been shown to produce lower rates of viable seed than larger populations (Eriksson *et al.* 1998; Morgan 1999; Carlsen *et al.* 2000; Matthies & Spillmann 2000; Soons & Heil 2002; Lambers *et al.* 2004). This suggests problems with genetic inbreeding producing less viable seeds coupled with ineffective pollination within small populations. The ability of forbs to flower and set viable seed is reduced without regular reduction of biomass via fire, mowing or physical removal (Schmidt & Belford 1993; Lunt 1994; Carlsen *et al.* 2000; Lofgren *et al.* 2000; Schultz 2001; Montalvo *et al.* 2002). Addition of seed to populations with compromised recruitment increased the chances of germination and recruitment of those species (Tilman 1997; Graae, Hansen & Sunde 2004; Mouquet *et al.* 2004).

Disturbance that creates safe microsites followed by sufficient water or persistent favorable weather conditions is needed by grassland forbs to recruit (De Jong *et al.* 1988; Hook, Lauenroth & Burke 1994; Morgan 1995a, 1995b; Lavorel 1999; Nicotra, Babicka & Westoby 2002; Eckstein 2005). In several cases in the United States, grassland forbs required a disturbance (by pocket gophers or fire), which reduced competition from the standing biomass creating bare soil. Disturbance, when coupled with sufficient moisture, enabled successful recruitment (Peart 1989; Tilman 1997). In Europe, soil disturbance and periodic removal of biomass via mowing or weed killing plus availability of water over summer were the most significant factors in recruitment of forbs (De Jong *et al.* 1988; Hobbs *et al.* 1992; Turnball *et al.* 2000; Zobel *et al.* 2000; Wirth & Pyke 2003; Hofmann *et al.* 2004; Eckstein 2005).

In Australia the recruitment of grassland forbs in our remaining remnant grasslands is a rare event even in areas with an abundance of existing forbs (Scarlett & Parsons 1989; Lunt 1990; Scarlett & Parsons 1992; Morgan 2000; Clarke *et al.* 2004), indicating that the seed rain should be adequate but ecological conditions are not right. With a return to a fire regime that is closer to what these plants evolved with regeneration was limited and few germinants survived beyond summer (Morgan 2001). Morgan (1998b) found that the annual seed rain due to small persistent seed banks limits recruitment of perennial dicots. Several studies by Lunt (1990a) and Morgan (1998c) showed that the soil seed banks of some native forbs did not persist into a second or third year. These studies don't consider the ecological processes of disturbance that have been greatly altered in the last 200+ years. These ecological processes most likely involved the churning of soil, dispersing seeds throughout the soil layers and creating and maintaining a vital soil seed bank (Donelan & Thompson 1980).

Morgan's studies on *Rutidosis leptorrhynchoides* in 1995 showed that suitable microsites are a limiting factor of recruitment over time, rather than seed production (Morgan 1995a, 1995b). Anderson also found that recruitment of long lived perennials was limited by a rarity of safe sites (microsites) (Anderson 1989). Generally, Australian grassland research has found that forbs have optimal recruitment in populations larger than 200 individuals with large gaps free from litter and moderate soil disturbance levels (Hobbs *et al.* 1988; Lunt 1994; McIntyre *et al.* 1994b; Morgan 1995b, 1997, 1998a, 1998b, 1999; Robinson 2003). Therefore in grasslands with a large enough population of a forb species and an increased availability of suitable microsites present, the greater chance there is of a viable seed finding a safe site (microsite) and successfully reaching maturity.

There has been very little research investigating and documenting the physical responses of plant characteristics to soil disturbance namely:

Seed production

No studies were located overseas in relation to seed production in grasslands. In Australian grasslands Morgan (1995) has found that the population density limits seed production in natural and re-introduced populations of *Rutidosis leptorrhychoides* (Morgan 1995b, 1999). Further research showed that populations with fewer than 30 plants produced significantly less viable seeds per flower head, than populations of greater than 500 plants (Morgan 2000). Lunt in 1994 found that a grassland fire stimulated eight out of nine forbs to flower profusely in the following year but flower production of these forbs decreased rapidly over time since fire (Lunt 1994). In 1997 Morgan found that twice as many *Rutidosis leptorrhynchoides* flowers were produced per plant in gaps of at least 100cm^2 in tall surrounding grassland compared with the same gap in short surrounding grassland but none of the seeds were viable (Morgan 1997). Hester and Hobbs (1992) on the W.A wheatbelt found increased flower production in two native forbs post weed removal which is the only study to find that a form of disturbed soil has promoted seed production in a system (Hester *et al.* 1992). Several authors have found that water stress is a limiting factor in grassland forbs seed production (Gilfedder & Kirkpatrick 1994; Morgan *et al.* 1994; Morgan 1995b, 1999). Removal of competition is seen as beneficial to grassland forb's seed production (Hester *et al.* 1992; Morgan 1997) but no research has been done on the effects of soil disturbance.

Root architecture

In America, Sheley (2002) for the Center for Invasive Plant Management implies that deep-rooted indigenous prairie plants can out compete weeds for moisture (Sheley 2002). Root biomass was lower in gaps as compared to that under plants in a semiarid grassland and that water availability was the primary limiting factor for root growth (Hook *et al.* 1994). Most Australian articles only make second hand observations from research into gaps that disturbance decreases the root competition from surviving plants (McIntyre *et al.* 1995; Morgan 1997). One study found that in low rainfall environments certain types of perennial plants (geophytes) were able to grow a very long thin taproot with less lateral roots at a very fast rate (Nicotra *et al.* 2002). This adaptation allows the plant to optimize its survival under drought conditions. No articles were found pertaining to root architecture in relation to soil disturbance in grasslands.

Soil moisture relationships in relation to soil disturbance & grassland

Many articles have stated that in grasslands worldwide water availability was found to be an important limiting factor in plant survival and productivity (Lavorel 1999; Eckstein 2005). One study remarks that the seedling survival was positively correlated to the water content in the top 10cm of soil (De Jong *et al.* 1988). In Australia Morgan (1995a) found that the autumn rains, which increase soil moisture levels to above 20%, was the trigger for germination of *Rutidosis leptorrhynchoides*. In 2001 Morgan while looking at recruitment in relation to fire found recruitment was more likely to be attributed to rainfall variations. Andersen (1989) found that long-lived perennials in a Victorian woodland environment with both soil disturbance and periods of favorable rainfall significantly affected seedling establishment but didn't look at them together. One study in a N. S. W. grassland found that at two sites, moderate soil disturbance in the presence of water enrichment promoted recruitment of an unusually high number of rare species (McIntyre *et al.* 1994a). Likewise Mason in 2004 found during drought years soil disturbance in a Victorian grassland significantly improves native grass (*Themedia triandra*) seedling's establishment due to the top 2-5cm of soil having greater soil moisture. None of these studies have looked at the relationship of soil moisture content between undisturbed and disturbed soil in relation to grassland forbs.

Disturbance impacts over time on recruitment

No studies were found either overseas or in Australia of the interactions of soil disturbance in a temporal sense (greater than 24 months) in relation to recruitment of grassland forbs. Studies done on soil disturbance effects in relation to germination and recruitment clearly state that a lack of long-term monitoring hinders the understanding of the effectiveness of soil disturbance and whether ongoing soil disturbance leads to self-sustaining populations (Turnball *et al.* 2000).

Introduced plants

Introduced plants present special challenges for grassland rehabilitation and in some cases severe alterations to the recruitment dynamics of native grasslands particularly in relation to soil disturbance. These weeds are able to exist and exploit the environment to the detriment of native species. Many of our current grassland weeds are forbs and grasses indigenous to other areas of the world eg Serrated Tussock - *Nassella trichotoma* a grass found in South America and Spear Thistle - *Cirsium vulgare* a forb from the Asteraceae family native to Europe (Auld & Medd 1999; Benvenuti 2004). They are adapted to a similar climate to Southern Australia (Mediterranean) and research shows that disturbance promotes recruitment in these species (Evans *et al.* 1972; Clements *et al.* 1996; Lofgren *et al.* 2000). Soil disturbance with the presence of viable seeds will encourage recruitment of many weeds in a suitable environment (Clements *et al.* 1996). The challenge is to limit the number of weed seeds in the environment before soil disturbance occurs. There are many different methods used to clear weeds (hand pulling, poisoning, ploughing and smothering) but creating bare soil only encourages whatever weedy seeds existing in the soil to germinate with the next rains. All the research points to an integrated method combining several steps to remove weeds (Phillips & Hocking 1996; Corr 2002; Beames, Hocking & Wlodarczyk 2005; Overmars 2005). Knowledge of the life-cycles of weeds' and natives' will help in effective control or removal of the weeds. Poisoning the weeds at the right time is vital to control them, especially before soil disturbance.

In summary our native grassland forb species and the introduced forbs both need disturbance to recruit (Kirkpatrick *et al.* 1998). That is the ecological niche they would occupy in any environment they arrive in.

Management

Much research has been done on the impacts of grasses, weeds and fire on grassland ecosystems (Phillips 1998; Wijesuriya 1999; Briese, Pettit & Anderson 2001; Gott 2004; Mason 2004). It is widely accepted that fire or some sort of regular biomass reduction (moderate grazing or mowing) is an important management tool to maintain all the species present in the grassland (Lunt 1997; Craigie & Hocking 1998). Some research has been able to effectively re-introduce native grasses, resulting in a significant impact on weeds with certain weed control regimes (Wijesuriya *et al.* 1998; Wijesuriya 1999; Mason 2004; Overmars 2005) but this work does not extend to native forbs.

One of the longest term restoration projects on the basalt plains is that of the Organ Pipes National Park (OPNP) which has been carried out for 30 years. Eighty-five different forb species have been planted from 1988 until 1993 on the riparian areas and basalt plains areas of the park. These areas have been burnt in the years 1993, 1995, 1997, and 1999 at which point only 47 species had survived. This suggests that fire is essential to help the forb population but may only assist some species. *Podolepis jaceiodes* had recruited and expanded its range in 1997 but subsequently became rare. *Senecio macrocarpus* has been the only forb to successfully form large populations on the site (Kendall 2003; McDougall & Morgan 2005). Hand planting large numbers of juvenile plants and conducting regular burns has not proved to be a successful management strategy as most of these species are progressively declining. Studies of the population dynamics of *Rutidosis leptorryhnchoides* by Morgan have shown the inappropriate nature of the present management and the lack of understanding of key ecological processes that determine population maintenance. Morgan's research predicted the decline and has documented the extinctions of many of the natural populations in his time (Morgan 1995a, 1995b, 1997, 1999, 2000). Much research has been done on the response of grassland forbs to recent human impacts but we still do not have a generalized model of grassland population dynamics that would allow us to develop management tools to effectively promote and maintain the current plant diversity in the field.

Why additional research is important

Grassland forbs are critical on many levels to the functioning and maintenance of grassland ecosystems. The loss of many key biological interactions such as those provided by animals (including humans) and fire with their attendant soil disturbance has impacted negatively on the ecosystem through lack of recruitment and specifically on individual plant health indicators such as seed production and root architecture. This is the starting point of the project proposed for my honours.

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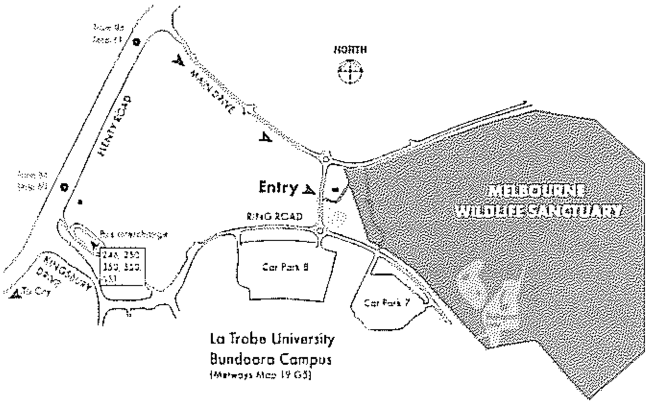

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